

## Appendix

# E

## **E.13 | Hazards and Risk Assessment**

# REPORT

## HAZARDS AND RISK ASSESSMENT

### SEPP RISK SCREENING AND BLADE THROW

#### DINAWAN WIND FARM (SSD-50725708)

#### EMM CONSULTING PTY LTD

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## ABBREVIATIONS

AC	Alternating Current
ADGC	Australian Dangerous Goods Code
BESS	Battery Energy Storage System
DA	Development Application
DG	Dangerous Goods
DPE	Department of Planning and Environment
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
ha	Hectare
HIPAP	Hazardous Industry Planning Advisory Paper
HV	High Voltage
km	Kilometres
kV	Kilovolt
LEP	Local Environmental Plan
LGA	Local Government Area
LPG	Liquefied Petroleum Gas
LSIR	Location Specific Individual Risk
MW	Megawatt
MWh	Megawatt hours
NSW	New South Wales
O&M	Operations and Maintenance
PHA	Preliminary Hazard Analysis
REZ	Renewable Energy Zone
rpm	Revolutions per minute
SDS	Safety Data Sheet
SEARs	(Planning) Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
WHS	Work Health and Safety
WTG	Wind Turbine Generator

## TERMINOLOGY

Consequence	Outcome or impact of a hazardous incident, including the potential for escalation.
Development footprint	The indicative extent of the project's ground disturbance area, including earthworks, associated with permanent infrastructure and temporary construction facilities.
Ice throw	The shedding of ice from a turbine blade while a turbine is in operation, with the motion of the blades potentially propelling ice over a greater distance.
Non-associated residence	A dwelling whose owners do not have parts of their property included in a land agreement with the proponent for the project.
Off-site	Areas extending beyond the development footprint boundary.
Project	Dinawan Wind Farm.
Project area	The land required for the project. The project area contains the entirety of all land lots that overlap with the development corridor. There are two private landholders with land within the project area. The project area includes parts of Goolgumbbla Road, Wilson Road, Fernbank Road, McLennons Bore Road and Kidman Way (including the road easement) and Coleambally Outfall Drain, where site access and/or electrical cabling may be required.
Proponent	Spark Renewables Pty Limited.
Risk	The likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may be either a frequency (the number of specified events occurring in unit time) or a probability (the probability of a specified event following a prior event), depending on the circumstances.

# 1. INTRODUCTION

## 1.1. Background

Spark Renewables Pty Ltd (Spark Renewables) proposes to develop the Dinawan Wind Farm (the project). The project includes the installation, operation, maintenance and decommissioning of up to approximately 200 wind turbine generators (WTGs) and associated infrastructure. The project will have a generation capacity of up to approximately 1,200 Megawatts (Alternating Current) (MW<sub>AC</sub>). The project is located about halfway between the towns of Coleambally and Jerilderie, within the Murrumbidgee and Edward River Local Government Areas (LGAs) in New South Wales (NSW). The project is within the South-West Renewable Energy Zone (REZ) and will connect to the Dinawan Substation that is currently under construction as part of the Project EnergyConnect interconnector.

The project is a State Significant Development (SSD) under the State Environmental Planning Policy (Planning Systems) 2021 and requires an Environmental Impact Statement (EIS) to accompany the Development Application (DA) submission, in accordance with the Environmental Planning and Assessment Regulation 2021.

Spark Renewables has commissioned EMM Consulting Pty Ltd (EMM) to prepare an EIS for the project. EMM has engaged Sherpa Consulting Pty Ltd (Sherpa) to address the *Dangerous Goods* and *Blade Throw* ‘Hazards and Risks’ assessment requirements of the Planning Secretary’s Environmental Assessment Requirements (SEARs), for input to the EIS.

## 1.2. Scope and objectives

The study objective was to address the (1) Dangerous Goods and (2) Blade Throw ‘Hazards and Risks’ assessment requirements of the SEARs, Ref [1]. The assessment requirements and references where they are addressed in this report are shown in Table 1.1.

**Table 1.1: Hazards and Risks assessment requirements**

Assessment requirements - <i>Hazards</i>	Section reference
Dangerous Goods - a preliminary risk screening completed in accordance with the <i>State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021</i> .	Section 3
Blade Throw – assess blade throw risks.	Section 4

## 1.3. Exclusions and limitations

The study exclusions and limitations are summarised in Table 1.2.

**Table 1.2: Exclusions and limitations**

No.	Item	Exclusions and limitations
1	Preliminary risk screening	<ul style="list-style-type: none"> <li>• The preliminary risk screening covers the assessment and determination of the ‘potentially hazardous’ nature of the project. Determination of whether the project is considered ‘potentially offensive’ was excluded.</li> <li>• The preliminary risk screening assesses storage and transport movements of hazardous substances with Dangerous Goods (DG) classification associated with the proposed operation of the project.</li> <li>• The assessment made in this study was based on information provided to Sherpa at the time of the study (e.g. DG types and quantities that will be stored and handled on site).</li> <li>• The preliminary risk screening excluded:               <ul style="list-style-type: none"> <li>– A review of codes and standards for storage and handling of DG, firefighting requirements, operations and emergency response (e.g. response to a spill or damaged/leaking container).</li> <li>– A review of whether the hazardous chemicals stored on site will exceed the placard and manifest threshold quantities specified in Schedule 11 of the NSW Work Health and Safety Regulation 2017 and subsequent requirements to comply with the Work Health and Safety (WHS) Regulation.</li> </ul> </li> </ul>
2	Blade throw risk assessment	<ul style="list-style-type: none"> <li>• Design elements for the WTGs may be subject to change prior to construction. Sherpa noted that the selection of the WTG supplier and layout of the WTGs will be finalised during detailed design. Detailed design will be conducted following project approval.</li> <li>• The SEARs do not include context nor specify objectives or requirements for the assessment. Blade throw risks to residential dwellings and BESS facilities were assessed. A BESS facility is not proposed for the project, however there are BESS facilities proposed for other SSDs located near the project. As a conservative approach blade throw impact to BESS facilities on nearest SSDs from the project was assessed. Refer to Section 4 for more details.</li> <li>• The calculated potential blade throw distances are theoretical maximum lateral throw distances based on the WTG assumed behaviour.</li> <li>• Assessment of ice throw impact distances was excluded. Sherpa’s definition of a blade throw event (i.e. structural failure incident involving the blade of a WTG) and assessment are consistent with other blade throw studies for similar wind farm facilities undertaken for SSD approval.</li> <li>• The cumulative blade throw risk impact to sensitive receptors from existing and proposed developments was not assessed. This requires knowledge of all other SSDs in the area. It is assumed that adjacent SSDs will also be subject to development controls to manage off-site risks.</li> </ul>

## 2. PROJECT DESCRIPTION

### 2.1. Location

The project will be located about halfway between the towns of Coleambally and Jerilderie, within the Murrumbidgee and Edward River LGAs, NSW. The project is within the South-West REZ.

