Oversby Consulting Pty Ltd
PO Box 369
Dardanup WA 6236
Tel 044 761 4411

Hydrology Assessment – Technical Report

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Project: Twin Hills Wind Farm

1. INTRODUCTION

This Hydrology Technical Report outlines the main water hydrology characteristics of the Twin Hills Wind Farm (subject site) and the proposed management of water for the development of the subject site.

It provides guidance on suitable options from responding to the current stormwater flows as well as managing the proposed runoff from the developed areas. This includes the areas around each turbine as well as the areas of supporting infrastructure associated with feeding the produced electricity into the grid network. The overall project layout can be seen in Figure 3.

2. SITE SUMMARY

2.1 General

The subject site is located approximately 260km north of Perth within the Shire of Three Springs, traversing both sides of the Eneabba – Three Springs Road. It is approximately 9,993 hectares (ha) and composed predominately of cleared broad acre agricultural land for crops and livestock grazing, with areas of remnant native vegetation throughout. The subject site can be seen in Figure 1 and 2.

2.2 Landform

The subject site contains a range of landforms including undulating sandplains, lateritic plateaus and breakaways, rises and low hills, and sandy drainage lines and springs. These are further detailed in Table 1.

Table 1: Subject Site landforms

Land system	Description	Area within Subject Site (ha)	% within Subject Site
Coalara System	Partially dissected plateau with lateritic caps and intervening sandy drainage lines; Pale and yellow deep sand, sandy gravels and sand over gravel	6,424.98	64.29
Otorowiri System	Undulating to rolling sandplain and low hills. Gentle to moderately steep valley sides at margins of Mooladara Hill System. Spring lines are a common occurrence	2,515.35	25.17
Mount Adams System	Gently undulating sandplain with low gravel ridges and occasional laterite breakaways	1,045.98	10.47
Mooladara Hill System	Sandplain with dissected lateritic outcrops on margins and prominent dry valleys and drainages; Yellow, pale and brown deep sands, sand over gravel, minor sandy gravel, sandy duplexes	6.97	0.07

The predominately sandy and gravelly soils will generally have a high permeability, meaning that low intensity rainfall will generally infiltrate into the soil profile. The areas of lateritic cap rock are likely to sheet water off during minor storms; however the surrounding sandy soils will generally infiltrate the localised runoff from the rock portions. Once the infiltration capacity of the soil has been exceeded, there is likely a high runoff rate for the steeper slopes around the edge of the hill systems, especially those within contributing cap rock catchments and incised channels that concentrate flows.

2.3 Climate

The climate of the subject site is characterised as a semi-arid Mediterranean climate. Based on the long-term rainfall data from Bureau of Meteorology Carnamah Station (located 35km to the east), the mean annual rainfall is approximately 376.2 mm. The majority of the rainfall in is winter, between the months of May and August. The warmest months of the year are between November and March, with daily maximum temperatures averaging above 30°C. The coolest months occur from June to August, with minimum temperatures consistently falling below 9°C.

3. EXISTING DRAINAGE AND WATER FEATURES

3.1 Major Catchments

The Subject site is located across two broad catchments which generally splits the subject site in half from northeast to southwest. The northwestern portion is within the Arrowsmith River Catchment, with the main Arrowsmith River channel being located approximately 8km from the edge of the subject site. The subject site discharges flows via numerous small waterways to Donkey Creek and other un-named creeks in a north westerly direction before entering the Arrowsmith River. This river tends to run west, then northwest, to the Indian Ocean.

The southeastern portion is within the Hill River Catchment. The subject site initially discharges to the Warradarge Creek and its associated tributaries. The Warradarge Creek begins upstream of the subject site (to the northeast), before traversing the subject site in south westerly direction. From here, the Warradarge Creek flows south for approximately 50km, before discharging into the Coomallo Creek and ultimately the Hill River.

3.2 Subject site waterways

The subject site’s landforms result in two main waterway types being present: *Concentrated flow routes* and *Broad flow channels*. These are outlined in more detail below. There are also numerous small dams located across the subject site, with a few being associated with the concentrated flow routes. The two types of waterways and dams can be seen in Figure 2.

Concentrated flow routes

The concentrated flow routes run through well defined, often steep valleys, that generally start near the upper portions of the hill systems. These are fed by small, localised catchments. These channels tend to run after high intensity storms, as well as sometimes containing minor spring flows. The channels tend to dissipate once they enter the areas of broad valleys, with the water generally infiltrating into the soil profile or spreading out into sheet flow with no or ill-defined channels.

