Topic 6 Section 4

Project Environmental Plan

Contents

Project Environmental Plan

The plan for managing the environment and environmental issues during construction is important. It represents a practical expression of the environmental conditions laid down in the contract and is binding on all concerned with project construction.

The following discussion of environmental plans and requirements for road construction work includes:

- Typical headings for the environmental management plan
- Annexure to the environmental management plan
- Conservation and revegetation requirements.

Typical Headings for an Environmental Management Plan

The environmental management plan for the works includes headings and content that may be either generic for most types of road construction projects, or tailored to the specific environmental requirements identified for the project. Typical headings for the environmental management plan for a road construction job may include:

- statement of the company's environmental policy and commitment
- details of the company management structure (organisational chart)
- company's statutory obligations for the environment
- brief description of work included in the contract
- list of specific environmental requirements for the project (e.g. erosion and sediment control, protection of native fauna, air quality)
- site environmental procedures (e.g. site induction, special management plans)
- action required in the event of an environmental non-conformance
- action required in the event of an environmental incident
- auditing and reporting requirements.

The Company's Environmental Policy and Commitment

The plan usually begins with a generic statement of the company's commitment to manage the environment during all phases of the project, and in line with legislative requirements. An example of such a statement follows:

> The Quality Policy Statement reproduced below confirms the company's commitment to maintain the standard of workmanship and products at the same time as satisfying the customers' needs.
>
> Essentially, any customer who has environmental concerns or requirements, whether they are equal to or greater than the requirements of the *Environmental Protection Act* 1994, shall have those needs met under the terms of the contract.
>
> The policy of the contractor is to provide workmanship and products to a standard that will adequately comply with the specifications and satisfy the customers' valid needs.
>
> To put this policy into effect, a primary objective of the company is to develop, establish and maintain an efficient quality management system based on AS/ISO 9002 for quality assurance in production, installation and servicing, with reference to AS2990 Cat B. This approach is adopted throughout all levels of the organisation, in order to complete projects on time, within budget and to the satisfaction of the customer and provide our company with adequate return on the assets employed.

Company Management Structure

Responsibilities for environmental management are outlined in the plan— for example, who is responsible for submission of erosion and sediment control plans. The purpose of such a statement is to ensure that all concerned with construction are aware of the names of persons responsible for the company's environmental management.

A company organisation chart may be used to show the position of these persons within the company management structure.

In many cases, the contractor's quality representative is appointed to handle environmental issues arising on site.

Company's Statutory Obligations

The management plan includes statements that require company staff to:

- obtain all required environmental permits before proceeding with the works
- incorporate into the environmental management plan all environmental requirements identified in the client's review of environmental factors and the environmental design report
- comply with the environmental management plan.

The requirement to comply with the environmental management plan usually extends to everyone on site, including subcontractors, sales representatives and visitors.

Description of the Work

This section of the plan is simply a brief description of all work included in the contract, usually listed under main headings such as Clearing and Grubbing, Topsoil Stripping, Excavation, etc.

Specific Management Requirements

This is the most detailed section of the plan and includes statements about the company's response to each type of environmental issue identified on site. Such issues may include:

- erosion and sediment control
- protection of native fauna
- air quality
- hazardous substances
- water discharged from site
- vegetation
- waste management
- noise control
- vibration
- restriction of access
- contamination
- environmental monitoring.

An example of a Specific Management Requirements section of an environmental management plan is shown on the following page.

Sample of Specific Management Requirements

1. Erosion and Sediment Control:

Erosion and sediment control will be undertaken in accordance with the details outlined on the Sediment and Erosion Control Plan (ESCP) to be submitted as Annexure A of this plan. The ESCP shall include the elements defined in sections A4.1, A4.2 and A4.3 of Soil Erosion and Sediment Control— Engineering Guidelines for Queensland Construction sites. The control measures are to be installed prior to site disturbance and shall be provided as soon as required during the course of the works. The project manager will obtain weather forecasts and take appropriate action based on the reports.

Clause 3 of MRS 11.51.01 refers in particular to minimising the extent of disturbance at (*name of location*) and directing all sediment-laden water over vegetated areas or via sediment control devices (refer to Sketch ESCP 001 in Annexure A). All plant and equipment will cross the creek at (*name of applicable crossing points*) to minimise disturbance to existing vegetated areas.

2. Protection of Native Fauna

Prior to any clearing, all vegetation shall be checked for the presence of fauna by an officer of Queensland Parks and Wildlife, or their nominated representative.

If any fauna present in the area will not leave areas to be cleared, they should be relocated and any injured fauna should be treated by a vet.

3. Air Quality

Airborne pollution (i.e. dust) will be minimised by keeping fills and haul roads in a moist condition. Wind direction and the direction of dust plumes will be monitored with respect to sensitive receptors such as (*nominate relevant areas, e.g. residences or picnic grounds*) along the length of the works.

If tracking of sediments is a problem with vehicles, a temporary shake-down construction access will be set up to eliminate this problem.

Scientific air-quality monitoring is not a contractual requirement, but on-going visual monitoring of the atmosphere will be maintained to reduce airborne dust that is of a sufficient level to pose a safety or health risk.

Compliance monitoring or management measures will also be implemented in response to any complaints related to air quality. Burning of materials is not permitted on site.

4. Hazardous Substances

All chemicals (including fuel and oil) are to be stored in the appropriate areas and bunded where applicable. No bulk fuel storages will be set up on site; all fuel will be picked up from the fuel distributor at [*supplier's location*] as required.

Other hazardous substances will be stored in [*identification of storage area*]. Any oils will be also stored in drums in a container. Spill clean-up kits will be kept at the site office, and be employed to prevent any spillage from contaminating soil or water. Spills MUST be reported to the environmental representative, so that this person can consult the superintendent or his representative to assess what action is to be taken.

MSDSs will be kept on site for all hazardous substances. As part of on-going training, all employees will be trained in the safe handling of any hazardous substances by reference to these MSDSs.

5. Quality of Water Discharged from Site

Water quality monitoring shall be carried out upstream and downstream of [*name of monitoring point*] while work is being undertaken within the creek catchment. Visual monitoring shall be undertaken weekly during the construction period and, in addition, following storm events exceeding 25mm/hour. The project manager will endeavour to ensure that all operations limit the release of contaminants as per the Australian Water Quality Guidelines for Fresh and Marine Waters (published by ANZECC, 1992) in addition to comparison with baseline monitoring results.

6. Vegetation:

Areas of vegetation defined by the superintendent will be protected and maintained during construction. In particular, bridge construction sites will be surveyed to identify trees that need to be removed, based on construction access requirements, creek bank stability and road safety considerations.

Areas to be cleared will be clearly defined on site with tree-spot marking paint. The hold point must be signed off prior to clearing. Following the joint survey, the remaining uncleared areas will be classified as "no-go" zones.

All disturbed areas will be topsoiled and revegetated on completion of all earthworks.

Management of weeds will be undertaken by removing all noxious weeds and preventing vehicles from exporting weeds from site. NATA certificates will be required for any seed and mulch proposed to be used on site, i.e. to confirm that the product is free from declared plants. Before construction starts, a qualified person shall inspect the site to identify declared plants.

7. Waste Management

Waste is to be stored in containers provided by the contractor. Waste is to be separated, if possible, for recycling. The contractor will monitor the amount of all waste generated and the disposal location, to ensure that all waste is disposed of legally. [*Name of local government*] operates a waste disposal facility at [*location*]; this should service all waste requirements encountered on this project.

Re-use of existing pavement materials and excavated materials will be proposed, where applicable, to reduce the volume of waste generated. Timber recovered from demolished bridges during the project will be disposed of in consultation with the principal, and may be used to provide fauna habitat, mulched for rehabilitation, or removed off site.

