APPENDIX O SOILS AND WATER ASSESSMENT

Hills of Gold Wind Farm

Wind Energy Partners Pty Limited

Soils and Water Assessment

Developed in Partnership by Clean Energy Partners Pty Limited

11 November 2020

Development Management by:

Project No.: 0550690

The business of sustainability

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11 November 2020

Hills of Gold Wind Farm

Soils and Water Assessment

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Wind Energy Partners (WEP) to undertake a Soils and Water Assessment for the proposed Hills of Gold Wind Farm, located on the ridgeline between Hanging Rock and Crawney Pass, 60 kilometres (km) south east of Tamworth NSW.

The proposed wind farm will comprise of a maximum of 70 turbines, with an approximate capacity of 420 megawatts (MW) to supply the national energy market (NEM). The proposal includes ancillary infrastructure including access tracks, laydown areas, road upgrades, two concrete batching facilities, underground and overhead electricity cabling, substation, battery energy storage system (BESS), a switching station and grid connection to the existing Liddell to Tamworth 330 kilovolt (kV) transmission line.

The Soils and Water Assessment identifies the existing soils and water environment of the Project Area, identifies impacts, describes mitigation measures to be implemented, quantifies the required water supply and details available water supply options.

Overall constraints are relatively minor due to the low to moderate erosion hazard over the majority of the Project Area to be impacted by construction. A standard suite of erosion and sediment controls will be adopted in most areas.

The Project will require an estimated 55 ML of water during the 24-month construction period. Water supply options are available to meet the needs of the construction phase. Water access licensing would need to be addressed depending on the preferred option, and should be discussed with WaterNSW.

The Ben Halls Gap National Park is located adjacent to the Project Area, immediately to the east of the ridgeline. A rare moss vegetation community has been identified in two drainage lines down-gradient of the Project as requiring additional consideration to ensure activities associated with the Project do not impact on the integrity of this sensitive community. The primary risk to impact upon the "sensitive location" is associated with runoff and sediment deposits during construction activities. Additional measures can be effectively implemented to appropriately mitigate potential impacts on the identified sensitive locations in the adjacent National Park.

A detailed Soil and Water Management Plan will be prepared for the project prior to construction commencing that incorporates the measures identified within this assessment.

1. INTRODUCTION

1.1 Background

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Wind Energy Partners (WEP) to undertake a Soils and Water Assessment for the proposed Hills of Gold Wind Farm, located on the ridgeline between Hanging Rock and Crawney Pass, 60 kilometres (km) south-east of Tamworth NSW (refer to Figure 1-1).

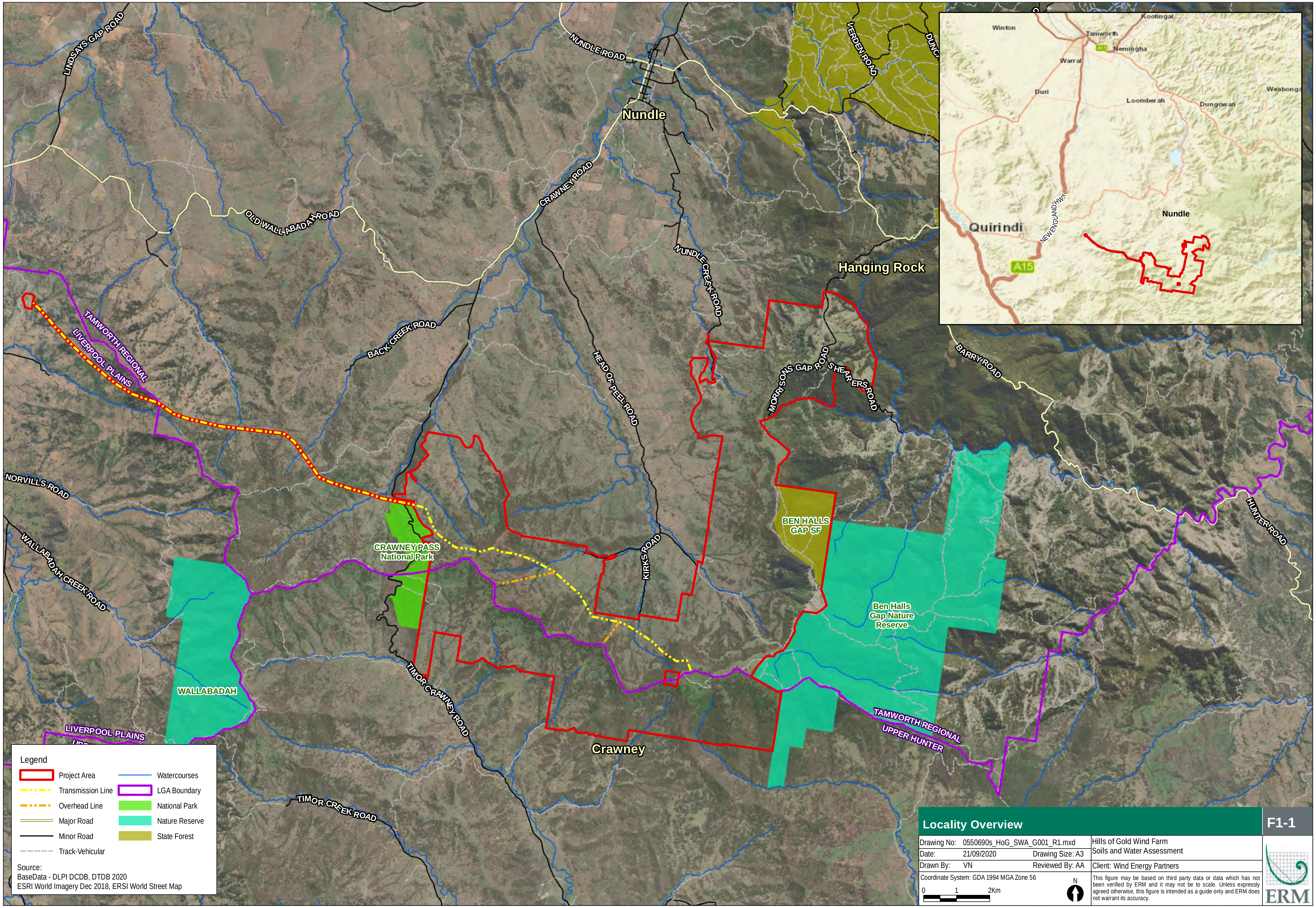
The proposed wind farm will comprise of a maximum of 70 turbines, with an approximate capacity of 420 megawatts (MW) to supply the national energy market (NEM). The proposal includes ancillary infrastructure including access tracks, laydown areas, road upgrades, two concrete batching facilities, underground and overhead electricity cabling, substation, battery energy storage system (BESS), a switching station and grid connection to the existing 330 kilovolt (kV) Liddell to Tamworth transmission line (collectively the ‘Project’).

The Project encompasses approximately 8,316 hectares (ha) (the ‘Project Area’) as outlined by the Project boundary in Figure 1-1 below.

1.2 Objectives

The Soils and Water Assessment has been prepared to:

- address the Secretary’s Environmental Assessment Requirements (SEARs) issued, in particular those under the Key Issues heading ‘Water & Soils’;
- describe the existing soil and water conditions across the Project Area;
- provide details of waterway crossings;
- identify likely impacts at water crossing locations and measures to minimise these impacts;
- identify the key potential soil and water impacts and assess associated risks;
- identify appropriate management and mitigation measures to ensure that construction and operation of the proposed wind farm would result in an acceptable level of environmental impact, pursuant to the *Environmental Planning and Assessment Act 1979* (EP&A Act) and other relevant legalisation. A Conceptual Soil and Water Management Plan has been provided to support this;
- analyse water demands and supply options to determine whether an adequate and secure water supply is available for the life of the Project;
- assess potential environmental impacts associated with the identified sources, including impacts on groundwater;
- identify the statutory (licensing) context of the water supply sources; and
- determine the balance of water supply based on expected construction and operation water requirements.



LINDSAYS GAP ROAD
NUNDLE ROAD
Nundle
VERDEN ROAD
CRAWNEY ROAD
OLD WALLABADAH ROAD
NUNDLE CREEK ROAD
Hanging Rock
BACK CREEK ROAD
TAMWORTH REGIONAL
LIVERPOOL PLAINS
HEAD OF PEEL ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
BARRY ROAD
NORVILLS ROAD
WALLABADAH CREEK ROAD
CRAWNEY PASS National Park
KIRKS ROAD
BEN HALLS GAP SF
Ben Halls Gap Nature Reserve
HUNTER ROAD
WALLABADAH
TIMOR CRAWNEY ROAD
LIVERPOOL PLAINS
Crawney
TAMWORTH REGIONAL
UPPER HUNTER
TIMOR CREEK ROAD
Winton
Kootingal
Tamworth
A15
Nemingha
Warral
Duri
Loomberah
Dungowan
Weabonga
Nundle
Quirindi
NEW ENGLAND HWY
A15
Legend
Project Area
Transmission Line
Overhead Line
Major Road
Minor Road
Track-Vehicular
Watercourses
LGA Boundary
National Park
Nature Reserve
State Forest
Source:
BaseData - DLPI DCDB, DTDB 2020
ESRI World Imagery Dec 2018, ERSI World Street Map
Locality Overview
F1-1
Drawing No: 0550690s_HoG_SWA_G001_R1.mxd
Date: 21/09/2020 Drawing Size: A3
Drawn By: VN Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56
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Hills of Gold Wind Farm
Soils and Water Assessment
Client: Wind Energy Partners
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1.3 Secretary's Environmental Assessment Requirements

The Proposal was determined to be State Significant Development with approval under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). SEARs were issued for the Proposal on 22 November 2018 by the Department of Planning, Industry and Environment (DPIE). The SEARs relevant to Soil and Water are presented in Table 1-1.

Table 1-1 Secretary's Environment Assessment Requirements

Issue	Requirement	Reference
Water & Soils	■ quantify water demand, identify water sources (surface and groundwater), including any licensing requirements, and determine whether an adequate and secure water supply is available for the development;	■ Chapter 3
	■ assess potential impacts on the quantity and quality of surface and groundwater resources, including impacts on other water users and watercourses;	■ Chapter 4
	■ where the project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the *DPI Water Guidelines for Controlled Activities* (DPI, 2012) and (if necessary) *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI, 2003); and	■ Section 4.2
	■ describe the measures to minimise surface and groundwater impacts, including how works on steep gradient land or erodible soil types would be managed and any contingency requirements to address residual impacts.	■ Section 4.3.3 and Chapter 5
Consultation Requirements	During the preparation of the EIS, consultation is required with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners (as relevant to this Soils and Water Assessment): ■ NSW Department of Industries (Agriculture and Fisheries) ■ NSW Office of Water ■ NSW Natural Resource Access Regulator ■ NSW Division of Resources and Geoscience ■ Local Lands Services (North West and Hunter regions) ■ Tamworth Regional Council ■ Upper Hunter Shire Council ■ Liverpool Plains Shire Council ■ Environment Protection Authority	■ Table 1-2

Consultation has been undertaken with the relevant government departments and agencies throughout the assessment process, as outlined in

Table 1-2.

Table 1-2 Agency Consultation

Agency	Date	Consultation Undertaken	Issues Raised
NSW Department of Industries (Agriculture and Fisheries)	20/07/20 30/07/20	Email correspondence Email response – Agriculture	■ Site Suitable for Development ■ Consider impacts to agricultural resources and land ■ Biosecurity Standards are met ■ Suitable traffic movements ■ Visual amenity achieved ■ Land stewardship met ■ Adequate consultation with community
WaterNSW	20/07/20	Email correspondence	■ No response received
NSW Natural Resources Access Regulator (NRAR)	20/07/20 20/08/20	Email correspondence Telecommunication response	■ No response received
NSW Division of Resources and Geoscience	20/07/20	Email correspondence	■ No response received
Local Land Services	20/07/20	Email correspondence	■ No response received
Environment Protection Authority	20/07/20	Email correspondence	■ No response received
Tamworth Regional Council	20/07/20 28/07/20	Email correspondence Email response	■ Elected not to add anything further at this time
Upper Hunter Shire Council	20/07/20 27/07/20	Email correspondence Email response	■ Address all matters contained in the SEARs ■ Anticipate proponent to enter into Voluntary Planning Agreement for a Community Enhancement Fund
Liverpool Plains Shire Council	20/07/20 10/08/20	Email correspondence Email response with letter attachment	■ Main consideration is in relation to traffic impacts

1.4 Regional and Local Context

The Project is located approximately 5 km south of Hanging Rock, 8 km southeast of Nundle and 60 km south east of Tamworth. The proposed development is located within the Tamworth Regional, Upper Hunter and Liverpool Plains local government areas. The general locality includes Ben Halls Gap National Park, Crawney Pass National Park, Ben Halls Gap State Forest, Hanging Rock State Forest and Nundle State Forest.

Hanging Rock and Nundle are towns which begun as pastoral runs and transformed into now former gold mining villages. Today, the main industries within the area are agriculture and tourism. Hanging Rock lookout provides scenic views of the Nundle Valley. The majority of dwellings in proximity to the proposed wind farm are lifestyle blocks located on Morrisons Gap Road and to a lesser extent Barry Road.

Land on which the Project is proposed to be located is owned by 14 freehold landholdings and includes Crown land paper roads (the Project Area). The Development Footprint within the Project Area, being that portion proposed to be disturbed, is predominately agricultural land with a high percentage of overstorey native vegetation adjacent to the Development Footprint and within steeper terrain. The Project Area has a history of grazing cattle with the native understorey converted to exotic pastures in many locations. The landownership that constitute the Project Area includes a number of rural dwellings in close proximity to the Development Footprint with each landowner holding a lease or agreement with WEP to host the development ('associated dwellings').

1.5 Project Description

The Project involves the construction, operation and commissioning of a wind farm with up to 70 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project has been revised and refined over time in response to design and constructability requirements, and in consideration of environmental constraints and the outcomes of community consultation.

The Project consists of the following key components:

- up to 70 WTGs, each with:
  - a maximum height of 230 m AGL (to the blade tip) with a generating capacity of approximately 6 MW;
  - a 4-7 part tubular steel tower holding the nacelle;
  - three blades mounted to a rotor hub and the gearbox and generator assembly housed in the nacelle; and
  - adjacent hardstands for use as crane pads and assembly / laydown areas;
- decommissioning of three current monitoring masts and installation of up to five additional monitoring masts for power testing. The five monitoring masts will be located close to a WTG location with a maximum height at appropriate to the WTG hub height. The exact number and location will be defined at the detailed design stage;
- a central 33 kV/330 kV electrical substation, including transformers, insulators, switchyard and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system (BESS) of 100/400 MWh (4 hours of storage);
- an internal private access road network (combined total length of approximately 48 km) connecting the WTGs and other Project infrastructure to the public road network;
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where possible);
- a 330 kV single circuit twin conductor overhead transmission line to connect the onsite substation to the existing TransGrid Liddell to Tamworth 330 kV overhead transmission line network, located approximately 18.8 km west of the substation, or approximately 13.5 km from the Project Area. A switching station will be constructed to connect the Project to the TransGrid Liddell to Tamworth 330 kV transmission line; and
- upgrades to local roads and waterway crossings, as required for the delivery, installation and maintenance of WTG components and other associated materials and structures.

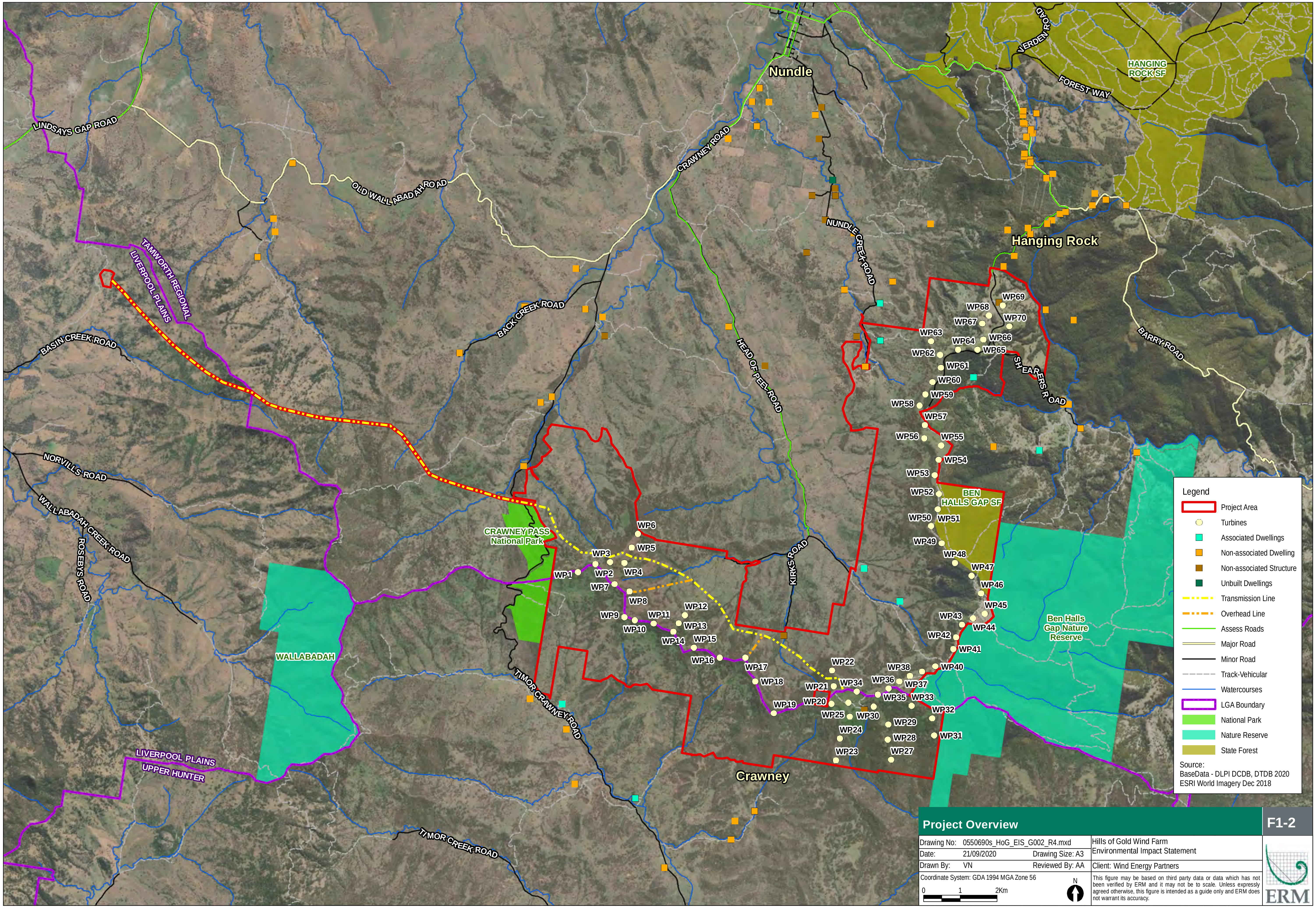
The following temporary elements will be required during construction of the Project:

- temporary site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce;

- two temporary concrete batching plants to supply concrete for WTG footings and substation construction works;
- earthworks for access roads, WTG platforms and foundations, including potential controlled blasting in certain areas;
- potentially rock crushing facilities for the generation of suitable aggregates for concrete batching and/or sized rock for access road and hardstand construction;
- up to seven hardstand areas for the temporary storage of construction materials, plant, and equipment construction;
- external water supply for concrete batching and construction activities; and
- the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure.

Collectively, these Project elements are referred to throughout this report as the 'Development Footprint', which occupies approximately 387 ha of the Project Area.

The Project layout and key design elements are detailed in Figure 1-2 below.



Project Overview

F1-2

Drawing No:	0550690s_HoG_EIS_G002_R4.mxd		Hills of Gold Wind Farm Environmental Impact Statement
Date:	21/09/2020	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners

Coordinate System: GDA 1994 MGA Zone 56

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1.6 Climate

An understanding of the existing climatic context of the Project Area has been developed through data available from the Australian Governments Bureau of Meteorology (BoM).

Climate data is available from BoM weather stations located at Nundle Head of the Peel (Station No. 055336) which is located within the Project Area, and the Nundle Post Office NSW (Station No. 055041) located approximately 8.5 km north west of the Project Area.

The Nundle Head of the Peel weather station is located at an elevation of approximately 785 m, whilst the Nundle Post Office sits at 595 m.

1.6.1 Rainfall

Monthly rainfall data from the Nundle Post Office (055041), which has been operational since 1890, was considered a more robust data source for average rainfall offering extensive historical data for the mean monthly rainfall in the region.

The mean monthly precipitation is summarised in Table 1-3 below, with the highest and lowest rainfall records highlighted in red and blue respectively and represented in Figure 1-3.

Table 1-3 Monthly Precipitation Data for 1890[1]-2020 (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	90.4	73.4	57.2	45.8	52.3	71.7	66.4	62.4	63.0	75.8	82.2	92.9	833.8
Lowest	5.0	0.0	0.0	0.0	0.0	5.6	1.3	0.0	0.0	6.1	1.6	0.0	303.9
Median	75.9	53.4	46.1	41.2	42.6	59.2	61.2	54.4	53.3	67.1	72.0	88.3	827.7
Highest	313.2	352.4	193.3	191.5	188.0	228.0	231.5	160.6	188.4	248.9	285.2	240.8	1302.3

[1] Nundle Post Office weather station has collected data since 1890, however some gaps exist in datasets collected for the following years: 1902, 1999-2001, 2003-08 and 2013-14.

Note: Data collected from BoM's climate data online, accessed 29 April 2020.

By comparison, the Nundle Head of the Peel weather station (055336) provides records of a narrower timeframe between 2006 and 2020, which shows similar data. The mean monthly rainfall records are highest in December with 131.8 mm, the lowest recorded month being April with 36.4 mm, and the annual average rainfall is 844.0 mm.

Figure 1-3 displays the average monthly trends for the area, displaying an increase in average rainfall experienced during the summer months. The annual changes in average rainfall since 1890 is shown in Figure 1-4.

