

A8 External impacts

A8.1 Introduction

Introduction

This appendix deals with externalities (both monetised and non-monetised), and guidance is given on how these effects may be assessed, quantified and reported.

For some of the external effects, eg, noise, a standard monetary value is provided. These monetary values can be included in the benefit cost ratio as a useful way of comparing projects and project options. The inclusion of any other monetary values for external effects must be clearly set out in the project summary sheet and in any funding application to Land Transport NZ, and double counting of any benefits must be avoided.

Vehicle emissions impacts including CO₂ are contained in appendix A9.

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A8.1 Introduction, continued

Requirement to consider effects

There are requirements under both the *Resource Management Act 1991* and the *Land Transport Management Act 2003* to consider effects beyond those to the immediate users of transport facilities. The *Resource Management Act* requires a statement of effects of a project on the environment. All effects shall be fully described, including the scale and extent of the effects.

In respect to the *Land Transport Management Act 2003*, Land Transport NZ must be satisfied – when preparing its National Land Transport Programme – that the programme (and the activities within the programme) contribute in an efficient and effective manner to:

- assisting economic development
- assisting safety and personal security
- improving access and mobility
- protecting and promoting public health
- ensuring environmental sustainability

In order to assess the degree to which each project contributes to the above requirements, there are a number of evaluation factors against which project performance can be assessed. With respect to environmental sustainability, the evaluation factors can include the impact of a project on:

- air quality
- greenhouse gasses
- noise and vibration
- water environment (quality)
- landscape impacts, etc.

If there are significant effects that need to be taken into account in a project evaluation it is more appropriate for the analyst to use the full procedures rather than the simplified procedures.

The monetised and non-monetised impact summary sheet (worksheet A8.1) shall include all significant impacts identified in this statement of effects. Where there are no significant impacts this should be stated in the project summary sheet.

A8.1 Introduction, continued

Extent of investigations required

The work required to describe and quantify monetised and non-monetised impacts will depend both on the likely severity of the effects and the difference between the effects of the existing situation and the effects of the various project options. It is possible that in some cases there will be no significant change to impacts resulting from a project. If this occurs, all that is required is a note to this effect.

If there is a significant difference between the monetised and non-monetised impacts of the project options, either in terms of their total effects or in the distribution of these effects, then these differences shall be described and where practicable quantified.

Where a project generates traffic the environmental effect of such induced traffic shall be assessed. An example may be a project to provide a shorter route. The fuel savings to existing traffic will provide environmental benefits (less emissions), but the shorter route may generate additional traffic, which in turn may have a negative environmental effect.

Wherever practicable, the scale of impact shall be measured in natural units, and the extent of the effects shall be quantified, eg, the number of persons affected.

In many cases, monetised and non-monetised impacts are not amenable to quantitative description. Accordingly, verbal qualitative descriptions shall also be presented, covering such issues as:

- historical background
- community attitudes
- characteristics of the area affected
- effects of the project.

Specialists in the appropriate disciplines may be required for the evaluation of significant monetised and non-monetised impacts. Public consultation and opinion surveys shall be undertaken for major projects.

Analysis of additional project costs

Analysis shall be undertaken to determine if the additional costs of higher cost options are justified by the additional benefits gained (refer to chapters 2 and 3). This approach shall be used to assess the cost effectiveness of any features of projects included to mitigate monetised and non-monetised impacts. It is not appropriate to arbitrarily include a range of mitigation features as part of the basic project if these features are not essential to the project.

A8.2 Road traffic noise

Road traffic noise

Noise is a disturbing or otherwise unwelcome sound, which is transmitted as a longitudinal pressure wave through the air or other medium as the result of the physical vibration of a source. Noise propagation is affected by wind and intervening absorbing and reflecting surfaces, and is attenuated with distance.

Road traffic noise sources include:

- engine and transmission vibration
- exhaust systems
- bodywork and load rattle
- air brake and friction brakes
- tyre/road surface contact
- horns, doors slamming, car audio systems
- aerodynamic noise

Impacts of road traffic noise

Road traffic noise is generally continuous, and long term exposure can have significant adverse effects. These can be categorised as disruptive impacts, such as sleep disturbance and speech interference, and psychological impacts such as annoyance reaction and other behavioural impacts. While there is no evidence of permanent hearing loss from road traffic noise, there is a great deal of evidence to show that noise can cause adverse health effects in people due mainly to stress-related factors.

While the untrained ear will generally only detect noise level differences of 3 decibels (dB) or more, smaller increases will still affect peoples well being. To increase the noise level by 3 dB requires a doubling of traffic volume.

A8.2 Road traffic noise, continued

Design guidelines for road traffic noise on State Highways

Design guidelines for the management of road traffic noise on state highways are given in *Transit New Zealand's Guidelines for the management of road traffic noise - state highway improvements*. These guidelines apply to noise-sensitive facilities adjacent to either new state highway alignments or to any other State Highway improvements, which require a new designation.