Broad flow routes

The broad flow routes travers the wide valley floors, often with little definition to the main flow channel, especially through areas containing intact native vegetation. The broad flow routes are fed by numerous concentrated flow route systems from within the subject site. The main flow routes are also fed by significant upstream catchments. Due to the flat grade and generally pervious sandy soils, these channels predominately only flow after large, long duration storm events across the majority of the catchment. They are therefore generally dry and are considered ephemeral. These systems include the Warradarge Creek.

4. MANAGEMENT OF POST DEVELOPMENT STORMWATER

The management of stormwater and the waterways has been reviewed to determine appropriate strategies which minimise impact within the site and the protection of critical infrastructure. The following provides more information on these aspects.

4.1 Management of current waterways

The management of the subject site's two main waterway types; Concentrated flow routes and Broad flow channels, are based on minimal impact to the current flow path and regime, while also protecting critical infrastructure. The strategies used to achieve this are outlined below.

Concentrated flow routes

As the concentrated flow routes tend to be confined to localised channels, the main strategy is to set all critical infrastructure back from the channel. The exact setback is to be determined as part of detailed design and survey of the water way and surrounds. Generally, a setback of 30m from the top of the channel is to be adopted. As such there is unlikely to be any disturbance of these waterways. Where there may be a need to cross the waterway, appropriate stabilisation is to be installed, that minimises any modification to the flow of water along the channel. This includes access tracks or underground services. Where there is evidence of erosion within the channel currently, that may potentially result in future impact on critical infrastructures or crossings, this erosion is to be remedied through appropriate stabilisation. This may include rock placement installation of geotextiles, vegetation planting and stock exclusion fencing.

Broad flow routes

The management of the broad flow channels is generally the same as for the concentrated flow channels. The main additional item is appropriate management of the large flood flows which may travers the flood plain during extreme rainfall. These rainfall events may result in wide shallow floodplains, composed of a flood fringe with slow moving water, within which is located a fast moving floodway. All critical infrastructure is to be located outside of the floodway portion. This will minimise the potential for erosion around the infrastructure and the deflection of flood water flows to new locations, with the associated risk of erosion or other detrimental impacts to other areas.

Infrastructure located within the flood fringe area is to generally be designed so that the infrastructure is raised above the 1% AEP water level (see Section 4.3). It is also to be designed so that the cross-sectional area of the flood fringe is not filled by more than 25%. This is to minimise impounding water and the potential increased flooding of other areas. It will also minimise the risk of increased flow velocities within the remaining cross sections area, with the associated risk of increased erosion. Any potential modification to the broad channel flow areas is to be analysed in more detailed as part of the detailed design process to determine the potential risks and associated mitigation strategies.

4.2 Management of development area runoff

The management of runoff from the turbines and supporting developed areas is to focus on both water quality management and the peak runoff rates.

Water quality

The main potential contaminants that may be present are fine sediments from hardstand areas. There is also the possibility for some chemical substances to be present, including hydrocarbons. These chemicals are generally to be contained within infrastructures and are unlikely to contaminate stormwater runoff during standard operations. Where there may be maintenance practices onsite that could result in these chemicals coming in contact with the subject site's ground surfaces, specific procedures are to be developed to manage the risk. This may include but not be limited to;

- Installing Oil/contaminant barriers around work site
- Spill kits being available
- Not undertaking works during periods of high intensity rain.
- Installing contaminant specific separator systems in locations where the risk may be ongoing and constant.

Due to the high permeability of the subject site's soils, the majority of water running off developed impervious areas is to be infiltrated within designed basins. The basins are to be composed of sandy material within the base and be planted with grass/pasture species, so that there is a constant vegetation cover.

The infiltration basins will remove sediments, and the majority of other minor contaminates that may be present form general vehicle movement and infrastructure operations. Generally, water quality structures are designed so that the entire 1EY storm event is captured and treated. As the development is utilising a full 10% AEP capture and infiltration strategy, the system will also be able to fully contain the 1EY.

Flow rate

An analysis of the pre and post development flow rate was undertaken for the areas of the subject site where the landuse is proposed to change. This analysis reviewed the modification of permeable soils to impervious surfaces such as hard packed gravel, concrete, bitumen and rooves. From this suitable detention systems were determined. The proposed landuse change areas (e.g. development areas) included the turbine and surrounds as well as the supporting infrastructure locations. These areas can be seen in Figure 2. This analysis was undertaken in DRAINS modelling software. As part of the analysis the following parameters and assumptions were used.

