FINAL REPORT

Stormwater Management Plan for the proposed Crookwell II Wind Farm

17 AUGUST 2009

Prepared for

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Date:	**17 August 2009**
Reference:	43167756/01/02
Status:	FINAL

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Introduction

1.1 Overview

This Stormwater Management Plan (SMP) has been prepared for the proposed Crookwell II Wind Farm located at Crookwell, NSW. The aim of the plan is to improve the management of stormwater within the project site.

The project site is located within the Upper Wollondilly River sub-catchment, part of the Warragamba Catchment. The plan is therefore consistent with the Integrated Catchment Management Plan for the Warragamba Catchment (NSW DLWC, 2003), also known as the Warragamba Catchment Blueprint (WCB).

The SMP:

- Describes the catchment of the site (Chapter 2);
- Identifies existing catchment conditions (Chapter 3);
- Establishes the values of the catchment (Chapter 4);
- States appropriate management objectives (Chapter 5);
- Identifies management issues (Chapter 6);
- Evaluates potential management practices (Chapter 7); and
- Presents a performance monitoring program (Chapter 8).

However, the Stormwater Management Plan does not:

- guarantee that water quality objectives will be achieved if all management options are implemented; or
- include detailed catchment water quality modelling, analyses and designs, but is based upon existing information which in some areas is very limited.

1.2 Project Summary

The proposed development would be located in the Southern Highlands of NSW, on a 2,088 hectare site located approximately 14 km south-east of Crookwell and 30 km north-west of Goulburn, in the vicinity of the existing Crookwell wind farm. The site has a long history of agricultural use, and is now largely used as pasture for grazing of sheep and cattle.

The proposed wind farm would comprise the following components:

- 46 turbines, each made up of an 80 m steel tower, a nacelle, and three fibreglass blades, each 45 m in length. The top of the blade sweep would be 128 m above ground level;
- a network of site tracks, providing access to each turbine across the site;
- a network of underground electrical cables, connecting each turbine to the electrical substation;
- an electrical substation and switchyard, connecting the wind farm to TransGrid's electrical transmission system; and
- a site control room / facilities building.

The construction works would consist of some limited site clearing, construction of the site access tracks, excavation and construction of the turbine foundations, trenching and installation of the underground cables, erection of the wind turbines, construction of the network connection and site buildings, and restoration of the site.

The wind farm would be manned during normal working hours by a small number of operational staff who would conduct regular inspections and maintenance of the equipment. It would also be remotely monitored 24 hours per day, with duty staff on-call to respond if required.

1.3 Project Stormwater Management

Wind turbines are generally located along ridge lines. Surface drainage within the site therefore generally flows either side from the ridgelines into the identified creeks and rivers within the valleys.

Proposed site access tracks will have drainage trenches installed to collect rainfall runoff from the compacted surface, to be discharged at evenly spaced distances into the surrounding grasslands for natural infiltration. Drainage trenches will be appropriately designed in the vicinity of watercourses to prevent scouring and discharge of sediment into the watercourse, and to allow for fish passage and other aquatic flora and fauna. Drainage trenches will be designed so that water flow will mimic the natural flow environment.

Culverts will be installed to provide flow paths beneath the site access tracks.

Drainage trenches and culverts will be designed according to the recommendations outlined in *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

During the construction a portable toilet facility will be provided with all waste removed off-site for treatment and disposal by a licensed contractor. During operations a permanent toilet and small on-site wastewater treatment facility will be constructed. The treatment facility will be self-contained without any external release of effluent.

2 Catchment Description

The following describes the catchment of the project site. The site for the proposed wind farm is located within the Southern Highlands of NSW, near the town of Crookwell. The project site spans Crookwell Road, approximately 14 km south-east of Crookwell and 30 km north-west of Goulburn, in the vicinity of the existing Crookwell wind farm. The total site area is approximately 2,088 ha, comprising undulating terrain of ridgelines and valleys, with varying slopes of 5% to >15%.

The catchment of the site extends north approximately 15km with the majority of the catchment draining through the site via Wollondilly River. The following descriptions of the project site and catchment are largely based on the Crookwell II Wind Farm Environmental Impact Statement (URS, 2004), herein referred to as the EIS. The project site, of which more information is available, is considered representative of the upstream catchment and is therefore often referred to in the following catchment descriptions.

2.1 Land Use

The site is largely cleared as a result of past agricultural activities and primarily consists of open grassland with a number of planted tree wind breaks, and isolated remnant woodland and other vegetated areas.

The site is currently used as agricultural land, primarily for grazing for both sheep and cattle. Historically, following land clearing in the early part of the 20th century, the site has always been used for various agricultural purposes.

