Golden Plains Wind Farm

WestWind Energy Pty Ltd (WestWind)

Preliminary Geomorphology Assessment

0002 | Final

26 May 2017

Client Reference

JACOBS

Golden Plains Wind and Solar Farm

Project No: IS164500
Document Title: Preliminary Geomorphology Assessment
Document No.: 0002
Revision: Final
Date: 26 May 2017
Client Name: WestWind Energy Pty Ltd (WestWind)
Client No: Client Reference
Project Manager: Phil Burn
Author: Peter Sandercock
File Name: J:\IE\Projects\03_Southern\IS164500\21 Deliverables\Preliminary Geomorphology\0002 Preliminary Geomorphology Assessment.docx

Jacobs Australia Pty Limited

80A Mitchell St
PO Box 952
Bendigo VIC 3552 Australia
T +61 3 5444 1861
F +61 3 5444 1862
www.jacobs.com

Document history and status

Revision	Date	Description	By	Review	Approved
0001	4/08/16	Draft	P. Sandercock	P Burn	
0002	1/11/17	Final	P. Sandercock	P Burn	

Contents

1. Introduction

1.1 Background

WestWind Energy Pty Ltd (WestWind) has secured land to the south, south east and west of Rokewood and on land at Barunah Park approximately 60 kilometres north west of Geelong, Victoria. WestWind is looking to progress a wind farm project at the site. The project is likely to consist of the order of up to 235 wind turbines within the 3 to 5 megawatt class with an overall height of 230 m and associated infrastructure.

WestWind has commissioned Jacobs to undertake a series of preliminary assessments to progress the Golden Plains Wind Farm. These assessments will be used to support a referral under the *Environment Effects Act 1978* (EE Act) to inform the future development of the project and identify matters for WestWind's future consideration. This report documents a preliminary geomorphology assessment of the landforms within the site and their sensitivity to physical changes associated with the project.

1.2 Report structure

The report contains three main sections:

- A description of the geology, geomorphology (landforms) and soils in the project area (Section 2).
- An assessment of the potential significance of landforms and their sensitivity to physical changes associated with the proposed development (Section 3).
- Conclusions from these preliminary geomorphology assessments and recommendations on measures to mitigate any potential impacts on the landforms (Section 4).

1.3 Methodology

This report is based primarily on a desktop review of publicly available geology, geomorphology and soils data, supported by a brief inspection of the site on the 2 August 2016 and 10 January 2017. The following is a list of information reviewed:

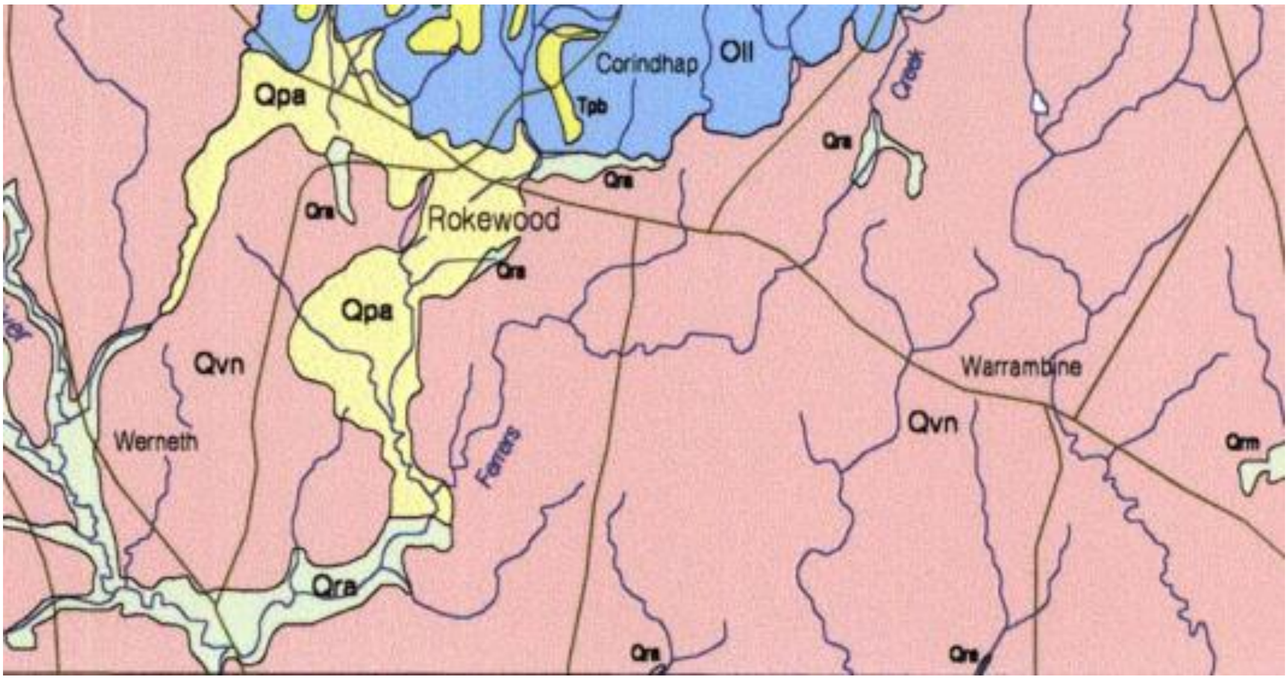
- 1:250 000 geological mapping and explanatory notes for the Colac and Ballarat Map Sheets (Edwards et al. 1996a, 1996b, VandenBerg 1997).
- A land resource assessment of the Corangamite Region (Robinson et al. 2013).
- Landslide and erosion susceptibility mapping in the CCMA Region (Dahlaus 2006).
- Information publically available online documenting planning layers, terrain land units, flood extents, Index of Stream Condition and aerial imagery (Biodiversity Interactive Map[1] and Google Earth).

