Final Report

Berrybank Sediment, Erosion and Water Quality Management Plan

17 JANUARY 2013

Prepared for

Berrybank Development Pty Ltd (BDPL)

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Executive Summary

Berrybank Development Pty Ltd is undertaking the required studies to comply with the conditions of planning permit to commence the construction and operation phase of the Berrybank Wind Farm located in Western Victoria. As part of this process a Stormwater, Erosion and Water Quality Management Plan (SEWQMP) has been commissioned for incorporation into the Environmental Management Plan.

The objective of the SEWQMP is to examine surface water management and erosion control measures required to be incorporated into the design and construction of the wind farm. In particular drainage and sediment issues resulting from the construction and use of the track infrastructure are addressed, and the type of temporary and permanent surface water and sediment controls appropriate to the project examined.

A temporary concrete batching plant is to be constructed, and will be utilised during the construction phase of works. This plan also addresses the environmental management requirements required for the batching plant.

Relevant Guidelines and Policies

When completing the detailed design of the Berrybank Wind Farm, particular policies, guidelines and standards will need to be considered and/or adhered to in the design of the drainage system, erosion control structures and tracks and in the siting of the temporary concrete batching plant, the most relevant being:

- Control of Erosion on Construction Sites, Soil Conservation Authority
- Construction Techniques for Sediment Pollution Control, Environment Protection Authority, May 1991
- Bunding Guidelines, Publication 347, Environment Protection Authority Victoria, December 1992
- Environmental Guidelines for Major Construction Sites, Environment Protection Authority, February 1996
- State Environment Protection Policy (Waters of Victoria), No. S-107 Environment Protection Authority Victoria, June 2003
- Environmental Guidelines for the Concrete Batching Industry, June 1998

Sediment and Erosion Controls

There are various controls that can be employed in the design and construction of the Berrybank Wind Farm to minimise the impact of the development on the local surface water system. Such controls include:

- vegetated swale drains;
- check dams;
- culverts;
- silt fences;
- vegetated buffers;
- slope stabilisation;

- sedimentation basins; and
- machinery crossings.

Concrete Batching Plant

The temporary concrete batching plant is proposed to be located on flat, farming land along Berrybank-Werneth Road. This site is greater than 100 metres from waterways and sensitive land uses. Appropriate environmental management of the batching plant will ensure that the potential for environmental impacts will be minimised.

Document Structure

The SEWQMP is divided into two parts:

- Part 1 is the principal SEWQMP document, which defines a proposed management framework. The SEWQMP is sufficiently detailed to demonstrate consideration of the potential environmental impacts associated with the project and how these could be managed. This part includes a review of relevant environmental legislation and regulations.
- Part 2 presents the environmental management procedures that support the SEWQMP by further detailing the implementation of environmental management strategies. The scope of the environmental management procedures reflects key environmental issues addressed by the SEWQMP.

Introduction

1.1 Background

Two Planning Permits were granted by the Minister for Planning under the Planning and Environment Act 1987 for the development of the Berrybank Wind Farm.

Permit Number 20092820 falls under the Golden Plains Planning Scheme. Golden Plains Shire Council is the Responsible Authority for administration and enforcement of the Permit. The Permit allows for the use and development of land for a wind energy facility (comprising up to 49 generators), including wind monitoring masts, business identification signage, access roads, sub-station, water storage tanks and removal of native vegetation subject to conditions.

Permit Number 20092821 falls under the Corangamite Planning Scheme. Corangamite Shire Council is the Responsible Authority for administration and enforcement of the Permit. The Permit allows for the use and development of land for a wind energy facility (comprising up to 50 generators), including anemometers (wind monitoring masts), business identification signage, access roads, sub-station, water storage tanks and removal of native vegetation subject to conditions.

Before the development starts an environmental management plan must be prepared to the satisfaction of the Minister for Planning, in consultation with the Department of Sustainability and Environment, Golden Plains Shire Council, Corangamite Shire Council, Country Fire Authority and other agencies as specified in condition 13, or as further directed by the Minister for Planning. The environmental management plan may be prepared in sections or stages. When approved, the plan will be endorsed by the Minister for Planning and will then form part of the Permit.

The environmental management plan must include a sediment, erosion and water quality management plan. This plan must be prepared in consultation with the Corangamite Catchment Management Authority, Environmental Protection Agency and other authorities as may be directed by the Minister for Planning. The requirements of the plan are listed in Table 1-1 below.

Table 1-1 Planning Permit Conditions

Planning Permit Requirement	SEWQMP Reference
1. Procedures to ensure that silt from batters, cut-off drains, table drains and road works is retained on the site during and after construction and replaced as soon as possible. To this end a) All land disturbances must be confined to a minimum practical working area; b) Soil to be removed must be stockpiled and separate soil horizons must be retained in separate stockpiles and not mixed as soon as possible in sequence; and c) Stockpiles must be located away from drainage lines;	3.1
2. Criteria for the siting of any temporary concrete batching plant associated with the development of the wind energy facility and the procedure for its removal and reinstatement of the site once its use finished. The establishment and operations of any such temporary concrete batching plant must be designed and operated in accordance with the EPA Publication 628, Environmental Guidelines for Concrete Batching Industry.	3.4
3. The installation of geo-textile silt fences (with sedimentation basins where appropriate) on all drainage lines from the site which are likely to receive run-off from disturbed areas.	3.1

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Planning Permit Requirement	SEWQMP Reference
4. Procedures to suppress dust from construction related activated. Appropriate measures may include water spraying of roads and stockpile, stabilising surfaces, temporary screening and/or wind fences, modifying construction activities during periods of heightened winds and revegetating exposed areas as soon as practicable.	3.2
5. Procedures to ensure that steep batters are treated in accordance with Environment Protection Authority Publication 275 Construction Techniques for Sediment Pollution Control.	3.1
6. Procedures for wastewater discharge management.	3.3
7. A process for overland flow management to prevent the concentration and diversion of waters onto steep or erosion prone slopes.	3.1
8. Pollution management measures for stored and stockpiled materials including waste materials, litter, contaminated run-off and any other potential source of pollution to ground or surface waters.	3.1, 3.3
9. Incorporation of pollution control measures outlines in EPA Publication 480.	3.1, 3.3
10. Siting of concrete batching plant and any on-site wastewater and disposal and disposal treatment fields at least 100 meters from any watercourse	3.4
11. Appropriate capacity and an agreed program for annual inspection and regular maintenance of any on-site wastewater management system constructed to service staff, contractors or visitors.	3.3
12. A program of inspection and remediation of localised erosion within a specified response time.	3.1

1.2 Scope

The objective of this report is to produce a Sediment, Erosion and Water Quality Management Plan (SEWQMP) addressing the relevant conditions of the Planning Permits outlined in section 7 of the RFT document (and listed above). We note that once completed and endorsed, the SEWQMP will form part of the Planning Permit.

The scope of the SEWQMP includes consideration of the environmental aspects associated with sediment, erosion and water quality.

Specifically the following environmental aspects have been considered:

- Sediment and erosion;
- Dust;
- Wastewater; and
- Environmental issues regarding the temporary concrete batching plant

1.3 Methodology

Following a review of the Condition of the Planning Permit, URS developed a set of tasks to complete the SEWQMP. These tasks are outlined below, the outcomes of which are detailed in sections 2.3.1 to 2.3.5.

Task 1: Inception Meeting

Task 2: Review of Requirements

Task 3: Review of Existing Conditions

Task 4: Stakeholder Consultation

Task 5: Prepare Sediment, Erosion and Water Quality Management Plan

1.3.1 Inception Meeting

The inception meeting for the SEWQMP was held between URS and BDPL on 11th November 2010. Present at the meeting were Ashley Lang, Chris Sprott and Peter Cohen of URS and Andrea Jou Elena of BDPL.

During this meeting the following items were discussed and agreed:

- Key URS and BDPL project team members
- Project objectives, scope and timing
- Project points of contact for URS and BDPL
- Project stakeholders to be identified and contacted
- Project communication and reporting structure
- Proposed project methodology
- Documentation to be reviewed
- Major project risks and mitigation

1.3.2 Review of Requirements

URS undertook a review of all requirements and other information available in order to be fully aware of the works and project background. The review included project documentation, Planning Permit conditions, the preferred location of wind turbines and other infrastructure (such as the temporary concrete batching plant and site access tracks), any relevant background environmental information and data (such as rainfall data) and other relevant information such as:

- EPA publication 628 *Environmental Guidelines for the Concrete Batching Industry*
- EPA publication 275 *Construction Techniques for Sediment Pollution Control*
- EPA publication 480 *Environmental Guidelines for Major Construction Sites*

1.3.3 Review of Existing Conditions

URS reviewed available site condition information as described in the Berrybank Wind Farm Planning Application Report (July 2009) and subsequent project information provided by BDPL, as well as information available from the Corangamite Catchment Management Authority (CMA).

Following this review, URS project team members conducted a site visit on 17th March 2011. The aim of the site inspection was to confirm the presence and flow of surface water, site drainage and watercourses within and surrounding the proposed wind farm development. The inspection included observations of the adjacent Gnarpurt Chain of Ponds, Naringall Creek and the number of small unformed drainage lines which cross the site. The outcomes of this site visit are detailed in section 2.1.

1.3.4 Stakeholder Consultation

During the development of the SEWQMP, URS met or liaised with nominated stakeholder representatives. URS met (or liaised over the telephone) with the following stakeholders:

- Environment Protection Authority (EPA) Victoria
  - *Phone call 22nd December 2010 and letter 13th May 2011*
- Corangamite Catchment Management Authority (CMA)
  - *Phone call 23rd December 2010 and letter 12th May 2011*
- Corangamite Shire Council
  - *Phone call 27th May 2010 and draft report sent on 31st May 2011*
- Golden Plains Shire Council
  - *Consultation during site visit on 17th March 2011 and draft report sent on 31st May 2011*
- Lismore Land Protection Group
  - *Phone call 22nd December 2010 and letter 13th May 2011*
- Department of Sustainability and Environment (DSE)
  - *Phone call 22nd December 2010 and letter 13th May 2011*

Each stakeholder group was invited to attend a site inspection at Berrybank with URS. Most groups declined the invitation; however representatives from Golden Plains Shire Council attended the site inspection on 17th March 2011 and discussed the project with URS.