8. Noise Control

All plant and equipment used on the project must be fitted with silencers that are in good working order; all plant is to be serviced on a regular basis. Working hours are to be strictly adhered to, including any local government requirements.

Where there is a potential for exposure to noise in excess of 85dB(A) for 8 hours, or a daily noise dose in excess of 1.0, a design solution or safe work procedure is to be established and implemented before work can proceed.

The requirements of the Environmental Protection (Noise) Policy 1997 are the minimum standard. Owners of neighbouring properties likely to be affected by noise must be consulted about the duration and purpose of the noise.

A complaints register will be established, for recording and follow-up of noise and other environmental complaints.

9. Vibration

Vibration receptors will be installed and monitoring undertaken when work is undertaken within 60m of any building. A condition survey will also be undertaken of the same properties before work commences. All properties likely to be affected by vibration will be notified 48 hours prior to commencement of work. All vibration will be limited to the levels stated in MRS 11.51, Clause 11.2. Any complaints about vibration will be reported immediately to the superintendent.

If required, a vibrograph that records peak particle velocities (PPVs) in accordance with AS 2187.2 will be used. This unit resets and records PPVs five seconds after every preceding measurement.

Direct communications will be maintained between the site supervisor and monitor, to ensure vibration levels do not exceed the levels stated above. In the event that vibration levels approach the limit, rolling techniques will be reviewed and alternative methods will be proposed.

10. Restriction of Access

Access to and from the site will be restricted to construction vehicles only, where practical.

A wash-out pit for concrete trucks will be provided as required, in an area agreed to by the superintendent. It is to be cleaned out when full. Its construction will require the use of a geotextile-lined earth bund. Unused concrete will be returned to the batch plant and not discharged on site.

11. Contamination

The site will be investigated, prior to commencement of construction, for the presence of any contamination by oil, fuel, lubricants, or other solid or liquid waste. Should there be any evidence of such contamination, the areas will be identified and contaminated materials will be removed from site to a tip set aside for the purpose.

All care will be taken in the regular servicing and refuelling of construction plant and equipment, to ensure that there is no further contamination. Servicing will be undertaken in a designated, bunded area. Any minor spills will be cleaned up, and waste oils and lubricants stored in containers, for removal off site to an approved waste disposal dump.

12. Environmental Monitoring Programme

The contact will be of approximately [*number of*] weeks' duration. Monitoring as listed in Table 1 will be implemented in a timely manner to match the submitted construction programme.

TABLE 1 – Monitoring Requirements

No.	Issue	Applicable during construction?	Frequency of monitoring
1	Erosion and sediment control	Y	Before clearing, then weekly or after heavy rainfall
2	Air quality	Y	Daily, or in response to any complaint.
3	Discharge water quality	Y	Weekly during construction, or after storms
4	Vegetation	Y	Existing weeds before start of work, and at end of maintenance period.
5	Waste	Y	Weekly
6	Noise and vibration	Y	Noise, if complaints received; vibration, while working within 60 m of any building.

Site Environmental Procedures

The site-specific environmental procedures may include an environmental site induction that must be completed by all persons who are required to work on site; and specific management plans.

The environmental site induction may include such headings as:

- Environmental management responsibilities on site
- Statutory and other obligations
- Management requirements relating to:
  - Noise and vibration
  - Dust
  - Runoff, erosion and sediment control
  - Water quality
  - Waste management
  - Vegetation values
  - Fauna values
  - Declared plants.

Specific management plans may be attached as annexures to the plan. They may relate to areas such as:

- Water quality
- Runoff, erosion and sediment control
- Declared plants.

Action Required in the Event of an Environmental Non-Conformance

This section of the plan describes what will be done if a condition arises that constitutes an environmental non-conformance. For example—

> During the construction phase, the contractor's quality representative will report any non-conformance in relation to the EMP and the ESCP to the project manager.
>
> The contractor's quality representative will also report any perceived breaches of legislative requirements to the relevant regulatory agencies.

Action Required in the Event of an Environmental Incident

This section of the plan describes what will be done if a condition arises that constitutes an environmental incident. For example—

> Subsequent to any departure from agreed and approved environmental procedure, the contractor's quality representative will complete and supply, to the superintendent's representative, a corrective action request (CAR).

Auditing and Reporting Requirements

This section of the plan identifies any requirements for self-assessment or other audits, and the contractor's reporting requirements. For example—

> *(Audits)*
>
> The contractor's quality representative will be responsible for conducting self-assessment audits as required, or at intervals not longer than fortnightly. The pro forma to be used will be as detailed in [*identify source document*].
>
> *(Reporting)*
>
> Any emergencies will be reported to the EPA in accordance with the requirements of The Environmental Protection Act 1994 and the Environmental Protection (Water) Policy 1997.

The contractor may require the quality representative to provide a report at monthly or other intervals, to address environmental issues such as the following:

- Monitoring data
- Audits
- Any other environmental surveys
- Environmental equipment tests
- Corrective actions.

This may be in any format required by the contractor. Supporting documentation, such as records of non-conformances, environmental correspondence registers, and complaints registers, may be required.

Annexure to the Environmental Plan

An annexure may be attached to the environmental plan, as a means of including detailed plans identified in the Specific Environmental Requirements section of the environmental management plan.

The following examples show three types of plan that may be included as an annexure to the environmental plan:

- Water quality plan
- Runoff, erosion and sediment control plan
- Declared plants plan.

WATER QUALITY PLAN

Objective

To minimise the effects of construction activities on the water quality in [*name of watercourse*].

Statutory Provisions

- *Environment Protection Act 1994*
- Environmental Protection (Water) Policy 1997

Targets

Implement best practice for:

- Minimising disturbance
- Drainage control
- Sediment control.

Management Actions

Ensure compliance with the ESCP.

- Check all construction vehicles and equipment weekly for oil and chemical leaks.
- Undertake all refuelling operations off-site, or within bunded areas where accidental spills cannot escape to stormwater and drainage systems.
- Contain rubbish and waste materials in suitable facilities to ensure litter does not enter stormwater drains.
- Implement temporary bunding whilst undertaking culvert works.

Monitoring

The CER shall:

- Inspect the disturbed and rehabilitated sections of the work corridor for erosion weekly and after significant rain events (defined as more than 12mm in 24hrs).
- Inspect erosion and sediment control devices daily to ensure effective operation.
- Monitor progress of vegetation works for stabilisation effectiveness.
- Monitor the implementation of the ESCP.
- Monitor water (visual) upstream and downstream of [name of watercourse].

Reporting

The CER shall log the outcome of inspections.

Corrective Action

Corrective actions shall be in accordance with the outcome of inspections.

RUNOFF, EROSION AND SEDIMENT CONTROL PLAN

Objective

To minimise the potential for soil erosion and transport of sediment to local waterways and properties.

Applicable Statutory Provisions

- *Environment Protection Act 1994*
- Environmental Protection (Water) Policy 1997

Target

All site discharges from disturbed areas are to pass through erosion and sediment control devices.

In accordance with the Main Roads Erosion and Sediment Control manual (Nov. 1997), implem-ent best practice for:

- Minimising disturbance
- Drainage control
- Erosion control
- Sediment control.

Management Actions

- Prepare an Erosion and Sediment Control Plan (ESCP) to address issues such as site disturbance, and control of drainage, erosion and sediment l.
- Ensure all soil erosion and sediment-control devices are installed prior to construction, site establishment and/or disturbance.
- Ensure all ground surfaces are exposed for the minimum time and over the least possible area.
- Revegetate disturbed areas as soon as practicable to stabilise soil cover.

Monitoring

The CER shall:

- Inspect the disturbed and rehabilitated sections of the work corridor for erosion weekly, and after significant rain events (>25mm/hour).
- Monitor progress of revegetation works for stabilisation effectiveness.
- Monitor the implementation of the ESCP.