Access to the project will be from Kidman Way via McLennons Road, Fernbank Road, Wilson Road and Goolgumbra Road. The project area<sup>1</sup> is divided into two distinct areas, the eastern wind area and the western wind area. The majority of the land within the project area is privately owned. The development footprint<sup>2</sup> will comprise an area of approximately 1,339 hectares (ha). The land within the development footprint is currently used for sheep and cattle grazing, with discrete areas for irrigated cropping.

The project area is adjacent to the Dinawan Substation, which forms part of Transgrid's Project EnergyConnect, a new high voltage (HV) interconnector being constructed between NSW and South Australia, with an additional connection to north-west Victoria.

An overview of the project location is shown in Figure 2.1. The indicative project layout are presented in Figure 2.2 (eastern area) and Figure 2.3 (western area), respectively.

### 2.2. Surrounding land use

The project area and surrounds are zoned RU1 Primary Production under the Jerilderie, Murrumbidgee and Conargo Local Environmental Plans (LEPs). The surrounding area land uses include rural residential, agriculture, and electrical and transport infrastructure. Other major projects in the vicinity of the project include Project EnergyConnect, Dinawan Solar Farm, Argoon Wind Farm, Bullawah Wind Farm and Yanco Delta Wind Farm (refer to Figure 2.1). Several other renewable energy generation projects (proposed and approved) are in the broader region, as shown in Figure 2.1.

The nearest towns to the project are Coleambally (22 km north) and Jerilderie (30 km south). Other major population centres include Griffith (80 km north) and Wagga Wagga (135 km east).

The area surrounding the project is sparsely populated. There are 14 residences within 5 km of a WTG. Of these, 4 are associated and 10 are non-associated residences. The closest non-associated residence (R019) is approximately 2 km from its nearest WTG (T122\_East).

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<sup>1</sup> The land required for the project. The project area contains the entirety of all land lots that overlap with the development corridor. There are two private landholders with land within the project area. The project area includes parts of Goolgumbra Road, Wilson Road, Fernbank Road, McLennons Bore Road and Kidman Way (including the road easement) and Coleambally Outfall Drain, where site access and/or electrical cabling may be required.

<sup>2</sup> The indicative extent of the project's ground disturbance area, including earthworks, associated with permanent infrastructure and temporary construction facilities.

Non-associated residences<sup>3</sup> or occupied areas are considered as sensitive receptors for the purposes of the risk assessment. The location of sensitive receptors in the area surrounding the project are shown in Figure 2.4.

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<sup>3</sup> Dwellings whose owners do not have parts of their property included in a land agreement with Spark Renewables for the project

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Figure 2.1: Project location

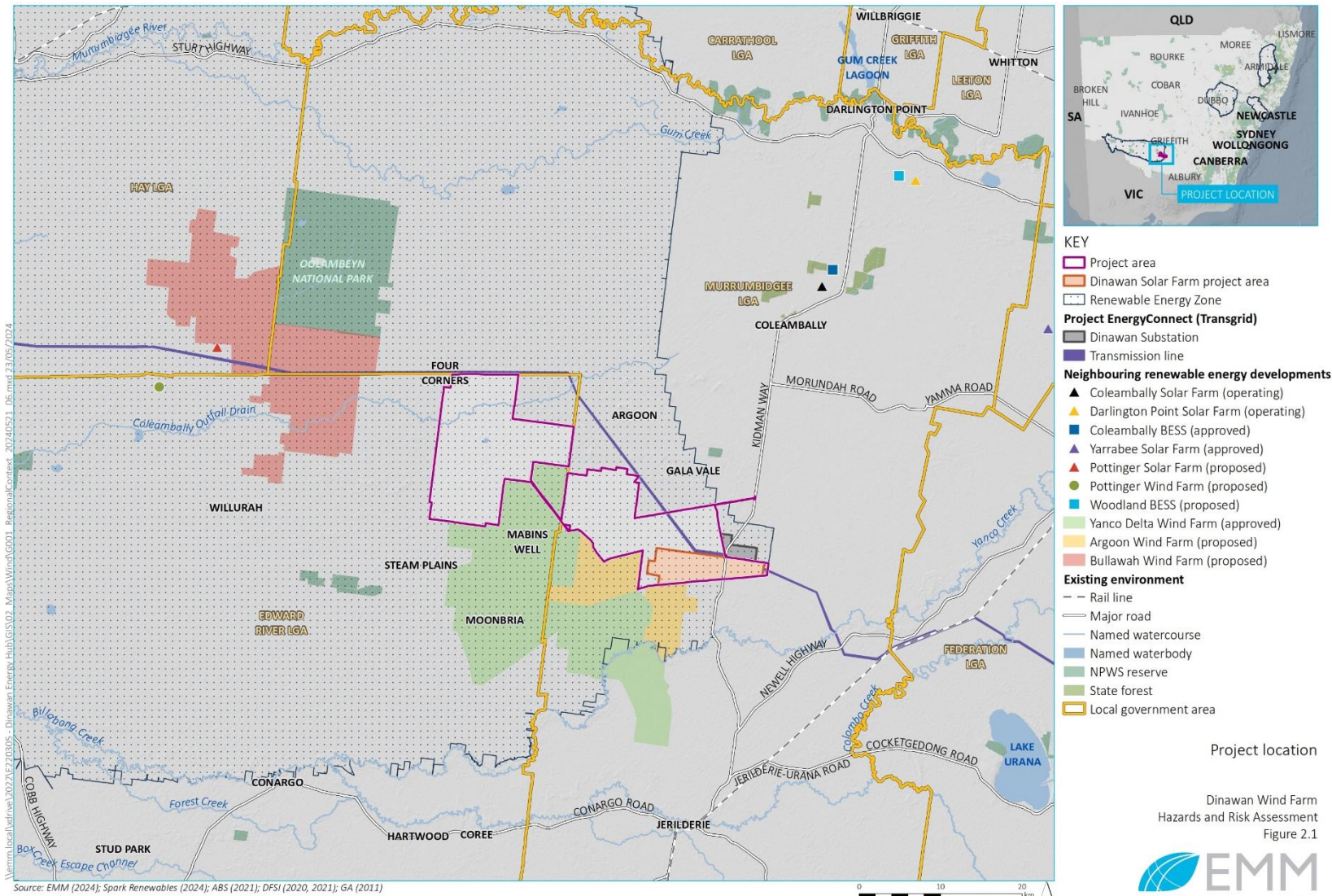


Figure 2.2: Project layout (Eastern area)