Overall the site is largely undeveloped, other than the construction of a number of homesteads associated with agricultural and recreational use (holiday homes), with unsealed rural tracks providing access from Crookwell Road.

The catchment of the site is similarly comprised of rural agricultural properties.

2.2 Regional Hydrology

The catchment of the proposed wind farm is located within the Upper Wollondilly River sub-catchment, part of the Warragamba Catchment, which in turn is part of the overall Sydney drinking water catchment.

The Warragamba Catchment covers an area of approximately 10,030 km^2 from which runoff flows into Lake Burragorang (formed by Warragamba Dam. Lake Burragorang is the major water supply for Sydney, supplying, with the Upper Nepean storages, 97% of Sydney's drinking water.

The largest inflow into Lake Burragorang is the Wollondilly River, which has its headwaters to the north and flows through the project site. The Wollondilly River flows south to Goulburn, and then north-east to Lake Burragorang. Its major tributaries include the Mulwaree, Tarlo, Paddy's and Wingecarribee rivers.

The Warragamba Catchment is subject to the provisions of the Integrated Catchment Management Plan for the Warragamba Catchment (DLWC, 2003), also known as the Warragamba Catchment Blueprint (WCB), which is managed by the Hawkesbury-Nepean Catchment Management Authority.

2.3 Topography

The site is generally undulating with a number of ridges and gullies, with elevations ranging from less than 800 m above Australian Height Datum (mAHD) in the gullies, up to 950 mAHD at the top of the ridges. The highest point on the site is Monument Hill, with an elevation of 952 mAHD. The majority of the site is grassed, although there are some rocky hilltops covered in Scotch thistle. Small stockpiles of rocks (gathered during past agricultural activities) are randomly scattered on the site.

The catchment of the site extending to the north reaches an elevation of 1000 mAHD and is similarly grassed.

Throughout the site and catchment, gullies have been carved by various watercourses, the principal watercourses being Wollondilly River to the east, First Creek just west of Crookwell Road, and Middle Creek along the western site boundary. These watercourses generally cross the site in a north-south direction. Various other creeks and a number of small farm dams are spread across the site and catchment.

2.4 Geology and Soil

2.4.1 Regional Geology

The general geology of the region is represented by Cainozoic era basalt, present on elevated areas south and east of Crookwell. Regional mapping indicates that a large granite body, the Wologorong-Tumborambora Granite, underlies the basalt. Interpretation of the Goulburn 1:250,000 Geological Sheet (Brunker & Offenburg, 1970) indicates that the site itself is divided into three geological formations, that is:

- Basalt;
- Granite; and
- Sedimentary rocks consisting of silty sandstone, micaceous siltstone, shale, phyllite, slate and quartzite.

2.4.2 Site Soil Landscapes

Four soil landscapes have been categorised within the site area, according to the Goulburn 1:250,000 Map Sheet (Hird, 1991), although as suggested by the geology, soils tend to fall into two groups based on the granite or basalt parent rock.

The Garland soil landscape, the predominant landscape of the site, is formed from the granitic parent material, most commonly light red sandy duplex soils on upper slopes and mottled yellow duplex soils with sandy textured topsoils and bleached A_2 horizons on mid and lower slopes. Sandy red and yellow earths are also found on sideslopes, with deep siliceous sands found in some drainage lines, and occasional granitic tors and pavements. Soils have formed in situ and from alluvial-colluvial deposits. Landforms tend to be gently undulating and undulating rises, and undulating and rolling low hills. Slope gradients tend to be less than 15%.

The landscape is associated with pockets of Wyangala soil landscape, which also occurs within the site boundary. The Wyangala landscape is also formed from the granite parent, with siliceous sands dominating, although red duplex and yellow podzolic soils, and red earths are also present. The typical landform tends to be rolling low hills to rolling hills, with gradients greater than 15%.

The other soil landscapes within the site boundaries (tending to the northern area and the ridgeline incorporating Monument Hill) derived from the basalt geology, identified as the Macalister soil landscape and the associated Taralga soil landscape.

The Macalister landscape occurs wherever remnants of Tertiary basalt flows have been incised to expose underlying Ordovician or Silurian sediments or granite batholiths. The unit also includes relatively small areas of soils formed on tertiary laterites and sands that are found close to the basalt. The relationship between the soil types is complex. Chocolate soils and minimal krasnozems are found in association with the basalt. Red and yellow podzolic soils and stony acid yellow earths have formed on the sediments. Lateritic red earths occur on the laterite deposits and sandy yellow earths on the tertiary sands. The soil landscape is an incised plateau, with undulating to rolling hills as typical landform patterns and gradients of 5-15%.