Reporting

The CER shall log the outcome of inspections.

Corrective Action

- Corrective action shall be in accordance with the outcome of inspections.
- Any failure/breach of erosion and sediment control systems are to be reported immediately to the CER.

DECLARED PLANTS PLAN

Objective

Maintain or reduce the influence of declared plants within and immediately adjacent to the work corridor. Ensure that native flora has a competitive advantage over the naturalised flora. (Note: Declared plants were formerly known as noxious weeds).

Applicable Statutory Provisions

- *Environment Protection Act 1994*
- Environmental Protection (Water) Policy 1997

Target

Minimise the extent of weed invasion within and immediately adjacent to the work corridor.

Management Actions

- Restrict vehicles to defined work corridor
- Rip temporary access tracks after use.
- Mulch transplanted seedlings and disturbed areas
- Rehabilitate completed areas as soon as practicable
- Inspection of site for noxious weeds and report to [*name of local government*].

Monitoring

Inspect plant and vehicles entering the site and wash wheels and tracks as required.

Inspect each rehabilitated area as soon as practicable after completion.

Inspect site prior to construction and at end of maintenance period.

Reporting

Log the outcome of inspections.

Corrective Action

Corrective action shall be in accordance with the outcome of inspections.

Conservation and Revegetation Requirements

The contractor must comply with all conditions of the contract related to environment, conservation and heritage.

Conservation Requirements

Supervisors must endeavour to minimise the destruction and wastage of natural resources. Cleared and stripped materials must be used to best advantage in revegetating any disturbed areas.

The natural resources most likely to be used or interfered with during road construction are timber, low-growing vegetation, humus-bearing topsoil, earth and rock, waterways and still water, wild life habitats, historic places and land marks, and natural scenery.

The following discussion must be read in conjunction with:

- plans and specifications contained in the contract
- requirements imposed by Queensland conservation or cultural legislation, such as the:
  - *Cultural Record (Landscapes Queensland and Queensland Estate) Act* 1987
  - *Queensland Heritage Act* 1992
  - *Environment Protection Act* 1994.

Techniques commonly employed to conserve natural resources are as follows.

Timber

Do not indiscriminately burn felled timbers. Some timbers can be used commercially—any logs of useful timbers must be set aside for salvage.

Sometimes, it may be possible to transplant valuable trees.

Do not allow felling and burning operations to destroy timber adjacent to the road formation.

Low-Growing Vegetation

- Remove large timber beforehand as a separate operation.
- Do not burn low-growing vegetation if it is possible to turn it into mulch. Stack this vegetation separately from heavy timbers.

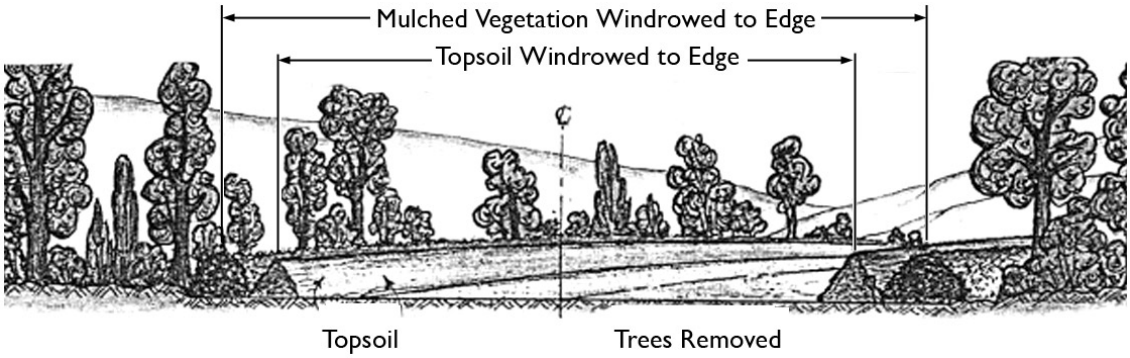
Large-scale vegetation mulching machines may be useful in urban and suburban areas where burning is not possible.

Conserving Mulch and Topsoil for Revegetation

The Supervisor must plan the job so that humus-bearing topsoil and natural grasses are removed to salvage stockpiles for subsequent use in revegetation work. The extent of this operation depends on the nature of the area to be cleared. For example:

In country with low scrub and few large trees, the trees and any dense, hard scrub must be selectively removed and transported by rake dozer to selected areas for subsequent disposal or burning.

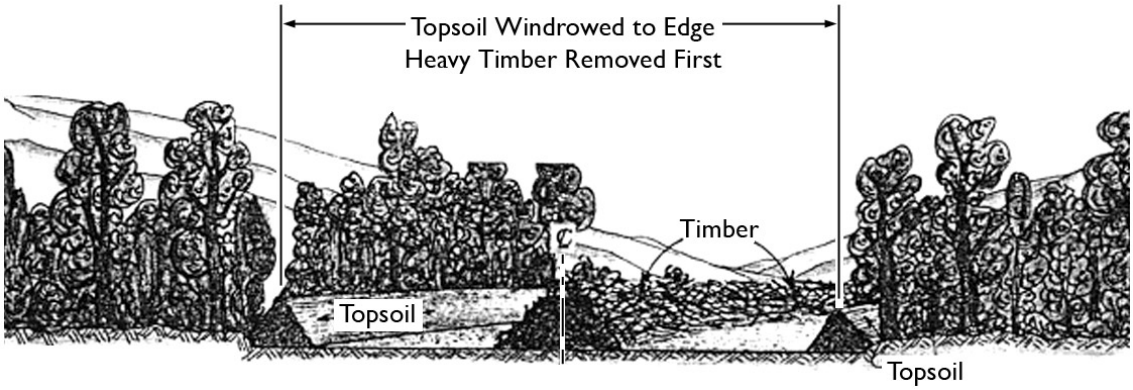
Light brush can then be mulched with a heavy disc plough and windrowed to edge of the cleared area, where it can be mixed with salvaged topsoil for reuse as an erosion and revegetation cover.



In open woodland with a greater number of large trees, a similar operation to that described above (i.e. for country with low scrub and few large trees) may be used. However, heavier equipment is required to dispose of heavy timbers.

In dense forest areas it is normally impossible to salvage the lighter undergrowth. Because of this, soil and timber should not be stockpiled together during clearing operations; otherwise, humus-bearing topsoil will be wasted. The timber should be stacked in the centre of the formation, and the topsoil windrowed to the edge.

Rake dozers are essential to ensure the stacked timber is relatively free of earth, to allow efficient burning. Clearing must progress well in advance of the earthworks, to allow burning to be carried out within the formation.



Spoil (Earth and Rock)

The disposal of spoil is potentially a major environmental problem, but one which can usually be resolved if good planning is carried out before the job begins. The estimated quantities of spoil are shown in the earthworks program; therefore the disposal of spoil can be planned in advance.

Earth spoil may be used to flatten batters, or to improve other areas of the road reservation. However, under no circumstances should the spoil be dumped indiscriminately over batters, or be left as irregular shapes in the finished roadworks.

Large rocks may be buried in fills, or placed on batter slopes as the work progresses. They must not be pushed into untidy heaps and simply left.

Waterways

- When constructing haul roads, do not allow waterways to become polluted with silt- bearing materials. A gravelly or rocky material should be used for filling, especially over pipes in waterways.
- Do not dump soil on the upstream side of waterholes.
- Temporary erosion control measures (e.g. silt fences) and siltation blocks must be provided during earthworks operations.
- Do not leave areas which have been disturbed by construction operations unprotected. They may be subject to erosion or siltation in the event of heavy rain.

Wild Life

- If the road reservation traverses a wildlife habitat, great care must be taken during construction to ensure minimum disturbance.
- Special precautions and the use of revegetation measures may be required in the case of certain species of wild life. (Examples include bellbird habitat in south Queensland and cassowary habitat in north Queensland).