The assessment point at which the design criteria apply is one metre in front of the most exposed point on the façades of existing residential buildings or educational facilities. An exception is in the case of noise buffer strips where the assessment point is the outer limit of the buffer strip.

The two criteria in the guidelines, both of which apply, are:

(a) Average noise design criteria

The average noise design levels for residential buildings and educational facilities at the assessment point are set out in table A8.1.

If it is not practicable or cost effective to meet the average design noise criterion at the assessment point given in table A8.1, then the guidelines specify internal noise design criteria. These criteria apply to all living rooms (including kitchens) and bedrooms in residential buildings, or teaching areas in educational facilities, with windows closed on the exposed walls.

The internal noise level criterion for residential buildings is either the level given in table A8.1 minus 20 dB(A), or 40 dB(A) Leq (24 hour), and for educational facilities the internal noise level criterion is either the level given in table A8.1 minus 20 dB(A), or 42 dB(A) Leq (24 hour), in each case whichever is the higher.

Table A8.1 Average noise design levels (leq (24 hour))

Noise area	Ambient noise level (dB(A))	Average noise design level (dB(A))
Low Areas with ambient noise levels of less than 50 dB(A) Leq (24 hour)	Less than 43	55
	43-50	Ambient + 12
Medium Areas with ambient noise levels of 50 to 59 dB(A) Leq (24 hour)	50-59	62
	59-67	Ambient + 3
High Areas with ambient noise levels of more than 59 dB(A) Leq (24 hour)	67-70	70
	more than 70	Ambient

A8.2 Road traffic noise, continued

Design guidelines for road traffic noise on State Highways, continued

(b) Single noise event design criterion

A single noise event is the maximum noise level emitted by a single vehicle passing the assessment point.

Where the assessment point for residential buildings and educational facilities is less than 12 metres from the nearside edge of the traffic lane, the *Transit Guidelines for the measurement of road traffic noise - state highway improvements* require noise reduction measures to reduce noise by at least 3 dB(A). This is designed to provide a level of protection to properties from the noise effects of single vehicles.

Mitigation of road traffic noise impacts

There are various options for reducing the effects of road traffic noise. These include realignment to increase the distance between the roadway and the assessment points, noise buffer strips, barriers, alternative road surfaces (Dravitzki et al 2002 and 2004) and building insulation.

Where project optimisation requires noise mitigation measures, the cost of such measures will be identified and included in the project cost as discussed in chapter 3.

Measurement and prediction of road traffic noise impacts

Traffic volumes used for noise predictions shall be based on forecasts of traffic flow 10 years after the completion of the project.

Equipment and methods for the measurement of noise shall comply with *NZS 6801: 1991 Measurement of sound*. Prediction of road traffic noise shall be carried out using the *United Kingdom Calculation of road traffic noise (1988)* method, calibrated to New Zealand conditions (refer to *Transit NZ Research report 28, Traffic noise from uninterrupted traffic flow (1994)*) and converted to the appropriate Leq index.

The conversion formulae to calculated Leq values from the L10 values derived from the *UK Calculation of road traffic noise (1988)* method are:

$$\text{Leq (24 hour)} = \text{L10 (18 hour)} - 3 \text{ dB(A)}$$

$$\text{Leq (1 hour)} = \text{L10 (1 hour)} - 3 \text{ dB(A)}$$

A8.2 Road traffic noise, continued

Valuation of road traffic noise impacts

There have been no specific studies carried out in New Zealand to determine the cost of road traffic noise however there is evidence to suggest that road traffic noise levels of 53 to 62 dBA do encourage people to move out of an area more quickly (Dravitzki et al, 2001).

A British survey (1995) of international (predominantly hedonic price) valuations suggests that the costs of noise are approximately 0.7% of affected property values per dB. A Canadian survey (Bein 1996) found that hedonic pricing revealed typical costs of 0.6% of affected property prices per dB, and the OECD recommends noise valuation based on 0.5% per dB. Bein argues that the total costs of noise are much higher than the change in property values because:

- consumers may not consider the full effects at time of purchase (supported by a German study which showed increased willingness to pay with increased understanding of noise);
- effects on other travellers and on occupants of commercial or institutional buildings are not captured;
- hedonic studies typically consider values of homes which experience noise above and below certain levels (a German study shows increasing willingness to pay as base noise rises).

A reasonable figure for New Zealand is suggested as being 1.2% of value of properties affected per dB of noise increase, (0.6% multiplied by a factor of two to take into account the factors mentioned by Bein). Using the median house price of \$327,000 (Real Estate Institute of NZ, 12 months to June 2007) and occupancy of 2.6 persons, this suggests a NPV cost of \$3,924 per dB per property and \$1,500 per dB per resident affected (\$410 per household or \$160 per person per year). This figure should be applied in all areas, since there is no reason to suppose that noise is less annoying to those in areas with low house prices. It is arguable as to what range of noise increase the cost should be applied to, but a conservative approach would be to apply it to any increase above existing ambient noise. This reflects a belief that most people dislike noise increases, even if the resulting noise is less than 50 dB.

