PART C

Chapter 6
Environment

June 2013

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Chapter 6 Amendments – June 2013

Revision Register

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6.1 Introduction

The road landscape design process must address the strategic objective of environment. Mitigation of environmental impacts associated with transport infrastructure projects and positive contribution to the ecological potential of the corridor, can be achieved through the effective asset management. Considering the environment throughout all stages of the concept, development, implementation and finalisation phases is important for maintaining and enhancing environmental values within the corridor. Environmental considerations to integrate within the road landscape include, yet are not limited to:

- environmentally significant areas;
- water management including water sensitive urban design;
- soil conservation;
- fauna movement; and
- flora conservation.

The Department has a legal duty under the *Environmental Protection Act (1994)* to take all reasonable and practicable measures to minimize or prevent environmental harm. Environmental harm can be defined as *"any adverse effect, or potential adverse effect (whether temporary or permanent) on an environmental value"* (International Erosion Control Association, 2008:pN.5). Similarly, designers have a significant responsibility to:

- protect, consolidate, recover and regenerate existing environmental features, ecosystems and local habitat;
- minimise disturbance to biodiversity values;
- enhance existing natural resources in a sustainable manner;
- reinstate fauna and flora corridors and connections; and
- implement environmentally sustainable solutions.

6.1.1 Environmental Processes and Reporting

There are a variety of different environmental processes that particular regions follow and types of environmental reports used. The choice of process and report selected will largely depend on the region and the type of project involved. Certain projects may require a full Environmental Approval Reports process to be undertaken. Other projects may only require a single Environmental Approval Report completed, or a number of separate reports; for example:

- Review of Environmental Factors;
- Environmental Management Plan; and
- Environmental Design Report.

For further information on environmental processes and reports required, refer to the Department's *Road Project Environmental Processes Manual*.

6.2 Benefits

The benefits of integrating environmental considerations within the road landscape are:

- protection and enhancement of national, regional and local environmental values within the corridor;
- mitigation of ongoing disturbances and potentially negative impacts to existing environmental features;
- prevention of future land degradation through the use of appropriate rehabilitation techniques;
- recognition and adoption of ecologically sensitive design principles and objectives;
- integration of water sensitive urban design principles and practices to improve water quality;
- reflection of natural surrounding landscape patterns by integrating adjacent environmental habitats and inherent landscape character; and
- a healthy and sustainable future for the environment.

6.3 Design Goals

The Environment design goals are:

- **Environmental Values -** conserve and enhance environmental values within the corridor.
- **Disturbance Mitigation -** minimise environmental disturbance and impact on the existing natural environment.
- **Rehabilitation -** develop suitable and effective site specific rehabilitation measures to disturbed and adversely affected areas.

6.3.1 Environmental Values

The primary function of transport networks is to facilitate the movement of people in an efficient and safe manner. There are also important environmental aspects which require conservation. Of fundamental importance is the conservation and enhancement of environment values in areas through which the corridor passes or adjoins.

Environmental values relate to the ecological health, public amenity and safety within the environment. This definition allows for the environment within the road landscape to be considered more holistic and inclusive of all aspects related to humans and their surroundings, including visual, social and economic factors. Environmental values encompass people and places which contribute to achieving public amenity as a whole. This ensures that these values are appropriately preserved within the road landscape.

Preserving or enhancing existing ecological processes is the most important consideration in maintaining environmental values within the road landscape. A thorough understanding of these values, are required to ensure that a sympathetic design is achieved. In the landscape planning stage of a proposal, ecological values need to be assessed, in unison with visual and cultural heritage values, as part of an integrated landscape assessment. This forms the basis for any future landscape design.

Disturbed areas with high environmental values will require a greater level of future rehabilitation. Implementing the principles of integration; including context sensitive design, and sustainability within the road landscape helps ensure design responsiveness to environmental values within the corridor.

