

Environmental Management Standard

Maintenance and construction of access tracks

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ENVIRONMENTAL MANAGEMENT STANDARD

HSE STRATEGY & SYSTEMS

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EMS 0006 MAINTENANCE AND CONSTRUCTION OF ACCESS TRACKS

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1.0 PURPOSE

To define the standard by which all access tracks used to service Endeavour Energy's electrical assets are to be constructed and maintained. This standard was developed in accordance with all relevant environmental legislation and is designed to meet the safe, operational requirements of the network.

2.0 SCOPE

This standard applies to the maintenance and construction of Endeavour Energy access tracks within the Endeavour Energy network area.

3.0 REFERENCES

Internal

Board Policy (Environment) 4.0 – Environment
Company Policy (Network) 9.2.5 – Network Asset Design
Company Procedure (Environment) GPE 0004 – Pesticide use
Company Procedure (Health & Safety) GSY1065 – Asbestos Management
Branch Form (Asset Standards & Design) FAT 0045 – Access Track Plan
Environmental Management Standard EMS 0001 – Environmental impact assessment and environmental management plans
Environmental Management Standard EMS 0004 – Managing Vegetation Near Electrical Infrastructure and Pest, Weed and Disease Mitigation
Environmental Management Standard EMS 0007- Waste Management
Environmental Management Standard EMS 0008 – Environmental incident response and management
Environmental Management Standard EMS 0012 - Notification of access to National Parks and Water NSW special and controlled areas
Environmental Management Standard EMS 0013 – Spoil management
Environmental Management Standard EMS 0014 – De-watering worksites
Environmental Management Standard EMS 0016 – Industrial and Construction Noise
Mains Design Instruction MDI 0044 – Easements Property Tenure
Mains Maintenance Instruction MMI 0012 – Overhead transmission line routine inspection
Mains Maintenance Instruction MMI 0013 – Vegetation Clearance Management
Environmental Compliance Obligations Register
Environmental Guidelines Handbook

External

Biosecurity Act 2015 (NSW)
Biodiversity Conservation Act 2016 (NSW)
Electricity Supply Act 1995 (NSW)
Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act)
Fisheries Management Act 1994 (NSW)
Heritage Act 1977 (NSW)
Local Land Services Act 2013 (NSW)
National Parks and Wildlife Act 1974 (NSW)
Pesticides Act 1999 (NSW)
Protection of the Environment Operations Act 1997 (NSW)
Rural Fires Act 1997 (NSW)
Environment Protection and Biodiversity Conservation Act 1999 (Cth)
Work Health and Safety Act 2011 (NSW)
ENA National Electricity Network Safety Code (ENA Doc 001-2008)

State Environmental Planning Policy (Infrastructure) 2007
State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017
State Environmental Planning Policy (Coastal Management) 2018 (NSW)
Sydney Water publication - *Track Stabilisation and Erosion Control Guidelines 1997*, (Wallis, R. Sydney Catchment Authority)
Managing Urban Stormwater: Soils & Construction (4th edition, Landcom, 2004) – referred to as Blue Book

4.0 DEFINITIONS AND ABBREVIATIONS

ASP

Accredited Service Provider for the purposes of undertaking contestable works.

Batter

Face of an embankment or cutting, produced as a result of earthmoving operations involving cutting and filling.

Batter drop-down

Constructed and stabilised drain to carry runoff down the track batters, typically down the line of greatest slope.

Batter stabilisation

Provision of adequate vegetative, structural, or mechanical measures to control erosion from access track batters. Measures include provision of catch drains, topsoiling, seeding or mulching, hydromulching, or use of geofabrics.

Blue Book

Managing Urban Stormwater: Soils & Construction (4th edition, Landcom, 2004)

Catchment area

Area determined by topographic features where falling rain will contribute to runoff at a particular point.

Causeway

Natural or constructed crossing that enables vehicles to ford a watercourse, drainage line or drainage depression.

Contractor

Any person or organisation that contracts to carry out work for Endeavour Energy.

Critical habitat

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities as declared identified under the *Biodiversity Conservation Act 2016* or the *Fisheries Management Act 1994*.

Cross bank

Mound of earth constructed across a track so that runoff is diverted from it. Cross banks are designed to handle larger flows than cross drains.

Cross drains

Drains of various forms that baulk the flow of water down a track and divert it across the track surface. The capacity of the drain is defined by its cross-section. Cross drains are designed to handle smaller flows than cross banks, but larger flows than can be controlled by crossfall drainage.

Crowning

Shaping of an access track formation so that water drains to both sides of the road.

Culvert

A pipe or similar structure used to direct water under the track.

Earth windrow

A ridge of soil that may build up along the edge of tracks during their construction and maintenance. This may prove useful in directing runoff to a stable outlet, in which case it is called a windrow drain. However, in other circumstances, it may prevent runoff leaving the track, causing erosion.

EIA

Environmental impact assessment. This may take the form of a Summary Environmental Report (SER), Review of Environmental Factors (REF) or Environmental Impact Statement (EIS) in accordance with EMS 0001 - Environmental impact assessment and environmental management plans.

Emergency works

As defined in accordance with the Infrastructure SEPP to be due to:

- a sudden natural event, including a storm, flood, tree fall, bush fire, land slip or coastal inundation; or
- accident, equipment failure or structural collapse; or
- damage caused by vandalism or arson.

EP&A Act

Environmental Planning and Assessment Act 1979 (NSW)

Erosion

The wearing away of the land by running water, rainfall, wind, ice or geological agents.

Exempt Development

As referred to in Clause 43 of the Infrastructure SEPP. Clause 20 of the Infrastructure SEPP specifies that to qualify as Exempt Development, the development must be carried out by or on behalf of a public authority (Exempt Development does not apply for activities carried out by ASPs and a SER at minimum must be submitted for activities involving access track improvements/construction) and 'must be carried out in accordance with all relevant requirements of the Blue Book, and must involve no more than minimal impact on the environment or amenity of the surrounding area, and must involve no more than minimal impact on the heritage significance of the item or area.' Exempt Development must not be carried out in a declared critical habitat of an endangered species, population or ecological community or in an identified wilderness area.

Fill

Previously excavated material that is used to raise (fill) the surface of an area to a specified level. This material must meet the requirements specified in EMS 0013 – Spoil Management.

Flume

Structures that can convey water from one level to another without causing erosion. In many instances, it is necessary to install flumes to protect batters or to assist the transfer of access track runoff away from erodible areas. All flumes consist of an inlet, a chute and an outlet

GIS

Geographic Information System

Gravel

A naturally occurring mixture of coarse mineral particles larger than sand and smaller than 75mm diameter. Gravel is placed on the surface of an access track to increase the load bearing capacity of poorer soils, allowing use by vehicles in wet weather.

Infall drainage

Drainage method for a section of access track located on steep side-slope terrain where the whole surface width is in-sloped against the natural surface side-slope. Infall drainage sheds rain water to the high terrain side of the access track. See also **crossfall drainage** and **outfall drainage**.

Infrastructure SEPP

State Environmental Planning Policy (Infrastructure) 2007

Maintenance Works

Comprises works that are exempt from an EIA. These works include those defined under Clause 43 of the Infrastructure SEPP and are on prescribed access tracks. Maintenance works are cyclic in nature and must be undertaken within a period of no greater than three years and/or within a timeframe determined by Endeavour Energy's Major Contracts branch.

Mitre drain

Drain used to conduct runoff water from the shoulders of an access track to a disposal area away from the access track alignment. The purpose of a mitre drain is to:

- spread concentrated water flow in a table drain to a low velocity flow across a vegetated natural surface, away from the access track formation; and
- relieve the flow in table drains before water volume and velocity becomes high enough for erosion to occur.

NPWS

National Parks and Wildlife Service

Outfall drainage

Drainage method for a section of access track located in steep side slope terrain where the whole surface width is sloped out in the same direction as the natural surface side slope. Outfall drainage sheds runoff to the low terrain side of the access track. See also **crossfall drainage** and **outfall drainage**.

Prescribed access track

An access track that has been mapped on Endeavour Energy's GIS mapping system and/or included as an access track asset in the Corporate Data system (Ellipse) and/or is covered by an existing EIA prepared by the Program Maintenance branch.

Relevant Environmental Personnel

The Relevant Environmental Personnel depends on the scope of the access track works and environmental risk identification in accordance with EMS 0001 - Environmental impact assessment and environmental management plans.

Sediment

Particles of soil material that have been transported by weathering action, and which can be deposited in drainage features, causing sedimentation.

Slope

Defined as a percentage, and is calculated using the following formula $\text{Slope} = (\text{rise} \div \text{run}) \times 100$

Swamp

Vegetated low lying area subject to waterlogging. Usually carries a distinctive vegetation type.