Costs of road noise shall be incorporated into the external impact valuation (worksheet A8.1) and valued at:

$$\$410 \text{ per year} \times \text{dB change} \times \text{number of households affected.}$$

Where noise affects schools, hospitals, high concentrations of pedestrians and other sensitive situations an analysis may be required to determine the cost of noise that is site specific. The methodology for undertaking a valuation of noise at sensitive sites should be appropriate to the site (ie, willingness to pay surveys may be appropriate for sites with high concentrations of pedestrians and inappropriate for hospital sites).

A8.2 Road traffic noise, continued

Reporting of road traffic noise impacts

The number of residential dwellings and the educational facilities affected by a change in road traffic noise exposure shall be reported in terms of:

- (a) the predicted change from the ambient noise level
- (b) the difference between the predicted noise level and average noise design levels given in table A8.1.

Predicted noise levels, which exceed the design guidelines given in *Transit New Zealand's Guidelines for the management of road traffic noise - State Highway improvements*, shall be reported on the worksheet A8.3.

Where noise is a significant issue, plans shall be prepared distinguishing each type of land use. These plans shall show:

- (a) contours of noise exposure in the do-minimum and for each project option, and changes in noise exposure in bands of 3 dB(A), ie, 0 to 3 dB(A), > 3 to 6 dB(A), > 6 to 9 dB(A)
- (b) the number of residents in each band
- (c) where the predicted noise level is above the average noise design levels given in table A8.1 or where the single event criterion should apply.

Where projects incorporate measures to mitigate noise, the incremental costs and benefits of these measures shall be reported. If appropriate these costs and benefits shall be reported for various levels of noise mitigation.

A8.3 Vibration

Vibration

Two types of vibration are evident alongside traffic routes; ground-borne vibrations and low frequency sound which can result in building vibrations.

The primary cause of ground-borne vibrations is the variation in contact forces between vehicle wheels and the road surface. The interaction between vehicle tyres and road surface irregularity can result in the release of significant energy. Therefore, roads with surface irregularities generate more vibrations than new, smooth roads. Once produced, ground conditions markedly affect the way in which ground-borne pressure waves are propagated. Also, distances between the road and dwelling locations will determine how much vibration energy actually reaches nearby properties.

Air-borne low frequency sound below 100 Hz can also induce building vibration. The primary cause of these vibrations is low-frequency vehicle-produced sound, which enters the building and can excite the building structure and/or the contents. This excitation at the natural frequency of the structure being excited is highly dependent upon the type of building structure, and its proximity to the road. In general, air-borne vibration is taken into account in the assessment of noise effects, ie, locations likely to experience significant air-borne traffic-induced vibrations are likely to have been assessed as high noise areas and the impact determined according to appendix A8.2.

Traffic induced vibrations are evident in many parts of New Zealand and variations occur because of sub-soil geological factors such as high water tables, light volcanic sub-soil, or peaty soils. Generally the levels of vibration perceived will be a function of vehicle size, speed, proximity to the road, sub-soil geology, building characteristics, and sensitivity at the receiver location.

Impacts of vibration

The mechanism of vibration disturbance for persons inside a building is a complex combination involving structural vibration and low frequency sound which may be either heard or felt as a body vibration. Both forms of traffic-induced vibration may produce resonance, which is perceived as sound (eg, rattling of windows), or perceived as a body vibration. Such factors as the direction of the vibration, the frequency distribution of the vibrations, and the time history of the vibrations should be taken into account for a comprehensive assessment.

Two main attributes are used to assess vibration, these are peak particle velocity and acceleration. For particle velocity it is generally sufficient to assess the impact of traffic-induced vibrations. This is based on the premise that traffic-induced vibrations are 'event based' and not generally continuous in nature. Where traffic-induced vibrations are of a continuous nature detailed procedures for measurement and assessment are contained in such documents as *BS 6472:1992 Guide to evaluation of human exposure to vibration in buildings*.

A8.3 Vibration, continued

Assessment criteria

The following two criteria are designed for the assessment of traffic-induced vibration for sporadic traffic events such as the passing of heavy vehicles in proximity to vibration sensitive locations (eg, residential housing, schools, hospitals, etc.) If the criteria for level one are met, then this shall be reported and no further assessment is required. If the criteria for level one are not met, a level two assessment is required which will involve a more detailed investigation.

(a) Level one criteria

Traffic induced vibration is assessed as not likely to cause adverse reaction if all the following criteria are met:

- (i) The minimum site-back distance between the building location and the nearside edge of the traffic lane conforms to the minimum distance of 12 metres specified in appendix A8.2.
- (ii) The road surface is reasonably smooth and meets a set minimum NAASRA count level. In 100 km/h posted speed limit areas a minimum roughness guide is 100 NAASRA counts (3.8 IRI) and in lower than 100 km/h posted speed limit areas a minimum roughness guide is 120 NAASRA counts (4.5 IRI). A check should be made of local road surface conditions in the vicinity of residential areas (or other land uses likely to be sensitive to vibration, eg hospitals). Features such as poorly fitted manhole covers, slumped bridge abutments, or road surface repairs not vertically aligned with the true road surface level (eg by more than 20 mm or more) shall be noted, and a level two assessment carried out.
- (iii) The site is in an area not commonly known to experience traffic-induced vibrations. This will require a subjective judgement based on local knowledge. For example, it is known that the light volcanic soils of the central North Island volcanic plateau and the peaty soils (with a high water table) in low lying areas of Christchurch city cause vibration impacts.