Figure 1-3 Monthly Precipitation Data for 1890-2020 (mm)

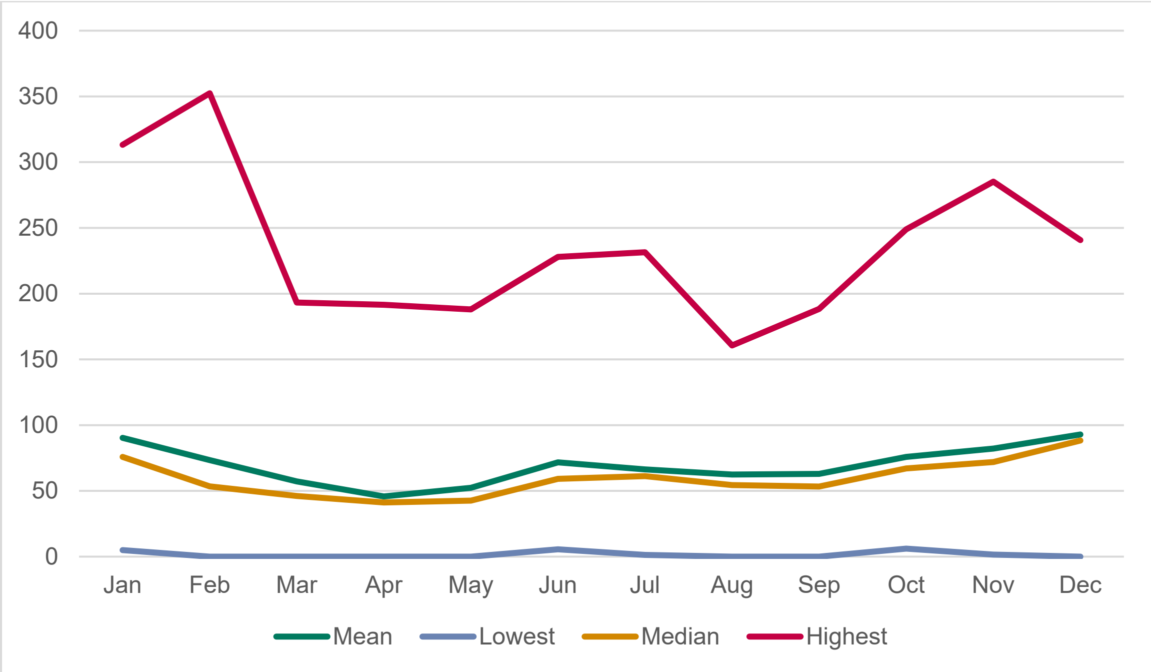
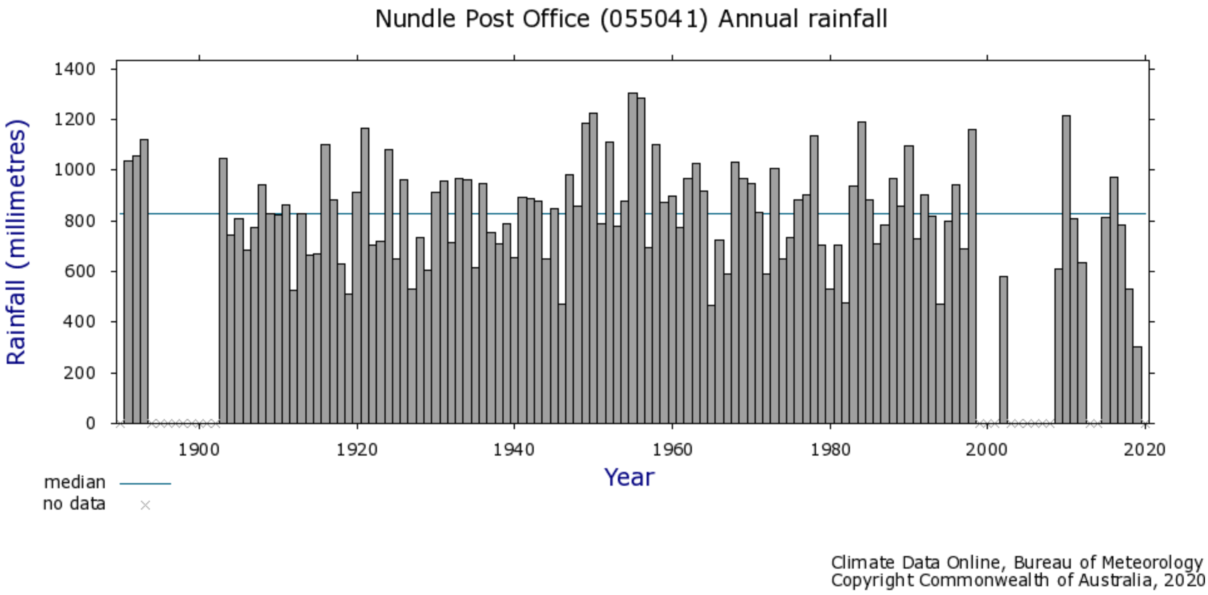


Figure 1-4 Nundle Post Office Annual Rainfall (BoM, 2020)



2. WATER LICENSING AND STATUTORY MATTERS

2.1 Water Management Act 2000

The objectives of the *Water Management Act 2000* (WM Act) is to provide for the sustainable and integrated management of the water sources of the State. This includes, among other matters; to protect, enhance and restore water sources and their associated ecosystems; to recognise and foster the significant social and economic benefits that result from the sustainable and efficient use of water; to provide for the sharing of water from water sources; and to encourage best practice in water management and use.

Section 4.41 of the EP&A Act confirms that approved State Significant Development (SSD) does not require approvals under WM Act Section 89 (water use), Section 90 (water management work) or Section 91(2) (controlled activity), however Section 91(3) aquifer interference approvals are not exempt (aquifer interference approvals have not been activated).

Given the SSD status, the Project is exempt from a controlled activity approval and does not require the application of the *Guidelines for controlled activities on waterfront land* (DoI, 2018).

The WM Act regulates the use and interference with surface and groundwater in NSW through 'Water Sharing Plans' (WSP). Six WSPs intersect with the Proposal area:

- *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012;*
- *Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources 2009;* and
- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.
- *Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010;*
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020;* and
- *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016.*

Given the large number of WSPs that intersect the Project Area, Figure 2-1 has been developed to detail the applicable boundaries of each plan in relation to the Project Area.

The provisions of these WSPs apply where water supply for the Project is to be accessed via surface and/or groundwater. Further discussion of these plans and how they relate to the Project is provided in the following sections and in Table 2-1.

2.1.1 Water Sharing Plans

WSPs are established as a statutory obligation under the WM Act developed as a 10 year management plan tailored to the guide water provisions and allocation for a given catchment area. Once a WSP commences, the licencing provisions of the WM Act come into effect in the plan area.

The purpose of WSPs are to:

- provide water users with a clear picture of when and how water will be available for extraction;
- protect the fundamental environmental health of the water source; and
- ensure the water source is sustainable in the long-term.

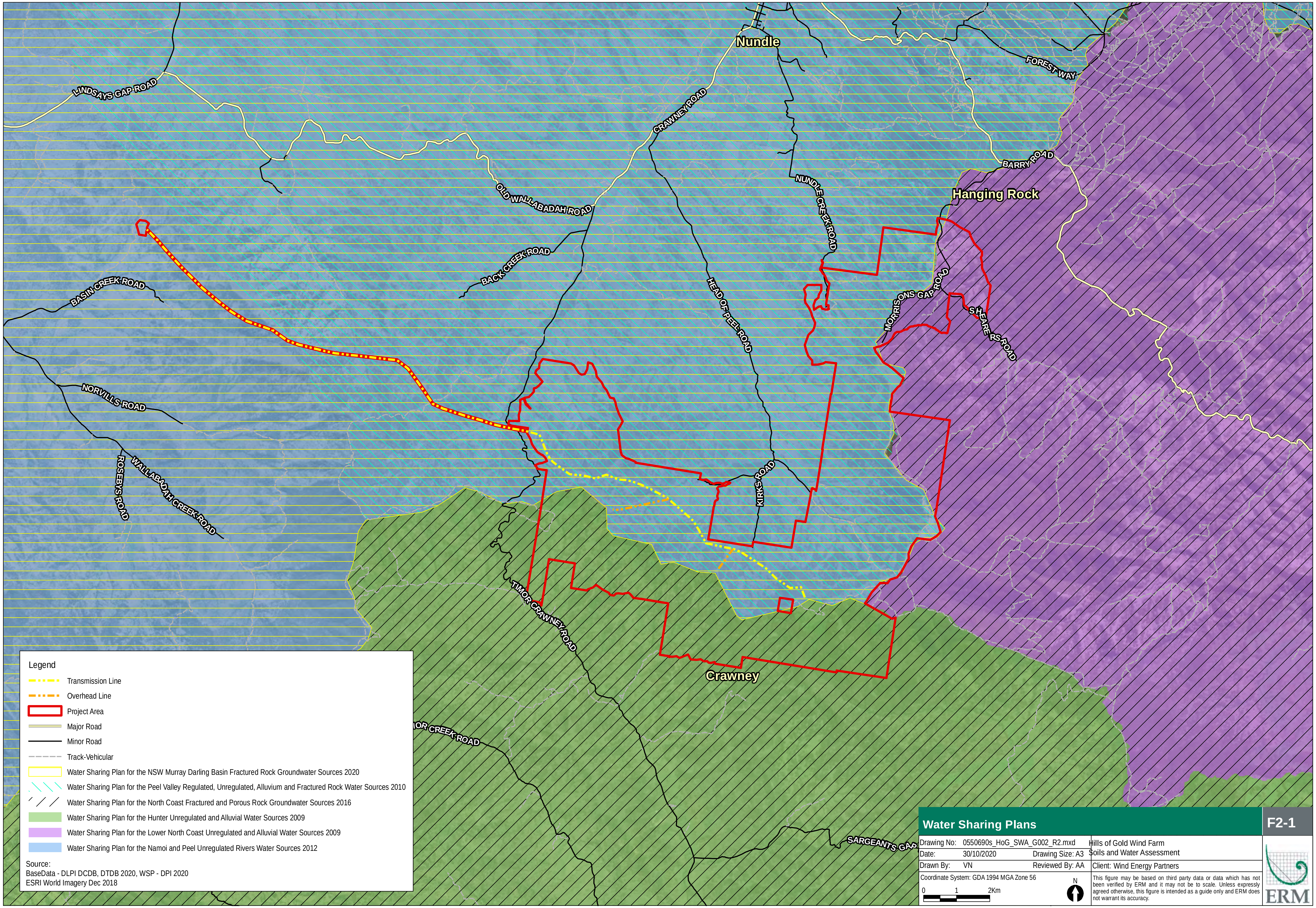

Nundle
Hanging Rock
Crawney
LINDSAYS GAP ROAD
CRAWNEY ROAD
FOREST WAY
BARRY ROAD
OLD WALLABADAH ROAD
NUNDLE CREEK ROAD
BACK CREEK ROAD
BASIN CREEK ROAD
HEAD OF PEEL ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
NORVILLS ROAD
ROSEBYS ROAD
WALLABADAH CREEK ROAD
KIRKS ROAD
TIMOR CRAWNEY ROAD
OR CREEK ROAD
SARGEANTS GAP
Legend
Transmission Line
Overhead Line
Project Area
Major Road
Minor Road
Track-Vehicular
Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020
Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010
Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016
Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009
Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources 2009
Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012
Source:
BaseData - DLPI DCDB, DTDB 2020, WSP - DPI 2020
ESRI World Imagery Dec 2018
Water Sharing Plans
F2-1
Drawing No: 0550690s_HoG_SWA_G002_R2.mxd
Date: 30/10/2020
Drawing Size: A3
Drawn By: VN
Reviewed By: AA
Hills of Gold Wind Farm
Soils and Water Assessment
Client: Wind Energy Partners
Coordinate System: GDA 1994 MGA Zone 56
0 1 2Km
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Table 2-1 Applicable Water Sharing Plans

Water Sharing Plan	GW or SW	Effective Date	WSP Capacity
Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012	SW	October 2012 to June 2023	■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 14.6 ML/year in the Chaffey Water Source.
Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources 2009	SW	August 2009 to June 2022	■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 0.3 ML/day in the Upper Barrington River Water Source.
Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009	SW	August 2009 to June 2022	■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 1.73 ML/day in the Isis River Water Source and 3.27 ML/day in the Upper Hunter River Water Source.
Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010	SW and GW	July 2020 to June 2030	■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 0.82 ML/day in the Peel Regulated River Water Source, 1.54 ML/day in the Peel Unregulated River Water Sources, 0.66 ML/day in the Peel Alluvium Water Source, and 11.1 ML/day in the Peel Fractured Rock Water Source.
Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016	GW	July 2016 to June 2026	■ The long-term average annual extraction limit for the New England Fold Belt Coast Groundwater Source is 60,000 ML/year ■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 9,605 ML/year in the New England Fold Belt Coast Groundwater Source.
Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020	GW	July 2020 to June 2030	■ At the commencement of this Plan, the water requirements of persons entitled to domestic and stock rights are 448 ML/year in the Peel Fractured Rock Water Source.

2.1.2 Basic Landowner Rights

Under the WM Act, extraction of water for basic landholder rights (BLR) does not require a licence, although in the case of accessing groundwater under BLR the bore must still be approved by the WaterNSW. Part 1 of the WM Act outlines basic landholder rights that include domestic and stock rights (Section 52 of the Act), harvestable rights (Section 53 of the Act) and native title rights (Section 55 of the Act). In relation to harvestable rights, Section 53 of the WM Act states:

> *'(1) An owner or occupier of a landholding within a harvestable rights area is entitled, without the need for any access licence, water supply work approval or water use approval, to do each of the following in accordance with the harvestable rights order by which the area is constituted:*
>
> > *(a) to construct and use one or more water supply works for the purpose of capturing and storing water of a kind specified by the harvestable rights order,*
> >
> > *(b) to take and use that water.'*

The WM Act establishes basic rights for access to water by rural landowners and outlines several categories of farm dams that do not require a licence. The harvestable rights provisions enable landholders to construct dams, in certain positions (e.g. on hillsides and minor watercourses), that capture up to 10% of the average regional rainfall run-off for their property without requiring a licence. This is known as the maximum harvestable rights dam capacity (MHRDC).

2.1.3 Water Access Licences

Except for basic landholder rights (discussed in Section 2.1.2), all other water extraction either requires an authorisation under a water access licence (WAL) or some form of exemption. The WM Act establishes categories and sub-categories of access licences.

The most relevant WAL categories for the Project are the 'unregulated river' (for surface water extraction) and aquifer (for groundwater extraction) categories. The total entitlement or share component for each category of access licence that applies at the start of the plan is estimated and is included in the relevant plan.

Surface Water Extraction

Extraction from a surface water supply from an unregulated water source (i.e. the Peel River) outside of the Project Area, will require a WAL under Section 56 of the WM Act in accordance with the annual extraction limits of the *'Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012'* and access rules for the relevant water source (as listed in Table 2-1 above).

Groundwater Extraction

Although the depth of groundwater with the Project Area has been recorded at 28 m (GW967488), landowner discussions have suggested groundwater depth extends beyond 60 m in other areas. In addition, any excavations are relatively shallow, with the turbine foundation construction activity at approximately 3 m – 5 m and cuttings approximately 10 m – 15 m, therefore it is not expected that the proposed construction activities would intercept groundwater.

There is the potential for one or more new groundwater production bores to be installed to supply water for construction (discussed further in Section 4.2.2). If this option is pursued then an application for a WAL under Section 56 of the WA Act will be required, in accordance with annual extraction limits and access rules of the relevant water sharing plan.

2.1.4 Aquifer Interference Policy

The NSW Aquifer Interference Policy (2012) describes the assessment process for protecting and managing potential impacts of aquifer interference activities on the water resources of NSW. The WM Act defines an aquifer interference activity as that which involves either:

- the penetration of an aquifer;
- the interference with water in an aquifer;
- the obstruction of the flow of water in an aquifer;
- the taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations; or
- the disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.

Section 3.3 of the Aquifer Interference Policy identifies activities such as trenching, access tracks, and building and work pads as activities defined as having minimal impact on water dependent assets. The Project works are considered as having minimal impact on water dependent assets with the most significant excavation works being the work pads and associated wind turbine foundations to a depth of approximately 3 – 5 m. Cuttings may be approximately 10 – 15 m. Aquifer interception is not anticipated, noting the estimated depth of the water table exceeding 60 m from existing recorded bore depths.

2.2 Implications for the Project

Given the SSD status of the Project, Section 4.41 of the EP&A Act negates the requirements for relevant approvals otherwise obtained through the WM Act, including a water use approval under Section 89, a water management work approval under Section 90, or an activity approval under Section 91 of the WM Act.

As discussed further in Section 3.2 of this report, the Project has four viable options available to source water, being:

- Council water supply, in agreement with the relevant Council(s);
- extraction of watercollected from existing (or new) dams using landowner harvestable rights or from an existing nearby landowner bore, in agreement to use their allocation;
- extraction from a new groundwater bore, which will require a WAL in consultation with WaterNSW; and
- extraction from a surface water source (e.g. Chaffey Dam), which will require a WAL in consultation with WaterNSW.

Confirmation of the proposed source will be determined following detailed design.

3. WATER BALANCE

3.1 Construction Water Demands

During the construction period, water will need to be sourced for the following purposes:

- concrete production (batching plant);
- construction of roads and hardstands; and
- dust suppression.

Based on an understanding of the construction requirements and the construction schedule, estimates have been made on the likely quantities of water required.

Information used to determine likely water requirements included:

- Total length of internal unsealed road network (may be either upgraded existing tracks, or new tracks including alternative options), including proposed alternatives is approximately 48 km. The internal road network will be constructed progressively over approximately a six month period with final wearing surface using compacted selected aggregates providing a stabilised all-weather surface which will require minimal dust control. For determining potential water demand, the length of access roads under construction at any one time will vary and is estimated at approximately 5-8 % of the internal network. The demand for water for dust control is driven by prevailing weather and the volume of plant and transport movements over sections of the road network disturbed but yet to be stabilised. Internal construction traffic movements vary as construction of individual footings and turbine erection progress, with some branch roads not trafficked for relatively long periods.
- It is assumed that access roads will be constructed to 5.5 m wide with 1.5 m shoulders on either side and with approximately 0.3-0.4 m depth of onsite and/or imported road base/aggregate that would need to be laid and compacted. Quarry sourced material can be supplied with moisture content at near optimum for compaction to minimise requirement for onsite addition. Hence, water demand for compaction is highly variable depending on moisture content of material and antecedent conditions with minimal constraints on quality and is estimated at 120 kL/km.
- Crane hardstands of approximately 115 m by 60 m will need to be constructed adjacent to the base of the WTGs to enable the erection of the turbine. Each pad will be constructed from cut and fill material and compacted selected aggregates providing a stabilised all-weather surface which will require minimal dust control. As for the access roads water demand for compaction is highly variable depending on moisture content of material and antecedent conditions and is estimated at 65 kL/pad.
- Water demand for dust suppression is determined by the extent of disturbed areas and whether under traffic, weather conditions such as rainfall, evaporation rates and wind speeds and is minimised by the construction of stabilised all-weather access roads. There is also increasing use of polymers and soil binders to combat dust generation on roadways, stockpiles and hardstands which greatly reduces the demand for water.
- An allowance of approximately 150 kL/day is provided for road maintenance, dust suppression and wash down, for the intensive six month period where the internal access roads are under construction. A lower demand of approximately 40 kL/day for the remaining portion of the 20 month period where traffic volumes associated with construction activities continue is predicted (assume full days on Monday to Friday and half days on Saturdays).

- Good quality water is required for concrete production for WTG footings. The final footing design is subject to final geotechnical investigations and turbine selection and is expected to be available prior to construction. However, an estimate based on there being 70 footings in total, hexagonal in shape, approximately 25 m in diameter. The volume of concrete is estimated at approximately 700 m^3 per foundation and a total concrete volume of approximately 49,000 m^3. Additional concrete will be required for construction of the substation and O&M foundations etc. and is estimated at an additional 2,000 m^3.

  Water input estimate is based on a typical cement:sand:aggregate ratio of 1:2:3 and a water:cement ratio of 0.4. The total water estimate to produce 51,000 m^3 of concrete is approximately 3,400 m^3 (or say 3.5 ML). Concrete production is expected to occur mainly between months seven and sixteen and with production at a relatively consistent rate during this time.

Based on a worst-case scenario, the total water demand over the 24 month construction period is approximately 55 ML. Actual demand will vary depending on rainfall patterns during construction and the final extent of access road construction and existing road upgrades (eg whether Morisons Gap Road is sealed - reduced dust suppression or if Head of the Peel Road is not upgraded – reduced construction water and dust control). The estimated total construction water demand is summarised in Table 3-1.

In addition to the key construction water demands, potable water will also be required for site amenities during construction and operation of the Project.

Table 3-1 Water Demand by Activity (ML)

Project Stage	Activity	Water Requirement
Construction	Concrete Production	3.5 ML
	Dust Control and washdown	41 ML
	General Use including earthworks compaction	10.5 ML
	TOTAL	55 ML

3.2 Water Supply Options

A number of water supply options have been canvassed, the key options being:

- surface water collection from existing (or new) dams;
- groundwater pumping from bores;
- water abstraction from a nearby permanent water source (i.e. Chaffey Dam); and
- tanking water to site from Council supply or other local WAL owners.

The Project may utilise a number of existing property dams scattered throughout the Project Area to store water during the construction period. These dams could be topped up with imported water providing an option to stage the water stores in close proximity to earthworks during construction of access tracks and turbine construction pads.

Water storages would be provided at the batching plant sites and for potable water at the site compounds.

3.2.1 Groundwater Pumping

A new bore, or bores, would need to be constructed to allow for groundwater pumping should this be considered a viable option. The bore/s would need to be licenced for industrial purposes. A water entitlement would then likely need to be purchased on the open market.

Six groundwater bores are located within the Project Area. GW967488 is recorded to intercept groundwater at a depth of 28 m and had a yield of 1.26 l/s. It could be reasonably assumed that if additional bores where established within the Project Area a yield of approximately 1.0 l/s could be secured. This amounts to a potential long-term pumping rate during standard construction hours of approximately 40 kL/day, or 1.2 ML/month. Assuming such yields were achieved, this would be capable of supplying a significant proportion of the construction water needs of the Project and hence reducing the demand for importing using water tankers. Consideration would need to be given to water storage and this could be in a new or existing dam or temporary tanks. All work would be subject to agreement with the landholders. It would be possible to on-sell any water entitlement over the new bore to the landholder at the completion of construction. Alternately, the landholder could apply for a new stock and domestic license over the bore.

3.2.2 Surface Water Abstraction

As outlined in Section 2.1 a WAL may be applied to source water from an unregulated water source. A potential water source is the Peel River. Review of online river flow data (available at https://realtimedata.waternsw.com.au/) indicated that the Peel River at Taroona (419081) had a daily flow rate of around 109 ML/day, as recorded on 19 August 2020. Review of water levels at Chaffey Dam on 19 August 2020, identified that the dam is currently at 24.9 % capacity with a current volume of 27,392 ML, receiving a net inflow of 136 ML in the past 24 hours.

Given the total requirement for all Project activities is limited to the 24 month construction period is approximately 55 ML, it could be possible to permit water abstraction for the Project without impacting environmental flows. WALs would have to be purchased to meet the Project needs.

3.2.3 Commercial Water Tanker

Where other resources including onsite dams are exhausted or unavailable, water will be sourced from an offsite source using a commercial water tanker, however this is anticipated to add considerable expense to the construction of the Project.

3.2.4 Water Availability

The Water Allocation Statement published by the DPIE, dated 6 August 2020, is a statement of the water availability for the Peel Valley. It was identified that Chaffey Dam was holding 25,000 ML and is at 23% capacity. The three months between August and October have been forecasted to be wetter than average for the Peel Valley. DPIE will provide an update on the Peel water resource availability in November 2020 (DPIE, 2020)

3.2.5 Summary

There are feasible options for the supply of water for the 24-month Project construction period. The four viable options available to source the estimated 55 ML of water required for construction include:

- Council water supply, with agreement with the relevant Council(s);
- extraction of water from an existing landowner bore, with agreement from the landowner;
- extraction from a new groundwater bore; and
- extraction from an external surface water source (e.g. Chaffey Dam or the Peel River).

If water is sourced from any bore or surface water source then all required water access licences would be obtained to authorise this.

All options involve different considerations and different water licencing and approval requirements.

Confirmation of the proposed water source will be determined following detailed design, however, it has been confirmed that adequate water supply is available for the development.

4. SOILS AND WATER ASSESSMENT

4.1 Methodology

Information was extracted from the SEED Portal (OEH, 2019), including the following datasets:

- the Australia Soil Classification (ASC) Soil Type map of NSW, which provides soil types across NSW using the Australian Soils Classification at Order level; and
- the Land and Soil Capability (LSC) mapping of NSW, which depicts the capability and limitations of land for sustaining certain land uses.

