23 October 2019

Correspondence Reference: CRWF-2-AEC-0021

CRWF Nominees Pty Ltd
Suite 1.01, Level 1,
17 Moore Street,
Canberra,
ACT 2614

Katrina O'Reilly
Team Leader Compliance
Department of Planning Industry and Environment
PO Box 5475 Wollongong
NSW 2520

Dear Katrina,

Crudine Ridge Wind Farm (SSD-6697) MOD1| Audit Response

A full independent audit was undertaken of the Crudine Ridge Wind Farm (CRWF) pursuant to Condition 8 and 9, Schedule 5 of SSD 6697 MOD1. The audit was undertaken on site by SNC Lavalin (SNC) on 10 and 11 September 2019. The audit team comprised Richard Peterson and Georgia Voura from SNC, Crudine Ridge Wind Farm was represented by Patric Millar.

Below is our Proponents Response to the audit pursuant to the provisions of Section 4.3 of the "Independent Audit Post Approval Requirements June 2018".

Sincerely,

Brendan McAvoy
Project Director
CWP Renewables Pty Ltd

Background

SNC Lavalin (SNC) was engaged by CWP Renewables (CWP) to undertake an independent Audit of the Crudine Ridge Wind Farm (CRWF) located on Aarons Pass Road, Pyramul. The audit was undertaken pursuant to Condition 8 and 9, Schedule 5 of SSD 6697 MOD1.

The audit was undertaken on 10 and 11 September 2019 and was undertaken by Richard Peterson and Georgia Voura from SNC, Crudine Ridge Wind Farm was represented by Patric Millar.

The audit consisted of an assessment of compliance against:

- Independent Audit Post Approval Requirements (Department of Planning and Environment 2018)
- Development Consent (SSD 6697 MOD1)
- Post approval documents, including an assessment of the effective implementation of Environmental Management Plans and Sub-Plans
- Any environmental licences or other approvals
- Environmental performance including but not limited to:
    - Actual impacts compared with Predicted impacts in the Environmental Impact Statement (EIS)
    - Physical extent of the development in comparison with the approved boundary, and any potential off-site impacts
    - Incidents, non-compliances and complaints
    - Performance of the development, with regard to agency policy and environmental issues identified during consultation when developing the scope of the audit
    - Feedback received from the Department, and other agencies and stakeholders on the environmental performance of the project
- Environmental Management System (EMS) at a high level
- A high-level assessment of whether Environmental Management Plans and Sub-Plans are adequate
- Any matter considered relevant by the auditor or the Department of Planning Industry and Environment (DPIE).

Areas of non-compliance

Three areas of non-compliance were identified. These are detailed in Table 1.

Corrective Actions

Corrective actions to be implemented by Crudine Ridge Wind Farm are detailed in Table 1.

Table 1 Audit Findings and Corrective Actions

Condition	Requirement	Status	Action / Recommendation	CRWF Action
3-17	Unless an EPL authorises otherwise, the Applicant shall ensure that the development does not cause any water pollution.	Non-compliant	A major storm event in January 2019 caused a discharge of turbid water below the substation site into the adjoining landholder's property. As the storm event exceeded Managing Urban Stormwater: Soils and Construction (Landcom, 2004) design criteria, it was not practical to control the runoff with the existing controls. Although no regulatory action was undertaken by the EPA the event was a potential breach of Condition L1.1 of EPL 21090.	See attached report from GEZ. See attached report from Soil Conservation Service.
3-18	The Applicant shall: a) ensure that all activities are undertaken in accordance with: • OEH's Managing Urban Stormwater: Soils and Construction (Landcom, 2004) manual, or its latest version; • DPI's guidelines for waterway crossings and fish passage, including:	Non-compliant	It was observed that the Project was not achieving compliance with the Blue Book - Managing Urban Stormwater: Soils and Construction (Landcom, 2004) A more consistent approach is required for the erosion and sediment control across the project including the following points:	See attached report from GEZ for detailed response. Key points of action: • GEZ have appointed an independent CPESC to provide advice on site • Soil and Water Management Plan has been updated • Significant areas have been treated with polymer to reduce rilling of batters since the audit

Condition	Requirement	Status	Action / Recommendation	CRWF Action
	○ Policy and Guidelines for Fish Friendly Waterway Crossings (2004), or its latest version; ○ Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway - Crossings (2004), or its latest version, and ○ - Water Guidelines for Controlled Activities on Waterfront Land (2012), or its latest version; and ensure that the storage and handling of all dangerous goods and hazardous materials is undertaken in accordance with AS1940-2004: The storage and handling of flammable and combustible liquids, or its latest version.		□ stabilisation of temporary stockpiles □ maintenance of sediment fences □ consistent use of polymer (or equivalent soil stabiliser) □ Prevention of rilling of temporary road batters It was also observed that additional spill kits and spill resources are required at permanent locations where refuelling is taking place. **Recommendation:** **The following recommendations are made:** • The appointed Certified Professional in Erosion and Sediment Control returns to the project to assess existing processes and resources dedicated to erosion and sediment control and provide recommendations to ensure • compliance with Blue Book Managing Urban Stormwater: Soils and	• Culverts and drainage works have been undertaken • An erosion and sediment control training program has been developed by a suitably qualified professional and will be delivered to key personnel • Spill kits are present at all refueling sites. See attached report from Soil Conservation Service for works undertaken at the substation site. Remediation works were undertaken at the substation site during mid October following the audit.

Condition	Requirement	Status	Action / Recommendation	CRWF Action
			Construction (Landcom, 2004) requirements. • Provide erosion and sediment control training to key management and supervisory personnel • Provide additional spill response resources (e.g. fully stocked wheelie bin) to vehicle refuelling area.	
5-10	The Applicant shall: a) make the following information publicly available on its website as relevant to the stage of the development: • the EA; • the final layout plans for the development; • current statutory approvals for the development; • approved strategies, plans or programs required under the conditions of this consent; • the proposed staging plans for the development if the construction, operation and/or • decommissioning of the development is to be staged;	Non-compliant	The final layout plans for the development and annual Statement of Compliance with the Environmental Protection Licence (EPL) were not available on the Project website. **Recommendation:** The documents are to be uploaded to the website.	The website has been updated to include: • Final layout plans • Statement of Compliance with the EPL

Conclusion

The areas of non-conformance identified by SNC Lavalin have been addressed and ongoing compliance will be reviewed in three months by an internal audit.

Crudine Ridge 132/33kV Substation
Soil and Water Management - Action Plan

Title
Crudine Ridge 132/33kV Substation, Soil and Water Management - Action Plan

Published by
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Reference
SCSPF19/271

More information
Chris Howarth,
Soil Conservation Service, PO Box 1447 Orange NSW 2800 p: 02 6391 3840 | e: chris.howarth@scs.nsw.gov.au]

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Danielle Orseic for proof reading the document.

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Version	Date	Author	Details	Sections modified
0.1	16.09.209	Chris Howarth	DRAFT	
0.2				
1.0	17.09.2019		Revision 1	

External distribution:

Version	Date	Prepared by (sign)	Approved by (sign)	Released to
1.0	17.09.2019			Andrew Scott (TransGrid) and Jaleel Shaheen (TransGrid)

1. Executive Summary

The Soil Conservation Service (SCS) has been engaged by TransGrid to prepare an Action Plan to control, prevent and minimise pollution into and from the disturbed area associated with Crudine Ridge 132/33kV Substation site.

There is no work currently going on at the site and it is unknown exactly when works will resume. Earthworks have commenced for the formation of the batters & bench, and site facilities have been established. A brief assessment of erosion and sediment control measures currently implemented on site are as follows,

- Nearly of all the dirty water on site is either trapped in low points within the excavation or passes through some form of a sediment trap.
- There was no sediment observed beyond the sediment fence at the bottom of the site, and it can be considered that the controls implemented so far have been effective to date.
- Most of the clean run-on water is diverted around the site by a topsoil bund and seems to be working well enough to date.
- There is a significant amount of exposed rock and gravel on site which helps reduce the generation of sediment during a rainfall causing runoff.

To improve and augment erosion and sediment controls on site the following measures are recommended,

- The sediment fence at the bottom of the site has perished and needs to be replaced with more robust material.
- The outlets on the sediment traps need to be replaced as the fabric is starting to break down and expose the soil beneath which can be eroded in a concentrated flow.
- The topsoil bunds to be reshaped to provide a more stable form and be stabilised from the effects of raindrop impact.
- Install a rock/bidum sediment trap on the outlet of the bottom sediment trap to better treat dirty water before it leaves site, better dissipate the outflow from the spillway on the sediment trap and provide a secondary control if the rock spillway fails.
- A rock/bidum sediment trap to be placed on the outlet of the clean water diversion at the top of the site to capture sediment from the topsoil bund and better dissipate the outflow

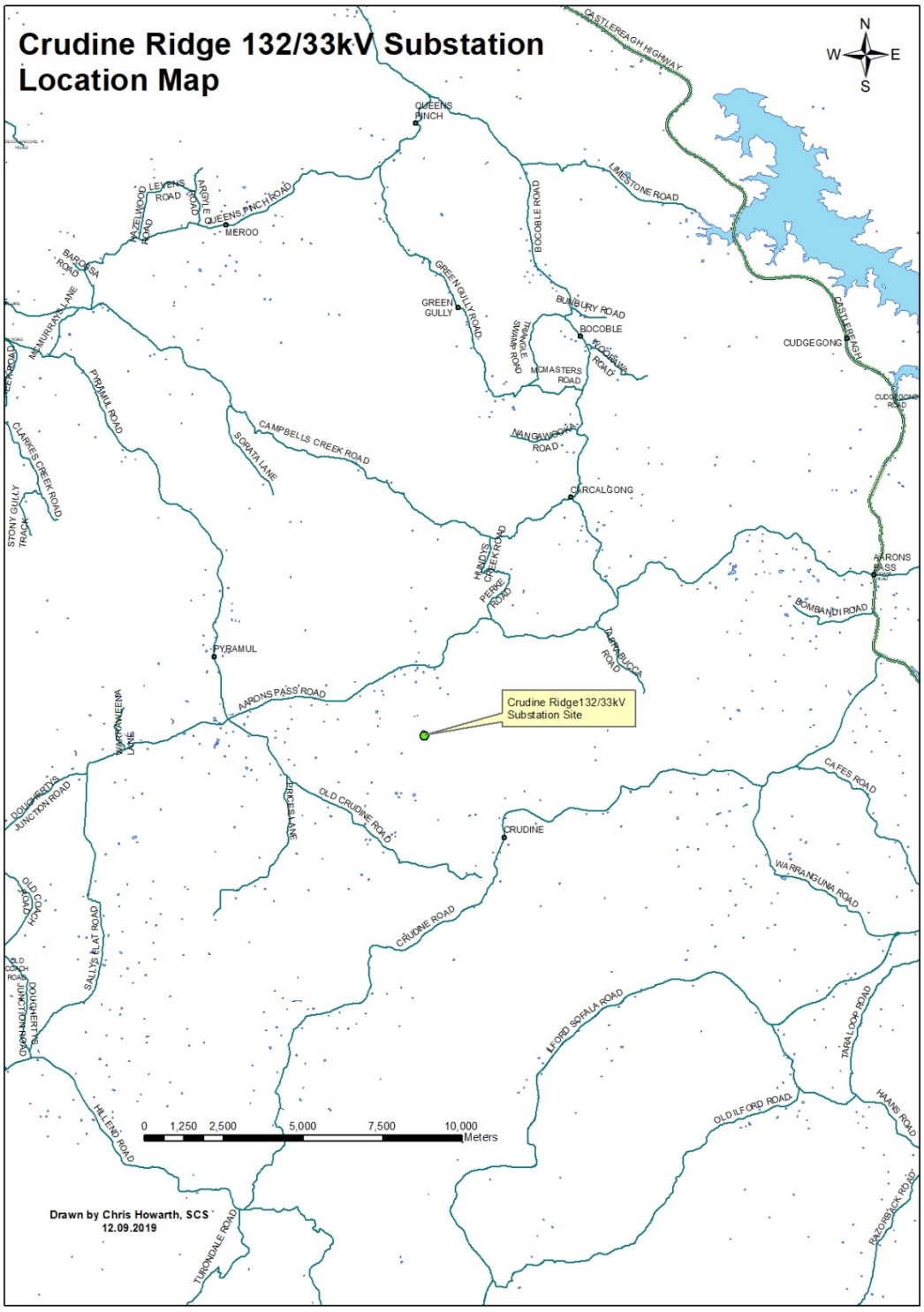
2. Contents

1. Executive Summary iii
2. Contents 4
3. Introduction 5
4. Site Description 6
4.1. Expected Soil Loss from Current Site Arrangements 7
5. Proposed Works 8
5.1. Sediment Control Works 8
5.2. Erosion Control Works 10
Appendix 1 Sketch Plan of Existing Stockpiles and Controls 12
Appendix 2 Soil Loss Calculation Sheets 14
Appendix 3 Sketch Plan of Proposed Works 19
References 21

3. Introduction

A site inspection of the substation site was carried out by Soil Conservation Specialist, Chris Howarth from the Soil Conservation Service (SCS) on the 05.02.2019 in conjunction with Andrew Scott from TransGrid. The objective of the inspection was to undertake review of soil and water management controls and measures within disturbed area of the substation site with the location shown in Figure 1 below.

Figure 1. Site Location



4. Site Description

Currently the site is shut down with no work being carried out on site. Earthworks were started, with the bench and associated batters for the substation site being roughly formed. A sketch diagram of the existing works is shown in Appendix 1 of this report.

Nearly all of the dirty water on site is either trapped in low points within the excavation or passes through some form of a sediment trap. The main sediment trap at the lowest point on site has collected a reasonable amount of sediment and no sediment was observed past the outlet of this structure. However the fabric underneath the rock outlet has started to decay and fine clay material can now wash out from beneath the rock, and the structure could potentially fail if subject to a flow event.

Photo 1. Water trapped in a low point of the excavation near the site offices.

Photo 2. Water Trapped in the sediment trap at the lowest point on site.

There is a significant amount of exposed rock and gravel on site which is a good thing in that it provides a stable ground cover and helps reduce the generation of sediment during a rainfall event causing runoff.

Most of the clean run-on water is diverted around the site by what could be considered a topsoil bund and seems to be working well enough to date. The flow paths for drainage around the site are mostly exposed, but there is rock lining in some of the steeper sections. The flat grade on the channel at the bottom of the site is helping to trap sediment in flow path. However the exposed channels on steeper sections have the potential to erode during a storm event causing runoff.

Photo 3. A topsoil bund diverting clean water around the site.

Photo 4. An example of the rocky material on the surface of the excavation.

The topsoil bunds at the top and bottom of the site have been roughly formed and are generating minor levels of sediment where there is loose material and concentrations of runoff coming off the top of the bund and eroding the sides. Note that the topsoil on site is extremely shallow and infertile and any good topsoil is very limited. The bunds appear to contain a significant amount of dispersible subsoil which has not grown any vegetation despite efforts over time to do so. The dispersible soils are a major limitation on site and will continue to contribute to the mobilisation of sediment.

The sediment fence at the bottom of the site below the topsoil bund has perished and is now ineffective. The fabric outlets on the sediment traps is also starting to break down and exposing the soil beneath to a concentrated flow increasing the potential for failure.

There was no sediment observed beyond the sediment fence at the bottom of the site and it can be considered that the controls implemented so far have been effective to date.

4.1. Expected Soil Loss from Current Site Arrangements

In reference to Section 6.2 of the Sediment and Erosion Control Sub Plan prepared by Dixon (2018), the criteria used in the calculations for the potential soil loss from the current site for an area of 1ha of disturbance are as follows:

- 2 year six hour storm event 7.27mm/hr
- Rainfall Erosivty 1330,
- Soil Erodibility Factor 0.04
- Slope length 70m, Average Gradient 10% & Slope Length/Gradient Factor 2.56,
- Cover Factor 1 (totally stripped of vegetation), and
- Erosion Control Practice Factor 0.9 (track walked up and down the slope)

The results in the spreadsheets in Appendix 2 show that over a two month period the expected soil loss is 16m^3. This can be managed without a sediment basin provided that existing controls are improved, and some new controls and measures are put in place. In particular controls should focus on erosion control rather than sediment control.

5. Proposed Works

The following measures are proposed to be implemented to improve the erosion and sediment controls on site. Refer to the sketch for proposed works for the specific locations on site in Appendix 3 of this report.

5.1. Sediment Control Works

Item 1 ***Sediment Fence below Topsoil Bund Bottom of site***

It is recommended to replace the sediment fence at the bottom of site with a better quality fabric to give it greater longevity such as Silt Fence 2000 utilising the steel posts that are already there.

Photo 5. An example where the sediment fence has deteriorated and needs to be replaced.

Item 2 ***Sediment Trap Bottom of Site***

Photo 6. An overview of the sediment trap with rock lined spillway.

For the sediment trap at the bottom of the site it is recommended to,

- Clean out the accumulated sediment and reform the topsoil batter / rock spillway to a minimum of 16m³ capacity,

- Replace the rock lined spillway so that it has A44 geofabric placed underneath the rock work to prevent the erosion of fine soil material beneath, and widen the outlet to a minimum of 2m in the base of the channel to reduce the risk of potential failure of the structure, and
- Place a rock/bidum sediment trap on the outlet of the rock spillway a minimum of 4m wide to better dissipate outflow from the spillway in a storm event.

Item 3 Low Point in North East Corner

For the low point in the north-east corner of the site it is recommended to,

- Replace the existing spillway with a rock lined channel a minimum of 2m wide, underlain with geofabric, and
- Remove accumulated sediment from low point to maintain 5m³ capacity.

Photo 7. The fabric on the spillway is starting to break down and will erode in a storm event.

Item 4 Clean Water Diversion South East Corner

It is recommended to place a rock/bidum check on the outlet of the clean water diversion a minimum of 3m wide to trap any sediment generated from the topsoil bunds, and better dissipate energy from the outlet in a storm event.

Photo 8. The outlet of the clean water diversion on the south east corner of the site.

5.2. Erosion Control Works

Item 5 Topsoil Bunds

Firstly it is recommended to reshape the topsoil bunds at the top, bottom and around both sides of the site to make the banks smooth and rounded, so that they shed drainage in sheet flow rather than concentrating small flows on uneven surfaces resulting in rill erosion.

On completing shaping of the topsoil bunds it is recommended to stabilise the surface to minimise the potential for the generation of sediment. Considering the high risk of failure with revegetation measures due to the extremely poor soil type it is recommended that a two stage approach is taken to stabilise the topsoil bunds. Firstly an effort should be made to establish a cover crop on the topsoil bunds to maintain some form of biological activity in the topsoil stockpiles albeit at a limited level. Otherwise of what good topsoil remains will only degrade over time. Secondly it is recommended to spray the surface of the topsoil bunds with a soil stabiliser to reduce the generation of sediment. The following measures are recommended,

- Apply Japanese Millet at 20 kg/ha, Rye Grass Seed at 10 kg/ha and Sub Clover at 5 kg/ha
- Apply fertiliser, Croplift 15 at 250 kg/ha, and
- Spray the topsoil bunds with anionic bitumen at 1-2 l/m²

Photo 9. The topsoil bund at the bottom of the site with a flat top that results in concentration of runoff from the surface in rills down the side.

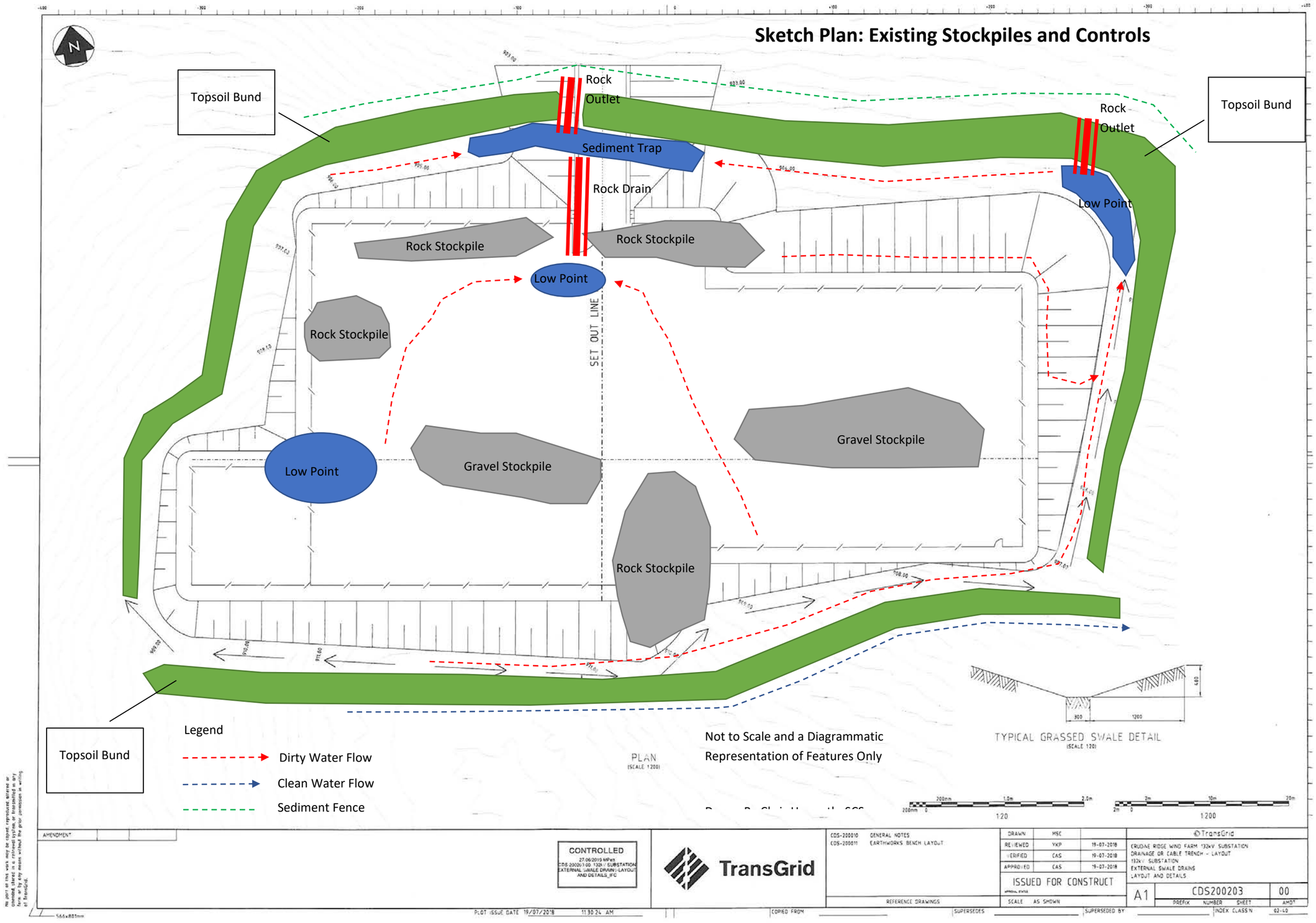
Photo 10. The topsoil bund at the top of the site directing clean water away.

Item 6 Drainage at the Gate

There is small area of dirty water below the topsoil bund on the south-east corner of the site missing the controls below. It is recommended to place a trafficable cross bank at the gate to direct this drainage into the dirty water system.