- Horton/ ILSAX drainage modelling method.
- ARR 2019 methodology and rainfall figures.
- A conservative soil factor of 2 was applied (moderate infiltration with potentially some restriction by lower hydraulic conductivity deeper soils) to reflect the sand soil over heavier soils and some areas of shallow rock/gravels.
- Antecedent Moisture Condition 3 used (12-25mm of rainfall in preceding 5 days).
- Relevant catchments areas were as per Table 2 and Figure 2.
- For pervious areas, a retardance coefficient of 0.1 was used to reflect low paddock grass.
- All pre development catchments were considered 100% impervious.
- Developed areas were considered to be 80% impervious, with 5% not directly connected.

The storms modelled were the 5min,10min,15min, 20min, 25min, 30min, 45min, 1 hr, 1.5hr, 2hr, 3hr, 4.5hr, 6hr and 9hr. Longer events were not modelled as the events peaked at 45min or less. These were modelled for the 10% AEP and 1%AEP.

Supporting Infrastructure Development Locations

The stormwater for each of the non-turbine supporting infrastructure areas is generally considered to be directed into a single basin. As part of detailed design, multiple basins or other infiltration systems may be utilised for each location The basins were assumed to have the following parameters:

- 1.1 – 1.2m deep
- Outlet pit at 0.8m deep
- Overflow weir at 1.0m
- Storage areas have an infiltration rate of 2m/day (likely conservative), with infiltration from base and sides
- The basins are sized to detain the entire 10% AEP with no discharge. This was to match the pre development runoff for the same locations, which showed no significant discharge in the 10% AEP. It is noted that there is likely to be some discharge in the steeper, rockier portions of the overall subject site.

The modelled storms were run in DRAINS using increasing basin storage volumes until there was no outflow in the 10% AEP. Using these assumptions, the storage required for each location was determined to be approximately 1m^3 of storage for every 35m^2 of total development area (includes pervious and impervious areas within provided development footprints). The preliminary storage for each location is outlined in Table 2. This is to be refined for each location as part of the detailed design process.

With the total capture and infiltration of the 10% AEP, the 1% AEP discharge rate is also managed so that the peak flow is below pre-development rates.

The comparison between pre and post-construction flow rates can be seen in Table 2.

Table 2: Preliminary Storage requirements

Site	Total Development Area (m^2)	Preliminary storage volume (m^3)	Pre development discharge rate (m^3/s)		Post development discharge rate (m^3/s)	
			10% AEP	1% AEP	10% AEP	1% AEP
1	44,505	1,272	0	0.359	0	0.266
2	57,103	1,632	0	0.461	0	0.278
3	165,039	4,715	0	1.330	0	0.594
4	145,145	4,147	0	1.17	0	0.546
5	58,179	1,662	0	0.470	0	0.282
6	57,342	1,638	0	0.463	0	0.279
7	50,821	1,452	0	0.410	0	0.253
8	181,757	5,193	0	1.470	0	0.598
9	130,076	3,716	0	1.050	0	0.508
10	55,589	1,588	0	0.499	0	0.272

Turbine Locations

For each turbine location the stormwater is to generally be sheeted to the downslope area of the turbine footprint. It is likely that the stormwater runoff could be dispersed within a grassed shallow swale that wraps around a portion of the perimeter. Based on a typical footprint of approximately 8340m^2, if it was 80% hardstand and needed to be stored in a basin, the detention volume would be around 230 - 240m^3, to contain the 10% AEP. The 1% AEP post development peak flow rate is also managed to approximately 0.075m^3/s (with the pre-development flow rate for a same area being 0.132m^3/s). It is likely that the final footprint of impervious area will be smaller for the majority of the turbines. The exact requirement for detention for each turbine is to be determined as part of the detailed design for each turbine.

4.3 Flood separation and management

Turbines and main development areas

Critical electrical infrastructure is to be maintained a minimum of 1.0m above the flood levels within the subject site. This includes floods/flows generated by the development as well as existing waterway floods. For non-electrical infrastructure, the finished floor level is to be a minimum of 0.5m above the subject site's waterway flood levels and 0.3m above any internal stormwater flow paths (within the development footprints) or basin top water levels.

The flood levels of the numerous waterways have not yet been determined through flood modelling. To allow for the determination of potential flood risks to guide future development, the following conservative parameters should be assumed;

- All concentrated flood routes less than 1km long will have a vertical flood level of 1m higher than the top of any defined channel, or where there is no defined channel, 1.5m above the low point of the valley.
- For concentrated flood routes greater than 1km and less than 5km, the vertical flood level is to be set 1.5m higher than the top of any defined channel, or where there is no defined channel, 2m above the low point of the valley.
- For concentrated flood routes greater than 1.5km, the vertical flood level is to be set 2.5m higher than the top of any defined channel, or where there is no defined channel, 3m above the low point of the valley. There is also to be a minimum horizontal setback of 30m from the top of the channel.
- For the broad flow channels the minimum flood risk area is to be set as the area 50m either side of the top of the main channel as well or 1.5m vertically above the top of the main channel.
- For the locations where the broad flow channels intersect with the road reserves, the flood risk area is to be set as the 1.5m vertically above the crest of the road. This level is to also apply to the backwater areas upstream of the road.

