Environmental & Social Consultants

PRELIMINARY HYDROLOGY ASSESSMENT

Moreton Hill Wind Farm

FINAL

November 2023

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Moreton Hill Wind Farm

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
MHWF Nominees Pty Ltd

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Report No.	22923/R05
Date:	November 2023

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	Emily Scott	29-May-23	Caroline Funnell	29-May-23
V2	Emily Scott	28-Sep-23	Emily Scott	28-Sep-23
Final	Emily Scott	8-Nov-23	Emily Scott	8-Nov-23

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1.0 Introduction

Umwelt has been engaged by MHWF Nominees Pty Ltd (MHWF Nominees) to prepare a Preliminary Hydrology Assessment to accompany the submission of a referral under the Victorian *Environment Effects Act 1978* (EE Act) for the proposed Moreton Hill Wind Farm (the Project).

The primary objective of the assessment was to identify existing surface water and hydrology conditions within the Project site and surrounds, and the preliminary identification of potential for impacts to arise from the Project.

1.1 Project Overview

The Project is located in the Central Highlands region of western Victoria, within the Golden Plains Shire and the Corangamite Shire, approximately 35 km southwest of Ballarat. The wind farm site is largely bound by the Glenelg Highway in the north, Linton-Mannibadar Road in the east, Lismore-Pittong Road in the south and Mount Bute Road in the west. Rokewood Skipton Road bisects the Project site from east to west. The closest towns to the Project are Skipton and Linton, approximately 5 km to the west and east of the Project, respectively (see **Figure 1.1**).

The Project involves a renewable energy facility comprising a wind farm, a battery energy storage facility and a transmission line to connect the Project to the electricity network, and includes (but is not limited to):

- Up to 62 wind turbines, each with a generation capacity of 6.8 MW and a maximum overall tip height of 252 m.
- Hardstands at the base of each turbine.
- Underground and overhead reticulation cabling between turbines.
- Onsite electrical substation.
- A 220 kV underground transmission line connecting the Project from the onsite substation into the electricity network at Berrybank Terminal Station.
- Battery Energy Storge System (BESS) with a storage capacity of approximately 150 MW and associated water storage tanks.
- 45,000 litre water tanks at the main site entrance locations or as recommended by the Country Fire Authority (CFA) or Bushfire Risk Assessment (Fire Risk Consultants, 2023).
- Internal site access tracks.
- Up to four permanent meteorological monitoring masts.
- Operations and maintenance facilities.
- Other permanent ancillary works, including road upgrades.

The Project also requires temporary infrastructure including two construction compounds, temporary laydown areas and two concrete batching plants.

1.2 Scope of Works

The scope of works for the preliminary hydrology assessment consisted of the following:

- Identification of surface water catchments and receiving water bodies and watercourses and existing flow regimes.
- Identification of the environmental values of surface waters within the Project site and immediately downstream and water quality objectives in accordance with applicable local catchment management plans.
- Review of available flood studies, modelling, and mapping to characterise flood risks and relevant floodplain risk management plans and local planning controls relevant to the Catchment Management Authority and Local Government Authorities.
- Preliminary assessment of flooding using a rapid TUFLOW modelling for the 1% Annual Exceedance Probability (AEP) event.
- Identification of local receiving environments such as wetlands, groundwater dependent ecosystems (GDEs), water supply, other ecological communities, and the potential for impacts.

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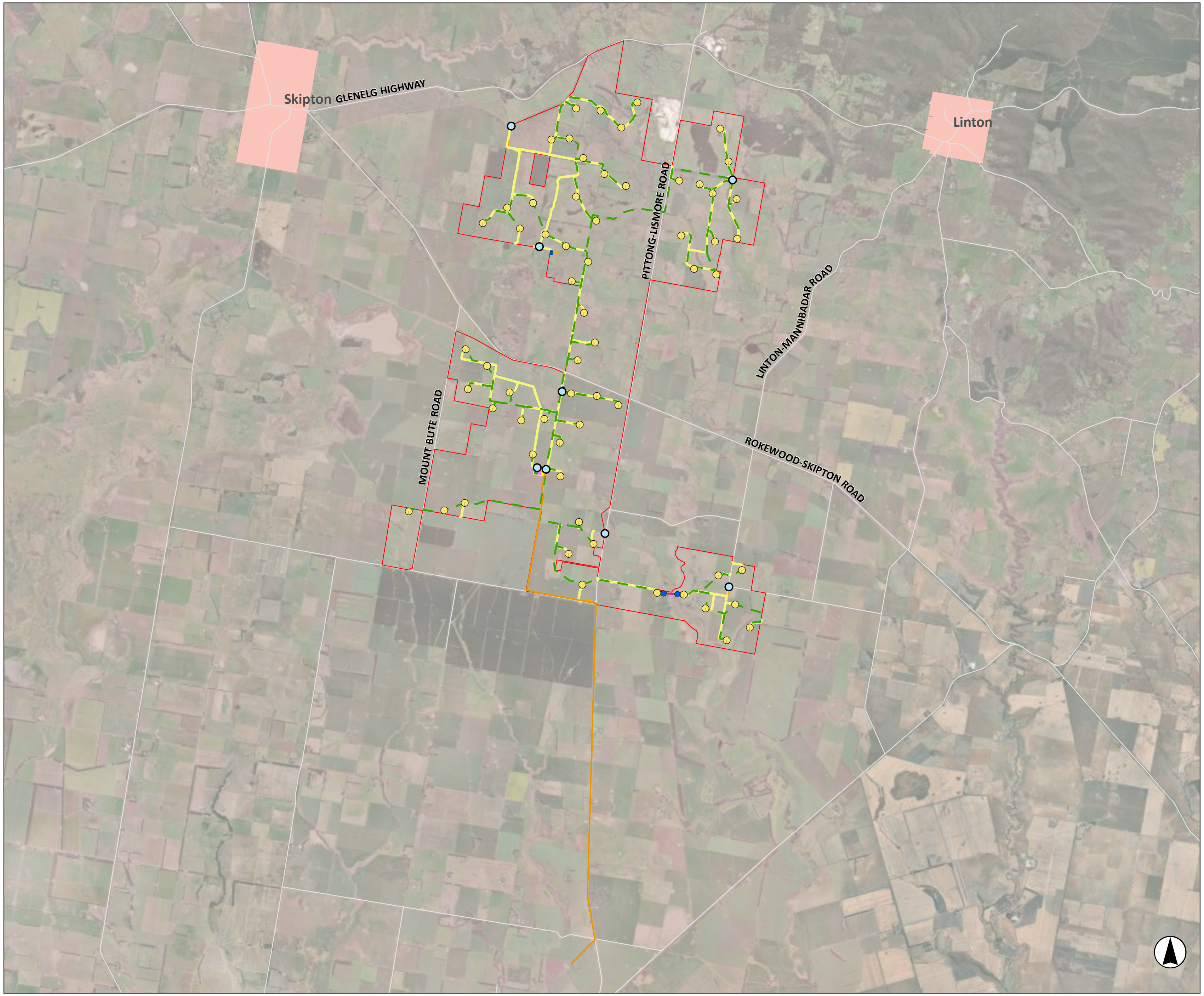
FIGURE 1.1