Table drain

Drain constructed along the side of an access track between the shoulder and a cut batter. It collects and drains water runoff away from the access track surface, and intercepts runoff water from cut batters that might otherwise flow onto the access track surface.

Toe

Bottom intersection line of two slope planes, for example, the toe of a fill is the perceived line around the intersection of a fill batter and the natural ground surface.

Watercourse

Channel, having a distinct bed or banks, down which surface water flows on a permanent or semi-permanent basis or, at least, for a substantial time under natural conditions after periods of heavy rain within its catchment.

Windrow

A mound of soil that is run off the end of a bulldozer or grader blade

5.0 ACTIONS

5.1 Environmental assessment requirements

The requirement for planning approval and the complexity of EIA documentation depends on the location and type of access track works in accordance with Company Environmental Management Standard EMS 0001 – Environmental impact assessment and environmental management plans as set out in the following sections.

5.1.1 Access track work not requiring an EIA

Emergency works

Emergency access track works that are carried out to maintain or restore electricity supply or to retain public safety or to protect buildings or the environment may be carried out without consent or any EIA under Part 5 of the EP&A Act. Any damage caused to property as a result of the emergency works is to be made good without delay. All works must be completed in accordance with the Blue Book and not have more than a minimal impact on the environment or any local or State heritage item. Damage to access tracks within Water NSW Special and Controlled Areas and/or National Parks Estate must be reported to the relevant authority as soon as reasonably practicable in accordance with EMS 0012.

Maintenance works

The following types of access track work are considered maintenance and do not require an EIA:

- Exempt Development in accordance with the Infrastructure SEPP – maintenance of existing access tracks in easements or rights of way, or on land subject to section 53 of the [Electricity Supply Act 1995](#).
- Prescribed access tracks – maintenance of existing access tracks that have been mapped on Endeavour Energy's **Environmental** GIS mapping system and/or included as an access track asset in the Corporate Data system (Ellipse) and/or is covered by an existing EIA.

- Access track maintenance within National Parks, Reserves and Water NSW Special Areas as defined in EMS 0012 – Notification of access to National Parks and Water NSW special and controlled areas. Includes minor activities including grading a track surface and maintaining drainage structures following appropriate notification to NPWS and/or Water NSW as stipulated in this standard.

All of these works shall be carried out following the environmental risk mitigation measures contained within Annexure 1 – Generic Environmental Management Plan for access tracks.

When undertaking emergency and maintenance works on access tracks, Endeavour Energy employees and contractors will review GIS information pertaining to environmental aspects (e.g. threatened species, aboriginal heritage) relevant to the access track. In the case of access track contractors, Endeavour Energy's Major Contracts branch will source this information from HSE Strategy and Systems at scheduled intervals and receive a screenshot from the contractor as an assurance measure that it has been appropriately uploaded. Endeavour Energy employees will seek advice from the relevant Environmental Business Partner and incorporate mitigation measures into their Work Hazard and Risk Assessment (WHRA). Contractors will seek advice from the relevant environmental specialist in the Major Contracts branch. **This information must be made available to workers for reference in the field.**

5.1.2 Access track works requiring an EIA and approvals

The following types of access track work require an EIA in accordance with EMS 0001 – Environmental impact assessment and environmental management plans:

- Works that involve constructing new access roads or tracks, significant upgrades to track structures and or additional track sections.
- Access track works with the potential to impact on:
 - o **State Environmental Planning Policy (Coastal Management) 2018 (NSW) – coastal wetlands and littoral rainforests.**
 - o Critical habitat for an endangered species, population or ecological community within a wilderness area.
 - o **Marine vegetation that is outside of approvals sought by Endeavour Energy.**
 - o Local or state heritage items.
- Construction and/or vegetation clearing within lands categorised as Regulated Land under the [Native Vegetation Regulatory map](#) (typically rural areas of the Endeavour Energy network area).
- Within National Parks or Water NSW Special Areas and Controlled Lands that are not defined as maintenance and/or inspection in EMS 0012 – Notification of access to National Parks and Water NSW special and controlled areas
- That requires substantial vegetation removal outside of previously cleared or disturbed areas, inclusive of the removal of low growing groundcover.

The EMP produced from the EIA will contain specific mitigation measures for environmental aspects relevant to the activity.

Access track works associated with the construction and/or upgrade of network assets may be incorporated into the EIA in accordance with EMS 0001 – Environmental impact assessment and environmental management plans.

It should be noted that access track maintenance or construction identified by an ASP as part of a contestable works project, will not be project managed by Endeavour Energy. Access track maintenance and construction requirements must be included in the SER Application and the identified environmental aspects must be appropriately mitigated for design certification purposes. An appropriately qualified person should be engaged to manage the project. Network Connections should seek advice from the relevant Environmental Business Partner to ascertain environmental aspects relevant to access track construction is adequately mitigated in the SER's EMP.

5.2 Access track construction and maintenance

The scope of works and the level of resources allocated to building or maintaining access tracks will depend largely on the importance of the asset that the track is servicing, the condition of the surface substrate and surrounding vegetation, and the gradient of the slope the track is traversing.

As a general rule, Endeavour Energy access tracks should be built to allow safe all weather access for 4-wheel drive vehicles.

The information in Table 1 and Annexure 2 – Access Track Design Considerations provides guidance on the access track formation for constructing new, or maintaining existing access tracks. However, the formation may be required to comply with set specifications determined through stakeholder consultation.

Table 1: Access track maintenance and construction guidelines

Track feature	Specification
Access track width	Four metres
Vegetation clearance width at edge	0 metres
Surface drainage works	Suitable for 4WD patrol vehicles
Passing bay	Where existing topography and vegetation permits
Turning circle or reversing bay	Eight metre diameter sufficient for 4WD patrol vehicles
Sediment and erosion control	Sufficient to prevent the migration off-site of sediment from the works area during construction and for a period of three months after construction
Fords, culverts & bridges	Constructed to support 30T vehicle and 15T axel weight for structures that support only one axle at any given time (i.e. pipe culvert)
Materials	Certified Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM) in accordance with EMS 0013 – Spoil Management and as determined by stakeholder consultation

5.3 Securing rights of access to electrical assets

Where possible, access tracks shall be located within Endeavour Energy easements to formalise access arrangements into the future.

Where access tracks must traverse outside of easements, consideration should be given to securing access by way of a land tenure agreements and or other legal instruments such as 'right of ways' where; access options to assets is limited, significant investment has been outlaid to upgrade and or construct an access or where there is future development planned for an area that may affect or obstruct access routes.

The appropriate land tenure agreement and or legal instrument should be discussed with Endeavour Energy's Property and Fleet branch.

5.4 Access track inspections and defect reporting

Access tracks need regular inspections so that they remain usable at all times and permit continuous access to Endeavour Energy's assets. The inspection and identification of access track defects is to be undertaken where possible in conjunction with MMI 0012 – Overhead transmission line routine inspection, and the vegetation management cycle.

In addition to the requirements MMI 0012 – Overhead transmission line routine inspection, all Endeavour Energy employees and contractors engaged by the Major Contracts Branch are responsible for reporting access track defects as they are identified. Where the initiating Endeavour Energy employee or contractor is unable to report the defect directly into the company system an Access Track Plan (Branch Form FAT 0045 – Access Track Plan) is to be prepared and submitted to the Program Maintenance Branch to be included in corporate systems.

Access track defects associated with the delivery of a contestable works project by an ASP shall be managed by Network Connections to enable conformance with this standard.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Safety, Human Resources & Environment has the authority and responsibility for approving this Standard.

Manager HSE Strategy and Systems has the authority and responsibility for administering this Standard.

Manager Major Contracts is responsible for the prioritisation of access tracks works and the development of programs for the construction and maintenance of access tracks.

Manager Network Connections has the authority and responsibility for allocating resources for the inspection of contestable works projects and monitoring conformance with this standard by ASPs.

Environmental Specialist – Access Tracks has the authority and responsibility for:

- the process of gathering and storing corporate access track information; and,
- managing the maintenance program of prescribed access tracks and the construction of access tracks that are captured within the access track program.

Endeavour Energy Environmental Business Partners have the responsibility for providing advice to Endeavour Energy employees in relation to the undertaking of emergency works on access tracks.

Endeavour Energy employees and contractors engaged by the Major Contracts branch have the authority and responsibility for reporting access track defects in accordance with this standard.