(b) Level two criteria

For sites that do not meet the level one criteria a more detailed assessment is required as follows:

- (i) Vibration levels shall be measured to determine the level of effect. Vibration measurement equipment usually consists of a transducer or pick-up, an amplifying device, and an amplitude or level indicator or recorder.
 - (ii) Vibration levels shall be measured at a representative position on the floor level of interest in a room that is normally occupied in a dwelling, or other building in which an assessment is required (eg hospital).
 - (iii) The peak particle velocity shall be measured during normal traffic conditions, especially during the passage of heavy vehicles past the site. Several recordings shall be made, and the highest particle velocities recorded.
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A8.3 Vibration, continued

Assessment criteria, continued

The following guideline levels shall be used in the assessment of vibration effects:

- minor impact 2 to 5 mm/sec
- major impact 5 mm/sec or greater

During measurements an inspection of the building for cracks and other building damage likely to have been caused by traffic-induced vibrations shall be noted and reported.

Mitigation of vibration impacts

There are a limited number of options for reducing the effects of vibration. These include:

- structural isolating houses from concrete driveways;
- the use of effective noise reducing fence designs;
- smoothing the road surface to mitigate wheel bounce and body pitch
- road realignment to increase the distance between the roadway and the building; and
- re-routing heavy vehicles to less sensitive roads or reducing the speed of heavy vehicles.

Reporting of vibration

In New Zealand it is anticipated that the quantifiable disbenefits of vibration will be very much site specific and apply in situations such as roads near historic buildings and to road construction in densely populated urban areas. In general, the number of buildings exposed to significant vibration (and an estimate of the numbers of people affected) shall be identified and recorded on maps.

For a level one assessment the report should include the locations assessed and an explanation of the reasons why the level one criteria has been met.

For a level two assessment the report shall contain a summary of the method, locations, and measurement results together with an assessment of whether either of the minor or major impact levels have been exceeded. Measurement results for one or two locations can be used to interpret the likely impact for other buildings of similar construction, and at similar distances from the nearside edge of the traffic lane.

A8.4 Water quality

Water quality

Water quality is affected by:

- short term impacts during construction such as modifications of river channels, and lake or sea beds causing interruption or change to natural flows and the release of sediment downstream caused by disturbances from engineering works
 - permanent modifications of river channels, and lake or sea beds, caused by engineering works, and modifications in ground water levels caused by aquifer penetration and changes in permeability or the shape of the ground surface
 - increased discharges resulting from modifications of natural flows caused by faster rates of run-off from paved surfaces and the use of storm water drains and channels
 - pollution of surface water and ground water.
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Impacts on water quality

Potential impacts include the following:

- surface water pollution from surface run-off or spray. Potential pollutants include suspended solids, lead and other heavy metals, organic materials (such as rubber, bitumen and oil), salt and herbicides or pesticides (from roadside maintenance)
 - surface water pollution from accidental spillage which is potentially very damaging
 - ground water pollution from either soakaways which discharge directly into ground water or surface waters which find their way into aquifers. Pollution of ground water can also occur when road construction disturbs contaminated ground
 - changes to water flows or levels which can increase the risk of flooding, interfere with aquifers, and affect the ecology of surrounding areas.
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Mitigation of impacts on water quality

Avoidance and mitigation of some effects is possible through a wide variety of measures including bunding, vacuuming and filtering during construction; stormwater run-off management using marginal strips along roads that provide for infiltration; and emergency management such as sealing of drains and collection of clean-up materials. For more detailed guidance on erosion and sediment control of earthworks refer to the *Auckland Regional Council publication Erosion and sediment control guidelines for earthworks, 1992*.

The assistance of regional councils shall be sought where appropriate on the water quality and the hydrological regime within the road corridor, and to obtain further advice on the mitigation of impacts.

A8.4 Water quality, continued

Measurement of impacts on water quality

All water effects are directly measurable through clarity and volume measurements (sediment), chemical analysis (water pollution), flow measurements (change in run-off rates), physical observation (some surface pollutants), and ground water level measurements. Appropriate measurement techniques are well established, and should be applied to determine the effects of road projects (Kingett, Mitchell and Associates 1992).

Prediction of impacts on water quality

If the impacts on water quality are significant reference shall be made to an appropriate design manual, eg, *UK Manual Design manual for roads and bridges, volume 11, Environmental assessment, part 10 - Water quality and drainage* or an equivalent.