The stakeholder response to the SEWQMP for Berrybank Wind Farm was positive, with no significant issues identified by any of the groups.

1.3.5 Prepare the SEWQMP

Following the completion of tasks 1 to 4, URS prepared the SEWQMP, and as described earlier the document is prepared in two parts, Part 1 the SEWQMP principal document and Part 2 the Environmental Management Procedures.

1.4 Document Structure

This document is presented in two parts as described below.

Part 1

Part 1 is the principal SEWQMP document, which defines a proposed management framework. The SEWQMP is sufficiently detailed to demonstrate consideration of the potential environmental impacts associated with the project and how these could be managed. This part includes a review of relevant environmental legislation and regulations.

A brief overview of the project is provided initially followed by a description of the site. Surface water management issues related to the wind farm infrastructure are identified and discussed.

- Site description, background, context and scope;
- Outline of relevant Government legislation and guidelines;
- Methodology in completing the SEWQMP; and
- Potential environmental impacts (specifically sediment, erosion, and water quality) associated with the project and how they will be managed.

Part 2

Part 2 presents the environmental management procedures that support the SEWQMP by further detailing the implementation of environmental management strategies. The scope of the environmental management procedures reflects key environmental issues addressed by the SEWQMP. The environmental management procedures described in Part 2 are:

- Sediment and erosion management procedure;
- Dust management procedure;
- Wastewater management procedure; and
- Temporary concrete batching plant management procedure.

1.5 Union Fenosa Environment Policy

Union Fenosa Wind Australia has an Environmental Policy (July 2009) which states:

Through its activity in the field of renewable energies, Union Fenosa is committed to respecting and conserving the Environment, and seeks to integrate this culture of environmental protection in the operation of its wind farms. Through this environmental policy Union Fenosa Wind Australia undertakes to:

- Implement and maintain an effective system of environmental management in accordance with ISO 14001 international standard.
- Comply with legislation and applicable environmental regulations.
- Prevent and minimise environmental impact in its activities while collaborating in the securing of sustainable development.

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- Set objectives and establish programs that go to support a continuous improvement in environmental behaviour.
- Provide suitable training and information to its personnel so as to promote the implementation of good environmental practices in the carrying out of their work.
- Demand that its suppliers and subcontractors display responsible environmental behaviour.
- Collaborate with environmental authorities in order to guarantee a high level of environmental protection.

Part 1 Sediment, Erosion and Water Quality Management Plan

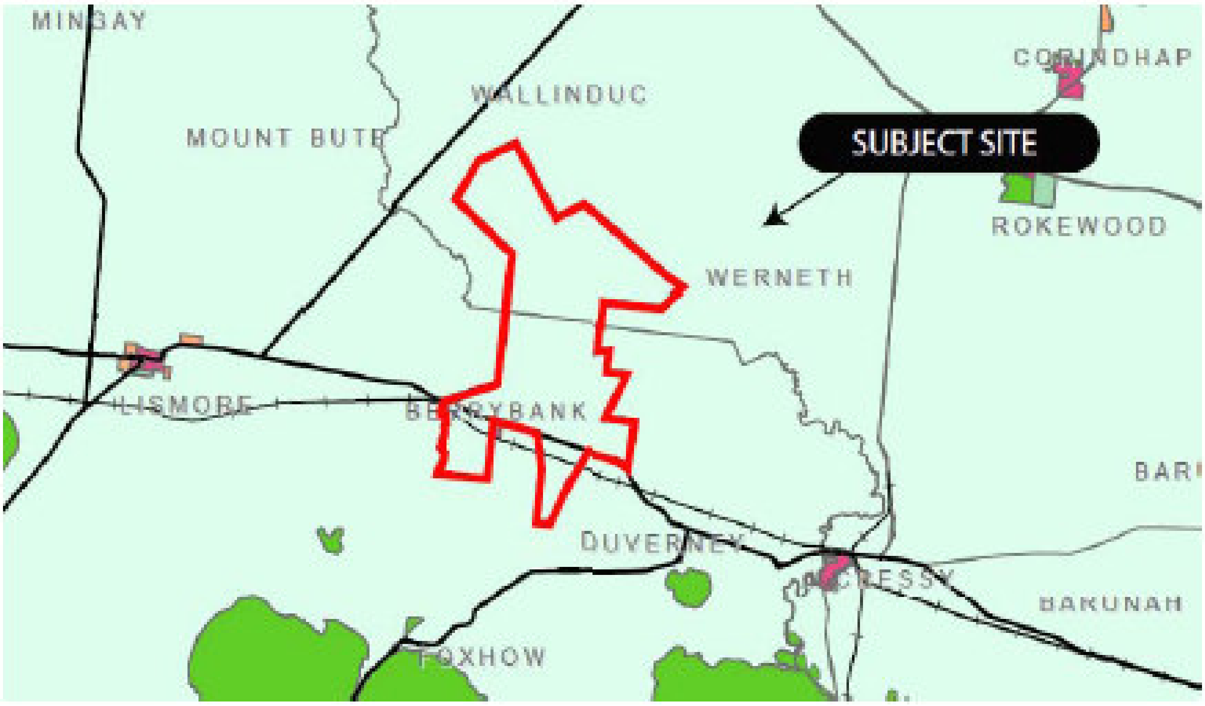
The objective of this SEWQMP is to protect areas from erosion by minimising land disturbance and to prevent surface runoff or concentration of surface water runoff that could lead to erosion or siltation of watercourses.

2.1 Site Description

2.1.1 Location

The site is located within South Western Victoria approximately 14km east of Lismore and 16km to the west of Cressy. The site is approximately 130km west of Melbourne within the Victorian district known as the Western Plains or Western District; refer to Figure 2-1 for the Locality Map.

Figure 2-1 Site Location

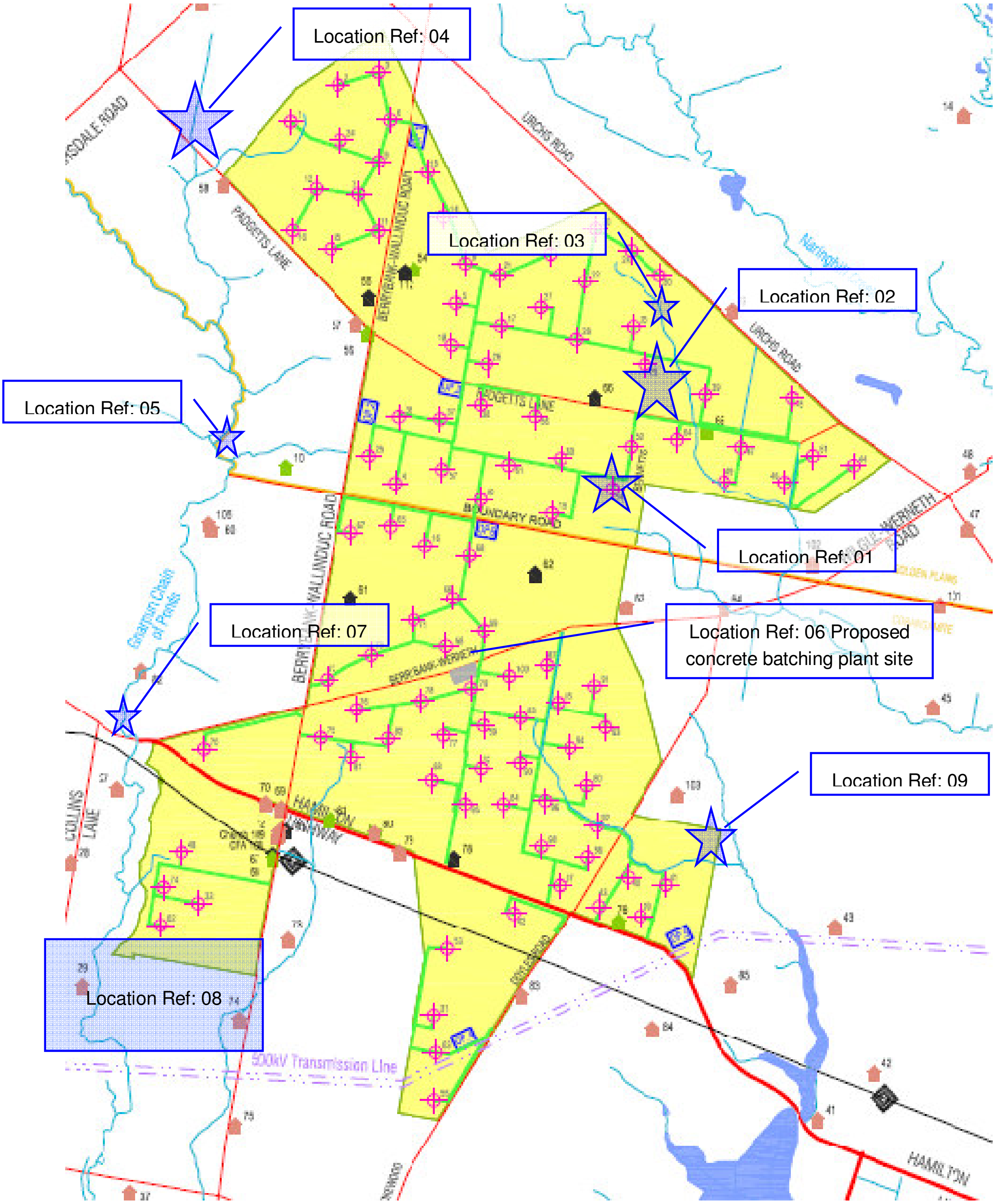


2.1.2 Overview of Proposed Site Layout

Based on a site visit the presence and flow of surface water, site drainage and watercourses within and surrounding the proposed wind farm development was confirmed. Visual observations were made of water bodies within and adjacent to the project site and included Gnarpurt Chain of Ponds, Naringall Creek and a number of small unformed drainage lines which cross the site. Nine surface water locations were observed in total, the locations of which are shown in Figure 2-2 below.