[1] http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

2. Description of the Area

2.1 Geology

Figure 2.1 illustrates the surface geology of the area which extends over two geological map sheets. The geology and landforms of the Golden Plains Wind Farm project site are dominated by Tertiary to Quaternary flows of basalt lava. A shallow drainage network has developed around these larval flows. The topography varies from 140 to 180 m in elevation across the area. Local eruption points adjacent to the project site include Mt Rebecca and Gow Hill.

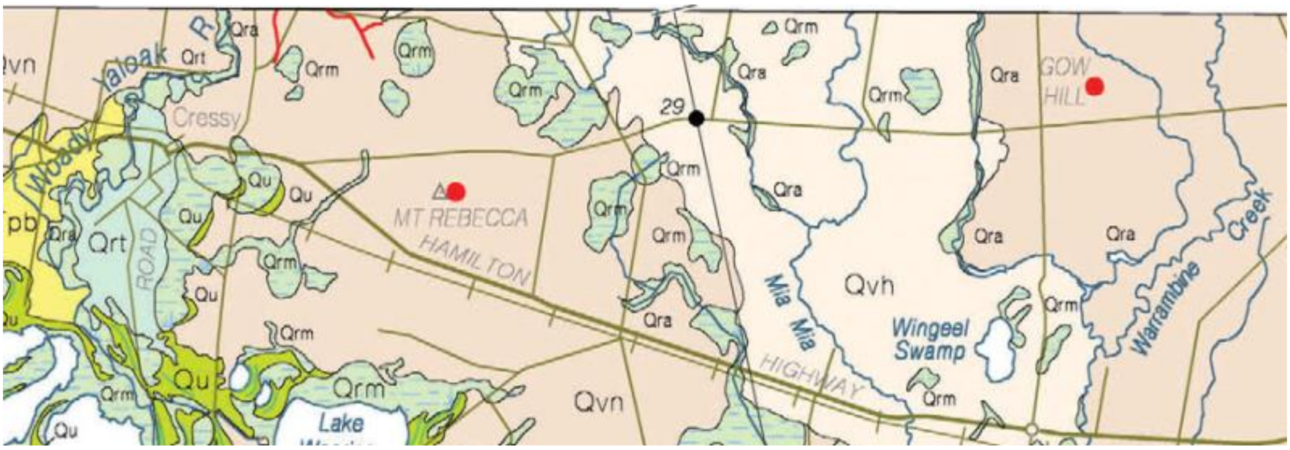


Qvn TERTIARY TO QUATERNARY *Extrusive: tholeiitic to alkaline basalts, minor scornia and ash*

Qra QUATERNARY *Fluvial: alluvium, gravel, sand,* silt

Qpa QUATERNARY *Fluvial: gravel, sand, silt*

Qrm QUATERNARY *Paludal: lagoon and swamp deposits: silt, clay*



Qrm QUATERNARY (Recent) *Swamp, lake and estuarine deposits: clay, silt, sand, humic sand, peat, locally calcareous, minor Coxiella and beds; moderately sorted and unconsolidated*.

Qra QUATERNARY (Recent) *Alluvial flood plain deposits: silt, sand, gravel; moderately sorted and poorly consolidated*.

Qvh TERTIARY Stony rise basalt, hummocky lava flows; olvine basalt, highly vesicular

Qvn TERTIARY Undifferentiated lava flows, lava ridges and valley flows: olvine basalt; commonly microvesicular, minor columnar jointing.

