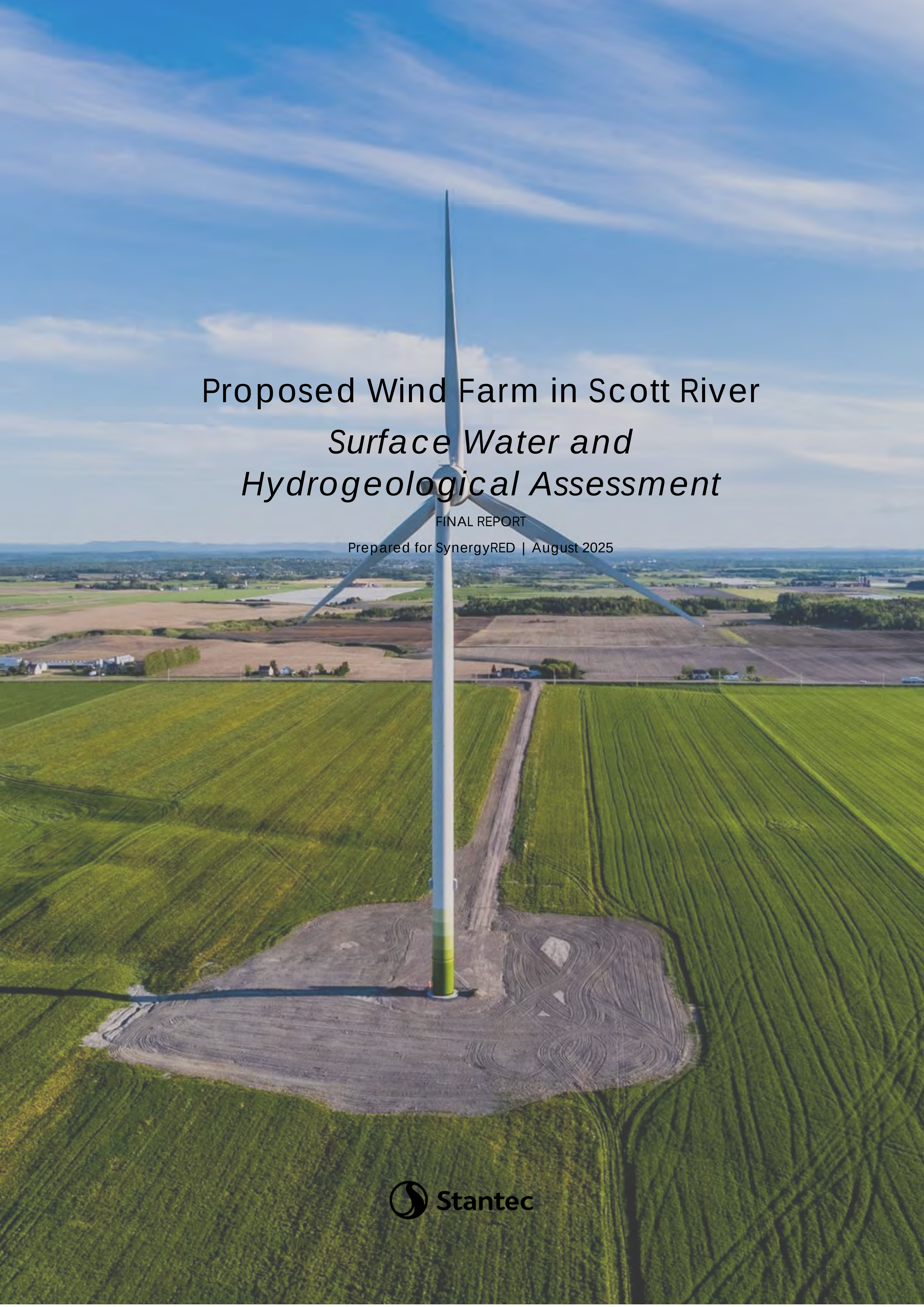

Proposed Wind Farm in Scott River

Surface Water and Hydrogeological Assessment

FINAL REPORT

Prepared for SynergyRED | August 2025

Stantec

Revision Schedule

Rev. No.	Date	Description	Prepared by	Quality Reviewer	Technical Independent Reviewer	Project Manager Final Approval
A	03/07/2025	Draft report for client review	Fariba Ebrahimi, Fergus Giec-Yorston, and Cameron Love	Sumari Veal, Cameron Love, and Mike Jorgensen, Brooke Hay	Sumari Veal, Mike Jorgensen, Fiona Taukulis and Nicole Bichel	
B	03/07/2025	Draft report for client review	Fariba Ebrahimi, Fergus Giec-Yorston, and Cameron Love	Sumari Veal, Mike Jorgensen, Fiona Taukulis and Nicole Bichel	Sumari Veal, Mike Jorgensen, Fiona Taukulis and Nicole Bichel	
C	03/07/2025	Draft report for client review	Fariba Ebrahimi, Fergus Giec-Yorston, and Cameron Love	Sumari Veal, Mike Jorgensen, Fiona Taukulis and Nicole Bichel	Sumari Veal, Mike Jorgensen, Fiona Taukulis and Nicole Bichel	
0	25/08/2025	Final Report	Joan Deng, Fiona Taukulis and Cameron Love	Fiona Taukulis	Fiona Taukulis	Loraine Roberts

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Executive Summary

Background, Scope and Objective

Synergy Renewable Energy Developments Pty Ltd (SynergyRED) engaged Stantec Australia Pty Ltd (Stantec) to support the environmental approvals for a proposed 100 MW wind farm in the locality of Scott River (the Proposal), approximately 15 km north-east of Augusta in the Margaret River region of Western Australia. The scope of works comprised a Surface Water and Hydrogeological Assessment (the Assessment) of the Study Area (approximately 4000 ha in size) to support their feasibility assessment and address environmental regulatory requirements for the Proposal. The objective of the Assessment was to provide surface water and hydrogeological conceptualisation of the Study Area, to inform optimisation of infrastructure, while recommending mitigation and management measures to minimise impacts to the hydrological regime. This Assessment is supported by a technical appendix on the groundwater dependent values of the Study Area.

Proposal Features

The Proposal is anticipated to involve construction and operation of up to 20 wind turbine generators across the Study Area, along with supporting infrastructure including meteorological towers, transmission line and associated foundations, concrete batching plant, access roads, borrow pits, offices and electrical substation and switch yard. During construction, dewatering will be required to a maximum depth of 2 to 3 m to support excavation and installation of foundations, with local disposal via sediment tanks/ponds and infiltration basins. Consideration of surface water and hydrogeological characteristics is required to avoid and mitigate impacts to potentially sensitive ecological and social receptors in the vicinity of the Study Area.

Surface Water Characteristics

Key surface water features in the region consist of historically modified catchments with artificial drains to facilitate the agricultural and plantation activities. These drains have not been built in a coordinated way and intersect with roads and natural drainage lines, resulting in several areas of localised ponding due to catchment modification.

The Study Area has a poorly defined ridgeline that runs approximately through the centre of the Study Area, segregating the 11 Blackwood and Scott River headwater catchments that discharge from the Study Area. Sheet flow occurs across cleared land areas, concentrating into more defined streamflow paths towards the Study Area boundary.

There are several areas of natural ponding following rainfall events in areas designated as wetlands and in depressions formed by historical anthropogenic activities. The roads on almost every boundary of the Study Area act as an impediment to flow paths and cause localised upstream ponding, apart from the southernmost catchment which sheet flows across agricultural land.

Hydrogeological Characteristics

The northern part of the Study Area is characterised by a thin layer of dune sands (<2 m) overlying alternating bands of clay and sand as well as peat, while in the central and south sections, dune sands are deeper (up to approximately 6 m) with interbedded ferricrete and/or clay. The Study Area is located within an area of high to moderate ASS potential (supported by preliminary test results) and is partly within DoW Groundwater Management Zone 7 (from the central area to the south); a buffer zone area defined by an acid sulfate soil plume from Beenup mine site used to restrict groundwater extraction.

The Study Area hosts the Superficial and Leederville Aquifers, with the latter identified within the upper 25 m of the profile. The Superficial Aquifer is localised and discontinuous and is generally hosted within the surficial sand. It includes perched groundwater above impermeable beds of the Leederville Formation, and local confinement zones of low permeability in the laterite (dominant sand and ferricrete) profile. The Leederville Aquifer lies beneath the Superficial Aquifer and is shallower in the north and deepens in the southern portion of the Study Area.

The Superficial Aquifer is recharged by direct diffuse rainfall infiltration and localised downward leakage from creeks, wetlands and irrigation through sandy soils. Potential upward leakage from the underlying Leederville Formation may also occur. The Leederville Aquifer is mostly recharged via lateral flow and vertical downward leakage from the Superficial Aquifer. Discharge from the Superficial Aquifer occurs via evapotranspiration, while the Leederville Aquifer discharges to major rivers and creeks. During the wet season the water table in the Superficial Aquifer is shallow and may locally discharge into wetlands or at the ground surface, while during the dry season, the water table is lowered, and some areas may become dry from reduced rainfall. Previous investigations in the area indicate that in winter the Superficial Aquifer may be connected to creeks, indicating that surface-water groundwater interactions may be ephemeral and seasonally influenced, although this has not been verified by this Assessment. It is unlikely that the deeper Leederville Aquifer is in direct connection to ephemeral surface water features in the Study Area. Registered groundwater pumping occurs within and surrounding the Study Area and is used primarily for irrigation.

Groundwater levels in the Superficial Aquifer and the Leederville Aquifer are strongly correlated to rainfall and are shallowest in winter. Continuous monitoring at the Study Area by Stantec indicated the water table fluctuated between March 2024 and September 2024 by approximately 2 m in both aquifer systems. Groundwater flow in both the Superficial and Leederville Aquifer was inferred to flow in a southward direction (southwest in the western Study Area and southeast in the southeastern Study Area).

The Superficial Aquifer and Leederville Aquifer are classified as freshwater, with total dissolved solids (TDS) typically less than 500 mg/L. The pH ranges from acidic to neutral, with elevated turbidity, copper, iron and manganese in both aquifer systems, while the Superficial Aquifer is also characterised by elevated aluminium and nitrogen concentrations.

Surface Water Assessment

Preliminary flood modelling comprised two-dimensional hydraulic modelling for the 50%, 20%, 10%, 5% and 1% Annual Exceedance Probability (AEP) existing climate scenario and 1% AEP climate change high emissions scenario flood events. Surface water modelling was undertaken to characterise the hydrological regime of formalised flow paths and areas of inundation in frequent to extreme rainfall events. The frequent flow regimes such as the 50% AEP demonstrate a minor extent of inundation with only a small number of defined flow paths discharging from the Study Area. The average flow depth is less than 100 mm across the Study Area in frequent flows, with approximately 100 mm conveyed along the defined flow paths.

Peak flow rates at the outlets during frequent flow regimes (50% AEP) and rare event regimes (1% AEP) range from 0.5 m^3/s to ~20 m^3/s, respectively and the maximum discharge rate of ~20 m^3/s in the 1% AEP from the Study Area is south to the Scott River. In addition, during a 50% AEP event maximum ponding depth of ~1.2 m occurred near the south-western boundary of the Study Area. Most areas of inundation with depths greater than 0.5 m in the frequent events (~50% AEP) occur upstream of roads acting as hydraulic controls with some ponding in areas with the appearance of wetlands or perched ponds. There are only a small number of defined flow paths discharging from the Study Area with flow rates of up to 0.5 m^3/s in the 50% AEP event.

The rare (1% and 2% AEP) flow regimes demonstrate a widespread level of inundation with all headwater catchments, other than one sub-catchment in the north-east, showing distinctive flow paths to discharge locations outside of the Study Area. The maximum ponding depth of ~2.8 m occurs in the forested northern-most sub-catchment in the Study Area. The second deepest ponding occurs at ~2.3 m in the same location to the 50% AEP near the south-western boundary of the Study Area. Several areas of inundation in the rare (1% and 2% AEP) events exceed 0.5 m in depth across the Study Area, including behind roads acting as hydraulic controls and in areas with the appearance of wetlands or perched ponds. All headwater catchments other than one in the north-east show distinctive rare event flow paths to the discharge locations outside of the Study Area. The maximum 1% AEP discharge rate of ~20 m^3/s from the Study Area is south to the Scott River.

Preliminary Dewatering Assessment

A hydrogeological conceptual model was developed using available data and investigations from the Study Area and surrounds. The model applied several zones to the Study Area, based on likely aquifer characterisation; Zone 1 (bore group WM01) comprising mostly sandy clay, Zone 2 (all other locations) consisting of predominantly sand, and a transition zone, assigned as an arbitrary boundary between the two zones. Preliminary construction dewatering steady-state modelling estimated the following distances to the 0.5 m and 1 m drawdown contours for the targeted dewatering levels for infrastructure components:

- Zone 1 Turbines: approximately 43 m (0.5 m contour) and 31 m (1.0 m contour).
- Zone 2 Turbines: approximately 117 m (0.5 m contour) and 60 m (1.0 m contour).
- Meteorological tower: approximately 86 m (0.5 m contour) and 34 m (1.0 m contour).

Initial pumping rates to attain the target drawdown after five days of pumping ranged between 1,525 m^3/d (Zone 2 meteorological tower) and 2,295 m^3/d (zone 2 turbines). Initial dewatering in zone 1 (turbines) was likely to be similar to the steady-state rate (average approximately 75 m^3/day). To maintain target drawdown, daily pumping rates in Zone 2 ranged between approximately 296 m^3/d (meteorological tower) and 2,058 m^3/d (turbines).

These predicted pumping rates assumed that no management structures were used to reduce lateral inflow. Based on the current predicted inflow model estimate for Zone 2, a water licence may be required due to the approximate steady-state in-flow volume taken, per excavation, and that the pumping rate may require higher than 10 L/s pumping rate over a period of more than 30 consecutive days.

Sensitive Receptors, Risk and Mitigation

The Assessment identified several potentially sensitive ecological (groundwater dependent ecosystems; GDEs) and social receptors that may be impacted by dewatering and excavation during construction. Key impacts from the development of the Proposal include changes to the hydrological regime and flow patterns, contamination of surface water and groundwater, sedimentation and erosion of surface environments, ASS exposure and runoff, and potential interactive effects associated with the acid groundwater plume from the closed Beenup Titanium Mine.

The preliminary risk assessment indicated that following mitigation the risk to hydrology is negligible. Inherent risk rankings of moderate were associated with potential impacts on GDEs from drawdown, exposure and drainage of ASS, and contamination, which were reduced to low following the implementation of mitigation measures including a shallow foundation design and reduced dewatering depth, civil works to be conducted during the dry season, where practicable, with adherence to specific measures in the ASSDMP and CEMP. The temporary and spatially constrained nature of the construction activities will also limit potential impacts to GDEs. Some data gata gaps remain in relation to the Proposal, and the risk assessment may require revision as additional information becomes available.

Abbreviations & Definitions

Abbreviation	Term
1D	One dimensional
2D	Two dimensional
AEP	Annual Exceedance Probability: *The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. A 1% AEP flood event has a 1% chance of occurring in any one year. The conversion from annual recurrence interval (ARI) to AEP is shown below:* *ARI (years) – equivalent AEP (%)* *1 yr ARI – 63% AEP* *5 yr ARI – 18% AEP* *20 yr ARI – 5% AEP* *100 yr ARI – 1% AEP* *2 yr ARI – 39% AEP* *10 yr ARI – 10% AEP* *50 yr ARI – 2% AEP*
AHD	Australian Height Datum, generally equivalent to metres above mean sea-level
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Annual Recurrence Interval *(see AEP)*
ARR 2019	Australian Rainfall and Runoff 2019: *With the release of ARR 2019, ARR 2016 was superseded (with ARR 1987 becoming superseded with the release of ARR 2016).*
BoM	Bureau of Meteorology
DEM	Digital Elevation Model
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority (Western Australia)
ESA	Environmentally Sensitive Area
GDE	Groundwater-dependent ecosystem
IFD	Intensity, Frequency, Duration
IFM	Index Flood Method: *Used in many locations across Western Australia with the assumption of homogeneous regions. It is important to note that most of the regressions for the runoff coefficient for the Index Flood Method are based on 2- or 5-year ARI flood data.*
LiDAR	Light detection and ranging data: *A remote sensing technology that uses laser light to sample the surface of the earth's surface to produce point cloud datasets that are able to be visualized, shared and used as an input to flood modelling*.
LBLCDC	Lower Blackwood Land Conservation District Committee
LOR	Limit of Reporting
mbgl	metres below ground level
mbTOC	metres below top of casing
ORP	Oxidation-Reduction Potential
RCP	Representative Concentration Pathway
RFFE	Regional Flood Frequency Estimation: *Uses a data-driven approach, which attempts to transfer flood characteristics from a group of gauged catchments to ungauged locations of interest.*
RL	Relative Level (typically equivalent to AHD)
ROG	rain-on-grid
RRM	Regional Rational Method: *Uses a probabilistic or statistical method for estimating the design peak flow by incorporating a runoff coefficient, catchment characteristics, and an average rainfall intensity of the same ARI derived from the IFD design curves for any location in Australia as described in ARR1987 Book 2 Section 1. Section 1.4.7 of ARR1987 Book 4 suggests that the Rational Method for the South-West Region of Western Australia is applicable for loamy soils with the runoff coefficient for ARI of 10 years (*C_{10}*) as the index variable.*
SILO	Scientific Information for Landowners
Study Area	The Study Area for this assessment is limited to the proposed development footprint of the wind farm. It does not include any areas associated with transportation or supporting infrastructure.
SWL	Standing water level

SWRWQA	Statewide River Water Quality Assessment
TUFLOW HPC Model	1D/2D Heavily Parallelised Compute (HPC) Hydraulic Model: *Generates gridded flood results from a complex model consisting of hydrological inflows, boundary conditions, hydraulic controls, 2D surface levels (from LiDAR, survey and design plans) and 1D network elements*.
WQIP	Water Quality Improvement Plan
WSE	Water Surface Elevation (m AHD)

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1 Introduction

1.1 Assessment Scope and Objective

Synergy Renewable Energy Developments Pty Ltd (SynergyRED) engaged Stantec Australia Pty Ltd (Stantec) to support the environmental approvals and planning for a proposed 100 MW wind farm in the locality of Scott River (the Proposal), approximately 15 km north-east of Augusta in the Margaret River region of Western Australia (Figure 1-1). The following scope of works has been completed or is near completion:

1. Aquatic Ecology Assessment (Appendix A).
2. Surface Water Assessment.
3. Hydrogeological Assessment.
4. Groundwater and Surface Water Monitoring.

This report addresses items 2 and 3, comprising the Surface Water and Hydrogeological Assessment (the Assessment) for the Study Area (Figure 1-1). Item 4 has been provided to SynergyRED as a separate deliverable. The objective of the Assessment was to provide surface water and hydrogeological conceptualisation of the location of the Proposal, to inform optimisation of infrastructure, while minimising impacts to the existing hydrological regime. To support the objective the following tasks were undertaken:

- Surface Water Assessment – flood characterisation assessment and modelling to identify inundation areas to inform the placement of Proposal infrastructure to mitigate impacts on surface flow post-development.
- Hydrogeological Assessment – characterisation of hydrogeology and modelling to predict potential changes in groundwater levels and drawdown extent across the Study Area, with the provision of constraints mapping to inform infrastructure layout in relation to potentially sensitive environmental receptors.
- Preliminary Risk Assessment – providing an understanding of key risks associated with the Assessment and indicating preliminary mitigation measures to prevent impacts to sensitive environmental receptors, focusing on groundwater dependent ecosystems.

1.2 Proposal Description

The Proposal is anticipated to involve construction and operation of up to 20 wind turbine generators, each of which will be up to 250 metres (m) in height. As the Proposal is in its early stages of planning and approvals, the location of infrastructure is yet to be finalised. The indicative infrastructure layout, including the turbine configuration is shown in Figure 1-2. Works required for the Proposal are expected to include:

1. Concrete foundations for turbine, transmission points (towers and poles), and meteorological (met) towers.
2. Construction and operation of a concrete batching plant during construction.
3. Construction of two meteorological towers.
4. Construction of crane hardstand area at each turbine location.
5. Buried electrical cables connecting each turbine to wind farm substation(s).
6. Access roads from public road to wind farm substation, turbines and other infrastructure.
7. Construction and installation of electrical substation(s) and switchyard.
8. Construction of operations and maintenance building and workshop.
9. Construction and installation of transmission poles or towers and connecting power lines from substation to the Western Power electricity network.
10. Construction of gravel borrow pits, and extraction of associated material.
11. Temporary construction laydown areas.
12. Temporary (short-term) dewatering to ensure safe, dry conditions during construction of concrete foundations for infrastructure.
13. Excess dewater is expected to be discharged to infiltration basins and/or used during construction (e.g., dust suppression or concrete batching, where appropriate).
14. Water for construction activities and associated infrastructure will be sourced and transported to site (i.e., no installation of water abstraction bores proposed), and/or utilise construction dewater (where appropriate).

1.3 Study Area

The Study Area (Figure 1-1) for the Proposal occupies an area of approximately 4000 hectares (ha) and comprises agricultural properties bound by Dennis Road to the east and Scott River Road to the west. The northern end is bordered by a fence line approximately 1.5 km south of the Brockman Highway, and the southern boundary extends approximately 1.5 km south of Governor Broome Road. The Study Area is zoned as general agriculture with conservation areas of remnant vegetation, and neighbours the historical rehabilitated BHP Beenup Titanium Mine. There are several plantations within the Study Area which are also zoned as general agriculture.

The Study Area is split between two main catchment areas with the Blackwood River catchment covering the west and north of the Study Area, and the Scott River catchment covering the east and south of the Study Area (Figure 1-2; Section 3.3.3). An area of 13.7 km^2 (43%) of the Study Area drains into the Blackwood River, while 18.3 km^2 (57%) of the Study Area drains into the Scott River.

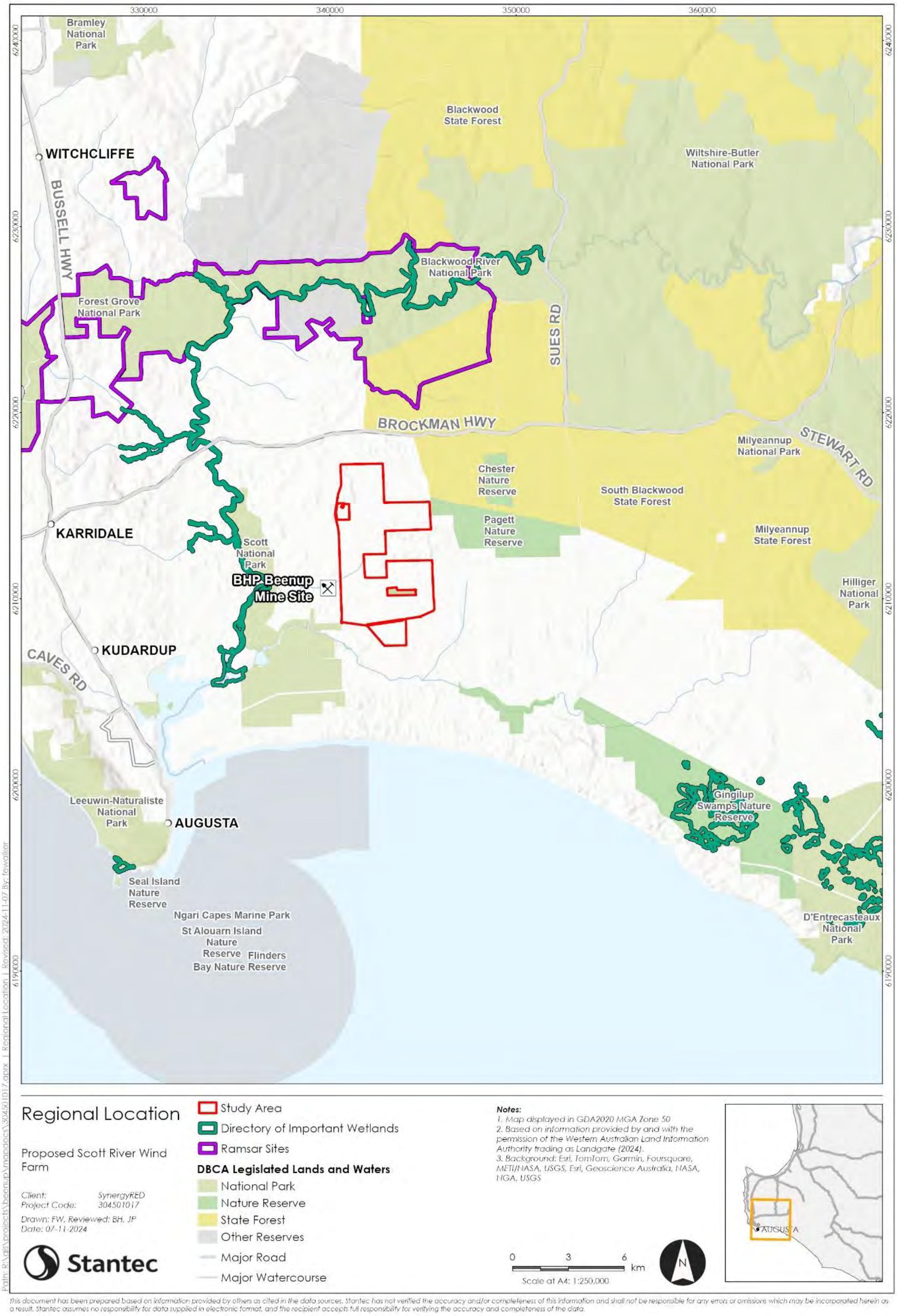


Figure 1-1: Location of the Proposal, showing the Study Area, in the southwest region of Western Australia.

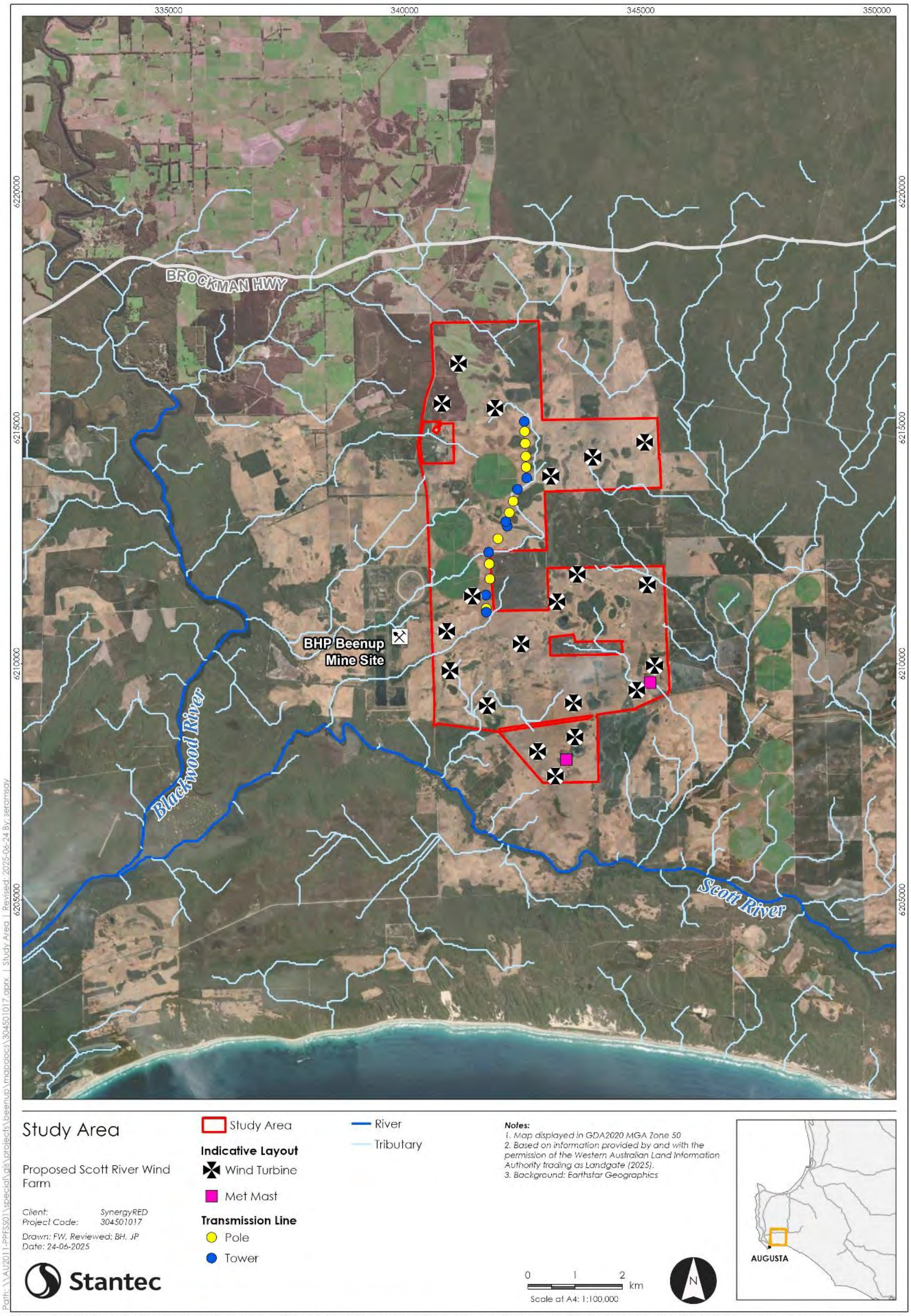


Figure 1-2: Study Area and indicative layout for the Proposal.

1.4 Regulatory Setting and Consultation

The Assessment has been undertaken in alignment with relevant legislation and guidance (Table 1-1) and prepared to a standard suitable for submission to the Department of Water and Environmental Regulation (DWER) and the Environmental Protection Authority (EPA) as part of the initial Referral and for planning purposes via Development Approval Application. Specific to the Proposal, applicable legislation and guidance is focussed on maintaining surface water and groundwater regimes to protect environmental values, including sensitive areas, conservation significant species and groundwater-dependent ecosystems (GDEs).

SynergyRED, assisted by Stantec, liaised with DWER and the Lower Blackwood Land Conservation District Committee (LBLCDC) to request existing groundwater and water quality studies for the Blackwood and Scott River catchments for review. Additional information was also provided by BHP for the rehabilitation of the historic Beenup Titanium Mine, closed in 1999. This was generally related to the historical surface and groundwater monitoring conducted for closure approvals.

Table 1-1: Relevant Western Australian legislation and guidance for the Proposal

Legislation and Guidance	Relevant Legislative Requirements
Biodiversity Conservation Act 2016	• Purpose: to provide greater protection for biodiversity, particularly threatened species and threatened ecological communities
Environmental Protection Act 1986	• Purpose: prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing
Statement of environmental principles, factors, objectives and aims of EIA (EPA 2023)	• Objective: EPA to use best endeavours to protect the environment and to prevent, control and abate pollution and environmental harm • Principles: Precautionary, intergenerational equity, conservation of biological diversity and ecological integrity • Factors: Inland Waters, Flora and Vegetation, Terrestrial Fauna, Terrestrial Environmental Quality
Environmental Factor Guideline – Inland Waters (EPA 2018)	• Objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected • Impacts: dewatering and disposal, construction of water off-takes, modification of drainage, impacts to waterways, wetlands or water quality/quantity, exposure of acid sulfate soils (ASS) and runoff • Waterbodies: conservation significant wetlands or waterways, wild rivers, springs/pools, ecosystems supporting significant species, GDEs.
Environmental Factor Guideline – Flora and Vegetation (EPA 2016a)	• Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. • Impacts: altered hydrology, including increase or decrease of groundwater level and alteration of surface water flow. • Flora: Locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater)
Environmental Factor Guideline – Terrestrial Fauna (EPA 2016b)	• Objective: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained • Impacts: pollution or modification of water quality and water regimes • Fauna: threatened or priority species, restricted species
Environmental Factor Guideline – Terrestrial Environmental Quality (EPA 2016c)	• Objective: To maintain the quality of land and soils so that environmental values are protected • Impacts: clearing in areas prone to erosion and salinisation, disturbance of ASS, land use causing soil contamination
Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes (DER 2015)	• Purpose: to provide technical and procedural advice to avoid environmental harm and to assist in achieving best practice environmental management in areas underlain by ASS
Operational Policy No. 5.12 – Hydrogeological Reporting Associated	• Purpose: to facilitate the assessment of groundwater licence applications for the grant, amendment or transfer of a licence to

Legislation and Guidance	Relevant Legislative Requirements
With A Groundwater Well License (DoW 2009a)	take groundwater and assessment of monitoring results to comply with licence conditions
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000)	• Purpose: to provide authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia and New Zealand
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Water Quality Australia 2021)	• Purpose: to expand upon, and refine, the ANZECC & ARMCANZ (2000) guidelines by providing an updated and expanded Water Quality Management Framework, guidance on its application, development of conceptual models, an outline of the weight-of-evidence process, provision of new and revised toxicant default guideline values and associated methods, new physical and chemical stressor guidance and default guidelines values for more regions, and improved information and guidance for cultural and spiritual values
Guideline: Assessment and management of contaminated sites (DWER 2021)	• Purpose: to provide guidance on the assessment and management of contaminated sites in Western Australia

2 Background Studies

Relevant surface water and hydrogeological studies were reviewed to gain insight into the hydrological conditions, and groundwater and geological categorisation of the Study Area and surrounds, in relation to potentially sensitive human and environmental receptors. Key assessment items are summarised in Table 2-1 below.

Table 2-1: Surface water, hydrogeology and other studies reviewed for the Assessment.

<table>
<tr><th>Investigation</th><th>Key Assessment Items</th></tr>
<tr><td>Lower Blackwood River and Scott River Flood Study (Water Authority of Western Australia 1992)</td><td>• The Lower Blackwood River and Scott River Flood Study was undertaken by the Water Authority of Western Australia (now Water Corporation) in 1992. The report presents the design flood estimation of the lower Blackwood and Scott Rivers for catchment areas of 1390 km^2 and 550 km^2, respectively.
• The rainfall-runoff routing RORB model used 1987 Australian Rainfall and Runoff methodologies to conduct flood frequency analysis. The RORB model used data in stream gauges in Scott River (Brennans Ford) and lower Blackwood River (Hut Pool and Darradup).
• The RORB model results for the Scott River at Brennans Ford provides the peak design flow for the 100-year, 20-year, and 10-year events of 120 m^3/s, 68 m^3/s, and 55 m^3/s, respectively. The critical duration for the 100-year event in the Scott River catchment is 3 days.
• The study also provided a Region Rational Method (RRM) and Index Flood Method (IFM) as validation of the RORB model results as provided in below table below for the Scott River.
• The RORB model results for the Scott River at Brennans Ford provides the peak design flow for the 100-year, 20-year, and 10-year events of 120 m^3/s, 68 m^3/s, and 55 m^3/s, respectively. The critical duration for the 100-year event in the Scott River catchment is 3 days.
• The Blackwood River peak flow was 1200 m^3/s based on the 100-year event. The critical duration for this peak flow is 4 days.
• The study focused on providing flow estimates which are located downstream of the Study Area. The study also excluded flood extent and velocity data. Therefore, the study cannot be directly used to ascertain existing surface water flow path extents, peak flows, and velocities for the headwater catchments within the Study Area.
• The study may be used as validation for regional flows in future studies if deemed appropriate yet remains outside the scope of this assessment.
<table>
<tr><th colspan="2">ARI (years)</th><th>2</th><th>5</th><th>10</th><th>20</th><th>50</th><th>100</th></tr>
<tr><td rowspan="3">Peak Flow (m^3/s)</td><td>RRM*</td><td>18.8</td><td>20.9</td><td>25.7</td><td>-</td><td>41.4</td><td>-</td></tr>
<tr><td>IFM**</td><td>21.9</td><td>33.2</td><td>43.7</td><td>-</td><td>76.9</td><td>-</td></tr>
<tr><td>RORB</td><td>-</td><td>-</td><td>55</td><td>68</td><td>-</td><td>120</td></tr>
</table>
*Note: * = Regional Rational Method (RRM) and ** = Index Flood Method (IFM).*</td></tr>
<tr><td>Scott River Action Plan (LBLCDC 2020)</td><td>• The Scott River Action Plan was prepared by the LBLCDC in December 2020. The report identified the Scott River catchment as an important and productive agricultural area (43%), with the remaining area comprising of reserves (53%) and unallocated crown land, rich in biodiversity. Water quality data was collected and analysed in the study to provide an indication of the Scott River catchment condition.
• Approximately 90% of the waterways assessed (~120 km of a total of 185 km of waterways) were rated as degraded or severely degraded due to the absence or limited vegetation cover in the riparian zones, significant bank erosion, and weed infestations. Heavy metal and acid forming potential analysis.
• The sub-catchments with waterways in better conditions were the Middle Scott Lower Reaches and the Lower Scott River. The Proposal Study Area is within the Lower Scott River sub-catchment area.
• Most minor waterways and tributaries assessed have lost much of the endemic flora and fauna. These findings match those of DWER Healthy Rivers Program which</td></tr>
</table>

Investigation	Key Assessment Items
	consists of detailed waterway assessments (using a different methodology) at key locations in the catchment. • A few properties have patches of native bush of high biodiversity value, but these are not always fenced off to exclude stock. • Several widespread weeds were recorded. Two declared species (Apple of Sodom and Cape Tulip) and some woody weeds. No Arum lily or Blackberry (Rubus fruticosus) were recorded in the catchment. • The biodiversity in the main channel is in good condition in terms of the number and diversity of flora and fauna species although there are signs of stress associated with upstream nutrient runoff along some sections. • A variety of natural and augmented natural drainage systems traverse the Scott River Catchment mainly from north to south that convey streamflow from the forested Barlee Scarp to the river. Drains have not been built in a coordinated way in the catchment but in response to land use needs and the most prolific drainage seems to be associated with plantation establishment. • The study will be used to assist with identification of existing environment conditions, as discussed throughout this report.
Healthy Estuaries Program (DWER 2005-2019) Healthy Rivers Program (DWER 2005-2019) Hardy Inlet: Blackwood catchment - nutrient report, 2019 (DWER 2023a) Hardy Inlet: Scott catchment - nutrient report, 2019 (DWER 2023b)	• The DWER Healthy Rivers and Estuaries Programs were designed to target known pressures and associated stressors in the Western Australian river and estuarine systems and to enable the detection of new issues. Some common threats to the waterways include altered flow regimes due to changing climate and anthropological factors, reduced catchment and streamside vegetation, invasion of exotic species, degradation of aquatic habitat, poor water quality (particularly eutrophication, secondary salinisation, low dissolved oxygen and contaminants) and barriers to movement of aquatic fauna. Baseline quality of groundwater aquifers at the mine (Warren Sands and Beenup Beds) • There are five surface water sampling sites in the region as part of the DWER Healthy Rivers program: • 6091051 Scott River – Brennans Bridge • 6091224 Scott River Trib – Coonack Downs • 6091225 Scott River Tributary – Governor Broome Rd • 6091226 Scott River Trib – Woodhouse • 6091309 Paynes Rd (Blackwood River Catchment) • Several nutrient reports were published in 2017-2019 as part of the Healthy Estuaries program for monitoring completed from 2005, including the most recent Beenup (Blackwood Catchment) and Lower Scott River Catchment Hardy Inlet Nutrient Reports in 2019. The sampling sites are illustrated in Figure 3-7.
Baseline Water Monitoring Program (Stantec, unpublished data)	• Surface water discharge points are ephemeral, with flow observed primarily following rainfall events. Sampling was feasible during the July, September, and January campaigns. • Wetlands showed more consistent water levels throughout the year, while Creekline discharge points remained dry during extended dry periods due to limited catchment sizes. • Groundwater levels showed strong correlation with rainfall, rising in wet and shoulder wet seasons and declining by up to 2.0 m during dry periods. • The Leederville Aquifer exhibited the highest groundwater levels in the northern portion of the Study Area (WM01), indicating a general southward flow direction. • Seasonal groundwater fluctuations were observed across the aquifers: - WM01 cluster: ~2.0 m - WM02 location: ~1.2 m - WM03 location: ~1.7 m Water Quality

Investigation	Key Assessment Items
	• Pesticide analyses in groundwater (April 2024) and surface water (July 2024) detected no contaminants above laboratory reporting limits. • Groundwater was generally fresh but mildly acidic, with an average pH of 6.0—below the Department of Health's trigger value for non-potable use (6.5). No clear seasonal trends in pH were observed. • Elevated concentrations of naturally occurring heavy metals (iron, aluminum, copper, manganese, and zinc) were detected in groundwater. • Surface water showed elevated nutrient levels—particularly nitrogen and phosphate—likely influenced by nearby agricultural land use. The details are discussed in detail in Section 4.7.
Scott Coastal Plain Bore Completion Reports, Volume 1 – sites 1 to 10. Hydrogeology Report 1995/35 (Baddock 1992)	• Conceptualisation of the regional hydrogeological landscape. • Bore completion reports for 22 sites (volume 1 and 2). • Bores relevant to the Study Area include SC5 (southwest Study Area boundary), SC9 (southeast Study Area boundary) and SC15 (western Study Area boundary).
Beenup Titanium Minerals Project: Annual Environment Report, 1996 (BHP 1996) Beenup Titanium Minerals Project: Annual Environment Report, 1997 (BHP 1997)	• Geotechnical investigations including drilling air-cores associated with the dredge mine path. • Heavy metal and acid forming potential analysis. • Geophysics surveys including seismic surveys, echo-sounding, acoustic surveys and wireline logging.
Beenup Titanium Minerals: Baseline Monitoring Report, 1998 (BHP 1998a)	• Incomplete report version – missing end pages. • Baseline quality of surface waters near the mine. • Baseline quality of groundwater aquifers at the mine (Warren Sands and Beenup Beds).
Beenup Titanium Minerals Project: Monitoring Bore Completion Report, November 1998 (BHP 1998b)	• Bore completion reports for monitoring bores 1 to 58; 109 to 117 and 128 to 138. • Description of the local geology and hydrogeological regime. • Reported groundwater bores relevant to the Study Area are DM22LB (lower Beenup), DM23UB (upper Beenup), DM28LB, DM29WS (Warren sands), B01LB, B02UB, B03WS, B04WS, B05WS, B06WS, B07WS, B08WS, B09WS, MDS137 and MDS138. These are located northeast, east or southeast of the mine operation area.
Hydrogeology Report No. HR 166 (Water and Rivers Commission 2000)	• Conceptualisation of the regional hydrogeological landscape. • Installation of 44 monitoring bores (up to 18 m deep) and three test pumping bores (with six observation bores) across nine sites. • Details local hydrogeology, relevant aquifer descriptions and geochemical parameters. • Bores relevant to the Study Area include SM41, SM42 and SM43 (southeast Study Area boundary) and SM44, SM45 and SM46 (southwest Study Area boundary).
SouthWest Groundwater Areas Allocation Plan (DoW 2009b)	• Detailing underlying geology to the SouthWest region. • Identifying major and minor potential aquifers within the region. • Adverse effects that climate change has had on the groundwater. • Analytical assessment of groundwater parameters and contamination related to mining activity. • Hydrological and hydrogeological surveys. • Groundwater-dependent ecosystems and key environmental values. • Groundwater-dependent cultural and social values.

Investigation	Key Assessment Items
Blackwood groundwater area subarea reference sheets: Plan companion for the SouthWest groundwater areas allocation plan (DoW 2009c)	• The Study Area intersects the Beenup Groundwater Management Subarea and the Blackwood Groundwater Management Area, Beenup Subarea of the South-West Groundwater Allocation Plan (Blackwood GMA Beenup Subarea). • It also intersects with Groundwater Management Zone 7 which is defined as a "buffer zone area defined by acid sulfate soil plume from Beenup mine site" (DoW 2009c). • As a consequence of the implementation of Groundwater Management Zone 7, water use from the Superficial, Leederville and Lesueur aquifers is restricted, meaning that no new water allocation and no new bores or excavations are permitted to be constructed in the Superficial or Leederville aquifers, within the management zone boundary, other than for exempt use, replacement of existing bores, monitoring purposes, or remediation (DoW 2009c).
Scott Coastal Plain: Bore Completion Report (DoW 2011)	• Provides a hydrogeological characterisation and understanding of groundwater-dependent ecosystems of the Scott Coastal Plain. • Bore completion details of shallow groundwater bores. The closest bores to the Study Area were EW17A, EW17B and EW18A (associated with Palusplain wetlands).
Beenup Titanium Minerals Project: Annual Environment Report (BHP 2015)	• Summary of the site conditions and contamination status. • Hydrographs for long term bore monitoring. • Bore construction and lithological logs.
Geotechnical Desktop Report (Stantec 2024a)	• Preliminary site setting and landscape characterisation of the Study Area. • Preliminary ASS assessment. • Recommendations for future sampling and analysis.
Preliminary Geotechnical and Baseline Contamination Report (Stantec 2024c)	• Installation of 3 geotechnical boreholes (piezometers) (WM01, WM02 and WM03) to 25 metres below ground level (mbgl). • 13 shallow piezometers installed up to 7 mbgl, in locations near the three deep piezometers. • 20 test pits were excavated across the Site at specific locations, each to a maximum depth of 2.0 m BGL or until refusal, soil sampling (including ASS sampling) occurring every 0.25m BGL.
Biological Surveys and Wetland Mapping for the Proposed Scott River Wind Farm (Phoenix in prep.-b)	• A Basic fauna survey was undertaken within the Study Area, indicating species of conservation significance. • Wetland boundaries were mapped within the Study Area and their classification and management category were determined on the basis of their biological values, in accordance with the biological attributes.
Detailed Flora and Vegetation Survey for the Proposed Scott River Wind Farm (Phoenix in prep.-a)	• A single season detailed flora and vegetation survey with targeted searches for threatened flora as well as introduced flora was undertaken in spring 2023. • Potential groundwater-dependent flora, vegetation and/or ecosystems were recorded where present.

3 Existing Environment

3.1 Biogeographical Context and Land Systems

The Study Area is located within the Warren (WAR) bioregion and the Southern Jarrah Forest subregion (Jarrah Forest 2; JF2) of Western Australia (Figure 3-4), as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (Thackway and Cresswall 1995). The IBRA classification system represents a landscape-based approach to classifying the land surface of Australia, delineated by a unifying set of environmental influences which has influences the occurrence of flora and fauna and their interaction with the physical environment (e.g. climate, geomorphology, landforms and lithology (DSEWPaC 2012).

Land systems are defined as an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation (Tille 2006). Land resources of the Busselton-Margaret River-Augusta- region have been mapped by the Natural Resources Assessment Group (NRAG) from the Department of Primary Industries and Regional Development (formerly the Department of Agriculture and Food; DAFWA), which provides a description of biophysical resources across each region (Tille and Lantzke 1988). The Study Area lies predominantly within the Scott River Plain land system (3,178 ha) and intersects the Nillup Plain land system (15.6 ha) (Table 3-1, Figure 3-5).

Table 3-1: Land systems and extent within the Study Area.

Land System	Description	Proportion
Nillup Plain System (Np)	Poorly drained plain, in the southern Donnybrook Sunkland. Sandy gravel, non-saline wet soil, grey deep sandy duplex, loamy gravel and pale deep sands. Jarrah-marri-paperbark woodland.	15.6 ha
Scott River Plain System (Sr)	Poorly drained coastal plain, in the southern Donnybrook Sunkland. Non-saline wet soil and pale deep sand. Heaths, sedgelands and jarrah-marri-paperbark woodland.	3,178.5 ha

3.2 Climate

3.2.1 Rainfall

The climate of the Study Area is described as moderate Mediterranean, with mild wet winters and hot summers. The Bureau of Meteorology (BoM) weather stations closest to the Study Area are Warner Glen (Station ID 009613), Alexandra Bridge (Station ID 009801), and Cape Leeuwin (Station ID 009518). A single Department of Water, Environment, and Regulation (DWER) rainfall station is located at Scott River – Brennans Ford (Station ID 509199). The Study Area is located approximately 7 km southeast from Warner Glen, 9 km southeast from Alexandra Bridge and 23 km northeast from Cape Leeuwin. Rainfall gauge locations are shown in Figure 3-7. The Scott River station is most representative of the climate conditions at the Study Area. Cape Leeuwin also provides ambient temperature readings otherwise unavailable at the other stations.

A review of all relevant stations is provided for context.

- Scott River – Brennans Ford (509199)
    - The average annual rainfall recorded at the DWER rainfall station is 953.2 mm comparative to the ten-year average of 934 mm. In 2023, the annual rainfall was 845 mm, which is below the ten-year average but exceedingly higher than that recorded at Cape Leeuwin.
- Warner Glen (Station ID 009613)
    - The ten-year annual average rainfall at Warner Glen is 958.7 mm (BoM 2024). Over the last 10 years, at Warner Glen, annual rainfall has been below the long-term annual average of 999.3 mm, with 762.4 mm in 2015, 767.8 mm in 2019 and 839.7 mm in 2023. The year 2021 was a “wet year” exception in the last 10 years, with 1221.8 mm recorded compared to the long-term average. Peak rainfall occurred in 2013 with a total of 1256 mm.
- Alexander Bridge (Station ID 009801)
    - Between 2013 and 2023, the annual average rainfall at Alexandra Bridge was 895.3 mm, below the long-term average of 1073.2 mm. In July 2013, the maximum rainfall reached 279.8 mm, which accounted for 20% of the annual total of 1333 mm. Notably, both 2013 and 2021 experienced above-average annual rainfall, with 1333 mm and 1292 mm, respectively.

- Cape Leeuwin (Station ID 009518)
    - The Cape Leeuwin rainfall and temperature gauge indicates an average annual rainfall of 770.8 mm from 2013 to 2023 relative to the long-term average of 950.4 mm. In 2023, the annual rainfall was 599.8 mm, which is below the ten-year average.
    - Cape Leeuwin records the highest mean maximum monthly temperature (25.5°C) in February and the lowest minimum mean monthly temperature (18°C) in July. The average monthly rainfall against temperature ranges at Cape Leeuwin from 2011 to 2023 is shown in Figure 3-1.

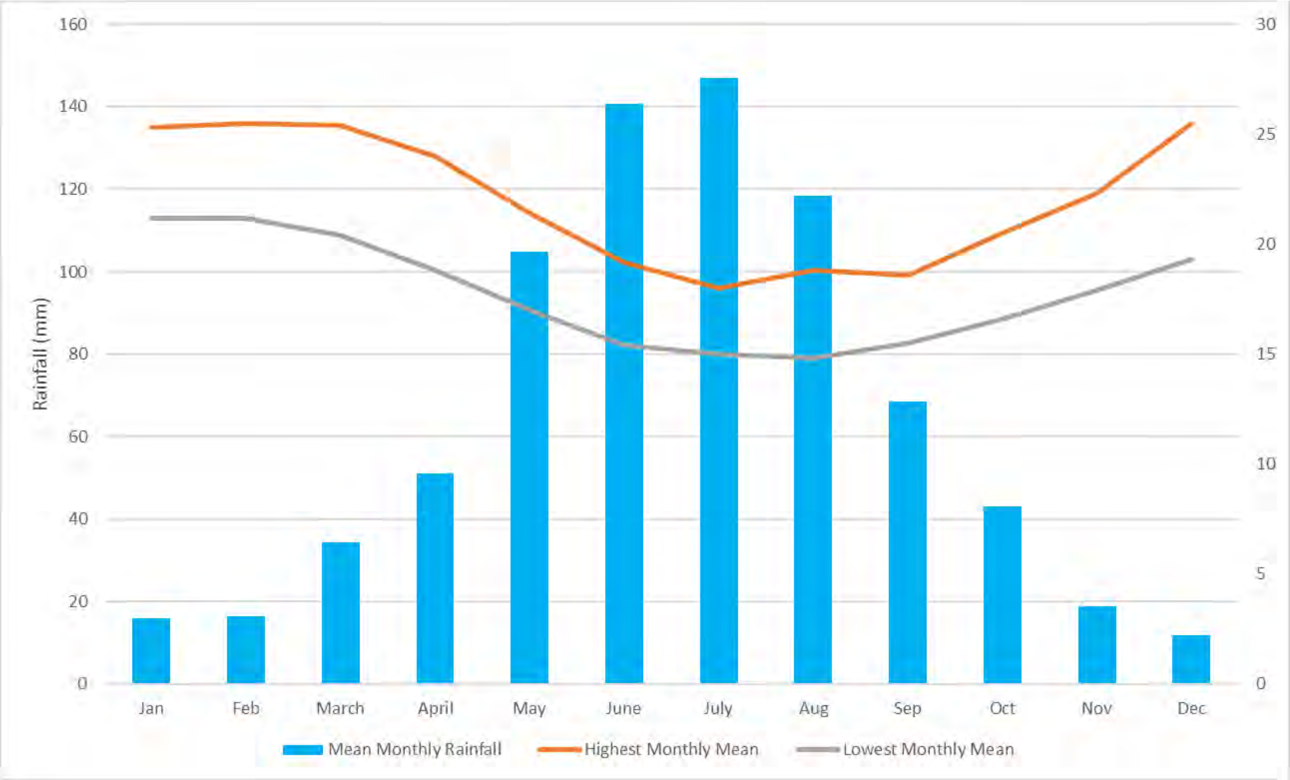


Figure 3-1: Monthly mean rainfall and mean maximum and minimum temperature at Cape Leeuwin (BoM Station ID 9518).

3.2.2 Scientific Information for Landowners (SILO) Data

The Scientific Information for Landowners (SILO) has grided evaporation across Australia, this assessment has extracted evaporation data available for (-34.25,115.30) the southern portion of the Study Area. For the long-term period from 2010 to 2023, the annual average pan evaporation is estimated as 1452 mm, with the annual average rainfall estimated as 932 mm. This shows a deficit between annual average rainfall and pan evaporation.

The long-term annual total rainfall and evaporation between 2010 to 2023 for the Study Area SILO site is presented inFigure 3-3. The maximum recorded rainfall was interpolated as 1207 mm in 2013 and 1152 mm in 2021. Notably, the highest yearly evaporation was interpolated in 2023, reaching 1734 mm. Comparing this to the annual rainfall of 793.3 mm at the same location in 2023, Figure 3-2 shows evaporation in 2023 exceeded the monthly rainfall for approximately 70% of the year.

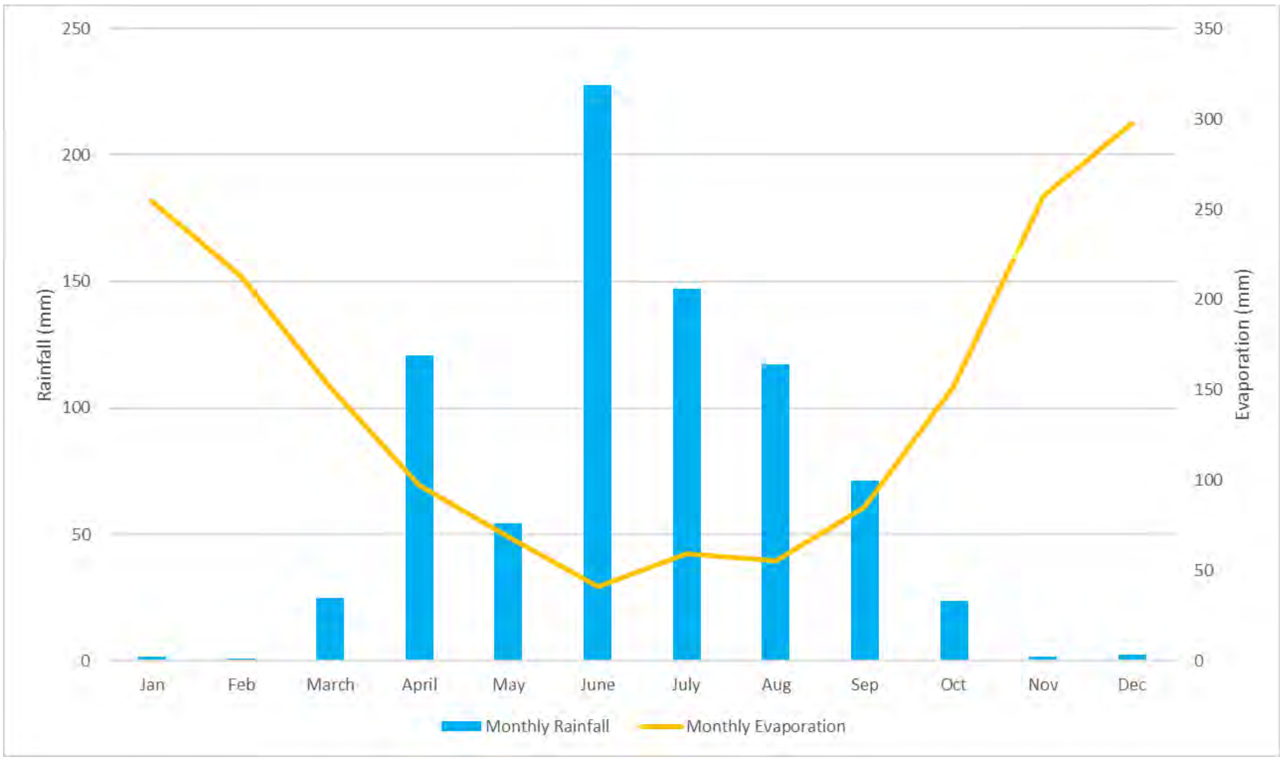


Figure 3-2: Monthly total rainfall and evaporation in 2023 at the Study Area (SILO 2024).