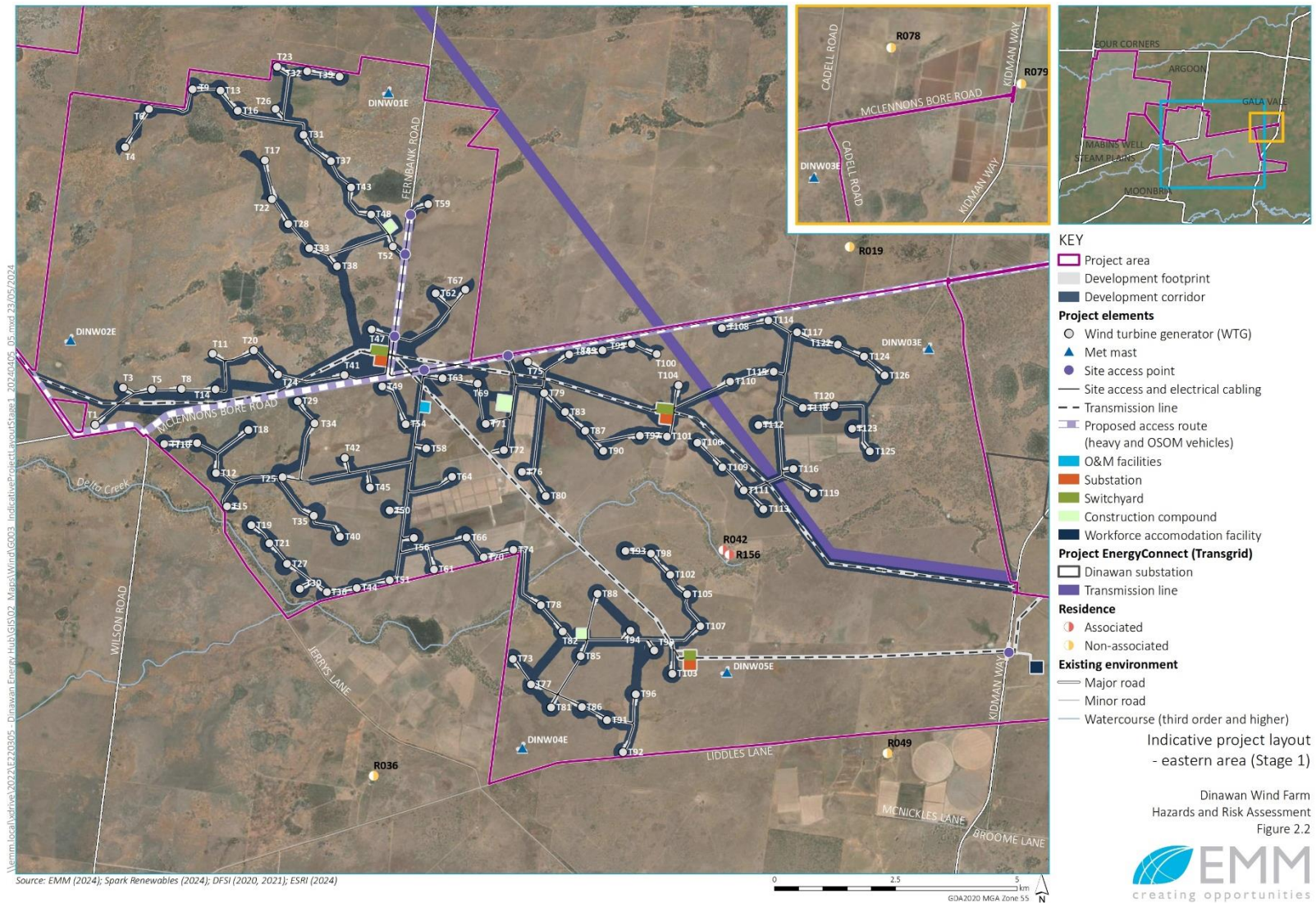


Figure 2.3: Project layout (Western area)