Photo 11. Site for trafficable cross bank near gate

Appendix 1 Sketch Plan of Existing Stockpiles and Controls


Sketch Plan: Existing Stockpiles and Controls
Topsoil Bund
Rock Outlet
Sediment Trap
Rock Drain
Rock Stockpile
Rock Stockpile
Low Point
Rock Stockpile
Low Point
Gravel Stockpile
Gravel Stockpile
Rock Stockpile
Rock Outlet
Low Point
Topsoil Bund
SET OUT LINE
Topsoil Bund
Legend
Dirty Water Flow
Clean Water Flow
Sediment Fence
PLAN
(SCALE 1:200)
Not to Scale and a Diagrammatic Representation of Features Only
TYPICAL GRASSED SWALE DETAIL
(SCALE 1:20)
1:20
1:200
CONTROLLED
TransGrid
ISSUED FOR CONSTRUCT
CDS200203
A1

Appendix 2 Soil Loss Calculation Sheets

SWMP Commentary, Detailed Calculations

Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: **Cridine Ridge Substation**

Site Location: **Cridine Ridge Substation**

Precinct: **Crudine**

Description of Site: **Sloping disturbed site with approximately 1ha of disturbed land contributing to off site flows.**

Site area	Site						Remarks
	Sub Catch						
Total catchment area (ha)	1						
Disturbed catchment area (ha)	1						

Soil analysis

% sand (faction 0.02 to 2.00 mm	10						Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)	30						
% clay (fraction finer than 0.002 mm)	60						
Dispersion percentage	50.0						E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	37.5						See Section 6.3.3(e)
Soil Texture Group	D						See Section 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5						See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	75						See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	16.8						See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	7.27						See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	1330						Automatic calculation from above data
Soil erodibility (*K*-factor)	0.04						RUSLE data can be obtained from Appendixes A, B and C
Slope length (m)	70						
Slope gradient (%)	10						
Length/gradient (*LS*-factor)	2.56						
Erosion control practice (*P*-factor)	0.9	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Calculations

Soil loss (t/ha/yr)	123						
Soil Loss Class	1						See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	94						
Sediment basin storage volume, m^3	16						See Sections 6.3.4(i) and 6.3.5 (e)

SWMP Commentary, Detailed Calculations

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
Sub Sation	1	8	58.5	86.4	101	117	138	155	0.8

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comment
		Sub Satior (m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	5 (m^3/s)	(m3/s)	
1 yr,tc	0.8	0.104						
5 yr,tc	0.95	0.183						
10 yr,tc	1	0.225						
20 yr,tc	1.05	0.273						
50 yr,tc	1.15	0.353						
100 yr,tc	1.2	0.414						

SWMP Commentary, Detailed Calculations

3. Volume of Sediment Basins: *Type C* Soils

Basin volume = settling zone volume + sediment storage volume

Settling Zone Volume

The settling zone volume for *Type C* soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

$$Q_{tc,0.25} = 0.5 \times [0.00278 \times C10 \times Fy \times I\ 1yr, tc \times A\ ]\ (m3/sec)$$

where:

$Q_{tc,0.25}$ = flow rate (m^3/sec) for the 0.25 ARI storm event
C_{10} = runoff coefficient (dimensionless for ARI of 10 years)
F_y = frequency factor for 1 year ARI storm
$I_{1\ yr,tc}$ = average rainfall intensity (mm/hr) for the 1-year ARI storm
A = area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{tc,\ 0.25}$ m2

Particle settling velocities under ideal conditions (Section 6.3.5(e))

Particle Size	Area Factor
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 100 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(v)).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	100% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	$Q_{tc,\ 0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
Sub Sation	0.052	4100	213	0.6	128	16	144	3	25.3	8.4
		4100						3		
		4100						3		
		4100						3		
		4100						3		
		4100						3		

SWMP Commentary, Detailed Calculations

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$$Q_{tc,0.25} = 0.5 \times [0.00278 \times C10 \times Fy \times I_{1yr,tc} \times A] \text{ (m3/sec)}$$

where:

$Q_{tc,0.25}$ = flow rate (m^3/sec) for the 0.25 ARI storm event
C_{10} = runoff coefficient (dimensionless for ARI of 10 years)
F_y = frequency factor for 1 year ARI storm
$I_{1\,yr,tc}$ = average rainfall intensity (mm/hr) for the 1-year ARI storm
A = area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{tc,\,0.25}$ m2

Particle settling velocities under ideal conditions (Section 6.3.5(e))

Particle Size	Area Factor
0.100	170
0.050	635
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Place an "X" in the box below to show the sediment storage zone design parameters used here:

	100% of settling zone capacity,
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Total Basin Volume

Site	$Q_{tc,\,0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
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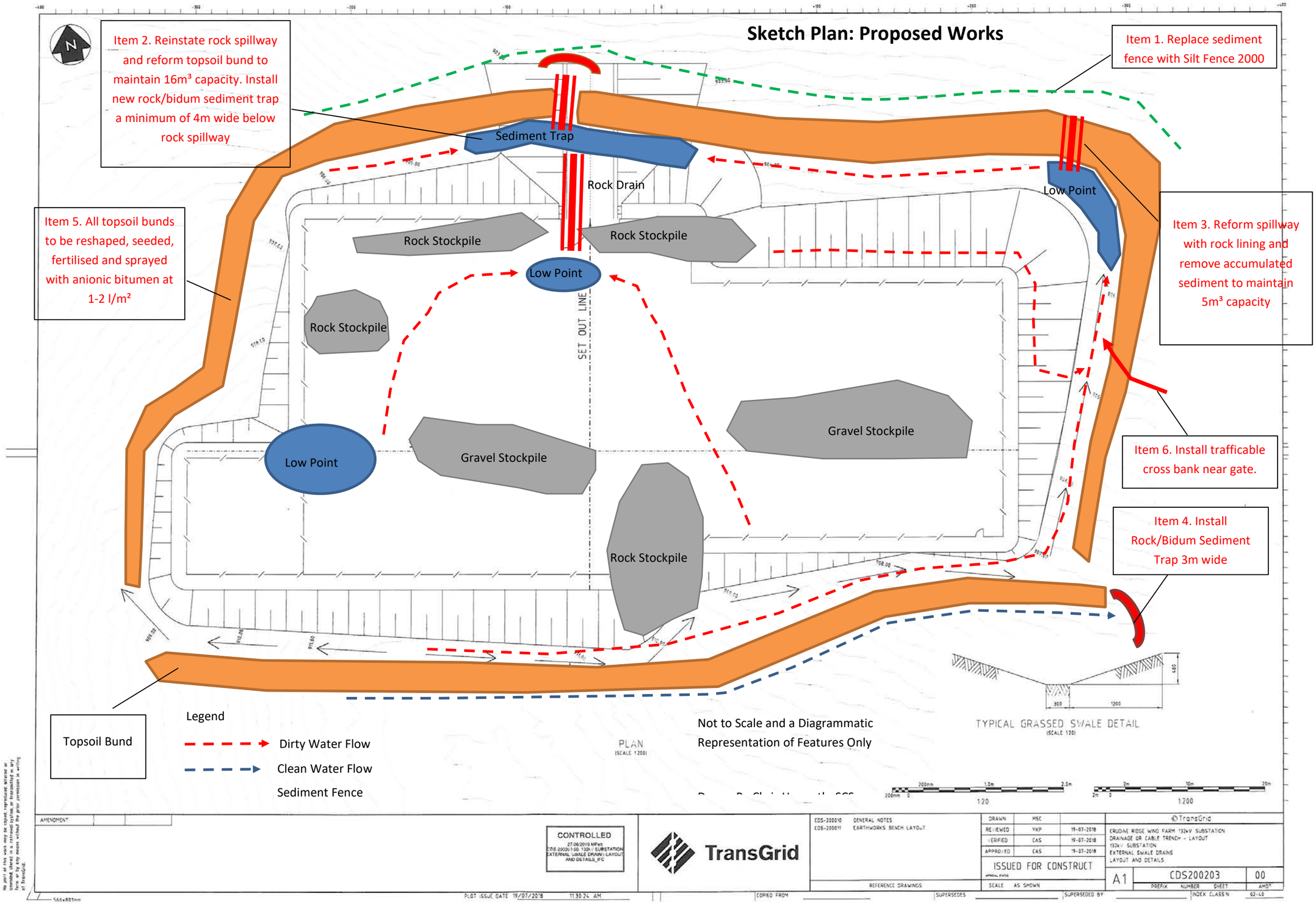
		4100						3		
		4100						3		
		4100						3		
		4100						3		
		4100						3		

Appendix 3 Sketch Plan of Proposed Works


Sketch Plan: Proposed Works
Item 2. Reinstate rock spillway and reform topsoil bund to maintain 16m³ capacity. Install new rock/bidum sediment trap a minimum of 4m wide below rock spillway
Item 1. Replace sediment fence with Silt Fence 2000
Item 5. All topsoil bunds to be reshaped, seeded, fertilised and sprayed with anionic bitumen at 1-2 l/m²
Item 3. Reform spillway with rock lining and remove accumulated sediment to maintain 5m³ capacity
Item 6. Install trafficable cross bank near gate.
Item 4. Install Rock/Bidum Sediment Trap 3m wide
Sediment Trap
Rock Drain
Low Point
Rock Stockpile
Rock Stockpile
Low Point
Rock Stockpile
SET OUT LINE
Low Point
Gravel Stockpile
Gravel Stockpile
Rock Stockpile
Topsoil Bund
Legend
Dirty Water Flow
Clean Water Flow
Sediment Fence
PLAN
(SCALE 1:200)
Not to Scale and a Diagrammatic Representation of Features Only
TYPICAL GRASSED SWALE DETAIL
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CONTROLLED
TransGrid
CDS-200010 GENERAL NOTES
CDS-200011 EARTHWORKS BENCH LAYOUT
DRAWN MSC
REVIEWED YKP 19-07-2018
VERIFIED CAS 19-07-2018
APPROVED CAS 19-07-2018
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CRUDINE RIDGE WIND FARM 132kV SUBSTATION
DRAINAGE OR CABLE TRENCH - LAYOUT
132kV SUBSTATION
EXTERNAL SWALE DRAINS
LAYOUT AND DETAILS
©TransGrid

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GEZ Consortium – Crudine Ridge Wind Farm Project

18 November 2019

Our Reference: ZX109-L-307-CRWF

Ms Beth McCaffrey
GEZ Consortium Manager
Ph: (02) 4044 2500
Level 5, 24 Honeysuckle Dr
Newcastle NSW 2300
PO Box 648 | Newcastle NSW 2300

CRWF Nominees Pty Ltd
Suite 1.01, Level 1
17 Moore Street
Canberra ACT 2614

Attention: **Tony Igo**

Subject: **Crudine Ridge Wind Farm | Independent Environmental Audit Report**

Dear Tony,

The Contractor refers to:

- EPC Contract dated 22 May 2018 (**Contract**) between CRWF Nominees Pty Ltd (**Principal**) and Zenviron Pty Ltd and General Electric International Inc (**Contractor**);
- CRWF EPC Contract deed relating to amendments and existing disputes dated 31 October 2019;
- The Contractor's correspondence ZX109-L-114-CRWF (Extreme Storm Event), dated 17 January 2019;
- The Contractor's correspondence ZX109-L-136-CRWF (Extreme Storm Event - Drainage and Hydrology Design), dated 14 February 2019;
- The Contractor's correspondence ZX109-L-254-CRWF (Independent Auditor), dated 26 August 2019;
- The Contractor's correspondence ZX109-L-274-CRWF (DPIE Environmental Notice), dated 17 September 2019;
- The Contractor's correspondence ZX109-L-287-CRWF (Environmental Compliance), dated 2 October 2019;
- Independent Audit Report SNC-140474-CRWF (ref. CRWF-GCOR-000330) received 8 November 2019; and
- Principal correspondence (ref. CRWF-2-GEZ-0148) dated 11 November 2019.

The Contractor acknowledges the receipt of the Independent Audit Report referenced above and provides the following formal response relating to the items 3-17 and 3-18 of Section 5 "Non-compliances and Recommendations", Table 3.

3-17 – NCR Summary
A major storm event in January 2019 caused a discharge of turbid water below the substation site into the adjoining landholder's property.

Contractor's Response
The Extreme Storm Event was determined to have an annual expected probability (AEP) of <1% of occurrence, as per data retrieved from the Australian Bureau of Meteorology Design Rainfall Data System using the coordinates and rainfall observations that were recorded during and after the event (the event resulted in around 80mm of rainfall within a 1-hour duration).

This Extreme Storm Event exceeded the design parameters of the Wind Farm Balance of Plant (BoP) site hydrology in accordance with Landcom 2004 "NSW Bluebook" for stormwater management. For clarity, the performance parameters of the Wind Farm BoP design for major flow events is defined below:

- Cross Road Drainage Flow Paths may be inundated in events greater than 50% AEP, however they must be protected against damage for events up to 5% AEP.
- Longitudinal Drainage must be contained within the table drains for events up to 50% AEP.

Following the damage sustained to completed and partially completed infrastructure during the Extreme Storm Event, the Contractor immediately carried out urgent re-establishment of permanent and temporary environmental controls as summarised below:

- Installed additional sediment capture basins where the formation earthworks are partially complete;
- Implemented additional clean water diversion drains;
- Cleaned and extended rock lined drains and temporary rock checks;
- Sediment basin repair and maintenance;
- Installation of temporary rock checks in partially completed areas that were likely to generate run off;
- Installation of cross cut contours on graded track and hardstand sections to reduce water velocity as well as initiate sediment drop out;
- Installation of sediment sumps downgrade of steeper track sections with installation of rock spillways; and
- Strengthening existing rock outlets in topsoil windrows.

Further remedial and preventative measures undertaken and ongoing since the event include:

- Approximately 50,000m^2 of temporary polymer stabilisation applied to higher erosion risk exposed soils where the formation earthworks are partially complete;
- Sediment basins and catch dams cleaned and capacity increased at key locations;
- Gypsum dosing of basins, drains and higher risk areas prior to forecasted weather events;
- Utilisation of water from basins for maintenance activities;

3-18 – NCR Summary

The Applicant shall ensure that all activities are undertaken in accordance with Landcom 2004 and the DPI's guidelines for waterway crossings and fish passage.

Auditor's Recommendation

- *The appointed Certified Professional in Erosion and Sediment Control returns to the project to assess existing processes and resources dedicated to erosion and sediment control and provide recommendations to ensure compliance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004) requirements;*
- *Provide erosion and sediment control training to key management and supervisory personnel;*
- *Provide additional spill response resources (e.g. fully stocked wheelie bin) to vehicle refuelling area; and*
- *Update works to ensure consistency with Managing Urban Stormwater: Soils and Construction (Landcom, 2004).*

Contractor's Response

The Contractor has engaged the services of a highly regarded Soil and Water Specialist (director of Australasian IECA Chapter and highly regarded industry professional) to undertake the scope of services summarised below, providing evidence that the updated soil and water management practices and strategies align with the Independent Audit recommendations to NCR 3-18:

1. Reviewing and updating the Contractor's Soil and Water Management Plan (SWMP);
    - **Status:** *Completed, refer to Attachment 5 for reference to the latest revision;*
2. Reviewing and developing supporting Soil and Water Management criteria and practices:
    - Implementation of a background water monitoring and sampling strategy to obtain a regional baseline water quality dataset relevant to the project site locality;
        - **Status:** *Strategy and procedure developed and implemented. Regional specific data collection commenced July 2019 with data collection ongoing*;
    - Review project typical storm water and soil management specifications and designs, including recommendations for suitable temporary and permanent stabilisation measures;
        - **Status:** *Design review completed, and recommendations provided;*
    - Consultation in the preparation of the Contractor's Progressive Erosion and Sediment Control Plans (PESCP), with ongoing support;
        - **Status:** *Initial reviews and consultation completed, ongoing (a sample current PESCP has been included in Attachment 4);*

3. Conduct an initial detailed inspection of the site to develop a prioritised and risk rated Comprehensive Action Plan (CAP) for Soil and Water management of work areas currently on hold and active work areas (APR);
    - **Status:** *Completed June 2019, refer to CAP included in Attachment 1;*
4. Conduct follow up quarterly CAP site inspections and status updates;
    - **Status:** *Completed September 2019, with latest CAP included in Attachment 1 (status date 31 October 2019). Key activities completed include approximately 70,000m^2 of additional temporary polymer stabilisation, installation of cross drains in partially completed areas, scour protection installation on cross drain inlets / outlets, heavy compost blanket installation at high areas outlined in the CAP, water diversions and extended rock checks / drain lining (refer to Attachment 2 sample photographs).*
5. Implementation of specialised equipment to further assist ongoing soil and water management:
    - Design and implementation of storm water high flow treatment systems in higher erosion risk areas where works are currently on hold;
        - **Status:** *Interim manual flocking process has been implemented (refer Attachment 2, Figure 8). High flow dosing system design has been completed, procurement in progress for implementation in CG1 higher risk locations November 2019.*
    - Acquire a mobile multi-purpose soil stabilisation unit (temporary polymer / hydro-mulch trailer) to facilitate the ongoing application of temporary and permanent soil stabilisation measures;
        - **Status:** *Procured and due for site delivery (including training) November 2019;*
6. Devise and implement appropriate training for Soil and Water management to key project personnel (Management and Supervision);
    - **Status:** *Immediate and interim sediment basin management training has been completed (involving flocking and coagulation processes to manage dewatering of basins, including practical components to reinforce methodology and procedures, refer to Attachment 3). An additional site specific training package is currently being developed by the soil and water specialist, scheduled to be delivered on receipt of the soil stabilisation unit. The training package includes legislative requirements for soil and water management, with a practical module focusing on site specific applications of erosion and sediment control, and site dewatering practices in accordance with the updated SWMP.*

With reference to the Auditor's recommendation to provide additional spill response resources at active refuelling areas, the Contractor clarifies that the referenced fuel cell is located in CG4 on long term stand-down and inactive. However the Contractor has reviewed this recommendation across the broader site and confirms additional Spill Kits and Spill Containment supplies have now been positioned in and around work fronts specifically in the vehicle refuelling areas, as demonstrated in Attachment 2, Figures 9-11.

The Contractor trusts that the information provided above, and the relevant attached documentation will assist in providing sufficient evidence to support the Contractor's ongoing commitment to soil and water management strategies in line with the Independent Audit recommendations associated with NCR 3-17 and 3-18.

Yours sincerely,

Beth McCaffrey

GEZ Contractors Representative

Attachments:
Attachment 1 – Soil and Water Management CAP
Attachment 2 – Sample Progress Photographs
Attachment 3 - Get Flocced Workshop – Certificate of Attendance
Attachment 4 – Sample current PESCP
Attachment 5 – Updated Soil and Water Management Plan

Attachment 1 – Soil and Water Management CAP

CRWF Environmental Inspection - North
(Soil and Water Compliance)

Progress observed 31 Oct 19

Initial Inspection Date: 3rd - 4th June
Attendees: Michael Francombe (EMM), Andrew Galland (AG)

Item	Area	Specific Location	Risk Rating	Issue Description	Mitigation Measures	Comments Sept 19	Status	GEZ Inspection 31 October 2019
1	N01M	Main compound	Medium	Back batter of compound sediment basin actively eroding, soil stockpile exposed	Construct lined inlet to basin, stabilise stockpile with polymer	Temp compound basin maintenance works completed	Actioned	
2	N02H	Culvert SW1H	High	Erosion of dispersive subsoil on inlet side of culvert. Inadequate outlet protection on D/S side	Remove rock from inlet and box out, treat dispersive subsoil with gypsum, remove check dams from the inlet drains + chainage, rock line and reconstruct inlet. Construct stilling pond rock energy dissipater on outlet	SW-1-H maintenance works conducted Gypsum treated Stilling pond installed downgrade of oulet Rock lined drain maintenance completed upgrae of culvert inlet	Actioned	
3	N03H	Culvert SW1J	High	Culvert outlets over unprotected soil with a steep gradient, inlet drains are eroding, no erosion protection around headwalls	Construct rock lined stilling pond energy dissipater on downstream side. Outlet of the stilling pond to be the stable grade of the flow line. Line inlet drain + chainage to the culvert. Rock protection around the pipe headwalls on both sides. Remove the windrow + chainage to maintain sheet flow	Rock lined drain installed downgrade of outlet Stilling pond installed Northern windrow pulled up along northern track batter	Actioned	
4	N04M	Track 1, chainage 1980	Medium	Due to Flow is concentrating unnecessarily on northern side of Track 1.	Create turnout and discharge over naturally stable rocky area. Remove the drain below the turn-out and return to sheet flow. Stabilise exposed soil with polymer		Partially Actioned	Completed other than application of polymer. Polymer scheduled to be applied Nov 19. Final works dependent on completing track and batter construction upon WF restart.
5	N05L	Track 1, chainage 2300 to culvert SW1M	Medium	Windrow on downstream side is concentrating flow. Table drain is actively eroding. There is a exposed soil stockpile on the upstream side that can wash into the drain. Due to hasty demobilisation upon suspension of works this track section and culvert was left un-complete	Remove the windrow on the downstream side, remove soil stockpile, rock line upslope drain to the top of the hill	Topsoil windrow pulled back over batter to promote sheet flow Upslope drain lined with rock	Actioned	
6	NO6L	Track 1, chainage 2310	Low	Windrow of downstream side is concentrating flow causing erosion	Remove windrow and construct back push diversion bank to divert flow to a stable vegetated area	Topsoil windrow pulled back over batter to promote sheet flow Push back diversion installed	Actioned	
7	NO7L	Track 2, pad 8	Low	Drain on south side of pad is concentrating flow.	Construct back-push diversion bank to divert flow to stable vegetated area		Not Commenced	
8	N08L	Track 2, pad 9	Low	Windrow on the western side is concentrating flow, due to suspension of works this track section was left un complete	Removal of temporary suspension rock checks to allow batter rehabilitation	Rock checks removed and windrow pulled back to promote sheet flow	Actioned	
9	N08L	Track 2, pad 9	Low	Windrow on the western side is concentrating flow, due to suspension of works this track section was left uncomplete	Remove windrow		Not Commenced	
10	N09L	Track 3, chainage 00 to 50	Low	Windrow on both sides of the track concentrates flow causing erosion, due to suspension of works this track section was left uncomplete	Removal of temporary suspension rock checks to allow batter rehabilitation		Not Commenced	
11	N09L	Track 3, chainage 00 to 50	Low	Windrow on both sides of the track concentrates flow causing erosion, due to suspension of works this track section was left uncomplete	Remove windrow		Partially Actioned	Where achievable, windrow has been pulled up and other rock checks reset. Drains turned out where achievable Final works dependent on completing track and batter construction upon WF restart.
12	N10L	Track 3, pads A06 and A07	Low	Batters are eroding	Pull vegetation debris onto the batters for erosion protection	Vegetation pulled over fill batters	Actioned	
13	N11L	Track 1, chainage 2950 to 3100	Low	Drain on upslope side of the road is eroding	Rock line the drain		Actioned	Completed
14	N12L	Culvert SW1S to chainage 3300	Low	Check dams were hastily constructed due to suspension of works, resulting in erosion	Either re-do check dams or rock line the drain		Actioned	Completed
15	N12L	Culvert SW1S to chainage 3300	Low	Check dams were hastily constructed due to suspension of works resulting in erosion. Oversized material used to install temporary rock checks	Remove suspension culvert inlet protection oversized rock and reline and reset protection	Inlet protection removed and re set	Actioned	
16	N13L	Track 4, chainage 670	Low	Windrow on west side of the track is concentrating flow, due suspension of works this track section was left un complete	Either remove windrow to return to sheet flow or construct drainage turnouts		Partially Actioned	Drain has been remediated, rock checks reset, polymer applied to southern drain and batter. Culvert outlet protection has been reset. Final works dependent on completing track and batter construction upon WF restart.
17	N14M	Track 4, chainage 300	Medium	Flow down the western side is eroding down the fill batter. A soil windrow is placed across the culvert outlet where it can blow out in flows	divert flow to the west before the fill batter. Construct rock lined drains with side of the track down to the culvert. Remove soil windrow below the culvert		Partially Actioned	work in progress
18	N14M	Track 4, chainage 300	Medium	Flow down the western side is eroding down the fill batter. A soil windrow is placed across the culvert outlet where it can blow out in flows. Due to hasty demobilisation upon suspension of works this track section was left un-complete	Removal of temporary suspension rock checks to allow batter rehabilitation	Rock checks removed and windrow pulled back to promote sheet flow	Actioned	
19	N15M	Track 1, culvert SW1T to chainage 3570	Medium	uncompleted due to suspension, culvert inlet drains are eroding needing reformation and protection	Rock line drains into the culvert either side of the road		Partially Actioned	North West drain windrow has been pulled up, turn outs installed, sealed with polymer. Final works dependent on completing track and batter construction upon WF restart.
20	N16L	Track 1, chainage 3570 to culvert SW1V	Low	Check dams are ineffective controlling erosion in the table drains	Rock line from the top of the hill down to the existing rock lining for culvert SW1V		Partially Actioned	Additional rock lining installed in key areas, polymer coating applied Remaining rock lining to be completed during suspension C&M phase
21	N17L	Track 1, chainage 3800 to 3850.	Low	Due to suspension batters were not top-dressed which led to hasty installation of rock lining which was poorly installed, erosion is occurring along the rock/ soil interface	Reinstall the rock lining so that water flows along the invert	Rock lining re instated to promote drainage in lined invert	Actioned	
22	N18H	Track 1, culvert SW-5A	High	Culvert does not have adequate outlet protection due to hasty installation upon suspension of works. Sediment basin is full of untreated turbid water.	Install rock lined stilling pond energy dissipater on downstream side of culvert. Treat and dewater basin. Consider installation of automatic flow activated dosing system on the basin. Confirm basin capacity is adequate for catchment and sediment load. Spray polymer on exposed soil and old track above track 1.	Stilling pond downgrade of culvert cleaned out of silt and re set rock lining EMM pricing and sizing HES basins (Flow activated dosing) EMM conducting surface water catchment and basin sizing Remaining works to be completed on receipt of hydro trailer	Partially Actioned	Disturbed areas in the associated upgrade catchment (track 5 and track 6) have been fully sealed with polymer stabilisation. Flow activated dosing rescheduled to be operational Nov 19 (due to supplier delivery of key components). Manual floc block method has proven effective and will be extended until flow activated dosing is in place.