Historic Places and Land Marks

Features of high cultural and historic value include heritage sites, buildings and artefacts of Aboriginal and non-Aboriginal origin together with other natural features of unique aesthetic (e.g. rock formations) or functional value.

Natural features could include:

- rare plants
- important vegetation
- fauna habitat
- wetlands
- watercourses
- geological features
- conservation reserves
- water catchment areas.

Sources of information on significant sites vary widely. Many sites are identified in the registers of the National Estate, State Heritage, Local Heritage, National Trust— Significant Trees, and Geological Monuments. Others sources include the gazetted boundaries of national parks and published information on endangered, rare, or vulnerable native plants and animals, plant communities and habitats.

Cultural Heritage Protection

Where aboriginal or European cultural heritage may be affected by road works, the contract will include conditions aimed at ensuring compliance with heritage legislation.

Under existing and proposed Commonwealth and State legislation, companies have a duty of care to protect and manage indigenous and non-indigenous cultural heritage that may be affected by civil and construction work, including road building and maintenance. This could involve the protection of places with cultural heritage value, such as:

- archaeological sites
- historic places
- culturally significant sites and landscapes.

Cultural Observer

The management of work at these locations may require that appropriate indigenous people be consulted and at times, engaged as consultants to assist in carrying out work in the area in an acceptable manner.

If there is a possibility of disturbing aboriginal relics during earthworks, it may be necessary to employ a cultural observer. Any discoveries constitute a hold point, and work must be stopped until protection of the relic can be arranged.

If sites with cultural heritage value have been identified in the environmental management plan or have been discovered during excavation or other work, it is important that supervisors make themselves aware of their roles and responsibilities.

Part of the supervisor's responsibilities may be to ensure that employees and sub- contractors are aware of the importance of protecting cultural heritage sites.

Supervisors must also become familiar with procedures that are outlined in the EMP or company policy for contacting the relevant authorities and for managing the protection of the site.

Protecting Roadside Remnant Vegetation

Responsibility for the care and control of roadsides, including vegetation, is vested in either the Main Roads Department, or local councils under the Local Government Act. In most cases, local councils must be consulted before any disturbance may occur.

Roadwork operations have the potential to adversely impact roadside environments—especially roadside vegetation. It is therefore important to be aware of the location of areas of significant vegetation in order that roadwork activities can be appropriately modified.

Weeds

Local or indigenous plants are species that naturally occur within a defined area and form part of the environment of a locality. In Queensland, a plant indigenous to Australia is defined under the Land Protection (Pest and Stock Route Management) Regulation 2003 as one:

> not originally introduced to Australia by human intervention, other than … plants introduced before the year 1600;

Indigenous species are distinct from 'exotic' vegetation, which has been introduced to an area by human activity; in Australia, this means vegetation introduced from another continent or island. In addition, plants that have been moved within Australia outside their natural range may become weeds (e.g. umbrella tree [*Brassaia actinophylla*] in south-east Queensland).

The acknowledged benefits of retaining the vegetation that is native to a particular place include:

- Maintenance of the natural balance between plants, insects and other animals
- Habitat for local flora and fauna populations
- A natural, sustainable, minimal-cost groundcover which helps prevent soil erosion and reduce storm water run-off damage
- Reduced maintenance costs.

There are many common examples of exotic vegetation; for example, camphor laurels, asparagus fern, Singapore daisy, prickly pear and mesquites.

Under the Land Protection (Pest and Stock Route Management) Act 2002, the Governor-in-Council may declare a non-indigenous plant species to be a class 1, class 2 or class 3 pest. A class 1 pest is one that:

> (i) is not commonly present or established in Queensland; and
>
> (ii) has the potential to cause an adverse economic, environmental or social impact in the State, another State or a part of the State or another State;

Examples of class 1 pest plants include gorse, honey locust, mesquites and sensitive plant (*Mimosa pigra*).

A plant may be declared a class 2 or class 3 pest if it:

> (i) is established in Queensland; and
>
> (ii) is causing, or has the potential to cause, an adverse economic, environmental or social impact in the State, another State or a part of the State or another State.

The difference between a class 2 and a class 3 pest depends on the significance of the plant's impact or potential impact; the area affected or likely to be affected; and the extent to which the plant has spread or is likely to spread.

Examples of class 2 pest plants in Queensland include:

- Thunbergia vines
- Giant rat's-tail grass
- Prickly pear
- Parthenium weed
- Cabomba
- Water lettuce.

Examples of class 3 pest plants in Queensland include:

- Madeira vine
- Camphor laurel
- Asparagus fern
- African tulip tree
- Lantana
- Singapore daisy.

The *Land Protection (Pest and Stock Route Management) Act* 2002 prohibits the driving or transporting of a vehicle, or anything by road, that is known, or should be known, to be contaminated with a declared weed, unless reasonable steps are taken prevent its escape.

For example, it would be reasonable for a farmer to cover a load of hay that is known or likely to be contaminated with giant rat's tail grass. In road construction work, a 'reasonable step' might include hosing off mud known to contain seeds of a weed species before transferring the vehicle to another job.

As discussed earlier in this section, a declared plants plan may be included as an annexure to the site environment management plan.

More information about laws relating to vegetation management in Queensland is available from the Department of Natural Resources and Mines website: www.nrm.qld.gov.au

Scenery and Landscape

A road should fit in with the landscape. Where possible, provision is made in the design to achieve this, but there are many details which must be taken care of during construction.

For example, when roadmaking material is won from borrow pits within the road reservation, the pits should be reshaped and revegetated after use. (Techniques for the treatment of shallow borrow pits are discussed later in this section).

General Notes on Conservation Requirements

Construction supervisors should ensure that:

- All construction is finished in a neat and tidy manner.
- Construction operations are planned such that any unsightly residual prisms of earth or rock on the downhill side of small cuttings are removed, and that the batters at the beginning and end of cuttings are flattened and rounded.
- Re-establishment of natural vegetation is encouraged (see later in this section).
- The construction does not create erosion problems (this means compliance with all erosion control measures specified in the contract).
- Irrespective of the methods employed in clearing, vegetation adjacent to the formation is preserved.

Revegetation Requirements

General Notes on Revegetation

Revegetating of disturbed areas is a necessary requirement for the conservation of the environment and the prevention of erosion.

The shapes of batters and the characteristics of many soils laid bare by roadworks are not conductive to the natural re-establishment of vegetation. Natural regeneration processes are therefore often assisted by mechanical and horticultural methods.

Acceleration of revegetation around roadworks requires a knowledge of both engineering and horticultural practices. All plants are living organisms, and for healthy growth they require the right conditions of temperature, light, moisture, and soil nutrients.

Condition of Soil for Revegetation

Soils that contain the necessary chemical elements for healthy plant growth and have a suitable pore structure will allow efficient revegetation. The spaces between the soil particles are especially important, as they ensure the correct balance of water and air and permit penetration by young food-collecting roots (i.e. the lateral and hair roots).

The most desirable soil texture includes appropriate numbers of large and small pores. The large pores permit infiltration of water and air, resulting in good drainage and aeration. The small pores (and the surfaces of the soil particles themselves) retain water.

The ratio of air to water in the pores determines, in part, the suitability of a soil for good plant growth.

The objective of accelerated revegetation is to achieve healthy, strong plant growth. Providing an appropriate soil texture is very important. The following facts should therefore be remembered:

- Clay soils have very few large pores. In clay, the movement of water and air is slow and root penetration is restricted. Compaction of the clay will further reduce the number and size of pores.
- Sandy soils have larger and more uniform pore spaces. As a result, these soils do not retain water for very long.
- The incorporation of organic material into clay soils and sandy soils improves the distribution of the various pore sizes.
- The most suitable (and most readily available) soil for revegetation is the top layer of the existing surface— the topsoil. This contains the organic matter necessary for plant life, as well as the seeds and roots of the vegetation growing on the site.