Reporting of impacts on water quality

The expected short term construction effects and permanent effects of projects on water quality shall be reported. This reporting shall include effects on ground water and natural water courses and levels, and the pollution effects of surface water run-off and potential accidental spillage.

Where projects incorporate measures to mitigate the effects on water quality, the incremental costs and benefits of these measures shall be reported.

A8.5 Special areas

Special areas

Projects may affect special areas either physically or by their proximity to such areas. These areas include:

- sites of cultural, spiritual, historic, aesthetic and amenity value including sites with historically, culturally or architecturally significant buildings, or sites of former buildings, and their environs
- archaeological sites, waahi tapu (sacred sites) and other sites of special importance to tangata whenua (people who hold customary authority over a particular area), including places at which significant events took place or are commemorated
- sites of special ecological, botanical, geological, geomorphological, or other scientific values, including rare landforms, either natural or modified, of special scientific or archaeological interest or cultural association. (For special ecological areas refer to appendix A8.6)
- important recreational areas including wilderness areas which derive special value through being little modified by human intervention.

Projects that affect these features either physically or by their proximity shall include consideration of such effects in the evaluation. These considerations will often involve Maori values, which have a special place in New Zealand law and custom.

Sources of information

The principal sources of information on special areas are:

- Regional and District Planning Schemes, which identify areas with special community values under such headings as 'listed buildings', 'identified sites', 'protected trees', and 'protected ecological areas'
- the Department of Conservation, which maintains a database of sites of archaeological and cultural significance
- the Historic Places Trust, which keeps a record of historic sites, including sites with and without legal protection.

There are sites and areas which can only be recognised through local knowledge. Examples are locally important recreational areas.

Waahi tapu are a special group. It may not be possible to readily identify the exact site or locality affected but consultation with those who hold mana whenua (customary authority) in the area will advise on the presence of waahi tapu. For guidance on consultation with tangata whenua refer to the *Ministry for the Environment booklet, Consultation with Tangata Whenua, (1991)*.

Impacts of land transport projects on special areas

The impact of road projects on special areas can be direct, completely or partially destroying the site; or indirect, detracting from the values for which the site is considered special. Examples would include removal of a historic building from its original location and disturbance of waahi tapu.

A8.5 Special areas, continued

Assessment of impacts on special areas

The value that a community places on a particular site will be specific to the site. This value can only be determined by experts who have knowledge of the site features. The value may be reflected by legal protection or planning classification, or through writings and traditions of the community and its institutions, but these sources cannot be relied upon alone.

Assessments of the value of special areas shall also include a process of public consultation. It is important to establish the relative importance that people place on different aspects of the project's impact on special sites and features.

Reporting of special areas

Any special areas affected shall be identified, described and, if appropriate, mapped. The expected impacts shall be described and community attitudes to these impacts on special areas shall be reported. The sources of information on special areas shall be indicated.

Where projects have been modified to protect or enhance special areas, the incremental benefits and costs of these measures shall be reported.

A8.6 Ecological impact

Ecological impact

The direct effects of roads on the human ecosystem are dealt with under noise, air pollution, visual impact and other sections of this appendix. This section is to give additional guidance on handling wider ecological impacts.

Ecology is the scientific study of interactions between and connections between organisms and their environment. Ecological studies are concerned with processes in ecosystems and with the interactions that determine the distribution and abundance of organisms. In ecology, many levels of organization are recognized and these include: ecosystems, biological communities, habitats, species and populations. A population is a group of organisms of the same kind (species) living in the same location (the habitat); for example, beech tree populations and earthworm populations. A habitat is the locality or site occupied by organisms and the term is sometimes used in connection with populations. A biological community is a group of populations of various species living and interacting together in a given place. Communities may be classified according to the dominant plant groups or most noticeable features: thus wetland communities, forest communities, pond communities, and rotting wood communities.

An ecosystem is the combination of biological communities, the physical environment (soil, water, air) and the processes contained therein. They consist of biological entities (animals, plant and other organisms) and most importantly the processes (energy flow, water, CO₂, mineral cycles). At a Department of Conservation workshop (27-28 April 1995) it was generally agreed that ecosystems could not be mapped because they have no boundaries. The use of 'ecosystem' is sometimes confused or equated with 'biological community' (which can be mapped).

Ecological impacts of land transport systems

Different ecological impacts may occur during the construction phase and the operational phase. The impacts will not be constrained within the boundaries of the operations or the finished product. The following is not comprehensive but could be used as a guide to identifying the types of ecological impacts.

(a) Effects within the operation and use area

(i) Direct habitat loss

Populations, habitats and biological communities may be damaged, reduced in extent and completely lost. Organisms will be lost and some entire populations or even species may become extinct.

(ii) Fragmentation and isolation

Equally important is fragmentation and isolation. That is, a transport system may divide and separate a population or a biological community. Populations and communities may also be wholly or partially isolated. Direct physical and chemical effects caused by the transport system.

(iii) Change in microclimate (light, moisture wind)

Will cause extinction of some populations. New organisms will colonise the new conditions.