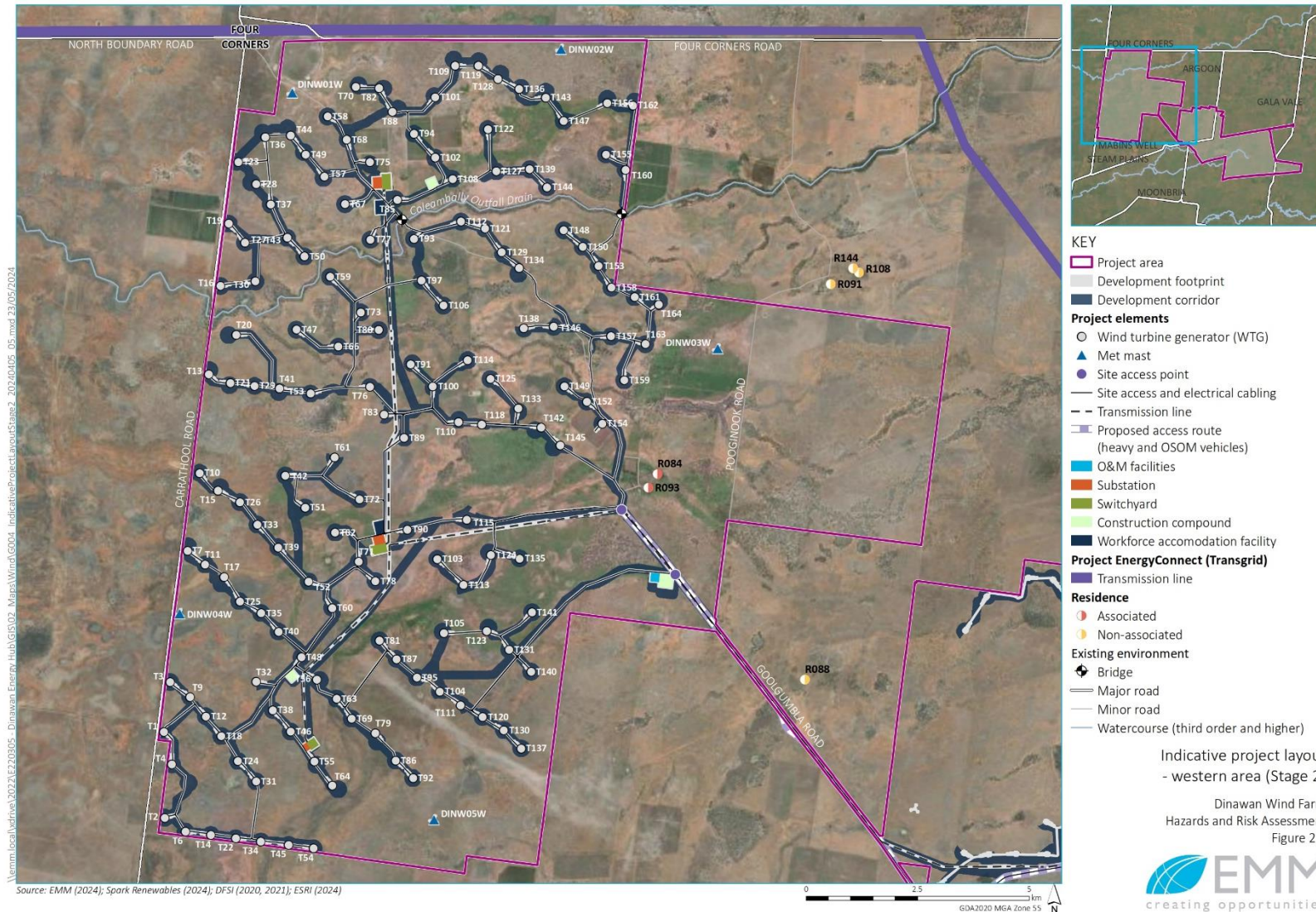
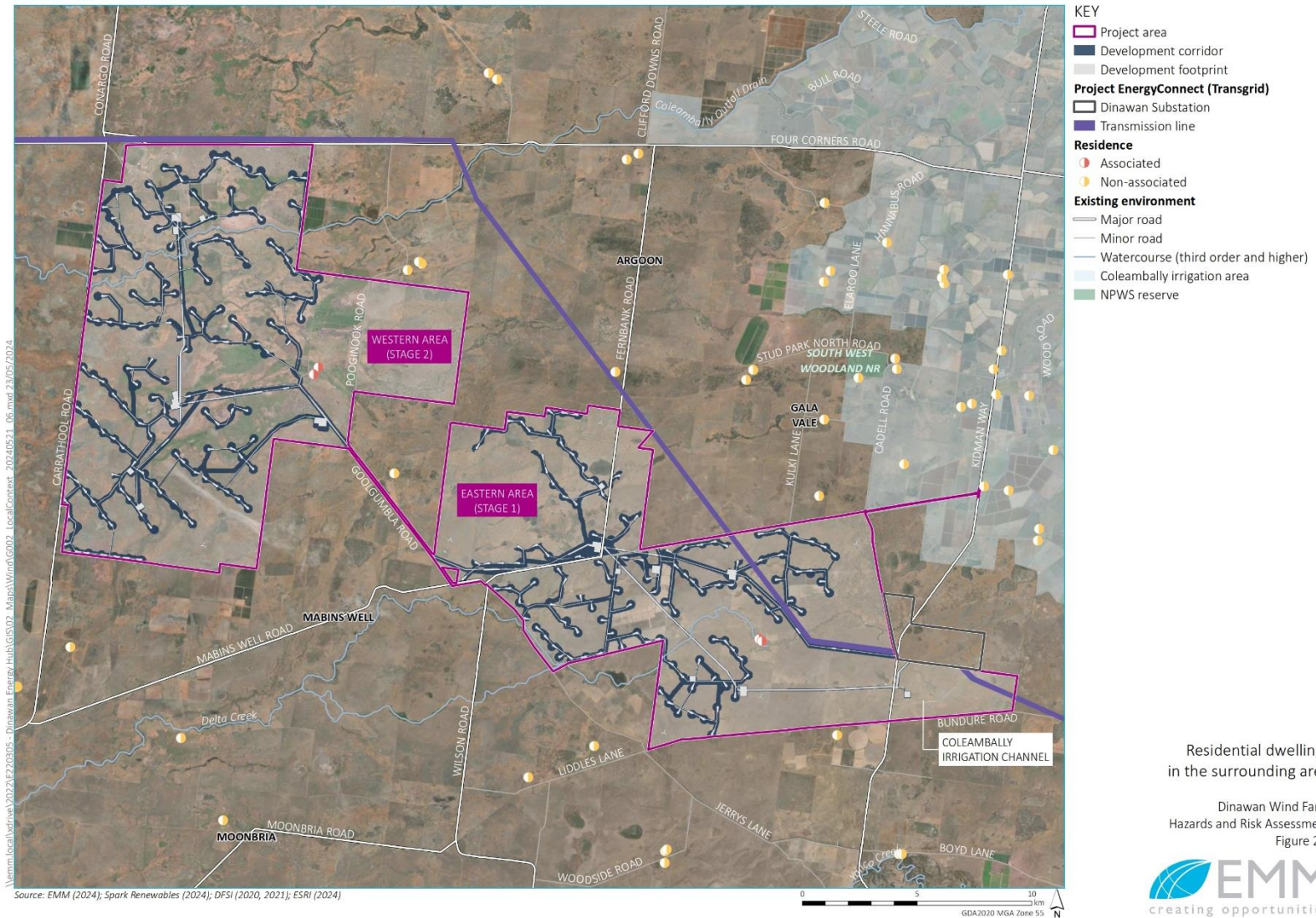


Figure 2.4: Residential dwellings in the surrounding area



Residential dwellings  
in the surrounding area

Dinawan Wind Farm  
Hazards and Risk Assessment  
Figure 2.4



### 2.3. Project key infrastructure

A summary of the indicative project key infrastructure and specification is provided in Table 2.1. A more detailed description is provided in Chapter 3 of the EIS. It should be noted that only the WTG is of relevance in this study (blade throw assessment).

**Table 2.1: Indicative project infrastructure and specification**

Component	Feature	Specification
Electricity generation	Wind turbine generators	<p>The project will consist of up to approximately 200 WTGs with a combined installed capacity of approximately 1.2 GW. Indicatively, the project WTG will have a maximum tip height of 280 m and rotor diameter of 200 m.</p> <p>The indicative layout includes 117 WTGs in the eastern and 150 WTGs in the western wind areas, respectively. The proposed layout is indicative and changes will be made during detailed design to ensure the total number of WTGs doesn't exceed approximately 200.</p>
Electrical infrastructure	On-site substations	The project will include up to five collector substations to transform electricity generated by the WTGs into a higher voltage for export to the Transgrid network via Dinawan Substation (part of Project EnergyConnect). The collector substations will convert 33 kV AC electricity from the WTGs to 330 kV.
	Electrical collection system	The project will include an internal network of underground and overhead powerlines to connect the WTGs (33 kV) to the collector substations. Connections will include power, earthing, and communications cables.
	Network connection	The project will include overhead transmission lines (330 kV) to connect the collector substations to the Dinawan Substation.
Operation and Maintenance (O&M) facilities	Control room, offices, stores, amenities	O&M facilities will be provided to support the project's operational activities and will comprise a control room, offices, storage and maintenance facilities and parking.
Access track network	Access tracks	An internal access track network connecting the WTGs and associated infrastructure will be constructed. The access track will be established for construction and maintained for use as operational access tracks.
Supporting infrastructure	Ancillary infrastructure	<ul style="list-style-type: none"> <li>• Lighting</li> <li>• Security cameras</li> <li>• Security fencing around the perimeter of high voltage electrical equipment (e.g. collector substations)</li> <li>• Lightning protection</li> <li>• Water tanks</li> <li>• Permanent meteorological masts (up to 200 m high).</li> </ul>