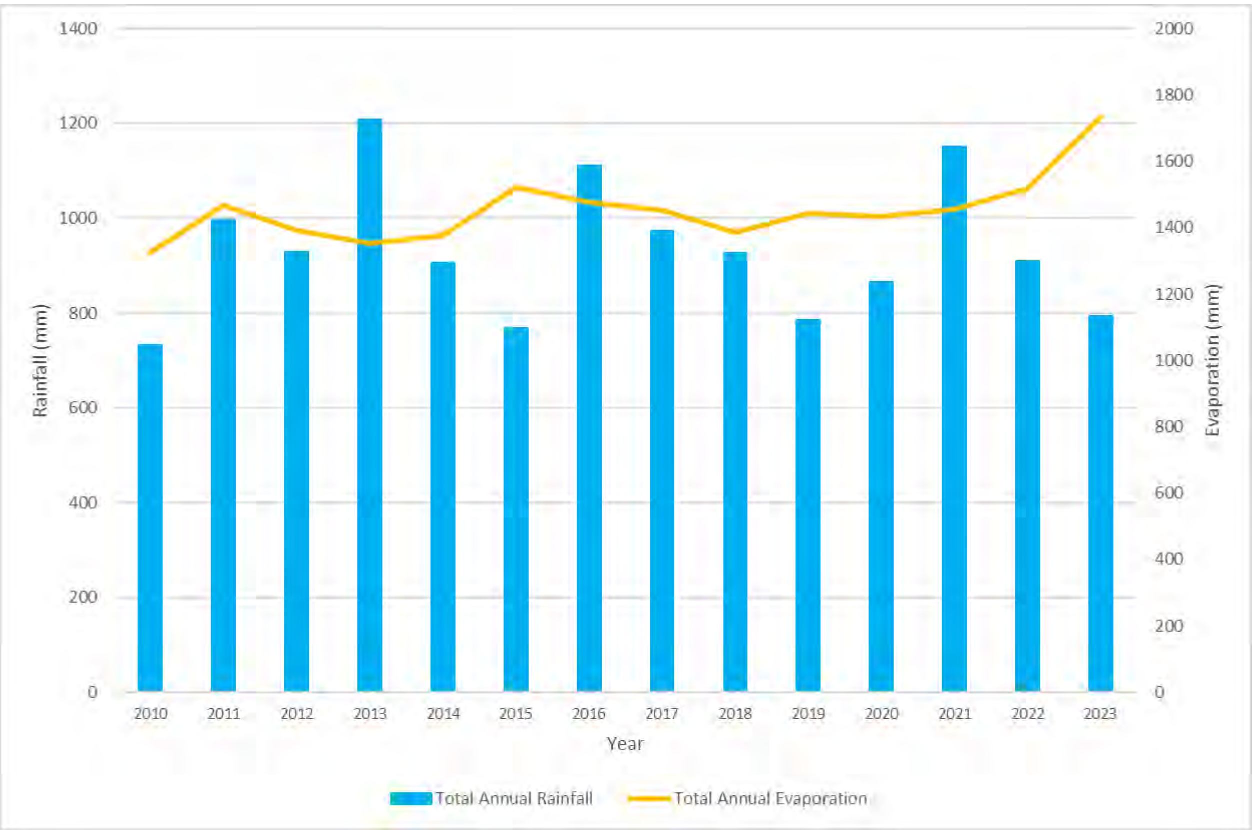


Figure 3-3: Annual total rainfall and evaporation in 2010-2023 at the Study Area (SILO 2024).

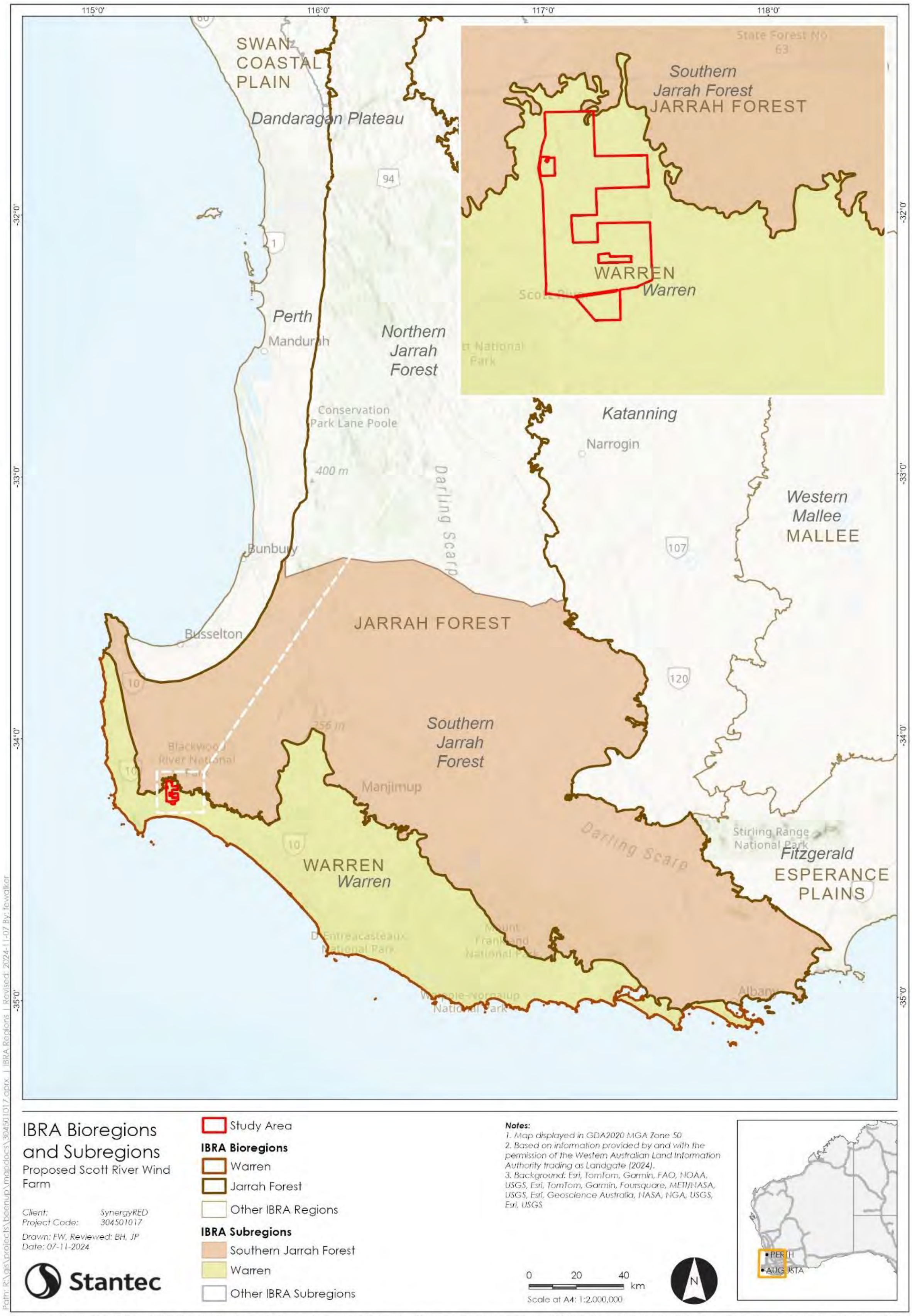


Figure 3-4: Location of the Proposal within the IBRA Southern Jarrah Forest subregion and the Warren bioregion.

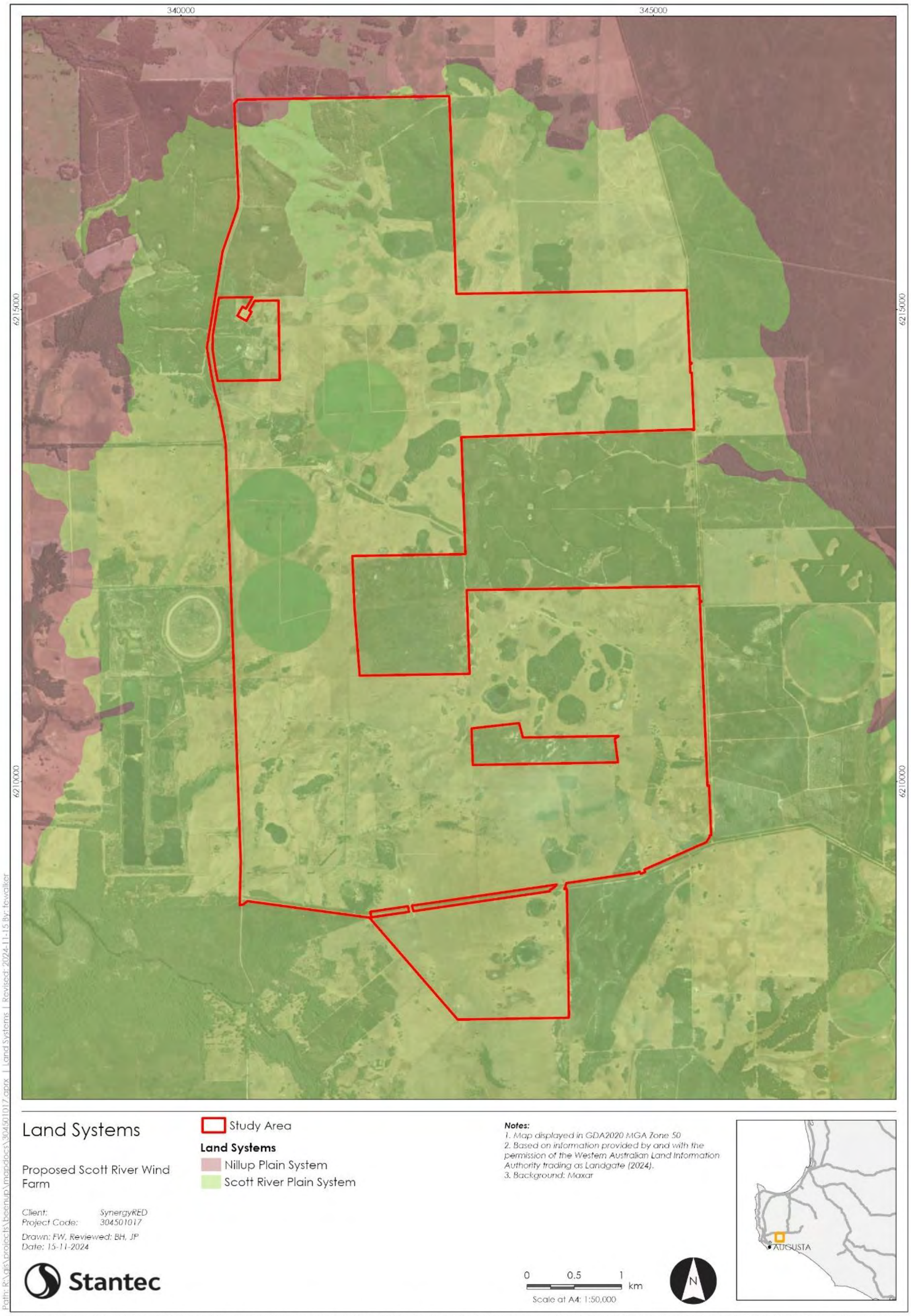


Figure 3-5: Location of the Nillup Plain and Scott River Plain land systems in relation to the Proposal.

3.3 Surface Water

3.3.1 Surface Water Management and Public Drinking Water Areas

The Study Area intersects with the Lower Blackwood, Beenup and Scott Surface Water Management Areas (Figure 3-6). The rivers in this region are known to be influenced by natural groundwater flows, supporting environmental values (DoW 2016). The Study Area is also located 10 km from the Fisher Road Wellfield Water Reserve Public Drinking Water Source Area (PDWSA) (Figure 3-6). The Study Area is at least 20 km from the next closest PDWSA; the Margaret River Catchment Area.

3.3.2 Regional Gauges and Sampling Sites

There are four gauges owned by the DWER, with an additional five surface water sampling sites located near the Study Area (Figure 3-7). The main rainfall gauge is 509199 Scott River – Brennans Ford. The three stream gauges include 609002 Scott River – Brennans Ford, 609060 Blackwood Tributary Beenup Wetland Outflows, and 609026 Scott River – Milyeannup Br (decommissioned). The five surface water sampling sites include:

- 6091051 Scott River – Brennans Bridge
- 6091224 Scott River Tributary – Coonack Downs
- 6091225 Scott River Tributary – Governor Broome Rd
- 6091226 Scott River Tributary – Woodhouse
- 6091309 Paynes Rd

The average annual flow recorded at Scott River – Brennans Ford (609002) for the period 1969-2018 was 88.5 GL, a decrease from the average of the period 1969- 2009 which was 94.7 GL. Between 1970-1999 the average flow was 106 GL and the average 2000-2019 flow was 61 GL, which shows a 42% reduction post-2000 (LBLCDC 2020).

There are three additional Bureau of Meteorology (BoM) rainfall gauges located near the Study Area (Figure 3-7):

- 009613 Warner Glen;
- 009518 Cape Leeuwin (also includes a temperature gauge); and
- 009801 Alexandra Bridge.

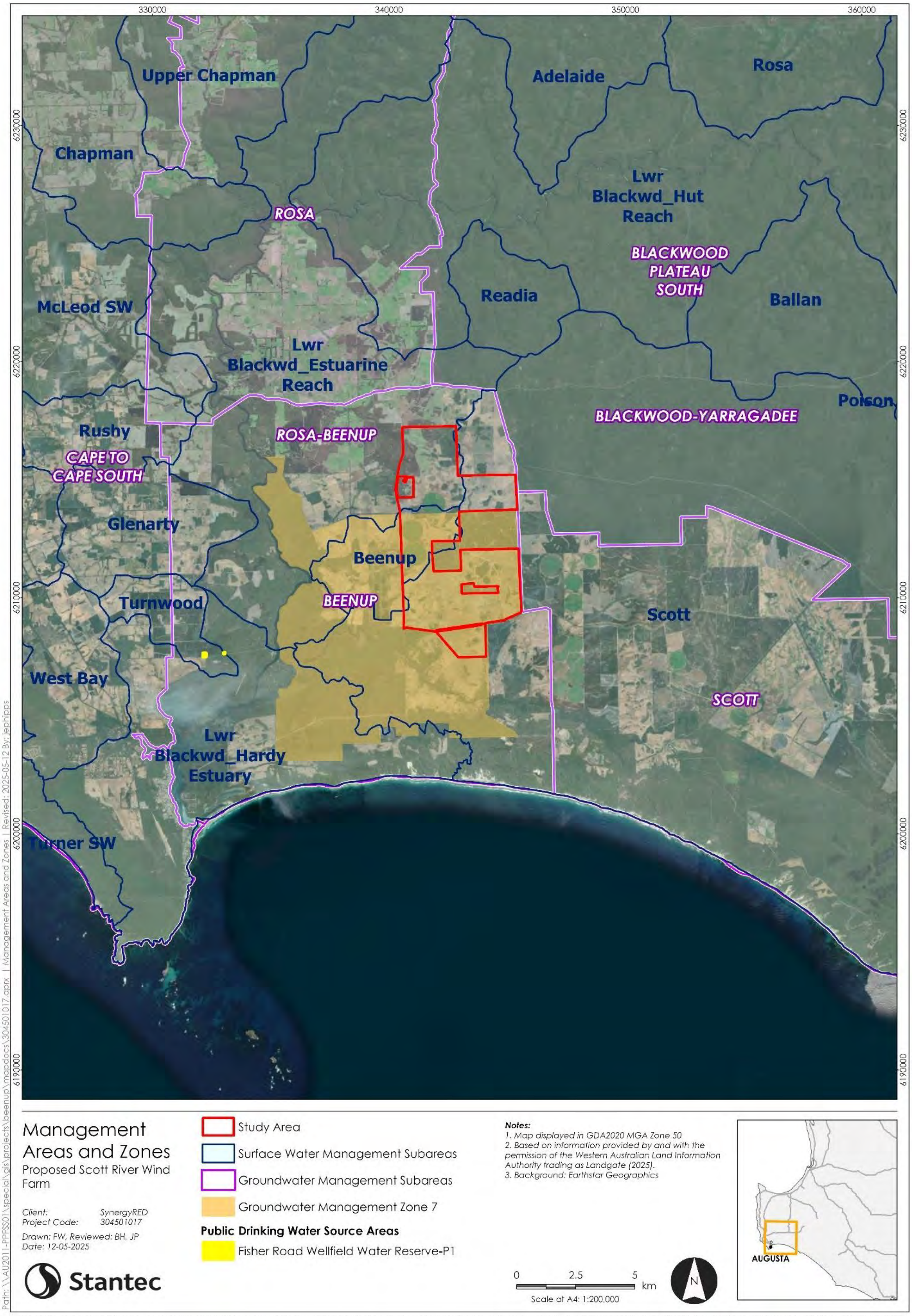


Figure 3-6: Water Management Areas and Public Drinking Water Sources in relation to the Study Area.

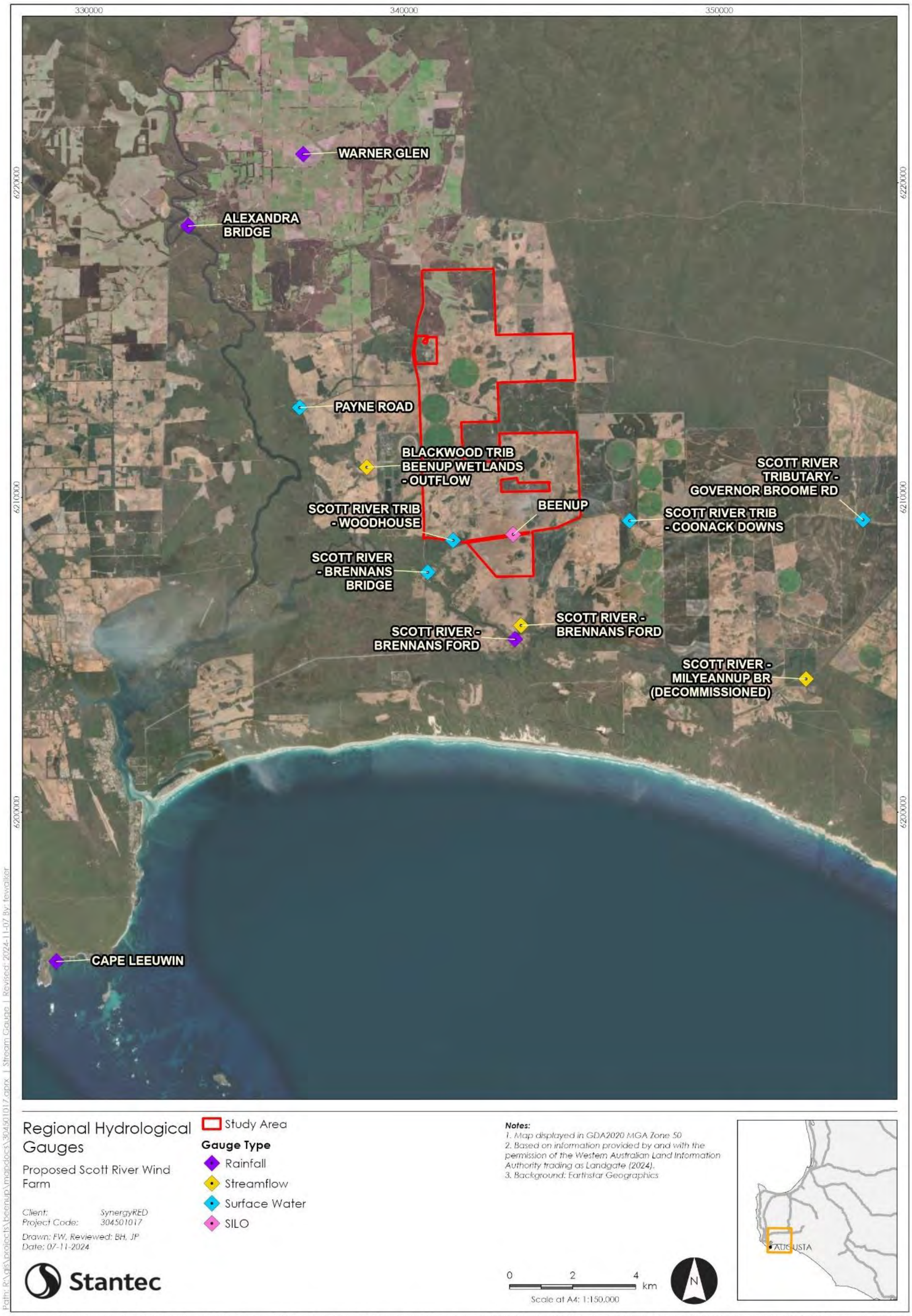


Figure 3-7: Gauge and sampling site locations in relation to the Study Area.

3.3.3 Topography

The Study Area is located on the Scott Coastal Plain, between the Darling Escarpment to the west and the Stirling Range to the east and wheatbelt to the north. With the southern boundary of the Study Area located approximately 4 km north of the Indian Ocean-Southwestern Australian coastline, the surface topography of the region abruptly rises in elevation, with 30m of elevation rise within 200 m of the coastline. North of the coastal dunes, the topography is gently undulating with no other significant topographical features.

Locally across the Study Area, there is a gradual increase in elevation from the southwest (as little as 9 m AHD) to the northeast (as great as 38 m AHD). There is a poorly defined drainage divide that runs approximately through the centre of the Study Area, segregating the Blackwood and Scott River headwater catchments.

There is an average slope from north to south of approximately 2.5 m/km and less than 1 m/km from east to west. The topographical data (DA94 MGA Zone 50 horizontal datum and referenced to the vertical Australian Height Datum) used for the Assessment consisted of two datasets. These datasets were used to resample a 1 m merged digital elevation model (DEM) for the entire Study Area (Figure 3-8) as follows:

- 1 m LiDAR data coverage from DWER was available for the southern part of the Study Area and the Scott River section; and
- 2 m resolution DEM tiles generated by Landgate was available for the entire Study Area; however, were only used for the northern section where the Scott River 1 m data was not available.

3.3.4 Catchment Delineation

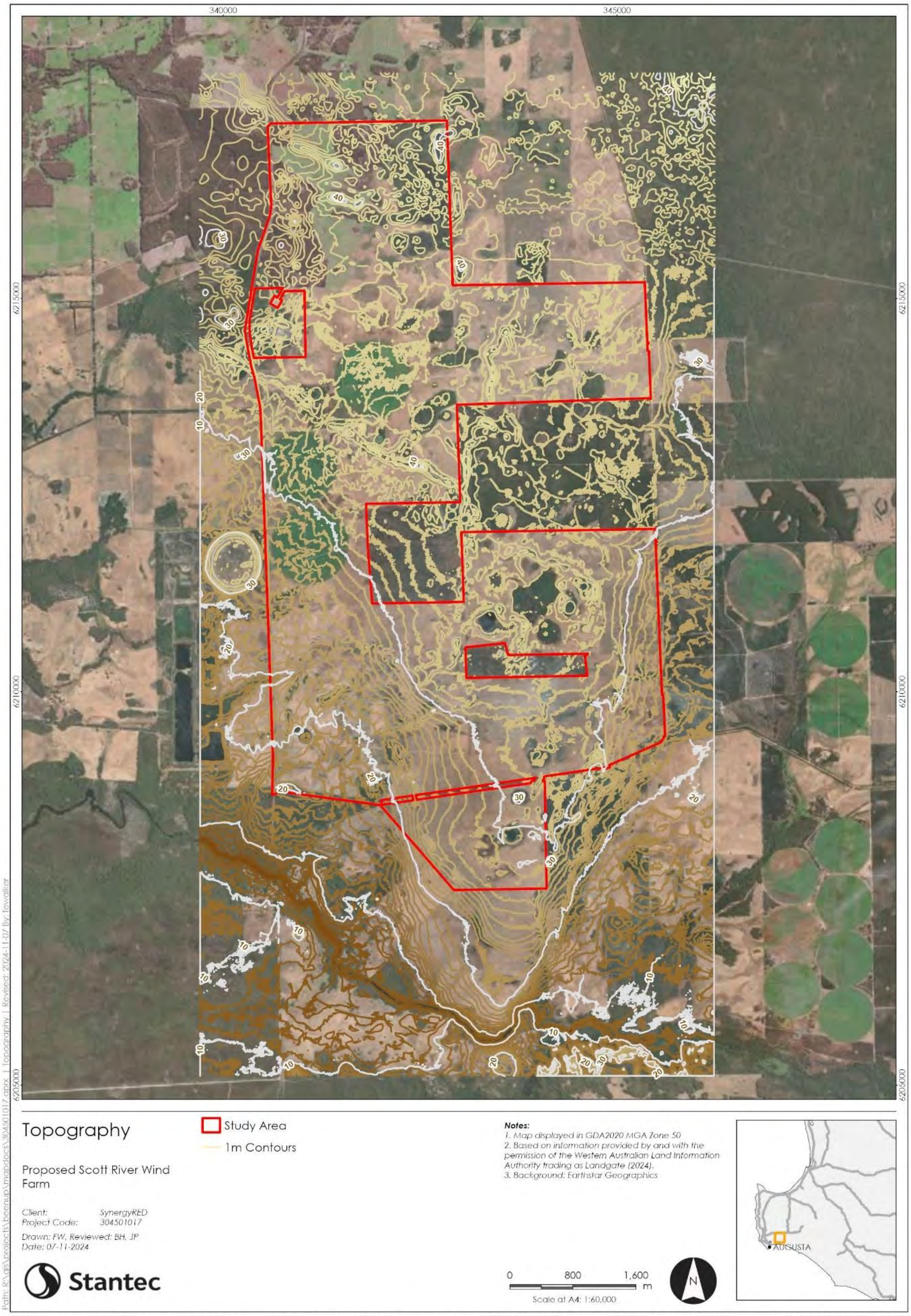
The Study Area intersects 11 headwater tributary catchments of the Scott and Blackwood Rivers. An area of 13.7 km² (43%) of the Study Area drains into the Blackwood River, while 18.3 km² (57%) of the Study Area drains into the Scott River (Figure 3-9). Drains to facilitate the agricultural and plantation activities in the Study Area have not been built in a coordinated way and intersect with roads and natural drainage lines, resulting in several areas of localised ponding due to catchment modification.

The sub-catchments were delineated using the Shuttle Radar Topography Mission (SRTM) publicly available topographical data for the region to quantify discharge locations from the Study Area and validate hydraulic results. The topographical data outlined in Section 3.3.3 was used to refine the local catchments but is not available for the full catchment extents required to ensure all external catchments have been considered.

The sub-catchments in the region are illustrated in (Figure 3-9) and details outlined in Table 3-2. Each of the sub-catchments which intersect the Study Area has at least one main flow path, which is deemed a key stream for the purposes of this Assessment.

Table 3-2: Regional Sub-catchment details relative to the Study Area.

River Catchment	Sub-catchment	Area (km²)	Area in Study Area (km²)	Reach Length (km)	Average Slope (m/km)
Scott River	**A**	7	2.2	1.6	6.1
	B	4.3	1.9	0.9	2.7
	C	9.6	4	1.9	7.6
	D	21.9	2	1.8	7.1
	E	8.2	6.6	1.2	7.2
Blackwood River	**F**	11.6	7.3	2.6	6.2
	G	8.2	1.8	1.2	5.4
Scott River	**H**	4.5	0.8	1.1	13.7
Blackwood River	**J**	9.4	1.4	1.1	5.0
	K	37.8	3.2	1.1	3.9
Scott River	**L**	21.7	0.8	0.5	1.1
	I	9	0	*Outside Study Area*	
	M	3.7	0		
	N	3.8	0		
	O	0.6	0		
	P	4.8	0		



Topography

Proposed Scott River Wind Farm

Client: SynergyRED
Project Code: 304501017
Drawn: FW, Reviewed: BH, JP
Date: 07-11-2024

Stantec

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

Figure 3-8: Topography data available for the Assessment in relation to the Study Area.

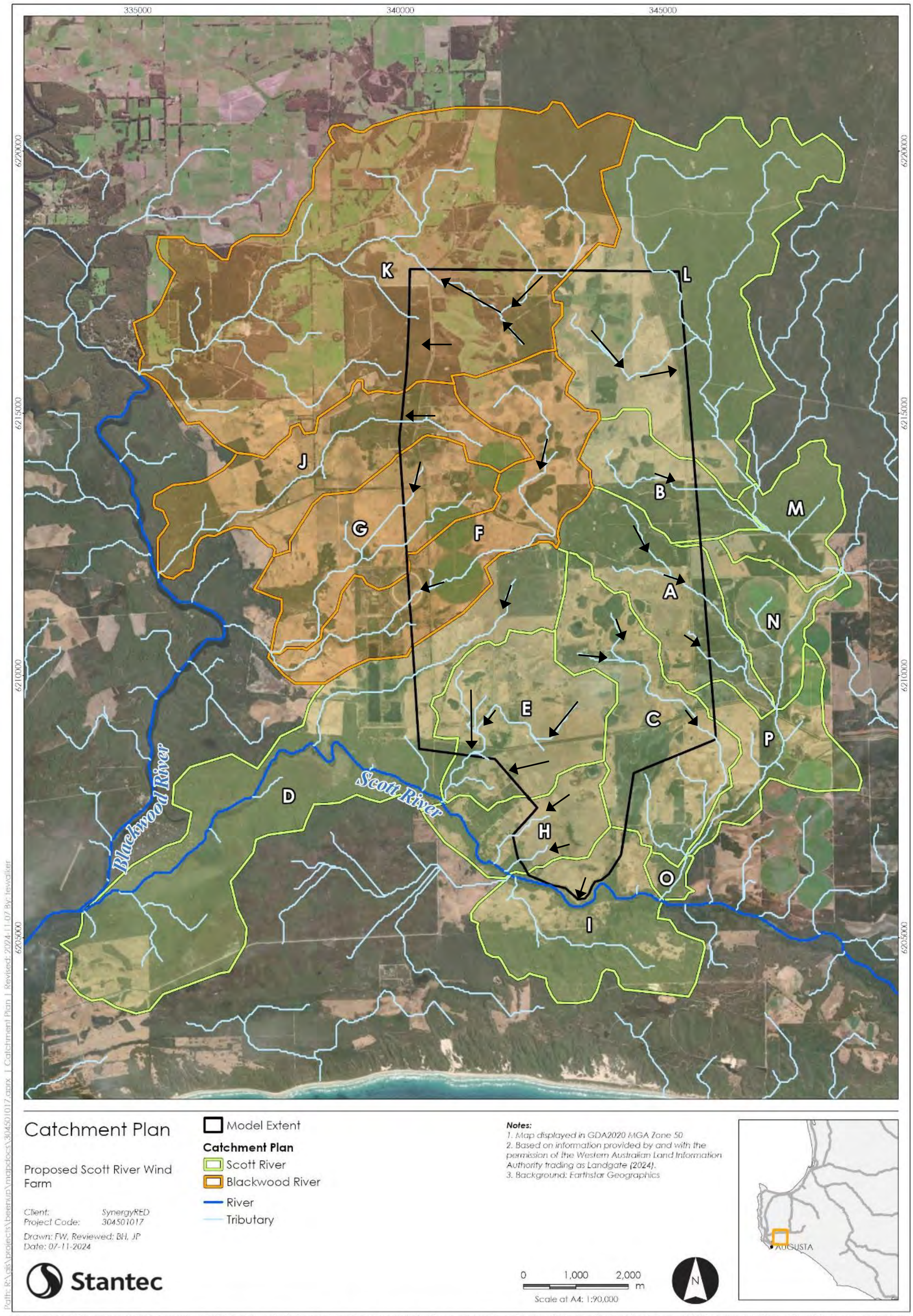


Figure 3-9:-Catchments, sub-catchments and flow path directions in relation to the hydraulic model extent.

3.3.5 Waterways and Wetlands

There are several ephemeral waterways and wetlands located within the Study Area (Figure 3-10). Minor waterways also traverse the Study Area, primarily flowing from northeast to southwest towards Blackwood River, located approximately 3.8 km to the east of the Study Area (Figure 3-9), with a smaller proportion flowing in a southeasterly direction towards Scott River located approximately 1km south of the Study Area. The Lower Scott River sub-catchment area is in better condition than the upper reaches of the Scott River. The main channel has a diverse assemblage of fauna, and the flora is in good condition, although there are signs of stress associated with upstream nutrient runoff along some sections (LBLCDC 2020).

The Blackwood River is a major river system within the catchment. During the dry summer months, groundwater from the Yarragadee and Leederville Aquifers contributes 30% to 100% of the discharge into the Blackwood River. During summer, the surrounding tributaries either contract or dry completely (Beatty et al. 2009).

The ecological values of the Blackwood River include a high native species richness and endemism of fish and crayfish as well as a diverse macroinvertebrate community. The Blackwood River is also an important nursery and spawning ground. Parts of the catchment also support extensive riparian vegetation. Groundwater influence plays an important role in maintaining aquatic biota and the riparian communities. However, the Blackwood River is subject to threats including salinisation (from land clearing) and reduced rainfall due to climate change (Beatty et al. 2009; Department of Water, Water Science Technical Series 2015).

The Study Area's waterways and wetlands are surrounded by agricultural land with and only remnant riparian vegetation remains (Figure 3-10). Three broad geomorphic wetland types have been mapped based on their topographical features and inundation regime (Semeniuk and Semeniuk 1995; 1997):

- Sumpland: located within a basin landform and defined as seasonally inundated.
- Dampland: located within a basin landform and defined as seasonally waterlogged.
- Palusplain: located on a flat landform and defined as seasonally waterlogged.

The Study Area was historically a widespread wetland environment and was predominantly palusplain (seasonally waterlogged flats), characterised by a series of damplands and sumplands in varying condition (Phoenix in prep.-b; V & C Semeniuk Research Group 1997).

3.3.6 Aquatic Habitat and Waterbirds

Ten fauna habitat types have been identified from within the Study Area, including three wetland types (Phoenix in prep.-b). The wetlands comprised seasonally inundated paperbark woodland, shrubland and sedgeland (Figure 3-11). They are sporadically distributed throughout the Study Area and are mostly ephemeral (seasonally inundated), with relatively shallow water levels when flooded (typically less than 1 m). In addition, there was one larger wetland south of Governor Broome Road and a wetland cluster in the northern section of the Study Area where surface water persisted into summer, suggesting a potential perennial regime (Phoenix in prep.-a).

The northern boundary of the Study Area contains a mosaic of remnant bushland and wetlands that are largely cohesive and provide important habitat for flora and fauna (Phoenix in prep.-b). In the centre of the Study Area, wetlands are separated by paddocks and are generally in poor condition, while to the south there is an isolated group of fenced wetlands and one larger, unfenced wetland (Phoenix in prep.-b).

The wetlands, paddocks and floodplains of the Study Area provide seasonal foraging habitat for waterbirds including migratory species. (Phoenix 2025a; in prep.-b). During the wetter months (May to September), large aggregations of waterbirds such as Straw-necked Ibis, Australian White Ibis, Australian Shelduck, Grey Teal, Black Swan, Pacific Black Duck and White-faced Heron are prevalent in the local waterways and wetlands, while from spring to early summer (September to November) there is an influx of migratory shorebirds (Phoenix 2025a; in prep.-b).

There have been seven significantly listed waterbird species (State and Commonwealth) recorded from the Study Area in low numbers, during prolonged periods of inundation (Phoenix in prep.-b). This includes several Sandpipers (Common Sandpiper, Wood Sandpiper and Marsh Sandpiper), as well as the Double-banded Plover, Blue-billed Duck, Osprey and Common Greenshank (Appendix A). A total of 11 State and Commonwealth listed significant aquatic and semi-aquatic species also have the potential to occur in wetlands and waterways across the Study Area. This comprises three crustaceans (two crayfish and one marron), one mollusc (Carter's Freshwater Mussel), five fish (including two *Galaxiella* species), and two frog (White and Orange Bellied Frog) species (Appendix A).

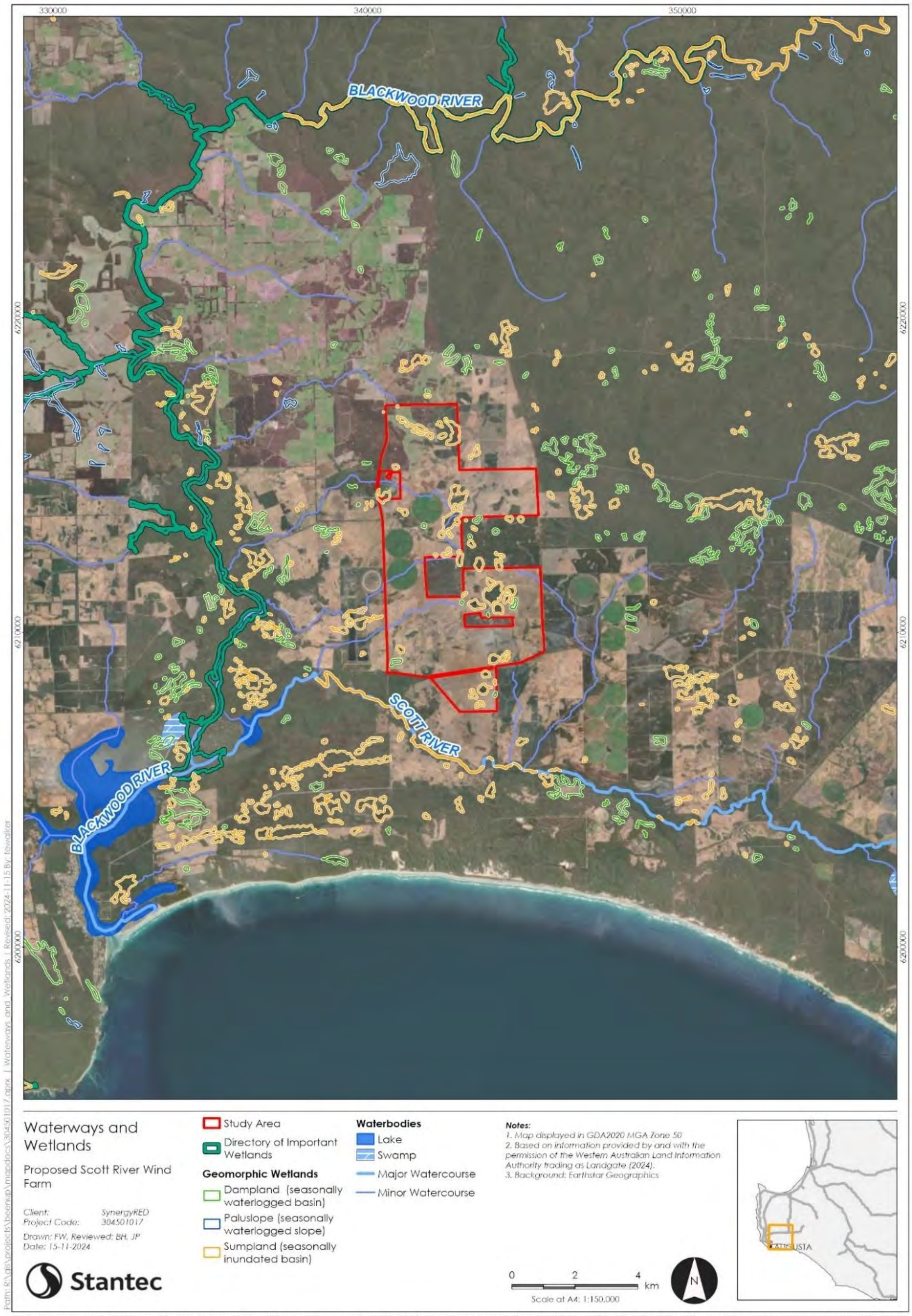


Figure 3-10: Waterbodies and geomorphic wetlands mapped within the Study Area. Spatial layer source (Semeniuk and Semeniuk 1995; 1997).

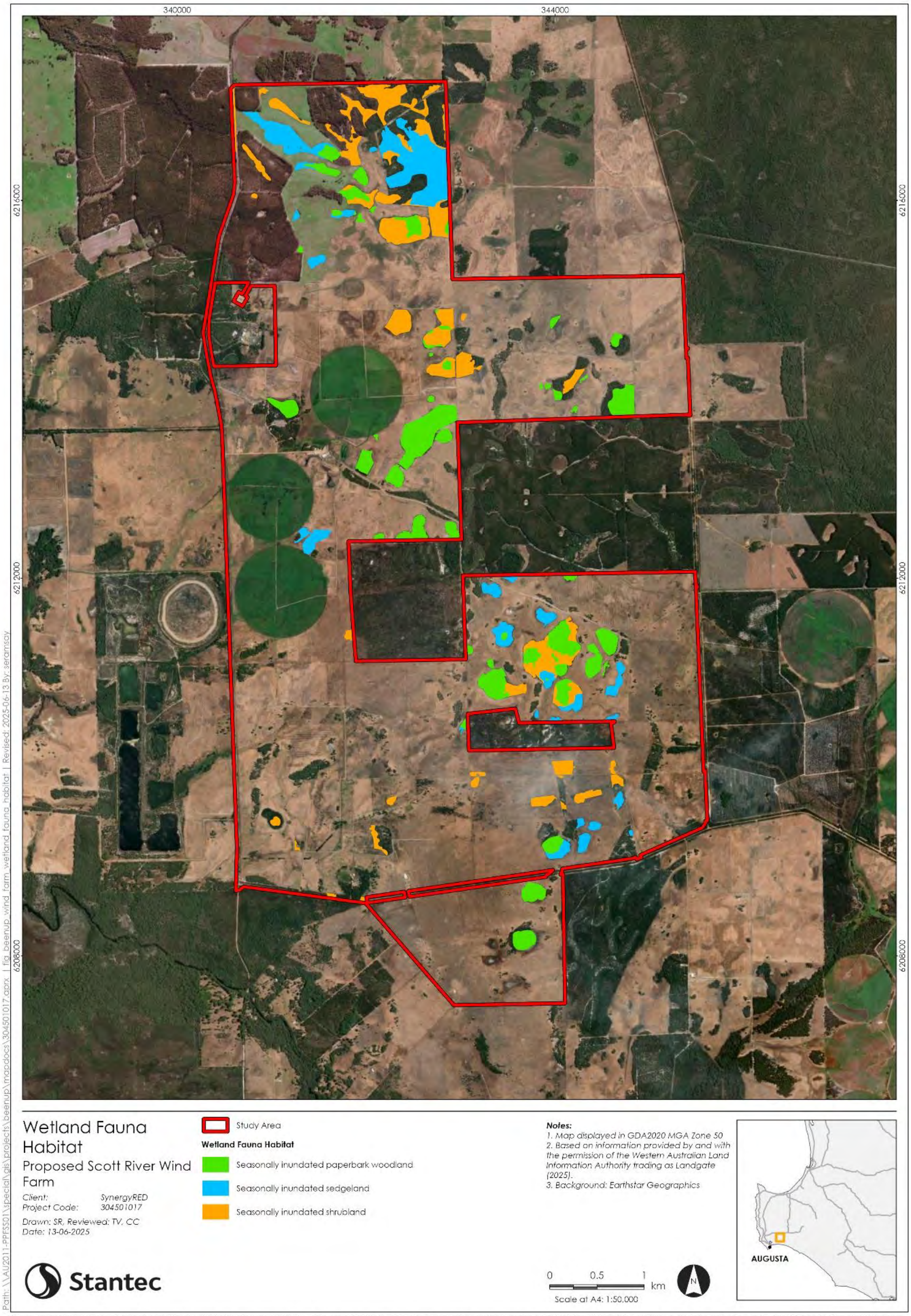


Figure 3-11: Wetland fauna habitats, within the Study Area. Spatial layer source (Phoenix in prep.-b).

3.3.7 Surface Water Quality

The DWER have undertaken surface water sampling at several locations as part of the Healthy Rivers Program, in the vicinity of the Study Area. The latest Beenup (Blackwood Catchment) and Lower Scott River Catchment Hardy Inlet Nutrient Reports in 2019 reported on the results at the 6091051 Scott River – Brennans Bridge, 6091226 Scott River Trib – Woodhouse and 6091309 Paynes Rd sites (Figure 3-7).

The ANZECC 2000 trigger values for benchmarking water quality were adopted in the DWER Healthy Rivers Program, as outlined in Table 3-3. The Statewide River Water Quality Assessment (SWRWQA) Classification Bands also used to classify water quality as part of the DWER sampling program are summarised in Table 3-4.

The report notes that a dairy shed is located immediately upstream of the Woodhouse site. As such, salinity (measured as total suspended solids; TSS) and concentrations of total nitrogen (TN) and total phosphorous (TP) are elevated for most measured contaminants at Woodhouse (on a tributary to the Scott River) compared to Brennans Bridge on the Scott River itself. The Woodhouse site has been incorporated into the ongoing site water quality monitoring being conducted in parallel to this scope of works as Surface Water Monitoring Site 5 (SW5).

Table 3-3: Benchmark water quality trigger values (ANZECC 2000).

Parameter	Units	Trigger Values
TP	mg/L	0.025
TN	mg/L	1.2
pH	unit	6.5 – 8.0
Dissolved Oxygen	(% saturation)	90 - 120

Table 3-4: Statewide River Water Quality Assessment (SWRWQA) Classification Bands.

Parameter (mg/L)	Very High	High	Moderate	Low
TP (SWRWQA 2009)	>0.20	>0.08 – 0.20	0.02 – 0.08	<0.02
TN (SWRWQA 2009)	>2	>1.2 – 2	0.75 – 1.2	<0.75
TSS (SWRWQA 2009)	>25	>10 – 25	>10 – 25	<5
Salinity (DoW 2014)	>3,000 (saline)	>1,000 – 3,000 (brackish)	500 – 1,000 (marginal)	<500 (fresh)

Note: Classification bands originally sourced from Statewide River Water River Water Quality Assessment (SWRWQA 2009) and Department of Water 2014, accessed via DWER (2024).

It is understood that nutrients enter the tributary streams from agricultural land use upstream of the sampling sites. Given the catchment is cleared and lacks fringing vegetation, nutrients tend to be washed into the streams quickly following rainfall events. Additional catchment-scale water quality factors identified include:

- High nutrient levels have been known to lead to algal bloom from fertilisers and dairy farming.
- Most of the soils in the cleared portion of the catchment have a low capacity to bind phosphorus. This is often so poor that any phosphorus applied to them can be quickly washed into drains and other waterways (DWER 2024).
- Low dissolved oxygen levels have been measured due to increasing temperature, algal bloom and reduced flows.
- Monitored sites show a first flush effect where nutrients, suspended solids and salts are mobilised following heavy rainfall. Much of this is probably the result of mineralisation of organic nitrogen in soils and drains over the summer period, and runoff of high-concentration waters from upstream agricultural areas which build up with fertiliser and animal waste over summer (DWER 2019).
- Salinity shows a slight inverse seasonal relationship, with concentrations being highest at the start and end of the flow year. This suggests that the start of the winter rains wash salts into the stream from surrounding land use as well as mobilising salts left behind in the stream after it dried the previous summer (DWER 2019).

It is possible the heavily vegetated main channel of the Scott River upstream of the Brennans Bridge site is acting like a large linear wetland, processing total ammonia and nitrate via plant uptake and denitrification (DWER 2019).

There are four key metrics against which water quality has been assessed at the sampling sites for Total Nitrogen (TN), Total Phosphorus (TP), pH, salinity and Total Suspended Solids (TSS). This includes:

- Australian and New Zealand Environment and Conservation Council (ANZECC) trigger values:
  - Payne Road mean TN concentration exceeds trigger value 2005-2010 and 2012-2019.
  - Payne Road mean TP concentration exceeds trigger value 2017-2018.
  - Brennans Bridge TN concentration moderately exceeds trigger values in 2016-2019.
  - Long-term Woodhouse TN or TP mean not reported against trigger values.
  - All annual pH medians at all sites were between the upper and lower trigger values.
- Statewide River Water Quality Assessment (SWRWQA) classification bands of low, moderate, high and very high:
  - Woodhouse mean TN classified as high (2005-2018) and very high (2019). It appears that TN concentrations increased at Woodhouse between 2016 to 2019.
  - Woodhouse mean TP classified as high (2005-2019).
  - Payne Road mean TN classified as high (2005-2019).
  - Payne Road mean TP classified as moderate (2005-2019).
  - Brennans Bridge TP concentration moderately exceeds trigger values in 2019.
  - All sites were recorded as having low mean TSS (2005-2019).
  - All sites were reported as having low mean salinity (up to 2018 SWRWQA approach).
- Hardy Inlet Water Quality Improvement Plan (WQIP) targets:
  - Woodhouse mean TN and TP exceeds winter median targets in 2016-2019 (from when they were established), being 1 mg/L and 0.1 mg/L, respectively.
- Water Resources Inventory 2014 salinity ranges for fresh, marginal, brackish or saline in the 2019 nutrient report (2018 nutrient report used the SWRWQA bands):
  - All sites were reported as fresh, with salinity levels less than 500 mg/L.

3.3.8 Cultural Heritage Places

A registered and lodged Aboriginal cultural heritage site intersects the Study Area and are associated with tributaries of the Blackwood River and Scott River. It is expected that SynergyRED will engage a specialist consultant to ensure that cultural heritage considerations are captured as part of stakeholder engagement as the Proposal develops.

3.4 Geology and Soils

3.4.1 Regional Geology

Published geological, geomorphological, and soil landscape information was reviewed by Stantec (2024a). Information provided within The Geological Survey of Western Australia (1967) 1:100,000 scale; Busselton and Augusta map sheet indicate that the Study Area is primarily underlain by Quaternary alluvium, comprising quartz-rich sand dunes and Cainozoic laterite. The Scott Coastal Plain is comprised of alluvial, lake, swamp, estuarine, and shoreline deposits unconformably overlying Mesozoic sediments (Leederville Formation of the Warnbro Group) and basalt flows or marine sediments of the Eocene.

The nearby 1:50,000 scale Karridale – Tooker map sheet (The Geological Survey of Western Australia, 2002) suggests that the Leederville Formation, comprising interbedded sedimentary rock and associated units derived via weathering may be encountered during excavation, underlying the dune deposits and laterite (ferricrete) across the site. The Leederville Formation is the only one of the three formations that comprise the Lower Cretaceous Warnbro Group to occur beneath the Scott Coastal Plain (Chan 2011). The Warnbro group was defined by BHP (1998, 2015) as a series of distinct lithological units comprising the Strucel Beds and Beenup Beds, which likely make up the Leederville Formation (Quindalup and Mowen Members) (Table 3-5).

The 1:500,000 linear structures' geological map indicates that the plateau upon which the site is located is bounded by two north-south faults (Figure 3-12). One fault or shear zone runs along the western portion of the site, and a major fault (Busselton Fault) runs along, and parallel to, the eastern boundary of the site. Further west lies the Alexandra Bridge Fault and then the Dunsborough Fault. The Study Area is situated within the Vasse Shelf, and the lateral extent (west to east) is from the Busselton Fault to the Dunsborough Fault (Chan 2011).

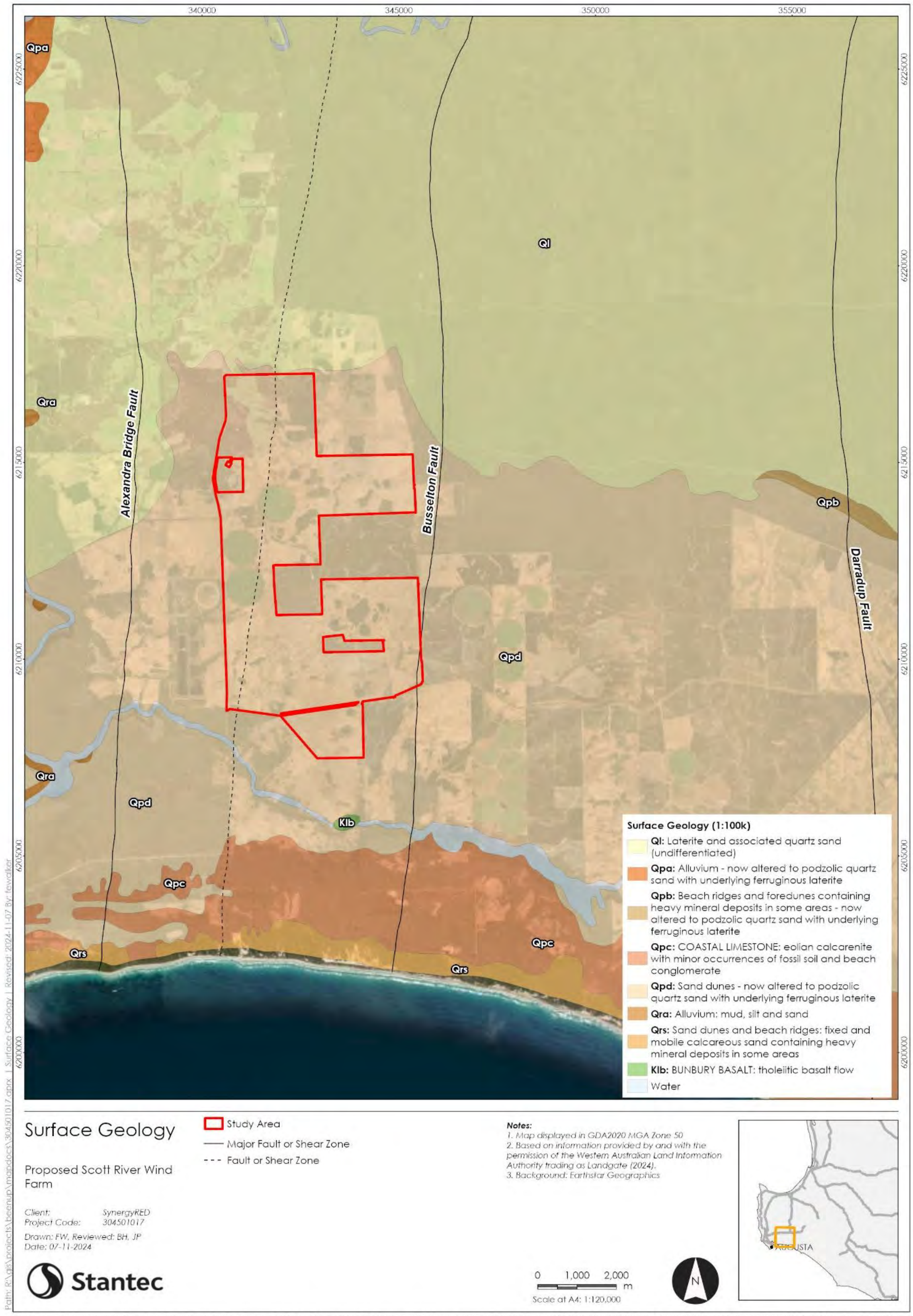


Figure 3-12: Surface geology in the vicinity of the Study Area.

An investigation was undertaken between 2014 and 2015 by Brockman South for the Alexandra Iron Ore Project (C19/2014) where a more detailed lithology map pertaining to the Study Area was developed (Brockman South Pty Ltd 2015). The report noted that basement strata did not crop out at the site, which is covered extensively by Quaternary superficial deposits deposited unconformably on unconsolidated sediment assigned to the Lower Cretaceous Warnbro Group (Figure 3-12).

Table 3-5: Generalised stratigraphy of the Study Area (Baddock 1995; Crostella 2000).

Era	Period / Epoch	Formation / Group	Dominant Lithology
Cainozoic	Quaternary / Holocene	Alluvium, lake and swamp deposits	Sand, clay, peat
Mesozoic	Early Cretaceous	Leederville Formation / Warnbro Group	Clay, sand, coal
		Bunbury Basalt	Basalt
	Triassic	Lesueur Sandstone	Sandstone

Geology across the site comprises siliceous dune sands deposited unconformably on the Leederville Formation. Within the dune sands localised diagenetic features comprise organic stained siliceous sands, bleached siliceous sands, and shallow sands overlying ferricrete (also referred to as coffee rock). The main geological stratigraphic units encountered at the Study Area are the Quaternary alluvium, lake and swamp deposits, the Early Cretaceous Leederville Formation and Triassic Lesueur Sandstone (Figure 3-13).