A8.6 Ecological impact, *continued*

Ecological impacts of land transport systems, continued

(b) Effects beyond the operation and use area

Facilitation of dispersal (along the transport route), of organisms which do not naturally occur in the area of the project. A road provides new conduits for dispersal of organisms not normally found in the area; these may include invasive, exotic species, which may impact on the local biological community. Similarly, vehicles and people travelling along transport systems may inadvertently help to disperse organisms (including invasive and pest species) along new projects.

Any alterations to the land will affect the soil, local climate and local physical and chemical conditions. Pollution from land transport systems may include sediments, hydrocarbons, metals, salt and nutrients and microbial organisms. Noise, dust, heavy metals and organic material may penetrate nearby biological communities and may also be transported along water systems. This in turn will affect individual organisms and biological communities beyond the transport system.

(c) Increased accessibility to regions resulting in impacts from humans and activities

Process for identifying impacts

The geographical extent of the impacts

Impacts may have direct and indirect ecological effects beyond the transport system. It is advised therefore that the geographical boundary for identifying ecological impacts be stated. It may also be important to state the time scale over which ecological effects are to be considered and how significant the effects are likely to be.

Designated, protected areas and protected species

These should be identified. Similarly, any indigenous species, biological community or any other aspects of an ecosystem of 'significance' (locally, regionally, internationally) should be identified. 'Significance' could be interpreted as being defined in law or it could be defined in terms of local community perceptions of what is significant.

Determining what is present in the area of the project

Information on what is present has to be obtained before the nature of ecological impacts can be considered. Information about what is present (species, communities etc) may come from direct surveys or existing information. It is not practical to obtain information about all organisms and all aspects of the ecology of the area (because of the limited time scales and because of the range and variety of different levels of biological diversity within an ecosystem or biological community). Therefore expert advice should be obtained about which organisms (groups or taxa) or aspects of ecology should be noted. This information might relate to a specific indigenous species or to a particular ecological process such as nutrient cycling within forest communities.

A8.6 Ecological impact, continued

Process for identifying impacts, continued

Quantifying and qualifying the impacts

It is not practical to assess all impacts within the stated geographical boundaries and time scales. It is also not possible to fully quantify all impacts because of lack of knowledge of how impacts affect species, habitats, communities or ecosystems. Therefore, the record of impacts will include general as well as specific information.

Mitigation and ecological restoration

Measures that can be introduced to limit the effects or restore components of ecosystems once the project is in place, and the cost of such measures are to be calculated.

Reporting ecological impacts

Potential sources of information should be identified. These may include government departments, regional and territorial authorities, environmental agencies, centres of education and local groups and experts.

The following should be reported:

- (a) designated areas, protected areas and protected species should be identified. Similarly, any species, biological community or any other aspects of an ecosystem of significance (locally, regionally, internationally) should be identified
- (b) geographical boundary, time scale and how significant the impacts are should be stated
- (c) biological communities should be identified (using agreed ecological classification methods) and mapped
- (d) any statutory requirements to liaise with certain groups or agencies.

Ecological surveys should be based on standard ecological field methods. The results should include an assessment of the limitations of the methods. It is impractical to survey all organisms and all components of ecosystems, therefore a selection has to be made and the rationale for that selection should be stated. It is also not practical to assess all impacts on all components of all ecosystems, therefore a selection has to be made and the rationale for that selection should be made clear.

Estimates should be made of the likelihood of components of ecosystems recovering (following construction of roads and other infrastructure) and the time scale for recovery. Where projects have been modified to protect or enhance components of ecosystems, the incremental costs and benefits shall be reported.

A8.7 Visual impacts

Visual impacts Landscape values are very subjective and the appearance of man-made structures in a natural setting may be pleasing to some and displeasing to others.

Roads that conform to the contours of the land are generally less intrusive than those through cuttings or on embankments.

In the urban landscape, the roadway is more than just a route for road vehicles; it is a public area for pedestrian movement and social intercourse, it allows light and air between buildings, and permits a view of the surroundings. Landscape elements such as proportion, exposure and enclosure, contrasts, long and short views, colour and lighting, hardness and softness of line, and architectural style all mix together to create the overall visual impact.

The negative visual amenity from living close to a traffic stream includes loss of privacy, night time glare from streetlights and passing vehicle headlights.

Visual impacts of roads

Visual impacts may be conceptually divided into:

- visual obstruction
- visual intrusion
- view from the road.

The visual impacts of roads and structures can be described as obstructive, in so far as they block the view, or intrusive when their appearance jars with the surroundings. Obstruction is more likely to be encountered in an urban setting.

In some cases a route may pass through an intrinsically attractive area and here the view from the road would be a consideration. The aesthetic appearance of urban and rural roads to road users should also be considered.

Mitigation of unattractive visual impacts

For projects which will significantly change the landscape, any aesthetic treatments based on impact assessments should be incorporated within the planning and design stages. Direct input of community values should be sought, given that visual impacts have a significant cultural component.