Endeavour Energy employees and ASPs involved in the maintenance and construction of access tracks have the responsibility for complying with this standard.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Manager HSE Strategy & Systems

Documentation Distribution Coordinator : Standards Process Coordinator

Annexure 1: Generic Environmental Management Plan for Access Track Works

Generic Environmental Management Plan

**For all access track maintenance and construction works carried out on
Endeavour Energy's network**

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1.0 INTRODUCTION

The following generic Environmental Management Plan (EMP) deals with all works associated with the maintenance and construction of access tracks carried out on Endeavour Energy's Network. This standard EMP must be adhered to for all access track works. All access track works must also be carried out in accordance with EMS 0006, and where necessary, an Environmental Impact Assessment (EIA) in the form of a SER or REF should be carried out prior to works commencing and approved by an appropriate delegated authority. The EIA may determine that specific mitigative measures may need to be in place to minimise any impact on the surrounding environment as a result of the activity. These mitigative measures must be used in conjunction with this standard environmental management plan and Environmental Guidelines Handbook to incorporate additional protection measures.

2.0 PURPOSE OF THE DOCUMENT

This EMP identifies the practical measures and actions that will be in place to reduce or eliminate potential adverse environmental impacts during maintenance and construction of access tracks. This document also addresses the environmental management for the activity in the event of non-conformance or for an accident or emergency situation.

For all other non-access track related works, refer to the EMP generated from the SER Application for activities requiring an EIA or the Endeavour Energy Environmental Guidelines Handbook. Reference should be made to EMS 0001 – Environmental impact assessment and environmental management plans to determine EIA requirements.

3.0 ENVIRONMENTAL MANAGEMENT PLAN

The following section documents the mitigative measures to be undertaken as part of the activity in order to minimise any detrimental impact on the surrounding environment.

3.1 Traffic and access

- Access track works are not to be carried out under any circumstances when the ground has been saturated by recent precipitation. Access track works must not occur in Water NSW Special and Controlled Areas during Catchment Closures (as advised by email from Water NSW). The typical trigger for catchment closures is 10 mm of rainfall in a 24 hour period.
- Pooled or ponded water located along the access track must be discharged in a controlled manner prior to works commencing using sediment and erosion techniques described below.

3.2 Visual impact

- Where materials are being imported into sensitive areas such as National Parks and/or WaterNSW Special and Controlled Areas care should be taken where possible and practical to choose locally sourced materials that match the surface of the existing track system. The material must be certified Virgin Excavated Natural Material.
- Where works are required to clear an entry point off a public road, where possible care should be taken to provide a visual screen using the surrounding vegetation so as to hide the presence of an access track, thereby discouraging the use of the track by recreational 4WD vehicles.

3.3 Water quality and soil erosion and sedimentation

3.3.1 Planning the job

- All access track works are to be designed to minimise the extent and degree of disturbance to both the ground surface and vegetation.
- All access tracks are to be designed and maintained in accordance with standard width and height specifications detailed in EMS 0006.
- All access tracks should incorporate surface drainage techniques in accordance with EMS 0006.
- Wherever possible works around natural stream or flow lines should be avoided.
- An erosion and sediment control plan must be prepared and implemented where required.
- For larger works spanning several days the programming of construction stages is required. Stages should include the early installation of drainage outlets and inlet protection works, progressive revegetation works where necessary, and progressive stabilisation of batters.
- Passing bays should be planned at regular intervals where existing vegetation and topography permits.

3.3.2 Site preparation/management

- All access track works that are within 40m of natural streams or flow lines must have sediment fencing or equivalent in place protecting the water course prior to the access track works commencing. Sediment controls must be removed when the area subject to disturbance has stabilised and no further erosion risk exists.
- Access track drainage channels (for example, mitre drains and cross banks) should not be constructed within 10m of a natural stream or watercourse.
- Where access track drainage channels are within 10 to 40m from a natural stream or water course, the flow path should be channelled through vegetated buffer zones where possible and protected with sediment fencing.
- Where works are greater than 40m from a natural stream or flow line sediment fencing is not required unless otherwise specified.

3.4 Work practices

3.4.1 General

- Practicing good housekeeping is expected on all access track construction sites.
- Any long-term stockpiles should be placed on a flat, grassed area and be covered to prevent dust generation and erosion. Stockpiles should not be placed within 40m of a natural stream or water course.
- All sediment fencing should be installed in accordance with EMS 0006.

- Any rehabilitation works shall be regularly maintained. Where works are found faulty, damaged or deficient, they should be promptly rectified.
- A spill kit appropriate to contain the largest volume of oil present (i.e. hydraulic oil, machine oil) is to be available on site at all times.

3.4.2 *Vegetation clearing*

- Where native vegetation has been cut it should be mulched to a maximum depth of 100mm and spread evenly over the access track surface to provide a seed base and minimise erosion and scouring.
- All cut noxious weeds are to be removed from the site without being mulched. These need to be disposed of to an EPA licensed waste facility.
- Low growing groundcover must not be removed unless approval has been received to do so.

3.4.3 *Pests, weeds and diseases*

- Refer to EMS 0004 – Managing Vegetation Near Electrical Infrastructure and Pest, Weed and Disease Mitigation for practices to avoid the spread of pests, weeds and diseases that may result from the maintenance and construction of access tracks.
- The hygiene protocol within EMS 0004 – Managing Vegetation Near Electrical Infrastructure and Pest, Weed and Disease Mitigation shall be used in areas of known pest, weed and disease infestation to prevent their spread to adjoining areas and to maintain the 'come clean and go clean' practices in accordance with the Biosecurity Act 2015 (NSW). These areas shall be identified in the EIA and through appropriate stakeholder management.

3.4.4 *Surface grading*

- Sediment and other materials located on footpaths, gutters or roadways will be swept on a daily basis or as required to prevent sediment being washed into nearby drains and watercourses. No sediment will be washed from the roadway into the stormwater system.
- All erosion and sediment controls will be maintained and inspected on a regular basis and immediately after rain events. All sediment controls should be maintained as necessary until the site is stable. Once the project site has been stabilised, temporary sediment controls will be removed.

3.4.5 *Importing fill*

- Imported fill should be of a hard, durable material unless otherwise specified.
- Imported fill should be locally sourced wherever possible.
- Imported fill should be certified VENM (Virgin excavated natural material) and weed free.

3.4.6 *Constructing hard surfaces*

- Care should be taken to minimise the disturbance to areas adjacent to the hard track surface.
- Truck washouts should be carried out in a designated area along the access track which is thoroughly protected with sediment fencing. Care should be taken to prevent excessive

moisture from accumulating in the washout area, and if necessary the washout area can be moved to a dry location.

3.4.7 *Fords and fill crossings*

- All works should be carried out during periods where water flow is minimal.
- Where possible natural stream flows should be diverted around the construction area, and restored to their original path when construction is complete.
- If diversion is not possible, low profile sediment control measures should be installed downstream within the creek bed to arrest any siltation that is mobilised during construction. At the completion of the project the sediment control measures should be removed and any deposited sediment disposed of at an EPA licensed waste facility.
- The area immediately adjacent to entrances to the crossing should be protected with sediment fencing during construction, and rehabilitated after construction.
- All stream crossings should be designed in accordance with the Department of Primary Industries requirements. Consultation with this authority must be undertaken in these cases as additional permits and approvals may need to be sought before the commencement of the activity.

3.5 Noise

- Construction noise will generally be within normal working hours, and will be controlled by the specifications set out in EMS 0016 – Industrial and Construction Noise Thus, work will be generally carried out during the following hours:
 1. Monday to Friday: 7.00 am to 6.00pm
 2. Saturdays: 8.00am to 1.00pm
- No work is planned to be carried out during Sundays or public holidays, or outside the above hours unless these works are scheduled to minimise inconvenience to customers.
- Every effort will be taken to minimise noise impacts.
- Those likely to be affected by excessive noise (for example, generator noise, excavation machinery and the like) will be notified prior to any work commencing.
- If the work is to be undertaken outside the times specified above, those likely to be affected by noise will be notified of the times between which the work will be carried out and the reasons why it is to be undertaken outside EPA guidelines.

3.6 Flora and fauna

- No endemic vegetation is to be removed or damaged as a result of this activity unless it has been identified as requiring removal during the EIA or in the case of Exempt Development under the Infrastructure SEPP 2007 is part of the scope of works. Vegetation removal that requires approval from an authority other than Endeavour Energy will not proceed until documented approval has been obtained. Relevant checks of GIS data will be made to determine if there are environmental aspects that require mitigation before commencing works in this case to demonstrate appropriate due diligence.

- All due care will be taken when working or accessing the site when in the vicinity of any vegetation in the locality.

3.7 Safety, hazards, and traffic management

- The work site will be cleared and made safe upon completion of works on a daily basis.
- All equipment and materials will be stored in a tidy manner, and in a way that does not impinge upon vehicular or pedestrian access ways.