Topsoil can vary in thickness from 15 mm to 25 mm (e.g. in sand dune country) to around 150 mm (on old alluvial flats). The limit (in depth) of the topsoil layer can usually be determined as an abrupt change in the colour of the soil.

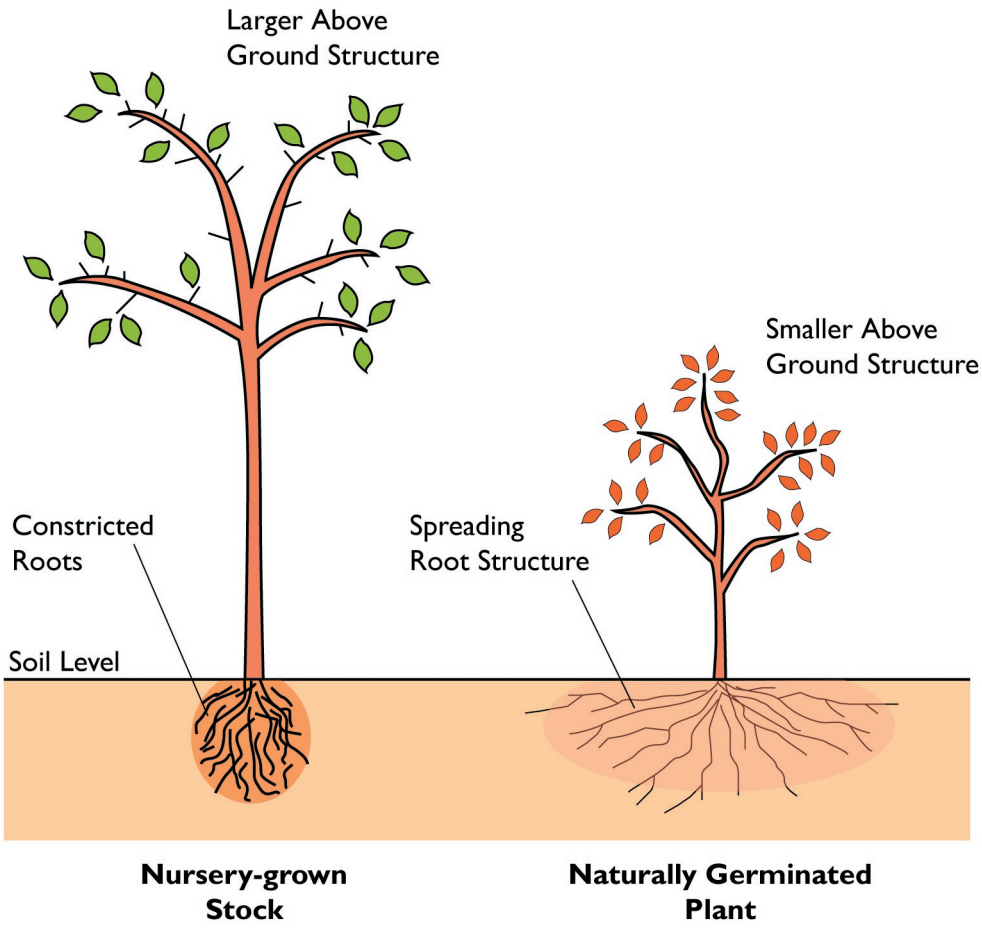
The thinner the topsoil layer, the greater the care required in clearing and stockpiling operations to minimise loss and/or contamination of the topsoil.

Moisture Conditions for Revegetation

Availability of water is the most important factor limiting the growth of plants. All the physiological and chemical processes of plant growth depend on absorption of water.

Water is absorbed mainly through the hair-root system, so it is very important that a wide, spreading root system is developed early in the plant's life.

There is a difference in plant structure between plants grown from seeds germinated naturally, and those germinated and grown as nursery stock. Seeds of species native to an area establish a deep root system before large stem and leaf structure is developed, while nursery stock tends to have a confined root system with large vegetative top.



Dissolved soil minerals and foods manufactured by the leaves of the plant move in solution through the plant. Water absorbed from the soil is eventually lost to the atmosphere by transpiration through pores in the surfaces of the leaves.

If a plant is not to wilt, it must absorb water through the roots as fast as it is used and transpired through the leaves. Plants will recover from temporary wilting as balancing moisture again becomes available from the soil.

Many plant species have a mechanism for reducing water loss at times of water shortage.

Not all the water entering the ground is available to the plant. A percentage of the water drains away through the large pores in the soil. However, if this excess water is not drained away, it will prove injurious to most plants (i.e. except those that are naturally tolerant of waterlogging).

Capillary water is held in the small pores of the soil. This is the water which is available for use by plants. The maximum amount of capillary water which can be retained by a particular soil is termed its field capacity or maximum storage capacity.

Plant growth is best if the amount of capillary water is maintained within the range of 50 to 100% of field capacity.

The table gives a list of physical tests that may be used to assess the available water in various soil types. However, it is important to realise that the table allows estimation of the percentage of field capacity, but not the actual quantity of water in the soil.

Percentage of available water in soil	**SOIL TYPE**		
	Sandy and sandy loams	*Loams*	*Clay and clay loams*
Above field capacity	Free water appears on surface when a ball of soil is bounced in the hand or squeezed.	Free water can be squeezed out.	Soil is very sticky and sloppy.
Field capacity (100% of available water)	No free water when squeezed but a ball leaves a wet outline on hand.	Soil sticky. No free water when a ball is squeezed, but wet outline on hand. Possible to roll long, thin rods of about 2 mm dia. between the finger and thumb.	As for loams.
75 - 100% of field capacity	Slightly cohesive. Forms a weak ball under pressure but breaks easily.	Soil is cohesive and pliable. Won't form 2 mm dia. rods.	Soil is cohesive; ribbons out between fingers easily. Has slick feeling.
50-75% of field capacity	Appears to be dry; won't hold together.	Soil is cohesive and will form a ball under pressure.	Forms a ball and will just ribbon out between thumb and forefinger.
20 - 25% of field capacity	Appears to be dry; won't form a ball.	Forms a crumbly ball under pressure.	Will still form a ball; won't ribbon out.
Under 25% of field capacity	Soil is dry and loose and will flow through fingers.	Crumbly; won't form a ball. Small lumps will crumble to powder.	As for loams.

Throughout the period in which plants are becoming established, supervisors should ensure that capillary water in the soil around the plant roots does not fall below 50%, as indicated by the physical tests. Because of this, the times for watering and the quantity of water to be applied cannot be fixed by arbitrary methods simply based on availability of equipment and personnel.

An efficient programme of watering is therefore the most important operation in revegetation. Investigation and trials will be necessary to establish such a programme, which must be maintained until the plants have become well established.

Except in the initial stages of revegetation when special watering is undertaken to allow seeds to germinate and the plants to establish, the water for the plants comes from natural intermittent rainfall absorbed into the soil. This water reaches the plant by capillary action from below the surface. A natural underground water table is established by gravitation.

It is therefore obvious that most plants will show better growth, and hence better survival, on flatter slopes.

Under normal conditions it is difficult to achieve good results on slopes steeper than 1 in 3, as moisture retention is poor. On such slopes additional pre-treatment and shaping of the surface is necessary if satisfactory revegetation is to be obtained in a reasonable time.

Materials for Revegetation

Materials used for revegetation can be divided into two categories:

- Those obtained from the job site.
- Those 'imported' from other areas.

Materials Obtained from the Job Site

Topsoil, grass, grass roots, brush and other suitable material may be stripped from the site and stockpiled before earthworks begin on site.