The broad greening concepts of urban forest and greenways (Chapter 1 of Part C) are examples of practices incorporating strong environmental values. Reinstating the urban forest and developing greenways within future transport and road infrastructure projects provides opportunities to reduce environmental harm and actively enhance ecological processes. The urban forest and greenways are important in contributing to environmental values within the road landscape by providing:

- enhancement of biodiversity through habitat creation;
- amelioration of the effects of habitat fragmentation through rebuilding of connectivity across wildlife corridors;
- fauna and flora linkages through provision of continuous vegetated corridors and buffers; and
- reinstatement of tree canopies, to provide shade and mitigation of heat island effect in urban areas (Figure C6-1).

Figure C6-1: Highly disturbed areas require reinstatement environmental values through context sensitive landscape design

6.3.1.1 Ecologically Sustainable Development

Applying the principles of ecologically sustainable development aims to assist in the preservation of environmental values. Australia's National Strategy for Ecologically Sustainable Development (1992) has set objectives specific to Urban and Transport Planning which include:

- *"to promote urban forms which minimise transport requirements, and improve the efficiency of land supply and infrastructure provision;*
- *to encourage the future development of urban transport systems which provide opportunities to limit the use of fossil fuels;*
- *to promote road design patterns with provision for and use of public transport modes; and*
- *to improve the amenity of local urban areas."*
- (Australian Government – Capital of, 1992:Part 2 – Sectoral Issues).

These objectives aim to reduce impacts of transport infrastructure construction on the environment through minimising usage of large amounts of natural resources. Sustainable production and consumption methods should also be promoted through the use of environmentally sound

technologies. Ways that ecologically sustainable development can be applied within the road landscape are:

- minimise the footprint of structures and minimise clearing;
- recycle products or use alternative construction materials which are of adequate strength and durability;
- use local materials from local suppliers (Figure C6-2);

Figure C6-2: Locally sourced stone used in wall, reduces transportation and haulage requirements

- use rapid and efficient construction techniques and methods to reduce construction program;
- apply site soil and mulch management practices by managing on site resources;
- incorporate hardy, low maintenance and water efficient vegetation (Figure C6-3);

Figure C6-3: Hardy, drought tolerant plant species selected to meet low maintenance requirements

- implement vegetation management principles as a method of improving air, land and water quality; and
- design low maintenance solutions to conserve energy and elongate asset life (Figure C6-4).

Figure C6-4: A simple planting treatment reduces maintenance requirements

6.3.1.2 Minimising Construction Impacts

Construction techniques can significantly impact environmental values. The benefits of minimizing impacts during construction on the environment include:

- improved noise and air (dust) quality;
- a reduction in pollutants;

- pest control;
- weed management;
- sediment control and erosion control; and
- flora and fauna protection and management.

General guidance on mitigating disturbance during construction includes:

- limiting extent of work areas (Figure C6-5) and intrusive access tracks;
- creating no-go zones for construction activities in environmentally sensitive areas;
- ensuring vegetation and trees to be retained are adequately marked and protected prior to clearing and excavation, and during construction;
- fencing off areas to be cleared and excavated before any works commence;
- implementing suitable erosion and sediment control measures for each construction phase (Figure C6-6);
- using machinery with the least impact;
- reuse and managed stockpiling site won resources (Figure C6-7), reducing the need for importing of topsoil, stone and mulch; and
- implementing intermediate landscape and revegetation techniques as soon as practical following bulk earth works, including temporary revegetation with seeding, organics blanket or hydromulch (Figure C6-8); as required to minimise erosion, sedimentation and dust impacts during construction.

Figure C6-5: Protecting environment from disturbance through limiting footprint

Figure C6-6: Erosion and sediment control measures minimizing construction impacts on adjoining residences

Figure C6-7: Removed local vegetation chipped for use as site mulch

Figure C6-8: Grass seeding used as a temporary erosion and sedimentation control measure during construction

6.3.2 Disturbance Mitigation

Mitigating disturbance to the environment within infrastructure corridor and to adjoining areas seeks to prevent and minimise environmental harm. It also ensures that environmental values are better preserved within immediate and surrounding areas.