Where there may be a need to locate critical infrastructure within flood prone areas, the infrastructure is to be confined to the flood fringe areas only, with no infrastructure within the floodway (the faster moving portion of the flooded areas). Analysis is also to be undertaken so that any potential restriction to the flow or loss of flood storage area does not have a significant impact on surrounding infrastructure or sensitive vegetation.

Other infrastructure

Where possible, any new potential stormwater detention areas or stormwater flow routes should be located outside of the existing powerline easements. This is to reduce the potential for risks associated with the increased electrical conductivity within flooded areas.

Where proposed access tracks are likely to travers flow channels, an analysis is to be undertaken to determine the potential erosion risk. Appropriate stabilisation of the crossing point and potentially the installation of culverts is to be undertaken as determined through the detailed design process. The analysis is to also review the impact of any increase in flood water levels on critical infrastructure, native vegetation and sensitive farmland immediately upstream of any crossing. Suitable mitigation strategies are to be adopted to minimise any negative impacts.

5. CONCLUSION AND RECOMMENDATIONS

From this initial hydrology analysis, it is determined that the subject site can be developed for its intended use of wind power generation, while suitably managing the site’s hydrology. To achieve this outcome the following future actions are recommended:

- Undertake a feature survey of the subject site’s flow paths/waterways and surrounds (including dams and potential flow paths should they fail). This is to confirm suitable separation is able to be achieved between flood flow paths and critical infrastructures including locations for turbines, other main development areas, access tracks, existing road reserve crossings and power easements where water may be detained.
- Undertake a feature survey of the proposed development areas so that the grade of the development area is understood as well as the direction of any sheet flow that may interact with the edge of the development.
- Review any available historical flood data for Warradarge Creek and other broad flow channels, including liaison with DWER Flood Branch and landholders.
- Undertake detailed analysis of each development location based on the final internal layout, that considers piped and overland flow paths for stormwater, along with determining suitable detention locations and sizing.
- Determine suitable finished levels for critical infrastructure so that suitable flood separation is achieved from the onsite stormwater flows and detention as well as the flood levels of the subject site’s waterways.
- Determine where there may be the need for any stabilising infrastructures or culverts associated with the crossing of waterways/ flow channels (includes access tracks and services).
- Undertaken geotechnical investigations for the development locations within the subject site to determine the general soil types and to determine the infiltration rate at the proposed basin locations.

FIGURES

LEGEND

- - - - - -	SUBJECT SITE
———	CADASTRE

REV	DATE	ISSUE DESCRIPTION	DRAWN	DESIGN	CHECK
A	3/3/26	ISSUED FOR APPROVAL	KJB	BO	BO

STATUS

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE

0 400 800 1200 1600 2000

SCALE 1:40000

CLIENT

TWINHILLS WIND FARM PTY LTD

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE. NOT FOR CONSTRUCTION UNLESS STAMPED BY CERTIFYING AUTHORITY

Oversby Consulting

PROJECT

TWINHILLS WIND FARM,
THREE SPRINGS

DRAWING TITLE

SITE PLAN

PROJECT No.	DRAWING No.	REVISION
B24045	001	A

LEGEND

- SUBJECT SITE
- CADASTRE
- CONTOURS
- PROPOSED INFRASTRUCTURE AREAS
- 8 SUPPORTING INFRASRUCTURE IDENTIFIER
- CONCENTRATED FLOW CHANNEL
- BROAD FLOW CHANNEL
- CHANNEL ROAD CROSINGS
- FARM DAMS
- CONTOUR SWALE