CRWF Environmental Inspection - North
(Soil and Water Compliance)

Progress observed 31 Oct 19

Initial Inspection Date: 3rd - 4th June
Attendees: Michael Francombe (EMM), Andrew Galland (AG)

Item	Area	Specific Location	Risk Rating	Issue Description	Mitigation Measures	Comments Sept 19	Status	GEZ Inspection 31 October 2019
23	N19H	Culvert SW-1-X and associated sediment basins	High	Culvert not installed due to incomplete construction resulting from the suspension of works. Basins appear to be undersized. Basin full of turbid water. Check dams hastily installed chainage 4400 to 4600 upon suspension of works	Install culvert with appropriate inlet and outlet protection. Treat and dewater basins. Consider installing flow activated automatic dosing systems. Check basin sizing. Shape and track role stockpiled/windrowed soil and spray with polymer. Spray drains with a heavy application of soil polymer.	Stilling pond cleaned out of silt and re set rock lining EMM pricing and sizing HES basins (Flow activated dosing) EMM conducting surface water catchment and basin sizing Remaining works to be completed on receipt of hydro trailer	Actioned	Disturbed areas in the associated upgrade catchment (track 1, track 5 and track 6) have been fully sealed with polymer stabilisation. Temporary poly pipe culverts have been installed to enable backfilling of exposed trench. Completed
24		Downer substation	Medium	Site appears to require a sediment basin. Exposed soils not stabilised. Sediment controls not maintained. Non associated works contributing to dirty project water concerns	Calculate soil loss to determine need for basin. Broadcast gypsum across the site. Polymer stabilised exposed soils. Clean out silt fence.	Note for CRWF to address with Grid Contractor		
25	N20L	Track 1, chainage 5850.	Low	Erosion along the track, exposed topsoil windrows/ stockpiles Due to incomplete construction resulting from the suspension	Construct cross bank 1% grade from the NE to NW. Polymer stabilise topsoil chainage 5680 to 5820	Cross bank installed Remaining works to be completed on receipt of hydro trailer	Partially Actioned	Cross bank installed however needs to be extended beyond existing eroded track to stable grassed areas. Additional polymer applied to protect exposed soil. Installed rock lined crossing in SD6 dam Remaining work is to extend cross bank through windrow to stable ground
26	N21H	Track 1, chainage 5750	High	Partially finished section of track. Track erosion, long steep slope Due to incomplete construction resulting from the suspension	Construct rock lined drain on the south side of the track down to the sediment basin. Construct a cross bank at chainage 5750 to intercept flow on the north side to the south and divert into the new rock lined drain. Construct a rock crossing from the bottom of the rock lined across the track into the sediment basin. Treat and dewater the sediment basin.	Rock lined drain installed Cross drain installed Rock crossing installed Sediment basin flocced	Actioned	
27	N22H	Track 1, culvert SW-1-Z	High	Culvert not installed due to incomplete construction resulting from the suspension. Track surface requires erosion protection	Install culvert including inlet and outlet protection.	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC	Partially Actioned	Track construction needs to progress to enable culvert install. Interim polymer stablisation measures have been impleted for the C&M suspension period.
28	N22H	Track 1, culvert SW-1-Z	High	Culvert not installed due to incomplete construction resulting from the suspension. Track surface requires erosion protection	Apply trafficable polymer to track surface	Remaining works to be completed on receipt of hydro trailer	Partially Actioned	Non-trafficable polymer applied to stockpiles adjacent to the track and drains Final works dependent on completing track construction upon WF restart.
29	N24H	Track 1, chainage 4950	High	Erosion along track due to unfinished track sections at time of project suspension.	Construct cross bank 1% grade draining to the east at chainage 49500. Extend cross bank to the natural grassed drainage depression. Install culvert SW-1-Y to convey water under the track to Four Winds Quarry 1 Dam 2. Treat basins and dewater. Check basin sizing. Consider install automatic flow activated dosing systems. Treat track surface with trafficable polymer.	Cross bank installed, outlet to natural ground through rock lined drain SW-1-Y installation still pending Remaining works to be completed on receipt of hydro trailer	Actioned	Cross bank has been installed and additional polymer applied. Final works (culvert install) dependent on completing track construction upon WF restart.
30	N25M	Track 1, pad 4	Medium	Unprotected soil stockpiles left due to equipment stand down on suspension of works	Shape stockpiles, track walk and apply polymer to exposed soils.	Remaining temporary stabilisation works to be completed on receipt of hydro trailer due to current observed crust on material and minimal dispersal	Actioned	Polymer stablisation has been completed
31	N26H	Track 6, pad 14	High	Unfinished pad, long slope lengths and exposed dispersive subsoils with hastily constructed sediment controls due to suspension of works.	Construct diversion bank on the southern end from the NE draining to the SE with a lined sediment sump Do the same at the northern end. Shape, track roll and polymer stabilise soil windrows, stockpiles. Gypsum treat dispersive subsoils.	Desilted 2x sediment sumps and reset rock. Remaining works to be completed on receipt of hydro trailer, inconjunction with civil works	Actioned	Diversion banks (x3) installed, sump installed, stabilised outlet installed, polymer stablisation has been completed in all disturbed areas
32	N27H	Track 6, pad 13	High	Unprotected soil stockpiles left due to equipment stand down on suspension of works	Shape stockpiles, track walk and apply polymer to exposed soils.	Remaining temporary stabilisation works to be completed on receipt of hydro trailer due to current observed crust on material and minimal dispersal	Actioned	Stockpiles assessed showing signs of stabilisation - mitigate erosion by added disturbance, by alternatively sealing with polymer stablisation. This has been completed
33	N28M	Batch plant	Medium	Outer batters and v drains are eroding	Install 700gsm coir mesh lined drains on the western and southern sides draining into the sediment basin. Install rock lined drop structures into the sediment basins. Seed and fertilise the drains before placing the coir mesh. Secure with a cold anionic bitumen emulsion. Install a gravel bund to protect the southern batter. Test and ameliorate the subsoil and topsoil on the batter and contour scarify. Seed and apply a soil mulch at 5000kg/ha and secure with cold anionic bitumen emulsion sufficiently thick enough to protect it from sheep damage.		Actioned	Soil testing completed and applicable amelioration determined, heavy compost blanket installed suited to test results.
34	N29L	Track 5, chainage 530	Low	Unprotected soil stockpiles and track due to equipment stand down on suspension of works	Shape stockpiles, track walk and apply polymer to exposed soils.	Remaining temporary stabilisation works to be completed on receipt of hydro trailer due to current observed crust on material and minimal dispersal	Not Commenced	
~~35~~	~~N30M~~	~~Track 5, chainage 300~~	~~Medium~~	~~Drain in northern side eroding, check dams on western side hastily constructed upon suspension of works~~	~~Considering topsoil batter above drain and straw mulch batter as per batch plant. Consider replacing check dams with rock lined drain on western side.~~		~~Not Commenced~~	Double up
36	N30M	Track 5, chainage 300	Medium	Drain in northern side eroding, check dams on western side hastily constructed upon suspension of works	Reconstruct hastily installed rock lined drain consider, polymer stabilise exposed soil during suspension period. Consider replacing check dams with rock lined drain on western side.	Rock lined drain re constructed, oversized rock replaced Remaining works to be completed on receipt of hydro trailer	Actioned	Rock lined drain re constructed, oversized rock replaced Polymer stablisation has been completed
37	General	Drains and rock dissipators	Medium	Eroding/scouring table drains due to incomplete and hasty construction prior to equipment stand down on suspension of works	Repair scour in drains and reset temporary rock checks (Rectify oversize rocks) Spread gypsum and re-profile scoured v drains as required	Maintenance to drain sections ongoing through northern section of the wind farm. Replacement of hastily placed over sized rock in unfinished sections is continuing through tracks 1 (W of pyramul Pastures/Healey boundary) 2, 3, 4 and 5	Partially Actioned	Progressed in priority areas as outlined above Ongoing maintenance will continue during the C&M suspension period
38	General	Culvert inlet and outlet scour protection	Medium	Eroding/scouring culvert inlets and outlets due to incomplete and hasty construction prior to equipment stand down on suspension of works	Repair scour in inlet and outlet beaching reset temporary rock checks (Rectify oversize rocks that was placed prior to the project suspension) Spread gypsum and re-profile scoured vdrains leading into culverts as required	Culvert inlet and outlet protection through northern section of project has commenced -Track 1 SW-1-D to W -Track 4 -Track 5	Partially Actioned	Progressed in priority areas as outlined above Ongoing maintenance will continue during the C&M suspension period

CRWF Environmental Inspection - South
(Soil and Water Compliance)

Progress observed 31 Oct 19

Initial Inspection Date: 3rd - 4th June
Attendees: Michael Francombe (EMM), Andrew Galland (AG)

Item	Area	Specific Location	Risk Rating	Issue Description	Mitigation Measures	Comments	Status	GEZ Inspection 31 October 2019
1	S1L	Track 19, chainage 2600 - 2200	Low	Check dams poorly installed (too high for drain capacity and spaced too far apart to be effective resulting in erosion of the table drain)	Either reinstall check dams with the correct height and correct spacing or rock line the drains.	Commenced, to be completed Existing rock checks cleaned of sediment	Partially Actioned	10 x turnouts installed in eastern and western drains to break slope lengths up and promote water egress from drains. Rock check resetting to be undertaken after high and medium risk tasks completed
2	S2L	Track 19, chainage 1900	Low	The rock energy dissipater installed on the southern side of the road has been poorly installed resulting in concentration of flow and erosion around the sides	Install a shallow rock stilling pond energy dissipater. Ensure it has a level outlet sill installed flush with the natural stable ground surface. If the soil is disturbed downstream of the sill during construction protect with a 700gsm coir mesh anchored with u shaped pins and cold anionic bitumen emulsion	Existing rock checks and energy dissipator cleaned of sediment	Not Commenced	
3	S3M	Track 19, chainage 1800 - 1650	Medium	Table drain on south-eastern side of the track is actively eroding due to the use and poor installation of rock check dams. Flow has not be turned out and concentrates down the road.	Construct trapezoidal turnouts where suitable outlet conditions exist either side of the road. The longitudinal gradients of the turnouts should not be more than 1%. Rock line the drains in between the turnouts.	Commenced, to be completed	Partially Actioned	10 x turnouts installed in eastern and western drains to break slope lengths up and promote water egress from drains. Rock check resetting to be undertaken after high and medium risk tasks completed
4	S4H	Track 19, culvert SW-19-G	High	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet.	Install culvert inlet and outlet protection. The outlet protection to include a stilling pond energy dissipator. The outlet of the energy dissipater most be flush with the stable ground level. Extend rock protection around the headwalls.	Existing inlet and outlet cleaned of sediment	Actioned	Inlets and outlets have been remediated, headwall installed. Additionally, disturbed areas sealed with polymer stabilisation
5	S5H	Track 19, culvert SW-19-E	High	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet. Table drain inlet protection does not extend into the culvert.	Install culvert inlet and outlet protection. The outlet protection to include a stilling pond energy dissipator. The outlet of the energy dissipater most be flush with the stable ground level. Extend rock protection around the headwalls.	Existing inlet and outlet cleaned of sediment	Actioned	Inlets and outlets have been remediated, headwall installed. Additionally, disturbed areas sealed with polymer stabilisation
6	S5H	Track 19, culvert SW-19-E	High	The culvert has overtopped and there is sediment downstream	Clean sediment	Sediment removed	Actioned	
7	S6M	Track 19, culvert SW - 19 -B	Medium	Drainage not turned out from table drain on the southern side. Check dams on the northern side of track 19 have been incorrectly installed from the culvert to the top of the hill and the drain is actively eroding.	Turn out southern table drain at suitable locations using a trapezoidal drain max 1% grade. Remove check dams on northern side and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock. Install culvert inlet and outlet protection.	Commenced, to be completed Existing rock checks cleaned of sediment	Partially Actioned	
8	S6M	Track 19, culvert SW - 19 -B	Medium	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet.	Turn out southern table drain at suitable locations using a trapezoidal drain max 1% grade. Remove check dams on northern side and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock. Install culvert inlet and outlet protection.	Existing inlet and outlet cleaned of sediment	Partially Actioned	
9	S7M	Track 19, chainage 550 to 400	Medium	Table drain on north-eastern side of the track is actively eroding due to the use and poor installation of rock check dams. Flow has not be turned out and concentrates down the road.	Turn out north-eastern table drain at chainage 440 approx. using a trapezoidal drain, max 1% grade. Remove check dams and rock line the drain from below the turnout to culvert SW-19-A	Commenced, to be completed Existing rock checks cleaned of sediment	Partially Actioned	
10	S8H	Track 19, culvert SW - 19 -A	High	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet. Table drain inlet protection does not extend into the culvert. Culvert and table drain	Install culvert inlet and outlet protection. The outlet protection to include a stilling pond energy dissipator. The outlet of the energy dissipater most be flush with the stable ground level. Extend rock protection around the headwalls.	Existing inlet and outlet cleaned of sediment	Actioned	Inlets and outlets have been remediated. Additionally, disturbed areas sealed with polymer stabilisation.
11	S9H	Track 11, culvert 11-A-L	High	Dispersive subsoil is present and is actively eroding on the upstream side. Culvert inlet and outlet protection is not adequately installed resulting in erosion of the inlet and outlet. Culvert installation incomplete due to the suspension of works. Flow has not be turned out on the southern side of the track and concentrates down the road. Flow has overtopped the culvert and the downstream fill batter has eroded.	Turn out southern table drain at a suitable location using a back-push bank max 1% grade. Remove check dams on both sides and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock. Install culvert inlet and outlet protection.	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Existing rock checks cleaned of sediment	Partially Actioned	Inlets and outlets have been remediated. Additionally, disturbed areas sealed with polymer stabilisation. Rock flume installed on outlet side. Order placed for additional headwalls upon DPIE approval of the works. Final headwall install expected Nov 19
12	S10L	Track 11, chainage 11400 to 11300	Low	Check dams are poorly installed (too high for drain capacity and spaced too far apart to be effective resulting in erosion of the table drain)	Re-construct the check dams or line with coir mesh, Geospray or rock	Existing rock checks cleaned of sediment	Partially Actioned	
13	S11M	Track 11, culvert 11-A-J	Low	Table drain on south-eastern side of the track is actively eroding due to the use and poor installation of rock check dams. Soil stockpile is exposed.	Remove check dams on north-western side of the track and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock.	Existing rock checks cleaned of sediment	Partially Actioned	Outlet has been remediated, rock flume installed. Additionally, disturbed areas sealed with polymer stabilisation. Inlet works to be completed
14	S11M	Track 11, culvert 11-A-J	Low	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet.	Install culvert inlet and outlet protection.	Existing rock checks cleaned of sediment	Partially Actioned	Outlet has been remediated, rock flume installed. Additionally, disturbed areas sealed with polymer stabilisation. Inlet works to be completed
15	S12L	Track 11, culvert 11-A-I	Low	Table drain on south-eastern side of the track is actively eroding due to the use and poor installation of rock check dams. Soil stockpile is exposed.	Remove check dams on north-western side of the track and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock.	Existing rock checks cleaned of sediment	Partially Actioned	
16	S12L	Track 11, culvert 11-A-I	Low	Culvert inlet and outlet temporary protection hastily installed due to the suspension resulting in erosion of the inlet and outlet.	Install culvert inlet and outlet protection.	Existing inlet and outlet cleaned of sediment	Partially Actioned	
17	S13L	Track 11, chainage 10750 to 10820	Low	Table drain on both sides of the track is actively eroding due to the use and poor installation of rock check dams.	Remove check dams and line with 700gsm coir mesh. The drain surface must be smooth prior to installing the mesh. Install with anchor trench, u shaped staples at 300mm centres and cold anionic bitumen emulsion. Alternatively use Geospray or rock.	Existing rock checks cleaned of sediment	Partially Actioned	
18	S14L	Track 11, culvert SW-11-A-G	Low	Culvert inlet and outlet protection hastily installed due to the suspension and the inlet and outlet are actively eroding. Table drain inlet protection does not extend into the culvert.	Install culvert inlet and outlet protection. The outlet protection to include a stilling pond energy dissipator. The outlet of the energy dissipater most be flush with the stable ground level. Extend rock protection around the headwalls.	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Built up sediment removed from unfinished culvert inlet and outlet	Partially Actioned	
19	S15L	Track 11, chainage 15900	Low	Drainage not turned out and is concentrating flow. Check dams poorly constructed too far apart.	Use back push diversion banks to divert flow from table drains at regular intervals with max 1% grade. Remove check dams	Existing rock checks cleaned of sediment	Partially Actioned	

CRWF Environmental Inspection - South
(Soil and Water Compliance)

Progress observed 31 Oct 19

Initial Inspection Date: 3rd - 4th June
Attendees: Michael Francombe (EMM), Andrew Galland (AG)

Item	Area	Specific Location	Risk Rating	Issue Description	Mitigation Measures	Comments	Status	GEZ Inspection 31 October 2019
20	S16L	Track 11, culvert SW-11-A-F	Low	Culvert outlet protection hastily installed due to the suspension of works	Install rock lined stilling pond energy dissipater. Outlet of dissipater must have a level sill at stable ground level	Existing rock checks cleaned of sediment	Partially Actioned	
21	S17L	Track 11, chainage 10100 to track 14	Low	Check dams are poorly installed (water runs around the checks dams and they are spaced too far apart to be effective resulting in erosion of the table drain on both sides of the track)	Either reinstall check dams with the correct shape and spacing or line with 700gsm coir mesh, Geospray or rock.	Existing rock checks cleaned of sediment	Partially Actioned	
22	S18L	Track 14, chainage 200 to the top of the track	Low	Check dams are poorly installed (water runs around the checks dams and they are spaced too far apart to be effective resulting in erosion of the table drain on both sides of the track)	Turn drainage out on eastern side using back push banks and remove check dams. Line western drain line with 700gsm coir mesh, Geospray or rock.	Existing rock checks cleaned of sediment	Partially Actioned	
23	S19M	Track 11, culvert SW-11-A-B	Medium	Culvert outlet protection incorrectly installed in hasty demobilisation upon suspension of works resulting in erosion. Drain on eastern side from culvert to track 14 is actively eroding	Install rock lined stilling pond energy dissipater. Outlet of dissipater must have a level sill at stable ground level. Line eastern drain line with 700gsm coir mesh, Geospray or rock. Test and ameliorate soil in the batter, seed and protect with a straw mulch 5000kg/ha protected with a heavy application of anionic bitumen emulsion to protect from sheep damage	Existing rock checks cleaned of sediment	Partially Actioned	
24	S20M	Track 11, chainage 90200 to culvert SW-11-A-B	Medium	Drainage not turned out and is concentrating flow on both sides of the track. Check dams poorly constructed too far apart.	Turn out drainage using trapezoidal drains where cut is required or back-push diversion banks else where.	Existing rock checks cleaned of sediment	Partially Actioned	
25	S21M	Track 11, chainage 8850 to 9000	Medium	The table drain on the western side of the track is actively eroding	Rock line the western side drain from the top of the hill to the outlet of culvert SW-11-A-A		Not Commenced	
26	S22H	Track 11, culvert SW-11-Z	High	Check dams are inappropriate due to the slope gradient and the table drains are actively eroding on both sides of the track.	line both table drains from the top of the hill into the inlet and outlet of culvert SW-11-Z	Existing rock checks cleaned of sediment	Partially Actioned	Resources prioritised to cover later onboarding of cross drainage crew following DPIE approval for cross drain works, works will be completed Nov 19.
27	S22H	Track 11, culvert SW-11-Z	High	Culvert not installed due to incomplete construction resulting from the suspension.	Install culvert including inlet and outlet protection	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Sediment removed on downgrade side Rilling repaired in road batter and lined with temporary rock scour protection	Partially Actioned	Culvert trench excavated, pipes installed and backfilled. Inlet headwall installed. Disturbed areas coated with polymer stabilisation Final works in progress to complete outlet works.
28	S23M	Track 11, culvert SW-11-Y	Medium	Western drain is eroding in the cut down to the culvert outlet due to poor check dam spacing and lack of lining	Line eastern drain line with 700gsm coir mesh, Geospray or rock. Test and ameliorate soil in the batter, seed and protect with a straw mulch 5000kg/ha protected with a heavy application of anionic bitumen emulsion to protect from sheep damage	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Built up sediment removed from unfinished culvert inlet and outlet	Partially Actioned	
29	S23M	Track 11, culvert SW-11-Y	Medium	Culvert not installed due to incomplete construction resulting from the suspension.	Install culvert including inlet and outlet protection	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Sediment removed on downgrade side Rilling repaired in road batter and lined with rock scour protection	Not Commenced	
30	S24L	Track 11, culvert SW-11-X	Low	Drain on the western side is eroding in the cut down to the culvert outlet due to poor check dam spacing and lack of lining	Line western side drain line with 700gsm coir mesh, Geospray or rock from the top of the hill. Test and ameliorate soil in the batter, seed and protect with a straw mulch 5000kg/ha protected with a heavy application of anionic bitumen emulsion to protect from sheep damage	Existing rock checks cleaned of sediment	Partially Actioned	
31	S24L	Track 11, culvert SW-11-X	Low	Culvert not installed due to the suspension of works	Install culvert including inlet and outlet protection	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC	Not Commenced	
32	S25M	Track 11, culvert SW-11-W	Medium	Drain on the western side is eroding in the cut down to the culvert outlet due to poor check dam spacing and lack of lining	Line western side drain line with 700gsm coir mesh, Geospray or rock from the top of the hill. Test and ameliorate soil in the batter, seed and protect with a straw mulch 5000kg/ha protected with a heavy application of anionic bitumen emulsion to protect from sheep damage	Existing rock checks cleaned of sediment	Partially Actioned	
33	S25M	Track 11, culvert SW-11-W	Medium	Culvert not installed due to the suspension of works	Install culvert including inlet and outlet protection	Existing inlet and outlet cleaned of sediment	Not Commenced	
34	S26H	Track 11, culvert SW-11-V	High	Large cut batter and long drain on eastern side is eroding poor stability due to works not being complete at time of work suspension	Rock line the eastern side drain into the culvert outlet. Install a series of rock 'cross vanes/v weirs' to stabilise erosion below the culvert with maximum 300mm drop. Design and construction fact sheet to be provided. Test and ameliorate soil in the batter, seed and protect with a straw mulch 5000kg/ha protected with a heavy application of anionic bitumen emulsion to protect from sheep damage	Existing rock checks cleaned of sediment	Actioned	Soil testing completed and applicable amelioration determined, heavy compost blanket installed suited to test results.
35	S26H	Track 11, culvert SW-11-V	High	Culvert not installed due to incomplete construction resulting from the suspension.	Install culvert including inlet and outlet protection	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Sediment removed on downgrade side Rilling repaired in road batter and lined with rock scour protection	Partially Actioned	Culvert trench excavated ready for pipe install. Disturbed areas coated with polymer stabilisation for mitigation before pipe crew installation works.
36	S27M	Track 11, culvert SW-11-T	Medium	Culvert not installed due to incomplete construction resulting from the suspension. Runoff has overtopped the track. Inlet drain is eroding on the western side	Install culvert with inlet and outlet protection and rock line western side drain to the top of the hill	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Sediment removed on downgrade side Rilling repaired in road batter and lined with rock scour protection	Partially Actioned	
37	S28L	Track 11, culvert SW-11-T to culvert SW-11-R	Low	Table drains are eroding	Line drains with 700gsm coir mesh, Geospray or rock.	Sediment removed from rock checks	Partially Actioned	
38	S29M	Track 11, SW-11-R	Medium	Table drains are eroding	Rock line drain on western drain negative chainage direction to the top of the hill. Line western drain positive chainage with 700gsm coir mesh, Geospray or rock	Sediment removed from rock checks	Partially Actioned	
39	S29M	Track 11, SW-11-R	Medium	Culvert not installed due to incomplete construction resulting from the suspension.	Rock line drain on western drain negative chainage direction to the top of the hill. Line western drain positive chainage with 700gsm coir mesh, Geospray or rock	Sediment removed on downgrade side Rilling repaired in road batter and lined with rock scour protection	Partially Actioned	