A8.7 Visual impacts, continued

Assessment of visual impacts, continued

Visual impacts shall be assessed as follows:

(a) Visual obstruction

The magnitude of the visual impact caused by an obstruction depends on:

- size of the obstruction in relation to the viewing point
- quality of the view being obstructed
- visual quality of the obstruction
- numbers of people or properties affected by the obstruction.

The size of an obstruction can be dealt with by physical measurement. This requires the identification of viewpoints and a measure of the degree of obstruction received.

(b) Visual intrusion

This relates to the appearance of the landscape and is a broader concept than visual obstruction. Numerical predictive methods of measuring visual intrusion have so far not achieved general acceptance. Therefore, the appraisal of visual intrusion shall be based on subjective assessments of the appearance of the different options.

The existing scene can be observed but the proposed scene can only be imagined or represented either as artist's impressions, photomontage or physical modelling. Photomontage can now be generated quite realistically by computer image processing.

Perceived loss of amenity by persons located close to a road and its traffic, and loss of privacy, night-time glare from streetlights and vehicle headlights also constitute visual intrusion.

(c) View from the road

The types of scenery and the extent to which travellers are able to view the scenery need to be considered. Many New Zealand roads pass through scenic areas but, having numerous sharp curves, create a conflict for the driver between viewing the landscape and concentrating on safe driving. Changes resulting from the project can be presented either as artist's impressions or photomontage.

Reporting of visual impact

The visual obstruction and intrusion of projects shall be reported including, where appropriate, artist's impressions of the project and the numbers of people affected. The view from the road shall be reported in terms of the quality of scenery visible from the road and the types of people expected to benefit. Where artist's impressions or photomontage are used to assist description, care shall be exercised to give a realistic impression of the project.

Where projects have been modified to protect or enhance their visual impact, the incremental costs and benefits of these measures shall be reported.

A8.8 Community severance

Community severance

Community severance is the dislocation and alienation a community feels as a result of roads which sever communities or hinder access. It includes the effect of traffic on security and mobility of people, particularly pedestrians and cyclists and the consequential effects on their movement patterns and interaction.

Impacts of severance

The effects of severance are initially experienced as increased travel times, and difficulty and anxiety in crossing or travelling alongside the road. The results of severance in the longer term are diversion of movements to other, possibly longer routes, and to alternative and possibly less favoured destinations, and the suppression of trips altogether. The degree of effect varies with a person's age, being more severe for children and the elderly. Also the effects of severance can become worse over time as a result of traffic growth on a route.

Assessment of severance impacts

The effects that need to be identified are the suppression of trips, the choice of less favoured destinations, the general feeling of dissatisfaction as a result of severance including the effects on pedestrians and cyclists by proximity to traffic, and changes to neighbourhood and community structures. To quantify these effects requires information on existing patterns of land use and community structures and interactions, particularly in relation to community facilities such as school, neighbourhood shops, outdoor recreation areas, public transport stops and places of work. Some changes in severance effect can be evaluated in a similar way to road traffic by calculating changes in travel times for pedestrians and cyclists and applying the travel time values given in this manual.

For existing traffic routes, severance impacts can be considered on the basis of increased or reduced costs to existing pedestrians crossing the road. The analysis should take account of any additional distance required to walk to a controlled intersection, the time spent waiting to cross and the crossing time. The extreme case of severance is a motorway with fenced reserves, which poses considerable barriers to vehicular traffic as well as pedestrian and cycle traffic. The degree of severance experienced will depend on the number and location of vehicular and pedestrian crossing points.

Reporting of severance effects

Any areas affected by severance shall be identified, described and, if appropriate, mapped. The location of community facilities and the effects of the project on the accessibility of these facilities, particularly for pedestrians and cyclists shall be reported. Travel time changes for cyclists and pedestrians should be included with other road user costs in the economic evaluation.

Main crossing points shall be marked and the numbers of crossing movements indicated. In the case of projects, such as motorways, which create major barriers, their effects on overall community structures shall be reported. Where projects have incorporated features to reduce community severance, the incremental costs and benefits of these measures shall be reported. The benefits of reduced travel times, particularly for pedestrians and cyclists, and accident savings, shall be quantified to determine incremental BCRs of these factors.

A8.9 Overshadowing

Overshadowing	Overshadowing refers to the shadows cast onto adjoining properties. It is analogous to the overshadowing effects of buildings, which are covered by the rules in district plans through daylight admission controls restricting the height and location of building development on individual sites. The overshadowing effect is also analogous to the overshadowing effects of trees on neighbours, where enjoyment of property and personal health is protected by the provisions of the <i>Property Law Amendment Act (1984)</i> .
Impacts of overshadowing	Where a structure, such as an embankment or overhead bridge, reduces the amount of direct sunlight on an occupied property, overshadowing has a negative impact. Positive benefits due to an increase in direct sunlight on occupied properties may accrue from the removal of buildings or structures.
Measurement of overshadowing	The changes in shadows cast by a structure shall be calculated from azimuth and altitude data for the sun during the year at the site's particular location. This shall be expressed in contours of sunshine hours lost or gained per year. An adjustment would be necessary to compensate for the average amount of cloud cover in a year, which will reduce the hours of direct sunlight.
Reporting of overshadowing	<p>The properties affected by overshadowing shall be identified, with a description of these properties and the predicted extent and effects of overshadowing.</p> <p>Where projects have been modified to mitigate the effects of overshadowing, the incremental benefits and costs of these measures shall be reported.</p>

A8.10 Isolation

Isolation

Isolation occurs when people are unable to access normal community facilities or where there are long distances to travel to these facilities. Isolation may arise because:

- roads are unreliable.
- people live in remote areas.