Project Site



Legend

- Wind Turbines
- Water Tank Location
- Overhead Electrical Reticulation Poles
- Overhead Electrical Reticulation
- Underground Electrical Reticulation
- Access Tracks
- Underground Transmission Line
- Site Substation
- Site Office Compound
- Laydown Areas
- Hardstand
- Battery 150MW
- Batching Plant
- Wind Farm Site
- Township

0 2 4
Kilometres

Scale 1:140,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

2.0 Existing Conditions

2.1 Surface Water Catchment, Topography and Hydrological Features

The local hydrological features in the vicinity of the Project are shown in **Figure 2.1**. The Project site is predominantly within the Corangamite Catchment Management Authority (CMA) boundary and lies in the upper catchment area of the Corangamite Basin. Defined watercourses within the Project site include the following which Vicmap Hydro mapping indicates are non-perennial:

- Mundy Gully which flows in a southerly direction.
- Gnarkeet Chain of Ponds which flows in a southerly direction.
- Naringhil Creek which flows in a southerly direction.
- Hoyles Creek which flows in a southerly direction and discharges to Naringhil Creek.

There is also a very small area on the northern boundary of the Project site within the Glenelg Hopkins CMA area that flows to the north to Mount Emu Creek.

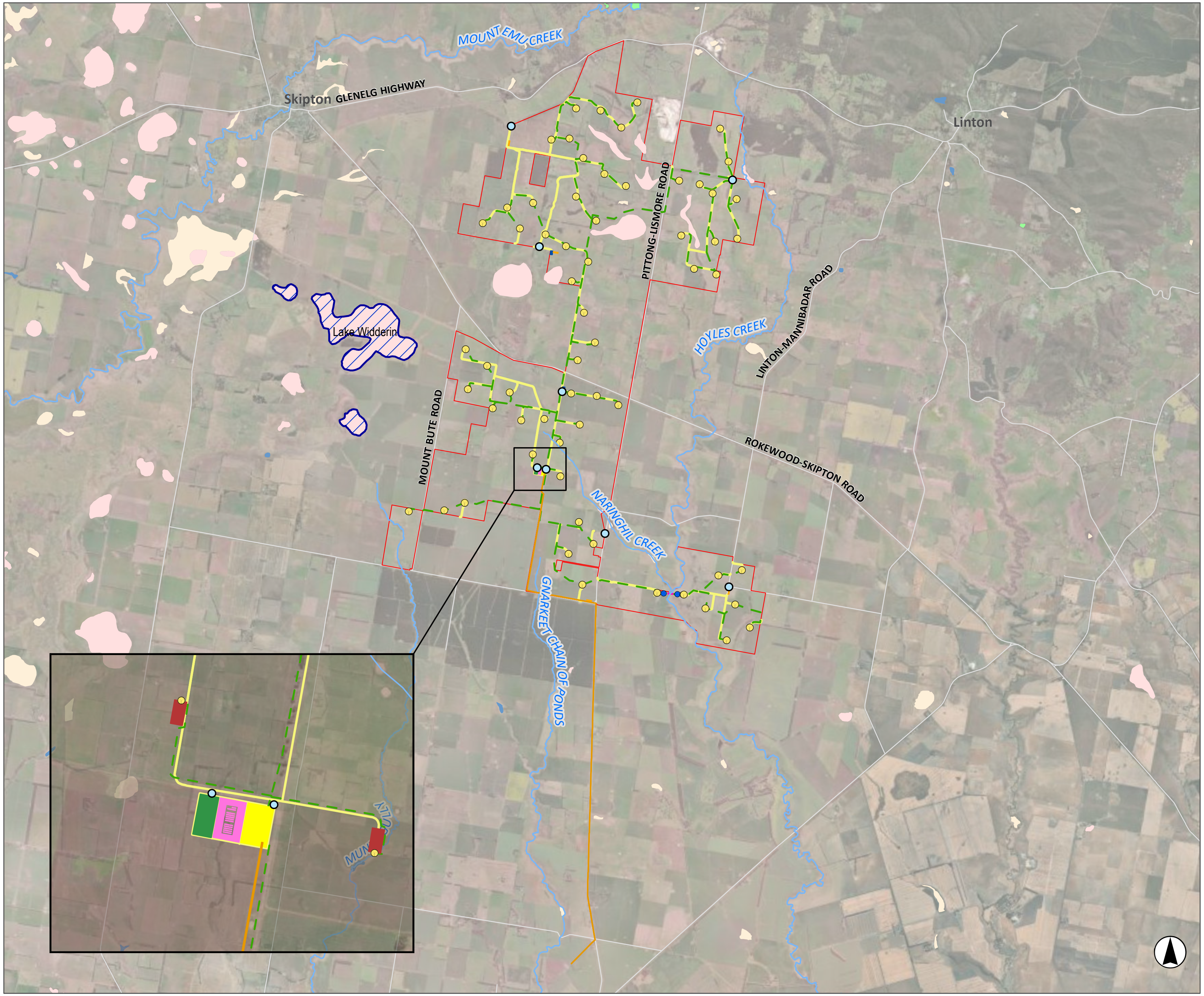
As shown on **Figure 2.2**, the majority of the Project site runoff flows to Hoyles Creek, however a smaller area of the Project site is located upstream of Lake Widderin / Widderin Swamps which is situated to the west of the Project and drains to Mundy Gully. Lake Widderin is listed as an "Important Wetland" in the *Directory of Important Wetlands in Australia* (2001). Additionally, there are several wetlands within the Project site, however none are listed as Important Wetlands or sensitive wetlands under the Ramsar Convention.

The local topography of the Project Site is shown in **Figure 2.2**. The Project site covers a series of ridgelines forming catchment divides in the north of the Project site. The topography grades from the highest peaks at elevations of over 390 m AHD down to around 220 m Australian Height Datum (AHD) along the watercourses at the southern Project site boundaries. The upper slopes draining from the high elevations can be relatively steep, generally flattening moving downstream where typical slopes are relatively flat and generally less than 2%.

The underground transmission line located along Willowvale Road does not intersect with any defined watercourses.