3.8 Heritage and archaeology

- Any known or suspected items of significance identified during the EIA or otherwise known to exist in the vicinity of the activity are not to be damaged and all due care is to be taken when working in the vicinity of such items. Approval from OEHL may be required before the commencement of works.
- During the course of any construction activities, if any material of European heritage or artefacts or burial remains likely to be of Aboriginal heritage, are sighted or unearthed, work will immediately cease, the relevant Environmental Business Partner will be contacted and the relevant department of OEHL (e.g. National Parks and Wildlife Service) will be notified.

3.9 Waste handling and disposal

- All wastes generated on site will be collected and re-used or recycled where possible or disposed of in an appropriate manner at an EPA licensed facility.
- All native vegetation mulch will be spread out over the access track unless otherwise specified in any site specific mitigation measures or environmental approvals.
- All noxious weed cuttings will be removed from site without being mulched or slashed and disposed of at an EPA licensed waste facility.
- All wastes will be managed in accordance with EMS 0007- Waste Management.
- Liquid handling will be in accordance with EMS 0007- Waste Management.
- All asbestos-containing waste will be kept wet, wrapped in plastic or otherwise sealed and removed from the site as soon as practicable, using covered bins or on a covered truck.
- All asbestos-containing waste will be disposed of in accordance with GSY 1065- Asbestos Management by utilising appropriately licensed contractors and EPA licensed disposal facility.

3.10 Community consultation

- It may be necessary to notify and negotiate with other stakeholders, affected landholders or customers that may be affected by the works before the commencement of construction. If an EIA has been performed for the activity, this construction notification will supplement mandatory notifications required during the assessment stage. The activity should be outlined to them and it may also be necessary to arrange mutually agreeable outcomes or actions to minimise any disruption impact on such persons. An example of a negotiated outcome may be organizing the hours or days of work to minimise disruptions to a customer, or negotiating for allowances for access across private land, and the like.

3.11 Air quality and dust suppression

- All vehicles and machinery are to be properly serviced and maintained to confirm that they do not cause undue air pollution.

- Dust will be controlled on site if necessary by using acceptable dust suppression techniques. These include the dampening down of the site, minimising the disturbance to ground cover and retaining, where possible, existing trees and shrubs to act as windbreaks.
- All vehicles transporting fill to and from a construction site shall be covered so as to prevent the emission of dust and other particles.

4.0 MONITORING OF IMPACTS

The foreman, project manager or superintendent in charge of the works will be responsible for the implementation and monitoring of environmental safeguards during the work. These safeguards include, but are not limited to items listed in the EMP above.

The foreman, project manager or superintendent in charge of the works is also responsible for ensuring that all employees, contractors and sub-contractors working on the project are briefed about the objectives and contents of this EMP. Each person carrying out works must be made aware of their personal responsibilities and reporting requirements. All persons carrying out works have the personal responsibility to act in accordance with this EMP and any other official written or verbal instructions, and must diligently and responsibly carry out all works assigned to them.

5.0 ACCIDENTS AND EMERGENCIES

All accidents and emergencies must be reported to relevant internal and external workers, as per standard Endeavour Energy procedures. The foreman, project manager, or superintendent in charge of this activity must contact the relevant Environmental Business Partner of Endeavour Energy and appropriate mitigative actions will then be determined to minimise any actual or potential damage to the surrounding environment. All environmental incidents shall be managed and reported in accordance with EMS 0008 – Environmental Incident Response and Management.

6.0 NON CONFORMANCES

Any non-conformances to the mitigative measures outlined in this EMP, or other written and verbal instructions given to contractors or sub-contractors will be rectified at the cost of the contractor, or sub-contractor to a level satisfactory to all parties. Such non-conformances will be reported to the relevant Environmental Business Partner and are considered an incident in accordance with EMS 0008 – Environmental Incident Response and Management.

7.0 APPROVAL

This document sets out the practical actions that will be in place to minimise the potential impact of the activity on the surrounding environment. All information contained in this document is to the best of my knowledge true and correct and does not by its presentation or omission of information materially mislead. All measures outlined in this document will be diligently implemented and any non-conformances will be promptly rectified. Accordingly, this EMP is hereby approved as an accurate, true and fair summary of the mitigative measures that will be in place.

NAME:.....

TITLE:.....

COMPANY:.....

DATE:.....

CONTACT ADDRESS:.....

TELEPHONE NUMBER:.....

Note: An amended EMP will require this page to be completed and the entire document must be forwarded, along with the EIA as part of the design certification process.

Annexure 2: Access Track Design Considerations

1. Causes of access track failure

The vast majority of access track failures can be directly attributed to one or more of the following causes:

- Inadequate or poorly constructed track surface drainage.
- Inadequate maintenance frequencies.
- Dispersive soils or geology.
- Poorly located access tracks.

2. Preventing access track failure

Some causes of track failure can be difficult to avoid especially local geology or track location. However, steps can be taken to confirm that the causes of track failure are mitigated as much as possible.

a) *Adequate surface drainage*

Good drainage is one of the most important features to be designed into an access track. The prompt removal of water from the surface will help avoid many problems related to access track construction and maintenance. This can include a multitude of drainage options, all of which are covered in detail in this Annexure.

b) *Adequate maintenance frequencies*

Access tracks need regular maintenance to allow continuous access to Endeavour Energy's core business assets. Regular maintenance can also avoid expensive track-reconstruction works that would otherwise be needed should the track be neglected.

Inadequate maintenance leads to excessive vegetation encroachment into the track, as well as track surface deterioration – both of which ultimately render the track unusable.

Drainage structures that fail because of poor maintenance have a cumulative effect down slope, often causing other drainage structures to fail, leading to track surface rilling and table drain erosion.

It is more efficient in terms of cost and time to provide adequate maintenance to existing access track drainage structures than ultimately having to reform the entire section of track because of failures.

Suitable maintenance frequencies will vary for each track, however, the following steps can be taken so that access tracks are adequately maintained:

- Inspection of all access tracks in accordance with MMI 0012 - Overhead transmission line routine inspection.
- Prompt reporting of access track defects.
- Prompt action to fix track defects.

c) *Properly locating access tracks*

An important planning consideration is the placement of the access tracks. The following principles should be followed, as far as practicable, in locating new access tracks. New tracks should be located:

- To minimise the length of track construction required.
- Where access track grades can be minimised.
- On ridges, or as high as possible on slopes to:
 - allow track drainage water to escape;
 - reduce the catchment area above the tracks; and,
 - reduce the number of drainage line crossings and associated drainage line disturbance.
- To avoid steep cross slopes.
- Away from filter strips, other drainage protection areas or riparian buffers except at watercourse and drainage line crossings.

New track locations should avoid:

- Areas where construction would expose highly dispersible soils where alternative access track locations are available.
- Swamps, soaks or other areas of poor or restricted drainage.
- Areas prone to mass movement from subsoils and bedrock.

3. Road formation

Three techniques can be used to minimise surface erosion outside intrusive in-access track structures, particularly on access tracks that are on a low grade:

- a. Crowning - the centre of the access track should be 150-300mm above the surface of the table drain of track edge (see **Figure 1**).
- b. Outfall drainage - grading the access track surface so that it slopes downwards across the access track away from the toe of the cut batter to the shoulder of the fill. On stable fill batters, any earth windrow that may have developed along the down slope side of the track should be removed so the water releases in a dispersed flow over the batter. If the fill batter is not stable, a windrow of soil can be retained to divert surface flows to a safe discharge point (see **Figure 2**).
- c. Infall drainage - directs the flows across the access track surface towards the cut batter. When using this technique it is essential to provide table drains and adequate culverts or concrete causeways to transfer the water over the fill batter. Failure to provide sufficient drainage will cause the table drain to erode and has the potential to make the access track untrafficable (see **Figure 3: Infall drainage**)