A desktop investigation of soil profile and soil map information by:

- Search of eSPADE data for NSW (OEH, 2012), including Soil Profiles, Bioregions and Hydrologic Soil Groups; and
- Search of WaterNSW data (available at https://realtimedata.waternsw.com.au/), including existing groundwater bores and real-time dams and rivers data

A site visit was conducted to inspect the proposed creek crossing locations associated with the transmission line and the potential bridge upgrade site on Lindsays Gap Road, to inform any measures required to meet guidelines, and to inform overall site soil and water management measures.

In addition, consideration of the NSW Water Quality Objectives (WQO) as they apply to the three catchment areas of the Project Area, being the Namoi, Manning and Hunter catchments (refer to Section 4.2.3).

Site based soil and/or water sampling was not undertaken given the availability of the aforementioned online resources and the limited disturbance to existing watercourses associated with the construction and operation of the wind farm.

4.2 Existing Environment

4.2.1 Topography and Bioregions

Landform and Elevation

The landform and topography of the Project Area is defined by the substantial mountains of the Great Dividing Range, with a range of plateaus, ridgelines and escarpments broadly positioned in a north-south direction, wrapping around with the southern extent forming the eastern end of the Liverpool Ranges. The steep ridgeline decline to the north undulating foothills with creeks and tributaries carving through the landscape, converging at the Peel River and Nundle Creek along Nundle Valley floor. Ben Halls Gap Nature Reserve and Ben Halls Gap State Forest bounds the Project Area to the southeast with Crawney Pass National Park marking the western boundary of the Project Area.

The elevation across the site ranges from 776 m to 1418 m Australian Height Datum (AHD). This elevation range highlights the significantly variable topography across the site. The ridgeline slopes dramatically downhill from the Project Footprint, generally forming a valley towards the Peel River. Topography of the Project Area is presented in Figure 4-1 below.

Bioregions

The Interim Biogeographic Regionalisation for Australia (IBRA) mapping provides a national and regional framework for understanding bioregions. Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Sub-regions are based on finer differences in geology, vegetation and other biophysical attributes and are the basis for determining the major regional ecosystems (Morgan & Terrey, 1992).

The Project Area intersects with three sub-regions being; the Peel IBRA Sub-region of the Nandewar Bioregion, the Walcha Plateau IBRA Sub-region of the New England Tableland Bioregion, and the Tomalla IBRA Sub-region of the North Coast Bioregion (refer Figure 4-1). Features of two of these Sub-regions are described by the NSW National Parks and Wildlife Services (2003) and is presented in Table 4-1 and Table 4-2.

(Note: descriptions were not available for the third subregion, being the Tomalla IBRA Sub-region of the North Coast Bioregion)

Table 4-1 Peel IBRA Sub-region of the Nandewar Bioregion

Feature	Description
Geology	Fine grained Silurian to Devonian sedimentary rocks. Strongly folded and faulted with marked northwest alignment. Areas of sub-horizontal Carboniferous shales and sandstones in the north. Limited areas of basalt cap from the Nandewar and Liverpool Ranges are included. Linear outcrops of serpentinite and scattered bodies of limestone.
Characteristic Landforms	Low peaked hills with north-westerly alignment. Basalt caps of dissected flows, moderate slopes and flat river valleys with alluvium. Karst landscapes in limestone.
Typical Soils	Shallow stony soils on ridges. Texture contrast soils on almost all slopes shifting in colour from red brown on upper slopes to yellow on lower slopes. Black earths on basalt. Dark, alkaline, pedal clays on limestone. Serpentinites have shallow stony profiles with concentrations of elements that are toxic to many plants. Alluvial loams and clays with moderate to high fertility in alluvium.
Vegetation	White box grassy woodlands, with yellow box and Blakely's red gum on lower slopes. Rough-barked apple and yellow box on flats. River oak and some river red gum along major streams. Patches of red stringybark and red ironbark on steeper slopes in the east. Silver-leaved ironbark on basalt caps, white cypress pine and kurrajong on stony areas in the west and north. Very large grass trees on serpentinite.

Table 4-2 Walcha Plateau IBRA Sub-region of the New England Tableland Bioregion

Feature	Description
Geology	Faulted inliers of Devonian and Carboniferous sandstone, conglomerate, minor limestone, slate, schist, amphibolite and volcanics. Small stock of granodiorite and central peak and ridge top fingers of Tertiary basalt.
Characteristic Landforms	Eastern and southern margin is the Great Escarpment. High central plateau capped by basalts. General topography undulating with small rugged areas often related to geology.
Typical Soils	Mellow and harsh texture contrast soils on sediments and granite. Red brown to black structured loams on basalt, thin in places and often stony.
Vegetation	Snow gum and black sallee on coldest wet ridges. Ribbon gum, mountain gum, silvertop stringybark, New England blackbutt, narrow-leaved peppermint, in moist high areas. New England stringybark, ribbon gum, and cool temperate rainforest elements in moist sheltered gullies.

4.2.2 Soils

Land and Soil Capability

The OEH (2017) have established the land and soil capability (LSC) to inform the inherent physical capacity of the land to sustain a range of land uses and management practices in the long-term without degradation to soil, land, air and water resources. The LSC assessment scheme uses biophysical features of the land and soil, including landform position, slope gradient, drainage, climate, soil type and soil characteristics, to derive detailed rating tables for a range of land and soil hazards. These hazards include water erosion, wind erosion, soil structure decline, soil acidification, salinity, waterlogging, shallow soils and mass movement. The mapping is based on an eight class system with values ranging between 1 and 8 which represent a decreasing capability of the land to sustain productive agricultural land use. Class 1 represents land capable of sustaining most land uses including those that have a high impact on the soil (e.g., regular cultivation), whilst class 8 represents land that can only sustain very low impact land uses (e.g., nature conservation), as shown in Table 4-3.

Table 4-3 Land and Soil Capability Scheme Classification (OEH, 2012)

LSC Class	General Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation).	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping and cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, gazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land:** Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. Onsite and offsite impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The LSC mapping identifies a large variation in Classes mapped across the Project Area, as shown in Figure 4-2.

The north and west facing slopes of the Project ridgeline are attributed the highest limitation class, being assessed under the LSC scheme to be rated Class 8, having extreme limitations to agricultural production. Class 8 land includes precipitous slopes (>50% slope) and cliffs or areas with a large proportion of rock outcrop (>70% area), though it is noted that the majority of the Project Footprint is on the ridgetop rather than the steep slopes to the valley. Recommended uses for Class 8 land are those compatible with the preservation of natural vegetation including water supply catchments, wildlife refuges, national and State parks, and scenic areas.

The western portion of the Project Area has been rated as a mixture of LSC Class 8 and Class 7, having severe limitations. Class 7 is unsuitable for any type of cropping or grazing, as it would result in severe erosion and degradation. The land may be suitable for commercial timber plantations or for native timber on undeveloped land. Class 7 land includes slopes of 33–50% and also includes areas with extreme soil erodibility (often sodic soils, or prior stream sand dunes), catchments where salinity and recharge are a serious problem, severely scalded areas and where rock outcrop, stoniness and shallow soils are a severe problem.

The eastern ridgeline, which stretches in a north-south direction, is classified as a mixture of LSC classes, being Class 3, Class 4 and Class 6 and having moderate to very severe limitations:

- Class 3 land has limitations that must be managed to prevent soil and land degradation. However, a range of widely available and readily implemented land management practices can overcome the limitations. Included are sloping lands (3–10%) with slopes longer than 500 m. It is important to minimise soil disturbance, maintain stubble cover and maintain good organic matter levels. This class includes other soils with acidification and soil structure limitations that are sufficient to require the application of specific management practices.
- Class 4 land has moderate to severe limitations for some land uses that need to be consciously managed to prevent soil and land degradation. The limitations can be overcome by specialised management practices with high levels of knowledge, expertise, inputs, investment and technology. This class includes sloping lands (10–20% slope).
- Class 6 land has very severe limitations for a wide range of land uses and few management practices are available to overcome these limitations. Land generally is suitable only for grazing with limitations and is not suitable for cultivation. Class 6 land includes steeply sloping lands (20–33% slope) that can erode severely even without cultivation, or land that will be subject to severe wind erosion when cultivated and left exposed.

The south-eastern corner of the Project Area is classified predominately as being Class 6 and Class 7, with pockets of Class 3 and Class 4. These Classes have been described above.

Biophysical Strategic Agricultural Land

Review of the Strategic Regional Land Use Policy (SRLUP) mapping available on the NSW Government Sharing and Enabling Environmental Data (SEED) website identified that a portion of the Project Site interacts with biophysical strategic agricultural land (BSAL).

BSAL maps identify the inherent land and water resources that are important on a national and state level for agriculture. The lands identified intrinsically have the best quality soil and water resources, topography, and are naturally capable of sustaining high levels of agricultural productivity and require minimal management practices to maintain this. A total of 313 ha of BSAL has been identified within the Project Area, of which only 39.8 ha occurs with the Development Footprint (refer to Figure 4-2).

A total of 2.8 million ha of BSAL has been identified and mapped at a regional scale across NSW. The Project Area encompasses approximately 0.000014% of the total land area mapped as BSAL within NSW. The use of the BSAL mapped area will have limited impacts as the current use of the land for grazing can continue concurrently with the operation of the wind farm.

Once the Project reaches the end of its investment and operational life, the Project infrastructure will be decommissioned and the Development Footprint returned to its pre-existing land use, or other land use in consultation with the landholders, as far as practicable.

Australian Soil Classification

A search of the ASC Soil Type Map of NSW (OEH, 2019) reveals that the Ferrosols soil type dominates the Project Area. Ferrosols are characterised by their deep red friable soils that lack strong texture contrast, which are high in free iron oxide and generally have a high clay content. Ferrosols have high agricultural potential because of their good structure and moderate to high chemical fertility and water-holding capacity. Water filtration rates are high, unless significant compaction has occurred.

The ASC Soil Type Map of NSW also revealed, to a lesser extent, the presence of Podosols, Chromosols and Hydrosols soil types. The extent of soil types, according to the ASC Soil Type mapping, is shown in Figure 4-3.

Soil Profiles

A search of OEH eSPADE (OEH, 2017) identified five soil profiles recorded either within the Project Area, or immediately adjacent to the Site. These five soil profiles are described in Table 4-4.

Table 4-4 Soil Profiles in Project Area

Soil Profile	Survey Date	Easting	Northing	Horizons	Soil Type	Surface pH
1003614 – 9	05/05/1998	327405	6508489	2	Brown Dermosol (ASC), Chocolate Soil (GSG)	5.5
1003614 – 10	05/05/1998	328705	6507889	2	Brown Dermosol (ASC), Chocolate Soil (GSG)	5.5
1000528 – 1	31/08/1993	326680	6500714	4	Krasnozem (GSG), Gn4.11 (PPF)	6.0
1000528 – 2	31/08/1993	326955	6502764	5	Krasnozem (GSG), Gn4.11 (PPF)	6.0
1000528 – 3	31/08/1993	326430	6504189	3	Krasnozem (GSG), Gn4.11 (PPF)	6.5

Soil Regolith Stability

The Soil Regolith Stability classification (aka. soil erodibility) is used in the assessment of soil erosion and water pollution hazards. Regolith includes all soil layers and biological cover above bedrock, with the classification assessed to a depth of one metre. The Project Area contains two classifications, predominately R3 with two small isolated areas mapped as R1. These two classifications are described as being:

- Class R1 – High coherence soils with low sediment delivery potential.
- Class R3 – High coherence soils with high sediment delivery potential.

The Development Footprint is primarily mapped as classed as R3(R1) where R3 is the dominant class and R1 the sub-dominant class. R3 stability class is clayey and silty soils which are liable to sheet erosion. Typically slowly permeable and drainage generally impeded. Earth batters and exposed surfaces subject to minor to moderately extensive rilling and minor slumping. Minor gully erosion may develop in drainage lines and incision may occur along road drains. Localised films of fine sediment at drain outlets and in drainage lines. R1 stability class are stable soils with no appreciable erosion. Generally well-drained, permeable soils. Earth batters stable. No or little general evidence of coarse or fine sediment movement.

Soil Hydrologic Groups

A search of the OEH eSPADE view (OEH, 2017) was utilised to identify the Hydrologic Groups within the Project Area. Hydrological Grouping of soils in NSW is a four class system, which identifies the soils infiltration and permeability characteristics. Across the Project Area, the soils are assigned ratings of A and B, representing the soils having high to moderate infiltration respectively. These two soil classes are described as:

- A — soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels. These soils have a high rate of water transmission.

- B – soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission and low to moderate runoff potential.

The area assigned to the A rating is a narrow section, generally aligning to the eastern ridgeline, extending from Morrisons Gap to the elbow of the Project area, with the remainder mapped as B rating. Hence the Project Area has generally permeable soils which reduce runoff potential with the depth to any water impermeable layer greater than 0.5 m. Hence combined with the topography of a narrow ridgeline and steep upper slopes the Project Area generally only consists of multiple small ephemeral gullies.

Modelled Soil Characteristics

eSPADE provides modelled soil properties for the State and has been used to gain a broad understanding of the likely site soil characteristics that will be encountered. The modelled soil properties considered relevant to the Project Area is provided in this section.

Soil acidity modelling demonstrates that across the Project Area, soil acidity ranges between a pH of 4.5 and 6 in the 0-30 cm layer. The soil acidity in the 30-100 cm layer becomes slightly less acidic, still ranging between 4.5 and 6, however the extent of area mapped with a pH between 5 and 6 is greater. These soil pH characteristics are not considered to be restrictive to construction activities or any required revegetation activities that may be required.

Exchangeable sodium percentage (ESP) is a measure of soil sodicity, with values of greater than 6% indicative of sodic soils. Issues related to sodic soils include:

- water permeability issues;
- surface crusting;
- more susceptible to erosion; and
- high sediment load in runoff that will not settle out over time.

eSPADE soil modelling for the Project Area identifies that in the 0-30cm soil profile, ESP is predominately less than 4%. With increasing depth, in the 30-100cm soil profile, the majority of the site remains less than 4% though there are isolated, small pockets between 4-6%.

The soils do not exhibit a significant constraint that cannot be managed through considered design and construction technique or operation management measure/potential amelioration. In the event that sodic soils are identified, management measures and limited soil sampling are to be implemented such as topsoil and subsoil separation.

Acid Sulfate Soils

A review of acid sulfate soil risk mapping has identified that no potential acid sulfate soils (PASS) are expected to occur across the Project Area (Naylor, et al., 1998).

Soils Summary

Overall, the soil character of the Project Area is identified as having low to moderate erodibility and generally permeable soils which reduces runoff potential. The primary concern for soil management is the disturbance of steep sloped areas. Detailed design has avoided proposed disturbance of steep sloped areas, with the primary ground excavation works associated with work pads located on the ridgeline.

4.2.3 Hydrology

Surface Water and Watercourse Crossings

In this section and elsewhere throughout this report, a reference to stream order relates to the Strahler system of stream ordering. This is explained as follows:

- starting at the top of a catchment, any watercourse that has no other watercourses flowing into it is classed as a first-order watercourse;
- where two first-order watercourse join, the watercourse becomes a second-order watercourse;
- if a second-order watercourse is joined by a first-order watercourse – it remains a second-order watercourse;
- when two or more second-order watercourses join they form a third-order watercourse; and
- a third-order watercourse does not become a fourth-order watercourse until it is joined by another third-order watercourse, and so on.

Numerous first-order watercourses are located in the Project Area, characteristic of its ridgeline nature. The majority of these flow north and west of the ridgeline into the Namoi catchment area. The southern portion of the Project Area flows south to the Hunter catchment area. A small portion of the eastern portion of the Project Area flows east to the Manning Catchment Area. Table 4-5 details the extent of the Project Area within each of these catchment areas and the percentage of the catchment area which the Project Area intersects with.

Table 4-5 Area of Project within Catchment Areas

Catchment	Project Area within Catchment (ha)	Project Area as % of Catchment Area
Namoi	5180.9	0.00123 %
Hunter	2254.6	0.00105 %
Manning	880	0.00105 %

There are fourteen named tributaries within the Project Area (refer to Figure 4-4), including those spanned by the transmission line:

- Back Creek
- Dead Eye Creek
- Goonoo Goonoo Creek
- Limestone Oaky Creek
- McDivitts Creek
- Nundle Creek
- Pages Creek
- Peel River
- Perrys Creek
- Ryan's Oaky Creek
- Talbots Creek
- Whites Creek
- Wombramurra Creek
- Woodleys Creek

There are no third-order streams or larger which are directly impacted upon by the Development Footprint.

The transport route along Lindsays Gap Road requires bridge upgrades at Goonoo Goonoo Creek and Middlebrook Creek. Further, should the Head of Peel Road be required for access of oversize / over-mass vehicles, upgrades to causeways and a bridge will be required at 13 locations along Head of Peel Road (refer to Figure 4-4). The locations include:

- Woodleys Creek at two locations
- Wardens Brook
- Peel River
- Nine unnamed Tributaries of Peel River

Typically, the first and second order streams are ephemeral gullies that will require culvert installations in the access tracks and the DPI guideline *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (2003) and DPI Water *Guidelines for watercourse crossings on waterfront land* (2012) are not required to be considered during detailed design.. However, at the location of the two creek crossings at Woodleys Creek, the existing bridge over the Peel River upstream of its confluence with Woodleys Creek, and crossings at two tributaries of Peel River (Wardens Brook and an unnamed tributary) are at third order streams or greater. The highest stream order is at the second creek crossing with Woodleys Creek at which point Talbots Creek joins and forms a fourth order stream. The current condition of this existing creek crossing is depicted in Photograph 4-1 below.

Consultation with Council has confirmed that any causeway and bridge upgrade works will require a Section 138 of the Roads Act 1993 approval and are to be designed and constructed in accordance with Council's Development Control Plan and Tamworth Regional Council's *Engineering Design Guidelines for Subdivisions and Developments* (dated March 2019). The DPI guidelines *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (2003) and *Guidelines for watercourse crossings on waterfront land* (2012) will also be considered during detailed design.

Photograph 4-1 Creek Crossing Proposed at Convergence of Woodleys Creek and Talbots Creek

Photo 1: Talbots Creek (left) converging with Woodleys Creek (right) at the existing creek crossing

Photo 2: Woodleys Creek flows across the existing creek crossing as a fourth-order stream

There are no areas within the Project Area mapped as flood prone land.

Water Quality Objectives

The NSW Water Quality Objectives (WQOs) are the agreed environmental values and long-term goals to achieve healthy waterways in surface water catchments across the State. The WQOs include a range of water quality indicated to help assess the current conditions of waterways and their ability to support its respective uses and values.

The WQOs for the three catchment areas are detailed in Table 4-7 below, with the indicators and associated trigger values for the identified environmental values of the receiving environment included.

Table 4-6 Water Quality Objectives

Catchment Areas	Applicable Water Quality Objectives	
Namoi, Hunter & Manning	■ Aquatic ecosystems,	*Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term*
	■ Visual amenity,	*Aesthetic qualities of waters*
	■ Secondary contact recreation	*Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed*
	■ Primary contact recreation	*Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed*
	■ Livestock water supply	*Protecting water quality to maximise the production of healthy livestock*
	■ Irrigation water supply	*Protecting the quality of waters applied to crops and pasture*
	■ Homestead water supply	*Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing*
	■ Drinking water – disinfection only, or ■ Drinking water – clarification and disinfection, or ■ Drinking water – groundwater	*Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment*
	■ Aquatic foods (to be cooked)	*Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.*
	■ Industrial water supplies	*Recognises the economic value of water as a resource for industrial use.*

Waterway health is assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (formerly ANZECC, 2000). The Guideline establishes values for various water quality measures which support the WQO's.

The WQO's identify the important economic value of water for industrial needs. As industry water supply needs are diverse, relevant water quality criteria are not summarised in the WQO's for the three catchment areas. Sources of water used for industry invariably have other environmental values, which mostly need water of a higher quality than that needed by industry. Further, individual industries generally have the capacity to monitor and treat the available water resources to meet their own needs. The Project requires a comparatively low amounts of water, which is able to be sourced from a range of sources in consultation with WaterNSW.

Transmission Line Creek Survey Effort

A site visit was conducted along the transmission line route to confirm availability of access tracks to the route and inspect locations where the transmission line will span creeks. The survey effort included visits to the following creeks, which at the route location were second or third order streams:

- Goonoo Goonoo Creek (second order);
- Back Creek (third order);
- Wombramurra Creek (third order);
- Woodleys Creek (second order); and
- Talbots Creek (second order).

All other creeks along the transmission line route or within the Development Footprint are first or minor second order streams. The transmission line is proposed to span creeks with pole sites located with sufficient buffer to minimise indirect impacts on aquatic habitats and water quality.

Erosion and sediment control measures will be implemented at the source of construction activities (e.g. pole and pad sites) and operational infrastructure (e.g. turbines) to ensure sediment is appropriately managed and impacts to waterways are adequately mitigated. Overall, the Project will result in an enhancement of any creek crossings requiring upgrading through post construction rehabilitation and stabilisation works, reducing the levels of downstream sediment and consequently mitigating existing impacts to water quality.

A photographic log displaying existing creek conditions at the transmission line route is provided in Appendix C.

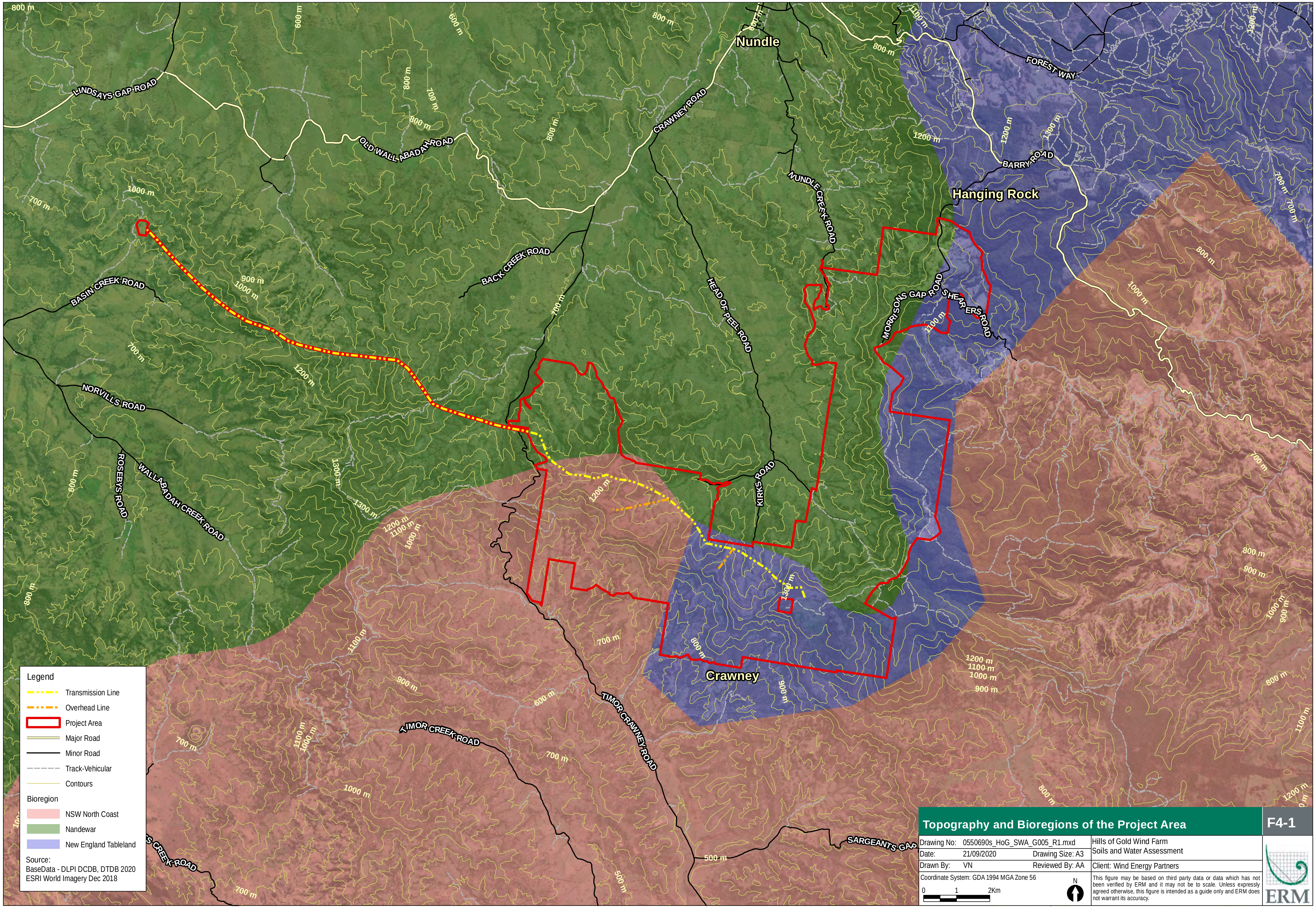
Sensitive Locations

The Ben Halls Gap National Park is located adjacent to the Project Area, immediately to the east of the ridgeline. In portions of the National Park, a rare moss has been identified as requiring additional consideration to ensure activities associated with the Project do not impact on the integrity of the rare moss. The primary risk to impact upon the “sensitive location” is associated with runoff and sediment deposits.