Applying landscape and revegetation treatments as quickly as possible is an effective method of providing mitigation from disturbance during construction. Other methods include, but are not limited to:

- maintaining existing vegetative ground cover or applying temporary landscape and revegetation cover to mitigate against erosion, sedimentation and dust issues; and
- delaying clearing and grubbing or staging of activities.

Detailed disturbance mitigation techniques and design strategies are outlined in Appendix 5 *Design Guidelines.*

Specific existing aspects relative to the transport infrastructure landscape which require mitigation from disturbance are:

- flora and fauna habitats;
- local landforms and landscape settings;
- soils; and
- waterways.

Environmental processes and reporting; particularly the road infrastructure project's review of environmental factors, will identify specific environmentally sensitive sites and areas which may require special treatment or protection measures. The data and documentation established within the review of environmental factors; or other environmental reports used, should be referred to when implementing site specific disturbance mitigation techniques.

6.3.2.1 Protecting Existing Habitat

Once the environmental values of an area are identified and the initial scale and extent of the transport construction proposal determined, opportunities for the protection of existing flora and fauna habitats can be clearly identified. The protection of habitats which already exist is a far more efficient and cost effective means of conserving existing ecological processes than developing or recreating new habitat. Required considerations during the assessment, planning and design stages of the project specifically for transport infrastructure landscape include:

- identifying highly environmentally sensitive areas requiring preservation;
- protecting of areas of highest habitat values particularly waterways (Figure C6-9);

Figure C6-9: Protecting the habitat values of waterways for future generations

- provide adequate buffers to environmentally sensitive areas of a suitable width to reduce edge effects;
- facilitating seed collection from suitable areas for future rehabilitation works;
- maintaining and establishing linkages to neighbouring sites with habitat value;
- ensuring connectivity between habitat areas, within and beyond the immediate corridor through appropriate fauna movement devices and associated landscape and urban design responses (Figure C6-10);
- restricting fauna access to motorways and facilitating movement to suitable habitat areas or connecting points (Figure C6-11); and
- retaining significant stands of vegetation, particularly older established trees and marine communities.

Figure C6-10: Connecting habitat areas through fauna movement devices integrated within the road landscape

Figure C6-11: Fauna fencing and adjoining landscape treatment limit fauna from accessing roadways

Priority should be given to retaining those habitat trees (individual species or a communities group) with an existing high:

- landscape significance relative to locality, landscape setting and character (Figure C6-12);
- retention value relative to average life expectancy, based on health, condition and longevity;
- habitat value for fauna;
- ability to stabilise soils on cuttings, embankments and along watercourses;
- visual prominence and degree of aesthetic impact and value;
- community and social value in terms of amenity (Figure C6-13);
- regrowth potential, particularly in regional landscapes; and
- level of cultural or heritage significance.

Refer to the Departments *Fauna Sensitive Urban Design Manual* for additional guidelines.

Figure C6-12: Retention of landscape character

Figure C6-13: Retaining significant trees for amenity value to community

6.3.2.2 Retaining Existing Local Landforms and Landscape Settings

Road alignments can modify the existing landscape within a locality. Wherever possible, disturbance to existing local landforms and landscape settings within the corridor should be minimised by:

- minimising extents of earthworks;
- reflecting existing landform as much as possible in earthworks;
- avoiding sensitive areas and of high natural value;
- minimising impacts on local hydrological systems; and
- reducing fragmentation of local and regional flora and fauna corridors.

Road alignments can be used effectively to minimise impacts on different land uses and reinforce or create boundaries (Figure C6-14).

Figure C6-14: Roadways as land use boundaries

Source: Roads and Traffic Authority - NSW (1998)

Roadway alignments should merge into the local setting. Horizontal and vertical alignments and techniques such as warping (rounding) and flattening of batters and embankments (Figure C6-15) can minimise environmental impacts on the existing landform as well as mitigate visual disturbance.