REV	DATE	ISSUE DESCRIPTION	DRAWN	DESIGN	CHECK
A	3/3/26	ISSUED FOR APPROVAL	KJB	BO	BO

STATUS

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE

0 400 800 1200 1600 2000
SCALE 1:40000

CLIENT
TWINHILLS WIND FARM PTY LTD

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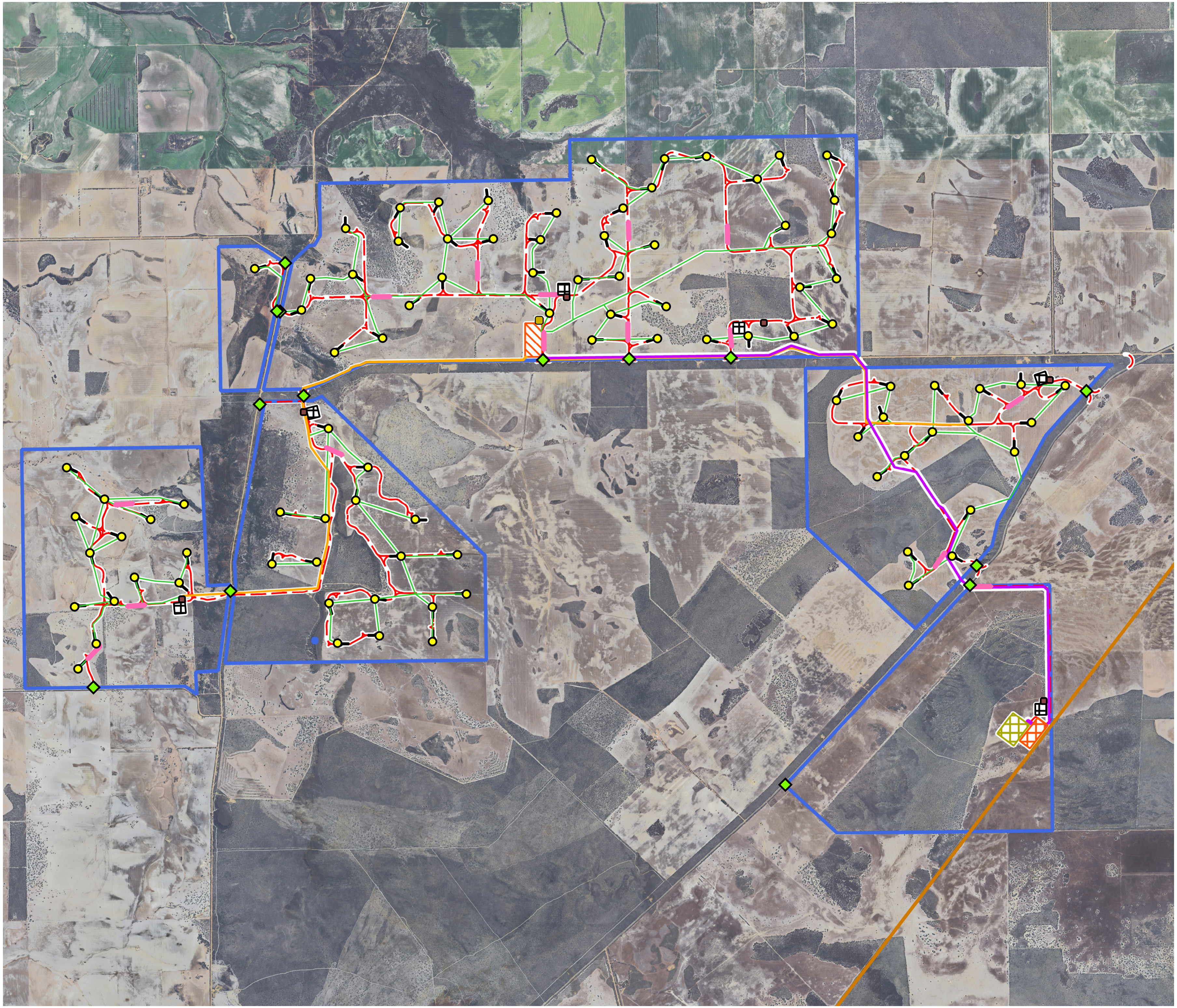
Oversby Consulting

PROJECT
TWINHILLS WIND FARM, THREE SPRINGS

DRAWING TITLE
HYDROLOGY PLAN

PROJECT No.	DRAWING No.	REVISION
B24045	002	A

FIGURE 3:
OVERVIEW WIND FARM INFRASTRUCTURE



Project boundary

Wind Turbine Generator (109 WTGs)

WTG construction area

Access Gate

Site O&M office and carpark

Concrete batching plant

Wind farm internal substation

Construction site office and compound

Grid terminal station

Battery Energy Storage System (BESS)

Staging area

Development footprint

Accessways

Underground cabling

Overhead cabling

Transmission line cabling

Existing grid transmission line

Ref: DWG 090.C.1
Author: J. Mourier
Approved: M. Gray
Date created: 12.02.2026
Datum: GDA2020 / MGA zone 50

N

3,000 m

WIND PROSPECT