Imported Materials

Imported materials may include:

- Topsoil from selected areas
- Seeds of selected plant species
- Live plants
- Grass sprigs and turf
- Erosion preventive mulches and soil stabilising agents
- Fertilisers
- Water.

Machinery is required for the incorporation of some of the above materials.

When using imported seeds and plants, seek the advice of qualified persons (i.e. those trained in agriculture, horticulture or forestry) regarding the selection of species and how and where they should be planted. Plants are living organisms and will germinate better when their particular requirements are met. Additional care may be needed to ensure their establishment under the prevailing conditions.

Procedures for Establishing Vegetation

Salvaging Natural Materials (Within the Limits of the Job)

It is best to use a method of clearing that ensures retention of light brush and topsoil.

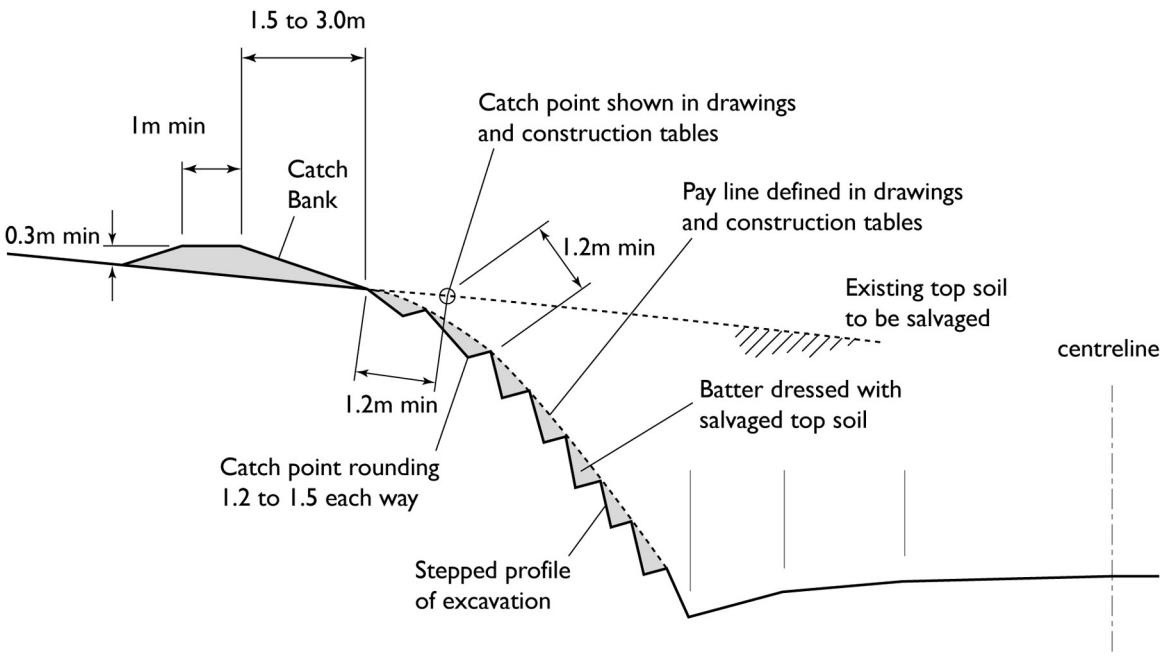
If possible, the topsoil should be windrowed outside the formation width; otherwise it should be removed to a stockpile. The stockpile must be positioned such that the material is readily accessible at a later stage.

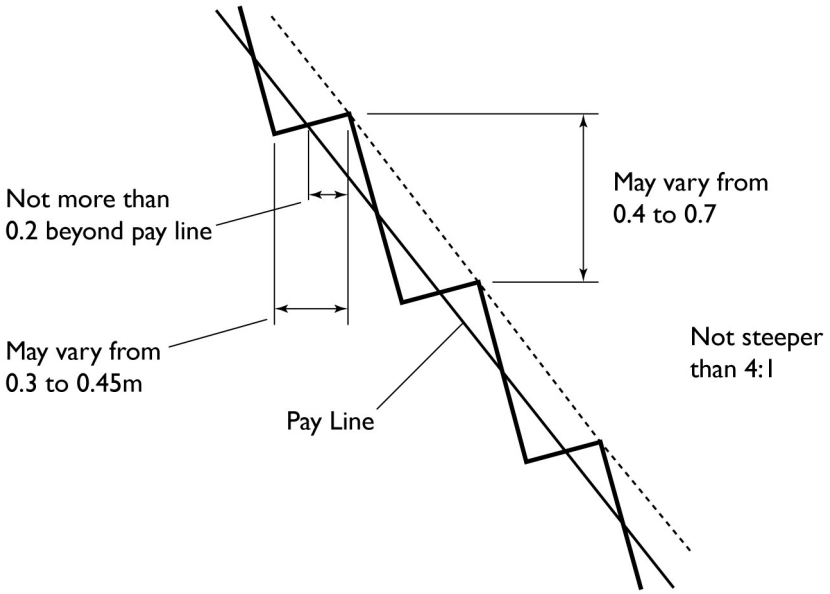
If clearing and salvaging of topsoil is undertaken with care, using good construction methods and suitable equipment, a depth of approximately 50 mm of topsoil may be all that is necessary to ensure adequate revegetation in disturbed areas.

Preparing Batters and Using Salvaged Materials on Cuttings

The batter slopes of most road cuttings are steeper than 1 on 3. Rock cuttings are usually 1 on 0.5. Revegetation should be undertaken on all cuttings other than full rock cuttings.

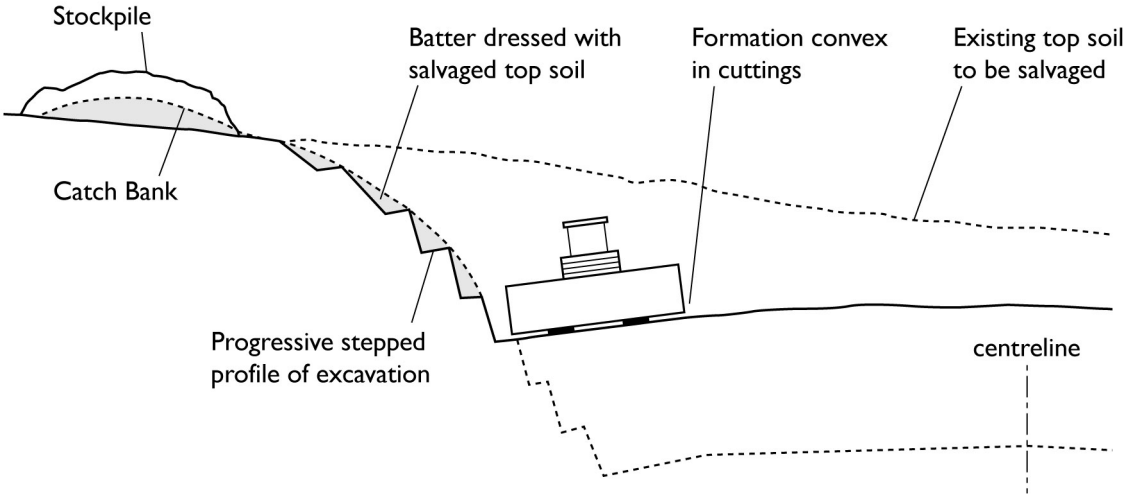
In order to obtain a dense coverage of vegetation on batter slopes of 1 on 3 or steeper, it is necessary to provide stable steps in the batter. This assists in retaining sufficient topsoil and moisture.





MRD Standard Drawing No. 1045 M

Carry out stepping progressively, as excavation proceeds. The usual (and generally the most economical) method is to cut each step (using a dozer) as a profiling operation at the toe of each stage of cutting, before excavating machinery moves in for the next stage.