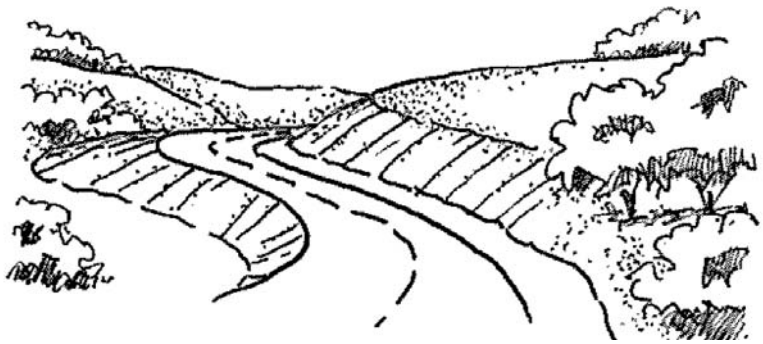

Figure C6-15: Rounding and flattening of batters and embankments

Source: Roads and Traffic Authority - NSW (1998)

Roadway alignments can also respond to vegetation features at a more detailed level (Figure C6-16) with suitable setbacks and road curvature to protect existing significant tree stands.

Figure C6-16: Roadway curvature responding to existing vegetation features

Source: Roads and Traffic Authority - NSW (1998)

Following the contours in road alignment can reduce earthworks, contrast with adjoining areas and minimise disturbance to adjoining land uses (Figure C6-17).

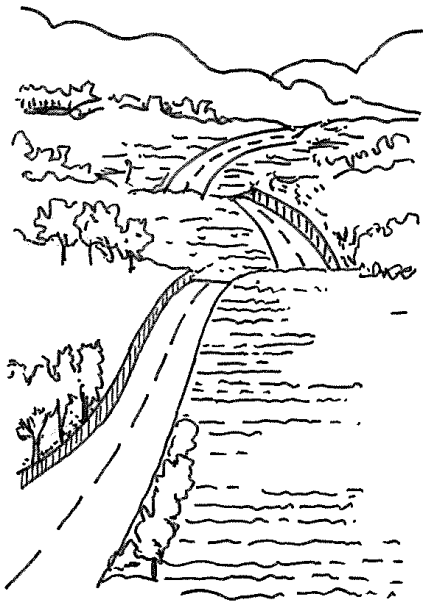

Figure C6-17: Existing landscape features promoted through roadway alignment

Source: Roads and Traffic Authority - NSW (1998)

Efficient use of the road reserve by integrating with multiple modes of transport also mitigates disturbance to local landforms reducing corridor area and associated impacts on adjoining land.

6.3.2.3 Soil Conservation

Soil is a valuable asset, particularly when it can be reused as planting media, and should be conserved where possible within the transport infrastructure corridor. Erosion removes valuable topsoil and produces sediment which in turn silts drains, creeks and rivers, affecting the water quality of waterways. Soil erosion can be accentuated through unnecessary construction and maintenance practices. The risk of soil erosion can be reduced by adopting the following disturbance mitigation principles:

- identification of erosive risk of topsoils and subsoils;

- scheduling earthworks, particularly clearing and grubbing, to expose the smallest possible area for the shortest possible time;
- disturbing soil as little as possible by limiting machinery access to construction areas only;
- maintaining existing vegetative ground cover until needs to be disturbed;
- stripping and stockpiling for later use, potentially as planting media; and
- protecting and stabilising subsoil and surface soils at the earliest opportunity after disturbance, through revegetation; slowing down water runoff, rill potential and assisting in erosion and sedimentation control, as well as providing dust reductions.

Unnecessary disturbance to soil within corridors can also effect existing healthy vegetation by:

- encouraging weed growth and competition with existing vegetation, increasing ongoing maintenance time and costs and fire risks along roadsides; and
- preventing the natural regeneration of native plants.

Development of Soil Management Plans and a Planting Media Management Plan, as described in the Departments *Soil Management Manual,* can assist in soil conservation and management.

6.3.2.4 Protecting Existing Waterways

In most cases, the crossing of waterways is unavoidable within transport infrastructure projects. However appropriate landscape design measures can be implemented to ensure that river and creek crossings are undertaken sensitively with minimal impact on the surrounding environment.