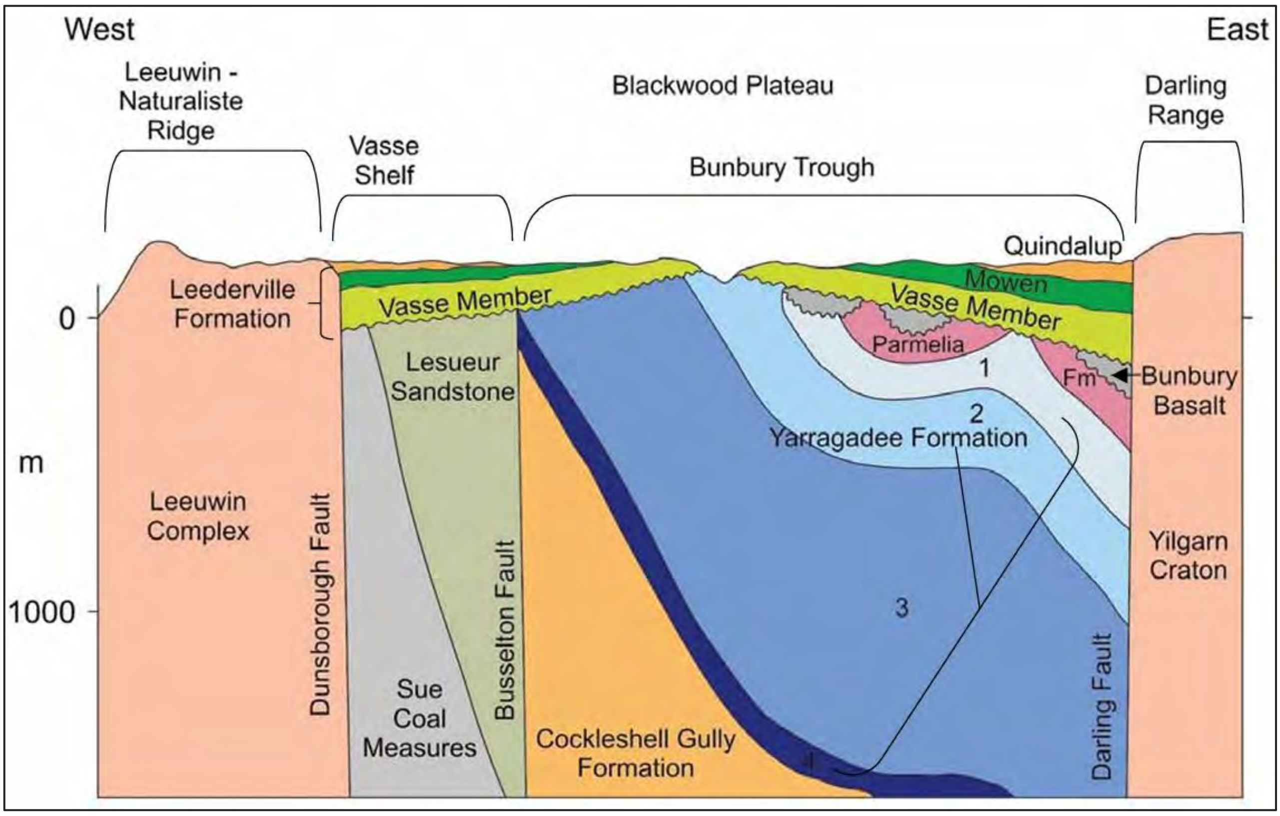


Figure 3-13: Regional conceptual cross-section (west to east) of the Southern Perth Basin.

3.4.2 Site Geology

The Study Area is situated within the eastern portion of the Vasse Shelf (DoW 2009a). The general site lithology is described in Stantec (Stantec 2024c) and is based on logs from test pits (TP01 to TP20) and boreholes (WM01 to WM03 bore groups), shown in Figure 3-14 and Appendix B, and is summarised as follows:

- Test pits (2 m depth maximum): The shallow sub-surface area, generally comprised a thin layer of topsoil, overlying sand (of various silty fines fraction), often overlying iron cemented rock strength material (ferricrete). Where ferricrete was not encountered, further sand was present to termination depth, though some layers with significant content of organic materials were encountered.
- Groundwater bores (up to ~25 m depth): Significantly varied sub-surface conditions, particularly between the north of the site (WM01 bore group) and the central and southern areas of the site (WM02 bore group and WM03 bore group, respectively). A summary of the bore group lithology is provided below.
    - WM01 bore group (north): A thin layer of dune sands (up to 2.0 m depth) overlying saturated grey and dark grey, interbedded / alternating bands of clayey and sandy soils and frequent pockets of organic and peaty material, likely residual soils developed on the Leederville Formation.
    - WM02 bore group (south): A layer of dune sands (up to 6.0 m depth) with interbedded ferricrete, indurated to a duricrust. The ferricrete was encountered as a thick, massive rock unit directly overlying weakly cemented organic rich sands, likely associated with historic dune swales and lacustrine depositional environments. The soils comprising dominant clay, below the sands, were likely residual soils developed on the Leederville Formation.
    - WM03 bore group (central south): Similar to WM02, dune sands up to 6.2 m below surface, and ferricrete was encountered as thick, massive rock unit within the sands. Weakly cemented organic rich sands were present directly beneath the ferricrete, extending to 6.2 m before intersecting clayey and sandy soils, likely residual soils developed on the Leederville Formation. A thin layer of sandstone was encountered at 19.65 m overlying more residual soils, which were encountered to the base of the hole.

Bores within 500 m of the Study Area (Mohsenzadeh and Diamond 2000)(Baddock 1992; BHP 1998; Chan 2011, BHP 2015) noted similar lithological sequences and are summarised as:

- Quaternary Deposit: Sand and silty sand from surface to 10 mbgl, thickening from west to east and north to south.
- Ferricrete of variable thicknesses, from <0.5 mbgl to approximately 10 mbgl.
- Leederville Formation (Warnbro Group): sands, silts and clays, underlying the Quaternary deposit and ferricrete, to at least 35 mbgl.

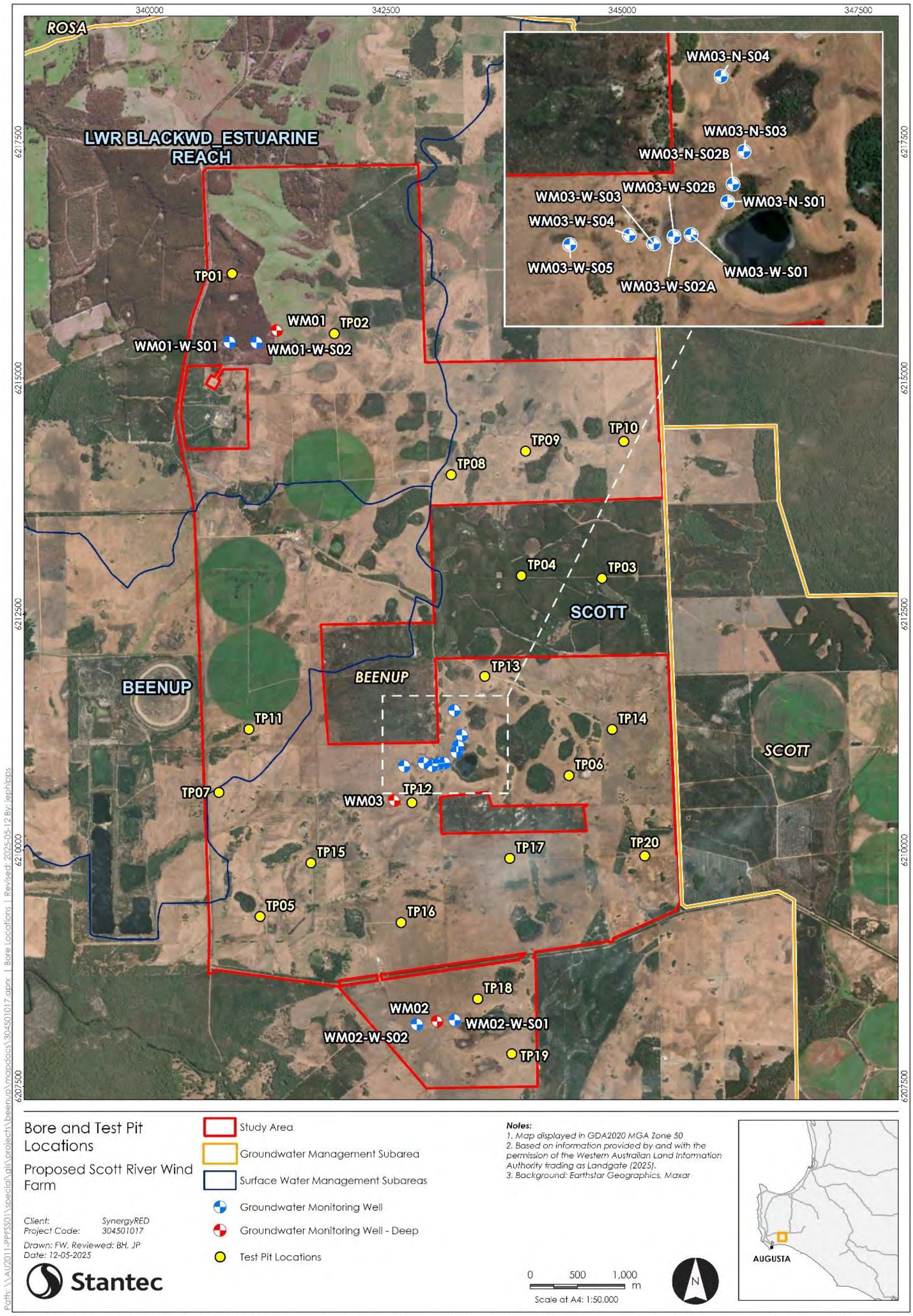


Figure 3-14: Groundwater bore locations (shallow and deep bores) and test pit locations.

3.4.3 Soils and ASS

The Study Area is located within the Scott Coastal Plain and is flanked by the Blackwood Plateau to the North, separated by the Barlee Scarp, and the Leeuwin Naturaliste Ridge to the West (Stantec 2023). Based on DWER 2019 Soil Landscape Mapping – Best Available (DPIRD-027), this Study Area is mostly covered by Scott River wet ironstone flat Phase (215SrSRwi), Scott River wet sandy depression Phase (215SrSRwd) and Scott River low dune Phase (215SrSRd2) (Figure 3-15). The Scott River Action Plan (LBLCDC 2020) translates these as varying from fine white, brown, and grey sands to ferricrete and clay (White 2012).

The Study Area is located within an area of high to moderate potential to contain ASS (derived from DWER-048 to 55) and is within Groundwater Management Zone 7 which is defined as a "*buffer zone area defined by acid sulfate soil plume from Beenup mine site*" (DoW 2009c). A preliminary ASS assessment was completed within the Study Area by Stantec (2024c). Soil samples were collected from 20 test pits (TP01 to TP20) and three geotechnical bores (MW01 to MW03). All samples recorded moderate to extreme reactions, indicating the possible presence of potential ASS (PASS). A suspension peroxide oxidation combined acidity and sulfur (SPOCAS) method analysis was then performed on the 70 samples and 50 of these exceeded the net acidity action criteria. An ASS Management Plan (ASSMP) was recommended to be developed and implemented for managing the disturbance of ASS.

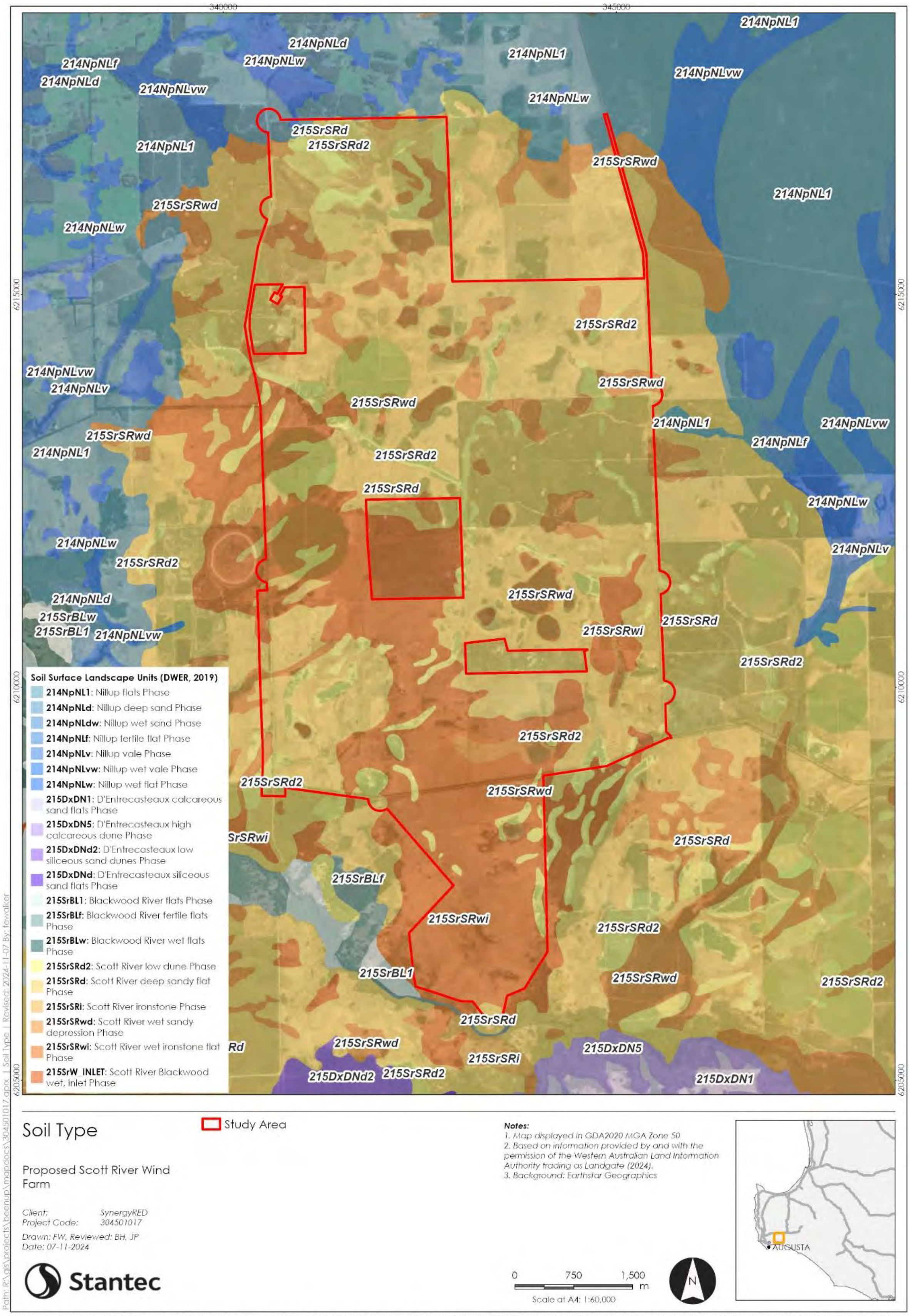


Figure 3-15: Soil landscape units (DPIRD-027) (DWER 2019) in the Study Area.

3.5 Groundwater

3.5.1 Groundwater Management

The Study Area intersects the Beenup Groundwater Management Subarea, and is also defined within the Blackwood Groundwater Management Area, Beenup Subarea of the South-West Groundwater Allocation Plan (Blackwood GMA Beenup Subarea) (Figure 3-6). It also intersects with Groundwater Management Zone 7 which is defined as a "*buffer zone area defined by acid sulfate soil plume from Beenup mine site*" (DoW 2009c). The historic Beenup Titanium Mine is located 50 m to the southwest of the Study Area at an approximate elevation of 17 mAHD.

The historic Beenup Titanium Mine site has been subject to extensive management, remediation, and rehabilitation as a result of the formation of an acid rock drainage plume, caused by waste rock generating acidic groundwater. In addition, the Leederville Aquifer is now artificially connected to the Lesueur Sandstone formation throughout the historic Beenup Titanium Mine site as a result of mining activities. The contaminated groundwater flows south towards the Scott River and Hardy Inlet (DoW 2009c) and is currently subject to increased monitoring to document movement of the plume. Management measures are also being implemented, including a reduction in abstraction to minimise changes in groundwater level to prevent exposure of ASS.

As a consequence of the implementation of Groundwater Management Zone 7, water use from the Superficial, Leederville and Lesueur aquifers is restricted, meaning that no new water allocation and no new bores or excavations are permitted to be constructed in the Superficial or Leederville aquifers, within the management zone boundary, other than for exempt use, replacement of existing bores, monitoring purposes, or remediation (DoW 2009c).

3.5.2 Registered Groundwater Bores and Other Users

There are 24 registered groundwater bores on, or within 500 m, of the Study Area. Of these, 11 are registered as being subject to monitoring, one is registered for water supply, one is registered for stock and domestic use, and 11 are registered as Unknown. Unknown registered bores appear to be associated with the historic Beenup Titanium Mine and are likely associated with groundwater monitoring. The next closest confirmed groundwater user outside of the 500 m buffer is the community of Courtenay, approximately 2 km to the northwest.

3.5.3 Groundwater-Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) rely on groundwater for some or all their water requirements and can include groundwater dependent vegetation (phreatophytes), wetlands and subterranean fauna. While there is limited understanding of the interaction between surface and groundwater in the Study Area, it has been confirmed that the area does not support suitable habitat for subterranean fauna (Invertebrate Solutions 2024).

Groundwater dependent vegetation is primarily characterised by a dominance of phreatophytes (obligate or facultative) with other mesophytes, xerophytes or halophytes occupying the understory (Thomas 2013). Obligate phreatophytes are riparian vegetation species that rely entirely on groundwater, while facultative phreatophytes use groundwater situationally (Thomas 2013). The Study Area contains seven vegetation types that are known or potential GDEs (across 176 ha), comprising obligate or facultative phreatophytes (Phoenix 2025a). These vegetation types are summarised in Table 3-5 and shown in Figure 3-16, and can be broadly described as follows:

- Four known GDEs comprising obligate phreatophytes that are representative or analogous to the Scott River Ironstone Association Threatened Ecological Community (TEC).
- Three potential GDEs comprising facultative phreatophytes, with dominant taxa including *Melaleuca rhaphiophylla* and *Melaleuca preissiana*.

In addition, another seven vegetation types occupying 110 ha of the Study Area, supported incidental or non-dominant occurrences of groundwater dependent flora. These communities lacked sufficient, intact vegetation units to be characterised as GDE; however, comprise incidental or non-dominant groundwater dependent flora (Table 3-5; Figure 3-16). Potential GDEs can be identified by the presence of indicator species (Table 3-7, Figure 3-16), including albeit not limited to the following:

- *Banksia ilicifolia and B. littoralis: obligate phreatophytes that inhabit areas with shallow groundwater depth and typically have access to a year-round use of groundwater (Canham et al. 2009).*
- *Banksia attenuata*: a facultative phreatophyte that can periodically resist drought and can persist in a range of hydrological conditions and geomorphological gradients as water sources become available (Canham *et al.* 2009).
- *Melaleuca rhaphiophylla* and *M. preissiana:* facultative phreatophytes that thrive in alluvial soils and swamps, but can adapt to water-limited environments by extracting water from near the soil surface or deeper sources, depending on water accessibility, groundwater salinity fluctuations and surface salt accumulation (Mensforth and Walker 1996; Steggles *et al.* 2016).
- *Eucalyptus* spp. are commonly facultative phreatophytes (Phoenix 2025a) that use deep-rooted systems to avoid drought and maintain high rates of evapotranspiration by tapping into groundwater pockets and soil moisture sources (Markey and Dillon 2011).

Potentially groundwater dependent flora (Figure 3-17) also provide habitats for significant terrestrial bird and mammal species (Phoenix 2025b; Stantec 2024b). For example, the Study Area recorded potential breeding trees (*Eucalyptus* species) within seasonally inundated shrubland and seasonally inundated paperbark (*Melaleuca* spp.) woodlands (Phoenix 2025b). Whereas potential groundwater dependent species such as *Banksia ilicifolia* and *Banksia attenuata* provide foraging habitat for significant cockatoo species (Johnston *et al.* 2016).

Confirmed and potential GDE vegetation types typically aligned with two of the mapped wetland fauna habitats in the Study Area, comprising seasonally inundated paperbark woodland and seasonally inundated sedgeland, which support *Melaleuca rhaphiophylla* and/or *Melaleuca preissiana* (Phoenix in prep.-b). These wetland fauna habitats are located throughout the Study Area, covering more than 200 ha, with more than 90% of the mapped habitats overlapping with confirmed and potential GDE vegetation types (Figure 3-16). It also appears that more perennial waterbodies occur in the south of the Study Area, which may interact with the Superficial Aquifer, however, the reliance on these systems on groundwater is currently unknown.

Table 3-6: Vegetation types confirmed or considered potential GDEs within the Study Area (Phoenix 2025a).

Vegetation Type	Description	Groundwater Dependence
Confirmed GDEs		
AmBsHc	Scott River Ironstone TEC.	Obligate
EmmTpAs	Analogous to Scott River Ironstone TEC; Scott River Ironstone TEC.	Obligate
Mj	GDE Scott River Ironstone TEC.	Obligate
XpMdLm	Scott River Ironstone TEC.	Obligate
Potential GDEs		
MpXpHfSs	Dominated by *Melaleuca* spp. particularly *M. preissiana.*	Facultative
MrCh	Dominated by *M. rhaphiophylla*, *M. preissiana.*	Facultative
MrTjLs	Dominated by *M. rhaphiophylla*, *M. preissiana.*	Facultative

Table 3-7: Vegetation types containing incidental or non-dominant groundwater dependent species, considered potential GDEs within the Study Area (Phoenix 2025a).

Vegetation Type	Incidental / Non-dominant Groundwater Dependent Flora Species	Groundwater Dependence
AsLs	Presence of *M. preissiana.*	Facultative
CcTpCeOh	Presence of *Banksia attenuata* and *M. preissiana.*	Facultative
EmmAffMtAsDb	Presence of *B. attenuata* and *B. ilicifolia.*	Facultative
EmmTpGoMtPu	Presence of *B. attenuate* (located north-east of Study Area).	Facultative
EmmXpMtDb	Presence of *B. littoralis* and *B. ilicifolia.*	Obligate
PeeLs	Presence of *B. littoralis.*	Obligate
TiLs	Presence of *M. rhaphiophylla.*	Facultative

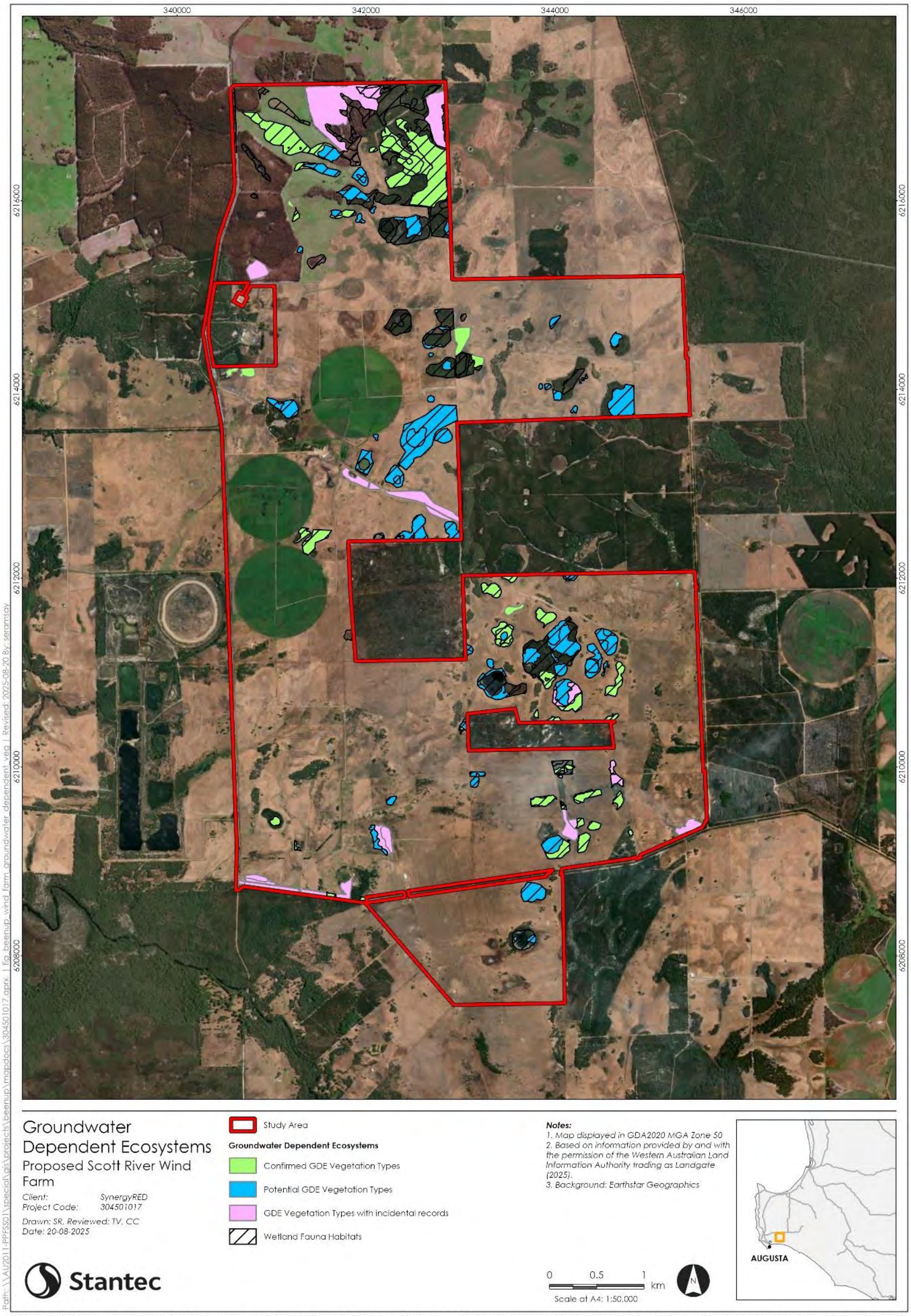


Figure 3-16: Confirmed and potential GDE vegetation types (including incidental records) and wetland fauna habitats (seasonally inundated paperbark woodland and seasonally inundated sedgeland) within the Study Area. Spatial layer source (Phoenix 2025a).

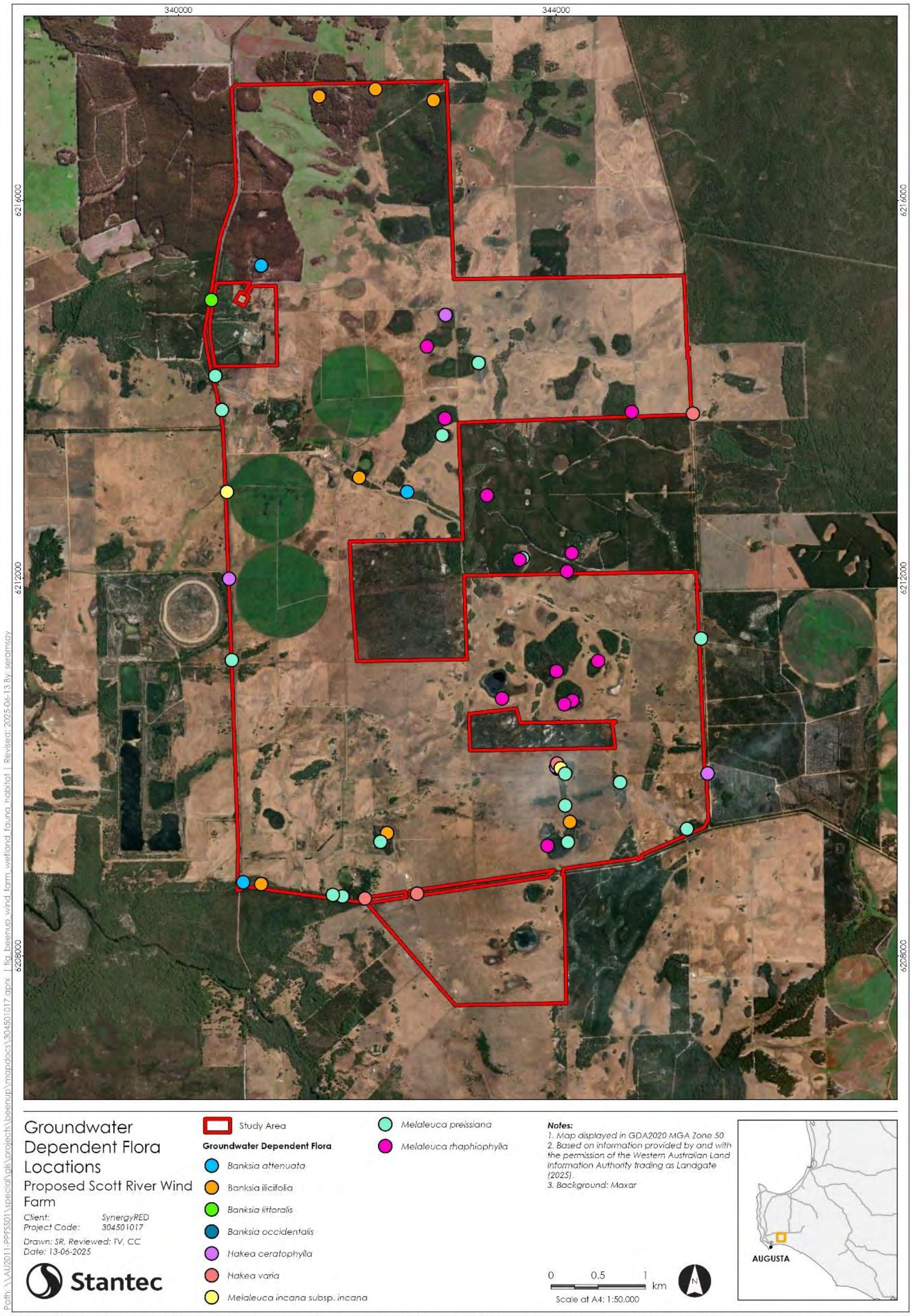


Figure 3-17: Groundwater dependent flora within the Study Area. Spatial layer source (Phoenix 2025a).

4 Hydrogeological Setting

4.1 Hydrostratigraphy

The regional Study Area is defined by three distinct hydrostratigraphic units within the Vasse Shelf; the Superficial, Leederville and Lesueur aquifers (Mohsenzadeh and Diamond 2000)(Baddock 1992, BHP 1998; Schafer *et. Al.,* 2008, Chan 2011, BHP 2015). A schematic model of the typical hydrological and geochemical elements associated with the upper 30 m of the historic Beenup Titanium Mine and southwest portion of the Study Area is presented in Figure 4-1.

The maximum depth of the Stantec (2024c) monitoring bores is approximately 25 m and the aquifer units associated with these bores are the Superficial Aquifer and Leederville Aquifer. Groundwater bores, including other nearby non-Stantec installed bores, and respective aquifer units within and near to the Study Area are summarised in Appendix C and Appendix D.

The Lesueur Sandstone aquifer is a deeper confined aquifer generally ranging from between 50 mbgl to 420 mbgl (Baddock, 1992; BHP 2015). The aquifer is only exploited for groundwater on the Vasse Shelf, where it is overlain by the Leederville or Superficial Formation and was not encountered during the 2024 Stantec investigations, nor is it likely to be encountered during the proposed development and therefore not summarised any further.

4.1.1 Superficial Aquifer

Regionally, a confining layer known as the Mowen aquitard separates the Superficial Aquifer from the underlying Leederville Aquifer. Excluding the coastal dunes, the Superficial Formation typically has a saturated thickness of less than 10 m; however, across the western sections of the broader coastal plains, it is only a few metres thick (Mohsenzadeh and Diamond 2000). The occurrence of the Superficial Aquifer is localised, including perched groundwater above impermeable beds of the Leederville formations, and local confinement zones of low permeability in the laterite (ferricrete) profile (DoW 2009b). This unit has also been described by BHP (1998, 2015) as the Warren Sands (Figure 4-1).

At the Study Area, the Quaternary Superficial Formation is a dominant sand and ferricrete of variable thickness and hosts a shallow unconfined aquifer with a water table, generally less than 3 m deep. Where ferricrete is present this may represent the accumulation and precipitation of dissolved iron at the water table, which is supported by high dissolved iron concentrations (iron 6-30 mg/L) (Section 3.3.7).

Stantec (2024c) reported groundwater seepage at several shallow test pits (TP01, TP07, TP08, TP09) that were defined as Quaternary dune deposits (superficial). These indicate that a discontinuous (likely seasonal) perched Superficial Aquifer is present locally across the Study Area. The Superficial Aquifer was identified in several Stantec (2024c) groundwater monitoring bores (WM01-W-S01, WM01-W-S02, WM02-W-S01, WM02-W-S02, WM03-N-S01, WM03-N-S03, WM03-N-S04 and WM03-N-S05), as well as at non-Stantec groundwater bores near the Study Area (Mohsenzadeh and Diamond 2000)(Baddock 1992, BHP 1998; Chan 2011, BHP 2015).

4.1.2 Leederville Aquifer (Warnbro Group)

Regionally the Leederville Aquifer on the Vasse Shelf (between Busselton and Dunsborough faults) is confined and lies beneath the Superficial Formation of the coastal plains. It can be found at the surface in certain areas of the Blackwood Plateau, where it has been weathered and lateritised. The Mowen aquitard is composed of the Quindalup and Mowen members, which are primarily made up of clay and silty clay units. In areas where the Quindalup Member is sand-dominant and the Mowen Member becomes thinner, there is a corresponding increase in sand content. As a combined unit, these members effectively integrate into the Leederville Aquifer, as a multi-layered aquifer, comprising discontinuous interbedded sequences of sand and clay, typically up to 100 m thick, and up to 200 m in some places. (DoW 2009). These defining features of the Leederville aquifer have been described by BHP (1998, 2015) as the Beenup Beds and Strucel Beds (Figure 4-1).

At the Study Area, the Leederville aquifer was identified in several Stantec (2024c) groundwater monitoring bores from 1.6 m to 9.25 mbgl (WM01, WM01-W-S01, WM02, WM02-W-S02, and WM03), including non-Stantec installed groundwater bores near the Study Area (Mohsenzadeh and Diamond 2000)(Baddock 1992, BHP 1998; Chan 2011). The Leederville formation appeared to become shallower toward the north and deepen toward the south, which is consistent with the regional understanding.

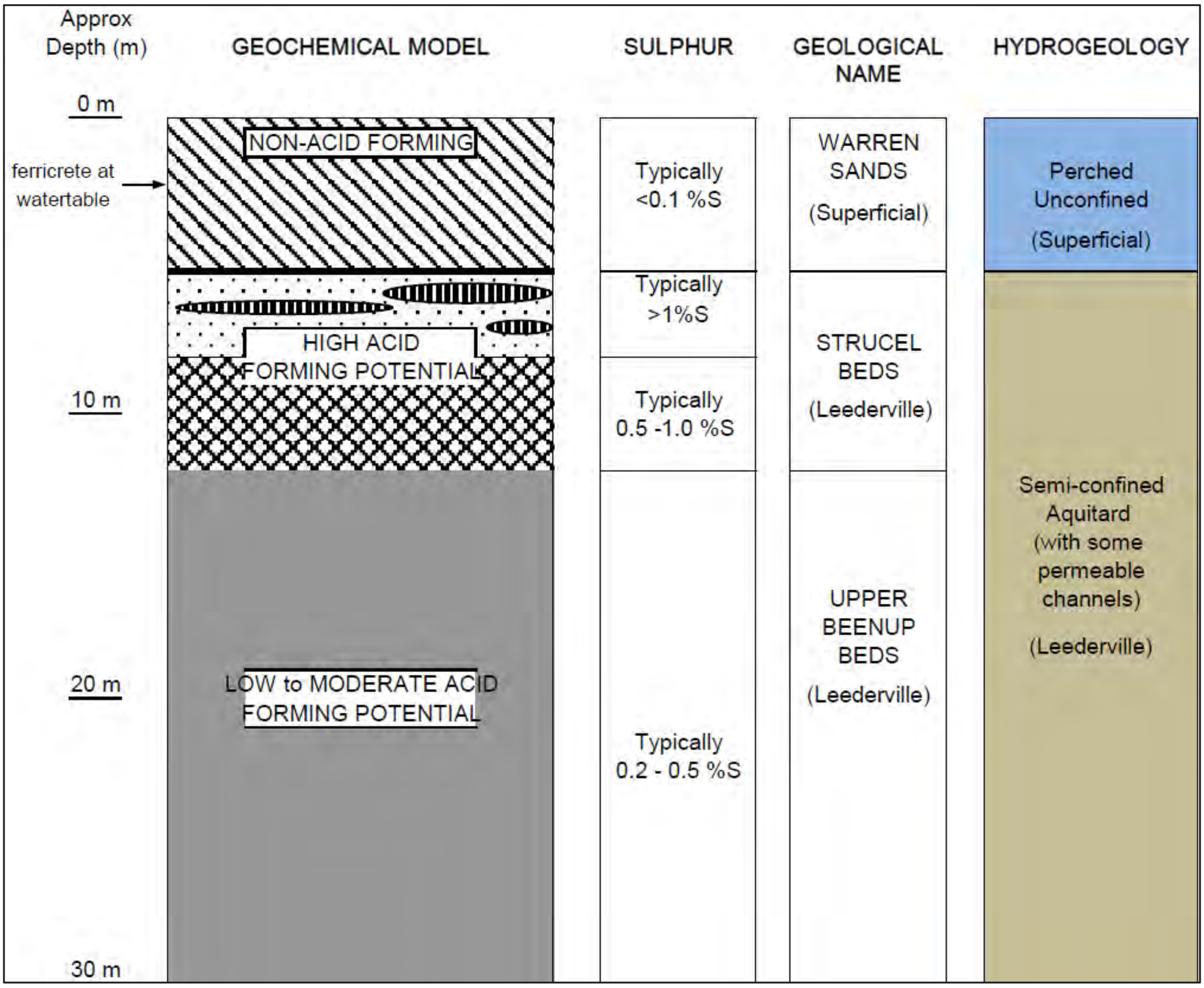


Figure 4-1: Hydrological and geochemical schematic conceptual model of the historic Beenup Titanium Mine (Leederville Formation) deposit (adapted from BHP 2015).

4.2 Groundwater Levels and Flow Direction

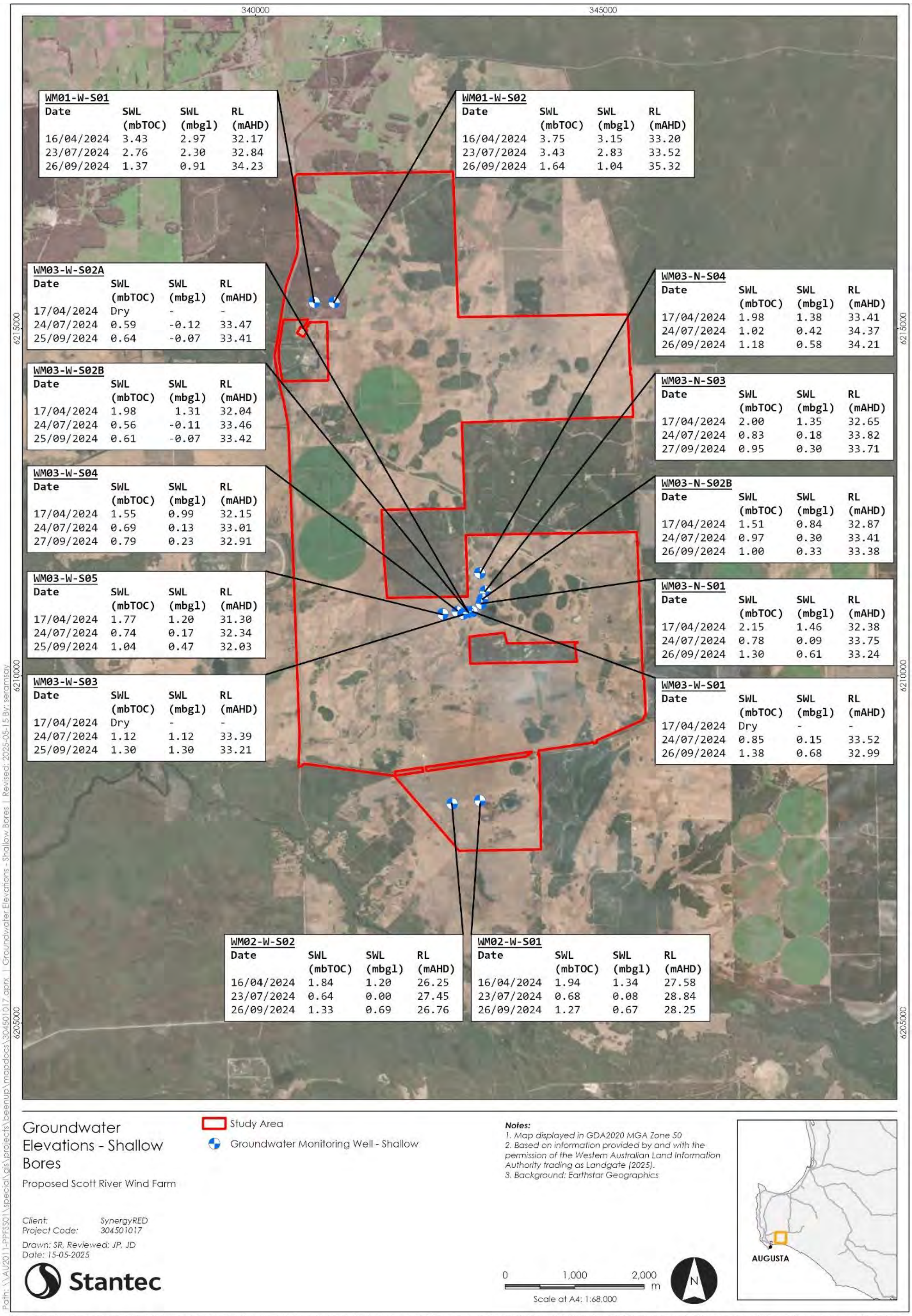
The long-term monitoring undertaken by BHP (2015) (between 10 and 34 years) indicates that groundwater levels in the Superficial Aquifer and the Leederville Aquifer have fluctuated between 1 m and 2 m in summer. BHP hydrographs indicate seasonal fluctuation between 1 m and 2 m with the highest groundwater levels between August and September, followed by a reduction between April and May (Appendix E). Groundwater SWL variations, reported by BHP (2015), throughout each year generally fluctuated between 2 m and 3 m. However, drawdown of up to 15 m was noted in monitoring bores in proximity to production bores.

Stantec undertook groundwater monitoring between April 2024 and September 2024. Groundwater standing water levels (SWLs) in the Superficial Aquifer (shallow bores) ranged from 0.56 metres below top of casing (mbTOC) (-0.11 mbgl) to 3.75 mbTOC (3.15 mbgl), corresponding to a relative level (RL) elevation range of between 26.25 m AHD and 35.32 m AHD (Figure 4-2). Several bores are situated within a localised topographic depression (in the form of wetlands or ponding) that is subject to surface inundation. It is uncertain whether the observed inundation is attributable to groundwater discharge or the accumulation of surface water. Groundwater flow within the Superficial Aquifer is likely discontinuous across the Study Area and local flow direction pathways may be variably influenced by seasonal rainfall, evapotranspiration and recharge. Generally, the groundwater flow direction is inferred to follow down topographic gradient, toward the south or southwest (Figure 4-4) and in the eastern Study Area, toward the southeast. Shallow test pits (TP01 – northwest, TP07 – southwest, TP08 – northeast, TP09 – northeast) encountered groundwater seepage from the Superficial Aquifer, ranging from 1.1 mbls to 2.0 mbls (Appendix C).

Groundwater SWLs in the Leederville Aquifer (deep bores) ranged from 0.72 mbTOC (0.07 mbgl) to 2.94 mbTOC (2.25 mbgl) (elevation RL ranged between 28.03 mAHD and 35.52 m AHD) (Figure 4-3). Groundwater SWLs recorded in the Leederville Aquifer were higher in the northern portion of the Study Area (WM01), which suggests a generally southward direction of flow (Figure 4-5.

Regional groundwater flow is generally from north to south, ultimately discharging downwards into the underlying formations, surface-water features such as the Scott River, and into the Southern Ocean (Chan 2011).The inferred groundwater flow direction of the Leederville Formation (WM01 - WM03) is from the north to the south (Figure 4-5). Elevations for the Superficial Aquifer also suggest a southward direction of flow Figure 4-4.

A summary of groundwater level gauging information from March to September 2024 is presented in Appendix C. Table E.4. Groundwater levels in both the Superficial and Leederville Aquifers showed clear seasonal variation that was strongly correlated to rainfall. Peak groundwater levels occurred mainly in winter months and at the beginning of spring (July to September) and declined by up to 2.0 m during dry periods. Seasonal groundwater fluctuations were observed across the Superficial Aquifer and the Leederville Aquifer with variations of approximately 2.0 m recorded from the WM01 cluster, approximately 1.2 m at WM02 and approximately 1.7 m at WM03.



WM01-W-S01

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	3.43	2.97	32.17
23/07/2024	2.76	2.30	32.84
26/09/2024	1.37	0.91	34.23

WM01-W-S02

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	3.75	3.15	33.20
23/07/2024	3.43	2.83	33.52
26/09/2024	1.64	1.04	35.32

WM03-W-S02A

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	Dry	-	-
24/07/2024	0.59	-0.12	33.47
25/09/2024	0.64	-0.07	33.41

WM03-W-S02B

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	1.98	1.31	32.04
24/07/2024	0.56	-0.11	33.46
25/09/2024	0.61	-0.07	33.42

WM03-W-S04

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	1.55	0.99	32.15
24/07/2024	0.69	0.13	33.01
27/09/2024	0.79	0.23	32.91

WM03-W-S05

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	1.77	1.20	31.30
24/07/2024	0.74	0.17	32.34
25/09/2024	1.04	0.47	32.03

WM03-W-S03

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	Dry	-	-
24/07/2024	1.12	1.12	33.39
25/09/2024	1.30	1.30	33.21

WM03-N-S04

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	1.98	1.38	33.41
24/07/2024	1.02	0.42	34.37
26/09/2024	1.18	0.58	34.21

WM03-N-S03

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	2.00	1.35	32.65
24/07/2024	0.83	0.18	33.82
27/09/2024	0.95	0.30	33.71

WM03-N-S02B

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	1.51	0.84	32.87
24/07/2024	0.97	0.30	33.41
26/09/2024	1.00	0.33	33.38

WM03-N-S01

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	2.15	1.46	32.38
24/07/2024	0.78	0.09	33.75
26/09/2024	1.30	0.61	33.24

WM03-W-S01

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	Dry	-	-
24/07/2024	0.85	0.15	33.52
26/09/2024	1.38	0.68	32.99

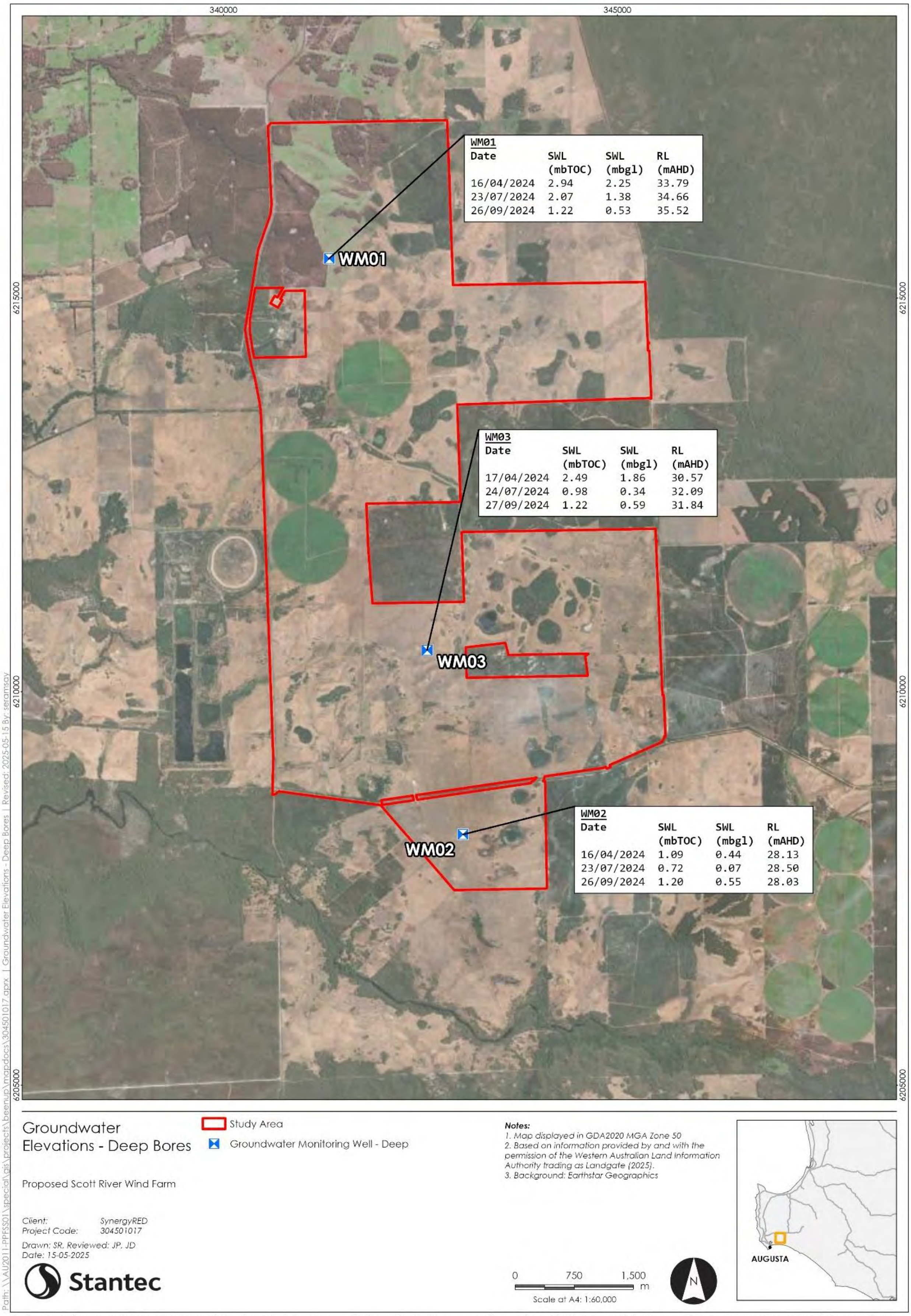
WM02-W-S02

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	1.84	1.20	26.25
23/07/2024	0.64	0.00	27.45
26/09/2024	1.33	0.69	26.76

WM02-W-S01

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	1.94	1.34	27.58
23/07/2024	0.68	0.08	28.84
26/09/2024	1.27	0.67	28.25

Figure 4-2: Superficial Aquifer groundwater depths and elevations (shallow bores).



WM01

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	2.94	2.25	33.79
23/07/2024	2.07	1.38	34.66
26/09/2024	1.22	0.53	35.52

WM03

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
17/04/2024	2.49	1.86	30.57
24/07/2024	0.98	0.34	32.09
27/09/2024	1.22	0.59	31.84

WM02

Date	SWL (mbTOC)	SWL (mbgl)	RL (mAHD)
16/04/2024	1.09	0.44	28.13
23/07/2024	0.72	0.07	28.50
26/09/2024	1.20	0.55	28.03

Notes:

1. Map displayed in GDA2020 MGA Zone 50

2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).

3. Background: Earthstar Geographics

Figure 4-3: Leederville Aquifer groundwater depths and elevations (deep bores).

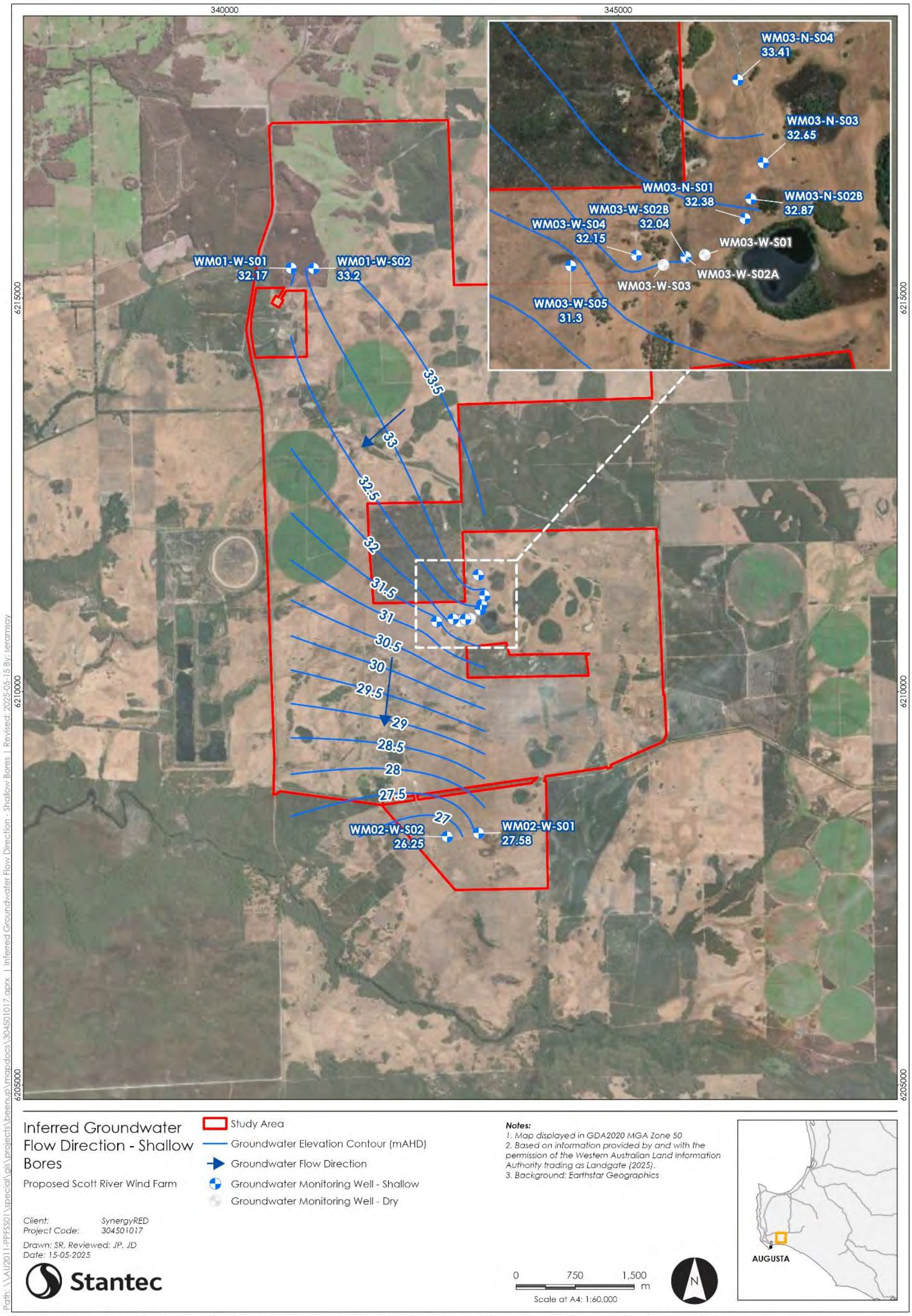


Figure 4-4: Superficial Aquifer groundwater inferred groundwater flow direction April 2025 (shallow bores).

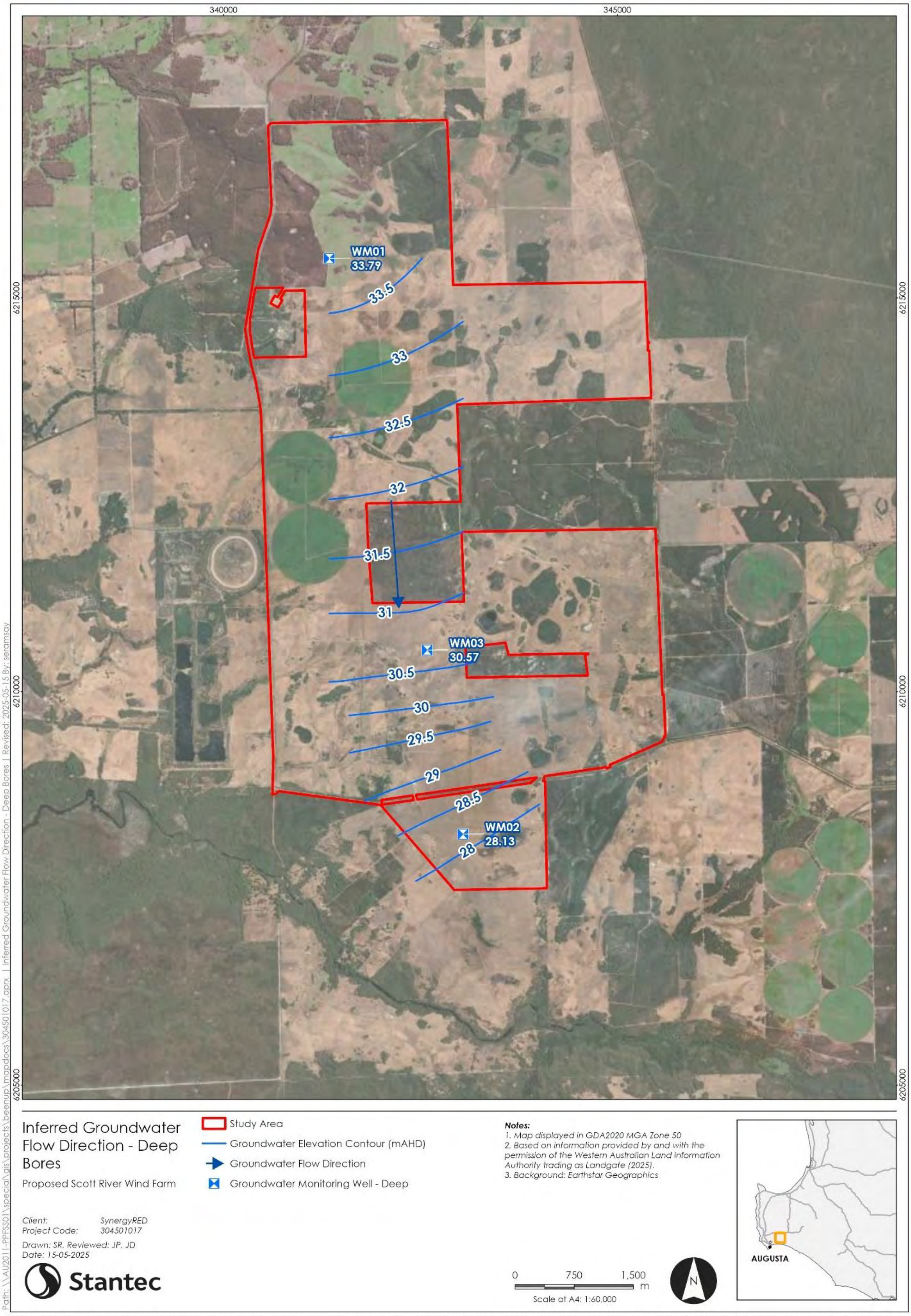


Figure 4-5: Leederville Aquifer groundwater inferred groundwater flow direction April 2025 (deep bores).