Additional measures are able to be effectively implemented to appropriately mitigate impacts associated with the identified sensitive location in the adjacent National Park. Measures are to be included in the progressive Erosion Sediment Control Plan (ESCP) to either;

- direct disturbed runoff away from the catchment area identified to contain the sensitive location, or
- process runoff through additional sediment controls (e.g. sumps and/or sediment basins) and discharge at a low, non-erosive velocity.

These measures are detail in Section 4.3.3, for inclusion in environmental management plans to be implemented across the site and to protect the identified sensitive locations.

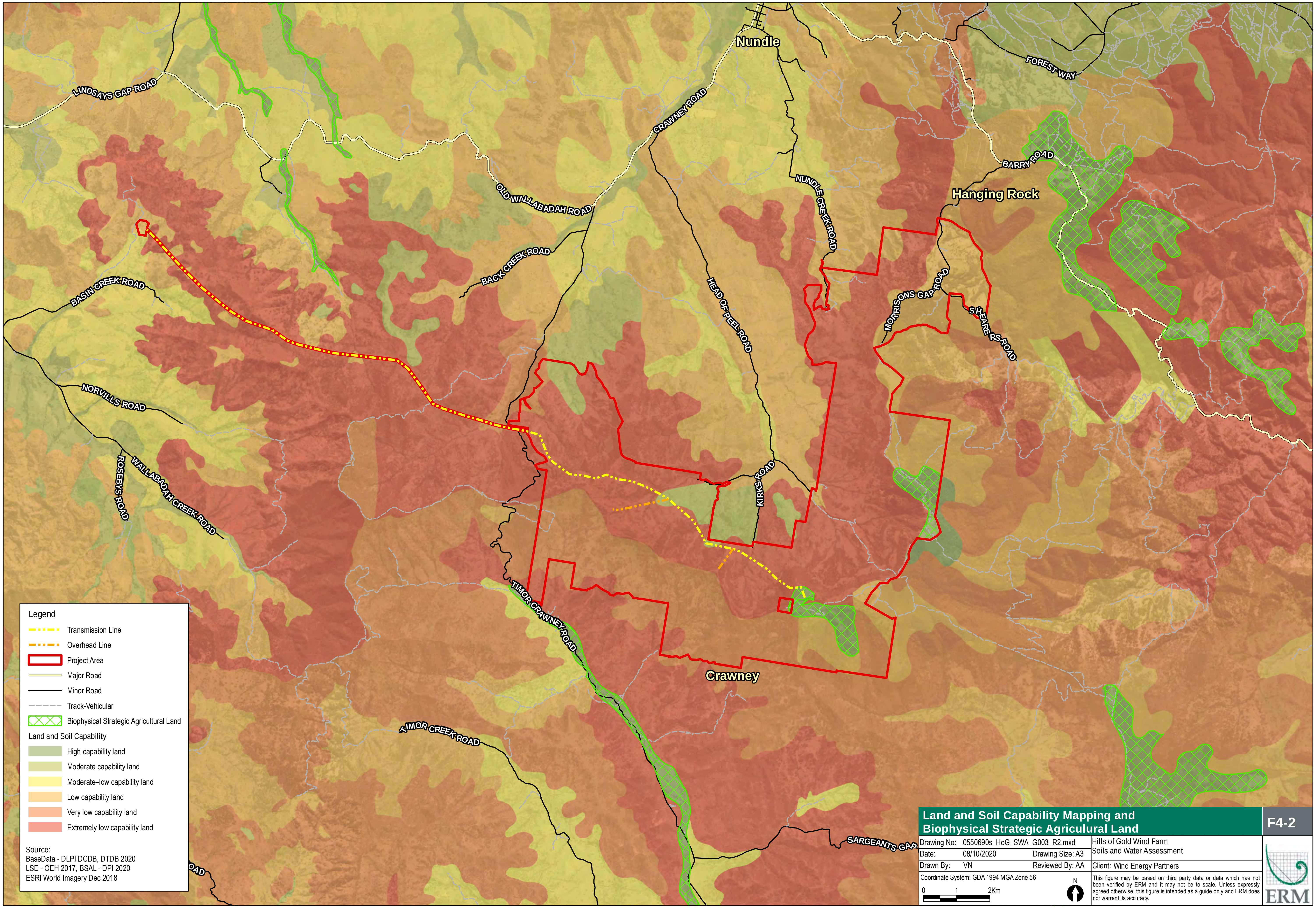


Topography and Bioregions of the Project Area

F4-1

Drawing No: 0550690s_HoG_SWA_G005_R1.mxd	Hills of Gold Wind Farm Soils and Water Assessment
Date: 21/09/2020 Drawing Size: A3	
Drawn By: VN Reviewed By: AA	Client: Wind Energy Partners
Coordinate System: GDA 1994 MGA Zone 56 0 1 2Km N	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Nundle
FOREST WAY
LINDSAYS GAP ROAD
CRAWNEY ROAD
BARRY ROAD
NUNDLE CREEK ROAD
Hanging Rock
OLD WALLABADAH ROAD
BACK CREEK ROAD
BASIN CREEK ROAD
HEAD OF PEEL ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
NORVILLS ROAD
ROSEBYS ROAD
WALLABADAH CREEK ROAD
KIRKS ROAD
TIMOR CRAWNEY ROAD
Crawney
TIMOR CREEK ROAD
SARGEANTS GAP
Legend
Transmission Line
Overhead Line
Project Area
Major Road
Minor Road
Track-Vehicular
Biophysical Strategic Agricultural Land
Land and Soil Capability
High capability land
Moderate capability land
Moderate–low capability land
Low capability land
Very low capability land
Extremely low capability land
Source:
BaseData - DLPI DCDB, DTDB 2020
LSE - OEH 2017, BSAL - DPI 2020
ESRI World Imagery Dec 2018
Land and Soil Capability Mapping and Biophysical Strategic Agriculural Land
F4-2
Drawing No: 0550690s_HoG_SWA_G003_R2.mxd
Date: 08/10/2020
Drawing Size: A3
Drawn By: VN
Reviewed By: AA
Hills of Gold Wind Farm
Soils and Water Assessment
Client: Wind Energy Partners
Coordinate System: GDA 1994 MGA Zone 56
0 1 2Km
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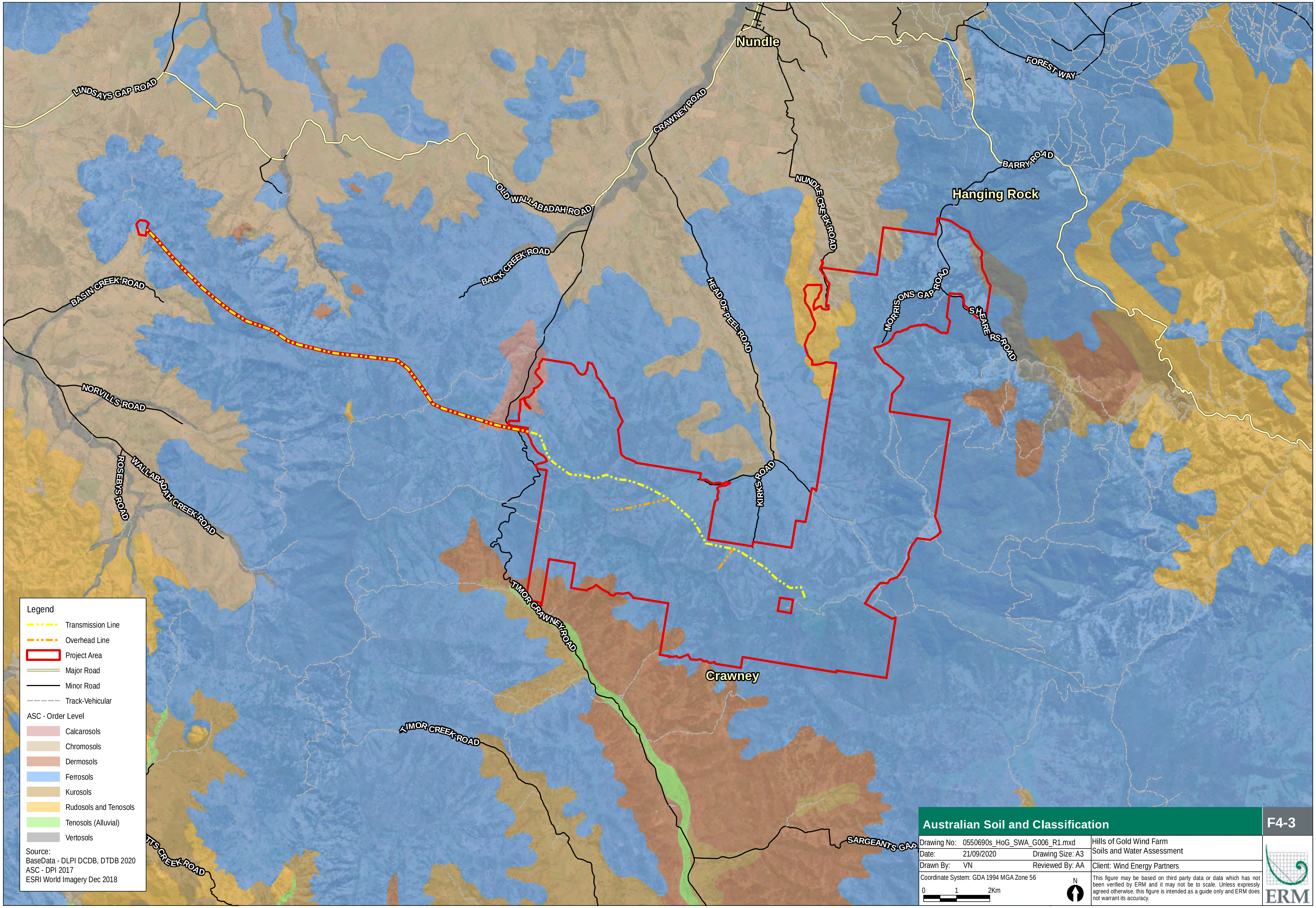
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.



Nundle
LINDSAYS GAP ROAD
CRAWNEY ROAD
FOREST WAY
BARRY ROAD
Hanging Rock
OLD WALLABADAH ROAD
NUNDLE CREEK ROAD
BACK CREEK ROAD
BASIN CREEK ROAD
HEAD OF PEEL ROAD
MORRISONS GAP ROAD
SHEARERS ROAD
NORVILLS ROAD
ROSEBYS ROAD
WALLABADAH CREEK ROAD
KIRKS ROAD
TIMOR CRAWNEY ROAD
Crawney
TIMOR CREEK ROAD
SARGEANTS GAP
Legend
Transmission Line
Overhead Line
Project Area
Major Road
Minor Road
Track-Vehicular
ASC - Order Level
Calcarosols
Chromosols
Dermosols
Ferrosols
Kurosols
Rudosols and Tenosols
Tenosols (Alluvial)
Vertosols
Source:
BaseData - DLPI DCDB, DTDB 2020
ASC - DPI 2017
ESRI World Imagery Dec 2018
Australian Soil and Classification
F4-3
Drawing No: 0550690s_HoG_SWA_G006_R1.mxd
Date: 21/09/2020
Drawing Size: A3
Drawn By: VN
Reviewed By: AA
Hills of Gold Wind Farm
Soils and Water Assessment
Client: Wind Energy Partners
Coordinate System: GDA 1994 MGA Zone 56
0 1 2Km
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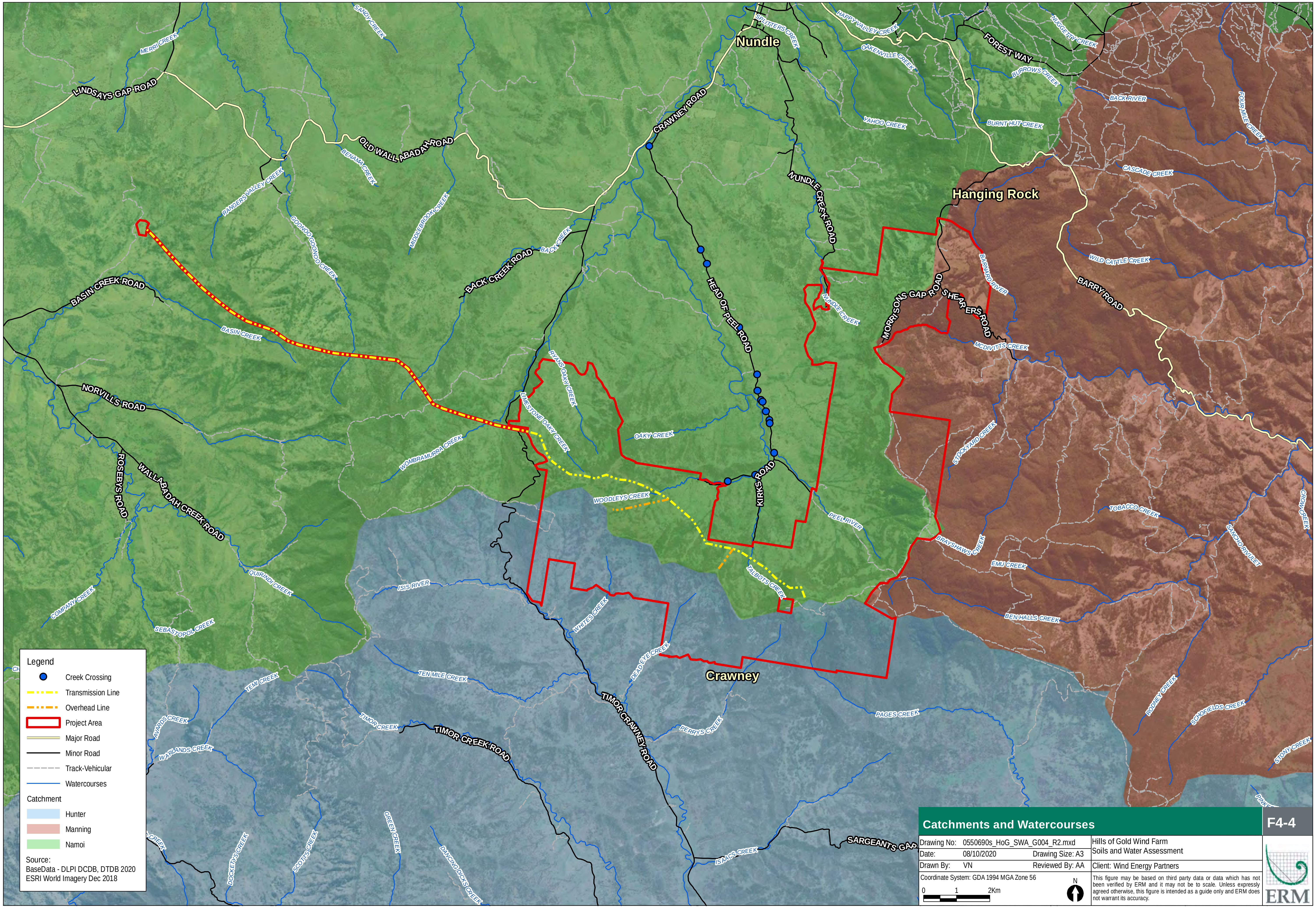
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.
ERM



Catchments and Watercourses

F4-4

Drawing No:	0550690s_HoG_SWA_G004_R2.mxd		Hills of Gold Wind Farm Soils and Water Assessment
Date:	08/10/2020	Drawing Size: A3	
Drawn By:	VN	Reviewed By: AA	Client: Wind Energy Partners
Coordinate System: GDA 1994 MGA Zone 56			

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

4.3 Assessment

4.3.1 Construction Impacts

Soils will be subject to disturbance during construction activities to allow for site establishment, installation of infrastructure and replacement of soils for revegetation. Specific construction activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in Table 4-7.

Table 4-7 Potential Construction Impacts to Soils and Water

Construction Activities	Potential Impacts to Soils and Water
All-weather Unsealed Road Network	■ creation of fugitive dust due to vehicle movements; ■ creation of fugitive dust due to onsite livestock movements; ■ erosion of unsealed roadways and resultant sedimentation of run-off from road surfaces; ■ erosion of roads and roadside drainage in areas of steep terrain or in inappropriately 'finished' locations; ■ insufficient compacting of the road surface which could lead to erosion or batter slips in areas of steep terrain; and ■ mud tracking at the confluence of internal access roads with the public road network.
Watercourse Crossings	■ erosion of drainage lines and subsequent sedimentation; ■ removal of vegetation and subsequent increased erosion potential; ■ any vehicle movement across unaltered watercourses during construction phase leaving wheel tracks and causing damage to creek beds; ■ potential for any unstable steep banks collapsing under weight of vehicles/machinery; and ■ bank erosion at creek crossings from culvert installations.
Water Supply	■ over-extraction of surface water or groundwater resulting in reduced environmental flows, reduced water availability for existing licensed users and impacts on water dependent ecosystems.
Establishment of Pad Sites (e.g. Laydown Area, Batching Area)	■ erosion of relatively large disturbed areas during establishment and subsequent sedimentation of run-off.
Turbine and Transmission Pole Foundations	■ erosion of soils around turbine/pole foundations; ■ potential increase to water filtration and subsequent impacts to groundwater; and ■ erosion from spoil stockpiles and subsequent sedimentation should it reach a waterway.
Dewatering of Site	■ potential interception of groundwater during construction of turbine foundation, requiring dewatering.
Ancillary Infrastructure (e.g. substation, operations and maintenance facility)	■ erosion of relatively large disturbed areas during establishment and subsequent sedimentation of run-off; and ■ erosion from spoil stockpiles and subsequent sedimentation should it reach a waterway.
Stockpile Management	■ erosion of stockpiles and loss of soil resource; and ■ subsequent sedimentation impacts.
General Construction Activities (e.g. Machinery Operations)	■ erosion of soil stockpiles created during excavation works; ■ hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery, etc); ■ contamination of soils from poor refuelling practices; and ■ discovery of previously contaminated sites.

4.3.2 Operational Impacts

Specific operational activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in Table 4-8.

Table 4-8 Potential Operational Impacts to Soils

Operational Activities	Potential Impacts to Soils and Water
Driving on All-weather Unsealed Road Network	■ creation of fugitive dust due to vehicle movements; ■ creation of fugitive dust due to onsite livestock movements; ■ erosion of roads and roadside drainage in areas of steep terrain or in inappropriately 'finished' locations; and ■ mud tracking at the confluence of internal access roads with the public road network.
Watercourse Crossings	■ any vehicle movement across unaltered watercourses during operational phase leaving wheel tracks and causing damage to creek beds; and ■ bank erosion at culvert crossings.
Pad Sites	■ potential for erosion and subsequent sedimentation of run-off during heavy rainfall.
General Operational Activities (e.g. Machinery Operations)	■ hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery, etc); ■ contamination of soils from poor refuelling practices; and ■ increased soil erosion following heavy rainfall and potential subsequent sedimentation.

4.3.3 Soils and Water Assessment

A review of the baseline data presented above and the site inspection suggests that overall potential risks to water and soils are relatively minor to moderate, with the primary constraints being steep slopes adjacent to the Project Footprint. This is on the basis that:

- for the most part, pad sites and access road construction occur on relatively low-moderate gradient lands high up in the respective drainage catchments;
- there is generally a very low risk of run-on or run-off of concentrated stormwater flows;
- construction sites within the Project Area generally present a low to moderate erosion hazard considering factors such as climate, soils and landform. Note that an erosion hazard assessment is provided in Appendix A;
- the landscape of the Project Area is relatively stable with no significant areas of erosion, with the exception of a few drainage lines within the northern and southern sections of the Project Area and no areas of noticeable erosion where construction activities are proposed;
- impacts on water flows is not anticipated for the construction of the Project, given the localised impacts are located upstream on the top of the ridgeline. Potential impacts downstream are able to be effectively managed at the source of works (i.e. velocity controls in areas with steep slopes) through the implementation of an progressive Erosion and Sediment Control Plan (ESCP);
- vegetated buffers lie between work areas and watercourses;
- sustainable water supply options will be pursued through consultation with landowners and relevant Government agencies. Licenses would be obtained as required; and
- additional measures are able to be effectively implemented to appropriately mitigate impacts associated with the identified sensitive locations in the adjacent National Park. Measures are to be included in the progressive ESCP to either:

- direct disturbed runoff away from the catchment area identified to contain the sensitive location, or
- process runoff through additional sediment controls (e.g. sumps and/or sediment basins) and discharge at a low, non-erosive velocities.

The identified risks can be managed through implementation of appropriate preventative and management measures. These would be outlined in a construction environmental management plan (CEMP) supplemented by a progressive ESCP prepared post-approval. Section 5 outlines a range of management practices that would contribute to sound management of the Project Area's soil and water resources.

A quantitative estimation of the sites erosion hazard was undertaken using the Revised Universal Soil Loss Equation (RUSLE) as described in Section 5.2 and provided in Appendix A.

5. CONCEPTUAL SOIL AND WATER MANAGEMENT PLAN

5.1 Introduction

In NSW, best practice guidance on soil and water management at construction sites is provided in the document *Managing Urban Stormwater: Soils and Construction*, *Volume 1, 4th edition* (Landcom, 2004). Landcom (2004) provides an overarching guideline, though is particularly targeted to urban development. A number of more targeted supporting guidelines are published under Volume 2 of the Managing Urban Stormwater series and include the following that are particularly relevant to construction of the Project:

- *Managing Urban Stormwater: Soils and Construction, Volume 2A, Installation of Services* (NSW Department of Environment and Climate Change, 2008a) (hereafter referred to as “Volume 2A”); and
- *Managing Urban Stormwater: Soils and Construction, Volume 2C, Unsealed Roads* (NSW Department of Environment and Climate Change, 2008b) (hereafter referred to as “Volume 2C”).

ERM has prepared this Conceptual Soil and Water Management Plan (SWMP) to outline the fundamental principles to be followed in the planning and implementation of erosion and sediment control measures for the Project. This Conceptual SWMP provides guidance on the suite of best management practices that may be relevant to control soil and water impacts during construction, and outlines how a combination of controls may be used during particular activities.