This landscape is closely associated with the Taralga soil landscape, which is also predominantly chocolate soils formed in situ from alluvial-colluvial material derived from tertiary laval flows of basalt and dolerite. Krasnozems and Xanthozems are found on crests. Landforms are typically plateaux or valleys of gently undulating to undulating rises with elevations greater than 800 m and slope gradients of 2-15%.

2.4.3 Soil Erosion

In the Garland landscape, gullying of drainage lines is the most frequent form of soil erosion, and gullies left to progress unchecked can often reach depths of greater than 3m. Sheet erosion occurs only in very dry years or following bushfires, because the predominantly slightly sandy textured soils respond quickly to even light falls of rain. Similarly, within the associated Wyangala landscape, some gully erosion is found within the drainage lines, and sheet erosion occurs following drought, bushfires or over-stocking.

In the Macalister landscape, little erosion occurs on the fertile soils formed on the basalt remains. Some gully and sheet erosion are present on other soil types. In the associated Taralga landscape, sheet erosion occurs where soils are cleared for cultivation, as well as on steep gradients where there is soil creep and occasional slumping.

Soil qualities for the different landscapes are summarised in Table 2-1.

Table 2-1 Site Soil Qualities

Criteria	Siliceous Sands	Yellow Podzolic Soils	Chocolate Soils	Red Podzolic Soils	Lateritic Red Earths	Yellow Earths
Soil Permeability	Well drained	Imperfect	Moderate	Moderately well drained	Well drained	Well drained
Erodibility (topsoil)	Moderate	Moderate	Low-Moderate	Moderate	Low	High
Erodibility (subsoil)	High	Moderate	Low	Low	Low	High
Erosion Hazard	High	High	Low-moderate	Low	Low	Moderate
Structural Degradation Hazard	High	High	Low	Low	Low	High

2.5 Climate

Climatic data has been sourced from the Bureau of Meteorology. The nearest climate station to the catchment is Crookwell Post Office (Station 070025). Daily maximum and minimum air temperatures have been recorded at this station for approximately 51 years between 1916 and 1975. Daily rainfall presently continues to be recorded at this station since commencement in 1883. Daily pan evaporation data is available from the nearest recording station, Goulburn TAFE (Station 070263) where recording presently continues since commencement in 1978. The following is a summary of the long term average climate information extracted from these records.

The climate of the Crookwell area is considered to be temperate, with cool to cold winters and warm to hot summers. Historical temperature records vary between - 9 °C and 38 °C with mean daily temperatures ranging from a minimum of -0.4 °C (July) to a maximum of 26.5°C (January).

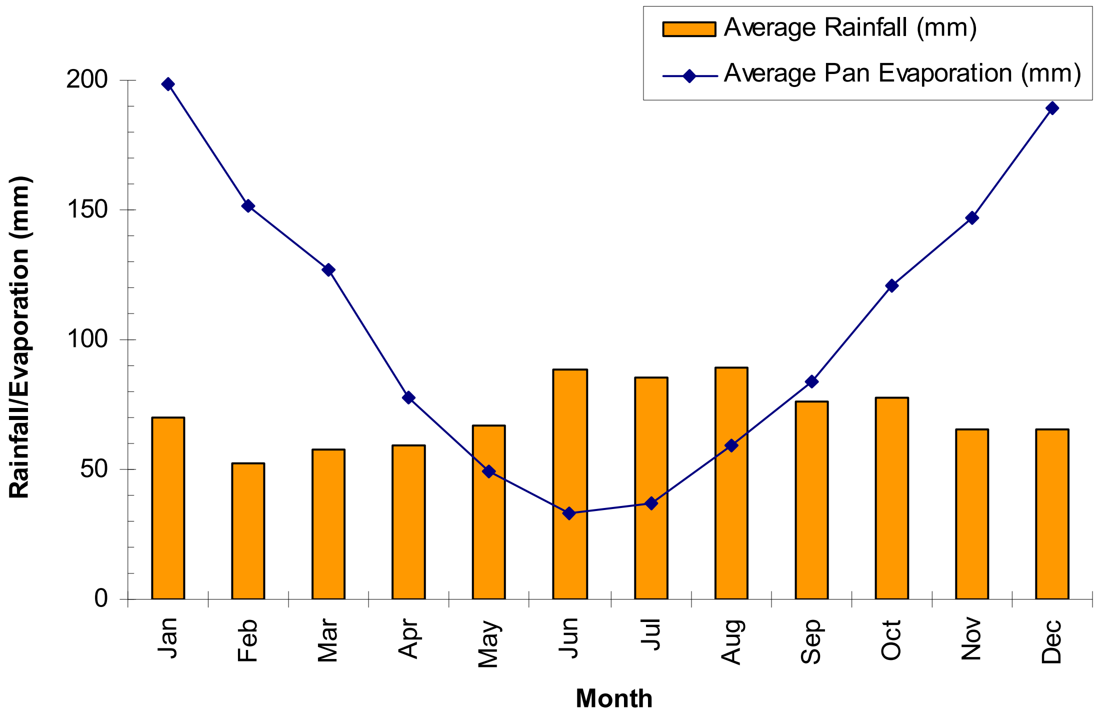
The average annual rainfall over the catchment is approximately 850 mm, evenly distributed over the year with a variance in mean monthly rainfalls between 50 mm and 90 mm. On average the highest rainfall occurs between June and October (highest in August) and the lowest rainfall between November and May (lowest in February).