CRWF Environmental Inspection - South
(Soil and Water Compliance)

Progress observed 31 Oct 19

Initial Inspection Date: 3rd - 4th June
Attendees: Michael Francombe (EMM), Andrew Galland (AG)

Item	Area	Specific Location	Risk Rating	Issue Description	Mitigation Measures	Comments	Status	GEZ Inspection 31 October 2019
40	S30H	Track 11, culvert SW-11-Q	High	Culvert not installed due to incomplete construction resulting from the suspension causing runoff to overtopped the track.	Install culvert including inlet and outlet protection	Enquiry placed with CRWF May '19 for approval to install cross drainage - TBC Sediment removed on downgrade side Rilling repaired in road batter and lined with rock scour protection	Partially Actioned	Pending pipe crew installation (now onsite and working through high priorities)
41	S31M	Track 11, chainage 5700 to 6100	Medium	Track drainage is not turned out at regular intervals concentrating flow down table drains resulting in erosion of the drains	Install trapezoidal shaped drainage turnouts where possible with a maximum gradient of 1%. Rock line in-between turn outs.		Not Commenced	
42	General re	Drains and rock dissipators	Medium	Eroding/scouring table drains due to hasty installation upon construction the suspension	Repair scour in drains and reset temporary rock checks (Rectify oversize rocks) Spread gypsum and re-profile scoured v drains as required	Sediment removed from rock checks	Partially Actioned	

Attachment 2 – Sample Progress Photographs

Figure 1: Heavy compost blanket applied to batter in CG4 (October 2019)

Figure 2: Temporary polymer stabilisation applied to works on hold (Track 6, CG1 October 2019)

Figure 3: Heavy compost blanket applied to batch plant bench drains (October 2019)

Figure 4: Cross drain outlet reset and temporary polymer stabilisation applied in CG4 (October 2019)

Figure 5: Temporary polymer stabilisation (second coating) applied to Track 1, CG1 higher risk areas where works are currently on hold (September 2019)

Figure 6: Temporary polymer stabilisation (initial coating) applied to Track 1, CG1 higher risk areas where works are currently on hold (March 2019)

Figure 7: Temporary polymer stabilisation (initial coating) applied to Track 5, CG1 higher risk areas where works are currently on hold (March 2019)

Figure 8: Post rain water management (manual flocking in process utilising floc blocks)

Figure 9: 110L Emergency Spill Kit implemented and located at the Vegetation Clearing Crew satellite compound on APR (approx. Ch10,000)

Figure 10: 110L Emergency Spill Kit implemented and located at the Civil Crew satellite compound located at the APR / Castlereagh Hwy intersection

Figure 11: 110L Emergency Spill Kit implemented and located at the main compound

Attachment 3 – Get Flocced Workshop – Certificate of Attendance

IECA
International Erosion Control Association
AUSTRALASIA

Certificate of Attendance

This is to certify that

Andrew Galland

Attended

"Get Flocced - Lake Mac - 2019"

28th Jun 19
Hunter Region, NSW

Total Activities : 1, the PDH credits for this event : 4

IECA
International Erosion Control Association
AUSTRALASIA

Certificate of Attendance

This is to certify that

Robert Mooney

Attended

"Get Flocced - Lake Mac - 2019"

28th Jun 19
Hunter Region, NSW

Total Activities : 1, the PDH credits for this event : 4

Attachment 4 – Sample Current PESCP

CRWF PESCP - Cover sheet

Incident management and reporting

All incidents will be reported and investigated, and corrective actions assigned to prevent future occurrences.

An incident may involve any action or activity deemed to be in non-compliance with the SWMP, PESCP's as well as actual or potential Material or Serious Environmental Harm, or Pollution of Waters pursuant to section 120 of the Protection of the Environment Operations Act 1997.

All incident reporting will be undertaken in accordance with the approved project Construction Environmental Management Plan.

Inspection and Monitoring

Inspections of drainage, erosion and sediment control measures will be undertaken:

- Weekly during normal construction hours;
- Daily during periods of rainfall; and
- Within 24 hours of the cessation of a rainfall event causing runoff to occur on or from the project (>15mm).

Periodic joint inspections will be undertaken by the Project Soil Erosion Specialist with the Senior Environmental Adviser to verify the adequacy of PESCP's and control measures for site conditions.

Upstream, downstream and discharge monitoring will be undertaken in accordance with Table 10.1 of the SWMP

- Monthly
- Post >10mm rain events July-Nov 2019
- Post >20mm rain events Nov 2019 – Project completion

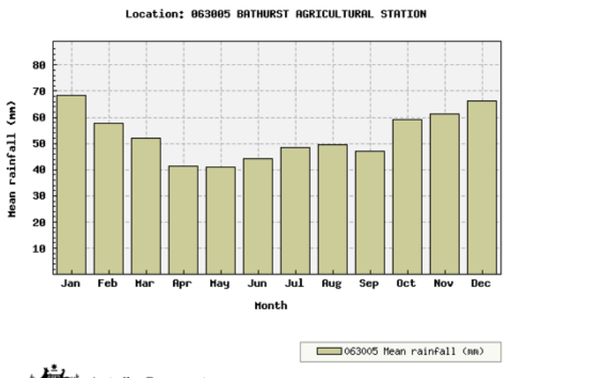
PESCP Key

Key

Project boundary
Contour
1st order drainage line
2nd order drainage line
3rd order drainage line
Clean water
Dirty water

Sensitive receptor (Natural Receiver)
Downstream farm dam
Topsoil bund/diversion
Sediment fence
Temporary stabilisation (e.g. Polymer, mulch)
Project Sediment Basin
Sediment retention trap
Permanent stabilisation (e.g. Rock lining, re-vegetation)
Temporary energy dissipator (Rock check, sand/gravel bag Mulch)
Stockpile (Mulch / Soil)

Monthly mean rainfall



Australian Government Bureau of Meteorology

Created on Tue 18 Jun 2019 12:08 PM AEST

Soil Erodibility

Table 4.2: Soil erodibility of major soil types within the project site

Soil Type	Topsoil Erodibility	Subsoil Erodibility	Susceptibility to Structural Degradation
Red Chromosols	Moderate	Low to moderate	High
Yellow Sodosols	Moderate to high	Moderate to high	High
Inceptic Tenosols	Moderate	-	High
Orthic Tenosols	Moderate to high	Moderate to high	High

Maintenance and remedial actions (Post significant rainfall events)

Drainage control

Lined clean water diversion drains and banks	Repair any damage to the liner (replace, re-anchor), repair any bunding or silt fence isolating the clean water catchment from the dirty water catchment.
Dirty water diversion drains and banks	Repair any erosion, re-line if necessary.
Temporary clean water culverts	Ensure turbid water cannot enter the pipe or outlet channel. Monitor for erosion around the inlet and outlet headwalls and repair as necessary. Check the pipe outlet energy dissipater for erosion and repair and/or modify as necessary.
Temporary bed level crossing	Ensure the bed level crossing protects the underlying soil from erosion. Repair and/or modify accordingly. Ensure the crossing is free from accumulated sediment. Maintain as necessary.
Temporary culvert waterway crossing	Ensure the geofabric sediment retention is installed correct and sediment cannot enter the waterway. Ensure the pipe is not blocked. Ensure accumulated sediment is removed from the rock or rock is replaced as necessary. Inspection after to flow events to ensure the crossing remains stable. Repair and/or modify as necessary.

Erosion control Temporary

Polymer soil stabiliser.	Reapply following rainfall or heavy vehicle traffic.
Cover crops	Test soil if there is poor growth of evidence of nutrients deficiencies. Apply additional soil ameliorants and reseed if soil surface cover is less than 70%.

Erosion control Permanent

Polymer soil stabiliser.	Reapply as necessary.
Gypsum amelioration of dispersive soil	Check for rill, gully and tunnel erosion. Re-test soil and incorporate additional gypsum in accordance with the soil testing results.
Lined channel, drains and batter chutes	Look for water flows under or beside the structure and repair and/or modify as necessary. Look for erosion around and downstream of the energy and repair and/or modify as necessary.
Revegetation – topsoil and straw mulching	Inspect for evidence of rill, gully, tunnel erosion, poor soil surface cover and nutrient deficiencies. Test soil apply ameliorants if necessary. Re-apply straw mulch and bitumen tackifier if necessary.

Sediment control temporary

Silt fences	Ensure silt fences pond water. If not, install additional panels. Check for blow-outs in the anchor trench. Re-anchor as necessary. Replace any ripped or damaged sediment fence.
Check dams	Check for erosion between check dams. Install additional check dams if necessary. Remove accumulated sediment.
Stabilised construction exits	Ensure rock is free from accumulated sediment. Replace as necessary.
Construction Sediment basins	Treat accumulated water with high efficiency coagulants and flocculants. Dewater when water quality is less than 50mg/L. Check basin inlets and outlets for erosion and repair as necessary. Check the basin wall for slumping or tunnel erosion. Repair as necessary. Remove accumulated sediment from the basin when it reaches the sediment storage zone marker.
Coagulants and flocculants	Check coagulant/flocculent levels in rainfall activated dosing units and replenish as necessary.

Construction notes:

- This PESCP should be read in conjunction with the project soil and water management plan
- Controls shown on plan are indicative only
- Dirty water' flow to sediment basins is to be maximised through the use of diversion banks, cut off drains and where installed, the permanent pavement drainage network.' key pits' are to be identified within the pavement drainage network and dirty water is to be directed to them where practicable.
- Sediment basins are to be managed in accordance with the soil and water management plan and dewatering protocol.
- Dewatering is to be undertaken in accordance with the soil and water management plan dewatering protocol
- Dirty water that can't be directed to sediment basin must be diverted to other project sediment control measures.
- Dust is to be minimised with water carts, limiting vehicle speeds and the use of soil polymers
- Disturbed areas are to be progressively revegetated with sterile cover crop or permanent vegetation design. temporary controls are to remain until site is stabilised and approved for removal by Environmental Advisor

TO BE PRINTED IN COLOUR

No	DESCRIPTION	DRN	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	AG	DS	AG	26-07-19

REVISION HISTORY

Crudine Ridge Wind Farm

cwp Asset Management

Zenviron

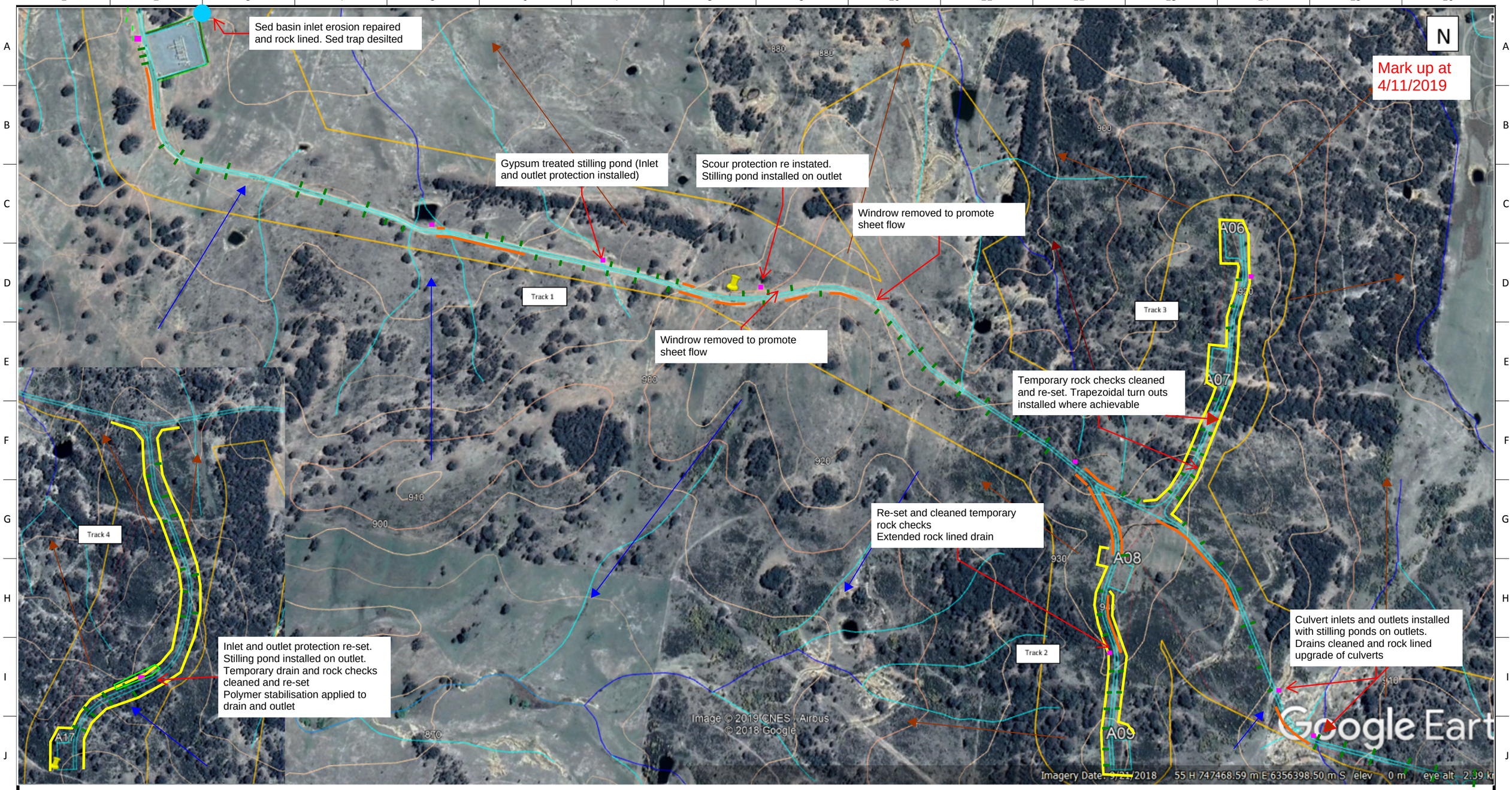
SIZE A3 | SCALE SHOWN

STATUS FOR CONSTRUCTION

PROJECT: CRUDINE RIDGE WIND FARM

TITLE: Progressive Erosion Sediment Control Plan Wind Farm - Sheet 1

DRAWING No. ZX109-DWG-7513 | REV 0



CONTROLLED
5/07/2019 MPett
ZX109-DWG-7511-1(0)_FC
Progressive Erosion Sediment Control Plan - Wind Farm - Sht 1

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No	DESCRIPTION	DRN	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	AG	DS	AG	26-07-19

REVISION HISTORY

Crudine Ridge Wind Farm

CWP Asset Management

Zenviron

SIZE A3 | SCALE SHOWN

STATUS FOR CONSTRUCTION

PROJECT: CRUDINE RIDGE WIND FARM

TITLE: Progressive Erosion Sediment Control Plan Wind Farm - Sheet 1

DRAWING No. ZX109-DWG-7511-1 | REV 0

Mark up at 4/11/2019

Inlet and outlet protection re-set.
Trapezoidal turn out installed
polymer stabilisation applied

Extended rock lined drain in graded sections.
Cleaned and re-set temporary rock checks

Cleaned and re-set temporary sed traps

Installed temporary culvert with rock lined inlet and outlet protection
Polymer stabilisation of track 1 from track 5 intersection to A01

Cleaned and re-set temporary sed traps and rock checks, drain slined with gypsum

Temporary polymer stabilisation
Track 1, track 6, track 6, glenroy quarry

Installation of sediment sumps
upgrade of sediment dam

installed temporary cross cut contours
Installed level outlet
Polymer stabilisation to exposed surfaces

Cleaned and re-set temporary rock chekcs
Replaced rock checks with rock lined drain in graded sections up to batch plant

Cleaned and re-set sed sumps

Installed lined drain

Profiled stockpiled material and sealed with polymer

Installed whoboys and sealed with polymer
Installed sed retention trap and rock lined outlet

Cleaned and re-set temporary sed traps

Extended existing lined drain

Applied temporary polymer stabilisation to disturbed areas of track 5 and 6

Installed heavy compost blanket in batch plant drains
Polymer stabilisation remaining batters

Cleaned and re-set temporary sed trap
Installed rock crossing into temporary sed trap
Re-set rock lined drain and temporary rock checks
Re applied polymer stabilisation

No	DESCRIPTION	DRN	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	AG	DS	AG	26-07-19

REVISION HISTORY

Crudine Ridge Wind Farm

cwp Asset Management

Zenviron

SIZE	A3
SCALE	SHOWN
STATUS	FOR CONSTRUCTION

PROJECT: CRUDINE RIDGE WIND FARM

TITLE: Progressive Erosion Sediment Control Plan
Wind Farm - Sheet 2

DRAWING No.: ZX109-DWG-7511-2

REV: 0

Attachment 5 – Updated Soil and Water Management Plan

Crudine Ridge Wind Farm

Soil and Water Management Plan

Sept 2019

Document number: ZX109-PLN-0031

Revision: 3

Author: Michael Frankcombe

Associate Director – Land, Water and Rehabilitation

Approver: Andrew Galland

Senior Environmental Adviser

Revision date: 09-Sep-19

Contents

1 INTRODUCTION 4
1.1 Context 4
1.2 Scope 4
1.3 Purpose 5
1.4 Objectives 5
1.5 Document Hierarchy 5
1.6 Associated Documents 6
2 STATUTORY REQUIREMENTS AND GUIDELINES 6
2.1 State 6
2.2 SSD-6697 MOD 1 6
2.3 Statement of Commitments 8
3 ROLES AND RESPONSIBILITIES 9
4 SITE CONSTRAINTS 10
4.1 Soils and Soil Landscapes 10
4.1.1 Burrendong 11
4.1.2 Mullion Creek 11
4.1.3 Mookerawa 12
4.1.4 Aaron's Pass 12
4.1.5 Sofala 13
4.1.6 Three Sisters 13
4.1.7 Soil erosion potential 15
4.2 Rainfall 15
4.3 Surface Water 16
4.4 Topography 20
4.5 Land-use and Vegetation 20
5 EROSION HAZARD ASSESSMENT 22
5.1 Erosion Hazard Assessment 22
6 DESIGNS STANDARDS 24
6.1 Drainage 24
6.2 Erosion Control 26
6.3 Sediment Control 28
7 MANAGEMENT STRATEGIES 29
7.1 Integrating the project design with site constraints 29
7.2 Minimise the Extent and Duration of Land Disturbance 29
7.3 Control Water Movement through site 29
7.4 Minimise Soil Erosion 30
7.5 Maximise Sediment Retention on Site 31
7.6 Prompt Stabilisation of Disturbed Areas 32
7.7 Maintain Drainage, Erosion and Sediment Control Measures 33
7.8 Monitor and Adjust Drainage, Erosion and Sediment Control Practices to Achieve Desired Performance Standards. 33
8 ENVIRONMENT SPECIFIC CONTROL MEASURES 34
8.1 Aaron's Pass Road 34
8.2 Access Tracks 35
8.3 Turbine Pads and Compounds 38
8.4 Cable trenches 39
8.5 Batch Plant 39

8.6 Other Significant Disturbance Areas 40
9 TRAINING AND COMPETENCIES 41
10 INSPECTION AND MAINTENANCE 42
10.1 Incidents and Complaints 42
10.2 Inspections, Audits and Monitoring 42
10.3 Maintenance and Remedial Actions 45
10.4 Wet weather and site shutdown procedures 46
11 REFERENCES 47
Appendix A – Turbid Water Treatment and Dewatering Procedure 48
Appendix B – Drainage, Erosion and Sediment Control Measure Fact Sheets 49

1 INTRODUCTION

1.1 Context

The Crudine Ridge Wind Farm is situated 45 kilometres south of Mudgee and 45 kilometres north of Bathurst, New South Wales (NSW) and is located in the Bathurst and Mid-Western Regional Council (MWRC) areas.

The GEZ Consortium has been engaged to undertake the design and construction of the wind farm that consists of erection of the Wind Turbine tower and Balance of Plant (BOP). The BOP and associated infrastructure, including foundations, electrical reticulation, on site tracks and ancillary facilities for the Crudine Ridge Wind Farm Project. The Project scope is summarised below

- Civil Works
  - WTG foundations and earthing and associated structures
  - Access Tracks & Site Entrances
  - Crane and Rigging Hardstands
  - Public Road Intersection Upgrades and Maintenance
  - Permanent and temporary benches
- Electrical Works
  - Met Masts installation
  - 33kV reticulation and terminations
  - Optic fiber cabling
  - Trenching and backfill
  - Overhead 33kV transmission line
  - Install Kiosk Transformers (supplied by others)
  - Installation of LV cabling to WT Converter
- Other
  - Temporary Site Compound
  - Permanent O&M Facilities

Wind Turbine Generators (37 x 3.63MW x 91.5 Hub Height x 137 dia.)