It is not feasible to prepare a detailed SWMP at this stage that addresses all work sites, as works will be dispersed over large distances, will occur in stages, and in many cases have not yet been subject to detailed design.

This Conceptual SWMP does not include detailed engineering design of structures, nor does it provide plans showing the layout of all erosion controls across the site. It is recommended that Progressive ESCPs should be prepared for this purpose once detailed design plans are available, particularly the detailed road, drainage and creek crossing designs. In many cases these progressive ESCPs will be relatively simple documents, such as a sketch plan showing the layout of controls with attached commentary, prepared on topographic or drainage plans.

The head construction contractor will prepare their own CEMP including a detailed Soil and Water Management Plan that will include elements of this Conceptual SWMP and any additional measures required to manage the erosion, sedimentation and water quality risks of the project. The SWMP will outline the requirements for preparation of Progressive ESCPs for each area of works, and with a particular focus on high risk locations such as on steep lands and in the vicinity of watercourses. It is recommended that the SWMP be prepared in accordance with the Managing Urban Stormwater guidelines, particularly Volumes 2A and 2C.

5.2 Erosion Hazard and Assessment

Erosion hazard was estimated using the Revised Universal Soil Loss Equation (RUSLE), provided in Appendix A. The RUSLE provides a quantitative estimation of erosion hazard based on five factors: rainfall erosivity; soil erodibility; slope length and gradient; soil cover and management practices. A detailed description of the RUSLE equation and its contributing factors is provided in Landcom (2004).

The overall erosion hazard has been assessed as low-moderate. This is a consequence of favourable climatic conditions (low rainfall erosivity) and the lower slope gradient where disturbance will occur on the ridgeline, which limit the generation of high velocity, erosive run-off. Localised areas of greater erosion hazard will exist, for example where steeper slopes occur (e.g. road batters) and in areas of concentrated water flow, such as along watercourses and table drains. Particular attention to erosion control should be applied in these areas.

5.3 General Management Practices

Landcom (2004) provides a range of soil and water management principles for construction sites. These principles should be a key component of the decision making process as earthworks are planned and undertaken. These principles are:

- investigate site features and assess constraints;
- develop and implement plans for the management of soil and water;
- minimise disturbance;
- strip and stockpile topsoil for use in subsequent rehabilitation;
- divert upslope (clean) stormwater around the disturbed site;
- reduce erosion;
- capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices;
- rehabilitate the site promptly and progressively as works progress; and
- inspect and maintain erosion and sediment control devices for the duration of the Project.

Industry standard erosion and sediment control measures are outlined in the following sections that will assist in meeting the principles outlined above.

Standard Drawings which further detail a management measure are referenced where relevant and provided in Appendix B.

5.3.1 Staging of Work

Staging of works is one of the simplest and most effective forms of erosion and sediment control. By limiting the exposed area to the minimum possible at any one time, reduces the risk of soil loss than if the entire sites earthworks are exposed.

Prior to disturbing an area the following management measures should be implemented:

- have a single stabilised site access point defined by barrier or sediment fencing, to prevent unnecessary disturbance at access locations;
- prior to disturbance, install sediment fence downslope and boundary fencing/flagging around perimeter of site to define the work areas and minimise disturbance outside construction boundaries (to be regularly maintained);
- install upstream stormwater diversion drains / bunds and stabilise their outlets (where required);
- install sediment traps with stabilised outlets as shown in Progressive ESCPs;
- direct run-off from disturbed areas to sediment traps during construction, using earth banks or drains;
- install checks at regular intervals to reduce scour velocity of flows;
- remove vegetation and store in appropriate locations (eg away from watercourses and riparian lands) and respread cut / mulched vegetation where appropriate during rehabilitation;
- commence earthworks, stripping topsoil and subsoil independently and storing these separately. Topsoil should be preserved for use later in rehabilitation;
- install erosion and sediment controls as required during progression of construction works and maintain existing controls;
- rehabilitate site as soon as practicable after completion of construction; and
- decommission / remove controls when site is successfully stabilised and vegetation established.

5.3.2 Stormwater Management

The following stormwater management controls apply to all construction activities and will be utilised during site development:

- where required, divert clean stormwater run-on away from areas to be disturbed by construction activities using earth banks or catch drains. Note that in some cases low-impact diversions can be created using sandbags or similar. Earth banks may also be used and construction requirements are shown in:
  - SD 5-5 for temporary earth banks (low flow); and
  - SD 5-6 for permanent earth banks (high flow).
- permanent diversion banks will be sized by a suitably qualified person, using hydrological data and design standards as recommended in Landcom (2004). Note that the need for upslope diversion may be removed where construction sites have minimal upslope catchment or the risk of stormwater run-on is low. This is likely to be the case for the vast majority of WTG sites;
- collect dirty water in earth banks or catch drains for diversion to sediment control structures as determined in the Progressive ESCP Drawings;
- install temporary earth diversion banks (refer SD 5-5) at the direction of the site manager to mitigate against unforeseen erosion hazards, particularly when rain is forecast. These shall be used to shorten slope lengths, or to divert localised run-on away from high hazard areas (such as unstable batters);
- check dams (SD 5-4) using rock aggregate, sandbags or geotextile “sausages” may be installed within drains and diversion channels to help reduce flow velocity and consequent erosion, especially on steep sections. Care to be taken to ensure there is adequate provision for a spillway that allows flows to be retained within the diversion channel and not escape thereby potentially causing scouring and/or flooding of adjacent lands; and
- maintain slope lengths no greater than 80 m in disturbed areas and preferably <50 m on exposed road surfaces and steep slopes. To reduce slope lengths in construction areas install temporary earth diversion banks following SD 5-5. On roads consider the use of cross banks and mitre drains to shed water from the surface.

5.3.3 Erosion Control

Erosion control should be prioritised in all aspects of the work – this being the most effective way to minimise site degradation and reduce potential impacts on land and water resources. Effective erosion control reduces the loss of sediment and improves the effectiveness and reliability of downstream sediment and pollution controls.

In addition to the erosion control measures outlined in the staging section above, the following are a series of general erosion control measures that apply to the day-to-day construction activities:

- stabilise the access point by sealing with concrete, asphalt or loose rock fill (refer SD6-14);
- limit unnecessary vehicle movements across the Project Area to those only required for construction activities and ensure movements are contained to the predefined construction access ways;
- limit stripping of topsoil to within two weeks of commencing construction activities to minimise the time and area that soil is exposed to erosive forces;
- where more than one contractor is onsite at any one time, co-ordinate works so that sites do not remain disturbed for longer than is necessary;
- stockpiles should be located greater than 40 m from natural waterways (refer SD 4-1);

- stockpiles are to have a buffer of at least 5 m from areas likely to receive concentrated water flows, including earth banks and roads;
- unsealed access roads are to be kept moist by water carts during windy conditions and times of heavy traffic, to prevent dust generation; and
- all areas of concentrated flow (diversion banks and waterways), will be designed by a suitably qualified person to convey and remain stable during the design storm event. Stabilisation with 350 gram per square metre (gsm) jute matting or equivalent may be required (refer SD 5-7).

5.3.4 Sediment Control

Sediment traps will be used to treat sediment laden run-off that is generated from disturbed areas and maintain the sediment as close as possible to its source.

Sediment traps work by trapping water and allowing the coarser fragment of the sediment to settle out under gravity. Sediment traps are most effective for sheet flows of run-off rather than concentrated flow. Use of sediment traps in areas of concentrated flow such as drains are often ineffective, with the result often being scouring and further erosion.

The most easily recognisable and common form of sediment trap is sediment fencing, but sediment traps may also include earth or mulch bunds, geotextiles, rock or a combination of these (such as a rock-sock which involves wrapping rock in geotextile). Installation and sizing of these traps should be such that water does not find an alternative flow path underneath or around the trap. Anchoring of the traps should be sufficient to provide for strength and reliability of the trap. Traps should be designed with consideration to larger storm events, and incorporate spillways and bypasses to prevent scouring and erosion of adjacent areas.

Sediment fencing will be a primary sediment control method used throughout the construction stage of the project. The following principles apply to the use of sediment fencing:

- sediment fence (refer SD 6-8) should be placed downslope of disturbed areas to help retain the coarser sediment fraction;
- sediment fences will have a return of 1 m upslope at intervals of approximately 20 m. Returns are installed to subdivide the catchment area of the sediment fence, to improve its effectiveness and help prevent structural damage during peak flows. The catchment area of each section of fence should be small enough to limit flow if concentrated at one point to less than 50 L/s in the 10-year ARI storm event;
- place sediment fence as close as possible to along the contour, to provide a maximum surface area to the passage of stormwater;
- sediment fences require regular maintenance, with captured sediment to be removed prior to it reaching a third of the height of the sediment fence. Place sediment extracted from maintenance in a suitable location so as to prevent further sedimentation; and
- sediment basins are a specific type of sediment trap comprising large earth dams designed to capture dirty water run-off, and are the most effective of all sediment trapping devices. They may only be required at the larger construction sites such as the concrete batching plant and substation. A large sump or sediment basin should be considered if disturbed area flows warrant upgradient of the sensitive creeklines of the adjacent National Park. Otherwise most of the work areas are relatively small and dispersed, and sediment control can be achieved using conventional sediment traps, without the use of sediment basins. Detailed design and sizing of sediment basins, where required, will be included in the Progressive ESCPs.

5.3.5 Pollution Control and Waste Management Measures

All fuels, oils and hazardous substances used onsite will be stored in appropriately bunded locations to prevent release to the environment. Bulk storage areas for fuels, oils and chemicals used during construction will be contained within an impervious bund to retain any spills of more than 110% of the volume of the largest container in the bunded area. Any spillage will be immediately contained and absorbed with a suitable absorbent material. Storage will comply with *AS 1940- 2004 The Storage and Handling of Flammable and Combustible Liquids*.

Spill clean-up kits will be located in numerous, well known locations throughout the site, and particularly within the precinct where the main infrastructure is proposed. Use of items within the spill kit will be demonstrated to all construction personnel. Spill kits should include floating booms in locations close to waterways (where relevant). Spill kits require regular maintenance to ensure that sufficient material is available in the event of a spill.

Material Safety Data Sheets (MSDS) will be available for all chemicals used on the site. All site personnel should be aware of the location of the MSDS.

Refuelling of equipment onsite or any other activity which could result in a spillage of a chemical, fuel or lubricant will be undertaken away from watercourses and stormwater drainage lines. In the event water is polluted by chemicals and/or firefighting materials (e.g. foams), the water will be collected, and disposed at an approved Liquid Waste Treatment Facility. A designated refuelling area should be established with drip trays installed and spill kits on stand-by. Should refuelling in the field be required, absorptive mats and drip trays are to be used in the refuelling process.

Bins will be available for the deposit of waste materials. Where possible, bins for recycling will be made available to facilitate separation and appropriate reuse or disposal of recyclable materials.

5.3.6 Site Rehabilitation

Predominately the majority of the areas that will be disturbed will be stabilised by the placement of concrete or the construction of a hardstand surface. However, rehabilitation of distributed soil will still be required progressively on the site as different aspects of the project are completed. As some individual construction areas are completed, rehabilitation should be undertaken immediately to stabilise and effectively finalise areas to prevent erosion and sediment issues. Site stabilisation can be achieved by several measures including the following:

- vegetative cover;
- mulch;
- rock armouring;
- paving;
- concrete;
- geofabrics; and
- synthetic soil binders.

It is essential that all disturbed lands be stabilised to mitigate ongoing erosion problems and prevent sediment pollution of downstream lands and waterways. The preferred site stabilisation method will be identified on a site by site basis and included within the Progressive ESCPs. In most areas it is likely that revegetation to pasture grasses would be the preferred approach.

When selecting stabilisation methods a key factor that will be considered is the form of water run-off over the stabilised area. Areas subject to concentrated flow (i.e. watercourses and drains) will require different stabilisation techniques to those subject to sheet flow.

In areas of sheet flow vegetation will generally be acceptable and the revegetation goal over much of the site will be to re-establish pasture grasses, to achieve a similar condition and pasture species composition to present so that the lands may continue to be used for grazing purposes.

Areas of concentrated flow can be subject to scouring velocities and periodic inundation that render vegetation establishment difficult or impossible. Therefore, measures like hard armouring, and use of geofabrics to assist vegetation establishment is often required. To determine appropriate stabilisation techniques in areas of concentrated flow peak flows will be calculated and stabilisation designed accordingly, by reference to guidelines such as Landcom (2004) that provide advice for acceptable velocities within vegetated channels. Particularly steep slopes may require protection in the form of hard armouring if it is considered unlikely that vegetation will become established or will become stressed and jeopardise the stability of the slope. This detail will be outlined in the Progressive ESCPs.

5.4 Specific Construction Activity Mitigation Measures

5.4.1 Pad Sites

The term 'pad sites' is used to describe areas that may be cleared, levelled and then stabilised with road base and aggregate, for example crane hardstand areas, the substation site, and the concrete batching plant. Pad sites should be established in accordance with Section 5.3.1.

A Generic Erosion Sediment Control Plan (ESCP) has been developed for the layout of a pad site, refer to Figure 5.1. An outline of the erosion and sediment control measures to be undertaken during trenching activities is also provided in Appendix B as Figure 6.1, Figure 6.2 and Figure 6.3 (reference numbers as per Landcom, 2004). The relevant Progressive ESCP will be developed following detailed design.

5.4.2 Trenching

The turbines will be linked across the Project Area through a network of underground electricity and fibre optic cables that predominately follow the internal access road network. The following management measures are relevant to trenching activities:

- minimise the land area to be disturbed;
- avoid trenching in locations of concentrated, permanent water flows;
- where possible utilise directional drilling techniques in areas of concentrated, permanent water flow;
- monitor weather and avoid opening trenches prior to forecast rainfall;
- fill trenches as soon as possible after opening – aim for three days from opening to closing trench;
- separate topsoil and subsoil during excavation and ensure that topsoil is replaced on the surface;
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;
- in the event sodic soils are identified, soil testing at 0-30cm and 30-100cm will be undertaken during the geotechnical investigation phase or prior to construction to determine if ameliorants are to be added to soils to address fertility/soil chemistry issues;
- when trenching parallel to site contours (across grade), soil from the excavation should be placed and compacted on the uphill side of the trench to form an earth bank. This is to prevent clean stormwater entering the trench (where after it must be managed as "dirty" water) by directing stormwater around and away from the open trench. This measure may be avoided where trenches are expected to be open for less than 24 hours and where the likelihood of rain is low;

- when trenching perpendicular to contours use sandbag plugs or bulkheads to shorten the length of stormwater flow and consequent erosion in the trench; and
- progressively backfill trenches and rehabilitate as soon as possible. Leave backfilled trenches with a slightly elevated profile to allow for settlement, and to prevent the trenches from becoming a depression that can concentrate stormwater run-off, and potential erode the replaced soil.

5.4.3 Dewatering

Water has the potential to collect in trenches, sediment traps and low lying depressions in the construction areas following rainfall events. This water is likely to become contaminated with suspended sediment and will require management to ensure that downstream waterways are not polluted.

Dewatering can be undertaken such that water collected is reused on the site within water carts, for dust suppression on unsealed access roads and watering of rehabilitated areas. Discharging run-off directly to a natural waterway is not supported. Low volumes of water can be discharged through vegetated areas to encourage infiltration and settlement of entrained sediment. Vegetated areas act as a filter, assisting in the removal of sediment from the discharged water. Dewatering bags may also be used.

5.4.4 Unsealed Internal Access Roads

A network of unsealed roads will be developed throughout the Project Area to allow access to the turbines, batching plant and other project infrastructure.

The focus of erosion and sediment control for unsealed roads will be on maintaining good stormwater drainage. The primary aim is to ensure that stormwater is readily shed from the road surface and, most importantly, is not allowed to track longitudinally along the road for any great distance. Onsite assessment and review of topographical mapping noted that proposed roads are located along ridgelines and in areas without large upslope catchments thus minimising the erosion hazard and drainage requirements.

The primary access point is from Morrisons Gap Road, with an additional alternative access point from Head of the Peel Road, which will connect to the internal road network. Mud tracking will be a risk in these locations and as such stabilised entry points will be required. Options may involve the sealing of the internal roads with bitumen for 50 m into the Project Area at confluence points with the two access roads or the use of cattle grids and wheel washes, or a layer of crushed rock.

The following mitigation measures should also be considered during the planning and implementation phases of the access road construction:

- limit the clearing width to the minimum that is practicable;
- retain any cleared vegetation (i.e. as mulch and sheared timber) for use later in rehabilitation;
- strip and stockpile topsoil separately for use in rehabilitation;
- minimise cut and fill by constructing the road at-grade where ever possible;
- ensure the road surface has a cross-sectional grade to allow free surface drainage and avoid excessive ponding and concentration of flow in wheel ruts;
- employ outfall drainage where practicable to shed water over the downslope batter of the road, especially where the road alignment is generally parallel to the contours;
- where the road is positioned along a crest or ridge use a crowned road surface that sheds water to both sides;
- when grading roads, avoid the formation of windrows along the shoulders. These retain water on the road surface and increase erosion;

- where table drains are used, ensure these are properly stabilised and install regularly spaced mitre drains to discharge water from drains, releasing to well vegetated, stable areas;
- mitre drains shall be installed regularly to convey run-off from the road shoulders and any table drains to disposal areas away from the road alignment. As a general rule the maximum spacing between mitre drains should be 50 m, however this may be reduced in high erosion hazard areas (e.g. on steep slopes). Mitre drains should have a grade of no more than 5 %. They should discharge to areas that are well stabilised and free of obstructions (e.g. large rocks, tree trunks);
- cross-banks (or rollover banks) or cross-drains should be considered in suitable locations to shed water from the road surface, discharging water in well vegetated, stable areas. Cross-banks are earth banks that extend across the road roughly perpendicular to the road alignment. They contain a bank and upstream channel to direct run-off across the road surface, to prevent the concentration of run-off along the road surface and reduce runoff velocities, thereby reducing erosion. These measures are highly useful where roads are aligned acutely to or perpendicular to the contours over long distances; and
- stabilise road batters using a suitable combination of rolled erosion control products (RECPs) such as jute matting, mulching, spray-on stabilisation measures (e.g. hydromulching or bitumen emulsion) revegetation and hard armouring where required (e.g. within flow lines).

A recommended waterway crossing standard drawing (SD5-1) is provided in Appendix B.

5.4.5 Concrete Batching Plant

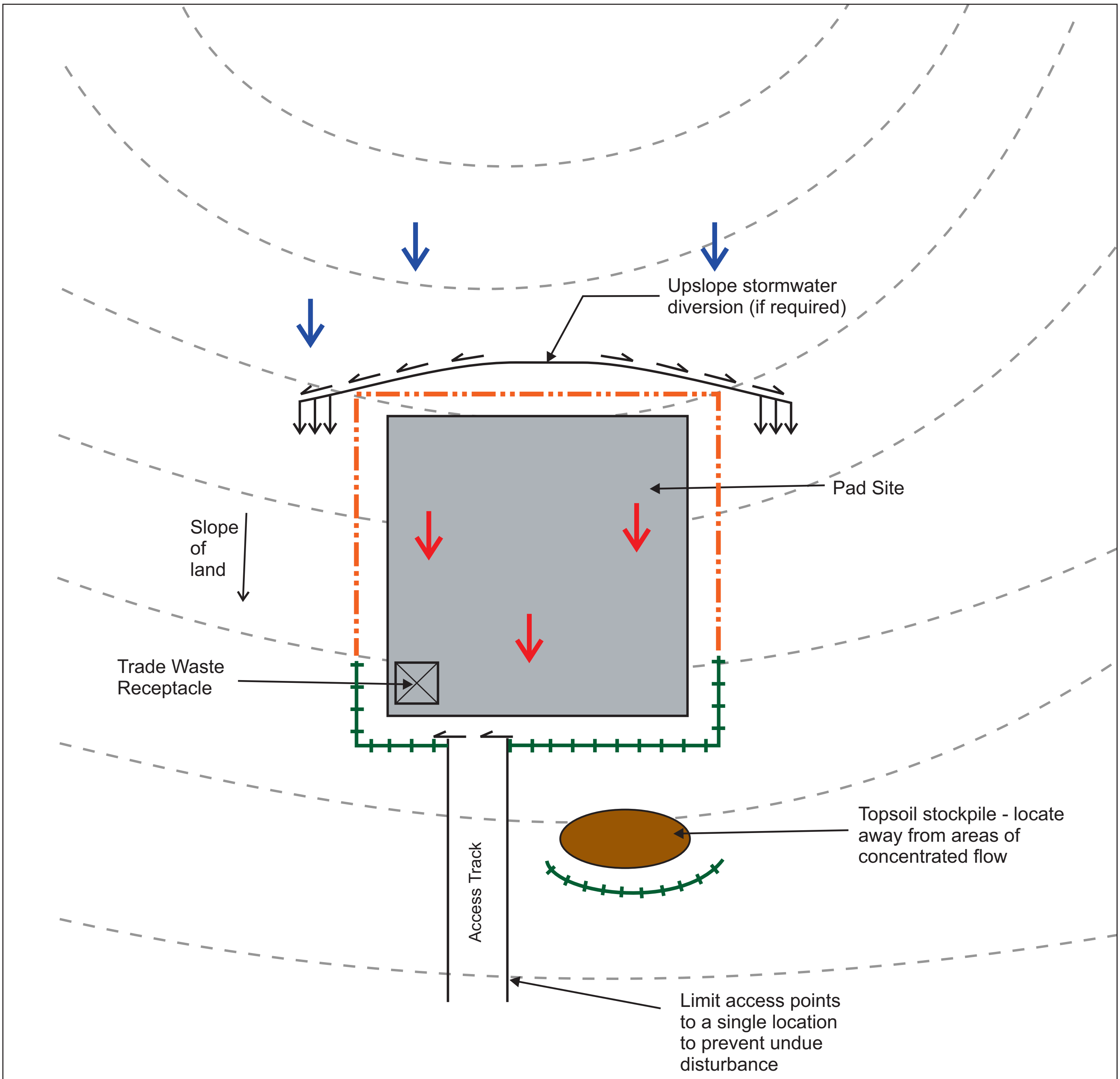
Establishment of the concrete batching plant will be similar to the establishment of all the pad sites and as such erosion and sediment controls are universal. However new water management issues arise during the operation of the plant due to the creation of run-off with entrained fine sediment and higher alkalinity run-off. The following mitigation measures are proposed during the operation of the concrete batching plant:

- separate stormwater collection and drainage systems will be provided to allow for discharge of clean stormwater (through a system designed to minimise local erosion) and collection and reuse of contaminated stormwater (through a first flush collection pit);
- a stormwater recycling system will be provided with capacity sufficient to store contaminated run-off generated by 20 mm rain within 24 hours, with operating management system to use collected wastewater as soon as possible (to maintain containment capacity);
- suitable washout locations will be provided for the placement of waste concrete and mortar slurries (either at the concrete batching plant or at individual works compounds, or both). These may comprise shallow excavations that are suitably bunded to prevent non-project impacted stormwater from entering the washout. Dried concrete will be disposed by an approved means;
- water within the washout will be encouraged to evaporate and/or infiltrate the soils;
- wet weather stormwater discharges will be monitored for pH and suspended solids;
- any excess contaminated waste water will be disposed of off-site by a licensed waste contractor; and
- the area of the batching plant will be fully rehabilitated after the construction phase is completed.

5.5 Site Monitoring and Maintenance

Essential to an effective system of sediment control devices, is an adequate inspection, maintenance and cleaning program. Inspections, particularly during storms, will show whether devices are operating effectively. Where a device proves inadequate, it should be quickly redesigned to make it effective.