2 Part 1 Sediment, Erosion and Water Quality Management Plan

Figure 2-2 Berrybank Site and Site Visit Locations



2.1.3 Land Use

The site is currently cleared farming land, as illustrated in Figure 2-3, with some stands of native vegetation, predominantly found along waterways. The land across the site is used for agriculture crops and sheep grazing.

There are signs of localised erosion in the area, such as silt build-up in some locations. However no major erosion was identified.

Figure 2-3 Land use in Berrybank

2.1.4 Topography

Berrybank and the surrounding area is a predominately flat landscape with areas of slightly undulating farmland (see Figure 2-4 below). The site ranges from 130 m to 210 m above sea level with a general downward slope towards the south and west of the site.

Figure 2-4 Typical Site Topography

2.1.5 Surface Water

Many low-lying areas of the site are subject to seasonal inundation. A number of natural waterways, waterholes and farm dams are located within and nearby the site. Figure 2-5 below shows some examples of existing surface water across the site. Stony Creek transects the centre of the site, in an east – west direction and is an ephemeral type creek. Discussions with local landholders indicate that waterways in the local area are ephemeral. The ephemeral waterways nearby include Naringhill Creek, Gnarpurt Chain of Ponds (to the west of the site), Lake Rosine, Lake Gnarpurt, Lake Corangamite, Lake Struan, Lake Martin and Cundare Pool.

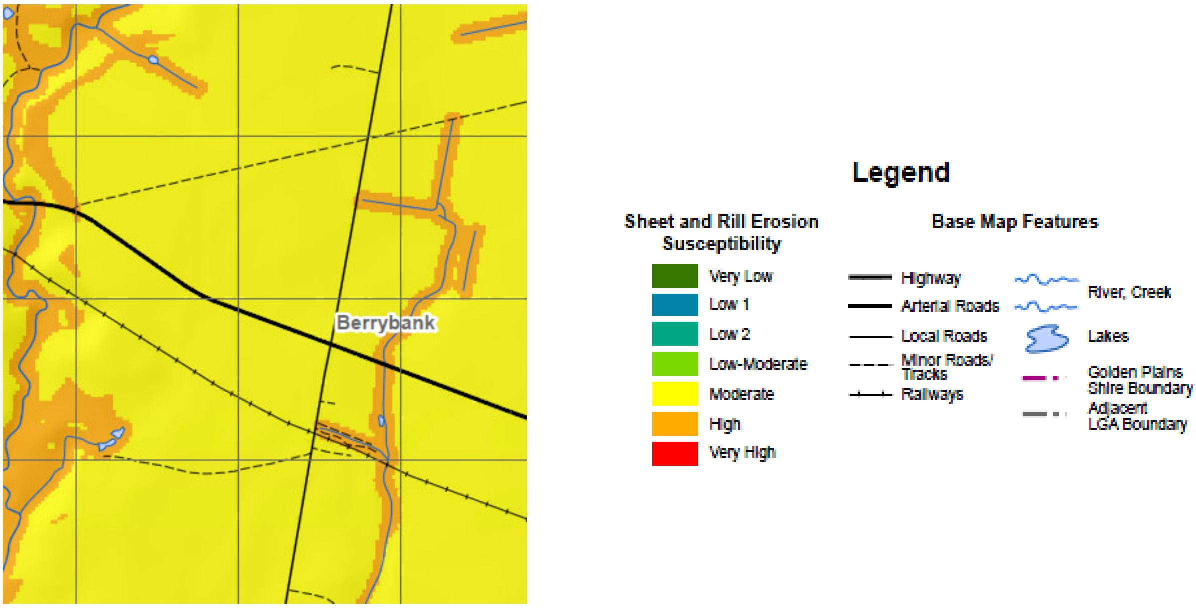
Most of the site is low lying and the whole site is generally wet and boggy following a rainfall event.

Figure 2-5 Existing Surface Water Bodies

2.1.6 Erosion Susceptibility

The site does not have an Erosion Susceptibility, ESO5 planning overlay associated with it, as per the *Berrybank Wind Farm Landscape and Visual Impact Assessment, 2009*. However, the overall site is rated “moderate” for sheet and rill erosion susceptibility and an increased susceptibility rating of “high” in areas within close proximity waterways. An example of the erosion susceptibility map for the area is provided in Figure 2-6.

Figure 2-6 Erosion Susceptibility (Corangamite CMA, 2006)

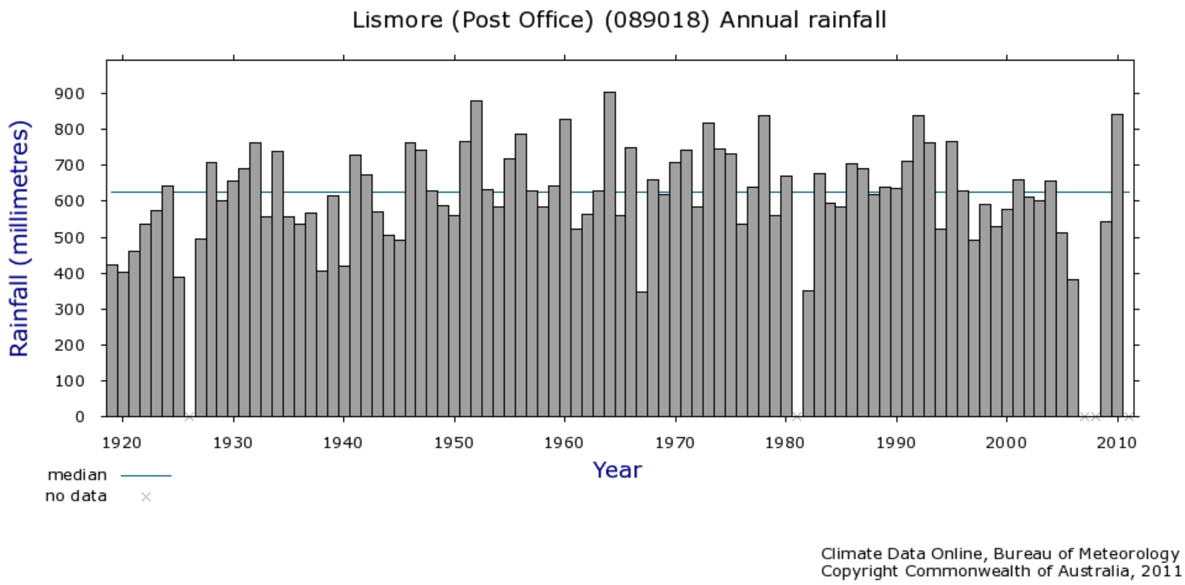


2.1.7 Rainfall

The average annual rainfall at the site is estimated to be in the order of between 347mm (lowest) to 903 (highest), based on annual rainfall data collected by the Bureau of Meteorology for the weather station at Lismore, which is the closest formal monitoring station to Berrybank.

The average annual rainfall at Lismore (from data collected between 1819 and 2011) is recorded as 624mm. Annual rainfall for Lismore is provided in Figure 2-7 below.

Figure 2-7 Annual Rainfall for Lismore



2.2 Relevant Environmental Legislation and Guidelines

When completing the detailed design of the Berrybank Wind Farm, environmental legislation, policies, guidelines and standards will need to be taken into consideration during the design of the drainage system, erosion control structures and tracks. Environmental legislation and guidelines relevant to the SEWQMP are discussed below.

Environment Protection Act 1970 (Victoria)

The *Environment Protection Act 1970* (the Act) is outcome oriented, with a basic philosophy of preventing pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. Key aims of the Act include sustainable use and holistic management of the environment, ensuring consultative processes are adopted so that community input is a key driver of environment protection goals and programs and encouraging a co-operative approach to environmental protection.

State Environment Planning Policy (SEPP) Waters of Victoria

The State Environment Protection Policy (SEPP) Waters of Victoria provides the sustainability principles that are to be used to guide the design of the Berrybank Wind Farm. It also contains environmental quality objectives and indicators to be considered in the design and guidelines for surface water management and works.

EPA Guidelines

- EPA publication 628 *Environmental Guidelines for the Concrete Batching Industry*
  - This guideline provides methods to achieve the best practical environmental outcome, while allowing flexibility as to how this will be achieved. These guidelines apply to concrete batching plants of all scale, regardless of whether they are subject to EPA works approval.
- EPA publication 275 *Construction Techniques for Sediment Pollution Control*
  - This publication provides a basic overview of various methods for drainage control on a typical construction site, some of which are relevant to this project.
- EPA publication 480 *Environmental Guidelines for Major Construction Sites*
  - With regard to the wind farm development these guidelines provide information on the likely impact of construction activities on the environment, the objectives to minimise various risks expected at construction sites and measures to manage the risks. The guidelines are not prescriptive or detailed, however they do provide some parameters for design and monitoring.

Catchment and Land Protection Act

The purpose of the Catchment and Land Protection Act is to set up a framework for the integrated management and protection of catchments and to encourage community participation in the management of land and water resources.

Control of Erosion on Construction Sites, Department of Conservation Forests & Lands, 1987

Although this publication can be said to be superseded with the *Environmental Guidelines for Major Construction Sites* EPA publication, it is a useful guide and illustration of simple methods of minimising land disturbance and reducing the amount of sediment leaving sites.

2.3 Potential Environmental Impacts

Through review of environmental legislation, the Planning Permit conditions, site inspection, stakeholder consultation, review of existing conditions and details of the wind farm proposal, several key environmental aspects have been identified that have the potential to create environmental impacts.