Component	Feature	Specification
Supporting infrastructure	Temporary construction facilities	<ul style="list-style-type: none"> <li>• Construction compounds</li> <li>• Offices and amenities</li> <li>• Concrete batching plants</li> <li>• Laydown, storage and parking areas</li> <li>• Meteorological masts</li> <li>• Storage and parking areas</li> <li>• Borrow pits</li> <li>• Water tanks and sediment management infrastructure</li> <li>• Worker accommodation facilities.</li> </ul>

## 2.4. Construction

Construction of the project is expected to be completed over approximately 60 months.

Temporary construction infrastructure, including construction compounds, site offices and internal access roads will be established before the construction work commences. An accommodation facility will be established to house workers during construction and progressively removed as the project moves into the operational stage. Most of the infrastructure would be prefabricated off-site, delivered and then assembled onsite.

## 2.5. Operations

The operational life of the project is expected to be in excess of 25-30 years.

The project will operate continuously for 24 hours per day, seven days per week.

During operations, there will be up to 50 employees to support ongoing operations and maintenance activities. Some activities will also be supported by contractor roles.

## 2.6. Decommissioning

Once the project reaches the end of its operational life, the project infrastructure will either be re-powered or decommissioned.

### 3. PRELIMINARY RISK SCREENING

#### 3.1. Overview

The objective of the preliminary risk screening was to determine whether the project is considered as 'potentially hazardous' in the context of SEPP (Resilience and Hazards) 2021.

SEPP (Resilience and Hazards) 2021, Ref [2], defines potentially hazardous industry as follows:

*'Potentially hazardous industry' means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:*

*(a) to human health, life or property, or*

*(b) to the biophysical environment,*

*and includes a hazardous industry and a hazardous storage establishment.*

Development proposals that are classified as 'potentially hazardous' industry must undergo a Preliminary Hazard Analysis (PHA) as per the requirements set in Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 *Guidelines for Hazard Analysis*, Ref [3], to determine the risk to people, property and the environment. If the residual risk exceeds the acceptability criteria, the development is considered as a 'hazardous industry' and may not be permissible within NSW.

To determine whether a proposed development is potentially hazardous, the NSW Department of Planning, Housing and Infrastructure<sup>4</sup> (DPHI) *Applying SEPP 33* guideline<sup>5</sup>, Ref [4], is used to undertake the risk screening process. The risk screening process considers the type and quantity of hazardous materials to be stored on site, distance of the storage area to the nearest site boundary, as well as the expected number of transport movements. Additionally, Appendices 2 and 3 of *Applying SEPP 33* include other risk factors to be considered to identify hazards outside the scope of the DG risk screening method and a list of industries that may be potentially hazardous, respectively.

'Hazardous materials' are defined within the guideline as substances that fall within the classification of the Australian Dangerous Goods Code (ADGC), i.e. have a DG classification. Detail of the DG classification is typically obtained from the materials' Safety Data Sheet (SDS).

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<sup>4</sup> Previously Department of Planning and Environment (DPE).

<sup>5</sup> SEPP No. 33 *Hazardous and Offensive Development* (SEPP 33) has been revoked and incorporated as Chapter 3 of *SEPP (Resilience and Hazards) 2021*. For the preliminary risk screening, the guidance document *Applying SEPP 33* still applies.

The *Applying SEPP 33* guideline is based on the 7th edition of ADGC, Ref [5], and refers to hazardous chemicals by their DG classification. Risk screening is undertaken by comparing the storage quantity and the number of road movements of the hazardous materials with the screening threshold specified in the guideline. The screening threshold presents the quantities below which it can be assumed that significant off-site risk is unlikely.

### 3.2. Risk screening

A summary of the expected hazardous materials to be stored and handled on site for the project, transport movements and the relevant SEPP screening threshold is presented in Table 3.1. These include Liquefied Petroleum Gas (LPG), gasoline and diesel. Diesel will be used during construction and operations. LPG and gasoline will be used during construction only (i.e. will not be stored or used for the long-term operations phase of the project) but are included in this study to cover the staged commencement of operations (i.e. some WTGs and project infrastructure may be operational while others are still being constructed and installed). The expected quantities are as advised by Spark Renewables.

Other materials considered as part of the SEPP risk screening include transformer oil and herbicide/pesticide. They are not considered to be potentially hazardous under the SEPP as:

- Transformer oil: it is not classified as DG and is excluded from risk screening. Additionally, it will not be stored with other flammable materials.
- Herbicide/pesticide: the DG classification will be product specific as determined from the respective SDS and the quantity to be stored on site is not likely to be significant.

**Table 3.1: Preliminary risk screening summary**

Material	DG Class	Category	Storage threshold	Transport threshold		Project storage quantities and applicable SEPP screening	Exceed threshold?
				Movements	Quantities		
LPG	2.1	Flammable gases	10 tonnes or 16 m <sup>3</sup>	> 500 (annual) > 30 (weekly)	2-5 tonnes	Amount to be stored on site (up to 10 tonnes) will not exceed the SEPP screening threshold. Number of movements will not be exceeded. Movements are expected to occur during construction only.	No
Gasoline	3 PG II	Flammable liquids	5 tonnes	> 750 (annual) > 45 (weekly)	3-10 tonnes	Amount to be stored on site (up to 5 tonnes) will not exceed the SEPP screening threshold. Number of movements will not be exceeded. Movements are expected to occur during construction only.	No
Diesel	C1	Combustible liquids	N/A	N/A	N/A	If diesel is stored in a separate storage area to gasoline, it is not considered to be potentially hazardous (i.e. no applicable storage screening threshold). If diesel is stored with other flammable liquids (e.g. gasoline), <i>Applying SEPP 33</i> guideline requires that it is to be treated as a Class 3 PG III as they may contribute fuel to a fire. Based on the amount to be stored on site (28,000 L or approximately 23.2 tonnes), separation distance of ≥ 10 m between the storage and the nearest sensitive receptor is required to be established. For this project, if diesel is stored with other flammable liquids (i.e. gasoline), a separation distance of at least 10 m to the nearest development footprint boundary will be maintained to ensure that the SEPP screening threshold is not exceeded. There is no applicable screening threshold for transportation.	No

### 3.3. Other risk factors

Appendix 2 of *Applying SEPP 33* outlines other risk factors for consideration to identify hazards outside the scope of the risk screening method.