The following design principles should be applied to waterway crossings relative to transport infrastructure landscapes, including to:

- ensure bridge designs have a minimal foot print, through maximising span to minimise frequency of pier structures within waterways;
- promote wide watercourses with shallow margins that allow opportunities for aquatic planting (Figure C6-18);
- establish vegetated linkage areas to assist in the reconnection of wildlife corridors along creek banks and significant riparian habitats interrupted, disturbed or removed by the road crossing;
- retain or re-establishing fauna corridors through the use of suitable fauna movement structures to minimise fauna mortality rates, including integrating appropriate vegetation treatments in support of these structures;
- maximise the use of benches beneath large bridges as wildlife underpasses including integrating suitable plant species for habitat; and
- implement subtle crossings over minor local waterways which are sympathetic to the surrounding landscape setting, rather than making a distinctive statement or creating a feature (Figures C6-19 and C6-20).

Figure C6-18: Planting to shallow margins of watercourse

Figure C6-19: A sympathetic road crossing over a local waterway, using lightweight construction materials

6.3.3 Rehabilitation

Rehabilitation of disturbed and impacted areas is required to preserve environmental values within the transport infrastructure corridor and ensure the long term management of the environment as a whole. Noise quality, air quality and pollutants, pests, weeds, and flora and fauna, are all significant environmental elements which may require rehabilitation within corridors. However, the key aspects relative to the landscape which may be disturbed and require rehabilitation are:

- **site soils**;
- **water systems**; and
- **vegetation**.

The most effective way that rehabilitation of site soils and water systems can be achieved is through landscape and revegetation treatments (Figure C6-20). Implementing these treatments within the transport infrastructure landscape also plays a supporting role in reinstating valuable habitats which may be disturbed, impacted or removed as a result of project works. Vegetation can provide valuable food and shelter for different types of fauna, improve water quality and assist in stabilising site soils to minimise erosion.

Figure C6-20: Effective rehabilitation of disturbed soils and water systems with landscape and revegetation treatments

6.3.3.1 Site Soils

The most common disturbance within transport infrastructure corridors relative to soils is erosion, dispersion and subsequently sediment. A number of preventative measures are available for application to deter and prevent erosion, dispersion and sediment build-up; both temporarily during construction and as long term permanent measures.

Specific measures to assist in mitigating and rehabilitating of erosion and dispersion, and control of sediment are:

- ameliorating soils; and
- establishing vegetation.

6.3.3.2 Site Soil Amelioration

Ameliorating site soils seeks to:

- manage undesirable soils and their characteristics; particularly mitigating erosion and dispersion in high risk soils and disturbed subsoils;
- provide a stable outer zone embankment through using a suitable subsoil material within; and
- ensure successful plant growth.

6.3.3.3 Establishment of Vegetation

Landscape treatments are one of the most effective methods in preventing ongoing soil loss. This is particularly important where soils are high risk (displaying high erosive and dispersive potential). Vegetation prevents erosion through the binding properties of plant root systems which resist the physical effects of wind, rain and sun. The establishment of vegetation also improves the performance of other more structural and hard erosion control devices as well as their aesthetic appearance. Establishment of landscape treatments to site soils plays an important role in:

- providing coverage to disturbed areas as soon as possible after exposure;
- stabilising steep and irregular batter and embankment slopes (Figure C6-21);
- reducing immediate impact of raindrops on ground surface, particularly in areas within high levels of natural rainfall;

Figure C6-21: Landscape treatments assisting in batter stabilisation

- limiting soil exposure to the effects of wind;
- binding surface and subsoils within benches and terraces on high cuttings; and
- reducing long term intensity of overland sheet flows from road pavements.