2.3.1 Potential changes to local and regional hydrologic regime

The proposed site for development is currently used for agriculture crops and sheep grazing. The construction of approximately 30km of tracks and hardstand areas has the potential to alter the hydrologic regime of the site. Generally when the land's surface cover is changed, in this case from grassed to unsealed tracks and hardstand areas, the quantity and timing of surface runoff during a rainfall event may change.

Compacted areas such as hardstands and tracks will have a higher runoff coefficient than grassed areas. This means that a larger proportion of rainfall will become surface runoff and the time of concentration, that is the time it takes water to runoff, is decreased. As well any embankments that are created as a result of the track construction may alter the location of natural flow paths by diverting surface runoff. Both of these changes to the local hydrologic regime if not managed adequately, have the potential to detrimentally impact on the regional hydrologic regime.

In this case however it is unlikely that the changes, if any, will be significant. Firstly the area of land converted to hardstand is relatively small and the majority of the tracks and potential track embankments are located away from most waterways or on existing farm access tracks. Secondly the tracks will not be sealed so whilst the runoff coefficient will increase compared with the current land use it will not increase as much as it would if the roads were to be sealed.

2.3.2 Potential impact on surface water quality

A development of this type has the potential to impact on the quality of surface runoff from the site and subsequently on the water quality of local receiving watercourses if not managed correctly.

It is essential that any surface runoff leaving the proposed development site comply with the Victorian State Environmental Protection Policy (Waters of Victoria) criteria for discharge to receiving watercourses.

Based on a review of the aerial photography with the proposed site layout and the topography, one of the key issues associated with surface water management will be water logging and possible soil erosion and subsequently an increase in the sediment concentration in surface runoff and siltation of local waterways.

It is understood that there will be a number of refuelling and wash-down stations at the site. Wastewater generated at these stations pose a risk of contamination to surface water from fuel or oil spills and sedimentation.

2.3.3 Potential erosion issues

A development of this nature has the potential to create areas of concentrated surface runoff. This could occur where the track drains discharge into local watercourses or alternatively where track embankments or work areas divert runoff from its natural flow path.

If not managed correctly, concentrated surface runoff has the potential to lead to localised erosion and the erosion of watercourses which can impact water quality, waterway hydraulic performance, aesthetics and potentially on local fauna habitat.

Due to the relatively flat terrain and the local geographical conditions erosion potential for the tracks is considered to be low. A number of the tracks are currently shown as having low grades. During a rainfall event concentrated sheet flow could develop along the tracks which have the potential to cause erosion.

Erosion potential requires consideration both in terms of damage to the site infrastructure (in particular the tracks) and also the potential for sediment laden runoff to discharge from site.

2.3.4 Flooding potential

The site is located in a relatively low rainfall area (average annual rainfall is approximately 600mm) and the potential for localised flooding during a storm event exists. However as the majority of the development including tracks and wind turbines are located away from natural watercourses in most places it is unlikely that flooding will cause a significant problem.

In the instance where proposed tracks cross local flow paths or track embankments are required, appropriately sized culverts will need to be incorporated in the design to ensure that localised flooding does not occur.

2.3.5 Potential dust impacts

As the proposed site is located in a rural area, the potential for creating a loss of amenity to sensitive land uses (such as local residents and schools) is low. Nonetheless, the construction and operation of the wind farm will need to be undertaken to minimise dust emissions to avoid potential off site issues. Settled dust can also be collected during storm events, creating sedimentation issues and potential impacts on local waterway quality.

2.3.6 Potential impacts of the temporary concrete batching plant

In determining the site for the temporary concrete batching plant, the following environmental elements will be considered.

Wastewater

Concrete batching plants have the potential to generate considerable quantities of wastewater which must be properly managed to protect local ecosystems. Wastewater may be generated from a variety of processes such as: dust suppression; uncontrolled runoff from contaminated areas; washout stations; and general cleaning. This water, if inappropriately managed, could have a detrimental effect on receiving waters such as increased acidity and turbidity.

Dust

Dust from cement, sand and aggregates are pollutants. Fine dust particles can enter neighbouring premises and adversely affect amenity. Dust must be controlled so there are no significant emissions from the plant.

Potential sources of dust emissions could originate from:

- Concrete batching plant activities
- Deliveries to site
- Stockpiled materials
- Other construction activities

Noise

Noise emitted from a concrete batching plant has the potential to impact on the amenity of the local community.

Major sources of noise at batching plants include:

- Trucks and other vehicles
- Batching equipment such as hydraulic pumps, conveyor belts and air valves
- Radios
- Reverse warning devices

Solid Wastes

The main solid waste generated by batching plants is waste concrete.

2.4 Management of Potential Environmental Impacts

Table 2-1 below provides a summary of the environmental aspects associated with sediment, erosion and water quality, including the temporary placement of a concrete batching plant, and their potential impacts on the environment. Management requirements to minimise the potential environmental impact are also summarised. The management of each of these potential environmental impacts is further detailed in *Part 2 – Environmental Management Procedures*.

2 Part 1 Sediment, Erosion and Water Quality Management Plan

Table 2-1 Summary of Potential Environmental Impacts and their Management

Environmental aspect	Potential environmental impacts	Management requirements	SEWQMP Part 2 Reference
Sediment and erosion	Siltation of local waterways and drainage lines Erosion of waterways Topsoil loss	Divert stormwater away from the site. Slow the rate of flow diverted before entering the natural drainage network. Silt fencing, swale drains, sediment basins. Regular maintenance and monitoring	3.1
Dust	Nuisance to neighbours Sediment entering waterways and drainage lines	Minimise areas to be cleared. Staged approach to site clearance. Water carts as required on access tracks. Seeding of soil stockpiles	3.2
Wastewater	Contamination of land and waterways	Provide sufficient bunding for capture of wastewater Clean up spills immediately Regular wastewater collection from site offices Reuse wastewater where possible	3.3
Temporary concrete batching plant	Nuisance to neighbours for air emissions, noise emissions Mismanagement of wastes and wastewater Contamination of land and waterways	Buffer distance of at least 100m to sensitive land uses. Sited on land that is not flood prone. Provide sufficient bunding for capture of wastewater and reuse. Monitor wet weather discharges for pH and suspended solids. Keep sand and aggregates damp. Keep pavements and surfaces clean. Clean up spills immediately. Select quieter equipment. Minimise the generation of waste concrete.	3.4

2.5 Audit, Review and Reporting

This document will be incorporated into an overall Berrybank Wind Farm Environmental Management Plan which will address the audit, review and reporting requirements for the project.

2.6 Incident Response

This document will be incorporated into an overall Berrybank Wind Farm Environmental Management Plan which will address the incident response requirements for the project.

Part 2 Environmental Management Procedures

This section presents a set of environmental management procedures to be utilised to minimise the potential environmental impacts of the Berrybank Wind Farm development in relation to sediment, erosion and water quality aspects as identified in Part 1 of this report. An environmental management procedure for the temporary concrete batching plant is also described.

The environmental aspects and management requirements are defined subsequently in this document, in respective sections under headings described below:

> **Issues:** Provides a description of the environmental issues in relation to the operation and decommissioning of the site.
>
> **Objective:** The desired environmental performance.
>
> **Requirements:** Management actions to be implemented in order to mitigate or prevent the potential impacts and to ensure that the environmental objective is met.

3.1 Sediment and Erosion Management Procedure

3.1.1 Issues

Construction of the proposed wind farm would involve the disturbance and excavation of large volumes of soil, for the creation of wind turbine foundations, internal access tracks and lay down areas.

The contact of rainfall and surface run-off with exposed or stockpiled soils in works areas would generate potentially sediment-contaminated stormwater requiring appropriate treatment and disposal.

Raise Bed farming is a prominent farming technique within the *Windfarm Site*. Raise Beds are a known farming method that reduces water logging, improves soil aeration, drainage and infiltration and maintains bed density for improved cropping. Five key items for this farming technique have been outlined within the Soil Quality Fact Sheets (2004) and are as follows;

- Bed orientation (north–south);
- Surface drainage (cross drains, catch drains);
- Waterways;
- Access; and
- Matching machinery.

The sediment and erosion management procures provided within this document identify techniques for minimising the impact of works to Raise Bed farmed areas.

3.1.2 Objective

Minimise soil erosion from disturbed areas and stockpiles and minimise the discharge of sediment to surface waters.

3 Part 2 Environmental Management Procedures

3.1.3 Requirements

Design

- Site access tracks and lay down areas shall:
  - Incorporate existing roads and tracks wherever possible, to minimise site disturbance
  - Be excluded from gullies and areas subject to inundation wherever possible, to minimise disturbance and the potential for sedimentation of waterways
- Topsoil from site access tracks and lay down areas shall:
  - Be stockpiled and retained for rehabilitation following construction
  - Be located a minimum of 30m from drainage lines
  - Not be placed in areas of native vegetation and grasses
- Stormwater drainage shall be designed to:
  - Divert flow away from disturbed areas
  - Slow the rate of peak flow wherever possible
  - Decrease the velocity of stormwater flow
  - Disperse stormwater flow
  - Minimise interference with local and regional hydrologic regimes
- Stormwater drainage shall be designed for the 1 in 10 year average recurrence interval (ARI) storm event (and for Raise Beds).
- Erosion and sediment control structures shall be designed to retain sediment on site.
- Erosion and sediment control structures shall be designed for the 1 in 2 year average recurrence interval (ARI) storm event.
- Typical stormwater drainage and sediment controls may include vegetated swale drains, check dams, culverts, silt fences, vegetated buffers and sedimentation basins. Design specifications for on site sediment and erosion control structures, including inspection and maintenance, are provided in Appendix A.
- Stormwater drainage shall be designed to avoid increased flooding or surface flows to Raise Bed areas.
- For Raise Beds, where a low ridge extends across the full width, Cross Drains need to extend the full distance and empty either in to a 'Waterway' drain or onto a wellgrassed surface of an adjacent area that is not bedded. Cross drains convey surface run-off to Catch Drains within raise beds. Catch Drains must collect and conduct water from the full width of an area of Raised Beds to ensure the water is removed from the field and placed back into the natural drainage line or creek, with required sediment controls. They do not need to have a single exit point, but all exits must safely dispose of the runoff within the catchment of origin. (Raise Bed Farming Manual)
- Vehicles / machinery traversing Raise Beds shall be avoided to reduce the impact of compacting Raise Beds.