Groundwater depths at nearby non-Stantec bores within the Superficial Aquifer were reported from 0.76 mbTOC to 3.0 mbTOC and in the Leederville Aquifer (Warnbro Group) from 0.25 mbTOC to 3.7 mbTOC. Depths were dependent on season and topographic elevation, greater levels in high topographic areas, and low elevation in low topographic areas, which is consistent with Stantec observations within the Study Area (Mohsenzadeh and Diamond 2000)(Baddock 1992, BHP 1998, Chan 2011).

Groundwater SWLs in the Stantec bores were measured continuously between March 2024 and September 2024. Through April 2024 rainfall was considerably below average. Hence, recorded water levels across the Study Area were likely to be much lower than during years with average or above-average rainfall. However, between June 2024 and September 2024 groundwater SWLs recorded in the Stantec bores had increased by up to approximately m in the superficial aquifer (Figure 4-6, Figure 4-7 and Figure 4-8) and approximately 2 m in the Leederville aquifer (Figure 4-9, Figure 4-10 and Figure 4-11). Since September 2024 groundwater levels have dropped between 0.5 m and 1.0 m in response to a lack of significant rain.

Seasonal variation in each aquifer appears to respond to rainfall, with the Superficial Aquifer (shallow bores) indicating a greater response compared to the Leederville Aquifer (deep bores). WM02 located in the southern Study Area indicated oscillating groundwater levels, with drawdown ranging between 0.15 to 0.3 mbgl, between February to March and in September 2024. This is characteristic of nearby groundwater extraction and pumping influences which aligns with likely seasonal irrigation pumping regimes.

In summary groundwater levels are influenced by seasonal variation and irrigation. All well locations that were identified to host groundwater throughout the year variably responded to rainfall, with increasing groundwater levels during the wetter months. Seasonal spatial influences were not as apparent, however Superficial Aquifer locations in the north appeared to respond with greater increases than central and south. The Leederville Aquifer level responses and increases were relatively consistent except for WM02, which only varied by up to 0.5 m and was seasonally influenced by nearby pumping effects.

The data within WM02 has been modified due to potential damage of the bore installation, this has been presented in Figure 4-14.

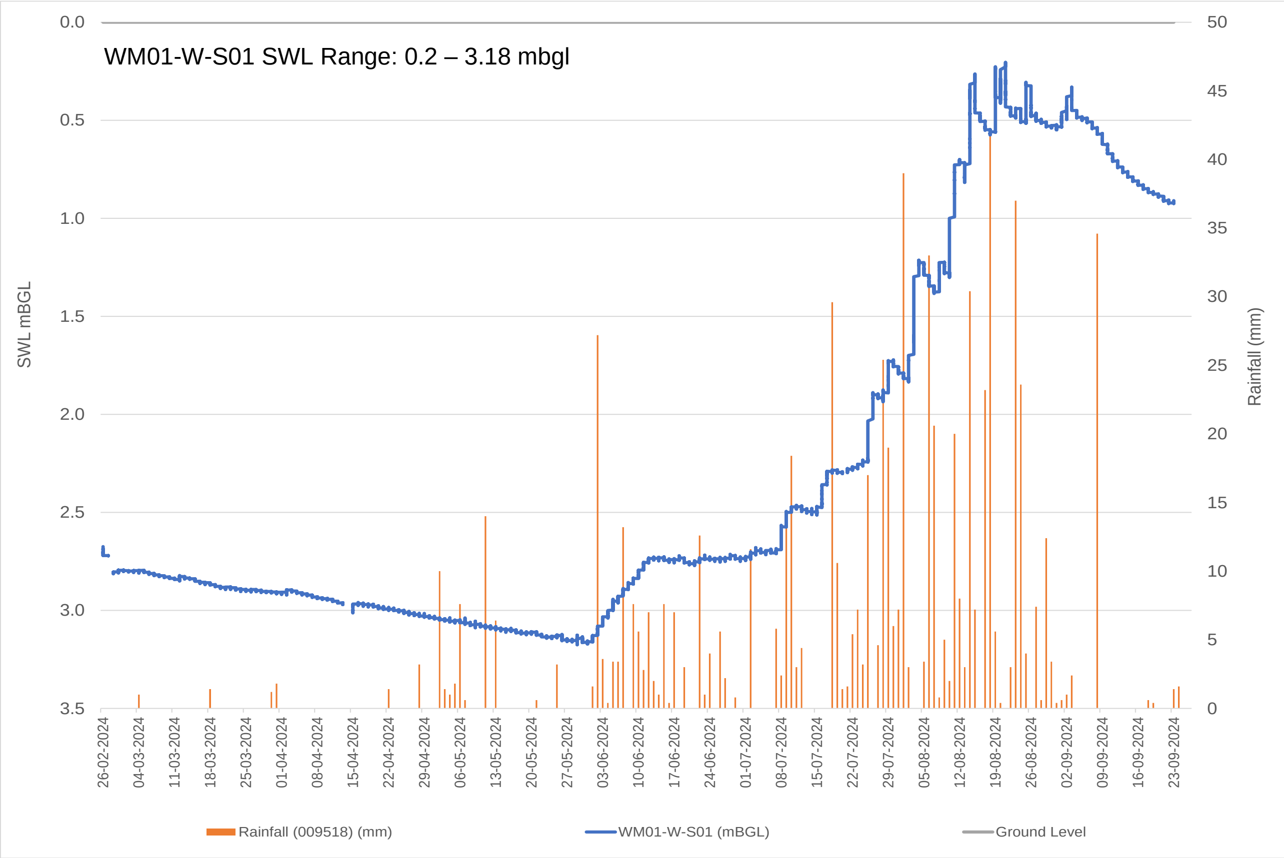


Figure 4-6: Recorded groundwater levels and rainfall, Superficial Aquifer (WM01-W-S01).

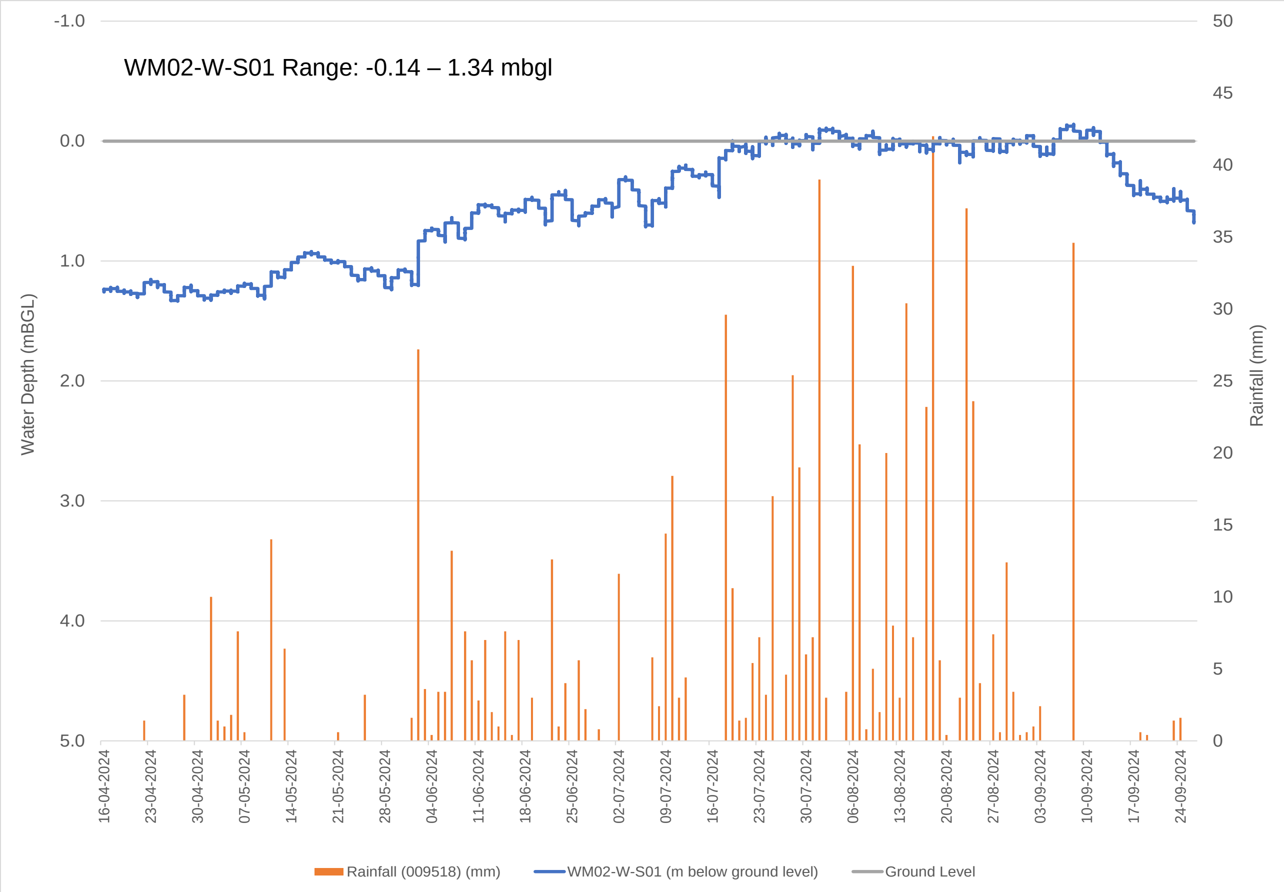


Figure 4-7: Recorded groundwater levels and rainfall, Superficial Aquifer (WM02-W-S01).

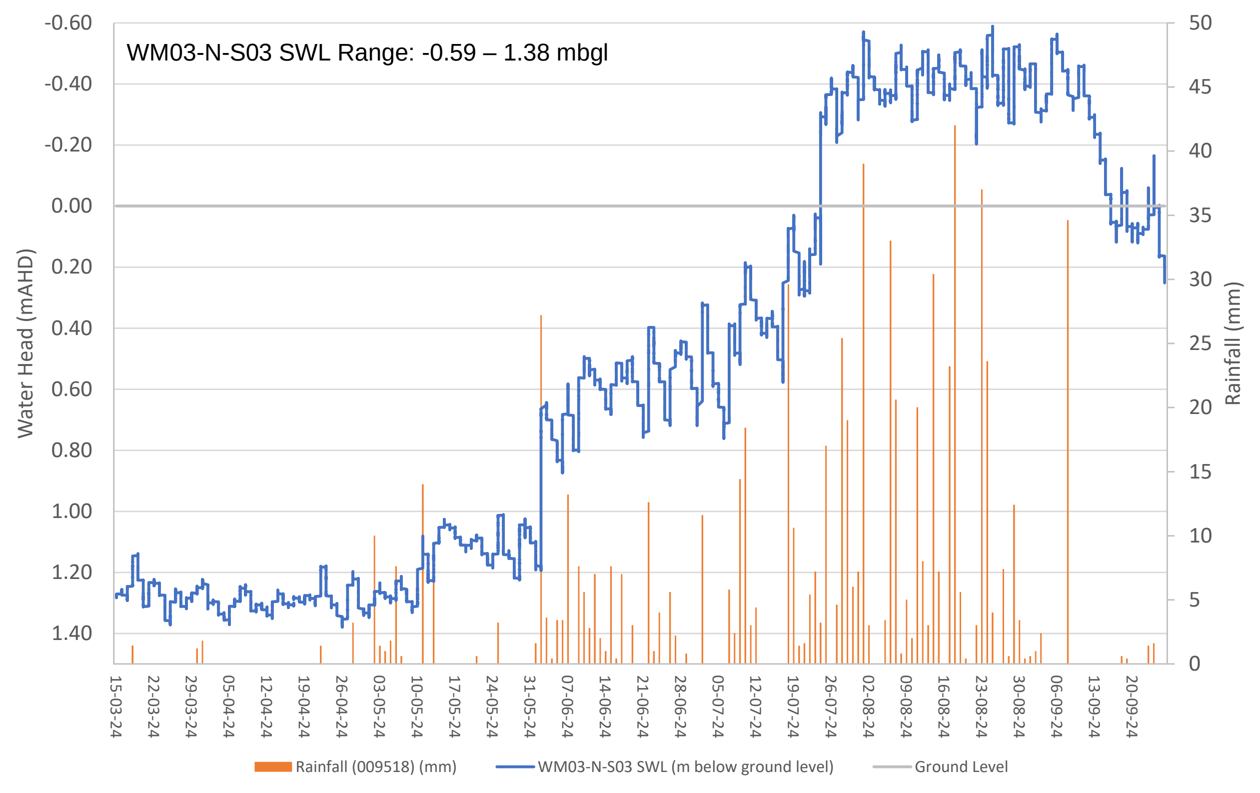


Figure 4-8: Recorded groundwater levels and rainfall, Superficial Aquifer (WM03-N-S03).

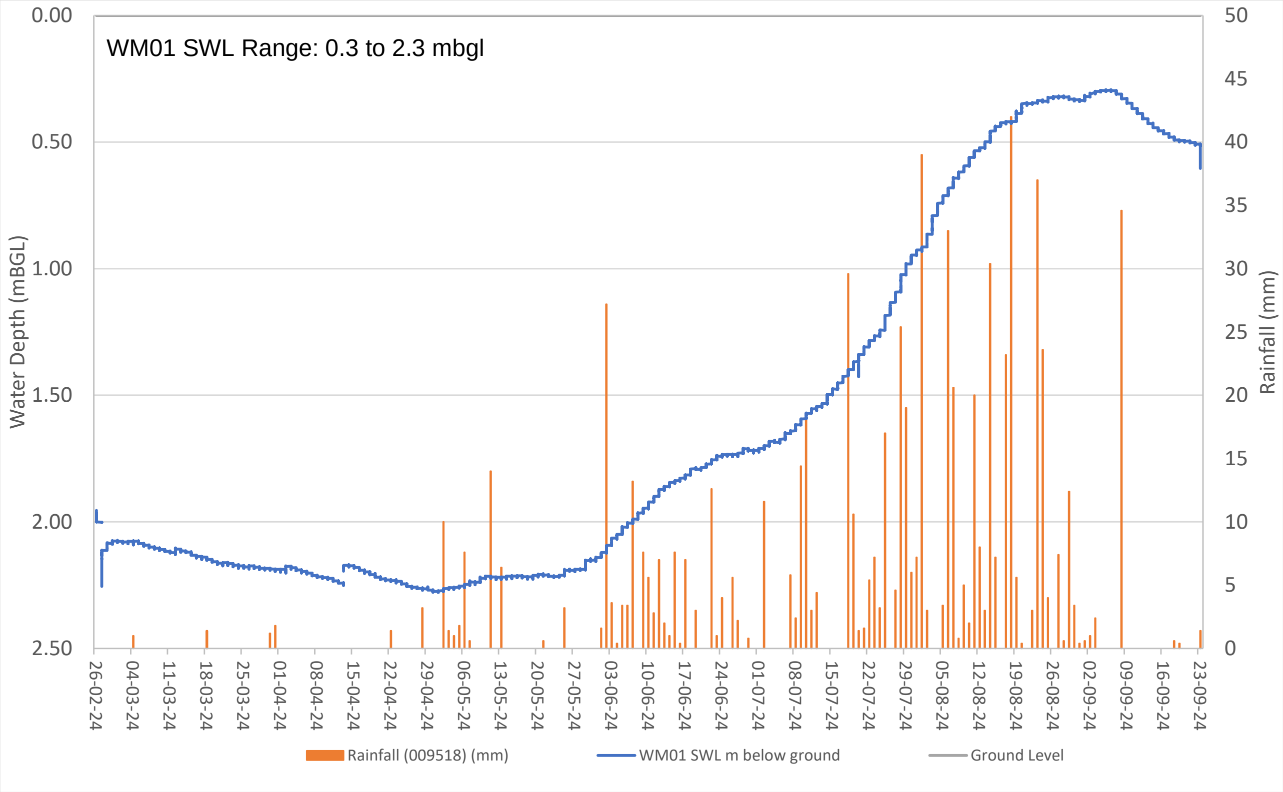


Figure 4-9: Recorded groundwater levels and rainfall, Leederville Aquifer (WM01).

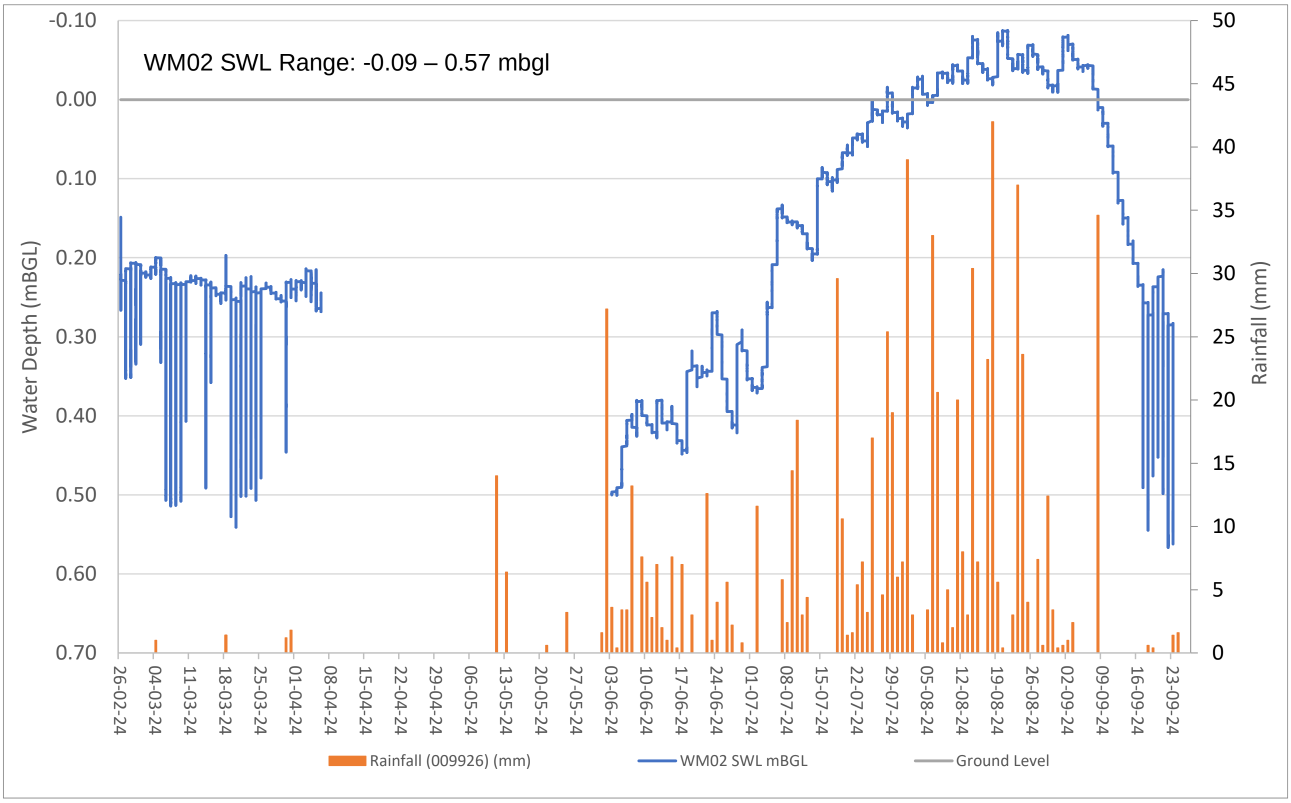


Figure 4-10: Recorded groundwater levels and rainfall, Leederville Aquifer (WM02).

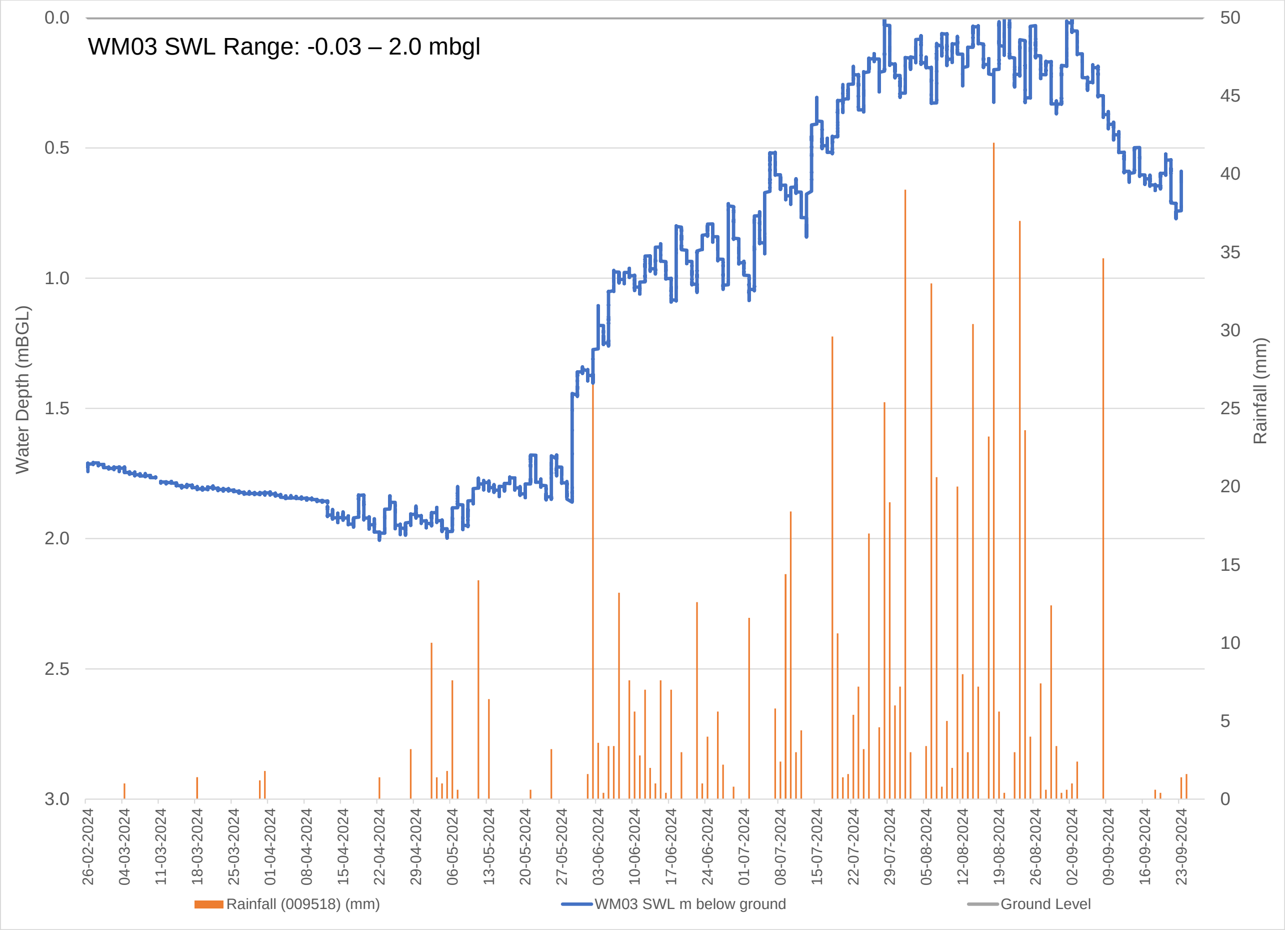


Figure 4-11: Recorded groundwater levels and rainfall, Leederville Aquifer (WM03).

4.3 Groundwater-Surface Water Interaction

In April 2024, Stantec monitored several potential surface water monitoring sites, with all locations dry except one location, which is located in the western area, closest to the historic Beenup Titanium Mine. Surface water at this location was suspected to be related to discharge from a nearby irrigator.

Assessment of potential surface water and groundwater interactions were unable to be adequately assessed at the groundwater bores, in relation to these interactions and their effects on nearby wetland features, due to the investigation being undertaken during an extended drought period. Monitoring also did not capture any wetland water levels and therefore it is difficult to quantify the direct relationship between the groundwater levels and wetlands.

A BHP (1998) assessment had indicated that the Superficial Aquifer was likely connected to creeks during wetter periods (winter), suggesting that surface water- groundwater interactions may be ephemeral and seasonally influenced. It can be inferred that for most of the Study Area locally perched and seasonally present groundwater within the Superficial Aquifer in proximity to wetlands and drainage features may be seasonally connected.

Areas in the low-lying southwest, southeast and closer to Scott River are likely to host perennial systems, due to discharge from the upgradient Superficial Aquifer and the general hydraulic gradient from the north to the south contributing lateral flow to these areas. It is unlikely that the deeper Leederville Aquifer was in direct connection to the ephemeral surface water features across most of the Study Area, except where potential outcropping in the northern area may occur.

With the currently available monitoring data and spatial coverage, confidently evaluating surface water-groundwater interactions across the broader study area is difficult to quantify and may need to be quantified on a localised basis.

4.4 Recharge and Discharge Processes

4.4.1 Groundwater Recharge

The Superficial Aquifer is recharged by direct diffuse rainfall infiltration and localised downward leakage from creeks, wetlands and irrigation through alluvial soils. Potential upward leakage from the underlying Leederville Formation may also occur (Baddock 1995). Lateral flow may enter the Superficial Aquifer from adjacent areas with higher groundwater levels, such as from nearby wetland areas and the dune peaks. During typical wetter seasons (winter) the water table is shallow (often surface expressing in wetlands and lakes); while during drier seasons (summer) some areas can become dry, with reduced rainfall affecting depth to the water table. The Leederville aquifer is recharged via lateral flow and vertical downward leakage from the Superficial Aquifer, with potential upward leakage from the Lesueur aquifer (BHP 1998, Chan 2011).

The data captured from the ongoing water level monitoring indicates a significant response between rainfall and groundwater levels, in both the shallow Superficial Aquifer by up to 2 m (Figure 4-6, Figure 4-7 and Figure 4-9) and deep Leederville Aquifer, approximately 2 m (Figure 4-9, Figure 4-10 and Figure 4-11).

4.4.2 Groundwater Discharge

Discharge from the Superficial Aquifer occurs via evapotranspiration, where the water-bearing zones of the Superficial Aquifer are within approximately 2 m of the unsealed land surface, from lateral flow into surface-water features and downward leakage into the underlying formations. Drainage and land-use activities may also affect the Superficial Aquifer further. The Leederville aquifer discharges to major rivers creeks or the coast and to other aquifers via vertical leakage. Groundwater pumping from the Superficial Aquifer and Leederville Aquifer occurs around the Study Area, as evidenced by numerous registered groundwater bores within 2 km of site, used for irrigation.

Irrigation bore extraction from the aquifer occurs within and around the Study Area. An increase in groundwater levels (Figure 4-6 to Figure 4-11) may also suggest that seasonal irrigation pumping has decreased or reduced. WM02 located in the south indicated oscillating groundwater levels between February to March and September 2024, which is characteristic of nearby groundwater pumping influences.

4.5 Aquifer Hydraulic Parameters

No hydraulic parameter testing has been completed at the site to date. Inferred values of hydraulic conductivity used in the drawdown model (Section 6) were based on bore log lithologies and particle size distribution of the saturated soils encountered during the installation of the geotechnical bores.

Estimates were conducted using Hydrosieve analysis for WM03 (4.0-5.0 m), which is in poorly graded sand. The calculated geomean hydraulic conductivity (K) is approximately 20 m/d. Literature values for fine sands ranged between 1 m/day and 5 m/day; while for medium sand up to 20 m/day is reported (Kruseman and deRitter, 2000), which is consistent with the geomean of approximately 20 m/d. A representative K value of 10 m/d has been adopted to reflect the interbedded sands, sandy clays, and clayey sands in which the shallow water table occurs. For the clayey sands to sandy clays noted in the log for WM01, literature values range between 0.001 m/d and 0.1 m/d.

The following storage characteristics (specific yield) were adopted based on bore log material description compared to literature values:

- Bore group WM01 sand clay to clayey sand: 5% (based on silt) (Morris and Johnson 1967).
- All other locations sand: 20% (based on typical sand) (Heath 1983).

4.6 Groundwater Flow Systems

Groundwater flow systems in any terrain characterise the occurrence of groundwater and its flow from areas of recharge to areas of discharge, often into surface water bodies. The main influences on groundwater occurrence and flow across the Study Area are:

- Rainfall distribution (providing maximum recharge to groundwater during winter periods, when rainfall is expected to exceed evaporation).
- Vegetation land clearing of formally remnant wetland environments would likely introduce more recharge into the underlying system, and potentially cause the shallow water table to rise.
- Spatial distribution of higher permeability, dominantly sandy layers (which have the potential to increase the percolation rate of infiltrating water).
- Spatial distribution of lower permeability clay, silt and ferricrete layers (which have the potential to slow the percolation of infiltrating water and confine deeper more permeable layers).
- There are several naturally occurring surface water features that may seasonally interact with the shallow Superficial Aquifer, near and within the Study Area, detailed as follows:
  - Ephemeral wetlands across the site, with the entire site characterised as a wetland environment. However, the majority of the site has been highly modified resulting in fragmented wetland communities distributed across the landscape.
  - Ephemeral creeks or drainage lines, which are evident across the site, are often connected to wetland groups, which discharge into inferred perennial rivers, such as the nearby Scott River.
  - Inferred perennial streams and the Scott River south of the Study Area.
- To the southwest of the site, the BHP former mine voids (now pit lakes) are still present and filled with water. These lakes may still be connected to the variable lithological units at these locations, where subsurface flow and connection is present.
- Existing groundwater users (i.e., water abstraction/irrigation).

Geological cross sections for the areas represented by WM01, WM02 and WM03 are shown in Figure 4-12 to Figure 4-14.

The Superficial Aquifer developed in the dune materials thickens from a thin veneer of approximately 2 m in the northern area at WM01 to between 4 m and 6 m in the central area at WM03, then approximately 10 m in the southern area at WM02.

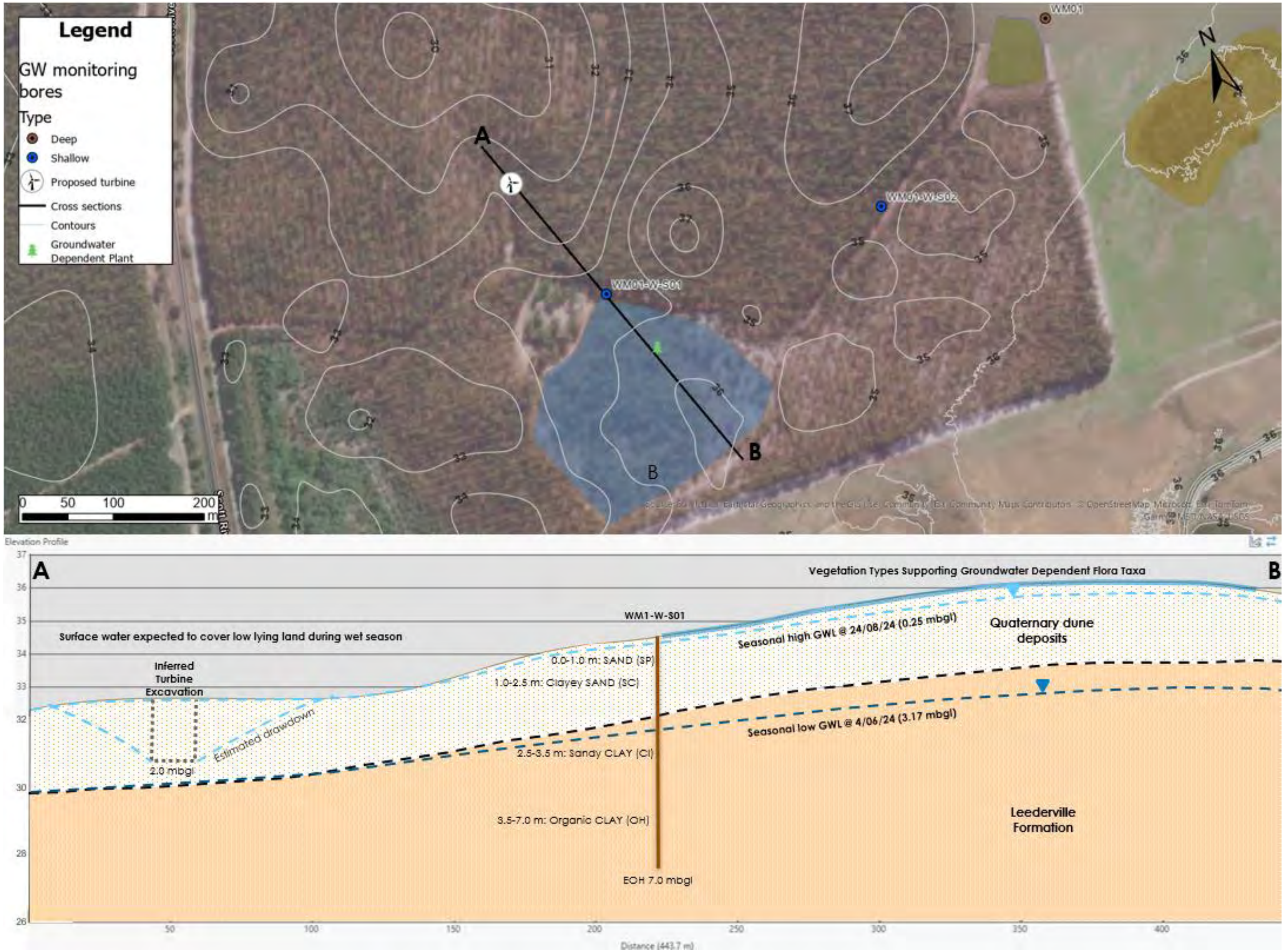


Figure 4-12: WM01-S01 geological cross section and predicted extent of targeted drawdown for turbines.

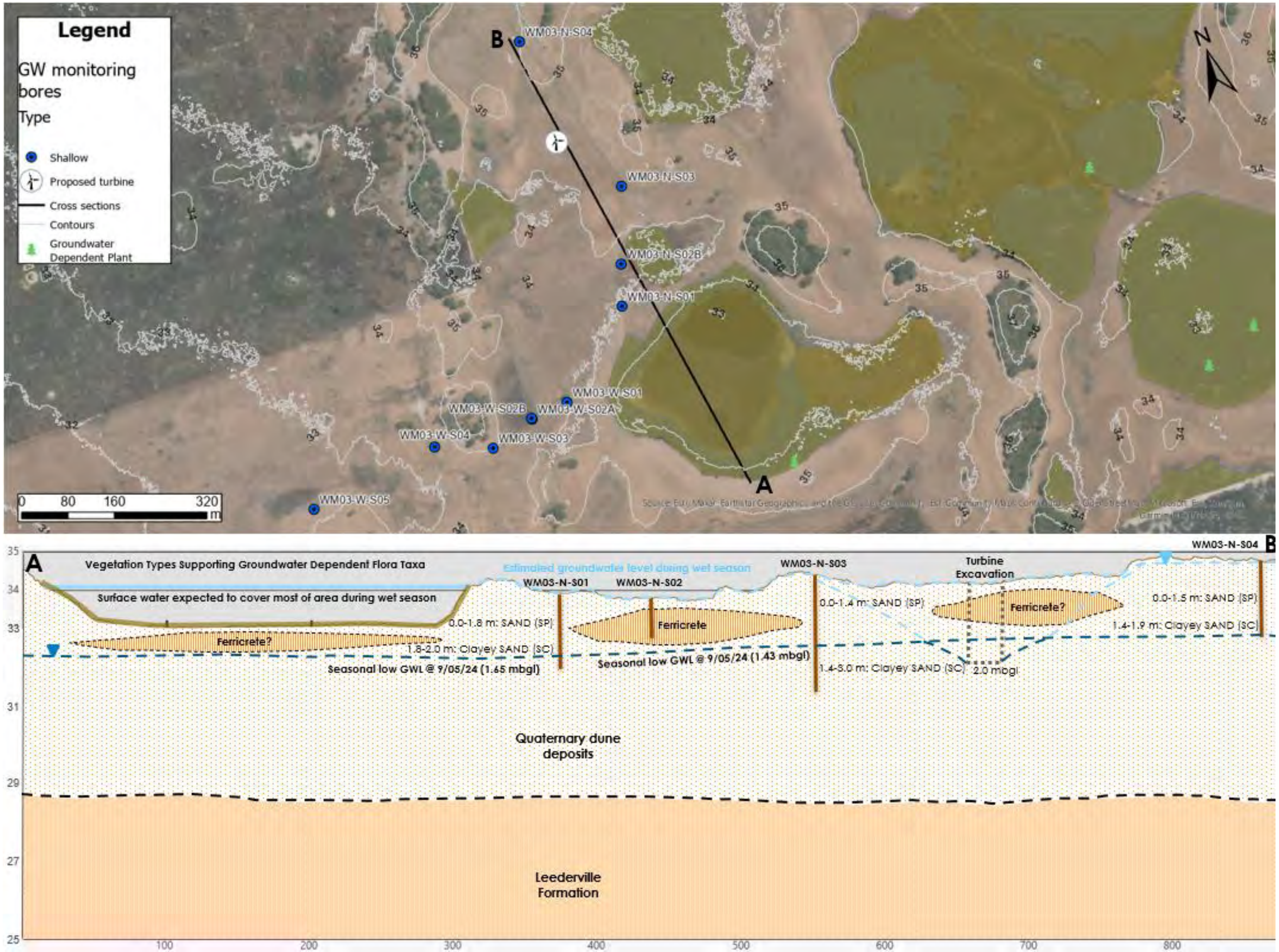


Figure 4-13: WM03 bore group area northern bore transect geological cross section and predicted extent of targeted drawdown for turbines.

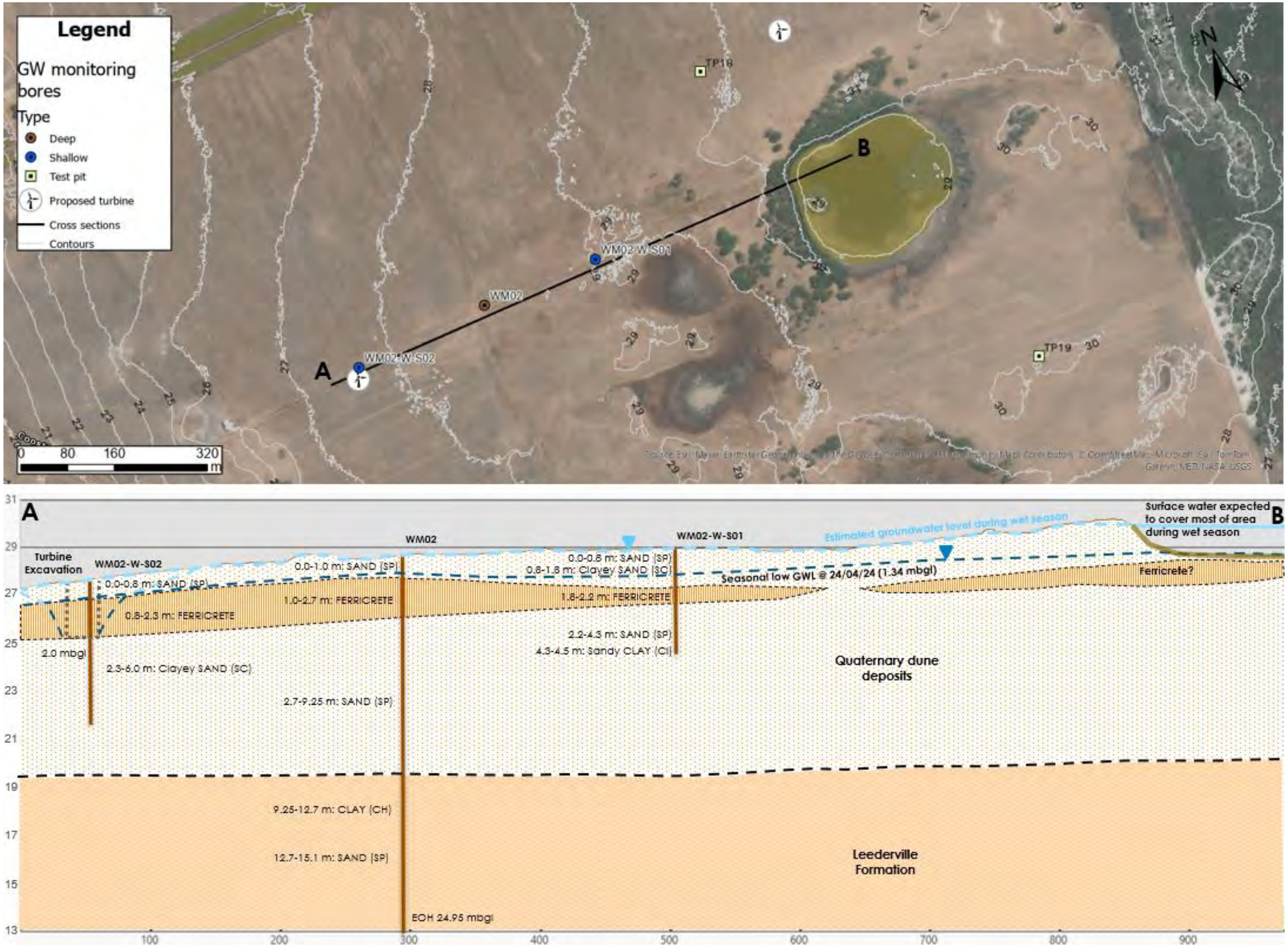


Figure 4-14: WM02 bore group area western bore transect geological cross section and predicted extent of targeted drawdown for turbines.

4.7 Groundwater Quality

Regionally, the Superficial Aquifer and Leederville Aquifer salinity is generally fresh, with total dissolved solids (TDS) of less than 500 mg/L (DoW 2009b). Groundwater monitored from nearby non-Stantec bores within the Superficial Aquifer ranged from approximately 200 to 500 mg/L (Baddock 1992, Chan 2011). Site-specific monitoring results are consistent with these regional values. Groundwater quality was classified as acidic to neutral and was freshwater. Several exceedances of relevant guideline triggers were recorded for the following parameters:

Superficial Aquifer

- pH at all monitoring bores and all monitoring events, majority of values acidic, no clear seasonal trends.
- Salinity at three monitoring bores during July 2024, September 2024, and January 2025, electrical conductivity at the majority of bores across all monitoring events, and chloride at one monitoring bore during July 2024, September 2024, and January 2025 were elevated; likely attributed to surrounding agricultural land use, clearing and runoff, although historical records exhibit a similar, or higher, average salinity compared with the Program; no clear seasonal trends were apparent.
- Turbidity at most bores across all monitoring events excluding two; likely attributed to surrounding agricultural land use, clearing and runoff; no clear seasonal trends except for July 2024 where records tended to be elevated across monitoring bores.
- Nutrient concentrations were variable and exceeded guideline triggers at the majority of bores across all monitoring events (excluding one bore) for total nitrogen, and ammonia at three monitoring bores during three monitoring events; influenced by infiltration of surface water impacted by the use of fertilisers on surrounding agricultural land; no clear seasonal trends excluding some elevated records in July 2024, with a spike in concentration in September 2024 (WM03-N-S03) likely attributed to infiltration from surface water and runoff following above average rainfall that occurred in winter.
- Dissolved metals were generally below the level of analytical detection except for aluminium, copper, iron and manganese which exceeded relevant guideline trigger values, with copper and iron elevated within all bores and aluminium consistently higher in bores WM03-N-S03 and WM03-W-S04; likely attributed to the mineralisation of the Superficial Aquifer, potentially with minor contribution from surface water infiltration by aluminium; no clear seasonal trends, although a spike in aluminium concentration occurred in September 2024 (WM03-N-S03).
- Pesticides were below the analytical limit of reporting (LOR) from surface water sites during the only two monitoring events where samples were analysed.

Leederville Aquifer

- pH at all monitoring bores and all monitoring events; majority of values acidic; no clear seasonal trends.
- Salinity at all monitoring bores and all monitoring events, and electrical conductivity at almost all bores across all monitoring events, excluding bore WM01; no clear seasonal trends.
- Turbidity was elevated at three bores across all monitoring events in July 2024, September 2024, January 2025; no clear seasonal trends.
- Nutrient concentrations were below the relevant guideline triggers across all bores and all monitoring events; no clear seasonal trends.
- Dissolved metals were generally below the level of analytical detection except for copper, iron and manganese which exceeded relevant guideline trigger values, with all three metals elevated across all bores during the majority of monitoring events; likely attributed to the mineralisation of the Leederville Aquifer; no clear seasonal trends.

A summary of groundwater quality from monitoring bores within the Study Area (Stantec 2025) is presented in Table 4-1.

Table 4-1: Summary of groundwater quality data from monitoring bores.

Aquifer	Key Groundwater Quality Characteristics
Superficial Aquifer	• pH was classified as acidic to neutral with all pH values exceeding the lower ANZECC & ARMCANZ (2000a) trigger value. • Salinity was classified as freshwater (mostly below 500 mg/L) and exceeded DoH (2014) non-potable use trigger at monitoring bores WM01-W-S02 (July 2024), WM03-N-S03 (September 2024), and WM03-W-S04 (July 2024, September 2024, January 2025). • Groundwater was dominated by sodium and chloride, with concentrations of chloride exceeding the DoH (2014) non-potable use trigger at WM03-W-S04 during July 2024, September 2024, and January 2025. • Electrical conductivity exceeded the ANZECC & ARMCANZ (2000a) trigger value at almost all bores across all monitoring events, excluding bore WM01-W-S02. • Turbidity exceeded the ANZECC & ARMCANZ (2000a) trigger value in the majority of bores excluding bores WM01 W S01 (September 2024) and WM01-W-S02 (January 2025). • Total nitrogen exceeded the ANZECC & ARMCANZ (2000a) trigger value within all bores and across the majority of monitoring events, excluding WM02-W-S02, and ammonia exceeded the DoH (2014) non potable use trigger at WM02-W-S01, WM03-N-S03, and WM03-W-S04 during July 2024, September 2024, and January 2025. • Aluminium exceeded the Water Quality Australia (2021) DGV and the DoH (2014) non-potable use trigger at WM03-N-S03 and WM03-W-S04 in April 2024, July 2024, September 2024, and January 2025. • Copper exceeded the Water Quality Australia (2021) DGV at all bores, predominantly during April and July 2024. • Iron exceeded the DoH (2014) non-potable use trigger and the ANZECC & ARMCANZ (2000b) agricultural irrigation LTV at all bores during the majority of monitoring events. • Manganese exceeded the ANZECC & ARMCANZ (2000b) agricultural irrigation LTV within bores WM01-W-S01 (July 2024, September 2024, January 2025), WM02-W-S02 (September 2024, January 2025), and WM03-W-S04 (July 2024).
Leederville Aquifer	• pH was classified as acidic to neutral with all pH values exceeding the lower ANZECC & ARMCANZ (2000a) trigger value. • Salinity was classified as freshwater (below 500 mg/L) and was dominated by sodium and chloride. • Electrical conductivity exceeded the ANZECC & ARMCANZ (2000a) trigger value at almost all bores across all monitoring events, excluding bore WM01. • Turbidity exceeded the ANZECC & ARMCANZ (2000a) trigger value in the majority of bores excluding bores WM01 (July 2024, September 2024, January 2025) and WM03 (September 2024, January 2025). • Nutrient concentrations were below the relevant guideline triggers across all bores and all monitoring events. • Copper exceeded the Water Quality Australia (2021) DGV at all bores, predominantly during April and July 2024 with a spike in concentration in January 2025. • Iron exceeded the DoH (2014) non-potable use trigger and the ANZECC & ARMCANZ (2000b) agricultural irrigation LTV in all three bores across all monitoring events excluding September 2024. • Manganese exceeded the ANZECC & ARMCANZ (2000b) agricultural irrigation LTV in bores WM02 and WM03 in July 2024, September 2024 and January 2025.

5 Surface Water Assessment

5.1 Approach

The surface water assessment was carried out to satisfy the EPA objective for Inland Waters, to ensure hydrological regimes and quality of surface water is maintained during construction and operation of the Proposal. To achieve this requirement, surface water modelling of the existing catchment is necessary to determine the extent of flow paths, peak flow and flow velocities. This information can be used to determine construction and operational elements which may influence this hydrodynamic behaviour.

5.2 Model Methodology

A two-dimensional (2D) rain-on-grid hydraulic model was developed for the Study Area to represent the disperse nature of planned infrastructure across the Study Area, and relative location to the headwaters. Furthermore, all watercourse flow paths have been assessed within the Study Area so this model can be utilised regardless of the Proposals final layout within the Study Area.

In using a rain-on-grid approach, rainfall hyetographs (rainfall depths over time) are applied directly to the hydraulic model grid, and flow paths are automatically computed by the hydraulic model based on the specific catchment characteristics, such as catchment shape, flow path slopes, and land use conditions. The hydraulic analysis software TUFLOW HPC (version 2023-03-AD-iDP-w64) was used to identify the surface flow characteristics.

5.3 Hydrology

5.3.1 Rainfall Depths and Temporal Patterns

Australian Rainfall and Runoff 2016 Intensity-Frequency-Duration (IFD) data was downloaded from the Bureau of Meteorology (BoM) website for -34.22°S, 115.29°E. Standard and non-standard durations were used, ranging from 20 minutes to 12 hours as shown in Table 5-1.

The QGIS 'ARR19' plugin was utilised to generate the required hyetographs for the applicable design events. The hyetographs that were developed represent the 'burst' part of the storm and exclude rainfall losses and pre-burst rainfall. These were applied separately using event-based loss values and are discussed in the upcoming section.

Table 5-1: Intensity Frequency Duration (IFD) Data (mm).

Annual Exceedance Probability (AEP)						
Duration	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
20 min	13.1	17.4	20.5	23.7	28.3	32
25 min	14.3	18.9	22.3	25.7	30.7	34.7
30 min	15.3	20.2	23.7	27.4	32.7	37
45 min	17.6	23.1	27.2	31.4	37.3	42.2
1 hour	19.5	25.4	29.8	34.4	40.8	46.1
1.5 hour	22.3	28.9	33.8	38.9	46.1	52.1
2 hours	24.6	31.7	36.9	42.5	50.3	56.7
3 hours	28.1	36	41.9	48.1	56.8	64.1
4.5 hour	32.2	41	47.6	54.4	64.3	72.5
6 hours	35.3	44.9	52	59.5	70.3	79.1
9 hours	40.1	51	58.9	67.3	79.4	89.4
12 hours	43.7	55.6	64.2	73.2	86.4	97.1

5.3.2 Climate Change (RCP 8.5)

A single 1% AEP climate change high emissions scenario Representative Concentration Pathway (RCP) 8.5 model run was conducted for the existing conditions. The climate change run will inform the potential increases in flood characteristics including flood levels, velocity, and potential hazards to the year 2090. The design depth of rainfall is increased based on the expected temperature rise within the scenario and location. ARR19 interim climate change factors (Engineers Australia March 2024) are presented in Table 5-2.

Table 5-2: ARR19 interim climate change factors for hydraulic model.

Scenario	Interim Climate Change Factor	Percentage Increase in Design Rainfall Depth
2090 RCP 8.5	4.5	24%

5.3.3 Rainfall Losses

Non-neutral initial and fixed continuing losses for the Study Area were selected based on modifying values from the ARR Data Hub presented in Table 5-3. The initial loss values represent the value for complete storms as the rainfall hyetographs were adjusted based on the median pre-burst rainfall using the QGIS ARR Data Hub plug-in. Non-neutral losses have been applied directly from the QGIS ARR data plug-in for this Assessment. This means for more frequent events and for durations less than 90 hours, the initial loss value applied was less than 27 mm, based on the pre-burst and rainfall depth. The adopted initial loss values for frequent events range between 3.1 mm to 27 mm.

Table 5-3: Loss parameters adopted in hydraulic model.

Interstation area	Initial Loss (mm)	Continuing Loss (mm/hr)
Beenup ARR Datahub	27	4.2

5.3.4 Design Event Selection

The initial hydraulic model was run for the full suite of applicable AEPs, durations and the associated temporal patterns to select a refined number of design events per AEP for the Study Area. Each AEP event has been run for the 20, 25, 30, 45, 60, 90, 120, 180, 360 and 720-minute durations. The 1% AEP Climate Change (CC) event (Table 5-2) has also been modelled for these durations.

This was found to capture all critical durations for the modelled extent. In total, over 300 model runs have been simulated within the hydraulic model. Design events were selected based on the median temporal pattern of the critical duration based on the water surface level outputs from TUFLOW for each AEP event. It is noted that when using TUFLOW outputs, as there are 10 ensemble temporal patterns for each duration, the ensemble peak flow result one above the 'true median' was selected (Table 5-4).

Table 5-4: Critical duration and median temporal pattern selection for hydraulic model.

AEP	Critical Duration	20 min	30 min	45 min	60 min	90 min	120 min	180 min	270 min	360 min	540 min	720 min
1% CC	Median Temporal Patterns	10	9	-	2	1, 8	10	2	10	4	6	7
1%		10	9	-	2	1, 8	10	2	10	4	6, 8	7, 9
2%		10	9	-	2	1, 8	6	2	10	7, 10	10	6
10%		9	10	10	-	10	1	7	10	7	2	10
50%		9	10	1	-	-	10	10	2	4	9	1

5.4 Hydraulic Model

5.4.1 Key Model Parameters

The key parameters adopted in the TUFLOW hydraulic model for the Assessment are summarised in Table 5-5.

Table 5-5: Key hydraulic model parameters adopted in the Assessment.