The average daily pan evaporation over the catchment is approximately 3.5 mm. Average daily pan evaporation shows a distinct summer peak (highest in January) and winter low (lowest in June).

A comparison of the average monthly rainfall and pan evaporation is illustrated in Figure 2-1. During summer the average monthly evaporation is considerably higher than the average monthly rainfall.

Long term climate data are summarised in Table 2-2.

Figure 2-1 Average Monthly Rainfall and Pan Evaporation



2 Catchment Description

Table 2-2 Climate Averages

Month	Mean Monthly Rainfall^ (mm)	Highest Daily Rainfall^ (mm)	Mean Daily Evaporation* (mm)	Mean Maximum Temperature^ (ºC)	Mean Minimum Temperature^ (ºC)
January	70.0	89.7	6.4	26.5	10.7
February	52.3	97.5	5.4	25.9	10.7
March	57.7	114.0	4.1	23.6	8.8
April	58.9	92.5	2.6	18.4	5.0
May	67.0	105.4	1.6	13.9	2.3
June	88.6	113.0	1.1	10.3	0.6
July	85.5	106.4	1.2	9.5	-0.4
August	89.8	62.7	1.9	11.0	0.3
September	75.9	57.9	2.8	14.7	2.1
October	77.4	78.2	3.9	18.3	4.6
November	65.3	80.3	4.9	21.4	6.7
December	65.7	96.5	6.1	25.0	9.0

(^) - Source: Bureau of Meterology (Station 070025, Crookwell Post Office)
(*) - Source: Bureau of Meterology (Station 070263, Goulburn TAFE)

Existing Catchment Conditions

3.1 Local Hydrology

The site for the proposed Crookwell II Wind Farm is located within the head waters of the Wollondilly River, within approximately 30 km of the catchment divide. The total site area is approximately 2,088 ha, comprising undulating terrain of ridgelines and valleys, with varying slopes of 5% to >15%. The majority of the site has been cleared of native vegetation and consists of grazing pasture, with a number of planted tree wind breaks. Isolated patches of vegetation and trees occur along the drainage lines. There are a number of small farm dams scattered throughout the site.

The site is drained by a number of creeks and rivers that mainly flow from north to south, including Middle Creek, First Creek, Wollondilly River, Stony Creek and Grays Creek. All these watercourses eventually drain into Wollondilly River (either above, at, or below Pejar Dam).

The Wollondilly River flows through the central portion of the site, Middle Creek on the western boundary, First Creek, Stony Creek, Grays Creek, and Pejar Creek on the eastern boundary. The Wollondilly River, Stony Creek, Grays Creek and Pejar Creek flow directly into Pejar Dam just south of the site. The creeks on the western side of the site have their headwaters just to the north of the site and discharge into the Wollondilly River below Pejar Dam. First Creek flows directly into the Wollondilly, approximately 3 km downstream of the site. Middle Creek discharges into Kialla Creek, approximately 5 km downstream of the site, which in turn discharges into the Wollondilly. The Wollondilly River is the major permanent watercourse within the site area, with the larger creeks such as First Creek and Middle Creek usually permanent (although dependant upon drought conditions in the area), and the other creeks ephemeral and typically only flow following heavy and sustained rainfall.

The area of the site on the western side of Crookwell Road is generally drained by Middle Creek and First Creek, whilst the area of the site on the eastern side of Crookwell Road is generally drained by the Wollondilly River, Stony Creek and Grays Creek.

Two small natural water bodies occur in the vicinity these being Pejar Lake, adjoining the northwest boundary of the site and Lake Edward, north of the site on the eastern side of Crookwell Road, about 2 km north of Pejar Lake. The most significant water body in the locality is Pejar Dam, an artificial water storage basin which adjoins the southern boundary of the site.