Shaving of batters using a grader is both costly and unnecessary. There is no need to cut steps in outcrops of hard rock, as such outcrops may be left exposed.

Salvaged topsoil and natural mulch should be progressively spread down the batter as excavation proceeds (e.g. to each 2 m depth of cut). The early use of topsoil in this manner speeds up revegetation and provides protection against erosion of the step.

'Overloading' of the steps with topsoil beyond the profile, as shown above, is undesirable as surplus topsoil is subject to slumping when soaked. Surplus topsoil may be dressed off and spread longitudinally using heavy chains attached to dozers, loaders or graders working along the slope.

On large areas of cut with steep batters, it may be necessary to cut benches to provide stability and control surface water. Water from outside the formation must not be allowed to flow over the cut faces.

On batter slopes flatter than 1 on 3, the surface of the batter should be scarified and salvaged topsoil should be spread over the scarified surface. Depending on the quality of the topsoil, a 35–50mm depth should be sufficient for initial plant growth. If necessary, light rolling with a sheepsfoot roller will provide added protection against erosion.

Preparing Batters and Using Salvaged Materials on Fills

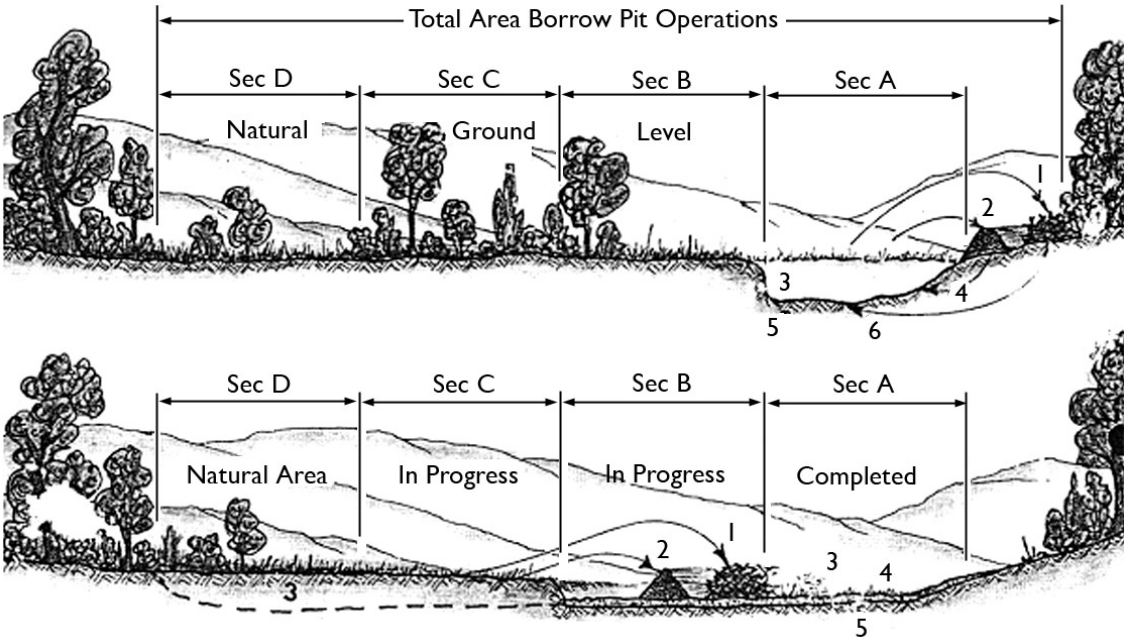
Batters of fills are easier to revegetate than batters of cuttings, as they are usually flatter and have a rougher surface profile (due to the methods of construction). Consequently, natural revegetation will generally occur earlier on fills because soil structure is more suitable and moisture retention is more favourable for plant growth.

Under normal conditions, the only pre-treatment necessary for fills is to leave the surface rough so that topsoil, when spread, will lodge in the small pockets. On steep fills, overloading with topsoil may result in surface slumps. On large fills, it may be necessary to provide berms to provide stability and surface water control. Temporary and/or permanent water diversion blocks may be necessary to direct water from the road formation onto more stable areas outside the fill.

Situations requiring more than the normal pre-treatment sometimes occur. These are discussed further on under the heading Use of Imported Materials.

Borrow Pits

Borrow pits should only be opened within the road reservation if such pits can be drained and reshaped to conform with, or improve on, the surrounding landform. All borrow pits should be revegetated. The drawing (below) shows a method of operating a shallow borrow pit.



The borrow operations are phased progressively from section A to section D, each section being developed as follows:

1. Remove existing vegetation and stockpile
2. Remove topsoil and stockpile
3. Remove borrow material
4. Return topsoil to floor of pit and spread evenly
5. Rip floor of pit along contour, mix in topsoil and water the area
6. Spread the salvaged vegetation evenly over the floor of the pit.

If borrow pits are located within a reservation and the reservation is also a stock route, the sides of the pits must be flattened (slope not to exceed 1 on 4). This step eliminates a potential hazard to stockmen, their horses and the stock.

Haul roads to borrow pits must be so located as to cause minimum erosion. As with other disturbed areas, they should be treated and revegetated.

Use of Imported Materials

In order to minimise problems of erosion and siltation, or because of a need to provide a public amenity, it may be necessary to obtain a cover of vegetation within a very short time, i.e. at a faster than natural rate. This will necessitate importation of other materials.

Topsoil

Topsoil is the most commonly imported material. Because of the large quantities that are often required, and the high cost of imported topsoil, great care must be taken to salvage the maximum available amount of topsoil from within the formation width.

Imported topsoil must have the necessary components for accelerated revegetation. The main points to be considered when deciding on a particular soil are:

Soil Factor	Soil Selection Criteria
Soil texture	Is the soil sandy, loamy, silty or clayey?
Soil structure	Is the soil cloddy, stony or friable? Does it contain organic matter produced from plant life? Does it exhibit a satisfactory pore structure?
pH value	Is the soil acid or alkaline?
Existing vegetation	Is the soil suitable as a natural cover? Does it contain any noxious weeds or unsuitable material?

Sprigging and Turfing

Sprigs of grass planted at regular intervals will eventually spread to cover an area. Turfs, however, provide a complete cover immediately.

Both methods are expensive and their use requires constant checking of the materials at their source, to ensure that undesirable plant species are not present. Care is needed in transportation and storage, because loss of moisture at an early period is detrimental to live root systems.

Additional surface treatment may be necessary to protect the plantings. For example, turfs on slopes may need to be securely pegged to the surface, and placed with joints staggered. Top-dressing of turfs is also necessary.

Sufficient watering must be carried out after planting to ensure that the soil in contact with the root systems retains sufficient moisture to balance transpiration. The amount of watering required is related to air temperature, relative humidity and air movements, but will generally vary from 20 to 30 ℓ/m^2 per week. Watering should be carried out daily (and at times, twice daily) for a period of several weeks after planting.

Seeding

Revegetation of disturbed areas is best accomplished by seeding with selected species of grasses or woody plants.

Seeds may be broadcast by hand, incorporated in surface mulches, or placed in the soil using agricultural machinery.

The seeds of most plant species employed in revegetation are small and require a light covering of earth or mulch to provide sufficient warmth and allow adequate retention of water for germination.

Vegetation planted or sown for the purpose of erosion control will only fulfil its purpose if it covers the area rapidly and establishes permanently. Plants that germinate rapidly and grow quickly are mainly annuals, and usually have a short life.

Consequently, where early cover is required, a mixture of seeds of an early crop and of a permanent crop should be used.

The selection of species should be made after consultation with local agriculturalists and horticulturalists. The rates of application will depend on the likely severity of the erosion and the agricultural procedures adopted.

The table shows typical application rates for various species of cover. These rates are provided for guidance only. Actual performance will vary, according to the conditions applicable to the site.