<table>
<tr><th>Parameter</th><th>Value</th></tr>
<tr><td>Model Extent</td><td>The hydraulic model extent includes the Study Area and an additional 100 m to 200 m offset to ensure model boundaries and potential instabilities are not influencing the flood results.</td></tr>
<tr><td>Grid Size</td><td>A hydraulic model grid size of 3 m was adopted. Sub-grid sampling (SGS) was enabled with a sample distance of 1 m.
This grid size was found to provide a suitable high-level resolution for the purposes of this assessment. It is noted that future design works may require smaller resolution grid cell computations and feature survey.</td></tr>
<tr><td>Direct Precipitation Inflow</td><td>The hydraulic model adopts a direct rainfall approach as outlined in Section 5.3, using a ‘2d_rf’ layer. This rainfall layer has been digitised based on the catchment of the Study Area. The hyetograph for each design event is applied evenly to every active cell within the ‘2d_rf’ layer.</td></tr>
<tr><td>Digital Elevation Model</td><td>The digital elevation model (DEM) for the hydraulic model was based on the 1 m DWER Scott River LiDAR of the region and 2 m Surface Elevation Model from Landgate. These datasets were incorporated into the hydraulic model in the form of a merged 1 m DEM. The extent of the two datasets is outlined in Section 3.3.3.
It should be noted that the accuracy and resolution of the datasets varied. The 1 m DWER Scott River Lidar had a vertical accuracy of 0.15 m while the 2 m Landgate dataset has a vertical accuracy of 0.8 m.</td></tr>
<tr><td>Roughness</td><td>Hydraulic roughness in the model is based on the inspection of aerial imagery. Manning’s ‘n’ roughness is spatially varied based on the level of vegetation on the floodplain, the presence of waterways and vegetation within those waterways as well as the presence of roads, buildings, and ponds (Figure 5-1).
<table>
<tr><th>Description</th><th>Manning's n</th></tr>
<tr><td>Dense Vegetation</td><td>0.05</td></tr>
<tr><td>Paved Road</td><td>0.025</td></tr>
<tr><td>Gravel Road</td><td>0.03</td></tr>
<tr><td>Open Water</td><td>0.025</td></tr>
<tr><td>Building</td><td>0.3</td></tr>
<tr><td>Low Vegetation Pervious Terrain (General)</td><td>0.035</td></tr>
</table></td></tr>
<tr><td>Boundaries</td><td>Several stage-discharge boundaries have been applied along the tributary outlets from the headwater catchments, approximately 100-200 m downstream of the Study Area. The slope of the corresponding flow path has been separately applied for each flow path.</td></tr>
<tr><td>Soil Infiltration</td><td>Rainfall losses are applied directly within TUFLOW. Multiple approaches can be used to model losses within TUFLOW, with a soil file being used for this assessment. This approach extracts water from wet 2D cells within the hydraulic model and is more suited to modelling rainfall losses, as opposed to interception losses. The soils layers were digitised initially using the roughness grids and then modified to suit the ARR 2019 land use categories for pervious and impervious areas.</td></tr>
</table>

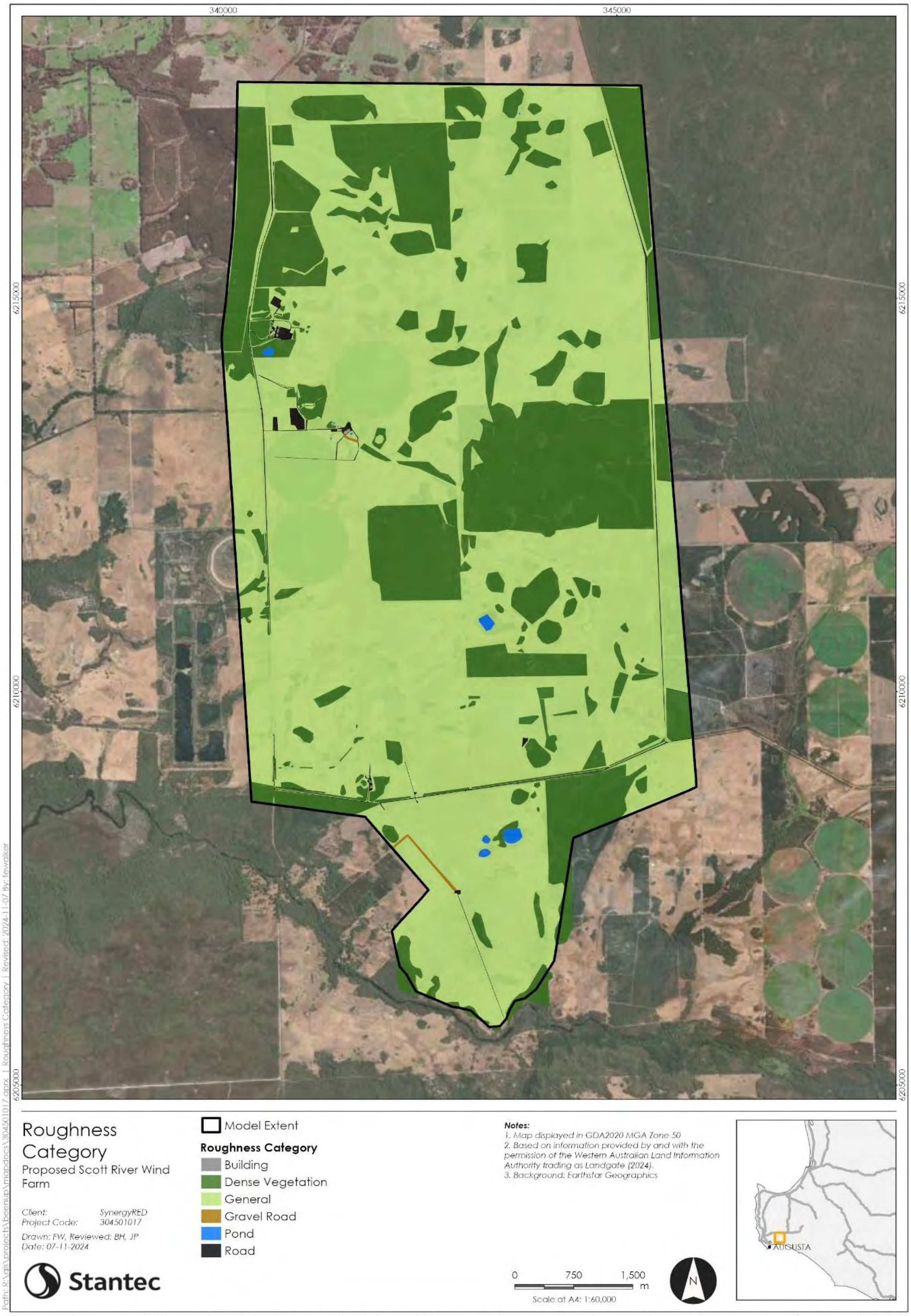


Figure 5-1: Hydraulic roughness categories adopted in hydraulic model.

5.5 Flood Results

5.5.1 Overview

Flood hazard has been assessed in accordance with Australian Rainfall and Runoff (2019) and the *Australian Emergency Management Institute Hazard Categorisation* criteria outlined in Table 5-7 and Figure 5-2. Flood mapping for peak flood extents, depths, peak flood velocities and hazards were prepared for the 1%, 2%, 10%, 50% and 1% AEP Climate Change existing case scenarios. The 1% AEP flood depths, velocities and hazard are illustrated in Figure 5-3 to Figure 5-5 The results in the northern portion of the Study Area which rely on the supplied Landgate dataset are considered to be of lower confidence than the results in the southern portion of the Study Area. This is evidenced by a slight artificial ponding that occurs between the two DEM datasets (~200 mm) and the reduced granularity in flow paths in the north.

The details of individual discharge locations for the 11 headwater subcatchments and areas of significant ponding are outlined in Appendix F and detailed flood maps are outlined in Appendix G. The following generalisations regarding the flood behaviour of the Study Area have been made to assist the environmental approvals:

- The frequent flow regimes such as the 50% AEP demonstrate a minor extent of inundation. The maximum ponding depth of ~1.2 m occurs near the south-western boundary of the Study Area, near the milking sheds and upstream of an access track.
- Most areas of inundation with depths greater than 0.5 m in the frequent events (50% AEP) occur upstream of roads acting as hydraulic controls with some ponding in areas with the appearance of wetlands or perched ponds. There are only a small number of defined flow paths discharging from the Study Area with flow rates of up to 0.5 m^3/s. (50% AEP).
- The rare (1% and 2% AEP) flow regimes demonstrate a widespread level of inundation. The maximum ponding depth of ~2.8 m occurs in the forested northern most sub-catchment in the Study Area. The second deepest ponding occurs at ~2.3 m in the same location to the 50% AEP near the south-western boundary of the Study Area.
- Several areas of inundation in the rare (1% and 2% AEP) events exceed 0.5 m in depth across the Study Area, including behind roads acting as hydraulic controls and in areas with the appearance of wetlands or perched ponds.
- All headwater catchments other than one in the north-east show distinctive rare event flow paths to the discharge locations outside of the Study Area.
- The maximum discharge rate of ~20 m^3/s from the Study Area is south to the Scott River at the location of the DWER sampling site 6091226 Scott River Trib – Woodhouse and the Proposal Surface Water Monitoring Location 5 (SW5).

5.5.2 Flood Velocity Criteria

Velocities in the baseline condition remain below the threshold of 2 m/s typically considered to contribute to general erosion and scour. Potential increases to velocity through the design phase will need to be quantified and design countermeasures constructed to ensure impacts to sensitive receptors and operational risks are mitigated in line with the recommended shear stress and velocity threshold guidance outlined in Table 5-6.

Table 5-6: Shear stress and velocity threshold guidance for future design information.

Material Category	Material Type	Permissible Shear Stress (N/m^2)	Permissible Velocity (m/s)
Soil	Alluvial silt (noncolloidal)	2	0.6
Soil	Alluvial silt (colloidal) or stiff clay	12	0.9-1.1
Gravel/Cobble	25-50 (mm)	16-32	1.5-1.8
Vegetation	Short native grass	45	1.2
Vegetation	Class C turf	48	1.1
Vegetation	Long native grass	81	1.8
Gravel/Cobble	150 (mm)	96	2.3
Vegetation	Class B turf	101	2.1
Riprap	150 (mm)	120	3
Vegetation	Class A turf	177	2.4
Riprap	230 (mm)	182	3.4

Material Category	Material Type	Permissible Shear Stress (N/m^2)	Permissible Velocity (m/s)
Gravel/Cobble	300 (mm)	192	3.7
Soil Bioengineering	Coir roll	239	2.4
Riprap	300 (mm)	244	4
Soil Bioengineering	Brush layering (initial/grown)	299	3.7
Riprap	450 (mm)	364	4.9
Soil Bioengineering	Vegetated coir mat	383	2.9
Soil Bioengineering	Live brush mattress (grown)	393	3.7
Hard surfacing	Gabions	479	5.8
Riprap	600 (mm)	484	5.5
Hard surfacing	Concrete	599	5.8

Adapted from source: https://www.marincounty.org/-/media/files/departments/pw/mcstoppp/residents/fischenichstabilitythresholds.pdf

5.5.3 Flood Hazard Criteria

Flood hazard has been assessed in accordance with Australian Rainfall and Runoff (2019) and the *Australian Emergency Management Institute Hazard Categorisation* criteria outlined in Table 5-7 and Figure 5-2. Flood hazards are typically low across the site despite widespread level of inundation in rare events. Areas of ponding demonstrate higher risk profiles (depths above 0.3 m) as expected and should be avoided in future design activities unless suitable mitigation measures are integrated for infrastructure resilience.

Table 5-7: Flood Hazard Classes ARR2019 for future design information.

Hazard Class	Description	Classification Limit (D x V)	Limiting Depth (m)	Limiting Velocity (m/s)
H1	Generally safe for vehicles, people and buildings.	≤ 0.3	0.3	2
H2	Unsafe for small vehicles.	≤ 0.6	0.5	2
H3	Unsafe for vehicles, children and the elderly.	≤ 0.6	1.2	2
H4	Unsafe for vehicles and people.	≤ 1.0	2	2
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.	≤ 4.0	4	4
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.	> 4.0	-	-

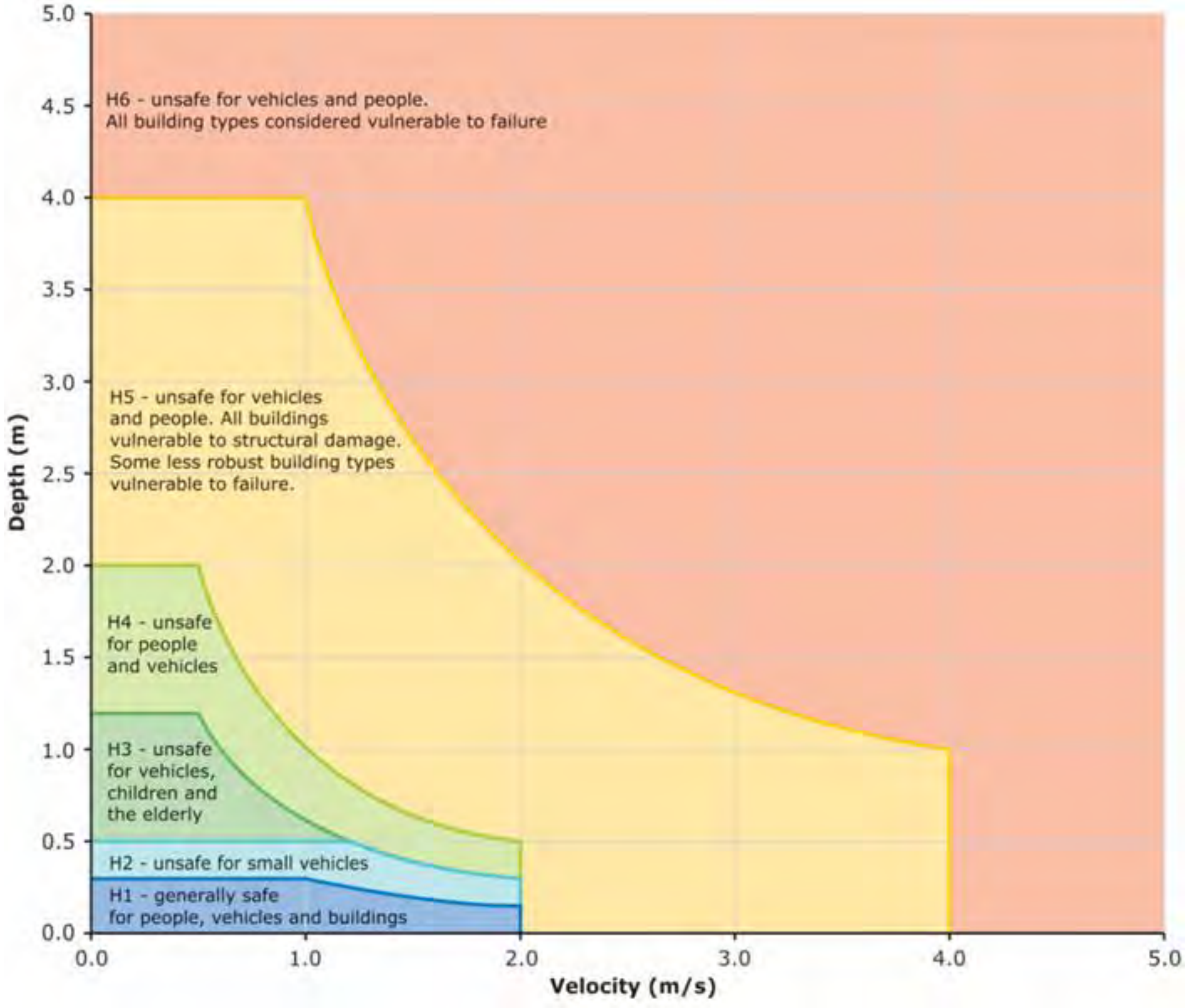


Figure 5-2: Australian emergency management institute hazard categories (2014).

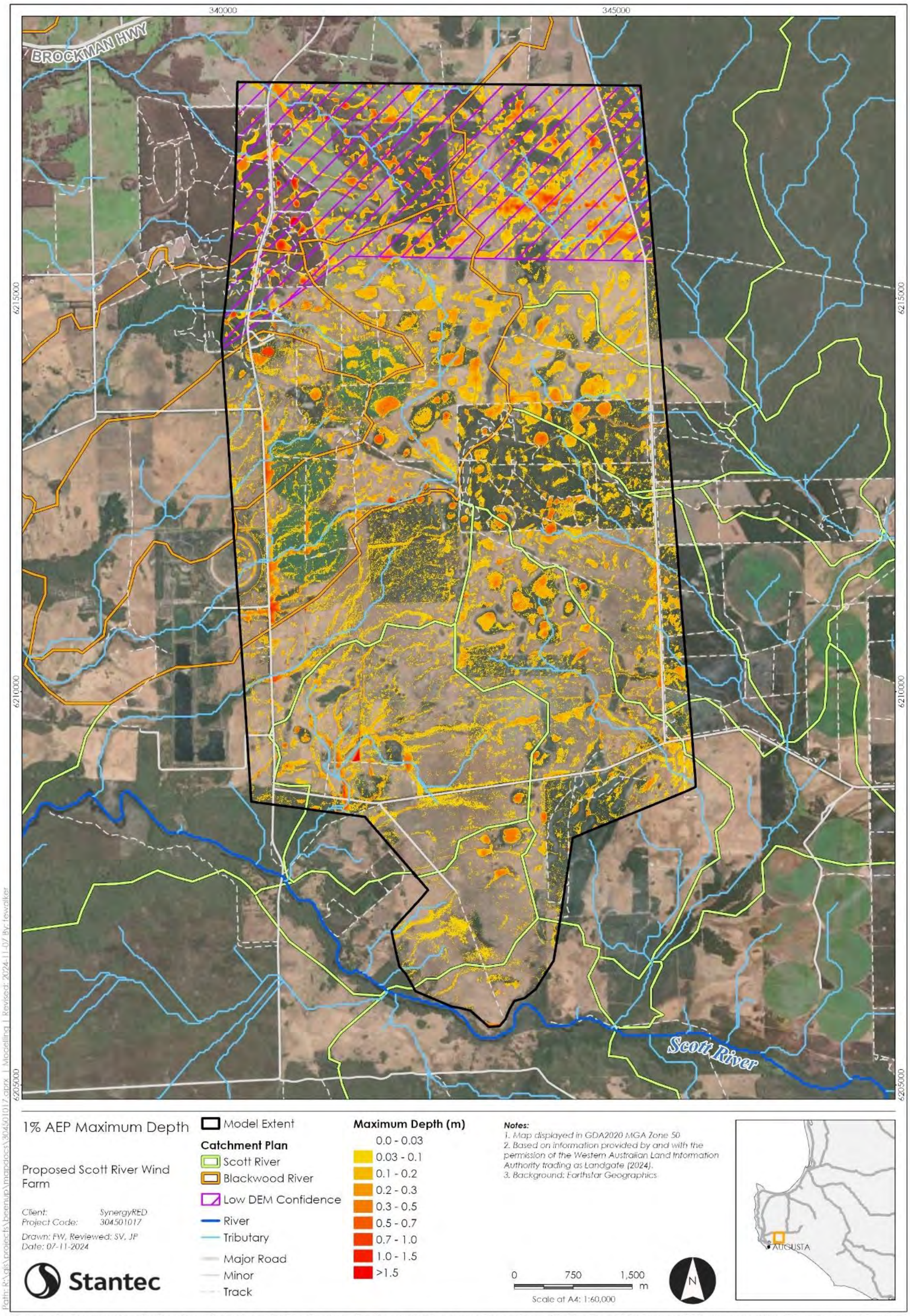


Figure 5-3: 1% AEP peak flood depths within the model extent.

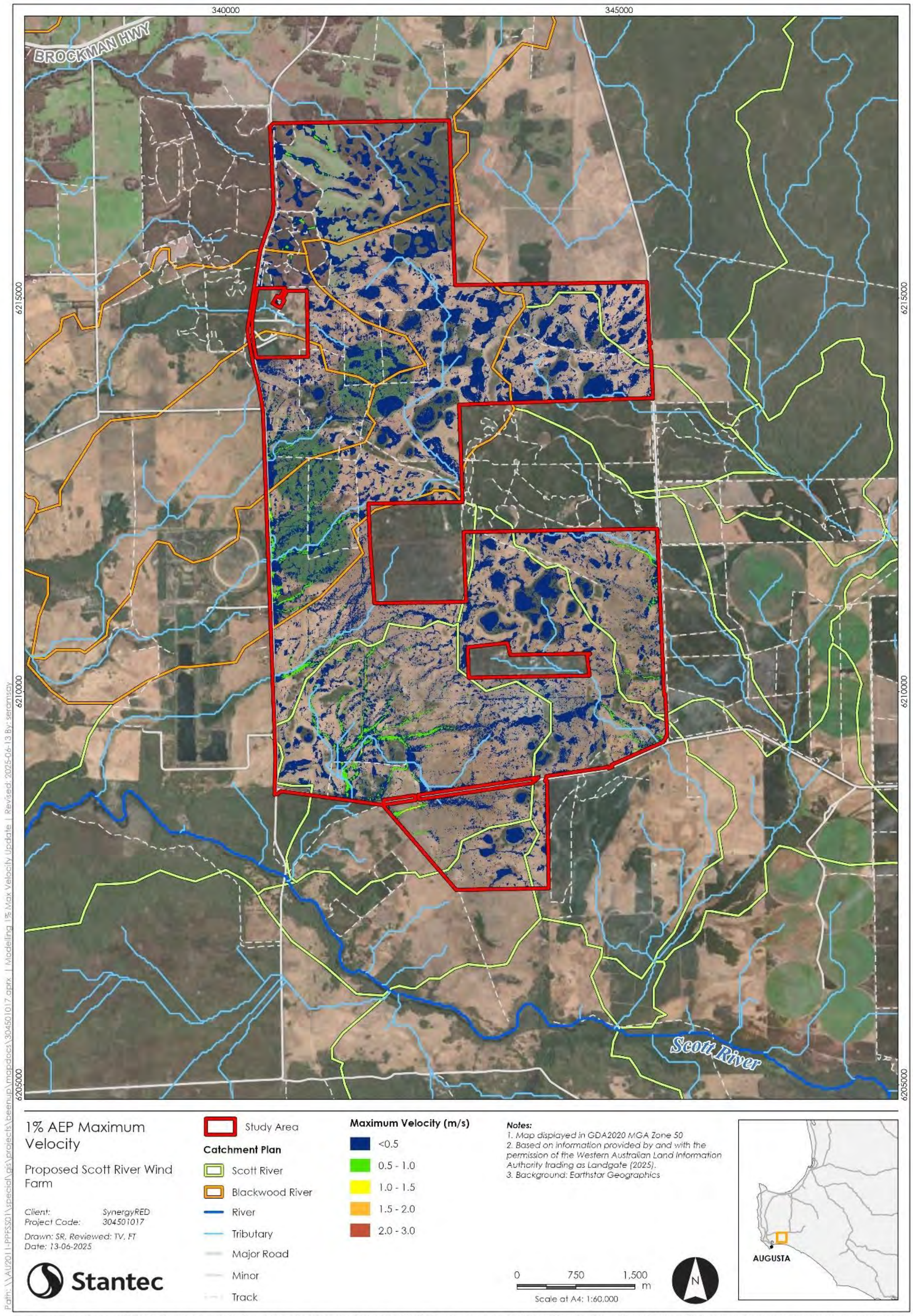


Figure 5-4: 1% AEP peak flood velocity within the model extent.

Note: there are localised areas where velocity exceeds 2m/s, this cannot be seen at this scale. A digital database has been provided to SynergyRED for infrastructure planning purposes.

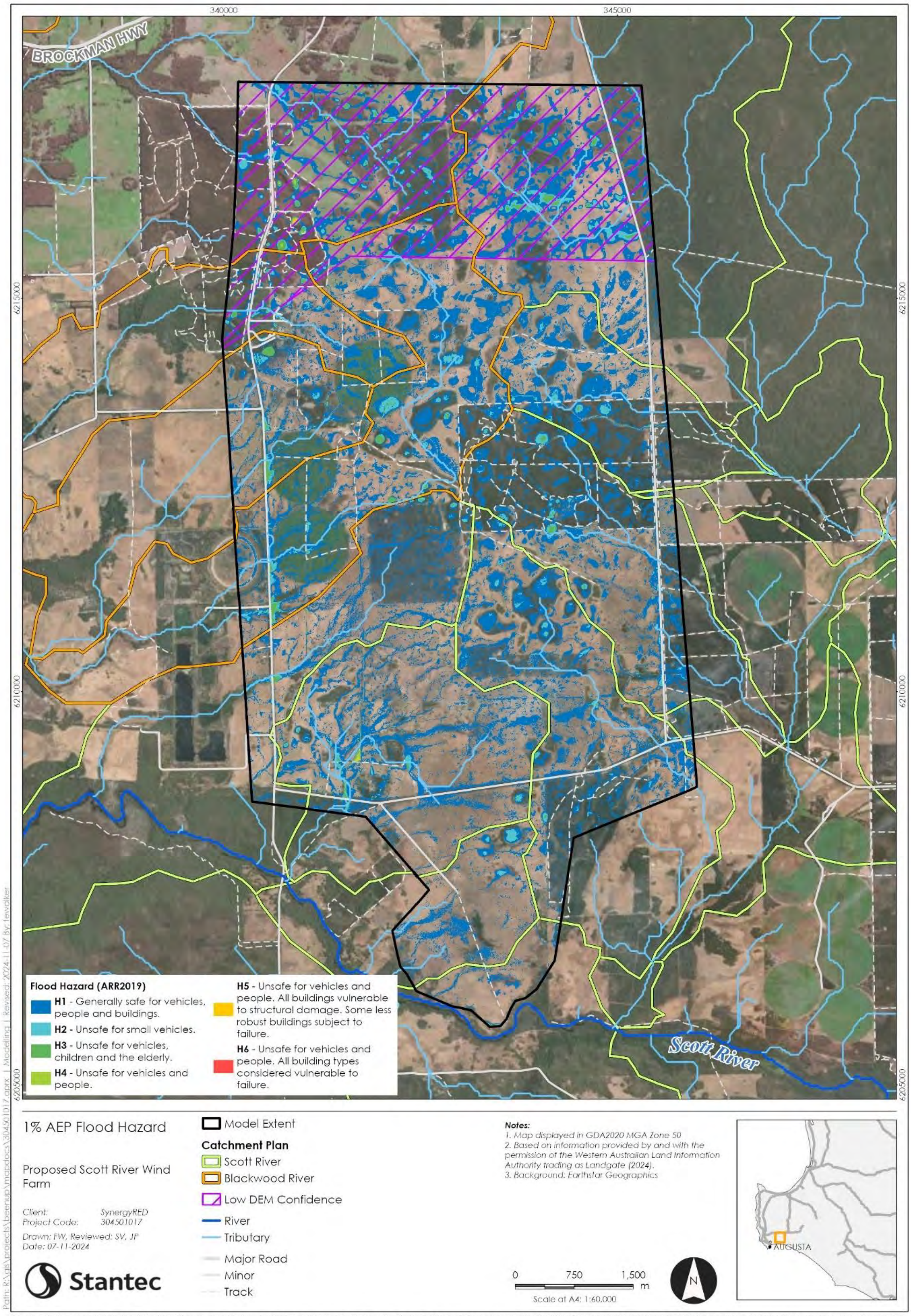


Figure 5-5: 1% AEP peak flood hazard (ARR 2019) within the model extent.

Note: there are localised areas where flood hazard exceeds H1 this cannot be seen at this scale. A digital database has been provided to SynergyRED for infrastructure planning purposes.

5.6 Design Event Validation

The Study Area is bound by roads on all edges where discharge from the catchments is occurring, apart from the southernmost catchment which sheet flows across the bordering agricultural land. The roads and historical drain diversions built as part of the agricultural operations (including tree plantations) have significantly impacted the natural hydrological regime. These controls, as well as the natural ponding which occurs across the site, limits the potential to validate the hydraulic model results to regional peak flow estimation methods that do not account for storage characteristics of the natural depressions, flow building up behind road embankments or catchment shape. The hydraulic model extent was maintained within a 100-200 m buffer from the Study Area extent (originally provided in April 2024) meaning that the full extent of the headwater catchments is not captured in the hydraulic model area. This is appropriate given the scope of the Proposal.

The maximum discharge rate of ~20 m^3/s in the 1% AEP from the Study Area is south to the Scott River at the location of the DWER sampling site 6091226 Scott River Trib – Woodhouse and the Surface Water Monitoring Location 5 (SW5) established for this Proposal. This flow rate correlates to an approximately 20-minute Rational Method calculation runoff response for the main, direct flow path to the discharge location. However, given the flow attenuation behind the roads across the catchment, the hydraulic model shows a peak flow occurring at approximately 2 hours.

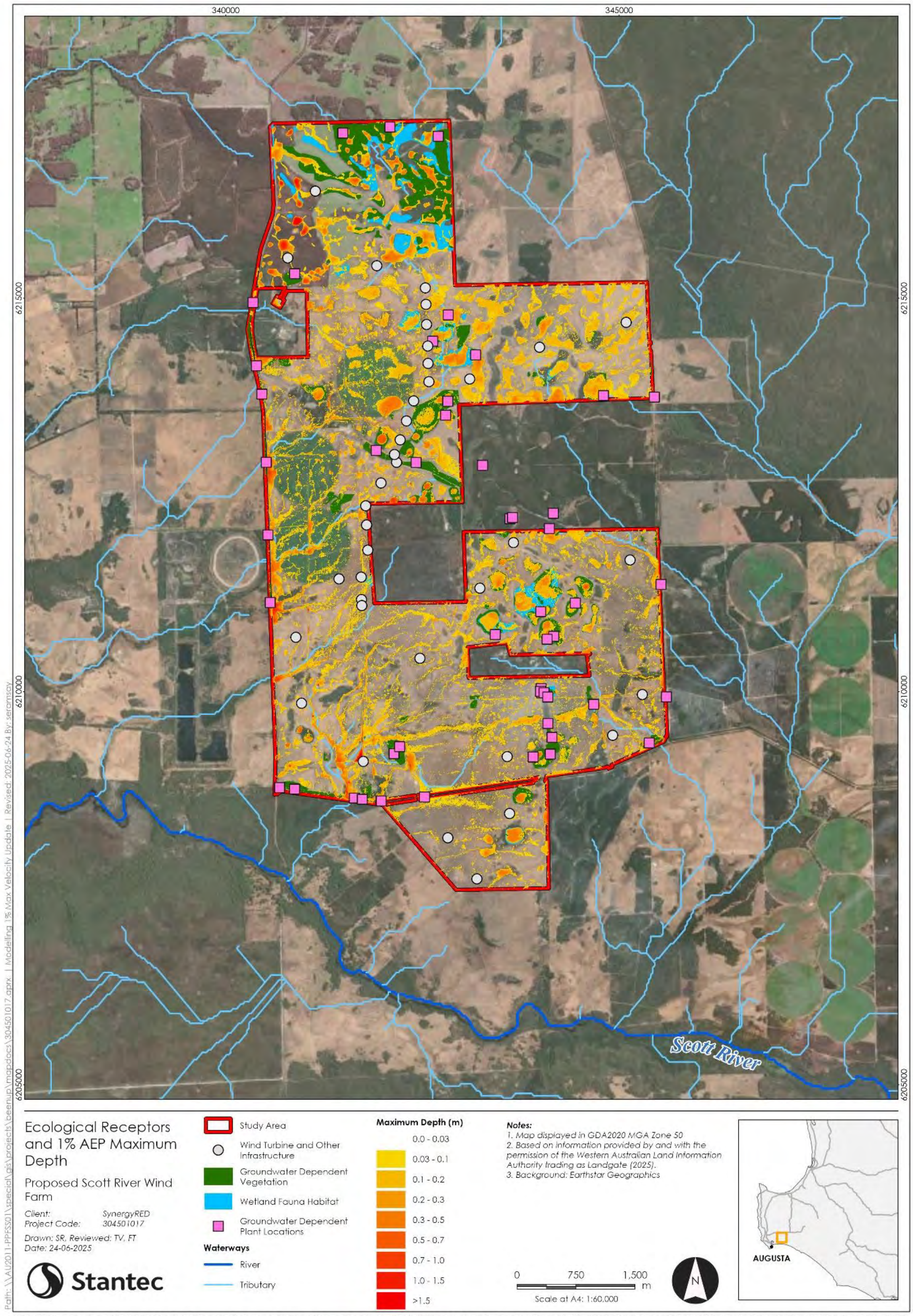


Figure 5-6: 1% AEP peak flood depths within the model extent.

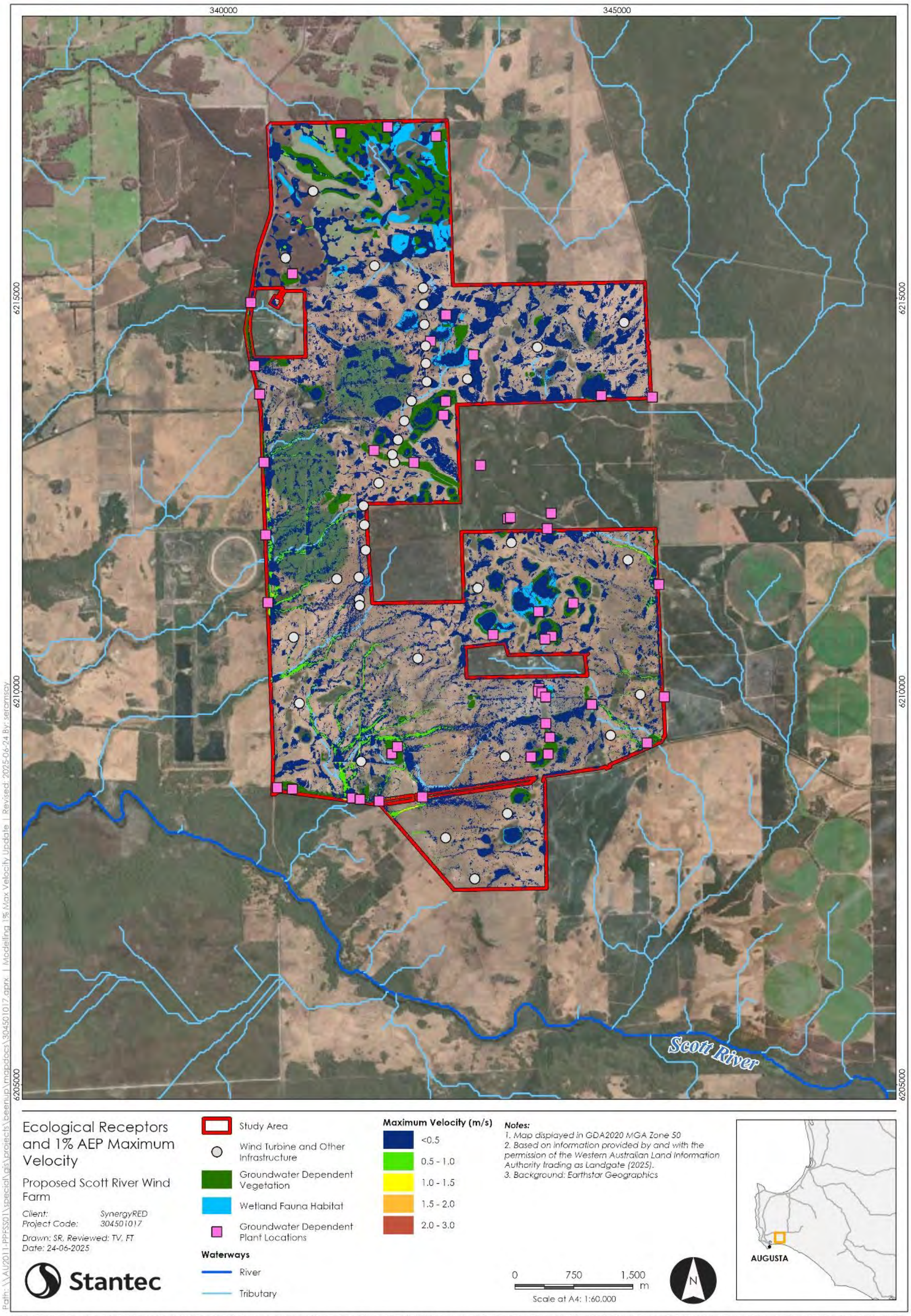


Figure 5-7: 1% AEP peak velocities within the model extent.

6 Preliminary Dewatering Assessment

6.1 Modelling Objective

The modelling objective was to evaluate predicted groundwater drawdown extents and groundwater inflows during construction dewatering for proposed infrastructure foundations likely to intercept groundwater. This includes the foundations for turbines, and meteorological towers.

The predicted groundwater drawdown extent is used as a preliminary diagnostic tool to inform the estimated groundwater drawdown extent to support the preliminary risk assessment. The groundwater inflows are estimated to inform potential groundwater take, and the groundwater management and potential licencing requirements.

6.2 Model Context

Construction dewatering at each proposed infrastructure foundation is anticipated based on the reported groundwater depth across the Study Area during the wetter months. A conservative approach was adopted by assuming the water table level was at surface (during wetter period) which is a typical approach for predicting groundwater dewatering within dynamic systems at the local level.

The proposed foundation excavations are assumed to be:

- Turbines: 0.8 mbgl and a target groundwater drawdown of 2 mbgl over an excavation of 30 m by 30 m.
- Meteorological tower: maximum design dimensions 1.5 mbgl and assumed groundwater drawdown to 3 mbgl with a single pier with an excavation footprint of 1.8 m by 1.8 m.

6.3 Model Design

The following models for an unconfined aquifer were used and are provided in more detail in Appendix H:

- Cooper Jacobs (Kruseman and Ridder 1994): Time-variant dewatering from a bore. This model was used to predict initial dewatering rates for specific time to achieve a target drawdown.
- Dupuit-Thiem (Kruseman and Ridder 1994): Steady-state dewatering from a bore. This model was used to predict steady-state dewatering discharge rates and distance-drawdown.
- Marinelli and Niccoli (2000) model: steady-state inflow into a mine pit. This model was used to predict steady-state dewatering discharge rates.

6.4 Assumptions and Limitations

The evaluation of groundwater distance-drawdown and inflows are based on simplified calculations assuming a likely range of aquifer hydraulic conductivities (both horizontal (K_h) and vertical (K_v)). Note that the hydraulic conductivity of the aquifer may change over several orders of magnitude over short distances. For each modelled scenario, the timeframe to attain steady-state conditions will depend upon the pumping rate used to attain the target groundwater level and has not been evaluated.

Vertical and horizontal spatial data limitations were considered, given that only three bore groups and 20 shallow test pit locations across the large Study Area were available to inform the aquifer conditions and models. Assumptions of the ground conditions (such as lithology) were made across areas where no data was available.

The dominant lithology described in bores and shallow test pits (up to 2 m deep) was used to classify the model inputs. Bore group WM01 in the northwest is a dominant shallow sandy clay and clayey sand (WM01) and was inferred to extend around the bore group. The bore groups WM03 and WM02 in the central south and southern area, respectively, and the majority of test pits are a dominant sand, therefore this material type was assigned to the remainder of the Study Area. The model did not include cumulative drawdown effects from concurrent nearby excavation and potential irrigation dewatering.

6.4.1 General Model Inputs

Specific adopted model inputs for the Cooper-Jacob, Dupuit-Thiem, and Marinelli and Niccoli models are presented in Appendix H. The following general modelling inputs applied to both time-variant and steady-state models:

- Excavation dimensions will be:
  - Turbines: 30 m by 30 m, depth 0.8-1.2 mbgl.
  - Meteorological towers: maximum dimensions – 1.8 m by 1.8 m, depth 1.5 mbgl.
- The models assume that the entire sub-surface is fully saturated from ground surface level.
- To provide dry working conditions across the excavation, groundwater was assumed to be lowered to a maximum depth of approximately:
  - Turbines: 2 mbgl.
  - Meteorological towers: 3 mbgl.
- Horizontal hydraulic conductivity (based on Domenico and Schwartz 1990) was assigned as two zones to enable flexibility across the site, with regards to potential infrastructure placement (see Figure 6-5):
  - **Zone 1** (bore group WM01): dominant sandy clay (typical silt, clay range) aquifer was assigned 0.5 m/day.
  - **Zone 2** (All other locations): dominant sand (typical fine sand range) aquifer was conservatively set to 20 m/day.
  - Transition zone: assigned to highlight an arbitrary boundary between the two zones and was estimated based on the limited soil bores and test pits in the northern area. The transition zone approximately circles the WM01 bore group and extends toward two proposed turbine locations in the north.

6.4.2 Time-variant Inflow

The following model assumptions have been made in evaluating time-variant groundwater inflow:

- The aquifer was unconfined, infinite, homogeneous, isotropic, uniform thickness and pumped at an initial transient pumping rate for the Cooper-Jacobs model to attain the target drawdown.
- 5 days of initial pumping to attain the target drawdown (which may vary per location) followed by steady-state pumping to maintain the target drawdown to satisfy the excavation development and typical 28-day curing of the concrete. Total dewatering is 33 days. The actual time needed to achieve the target groundwater drawdown may vary between excavation sites—it could be shorter or longer than five days, depending on conditions.
- The discharge is from a single, small diameter bore that is fully penetrating.
- Aquifer thickness was set to 20 m to satisfy the model equations.
- A specific yield of:
  - Zone 1 sandy clay or clayey sand 5% (based on silt) (Morris and Johnson 1967).
  - Zone 2 sand 20% (based on typical sand) (Heath 1983).

6.4.3 Steady-state Inflow & Distance-Drawdown

The following model assumptions have been made in evaluating steady-state groundwater inflow and distance-drawdown:

- The aquifer was infinite, homogeneous and anisotropic in both zones (Marinelli and Niccoli 2000).
- For the Dupuit-Thiem model
  - the aquifer was considered unconfined and was evaluated for steady-state constant daily discharge rate to maintain the target drawdown.
  - flat initial water table with pumping from a fully penetrating bore under steady-state conditions.
- For the Marinelli and Niccoli model
  - recharge was 30% of the average annual rainfall of 933 mm for the nearest BOM station (Scott River).
  - vertical conductivity was assumed to be half of the horizontal hydraulic conductivity, to account for a matrix comprised of sand.
- No sheet piling or cut off walls are used.

6.5 Model Output

6.5.1 Distance-Drawdown

Modelled steady-state output for the distance from the centre of the excavation to drawdown values are presented in Figure 6-1 to Figure 6-3 for the turbines, and meteorological towers. For each type of infrastructure, the predicted distance-drawdown is based on steady-state discharge predicted by the steady-state Dupuit-Thiem model. The seasonal variation for the Study Area is conservatively assumed to be approximately 1 to 2 m for the Superficial Aquifer (see Section 4.2) and is presented to visually compare to the estimated distance-drawdown modelling and to inform the risk assessment (Section 7).

For the turbines in Zone 1, the predicted steady-state distance drawdown curve is presented in Figure 6-1. The predicted distance to 0.5 m drawdown is approximately 43 m. For the turbines in Zone 2, Figure 6-2 presents a distance-drawdown curve for steady-state conditions. The predicted distance to 0.5 m drawdown is approximately 117 m.

The predicted steady-state distance to drawdown for dewatering the meteorological tower excavation for the target drawdown of 3 m (assumed sand aquifer, K_h =20 m/d) is presented in Figure 6-3. The predicted distance to 0.5 m of drawdown is approximately 86 m.

A summary of predicted distance-drawdowns for the proposed excavations under steady-state conditions is presented in Table 6-1.

Table 6-1: Summary of predicted steady-state distance-drawdown (Dupuit-Thiem).

Structure Type	Target Drawdown (m)	Zone	Predicted Distance-Drawdown (m) from Centre of Bore to a Depth (m) of			
			>3	2	1	0.5
Turbine Tower	2	Zone 1	9.5	17	31	43
		Zone 2	5	17	60	117
Meteorological towers	3	Zone 1	*N/A*	*N/A*	*N/A*	*N/A*
		Zone 2	1	6	34	86

N/A not applicable. Meteorological tower not proposed in the north. Zone 1 northern area around WM01 bore group; Zone 2 central southern bore groups WM03 and WM02 and test pits.

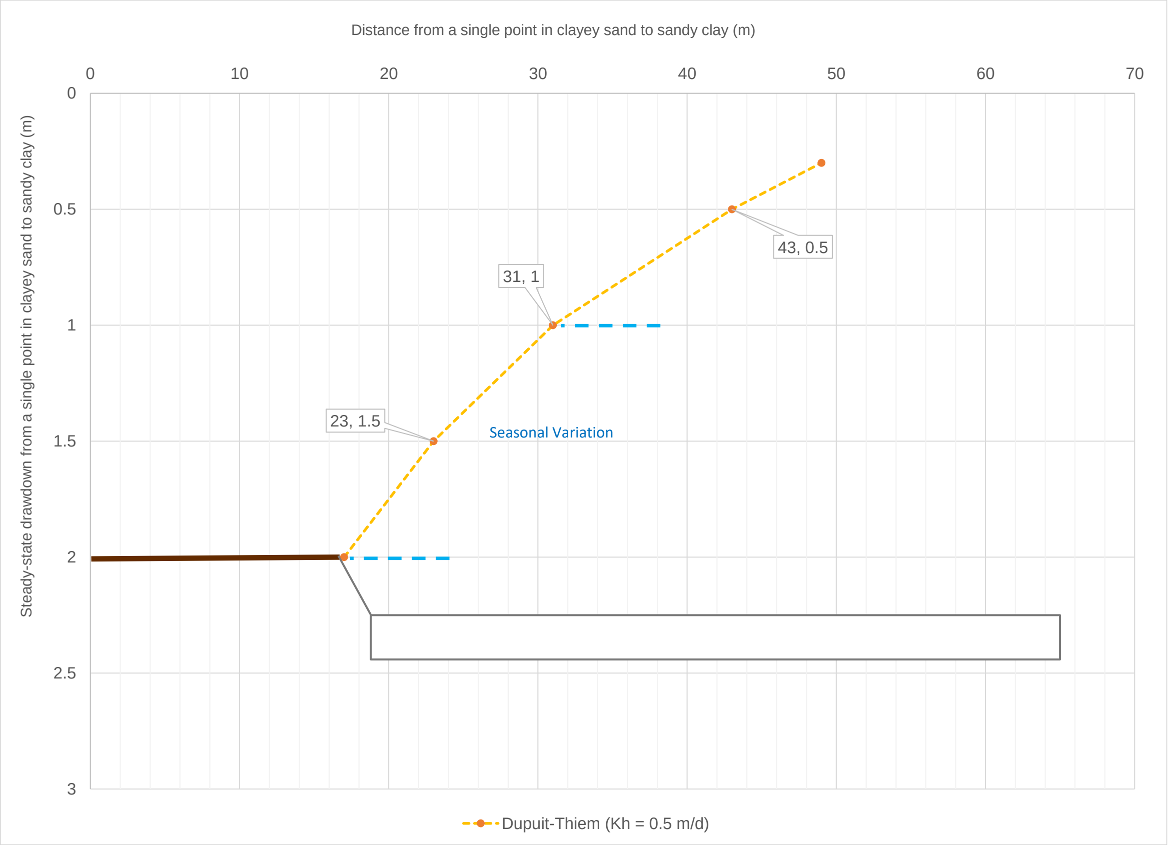


Figure 6-1: Zone 1 turbine evaluation of steady-state Dupuit-Thiem distance-drawdown (K_h=0.5 m/d).

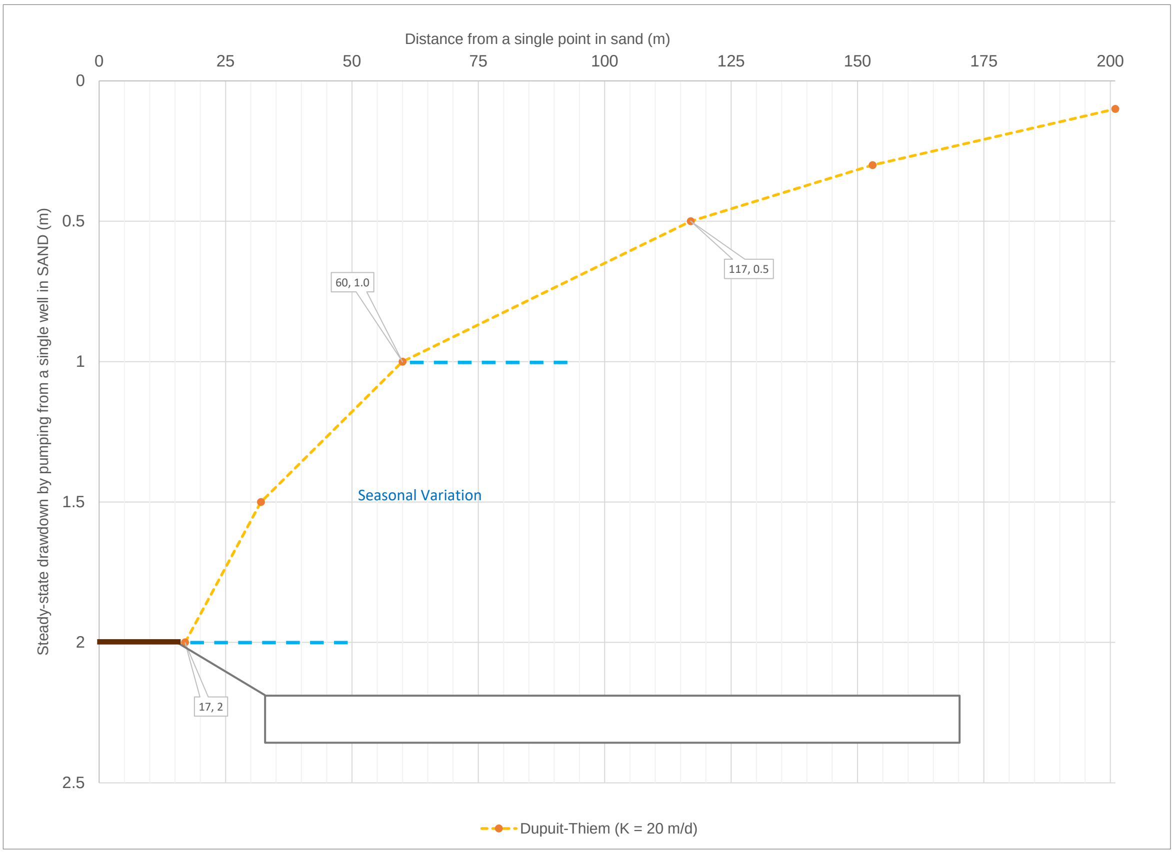


Figure 6-2: Zone 2 turbine evaluation of steady-state Dupuit-Thiem distance-drawdown.

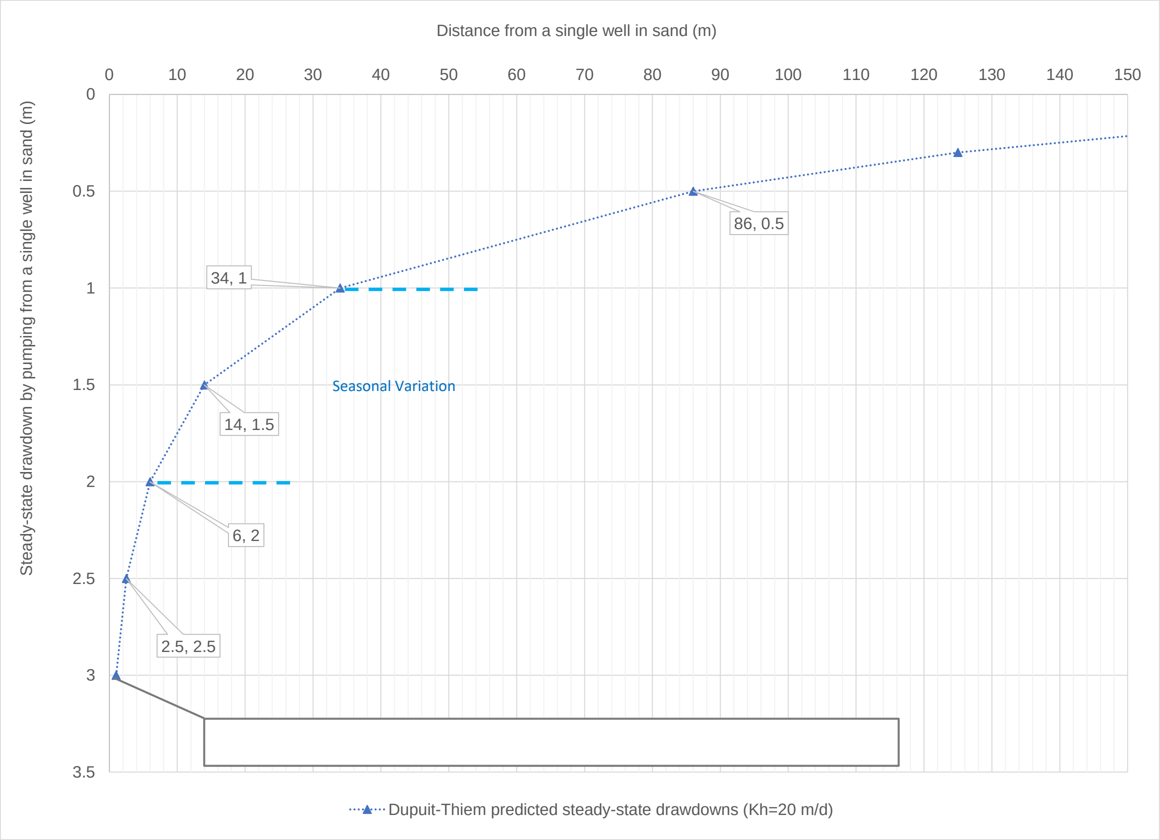


Figure 6-3: Zone 2 meteorological towers evaluation of steady-state distance-drawdown.

6.5.2 Rate of Inflow to Excavation

6.5.2.1 Initial Time-Variant Pumping

Elapsed time to attain the target drawdown depends upon the pumping rate. For the meteorological towers and turbines in zone 2, to achieve the target drawdown at 5 days the following pumping rate is required, per location in Table 6-2.

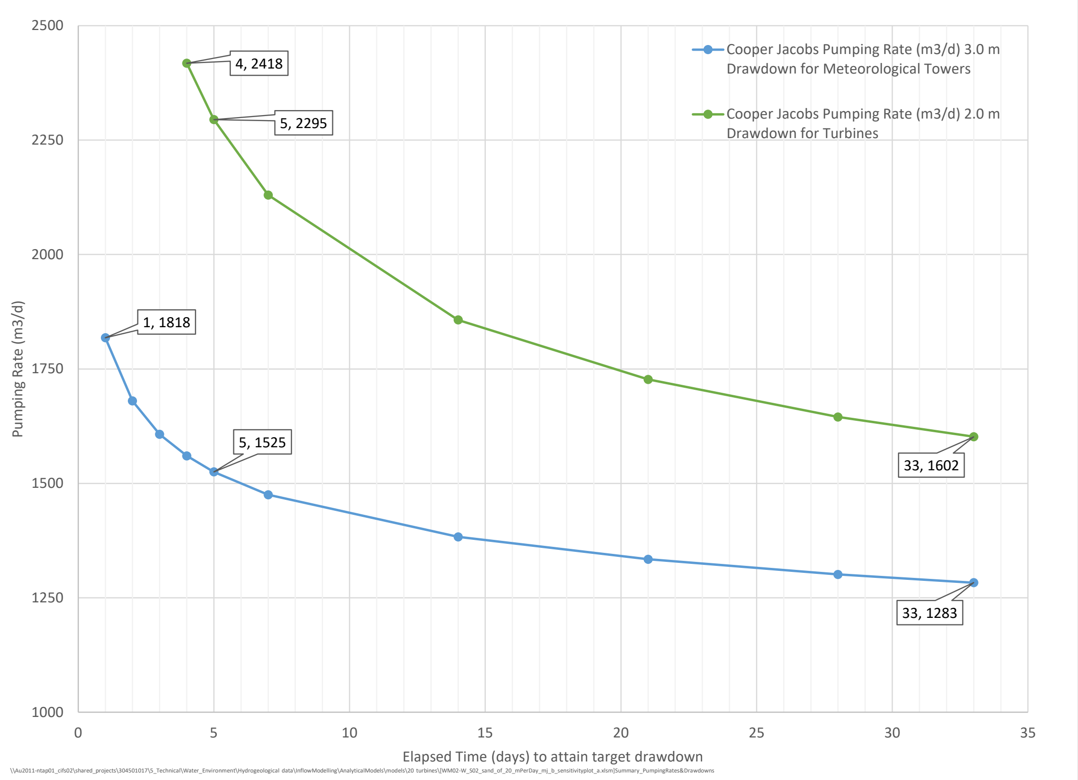
Table 6-2 Summary of time-variant discharge rates, per zone.

Model Type	Zone	Hydraulic Conductivity (m/day)	Turbine: Discharge to Achieve Target 2.0 m Drawdown After 5 Days			Met Towers: Discharge to Achieve Target 3.0 m Drawdown After 5 Days		
			Discharge (m^3/day)	Pumping Rate (L/s)	Cumulative Volume in 5 days (m^3)	Discharge (m^3/day)	Pumping Rate (L/s)	Cumulative Volume in 5 days (m^3)
Cooper Jacobs	1	0.5[1]	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
	2	20[2]	2,295	27	11,475	1,525	18	7,625

Notes:
n/a model was unable to calculate initial discharge for target drawdown. To satisfy the model equation, when Zone 1 was 0.5 m/day, the transient pumping estimated over 35 days to be valid and therefore was unable to be calculated. A steady-state model was likely to be representative of the initial discharge (see below).
[1] Clayey sand and sandy clay;
[2] Sand.

As shown on Figure 6-4, for Zone 2, pumping rates to achieve a target drawdown was variable for both infrastructure type. For the meteorological tower excavation, pumping rates were lower, which reflects the smaller excavation volume compared to the turbine excavation. Pumping rates to achieve target drawdown are dependent on the aquifer properties and could vary, such that realistic target drawdown times and dewatering rates may take longer.

Zone 1 time-variant data was unavailable for the period up to 33 days, because the analytical models are not valid for lower K_h values with low drawdown targets and larger radius of influence targets (drawdown targets across vast footprints). To satisfy the model equation, when Zone 1 was 0.5 m/day, the transient pumping estimated 36 days to be valid and therefore was not used to predict initial dewatering rates. A steady-state model was likely to be representative of the initial discharge. The model at 36 days indicated a discharge of 62 m^3/day, which is within range of the steady-state models (see Table 6-3.



\\Au2011-ntap01_cifs02\shared_projects\304501017\5_Technical\Water_Environment\Hydrogeological data\InflowModelling\AnalyticalModels\models\20 turbines\[WM02-W_S02_sand_of_20_mPerDay_mj_b_sensitivityplot_a.xlsm]Summary_PumpingRates&Drawdowns

Figure 6-4: Zone 2 various elapsed times and corresponding pumping rates to attain target drawdown.