There are three prominent ridgelines that run essentially north-south through the project site. Runoff from the ridgeline on the western boundary drains west to Middle Creek and east to First Creek. The second ridgeline follows the path of Crookwell Road. Run-off from this ridgeline drains west into First Creek and east into the Wollondilly River. The third major ridgeline on the site runs along the eastern side of the site. Run-off from this ridgeline drains west into the two minor tributaries of the Wollondilly River (Grays Creek and Stony Creek) and east into Pejar Creek.

Pejar Dam was created as part of the drinking water supply scheme for Goulburn and is owned by Greater Argyle Council. Pejar Dam is the largest of the three water storages operated by Greater Argyle Council with a maximum capacity of 9,000 megalitres. Water is only drawn from Pejar Dam when the other two storages (Sooley Dam, located on Bumana Creek, and Rossi Weir, located further downstream on the Wollondilly River) cannot meet the water demand due to inadequate capacity or poor water quality.

3.2 Surface Water Quality

There is no water quality data available for the Wollondilly River and creeks in or near the project site. The nearest Sydney Catchment Authority monitoring station is downstream of Goulburn, and hence is not considered representative of the water quality at the site. In addition, only monitoring of flows and blue-green algae is carried out at Pejar Dam.

However, the surface water quality from the site would be consistent with the surrounding land use (i.e. grazing land) in the Wollondilly River catchment. The site has been extensively cleared with very little remaining native vegetation and has been used for a variety of agricultural uses for over 100 years, now predominantly sheep grazing and other livestock.

There is evidence of erosion occurring on the site, for example at the existing farm access crossing of the Wollondilly River. There is also generally unrestricted access by stock to the main river and other creeks/drainage lines across the property. Such activities can cause elevated levels of nutrients in the watercourses due mostly to stock access to the creeks, as well as elevated levels of suspended sediments in the watercourses, due to soil and river bank erosion caused by stock and general farm activities if these are not managed effectively.

3.3 Flooding

No flood plans defining flood levels are available for the site.

3.4 Soil Contamination

The site has a history of use for grazing sheep and cattle. There is no account of the site having ever been used for any use other than agricultural and associated activities. In addition, no records of previous livestock dip sites have been identified in the areas where construction works are proposed to be carried out.

On this basis, no contamination of the site is expected.

Catchment Values

The following key values of the catchment have been recognised:

Ecological Values

- Diversity of native fauna and flora in and near the creeks and rivers
- Water quality of Wollondilly River

Social Values

- Visual amenity of Wollondilly River and surrounding recreational areas
- Public health and safety

Economic Values

- Property values adjacent to Wollondilly River
- Tourism

Stormwater Management Objectives

5.1 Ecologically Sustainable Development

Stormwater management in the catchment is to be based on ecologically sustainable development (ESD) principles. ESD requires effective integration of economic and environmental considerations in decision-making processes. ESD can be achieved through the implementation of the following principles and programs:

- The precautionary principle – namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- Inter-generational equity – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for future generations.
- Conservation of biological diversity and ecological integrity.
- Improved valuation and pricing of environmental resources.

5.2 First Order Objectives

The following First Order Objectives are those identified by the Warragamba Catchment Blueprint (WCB):

- Clean, healthy, productive surface and groundwater.
- Productive and protective vegetation and soil achieving an ecological balance.
- The cultural heritage values within the catchment are acknowledged, respected, maintained and enhanced.
- A stable and aesthetically pleasing landscape that sustains social and economic land management.
- An aware and responsible community whose actions sustain and improve to quality of life in the catchment.
- Clean, healthy air.

5.3 Management Objectives

Management objectives have been developed to protect the catchment values. These include both long term commitments and short term quantifiable objectives as outlined below in Table 5-1. It is expected that the short-term management objectives will evolve and be refined as our understanding of the catchment and its processes improves.