Figure 2.1 : Excerpts from Ballarat (upper panel) and Colac (lower panel) 1:250,000 Geological Maps (Edwards et al. 1996b, VandenBerg 1997).

2.2 Geomorphology

The project site is positioned on what is broadly referred to as the Western Volcanic Plains. These plains were built up by sporadic volcanic eruptions over a period of 5 million years. Much of the plains were formed from lobes of larva which flowed from the eruption points, overlapping to form a veneer of basalt larval flows.

Streams draining the volcanic plains generally have a limited catchment area and the relatively low elevation and moderate rainfall reduces available runoff. Streams are generally weakly incised across the volcanic plains, and this is this case at the project site. Successive lava flows have disrupted surface drainage, with closed and semi-enclosed depressions containing wetlands. Alluvial floodplain deposits are also associated with the stream network.

Examples of the different landforms distributed across the project site are presented in Figure 2.2. The low relief topography gives rise to drainage depressions, wetlands and weakly incised waterways. Broad flat plains also characterise large parts of the project site.

Larva ridge in foreground with basal boulders covering the surface sloping towards semi-enclosed wetland that forms part of Mia Mia Creek in background (West of Eastern Access Road)

Closed drainage depression containing wetland, referred to as Baths Swamp (West of Bells Road)

Ferrers Creek, a relatively small stream incised into the volcanic plains (West of Geggies Road)

Flat volcanic plains. Basalt boulders are scattered across the surface in foreground but absent in background, most likely removed to improve the productivity of agricultural land (West of Wingeel Road)

Figure 2.2 : Selection of photographs highlighting different landform features that are present at the project site. **Source, Jacobs**

2.3 Soils

This description of the soils is based on that documented in Robinson et al. (2013). Three different soil types and their potential occurrence in the landscape are described in Table 2.1.

Table 2.1 : Soil types and their potential occurrence in the landscape (Robinson et al. 2013)

Soil Type	Potential occurrence in landscape
Black and grey strongly sodic texture contrast soils	Occur extensively on the basic volcanic plains, generally in less stony areas.
Brown, black and grey non-sodic and sodic texture contrast soils	Occur extensively on basic volcanic deposits including ash deposits and moister areas (compared with the strongly sodic soils) and can be moderately acidic to alkaline.
Red and black strongly structured gradational and uniform soils (earths and loams)	Occur on basic volcanic deposits in well drained areas and positions, such as eruption points and associated scoria and ash deposits, as well as scattered occurrences on the basaltic volcanic plains including many stony rises.

At the time of the field inspection in August 2016 the soils were visibly noted as being saturated with water, this even being observed on the high points of the landscape and sloping areas. The saturated conditions are likely a response to a recent period of increased rainfall combined with generally shallow water tables that characterise the region and higher potential for waterlogging that is typically associated with clayey soils.

Saturated soils on elevated ridge (East of Eastern Access Road)

Waterlogged soils on slopes (East of Eastern Access Road)

Figure 2.3 : Selection of photographs showing condition of saturated soils at the project site at the time of the field inspection (August 2016**). Source, Jacobs**

3. Landform Significance and Sensitivity

3.1 Potential landform significance

A selection of photographs for the project site that shows the condition and significance of different landform features is presented in Figure 3.1. No sites of geological and geomorphological significance have been formally recognised in the project site[2].

Lava ridge and lobe formations, the overall morphology of these features are preserved in the landscape. Note also standing water (East of Meadows Road)

Harvesting of basalt boulders from volcanic plains and formation of rock piles (West of Wingeel Road)

Stony rise (West of Wingeel Road)

Rock wall in foreground and piles of harvested basalt boulders distributed across plains (North of Cressy Shelford Road)

Figure 3.1 : Selection of photographs that highlight condition of landform features at the project site**. Source, Jacobs**

Some larva ridge and lobe features still remain in the landscape as high points. The project site is subject to extensive grazing and cropping (Figure 3.2). In order to improve the agricultural productivity of the area, rock boulders have been removed and these areas levelled. Harvested rock has been used to form rock walls or stored in rock piles. The natural surface topography and landforms have been markedly altered through this process.