Impacts of isolation

The impacts of the above two aspects of isolation are as follows:

- (a) Areas may be isolated by road closures caused by flooding, slips, collapses of bridge structures, etc. Areas served by only one road are particularly vulnerable to road closures but potentially access to and from major towns and cities can also be disrupted by events such as flooding and major earthquakes. The impacts of these road closures are firstly that people and businesses are unable to undertake normal activities and secondly there is the potential of being unable to deal with emergencies. In situations where road closures occur frequently, the threat of road closures may also create a sense of insecurity.
- (b) In the case of remote areas, people generally live there by preference. Thus the only case where a valid benefit for isolation shall be claimed is where an existing link has been cut, eg where an existing bridge gets washed away. In this case the project to replace the bridge would produce benefits in terms of reducing unwanted isolation.

Reporting of isolation

In the case of unreliable roads, isolation shall be reported in terms of:

- the number of residents affected by road closures.
- frequency and duration of road closures.
- availability of alternative routes, particularly for emergencies.
- degree of disruption caused by road closures, eg to commerce and to commuters and school children.

In the case of remote areas threatened with isolation, isolation shall be reported in terms of:

- number of residents in the remote area
- additional distance to community facilities by alternative routes
- visitor and tourist potential of the area.
- Where projects reduce isolation or the threat of isolation, the benefits shall be quantified, where possible.

A8.11 References

References

1. Auckland Regional Council, Erosion and sediment control guidelines for earthworks, 1992.
2. Beca Carter Hollings & Ferner Ltd, *Traffic noise from interrupted traffic flows*, report to Transit New Zealand, January 1991
3. P Bein, C J Johnson, T Litman, *Monetization of environmental impacts on roads*, Planning services branch, Ministry of Transportation and Highways, Victoria, British Columbia, 1995.
4. British Standards, *Guide to evaluation of human exposure to vibration in buildings*, BS 6472:1992
5. Butcher Partners Ltd, *A review of valuation of intangibles for roading project analysis*, report to Transit New Zealand, November 1996
6. M Copeland, *The economic contribution of rural roads*, report to Transit New Zealand, June 1993
7. V K Dravitzki, J Mitchell, C W B Wood, A Hyndman, S Collins, P Kerslake, *Traffic noise guidelines for low noise areas in New Zealand*, Transfund New Zealand research report 190, 2001.
8. V K Dravitzki, C W B Wood, *Effects of road texture on traffic noise and community annoyance at urban driving speeds*, Transit New Zealand research report, 2002.
9. V K Dravitzki, D Walton C W B Wood, *Road traffic noise: determining the influence of New Zealand road surfaces on noise levels and community annoyance*, Transfund New Zealand research report 612, 2004.
10. Great Britain Department of Transport, *Design manual for roads and bridges, volume 11, Environmental assessment, part 10 - Water quality and drainage*, 1998.
11. Highways Agency UK, *Design manual for roads and bridges, volume 11, Environmental assessment, section 3 - Environmental assessment techniques, part 1 - Air quality, annex 4 - Potential mitigation measures*, Highways Agency UK, 2003.
<http://www.officialdocuments.co.uk/document/deps/ha/dmrb/index.htm>
12. M Hunt, S Samuels, *Prediction of interrupted traffic flow noise; A review of methods and selection of a model for use in New Zealand*, report to Transit New Zealand, November 1990
13. Kingett Mitchell and Associates Ltd, *An assessment of stormwater quality and the implications for treatment of stormwater in the Auckland Region*, report to Auckland Regional Council, 1992.
14. Ministry for the Environment, *Consultation with Tangata Whenua*, Ministry for the Environment, Wellington, 1991. <http://www.mfe.govt.nz/publications/>

A8.11 References, continued

References,
continued

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15. I F Spellerberg, *Evaluation and assessment for conservation*, University of Southampton, UK, 1992.
 16. R Tinch, *The valuation of environmental externalities*, report for the Department of Transport, London, 1995.
 17. Transit New Zealand, *Guidelines for the management of road traffic noise - state highway improvements*, 1994.
 18. Transplan Consulting, *Quantification of intangibles*, Transit New Zealand research report No 12, Wellington, 1993.
 19. Works Consultancy Services Ltd, *Land transport externalities*, Transit New Zealand research report No 19, 1993.
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