Figure 1: Crowning

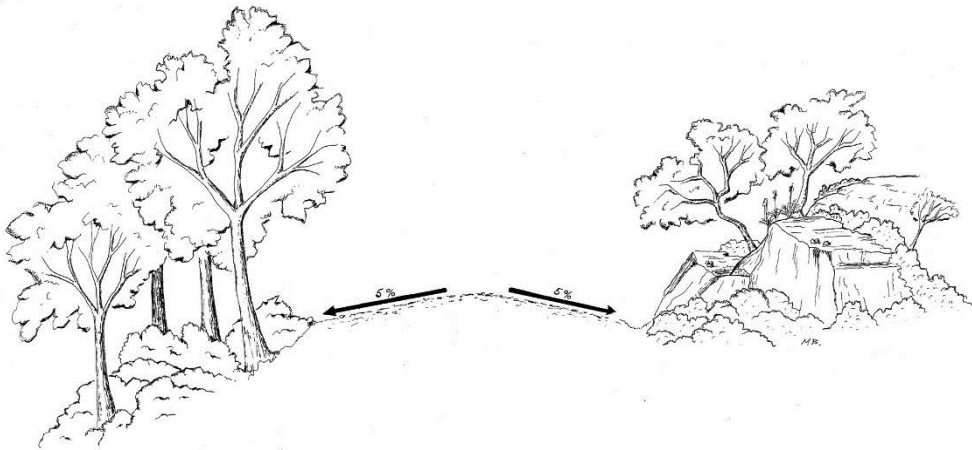


Figure 2: Outfall drainage

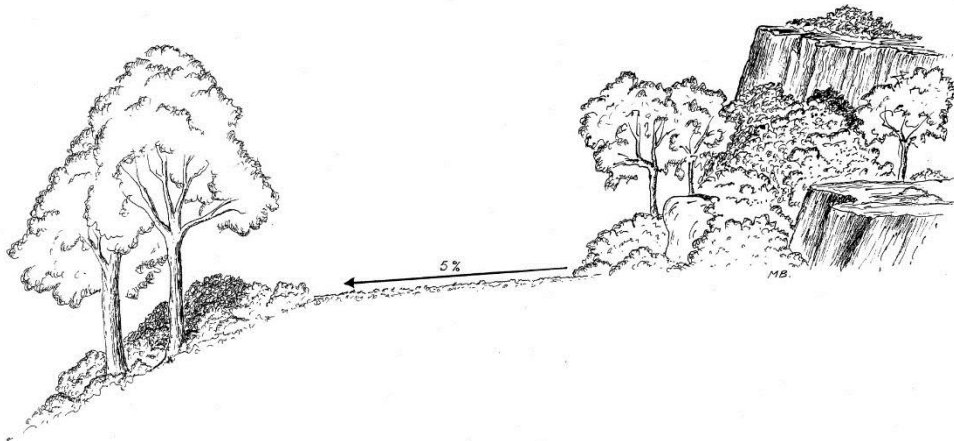
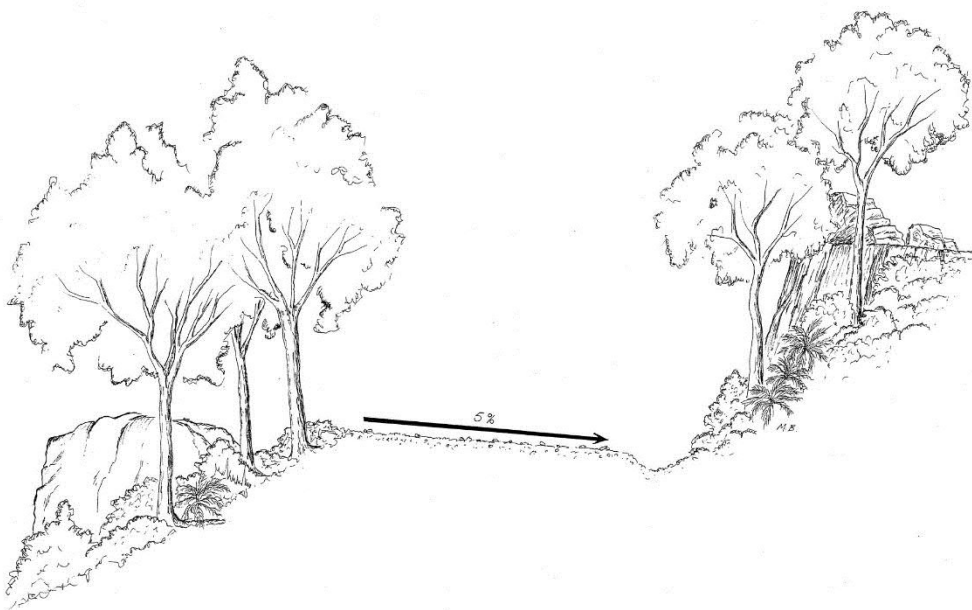


Figure 3: Infall drainage



4. Drainage structures

a) Cross banks

The frequency of access track drainage structures, such as cross banks and mitre drains, should be determined by the following calculation:

$$300 \div \text{slope}\%$$

For example, a 20% slope would be $300 \div 20 = 15$; therefore a bank or mitre drain would be required every 15 metres.

Cross banks are earthen banks built onto the access track surface, usually constructed of the natural road base material, but clean imported material can be used if the natural material is not available or of an unacceptable standard.

Cross banks are designed to collect access track run-off at strategic points and divert the cumulative flow across the surface of the access track to a safe discharge site (see **Figure 4: Cross bank**).

Well-constructed and positioned banks can provide a low maintenance, cost efficient means of draining unsealed access tracks.

The location and frequency of banks needs to be determined in the field. When assessing an existing access track, take note of where the track surface has begun to degrade, such as surface rilling or erosion in the table drain. These points indicate where the run-off has developed enough energy to cause erosion and are key locations for cross banks.

On both new and existing access tracks, care must be given to the location of discharge points for the drains. The discharge site must be stable and clear of obstructions that may force the water back onto the track.

Once a suitable site has been chosen for the construction of the bank, rip the track to a depth of 20cm - 30cm for several metres back from the site. This loose material can then be pushed up to form the bank. The material used for bank construction should be free of sticks and logs which, as they decay, can contribute to bank failure.

The bank should be formed from the uphill batter to the outside of the track, making sure that the cross bank is flush with the cut batter. It is preferred that a long shallow excavation for the material is achieved rather than a short deep excavation. This will allow run-off to collect and be diverted, while also allowing easy traversing by vehicles.

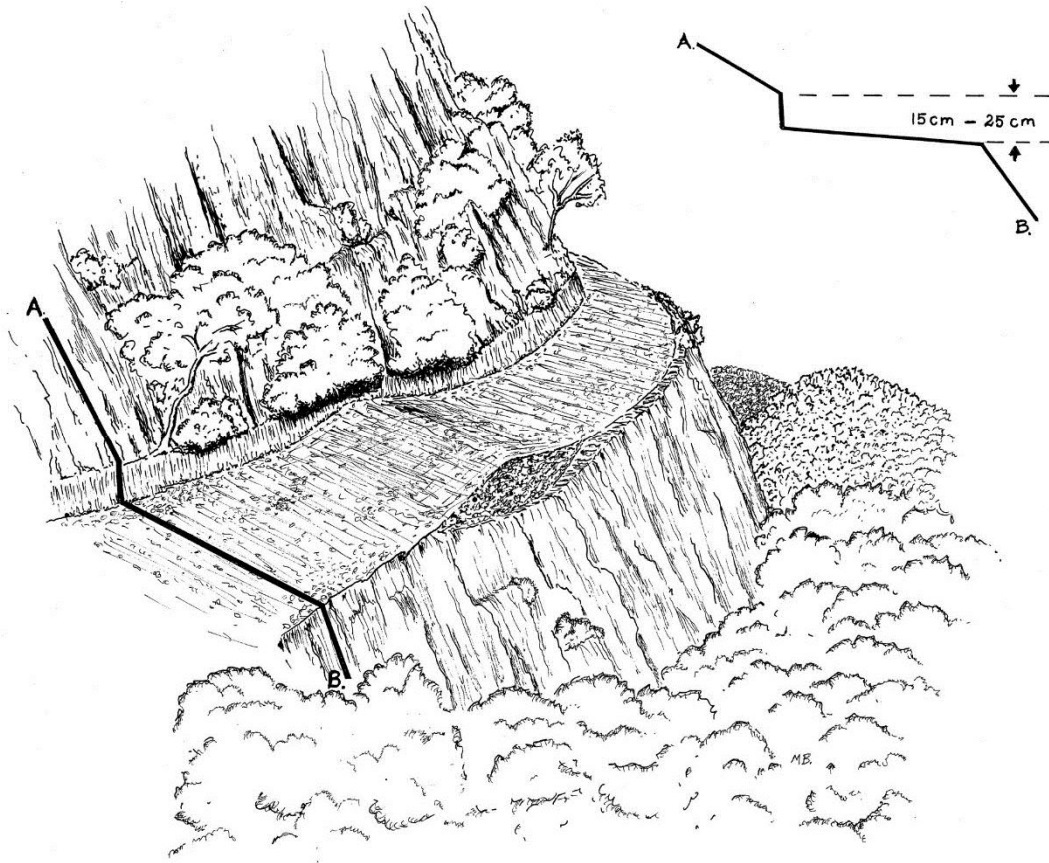
The bank requires a slight angle to allow the water to be diverted freely off the track and to prevent ponding behind the bank (ponding may cause the bank to breach). The bank should be regularly compacted by the machine during construction.

Any loose earth or other material that may restrict the water flow off the track should be removed from the excavation. The bank can be up to 0.6m from the base of the excavation to the top of the crest with a crest width of up to 2m - 3m, which will allow easy traversing by vehicles.