Recommended Inspection Schedules will be developed in the Detailed Construction Soil and Water Management Plan following approval.



Notes:

1. Monitor weather forecasts and avoid large ground disturbances prior to rain.
2. Install controls prior to disturbance.
3. Separate topsoil and subsoil during works.
4. Limit time of disturbance to minimum extent possible.
5. Progressively rehabilitate/stabilise as soon as possible.

Legend

- Earth Bank (refer to SD5-5)
- Level Spreader (refer to SD5-6)
- Sediment Fence (refer to SD6-8)
- Barrier Fence
- Topsoil Stockpile (refer to SD4-1)
- Clean Runoff
- Project Impacted Runoff
- Example Contours

Generic Erosion and Sediment Control Plan for Pad Site

F5.1

Drawing No: 0550690s_HoG_WSH_C001_R0.cdr		**Hills of Gold Wind Farm**
Date: 19/10/2020	Drawing size: A4	
Drawn by: VN	Reviewed by: LG	Client: Wind Energy Partners
Drawing Not to Scale	N	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

5.6 Compatibility with Other Land Uses

The Project Area has historically been used for agricultural purposes, noting land clearing of the area to allow for agricultural utility. The main land uses of the surrounding area are agriculture, timber, and tourism. Surrounding land uses are described in detail in Chapter 4.2 above and is predominately zoned for agricultural purposes.

In understanding compatibility with other land uses, identifying and assessing the potential for land use conflict to occur between neighbouring land uses is a key process. It helps land managers and consent authorities assess the possibility for and potential level of future land use conflict.

In accordance with the Land Use Conflict Risk Assessment (LUCRA) Guide (DPI, 2011), a risk ranking matrix is used to rank the identified potential land use conflicts, by assessing the environmental, public health and amenity impacts according to both the ‘probability of occurrence’ and the ‘consequent of the impact’.

The risk ranking matrix yields a rank from 1 to 25. A rank of 25 is the highest magnitude of risk (aka. an almost certain and severe risk) while a rank of 1 represents the lowest (aka. a rare and negligible risk). Each activity associated with the Project has been assigned an initial risk ranking determined through the risk ranking matrix.

For those activities which score a risk ranking of 10 or lower, these are considered to be of a low risk for conflict to arise and subsequently do not need further management to reduce their potential impact. However, for activities that were identified to have a risk ranking above 10, the LUCRA is designed to define controls through various management strategies to reduce the risk for conflict.

In order to lower the risk values of activities associated with the proposed development, relevant risk reduction controls are identified for each identified potential conflict as management strategies. Consideration is given to lower both the probability and the negative consequences. The risk reduction controls will allow a revision of the risk level on the basis of the implementation of the management strategies. The objective is to identify and define controls that lower the risk ranking score to 10 or below.

In this way, management strategies are developed to minimise such effects or potential for land use conflict to arise. For each of the management strategies, performance targets are identified as well as details of how the effectiveness of the strategy will be monitored.

This LUCRA process has identified and assessed the potential for activities associated with the Project to potentially cause land use conflict. The management strategies listed in Table 5-1 provide plans to reduce identified potential conflict items that originally received a Risk Rating above 10. In order to ensure these management strategies are successfully implemented, performance monitoring is an important ongoing tool throughout the construction and operation stages of the Project. Performance targets are outlined below in Table 5-1.

Table 5-1 Management Strategy

Identified Potential Conflict	Original Risk Ranking (ORR)	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Adjacent Land Use Activities	Probability: B Consequence: 3 ORR: 17	■ Consideration of neighbouring activities will be taken during the preparation of the Operational Environment Management Plan (OEMP). ■ Onsite dust suppression will be adopted to minimise the potential of dust dispersion generated from the Project impacting upon neighbouring land. ■ Conversely, adjacent land uses are not anticipated to significantly impact upon the operation and functionality of the Project.	Probability: D Consequence: 5 RRR: 2	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in CEMP and OEMP
Soil Erosion	Probability: B Consequence: 3 ORR: 17	■ The Soils and Water Assessment has assessed the impacts of construction and operation for the Project and provided mitigation measures, as outlined in Chapter 16 of the EIS. ■ Soil erosion measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: C Consequence: 5 RRR: 4	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in CEMP, OEMP and Erosion and Sediment Control Plan (ESCP)
Water	Probability: D Consequence: 3 ORR: 9	■ The Soils and Water Assessment has assessed the impacts of construction and operation for the Project and provided mitigation measures, as outlined in Chapter 16 of the EIS. ■ Water management measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: D Consequence: 5 RRR: 2	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in CEMP, OEMP and ESCP.
Noise	Probability: A Consequence: 3 ORR: 20	■ The Noise and Vibration Impact Assessment has assessed the noise impacts of construction and operation for the Project and provided mitigation measures, as outlined in Chapter 10 of the EIS. ■ Construction activities will be limited to standard working hours: – Monday to Friday, 7am to 6pm – Saturday, 8am to 1pm – No construction work is to take place on Sundays or public holidays. ■ Construction noise management and mitigation will be addressed in the Construction Environment Management Plan (CEMP).	Probability: D Consequence: 4 RRR: 5	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures CEMP, OEMP and Noise Management sub-plan

Identified Potential Conflict	Original Risk Ranking (ORR)	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Visual	Probability: A Consequence: 3 ORR: 20	■ The Visual Impact Assessment has considered the visibility of Project infrastructure and has provided mitigation measures as outlined in Chapter 11 of the EIS.	Probability: C Consequence: 4 RRR: 8	Successful implementation of landscape management measures, and Monitoring of landscaping management measures will be monitored in accordance with the CEMP and OEMP.
Aviation	Probability: E Consequence: 1 ORR: 15	■ Aviation safety impacts are assessed in the Aviation Impact Assessment. ■ The Project will impact the 25 nm MSA at Scone Airport in the sector bounded by bearings 070º and 290º. ■ Recommendations and mitigation measures, as detailed in the AIA, are outlined in Chapter 13 of the EIS.	Probability: E Consequence: 4 RRR: 3	Successful implementation of aviation mitigation measures.
Bushfire	Probability: C Consequence: 2 ORR: 18	■ Implementation of a Bushfire Management Plan will significantly reduce the potential for a bushfire arising during operation of the wind farm, and also to reduce the threat of damaging Project assets.	Probability: D Consequence: 4 RRR: 5	Implementation of mitigation measures through the CEMP, OEMP and Bushfire Management Plan
Air Quality	Probability: B Consequence: 3 ORR: 17	■ Dust generated during the construction and decommissioning stages of the Project are to be managed using dust suppression as required. ■ During operation, dust is not expected to generate a significant potential conflict, however this will be managed in accordance with the OEMP.	Probability: C Consequence: 5 RRR: 4	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in CEMP and OEMP

6. MITIGATION MEASURES

The following measures will be implemented to address potential soil and water impacts:

- prepare a detailed Soil and Water Management Plan (SWMP) prior to construction commencing. The SWMP should be prepared by a suitably qualified person, such as a soil conservationist;
- prepare Progressive Erosion and Sediment Control Plans within the SWMP as the Project progresses to address management requirements at individual work sites;
- design and construct the Project to minimise land disturbance and therefore reduce the erosion hazard;
- stage construction activities to minimise the duration and extent of land disturbance;
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;
- divert upslope (clean) stormwater around the disturbed sites and capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices;
- rehabilitate the site promptly and progressively as works progress;
- inspect and maintain erosion and sediment control devices for the duration of the Project construction stage;
- avoid land disturbance beyond that identified in the assessment within 20 m of minor streams (first and second order watercourses) and 40 m of third order or higher watercourses;
- ensure appropriate procedures are in place for the transport, storage and handling of fuels, oils and other hazardous substances, including availability of spill clean-up kits;
- construct required access tracks at any early stage to minimises disturbance during construction;
- obtain all necessary water access licences; and
- ensure appropriate stormwater, collection, treatment and recycling at the concrete batch plant, in accordance with good practice and any requirements of the NSW Environmental Protection Authority.

6.1 Sensitive Areas Mitigation Measures

The Ben Halls Gap Nature Reserve is located adjacent to the Project Area, immediately to the east of the ridgeline. In portions of the National Park, a rare moss has been identified as requiring additional consideration to ensure activities associated with the Project do not impact on the integrity of the rare moss. The primary risk to impact upon the “sensitive location” is associated with runoff and sediment deposits.

Additional measures are able to be effectively implemented to appropriately mitigate impacts associated with the identified sensitive location in the adjacent National Park. Measures are to be included in the progressive ESCP to either;

- direct disturbed runoff away from the catchment area identified to contain the sensitive location, or
- process runoff through additional sediment controls (e.g. sumps and/or sediment basins) and discharge at a low, non-erosive velocity.

These measures are to be included in any environmental management plans to be implemented across the site, to protect the identified sensitive locations.

7. CONCLUSION

This Soils and Water Assessment identifies soil and water constraints related to the Project. Overall constraints are relatively minor due to the low to moderate erosion hazard over the majority of the Project Area to be impacted by construction. A standard suite of erosion and sediment controls may be adopted in most areas.

Review of groundwater wells within the Project Area identifies that the groundwater aquifer occurs at depths greater than would be intercepted by earthworks associated with the Project construction.

Water supply options are available to meet the needs of the construction phase. The four viable options available to source the estimated 55 ML of water required for construction include:

- Council water supply, in agreement with the relevant Council(s);
- extraction of water collected from existing (or new) dams using landowner harvestable rights or from an existing nearby landowner bore, in agreement to use their allocation;
- extraction from a new groundwater bore, which will require a WAL in consultation with WaterNSW; and
- extraction from a surface water source (e.g. Chaffey Dam), which will require a WAL in consultation with WaterNSW.

Water access licencing requirements will be confirmed in consultation with WaterNSW and all required licences obtained once the preferred option has been determined.

The Project Area intersects with three catchment areas. It is highlighted that the Project Area comprises less than 0.00123% of each catchment area. The Development Footprint only directly intersects with five waterways associated with creek crossings along the transmission line and the proposed bridge upgrade on Lindsays Gap Road. The site visit has confirmed that the existing condition of existing creek crossings is poor. The Project will include enhancement of these creek crossings, including regular management measures, which will result in an improvement of downstream sediment impacts and water quality.

A number of mitigation measures are proposed for the Project to address potential soil and water impacts, including the preparation of progressive ESCP's to address management requirements at individual work sites. A detailed Soil and Water Management Plan should also be prepared for the project prior to construction commencing that incorporates the measures identified within this assessment.

8. REFERENCES

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APPENDIX A EROSION HAZARD ASSESSMENT

A.1 REVISED UNIVERSAL SOIL LOSS EQUATION

Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004) describes a method for assessing erosion hazard using the revised universal soil loss equation (RUSLE). The RUSLE is designed to predict the long term, average, annual soil loss from sheet and rill erosion at nominated sites under specified management conditions. It is used to assess erosion hazard at construction sites and estimate sediment flux to sediment traps.

The RUSLE equation is represented by:

A = R K LS P C

where,

A = computed soil loss (tonnes/ha/yr)

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length/gradient factor

P = erosion control practice factor

C = ground cover and management factor.

R-Factor

The rainfall erosivity factor, *R*, is a measure of the ability of rainfall to cause erosion. It is the product of two components; total energy (E) and maximum 30 minute intensity for each storm (I_{30}). Rosewell and Turner (1992) identified a strong correlation between the R-factor and the 2-year ARI, 6-hour storm event (denoted S) and proposed the following equation:

$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$

Where S = 7.49 mm/h (at Hills of Gold, from IFD chart)

Using the above, at Hills of Gold Wind Farm is **R = 1,388.**

K-Factor

The soil erodibility factor, K, is a measure of the susceptibility of soil particles to detachment and transport by rainfall and run-off. Texture is the principle component affecting K, but structure, organic matter and permeability also contribute. In the RUSLE, it is a quantitative value that is normally experimentally determined.

Soil K-factor data was estimated with reference to the soil descriptions provided in Hird (1991). Review of all the soil landscapes and the erodibility of the topsoil and subsoils allowed for the conservative estimate of the average erodibility to be high and thus a conservative estimate for the K-factor of 0.05 is considered appropriate. Generally, K-factor ranges from 0.005 (very low) to 0.075 (very high) (Landcom 2004).

Therefore, **K = 0.05**.

LS-Factor

The slope length-gradient factor, LS, describes the combined effect of slope length and slope gradient on soil loss. It is the ratio of soil loss per unit area at any particular site to the corresponding loss from a specific experimental plot of known length and gradient. The LS factor can be read from Table AI in Landcom (2004). It should be noted that an increase in slope gradient has a proportionately greater effect on LS, compared with an increase in slope length.

The Project Area has variable gradients including some areas with slopes up to about 15 % (and in some areas higher), but in the turbine locations is commonly only gently sloping with gradients less than 5 %. Slope lengths in disturbed areas would be typically less than 80 m. Under the combination of 80 m slope length and 5 % gradient the LS Factor is 1.19. On steeper slopes it is assumed that slope lengths would be kept shorter through the use of appropriate stormwater controls. Under the combination of 40 m slope length and 15 % gradient the **LS Factor is 3.00.**

P-Factor

The erosion control practice factor, P, is the ratio of soil loss with a nominated surface condition ploughed up and down the slope. It is reduced by practices that reduce both the velocity of run-off and the tendency of run-off to flow directly downhill. At construction and mining sites, it reflects the roughening or smoothing of the soil surface by machinery. The **P-factor used here is 1.3** that is normally assigned to compacted construction sites.

C-Factor

The cover factor, C, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. The most effective method of reducing the C-factor is maintenance, or formation of a good ground cover. The best practices are those that reduce both the amount of soil exposed to raindrop impact and the erosive effects of run-off.

The C-factor assigned here during mining operations is 1.0, typical of that for bare, compacted soil. Table A3 in Landcom (2004) provides estimated C-factors for various cover types. It is worth noting that the C-factor is the factor that can be most readily manipulated to affect a change in erosion hazard. For example, changing the soil surface from a condition of bare, compacted earth (C = 1.0) to one with 70% cover of grasses (C = 0.05) leads to a proportionate reduction in soil loss, i.e. 20 times lower erosion hazard.

C-Factor = 1.0

A.2 PREDICTED SOIL LOSS

A = R K LS P C

where,

R = 1,388

K = 0.05

LS = 3.00

P = 1.3

C = 1.0

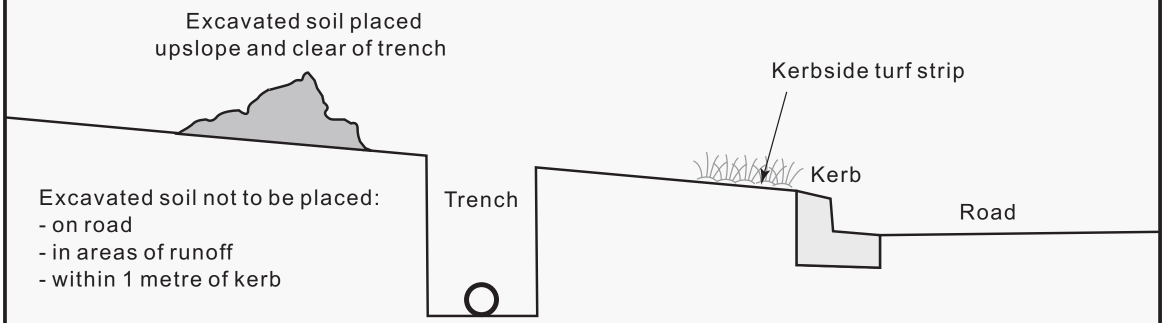
Therefore, A = 270.66 tonnes per hectare per year.

Using the RUSLE, the predicted annual soil loss is 271 tonnes/hectare/year under the combination of 80 m slope length and 5 % gradient. This is Soil Loss Class 3 226 to 350 tonnes/ha/yr) which is rated low-moderate (refer Table 4.2 in Landcom 2004). Under the combination of 40 m slope length and 15 % gradient predicted annual soil loss is 246 tonnes/hectare/year which also Soil Loss Class 3.

Based on this assessment it is concluded that the overall site erosion hazard is low to moderate and consequently, a standard suite of erosion and sediment controls may be widely employed. Specialised techniques may be required in high hazard areas, such as steep slopes and areas of concentrated flow.

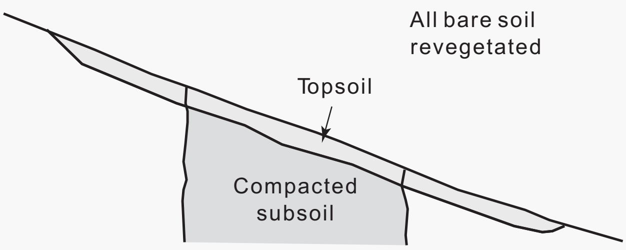
APPENDIX B STANDARD DRAWINGS

When excavating trench...

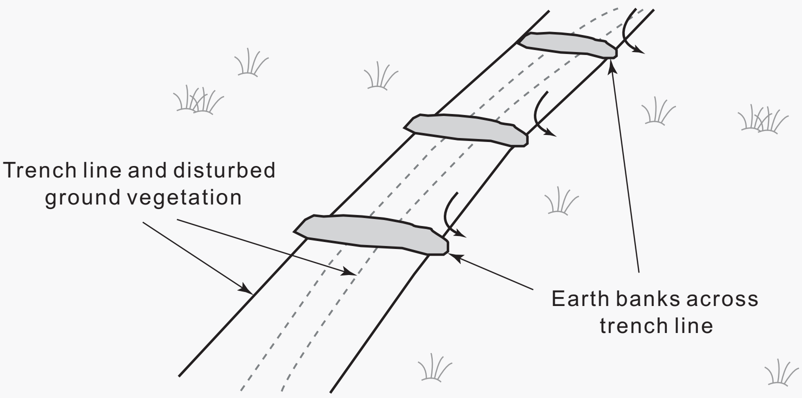


When backfilling trench...

Trench backfilled, compacted to 95 per cent standard compaction, topsoiled, levelled and topped up as necessary should subsidence occur



On steep and/or long sections of trench...



Construction notes for figure 6.1

1. Do not open any trench unless it is likely to be closed in three days
2. Place excavated material up-slope of the trench
3. Stockpile topsoil separately from subsoil
4. Divert runoff from the line of the cut with diversions as directed by SD 5-2
5. Rehabilitate in accordance with specification

Figure 6.1 Erosion and sediment control during trenching activities

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

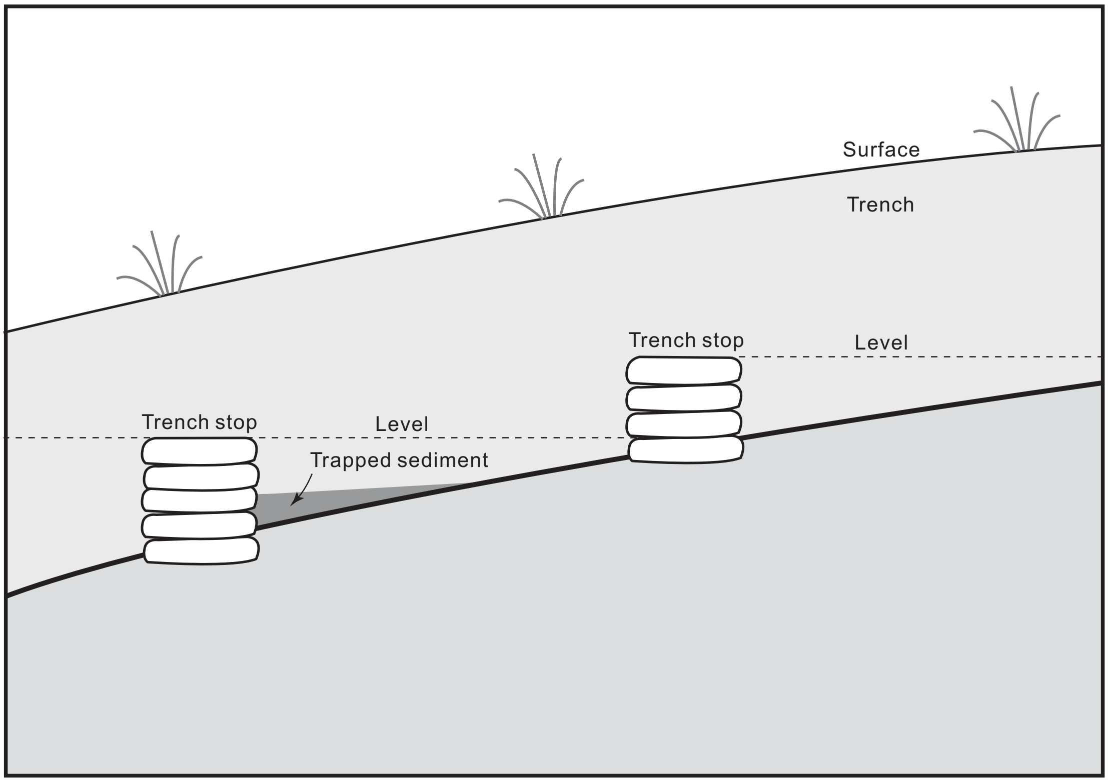


Figure 6.2 Typical trench stop detail

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

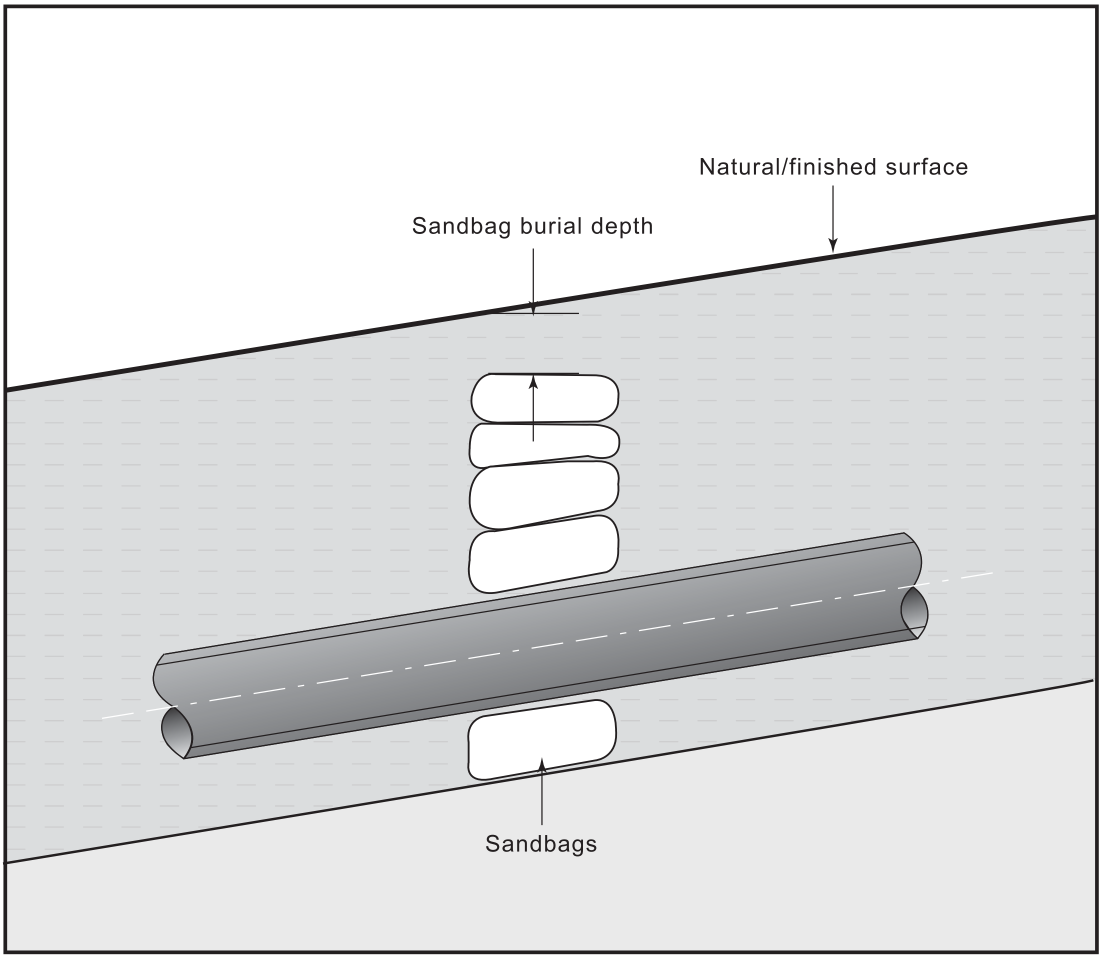
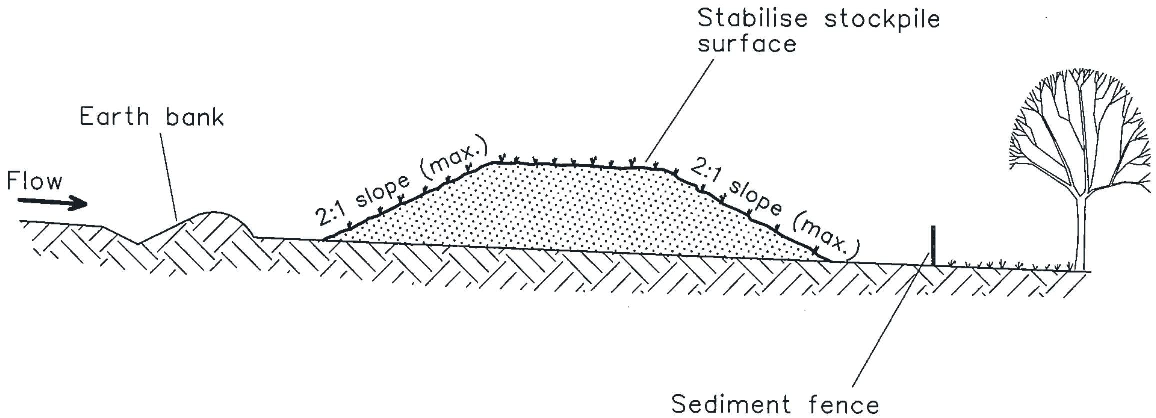