- Design, manufacture and shipment
- Logistics from Port of Newcastle to the project site
- Base and Mid tower installation
- Upper mid top nacelle hub & blade installation
- Mechanical and electrical fit-out
- WTG commissioning

The construction of the project substation and external overhead transmission line does not form part of GEZ's scope of works these works will be completed by other contractors.

GEZ are constructing the Project on behalf of CWP Renewables.

1.2 Scope

The Soil and Water Management Plan (SWMP) has been prepared for the Crudine Ridge Wind Farm (CRWF) as part of the overall Construction Environmental Management Plan (CEMP) in response to planning permit conditions issued by NSW DPE SSD-6697 MOD 1.

This Soil and Water Management Plan has been developed consistent with the principles discussed in the following publications and documents:

- International Erosion Control Association (Australasian Chapter) 2008 *Best Practice Erosion and Sediment Control.*
- Landcom, 2004. *Managing Urban Stormwater, Soils and Construction Volume 1*.
- NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2A Installation of Services*
- NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2C Unsealed Roads*.
- NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2D Main Road Construction*.

1.3 Purpose

The purpose of this Soil and Water Management Plan (SWMP) is to describe how soil and water will be managed and controlled during construction and risks to water in the area of impact of the Project.

1.4 Objectives

The objective of this SWMP are to:

- minimise potential impacts on receiving lands and waters resulting from construction activities;
- conserve and protect project soils resources; and
- ensure compliance with relevant regulatory requirements.

1.5 Document Hierarchy

A two-level approach to erosion and sediment control planning has been applied on this Project by adopting an overarching SWMP (this document) and location specific progressive erosion and sediment control plans (PESCP's).

PESCP's will be prepared for all disturbed areas. PESCP's will also be used in conjunction with site or activity specific Environmental Work Method Statements (EWMS) to provide more detailed site-specific environmental mitigation measures.

This SWMP for the project provides detailed background information, erosion risk assessment, overall drainage, erosion and sediment control approach, design standards and management strategies.
The PESCP's will be reviewed by a Certified Practitioner of Erosion and Sediment Control (CPESC) and will include:

- Contours and drainage paths;
- Clean and dirty water catchments;
- Limits of disturbance;
- Extent of earthworks;
- Location of control measures;
- Sensitive receptors;
- Temporary stabilisation requirements; and
- Specific operating procedures.

PESCP's will be developed by the Senior Environmental Advisor in consultation with construction personnel and the Project Erosion Specialist (CPESC), and modified as required when:

- Site conditions evolve;
- Flow paths change;

Construction activities that affected the characteristics of ground conditions change.

1.6 Associated Documents

The associated and supporting documents to this SWMP include:

- Progressive Erosion and Sediment Control Plan template;
- Vegetation Disturbance Permit;
- EWMS; and
- Dewatering Permit.

2 STATUTORY REQUIREMENTS AND GUIDELINES

2.1 State

Legislation relevant to erosion and sediment control includes:

- *Environmental Planning and Assessment Act 1979*.
- *Environmental Planning and Assessment Regulation 2000*.
- *Protection of the Environment Operations Act 1997*.
- *Protection of the Environment Operations (General) Regulation 2009.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in the CEMP and the GEZ project legal obligations register.

The main guidelines and specifications relevant to this Plan include:

- CWP Renewables 2018 *Roads and Hardstand Specifications Crudine Ridge Wind Farm*.
- International Erosion Control Association (Australasian Chapter) 2008 *Best Practice Erosion and Sediment Control.*
- Landcom, 2004. *Managing Urban Stormwater, Soils and Construction Volume 1*.
- NSW Fisheries Office of Conservation, 2003.*Why do fish need to cross the road – fish passage requirements for waterway crossings.*
- NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2A Installation of Services*
- NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2C Unsealed Roads*.
  NSW Department of Climate Change, 2008. *Managing Urban Stormwater, Soils and Construction Volume 2D Main Road Construction*

2.2 SSD-6697 MOD 1

The conditions of approval from SSD-6697 MOD 1 that relate to soil and water management are listed in Table 2.1 below:

Table 2.1 Soil and water management conditions of approval

Schedule	Condition number	Requirement	Where addressed
3	17	Unless an EPL authorises otherwise, the Applicant shall ensure that the development does not cause any water pollution.	This document

Table 2.1 Soil and water management conditions of approval

Schedule	Condition number	Requirement	Where addressed
		Note: Section 120 of the POEO Act makes it an offence to pollute any waters.	
3	18	The Applicant shall: (a) ensure that all activities are undertaken in accordance with: • Managing Urban Stormwater: Soils and Construction (Landcom, 2004) manual, or its latest version;	Section 2
		• guidelines for waterway crossings and fish passage, including: ○ Policy and Guidelines for Fish Friendly Waterway Crossings (2004), or its latest version; ○ Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004), or its latest version; and ○ Water Guidelines for Controlled Activities on Waterfront Land (2012), or its latest version; and	Section 8.2
		(b) ensure that the storage and handling of all dangerous goods and hazardous materials is undertaken in accordance with AS1940-2004: The storage and handling of flammable and combustible liquids, or its latest version.	Addressed in the CEMP
3	41	The Applicant shall rehabilitate all areas of the site not proposed for future disturbance progressively, that is, as soon as reasonably practicable following construction or decommissioning. All reasonable and feasible measures must be taken to minimise the total area exposed at any time. Interim rehabilitation strategies shall be employed when area prone to dust generation, soil erosion and weed incursion cannot yet be permanently rehabilitated.	Section 7.6 and 8
5	6	The Department must be notified in writing to compliance@planning.nsw.gov.au immediately after the applicant becomes aware of the incident. The notification must identify the development, including the	Section 10.1

Table 2.1 Soil and water management conditions of approval

Schedule	Condition number	Requirement	Where addressed
		development application number and the name of the development and set out the location and nature of the incident.	

Landcom (2004) recommends that SWMP's be prepared for development works greater than 2500m^2. As the area of disturbance of the project is greater than 2500m^2 this SWMP has been prepared to address this recommendation.

2.3 Statement of Commitments

The Statement of Commitments that relate to soil and water management are listed in Table 2.2 below.

Table 2.2 Soil and water management statement of commitments

Statement of Commitment number	Commitment	Where addressed
004	Reinstate disturbed soil areas after completion of construction and decommissioning which would include re-contouring and re-seeding with appropriate plant species and local materials where feasible.	Section 7.6 and 8
005	Enforce safeguards to control and minimise dust emissions during construction and decommissioning	Section 8
059	All required watercourse crossings will be designed to protect and enhance water flow, water quality, stream ecology and existing riparian vegetation.	Section 6
060	A CEMP sub-plan will be developed to ensure soil disturbance and erosion from surface run-off is minimised and in order to minimise disturbance to water resources and riparian zones in the area. This sub-plan will include:	This document
	Monitoring of low and high flow conditions is to be regularly undertaken prior to the commencement of works to determine baseline water quality parameters. Surface water monitoring locations should include: Crudine River (downstream of the confluence with Sugarloaf Creek); Cowflat Creek (upstream of the confluence with Stinking Water Creek); Downstream of the confluence with Tunnabidgee Creek and Long Gully; and Salters Creek (upstream of confluence with Tunnabidgee Creek	Section 10.2
	All ancillary drainage infrastructure, e.g., sediment and litter traps are to, where practicable, be located outside the riparian corridor. Runoff is to be of an appropriate water quality and quantity before discharge into a riparian corridor or watercourse;	Section 6.3

Table 2.2 Soil and water management statement of commitments

Statement of Commitment number	Commitment	Where addressed
	All stockpiles are to be located away from drainage lines and natural watercourses, road surfaces and trees and, where necessary, are to be appropriately protected to contain sediment and runoff (eg sediment fencing);	Section 8
	Regular inspection, maintenance and cleaning of water quality and sedimentation control devices; and	Section 10.2
071	Soil and water management measures consistent with Landcom (2004) to be employed during construction to minimise soil erosion and the discharge of sediment and other pollutants to land and / or water.	This document
072	Develop a CEMP sub-plan to provide specific measures for soil including:	This document
	All disturbed soil surfaces to be stabilised as soon as practicable after works have ceased in the area;	Section 2.6
	All stockpiles to be covered where practicable to minimise the loss of material during high wind and rain events. Where practicable, stockpiles to be placed in areas sheltered from the wind or seeded with a cover crop	Section 2.6
	Planning for erosion and sediment control concurrently with engineering design, prior to any works commencing;	This is beyond the scope of this SWMP as engineering design has been completed prior to this SWMP being prepared
	Progressive rehabilitation of disturbed land as soon as practicable;	Section 7.6
	Jute matting or similar to be used to stabilise the soil and minimise weed invasion;	Not appropriate for this environment
	Implementation of management measures to minimise sediment and runoff from entering watercourses;	Section 6.3

3 ROLES AND RESPONSIBILITIES

Table 3.1 outlines the responsibilities of personnel with respect to drainage, erosion and sediment control.

Table 3.1 – Roles and Responsibilities

Role	Responsibility
Project Manager (EPC Project Manager)	Overall responsibility for drainage, erosion and sediment control implementation; Ensure the provision of resources for implementation of drainage, erosion and sediment control; Ensure the prompt implementation of measures to mitigate erosion and sediment control impacts.
EPC Deputy Project Manager	Assist the EPC Project manager at a site level with the provision of resources for implementation of drainage, erosion and sediment control; Ensure the prompt implementation of measures to mitigate erosion and sediment control impacts.

Table 3.1 – Roles and Responsibilities

Role	Responsibility
Site Manager & Construction Managers	Ensuring the requirements of this management plan are understood and implemented Making resources available to enable execution of environmental activities Monitoring subcontractor adherence to environmental requirements Review effectiveness of subcontractor activities with particular emphasis on Soil and water management Implementing wet weather preparations and protocols
Project Engineers	Responsible for drainage, erosion and sediment control implementation for their given area/project; Assist with preparation and approve Vegetation Disturbance Permit (VDP) prior to undertaking any works; Request EWMS development from Senior Environmental Advisor prior to undertaking works; Design drainage, erosion and sediment control measures as required; Inspection control measure installation and maintenance; Inspect and management offsite impacts; and Report non-conformances and incidents to the Senior Environmental Adviser and Site Manager.
Site Supervisor/Foreman	Monitor predicted and actual rainfall; Seek a Dewatering Permit (DP) prior to discharging any water; Seek a VDP prior to clearing vegetation; Seek EWMS prior to commencing works Ensure wet weather and/or weekend protection measures are implemented when required; Inspect and maintain control measures; and Maintain records of inspection and maintenance.
Senior Environmental Adviser (EPC Environmental Officer)	Prepare and review Progressive ESCP's; Conduct monitoring; Inspect control measures; Assist with VDP preparation; Generate and approve EWMS's; Issue DP's; Undertake audits; Report and investigate non-conformances and incidents; and Notify the CWP Renewables of any incidents or *Environmental Harm* being caused
Soil Erosion Specialist (CPESC)	Asist with the preparation and review of Progressive ESCP's; Conduct site inspections and audits as required; Assist in the preparation of EWMS's as required; Provide drainage, erosion and sediment control advice; and Prepare and present training.
All personnel	Report any damage to control measures and any potential or actual *Environmental Harm* to their Supervisor or the Environmental Adviser/Officer.

4 SITE CONSTRAINTS

4.1 Soils and Soil Landscapes

Soil landscapes in the region have been mapped (Figure 1) and described by Kovac et al (1989) in the Bathurst 1:250 000 map sheet and Murphy and Lawrie (1998) in the Dubbo 1:250 000 map sheet. The main soil landscapes in the project area are the Burrendong, Mullion Creek, Mookerawa and Aarons Pass units (Table 4.1), with the bulk of the infrastructure occurring on the Mookerawa and Mullion Creek units.

Table 4.1: Soil landscapes with the project area

Soil Landscape	Soil Types (Australian Soil Classification)	Project Component
Burrendong (bd)	Red Chromosols (mid-slope)	Road and hardstand areas
	Yellow Sodosols (drainage lines)	Turbines
	Inceptic Tenosols (higher slopes)	Overhead line

		Aarons Pass Road
Mullion Creek (mu)	Red Chromosols (higher crests) Yellow Sodosols (lower slopes and drainage lines)	Turbines Site compound Road and hardstand areas Collector Substation Overhead line Aarons Pass Road
Mookerawa (mk)	Red Chromosols (crests and upper slopes) Yellow Sodosols (lower slopes and drainage lines)	Turbines Site compound Rock crushing batching plant Road and hardstand areas Collector Substation Overhead line Aarons Pass Road
Aaron's Pass (ap)	Orthic Tenosols (steep slopes) Yellow Sodosols (lower slopes)	Switching Substation Overhead line Aarons Pass Road
Sofala (so)	Mainly Red Podzolic and Red Podzolic Soil/Krasnozem intergrades Brown Soils on mid-slopes. Yellow Podzolic/Solodic Soils on lower slopes	Aarons Pass Road
Three Sisters (ts)	Shallow leached loams on slopes Shallow sands on crests and upperslopes	Aarons Pass Road

4.1.1 Burrendong

The Burrendong unit is typified by shallow soils on rolling to steep hills, with Rudosols (skeletal soils) occurring near rock outcrops on the higher slopes. Shallow Red Chromosols are found on the mid-slopes and Yellow Sodosols on the mid-slopes and drainage lines. Yellow Kandosols (massive earths) are common on the lower slopes of this unit.

Soil profiles in this unit are duplex with sandy loam topsoil overlying clay loam or medium clay. The subsoil of the Chromosols is typically heavier clays and imperfectly drained, while the Sodosols on the mid-slopes tend to have a bleached A2 horizon and a poorly drained profile. The profiles are shallow and weathered parent material can occur at as shallow as 500 mm in the skeletal soils higher on the slopes.

These soils have low shrink swell potential. While generally stable with sufficient ground cover, clearing can lead to sheet erosion. These soils have a moderate to high mass movement hazard and clearing of the skeletal soils on the upper slopes and crests can cause slumping. The hard-setting topsoils provide a high runoff potential and soil disturbance (such as cultivation) can cause structural breakdown to a massive condition (i.e. the soil layer becomes a solid mass devoid of aggregates). Localised sodic upper subsoils (the top 200 mm of the B horizon) also occur.

4.1.2 Mullion Creek

The Mullion Creek soil landscape forms on the undulating low hills between 560 – 980 m above sea level. Red Chromosols are found on the crests and upper slopes with Yellow Sodosols occurring on mid to lower slopes and in drainage lines.

Similar to those in the Burrendong unit, typical soil profiles are duplex and shallow (<2 m) comprising of a hard-setting topsoil (loam/sandy loam) overlying clay loam/clay. These soils exhibit shrink swell characteristics and are also highly susceptible to structural decline/degradation as a result of disturbance (such as cultivation, raindrop impact, saturation, and compaction) which can lead to increased runoff and erosion and impede plant growth. These soils also have a high runoff potential due to the hard-setting topsoils and relatively impermeable clayey subsoils.

Widespread dispersible sodic sub-surfaces on the lower slopes mean that these soils are susceptible to severe gully erosion. The soils in the lower slopes (Yellow Sodosols) are also subject to tunnelling. Moderate sheet and gully erosion are common when surface cover is low, with tunnel erosion occurring in areas of severe gully erosion. High soil salinity is common across the Mullion Creek landscape, particularly on the lower slopes and foot slopes and along drainage lines and in depressions.

4.1.3 Mookerawa

The Mookerawa landscape is characterised by Red Chromosols and Yellow Sodosols formed on rolling low hills to rolling hills. Shallow siliceous sands and loams (Rudosols) are common on hills with rock outcrops. Shallow Red Chromosols are found on the crests and upper slopes while Yellow Sodosols are common on the lower slopes and in drainage depressions.

These soils are duplex with a sandy loam/sandy clay loam topsoil overlying clay loam or medium clay. The subsoil of the Chromosols are typically heavier clays (light medium to heavy) and imperfectly drained, while the Sodosols on the midslopes tend to have a bleached and dispersible A2 horizon and a poorly drained profile (clay loam to light clay subsoil). The clayey subsoils mean these soils have a low to moderate shrink swell potential. Profiles are typically shallow (<2 m) although can be less than 1 m on crests and upper slopes.

High soil salinity levels are common across the Mookerawa landscape, particularly in drainage lines, depressions and the lower slopes. Sodic subsurfaces are common and the soils are susceptible to slumping, gullying and tunnel erosion. These soils are also highly susceptible to structural degradation as a result of disturbance and have hard setting topsoils. While generally stable with sufficient ground cover, sheet erosion can occur if cleared of native vegetation.

4.1.4 Aaron's Pass

The north-eastern extent of the project site falls within the Aaron's Pass soil landscape unit characterised by rolling low hills up to 100 m elevation. Orthic Tenosols (earthy sands and siliceous sands) are common on the upper and mid-slopes and Yellow Sodosols and bleached sands (Sodosols) are common on lower slopes. Rock outcrops are also common.

Massive loamy sandy topsoils are underlain by sandy loam/clayey sands. A bleached A2 horizon is found on the lower slopes above a clayey subsoil causing poor drainage and seasonal water logging. *In situ* weathered bedrock can be found as shallow as 600 mm on the upper slopes.

Sodic upper subsoils (the top 200 mm of the B horizon) are common and the erosion hazard for this landscape is moderate which increases with the clearance of groundcover and soil cultivation. The weakly structured soils are also susceptible to structural degradation. The sandier soils encountered on the higher slopes have a low wet bearing strength and low shrink-swell potential, which increases downslope as the soils become more clayey.

4.1.5 Sofala

An approximately 800m section of Aarons Pass Road upgrade falls within the Sofala soil landscape approximately 7km west of the intersection with the Castlereagh Highway.

The Sofala soil land unit consists mainly of Red Podzolic Soil and Red Podzolic Soil/Krasnozem intergrades on undulating to rolling low hills up to 120m. Brown Soils are found on the mid-slopes and Yellow Podzolic/Solodic Soils are found on the lower slopes with some shallow loams on crests.

The soils are slightly to moderately erodible except where Sodosols are present, where the erodibility is high due to dispersion. Maintaining soil cover is key to minimising erosion of these soils.

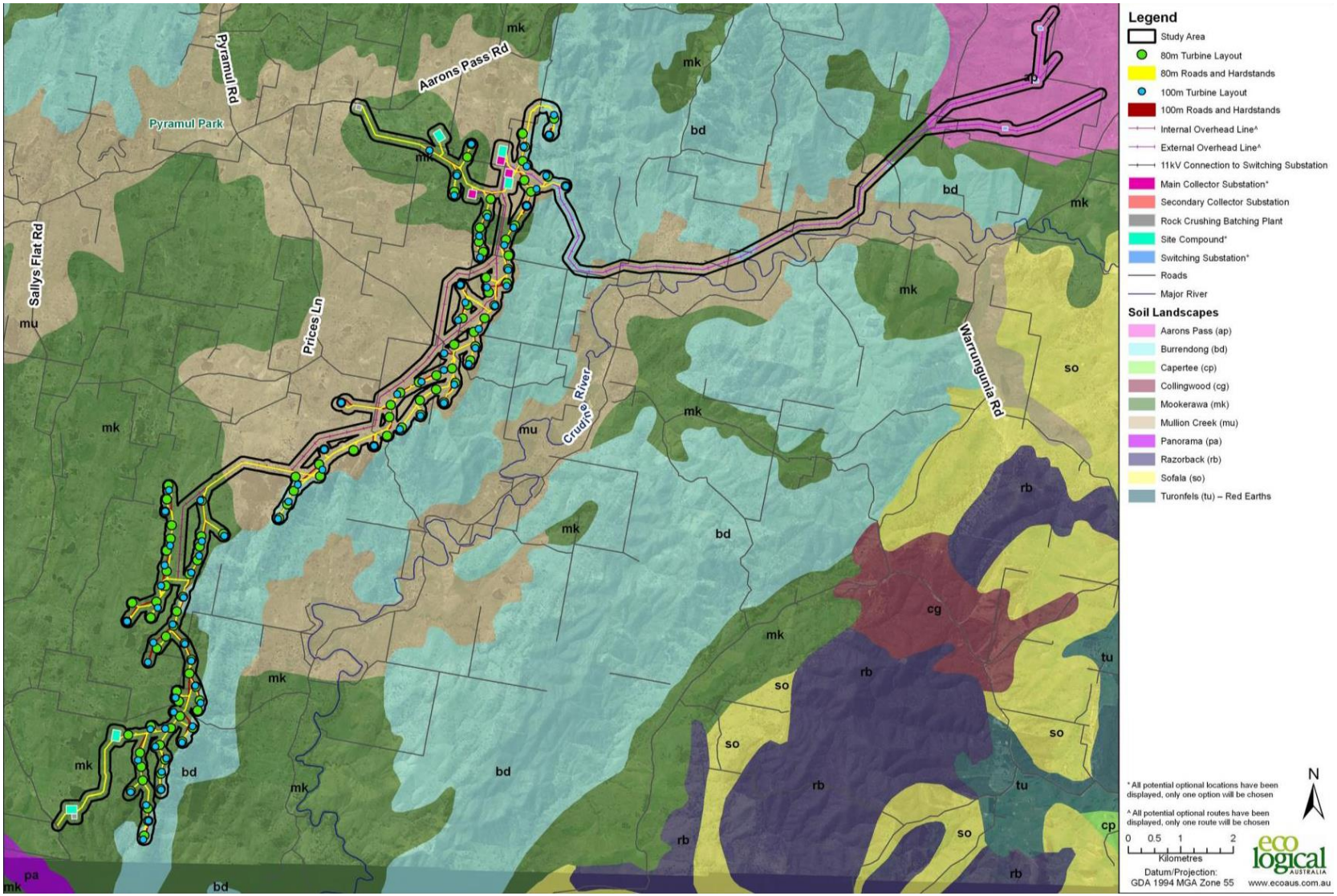
4.1.6 Three Sisters

An approximately 315m section of Aarons Pass Road from approximately 4.4km west to 4.7km west of the intersection with the Castlereagh Highway on the north-western side, falls within the Three Sisters soil landscape.

The Three Sisters soil landscape consists of shallow leached loams on slopes with shallow sands on crests and upper slopes. The landscape is dominated by steep, rocky slopes with local relief from 150 to 350m. Boulder debris are common from free slopes.

The soils have a high to very high erosion hazard due to the steep slopes and non-cohesive soil properties

Figure 4.1 – Project soil landscapes (from Figure 6 Eco Logical (2011)



4.1.7 Soil erosion potential

Soil Erodibility (K-Factor) is a measure of the susceptibility of individual soil particles to detach and be transported by rainfall and runoff (Landcom 2004). The K-Factor generally ranges from 0.005 (very low) to 0.075 (very high) (Landcom 2004). While soil texture is the primary driver of the K-factor, soil structure, organic matter and dispersion also influence the value.

Due to the lack of published and current mapping of soil landscape information for the study site, and the presence of dispersive soils, a K-Factor of 0.06 has been adopted as recommended by Loch et al (1998).

Characteristics of the dominant soil types found across the site are summarised below (Table 4.2).