FIGURE 2.1

Hydrological Features



Legend

- Wind Turbines
- Water Tank Location
- Overhead Electrical Reticulation Poles
- Overhead Electrical Reticulation
- Underground Electrical Reticulation
- Access Tracks
- Underground Transmission Line
- Site Substation
- Site Office Compound
- Laydown Areas
- Hardstand
- Battery 150MW
- Batching Plant
- Wind Farm Site
- Important Wetland

Current Wetland

- Forest/woodland
- No emergent vegetation
- Sedge/grass/forb
- Unknown

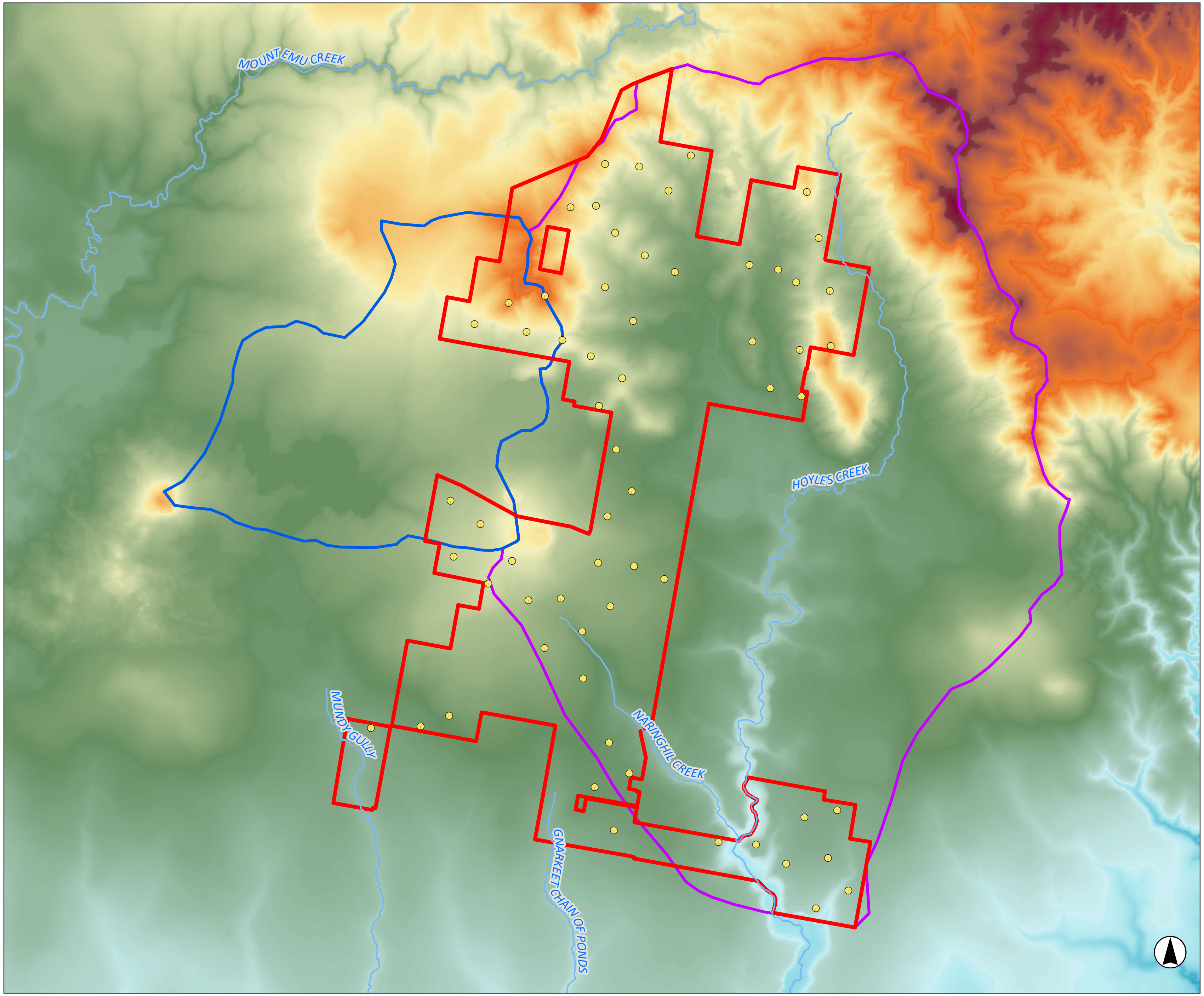
0 1 2
Kilometres

Scale 1:140,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

FIGURE 2.2

Topography



Legend

- Wind Turbines
- Wind Farm Site
- Hoyles Creek Catchment Area
- Widderin Swamp Catchment Area
- Waterways

Elevation (m)

480

170

0 1 2

Kilometres

Scale 1:100,000 at A4

GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

2.2 Groundwater Dependent Ecosystems (GDEs)

Mapped Groundwater Dependent Ecosystems (GDEs) that could be impacted by the Project are shown on **Figure 2.3**. There are both aquatic and terrestrial GDEs located within and surrounding the Project site.

Moderate to high potential aquatic GDEs are present to the west and downstream of the Project site at Widderin Swamps. It is noted however that only a small proportion of the Project site flows to Widderin Swamps with 5 of the proposed turbines located within the Widderin Swamps catchment area and two turbines located on the ridgeline between the Hoyles Creek catchment and Widderin Swamp catchment. The catchment areas are shown on **Figure 2.2**.

Low to moderate potential aquatic GDEs are present within the Project site. The aquatic GDEs within the Project area are described as wetland ecosystems.