Table 5-1 Stormwater Treatment Objectives

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Stormwater Management Objectives
Ecological Values		
Diversity of native fauna and flora in and near the creeks and rivers	Protect and enhance existing riparian vegetation and natural watercourses	Protect all vegetation of ecological significance and natural watercourses from future developments and the impacts of stormwater

5 Stormwater Management Objectives

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Stormwater Management Objectives
Water quality of Watercourses	Stormwater management to mimic the natural flow environment and water quality where practically feasible	Protect downstream waterways from construction and operational impacts of stormwater
Social Values		
Visual amenity of Wollondilly River and surrounding recreational areas	Maximise the visual amenity of watercourses - clear rather than murky water	Control of sheet flow and bank erosion in a sustainable manner
Public health and safety	Ensure that the stormwater system is of minimal risk to public health	Public safety considered in the design and construction of all structural stormwater management works
Economic Values		
Property values adjacent to Wollondilly River	Achieved by above objectives	Achieved by above objectives
Tourism	Achieved by above objectives	Achieved by above objectives

Stormwater Management Issues

6.1 Issues and Causes

Stormwater management issues are considered to be factors that may impede or prevent the achievement of the stormwater management objectives outlined in Chapter 5. Stormwater management issues have been categorised as environmental, managerial, and social. The specific stormwater management issues have been identified from a desk-top study of existing information, primarily the EIS. Table 6-1 summaries the identified stormwater management issues and predicted causes associated with the proposed site development.

Table 6-1 Stormwater Management Issues and Causes

Category	Issues	Possible Causes
Environmental	1. Channel and gully formation and soil erosion	• Reduced infiltration thereby increasing runoff volumes and concentrate flows. Any concentration of flows has the potential to cause soil erosion. Relevant site works include: — Compaction of soils and placement of crushed rock on the surface associated with the construction of the turbine footings, access tracks, control room building and electrical substation and; — Final footprint of the turbine footings, access tracks, car park, control room building and electrical substation. • Concentration of flows. Any concentration of flows has the potential to cause soil erosion. Relevant site works include: — Installation of surface drains and outlets; — Installation of culverts beneath access tracks. • Increased runoff volumes due to reduced evapotranspiration. Relevant site works include: — Clearing of non-native trees currently acting as wind breaks; — Clearing of riparian vegetation at cable and access track creek crossings. • Destabilized soil profile has the potential to cause soil erosion. Relevant site works include: — Clearing of non-native trees currently acting as wind breaks; — Clearing of riparian vegetation at cable and access track creek crossings.
	2. Elevated levels of suspended solids and increased sedimentation of watercourses, in particular following storm events	• Soil erosion as above (Issue 1) has the potential to mobilise sediments which if released to a watercourse could increase the load of suspended sediments and increase sedimentation of the creek bed. • Additional site works which may mobilise sediments which if released to a watercourse could increase the load of suspended sediments and increase sedimentation of the creek bed include: — Disturbance of the ground surface and excavation work associated with the construction of the turbine footings, access tracks, access track crossings, control room building, electrical substation and cable trench; — Disturbance of the ground surface associated with the maintenance of the underground electricity cable line; — Disturbance of the drainage channels associated with the construction of access track crossings; — Disturbance of the river bank associated with the construction and maintenance of the cable crossing; — Clearing of non-native trees currently acting as wind breaks; — Clearing of riparian vegetation at cable and access track creek

6 Stormwater Management Issues

Category	Issues	Possible Causes
Environmental		— crossings; — Damage to access track creek crossings during operation. • Leaks or spills from wastewater systems if released to a watercourse or drainage line may increase the load of suspended sediments and increase sedimentation of the creek bed.
	3. Spill contamination of soils and watercourses	• Leaks or spills from a variety of sources have the potential to contaminate soils and enter drainage lines and watercourse. Contamination sources may include: — Site access vehicles; — Vehicle refuelling; — Storage and use of materials for construction and maintenance; — Storage of waste materials; — Transformer oils.
	4. Elevated bacterial (faecal coliforms) pathogen and nutrient levels in watercourses	• Wastewater generated by human occupation (black water) during construction and operation. If released, leaked or spilled into the environment the wastewater treated or untreated has the potential to contaminate watercourses with bacteria, pathogens and nutrients. • An increase in livestock within the catchment may also increase faecal contamination in down slope watercourses. • Excessive fertilizer application within the catchment may also increase nutrient levels in down slope watercourses.
	5. Weed growth in and surrounding watercourses	• Altered water quality due to Issues 2-4 identified above has the potential to allow/increase weed growth in and surrounding watercourses. Increased nutrient levels in watercourses (Issue 4) support the growth of weeds. Degraded water quality (Issues 2-3) may also weeds to outcompete native vegetation. • Changes to soil moisture from altered hydrology may also allow weeds to outcompete native vegetation. Soil moisture may be affected by reduced infiltration, concentration of flows and increased runoff volumes (see possible causes identifies in Issue 1).
	6. Degradation and depletion of riparian vegetation and aquatic habitat	• Altered hydrology due to reduced infiltration, concentration of flows and increased runoff volumes (see possible causes identifies in Issue 1). • Altered water quality due to Issues 2- 5 identified above. • Clearing of riparian vegetation may occur due to the following site works: — Cable creek crossing; — Access track creek crossings; — Installation of surface drains and outlets; — Installation of culverts beneath access tracks.
Managerial	7. Poor erosion and sediment control on construction sites	• Insufficient staff • Insufficient planning • Insufficient time available to spend on each site • No single person responsible for the site
	8. Poor river maintenance	• Lack of resources and planning • Mixed ownership