6.5.2.2 Steady-state Pumping

Steady-state inflow rates predicted using the Dupuit-Thiem model and Marinelli and Niccoli model for the Zone 1 and Zone 2 are presented in Appendix H, with summary steady-state pumping rates presented in Table 6-3. For the Zone 1, the Dupuit-Thiem model and Marinelli & Niccoli model predicted a steady-state inflow of approximately 95 and 56 m^3/d, respectively. For Zone 2, the Dupuit-Thiem model and Marinelli & Niccoli model predicted a steady-state inflow for the turbines of approximately 1,833 m^3/day and 2,045 m^3/day, respectively, and the met tower 296 m^3/day, respectively.

These pumping rates are conservative based on the adopted horizontal hydraulic conductivity values and the absence of any cutoff structures in the excavation, such as sheet piles. Note that initial inflows are predicted to be greater to attain the target drawdown within a week, then the pumping rate would be reduced to maintain the target depth under steady-state conditions.

Table 6-3: Summary of steady-state model pumping rates.

Model Type	Zone	Target 2.0 m Drawdown for a Single Turbine			Target 3.0 m Drawdown for a Single Met Tower		
		Discharge (m^3/day)	Pumping Rate (L/s)	Cumulative Volume (m^3)	Discharge (m^3/day)	Pumping Rate (L/s)	Cumulative Volume (m^3)
Dupuit-Thiem	1	95	1	2,660[1]	*n/a*	*n/a*	*n/a*
	2	1,833	21	51,324	-	-	-
Marinelli & Niccoli	1	56	0.7	1,568	*n/a*	*n/a*	*n/a*
	2	2,045	24	57,260	296	3.4	8,204[2]

Notes:
n/a met tower not proposed within the northern area Zone 1;
-Dupuit-Thiem model not used for inflow rate in zone 2, only Marinelli and Niccoli
[1] cumulative value is based on 5 days to reach target drawdown using the steady-state inflow and 28 days dewatering, total 33 days
[2] cumulative value is based on 5 days to reach target drawdown using the time-variant pumping and steady-state 28 days dewatering, total 33 days

6.5.2.3 Inflow Summary

A summary of the estimated pumping rates for both Study Area zones are presented in Table 6-4.

Table 6-4: Summary of Pumping Rates and Estimated Volume, per location.

Zone	Turbine: Discharge for Target 2.0 m Drawdown After 33 Days			Met Tower: Discharge for Target 3.0 m Drawdown After 33 Days		
	Discharge[1] (m^3/day)	Pumping Rate (L/s)	Cumulative Volume in 33 days (m^3)	Discharge (m^3/day)	Pumping Rate (L/s)	Cumulative Volume in 33 days (m^3)
1	75.5	0.9	2,492[1]	-	-	-
2	2,058	24	65,767[2]	296	3.4	15,829[2]

Note:
Initial pumping rate to achieve target drawdown will be higher before achieving steady state
- Met tower not planned to be installed in Zone 1
[1] Mean steady-state models
[2] Cumulative total based on discharge from time-variant 5 days to achieve target drawdown and 28 days steady-state model output

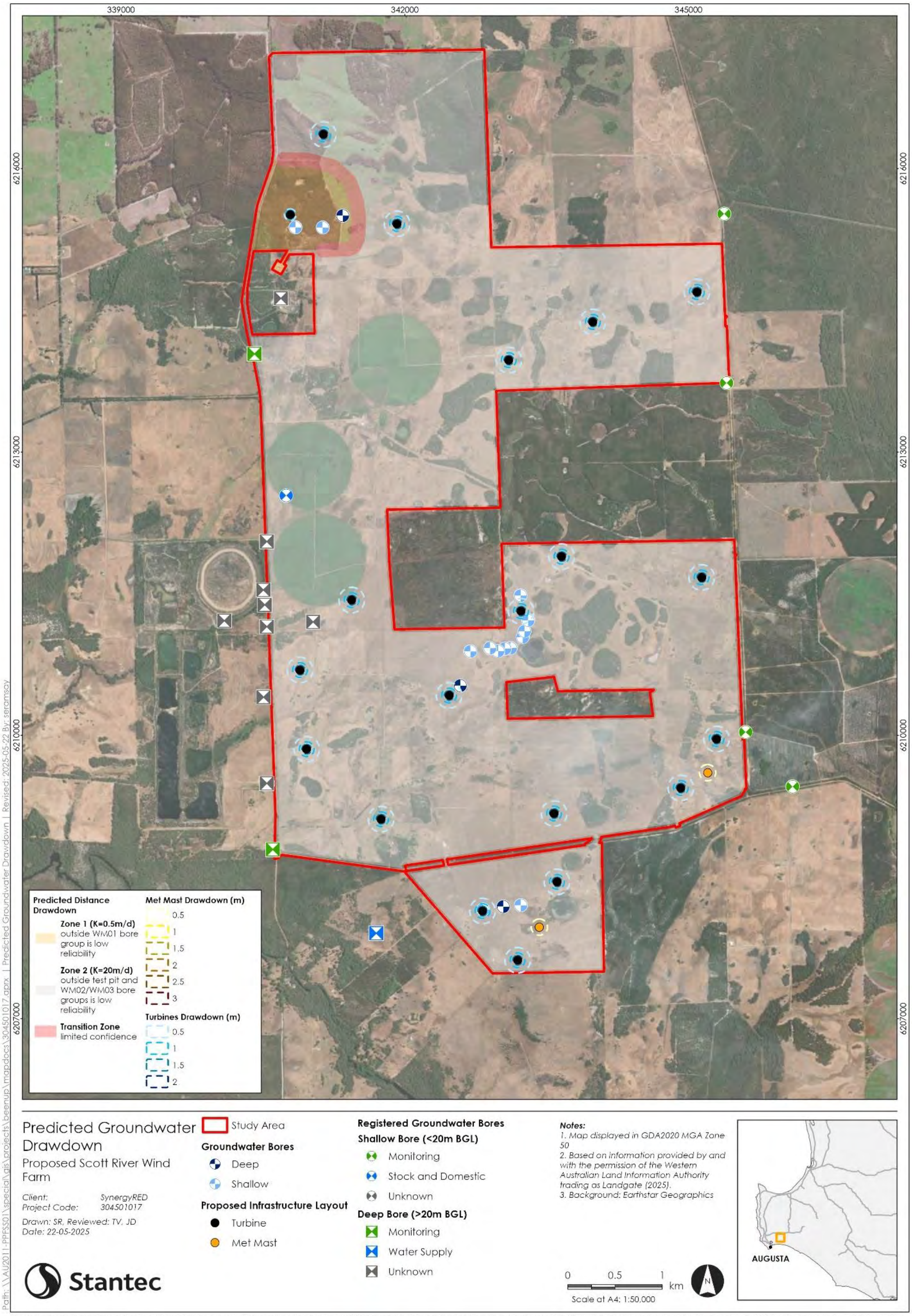


Figure 6-5: Predicted steady-state drawdown versus distance across the hydrological zones of the Study Area.

6.6 Drawdown Interaction and Expected Recovery

The predicted distance-drawdown model results vary depending on the drawdown target of foundation types and the hydrogeological characteristics across the Study Area (Figure 6-6). The greatest lateral extent (0.5 m drawdown contour) is predicted at the turbines (117 m) in Zone 2 compared to only 43 m in Zone 1 and attributed to varying hydrogeological characteristics. Meteorological towers located in Zone 2 have a predicted lateral extent of 86 m at the 0.5 m drawdown contour.

Under the proposed dewatering scenario, the drawdown extents that are predicted to potentially interact with GDEs (Section 3.5.3) are shown in Figure 6-6 and social receptors in Figure 6-7. The total area of interaction with GDEs (0.5 to 2 m drawdown extent) is 0.04 ha (Table 6-5), which only occurs in Zone 2 (Figure 6-6). This includes 0.04 ha of confirmed and potential groundwater dependent vegetation types (Mj and MrCh), which have also been mapped as wetland fauna habitats, comprising seasonally inundated Paperbark Woodland and Seasonally Inundated Sedgeland (Table 6-5). No GDE flora records intersect the predicted drawdown extents (Figure 6-6).

The predicted drawdown extent between 0.5 m to 2 m is typically confined to within the Study Area, with minor drawdown extending onto adjacent tenure considered minor, temporary, and well within the observed natural seasonal groundwater variation (Figure 6-6, Figure 6-7). While there is also the potential for cumulative drawdown impacts to occur in relation to other bore users in the Study Area (shallow bores down to 20 mbgl; Stock and Domestic Bore Number 60910768 and Water Supply Bore Number 60910782), predicted modelling does not indicate interference (Figure 6-7).

However, as dewatering for construction and excavation is expected to occur during the dry season (where practicable), it is anticipated that groundwater levels in the Superficial Aquifer would unlikely be encountered or would likely recover during the subsequent winter period (under average rainfall conditions). Groundwater in the Leederville Aquifer is not anticipated to be intercepted during the turbine and meteorological tower excavation dewatering. However, if this did occur, this system is likely to recover comparatively quicker (within weeks to months), as it is recharged via horizontal and vertical flow from the north towards the south and vertical downward leakage from the Superficial Aquifer. Regardless, the temporary and spatially constrained nature of potential dewatering and predicted drawdown is expected to maintain the existing hydraulic regime and avoid long-term impacts on groundwater users and GDEs.

Table 6-5: GDEs including vegetation types and wetland fauna habitats interacting with predicted drawdown extents.

GDE Category and Sub-Category		Area within Drawdown Extents (ha)		
		>2m	1m - 2m	0.5m - 1m
Confirmed GDE	**Vegetation Type** Scott River Ironstone TEC (Mj) **Wetland Fauna Habitat** Seasonally inundated sedgeland (containing *Melaleuca rhaphiophylla*)	0	0	0.03
Potential GDE	**Vegetation Types** Dominated by *Melaleuca rhaphiophylla* and *Melaleuca preissiana* (MrCh) **Wetland Fauna Habitat** Seasonally inundated paperbark woodland (containing *Melaleuca rhaphiophylla* and *Melaleuca preissiana)*	0	0	0.01
Total (ha)		**0**	**0**	**0.04**

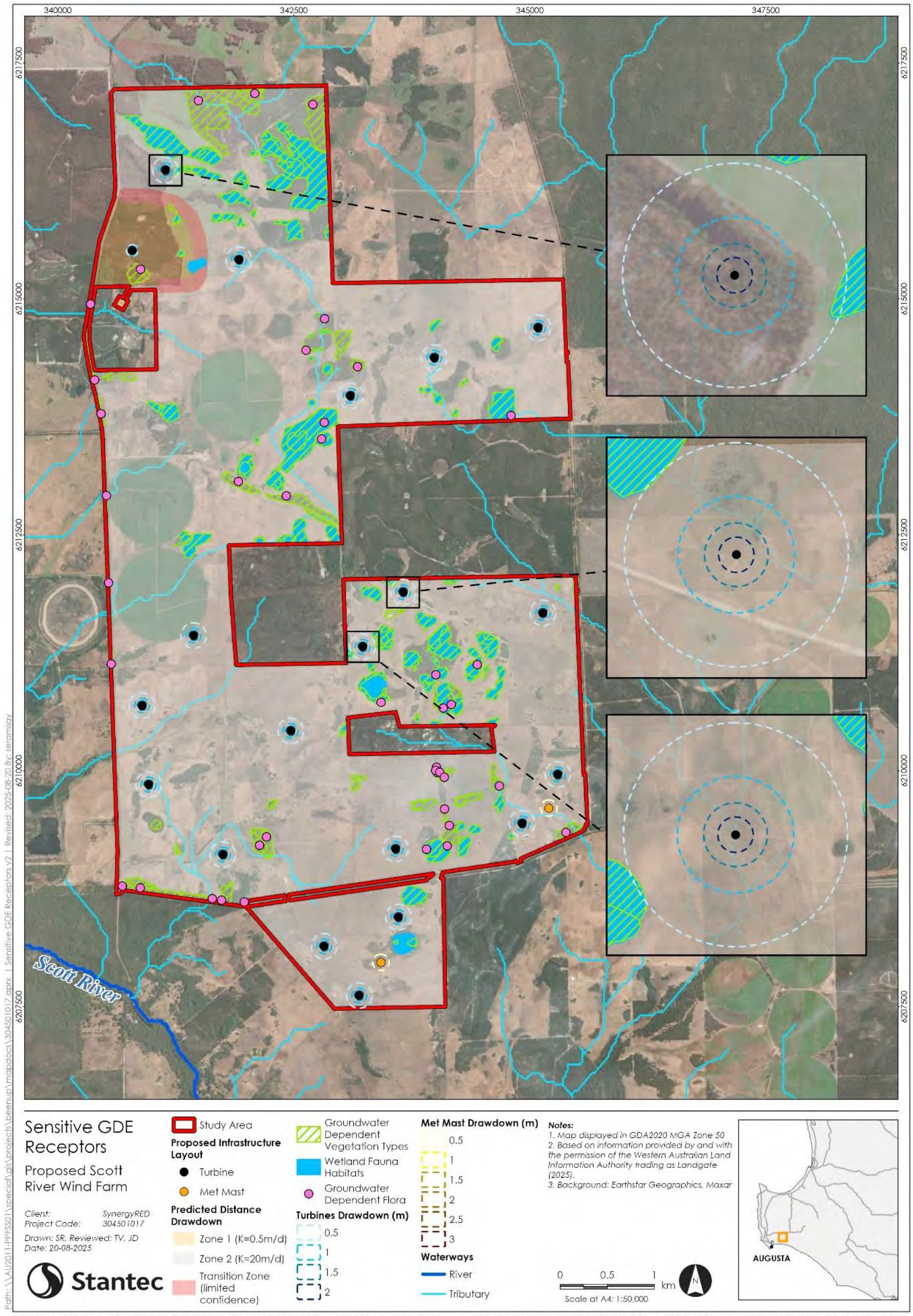


Figure 6-6: Predicted groundwater drawdown and potentially sensitive GDE receptors across the Study Area. Mapped receptors comprise GDE vegetation types with confirmed, potential and incidental records and wetland fauna habitats including seasonally inundated paperbark woodland and seasonally inundated sedgeland.

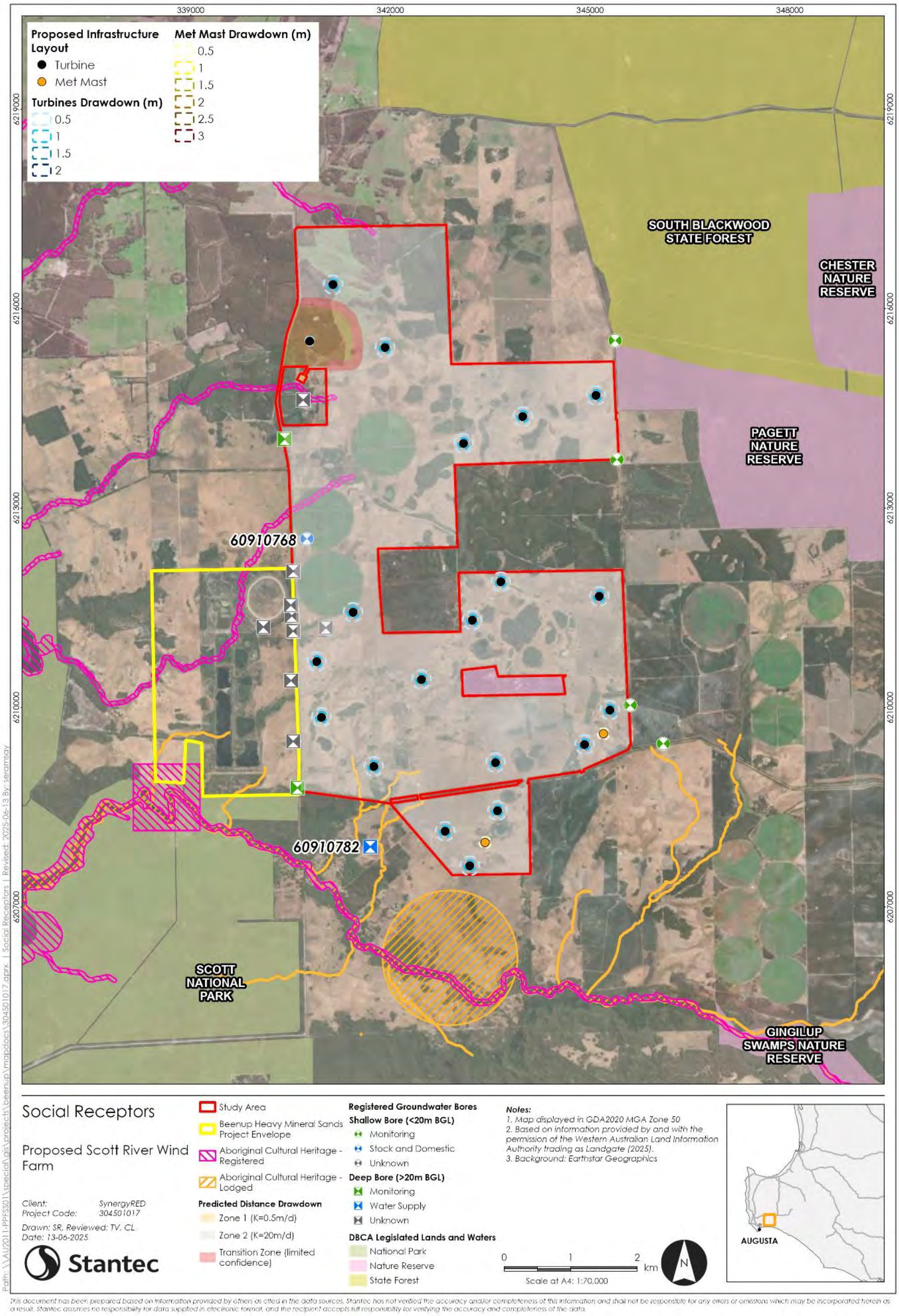


Figure 6-7: Predicted groundwater drawdown and potentially sensitive social receptors across the Study Area.

7 Preliminary Risk Assessment

7.1 Sensitive Receptors and Potential Impacts

The preliminary risk assessment for the Proposal is presented in Table 7-1 and is based on the outcomes of a workshop undertaken by SynergyRED and Stantec in May 2024 as well as the subsequent findings of this Assessment. It follows the SynergyRED Risk Assessment Framework (Appendix I) and applies mitigation and management actions approved by SynergyRED (Appendix J), with additional considerations provided if required.

The preliminary risk assessment considered the indicative infrastructure layout comprising wind turbines and meteorological towers, and construction activities of the Proposal, which may cause changes to surface water and hydrogeology, impacting potentially sensitive ecological and social receptors:

- Ecological receptors, including known and potential groundwater dependent ecosystems (GDEs) comprising obligate and facultative phreatophytes and three wetland types (seasonally inundated paperbark woodland, seasonally inundated shrubland and seasonally inundated sedgeland).
- Social receptors, including local stakeholders such as adjacent landowners or bore users (pastoralists), tenure holders (BHP), and Traditional Owner groups.

The potential impacts of the Proposal (Table 7-1), which may pose a risk to these receptors are summarised as follows:

- Surface water: changes to the hydrological regime and flow patterns of the area due to the infrastructure layout, contamination from spills of hazardous material, sedimentation or erosion, excavation and exposure of ASS and runoff;
- Groundwater: temporary drawdown associated with construction dewatering leading to reduced levels (quantity), contamination of groundwater from chemicals, and excavation and exposure of ASS, as well as possible cumulative impacts; and
- Interaction: reduced interaction of surface and groundwater causing a decrease in the hydroperiod of wetlands or waterways, or interactive effects from acidified groundwater drawn from the adjacent historic Beenup Titanium Mine.

Table 7-1: Preliminary risk assessment for the Proposal, in relation to potential impacts on the surface water and hydrogeological regimes of the Study Area and surrounds

(risk rankings: Red = High, Orange = Moderate, Green = Low and Blue = Negligible).

#	Hazard Type	Hazard	Risk Event Description	Causes and Impacts	Inherent Risk			Considerations and Mitigation Measures	Residual Risk		
					Like.	Cons.	Risk		Like.	Cons.	Risk
1	Natural Environment / Ecosystem and Social	Ecosystem Change	Infrastructure will modify the existing hydrological characteristics.	Proposed infrastructure (including planned access roads) will interfere with existing flow paths, and/or inadequate sizing and location of surface water management infrastructure which may cause the following hydrological changes: (1) Increased surface water inundation; (2) Increased duration of inundation; (3) Decreased flow to downstream ecological receptors; (4) Waterlogging of adjacent upstream ecological receptors; and (5) Increased erosion and sedimentation.	Almost Certain (L5)	C2	R19 (Mod.)	**Considerations** • Modelling indicates that frequent flow regimes (50% AEP) correspond to a minor inundation extent and limited number of flow paths discharging from the Study Area, and most areas with inundation depths >0.5 m occur upstream. • Areas with flood depths exceeding 0.3m are categorised as being of likely risk to infrastructure and public safety should be avoided as part of infrastructure resilience planning. • Civil infrastructure will be located and designed to ensure specific risk-based flood vulnerability requirements have been addressed. • There is no flood extent data available for Scott River and the downstream tailwater condition is unknown and has been compensated for by establishing a 500mm buffer zone from the Scott River. **Summary of Mitigation Measures (Appendix J)** • Construction activities will be undertaken during the dry season, where practicable (J.2.1). • There will be no diversion of the key waterways (J.2.2). • Runoff from substation, office and concrete batching areas will be captured and directed to an on-site retention basin for settlement before infiltrating internally and/or controlled discharge through the stormwater overflow designed to manage sediment removal and reduce stormwater velocity (J.2.2). • Civil infrastructure will be located and designed to ensure specific risk-based flood vulnerability requirements have been addressed (J.2.3). • Where possible, velocities will be maintained below erosion threshold, and sediment management aligned with the CEMP (J.2.3). • Suitable erosion protection will be installed in line with relevant guidelines (J.2.3). • Exposed soils will be vegetated or have engineered erosion protection where velocities exceed 1m/s and remain below 2m/s (J.2.3). • Design and construction works will ensure that local grading and excavation areas do not create areas of pooled water (J.2.3). • Modification of existing drainage structures that contain or control the movement of soil or water (e.g. drains) will be avoided unless the proposed modification will improve drainage and not lead to any detrimental impacts to downstream receptors (J.2.3). • Drainage control structures (e.g. drains and culverts) will be appropriately located, designed and constructed and maintained to maintain surface water flow regimes and minimise erosion (J.2.3 & J.2.4). • Implementation of hazardous material containment and sediment barriers to prevent runoff into wetlands and waterways during construction (J.1.5) • Development and implementation of a CEMP and ASSDMP, applying suitable mitigation measures (J.2.5 & J.2.6). • Adhere to the relevant SynergyRED mandatory environment and cultural heritage management measures (SYN-STD-ENV-0001 Rev. 2 July 2024) to maintain surface and groundwater regimes (J.2.6).	Unlikely (L2)	C2	R5 (Negl.)
2	Natural Environment / Ecosystem and Social	Ecosystem Change	Construction activities, including dewatering, leading to change in groundwater flows and/or reduced groundwater levels (quantity), adversely impacting ecological	Dewatering drawdown in support of constructing the concrete foundations for the Project infrastructure will cause a temporary reduction in groundwater levels (quantity) within the Superficial Aquifer, potentially impacting the hydroperiod and health of GDEs.	Likely (L4)	C3	R18 (Mod.)	**Considerations** • Dewatering for excavation is estimated at approximately four weeks per foundation, and if interaction occurs with the Superficial Aquifer, expected recovery is the subsequent winter period, with no anticipated interaction with the Leederville Aquifer. • Modelling indicates drawdown will be constrained to the Superficial Aquifer (which is known to dry out in some areas during the dry season) and is typically within natural seasonal variation.	Unlikely (L2)	C3	R8 (Low)

#	Hazard Type	Hazard	Risk Event Description	Causes and Impacts	Inherent Risk			Considerations and Mitigation Measures	Residual Risk		
					Like.	Cons.	Risk		Like.	Cons.	Risk
			and social receptors in the Study Area and immediate surrounds.					- Proposed drawdown modelling intercepts 0.04 ha of known and potential GDEs. This drawdown modelling conservatively assumes ground water level at surface (i.e. drawdown when the water table is at its highest). - Cumulative impacts are not expected, with no interaction of drawdown between infrastructure. **Summary of Mitigation Measures (Appendix J)** - Construction activities will be undertaken during the dry season, where practicable to minimise volume of dewatering (J.2.1). - Alternative turbine foundation design will reduce the dewatering requirement from 5-6m to 2m (J.2.5). - Dewater will not be discharged to local waterways/wetlands (J.2.5). - Dewatering to be undertaken in line with ASSDMP prepared in accordance with relevant regulatory guidelines and objectives, including any pumping, storage, treatment, discharge procedures, testing and monitoring requirements (J.2.5).			
				Dewatering during construction may reduce groundwater and surface water interactions or baseflow to nearby wetlands or rivers, leading to a temporary reduction in groundwater quantity and decrease in the duration of inundation (hydroperiod) of waterbodies, adversely impacting sensitive ecological receptors.	Likely (L4)	C3	R18 (Mod.)	**Considerations** - Dewatering for excavation is estimated at approximately four weeks per foundation, and if interaction occurs with the Superficial Aquifer, expected recovery is the subsequent winter period, with no anticipated interaction with the Leederville Aquifer. - Modelling indicates drawdown will be constrained to the Superficial Aquifer (which is known to dry out in some areas during the dry season) and is typically within natural seasonal variation. - Proposed drawdown modelling intercepts 0.04 ha of known and potential GDEs. This drawdown modelling conservatively assumes ground water level at surface (i.e. drawdown when the water table is at its highest). - Cumulative impacts are not expected, with no interaction of drawdown between infrastructure. - Waterways and wetlands are seasonal and typically dry during periods of low rainfall. **Summary of Mitigation Measures (Appendix J)** - Construction activities will be undertaken during the dry season, where practicable (J.2.1). - Alternative turbine foundation design will reduce the dewatering requirement from 5-6m to 2m (J.2.5). - Dewatering to be undertaken in line with ASSDMP prepared in accordance with relevant regulatory guidelines and objectives, including any pumping, storage, treatment, discharge procedures, testing and monitoring requirements (J.2.5). This includes infiltration of dewater as close to the source as possible, to limit drawdown.	Unlikely (L2)	C3	R8 (Low)
				Dewatering in support of constructing the concrete foundations for project infrastructure may lead to temporary reduced downstream water security impacting social receptors, due to a temporary reduction in groundwater quantity within the Superficial Aquifer.	Likely (L4)	C3	R18 (Mod.)	**Considerations** - Dewatering for excavation is estimated at approximately four weeks per foundation, and if interaction occurs with the Superficial Aquifer, expected recovery is the subsequent winter period, with no anticipated interaction with the Leederville Aquifer. - Modelling indicates drawdown will be constrained to the Superficial Aquifer (which is known to dry out in some areas during the dry season) and is typically within natural seasonal variation. - Cumulative impacts are not expected, with no interaction of drawdown between infrastructure. - There are no expected impacts to local stakeholders (i.e., 0.5 m contour does not intercept other shallow groundwater users), with SynergyRED continuing to consult extensively to communicate mitigation and management measures. - There is no expected interaction with the acidic plume from the historic Beenup Titanium Mine, which is in the Leederville Aquifer.	Unlikely (L2)	C4	R12 (Low)

#	Hazard Type	Hazard	Risk Event Description	Causes and Impacts	Inherent Risk			Considerations and Mitigation Measures	Residual Risk		
					Like.	Cons.	Risk		Like.	Cons.	Risk
								Summary of Mitigation Measures (Appendix J) • Land next to waterbodies will remain undisturbed for as long as possible, to prevent sedimentation into drainage systems (J.1.6). • Construction activities will be undertaken during the dry season, where possible (J.2.1). • Alternative foundation design will reduce the dewatering requirement from 5-6m to 1.2m (J.2.5). • Dewatering will not be discharged to local waterways/wetlands (J.2.5). • Development and implementation of a suitable CEMP and ASSDMP, applying suitable mitigation measures (J.2.5 & J.2.6). • Adhere to the relevant SynergyRED mandatory environment and cultural heritage management measures (SYN-STD-ENV-0001 Rev. 2 July 2024) to maintain surface and groundwater regimes (J.2.6).			
				Excavation of foundations for project infrastructure penetrates an aquitard (ferricrete or clay layers) causing excessive leakage from the Superficial Aquifer, and reducing the hydroperiod and health of any associated GDEs.	Unlikely (L2)	C3	R8 (Low)	**Considerations** • Penetration of the aquitard considered unlikely to occur due to shallow nature of foundations. • Ferricrete is not consistent (locally confined) across the Study Area. **Summary of Mitigation Measures (Appendix J)** • Construction activities will be undertaken during the dry season, where practicable (J.2.1). • Alternative foundation design will reduce the excavation requirement from 4.5-5 m to 0.8-1.2m (J.2.5). • Dewatering to be undertaken in line with ASSDMP prepared in accordance with relevant regulatory guidelines and objectives, including any pumping, storage, treatment, discharge procedures, testing and monitoring requirements (J.2.5). This includes infiltration of dewater as close to the source as possible, to limit drawdown.	Rare (L1)	C3	R4 (Negl.)
				Dewatering during construction may draw in the adjacent acid mine plume, potentially redirecting mine-impacted groundwater adversely affecting the groundwater quality of the superficial aquifer and reducing the health or causing the death of GDEs	Possible (L3)	C4	R17 (Mod.)	**Considerations** • There is no expected interaction with the acidic plume from the historic Beenup Titanium Mine, which is in the Leederville Aquifer. **Summary of Mitigation Measures (Appendix J)** • Construction activities will be undertaken during the dry season, where practicable (J.2.1). • Alternative turbine foundation design will reduce the dewatering requirement from 5-6m to 2m (J.2.5). • Dewatering to be undertaken in line with ASSDMP prepared in accordance with relevant regulatory guidelines and objectives, including any pumping, storage, treatment, discharge procedures, testing and monitoring requirements (J.2.5). This includes infiltration of dewater as close to source as possible, particularly between dewatering location and any sensitive ecological receptor to limit cone of depression.	Rare (L1)	C4	R7 (Low)
				The concrete foundations for project infrastructure may alter groundwater flow in the Superficial Aquifer (i.e., mounding upstream of the foundation, and groundwater shadow downstream of the foundation) impacting the health of GDEs or downstream ecological receptors.	Unlikely (L2)	C1	R3 (Negl.)	**Considerations** • The footprint of the foundations is minor compared to the size of the Study Area. • Any potential mounding or flow disruption is expected to be less than the seasonal variations. **Summary of Mitigation Measures (Appendix J)** • Construction activities will be undertaken during the dry season, where possible (J.2.1).	Rare (L1)	C1	R1 (Negl.)

<table>
<tr><th rowspan="2">#</th><th rowspan="2">Hazard Type</th><th rowspan="2">Hazard</th><th rowspan="2">Risk Event Description</th><th rowspan="2">Causes and Impacts</th><th colspan="3">Inherent Risk</th><th rowspan="2">Considerations and Mitigation Measures</th><th colspan="3">Residual Risk</th></tr>
<tr><th>Like.</th><th>Cons.</th><th>Risk</th><th>Like.</th><th>Cons.</th><th>Risk</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>• Alternative turbine foundation design will reduce the excavation requirement from 4.5-5m to 0.8-1.2m (J.2.5).</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Natural Environment / Ecosystem and Social</td><td>Ecosystem Change</td><td>Construction activities adversely impact surface water and/or groundwater quality, and sensitive receptors in the Study Area and immediate surrounds.</td><td>Excavation of foundations may penetrate an aquitard and cause alterations in groundwater quality leading to the reduced health or death of sensitive ecological receptors.</td><td>Unlikely (L2)</td><td>C3</td><td>R8
(Low)</td><td>Considerations
• Penetration of the aquitard considered unlikely to occur due to shallow nature of foundations.
• Ferricrete is not consistent (locally confined) across the Study Area.
Summary of Mitigation Measures (Appendix J)
• Construction activities will be undertaken during the dry season, where possible (J.2.1).
• Alternative foundation design will reduce the dewatering requirement from 5-6m to 1.2m (J.2.5).
• Development and implementation of CEMP and ASSDMP, applying suitable mitigation measures (J.2.5 & J.2.6).
• Adhere to the relevant SynergyRED mandatory environment and cultural heritage management measures (SYN-STD-ENV-0001 Rev. 2 July 2024) to maintain surface and groundwater regimes (J.2.6).</td><td>Rare
(L1)</td><td>C3</td><td>R4
(Negl.)</td></tr>
</table>

				Potential for contamination of soils, surface water and/or groundwater due to disturbance and/or inappropriate handling of ASS or other materials (e.g., chemicals/hydrocarbons), impacting sensitive ecological or social receptors.	Possible (L3)	C4	R17 (Mod.)	**Considerations** • While the Study Area has a high to moderate potential of containing ASS, the Leederville Aquifer poses the greatest risk and is not anticipated to be disturbed. • **Summary of Mitigation Measures (Appendix J)** • Appropriate management of hazardous substances and materials will be undertaken on site, including storage (J.1.8). • Hydrocarbons to be managed at appropriate fuel locations, with practicable containment and remediation measures (J.1.8). • Areas that may contain contaminants will be bunded and stormwater will be captured (J.1.8). • Implementation of hazardous material containment, sediment barriers and buffers, to prevent runoff into wetlands and waterways during construction (J.1.8 and J.2.4). • Runoff from substation, office and concrete batching areas will be captured and directed to the on-site retention basin for settlement and infiltration (J.1.8). • Alternative turbine foundation design adopted to reduce the excavation and dewatering requirement from 4.5-5 to 0.8-1.2 and 5-6m to 2m respectively (J.2.3). • Dewatering to be undertaken in line with ASSDMP prepared in accordance with relevant regulatory guidelines and objectives, including any pumping, storage, treatment, discharge procedures, testing and monitoring requirements (J.2.5). • Dewater will not be discharged to local waterways/wetlands (J.2.5) and no fuelling or servicing within 50 m of waterways/wetlands (J.1.8). • Development and implementation of a CEMP (J.2.6) to appropriately manage construction activities.	Unlikely (L2)	C4	R12 (Low)

#	Hazard Type	Hazard	Risk Event Description	Causes and Impacts	Inherent Risk			Considerations and Mitigation Measures	Residual Risk		
					Like.	Cons.	Risk		Like.	Cons.	Risk
4	Natural Environment / Ecosystem and Social	Ecosystem Change	Construction activities that disturb soil and may result in adverse impacts to sensitive receptors within the Study Area and its immediate surrounds.	Mobilisation of existing nitrogen and phosphorus in soils during construction and runoff into wetlands and waterways, adversely impacting sensitive ecological receptors.	Likely (L4)	C2	R14 (Mod.)	**Considerations** • Existing and surrounding land has been cleared due to pastoral and agricultural activities, and contains elevated levels of nitrogen, phosphorus. **Summary of Mitigation Measures (Appendix J)** • Implementation of sediment barriers to prevent runoff into wetlands and waterways during construction (J.1.8). • Construction activities will be undertaken during the dry season, where possible, to minimise runoff (J.2.1) and drainage features will be appropriately located, designed and constructed (J.2.3). • Development and implementation of a CEMP and ASSDMP, applying suitable mitigation measures (J.2.5 & J.2.6). • Adhere to the relevant SynergyRED mandatory environment and cultural heritage management measures (SYN-STD-ENV-0001 Rev. 2 July 2024) to maintain surface and groundwater regimes (J.2.6).	Unlikely (L2)	C2	R5 (Negl.)

7.2 Key Residual Risks and Mitigation

Following the implementation of mitigation measures (predominantly civil design) to minimise potential impacts to surface water and hydrological regimes throughout the Study Area, the residual risk from the Proposal is predicted to be **Negligible**. (Table 7-1). The remaining key inherent risks are associated with groundwater drawdown, exposure and drainage of ASS and potential contamination, during excavation, dewatering and construction (Table 7-1). These were assigned **Moderate** inherent risk rankings (Table 7-1), however, following the implementation of management and mitigation measures (Appendix J), residual risks were assessed as **Low** (Table 7-1). The key mitigation measures for the Proposal, specific to dewatering, ASS and contamination includes:

- SynergyRED have adopted an alternative foundation design that is shallower and installed using piling technology, reducing the depth of dewatering from 5-6 m to 1-2 m.
- Construction, specifically early civil works and dewatering activities are scheduled to be conducted during the dry season, where practicable, with only temporary dewatering needed for the turbines and meteorological towers.
- All construction and management activities will adhere to an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) prepared in accordance with relevant DWER guidelines and a Construction and Environmental Management Plan (CEMP) outlining site-specific actions.

Potential impacts to sensitive receptors (Figure 6-7) should be considered in the context of the temporary and spatially constrained nature of the construction activities for the Proposal, the natural seasonal variation of groundwater, and the implementation of management measures. Therefore, it is expected that **environmental risks can be avoided or adequately mitigated**, with no expected long-term impacts to groundwater or GDEs, with the following key considerations (Table 7-1):

- Dewatering for excavation will be temporary and constrained to the Superficial Aquifer.
- The estimated timeframe for excavation is approximately four weeks per foundation, with a targeted drawdown at the edge of the foundations of 2 m for the turbines and 3 m for the meteorological towers.
- Seasonal variation of groundwater for both aquifer systems in the Study Area is approximately 2 m.
- Cumulative impacts are not expected, with no interaction or overlap of predicted drawdown in the Study Area.
- The total area of known and potential GDEs (including vegetation and wetland fauna habitats) that intercepts the predicted drawdown extent is 0.04 ha (within the 0.5 to 2 m drawdown contours), which is well within seasonal variation.
- Predicted drawdown extents will not interact with the acid groundwater plume in the Leederville Aquifer, associated with the historic Beenup Titanium Mine.
- Dewatering is expected to occur in the dry season (where practical), and if intercepted, the Superficial Aquifer is expected to recover during the subsequent winter period (under average rainfall conditions). In addition, while not anticipated, if interaction occurs with the Leederville Aquifer, more rapid recovery is predicted (within weeks to months).

As planning and design for the Proposal progresses, SynergyRED should continue to liaise with local stakeholders including groundwater users and landowners, Traditional Owners and BHP representatives to communicate the expected low risk to sensitive receptors within the Study Area. The final Proposal design specifications will also be outlined in the CEMP and associated ASSDMP, with additional information used to revise this preliminary risk assessment.

8 Conclusions and Gap Analysis

8.1 Assessment Summary

8.1.1 Proposal Features

The Proposal is anticipated to involve construction and operation of up to 20 wind turbine generators across the Study Area, along with supporting infrastructure including meteorological towers, transmission line and associated foundations, concrete batching plant, access roads, borrow pits, offices and electrical substation and switch yard. During construction, dewatering will be required to a maximum depth of 2 to 3 m to support excavation and installation of foundations, with local disposal via sediment tanks/ponds and infiltration basins. Consideration of surface water and hydrogeological characteristics is required to avoid and mitigate impacts to potentially sensitive ecological and social receptors in the vicinity of the Study Area.

8.1.2 Surface Water Characteristics

Key surface water features in the region consist of historically modified catchments with artificial drains to facilitate the agricultural and plantation activities. These drains have not been built in a coordinated way and intersect with roads and natural drainage lines, resulting in several areas of localised ponding due to catchment modification.

The Study Area has a poorly defined ridgeline that runs approximately through the centre of the Study Area, segregating the 11 Blackwood and Scott River headwater catchments that discharge from the Study Area. Sheet flow occurs across cleared land areas, concentrating into more defined streamflow paths towards the Study Area boundary.

There are several areas of natural ponding following rainfall events in areas designated as wetlands and in depressions formed by historical anthropogenic activities. The roads on almost every boundary of the Study Area act as an impediment to flow paths and cause localised upstream ponding, apart from the southernmost catchment which sheet flows across agricultural land.

8.1.3 Hydrogeological Characteristics

The northern part of the Study Area is characterised by a thin layer of dune sands (<2 m) overlying alternating bands of clay and sand as well as peat, while in the central and south sections, dune sands are deeper (up to approximately 6 m) with interbedded ferricrete and/or clay. The Study Area is located within an area of high to moderate ASS potential (supported by preliminary test results) and is partly within DoW Groundwater Management Zone 7 (from the central area to the south); a buffer zone area defined by an acid sulfate soil plume from Beenup mine site used to restrict groundwater extraction.

The Study Area hosts the Superficial and Leederville Aquifers, with the latter identified within the upper 25 m of the profile. The Superficial Aquifer is localised and discontinuous and is generally hosted within the surficial sand. It includes perched groundwater above impermeable beds of the Leederville Formation, and local confinement zones of low permeability in the laterite (dominant sand and ferricrete) profile. The Leederville Aquifer lies beneath the Superficial Aquifer and is shallower in the north and deepens in the southern portion of the Study Area.

The Superficial Aquifer is recharged by direct diffuse rainfall infiltration and localised downward leakage from creeks, wetlands and irrigation through sandy soils. Potential upward leakage from the underlying Leederville Formation may also occur. The Leederville Aquifer is mostly recharged via lateral flow and vertical downward leakage from the Superficial Aquifer. Discharge from the Superficial Aquifer occurs via evapotranspiration, while the Leederville Aquifer discharges to major rivers and creeks. During the wet season the water table in the Superficial Aquifer is shallow and may locally discharge into wetlands or at the ground surface, while during the dry season, the water table is lowered, and some areas may become dry from reduced rainfall. Previous investigations in the area indicate that in winter the Superficial Aquifer may be connected to creeks, indicating that surface-water groundwater interactions may be ephemeral and seasonally influenced, although this has not been verified by this Assessment. It is unlikely that the deeper Leederville Aquifer is in direct connection to ephemeral surface water features in the Study Area. Registered groundwater pumping occurs within and surrounding the Study Area and is used primarily for irrigation.

Groundwater levels in the Superficial Aquifer and the Leederville Aquifer are strongly correlated to rainfall and are shallowest in winter. Continuous monitoring at the Study Area by Stantec indicated the water table fluctuated between March 2024 and September 2024 by approximately 2 m in both aquifer systems. Groundwater flow in both the Superficial and Leederville Aquifer was inferred to flow in a southward direction (southwest in the western Study Area and southeast in the southeastern Study Area).

The Superficial Aquifer and Leederville Aquifer are classified as freshwater, with total dissolved solids (TDS) typically less than 500 mg/L. The pH ranges from acidic to neutral, with elevated turbidity, copper, iron and manganese in both aquifer systems, while the Superficial Aquifer is also characterised by elevated aluminium and nitrogen concentrations.

8.1.4 Surface Water Assessment

Preliminary flood modelling comprised two-dimensional hydraulic modelling for the 50%, 20%, 10%, 5% and 1% Annual Exceedance Probability (AEP) existing climate scenario and 1% AEP climate change high emissions scenario flood events. Surface water modelling was undertaken to characterise the hydrological regime of formalised flow paths and areas of inundation in frequent to extreme rainfall events. The frequent flow regimes such as the 50% AEP demonstrate a minor extent of inundation with only a small number of defined flow paths discharging from the Study Area. The average flow depth is less than 100 mm across the Study Area in frequent flows, with approximately 100mm conveyed along the defined flow paths.

Peak flow rates at the outlets during frequent flow regimes (50% AEP) and rare event regimes (1% AEP) range from 0.5 m^3/s to ~20 m^3/s, respectively and the maximum discharge rate of ~20 m^3/s in the 1% AEP from the Study Area is south to the Scott River. In addition, during a 50% AEP event maximum ponding depth of ~1.2 m occurred near the south-western boundary of the Study Area. Most areas of inundation with depths greater than 0.5 m in the frequent events (~50% AEP) occur upstream of roads acting as hydraulic controls with some ponding in areas with the appearance of wetlands or perched ponds. There are only a small number of defined flow paths discharging from the Study Area with flow rates of up to 0.5 m^3/s in the 50% AEP event.

The rare (1% and 2% AEP) flow regimes demonstrate a widespread level of inundation with all headwater catchments, other than one sub-catchment in the north-east, showing distinctive flow paths to discharge locations outside of the Study Area. The maximum ponding depth of ~2.8 m occurs in the forested northern-most sub-catchment in the Study Area. The second deepest ponding occurs at ~2.3 m in the same location to the 50% AEP near the south-western boundary of the Study Area. Several areas of inundation in the rare (1% and 2% AEP) events exceed 0.5 m in depth across the Study Area, including behind roads acting as hydraulic controls and in areas with the appearance of wetlands or perched ponds. All headwater catchments other than one in the north-east show distinctive rare event flow paths to the discharge locations outside of the Study Area. The maximum 1% AEP discharge rate of ~20 m^3/s from the Study Area is south of the Scott River.

8.1.5 Preliminary Dewatering Assessment

A hydrogeological conceptual model was developed using available data and investigations from the Study Area and surrounds. The model applied several zones to the Study Area, based on likely aquifer characterisation; Zone 1 (bore group WM01) comprising mostly sandy clay, Zone 2 (all other locations) consisting of predominantly sand, and a transition zone, assigned as an arbitrary boundary between the two zones. Preliminary construction dewatering steady-state modelling estimated the following distances to the 0.5 m and 1 m drawdown contours for the targeted dewatering levels for infrastructure components:

- Zone 1 Turbines: approximately 43 m (0.5 m contour) and 31 m (1.0 m contour).
- Zone 2 Turbines: approximately 117 m (0.5 m contour) and 60 m (1.0 m contour).
- Meteorological tower: approximately 86 m (0.5 m contour) and 34 m (1.0 m contour).

Initial pumping rates to attain the target drawdowns after five days of pumping ranged between 1,525 m^3/d (Zone 2 meteorological tower) and 2,295 m^3/d (zone 2 turbines). Initial dewatering in zone 1 (turbines) was likely to be similar to the steady-state rate (average approximately 75 m^3/day). To maintain target drawdown, daily pumping rates in zone 2 ranged between approximately 296 m^3/d (meteorological tower) and 2,058 m^3/d (turbines).

These predicted pumping rates assumed that no management structures were used to reduce lateral inflow. Based on the current predicted inflow model estimate for Zone 2, a water licence may be required due to the approximate steady-state in-flow volume taken, per excavation, and that the pumping rate may require higher than 10 L/s pumping rate over a period of more than 30 consecutive days.

8.1.6 Sensitive Receptors, Risk and Mitigation

The Assessment identified several potentially sensitive ecological (GDEs) and social receptors that may be impacted by dewatering and excavation during construction. Key impacts from the development of the Proposal include changes to the hydrological regime and flow patterns, contamination of surface water and groundwater, sedimentation and erosion of surface environments, ASS exposure and runoff, and potential interactive effects associated with the acid groundwater plume from the closed Beenup Titanium Mine.

The preliminary risk assessment indicated that following mitigation the risk to hydrology is negligible. Inherent risk rankings of moderate were associated with potential impacts on GDEs from drawdown, exposure and drainage of ASS, and contamination, which were reduced to low following the implementation of mitigation measures including a shallow foundation design and reduced dewatering depth, civil works to be conducted during the dry season, where practicable, and adherence to specific measures in the ASSDMP and CEMP. The temporary and spatially constrained nature of the construction activities will also limit potential impacts to GDEs.

8.2 Information and Data Gaps

The following surface water and hydrogeological information and data gaps were identified during the Assessment, for consideration by SynergyRED as the Proposal progresses:

- Spatial Data
    - Limited spatial coverage of high-resolution topographical data, especially in the northern section of the Study Area. Topographical data is available in varying resolution and accuracy across the Study Area. Two datasets have been merged with the northern area being considered of lower confidence.
- Surface Water
    - There is limited local surface water level correlation to historical rainfall events to provide Study Area-specific validation of modelled flows and water surface elevations.
    - There are no active or continuous water level recordings on the watercourses directly downstream of the Proposal, which may be addressed by the installation of local telemetric water level and rainfall monitoring to validate modelled flows.
    - No availability of local drainage information on culverts or crossovers and therefore baseline flow conditions may not accurately reflect local flow regimes.
    - There is no flood extent data available for Scott River and the downstream tailwater condition is unknown and has been compensated for by establishing a 500 mm buffer zone from the Scott River.
    - Modelling adopted the 2016 Intensity Frequency Duration (IFDs) in line with ARR2019 methodology, as was conducted prior to August 2024 updates regarding climate change considerations.
- Hydrogeology
    - There is limited data for spatial coverage and temporal groundwater level and groundwater quality monitoring data from shallow and deep monitoring bores and natural long-term seasonal variation within the Study Area.
    - There is limited information on the conceptual hydrogeological landscape and understanding of ecological receptors reliance on groundwater to definitively characterise potential impact to the environment associated with drawdown.
    - There is limited understanding of potential surface water and groundwater interactions, due to seasonal monitoring limitations.
    - There is limited geotechnical and acid sulfate soil investigations across the Study Area, which would be required to inform appropriate construction methodologies (e.g., foundation type), dewatering requirements and management during construction.
- Preliminary Risk Assessment and Mitigation
    - A revised hydrological conceptual model and impact assessment based on final layout of the Proposal (e.g., access roads, buildings, turbine and transmission tower foundations) may be required to understand changes to the surface water regime (flow frequency and flow volume).
    - The preliminary risk assessment may require revision following additional ASS or hydrogeological studies and definition of the final layout.

9 References

ANZECC & ARMCANZ, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand. (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Commonwealth of Australia, Canberra, ACT.

Baddock, L. J. (1992). Scott Coastal Plain bore completion reports, Volume 1 – sites 1 to 10. Hydrogeology Report 1995/35., Unpublished data prepared for the Geological Survey of Western Australia.

Baddock, L. J. (1995). Geology and Hydrogeology of the Scott Coastal Plain, Perth Basin; Record 1995/7. Geological Survey of Western Australia, Department of Minerals and Energy, Perth, WA.

BHP. (1996). Beenup Titanium Minerals Project: Annual Environment Report, 1996. Unpublished report prepared by BHP.

BHP. (1997). Beenup Titanium Minerals Project: Annual Environment Report, 1997. Unpublished report prepared by BHP.

BHP. (1998a). Beenup Titanium Minerals: Baseline Monitoring Report, 1998. Unpublished report prepared by BHP.

BHP. (1998b). Beenup Titanium Minerals Project: Monitoring Bore Completion Report, November 1998. Unpublished report prepared by BHP.

BHP. (2015). Beenup Titanium Minerals Project: Annual Environment Report, 2015. Unpublished report prepared by BHP.

BirdLife Australia. (2019). Birdlife Australia - Common Greenshank. Available online at http://www.birdlife.org.au/bird-profile/common-greenshank.

Birdlife International. (2015). Species fact sheet: Blue-billed Duck (Oxyura australis). Birdlife International.

Brockman South Pty Ltd. (2015). Alexandra Iron Ore Project, Combined Annual Report 2014. Unpublished report prepared by Brockman South Pty Ltd.

Canham, C., Froend, R. and Stock, W. (2009). Water stress vulnerability of four Banksia species incontrasting ecohydrological habitats on the GnangaraMound, Western Australia. *Plant, Cell and Environment* 32: 64–72.

Crostella, A. a. B., J. (2000). Geology and petroleum exploration of the central and southern Perth Basin, Report 57. Western Australia Geological Survey, Perth, WA.

DCCEEW. (2024a). Species Profile and Threats Database: Charadrius bicinctus — Double-banded Plover. Department of Climate Change, Energy, the Environment and Water. Available online at https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=895.

DCCEEW. (2024b). Species Profile and Threats Database: Actitis hypoleucos — Common Sandpiper. Department of Climate Change, Energy, the Environment and Water. Available online at https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59309.

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2024c). Conservation Advice for Tringa nebularia (common greenshank). Canberra: Department of Climate Change, Energy, the Environment and Water.

del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. and de Juana, E. (2014). Handbook of the Birds of the World Alive. Lynx Edicions. Available online at.

DER, Department of Environment Regulation. (2015). Treatment and management of soil and water in acid sulfate soil landscapes. Government of Western Australia, Perth, Western Australia.

DoW, Department of Water. (2009a). Operational Policy No. 5.12 – Hydrogeological Reporting Associated With A Groundwater Well License. Government of Western Australia, Perth, WA.

DoW, Department of Water. (2009b). SouthWest Groundwater Areas Allocation Plan. Government of Western Australia, Perth, WA.

DoW, Department of Water. (2009c). Blackwood groundwater area subarea reference sheets: Plan companion for the South West groundwater areas allocation plan. Government of Western Australia, Perth, WA.

DoW, Department of Water. (2011). Scott Coastal Plain: Bore Completion Report, January 2011.

DoW, Department of Water. (2016). The importance of groundwater to the Blackwood and other iconic rivers of the south-west. Government of Western Australia, Perth, WA.

DSEWPaC, Department of Sustainability, Environment, Water, Population and Communities. (2012). Interim Biogeographic Regionalisation for Australia (IBRA) Version 7 - bioregions.

DWER, Department of Water and Environmental Regulation. (2021). Guideline: Assessment and management of contaminated sites. Government of Western Australia, Perth, WA.

DWER, Department of Water and Environmental Regulation. (2023b). Hardy Inlet: Scott catchment - nutrient report, 2019. Department of Water and Environmental Regulation, Perth, WA.

DWER, Department of Water and Environmental Regulation. (2024). Available online at Data analysis - catchment nutrient reports - Healthy Estuaries.

EPA, Environmental Protection Authority. (2016a). Environmental Factor Guideline - Flora and Vegetation. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2016b). Environmental Factor Guideline - Terrestrial Fauna. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2016c). Environmental Factor Guideline - Terrestrial Environmental Quality. Government of Western Australia, Perth, WA.

EPA, Environmental Protection Authority. (2018). Environmental Factor Guideline - Inland Waters. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2023). Statement of environmental principles, factors, objectives and aims of EIA. Government of Western Australia, Perth, Western Australia.

Heath, R. C. (1983). Basic ground-water hydrology, Water-Supply Paper 2220. U.S. Geological Survey.

Invertebrate Solutions. (2024). Desktop Assessment of Subterranean Fauna for a proposed wind farm in Scott River, Western Australia.

Johnston, T., Stock, W. and Mawson, P. (2016). Foraging by Carnaby's Black-Cockatoo in Banksia woodland on the Swan Coastal Plain, Western Australia. *Emu-Austral Ornithology* 116(3): 284-293.

LBLCDC, Lower Blackwood Land Conservation District Committee. (2020). Scott River Action Plan. Unpublished report prepared by the LBLCDC.

Markey, A. and Dillon, S. (2011). Flora and vegetation of the banded iron formations of the Yilgarn Craton: the northern Yerilgee Hills, Menzies.

Mensforth, L. and Walker, G. R. (1996). Root dynamics of Melaleuca halmaturorum in response to fluctuating saline groundwater.

Mohsenzadeh and Diamond. (2000). Hydrogeology report No HR 166. Modelling nutrient management on Scott coastal plain. Bore completion report and pumping test results stage 2. Water and Rivers Commission, Perth, WA.

Morris, D. A. and Johnson, A. I. (1967). Summary of hydrologic and physical properties of rock and soil materials as analysed by the Hydrologic Laboratory of the U.S. Geological Survey, Water-Supply Paper 1839-D. U.S. Geological Survey.

Ninox. (2011). Monitoring of waterbirds and vertebrate fauna at the Beenup Mineral Sands Mine site 2005-2011. Ninox Wildlife Consulting, Perth, WA.

Phoenix, Environmental Sciences. (2025a). Detailed Flora and Vegetation Survey for the Proposed Scott River Wind Farm.

Phoenix, Environmental Sciences. (2025b). Basic and targeted vertebrate fauna survey for a Proposed Wind Farm in Scott River.

Phoenix, Environmental Services. (in prep.-a). Detailed Flora and Vegetation Survey for the Proposed Scott River Wind Farm. Unpublished report prepared for SynergyRED.

Phoenix, Environmental Services. (in prep.-b). Biological Surveys and Wetland Mapping for the Proposed Scott River Wind Farm. Unpublished report prepared for SynergyRED.

Stantec. (2024a). Geotechnical Desktop Report. Unpublished report prepared for SynergyRED.

Stantec. (2024b). Proposed Scott River Wind Farm: Groundwater-dependent Values - Technical Assessment. Unpublished report prepared for SynergyRED.

Stantec. (2024c). Preliminary Geotechnical and Baseline Contamination Report. Unpublished report prepared for SynergyRED.

Stantec. (2025). Proposed Scott River Wind Farm: Groundwater and Surface Water Monitoring Program.

Steggles, E., Holland, K., Chittleborough, D. J., Doudle, S., Clarke, L., Watling, J. and Facelli, J. (2016). The potential for deep groundwater use by Acacia papyrocarpa (Western myall) in a water-limited environment.

Thackway, R. and Cresswall, I. D. (1995). An interim biogeographic regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program. Department of the Environment and Water Resources. Available online at http://www.environment.gov.au/parks/nrs/ibra/version4-0/framework/ibrintro.html#ch1.

Thomas, F. M. (2013). Ecology of Phreatophytes. Springer Berlin Heidelberg,

Tille, P. (2006). Soil-landscapes of Western Australia's Rangelands and Arid Interior. Department of Agriculture and Food Resource Management Technical Report 313.