Selection of species and specific application rates must be decided upon at the time of construction, as some of the grasses shown in the table are for winter planting and others for summer planting.

Material	Rate	Remarks
White Panicum	28 kg /ha	Selection of species, fertilisers and stabilising agents is determined after consultations to determine those most suitable for planting at time of construction and under the prevailing conditions.
Oats	28 kg /ha	
Green couch	22-28 kg/ha	
Rhodes grass	2–6 kg/ha	
Molasses grass	0.5 kg/ha	
Siratro	11 kg/ha	
Native species (mixed)	3–7 kg/ha	
Fertiliser	500–750 kg/ha	
Lime	tonnes/ha	To be used only where soil is too acid for plant species.
Plastic emulsion dilution rate (in water)	300–1100 kg/ha 20:1 to 60:1	
Prepared wood fibre or wood pulp	250 kg/ha	Applied as a slurry.
Bitumen emulsion dilution rate (in water)	1:1	

Revegetation with Plants

The use of nursery-raised plants is normally restricted to the implementation of approved landscape designs. In this case, the species are carefully selected. For example, large trees may be employed to stabilise an embankment by reducing the sub-soil moisture in areas prone to slip failure or slumping.

Horticultural knowledge required to successfully establish live plants in roadside revegetation areas is beyond the scope of this course. The supervisor must therefore ensure that the specifications and instructions given regarding planting, and subsequent care of planted areas, are followed meticulously. If problems arise, advice should be sought from the person responsible for the preparation of the specification and instructions or, if necessary, from an experienced agriculturalist or horticulturalist.

Mulches and Soil Stabilising Agents

Mulches and soil stabilising agents are used to provide protection against surface erosion until vegetation becomes well established.

Mulches provide a surface covering of organic material. The cover breaks up the energy of raindrops, absorbs moisture, and reduces the speed of water runoff. The covering must be porous, allowing penetration of light and air. For this reason, heavy applications of dense mulching materials should be avoided.

Soil stabilising agents consists of a sprayed application of organic and/or inorganic material onto the ground surface. The agent strengthens the surface, enabling it to resist erosion.

Satisfactory mulching and soil stabilising materials include:

- Leaf mould and brush
- Sawdust and other vegetable fibres
- Prepared wood fibre and wood pulp*
- Porous plastic emulsions*
- Bituminous emulsions*

(* Typical application rates are given in the table).

Mulches and soil-stabilising agents may be applied by hand, or by mechanical means. The materials used must be free of any additives which may prove injurious to either germination or plant growth.

Fertilisers

Plants require a ready supply of nutrient elements, such as:

- carbon, hydrogen and oxygen (available from the air and water in the soil)
- nitrogen, phosphorous, sulphur, potassium, calcium and magnesium (available in varying quantities from the soil, or supplied as additives).

A further group of nutrient "trace elements" (e.g. iron, copper and manganese) are essential for good growth. These are either available from the soil or supplied as additives.

When nutrient elements are supplied as additives, they are called fertilisers. The elements are normally absorbed through the plant root system, provided sufficient available moisture is present. No fertilisers should be added to a soil unless additional water is also applied.

Fertilisers may be either organic or inorganic in origin. Nutrient elements can be supplied in varying proportions. The type of fertiliser needed will depend on the relative deficiency of particular elements in the soil.

Commercial fertilisers are rated on the percentage of nitrogen (N), phosphorous (P), and potassium (K) present. The ratios are clearly shown on the product labels. Fertilisers may be formulated with or without trace elements.

The manufacture of commercial fertilisers is based on the economics of supplying the necessary elements in the cheapest way. Use of the correct fertiliser will make available the nutrients which are deficient in a particular soil, without waste.

Before selecting a fertiliser, the particular deficiencies of the soil should be known. Where doubt exists, samples of the soil should be tested or advice should be sought from a qualified person.

Nearly all soils will respond to nitrogen fertilisers, provided sufficient water is made available to support added plant growth.

Most soils will benefit from the addition of phosphorous, provided the nitrogen content has been built up.

Some soils will require the addition of potassium. The addition of other elements will depend on known deficiencies.

Fertilisers, used properly, are essential in any accelerated revegetation program. Use of quantities in excess of the recommended rates is dangerous, and will result in 'plant burn'. Light but more frequent applications of fertiliser are desirable.

Importance of Obtaining Reliable Advice

Because of climatic variations, failures in revegetation work must be expected, just as crop failures occur from time to time even on the best-run agricultural properties.

To minimise such failures, advice must be sought from agriculturalists and horticulturalists experienced in the growing and care of plants. However, caution must be exercised in accepting advice.

The person from whom advice is sought should have expertise in:

- establishing plants under harsh conditions, such as those usually associated with roadside revegetation
- knowledge of plant species naturally suited to the district in which revegetation will take place.

Section 4 – Assessment Activities

For information on how these assessment activities may be used as part of the learning process, see the section on 'Assessment' in the 'Topic Descriptor' section at the front of this topic.

Theory Questions

The following questions allow you to assess your progress in understanding the material presented in Section 4. The questions may be of any of the following types:

- multiple choice (identify correct answer or answers)
- multiple choice (identify incorrect answer or answers)
- fill in the gaps in a sentence or statement
- identify a sentence or statement as TRUE or FALSE
- write a few sentences or a short paragraph.

Answers to the question are shown in the separate 'Answer' section.

Question 1

The Environmental Management Plan (EMP) has a section headed Specific Management Requirements that includes statements about the company's response to each type of environmental issue identified on site. List five typical environmental issues that could arise.

_____

_____

_____

_____

_____

Question 2

Complete the following statement:

Subsequent to any departure from agreed and approved environmental procedure, the contractor's quality representative will complete a _____ _____ _____ and supply it to the Superintendent's representative.

Question 3

Explain the meaning of the following acronyms:

EPA _____

ESCP _____

EMP _____

CAR _____

Question 4

List six natural resources that are most likely to be used or interfered with during road construction.

_____

_____

_____

_____

_____

_____

Question 5

Describe three methods for protecting waterways during road construction.

_____

_____

_____

_____

_____

_____

Question 6

Complete the following sentences:

If there is a possibility of disturbing aboriginal relics during earthworks, it may be necessary to employ a _____ _____. Any discoveries constitute a hold point, and work must be _____ until protection of the relic can be arranged.

Question 7

Give the definition of a plant that may be classed as a class 2 or class 3 pest in Queensland.

(i) _____

(ii) _____

_____

_____

Question 8

When a cutting is made, stepping is often carried out to allow vegetation to establish on the bank. Explain how stepped banks are prepared for revegetation.

_____

_____

_____

Question 9

Plants rely on water collected by capillary action from their root systems. The amount of water that is available to the roots depends on the soil's field capacity. What is the desirable range of soil field capacities?

_____

Practical Exercises

Practical Exercise 1

Ask your supervisor if you can obtain a copy of the environmental plan for the project you are working on. Does it include provisions for any of the following?

- Control of erosion and sedimentation
- Protection of native fauna
- Air quality
- Hazardous substances
- Water quality
- Vegetation
- Waste management
- Noise/vibration.

Practical Exercise 2

Do any of the following specific environmental issues exist on the construction site you are working on? What steps are being taken to protect particular areas or features?

- Historic places
- Land marks
- Cultural heritage
- Roadside remnant vegetation.

Practical Exercise 3

Can you identify any plants that might be declared pests under the legislation applicable to the construction site you are working on? Can you recommend any measures that would help to prevent them from spreading away from the site?

Practical Exercise 4

Using the tests shown on page 25 of the topic learning material, identify the main soil types present on the construction site. How did you identify them? What is the approximate moisture content of each?

Practical Exercise 5

What procedures are being used on site for re-establishment of vegetation? What differences are there in the methods being used to re-vegetate cuts and fills?