---

[2] http://vro.agriculture.vic.gov.au/dpi/vro/coranregn.nsf/pages/corangamite_landform_significance

Rock piles harvested from plains providing pasture for stock (West of Bells Road)

Cropped area, with notable absence of basalt boulders. It is likely that these have been removed and the land levelled. (East of Geggies Road)

Figure 3.2 : Photographs showing alteration of landforms linked to grazing and cropping activities across the site. **Source, Jacobs**

The waterways that traverse the project site (Mia Mia Creek, Ferres Creek, Kurac a Rac Creek or its alternative name Meadows Creek and Woady Yaloak River) are mapped as having a poor or marginal Index of Stream Condition[3]. The degraded nature of these waterways was apparent during field observations. The waterways directly adjoin cropped land or open pasture and are generally unfenced, which provides open access to stock (Figure 3.3). Kurac a Rac Creek east of Meadows Road was observed to be in a poor condition, with an incised morphology, a general absence of vegetation and a number of dead trees noted along its course (Figure 3.3).

Mia Mia Creek comprises a series of wetlands and connecting channels (West of Eastern Access Road)

Degraded section of Kurac a Rac Creek (also referred to as Meadows Creek) incised through alluvial floodplain (East of Meadows Road)

Figure 3.3 : Selected photographs of Mia Mia and Kurac a Rac Creek which are fairly representative of the condition of waterways across the project site. Wetland and stream corridors are unfenced, the vegetation and channel form are in a degraded state. **Source, Jacobs**

[3] http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

Woady Yaloak River, looking upstream from Gilletts Road bridge at channel with sand bend and degraded channel banks.

Woady Yaloak River, looking downstream from Gilletts Road bridge at channel. Stock were observed grazing within the channel.

Figure 3.4 : Woady Yaloak River looking upstream and downstream from Gilletts Road bridge at degraded channel conditions. **Source, Jacobs**

3.2 Landform sensitivity

Construction and operation of the project will modify the terrain and surface geology of the area on which the infrastructure are built. This will include excavations for turbine towers, transmission line and associated infrastructure, underground cables and construction of vehicle tracks.

Landforms that are potentially sensitive to physical changes include the stony rises and ridges that have steep gradients and where there are rapid changes of slope and aspect. These rocky strewn surfaces are a constraint on constructability of infrastructure as well as the movement of vehicles traversing the site. The swampy depressions and creek-lines that are prone to flooding and have compressible soils are also sensitive to physical change. Low lying areas that are waterlogged with organic soils also have low load-bearing capacity. These areas should be taken into account when siting tracks and project infrastructure.

The erodibility of soils is increased when vegetation is removed from the surface during earthworks and/or drainage patterns are altered so that areas experience higher rates of runoff, and potentially increased erosion risk. These risks will need to be managed during soil excavation, stock-piling and back-filling. Dahlaus (2006) showed that erosion susceptibility of landforms and soils was generally low for the project site. Areas of potential for sheet and rill erosion were very low, except for along drainage lines which had a moderate susceptibility. Gully erosion susceptibility was classed as very low across the project site.

The potential for large scale mass movement of surface and subsurface soil and regolith is limited by the low local relief and the absence of long steep slopes. Large loose blocks on the crests and upper slopes of lava ridges have the potential to topple, roll or slide, particularly when disturbed by machinery.

Ground conditions at the time of the field inspection in August 2016 were very wet, with saturated soils and standing water observed across the project site, in depressions, on sloping ground as well as on tops of lava ridges. Public roads traversing the site were still trafficable, although slippery in some locations, with water collected in drains or adjacent berms running alongside the roads. Informal tracks heading off into pasture and cropped fields lack drainage works. Water was ponded at the surface and the presence of wheel ruts attests to waterlogged soils and generally boggy conditions limiting vehicle movements (Figure 3.1).

Waterlogged soils, boggy conditions and wheel ruts
(West of Bells Road)

Ponded water on track through cropped area
(East of Meadows Road)

Figure 3.5 : Observed saturated soil conditions and ponding of water at surface of tracks traversing pasture and cropped fields at the project site when inspected (August 2016). **Source, Jacobs**

4. Conclusions and Management Recommendations

4.1 Landforms and sensitivity to physical changes

The geology and landforms of the project site are dominated by Tertiary to Quaternary flows of basalt lava. A shallow drainage network has developed around these larval flows. Successive lava flows have disrupted surface drainage, with closed and semi-enclosed depressions containing wetlands. At the time of the field inspection in August 2016 the soils were visibly noted as being saturated with water, this even being observed on the high points of the landscape and sloping areas.

The natural surface topography and landforms across the project site have been markedly altered as a result of grazing and cropping. Rock boulders have been removed from the landscape, particularly on the volcanic plains and these areas levelled. Harvested rock has been used to form rock walls or stored in rock piles. The waterways that traverse the project site are mapped as having a poor or marginal Index of Stream Condition. The waterways directly adjoin cropped land or open pasture and are generally unfenced, which provides open access to stock, contributing to their poor condition and incised channel form.