6.3.3.4 Water Systems

Paved surfaces produce substantial volumes of water runoff which require long term management to achieve positive environmental outcomes. Applying the principles of water sensitive urban design enables an integrated and holistic approach to the management of water systems, particularly storm water within urban areas. The key principles of water sensitive urban design are to:

- *"protect existing natural features and ecological processes;*
- *maintain the natural hydrologic behaviour of catchments;*
- *protect water quality of surface and ground waters;*
- *minimise demand on the reticulated water supply system;*
- *minimise sewage discharges to the natural environment; and*
- *integrate water into the landscape to enhance visual, social, cultural heritage and ecological values"* (Healthy Waterways, 2006:p1-2).

A number of water system treatment devices can be implemented within transport infrastructure projects to manage storm water runoff and improve water quality. These are designed either as water detention or infiltration systems and can perform one or a combination of measures including:

- permanent storage of water;
- temporary storage of influxes of water;
- discharging water where required (to control volumes of stored water within devices);
- conveying and distribute overland sheet flow to outlets;
- filtering runoff (particularly before runoff infiltrates into soils);
- removing pollutants from runoff; and
- transitional filter areas to major downstream drainage systems.

Devices include:

swales (incorporating buffer strips);

- bioretention swales;
- sediment basins;
- bioretention basins;
- constructed wetlands;
- infiltration measures;
- sand filters; and
- aquifer storage and recovery.

Selecting a suitable water system treatment device is determined by its overall designated purpose within a particular project situation and generally requires:

- an assessment of broad scale drainage requirements within the whole corridor;
- data collection on the hydrological regime of the local water catchment, including likely frequency of drought, annual rainfall, intensity and frequency of storms;
- an analysis of existing landscape conditions; for example, topography;
- anticipated water runoff volumes and velocities;
- required water detention time (if a detention system); and
- an assessment of maintenance requirements (including access), cost and proven performance.

The final design of particular devices will depend on factors such as road formation, topography, local landscape conditions, existing utilities and geology. Detailed information on the hydraulic design and technical details regarding water systems is available within the Department's *Road Drainage Manual* and other current Queensland based Water Sensitive Urban Design documents including:

- Healthy Waterways: *Water Sensitive Urban Design – Technical Design Guidelines for South East Queensland (Version 1, 2006).*

For projects within the proximity of coastal water locations, reference should be made to:

- Queensland Government: Guideline – *EPA Best Practice Urban Storm water Management-Erosion and Sediment Control* (relative to) *State and Regional Coastal Management Plans – Queensland's Coastal Policy* (2008).

The benefits of integrating water sensitive urban design practices into the road landscape include:

- water quality enhancements;
- maintenance of existing natural hydrological processes;
- accommodating drought and flood conditions, ensuring greater resilience and adaptability;
- implementing plant species which successfully respond to water constraints and inconsistent conditions;
- enhancement of biodiversity values through developing habitat corridors and linkages within water systems; and
- improved visual amenity through enhancement with landscape and revegetation treatments.

6.3.3.5 Application of Landscape Treatments

Vegetation treatments within water systems provide a significant role in the conveyance and filtering of storm water run-off within transport infrastructure corridors, to meet required water quality outcomes. Treatments assist in pre-treating run-off before it is transferred for retention, detention, storage or discharge. The use of vegetated buffers serves to trap and filter contaminants before they enter water bodies. Riparian buffers around ponds, pools and streams are particularly effective in improving water quality. Planted areas to water systems can become visually positive and attractive landscape features in themselves, particularly when applied to retention systems designed for permanent water storage. All treatments need to be coordinated with the engineering design to ensure allowances are made for the treatment in the civil/ hydraulic design.

Vegetation can also be applied as perimeter planting to water systems to improve their aesthetics, particularly of hard drainage structures (Figure C6-22).

Figure C6-22: The use of vegetation around drainage structure to improve aesthetics and improve integration

6.3.3.6 Irrigation

In most instances, soil amelioration and selection of appropriate plant species should negate the requirement for permanent and ongoing irrigation systems to be installed. This ensures that water is conserved as a natural resource. The Department's approach is to discourage the use of irrigation systems in most cases, except for:

- specific cases, such as high profile transport stations, where planting will be unsuccessful without a consistent watering regime; and
- on a temporary basis during the establishment and maintenance periods of revegetation programs.