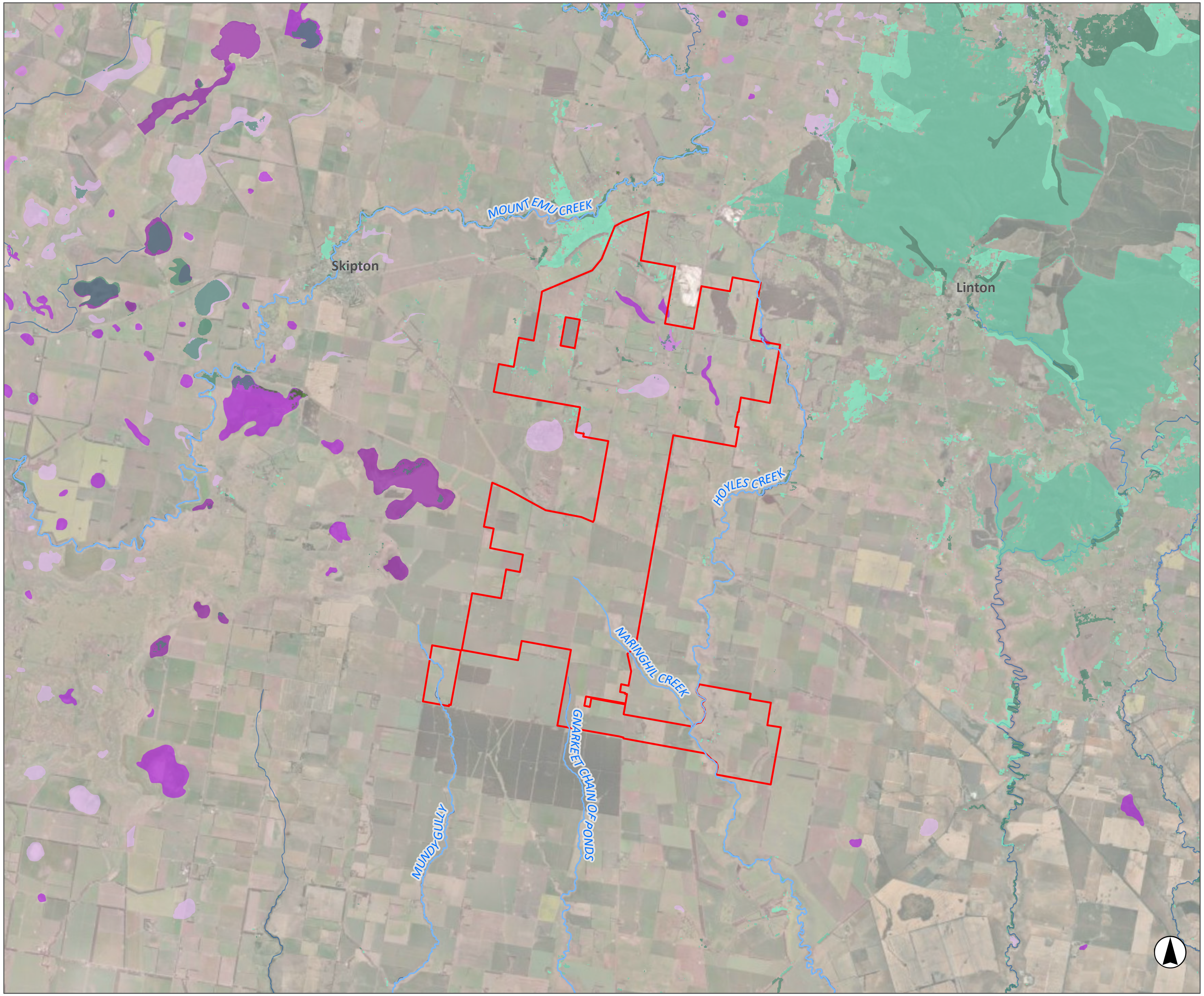
Small areas of low, moderate and high potential terrestrial GDEs are located within the Project site. The terrestrial GDEs are described as Grassy Woodland, Plains Grassy Woodland, Plains Sedgy Wetland and Riparian Woodland ecosystem types (BOM, 2017).

2.3 Water Usage and Source

The Project site is located within the Southern Rural Water and Central Highlands Water management areas. There are no registered groundwater bores within the Project site as shown on **Figure 2.3**.

FIGURE 2.3

Groundwater Dependent Ecosystems



Legend

- Wind Farm Site
- Waterways

Terrestrial GDE

- High potential GDE - from national assessment
- Low potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Known GDE - from regional studies

Aquatic GDE

- High potential GDE - from national assessment
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Unclassified potential GDE - from regional studies

0 1 2
Kilometres

Scale 1:150,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

2.4 Environment Quality Indicators and Objectives

The environmental quality indicators for the Corangamite Basin presented in **Table 2.1** are considered relevant to the Project. However, it is expected that the Project site water may vary outside of the range in water quality for the parameters presented in **Table 2.1** due to natural variation and existing impacts associated with agricultural activities. As such, water quality monitoring upstream and downstream of potential Project impacts would detect any changes in water quality with the Project and allow adaptive management to be implemented as required.

Table 2.1 Project Relevant Environmental Quality Indicators – Corangamite Basin

Parameter	Units	Value/Range
Total Phosphorus	µg/L	75^{th} percentile: ≤55
Total Nitrogen	µg/L	75^{th} percentile: ≤1000
Dissolved oxygen	% saturation	25^{th} percentile: ≥65 Maximum: 130
Turbidity	NTU	75^{th} percentile: ≤20
Electrical conductivity	µS/cm @ 25°C	75^{th} percentile: ≤2000
pH	-	25^{th} percentile: ≥7 75^{th} percentile: ≤8
Toxicants Water	-	95% protection
Toxicants Sediment	-	Low

3.0 Flooding

There is limited flood study data available for the Project site and therefore, flood risk has been assessed with a high-level hydraulic model as described below.

3.1 Rapid TUFLOW Hydraulic Assessment

3.1.1 Model Setup

A TUFLOW hydraulic model was developed to estimate indicative 1% Annual Exceedance Probability (AEP) flood extents to assist in consideration of site design and configuration. The setup and configuration of the TUFLOW model is outlined as follows:

- A 10 m resolution Digital Elevation Model (DEM) was available from Vicmap. A TUFLOW 2dimensional (2D) domain resolution of 10 m was adopted for the Project site. The ground surface elevation for the TUFLOW model grid points are sampled directly from the DEM. It is noted that LiDAR for the Project site will be flown in the near future and it is recommended that the DEM is updated with this LiDAR if the model is refined in the future.
- Design rainfall inputs are derived from the latest Australian Rainfall and Runoff (ARR) 2019 guidelines These consist of 2016 Intensity-Frequency-Duration (IFD) design rainfalls available from the Bureau of Meteorology (*http://www.bom.gov.au/water/designRainfalls/revised-ifd/*) with an ensemble of ten temporal patterns for each storm duration available from the ARR datahub.
- Design storm rainfall losses were estimated using the ARR datahub. For the 1% AEP design event these were typically in the order of 20 mm for storm durations up to 24 hours. The continuing loss was 4.9 mm/hr.
- A course resolution hydraulic roughness map was established using aerial imagery. The Manning 'n' value of 0.06 was adopted and 0.02 for ponding. Aerial photography of the Project site will be prepared in the near future, which will enable the hydraulic roughness map to be refined based on this aerial imagery.
- No hydraulic structures were included in the model.
- An initial water level was applied to ponds and dams assuming at capacity.

3.1.2 Verification of Results

There are no river flow gauges in the vicinity of the Project site and therefore, in the absence of calibration data, the estimated design flows were compared with those produced by the ARR Regional Flood Frequency Estimation (RFFE) method. The RFFE Method is a replacement for the Probabilistic Rational Method described in the previous version of ARR. There is a general agreement between the TUFLOW and RFFE derived flows, i.e. the TUFLOW lower and upper range at all four locations. Accordingly, the developed TUFLOW model is considered fit for purpose.