Maintenance: Some common problems that may arise with cross banks are the development of depressions in the crest caused by vehicles continually crossing at the same point, or the vehicle towbar gouging a channel through the bank crest. These depressions provide low points for water to overtop the bank, which will progressively lead to bank failure.

Motorbikes, poor compaction, regular wet weather use and ponding can all lead to bank failure. The bank must merge well with the cut batter or water will by-pass the bank. Similarly, the outlet must be clear of debris to prevent water returning to the track.

Figure 4: Cross bank



b) Cross drains

Cross drains are excavated, dished drains in the access track surface (see **Figure 5: Cross drain**).

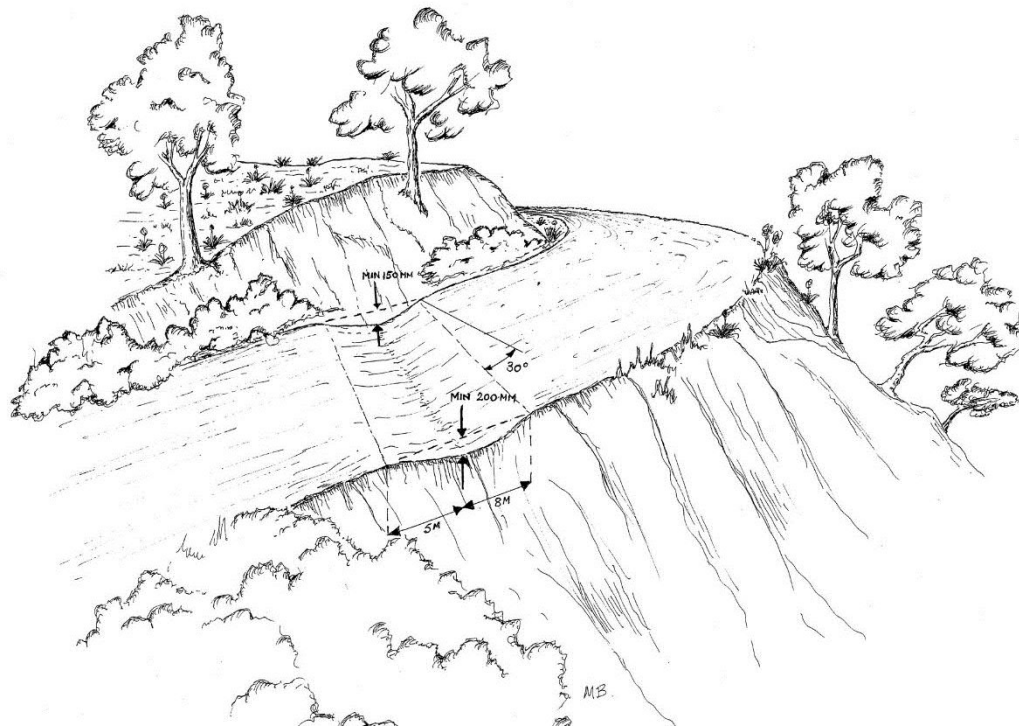
The drains can be rough to travel through and are generally used only on minor roads and tracks. By extending the dimensions during construction, cross drains can be easily traversed by most vehicles.

Cross drains do not have the same water carrying capacity as cross banks, with a greater likelihood of overtopping occurring on steep slopes. Cross drains should be used only on grades less than 10%.

Construction of cross drains is inexpensive and quick. The drain should be angled at 30° to the right angle to provide a free draining gradient, and excavated to a minimum of 150mm at the toe of the cut batter to 200mm at the track shoulder. The drain must allow the free flow of water across the track. A long shallow excavation of 8m above the drain, and a shorter 5m exit from the drain, will allow for easy traversing by vehicles. Excavated material can be distributed to a depth of 75mm or more on the track surface below the cross drain to increase its capacity.

Maintenance: Generally, maintenance on cross drains is low with perhaps some periodic desilting, however ensuring that the cross drain is constructed with at least a 30° angle largely eliminates this. When conducting maintenance checks, inspect the discharge site for developing erosion and the cross drain for an accumulation of silt and evidence of overtopping.

Figure 5: Cross drain



c) *Rolling grades*

On many minor access tracks, the surface is generally level, with no crowning. By rolling the grade, that is, installing a series of gently undulating dips, along the track grade, the water can be effectively transferred off the track (see **Figure 6: Rolling grade**).

Figure 6: Rolling grade, this technique is generally used on minor access tracks and would be suitable for reasonably steep grades. Often, the topography of the terrain, such as natural undulations and drainage lines, can assist in installing rolled grades.

The technique requires depressions to be excavated along the length of the track, resulting in an undulating surface. It is important that within each of the depressions that water will flow freely to the discharge site by installing the depression on an adverse grade, and that the floor of the dip is angled at 30° to the right angle.

Maintenance: Limited to periodic inspections for erosion on the depression floor and at the discharge site. The potential for rilling of the track surface is reduced because of the minimised catchment for each depression.

Figure 6: Rolling grade



d) Table drains

A table drain runs parallel and adjacent to the track, and is constructed as part of the track formation.

To guard against scouring of the table drain bed, sufficient water disposal points, such as mitre drains, are required.

When possible, the table drain should have a cross sectional base in the shape of a U, preferably 1.0m - 2.0m wide at the base. This assists in reducing flow velocities and erosion. Often, the table drain can be stabilised by armouring with rock, grasses or native vegetation.

Maintenance: The table drain should be inspected for evidence of erosion. If erosion is occurring, the site may require additional water disposal points or it may be that existing disposal points have failed. It is important that during maintenance activities the drainage structures are kept open and are not adversely affected by track maintenance works.

e) Mitre drains

Mitre drains are simple, low cost drainage options suitable for most types of access tracks, particularly when used in combination with other techniques, such as cross banks and cross drains. The mitre drain diverts water away from the table drain at strategic points and discharges the flow into the trackside vegetation (see **Figure 7**).

Mitre drains do not cause any impediment to vehicles or track speed. A combination of track crowning and mitre drains provides adequate drainage on ridge tracks, however, they can be used intermittently with other in-track structures to enable track stability on steeper slopes. The drain is cut from the table drain, on a slight angle to the track into the trackside vegetation. The length of the drain is best determined on-site as this can vary depending on the location of an appropriate outlet point.

It is essential that the discharge site is positioned so water does not re-enter the track by way of another drainage line.

The drain should be constructed to a depth of no more than 300mm. It is not necessary to have a deep excavated channel as the run-off should flow freely into the drain and is directed only into trackside vegetation.

During construction it is a common fault to observe mitre drains bypassed by table drain flows. To enable the run-off to enter the mitre drain from the table drain it may be necessary to dish the mitre drain entrance to encourage water flow, or to construct an earthen headwall to direct flows.

Mitre drains are often V-shaped in cross section; however, where a drain is required to carry larger flows, a flat floored design will be more stable and have a greater capacity. Construction can be completed using a grader, bulldozer, front end loader or back hoe. Equipment used will depend on its availability and its capacity to minimise disturbance to the surrounding environment.

Maintenance: Occasionally, mitre drains may require desilting. Failure to undertake this maintenance will cause water to overtop the drain and return to the track or to bypass the drain altogether. Drains that have been constructed correctly will tend to flush sediment clear of the channel in a high rainfall event.

Water bypassing mitre drains has the potential to cause table drain erosion, and increases the likelihood of failure in the next drainage structure.

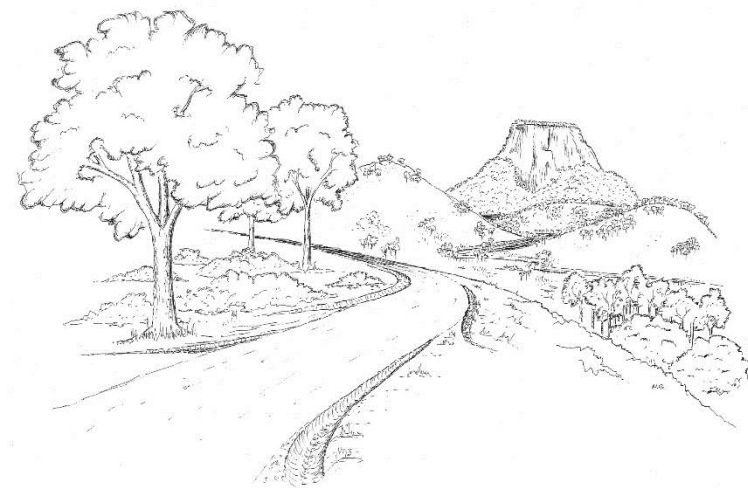
It is a common observation on access tracks that receive regular surface maintenance that often the track is lower than the inlet of the mitre drains. This is caused by the continual removal of track material during maintenance, deepening the track.