Tille, P. J. and Lantzke, N. C. (1988). Land Resources Of Busselton-Margaret River-Augusta, Western Australia: Augusta Map Sheet. Department of Agriculture WA: Division of Resource Management,

V & C Semeniuk Research Group. (1997). Mapping and classification of wetlands from Augusta to Walpole in the south-west of Western Australia. Water and Rivers Commission, Perth.

Water Authority of Western Australia. (1992). Lower Blackwood River and Scott River Flod Study, Report No. WS95. Government of Western Australia, Perth, WA.

Water Quality Australia. (2021). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian State & Territory Governments, Canberra ACT, Australia.

Appendices

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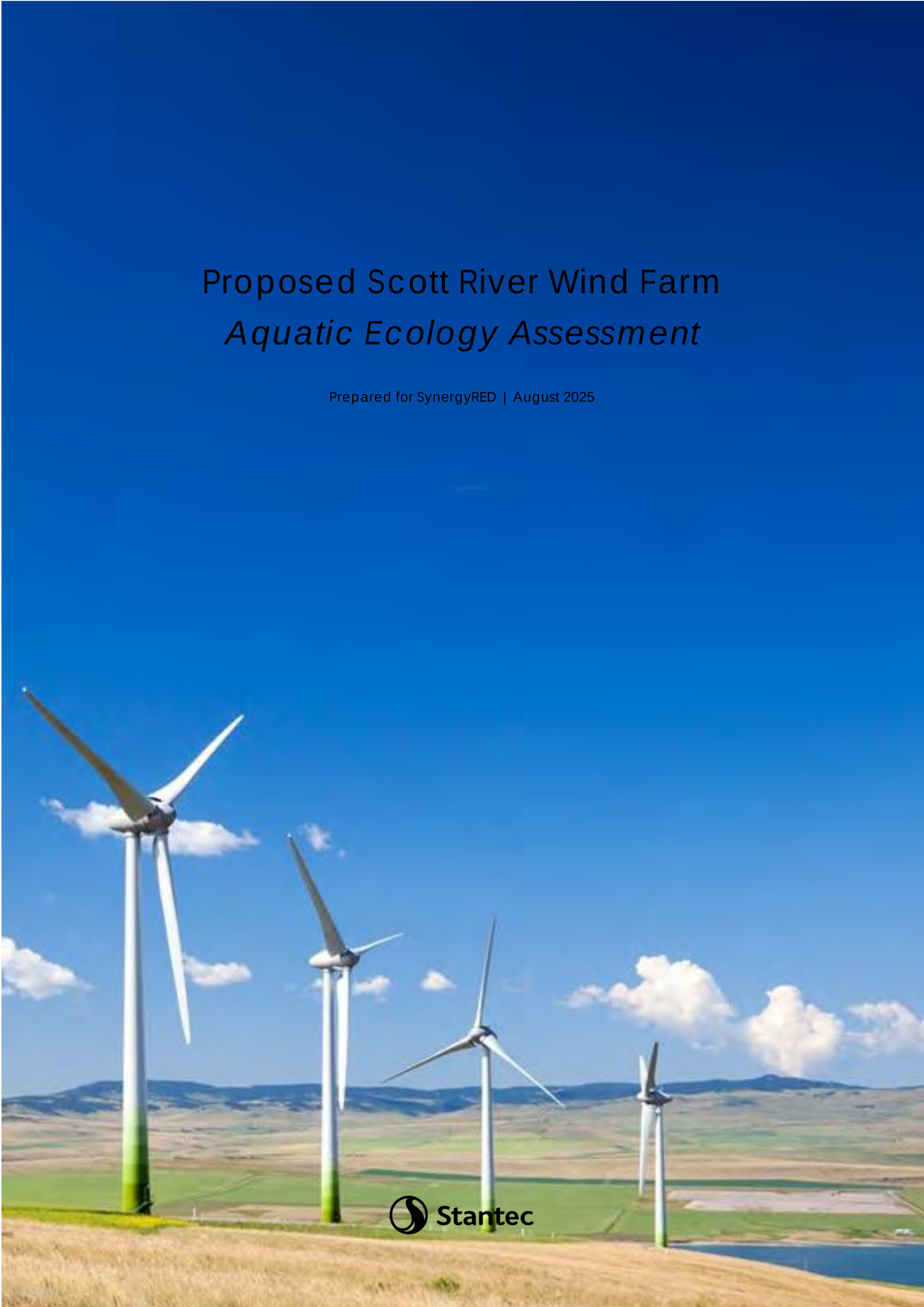
Appendix A Aquatic Ecology Assessment Stantec (2024b)



Proposed Scott River Wind Farm

Aquatic Ecology Assessment

Prepared for SynergyRED | August 2025

Stantec

Revision Schedule

Rev No.	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
A	14/02/2025	Draft report for client review	Kate Walker, Brooke Hay,	Brooke Hay	Fiona Taukulis	Joan Deng
B	02/07/2025	Final memo	Fiona Taukulis	Fiona Taukulis	Fiona Taukulis	Joan Deng
C	25/08/2025	Revised final memo	Fiona Taukulis	Fiona Taukulis	Fiona Taukulis	Joan Deng

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1 Introduction

1.1 Assessment Scope and Objective

Synergy Renewable Energy Development (SynergyRED) engaged Stantec Australia Pty Ltd (Stantec) to support the environmental approvals and planning for a proposed 100 MW wind farm in the locality of Scott River (the Project), approximately 15 km north-east of Augusta in the Margaret River region of Western Australia (Figure 1-1). The following scope of works has been completed:

1. Aquatic Ecology Assessment;
2. Surface Water Assessment;
3. Hydrogeological Assessment; and
4. Groundwater and Surface Water Monitoring.

Item 1 is presented in this stand-alone technical memorandum; the Aquatic Ecology Assessment (the Assessment), provided as a technical appendix to items 2 and 3, while Item 4 has also been completed and submitted as a separate deliverable. The objective of this Assessment was to provide an understanding of the aquatic ecology values of the Study Area (Figure 1-1) in relation the Project. To address the objective a desktop review was undertaken including searching relevant databases and literature, with the information summarised in this memorandum.

1.2 Project Layout and Study Area

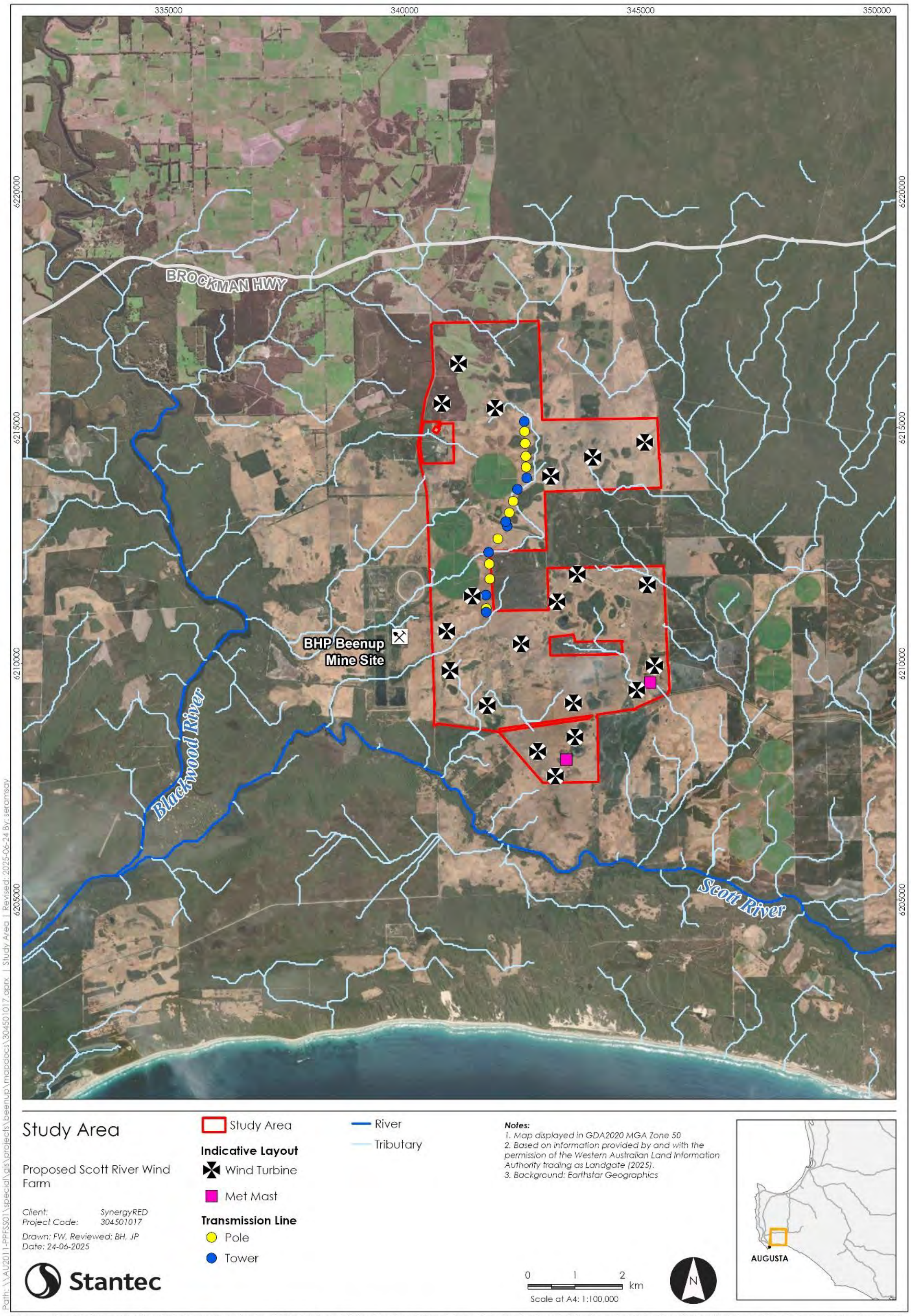
The Proposal is anticipated to involve construction and operation of up to 20 wind turbine generators, each of which will be up to 250 metres (m) in height. As the Proposal is in its early stages of planning and approvals, the location of infrastructure is yet to be finalised. The configuration of the turbines and the infrastructure layout within the Study Area (equivalent to the Development Envelope) is shown in Figure 1-1. Supporting infrastructure also includes transmission poles and towers and a meteorological mast.

The Study Area (Figure 1-1) for the Project occupies an area of approximately 4,000 hectares (ha) and comprises agricultural properties bound by Dennis Road to the east and Scott River to the south, and west. The northern end is bordered by a fence line approximately 1.5 km south of the Brockman Highway. The Study Area is zoned as general agriculture with conservation areas of remnant vegetation, and neighbours the historical rehabilitated BHP Beenup Titanium Mine. There are several plantations within the Study Area which are also zoned as general agriculture.

1.3 Regulatory Setting

The Assessment has been undertaken considering relevant legislation and guidance including:

- *Biodiversity Conservation Act 2016*;
- *Environmental Protection Act 1986*;
- *Environment Protection and Biodiversity Conservation Act 1999*; and
- Environmental Factor Guideline – Inland Waters (EPA 2018);



Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2025).
3. Background: Earthstar Geographics

Figure 1-1: Study Area and proposed infrastructure layout for the Project.

2 Approach

A desktop assessment was undertaken to understand the aquatic ecology values of the Study Area and surrounds, comprising database searches and a literature review. The summary of relevant accessed databases and datasets is provided in Table 2-1, while the complete results are provided in Appendix A. Literature reviewed included information on inland waters, hydrology, and hydrogeology studies commissioned by SynergyRED and publicly available literature. The relevant literature review results are discussed in Section 4.

Table 2-1: Summary of databases and datasets accessed as part of the Assessment.

Reference	Database	Search Method	Buffer
DCCEEW (2020)	Australian Ramsar Wetlands: Internationally Important Wetlands	Manual search	-
DCCEEW (2019)	Directory of Important Wetlands: Nationally Important Wetlands	Manual search	-
BirdLife Australia (2024)	Birdata	Central coordinate (34°13’16.43” S 115°17’27.90” E)	50 km
Western Australian Government (2005)	Environmental Protection (Environmentally Sensitive Areas) Notice 2005	Manual search of list	-
WAM (2024a; 2024b; 2024c; 2024d)	Arachnida/Myriopoda, Insecta, Crustacea and Mollusca Databases	Northwest coordinate (33.543032° 114.592429°) Southeast coordinate (34.300442° 115.444722°)	-

3 Existing Environment

3.1 Biogeographic Context & Land Systems

The Study Area is located within the Warren (WAR) bioregion and the Southern Jarrah Forest subregion (Jarrah Forest 2; JF2) of Western Australia (Figure 3-1) (Thackway and Cresswall 1995). The Warren bioregion occurs on the dissected undulating Leeuwin Complex, Southern Perth Basin (Blackwood Plateau), and South-West intrusions of the Yilgarn Craton and western parts of the Albany Orogen (Hearn *et al.* 2001). Loamy soils support Karri forest, laterites support Jarrah-Marri forest, leached sandy soils in depressions and plains supporting low Jarrah woodlands and paperbark/sedge swamps, and Holocene marine dunes are characterised by *Agonis flexuosa* and *Banksia* woodlands and heaths (Hearn *et al.* 2001).

The Southern Jarrah Forest subregion occurs on the duricrusted plateau of the Yilgarn Craton (Hearn *et al.* 2002). South of Collie, the plateau broadens and slopes gently to the south coast. Drainage is still dissected in the west but broadening and levelling of the surface in the east causes poor drainage and large and small wetlands. Vegetation comprises Jarrah–Marri forest in the west and Marri and Wandoo woodlands in the east, with extensive swamp vegetation in the south–east, dominated by Paperbarks and Swamp Yate (Hearn *et al.* 2002). The understory component of the forest and woodland reflects the more mesic nature of this area; however, *Baumea* reed beds within freshwater wetland are a unique feature occurring within forested and adjacent areas (Hearn *et al.* 2002). The majority of the diversity in the communities occurs on the lower slopes or near granite soils where there are rapid changes in site conditions (Hearn *et al.* 2002).

The Southwest of Western Australia is considered to be a highly biodiverse area of the world for vascular plants (Hearn *et al.* 2001) with a high centre of endemism for both plants and aquatic fauna. High concentrations of endemic plants are noted from the Scott River Plains, the Leeuwin Naturaliste Ridge, and the area surrounding Walpole. Aquatic fauna of the Warren bioregion shows a similar endemism, with the freshwater cray genus *Engaewa* endemic to the bioregion (Hearn *et al.* 2001). Both the Warren bioregion and the Southern Jarrah Forest subregion are also considered to be a refugia containing relict taxa representative of a wetter milder climate, characterised by vascular and cryptic flora and invertebrate species normally associated with rainforests of Southeastern Australia (Hearn *et al.* 2001; Hearn *et al.* 2002). For example, *Moggridgea* (genus of tree-dwelling spiders) and Onychophora (velvet worm) taxa residing within Tingle forests, relictual and other aquatic invertebrates within peat/organic wetlands, and the limestone cave and karst systems that support endemic invertebrate fauna on the west coast (Hearn *et al.* 2001).

As with the Warren bioregion, the Southern Jarrah Forest subregion is also characterised by peat swamp communities and fresh to saline wetland systems which support endemic invertebrate fauna (Hearn *et al.* 2002). Other fauna unique to the area includes restricted and rare frogs, comprising the White-bellied Frog (*Anstisia alba*; Critically Endangered, BC Act/EPBC Act), the Orange-bellied Frog (*Anstisia vitellina*, Vulnerable, BC Act/EPBC Act), and the Sunset Frog (*Spicospina flammocaerulea*; Vulnerable, BC Act/EPBC Act) (Hearn *et al.* 2002).

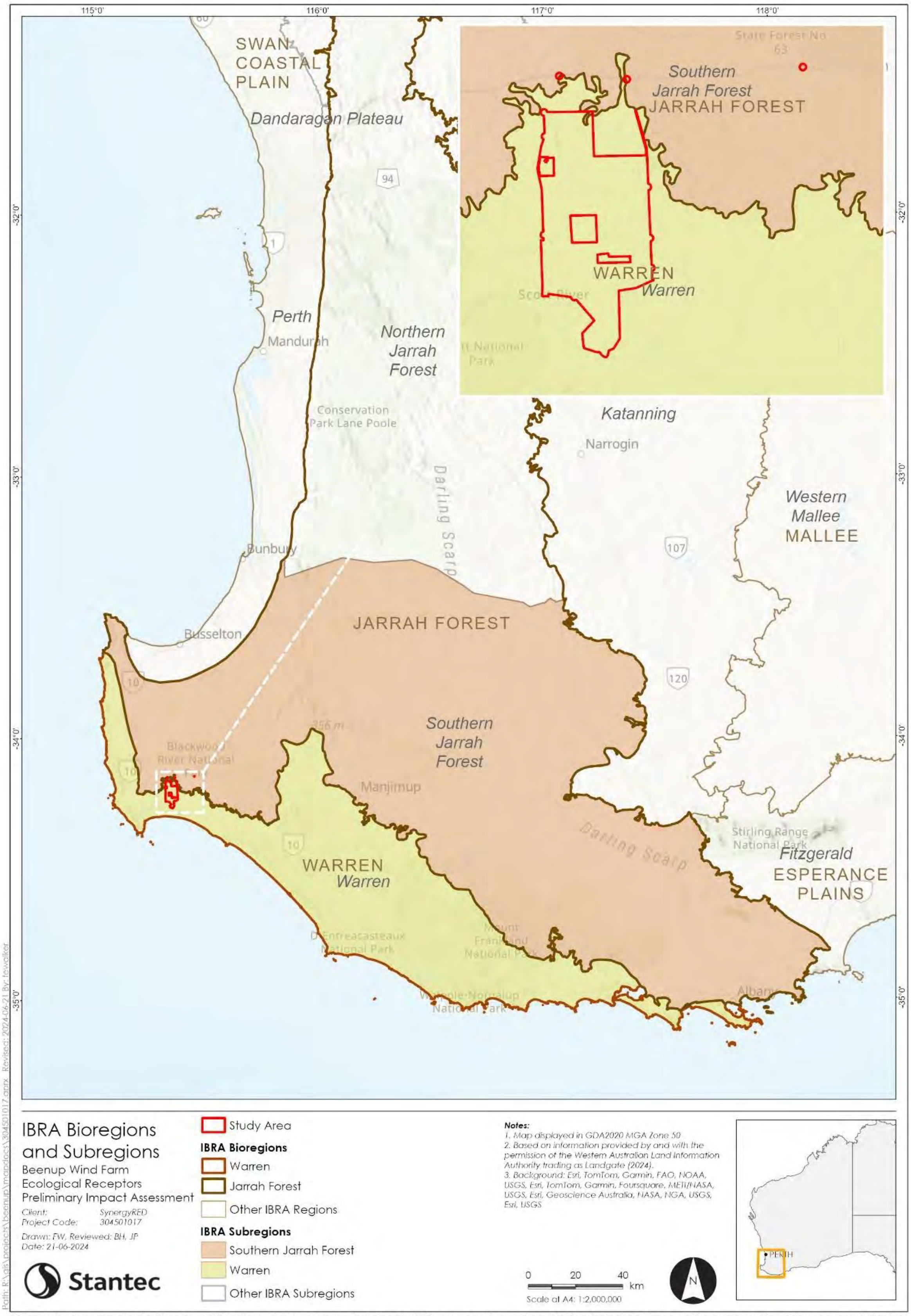


Figure 3-1: Location of the Project within the Warren bioregion and the Southern Jarrah Forest subregion.

3.2 Climate

3.2.1 Rainfall and Temperature

The climate of the Warren Bioregion and the Southern Jarrah Forest Subregion is classified as moderate Mediterranean and warm Mediterranean, respectively, characterised by mild, wet winters and hot, dry summers. The closest Bureau of Meteorology (BoM) stations to the Project are Warner Glen (009613), Alexandra Bridge (009801), and Cape Leeuwin (009518), which record an average annual rainfall of approximately 850 to 900 mm (Figure 3-2), with around 80% of this rainfall typically occurring between May and September. The average annual pan evaporation (based on SILO data) is approximately 1,500 mm, with summer months (December to February) experiencing the highest rates (200 to 300 mm/month), and winter months (June to August) being considerably lower (Figure 3-2).

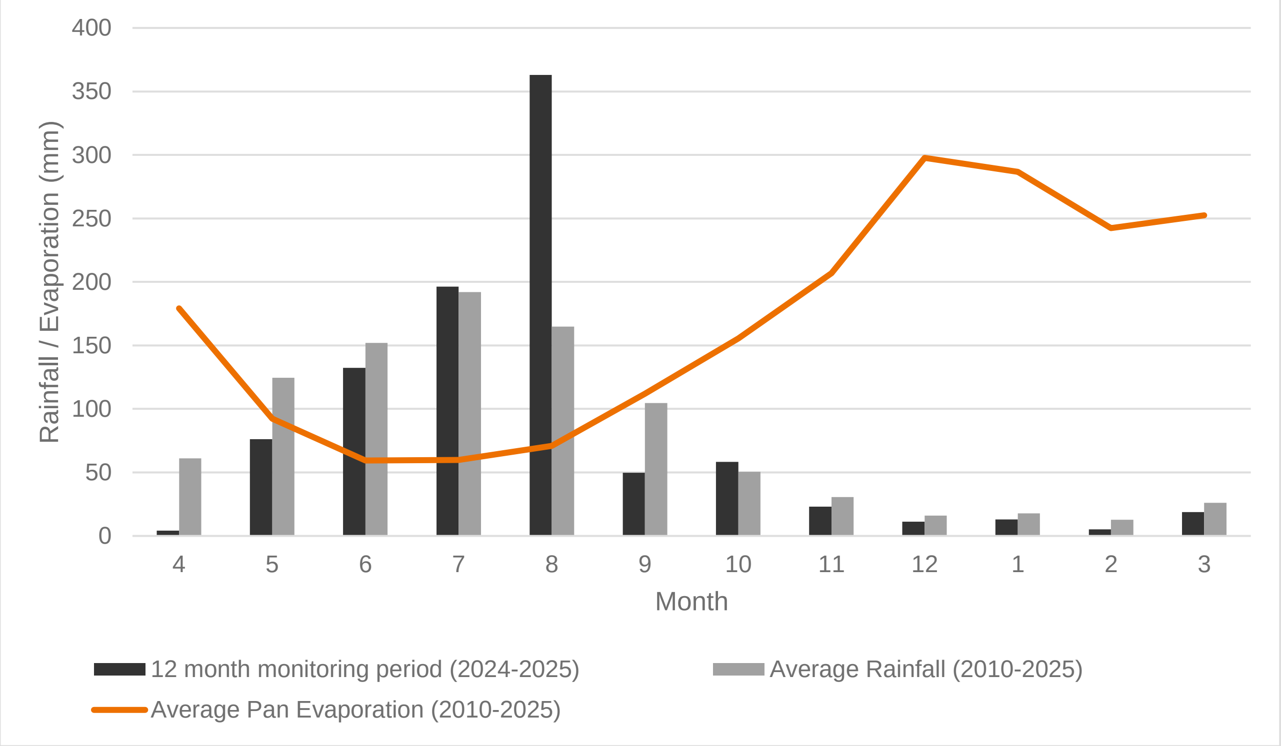


Figure 3-2: Monthly total rainfall and evaporation in 2023 at the Study Area (SILO 2024 - 2025).

3.3 Hydrogeology

Detailed hydrogeological characterisation is provided in the Surface Water and Hydrogeological Assessment (Stantec 2024). The northern part of the Study Area is characterised by a thin layer of dune sands (<2 m) overlying alternating bands of clay and sand as well as peat, while in the central and south sections, dune sands are deeper (up to approximately 6 m) followed by ferricrete and/or clay. The Study Area is also located within an area of high to moderate ASS potential (supported by preliminary test results) and is potentially impacted by an acid rock drainage plume from the Beenup Titanium Mine.

The Study Area comprises the Superficial and Leederville Aquifers, occurring in the upper 25 m of the profile. The Superficial Aquifer is localised and discontinuous and is generally less than 3 m deep. It includes perched groundwater above impermeable beds of the Leederville formations, and local confinement zones of low permeability in the laterite (dominant sand and ferricrete) profile. The Leederville Aquifer lies beneath the Superficial Formation and appears shallower toward the north and deepening in the southern portion of the Study Area.

The Superficial Aquifer is recharged by direct diffuse rainfall infiltration and localised downward leakage from creeks, wetlands and irrigation through alluvial soils. Potential upward leakage from the underlying Leederville Formation may also occur. During winter the water table is shallow and often discharges into wetlands, while during summer, some areas become dry, with reduced rainfall affecting depth to the water table. The Leederville Aquifer is mostly recharged via lateral flow and vertical downward leakage from the Superficial Aquifer. Discharge from the Superficial Aquifer occurs via evapotranspiration, while the Leederville Aquifer discharges to major rivers and creeks. Groundwater pumping is known from both on within and surrounding the Study Area, used primarily for irrigation. The Superficial Aquifer and Leederville Aquifer is generally freshwater, with total dissolved solids (TDS) of less than 500 mg/L.

Groundwater levels in the Superficial Aquifer and the Leederville Aquifer are strongly correlated to rainfall and are shallowest in winter (approximately 0.5 m below land surface for the former) and typically fluctuate between 1 m and 2 m in summer, generally flowing in a southward direction. Previous investigations in the area indicate that in winter the Superficial Aquifer may be connected to creeks, indicating that surface-water groundwater interactions may be ephemeral and seasonally influenced, although this remains a knowledge gap. It is unlikely that the deeper Leederville Aquifer is in direct connection to ephemeral surface water features in the Study Area.

3.4 Surface Water

The Study Area is split between two main catchment areas with the Blackwood River catchment covering the west and north of the Study Area, and the Scott River catchment covering the east and south of the Study Area. An area of 13.7 km² (43%) of the Study Area drains into the Blackwood River, while 18.3 km² (57%) of the Study Area drains into the Scott River.

Key surface water features in the region consist of historically modified catchments with artificial drains to facilitate the agricultural and plantation activities (Figure 3-3). These drains have not been built in a coordinated way and intersect with roads and natural drainage lines, resulting in several areas of localised ponding due to catchment modification.

Local surface water characteristics are detailed in the Surface Water and Hydrogeological Assessment (Stantec 2024). The Study Area has a poorly defined ridgeline that runs approximately through the centre of the Study Area, segregating the 11 Blackwood and Scott River headwater catchments that discharge from the Study Area (Figure 3-3). Sheet flow occurs across cleared land areas, concentrating into more defined streamflow paths towards the Study Area boundary.

There are several areas of natural ponding following rainfall events in areas designated as wetlands and in depressions formed by historical anthropogenic activities. The roads on almost every boundary of the Study Area act as an impediment to flow paths and cause localised upstream ponding, apart from the southernmost catchment which sheet flows across agricultural land.

Surface water quality, undertaken as part of the Healthy Rivers Program in the vicinity of the Study Area indicates salinity (measured as total suspended solids; TSS) and nutrient concentrations (total nitrogen and total phosphorous) are typically elevated in tributaries compared to Scott River. This has been attributed to catchment clearing and agricultural runoff. Waterways are also subject to increased nutrients and salts following heavy rainfall, while salinity also increases during the summer period. In addition, low flow conditions, high temperatures and algal blooms during the warmer months can result in low dissolved oxygen levels (DWER 2019).

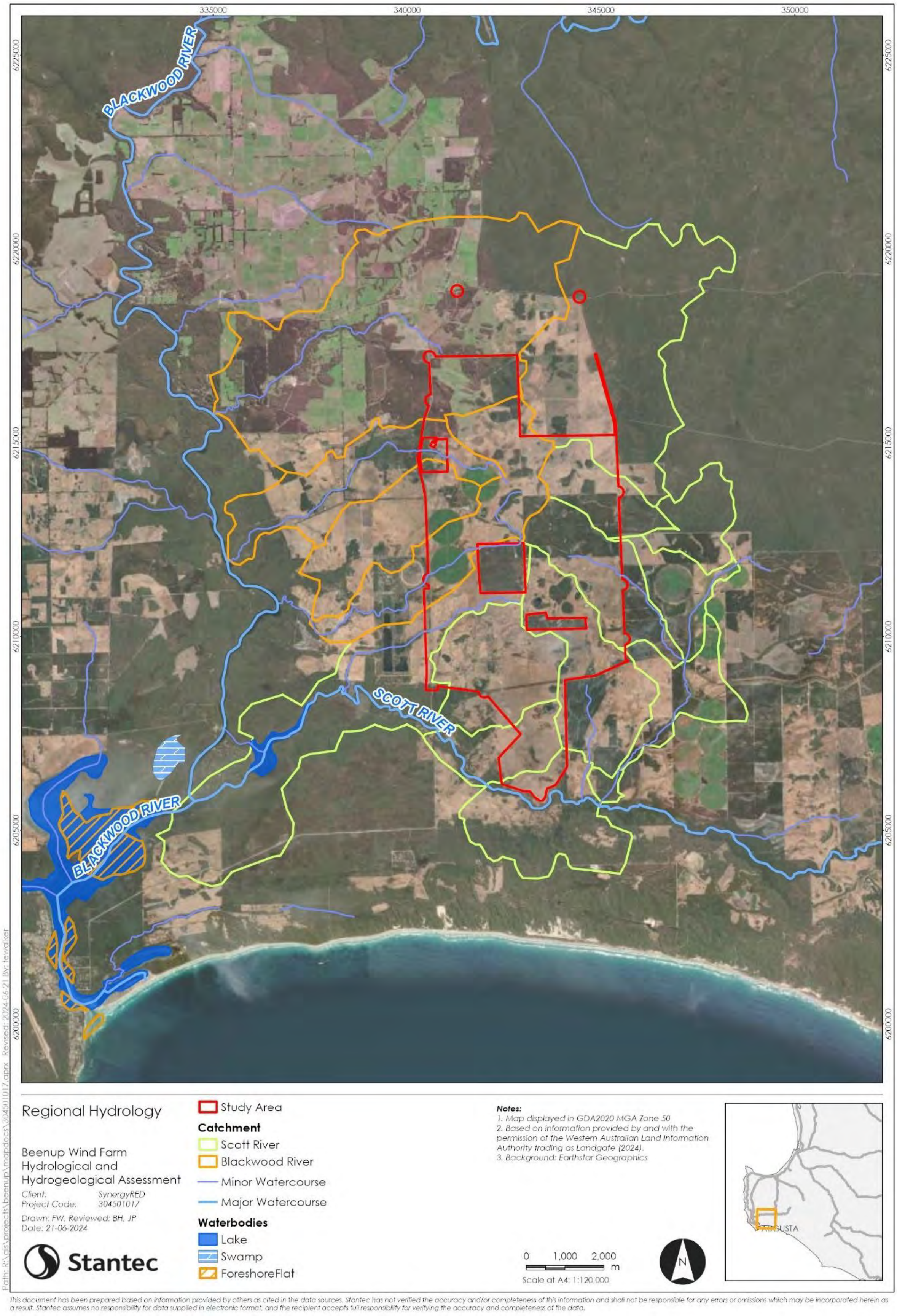


Figure 3-3: Regional hydrology showing the Study Area and catchment divides.

4 Results

4.1 Database Searches

The desktop assessment identified three nationally important wetlands, and one wetland with a nomination to be recognised as an internationally important wetland (Table 4-1) within 20 km of the Study Area. Of these the Spearwood Creek Wetlands were closest and located 3 km to the north and are being considered for Ramsar listing. Spearwood Creek is a tributary of the Blackwood River the wetlands are known for their rich biodiversity and the presence of rare flora and fauna, including the burrowing freshwater crayfish (*Engaewa pseudoreducta*). The Blackwood River and its tributaries, approximately 4 km from the Study Area are listed as nationally important due to their ecological significance, supporting threatened ecological communities and listed flora and fauna. The remaining systems are located more than 10 km from the Study Area.

Table 4-1: Significant ecosystems and communities recorded from the desktop assessment.

Ecosystem/Community	Conservation Significance		Distance From Study Area
	BC Act	EPBC Act	
Spearwood Creek Wetlands	-	*Internationally Important Wetland	3 km north
Blackwood River (Lower Reaches) and Tributaries System	-	Nationally Important Wetland	4 km west
Cape Leeuwin System	-	Nationally Important Wetland	17 km southwest
Gingilup-Jasper Wetland System	-	Nationally Important Wetland	13 km southeast

*Note: *Spearwood Creek Wetlands is a draft proposed wetland of international significance.*

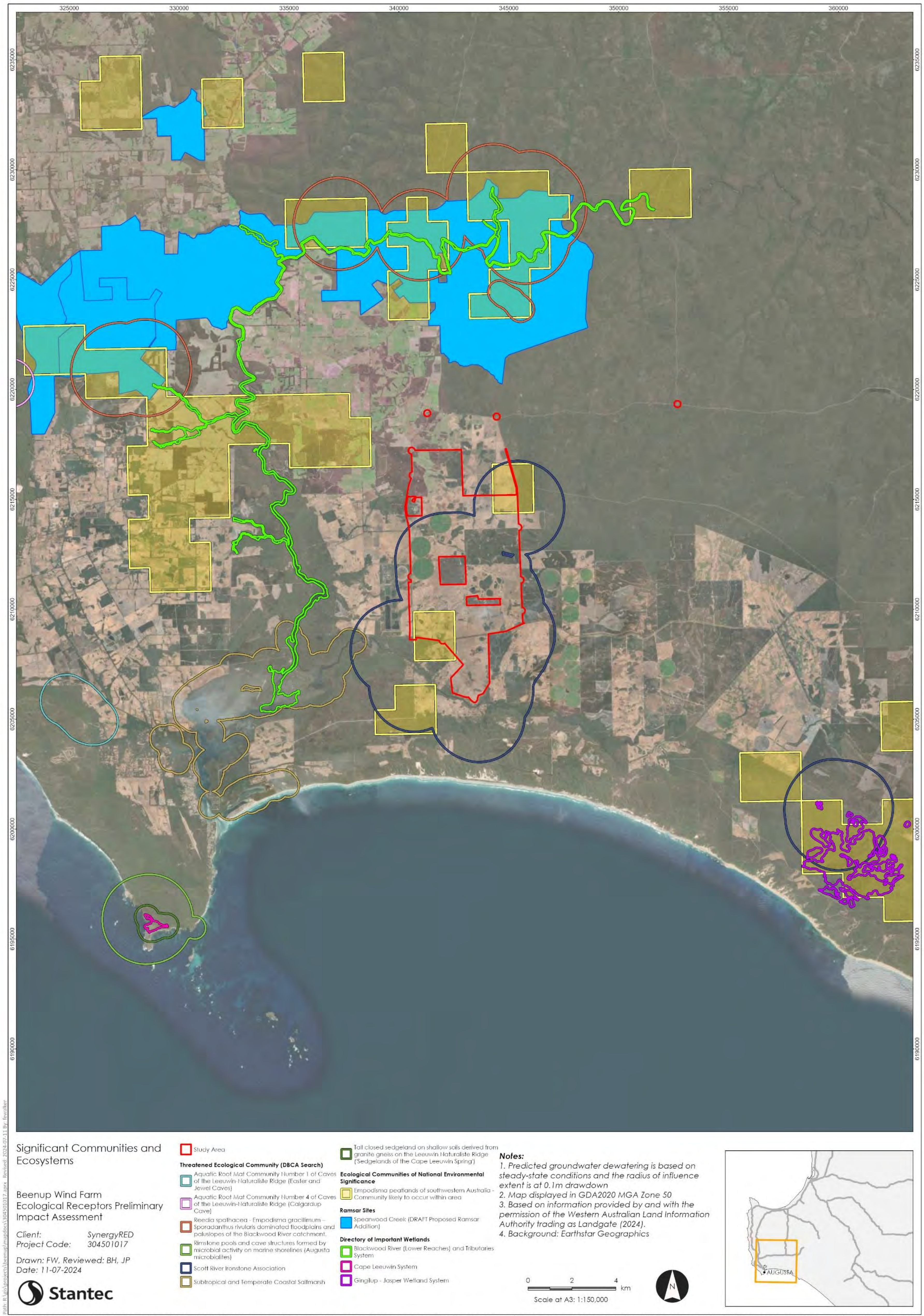


Figure 4-1: Significant wetlands in relation to the Study Area.

4.2 Literature Review

4.2.1 Wetlands and Waterways

There are several ephemeral waterways and wetlands located within the Study Area (Figure 4-2). The Scott River, which flows into the Blackwood River, is located in the southwest section of the Study Area. A number of minor waterways also traverse the Study Area, primarily flowing from northeast to southwest towards Blackwood River (Figure 4-2), with a smaller proportion flowing in a southeasterly direction towards Scott River. The Lower Scott River sub-catchment area, that parts of the Study Area discharge into, is in better condition that the upper reaches of the Scott River. The biodiversity in the main channel is in good condition in terms of the number and diversity of flora and fauna species, although there are signs of stress associated with upstream nutrient runoff along some sections (LBLCDC 2020).

The Blackwood River is a major river system within the catchment. During the dry summer months, groundwater from the Yarragadee and Leederville Aquifers contribute to 30% to 100% of the discharge into the Blackwood River. During this period, surrounding tributaries either contract or dry completely (Beatty et al. 2009).

The ecological values of the Blackwood River include a high native species richness and endemism of fish and crayfish as well as a diverse macroinvertebrate community. The Blackwood River is also an important nursery and spawning ground. Parts of the catchment also support extensive riparian vegetation. Groundwater influence plays an important role in maintaining aquatic biota and the riparian communities. However, the Blackwood River is subject to threats including salinisation (from land clearing) and reduced rainfall due to climate change (Beatty et al. 2009; Department of Water, Water Science Technical Series 2015).

Within the Study Area, waterways and wetlands are surrounded by agricultural land with only remnant riparian vegetation remaining (Figure 4-2). While it is likely that there is some groundwater dependency and interaction with surface water and groundwater in the Study Area, the degree to which this occurs is unknown. Three geomorphic wetland types have been mapped based on Semeniuk and Semeniuk (1995; 1997), which classifies wetlands according to their features and inundation regime (Figure 4-2).

- sumpland – located within a basin landform and defined as seasonally inundated, of which 30 are Conservation category;
- dampland – located within a basin landform and defined as seasonally waterlogged, of which nine are Conservation category; and
- palusplain – located on a flat landform and defined as seasonally waterlogged, of which two are Conservation category.

The geomorphic wetlands are further classified by Semeniuk and Semeniuk (1995) into the following categories; Conservation (defined as supporting a high level of attributes and functions), Resource Enhancement, Multiple Use, Intensive Dairy Farm Paddock (Table 4-2). Within the Study Area, the majority of Palusplain wetland types (>200) that are part of the Intensive Dairy Farm Paddock category occur in the Study Area, and also comprise the largest area (>3,900 ha), equivalent to 90% of the total wetlands (Table 4-2). The remaining geomorphic wetlands under the various classifications contribute to only a minor proportion of the study Area (approximately 400 ha), or less than 10% of the total wetlands.

The Study Area was historically a wetland environment and is predominantly palusplain (seasonally waterlogged flats), characterised by a series of damplands and sumplands in varying condition (Phoenix in prep.-a; V & C Semeniuk Research Group 1997). On the northern boundary of the Study Area there is a mosaic of remnant bushland and wetlands that are largely cohesive and provide important habitat for flora and fauna (Phoenix in prep.-a). In the centre of the Study Area, wetlands are separated by paddocks and are generally in poor condition, while to the south there is an isolated group of fenced wetlands. In the southern section there is one larger, unfenced wetland which, when inundated, supports waterbirds including the Wood Sandpiper (*Tringa glareola*), which is listed under the BC Act and EPBC Act as Migratory (Phoenix in prep.-a).

4.2.2 Aquatic Habitat and Waterbirds

Ten fauna habitat types have been identified from the Study Area, including three wetland types (Phoenix in prep.-b). The wetlands comprised seasonally inundated paperbark woodland, shrubland and sedgeland (Phoenix in prep.-a; b) (**Figure 4-3**). They are sporadically distributed throughout the Study Area and are mostly ephemeral (seasonally inundated), with relatively shallow water levels when flooded (typically less than 1 m). In addition, there was one larger wetland south of Governor Broome Road and a wetland cluster in the northern section of the Study Area where surface water persisted into summer, suggesting a potential perennial regime (Phoenix in prep.-a).

The northern boundary of the Study Area contains a mosaic of remnant bushland and wetlands that are largely cohesive and provide important habitat for flora and fauna (Phoenix in prep.-b) (**Figure 4-3**). In the centre of the Study Area, wetlands are separated by paddocks and are generally in poor condition, while to the south there is an isolated group of fenced wetlands and one larger, unfenced wetland (Phoenix in prep.-b).

The wetlands, paddocks and floodplains of the Study Area provide seasonal foraging habitat for waterbirds including migratory species (Phoenix 2025; in prep.-b). During the wetter months (May to September), large aggregations of waterbirds such as Straw-necked Ibis, Australian White Ibis, Australian Shelduck, Grey Teal, Black Swan, Pacific Black Duck and White-faced Heron are prevalent in the local waterways and wetlands, while from spring to early summer (September to November) there is an influx of migratory shorebirds (Phoenix 2025; in prep.-b). There have been seven significantly listed waterbird species (State and Commonwealth) that have also been recorded from the Study Area during prolonged periods of inundation (Phoenix in prep.-b). This includes several Sandpipers (Common Sandpiper, Wood Sandpiper and Marsh Sandpiper), as well as the Double-banded Plover, Blue-billed Duck, Osprey and Common Greenshank (Table 4-3).

Table 4-2: Number of wetlands located within the Study Area and their wetland management category, geomorphic classification, and area.

Wetland Management Category	Wetland Geomorphic Classification	No. of Wetlands	Mean Area (ha)	Total Area (ha)
Conservation	Dampland	9	4	36.4
	Palusplain	2	3.4	6.9
	Sumpland	30	5.1	152
Resource Enhancement	Dampland	6	7.4	44.2
	Palusplain	4	1.5	6.1
	Sumpland	24	3.5	83.5
Multiple Use	Creek [1]	6	0.3	1.6
	Dampland	12	1.7	20.9
	Palusplain	9	2.4	21.6
	Sumpland	22	1.3	29.7
Intensive dairy farm paddock	Palusplain	210	18.7	3,920.40
Total		**334**	**49.3**	**4,323.30**

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[1] *Seasonally inundated channel.*

Table 4-3: Significant waterbird and migratory species recorded within the vicinity of the Study Area (Source (Phoenix in prep.-b).

Common name	Scientific Name	Habitat and Records	EPBC / BC Act
Actitis hypoleucos	Common Sandpiper	Inhabits a wide variety of coastal wetlands, waterways and inland wetlands. Typically found at small ponds, large inlets, and mudflats where they forage on the shoreline (DCCEEW 2024b). • *A. hypoleucos* migrates to the Southwest in September to October (DCCEEW 2024b).	MI
Anarhynchus bicinctus	Double-banded Plover	Found on littoral, estuarine and fresh or saline terrestrial wetlands, rivers, saltmarshes, lagoons, grasslands and pasture. Also occurs on muddy, sandy, shingled or rocky beaches, bays and inlets (DCCEEW 2024a).	MI
Oxyura australis	Blue-billed Duck	Endemic to Australia's temperate regions, inhabiting terrestrial wetlands (fresh or saline) with extensive bordering vegetation, including artificial wetlands (Birdlife International 2015; del Hoyo *et al.* 2014). Located at the larger lakes in the seasonally inundated sedgeland (Ninox 2011).	P4
Pandion haliaetus	Osprey	Recorded in the vicinity of the Study Area. *P. haliaetus* has a broad habitat ranging from littoral and coastal habitats to the terrestrial wetlands of tropical and temperate Australia.	MI
Tringa glareola	Wood Sandpiper	Commonly observed foraging in shallow, freshwater wetlands, typically where grasses or aquatic plants are present in the Study Area.	MI
Tringa nebularia	Common Greenshank	Recorded in the vicinity of the Study Area (principally associated with the Blackwood River, Scott River and the artificial wetlands to the west) (DCCEEW 2024c) (BirdLife Australia 2019). • *T. nebularia* migrate to the south-west in August and become common throughout October in the vicinity of the Study Area. • These waterbirds benefit from the suitable foraging habitat present at coastal wetlands, lakes and swamps.	EN / MI
Tringa stagnatilis	Marsh Sandpiper	This waterbird forages a wide variety of habitats, including wetlands and inundated floodplains within the vicinity of the Study Area. • *T. stagnatilis* commence their migration into the Southwest during September, with numbers peaking during November to February.	MI

Figure 4-2: Waterways, wetlands and geomorphic wetlands mapped within the Study Area.

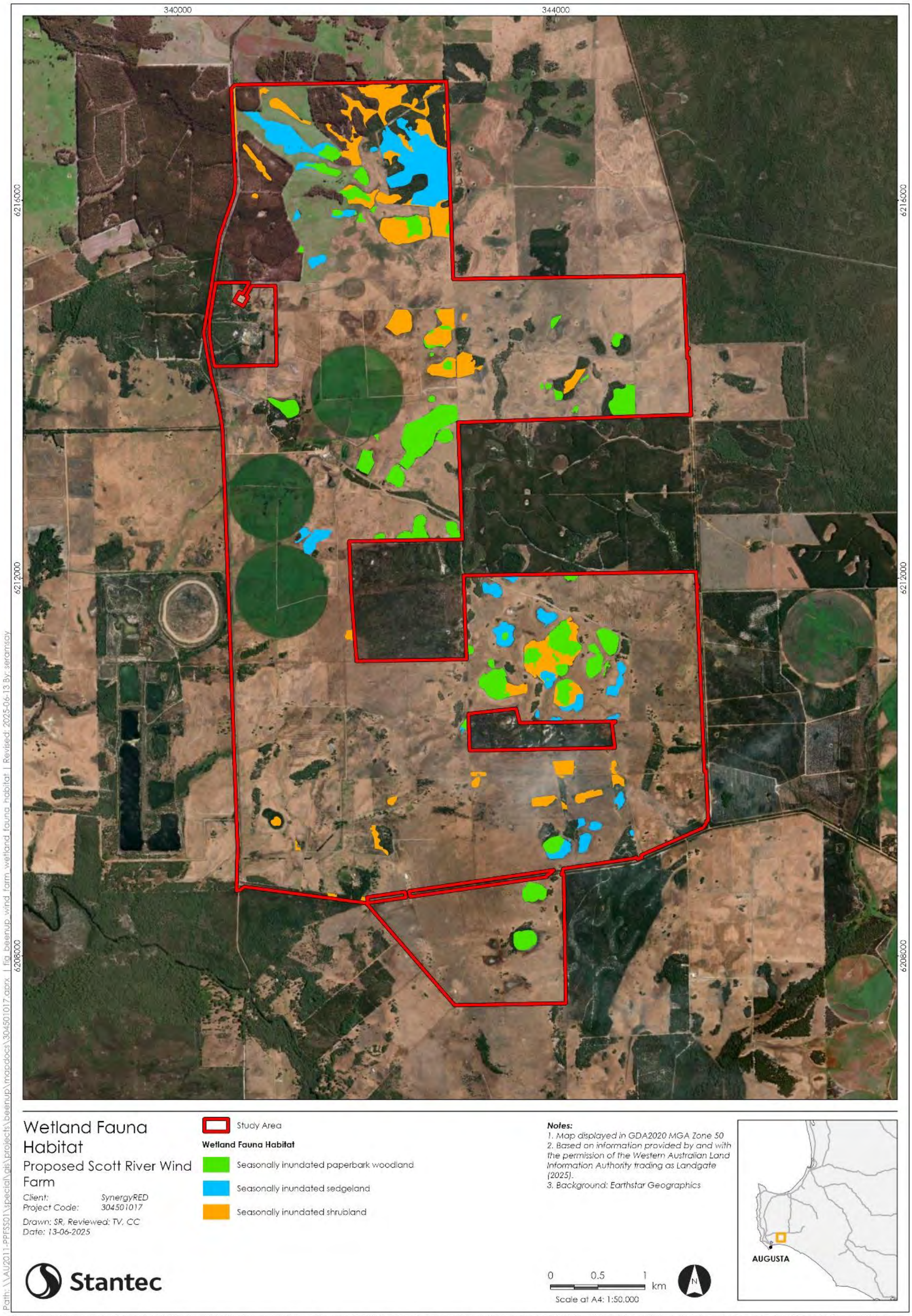


Figure 4-3: Wetland fauna habitat types, within the Study Area (Spatial Data Source: Phoenix in prep.-b).

4.2.3 Aquatic Ecology

4.2.3.1 Surface Water Quality

As part of the DWER's Healthy Rivers and Estuaries Program, monitoring data from 2005 is available for several locations near the Study Area. This includes Brennans Bridge on the Scott River, Woodhouse on a tributary of the Scott River, and at Paynes Road on the Scott River (DWER 2023a; b).

The following catchment-scale water quality influences and trends were identified, as follows (DWER 2019):

- Nutrients enter waterways within the local catchment as a result of agricultural land use, exacerbated by native vegetation clearing (particularly within the riparian zone of wetlands).
- High nutrient concentration is likely to cause algal blooms in waterways, associated with fertiliser use and dairy farming.
- Most of the soil in the cleared area of the catchment has a low capacity to bind phosphorus.
- Low dissolved oxygen concentration has been measured due to increasing temperature, algal bloom and reduced surface water flow.
- Monitored sites show a first flush effect where nutrients, suspended solids, and salts are mobilised following heavy rainfall. This is likely due to mineralisation of organic nitrogen in soil and drains over the summer period, and runoff of high-concentration water from upstream agricultural areas.
- Salinity shows a slight inverse seasonal relationship, with concentration being highest at the start and end of the flow year. At the start of winter, rain likely wash salts into the stream from surrounding land and mobilises salts left behind in dry stream beds from the previous summer.

The monitoring data comprises four key metrics against which water quality parameters have been assessed, which comprise total nitrogen (TN), total phosphorus (TP), pH, salinity and total suspended solids (TSS). The results are summarised as follows:

- ANZECC & ARMCANZ (2000) trigger values:
  - Payne Road mean TN concentration exceeds trigger value 2005-1010 and 2012-2019.
  - Payne Road mean TP concentration exceeds trigger value 2017-2018.
  - Long-term Woodhouse TN or TP mean not reported against trigger values.
  - All annual pH medians at all sites were between the upper and lower trigger values.
- Statewide River Water Quality Assessment (SWRWQA) classification bands of low, moderate, high and very high:
  - Woodhouse mean TN classified as high (2005-2018) and very high (2019); appears that TN concentrations increased at Woodhouse between 2016 to 2019.
  - Woodhouse mean TP classified as high (2005-2019).
  - Payne Road mean TN classified as high (2005-2019).
  - Payne Road mean TP classified as moderate (2005-2019).
  - All sites were recorded as having low mean TSS (2005-2019).
  - All sites were reported as having low mean salinity (up to 2018; SWRWQA approach).
- Water Quality Improvement Plan (WQIP) targets:
  - Woodhouse mean TN and TP exceeds targets 2016-2019 from when they were established.
- Water Resources Inventory 2014 salinity ranges for fresh, marginal, brackish or saline in the 2019 nutrient report (2018 nutrient report used the SWRWQA bands):
  - All sites were reported as freshwater.

4.2.3.2 Aquatic Biota

The desktop assessment reviewed information available on aquatic biota (including semi-aquatic biota), and identified three crustaceans, one mollusc, five fish, and two frog species with the potential to occur within, or adjacent to, the Study Area (Table 4-4). Crustaceans recorded as having the potential to occur within, or adjacent to, the Study Area comprised the Margaret River Hairy Marron (*Cherax tenuimanus*) (Cr, BC Act; Cr, EPBC Act), the Margaret River Burrowing Crayfish (*Engaewa pseudoreducta*) (Cr, BC Act; Cr, EPBC Act), and the Dunsborough Burrowing Crayfish (*Engaewa reducta*) (En, BC Act; Cr, EPBC Act) (Table 4-4) (DBCA 2024b; WAM 2024b).

Carter's Freshwater Mussel (*Westralunio carteri*), which is endemic to the southwest of Western Australia and listed as Vulnerable under both the BC Act and the EPBC Act is known to occur in slow flowing permanent and semi-permanent riverine habitats, pools and dams between Moore River and Esperance (Klunzinger *et al.* 2015). However, its extent of occurrence is estimated to have declined by 49% in the last 50 years (Klunzinger *et al.* 2015; Walker *et al.* 2014), leading to its listing as Vulnerable. While *Westralunio carteri* is the listed entity, the species has recently been revised into three distinct and separate species within the southwest of Western Australia; *Westralunio carteri*, *Westralunio inbisi inbisi*, and *Westralunio inbisi meridiemus* (Klunzinger *et al.* 2022). In the vicinity of the Study Area, there is potential for both *Westralunio inbisi inbisi*, and *Westralunio inbisi meridiemus* to occur in Scott River, Chapman Brook, and St. John Brook (Klunzinger *et al.* 2022).

A baseline study on the aquatic fauna of the Blackwood River and its tributaries indicates that, due to salinisation, the forested tributaries of this system are integral to the conservation of aquatic biota, in particular for significant fish species (Morgan and Beatty 2005). Balston's Pygmy Perch (*Nannatherina balstoni*) (Vu, BC Act; Vu, EPBC Act) is known from the Scott River, restricted to tributaries and/or a perennial section of the main channel of the Blackwood River that receives freshwater baseflow from associated groundwater aquifers (Beatty *et al.* 2011). The Salamanderfish (*Lepidogalaxias salamandroides*) (En, BC Act) and Black-stripe Minnow (*Galaxiella nigrostriata*) (En, BC Act; Enn, EPBC Act) have also been documented from the Blackwood River catchment in pools across the Scott River floodplain (Morgan and Beatty 2005). A reduction in groundwater levels has the potential to impact on this species during their aestivation phase. Similarly, the Black-stripe Minnow is generally restricted to ephemeral pools during dry conditions, burrowing into the substrate when pools dry out in warmer months (Morgan and Beatty 2005).

Other fish species documented from the local catchment of the Study Area include the Western Galaxias (*Galaxias occidentalis*), considered widespread, and the Western Pygmy Perch (*Nannoperca vittate*), restricted to the Blackwood River and the lower catchment, and the Western Dwarf Galaxias (*Galaxiella munda*) (Beatty *et al.* 2011; Morgan and Beatty 2005). The Freshwater Cobler (*Tandanus bostocki*), Nightfish (*Bostockia porosa*), Long-headed Goby (*Afurcagobius suppositus*), Blue-spot Goby (*Pseudogobius olorum*), and the Western Hardyhead (*Leptatherina wallacei*) have also been recorded (Morgan and Beatty 2005).

Four exotic fish species are known from the local catchment of the Study Area including the Goldfish (**Carassius auratus*), the Eastern Mosquitofish (**Gambusia holbrooki*), the Redfin Perch (**Perca fluviatilis*), and the Rainbow Trout (**Oncorhychus mykiss*). Of these, the Rainbow Trout was stocked by the then Western Australian Department of Fisheries (now Department of Primary Industries and Regional development; DPIRD) (Morgan and Beatty 2005).

North of the Brockman Highway are also known to support both the White-bellied Frog and Orange-bellied Frog (Table 4-4), having an extremely restricted and fragmented distribution within the area of occurrence. The White-bellied Frog occurs within an area north and west of the Blackwood River between Margaret River and Augusta (Roberts *et al.* 1999) and the Orange-bellied Frog is confined to a 6.3 km² area east of the Leeuwin-Naturaliste Ridge (Tyler 1997). The White-bellied Frog is predicted to occur over an area of approximately 130 km² with a probable decline of more than 70% of its range. Its current area of occupancy is less than 2.5 km² (Roberts *et al.* 1999), with approximately 80% of both its extent of occurrence and percent of the area of occupancy occurring on private land (Wardell-Johnson *et al.* 1995). The White-bellied Frog occurs in permanently moist sites in relatively dry and seasonal climatic zones.

The Orange-bellied Frog is known from the lower reaches of six waterways that drain south into the Blackwood River (Wardell-Johnson *et al.* 1995). It is considered unlikely that many additional undetected populations exist due to the high survey effort undertaken prior to, and within the first two years of, the implementation of the Orange-bellied and White-bellied Frogs Recovery Plan (DPaW 2015). Only six populations of the Orange-bellied Frog are known (Roberts *et al.* 1999), wholly distributed within State Forests (Tyler 1997), including the Blackwood River National Park. This species occurs in permanently moist sites within six unconnected and undisturbed areas of riparian vegetation at an elevation of 120 m, and is abundant at seepages (Tyler 1997).

The males of both frog species call from small depressions in clay under dense vegetation cover. There is no free swimming or feeding stage and eggs are deposited as a jelly mass in small depressions, with eggs hatching and tadpoles developing without the need for surface water (Roberts *et al.* 1990). The majority of waterways and winter-wet depressions are characterised by dominant plant species including *Homalospermum firmum*, *Taraxis grossa*, *Boronia molloyae*, *Acacia uliginosa*, *Taxandria linearifolia*, and *Astartea fascicularis* (Wardell-Johnson *et al.* 1995).