Table 3.1 Comparison of 1% AEP Design Flow Estimates

Location (Refer to Figure 4.1)	TUFLOW Peak Flow (m^3/s)	RFFE Estimate (m^3/s)	RFFE Lower-Upper Range (m^3/s)
Q1	108	51.4	17–161
Q2	17	21.9	8–67
Q3	43	13	4–43
Q4	46	16.5	5–53

3.1.3 Results and Discussion

The flood model results provide the spatial distribution of flood depth, velocity and hazard across the Project site. The peak design flood conditions for the 1% AEP event are provided in **Figure 3.1, Figure 3.2** and **Figure 3.3,** for the flood depth, velocity and hazard category distributions respectively.

The flood model results have been filtered to show only inundation areas with depth greater than 0.1 m. This is required in using the direct rainfall modelling approach whereby very shallow sheet flow derived from simulating the rainfall-runoff process at every grid cell in the model.

Within the Project site, the 1% AEP flooding is relatively confined within the watercourses. Typical inundation widths along the watercourse alignments are in the order of 100 m with inundation depths up to 3.5 m towards the downstream limit of the Project site with corresponding flow velocities in the order of 2–3 m/s. The mapping shows some minor storage areas corresponding to the existing farm dams on site.

The flood hazard classification may be an important characteristic to consider if infrastructure is required within the design flood inundation extents (note this may include internal access roads and transmission lines that traverse watercourse alignments). The flood hazard is typically assessed in accordance with ARR 2019, which defines six hazard categories as presented in **Figure 3.4**.

The highest flood hazard categories are within the mapped flood extents along the main watercourse alignments as expected. Zones of high hazard (i.e. H5-H6 category) are predicted within the main channels. The higher hazard classes of H5-H6 should be avoided to limit potential damage to infrastructure, noting however that the majority of this hazard level is within the mainstream alignments. **Figure 3.3** shows that the Project's infrastructure does not intersect with these zones of high hazards, except for the crossing of Naringhil Creek / Hoyles Creek in the south-east by electrical reticulation. However, this crossing is proposed to be via overhead reticulation which avoids infrastructure intersecting with these zones of high hazard and avoids direct impacts on this watercourse. The overhead electrical reticulation poles are situated outside of these zones of high hazard.

The 1% AEP flood extents are well-defined along the main alignment of the watercourses and ponds and a large area within the Project site can be considered as "flood-free" up to the 1% AEP design event magnitude. Accordingly, the mapped flood-free area and low flood hazard zones (low depth and velocity) can be considered suitable for siting of Project infrastructure.

Waterway crossings on internal access roads will warrant considerations of the flood conditions in these watercourses with appropriate design of cross drainage to achieve flood immunity requirements for the access roads.

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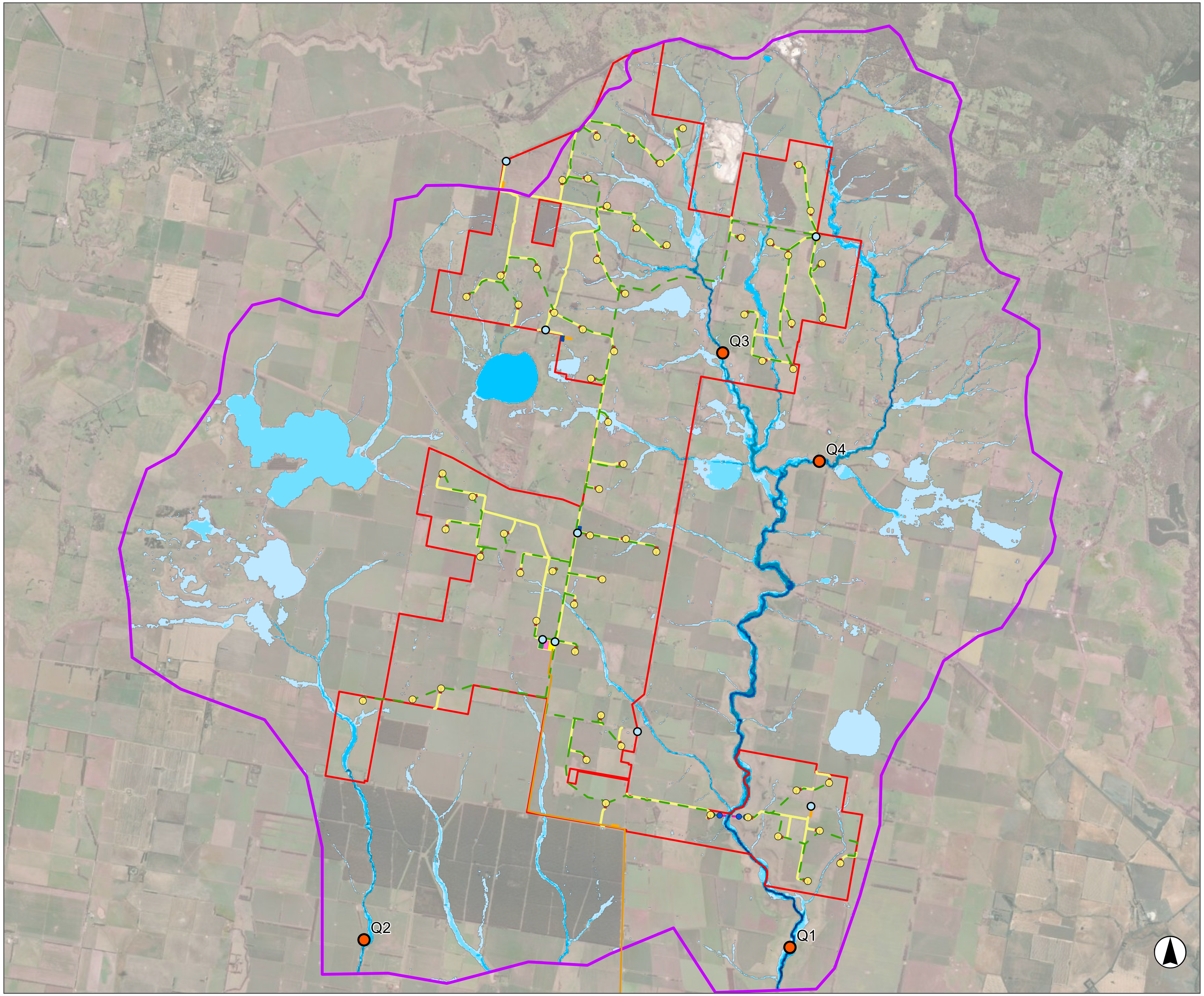

FIGURE 3.1

Indicative 1% AEP Flood Depths

Legend

- Wind Turbines
- Water Tank Location
- Overhead Electrical Reticulation Poles
- Overhead Electrical Reticulation
- Underground Electrical Reticulation
- Access Tracks
- Underground Transmission Line
- Site Substation
- Site Office Compound
- Laydown Areas
- Hardstand
- Battery 150MW
- Batching Plant
- Wind Farm Site
- Model Extent
- Flow Comparison Points