A review of these risk factors was completed, and it was noted that the project would not involve:

- Storage or transport of incompatible materials (i.e. hazardous and non-hazardous). Hazardous materials will be stored in dedicated areas and storage protocols in accordance with standard and guidelines will be followed.
- Generation of hazardous waste.
- Possible generation of dust within confined areas.
- Activities involving hazardous materials with potential to cause significant off-site impacts.
- Incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition.
- Storage or processing operations involving high (or extremely low) temperature and/or pressures.
- Hazardous materials and processes with known past incidents (or near misses) that resulted in significant off-site impacts at similar wind farm developments.

### 3.4. Industries that may fall within the Resilience and Hazards SEPP

Appendix 3 of *Applying SEPP 33* provides a list of industries that may be potentially hazardous. It is noted that this list is illustrative rather than exhaustive. The current edition of the guideline does not include wind farms or power generation facilities in the example industry listings that may fall within the Resilience and Hazards SEPP or be considered as potentially hazardous.

### 3.5. Conclusions

The preliminary risk screening found that the project is not considered as 'potentially hazardous' within the meaning of SEPP (Resilience and Hazards) 2021 and does not require a PHA.

The main findings of the preliminary risk screening are summarised as follows:

- The storage and transport of hazardous materials for the project will not exceed the relevant risk screening threshold.
- No other risk factors have been identified that could result in significant off-site impacts.
- The project is not considered as 'potentially hazardous' with respect to DG storage and transportation and does not require a PHA.

## 4. BLADE THROW RISK ASSESSMENT

### 4.1. Overview

A blade throw is a structural failure incident involving the blade of a WTG resulting, in a fragment of the blade or the entire blade detaching from the rotor and being thrown as a projectile into the surrounding area. The blade detachment can be caused by physical damage from environmental factors such as lightning or extreme wind conditions which exceed the load of the WTG structure. Over time, mechanical stress, corrosion, improper design and installation can also weaken the material structure, resulting in blade failures. Consequences include damage to other onsite infrastructure and off-site receptors, resulting in injury/fatality and property damage.

The SEARs for the project require a blade throw risk assessment to be completed for input to the EIS. However, the SEARs do not include context nor specify objectives or requirements for the assessment:

*Blade Throw – assess blade throw risks.*

SEARs for a similar project (Junction Rivers Wind Farm, issued 19 December 2023) note requirements for the blade throw risk assessment to include consideration of associated dwellings, non-associated dwellings and battery energy storage system (BESS) facilities.

A BESS facility is not proposed for the project, however there are BESS facilities proposed for other SSDs located near the project. Blade throw impact to BESS facilities on nearest known SSDs from the project was assessed.

The following activities were completed for the assessment:

1. Estimation of the blade throw distance.
2. Review of separation distances from the residences and nearest BESS facilities to the closest project WTGs to identify any potential impacts.
3. Review of the likelihood of a blade throw event and fatality risk.
4. Assessment of individual fatality risk against the NSW DPHI HIPAP No. 4 Risk Criteria, Ref [6].

### 4.2. Estimation of the blade throw distance

The following approach was used:

1. Calculation of the theoretical maximum lateral throw distances using a point-mass blade fragment analysis (quantitative estimation).
2. Review of published blade throw simulation results for similar WTG dimensions (qualitative verification).

#### 4.2.1. Quantitative determination

Calculation of the theoretical maximum lateral throw distances was performed using the point-mass blade fragment analysis based on the work completed by Rogers et al as an approach to define WTG setback distances, Ref [7]. The method considers a blade throw involving a blade fragment at the tip of the blade (highest speed), providing bounds on expected setbacks for a given set of turbine parameters. The method was extended to calculate lateral throw from (1) a blade fragment 20% of the entire length from the tip and (2) entire blade, by modifying the radial length (based on centre of gravity of the fragment) and the associated velocity at the centre of gravity of the desired section for the specified rotor revolutions per minute (rpm).

The lateral throw distance was calculated using the following equation, Ref [7]:

$$D = \frac{v_T^2 s_{\theta_T} c_{\theta_T} \pm v_T^2 \sqrt{s_{\theta_T}^2 c_{\theta_T}^2 + 2 \frac{g}{v_T^2} (h - R c_{\theta_T}) c_{\theta_T}^2}}{g}$$

where:

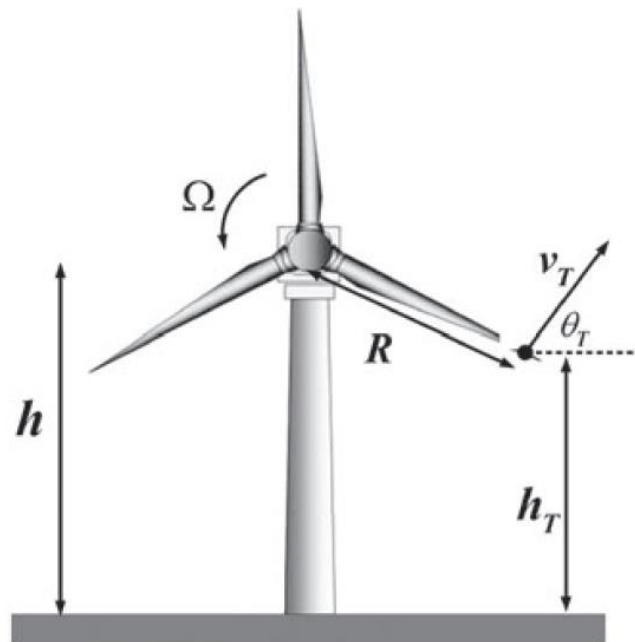
- D Lateral blade throw distance (m)
- $v_T$  Velocity at the tip of the rotor blade (m/s)
- $\theta_T$  Throw angle – refer to Figure 4.1
- $s_{\theta_T}$   $\sin(\theta_T)$
- $c_{\theta_T}$   $\cos(\theta_T)$
- g Acceleration due to gravity (m/s<sup>2</sup>)
- h Hub height (m)
- R Radial length of the rotor blade (m)

The blade fragment throw diagram is shown in Figure 4.1. The input parameters used for the calculation are presented in Table 4.1.

**Table 4.1: Input parameters**

Parameter	Units	Value	Remarks
Maximum tip height	m	280	Indicative dimension as advised by Spark Renewables
Rotor diameter	m	200	Indicative dimension as advised by Spark Renewables
Rotor radius	m	100	Length of one blade
Rotor operating speed	rpm	6-10	Depending on configuration, Ref [8]
Speed used for assessment	rpm	10	Maximum operating speed (conservative)
	rpm	15	Overspeed at 1.5x operating speed
Release angle	deg	45	Maximum projectile range.