Table 4.2: Soil erodibility of major soil types within the project site

Soil Type	Topsoil Erodibility	Subsoil Erodibility	Susceptibility to Structural Degradation
Red Chromosols	Moderate	Low to moderate	High
Yellow Sodosols	Moderate to high	Moderate to high	High
Inceptic Tenosols	Moderate	-	High
Orthic Tenosols	Moderate to high	Moderate to high	High
Brown Earths	Low to moderate	Low to moderate	High
Red Podzols	Low to moderate	Low to moderate	High
Yellow Podzols	Moderate to high	Moderate to high	High

4.2 Rainfall

Rainfall Erosivity (R-Factor) is a measure of the ability of rainfall to cause erosion and is calculated based on total energy and maximum 30-minute storm intensity (Landcom 2004).

The Rainfall Erosivity is commonly determined from *Rainfall Erosivity Values for NSW (1:5,000,000)* in *Appendix B* of the Landcom (2004). However, it can be more accurately calculated using the formula:

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

Where S is the 2 year ARI, 6 hour rainfall event in mm (Rosewell and Turner, 1992)

S = 7.3 mm/h (Icubed consulting (2018))

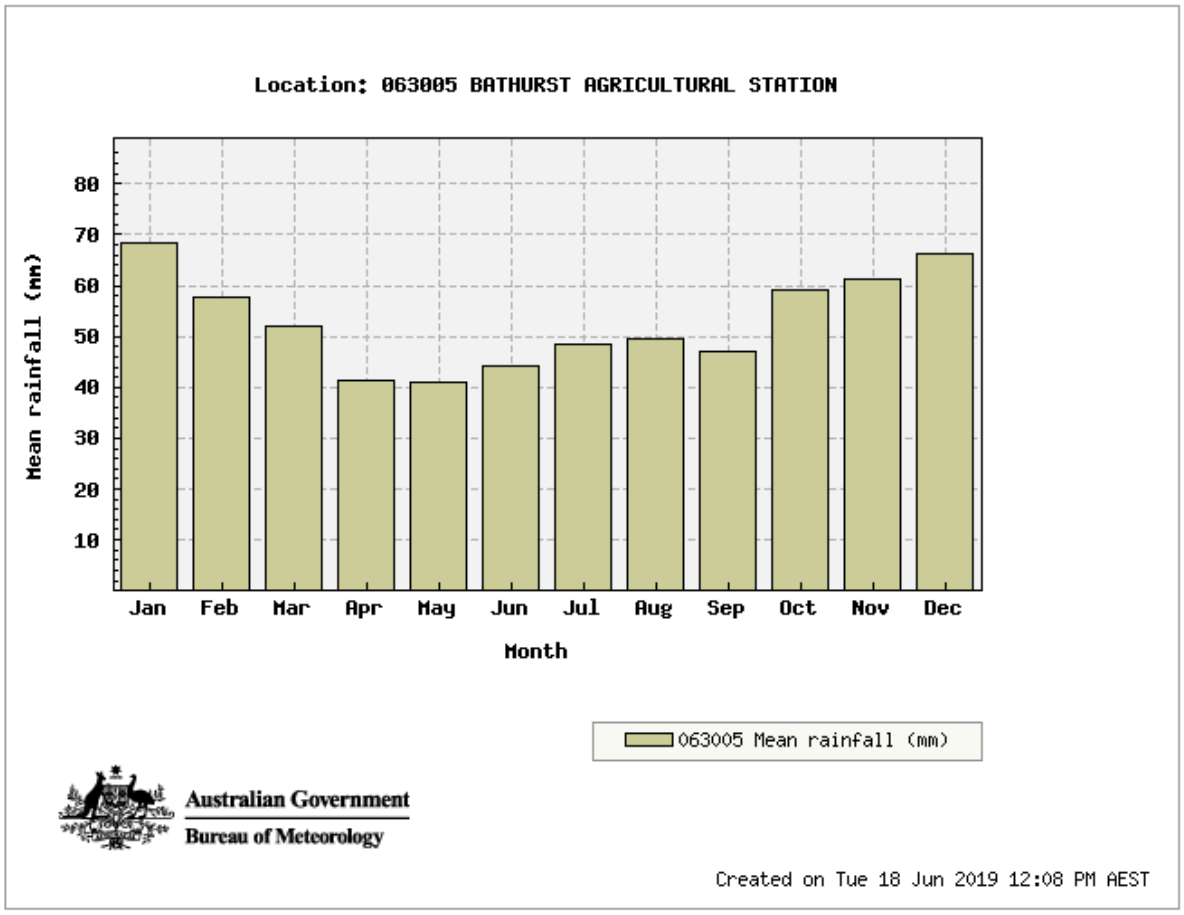
The R factor is 1336.

The R-Factor varies between 600 in parts of western NSW to over 10,000 on the far north coast of NSW. Given this range, the Rainfall Erosivity for the site can be considered low.

Rainfall information was obtained from the Bureau of Meteorology Bathurst Agricultural Station AWS (Site number: 063005). The area experiences slight dominant rainfall, with January being the wettest month with an average of 68.1 mm which generally comes from summer storms. The annual average rainfall is 636.3mm (BoM 2011).

Monthly rainfall averages are shown in Figure 4.2.

Figure 4.2 – Project area monthly mean rainfall data (BoM 2019)



4.3 Surface Water

The project lies within the upland reaches of the Macquarie-Bogan catchment and is part of the Central West CMA (Figure 4.3). The majority of the Project area drains to the west and north-west. A number of small ephemeral creeks and gullies drain the ridges of the Project site into 3rd order streams including Stinking Water Creek, Tunnabidgee Creek, Long Gully Creek and Salters Creek (Figure 4.4). These streams then flow into Pyramul Creek, a major southern tributary of the Macquarie River.

Drainage from the north-eastern arm of the Project (development which consists primarily of transmission lines and a switching station option) is to the east/south-east into the Crudine River via several ephemeral creeks and gullies. The Crudine River is a tributary of the Turon River, which then flows into the Macquarie River.

Burrendong Dam is downstream of the confluence of both the Turon River and Pyramul Creek with the Macquarie River. Burrendong Dam is a water source for irrigation and stock and household needs in the Macquarie Valley and environmental flows to the Macquarie Marshes (NSW State Water 2009).

The Department of Planning, Industry and Environment – Water (DPIE – Water) monitoring station on the Crudine River upstream of the Turon River Junction (number 421041) was operational between 1963 and 1981; no water quality data is available from this station. Similarly, the DPIE – Water monitoring station at Pyramul Creek up stream of Hill End Road (number 421100; 1975-1986) did not record water quality data.

Other DPIE – Water monitoring stations are situated further down the catchment; however, water quality would be influenced by a large catchment area and would not accurately reflect system inputs close to the proposal. Therefore, long term water quality data is not currently available for the study area.

Figure 4.3 – Project catchment boundaries (from Figure 7 Ecological (2011)

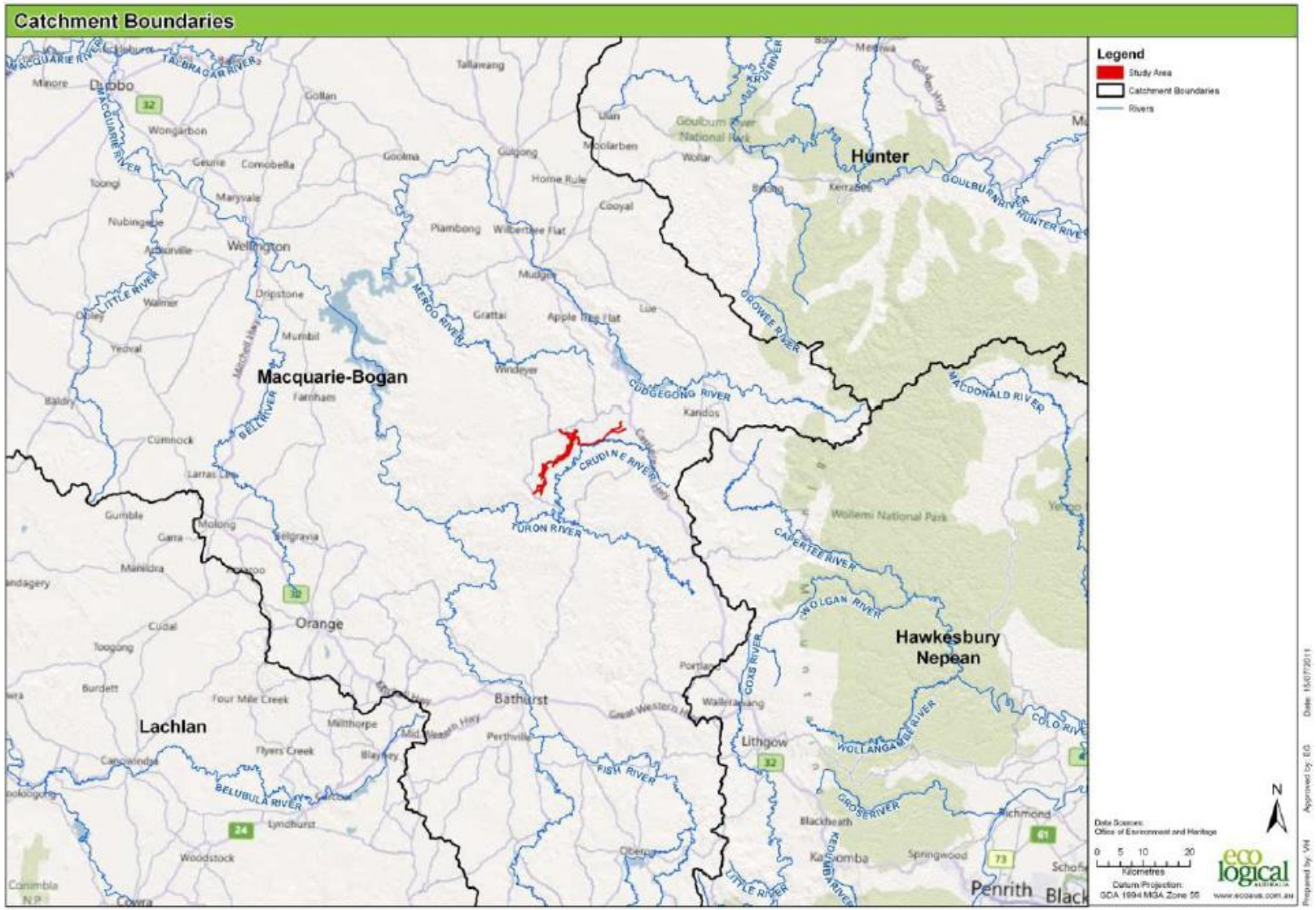


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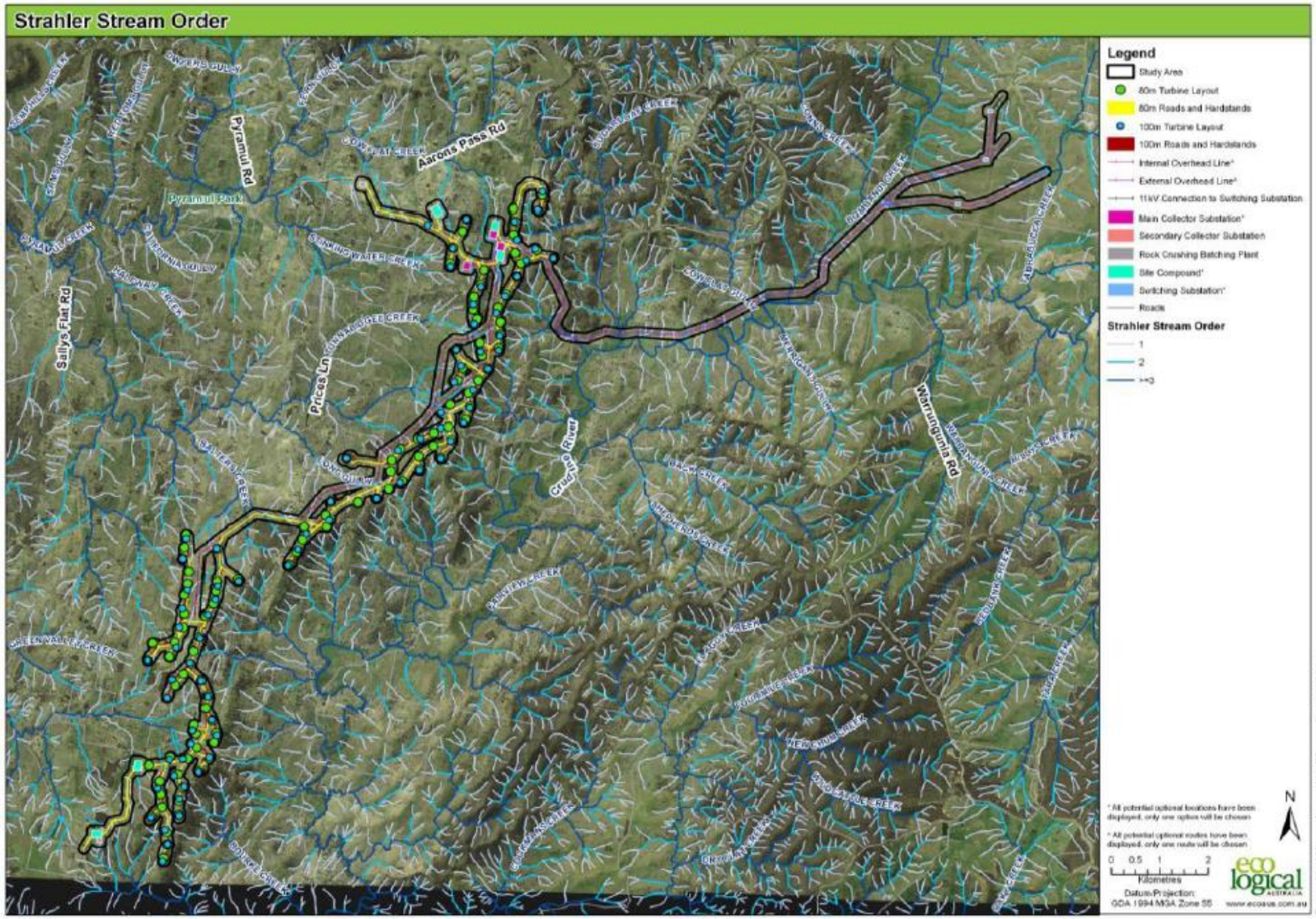
Figure 4.4 – Project catchment boundaries (from Figure 8 Ecological (2011)



Surface water quality monitoring undertaken by the projects demonstrates elevated upstream and downstream turbidity and total suspended solids (TSS) due to active creek and riverbed and bank erosion and run-off from unsealed roads and surrounding highly degraded grazing lands with active erosion. As such, a target discharge water quality TSS of 50mg/L is considered unrealistic. GEZ will consult with CWP Renewables and the EPA to determine appropriate surface water quality discharge criteria.

4.4 Topography

The Crudine Ridge Wind Farm proposal is located 45 km south of Mudgee and 45km north of Bathurst, New South Wales. The turbines are proposed to extend along Crudine Ridge for a distance of 16 km, south west from Aarons Pass Road (Wind Prospect CWP 2011).

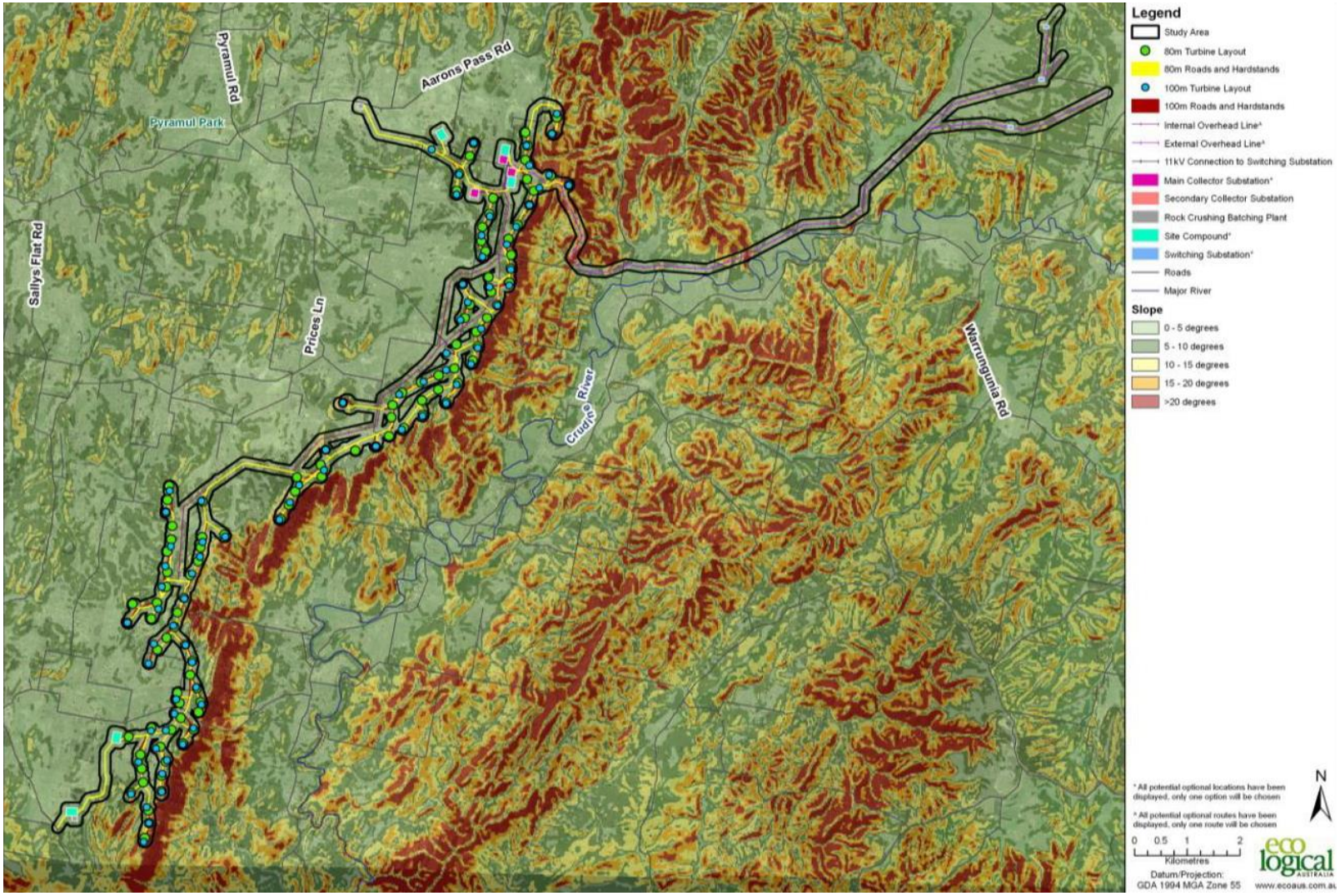
Crudine Ridge extends from near Toolamanang in the north down to Cunningham. Pleasant Ridge is to the east of Crudine Ridge with Crudine River running between the two. The topography surrounding these two ridges is gently undulating. The individual turbines will be located on the western slopes of Crudine Ridge. The ridgeline is of moderate to high elevation (890 m to 1000 m Australian Height Datum (AHD)). The western slopes of the Project site are generally less than 10 degrees although some parts of the footprint fall on steeper slopes (more than 15 degrees). The eastern slopes of Crudine Ridge are steeper with slopes in excess of 20 degrees (Figure 4.5).

4.5 Land-use and Vegetation

The area within and surrounding the CRWF site is predominantly used for grazing, with much of the western slopes of Crudine Ridge being cleared of woody vegetation. Due to past and present land use practices the landscape has experienced various levels of degradation which is evident with the presence of eroded gullies and clearing of trees.

Zenviron

Figure 4.5 – Project area topography (from Figure 3 Ecobiological (2011)



At present there are five wind farms existing or proposed within a 100 km radius of the proposal site. Blayney and Hampton wind farms are operational and are approximately 65 and 80 km to the south-west respectively. Proposals for other wind farms in the area include Uungula (65 km to the north-west) and Flyers Creek and Bodangora (approximately 65 and 80 km to the south-west respectively). DGRs have been issued for these projects for the environmental assessments.

5 EROSION HAZARD ASSESSMENT

5.1 Erosion Hazard Assessment

Erosion potential of a soil is determined by its physical and chemical properties. K factors for site soils were not determined during the Environmental Assessment, however as dispersive soils are present within the subsoils of all soil landscapes with the project area, Loch et al (1998) recommends a minimum value of 0.06 be adopted.

Table 5.1, adapted from Table 4 from *Crudine Ridge Wind Farm Water and Soil Assessment* Ecological Australia 2011 (Ecological 2011), provides an assessment of erosion potential for each of the soil types within the project area.

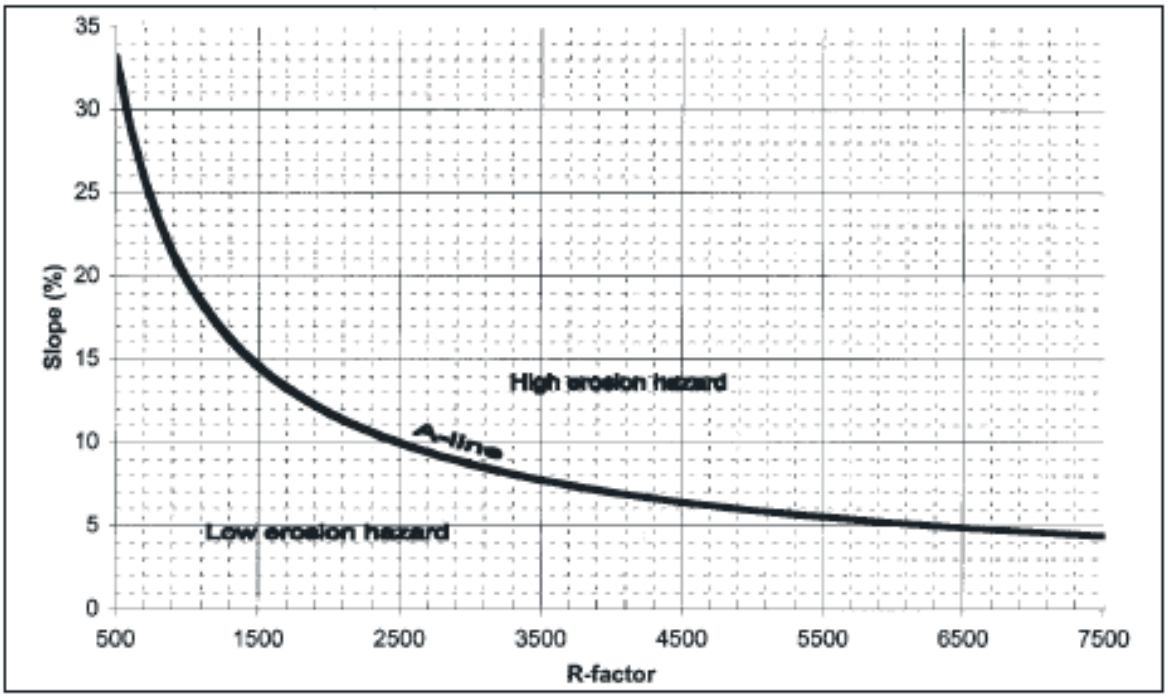
Table 5.1 – Soil erosion potential

Property	**Soil Type**		
	Red Chromosols	**Yellow Sodosols**	**Tenosols**
Texture	Sandy clay to heavier clay	Dandy clay, clay loam to heavier clay	Sand to light sandy clay
Erosion hazard	Moderate to very high	Moderate to high	Moderate to high
Sodicity	Sodic subsoils	Sodic subsoils	No

There is a high tunnel and gully erosion risk when dispersive subsoils are required to be disturbed for construction purposes.