Indicative 1% AEP Flood Depths

Water Depth (m)

- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 1 2
Kilometres

Scale 1:100,000 at A4
GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

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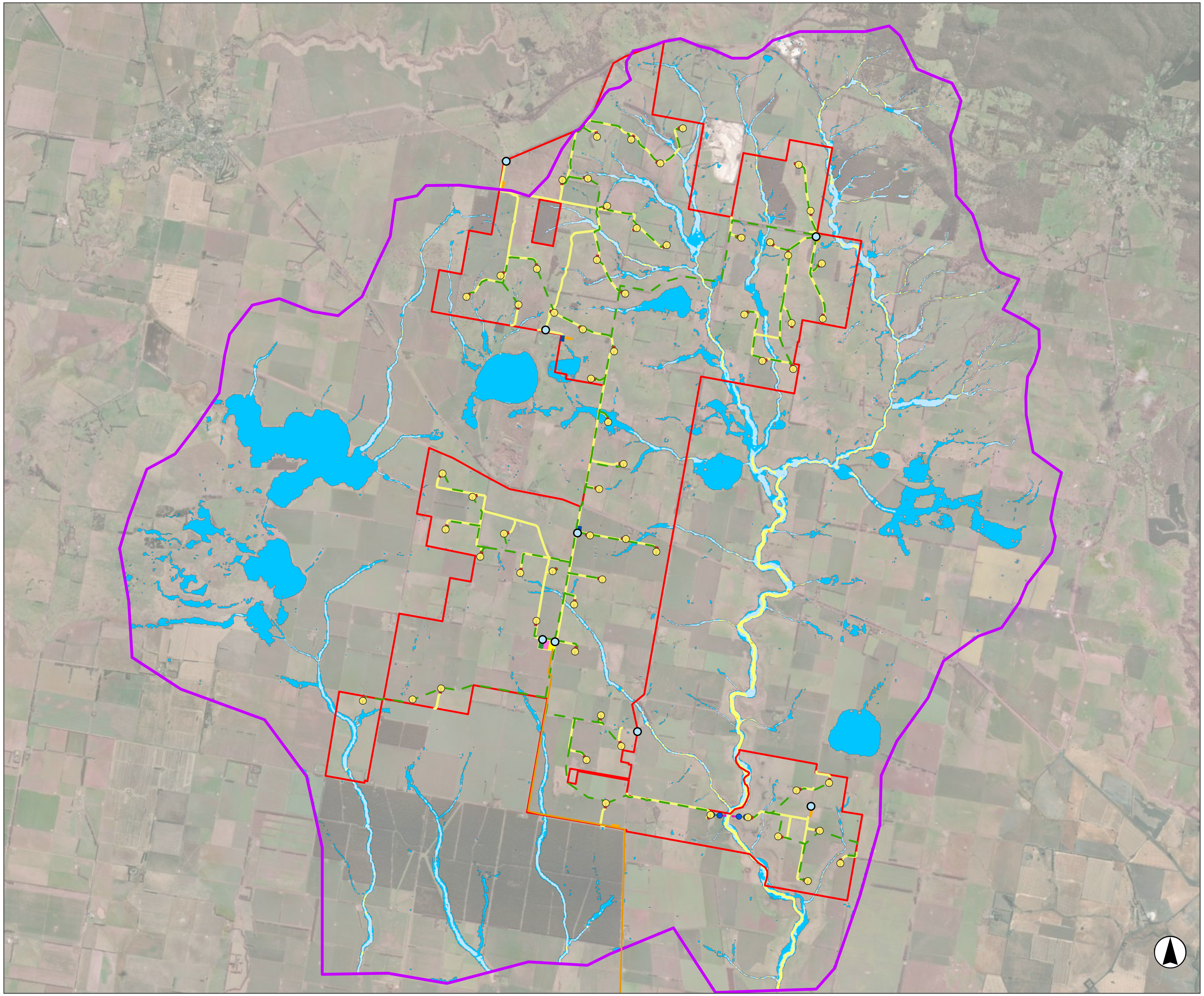
FIGURE 3.2

Indicative 1% AEP Flood Velocities



Legend

- Wind Turbines
- Water Tank Location
- Overhead Electrical Reticulation Poles
- Overhead Electrical Reticulation
- Underground Electrical Reticulation
- Access Tracks
- Underground Transmission Line
- Site Substation
- Site Office Compound
- Laydown Areas
- Hardstand
- Battery 150MW
- Batching Plant
- Wind Farm Site
- Model Extent