3 Part 2 Environmental Management Procedures

Construction and Decommissioning

- All land disturbances shall be confined to a minimum practical working area.
- As the Berrybank site is low lying, there is a risk of water logging to occur following heavy rain events. Therefore drainage lines should be installed to divert clean stormwater away from the construction site and minimise the amount of sediment-laden run-off to be managed.
- Vehicular traffic shall be restricted to designated site entry and exit points
- Wash down areas shall be in place to ensure that mud is removed from construction vehicles prior to entering the local road network.
- Plant, equipment and materials storage shall be restricted to constructed lay down areas.
- Soil stockpiles shall be seeded as necessary to minimise material loss.
- Geo-textile silt fences shall be installed (with sedimentation basins where appropriate) on all drainage lines from the site which are likely to receive run-off from disturbed areas.
- Stormwater drainage and sediment control structures shall be inspected on a regular basis and maintained to ensure their ongoing effectiveness.
- Where access tracks are to be constructed, it is important to minimise the area to be disturbed, so as to maximise the collection and reuse of topsoil on site and to provide a non-erodible track surfacing using a crushed rock pavement. This will reduce erosion and dust generation and should be used with grassed swales, silt fences, and/or small sediment ponds where required as per EPA Guidelines for Major Construction Sites.
- Ideally, crossing waterways should be avoided if at all possible, where this is not feasible, the use of existing roads and fords would be the preferred option and these should be considered before the construction of new fords. Existing and new fords may require hardening to prevent erosion caused by heavy construction vehicles. To ensure sufficient hardening against erosion, rock and gravel should be placed on and near the stream crossing. Permits would be required from Corangamite CMA for any temporary waterway crossings.
- Stormwater drainage shall be designed to avoid increased flooding or surface flows to Raise Bed areas.
- For Raise Beds, where a low ridge extends across the full width, Cross Drains need to extend the full distance and empty either in to a ‘Waterway’ drain or onto a well grassed surface of an adjacent area that is not bedded. Cross drains convey surface run-off to Catch Drains within raise beds. Catch Drains must collect and conduct water from the full width of an area of Raised Beds to ensure the water is removed from the field and placed back into the natural drainage line or creek, with required sediment controls. They do not need to have a single exit point, but all exits must safely dispose of the runoff within the catchment of origin. (Raise Bed Farming Manual)
- Vehicles / machinery traversing Raise Beds shall be avoided to reduce the impact of compacting Raise Beds.

3 Part 2 Environmental Management Procedures

Operation

- All land disturbances shall be confined to a minimum practical working area.
- Soil to be removed shall be stockpiled and separate soil horizons retained in separate stockpiles and not mixed, and replaced as soon as possible in sequence.
- Soil stockpiles shall be located away from drainage lines. This requires placing such materials on high ground. Avoid placing stockpiles in gullies or other likely confluences where flow may cause sediment transportation. Stockpiles should also be provisioned with sediment fences, placed so as to cause minimal disruption to the natural flow paths.
- Vehicular traffic shall be restricted to constructed site access roads and designated site entry and exit points.
- Plant, equipment and materials storage shall be restricted to constructed lay down areas.
- Geo-textile silt fences shall be installed (with sedimentation basins where appropriate) on all drainage lines from the site which are likely to receive run-off from disturbed areas.
- Stormwater drainage and sediment control structures shall be inspected on a regular basis and maintained to ensure their ongoing effectiveness.
- Any community complaints shall be promptly investigated and responded to, and any necessary corrective action initiated.
- Stormwater drainage and sediment controls shall provide for drainage from Raise Beds. For example, the invert of table drains shall be equal to or less than the level of the Raise Bed base. (GRDC, Raise Bed Farming Manual)
- Stormwater drainage shall be designed to avoid increased flooding or surface flows to Raise Bed areas.
- Vehicles / machinery traversing Raise Beds shall be avoided to reduce the impact of compacting Raise Beds.

Monitoring

- Stormwater drainage and sediment control structures shall be inspected on a regular basis and maintained to ensure their ongoing effectiveness.
- In the case that erosion due to works is noted during monitoring, the erosion shall be responded to and rectified as soon as practical. Should an erosion / sediment control method fail to adequately perform, this method shall be assessed and alternatives shall be potentially investigated.
- A water quality monitoring program shall be implemented to monitor and assess potential impacts of the proposed development on receiving waterways (including the physical, chemical and biological environment).
- Water quality monitoring sites shall be established:
  - downstream of sediment control structures (discharge sites)
  - within receiving waterways (in–stream sites)

3 Part 2 Environmental Management Procedures

- An appropriate number of in–stream sites shall be established, to enable a ‘typical’ range of environmental conditions to be determined
- Water quality indicators for discharge sites shall include:
  - flow
  - suspended solids
  - turbidity
- Water quality indicators for in–stream sites shall include:
  - flow
  - suspended solids
  - turbidity
  - electrical conductivity
  - pH
  - temperature
  - dissolved oxygen
  - nitrogen (total)
  - phosphorus (total)
  - total petroleum hydrocarbons (as relevant)
- Sampling and analysis shall be performed in accordance with EPA Publication 441.7 (*A Guide to the Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*)
- Monitoring results shall be interpreted by an appropriately qualified environmental professional
- Monitoring results shall be compared against:
  - relevant performance objectives defined in the State Environment Protection Policy (Waters of Victoria)
  - any long-term monitoring data maintained by EPA and DSE for relevant sites in the region.

3.2 Dust Management Procedure

3.2.1 Issues

Construction of the proposed wind farm would involve the disturbance and excavation of large volumes of soil, for the creation of wind turbine foundations, internal access tracks and lay down areas. Excavation and earthworks, vehicular movement and construction activities have the potential to impact on the local air environment through the generation of dust.

3.2.2 Objective

Minimise dust emissions generated from construction activities.

3.2.3 Requirements

Design

- Site access tracks and lay down areas shall:
  - Incorporate existing roads and tracks wherever possible, to minimise site disturbance
  - Be ‘top dressed’ with 150 mm of crushed rock, to minimise dust generation.

Construction and Decommissioning

- Vehicular traffic shall be restricted to designated site entry and exit points
- During construction of access tracks and lay down areas, exposed soils shall be sprayed with water to suppress any nuisance dust. Water applied to access tracks shall be managed such that run-off is minimised.
- Following construction of access tracks and lay down areas:
  - Vehicular traffic shall be restricted to constructed site access roads
  - Plant, equipment and materials storage shall be restricted to constructed lay down areas
- Soil stockpiles shall be seeded as necessary to minimise material loss.
- Disturbed areas shall be reinstated and revegetated as soon as reasonably practical.
- Any community complaints shall be promptly investigated and responded to, and any necessary corrective action initiated.

Operation

- During operation water carts shall be used as required to spray water on access track and soil stockpiles to minimise dust generation.
- Vehicular traffic shall be restricted to constructed site access roads and designated site entry and exit points.
- Plant, equipment and materials storage shall be restricted to constructed lay down areas.
- Any community complaints shall be promptly investigated and responded to, and any necessary corrective action initiated.

3.3 Wastewater Management Procedure

3.3.1 Issues

The deposition of oil and grease on roads and other surfaces from vehicles and machinery, septic wastewater or spills of chemicals or fuels can be potential sources of stormwater contamination.

3.3.2 Objective

To minimise and manage all wastewater generated on site to ensure that no adverse amenity, health or environmental impact occurs.

3.3.3 Requirements

Design

- The lay down areas would be designed to comply with all regulatory and non regulatory requirements for the transport, storage and use of hazardous substances, including fuels and chemicals.
- All domestic wastewater (grey water and black water) generated from the maintenance building will flow to an underground septic system. The septic system shall be managed in accordance with EPA permits and requirements, including monitoring and maintenance requirements.

Construction and Decommissioning

- Minimise the quantities used and use chemicals that pose the least potential risk to human health and the environment.
- Maintain a manifest and a register of Material Safety Data Sheets (MSDSs) for all chemicals being stored at the site.
- Prescribed waste shall be removed from the construction site on a progressive basis and not allowed to stockpile unduly.
- Refuelling of vehicles and machinery shall only occur in designated refuelling areas.
- Refuelling and wash down areas shall be appropriately bunded to contain any spills or leakage.
- Chemicals and fuels shall be appropriately bunded to contain any spills or leakage.
- Spill kits shall be located at all work areas, particularly those in close proximity to surface waters.

- General maintenance of equipment shall be undertaken off site where practicable.
- Portable toilets shall be maintained by a specialised contractor to minimise leaks and spills to the environment.
- Litter shall be managed to ensure it does not end up in wastewater or stormwater off site.

Operation

- Minimise the quantities used and use chemicals that pose the least potential risk to human health and the environment.
- Maintain a manifest and a register of Material Safety Data Sheets (MSDSs) for all chemicals being stored at the site.
- To avoid construction machinery dropping mud from their tyres on roads when they leave the construction site such measures as cattle grids, logs or railway sleepers filled with crushed rock and/or a small sediment trap can be used to shake the soil from their tracks.
- All domestic wastewater (grey water and black water) generated from the maintenance building will flow to an underground septic system. The septic system shall be managed in accordance with EPA permits and requirements, including monitoring and maintenance requirements.
- Manage vehicle wash down area run-off to minimise potential issues such as ponding, weed dispersion and surface water quality impacts.
- Spill kits shall be located at all work areas, particularly those in close proximity to surface waters.
- Spills shall be cleaned up immediately, spill kit materials replenished, and waste from spill clean up shall be disposed via a licensed prescribed waste contractor.
- An agreed program for annual inspection shall be developed that will provide a maintenance schedule for the on-site management of the wastewater system.
- Litter shall be managed to ensure it does not end up in wastewater or stormwater off site.