Category	Issues	Possible Causes
Social	9. General lack of understanding of catchment issues by the community and site personnel	• Insufficient public awareness campaigns • Insufficient notice/warning signage • Insufficient site personnel site training
	10. Poor visual amenity of watercourses	• Degradation and depletion of riparian vegetation and aquatic habitat (see possible causes identifies in Issue 6).

6.2 Relevant Project Details

The total area of land affected by construction activities would be around 22 hectares out of a total site area of 2088 hectares (approximately 1.1% of the total site area) of which approximately 15 hectares would be progressively rehabilitated back to the current grassed site condition. Around 7 hectares (or 0.3% of the total site area) would remain as permanent structures or tracks. It is important to note that the total proposed works would not occur all at the same time, which means that the area disturbed by the proposed construction works would be substantially less than the total construction impact area.

Given the relatively small area affected by the proposed developed, both for construction activities and more so for the operational phase, relative to the total size of the site, no change to the total amount of site runoff is anticipated. The principal change to the hydrology of the site and therefore water quality risk from the proposed development is the concentration of flows resulting from lower permeability surfaces, such as the area surrounding the base of the turbines, the roads and the substation area. Concentration of flows can lead to an increased risk of soil erosion down slope of the affected area.

With the exception of the electrical substation and the on-site wastewater treatment system at the control room / facilities building, the principal pollutants resulting from the proposed construction and operational activities is a potential increase in sediment laden runoff, which if discharged to watercourses, could increase the amount of suspended sediments in the water and sedimentation of the creek system.

The potential pollutants that could result from the operation of an electricity substation are oils from the transformers and the sub-station should be bunded to contain any spill or storage failure. The potential pollutants from the on-site wastewater treatment system include bacteria, pathogens and nutrients.

7

Stormwater Management Options

7.1 Identification of Potential Management Options

A broad range of structural and non-structural practices are available to address identified stormwater management issues. Table 7-1 provides a list of practices which have been identified as potential options to address the identified stormwater management issues.

Table 7-1 Potential Management Options

Issue	Potential Management Option
1. Channel and gully formation and soil erosion 2. Elevated levels of suspended solids and increased sedimentation of watercourses, in particular following storm events	• Implementation of Erosion and Sediment Control Plans during construction activities. • Scour protection to be considered in the design of all temporary and permanent drainage trenches and outlets. Stormwater flows to be at sufficiently low velocities so as not to cause erosion of downstream slopes. Where not achievable additional scour protection works are to be installed. • Scour protection works and erosion and sediment control measures to be monitored for effectiveness on a regular basis. • Development of an action plan as part of the monitoring program which would be initiated in the event that an erosion or sedimentation feature is identified during monitoring. • Vegetation clearing to be minimised. • Ground disturbances to be minimised in terms of area and duration. • Where practical, disturbed ground surfaces are to be rehabilitated with native vegetation. Rehabilitation to be regularly monitored. • Traffic to be restricted to defined access tracks, construction impact areas, and operational areas. • Minimise on-site vehicle use during and after wet weather events.
3. Spill contamination of soils and watercourses	• Development and implementation of an emergency response plan in the event that a spill occurs, including mitigation measures should the spill not be able to be contained on site. • Installation of a dedicated material storage area in the facilities building, to provide containment for any spills during maintenance activities. • Spill kits to be provided on site, for both construction and operation phases. Refuelling will only be allowed in suitably controlled areas or areas where kits are stored. • Timely and appropriate disposal of accidental spills and any contaminated spoil, water or waste generated. • Selection of an oil-water separator, using latest best practice in the industry, based on Energy Australia and TransGrid practices. • Final selection of locations for wastewater treatment plant and oil-water separator to be a minimum of 100 metres from any permanent creek or river and 40 metres from any drainage depression. • Regular monitoring to be conducted to ensure all material handling and waste management procedures are being implemented and remain appropriate to the site activities being undertaken.
4. Elevated bacterial (faecal coliforms) pathogen and nutrient levels in watercourses	• Selection of a proprietary waste water treatment system which does not allow any external release of effluent. • Establish a maintenance agreement with a licensed contractor (certified to ISO14000 standard requirements) to ensure the treatment systems meet design specifications. • Development of an emergency response plan in the event of an accidental failure of treatment systems. • Nearby residents' education campaign in relation to fertilizer application and the impacts of agricultural stormwater runoff on catchment values.