Indicative 1% AEP Flood Velocities

Water Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- > 3.0

0 1 2

Kilometres

Scale 1:100,000 at A4

GDA2020 MGA Zone 54

Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

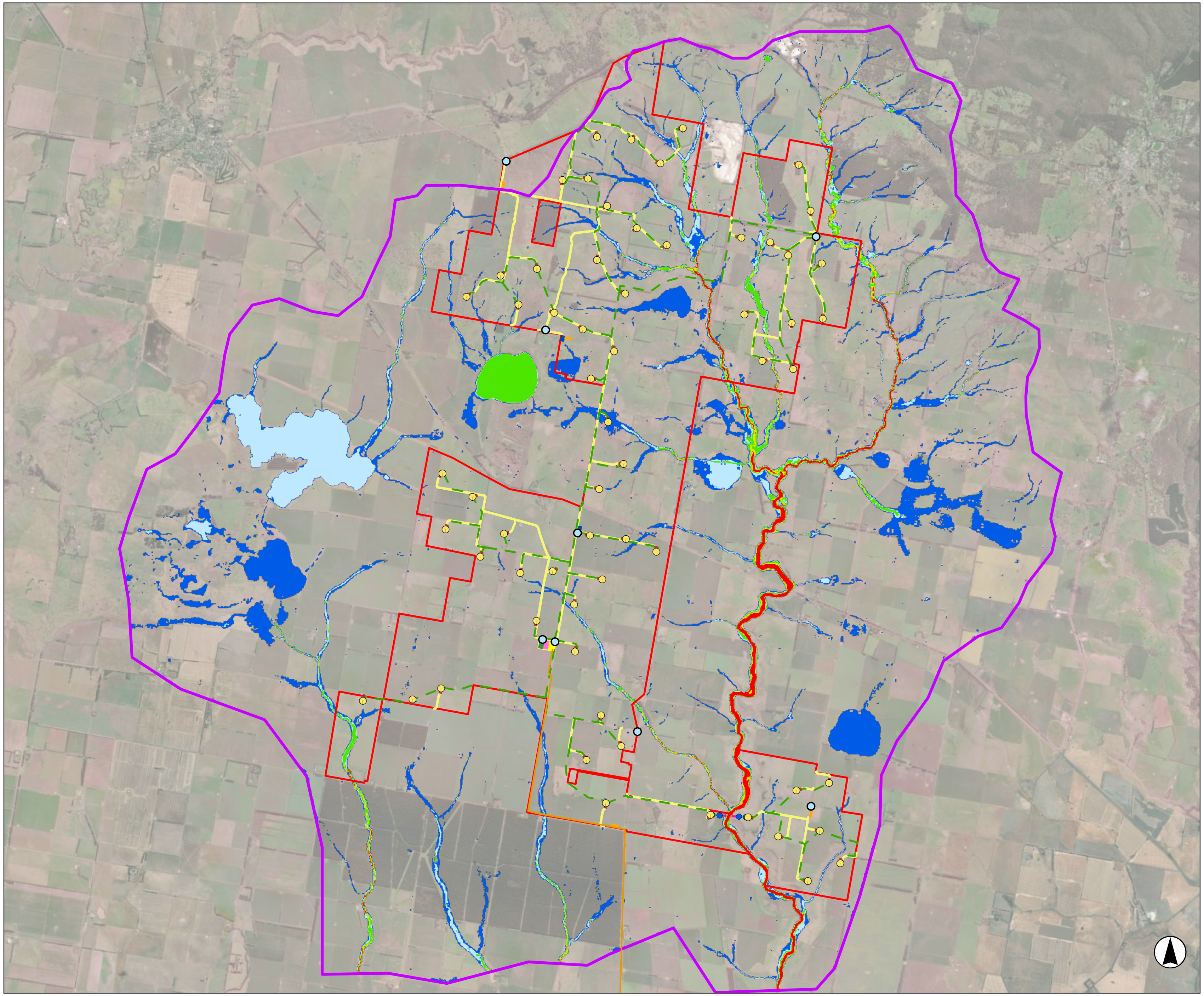


FIGURE 3.3

Indicative 1% AEP Flood Hazard Categories

Legend

- Wind Turbines
- Water Tank Location
- Overhead Electrical Reticulation Poles
- Overhead Electrical Reticulation
- Underground Electrical Reticulation
- Access Tracks
- Underground Transmission Line
- Site Substation
- Site Office Compound
- Laydown Areas
- Hardstand
- Battery 150MW
- Batching Plant
- Wind Farm Site
- Model Extent

Indicative 1% AEP Flood Hazard Categories

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

0 1 2

Kilometres

Scale 1:100,000 at A4

GDA2020 MGA Zone 54

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Image Source: ESRI Basemap (2023) **Data source:** VIC DEECA (2023)

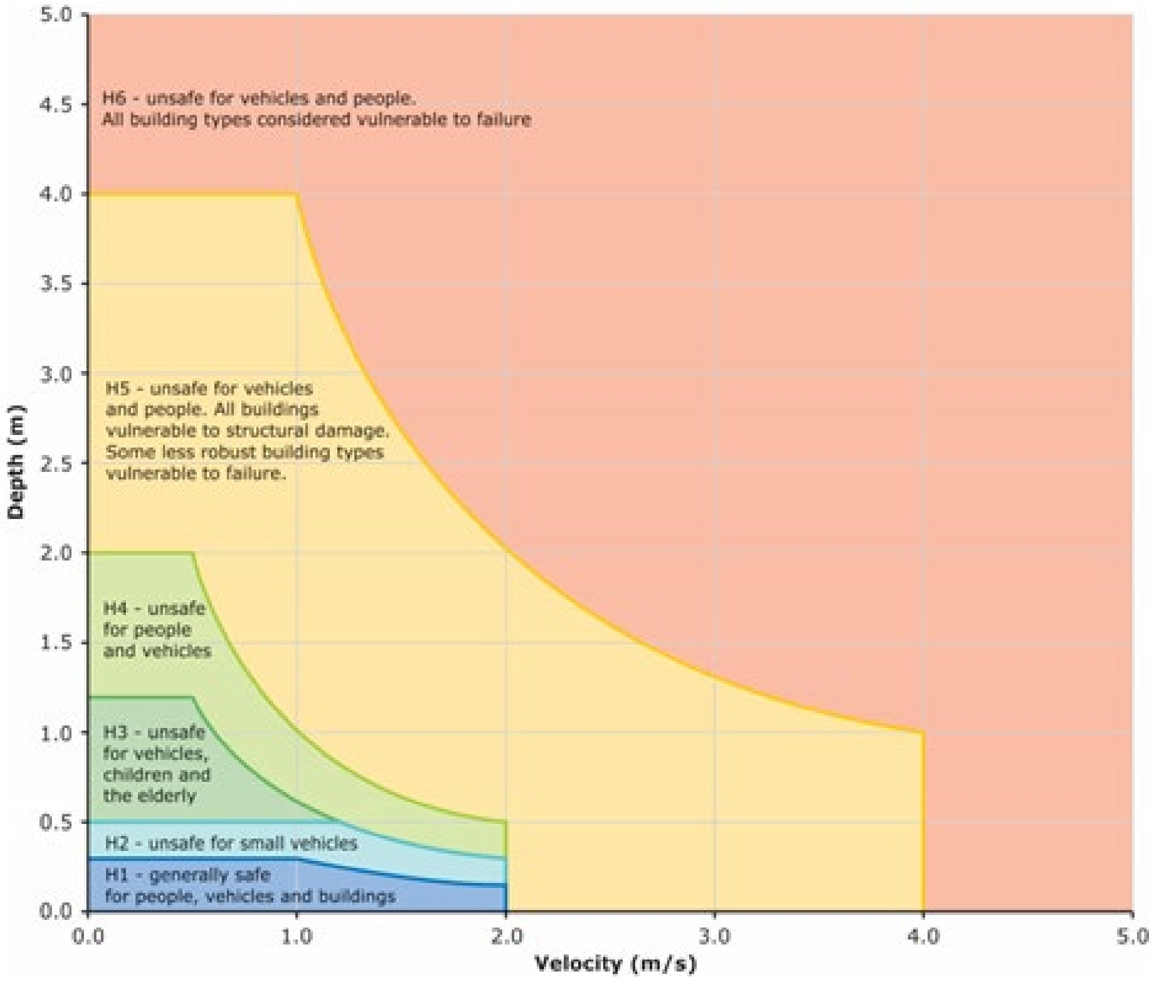

Figure 3.4 Combined Flood Hazard Curves (Smith et al. 2014)

4.0 Potential Impacts

Following definition of the existing environmental context of the Project site, potential surface water and hydrology impacts have been identified with consideration of the Project design, construction, and operation activities in the context of the existing conditions (see **Table 4.1**).

The primary impacts related to surface water are expected during the construction and decommissioning phases of the Project and are associated with surface water quality risks, mainly at the intersection of the construction works with watercourses and a general risk of erosion as a result of disturbed or exposed soils. These potential impacts are primarily a result of potential trenching through waterways if required by the Project, and surface water runoff from disturbed areas. However, these potential impacts are not considered likely to be significant.