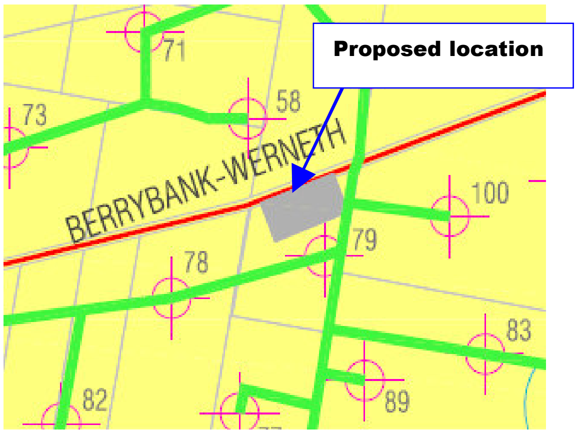
3.4 Temporary Concrete Batching Plant Management Procedure

3.4.1 Issues

A temporary concrete batching plant will be sited within the extents of the planned wind farm site and will be operational throughout the construction phase. The specific location proposed by BDPL is along Berrybank-Werneth Road, as illustrated in Figure 3-1 below.

3 Part 2 Environmental Management Procedures

Figure 3-1 Proposed concrete batching plant location



The proposed location of the concrete batching plant is currently cleared farming land. The surrounding area predominately has similar terrain and land use, generally flat with some areas of slight undulations. It is noted that there are no natural surface water bodies or gullies located within close proximity to the currently proposed concrete batching plant site.

In determining the site for the temporary concrete batching plant, the following environmental elements will be considered.

Wastewater

Concrete batching plants have the potential to generate considerable quantities of wastewater which must be properly managed to protect local ecosystems. Wastewater may be generated from a variety of processes such as: dust suppression; uncontrolled runoff from contaminated areas; washout stations; and general cleaning. This water, if inappropriately managed, could have a detrimental effect on receiving waters such as increased acidity and turbidity.

Dust

Dust from cement, sand and aggregates are pollutants. Fine dust particles can enter neighbouring premises and adversely affect amenity. Dust must be controlled so there are no significant emissions from the plant.

Potential sources of dust emissions could originate from:

- Concrete batching plant activities
- Deliveries to site
- Stockpiled materials
- Other construction activities

Noise

Noise emitted from a concrete batching plant has the potential to impact on the amenity of the local community.

Major sources of noise at batching plants include:

- Trucks and other vehicles
- Batching equipment such as hydraulic pumps, conveyor belts and air valves

- Radios
- Reverse warning devices

Solid Wastes

The main solid waste generated by batching plants is waste concrete.

3.4.2 Objective

Siting and management of the temporary concrete batching plant to minimise any adverse environmental impacts.

Requirements

Design

- Siting of concrete batching plant and any on-site wastewater and disposal and disposal treatment fields shall be at least 100 meters from any watercourse.
- The batching plant should be located so that contaminated stormwater and process wastewater can be retained on-site. The land should not be flood prone (it should have a flood average recurrence interval less than 100 years).
- The batching plant shall be located at least 100 metres from sensitive areas (including residents, hospitals, schools and caravan parks) to minimise dust and noise issues.
- The batching plant should be sheltered from wind to reduce dust problems.

Construction and Decommissioning

- To manage wastewater and contaminated rainwater, a collection pond shall be constructed. Water from the pond could be reused in the batching of concrete (reducing water demand). Alternatively wastewater will need to be collected and treated by a licensed EPA waste water treater.
- To avoid stormwater run-off from other areas on site combining with contaminated surface water run-off the following areas will be paved and bunded:
  - Agitator washout area
  - Truck washing area
  - Concrete batching area
  - Any other areas that may generate stormwater contaminated with cement dust or residues
- The system's storage capacity shall be sufficient to store the runoff from the bunded areas generated by 20 mm of rain.
- Collection pits should contain a sloping sludge interceptor, to separate water and sediments.
- Wastewater should be pumped from the collection pit to a recycling tank. The pit should have a primary pump triggered by a float switch and a backup pump which automatically activates if the primary fails.
- Collection pits should be provided with two visual alarms. The first should activate when the primary pump fails. The second should activate when water reaches the high level mark in the pit. Both alarms should activate warning devices on the operator's console.

3 Part 2 Environmental Management Procedures

- Surface water shall only be allowed to discharge from the concrete batching plant during wet weather. All discharges shall be monitored for pH and suspended solids concentration.
- Where it is not able to be reused on site, surface water discharges from the batching plant shall comply with the following:
  - Have a pH level between 6 and 9
  - Have a suspended solids levels of less than 80 mg/L
  - Do not occur during dry weather
- Records of all discharges shall be maintained.
- Concrete truck wash water shall be collected onsite and managed to prevent any impact on the environment. Reuse options will be investigated and implemented where practicable.
- Excess concrete from the concrete batching plant and general waste to be disposed offsite at an appropriate waste management facility.
- To minimise dust emissions the following shall be undertaken where practicable:
  - Keep sand and aggregates damp
  - Cover or enclose conveyor belts and hoppers
  - Keep pavements and surfaces clean
  - Fit cement silos with high level alarms, multibag pulse jet filters, airtight inspection hatches and automatic cut-off switches on the filler lines
  - Keep duct work airtight
  - Enclose the loading bay
  - Develop and implement an inspection regime for all dust control components
  - Clean up spills immediately
- To minimise noise emissions the following shall be undertaken where practicable:
  - Select quieter equipment
  - Alter or enclose equipment to reduce noise at the source
  - Isolating noise generating equipment by using an acoustic enclosure, for example perforated metal facing with rockwool or glasswool insulation or acoustic screens;
  - Reducing sound reverberation within the plant by using acoustic wall absorbers or wall insulation such as rockwool or glasswool
  - Ensure hooters are used for emergencies only
  - Avoid public address systems for paging staff
- Where required, the local community will be liaised regarding potential noise and dust issues from the batching plant.
- Wherever practicable, the generation of waste concrete will be minimised and concrete recycling opportunities will be identified and utilised as far as possible.
- Recycling programs shall be established for aluminium cans, glass bottles, packaging materials, cardboard and paper.

3 Part 2 Environmental Management Procedures

- The temporary concrete batching plant will be decommissioned once construction of the wind farm is complete. All batching plant materials, site offices and vehicles shall be removed from site. All wastes such as excess concrete and general waste shall be appropriately disposed and recycled where possible. Any contaminated material such as soil shall be cleaned up and disposed as prescribed waste using a licensed prescribed waste transporter. Stockpiled topsoil shall be re-spread and all cleared vegetation will be reinstated.

Conclusions and Recommendations

From review of the available documentation, site inspection, and discussions with stakeholders, the following conclusions and recommendations are presented in respect to the management of sediment, erosion and water quality for the proposed Berrybank Wind Farm:

- Clearing of land for construction of the wind farm should be done in a systematic manner such that topsoil exposure and thus the potential for erosion and dust creation is minimised.
- The Berrybank site is very low lying and therefore at risk of water logging. Surface water should be diverted around the site and the rate of flow slowed where possible to reduce the amount of sediment-laden run-off from being created and needing to be managed.
- Sediment controls, such as silt fencing, swale drains and sediment basins will need to be carefully constructed to avoid impacting on local waterways, in particular the Gnarpurt Chain of Ponds, Naringall Creek and a number of small unformed drainage lines which cross the site.
- Removal of septic tank wastewater (including grey water and black water) will need to be conducted by an appropriately licensed waste transporter.
- All designated refuelling and wash down areas should be managed such that wastewaters generated are captured and appropriately managed prior to disposal.
- The proposed location of the temporary concrete batching plant as described would be sited at a distance greater than 100 metres from surface waters and sensitive land uses. This is consistent with the siting requirements of EPA publication 628 *Environmental Guidelines for the Concrete Batching Industry* and should ensure that the potential environmental impacts are greatly reduced.
- The batching plant should be managed such that environmental impacts such as dust, noise and wastewater discharge are minimised, through best practice design and operation (e.g. wastewater should be recycled through the plant to reduce the need for treatment and off site disposal).

References

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US EPA, (2000) *Recommended Practices Manual: A Guideline for Maintenance and Service of Unpaved Roads*, Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority, February 2000, http://water.epa.gov/polwaste/nps/upload/2003_07_02_nps_unpavedroads_unpavedtxtonly.pdf.

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Berrybank Development Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 2 October 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March 2011 and the date specified on this report and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Design specifications for on site sediment and erosion control structures

Appendix A

A.1 Vegetated Swale Drains

Swales are open vegetated channels that capture overland flow. They are typically found in small country towns and can be used as an alternative stormwater conveyance system to the conventional kerb and channel along roads and associated underground stormwater pipe.

The configuration of swales is such that side and longitudinal slopes are gentle. Together with the vegetation, the swales attenuate flow and as a result decrease the peak of a rainfall event. The vegetation also acts to facilitate deposition of solids washed off the tracks, and assists with the removal of nutrients. They allow some degree of stormwater infiltration into the sub-surface and their effectiveness as an infiltration system depends on the presence of vegetation to maintain soil porosity.

Advantages

- Improves water quality.
- Can be incorporated into the landscape.
- Visible operation.
- Reduction of peak flows and flow attenuation for frequent events.
- The removal of pollutants.
- Promotion of runoff infiltration.
- Lower capital costs.

Limitations

- Typically ineffective in, and vulnerable to, large storms, because high-velocity flows can erode the vegetated cover.
- They are impractical in areas with very flat grades, steep topography, or wet or poorly drained soils.
- They can become drowning hazards, mosquito breeding areas, and may emit odours.
- They are impractical in areas with erosive soils or where a dense vegetative cover is difficult to maintain.