Erosion hazard for the project area has been determined using the procedure described in section 4.4.1 of Landcom 2004. The first step in the hazard assessment is a simple process using Figure 4.6 from Landcom 2004 (reproduced as Figure 5.1) that considers slope of the land and the Rainfall Erosivity or R factor.

Figure 5.1 Assessment of potential erosion hazard (Figure 4.6 Landcom 2004)



The rainfall erosivity factor (R factor) for the project is 1,336.

Applying the site R factor of 1,336 and upper slope gradients to project soil landscapes and construction areas results in an erosion hazard ranging from low to high. This is presented in Table 5.2.

Table 5.2 Project Erosion Hazard

Soil Landscape	Soil Types (Australian Soil Classification)	Project Component	Slope Range	Erosion hazard
Burrendong (bd)	Red Chromosols (mid-slope) Yellow Sodosols (drainage lines) Inceptic Tenosols (higher slopes)	Road and hardstand areas Turbines Overhead line Aarons Pass Road	20 to 50%	High
Mullion Creek (mu)	Red Chromosols (higher crests) Yellow Sodosols (lower slopes and drainage lines)	Turbines Site compound Road and hardstand areas Collector Substation Overhead line Aarons Pass Road	3 to6%, up to 12%	Low
Mookerawa (mk)	Red Chromosols (crests and upper slopes) Yellow Sodosols (lower slopes and drainage lines)	Turbines Site compound Rock crushing batching plant Road and hardstand areas Collector Substation Overhead line Aarons Pass Road	8 to30%, generally less than 15%	Low to high
Aaron's Pass (ap)	Orthic Tenosols (steep slopes)	Switching Substation Overhead line Aarons Pass Road	4 to 8%, sometimes up to 20%	Generally low

Table 5.2 Project Erosion Hazard

Soil Landscape	Soil Types (Australian Soil Classification)	Project Component	Slope Range	Erosion hazard
	Yellow Sodosols (lower slopes)			
Sofala (so)	Mainly Red Podzolic and Red Podzolic Soil/Krasnozem intergrades Brown Soils on mid-slopes. Yellow Podzolic/Solodic Soils on lower slopes	Aarons Pass Road	8 to 15%	Moderate to high
Three Sisters (ts)	Shallow leached loams on slopes Shallow sands on crests and upperslopes	Aarons Pass Road	20 to 50%	Moderate to high

A high erosion hazard requires further detailed assessment in accordance with section 4.4.2 of Landcom 2004 to determine soil loss classes. Soil loss classes are described in Table 5.3 and are based on a nominal 80m slope length. The Revised Universal Soil Loss Equation (RUSLE) is used to predict the soil loss to determine the soil loss classes. RUSLE calculates the annual average erosion in tonnes per hectare from rill and interill (sheet) erosion. It does not consider gully or tunnel erosion and does not calculate peak erosion.

The soils on site that have the greatest erosion potential are dispersive soils with an exchangeable sodium percentage of >4%. These are found in subsoils of all the project soil landscapes. For the purposes of determining soil loss classes a K-factor of 0.06 and a cover factor (C-factor) of 1.0 (completely disturbed) has been adopted.

Table 5.3 Soil Loss Classes (adapted from Table 4.2 Landcom 2004).

Soil Loss Class	Calculated Soil Loss (t/ha/y)	Erosion Hazard
1	0 to 150	Very low
2	151 to 225	low
3	226 to 350	Low-moderate
4	351 to 500	moderate
5	501 to 750	high
6	751 to 1500	Very high
7	>1500	Extremely high

Calculated soil loss ranges from 69.7 t/ha/y in flat areas to 1244 t/h/y in steep areas resulting in soil loss classes (SLC) from 1 to 6 with an erosion hazard ranging from very low to very high.

SLC 4 or higher triggers certain management actions in accordance with section 4.4.2 of Landcom (2004). These are discussed in sections 7 and 8.

6 DESIGNS STANDARDS

6.1 Drainage

Design standards for drainage, erosion and sediment control are derived from:

- Landcom (2004);
- DECC (2008 and 2008a); and
- Project drainage specifications.

The minimum erosion and sediment control drainage standards adopted for the Project are shown below in Table 6.1. Permanent drainage design standards are provided in Table 6.2.

Table 6.1 – Temporary Erosion and Sediment Control Design ARI Standards

Duration of Disturbance	< 6 months		6 – 12 months		1 – 3 years		Reference Source
Sensitivity of receiving environment	standard	sensitive	standard	sensitive	standard	sensitive	
	Design ARI						
Temporary drainage (erosion) controls • Designed to have a non-erosive hydraulic capacity to convey	2 yr	5 yr	5 yr	10 yr	10 yr	20 yr	DEEC (2008)
Temporary sediment control measures • Should be constructed to remain structurally sound in:	2 yr	5 yr	5 yr	10 yr	10 yr	20 yr	DEEC (2008)
Type F or D sediment basin • Designed to achieve required water quality for storms up to the nominated 5 day %ile event • Embankment and spillway designed to be structurally sound in the nominated flow event	75th 10 yr	80th 20yr	80th 20 yr	85th 50 yr	80th 50 yr	85th 100 yr	DEEC (2008)

Adapted for site conditions from Table 6.1 from DECC (2008) and DECC (2008a). Where a conflict exists, the highest nominated standard will be adopted. The Project has adopted 80th percentile 5-day rainfall depth for sediment basins in standard environments and 85th percentile rainfall depth for sensitive environments.

Table 6.2 – Permanent Drainage Design Standards

Drainage Type	Standard	Reference Source
Windfarm		
Access track cross drainage		
Culvert	Q2	Icubed consulting (2018)
Embankment	Stable during overtopping (Q20-Q2)	Icubed consulting (2018)
Access track longitudinal drainage		
Table drain	Q50	Icubed consulting (2018)
Wind Turbine Foundations/ O&M Facility / Substations	Q100	Icubed consulting (2018)
Aarons Pass Road		
All drainage	Match current culverts and drains	Pers.com. N Canto (2019)

Several unsealed roads and tracks will be required on site for access and maintenance purposes. In some cases, existing tracks will be modified and realignment or construction will be required for other existing tracks.

In all cases GEZ will minimise the risk of erosion associated with track and roads by avoiding the concentration of flow to the maximum possible extent. One of the ways this will be achieved is via turning out track and road drainage at regular intervals. Drainage turn outs will be via trapezoidal based mitre drains where project clearing limits dictate disturbance is within allowable clearance areas/limits (Non-Endangered Ecological Communities (EEC) and sensitive vegetation areas etc.) Where project clearance limits constrain drainage turnout design appropriate stabilisation measures will be implemented in track drains (Temporary rock checks, tackifier polymers/Geospray, Coir mesh, rock lining etc)

Spacing of the mitre drains is generally dependent on-site topography and conditions however the horizontal spacing proposed in Table 6.3 will be used to provide guidance.

Table 6.3 – Mitre Drain Spacing

Table drain slope (%)	Horizontal spacing of mitre drains (m)
0 to 2%	120
>2% but ≤ 4%	60
>4% but ≤ 8%	30
> 8%	15

Adopted from Table 4.3.12 from IECA (2008)

On tracks used by project equipment and light vehicles not subject to formal design, cross banks (trafficable inclined diversion banks) may be used as an effective means on reducing slope length and flow velocity. Cross banks will be constructed on temporary access tracks at the horizontal spacing proposed in Table 6.4.
Cross banks can also be implemented as an interim measure on partially constructed project tracks and hardstands during project shutdowns or in anticipation of inclement weather events.

Table 6.4 – Cross Bank spacing

Road Grade	Cross Bank Spacing
Up to 14% (8°)	60 to 70m
14%-21% (8°-12°)	50 to 60m

6.2 Erosion Control

Erosion control standards are generally addressed in Section 6.1 Drainage. There are, however, several important erosion control standards that will be adopted for the Project, in addition to those described in Section 6.1.

For effective erosion protection from rain drop splash erosion approximately 70% soil surface cover is required. Suitable soil surface covers for the project may include:

- Grasses and legumes;
- Gravel and rock;
- Geofabric;
- Hydraulically and pneumatically applied mulches; and/or
- Polymer soil stabilisers.

In accordance with Landcom (2004), GEZ will adopt a 70% soil surface cover as the indicator for the provision of adequate erosion protection in sheet flow environments and the target C-factors nominated in Table 6.5. Soil covers that may be utilised on site include:

- Grasses and legumes;
- Hydro-mulch or straw mulch;
- Polymer based soil stabilisers.

Table 6.5 – Target C factors and timing for stabilisation works

Lands	Target C-factor	Target C-factor
Waterways and other areas subjected to concentrated flows, post construction	0.05	A target C factor of 0.05 (approx. 70% soil surface cover) will aim to be achieved 10 days from completion of construction and prior to exposure to concentrated flows.
All lands, including waterways and stockpiles during construction	0.15	A target C factor of 0.15 (approx. 50% soil surface cover) will aim to be achieved 20 working days of inactivity or from completion of construction.
Stockpiles, post construction	0.10	A target C factor of 0.10 (approximately 60% soil surface cover) will aim to be achieved 10 working days from completion of construction.

For concentrated flow environments, erosion protection will be employed when the maximum permissible velocity of the soil is exceeded. Table 6.6 shows the maximum permissible velocities for various soil types.

Table 6.6 – Maximum permissible velocity for various soil types

Soil description	Allowable velocity	Impacted by the Project	Comments
Extremely erodible soils	0.3m/s	Yes	Dispersive clays are highly erodible at low flow velocities and should be gypsum treated or capped with stable soil.
Sandy soils	0.45m/s	Yes	Highly erodible soils may include: Lithosols, Alluvials, Podzols, Silicious sands, Soloths, Solodized solonetz, Grey podzolics, some Black earths, fine surface texture-contrast soil and Soil Groups ML and CL.
Highly erodible soils	0.4 to 0.5m/s	Yes	
Sandy loam soils	0.5m/s	Yes	Moderately erodible soils may include: Red earths, Red or Yellow podzolics, some Black earths, Grey or Brown clays, Prairie soils and Soil Groups SW, SP, SM, SC.
Moderately erodible soils	0.6m/s	Yes	Erosion-resistant soils may include: Xanthozem, Euchrozem, Krasnozems, some Red earth soils and Soil Groups GW, GP, GM, GC, MH and CH.
Silty loam soils	0.6m/s	No	
Low erodible soils	0.7m/s	No	
Firm loam soils	0.7m/s	No	
Stiff clay very colloidal soils	1.1m/s	No	

From Table A23 IECA (2008)

Table 6.6 demonstrates that the maximum permissible velocities for soils impacted by the project ranges from 0.3m/s to 0.6m/s. GEZ will line concentrated flow areas where the maximum permissible velocity of the soil will or is likely to be exceeded.

Channel liners likely to be used on the project include:

- Hydraulically applied channel liners such as Geospray™;
- Grass;
- Jute mesh, Coir mesh and grass;
- Turf reinforcement mesh and grass; and
- Rock.

The project will impact moderately to highly dispersive soils. Dispersive soils are sodium dominated soils with weak ionic bonding which cause the clay particles to blow apart when wet. Magnesic soils can demonstrate similar behaviour.

The most effective treatment for soil dispersion is either capping or the incorporation of calcium sulfate (gypsum) into the soil. The calcium ions in the gypsum displace the sodium ions in the soils resulting in a more cohesive soil. Lime cannot be used as lime does not dissolve when pH is higher than 6.5.
Exposed dispersive soils disturbed by the project will either be capped with non-dispersive material or treated so that dispersion percentage is less than or equal to 4%.

6.3 Sediment Control

Soil loss calculations and the need for turbidity control due to the sensitivity of the receiving environment, has triggered the requirement for sediment basins at many locations along the project. These will be shown in the PESCP's. The need for additional sediment basins will be determined during the preparation of PESCP's for discrete areas of disturbance.

The design standards for sediment control measures in accordance with Landcom (2004) and DECC (2008) are provided in Table 6.1. Construction sediment basins will be designed to capture and treat all run off from the 80th percentile, 5-day rainfall depth in non-sensitive areas or the 85th percentile, five (5) day rainfall depth in sensitive areas. Alternatively, high efficiency sediment basins may be used. These will be designed and operated in accordance with Appendix B (2014) of IECA (2008).

Sediment basins will be operated as 5-day basins, that is, the time between filling, treatment, achievement of desired water quality and dewatering shall be 5 days.

Sediment basins will be dewatered using pumps. The water will either be re-used on site or discharged from site. Appropriate energy dissipaters will be installed at the pump outlet to ensure erosion does not occur at the outlet points.

Sediment basin walls will be constructed from clean non-dispersive subsoil and be free of roots, woody vegetation, roots and other unsuitable material. If it is necessary to construct sediment basin walls from dispersive subsoil, it will be gypsum treated. The sediment basin inlets and outlets will be lined to minimise erosion of the inlets and outlets.

A site sediment basin and dewatering procedure is provided in Appendix 1.

7 MANAGEMENT STRATEGIES

7.1 Integrating the project design with site constraints

GEZ have designed the project to utilise the existing topography where practical, to avoid extensive land reshaping during construction or during the rehabilitation phase and minimise the potential for soil erosion. Some cut and fill however, is required to achieve desired horizontal and vertical alignments of access tracks, to construct footings for the towers and a concrete batching plant. Cutting will also be required to excavate bulk material from significant disturbance areas.

7.2 Minimise the Extent and Duration of Land Disturbance

A Vegetation Disturbance Permit (VDP)\ and EWMS process will be used to ensure unnecessary land disturbance does not occur. The Permits will be provided by the Project Engineers and Senior Environmental Advisor or delegate. Sites are inspected prior to disturbance and necessary environmental, flora and fauna, cultural, drainage and erosion and sediment controls are planned and implemented as required.

GEZ will schedule and sequence major land disturbing activities on lands SLC 4 or higher to avoid high rainfall erosivity periods from December to January where practical to minimise the erosion risk from summer storms.

Progressive rehabilitation and stabilisation will be undertaken to reduce the extent and duration of land disturbance. The timing of progressive rehabilitation works will generally be in accordance with Table 6.5. GEZ will implement wet weather and extended duration shut down procedures to ensure the project is suitably protected for when rainfall occurs.

7.3 Control Water Movement through site

Where feasible, lined clean water drains will be constructed to divert clean run-on water around disturbed lands, to minimise the volume of potentially turbid water that needs to be treated and the size of drainage, erosion and sediment control measures. Clean water drains will be lined with grass, polymer or other material dependent on soil type, flow velocities and anticipated design life. These are shown in Table 7.1.

Table 7.1-Temporary and Permanent Clean Water Drain Lining

Drain Type	Lining Type
Temporary	Soil polymer, Geo spray™, geofabric or Soil Erosion Specialist agreed equivalent stabilisation measure
Permanent	Jute mesh, coir mesh, Geo spray™, TRM, rock or Soil Erosion Specialist agreed equivalent stabilisation measure

Generally, drainage design will aim to maintain sheet flow conditions in order to minimise erosion potential. Where possible, turn-outs will be used to divert flow to stable natural areas. Where flow concentration is necessary, channels will be lined where the flow velocity exceeds the maximum permissible velocity of the soil. The excavation of unlined channels in dispersive soils will be avoided where possible to minimise the potential for gully and tunnel erosion.

Temporary culverts may be used where practical to assist segregation of clean and dirty water on site.

7.4 Minimise Soil Erosion

The most effective form of sediment control is erosion control. Sediment and turbid water are only generated when erosion occurs. Effective erosion control is therefore a fundamental component of GEZ's drainage, erosion and sediment control strategies.

The types of erosion that can potentially occur at the project area are:

- Raindrop splash erosion;
- Sheet erosion;
- Rill erosion;
- Gully erosion; and
- Chemical erosion (dispersion).

Raindrop splash erosion is most effectively controlled by providing soil surface cover. GEZ will achieve this by:

- Minimising the extent and duration of soil disturbance;
- Retaining vegetation on site;
- Progressively rehabilitating disturbed areas; and
- Covering and binding exposed soils with gravel, geofabric, mulches and soil stabilisers.

Rill erosion is effectively controlled by minimising slope length and gradient. GEZ will achieve this by:

- Minimising disturbance to steeply grading areas where possible;
- Reducing slope gradient and length;
- Avoiding disturbance to dispersive soils;
- Treating dispersive soils with gypsum; and
- Progressively revegetating disturbed areas.

Gully erosion is effectively controlled by minimising the concentration of flow and slowing flow velocity. GEZ will achieve this by:

- Encouraging sheet flow where possible;
- Lining drains where flow velocities exceed the maximum permissible velocity of the soil (temporary and permanent);
- Providing energy dissipaters out the outlet of channels, drains and culverts;
- Avoiding disturbance to dispersive soils; and
- Treating dispersive soils with gypsum if disturbed.

Chemical erosion is effectively controlled by minimising the disturbance of dispersive soils and maintaining sheet flow conditions. GEZ will achieve this by:

- Avoiding the concentration of flow where dispersive soils are present;
- Avoid ponding water on areas of dispersive soil;
- Avoiding disturbance of dispersive soils; and
- Treating dispersive soils with gypsum if required.

Energy dissipaters will be used at the outlets of drains and spillways to reduce flow velocities to less than the maximum permissible velocity for the soil type.

7.5 Maximise Sediment Retention on Site

As discussed in section 7.4, the most effective form of sediment control is erosion control. Irrespective of how well designed and implemented erosion control is on site, sediment and turbid water will always be generated during rainfall events on construction projects.

GEZ will employ a range of Type 1, 2 and 3 sediment controls (as defined in IECA 2008) on site (refer Table 7.2.) that are appropriate for the flow conditions and performance required. Type 3 sediment controls trap primarily the sand sized particle, Type 2 sediment controls trap the sand and silt sized particles and Type 1 sediment controls trap sand, silt and clay sized sediment particles up to and including the design rain event.

Table 7.2 - Sediment Controls

Type 1	Type 2	Type 3
Sheet flow treatment techniques		
		Buffer Zone Sediment Fence
Concentrated flow treatment techniques		
Sediment Basin (Type F/D)	Rock Filter Dam Pocket Sediment Basin	Sand/gravel Bag Check Dam Rock Check Dam
De-watering sediment control techniques		
Sediment Basin (Type F/D)	Filter Bag or Filter Tube Gravel filter	Grass Filter Bed Sediment Fence
In-stream sediment control techniques		
Pump turbid water to an off-line Sediment Basin (Type F/D)	Water-filled Bag Barrier	Floating silt curtain

Adapted from Table 4.5.3 IECA (2008) to suit site specific conditions.

Sediment basins will generally be used on site where the calculated soil loss exceeds 150 t/ha/y and it is essential to control turbidity. Where the predicted soil loss exceeds 150 t/ha/y, but it is not possible or practical to install sediment basins enhanced source control will be undertaken, as outlined within Section 8 and the Progressive Erosion and Sediment Control Plans.

Sediment basins will be treated with suitable coagulants and/or flocculants, to achieve minimum water quality requirements as shown in Table 7.3.

Table 7.3 – Discharge Water Quality

Criteria Water Quality Requirement	Criteria Water Quality Requirement
Total Suspended Solids	Current EPL limit states 50 (subject to baseline water sampling and negotiation with CWP Renewables and the EPA)
pH	6.5 – 8.5
Oil and grease	No visible hydrocarbon sheen

Sediment basins used for the containment of turbid construction water on NSW projects are typically treated with Calcium Sulphate (Gypsum) which is a low solubility metal salt. While Gypsum is largely accepted as an inert material and ecologically safe product, the chemistry for water treatment is poorly understood and there are wide knowledge gaps in its use and effectiveness on a wide range of site situations that can often result is slow treatment times and the generation of ‘pin’ flocs that are easily remobilised by wind and wave action, and flow

in sediment basins. Gypsum is most effective when it is used 'passively' in sediment basin catchments, that is, broadcast over disturbed ground or placed in sediment basin inlet drains. The use of Gypsum on the CRWF will generally be by this method.

There are other chemicals that can be used to treat sediment basins and other sources of accumulated turbid water such as Aluminium chloro-hydrate, Chitosan based biopolymers and Polyacrylamide (PAM) long-chain polymers however, regulators are concerned about the potential ecotoxicity of these chemicals if used incorrectly.

GEZ proposed to use appropriate coagulants and flocculants to ensure water releases comply with EPL limits. Jar testing of site turbid water will be undertaken in accordance with Appendix B (2018) of IECA (2008) to select appropriate the appropriate coagulants and/or flocculant and to determine dosing rates.

Sediment basins and other excavations requiring dewatering will be treated using a combination of the following methods:

- Gypsum will either be broadcast over disturbed ground or spread in the basin inlet drains. PAM floc blocks may also be placed in the basin inlet drains.
- High efficiency coagulants and/or flocculants will be dosed into the sediment basin inflow using flow activated dosing units.
- A pump will be set up to create a circulation within the basin/trench and coagulant will be injected into the pump suction and if necessary, flocculant will be injected into the pump discharge line and will continue until the desired water quality is achieved.

Type D basins and trenches will be dewatered following treatment. This will be undertaken using either a syphon or a pump. The siphon inlet and pump foot valve will be secured above the basin floor so that sediment is not pumped out during the dewatering process. Dewatering will always be supervised. The pump discharge will be located on either existing rocky or grassed areas to minimise the potential for erosion.

If high efficiency basins are used, they will be Type B basins which are a flow through basin that do not require dewatering.

7.6 Prompt Stabilisation of Disturbed Areas

GEZ will also utilise temporary and permanent covers and polymer soil stabilisers where appropriate to promptly stabilise disturbed areas in accordance with Table 6.5. Permanent stabilisation works will be undertaken in accordance with the *Crudine Ridge Wind Farm Roads and Hardstand Specifications* CRWF_Schedule 05_Roads and Hardstand Specification Revision E that states:

'The Contractor is responsible for rehabilitation of earth works completed by the Contractor within the Site and Public Road upgrade areas. The rehabilitation shall be undertaken in accordance with the Environmental Approvals, the Landowners Obligations and the requirements of the Authorities. Revegetation and distribution of surface rock is to be consistent with the natural surroundings.'

Development Consent SSD-6697 specifies rehabilitation requirements in Schedule 3, Condition 41 that requires progressive rehabilitation to be undertaken as soon as reasonably practical following construction or decommissioning. All reasonable and feasible measures must be taken to minimise the total area exposed at any time. Interim rehabilitation strategies

shall be employed when areas prone to dust generation, soil erosion and weed incursion cannot yet be permanently rehabilitated.

Stabilisation and revegetation measures are summarised in Section 8. Disturbed areas will be stabilised with grass species acceptable to the background landowners. It may be necessary to install temporary electric fences or use heavy mulch applications to protect rehabilitation areas from damage from sheep. Several solutions may be trialled to determine the most appropriate methodology.

Rehabilitation criteria will be included in the Inspection and Test Plans for construction areas. The Soil Erosion Specialist will compare rehabilitated areas to reference areas immediately adjacent to the construction areas to verify successful rehabilitation of the lot in question.

7.7 Maintain Drainage, Erosion and Sediment Control Measures

GEZ will maintain all drainage, erosion and sediment control measures until their function is no longer required and a minimum of six months or until 70% vegetation cover is achieved. Technical notes for drainage, erosion and sediment control measures to be used on the Project are included in Appendix 2. These technical notes include construction and maintenance requirements for the control measures.

As outlined in Section 10.2, inspections of control measures will be undertaken following rainfall that causes run-off or weekly during dry conditions.

Inspections will be undertaken by the Senior Environmental Advisor or delegate.

Joint inspections of drainage, erosion and sediment control measures will be undertaken with the Project Soil Erosion Specialist as required.