Figure 4.1: Blade fragment throw diagram, Ref [7]



The calculated blade fragment throw results are presented in Table 4.2. In their work, Rogers et al. noted that blade fragment velocity is the key driver to maximum throw distance. The rotor operating speed will be between 6-8 rpm depending on the configuration. For the assessment, 10 rpm and 15 rpm were used which represents the maximum operating speed and overspeed conditions, respectively. The velocities at the blade tip and each fragment length analysed were calculated from these operating speeds.

For all cases, the calculated blade fragment throw distance is greater than the WTG tower collapse event of which the impact distance is estimated equivalent to that of the maximum tip height of the WTG (i.e. 280 m).

Table 4.2: Calculated blade throw distances

WTG details	Operating conditions	Blade throw distance (throw velocity)		
		Blade tip fragment	Blade fragment 20% of the entire length measured from the tip	Entire blade
<u>Rotor diameter:</u> 200 m <u>Tip height:</u> 280 m <u>Hub Height:</u> 180 m <u>Release angle*:</u> 45°	Operating speed (10 rpm)	1,218 m (105 m/s)	1,010 m (94 m/s)	385 m (52 m/s)
	Overspeed (15 rpm)	2,620 m (157 m/s)	2,148 m (141 m/s)	750 m (79 m/s)

\*The angle that results in the largest throw distance varies with the relative elevation of the turbine and the landing point. Given the flat terrain, the relative elevation between the turbine and the landing are not material to the results and 45 degrees is used.

#### 4.2.2. Qualitative verification

A qualitative verification of the calculated blade throw impact distances was carried out by reviewing published simulation results based on the work completed by Sarlak et al, Ref [9]. Sarlak et al analysed throw distance from four different turbines (2.3, 5, 10, and 20 MW) at tip speeds of 70 m/s and 100 m/s and throw angle of 45°. The throw distances from (1) entire blade, and (2) blade fragment of 20% the blade length were analysed.

For the qualitative verification, the calculated blade fragment throw impact distances (entire blade and blade fragment 20% of entire blade from the tip) were compared to the published simulation results for a turbine with similar parameters. The dimensions of the turbines analysed by Sarlak et al, Ref [9], and simulated blade throw distances are shown in Table 4.3.

**Table 4.3: Sarlak et al simulated blade throw distances, Ref [9]**

Capacity (MW)	Rotor diameter (m)	Tip height (m)	Release angle (deg)	Tip speed (m/s)	Entire blade throw (m)	Blade fragment throw (20% by length) (m)
2.3	90	145	45	70	140	430
				100	200	520
5	132	213	45	70	160	500
				100	230	870
10	186	301	45	70	180	550
				100	260	920
20	264	426	45	70	210	610
				100	300	1,000

Sherpa's observations are as follows:

- The throw distance for an entire blade is smaller than that of blade fragments. Smaller blade fragments fly farther than larger fragments due to higher initial release velocity, Ref [9].
- The simulated results for the 10 MW turbine can be used for the qualitative comparison with the calculated throw distances in Table 4.2 noting that the turbine dimensions are approximate/not dissimilar to the WTG dimensions for the project.
- Comparison against the simulated results for the 10 MW turbine:
  - The simulated results include throw distances at tip speed of 70 m/s and 100 m/s. Only simulated results for the 100 m/s tip speed were compared to the calculated throw distances at 105 m/s tip speed (shown in Table 4.2).
  - Entire blade throw: the calculated throw distance in this study is more conservative with throw distance of 385 m compared to the simulated result of 260 m.

- Blade fragment throw (20% by length): the calculated throw distance in this study is more conservative but not dissimilar with throw distance of 1,010 m compared to the simulated result of 920 m.

### 4.3. Impact to residences and nearest BESS facilities

As a conservative approach, potential impact was determined based on the calculated throw distances from the overspeed condition (tip speed 157 m/s).

#### 4.3.1. Residences (associated and non-associated)

Residences within the maximum predicted blade throw distance for the overspeed condition (2,620 m) are shown in Table 4.4. Other residences located beyond 2,620 m from a WTG are not predicted to be impacted by blade throw.

Note: If determined based on calculated throw distances from the operating speed (tip speed 105 m/s), potential impacts are predicted from the blade tip fragment scenario only for two associated residences, R042 and R156.

**Table 4.4: Residences within maximum predicted blade throw distance (overspeed condition)**

ID	Type	Closest WTG <sup>(a)</sup>	Distance to closest WTG (m)	Blade throw impact (Y/N)?		
				Blade tip fragment	Fragment 20% of the entire length measured from the tip	Entire blade
R042	Associated	T105_E	1,176	Yes	Yes	No
R156	Associated	T113_E	1,177	Yes	Yes	No
R084	Associated	T154_W	1,675	Yes	Yes	No
R093	Associated	T154_W	1,771	Yes	Yes	No
R019	Non-associated	T122_E	2,041	Yes	Yes	No
R143	Non-associated	T39_E	2,494	Yes	No	No

Note:  
(a) E and W denote turbines within the Eastern and Western areas.

#### 4.3.2. Nearest BESS

Other SSDs nearest to the project include (refer to Figure 2.1):

- The Yanco Delta Wind Farm (approved): south-west of the project's eastern area
- The Dinawan Solar Farm (proposed): east of the project's eastern area
- The Argoon Wind Farm (proposed): south of the project's eastern area.

The potential blade throw impacts for the overspeed condition from the project’s WTG to the adjacent BESS facilities are shown in Table 4.5. At the time of this study, the EIS for the Argoon Wind Farm was not available and the location of the BESS facility is not known and excluded from the review.

Note: If determined based on calculated throw distances from the operating speed (tip speed 105 m/s), both the (1) Yanco Delta Wind Farm and (2) Dinawan Solar Farm BESS facilities are not predicted to be impacted by blade throw.

**Table 4.5: Separation distances between BESS facilities and closest WTG**

BESS	Closest WTG <sup>(a)</sup>	Distance to closest WTG (m)	Blade throw impact (Y/N)?		
			Blade tip fragment	Fragment 20% of the entire length measured from the tip	Entire blade
Yanco Delta Wind Farm	T001_E	1,600 <sup>(b)</sup>	Yes	Yes	No
Dinawan Solar Farm	T107_E	3,282 <sup>(c)</sup>	No	No	No
Note: a) E denotes turbines within the Eastern area. b) Estimated from the Yanco Delta Wind Farm DPHI Assessment Report (Site layout figure). c) Estimated from the spatial data pack provided by Spark Renewables.					