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7 Stormwater Management Options

Issue	Potential Management Option
5. Weed growth in and surrounding watercourses	• Management options regarding altered hydrology and water quality identified above in Issues 1-4. • Weed growth to be monitored as part of vegetation monitoring. • Nearby residents' education campaign in relation to fertilizer application and the impacts of agricultural stormwater runoff on catchment values along with weed identification and management.
6. Degradation and depletion of riparian vegetation and aquatic habitat	• Clearing or riparian vegetation to be minimised and revegetated where practical. • Management options regarding altered hydrology, water quality and weed growth identified above in Issues 1-5.
7. Poor erosion and sediment control on construction sites	• Implementation of Erosion and Sediment Control Plans during construction activities. • Regular monitoring to be undertaken to ensure effectiveness of erosion and sediment control measures.
8. Poor river maintenance	• Define managerial parties • Roles and responsibilities regarding river maintenance to be clearly defined and understood by all parties involved including site personnel.
9. General lack of understanding of catchment issues by the community and site personnel	• Nearby residents' education campaign in relation to relevant construction activities, stormwater management, use of fertilisers, weed identification and management, and the impacts of stormwater runoff on catchment values. • Educational training of construction and operational site personnel aimed at erosion and sediment control, vegetation management, waste and spill management at the site during construction, operation and maintenance activities • Notice/warning signage of stormwater management practices to be posted along access tracks, construction sites, site access points and nearby potentially affected community roadways.
10. Poor visual amenity of watercourses	• Management options regarding the degradation and depletion of riparian vegetation and aquatic habitat identified in Issue 6.

7.2 Implementation

The identified stormwater management options are to be implemented as part of the design, construction and operation of Crookwell II Wind Farm. Stormwater management practices implemented may further develop over time as the response of the catchment to the proposed development becomes apparent.

Monitoring

Stormwater monitoring will be undertaken to determine the performance of implemented stormwater management practices. Monitoring of stormwater management will generally be observational at construction, operational and maintenances areas and involve the following regular inspections:

- Areas surrounding turbine sites, substation, access tracks, drainage trenches, culverts, creek crossings including down slope environments;
- Erosion control structures and bunded areas;
- Rehabilitation sites and vegetated areas surrounding site works.

Monitoring will focus on:

- Erosion and Sedimentation Control
  - Inspection of erosion hazards such as steep slopes, concentrated drainage flows and creek crossings;
  - Determining whether erosion features are forming or sedimentation is occurring;
  - Aim to evaluate the effectiveness of implemented erosion and sediment control measures and evaluate if additional measures are required.
- Vegetation Management
  - Inspection of extent of vegetation clearing, condition of existing vegetation in and surrounding extent of construction works and condition of rehabilitated areas;
  - Ensuring that in rehabilitated areas vegetation has been established as planned and that no erosion features have developed;
  - Ensuring weed growth is not encouraged;
  - Aim to evaluate the effectiveness of vegetation protection and rehabilitation measures.
- Waste and Spill Management
  - Inspection of storage and handing of waste materials;
  - Determining whether waste is being handled according to best management practices in order to prevent contamination of the surrounding environment;
  - Aim to evaluate the effectiveness of implemented waste and spill management practices.

Regular inspections will be scheduled more frequently during construction activities and vary depending on construction staging. Additional inspections will also occur following significant rainfall events within a reasonable timeframe.

During construction activities sedimentation basins may be required. If water from such basins is to be discharged to downstream watercourses or drainage lines, additional water quality measures may be required to reduce silt load and to ensure captured sediment is not mobilised. This may include monitoring background as well as treated outflow water quality. If any other such controlled discharge is to be made to the receiving environment, similarly additional water quality monitoring may be required.

In the event of any suspected spill contamination of watercourses additional water quality testing may be required in order to ascertain appropriate corrective treatment measures.

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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 Union Fenosa Wind Australia Pty Ltd and its subsidiaries and its contractors working on the project, 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 2nd June 2009.

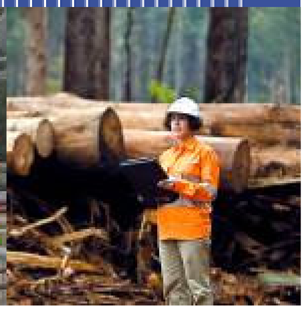
The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations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

This report was prepared between 15th June and 30th June 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.







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