Design

Design conditions for swale drains are noted in various national and international publications. The criteria noted below is that suggested for urban swales by Engineers Australia (June 2003) and Melbourne Water (2004), which can be adopted for the swales proposed at the Berrybank Wind Farm.

Geometry – Minimise sharp corners with trapezoidal or parabolic shapes and side slopes no steeper than 1:3 (v:h)

Longitudinal Slope – In the range of 1-4% to promote uniform flow conditions across the cross section of the channel. Check dams should be installed if slopes exceed 4% and underdrains installed if slopes are less than 1%. Slopes below 1% could lead to ponding (except where there is adequate infiltration), whilst slopes in excess of 4% increase the risk of scouring, erosion and re-suspension.

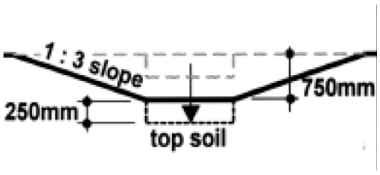
Appendix A

Swale Width – Should be limited to no more than 2.5 m, unless structural measures are used to ensure uniform spread of flow.

Maximum Flow Velocity – Should be less than of 0.5 m/s for the 1 year ARI event and a maximum velocity of 1.0 m/s for the 100 year ARI event.

Mannings n Value – The recommended Manning's n value is between 0.15 and 0.3 for flow conditions where the depth of flow is below the height of the vegetation. For the 100 year event, the Manning's n value is significantly lower and is of the order of 0.03.

Figure A-1 Example configuration cross section of swale



Moving downstream along a swale the size of the contributing catchment area will increase and thus the magnitude of the design flow corresponding to the probabilistic design event will also increase. Consequently it will be necessary to widen the swales to accommodate for the increased flow.

Vegetation

Vegetation of the swale can range from grass to native shrubs, depending on hydraulic and landscape requirements and on the location, type and nature of the swale drain design. Vegetation is required to cover the whole width of the swale, be capable of withstanding design flows and be of sufficient density to provide good filtration.

Maintenance

Swale systems treat runoff by filtering it through vegetation and then passing the runoff downstream. Treatment relies upon contact with vegetation and therefore maintaining vegetation growth is the main maintenance objective. In addition, they have a flood conveyance role that needs to be maintained to ensure adequate flood protection (Melbourne Water, 2004).

The potential for rilling and erosion down a swale needs to be carefully monitored, particularly during establishment of the swales.

Routine maintenance includes mowing, watering, fertilising, removal of sediment, removal of weeds and noxious plants, re-establishment of plants and repair of any damaged areas within a channel. Inspections will also be required following large storm events to check for scour.

Appendix A

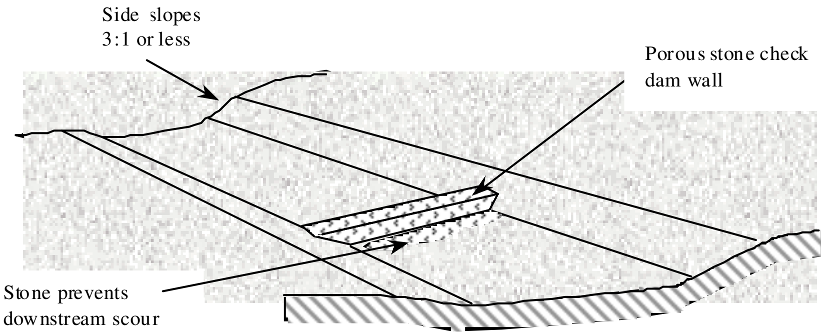
A.2 Check dams

For steep swales, i.e. greater than 4%, check dams can be used to help distribute flows across a swale, to promote additional infiltration, to increase storage, and to reduce flow velocities.

The check dam is made from graded porous broken stone. They are typically low and constructed at the base of a swale.

Runoff will pond behind the dam allowing sediment to settle out. As the check dam is made of stone, it will allow the ponded water to discharge slowly towards the outlet. This improves the efficiency of the swale.

FigureA-2 Schematic of check dam in swales



Design

The design criterion for check dams is minimal. Melbourne Water (2004) suggests that check dams be used in swales where the longitudinal gradient is greater than 4% and that the check dam wall is low, e.g. 100mm.

The material from which the check dam wall is made is important, as it must allow low flows to filter through and not allow water to accumulate behind it for an extended period of time, as this will encourage mosquito problems.

Maintenance

As with swales check dams also require routine maintenance to ensure their integrity and to remove any accumulated debris behind the check dam wall.

A.3 Culverts

In the case of the proposed Berrybank Wind Farm, existing culverts are used to convey concentrated flows under an embankment, through natural watercourses, as illustrated in Section 2.1 of the SEWQMP.

Appendix A

Design

The design objectives for culverts are:

- to pass the design flow through the pipe;
- to limit surcharging upstream of the culvert; and
- to protect against downstream scour.

The outlet velocity for the design flow will be determined from the hydraulic calculations. The part full velocities for the culvert need to be determined for a range of flows to check for the scouring velocities at the outlet to ensure that the culvert is not laid on a steep grade which will cause regular high velocity flow to be directed downstream. The outlet velocity into an open watercourse should be less than 2.0 m/s for the design flow. Where this can not be achieved scour protection works need to be designed (Melbourne Water, 2002).

Maintenance

Maintenance of culverts is relatively low and includes monitoring for erosion directly upstream and downstream of the structure, and silt accumulation inside the culvert.

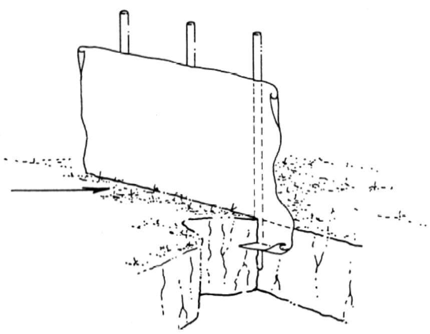
A.4 Silt fences

Silt fences are used as temporary perimeter controls around sites where there will be soil disturbance due to construction activities. They consist of a length of filter fabric stretched between anchoring posts spaced at regular intervals. The filter fabric should be entrenched in the ground between the support posts. When installed correctly and inspected frequently, silt fences can be an effective barrier to sediment leaving the site in storm water runoff.

In some instances straw or hay bales can be used as silt fences, however their failure rates are higher than fences with a filter fabric, and given the fact that cattle will be grazing the wind farm area hay bales are not considered appropriate as silt fences in this instance.

Figure A-3 and **Figure A-4** illustrate silt fences. They are appropriate in areas where runoff will be occurring as low-level shallow flow.

Figure A-3 Schematic of a silt fence



Appendix A

Figure A-4 Example of silt fence used during construction of Te Apiti Wind Farm in New Zealand

Advantages

- Easy installation.
- Low cost.
- More effective than hay bales (which are not appropriate at this site due to stock)

Limitations

- Proper installation is critical for effective performance.
- Frequent inspection and maintenance required.

Maintenance

Silt fences should be inspected regularly as well as after each rainfall event to ensure that they are intact and that there are no gaps at the fence-ground interface or tears along the length of the fence. If gaps or tears are found, they should be repaired or the fabric should be replaced immediately. Accumulated sediments should be removed from the fence base as they accumulate. The accumulated sediments must also be removed prior to removing the fence following completion of construction.

A.5 Vegetated buffers

The incorporation of vegetated buffer strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Vegetated buffer strips suitable for the Berrybank Wind Farm would be treed areas, the vegetation being of the type of shrubs one to two metres in height that are typical of the area. Flow conditions across a buffer strip are typically well distributed with shallow flow depths and high hydraulic roughness attributed to the vegetation. These flow conditions are conducive to reduction in stormwater suspended solids. With their requirement for uniformly distributed flow, buffer strips are well suited to treatment of road runoff, allowed to flow evenly from the road surface.

Appendix A

Design

There are at present no definitive design guidelines for buffer strips (Engineers Australia, 2003). Critical design considerations include:

- Means of ensuring a well distributed spreading of stormwater over the buffer strip;
- Slope; and
- Vegetation density.

Poor entry conditions and sparse vegetation cover will lead to concentration of flows and subsequent formation of rills and erosion pathways on the buffer strip. Whilst longitudinal slope of up 20% have been found to operate satisfactorily in a well designed and constructed buffer strip, this is strongly dependent on the condition that an even flow distribution is maintained. Typically, maximum slopes of around 5% should be maintained where possible. Maximum velocities should be maintained below 0.4 m/s (Engineers Australia, 2003). Where there is any likelihood of flow convergence, then flow-spreaders in the form of check dams should be used.

Maintenance

Maintenance may be necessary to remove deposited sediment from buffer strips subsequently provision should be made for easy access to maintain these areas. Avoiding excessive sediment loading, particularly during construction activities, will extend the operating life of a buffer strip. Occurrence of any erosion (such as rilling), should it occur, should be rectified, so that major damage to the buffer does not occur. Regular inspection should also be undertaken to ensure that vegetation is in reasonable condition (Engineers Australia, 2003).

A.6 Sedimentation basins

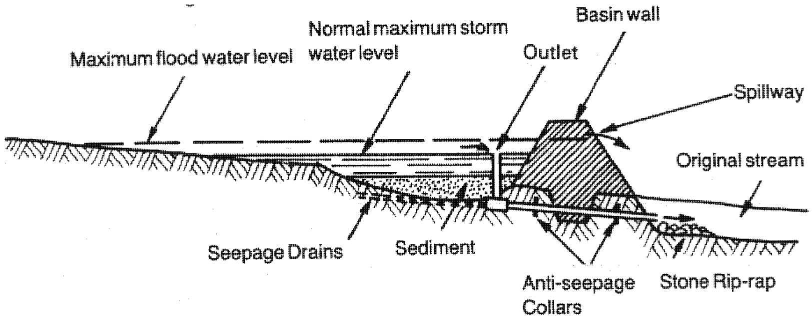
Sedimentation basins can be constructed as natural ponds using site soils. They retain sediments by simply enlarging a channel so that velocities are reduced and sediments settle to the bottom.