#### 4.4. Review of the likelihood of a blade throw event and fatality risk

Based on Sherpa’s literature search, publicly available statistical data for blade throw incidents from a WTG is limited. For this study, approximation of likelihood of a blade throw event was based on the guidance provided in the Netherlands’ Wind Turbine Risk Zoning Handbook (which was first published in the early 2000s).

The 2014 edition of the Netherlands’ Wind Turbine Risk Zoning Handbook, Ref [10], provides the following ‘rule of thumb’ guidance on the Location Specific Individual Risk (LSIR) for the area surrounding the WTG:

1. The LSIR of  $1 \times 10^{-5}$  per year contour for distance equal to half the rotor diameter.
2. The LSIR of  $1 \times 10^{-6}$  per year contour for distance equal to either the (1) hub height plus half the rotor diameter (i.e. tip height) or (2) maximum throw distance at nominal rotor speed for an entire blade, whichever is greater.

As a conservative approach, in this study the radius from a WTG to LSIR of  $1 \times 10^{-6}$  per year contour was based on the entire blade throw distance for the overspeed condition (rather than normal operating condition).

Applying the above rule set guidance to the calculated throw distances, distances from the WTG for the project to the specified LSIR are shown in Table 4.6. At distances greater than those specified above, the risk will be less than the LSIR. For blade throw

from smaller fragments, although the potential throw distance is greater, the associated risk will be less as it will impact a smaller footprint in a larger area on which the fragment could land (lower likelihood of the fragment hitting a receptor compared to an entire blade, i.e.  $< 1 \times 10^{-6}$  per year).

**Table 4.6: Distances from WTG to LSIR  $10^{-5}$  and  $10^{-6}$  per year**

WTG details	Throw distance from an entire blade at overspeed condition (m)	Distance from WTG (m)	
		LSIR $10^{-5}$ per year	LSIR $10^{-6}$ per year
Rotor diameter: 200 m Tip height: 280 m Hub Height: 180 m	750	100	750*
Note: * The entire blade throw distance at overspeed condition is greater than WTG tip height.			

#### 4.5. Assessment against HIPAP No. 4 criteria

The NSW DPHI HIPAP No. 4 *Risk Criteria for Land Use Safety Planning*, Ref [6], specifies the risk criteria for land use safety studies to determine acceptability of a proposed development with respect to the existing surrounding land uses.

The HIPAP No. 4 individual fatality risk criterion for residential land use is  $1 \times 10^{-6}$  per year (i.e. 1 in a million per year). Based on the calculated throw distances and applying the guidance outlined in the Netherland’s Wind Turbine Risk Zoning Handbook, Ref [10], the risk criterion for residential land use is met as there are no residences within 750 m of a WTG. The closest residence is located approximately 1,176 m (R042; associated) from its nearest WTG (T105\_E). Table 4.4 shows that there are up to 6 residences that may be impacted from a blade throw event. Of these, 4 are associated and 2 are non-associated residences. As these residences are outside the LSIR  $1 \times 10^{-6}$  per year area, societal risk from the project is expected to be negligible.

For blade throw impact to BESS facilities on nearest SSDs, the HIPAP No. 4 risk criterion for accident propagation of  $50 \times 10^{-6}$  per year (i.e. 50 in a million per year) is considered appropriate for assessment. Inferring from Table 4.6, distance from WTG to LSIR of  $50 \times 10^{-6}$  per year is less than 100 m. As the nearest BESS is located at least 1,600 m from the nearest WTG (T\_001E), the risk criterion for accident propagation is met.

## 5. CONCLUSIONS

### 5.1. Preliminary risk screening

A preliminary risk screening was completed in accordance with the *Applying SEPP 33* guideline to determine whether the project is considered as 'potentially hazardous' in the context of SEPP (Resilience and Hazards) 2021.

The preliminary risk screening found that:

- The storage and transport of hazardous materials for the project will not exceed the relevant risk screening threshold.
- No other risk factors have been identified that could result in significant off-site impacts.
- The project is not considered as 'potentially hazardous' with respect to DG storage and transportation and does not require a PHA.

### 5.2. Blade throw risk assessment

An assessment was undertaken to assess the blade throw risks with respect to associated and non-associated dwellings in the surrounding areas of the project against the HIPAP No. 4 risk criterion of residential land uses.

The blade throw risk assessment found that:

- The theoretical maximum lateral throw distances for a blade tip fragment were estimated to be 1,218 m (maximum operating speed) and 2,620 m (overspeed conditions). The throw distance for the overspeed condition may potentially impact 4 associated residences (R04, R84, R93, R156) and 2 non-associated residences (R19, R43). However, based on the guidance outlined in the Netherlands' Wind Turbine Risk Zoning Handbook, the risk is less than  $1 \times 10^{-6}$  per year.
- The lateral throw distances for an entire blade were estimated to be 385 m (maximum operating speed) and 750 m (overspeed conditions). There are no residences within these impact distances. The closest residence is located approximately 1,176 m (R042; associated) from its nearest WTG (T105\_E).
- As all residences are outside of the LSIR  $1 \times 10^{-6}$  per year area, the blade throw risk from the project meets the HIPAP No. 4 individual fatality risk criterion based on separation and societal risk criteria due to the low frequency and limited impact footprint (single residence in the worst case).
- As the nearest known BESS is located at least 1,600 m from the nearest project WTG (T\_001E), the blade throw risk from the project meets the HIPAP No. 4 accident propagation risk criterion based on separation distance.

Upon any modifications made to the project's design, specifically the WTG locations, the assessment should be reviewed and updated as required to ensure that the findings made in this report are still valid.

## 6. REFERENCES

- [1] NSW Department of Planning and Environment, "Planning Secretary's Environmental Assessment Requirements, SSD-50725708," December 2022.
- [2] NSW Government, "State Environmental Planning Policy (Resilience and Hazards)," 2021.
- [3] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No 6 - Guidelines for Hazard Analysis," 2011.
- [4] NSW Department of Planning, "Hazardous and Offensive Development Application Guidelines - Applying SEPP 33," 2011.
- [5] National Transport Commission, "Australian Code for the Transport of Dangerous Goods by Road and Rail Edition 7," January 2009.
- [6] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No 4 - Risk Criteria for Land Use Planning," 2011.
- [7] Rogers J., Slegers N., Costello M., "A method for defining wind turbine setback standards," 2012.
- [8] EMM Consulting Pty Ltd, "Dinawan Wind Farm Project Description," E220305\_DEH\_WInd\_PD\_V3, 2024.
- [9] Sarlak H., Sorensen J.N., "Analysis of throw distances of detached objects from horizontal-axis wind turbines," 2016.
- [10] Rijksdienst voor Ondernemend Nederland, "Handboek Risicozonering Windturbines," 2014.