It is essential after any track surface maintenance that all mitre drains are reopened (deepened if necessary) and cleared of any windrowed soil.

Attention to detail will prevent table drain and track surface erosion by allowing the water to enter the drains and be dispersed. Windrowed material can be returned to the surface of the track.

When conducting maintenance checks, the table drain and mitre drains should be inspected for erosion. Where this occurs, it may be necessary to install further mitre drains or where this is not possible, to reinforce existing drains using rock or geotextiles.

Figure 7: Mitre drain



5. Batters

A batter is the face of an embankment or cutting, produced as a result of earthmoving operations involving cutting or filling. A cut batter is the face that is exposed as a result of the removal of material, while a fill batter is the face created by the deposition of fill.

Large areas exposed during cut and fill operations present a particular erosion problem. Rainfall impact on the batter slope, erosion of the batter toe and run-off over unconsolidated fill material, can all contribute to an erosion problem and compromise the integrity of the works.

When constructing batters, consult the following table for an indication of the maximum batter slopes according to soil type or rock stability.

To improve batter stability, several factors should be incorporated into the design. Initially the batter should not exceed the maximum permissible slope. Some batters, especially where they exceed 1.5m in height on erodible soils, may require special drainage works.

Soil type:	Slope (Horizontal : vertical)
Rocks - slip plane horizontal or dipping away from cutting	0.5 : 1
Rocks - slip plane dipping toward cutting	1.5 : 1
Well graded gravels	1 : 1
Poorly graded gravels	1.5 : 1
Clayey or silty gravels	2 : 1
Silts and fine sands	2.5 : 1

Diversion banks and/or cut-off drains are often necessary above the batter to prevent water cascading over the excavation, while chutes can be used to transfer water down the slope over the batter if alternative natural discharge sites are not available. Long term stabilisation can be achieved by revegetating the batter. In any works, revegetation is best achieved by using the top soil that occurs on site. Revegetation attempts should be initiated progressively through the development, but as a minimum, immediately after construction. The tilth created by the earthworks often provides a receptive seed bed for the revegetation species.

Depending on the quality and persistence of the vegetation established, some drainage structures may be required only temporarily. Permanent drainage should be provided at the toe of cut batters and at the top of fill batters. Energy dissipators are required at the end of chutes and culverts.

Terraced batters should be considered on slopes greater than 3H : 1V and where the vertical height exceeds 5m. Each terrace should be a minimum of 2m in width placed at every 5m of vertical height, sloped inwards, and have a longitudinal grade to provide adequate drainage. In some instances, near vertical batters may be necessary, particularly when cutting through rock or firmly consolidated subsoils. In these instances a wider horizontal area is required between the toe of the batter and the track. Occasionally, barriers may have to be erected to restrict slumped material from entering drainage structures and to act as retaining walls on smaller batters.

If the appropriate drainage is installed and the batter is adequately revegetated, the site should remain stable in the long term. Maintenance activities around batters should avoid compromising the integrity of existing drainage structures, such as diversion banks, table drains and chutes. If the existing drainage has failed, or is damaged as a result of maintenance activities, immediate remedial works are required.

Maintenance: Occasionally, batters will slump and deposit a quantity of soil to the base of the batter. Where this does not interfere with the track drainage, the material should be left where it is; removing the material may cause further slumping and the ongoing instability of the batter. Maintenance of the track surface and drains should not affect the toe of the batter. Often the toe is removed and/or undercut by regular grading, which causes batter instability and slumping. Continued slumping of batters and erosion of the batter surface should be investigated to determine its cause. Extra drainage or revegetation may be required to rectify the problem.

6. Flumes

Flumes are structures that can convey water from one level to another without causing erosion. In many instances it is necessary to install flumes to protect batters or to assist the transfer of track runoff away from erodible areas. All flumes consist of an inlet, a chute and an outlet.

Chutes carry the water down the slope and can be constructed using round or semi-circular pipes of galvanised steel, concrete, fibreglass, or PVC, or can be formed using timber, rock, cement, geotextiles, jute mesh and bitumen, or with the use of vegetation.

The inlet should be designed so that all intended flows are directed to that point. Diversion banks, box inlets or headwalls (or a combination of these) can achieve this. It is essential that water does not escape around the inlet structure as this could cause the structure to fail and will affect the stability of the batter while increasing the erosion potential of the site. A batter may require more than one flume to successfully transfer the water; however, this will depend on the batter size, catchment size and the size of the structure.

Flumes can also be used to carry water over unconsolidated fill batters. At the outlet of any flume it is important to install an energy dissipator to slow water velocity and prevent scouring at the disposal point.

After the batters have stabilised through revegetation, it may be desirable, from a maintenance perspective, to remove the diversion structures and flumes to allow the water to flow as dispersed run-off over the length of the batter.

Flumes can be crucial in containing headward gully erosion. Depending on a number of variables, such as catchment size, soils and gully depth, the chute may be in the form of pipes, rock, concrete or vegetation. Gully head control structures are often complex in their design which can incorporate drainage of sub-surface seepage, diversion banks and often standing wave designs. Advice should be sought when considering these types of structures.

7. Culverts

Culverts can be purchased in a wide range of materials, including concrete, iron or PVC. The advantages of culverts are their capacity to carry water away from a table drain or a drainage line under the track whilst not affecting the trafficability of the track surface or restricting the type of vehicle that can use the track.

Culverts are regularly used on tracks that require all weather use and access by all types of vehicles and are often seen on dirt tracks in forested areas. Higher class access tracks are often sealed and have concrete lined or rock armoured table drains. This is not the case in most minor tracks and, consequently, it is a common sight to see culverts blocked by sediment and forest debris. The failure of a culvert to successfully transfer table drain flows produces a greater water load onto the track surface or the following structure down slope which, in turn, may fail as a consequence. There is often an erosive impact on the table drain and track surface when this occurs.

As the potential for culverts to block is always apparent, especially in forested areas, any new access track construction, upgrades or extensive maintenance should avoid the installation of new culverts. Culverts are expensive to purchase and labour intensive to install and maintain free of blockages. It would be better to use some of the other options outlined in this document, when possible.

Culverts are most effective when installed with a headwall and/or box inlet. Box inlets and headwalls direct water into the pipe, while allowing water to weir, forcing the pipe to run at its greatest capacity. When the pipe is flowing at its full capacity, the pipe becomes self-scouring, clearing itself of sediment and debris. Culverts installed on trackside drainage should always have a headwall and/or box inlet. Both box inlets and headwalls are available in pre-cast forms.

The culvert size for track drainage should be based on the catchment area of the drain. However, as a general rule, in forested areas, culverts should have a minimum diameter of 450mm to prevent the risk of blockage by forest litter.

The trench must be excavated to a depth that, when backfilled, will cover the pipe sufficiently to avoid impacts from periodic track maintenance. When the trench has been excavated to the desired depth, the bedding material is laid along the trench floor. This material should have a high permeability, high stability when wet and be free of organic matter. It is essential that the pipe is well seated along its entire length to avoid any movement that may result in pipe failure.

Any pipe joins should be well butted together and sealed with an approved sealant. Pipe bedding material can be used to backfill around the pipe, to a depth of half the pipe's diameter. Further backfilling, using previously excavated material, should be completed in layers with regular compaction.

Roadside culverts should be orientated down slope on a slight angle or excavated and laid on an adverse grade so that water flows freely through the pipe. The outlet of the culvert should be at natural surface when possible. If necessary, drop structures, energy dissipators and/or flow dispersers may be required to prevent erosion occurring at the outlet point.

Culverts at drainage lines and watercourses should be installed directly in the line of the flow and the water should enter and discharge at the natural surface level to prevent erosion.

The use of half pipes, which effectively straddle the stream bed, allow water to flow over the natural surface of the drainage line and does not restrict the movement of aquatic animals. Pipe blockages and leaks should be noted when conducting maintenance inspections. Attention should also be given to signs of overflows, erosion at the inlet or outlet of the culvert, or undermining of the pipe structure.

8. Log and earth fill crossings

Log and earth fill crossings are often used to cross some streams and drainage lines. The technique involves the placement of logs into the channel until the desired height has been obtained. The structure is frequently covered with earth to provide a more trafficable surface. Low flows can pass through the structure without difficulty; however, in high flows the structure can impede the water flow and act as a weir with flows eventually cascading over the structure. The overflow and turbulence created by the logs in the drainage line can often cause scouring of the channel and banks as well as the loss of the crossing's surfacing material. With the onset of erosion, the structure can become unstable and unsafe for crossing while contributing sediment to the system.