Flow into the sedimentation basin might be via swale drains or concentrated flow from a culvert or pipe. Depending on the vicinity of the sedimentation basin to a watercourse, the outlet from the sedimentation basin can either be directed flow through a pipe, as illustrated in **Figure A-5**, or dispersed flow as water is retained in the structure until overflow occurs, allowing maximum settling time.

Sedimentation basins can be used as permanent systems integrated into a drainage design or as temporary measures to control sediment discharge during construction.

Appendix A

Figure A-5 Schematic of sedimentation basin with piped outlet (Ransom)



Design

The required size of a sedimentation basin is calculated to match the settling velocity of a target sediment size with a design flow.

Typically, a large proportion of nutrients in stormwater will be bound to the suspended sediment particles. Therefore, since sedimentation basins are designed to facilitate the settling of sediment, they are also effective at removing a large proportion of particulate-based nutrients from the water column.

The rate at which a sedimentation basin removes sediment from the water column is affected by the sediment particle size, the velocity of the water, and the length of time that the basin retains the stormwater.

Maintenance

Sedimentation basins treat runoff by slowing flow velocities and promoting settlement of coarse to medium sized sediments. Maintenance revolves around ensuring inlet erosion protection is operating as designed, checking for excessive sediment loads and ensuring that the overflow or outlet is not blocked with debris.

Regular checks of sediment build up will be required as sediment loads from the catchment can vary, particularly during construction. The basins should be cleaned out if more than half full of accumulated sediment (Melbourne Water, 2004).

Maintenance of sedimentation basins is performed by excavating collected sediments following dewatering of the basins. Typically sediment basins are designed for maintenance frequencies of between one and five years but this varies depending on the catchment disturbance and activities.

The cleaning procedure involves dewatering the basin, removing sediments and re-establishing the area. The nature of collected pollutants can determine their suitability for disposal. Sediment traps are typically designed for coarse sediments only (typically 0.125 mm) and this material is expected to have relatively low contamination, however should be monitored during maintenance.

Appendix A

A.7 Slope Stabilisation

The preliminary design completed for the internal tracks at the Berrybank Wind Farm has sought to minimise and avoid as much as possible the need for slope stabilisation. However where a steep slope is unavoidable, slope stabilisation must be considered.

The steeper the slope of an embankment, the greater the potential of soil loss from erosion. Soil erosion by water also increases as the slope length increases due to the greater accumulation of runoff.

Slope stabilisation is the process of establishing and implementing resistive measures against erosion and failure of cut slopes or fill embankments. Stabilisation may be achieved by either mechanical (structural) means, such as blankets, geofabrics and rockwork, and/or by using vegetation.

Slope failure occurs when a section of the bank slides. There are a number of potential causes of slope failure including:

- The slope gradient is too steep for the strength of the soil;
- Improper soil compaction;
- Slope toe erosion; and
- Excessive artificial loads placed on the slope.

Proper long term stabilisation of banks along tracks and drainage ways may significantly reduce and possibly prevent costly maintenance, and may considerably contribute to the reduction and prevention of erosion and potential sediment delivery into watercourses.

Bank construction and maintenance procedures in relation to compaction, slope gradient, and surface grading is critical to establishing a long term, stable slope.

There are various methods able to be used to stabilise a slope. These methods, a sample of which are described below and illustrated in **Figure A-6**, can be grouped into bank grading, vegetation and structures (US EPA, 2000):

Bank grading techniques

- Terracing. Terracing is the construction of benches on long and/or excessively steep slopes to provide breaks in the slope that will intercept runoff.
- Cutting and/or filling the removal and/or addition of soil to the bank to create the desired slope.
- Keying a slope is achieved by the cutting a trench or bench into a slope surface prior to placing fill on it in order to prevent slippage or creep of the added fill.

Vegetation

- Vegetation by grass seeding. Grass seeding is the most efficient and cost effective method of stabilising slopes. This method should always be considered first and used wherever possible. Grass will slow water movement and allow more infiltration.
- Vegetation by trees and shrubs. Trees and shrubs can be used to create a good vegetative filter strip and stabilise steep or wet slopes, watercourse banks, and/or other areas where stronger and/or larger vegetation than grass is needed for stabilisation.

Appendix A

Structures

- Gabion retaining wall. A gabion retain wall consists of rectangular wire mesh boxes filled with stone, stacked and assembled as a near vertical or stepped wall to support the vertical earth material behind it. They can increase infiltration by absorbing some runoff into its porous mass.
- Log or timber crib retaining wall. This retaining wall consists of a rectangular box made of logs or treated timer, filled with soil, rock or other fill material to provide a stable slope.
- Mechanical riprap. A lining of rock riprap overlying a filter such as a geofabric, covering the surface of a slope can be placed to protect it from erosion. Rock size is dependent on the gradient of the slope and the velocity of runoff over it.
- Vegetated riprap. The lining of rock riprap mentioned previously can be planted with vegetation to retard velocities and provide enhanced slope stability.

As part of the above methods of slope stabilisation, mats, blankets and geotextiles can be used to stabilise soils. Mats and blankets prevent erosion on a temporary basis and can be used on steep slopes, in drains (such as swales) and other areas prone to erosion. They usually deteriorate giving way to vegetation to hold the soil. Synthetic geotextiles are permeable and can be used in protecting and filtering soils and/or increasing the strength of the soil profile. Geotextiles can be used under riprap, or placed at or below the soil surface to provide improved strength and erosion resistance.

Design

Design of slope stabilisation is dependent on various factors including:

- The location of the slope to be stabilised.
- The slope gradient.
- Aesthetics to be achieved.
- Surface water management controls to capture runoff and retardation of runoff velocity required.

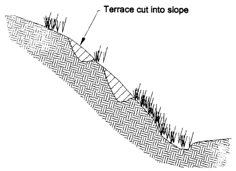
Maintenance

Maintenance of stabilised banks involves regular checking and repairing any vegetation or damaged structure.

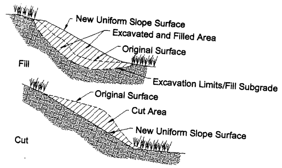
Appendix A

Figure A-6 Slope Stabilisation Techniques (US EPA, 2000)

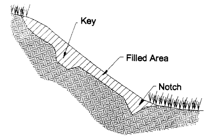
Bank grading techniques



Slope Terracing

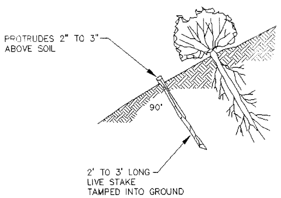


Slope Shaping by Cutting and/or Filling

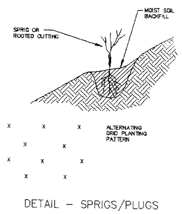


Slope Keying for Fill Placement

Vegetation

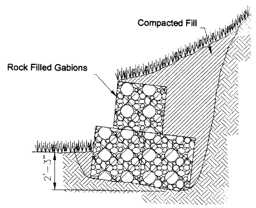


Live Stake Planting

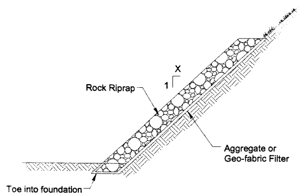


Sprig/Plug Planting

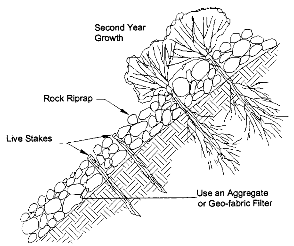
Structures



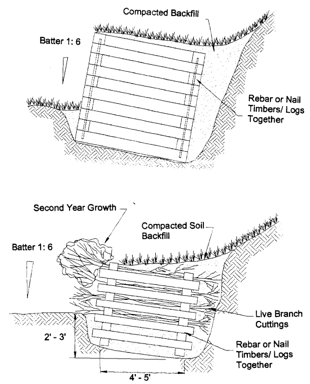
Gabion Retaining Wall



Mechanical Riprap Revetment



Vegetated Riprap Revetment



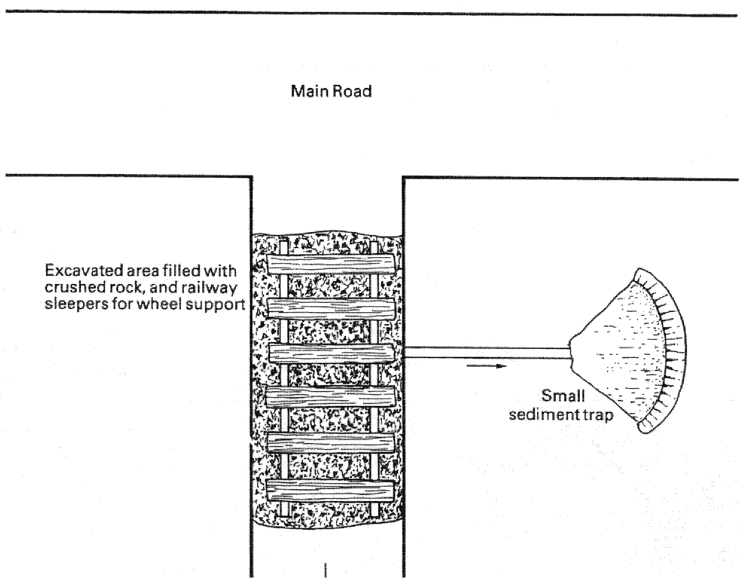
Log or Timber Crib Retaining Wall

Reference US EPA (2000)

A.8 Machinery crossings

To avoid construction machinery dropping mud from their tyres on roads when they leave the construction site such measures as cattle grids, logs or railway sleepers filled with crushed rock and/or a small sediment trap can be used to shake the soil from their tracks. **Figure A-7** below illustrates an example of a construction site entrance to capture sediment deposited from construction vehicles.

Figure A-7 Example of construction site entrance sediment control (Ransom)



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