Table 4.1 Potential Impacts

Environmental Aspect	Description of Potential Impact	Potential Mitigation Measures
Surface Water Quality – Erosion and Sedimentation (construction)	Construction and decommissioning activities such as vegetation removal, earthworks (including disturbance of acid sulfate soils, if present) and movement of heavy vehicles have the potential to impact the surface water quality of watercourses within the Project site and result in soil erosion and sedimentation in downstream waterways. Discharge of sediments (both air and water borne) from exposed ground during construction may result in adverse impacts on receiving environment surface water quality.	It is noted that the Geotechnical Desktop Study prepared for the Project (Melbourne Geotechnics, 2023) determined that it is unlikely for acid sulfate soils to be present within the Project site. • Works in waterways should be avoided during wet weather. • Works on Waterways Permits will be required and design of waterway crossings for roads and cables, etc., will adhere to the permit conditions and design requirements of the local CMA. • Industry best practice Construction Environmental Management Plan (CEMP) to be implemented which includes a Waste Management Plan that addresses the storage and stockpiling of raw materials, transport of materials to site, and disposal of materials. This should also include measures to manage any potential Acid Sulfate Soils if found in excavated fill material, in accordance with the Acid Sulfate Soil Guidelines. • Erosion and sediment control measures to be detailed in a CEMP including establishment of appropriate drainage during construction, sediment controls such as sediment sumps and fencing, stockpile management, oil booms and/or sediment traps applied during works in waterways, and reinstatement measures such as reseeding and revegetation after construction works are complete. • A CEMP will be developed for the Project which will incorporate an Erosion and Sediment Control Plan and detail methods for minimising sediment laden runoff in accordance with the International Erosion Control Association's (IECA) Best Practice Erosion and Sediment (BPES) guidelines (IECA, 2008). • Water will be used for dust suppression in order to minimise airborne contaminants.
Surface Water Quality – Trenching (construction)	Trenching of ephemeral watercourses (which may occur as a result of burying the reticulation cables) and movement of heavy vehicles have the potential to impact the surface water quality of watercourses within the Project site and result in soil erosion and sedimentation in downstream waterways.	It is noted that of the defined watercourses within the Project site, only Naringhil Creek is crossed by underground reticulation (on Rankin Road) and may be trenched. The crossing of Naringhil Creek / Hoyles Creek in the south-east by reticulation is proposed to be via overhead reticulation to avoid direct impacts on this watercourse associated with trenching, as well as avoid direct impacts on native vegetation and cultural heritage. The underground transmission line does not intersect with any defined waterways. The following mitigation measures should be considered for trenching across waterways, if required: • Watercourses only to be trenched if the bed is dry, and works not to be undertaken in wet weather. • Trenching of a watercourse bank is to start at the top of the slope and work downwards. • Temporary bunding, silt fencing, and sediment dam installation are to be constructed if required. • Watercourse walls are to be re-established to a stable slope consistent with the 'natural' slope. Shaping should remove irregularities that would interfere with flows. • Where the watercourse has a surface layer of coarse material (rocks, pebbles, gravel) care should be taken to restore this surface layer.

Environmental Aspect	Description of Potential Impact	Potential Mitigation Measures
Surface Water Quality – Spills, Leaks and Litter (construction and operation)	Fuel or chemical spills, or inappropriate material storage, resulting in contamination of groundwater and/or nearby waterways and sensitive waterbodies (i.e. wetlands), resulting in environmental degradation.	• Industry best practice CEMP to be implemented which includes a Waste Management Plan that addresses the storage and stockpiling of raw materials, transport of materials to site, and disposal of materials. • Appropriate storage and bunding of hazardous goods and fuels to be in accordance with best practice and safety sheets as detailed in a CEMP. • Location of site sheds/storage areas and construction vehicle parking to be identified in CEMP away from sensitive areas, including a buffer distance from waterways. • Spill Management Protocol to be implemented if any spills occur in the Project site.
Groundwater (construction)	Impacts to groundwater resources including Groundwater Dependent Ecosystems (GDEs).	It is noted that depth to groundwater across the Project site has not been determined at this stage. The following mitigation measures should be considered: • Avoid intersecting the groundwater table during construction. • If groundwater is intersected, a dewatering plan will be prepared and implemented to ensure groundwater is managed appropriately. The dewatering plan would be incorporated into the CEMP.
Surface Water Quality (operation)	Discharge of stormwater from the Project site during operation resulting in adverse impacts on receiving environment surface and groundwater water quality.	• Operation phase mitigation measures will be guided by an Operational Management Plan developed for the Project, which will detail methods for minimising sediment loss from the Project site in accordance with best practice guidelines. • Stormwater runoff from the Project site during the operational phase will be discharged diffusely across the Project site via vegetated surfaces wherever practicable and will collect and direct stormwater to nearby drainage systems or watercourses.
Surface Water Geomorphology (operation)	Discharge of stormwater from the Project site during operational phase resulting in adverse impacts on receiving environment surface water geomorphology (e.g. stream bank erosion and scouring) or hydroecology.	• Although peak flows of stormwater runoff from the Project may increase slightly post-development at locations where surfaces are made impervious or less pervious, these increases are not expected to impact the downstream environment. This is because only a very small proportion of the catchment will be subject to development (largely only substation and BESS, turbine hardstands and transmission line pole base areas) and this runoff is expected to form a very small percentage of peak flow in receiving watercourses. • Additional specific mitigation measures to control stormwater discharge from the Project site are not considered necessary given the small volume discharged in the context of each receiving catchment. The proposed mitigation measures are considered to reduce any impacts to stream water quality and geomorphology.

5.0 Conclusion and Recommendations

This preliminary hydrology assessment has reviewed information and data to understand the potential impacts of the Project on water resources within the Project site. The scope of work involved:

- Undertaking a review of Project catchments, topography, and drainage.
- Identifying sensitive areas including wetlands and groundwater dependent ecosystems that could be impacted by the Project.
- A high-level hydrology assessment was undertaken to map the watercourse features in the Project site and develop a preliminary TUFLOW model to map indicative flood inundation extents.

The following observations are noted with respect to potential constraints on the Project:

- There are several wetlands within the Project site. A small proportion of the Project site is located upstream of Lake Widderin which is listed as an "Important Wetland".
- Various low to high potential aquatic and terrestrial wetland ecosystems have been identified within the Project site.
- The derived flood mapping indicates that flooding within the Project site is relatively confined along the watercourses for a 1% AEP flood event. Accordingly, it is considered there are no major constraints on potential development of the site with regard to flood risk.
- The greatest potential for impacts on surface water and hydrology is during construction, however impacts are not anticipated to be significant with the implementation of industry standard mitigation measures which would be implemented through a CEMP.

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