Log and earth fill crossings can also act as physical barriers and restrict the movement of aquatic and terrestrial animals along the drainage line.

Whilst these structures exist throughout the Endeavour Energy franchise area, no further construction should take place during new access track construction or maintenance activities. As existing log and earth fill crossings fail, they should be removed and replaced by alternative, lower impact options.

9. Fords

Constructed fords provide a stable track surface across watercourses but often require importation of rock, either locally or from another source, or use of concrete. Generally, the upstream side of the ford will merge to the natural surface of the watercourse bed, however, there is often a height difference between the ford and bed level on the downstream side. Energy dissipators are sometimes required to prevent erosion occurring in the stream bed because of this height difference. The structure does not usually affect the stream flow, however, the upstream progression by aquatic animals can be impeded if the height difference from the stream bed to the ford is too great.

Not all ford sites require extensive in-stream structures. Often, natural rock outcrops provide ample traction for safe crossings. In other instances, it may be necessary to use natural materials to stabilise the stream bed. To prevent the imported material from being washed away, a retaining wall is sometimes required. The wall height will vary depending on the site, but it only needs to be sufficient to contain the material that is to be placed behind it - in most cases, the lower the better. The wall can be constructed using large rocks, logs or artificial material such as concrete. The surfacing material can be placed behind the wall and levelled. This is often rocks, but concrete is also regularly used.

Gabion baskets and mattresses, capped with concrete, are commonly used to provide effective, long lasting fords. The streambed needs to be excavated to install the gabion design.

Entrances to the crossing should be as level as possible. This assists vehicle access in and out of the creek while minimising the occurrence of erosion. If the soils are unstable or the track is steep, drainage controls should be placed at the top of the cutting, and if it is a long approach to the watercourse, also at strategic points along the grade.

It is often useful to stabilise the track immediately beside the watercourse with coarse aggregate material to prevent erosion. Gabion mattresses can be effectively used for this purpose. Excavation works are required when installing a gabion basket/mattress design so that the top of the mattress is at the same level as the streambed or bank.

On unsealed access tracks, preference should be given to the use of concrete crossings or fords rather than the use of culverts. Concrete crossings are self-cleaning, easy to traverse and are low maintenance.

A concrete ford can be used in conjunction with, or to replace, culverts where drainage lines cross the track. The crossings are constructed to allow easy traversing by vehicle and may need energy dissipators, such as gabions, at the outlet.

If the causeway is being used without culverts, the upstream surface of the crossing should be level with the natural surface. Causeways can be used in conjunction with culverts by laying the concrete over the pipes. The pipes provide an avenue for normal trickle flows with the causeway providing non-erosive passage for higher flows. It is important that the causeway is keyed into the natural surface (to 0.5m) so that water does not undermine the structure. Concrete should be poured, with appropriate reinforcement, by an experienced operator. With the variability of soils and topography, the design of concrete causeways will need to be site specific.

10. Erosion and sediment control

a) *Silt traps*

Silt traps are small excavations located at the discharge point of various drainage options such as culverts and mitre drains. The traps provide small storage areas for sediment laden run-off to be collected and contained. By reducing the velocity of the run-off, sediment can settle out and be stored in the trap excavation, while the reduced velocity helps prevent erosion at the outlet point. The effectiveness of the trap is reduced as it reaches its storage capacity of both water and stored sediment. Often, silt cloth is erected on the downstream side of the excavation to increase the silt trap's storage capacity and to assist in removing sediment from overflows.

It is generally sufficient to allow diverted run-off to filter through vegetation to encourage the release of sediment. However, the access track drainage is often located adjacent to watercourses or denuded areas where the vegetation is not sufficient to reduce run-off velocity. It is in these situations where a silt trap can provide some assistance in sediment removal.

The excavation should be positioned so as to collect the run-off from the discharge structure. The capacity of the trap should be sufficient to handle moderate rainfall events, but often the topography and geology of the site will influence the excavation size. The outlet of the trap should be at top water level as this is where the cleanest water will be located. The water released should discharge through sediment cloth to further remove sediment. The outlet of the trap can have a variety of designs, including trickle pipes and formed spillways. It is more common to see traps that simply release water over the lower end of the excavation and release through sediment cloth. Access to traps should be available to allow regular cleaning and, preferably, large enough to allow a machine such as a front-end loader to efficiently remove sediment.

It may be desirable in some circumstances to install temporary sediment traps. Straw bales firmly secured to the ground and abutted tightly to each other can effectively filter small quantities of run-off and sediment. The bales require seating into the ground to a depth of 100mm so water does not go under them. The outlet can be lined with crushed rock to assist filtering and reduce flow velocities. Other options include brush banks, sediment cloth fences, portable tanks and gabions, that all aim to reduce flow velocities and allow sediment to settle out.

Temporary sediment traps should not be relied upon to provide long-term sediment control. If sediment is perceived as being a long term problem, larger retention basins should be considered to reduce the frequency of maintenance. Excavated sediment traps, such as those that occur along many of the fire tracks, should be cleaned regularly. The material removed should be placed at a site where it will not be readily transported off-site by water again. The sediment cloth should be checked to confirm it is working effectively and not torn, perished, lifted or collapsed. The trap should be checked for erosion occurring at the inlets and outlets during routine maintenance inspections.

Silt traps are inexpensive to install and can work very effectively in the short term, however, ongoing maintenance is required. It is essential that sediment traps are regularly desilted as they will become increasingly ineffective as their silt capacity is approached.

b) *Silt fencing*

Silt fences can be constructed with a variety of materials in a number of designs. The objective is to allow sediment laden water to slowly filter through a pervious material, trapping the coarse grained sediments as it passes. The structure is usually a temporary measure to trap sediments mobilised during a period of soil disturbance, for example, construction activities or access track maintenance. Where there is potential for longer term soil loss from the site, more permanent

measures should be implemented. The continued accumulation of sediment against the fence indicates that the development site is unstable and further soil conservation techniques should be implemented.

Silt fences can be constructed from straw bales and brushwood, but the most common is the use of commercially available filter fabrics. Popular products are woven, polypropylene yarns, treated to resist perishing by exposure to sunlight. Due to the long life of these products, the fencing material can be reused at numerous sites after adequate soil stabilisation has taken place.

Some products require a backing material such as wire netting or an equivalent substrate, such as bales, rocks or logs. Other products are free standing with only the use of wooden posts as support. A feature that is important to all silt fencing is that the filter cloth material is laid into a trench (100mm to 150mm) so that the water and accumulated sediment do not pass under the fence.

Whilst most silt fencing should be used only for temporary control of sediment movement, more rigorous designs can assist in stabilising gully floors and can effectively trap and store large volumes of sediment. By using steel posts, plain wire, wire netting and reinforcing mesh, a very effective and low cost weir can be constructed. The weir, placed in a gully floor or drainage line, collects forest debris, which builds a filter for successive water flows. The water pools behind the debris, filtering through the structure leaving the sediment behind. Eventually, the sediment will collect to the top of the fence, at which time it may be necessary to build another fence on top of the sediment, or another fence could be constructed either further upstream or down. Using a survey level, it is possible to place a series of weirs in succession so that the sediment contained in each weir (when full) is deposited to the base of the previous weir.

This process stabilises the gully floor by eliminating nick points, widening the gully floor (therefore slowing the water velocity), encouraging revegetation and assisting the stabilisation of the gully walls.

The fencing is best located in sites that are relatively smooth and slope gently from the gully floor and the gully side. Sometimes, a wing wall may be required to protect the gully wall and to direct flows into the centre of the weir.

High weirs will trap more sediment; however they are more susceptible to collapse because of the greater water pressures and turbulence. Weirs of 0.50m - 0.60m are considered the most successful; however, weirs of up to 1.0m have been used successfully.

Steel posts are driven into the gully floor and spaced 1.0m apart. The top of all the posts should be at the same level. Plain wire is threaded through the top holes and returned on the outside. The wire is then twisted between each post to tension the wire and strengthen the weir.

This process is repeated through the bottom holes and usually another wire is run through the middle holes. Reinforced mesh is placed against the posts, on the upstream side, and wired to the posts and tensioned. Wire netting is then laid against each side of the mesh and on the gully floor. The netting is wired to the mesh and heavy gauge plain wire can be used to pin the netting to the gully floor. It may be necessary to cut the mesh to the contour of the gully wall to create a snug fit. Alternatively, the wall can be excavated to allow the placement of the mesh into the wall.

Two extra steel posts can be driven in upstream of the structure and guy wires used to help support the structure during high flows.

The sites need to be inspected to determine the integrity of the structure, any developing erosion caused by scouring (or plunge pools), and to gauge the rate of sediment being deposited. New

fences should be inspected immediately after an initial high rainfall event. Problems should be corrected as they occur.