Figure 6.3 Detail of typical seepage collar or bulkhead

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

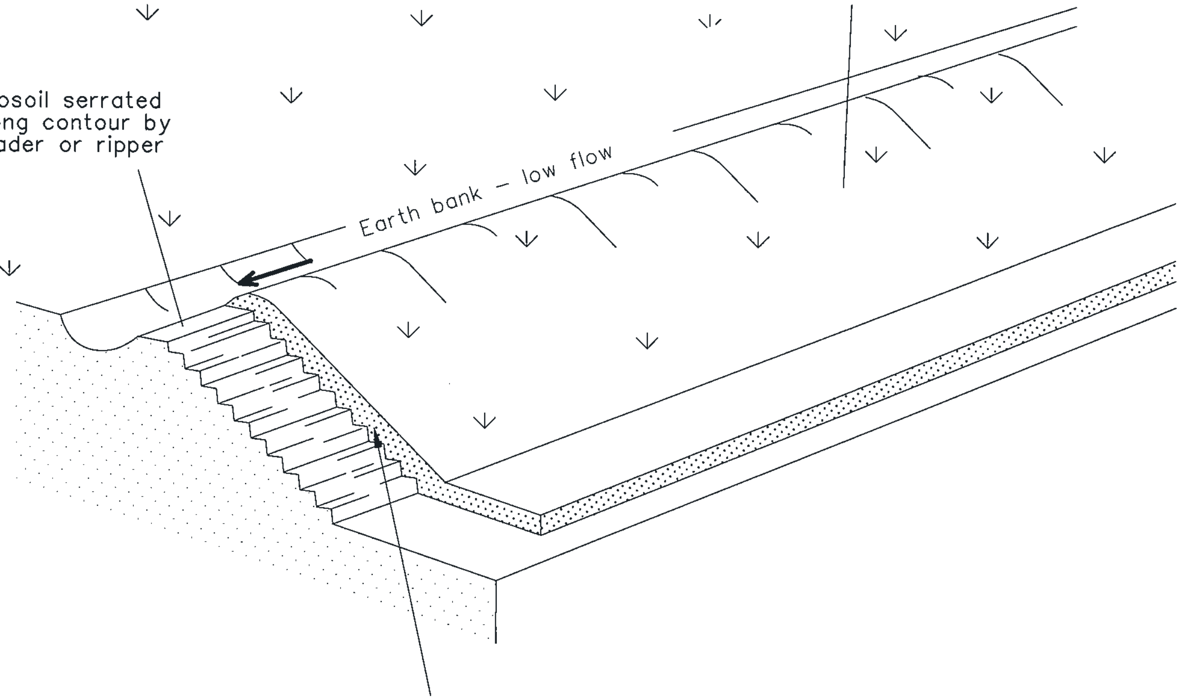


Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES **SD 4-1**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.

2. Add soil ameliorants as required by the ESCP or SWMP.

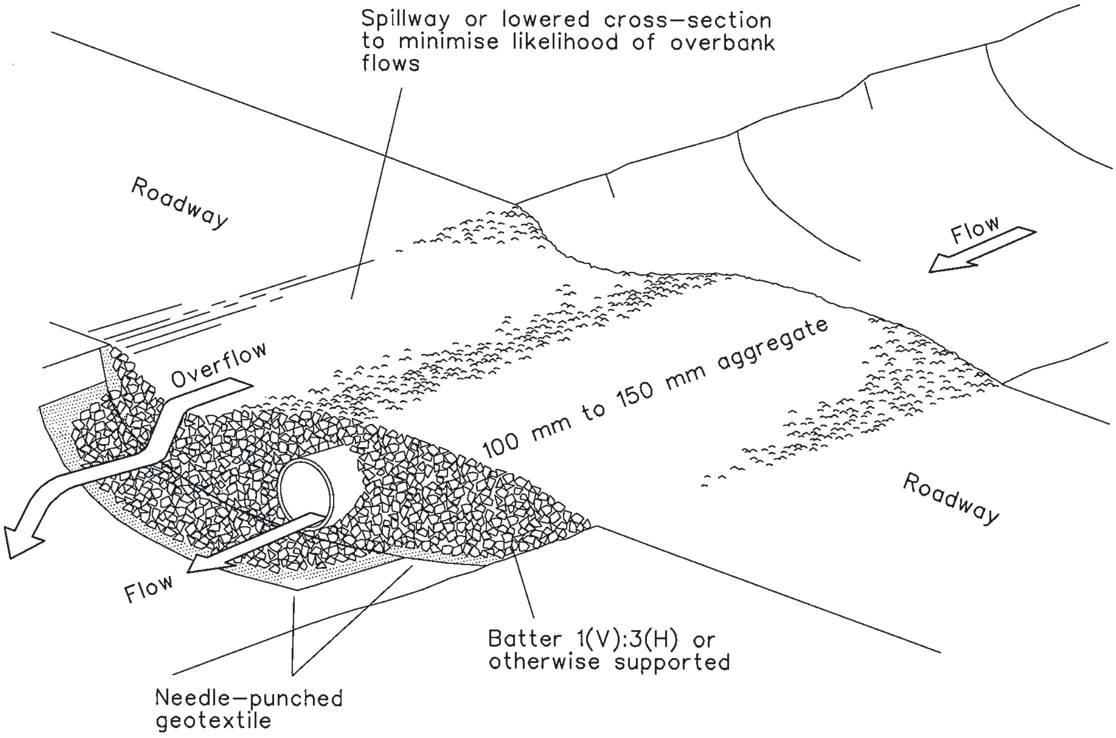
3. Rip to a depth of 300 mm if compacted layers occur.

4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL

SD 4-2

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



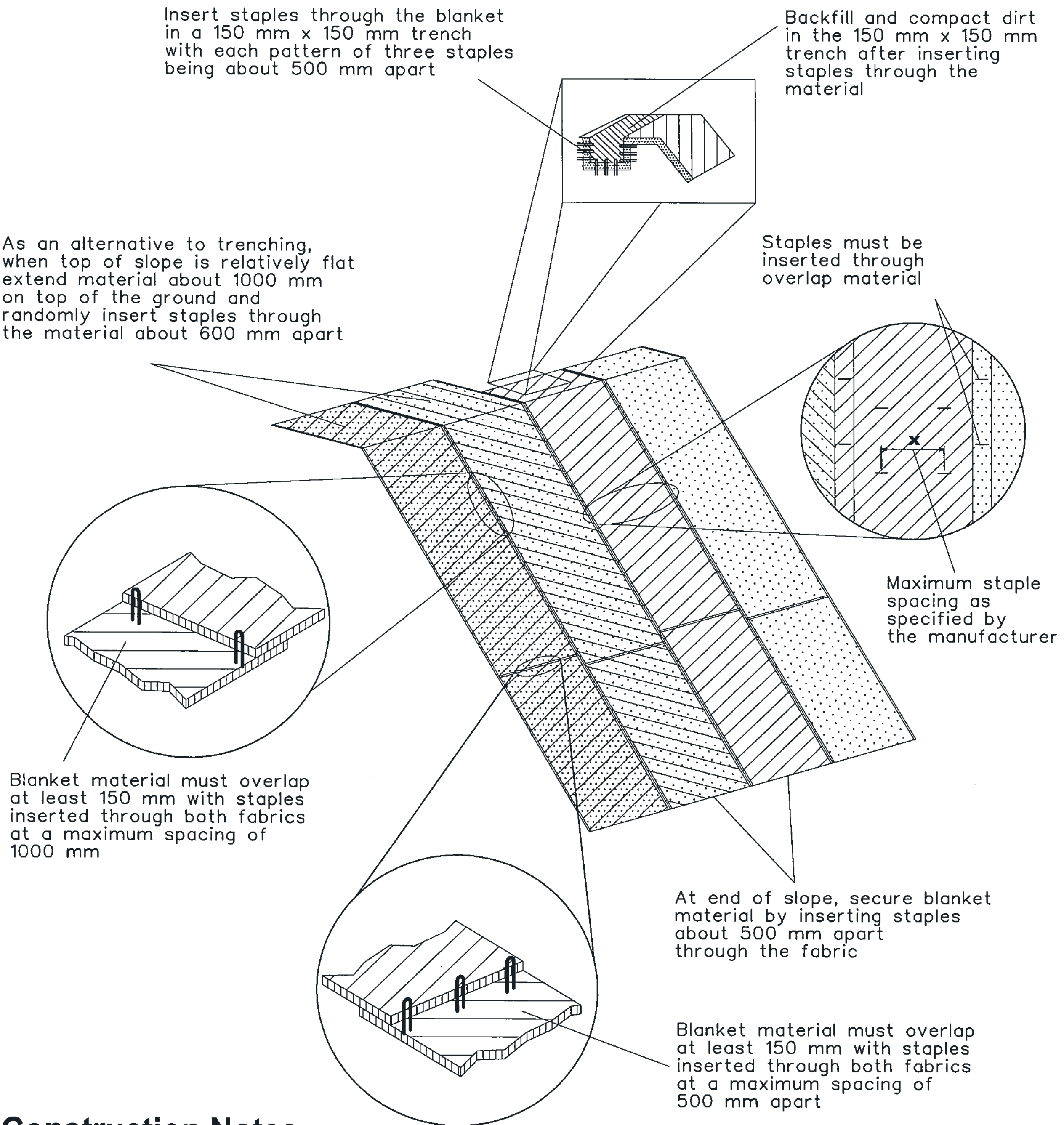
Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING

SD 5-1

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



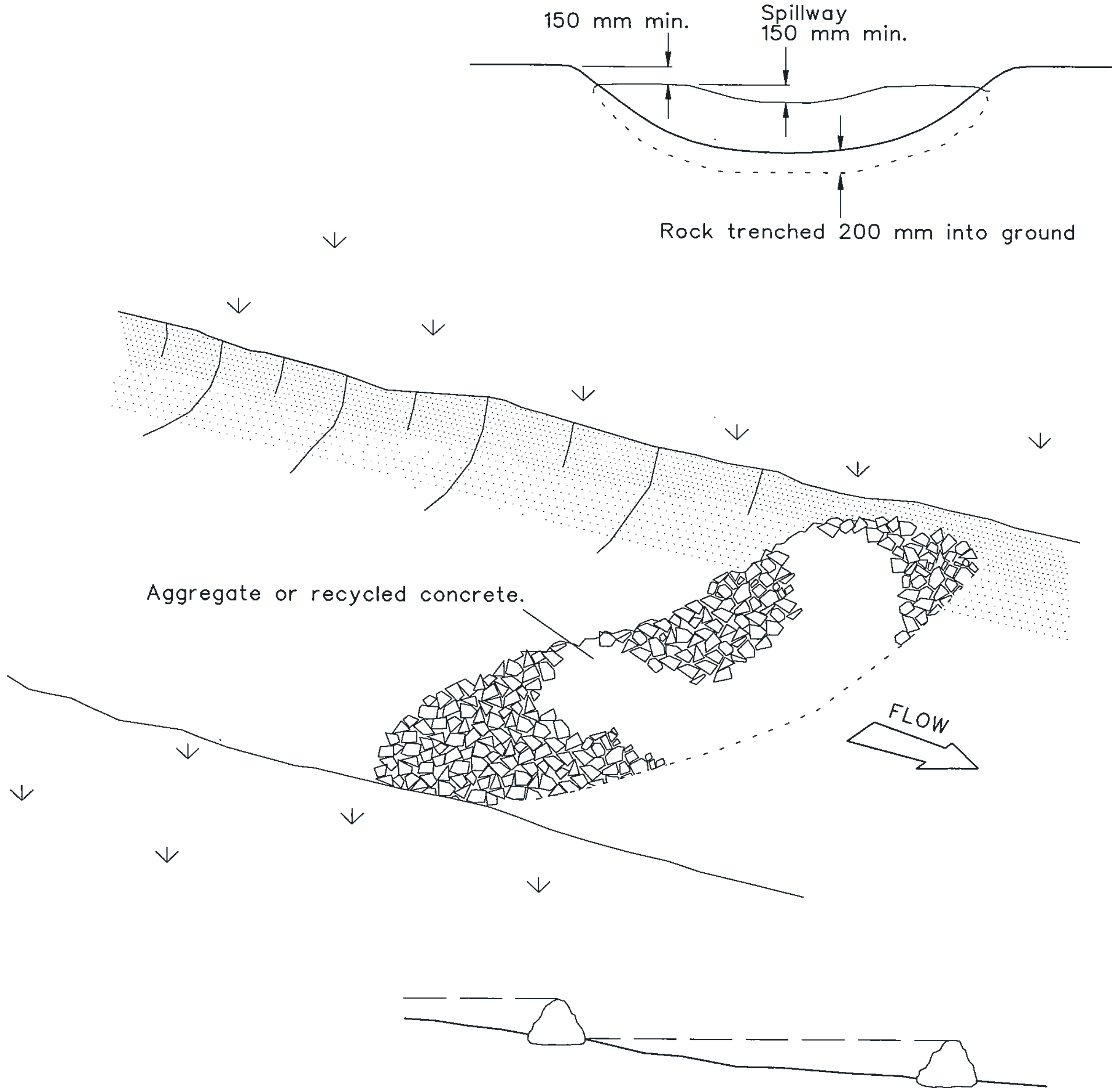
Construction Notes

1. Remove any rocks, clods, sticks or grass from the ground surface before laying the matting.
2. Spread topsoil to at least 75 mm depth.
3. Where appropriate, complete fertilising and seeding on a properly prepared seedbed (Standard Drawing 7-1) before laying the matting.
4. Ensure the fabric can be continuously in contact with the soil by grading the surface carefully first.
5. Lay the matting in "shingle-fashion" with the ends of each upstream roll overlapping the next roll downslope.
6. Ensure sufficient staples are used to maintain a good contact between the soil and the matting.

RECP : SHEET FLOW

SD 5-2

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.

2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.

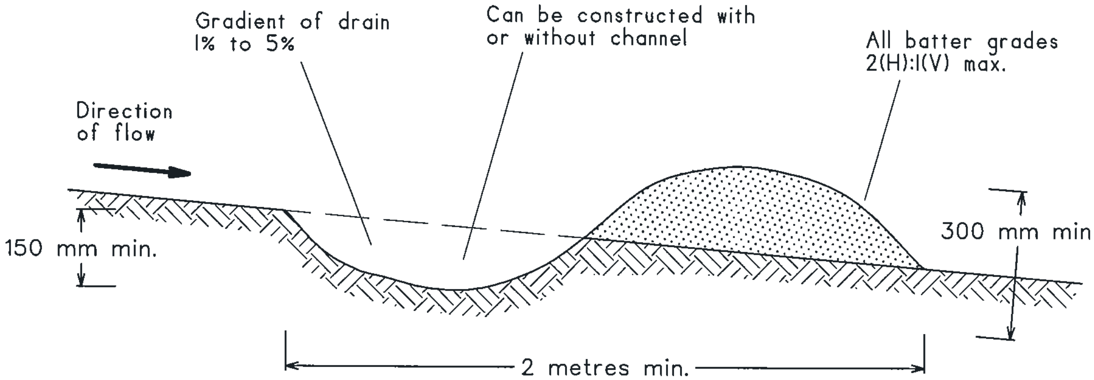
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.

4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM

SD 5-4

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

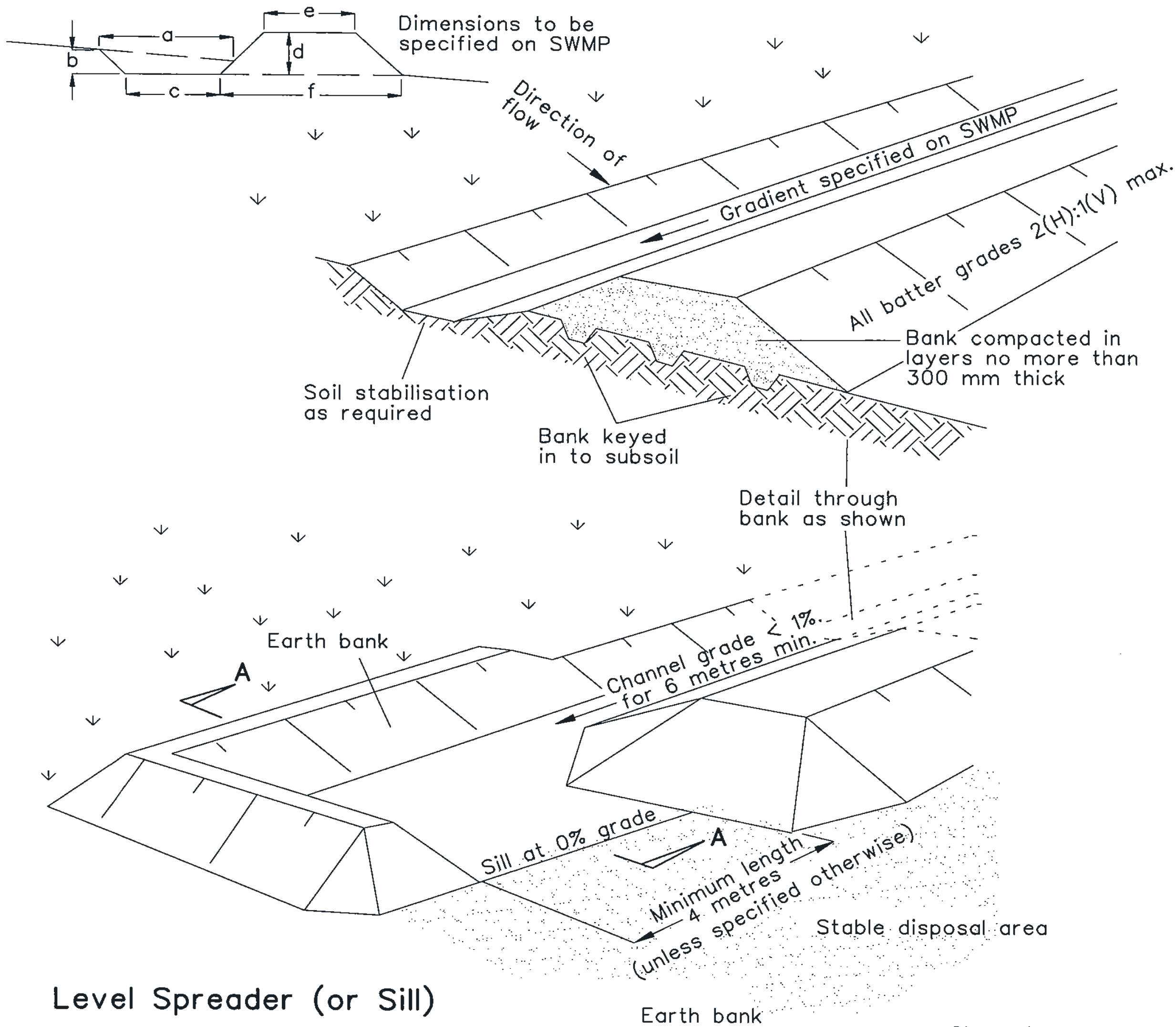
Construction Notes

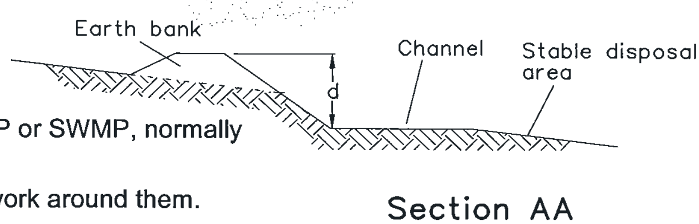
1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW)