GEZ will maintain control measures to maximum practicable extent so that control measures:

- Are in accordance with the specified operational standard for each drainage, erosion and sediment control measure; and
- Prevent or minimise safety risks.

All water, debris and sediment removed from control measures will be disposed of or re-used in a manner that will not create an erosion or pollution hazard.

7.8 Monitor and Adjust Drainage, Erosion and Sediment Control Practices to Achieve Desired Performance Standards.

GEZ have adopted a hierarchical ESCP system to ensure that the Project ESCP's are living documents that can and will be modified as site conditions change, or if the adopted control measures fail to achieve the desired treatment standard.
If a site inspection or environmental monitoring identifies a significant failure of the adopted drainage, erosion and sediment control measures, a critical evaluation of the failure will be undertaken to determine the cause and appropriate modifications will be made to the control on site and Progressive ESCP's will be amended.

8 ENVIRONMENT SPECIFIC CONTROL MEASURES

8.1 Aaron's Pass Road

The drainage, erosion and sediment control measures planned to be utilised for the upgrade of Aaron's Pass Road are described in Table 8.1.

Table 8.1 – Aarons Pass Road Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative	
PESCP preparation by CPESC	To protect *Acacia meiantha* and *Pomaderris cotoneaster*
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive vegetation/ land disturbance
Drainage control	
Lined table drains	To convey track run-off in a non-erosive manner.
Mitre drains	To divert track run-off away from the track to reduce the volume and velocity of drainage.
Pipe culverts	To allow vehicle access over ephemeral creeks and to allow clean up-stream water to pass through the construction zone without contamination.
Erosion Control	
Temporary	
Check dams	To reduce flow velocity in the access track table drains and mitre drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Cementitious hydrocolloid hydraulically applied soils stabiliser (Geospray)	To protect exposed cut and fill embankments steeper than 1(v):2(h) and/or where overland flows are anticipated from erosion
Biologically enhanced straw-based hydromulch (Enviromatrix)	To protect exposed cut and fill embankments where a revegetation outcome is required and there are no overland flows
Coir mesh anchored with 'Duck-billed' soil anchors	To protect steep cut batters from the shear stress from overland flow until vegetation establishes.
3-D polyamide soil filled TRM with HDPE geogrid anchored with 'Duck-billed' soil anchors	To protect steep cut batters from the shear stress from overland flow until vegetation establishes and to provide geotechnical stability.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Rock/soil matrix	To protect steep cut and fill batters from erosion and promote vegetation establishment
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h)
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Cross Vane ('v' or 'weir')	Redirective natural channel design structure to move flow away from creek banks to protect them from erosion and to provide creek bed grade stabilisation.
Rock Vane	Redirective natural channel design structure to move flow away from creek banks in lieu of rock armouring.
J-hook Vane	Combination of a Cross Vane and Rock Vane
Sediment Control	

Temporary	
Mulch bunds	To capture sediment and turbid run-off
Check dams	Capture small quantities of coarse sediment in the table drains and mitre drains.
Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.
Sediment Fence	To capture coarse sediment in sheet flow environments where vegetation protection requirements and clearing limits prohibit the use of mulch bunds.

8.2 Access Tracks

The drainage, erosion and sediment control measures planned to be utilised for project access tracks are described in Table 8.2.

Track 11 crosses Salters Creek which is an ephemeral 3rd order stream (Eco Logical, 2011). The requirements for fish passage for water crossings are described in *Why do fish need to cross the road? Fish passage requirements for waterway crossings* NSW Fisheries 2003 (NSW Fisheries 2003). Waterway types and minimum recommended crossing types are determined from Table 1 from NSW Fisheries 2003. These and recommended design requirements are shown in Table 8.3.

Salters Creek is considered to be a Class 3 at its intersection with track 11 and the project has adopted a culvert for this crossing waterway in accordance with Table 8.3 with the following key design characteristics:

- Culverts are aligned with the existing creek channel
- The culverts have the same gradient has the existing creek channel
- The culverts have a Q20 hydraulic capacity (minimum require is Q2)
- The culverts have a diameter of 900mm (minimum recommended diameter is 450mm)
- The track will generally be perpendicular to the creek
- Rock inlet and outlet protection will be provided to protect the stream bed and banks from erosion.
- The track surface will be stabilised with gravel and possibly soil stabilising polymer on the approaches to the creek to minimise the potential for erosion and the generation of sediment and turbid runoff.

A PESCP and EWMS will be prepared for the construction of the crossing.

The project crosses numerous other 1st and 2nd order streams and these all have culvert crossings designed in accordance with Table 6.2.

Table 8.2 – Access Track Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative	
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive land disturbance
Drainage control	
Lined table drains	To convey track run-off in a non-erosive manner.
Mitre drains	To divert track run-off away from the track to reduce the volume and velocity of drainage.
Trafficable Cross Banks	To minimise track erosion, disperse water to reduce slope lengths and velocity
Pipe culverts	To allow vehicle access over ephemeral creeks and to allow clean up-stream water to pass through the construction zone without contamination. Maintain natural drainage paths.
Erosion Control	
Temporary	
Check dams	To reduce flow velocity in the access track table drains and mitre drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Cementitious hydrocolloid hydraulically applied soils stabiliser (Geospray)	To protect exposed cut and fill embankments steeper than 1(v):2(h) and/or where overland flows are anticipated from erosion
Amelioration of dispersive soils with Gypsum	Reducing the ESP of dispersive soils to <4% to minimise dispersion
Pneumatically applied straw mulch with bitumen tackifier	To protect newly seeded areas from erosion and damage from grazing sheep.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h)
Tree debris	To protect fill embankments from erosion
Rock/soil matrix	To protect steep cut and fill batters from erosion and promote vegetation establishment
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Cross Vane (‘v’ or ‘weir’)	Redirective natural channel design structure to move flow away from creek banks to protect them from erosion and to provide creek bed grade stabilisation.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in the table drains and mitre drains.

Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.
Sediment Fence	To capture coarse sediment in sheet flow environments.
Type D/F or high efficiency sediment basin	To capture and treat sediment and turbid runoff

Table 8.3 – Fish passage classes, recommended crossing types and design requirements

Waterway Class	Class 1	Class 2	Class 3	Class 4
Waterway characteristics	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi - permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).
Crossed by project	No	No	Yes	Yes
Preferred crossing type	Temporary bridge or Arch (mandatory on OPP waterways)	Temporary bridge, arch or box culverts	Causeway with culverts	Causeway with culverts or ford
Hydraulic capacity	Bridge deck must not impede the bank full flow	Bank full channel capacity	2 year ARI	2 year ARI
Flow velocity	N/A – culverts not be used in Class 1 waterways	N/A if` temporary bridge used, 0.3m/s in culverts	0.3m/s	N/A provided energy dissipaters constructed on outlet to reduce flow the ≤ the maximum permissible velocity of bed and bank material
Structural stability	Design life ≤12 months – 10 year over overtopping event, design life > 12 months – 20 year overtopping event			
Minimum pipe culvert size	450mm	+450mm	450mm	N/A
Upstream and downstream bed and bank roughness	Riparian vegetation	Riparian vegetation (cut stump is acceptable). If vegetation is removed then equivalent bank surface roughness	Riparian vegetation (cut stump is acceptable). If vegetation is removed then equivalent bank surface roughness	N/A. Erosion protection is required.

	must be provided to create boundary layers to allow upstream fish movement.	must be provided to create boundary layers to allow upstream fish movement.	
Minimum upstream and downstream batter gradients	N/A	1(v):3(h)	1(v):3(h)	1(v):3(h)

8.3 Turbine Pads and Compounds

The drainage, erosion and sediment control measures planned to be utilised for turbine pads and compounds are described in Table 8.4.

Table 8.4 – Turbine Pad Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative control	
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive land disturbance
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Mitre drains	To divert run-off to reduce the volume and velocity of drainage.
Erosion Control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Cementitious hydrocolloid hydraulically applied soils stabiliser (Geospray)	To protect exposed cut and fill embankments steeper than 1(v):2(h) and/or where overland flows are anticipated from erosion
Amelioration of dispersive soils with Gypsum	Reducing the ESP of dispersive soils to <4% to minimise dispersion
Pneumatically applied straw mulch with bitumen tackifier	To protect newly seeded areas from erosion and damage from grazing sheep.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h)
Tree debris	To protect fill embankments from erosion
Rock/soil matrix	To protect steep cut and fill batters from erosion and promote vegetation establishment
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.

Table 8.4 – Turbine Pad Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Sediment Fence	To capture coarse sediment in sheet flow environments.
Type D/F sediment basin	To capture and treat sediment and turbid runoff

8.4 Cable trenches

The drainage, erosion and sediment control measures planned to be utilised for cable trenches are described in Table 8.5.

Table 8.5 – Cable trench Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative control	
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive land disturbance
Drainage control	
Trafficable Cross Banks	To divert longitudinal flows away from the cable trench to stable vegetated areas
Erosion Control	
Temporary	
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Amelioration of dispersive soils with Gypsum	Reducing the ESP of dispersive soils to <4% to minimise dispersion
Cementitious hydrocolloid hydraulically applied soils stabiliser (Geospray)	To protect exposed cut and fill embankments steeper than 1(v):2(h) and/or where overland flows are anticipated from erosion
Pneumatically applied straw mulch with bitumen tackifier	To protect newly seeded areas from erosion and damage from grazing sheep.
Vegetated trafficable Cross Banks	To divert longitudinal flows away from the cable trench to stable vegetated areas
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h)
Sediment Control	
Temporary	
Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.
Sediment Fence	To capture coarse sediment in sheet flow environments.

8.5 Batch Plant

The drainage, erosion and sediment control measures planned to be utilised for turbine pads, sub-stations and compounds are described in Table 8.6.

Table 8.6 – Batch Plant Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative control	
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive land disturbance
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Mitre drains	To divert run-off to reduce the volume and velocity of drainage.
Erosion Control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Amelioration of dispersive soils with Gypsum	Reducing the ESP of dispersive soils to <4% to minimise dispersion
Pneumatically applied straw mulch with bitumen tackifier	To protect newly seeded areas from erosion and damage from grazing sheep.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Rock/soil matrix	To protect steep cut and fill batters from erosion and promote vegetation establishment
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.
Sediment Fence	To capture coarse sediment in sheet flow environments.
Type D/F, high efficiency sediment basin	To capture and treat sediment and turbid runoff

8.6 Other Significant Disturbance Areas

The drainage, erosion and sediment control measures planned to be utilised for other significant disturbance areas are described in Table 8.7.

Table 8.7 – Significant Disturbance Area Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Administrative control	
Vegetation Disturbance Permit	To ensure no unauthorised or excessive land disturbance
Flagging of clearing limits	To ensure no unauthorised or excessive land disturbance
Drainage control	
Trafficable Cross Banks	To divert disturbance area runoff from the access track to sediment controls
Lined drains	To convey run-off in a non-erosive manner.
Mitre drains	To divert run-off to reduce the volume and velocity of drainage.
Erosion Control	

Table 8.7 – Significant Disturbance Area Drainage, Erosion and Sediment Control Measures

Control Measure	Purpose
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser.	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Amelioration of dispersive soils with Gypsum	Reducing the ESP of dispersive soils to <4% to minimise dispersion
Pneumatically applied straw mulch with bitumen tackifier	To protect newly seeded areas from erosion and damage from grazing sheep.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Rock/soil matrix	To protect steep cut and fill batters from erosion and promote vegetation establishment
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Flocc blocks and/or topical application of Gypsum	To increase sediment particle size to improve the efficiency of Type 2 and Type 3 sediment controls.
Sediment Fence	To capture coarse sediment in sheet flow environments.
Type D/F, high efficiency sediment basin	To capture and treat sediment and turbid runoff

Fact sheets for the various control measures detailing their design, implementation and maintenance requirements are provided in Appendix B.

9 TRAINING AND COMPETENCIES

All Project personnel including contractors will have an appropriate level of drainage, erosion and sediment control training. There will be three levels of competency training for personnel:

Level 1 – This will be basic awareness level training for all site personnel, and it will be provided during site inductions.

Level 2 – This will be one day training for foreman, engineers, supervisors and environmental personnel on the legal aspects of drainage, erosion and sediment control, fundaments and site-specific strategies, techniques and requirements.

Level 3 – This will consist of toolbox topics on specific drainage, erosion and sediment aspects. It may be targeted to the entire workforce or specific personnel or crews.

The Level 1 training will be prepared by the Senior Environmental Adviser and presented by the Senior Environmental Adviser.

The Level 2 training will be prepared and presented by the Project Soil Erosion Specialist.

Level 3 training will be prepared and presented by the Senior Environmental Adviser and Senior Environmental Adviser.

10 INSPECTION AND MAINTENANCE

10.1 Incidents and Complaints

All incidents will be reported and investigated, and corrective actions assigned to prevent future occurrences.

An incident may involve any action or activity deemed to be in non-compliance with this SWMP, PESCP's as well as actual or potential Material or Serious Environmental Harm, or *Pollution of Waters* pursuant to section 120 of the *Protection of the Environment Operations Act 1997*.

All incident reporting will be undertaken in accordance with section 4 of the GEZ CEMP.

10.2 Inspections, Audits and Monitoring

Inspections of drainage, erosion and sediment control measures will be undertaken:

- Weekly during normal construction hours;
- Daily during periods of rainfall; and
- Within 24 hours of the cessation of a rainfall event causing runoff to occur on or from the project (≥10mm).

A Zenviron weekly environmental inspection checklist is utilised to record the outcomes from these inspections.

Joint inspections will be undertaken by the Project Soil Erosion Specialist with the Senior Environmental Adviser to verify the adequacy of PESCP's and control measures for site conditions.

Periodic ERSD compliance audits may be undertaken by the Soil Erosion Specialist jointly with the EPC Environmental Advisor in accordance with the GEZ CEMP audit schedule.

Upstream, downstream and discharge monitoring will be undertaken in accordance with Table 10.1. Water monitoring locations are shown in Figure 10.1.

Project water discharge parameters are subject to baseline water sampling analysis by the Soil and Erosion Specialist for EPA consideration. Due to regional water baseline quality potential to exceed current discharge limits, baseline sampling is being undertaken to determine a more regionally accurate TSS limit for CRWF water discharge.

Table 10.1 – Project water monitoring

ID	Name	Purpose	Parameters	Frequency	Sampling method
NR1a	Crudine River	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR1b	Crudine River	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR2	Cow Flat Creek	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR3	Green Valley Creek	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter

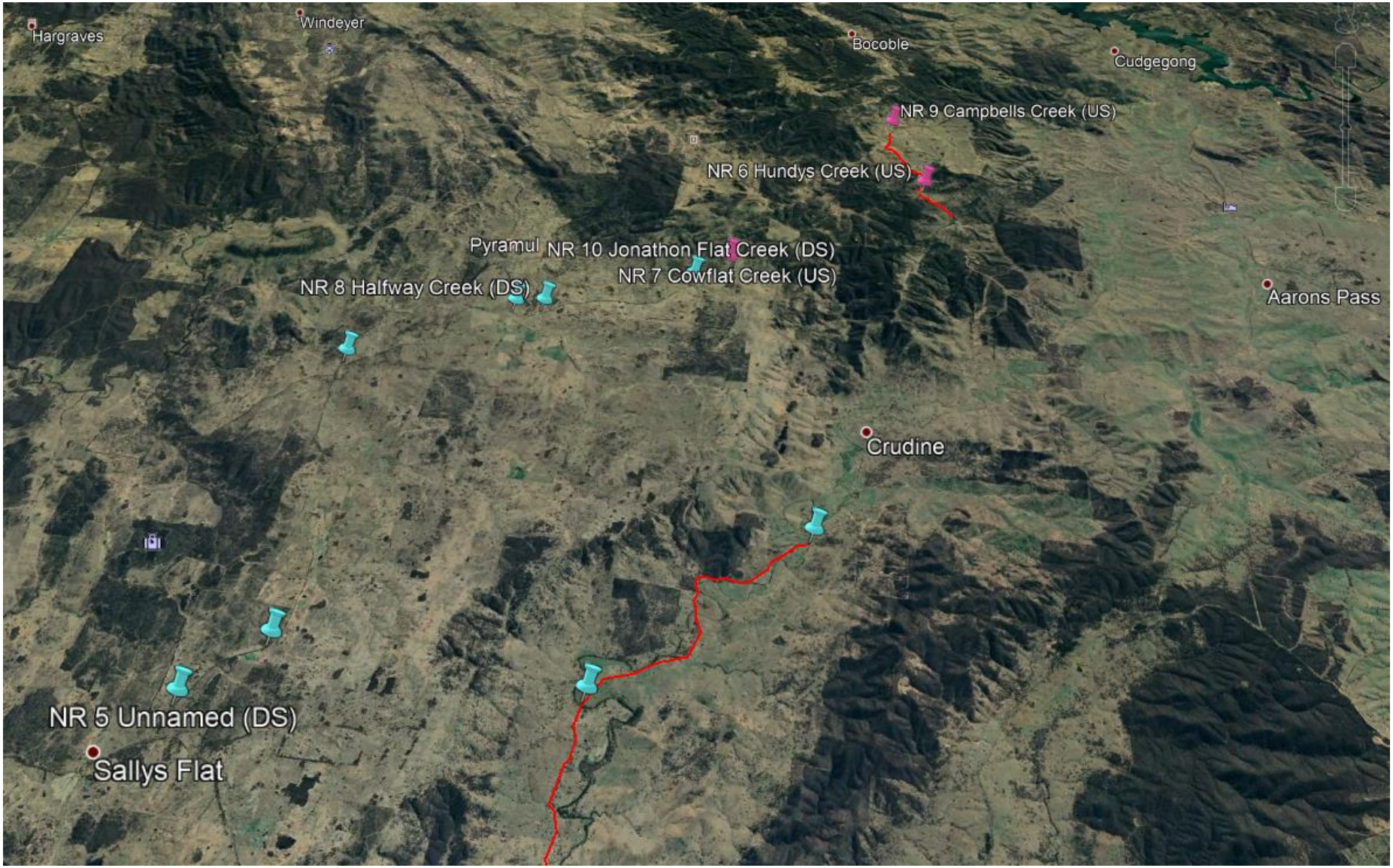
Table 10.1 – Project water monitoring

ID	Name	Purpose	Parameters	Frequency	Sampling method
NR4	Tunnabidgee Creek	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR5	Unnamed (Tributary to Green Valley Creek)	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR6	Hundys Creek	Upstream background monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR7	Cow Flat Creek	Upstream background monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR8	Halfway Creek	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR9	Campbells Creek	Upstream background monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
NR10	Jonathans Flat Creek	Downstream impact monitoring	TSS, NTU, pH, EC and DO (%)	Monthly and post rainfall monitoring	Grab sample and portable meter
Sediment basins		Discharge monitoring	TSS, NTU, pH and EC	Prior to discharge Every 4 hours during	portable meter portable meter

*Frequency

1. Monthly sampling at all locations
2. Post rainfall sampling at all locations;
    - July – October 2019 sampling after 10mm> rain events (Within 36hrs of the completion of the rain event)
    - November 2019 onwards sampling after 20mm> rain events (Within 36hrs of the completion of the rain event)

Figure 10.1 – Project water monitoring locations



10.3 Maintenance and Remedial Actions

Many different types of drainage, erosion and sediment control measures are utilised within the Project area. A description of the key measures used and maintenance and remedial actions likely to be undertaken are provided in Table 10.1.

Table 10.2 – Maintenance and Remedial Actions

Control Measure	Maintenance and Remedial Actions
Drainage control	
Lined clean water diversion drains and banks	Repair any damage to the liner (replace, re-anchor), repair any bunding or silt fence isolating the clean water catchment from the dirty water catchment.
Dirty water diversion drains and banks	Repair any erosion, re-line if necessary.
Temporary clean water culverts	Ensure turbid water cannot enter the pipe or outlet channel. Monitor for erosion around the inlet and outlet headwalls and repair as necessary. Check the pipe outlet energy dissipater for erosion and repair and/or modify as necessary.
Temporary bed level crossing	Ensure the bed level crossing protects the underlying soil from erosion. Repair and/or modify accordingly. Ensure the crossing is free from accumulated sediment. Maintain as necessary.
Temporary culvert waterway crossing	Ensure the geofabric sediment retention is installed correct and sediment cannot enter the waterway. Ensure the pipe is not blocked. Ensure accumulated sediment is removed from the rock or rock is replaced as necessary. Inspection after to flow events to ensure the crossing remains stable. Repair and/or modify as necessary.
Erosion Control	
Temporary	
Polymer soil stabiliser.	Reapply following rainfall or heavy vehicle traffic.
Cover crops	Test soil if there is poor growth of evidence of nutrients deficiencies. Apply additional soil ameliorants and reseed if soil surface cover is less than 70%.
Permanent	
Polymer soil stabiliser.	Reapply as necessary.
Gypsum amelioration of dispersive soil	Check for rill, gully and tunnel erosion. Re-test soil and incorporate additional gypsum in accordance with the soil testing results.
Lined channel, drains and batter chutes	Look for water flows under or beside the structure and repair and/or modify as necessary. Look for erosion around and downstream of the energy and repair and/or modify as necessary.
Revegetation	Inspect for evidence of rill, gully, tunnel erosion, poor soil surface cover and nutrient deficiencies. Test the soil, apply ameliorants if necessary. Re-apply hydro mulch if necessary.
Sediment Control	
Temporary	
Silt fences	Ensure silt fences pond water. If not, install additional panels. Check for blow-outs in the anchor trench. Re-anchor as necessary. Replace any ripped or damaged sediment fence.
Check dams	Check for erosion between check dams. Install additional check dams if necessary. Remove accumulated sediment.
Stabilised construction exits	Ensure rock is free from accumulated sediment. Replace as necessary.
Construction Sediment basins	Treat accumulated water with high efficiency coagulants and flocculants. Dewater when water quality is less than nominated water quality limits. Check basin inlets and outlets for erosion and repair as necessary. Check the basin wall for slumping or tunnel erosion. Repair as necessary. Remove accumulated sediment from the basin when it reaches the sediment storage zone marker.
Coagulants and flocculants	Check coagulant/flocculent levels in rainfall activated dosing units and replenish as necessary.

10.4 Wet weather and site shutdown procedures

The Senior Environmental Adviser will monitor weather forecasts daily. Where the forecasts indicate that there is a ≥ 60% chance of ≥ 10mm of predicted rainfall, the Senior Environmental Adviser will notify the Site Manager and/or Construction Manager and the wet weather preparedness procedure will be implemented.

The Construction Manager shall initiate erosion and sediment control preparedness at:

- The end of the working day; or
- In the event of imminent rainfall by instruction from the Site Manager or Senior Environmental Adviser; or
- If it is otherwise evident that rainfall is imminent.

Erosion and sediment control preparedness shall include but not be limited to:

- Ensuring clean water diversions are in place (where required).
- Moving spoil from at risk areas (eg from drains, gullies).
- Constructing temporary drains to ensure dirty catchments are diverted to sediment control measures.
- Stabilise unprotected soil stockpiles and erosion prone embankments will soil stabilising polymers and ensure necessary sediment control are in place.
- Ensure sediment traps have been desilted, basins dewatered, and they are operating correctly.
- Implement any remaining controls in accordance with the PESCP.
- Implemented any additional controls as recommended by the Senior Environmental Adviser and/or Soil Erosion Specialist.

11 REFERENCES

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Appendix A – Turbid Water Treatment and Dewatering Procedure

Appendix B – Drainage, Erosion and Sediment Control Measure Fact Sheets