Previous work by Dahlaus (2006) and Robinson et al. (2013) showed that erosion susceptibility of landforms and soils was generally low for the project site. Areas of potential for sheet and rill erosion were assessed as very low, except for along drainage lines which had a moderate susceptibility. Gully erosion susceptibility was classed as very low across the project site. Landforms that are potentially sensitive to physical changes associated with the construction and operation of the wind and solar farm include the stony rises and ridges that have steep gradients and where there are rapid changes of slope and aspect. Low lying areas that are waterlogged with organic soils also have low load-bearing capacity. These areas should be taken into account when siting tracks and project infrastructure.

4.2 Management recommendations

While the landforms and soils of the project site are regarded as having low erodibility (Dahlaus 2006, Robinson et al. 2013), this does not take into account the localised impact construction or frequent movement of heavy vehicles. This has the potential to alter the topography of the landforms, reduce vegetation cover and cause compaction and breakdown of soil structure resulting in the erosion and degradation of unprotected surfaces. This would have direct on-site impact and may also have off-site impacts for soil and water quality.

These potential impacts can be mitigated by careful site management. It is recommended that an Erosion and Sediment Management Plan is developed that recognises the potential for the erosion and degradation of landforms and implements appropriate procedures to avoid or minimise those impacts. The following is a list of procedures developed for general erosion and sediment control, soil stockpiles, access tracks and hardstand areas, and waterway crossings which should be included within such a Plan.

- General erosion and sediment control
  - Minimising land clearance and avoid clearing steep slopes;
  - Protecting existing drainage lines and minimising the diversion of these lines;
  - Diverting surface water around the construction footprint of the associated infrastructure using drainage structures such as catch drains, bunds, silt fences etc;
  - Installing erosion control measures to minimise the amount of silt erosion and to prevent the export of sediments from the site. Measures are likely to include geotextile silt fences (with sedimentation basins where appropriate) being located on all drainage lines which are likely to receive runoff from exposed and disturbed areas;
  - Locating sediment traps and basins so they do not create adverse flood risks;
  - Using wherever possible, existing vegetation surrounding the construction site as a buffer zone for filtering surface runoff.

- Soil stockpiles
  - Locating all soil stockpiles at least 30 m away from drainage lines;
  - Retaining separate soil horizons in separate stockpiles and not mixed;
  - Designing stockpiles with slopes no greater than 2:1 (horizontal/vertical);
  - Stabilising stockpiles and implementing control measures. Measures may include mulching top soil and seeding the stockpile with sterile grasses;
  - Manage dust suppression to prevent surface water runoff;
  - Implementation, of sediment controls, if necessary, around unstable stockpiles.
- Access tracks and hard stand areas
  - Designing access tracks constructed to minimise erosion and avoid the generation of mud both during and after construction. Mitigation methods include:
    1) Constructing windrows along the boundary of each track in areas prone to erosion;
    2) Compacting crushed rock into the surface to bind it together;
    3) Avoiding tracks that run directly down a face of the slope. If this is unavoidable, regular gutters across tracks running directly down the face of a slope;
  - Ongoing maintenance of access tracks and hardstand areas to limit any erosion. Specific attention to to access tracks that are on steeper gradients, near waterways and at waterway crossings. Minimise physical disturbance to the banks and beds of waterways;
  - Limiting site access to nominated and controlled areas;
  - Minimise soil and mud on public roads.
- Waterway crossings
  - Preparing a Work Method Statement prior to construction to specifically address sediment and silt management controls and vegetation management techniques.
  - Submitting a Work Method Statement for approval prior to construction which specifically addresses:
    1) Processes for machinery to access the waterway,
    2) How flows will be diverted in low and high flow events,
    3) Evacuation procedures in times of high flows.

5. References

Dahlaus, P. (2006). Landslide and Erosion Susceptibility Mapping in the CCMA Region: Report prepared by A.S. Miner Geotechnical Consulting Engineers.

Edwards, J., Tickell, S. J., Willocks, A. J., Eaton, A. R., & Cramer, M. L. (1996a). Colac (Vol. 98): Geological Survey of Victoria Report.

Edwards, J., Tickell, S. J., Willocks, A. J., Eaton, A. R., & Cramer, M. L. (Cartographer). (1996b). Colac 1:250,000 geological map.

Robinson, N., Rees, D., Reynard, K., MacEwan, R., Dahlaus, P., Imhof, M., Boyle, G., & Baxter, N. (2013). A land resources assessment of the Corangamite region: Report prepared by Primary Industries Research Victoria, Bendigo.

VandenBerg, A. H. M. (Cartographer). (1997). Ballarat 1:250,000 geological map.