SD 5-5

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



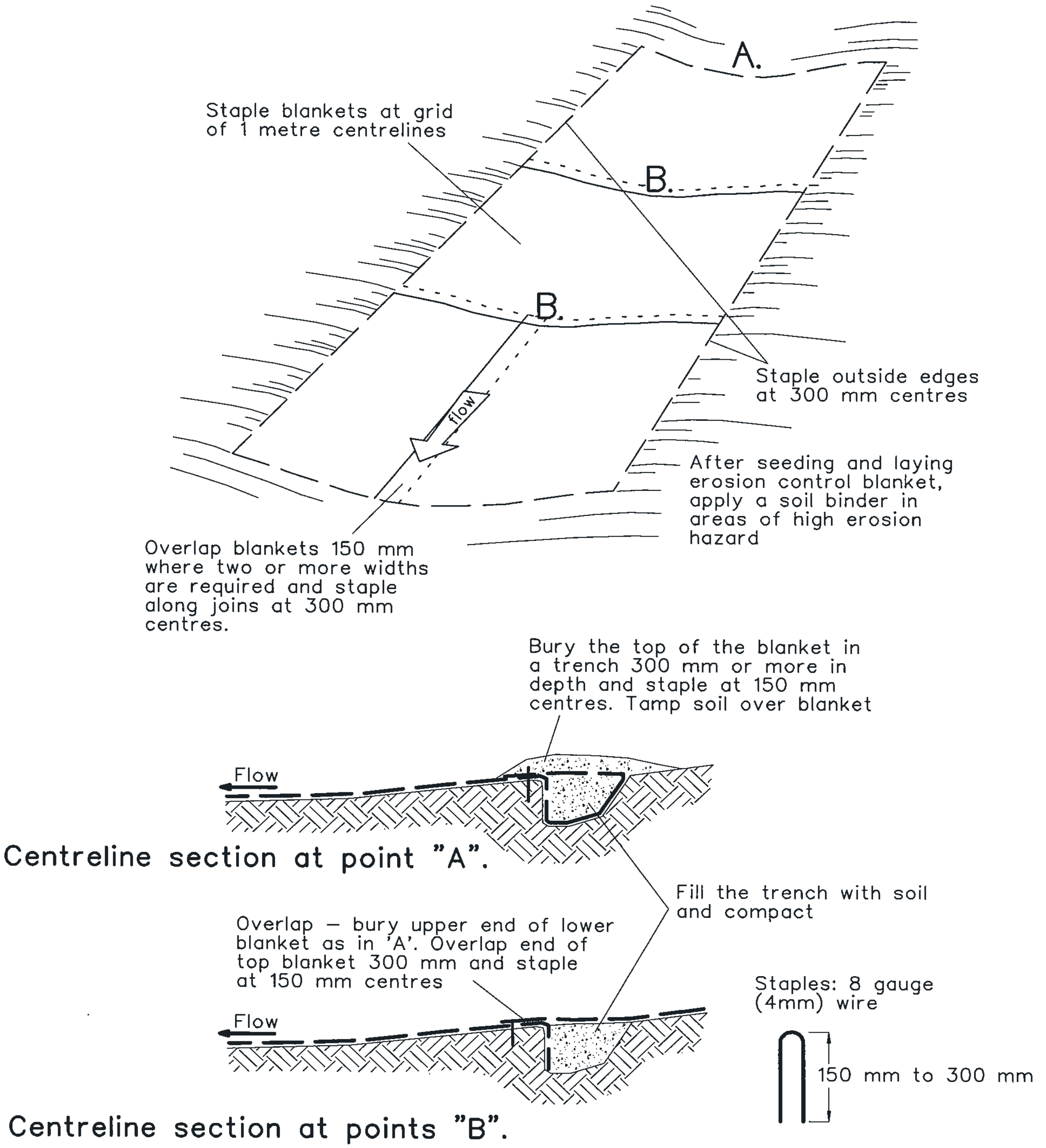


Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) SD 5-6

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

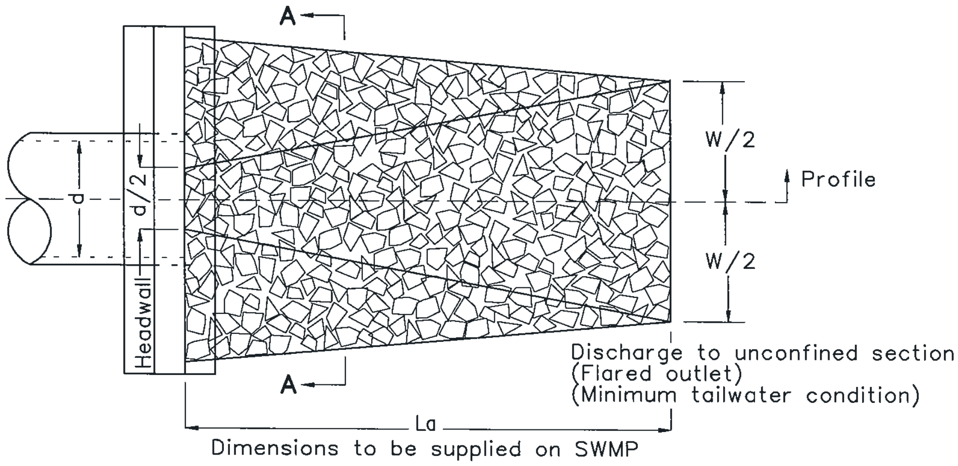


Construction Notes

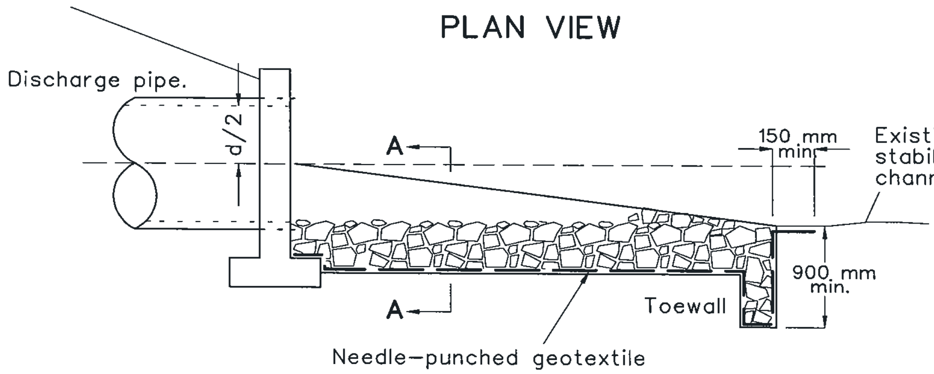
1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

RECP : CONCENTRATED FLOW **SD 5-7**

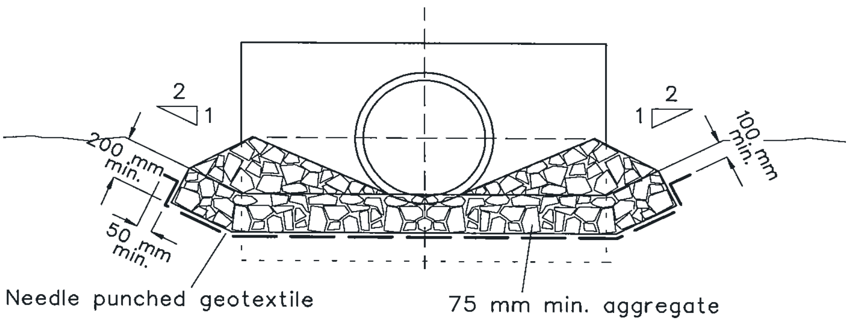
SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



PLAN VIEW



PLAN VIEW



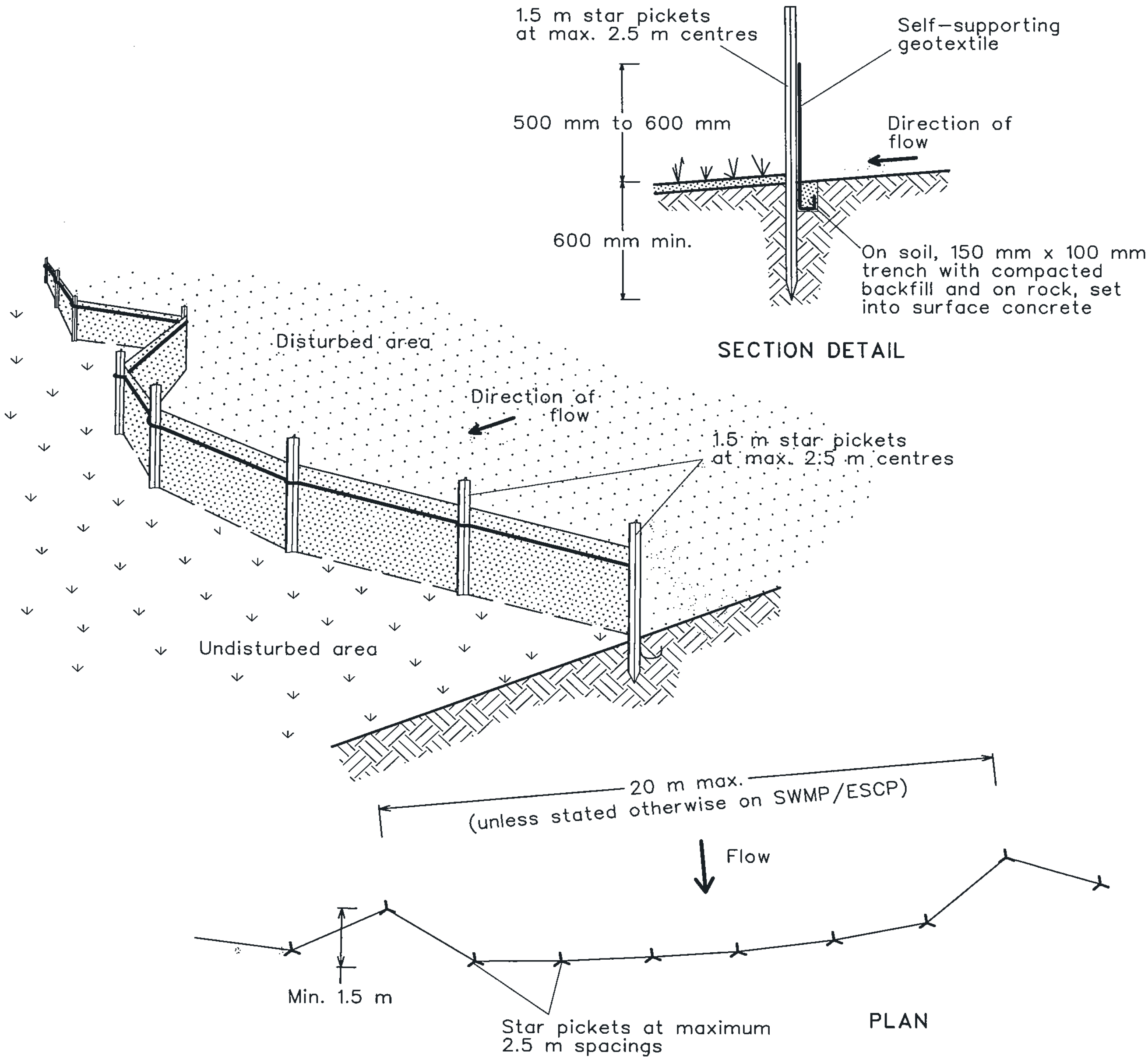
CROSS SECTION AA

Construction Notes

1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipater or the outlet protection conforms to the grading limits specified on the SWMP.

ENERGY DISSIPATER **SD 5-8**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.

2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.

3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.

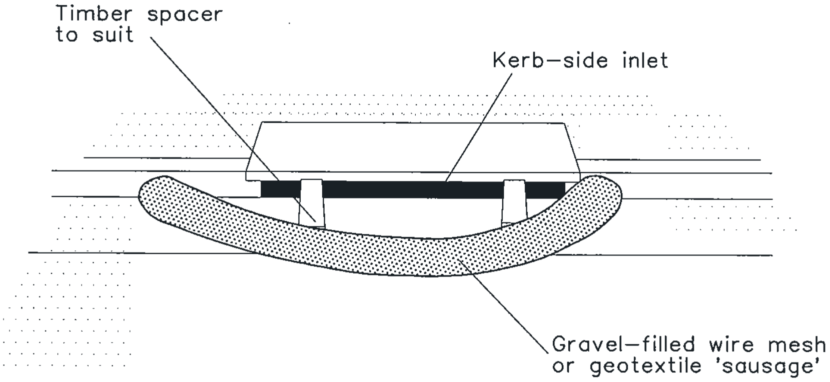
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.

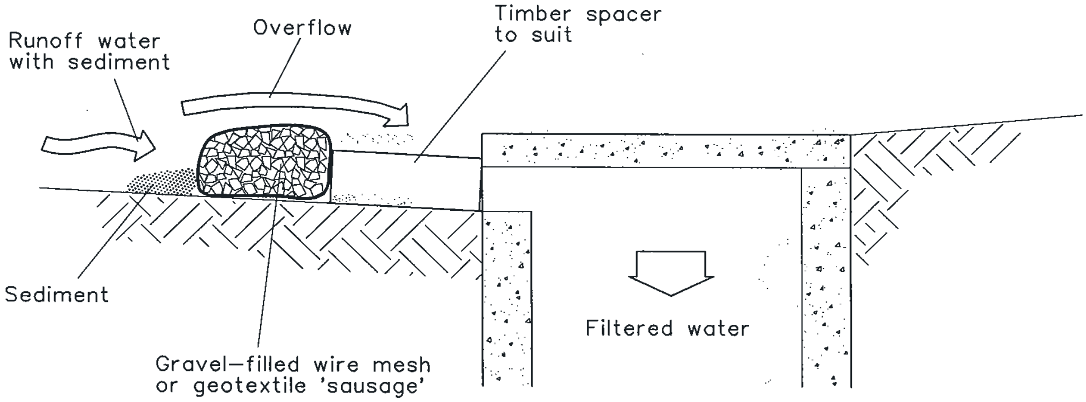
5. Join sections of fabric at a support post with a 150-mm overlap.

6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)





NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

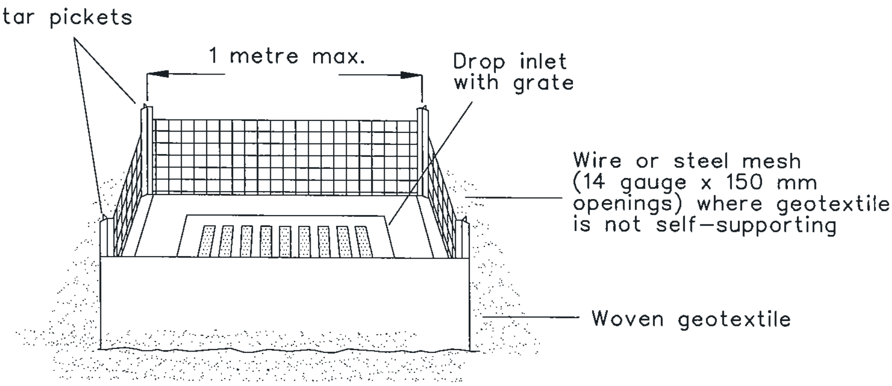
Construction Notes

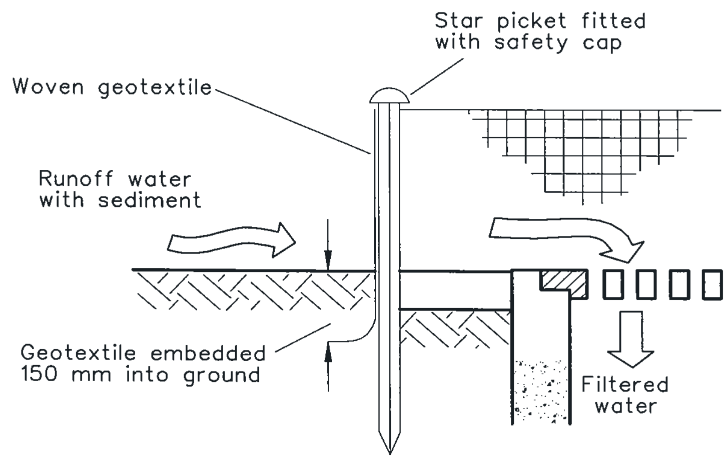
1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

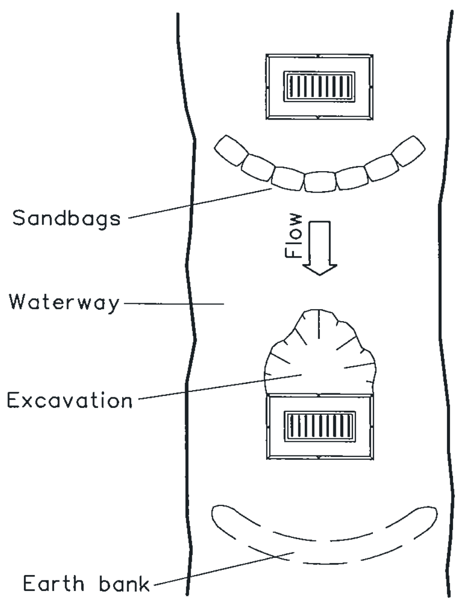
MESH AND GRAVEL INLET FILTER

SD 6-11

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)







For drop inlets at non-sag points, sandbags, earth bank or excavation used to create artificial sag point

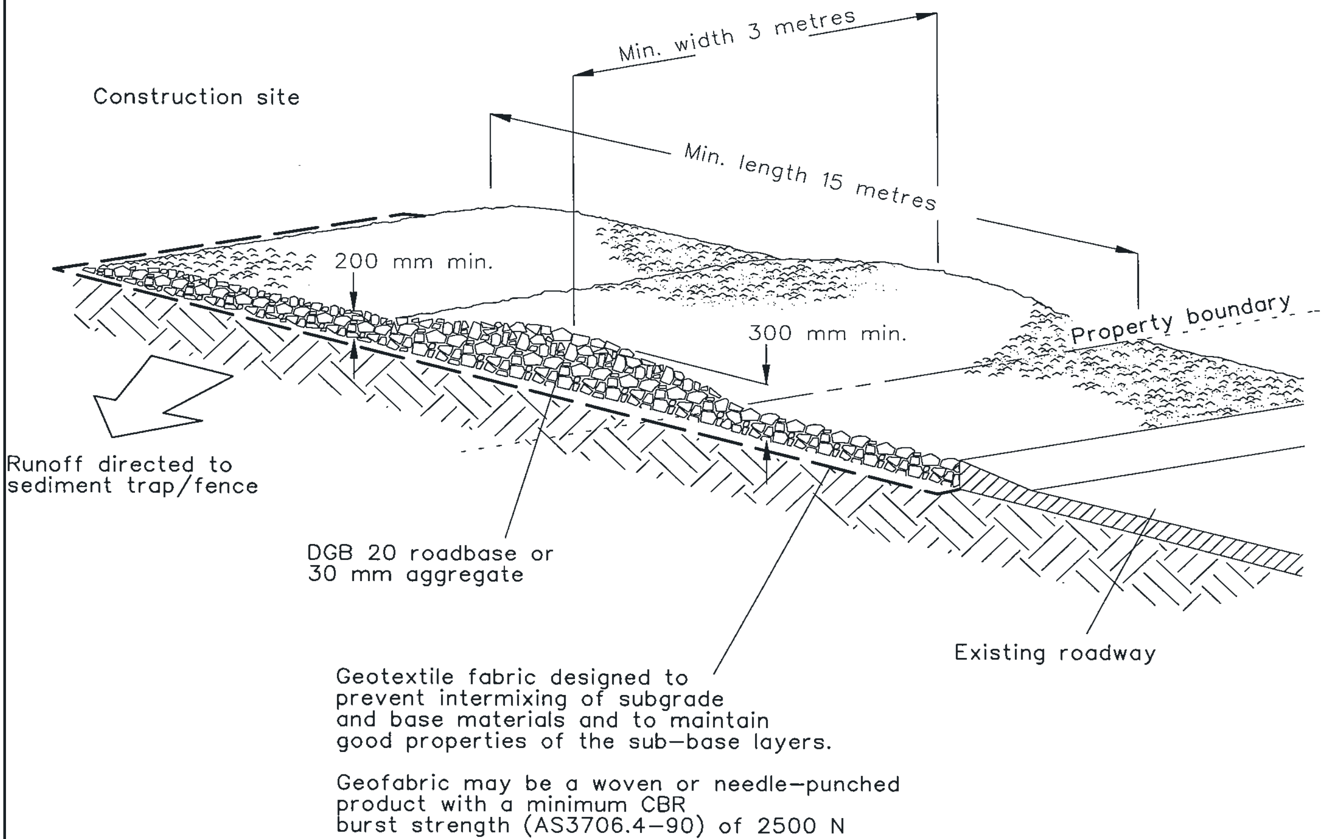
Construction Notes

1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-7 and Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

GEOTEXTILE INLET FILTER

SD 6-12

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



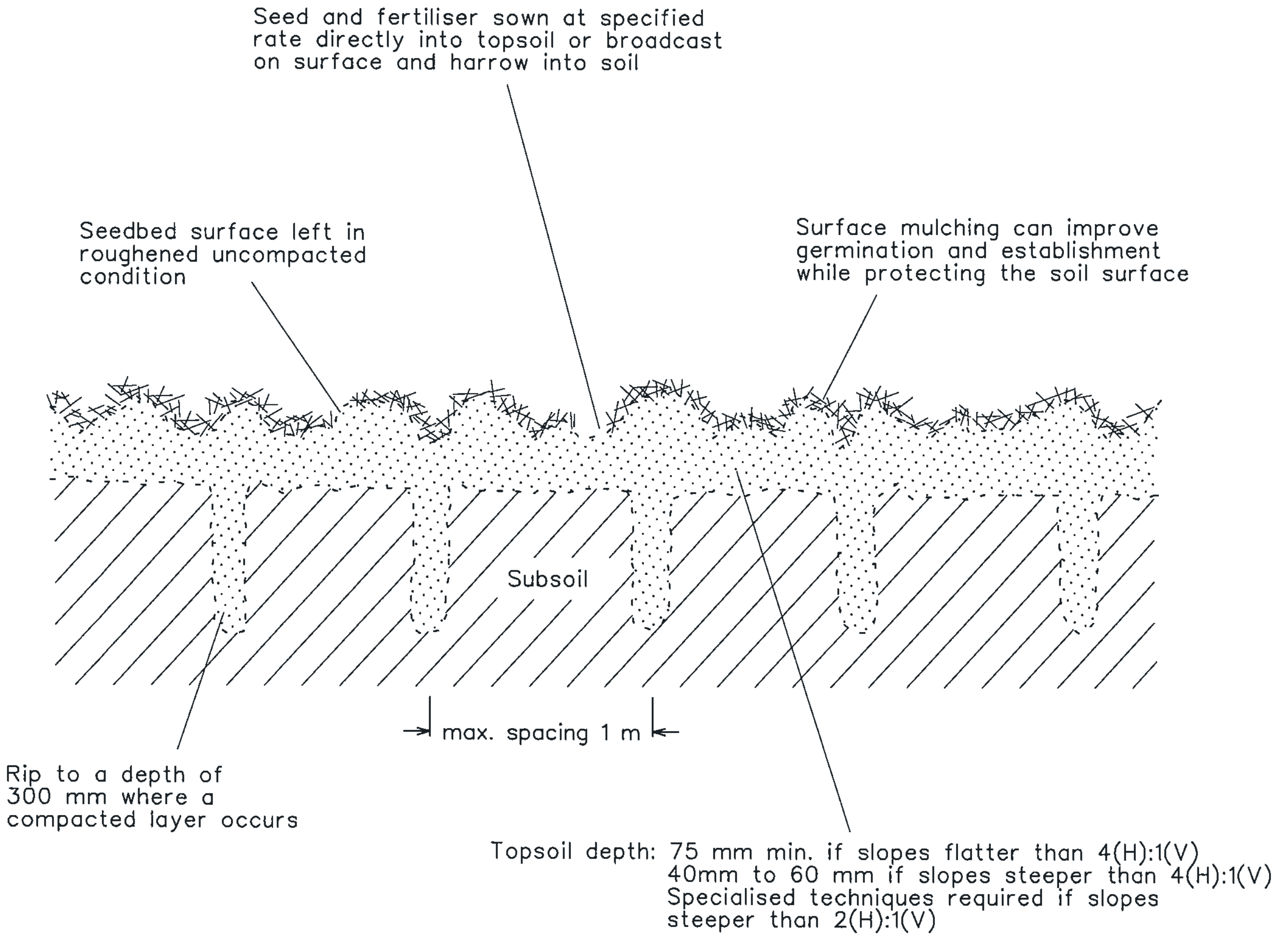
Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS

SD 6-14

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION

SD 7-1

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

APPENDIX C TRANSMISSION LINE ROUTE PHOTOGRAPHIC LOG

Photo 1: Goonoo Goonoo Creek

Photo 2: Goonoo Goonoo Creek

Photo 3: Back Creek

Photo 4: Back Creek

Photo 5: Wombramurra Creek

Photo 5: Wombramurra Creek

Photo 7: Woodleys Creek

Photo 8: Woodleys Creek

Photo 9: Talbots Creek

Photo 10: Talbots Creek

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