All aquatic and semi-aquatic fauna species have the potential to be groundwater-dependent, where wetlands in the Study Area are supported by the shallow groundwater aquifer, and where there is connectivity between the shallow aquifer and the deep aquifer. However, the level of connectivity between surface water and groundwater is currently unknown.

Table 4-4: Significant aquatic fauna species with the potential to occur within, or adjacent to, the Study Area.

Common Name	Scientific Name	BC Act	EPBC Act
Crustacean			
Margaret River Hairy Marron	*Cherax tenuimanus*	Cr	Cr
Margaret River Burrowing Crayfish	*Engaewa pseudoreducta*	Cr	Cr
Dunsborough Burrowing Crayfish	*Engaewa reducta*	En	Cr
Mollusc			
Carter's Freshwater Mussel	*Westralunio carteri*	Vu	Vu
Fish			
Black-stripe Minnow	*Galaxiella nigrostriata*	En	En
Balston's Pygmy Perch	*Nannatherina balstoni*	Vu	Vu
Salamanderfish	*Lepidogalaxias salamandroides*	En	-
Western Dwarf Galaxias	*Galaxiella munda*	Vu	-
Pouched Lamprey	*Geotria australis*	P3	-
Frog			
White-bellied Frog	*Anstisia alba*	Cr	Cr^
Orange-bellied Frog	*Anstisia vitellina*	Vu	Vu*

*Note: ^ indicates that this species is listed under the EPBC Act as Geocrinia alba under the EPBC Act; * indictes that this species is listed under the EPBC Act as Geocrinia vitellina.*

5 Conclusions

There are several ephemeral waterways and wetlands located within the Study Area including the Scott River, which flows into the Blackwood River. The ecological values of both river systems is considered high, with some sections supporting diverse fish, crayfish and macroinvertebrate communities. However, waterways and wetlands in the local catchment have also been impacted by elevated nutrients, salinisation, and sedimentation, attributed to clearing and agricultural land use.

The Study Area was historically a wetland environment and is predominantly palusplain (seasonally waterlogged flats), characterised by a series of damplands and sumplands in varying condition. Three wetland fauna habitat types have also been identified from the Study Area including seasonally inundated paperbark woodland, shrubland and sedgeland.

There have been seven significantly listed waterbird species (State and Commonwealth) recorded from the Study Area in low numbers during prolonged periods of inundation. This includes several Sandpipers (Common Sandpiper, Wood Sandpiper and Marsh Sandpiper), as well as the Double-banded Plover, Blue-billed Duck, Osprey and Common Greenshank. A total of 11 State and Commonwealth listed significant aquatic and semi-aquatic species also have the potential to occur in wetlands and waterways across the Study Area. This comprises three crustaceans (two crayfish and one marron), one mollusc (Carter’s Freshwater Mussel), five fish (including two *Galaxiella* species), and two frog (White and Orange Bellied Frog) species.

6 References

ANZECC & ARMCANZ, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand. (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, The Guidelines (Chapters 1-7). Environment Australia, Canberra.

Beatty, S. J., Morgan, D. L., Rashnavadi, M. and Lymbery, A. J. (2011). Salinity tolerances of endemic freshwater fishes of south-western Australia: implications for conservation in a biodiversity hotspot. *Marine and Freshwater Research* 62: 91-100.

BHP. (2015). Beenup Titanium Minerals Project Annual Environment Report. Unpublished report prepared by BHP.

BirdLife Australia. (2024). Birdata (custom search). BirdLife Australia,

BoM, Bureau of Meteorology. (2024). Groundwater Dependent Ecosystems Atlas. Commonwealth of Australia, Canberra, Australian Capital Territory.

Brockman South Pty Ltd. (2015). Alexandra Iron Ore Project, Combined Annual Report 2014. Unpublished report prepared by Brockman South Pty Ltd.

Chan, M. Y. (2011). Bore Completion Report: Scott Coastal Plain, Hydrogeological report series, Report no. HR296. Department of Water, Government of Western Australia, Perth, WA.

DBCA, Department of Biodiversity Conservation and Attractions. (2023a). Priority Ecological Communities For Western Australia Version 35.

DBCA, Department of Biodiversity, Conservation and Attractions. (2023b). Threatened ecological community list 2023. Government of Western Australia, Perth, WA.

DBCA, Department of Biodiversity, Conservation and Attractions. (2024a). Threatened and Priority Flora List (TP List) (custom search). Government of Wewstern Australia, Perth, Western Australia.

DBCA, Department of Biodiversity, Conservation and Attractions. (2024b). Threatened and Priority Fauna Database (custom search).

DCCEEW, Department of Climate Change Energy the Environment and Water. (2024a). Ecological Communities of National Environmental Significance: Download ECNES data. Canberra, ACT.

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2019). Directory of Important Wetlands: Search for a Nationally Important Wetland. Commonwealth of Australia, Canberra, ACT.

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2020). Australian Wetlands Database: Ramsar wetlands. Commonwealth of Australia, Canberra, ACT.

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2023). EPBC Act Threatened Ecological Communities in Western Australia. Canberra, ACT.

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2024b). Protected Matters Search Tool (custom search). Commonwealth of Australia, Canberra, Australian Capital Territory.

DPaW, Department of Parks and Wildlife. (2015). White-bellied and Orange-bellied Frogs (Geocrinia alba and Geocrinia vitellina) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia.

DWER, Department of Water and Environmental Regulation. (2023a). Hardy Inlet: Scott catchment - nutrient report, 2019. Department of Water and Environmental Regulation, Perth, WA.

DWER, Department of Water and Environmental Regulation. (2023b). Hardy Inlet: Blackwood catchment - nutrient report, 2019. Department of Water and Environmental Regulation, Perth, WA.

EPA, Environmental Protection Authority. (2016a). Environmental Factor Guideline - Flora and Vegetation. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2016b). Environmental Factor Guideline - Terrestrial Fauna. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2016c). Environmental Factor Guideline - Subterranean Fauna. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2018). Environmental Factor Guideline - Inland Waters. Government of Western Australia, Perth, Western Australia.

EPA, Environmental Protection Authority. (2023). Statement of environmental principles, factors, objectives and aims of EIA. Government of Western Australia, Perth, Western Australia.

Government of Western Australia. (2023). Water licensing exemptions. Government of Western Australia. Available online at https://www.wa.gov.au/service/building-utilities-and-essential-services/integrated-essential-services/water-licensing-exemptions.

Hearn, R., Williams, K. and Comer, S. (2001). Warren (WAR – Warren). In: M. Cowan (ed) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth, Western Australia., pp 637-655

Hearn, R., Williams, K., Comer, S. and Beecham, B. (2002). Jarrah Forest 2 (JF2 - Southern Jarrah Forest subregion).

Klunzinger, M., Beatty, S. J., Morgan, D. L., Pinder, A. M. and J., L. A. (2015). Range decline and conservation status of *Westralunio carteri* Iredale, 1934 (Bivalvia : Hyriidae) from south-western Australia. *Australian Journal of Zoology* 63: 127-135.

Klunzinger, M. W., Whisson, C., Zieritz, A., Benson, J. A., Stewart, B. A. and Kirkendale, L. (2022). Integrated taxonomy reveals new threatened freshwater mussels (Bivalvia: Hyriidae: Westralunio) from southwestern Australia. *Scientific Reports* 12(1): 20385.

Morgan, D. L. and Beatty, S. J. (2005). Baseline study on the fish and freshwater crayfish fauna in the Blackwood River and its tributaries receiving discharge from the Yarragadee Aquifer. Unpublished report prepared by Murdoch University Centre for Fish & Fisheries Research.

Phoenix, Environmental Services. (2023). Detailed Stygofauna Survey for the Swann Road borefield, Walpole EIA Project. Unpublished report prepared for RPS AAP Consulting Pty Ltd.

Phoenix, Environmental Services. (in prep.). Biological Surveys and Wetland Mapping for the Beenup Wind Farm Project. Unpublished report prepared for SynergyRED.

Purdie, B. R., Tille, P. J. and Schoknecht, N. R. (2004). Soil-landscape mapping in south-Western Australia: an overview of methodology and outputs. Department of Agriculture and Food, Perth, Western Australia.

Roberts, D., Conroy, S. and Williams, K. (1999). Declines and Disappearances of Australian Frogs: Conservation status of frogs in Western Australia. In: A. Campbell (ed). Environment Australia, Canberra, ACT, pp 177-184

Roberts, J. D., Wardell-Johnson, G. and Barendse, W. (1990). Extended descriptions of Geocrinia vitellina and Geocrinia alba (Anura: Myobatrachidae) from south-western Australia, with comments on the status of G. lutea. *Records of the Western Australian Museum* 14: 427-437.

Semeniuk, V. and Semeniuk, C. A. (1995). A geomorphic approach to global classification for inland wetlands. *Vegetatio* 118: 103-124.

Semeniuk, V. and Semeniuk, C. A. (1997). A geomorphic approach to global classification for natural inland wetlands and rationalization of the system used by the Ramsar Convention - a discussion. *Wetland Ecology and Management* 5: 145-158.

Stantec. (2024a). Beenup Wind Farm – Hydrological & Hydrogeological Assessment. Unpublished report prepared for SynergyRED.

Stantec. (2024b). Preliminary Geotechnical and Baseline Contamination Report. Unpublished report prepared for SynergyRED.

Stantec. (2024c). Geotechnical Desktop Report. Unpublished report prepared for SynergyRED.

Thackway, R. and Cresswall, I. D. (1995). An interim biogeographic regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program. Department of the Environment and Water Resources. Available online at http://www.environment.gov.au/parks/nrs/ibra/version4-0/framework/ibrintro.html#ch1.

Tille, P. (2006). Soil-landscapes of Western Australia's Rangelands and Arid Interior. Department of Agriculture and Food Resource Management Technical Report 313.

Tille, P. J. and Lantzke, N. C. (1988). Land Resources Of Busselton-Margaret River-Augusta, Western Australia: Augusta Map Sheet. Department of Agriculture WA: Division of Resource Management,

TSSC, Threatened Species Scientific Committee. (2023). Approved Conservation Advice for the *Empodisma* peatlands of southwestern Australia. Department of Climate Change, Energy, the Environment and Water, Canberra, ACT.

Tyler, M. J. (1997). The Action Plan for Australian Frogs. Environment Australia, Canberra, ACT.

V & C Semeniuk Research Group. (1997). Mapping and classification of wetlands from Augusta to Walpole in the south-west of Western Australia. Water and Rivers Commission, Perth.

Walker, F. W., Jones, H. J. and Klunzinger, M. W. (2014). Bivalves in a bottleneck: taxonomy, phylogeography and conservation of freshwater mussels (Bivalvia: Unionoida) in Australasia. *Hydrobiologia* 735: 61-79.

WAM, Western Australian Museum. (2024a). WAM Collections Databases: Mollusca. Unpublished data set provided by the Western Australian Museum.

WAM, Western Australian Museum. (2024b). WAM Collections Databases: Crustacea. Unpublished data set provided by the Western Australian Museum.

WAM, Western Australian Museum. (2024c). WAM Collections Databases: Insecta. Unpublished data set provided by the Western Australian Museum.

WAM, Western Australian Museum. (2024d). WAM Collections Databases: Arachnida/Myriapoda. Unpublished data set provided by the Western Australian Museum.

Wardell-Johnson, G., Roberts, J. D., Driscoll, D. and Williams, K. (1995). NON CURRENT Orange-bellied and White-bellied Frogs Recovery Plan - 1992 - 2001. CALM, Perth, WA.

Western Australian Government. (2005). Environmental Protection (Environmentally Sensitive Areas) Notice 2005.

Appendices

We design with community in mind

Appendix A Database Search Results

Table A- 1: Crustacea results from WAM database search in the vicinity of the Study Area.

Order	Taxa
Amphipoda	*Amphipoda sp.*
	Ampithoe geographe
	Austrothoe ochos
	Exemption vasse
	Melita oba
	Paragrubia dongara
	Paranexes yallingup
	Sunamphitoe jonathani
	Sunamphitoe naturaliste
	Sunamphitoe stevesmithi
	Totgammarus eximius
	Wesniphargus nichollsi
Arguloidea	*Argulus macropterus*
Cyclopoida	*Bomolochidae sp.*
	Neocyclops australiensis
Decapoda	*Actaea calculosa*
	Actaemorpha sp.
	Alpheus novaezealandiae
	Alpheus parasocialis
	Alpheus sp.
	Aniculus sp.
	Calcinus dapsiles
	Calcinus sp.
	Caridea sp.
	Ceratoplax glaberrima
	Cherax bicarinatus
	Cherax cainii
	Cherax crassimanus
	Cherax glaber

	Cherax glabrimanus
	Cherax neocarinatus
	Cherax preissii
	Cherax quinquecarinatus
	Cherax sp.
	Cherax spp.
	Cherax tenuimanus
	Clibanarius taeniatus
	Cryptodromia hilgendorfi
	Dromiidae sp.
	Engaewa pseudoreducta
	Engaewa reducta
	Engaewa similis
	Eplumula australiensis
	Fultodromia nodipes
	Gomeza bicornis
	Heteropanope serratifrons
	Latreillia sp.
	Leptomithrax sternocostulatus
	Lomis hirta
	Majidae sp.
	Megametope carinatus
	Metapenaeopsis novaeguineae
	Naxia tumida
	Naxia spinosa
	Nectocarcinus spinifrons
	Ocypode convexa
	Ovalipes punctatus
	Ozius truncatus
	Paguristes purpureantennatus
	Paguristes sulcatus

	Pagurus sinuatus
	Palaemonetes australis
	Paraxiopsis brocki
	Pilumnopeus serratifrons
	Pilumnus rufopunctatus
	Portunus armatus
	Stenopus?
	Trachypenaeus curvirostris
	Trigonoplax longirostris
	Upogebia bowerbankii
Diplostraca	*Lynceus tatei*
Euphausiacea	*Euphausia mutica*
	Stylocheiron carinatum
	Stylocheiron micropthalma
	Thysanopoda tricuspidata
Harpacticoida	*Kinnecaris eberhardi*
Isopoda	*Buddelundia `sp. 6 (Judd 2002)`*
	Buddelundia nigripes
	Eurygastor? sp.
	Hanoniscus `sp. 1 (Judd 2002)`
	Isopoda sp.
	Laevophiloscia `sp. 1 (Judd 2002)`
	Laevophiloscia `sp. 2 (Judd 2002)`
	Marine isopod
	Philosciidae sp.
	Platyarthridae `sp. 1 (Judd 2002)`
	Pseudodiploexochus `sp. 1 (Judd 2002)`
	Pseudodiploexochus `sp. 2 (Judd 2002)`
	Pseudolaureola wilsmorei
	Spherillo `sp. 5 (Judd 2002)`
	Styloniscidae sp.

	Styloniscus `sp. 1 (Judd 2002)`
	Styloniscus `sp. 7 (Judd 2002)`
Pedunculata	*Ibla quadrivalvis*
	Smilium peronii
Podocopida	*Acandona admiratio*
	Entocytheridae sp.
Sessilia	*Acasta sp.*
	Amphibalanus sp.
	Austromegabalanus nigrescens
	Balanus trigonus
	Elminius covertus
	Epopella simplex
	Tetraclitella purpurascens
	Tetrapachylasma ferrugomaculosa
Siphonostomatoida	*Caligus pelamydis*
	Hatschekia sp.

Table A- 2: Arachnida results from WAM Database search in the vicinity of the Study Area.

Order	Scientific Name
Acari	*Acari sp.*
	Neopilionidae sp.
	Oribatida sp.
Araneae	*sp.*
	`570 group` `sp.`
	`cf. Oreo` sp.
	`Chenistonia` sp.
	`Ctenopalpus` `sp.`
	`Diaea` sp.
	`Dipoena` `HMS group C` `setosa (hadC7?)`
	`Fissidentati` sp.
	`Forsterina?` `Glenbourne sp. 2`
	`Forsterina?` `sp. A`
	`Genus 2` `Glenbourne sp. 1`
	`Genus indet.` `HMS group D`
	`Genus indet.` `sp. A?`
	`Genus indet.` `sp. B`
	`Genus indet.` `sp. C`
	`Genus indet.` `sp. D`
	`Genus indet.` `sp. E`
	`Genus indet.` `sp. F`
	`Genus indet.` `sp. G`
	`Genus indet.` `sp. H`
	`Genus indet.` `sp. indet. (juvenile)`
	`Genus indet.` sp.
	`Heurodes` `sp. 03(VWF790)`
	`Heurodes` `turritus`
	`HMS group B` `HadB5`
	`HMS group C` `HadC13`

	`HMS group D`
	`HMS group G` sp.
	`Holoplatys spp. grp` sp.
	`Jotus` michaelseni
	`Laperousea?` `sp. D`
	`Lepthyphantes?` `sp. E`
	`Lycidas` `big embolus`
	`Lycidas` sp.
	`Maratus` `sp.`
	`Miturgopelma` `WA247`
	`Miturgopelma` sp.
	`New Genus A` sp.
	`Pelicinus?` sp.
	`Phoroncidia?` sp.
	`Rebilus`
	`sp. G` sp.
	`Zoridae?` sp.
	Achaearanea sp.
	Adoxotoma sexmaculata
	Amaurobiidae sp.
	Aname `mainae`
	Aname `MYG010`
	Aname `MYG036`
	Aname `MYG184`
	Aname sp.
	Anapidae sp.
	Anzacia sp.
	Arachnura higginsi
	Arachnura sp.
	Araneae sp.
	Araneus eburneiventris

	Argiope `trifasciata (juvenile)`
	Argiope protensa
	Argiope trifasciata
	Argoctenus `sp. A`
	Argyrodes `antipodianus spp. group`
	Argyrodes `fissifrons spp. group.`
	Argyrodes sp.
	Ariadna sp.
	Arkys sp.
	Arkys walckenaeri
	Artoria `sp. (VWF142)`
	Artoria `sp. (VWF142)`
	Artoria `sp.`
	Artoria cingulipes
	Artoria flavimana
	Artoria linnaei
	Artoria sp.
	Artoria taeniifera
	Artoriopsis expolita
	Asadipus kunderang
	Asianopis schomburgki
	Austracantha minax
	Australomimetus diabolicus
	Australomimetus djuka
	Australomimetus sp.
	Australomimetus tasmaniensis
	Australomisidia sp.
	Baalzebub sp.
	Backobourkia `sp. indet. (juvenile)`
	Backobourkia brounii
	Backobourkia heroine

	Badumna microps
	Badumna sp.
	Baiami `sp. indet. (juvenile)`
	Baiami `sp.`
	Baiami `tegenarioides?`
	Baiami sp.
	Baiami tegenarioides
	Baiami torbayensis
	Baiami volucripes
	Bertmainius opimus
	Carepalxis `sp. 4`
	Carepalxis `sp. 7`
	Carepalxis `sp. indet. (juvenile)`
	Carepalxis `sp.`
	Chasmocephalon sp.
	Cheiracanthium `sp. A`
	Cheiracanthium `sp. A`
	Cheiracanthium `sp. A`
	Chenistonia boranup
	Clubiona `sp. 91`
	Clubiona `sp. A`
	Clubiona sp.
	Corasoides `Glenbourne sp. 1`
	Corasoides occidentalis
	Corasoides sp.
	Crustulina bicruciata
	Cyatholipidae sp.
	Cyclosa `sp. (VWF720)`
	Cyclosa `sp. (VWF792)`
	Cyclosa trilobata
	Cyrtophora parnasia

	Cytaea `sp.`
	Damoetas sp.
	Delena lapidicola
	Delena sp.
	Deliochus zelivira
	Desidae sp.
	Diaea `pilula?`
	Dingosa `sp. indet. (juvenile)`
	Dolophones `sp. (VWF771)`
	Dolophones `sp. (VWF774)`
	Emertonella maga
	Encoptarthria
	Encoptarthria `sp. A`
	Encoptarthria `sp. B`
	Encoptarthria echemophthalma
	Episinus `sp. A`
	Episinus sp.
	Eriophora `pustulosa group`
	Eriophora pustulosa
	Euoplos sp.
	Euryopis `sp. 1`
	Euryopis `sp. A`
	Euryopis `sp. B`
	Euryopis sp.
	Forsterina sp.
	Gnaphosidae sp.
	Grymeus `platnicki`
	Grymeus `sp. A`
	Grymeus sp.
	Habronestes `sp. A, australiensis group`
	Habronestes `sp. B, pictus group`

	Habronestes `sp. B`
	Habronestes sp.
	Hestimodema `Gen. 1, sp. 1`
	Hestimodema `Glenbourne`
	Hestimodema `McKenzie1`
	Hestimodema sp.
	Holasteron aspinosum
	Holoplatys sp.
	Hortophora biapicata
	Idiosoma sp.
	Isopeda leishmanni
	Kangarosa properipes
	Karaops ellenae
	Lampona brevipes
	Lampona cylindrata
	Lamponella ainslie
	Latrodectus hasseltii
	Leucauge sp.
	Linyphiidae sp.
	Lycidas `speckled`
	Lycidas chlorophthalmus
	Lycidas michaelseni
	Lycosa gilberta
	Lycosidae sp.
	Maratus boranup
	Maratus fletcheri
	Maratus madelineae
	Maratus pavonis
	Maratus pinniger
	Matilda `sp. A`
	Micropholcomma `sp. A`

	Micropholcommatinae sp.
	Missulena granulosa
	Missulena hoggi
	Missulena occatoria
	Missulena sp.
	Mituliodon tarantulinus
	Miturga sp.
	Miturgidae sp.
	Molycriinae sp.
	Myrmarachne `sp. indet. (juvenile)`
	Myrmopopaea sp.
	Nanometa sp.
	Neoscona `sp.`
	Neosparassus `sp. A`
	Neosparassus `sp. B`
	Neosparassus diana
	Neosparassus sp.
	Neosparassus sp.
	Neostorena `sp. A`
	Neostorena `sp. B`
	Nicodamus mainae
	Nyssus coloripes
	Nyssus sp.
	Oecobius navus
	Opisthoncus `Glenbourne sp. 1`
	Opopaea sp.
	Orchestina sp.
	Ornodolomedes nicholsoni
	Orsolobidae sp.
	Oxyopes `sp.`
	Oxyopes gracilipes

	Ozarchaea harveyi
	Paraplectanoides crassipes
	Pelicinus `sp. A`
	Pelicinus sp.
	Pentasteron `sp. A`
	Pentasteron `sp. nov.`
	Pentasteron intermedium
	Pholcomma sp.
	Pholcus phalangioides
	Phonognatha melania
	Phonognatha sp.
	Phoroncidia `sp. 1`
	Phryganoporus `sp. A`
	Phryganoporus nigrinus
	Phycosoma `L1-complex`
	Phycosoma sp.
	Pinkfloydia `sp. indet. (juvenile)`
	Pinkfloydia harveii
	Plebs cyphoxis
	Plebs eburnus
	Prionosternum nitidiceps
	Prodidomidae sp.
	Proshermacha `MYG434`
	Proshermacha `MYG434` `voucher MYG434`
	Proshermacha `MYG488`
	Proshermacha `MYG488` `voucher MYG494`
	Proshermacha `sp. indet. (female)`
	Proshermacha `sp. indet. (juvenile)`
	Proshermacha sp.
	Raveniella peckorum
	Salsa recherchensis

	Salticidae sp.
	Salticidae sp.
	Scytodes thoracica
	Servaea spinibarbis
	Sidymella `Glenbourne sp. 1`
	Sidymella `Glenbourne sp. 2`
	Sidymella `Glenbourne sp. 3`
	Sidymella `Machado sp. nov. 1`
	Sidymella `sp.`
	Simaetha tenuior
	Socca pustulosa
	Socca senicaudata
	Sondra `Glenbourne sp. 1`
	Sondra sp.
	Sparassidae sp.
	Steatoda `native sp.`
	Steatoda `sp. A`
	Steatoda grossa
	Stephanopis `sp.`
	Stephanopis barbipes
	Stephanopis sp.
	Storena formosa
	Storosa `grayi`
	Storosa `sp. A`
	Storosa `sp. B`
	Storosa sp.
	Storosa tetrica
	Synothele `new sp. 91`
	Tamopsis perthensis
	Tamopsis sp.
	Taphiassa robertsi

	Taphiassa robertsi
	Tasmanicosa leuckartii
	Tasmanoonops `augusta`
	Tetragnatha sp.
	Tharpyna sp.
	Theridiidae sp.
	Theridiosomatidae sp.
	Toxops `sp.`
	Trachycosmus sculptilis
	Trachytrema castaneum
	Trichonephila edulis
	Venator `cf. immansuetus`
	Venator `VWF sp. 138`
	Venator `VWF sp. 139`
	Venator `VWF sp. 140`
	Venator immansuetus
	Venatrix pullastra
	Westrarchaea pusilla
	Xestaspis `sp. A`
	Xestaspis sp.
	Zephyrarchaea janineae
	Zodariidae sp.
	Zoridae sp.
Cephalostigmata	*Cephalostigmata sp.*
Chordeumatida	*Australeuma sp.*
Euonychorphora	*Kumbadjena occidentalis*
	Kumbadjena sp.
Geophilida	*Chilenophilidae sp.*
	Geophilida sp.
	Mecistocephalidae sp.
Ixodida	*`Haemaphysalis?` `sp. indet. (larva)`*

	Amblyomma `sp. indet. (larva)`
	Amblyomma triguttatum triguttatum
	Bothriocroton hydrosauri
	Ixodes australiensis
	Ixodes sp.
Julida	*Ommatoiulus moreleti*
Lithobiida	*Henicops dentatus*
	Lithobiida sp.
Opiliones	*`?Neopilionidae` sp.*
	`Calliuncus?` `sp. indet. (juvenile)`
	`Calliuncus?` sp.
	`Genus 3` sp.
	`Genus 5` sp.
	`Genus 7?` sp.
	`Genus 8` sp.
	`Genus indet.` sp.
	`Nunciella?` `sp.`
	`Perthacantha?` sp.
	Ballarra longipalpus
	Calliuncus labyrinthus
	Calliuncus sp.
	Megalopsalis `sp.`
	Megalopsalis minima
	Megalopsalis porongorupensis
	Megalopsalis sp.
	Megalopsalis walpolensis
	Neopilionidae sp.
	Nunciella `sp. 3`
	Nunciella `sp. 4`
	Nunciella aspera
	Nunciella sp.

	Opiliones sp.
	Perthacantha `sp.`
	Perthacantha sp.
	Triaenobunus `sp. nov.`
	Triaenonychidae sp.
Pantopoda	*Ammothea australiensis*
Polydesmida	*`Akamptogonus?` sp.*
	`Paradoxosomatidae?` sp.
	Akamptogonus novarae
	Antichiropodini `sp. indet. (juveniles)`
	Antichiropodini sp.
	Antichiropus `DIP080, GB1`
	Antichiropus `DIP080, GB1`
	Antichiropus `DIP110`
	Antichiropus `DIP238`
	Antichiropus `DIP238` `voucher DIP238`
	Antichiropus `DIP244`
	Antichiropus `sp. indet. (female)`
	Antichiropus `sp. indet. (juvenile)`
	Antichiropus `sp. indet. (male)`
	Antichiropus sp.
	Dalodesmidae sp.
	Oxidus gracilis
	Paradoxosomatidae sp.
	Polydesmida sp.
	Solaenodolichopus pruvoti
Polyzoniida	*`DIPAAG` `DIP193`*
	Polyzoniida sp.
	Siphonotidae sp.
	Siphonotus flavomarginatus
Pseudoscorpiones	*Austrochthonius*

	Austrochthonius `PSE188, similis`
	Austrochthonius `PSE189, austini`
	Austrochthonius `sp. indet. (juvenile)`
	Austrochthonius sp.
	Beierolpium `sp.`
	Calymmachernes angulatus
	Chthoniidae sp.
	Conicochernes crassus
	Geogarypus taylori
	Lagynochthonius australicus
	Lagynochthonius australicus `australicus`
	Nesidiochernes
	Nesidiochernes `sp.`
	Oratemnus curtus
	Protochelifer `sp.`
	Protochelifer cavernarum
	Protochelifer sp.
	Pseudotyrannochthonius `Northern Warren`
	Pseudotyrannochthonius giganteus
	Solinus `sp. indet.`
	Synsphyronus magnus
Sarcoptiformes	*Acaridae sp.*
	Cytostethum tasmaniense
Scolopendrida	*Cormocephalus aurantiipes*
	Cormocephalus hartmeyeri
	Cormocephalus novaehollandiae
	Cormocephalus strigosus
	Cryptopidae sp.
	Cryptops sp.
	Scolopendra laeta
Scorpiones	*Cercophonius `sp.`*

	Cercophonius `sulcatus?`
	Cercophonius granulosus
	Cercophonius sp.
	Cercophonius sulcatus
	Lychas `austroccidentalis`
	Scorpiones sp.
	Urodacus `armatus`
	Urodacus `sp. A`
	Urodacus novaehollandiae
	Urodacus sp.
Scutigerida	*Allothereua maculata*
	Allothereua sp.
	Prothereua `sp.`
Spirostreptida	*Atelomastix nigrescens*
	Iulomorphidae sp.
	Podykipus sp.
	Spirostreptida sp.
	Spirostreptida sp.
	Spirostreptida sp.
Trombidiformes	*Australotiphys barmutai*
	Chaussieria warregense
	Chyzeriidae sp.
	Neocaeculus sp.
	Trombidiidae sp.
	Diplopoda sp.
	Diplopoda sp.
	Diplopoda sp.

Table A- 3: WA Herbarium Database search in the vicinity of the Study Area.

Group/Plant Family	Scientific Name	Common Name	BC Act
Fabaceae	*Acacia inops*		P3
Fabaceae	*Acacia lateriticola var. Glabrous variant (B.R. Maslin 6765)*		P3
Fabaceae	*Acacia tayloriana*		P4
Apiaceae	*Actinotus repens*		P3
Proteaceae	*Adenanthos detmoldii*	Scott River Jugflower	P4
Proteaceae	*Adenanthos x pamela*		P4
Amanitaceae	*Amanita fibrillopes*		P3
Ericaceae	*Andersonia ferricola*		P1
Ericaceae	*Andersonia sp. Amabile (N. Gibson & M. Lyons 355)*		P3
Fabaceae	*Aotus carinata*		P4
Myrtaceae	*Astartea onycis*		P4
Proteaceae	*Banksia meisneri subsp. Ascendens*	Scott River Banksia	P4
Proteaceae	*Banksia nivea subsp. uliginosa*	Swamp Honeypot	T
Proteaceae	*Banksia sessilis var. cordata*		P4
Asteraceae	*Blennospora doliiformis*		P3
Rutaceae	*Boronia anceps*		P3
Rutaceae	*Boronia exilis*	Scott River Boronia	T
Orchidaceae	*Caladenia abbreviata*	Coastal Spider Orchid	P3
Myrtaceae	*Calothamnus lateralis var. crassus*		P3
Cyperaceae	*Caustis sp. Boyanup (G.S. McCutcheon 1706)*		P3
Restionaceae	*Chordifex gracilior*		P3
Restionaceae	*Chordifex jacksonii*		P3
Fabaceae	*Chorizema carinatum*		P3
Proteaceae	*Conospermum quadripetalum*		T
Cyperaceae	*Cyathochaeta stipoides*		P3
Cyperaceae	*Cyathochaeta teretifolia*		P3
Goodeniaceae	*Dampiera heteroptera*		P3
Myrtaceae	*Darwinia ferricola*	Scott River Darwinia	T

Orchidaceae	*Diuris heberlei*	Heberle's Donkey Orchid	P2
Orchidaceae	*Drakaea micrantha*	Dwarf Hammer-orchid	T
Droseraceae	*Drosera binata*		P2
Droseraceae	*Drosera fimbriata*	Manypeaks Sundew	P4
Fabaceae	*Gastrolobium formosum*		P3
Haloragaceae	*Gonocarpus pusillus*		P4
Haloragaceae	*Gonocarpus simplex*		P4
Proteaceae	*Grevillea brachystylis subsp. australis*		T
Proteaceae	*Grevillea manglesioides subsp. ferricola*		P3
Proteaceae	*Grevillea papillosa*		P3
Lamiaceae	*Hemigenia obovata*		P1
Lamiaceae	*Hemigenia sp. Nillup (R.D. Royce 98)*		P2
Restionaceae	*Hypolaena robusta*		P4
Proteaceae	*Isopogon formosus subsp. dasylepis*		P3
Proteaceae	*Lambertia orbifolia subsp. Scott River Plains (L.W. Sage 684)*		T
Proteaceae	*Lambertia orbifolia subsp. vespera*	Scott River Honeysuckle	T
Asteraceae	*Leptinella drummondii*		P3
Santalaceae	*Leptomeria dielsiana*	Diels' Currant Bush	EX
Santalaceae	*Leptomeria furtiva*		P2
Restionaceae	*Lepyrodia extensa*		P2
Restionaceae	*Lepyrodia heleocharoides*		P3
Ericaceae	*Leucopogon alternifolius*		P3
Ericaceae	*Leucopogon incisus*		P2
Ericaceae	*Leucopogon wheelerae*		P3
Stylidiaceae	*Levenhookia preissii*	Preiss's Stylewort	P1
Restionaceae	*Loxocarya magna*		P3
Cyperaceae	*Machaerina ascendens*		P2
Myrtaceae	*Melaleuca basicephala*		P4
Haloragaceae	*Myriophyllum trifidum*	Three-lobed Meziella	P4
Myrtaceae	*Pericalymma megaphyllum*		P1

Philydraceae	*Philydrella pygmaea subsp. Minima*		P1
Violaceae	*Pigea volubilis*		P2
Restionaceae	*Platychorda rivalis*		P1
Fabaceae	*Pultenaea pinifolia*		P3
Fabaceae	*Pultenaea skinneri*		P4
Cyperaceae	*Reedia spathacea*	Reedia	T
Cyperaceae	*Schoenus indutus*		P1
Cyperaceae	*Schoenus loliaceus*		P2
Rhamnaceae	*Stenanthemum sublineare*		P2
Stylidiaceae	*Stylidium leeuwinense*		P4
Stylidiaceae	*Stylidium sp. Scott River Plain (N.G. Marchant 74/23)*		P1
Stylidiaceae	*Stylidium trudgenii*		P3
Ericaceae	*Styphelia intricata*		P2
Proteaceae	*Synaphea macrophylla*		P1
Proteaceae	*Synaphea nexosa*		P1
Proteaceae	*Synaphea otiostigma*		P3
Proteaceae	*Synaphea petiolaris subsp. Simplex*		P3
Asparagaceae	*Thysanotus formosus*		P1
Cyperaceae	*Tricostularia davisii*	Davis' Tricostularia	P3
Celastraceae	*Tripterococcus sp. Brachylobus (A.S. George 14234)*		P4
Myrtaceae	*Verticordia lehmannii*		P4
Myrtaceae	*Verticordia plumosa var. vassensis*	Vasse Featherflower	T
Xyridaceae	*Xyris maxima*		P2

Table A- 4: Birdata Database search results in the viscintiy of the Study Area.

Common Name	Scientific Name	EPBC Act
Inland Thornbill	*Acanthiza apicalis*	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	
Western Thornbill	*Acanthiza inornata*	
Western Spinebill	*Acanthorhynchus superciliosus*	
Collared Sparrowhawk	*Accipiter cirrocephalus*	
Brown Goshawk	*Accipiter fasciatus*	
Australian Reed-Warbler	*Acrocephalus australis*	
Common Sandpiper	*Actitis hypoleucos*	
Australian Owlet-nightjar	*Aegotheles cristatus*	
Grey Teal	*Anas gracilis*	
Pacific Black Duck	*Anas superciliosa*	
Australasian Darter	*Anhinga novaehollandiae*	
Red Wattlebird	*Anthochaera carunculata*	
Western Wattlebird	*Anthochaera lunulata*	
Australasian Pipit	*Anthus novaeseelandiae*	
Wedge-tailed Eagle	*Aquila audax*	
Great Egret	*Ardea alba*	
White-necked Heron	*Ardea pacifica*	
Flesh-footed Shearwater	*Ardenna carneipes*	
Wedge-tailed Shearwater	*Ardenna pacifica*	
Short-tailed Shearwater	*Ardenna tenuirostris*	
Ruddy Turnstone	*Arenaria interpres*	
Black-faced Woodswallow	*Artamus cinereus*	
Dusky Woodswallow	*Artamus cyanopterus*	
Hardhead	*Aythya australis*	
Australian Ringneck	*Barnardius zonarius*	
Musk Duck	*Biziura lobata*	
Cattle Egret	*Bubulcus ibis*	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	

Sharp-tailed Sandpiper	*Calidris acuminata*	VU
Sanderling	*Calidris alba*	
Red Knot	*Calidris canutus*	VU
Curlew Sandpiper	*Calidris ferruginea*	CR
Red-necked Stint	*Calidris ruficollis*	
Long-toed Stint	*Calidris subminuta*	
Great Knot	*Calidris tenuirostris*	VU
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	VU
Brown Skua	*Catharacta antarctica*	
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	
Shining Bronze-Cuckoo	*Chalcites lucidus*	
Greater Sand Plover	*Charadrius leschenaultii*	VU
Red-capped Plover	*Charadrius ruficapillus*	
Australian Wood Duck	*Chenonetta jubata*	
Whiskered Tern	*Chlidonias hybrida*	
Swamp Harrier	*Circus approximans*	
Banded Stilt	*Cladorhynchus leucocephalus*	
Rufous Treecreeper	*Climacteris rufus*	
Grey Shrike-thrush	*Colluricincla harmonica*	
Rock Dove	*Columba livia*	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	
Australian Raven	*Corvus coronoides*	
Stubble Quail	*Coturnix pectoralis*	
Grey Butcherbird	*Cracticus torquatus*	
Black Swan	*Cygnus atratus*	
Laughing Kookaburra	*Dacelo novaeguineae*	
Varied Sittella	*Daphoenositta chrysoptera*	
Wandering Albatross	*Diomedea exulans*	
Emu	*Dromaius novaehollandiae*	
Little Egret	*Egretta garzetta*	
White-faced Heron	*Egretta novaehollandiae*	

Eastern Reef Egret	*Egretta sacra*	
Black-shouldered Kite	*Elanus axillaris*	
Black-fronted Dotterel	*Elseyornis melanops*	
Galah	*Eolophus roseicapilla*	
Western Yellow Robin	*Eopsaltria griseogularis*	
White-fronted Chat	*Epthianura albifrons*	
Brown Falcon	*Falco berigora*	
Nankeen Kestrel	*Falco cenchroides*	
Australian Hobby	*Falco longipennis*	
Peregrine Falcon	*Falco peregrinus*	
Crested Shrike-tit	*Falcunculus frontatus*	
Eurasian Coot	*Fulica atra*	
Dusky Moorhen	*Gallinula tenebrosa*	
Singing Honeyeater	*Gavicalis virescens*	
Western Gerygone	*Gerygone fusca*	
Tawny-crowned Honeyeater	*Gliciphila melanops*	
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	
Magpie-lark	*Grallina cyanoleuca*	
Australian Magpie	*Gymnorhina tibicen*	
Sooty Oystercatcher	*Haematopus fuliginosus*	
Australian Pied Oystercatcher	*Haematopus longirostris*	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	
Whistling Kite	*Haliastur sphenurus*	
Pallid Cuckoo	*Heteroscenes pallidus*	
Little Eagle	*Hieraaetus morphnoides*	
Pied Stilt	*Himantopus leucocephalus*	
Welcome Swallow	*Hirundo neoxena*	
Caspian Tern	*Hydroprogne caspia*	
Australian Little Bittern	*Ixobrychus dubius*	
Black Bittern	*Ixobrychus flavicollis*	
White-winged Triller	*Lalage tricolor*	

Kelp Gull	*Larus dominicanus*	
Silver Gull	*Larus novaehollandiae*	
Pacific Gull	*Larus pacificus*	
Brown Honeyeater	*Lichmera indistincta*	
Bar-tailed Godwit	*Limosa lapponica*	EN
Black-tailed Godwit	*Limosa limosa*	
Square-tailed Kite	*Lophoictinia isura*	
Southern Giant-Petrel	*Macronectes giganteus*	EN
Red-winged Fairy-wren	*Malurus elegans*	
Splendid Fairy-wren	*Malurus splendens*	
White-naped Honeyeater	*Melithreptus lunatus*	
Rainbow Bee-eater	*Merops ornatus*	
Little Pied Cormorant	*Microcarbo melanoleucos*	
Black Kite	*Milvus migrans*	
Australasian Gannet	*Morus serrator*	
Restless Flycatcher	*Myiagra inquieta*	
Elegant Parrot	*Neophema elegans*	
Rock Parrot	*Neophema petrophila*	
Southern Boobook	*Ninox boobook*	
Barking Owl	*Ninox connivens*	
Whimbrel	*Numenius phaeopus*	
Helmeted Guineafowl	*Numida meleagris*	
Nankeen Night-Heron	*Nycticorax caledonicus*	
Crested Pigeon	*Ocyphaps lophotes*	
Bridled Tern	*Onychoprion anaethetus*	
Blue-billed Duck	*Oxyura australis*	
Golden Whistler	*Pachycephala pectoralis*	
Rufous Whistler	*Pachycephala rufiventris*	
Slender-billed Prion	*Pachyptila belcheri*	
Osprey	*Pandion haliaetus*	
Spotted Pardalote	*Pardalotus punctatus*	

Striated Pardalote	*Pardalotus striatus*	
White-faced Storm-Petrel	*Pelagodroma marina*	
Australian Pelican	*Pelecanus conspicillatus*	
Fairy Martin	*Petrochelidon ariel*	
Tree Martin	*Petrochelidon nigricans*	
Scarlet Robin	*Petroica boodang*	
Red-capped Robin	*Petroica goodenovii*	
Great Cormorant	*Phalacrocorax carbo*	
Black-faced Cormorant	*Phalacrocorax fuscescens*	
Little Black Cormorant	*Phalacrocorax sulcirostris*	
Great Pied Cormorant	*Phalacrocorax varius*	
Common Bronzewing	*Phaps chalcoptera*	
Brush Bronzewing	*Phaps elegans*	
White-cheeked Honeyeater	*Phylidonyris niger*	
New Holland Honeyeater	*Phylidonyris novaehollandiae*	
Yellow-billed Spoonbill	*Platalea flavipes*	
Royal Spoonbill	*Platalea regia*	
Western Rosella	*Platycercus icterotis*	
Glossy Ibis	*Plegadis falcinellus*	
Pacific Golden Plover	*Pluvialis fulva*	
Grey Plover	*Pluvialis squatarola*	
Tawny Frogmouth	*Podargus strigoides*	
Hoary-headed Grebe	*Poliocephalus poliocephalus*	
Regent Parrot	*Polytelis anthopeplus*	
Little Grassbird	*Poodytes gramineus*	
Purple Swamphen	*Porphyrio porphyrio*	
Little Shearwater	*Puffinus assimilis*	
Hutton's Shearwater	*Puffinus huttoni*	
Red-capped Parrot	*Purpureicephalus spurius*	
White-breasted Robin	*Quoyornis georgianus*	
Red-necked Avocet	*Recurvirostra novaehollandiae*	

Grey Fantail	*Rhipidura albiscapa*	
Willie Wagtail	*Rhipidura leucophrys*	
White-browed Scrubwren	*Sericornis frontalis*	
Weebill	*Smicrornis brevirostris*	
Australasian Shoveler	*Spatula rhynchotis*	
Laughing Dove	*Spilopelia senegalensis*	
Red-eared Firetail	*Stagonopleura oculata*	
Pomarine Jaeger	*Stercorarius pomarinus*	
Little Tern	*Sternula albifrons*	
Fairy Tern	*Sternula nereis*	VU
Southern Emu-wren	*Stipiturus malachurus*	
Grey Currawong	*Strepera versicolor*	
Brown Quail	*Synoicus ypsilophorus*	
Australasian Grebe	*Tachybaptus novaehollandiae*	
Australian Shelduck	*Tadorna tadornoides*	
Indian Yellow-nosed Albatross	*Thalassarche carteri*	
Shy Albatross	*Thalassarche cauta*	
Black-browed Albatross	*Thalassarche melanophris*	
Greater Crested Tern	*Thalasseus bergii*	
Hooded Plover	*Thinornis cucullatus*	
Australian White Ibis	*Threskiornis moluccus*	
Straw-necked Ibis	*Threskiornis spinicollis*	
Sacred Kingfisher	*Todiramphus sanctus*	
Wood Sandpiper	*Tringa glareola*	
Common Greenshank	*Tringa nebularia*	EN
Marsh Sandpiper	*Tringa stagnatilis*	
Painted Button-quail	*Turnix varius*	
Barn Owl	*Tyto alba*	
Masked Owl	*Tyto novaehollandiae*	
Banded Lapwing	*Vanellus tricolor*	

Baudin's Black-Cockatoo	*Zanda baudinii*	EN
Carnaby's Black-Cockatoo	*Zanda latirostris*	EN
Baillon's Crake	*Zapornia pusilla*	
Spotless Crake	*Zapornia tabuensis*	
Silvereye	*Zosterops lateralis*	

DESIGN WITH
COMMUNITY
IN MIND

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. That's why at Stantec, we always design with community in mind.

We care about the communities we serve—because they're our communities too. This allows us to assess what's needed and connect our expertise, to appreciate nuances and envision what's never been considered, to bring together diverse perspectives so we can collaborate toward a shared success.

We're designers, engineers, scientists, and Project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in Projects that advance the quality of life in communities across the globe.

Stantec trades on the TSX and the NYSE under the symbol STN.
Visit us at stantec.com or find us on social media.

Ground Floor, 226 Adelaide Terrace, PERTH WA 6000

Tel: +61 8 6222 7000 | www.stantec.com

Appendix B Hydrogeology Borelogs

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

Hole No: WM1-W-S01

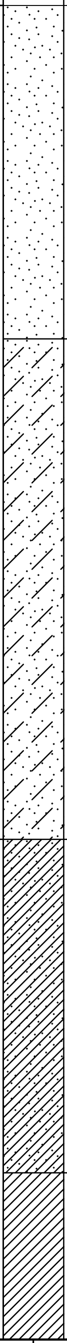
Sheet: 1 of 2

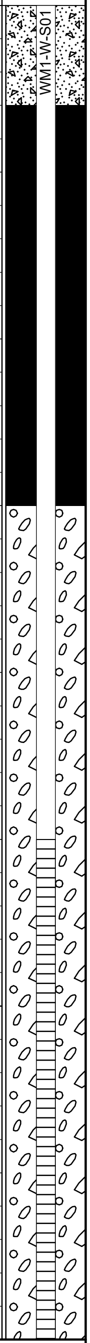
Position: E340844.970 N6215378.790 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 35.140 m AHD
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech
Data Started: 12/3/24
Date Completed: 12/3/24
Logged By: NM
Checked By:

Method	Casing	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Observations / Description of Defects	Water Level
DPP	N/A	0.00–1.00m	Quaternary Dune Deposits	SAND (SP): fine to medium-grained; sub-rounded to sub-angular; quartz; pale brown, mottled orange-brown; trace silt, non-plastic; trace rootlets to 0.2m depth. (Aeolian)	Uc	0.00: Stickup: 0.5m	
		1.00–2.50m	Quaternary Dune Deposits	Clayey SAND (SC): fine to medium-grained; sub-rounded to sub-angular; quartz & iron oxide; grey, mottled yellow-brown; clay, low plasticity. (Aeolian)			
		2.50–3.50m	Leederville Formation	Sandy CLAY (CI): medium plasticity; grey; sand, fine to medium grained, sub-rounded to angular, quartz & lithics. (Residual)	Wk		▽ 3.0
		3.50–4.00m	Leederville Formation	Organic CLAY (OH): medium to high plasticity; dark grey to black; trace sand, fine-grained, quartz & lithics. (Residual).			

RL (m AHD): 35.0, 34.5, 34.0, 33.5, 33.0, 32.5, 32.0, 31.5
Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5

Average Natural Defect Spacing (mm): 20, 60, 200, 600, 2000





DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽ Water Level on date shown
► water inflow
◄ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

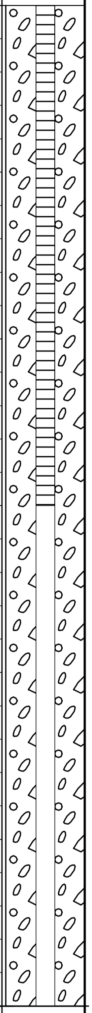
STANTEC AUSTRALIA PTY LTD

CORE LOG SHEET

Hole No: WM1-W-S01

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017
Sheet: 2 of 2
Position: E340844.970 N6215378.790 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 35.140 m AHD
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech
Data Started: 12/3/24
Date Completed: 12/3/24
Logged By: NM
Checked By:

Drilling: Method	Drilling: Casing	Drilling: Core Run	RL (m AHD)	Depth (m)	Material Description: Geology	Material Description: Graphic Log	Material Description: LITHOLOGY	Material Description: Weathering / Cementation	Material Description: Strength / Density / Consistency	Material Description: Sample or Field Test	Material Description: TCR (%)	Defect Description: RQD (%)	Defect Description: Average Natural Defect Spacing (mm) 20 60 200 600 2000	Defect Description: Observations / Description of Defects	Water Level	Monitoring Well Details
DPP			31.0 30.5 30.0 29.5 29.0 28.5	4.5 5.0 5.5 6.0 6.5 7.0	Leederville Formation		Organic CLAY (OH): high plasticity; black. (Residual) 7.00m	Wk								
			28.0 27.5	7.5			TERMINATED AT 7.00 m Target depth Soil Logging									



DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER
- ▽ Water Level on date shown
- ► water inflow
- ◄ water outflow

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TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY	
PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
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VN	Veneer (thin or patchy)
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Stantec

CORE BOX - PHOTO SHEET Hole ID: WM1-W-S01

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

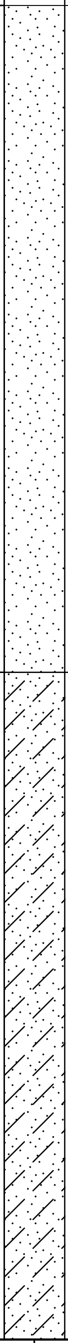
Job No: 304501017

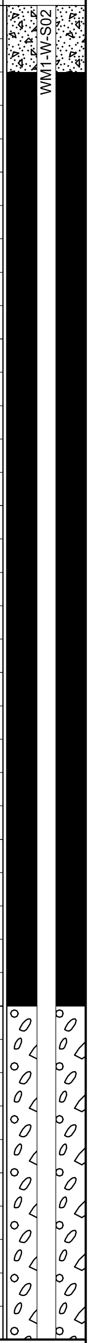
WM1-W-S01: 0 - 7m, Boxes 1

CORE LOG SHEET

Client: Synergy RED			**Hole No: WM1-W-S02**
Project: Beenup Wind Farm Project			
Location: Shire of Augusta Margaret River		**Job No: 304501017**	**Sheet: 1 of 2**
Position: E341131.110 N6215376.110 50 MGA94		**Angle from Horizontal: 90°**	**Surface Elevation: 36.350 m AHD**
Rig Type: Geoprobe 7822dt		**Mounting: Light Vehicle**	**Contractor: National Geotech**
Data Started: 12/3/24	**Date Completed: 12/3/24**	**Logged By: NM**	**Checked By:**

Drilling: Method	Drilling: Casing	Drilling: Core Run	RL (m AHD)	Depth (m)	Material Description: Geology	Material Description: Graphic Log	Material Description: LITHOLOGY	Material Description: Weathering / Cementation	Material Description: Strength / Density / Consistency	Material Description: Sample or Field Test	Material Description: TCR (%)	Defect Description: RQD (%)	Defect Description: Average Natural Defect Spacing (mm) 20 60 200 600 2000	Defect Description: Observations / Description of Defects	Defect Description: Water Level	Defect Description: Monitoring Well Details
DPP	N/A		36.0 35.5 35.0 34.5	0.5 1.0 1.5 2.00m	Quaternary Dune Deposits		SAND (SP): fine to medium-grained; sub-rounded to sub-angular; quartz; dark brown to grey; trace silt, non-plastic; trace rootlets to 0.8m depth (Aeolian).	Uc						0.00: Stickup: 0.65m		WM1-W-S02
			34.0 33.5 33.0 32.5	2.0 2.5 3.0 3.5	Leederville Formation		Clayey SAND (SC): fine to coarse-grained; sub-rounded to sub-angular; quartz; grey; clay, low to medium-plasticity. (Residual)								Whilst Drilling	





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Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

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CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

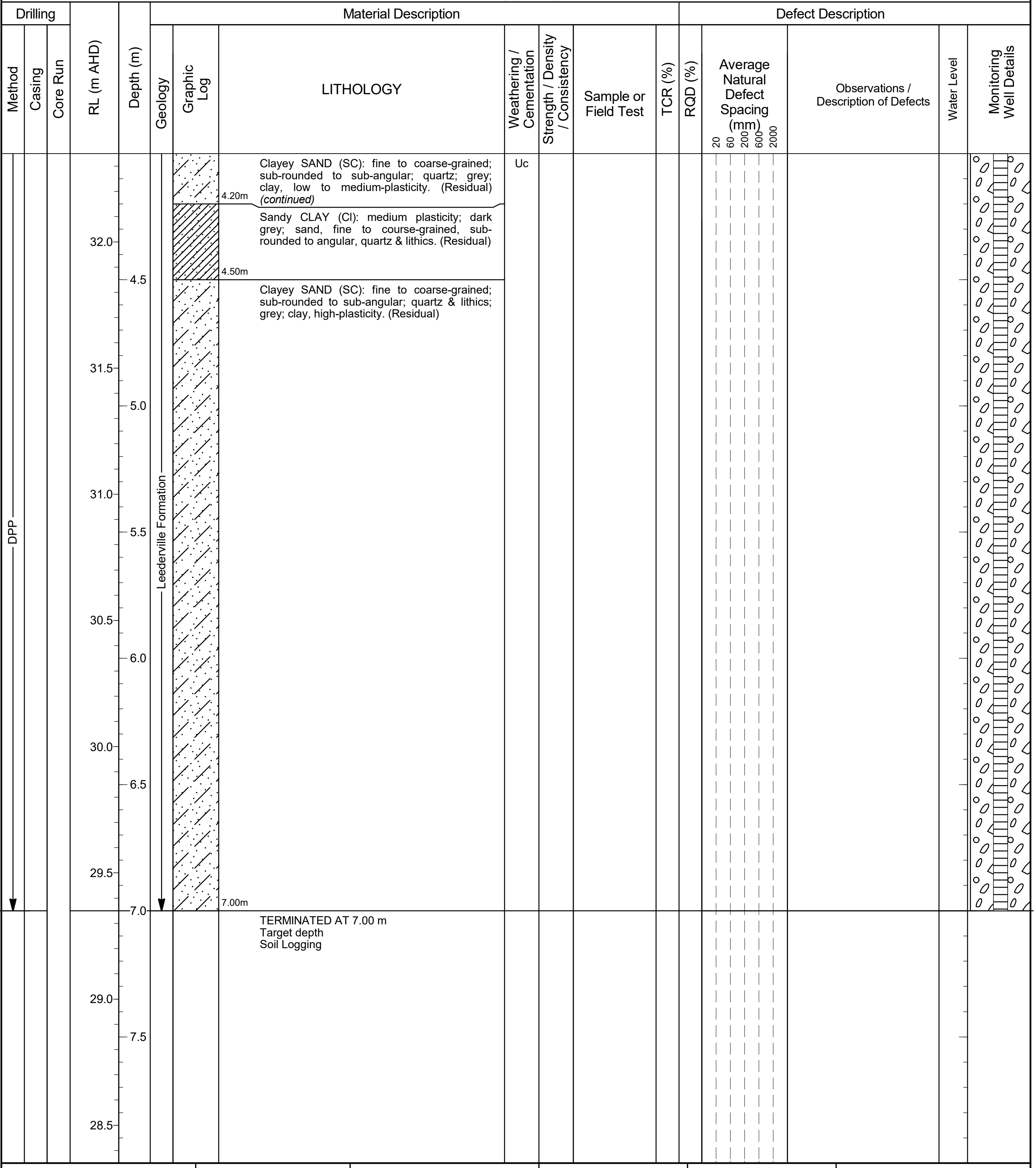
Hole No: WM1-W-S02

Sheet: 2 of 2

Position: E341131.110 N6215376.110 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 36.350 m AHD

Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 12/3/24
Date Completed: 12/3/24
Logged By: NM
Checked By:



Clayey SAND (SC): fine to coarse-grained; sub-rounded to sub-angular; quartz; grey; clay, low to medium-plasticity. (Residual) *(continued)*

Sandy CLAY (CI): medium plasticity; dark grey; sand, fine to course-grained, sub-rounded to angular, quartz & lithics. (Residual)

Clayey SAND (SC): fine to coarse-grained; sub-rounded to sub-angular; quartz & lithics; grey; clay, high-plasticity. (Residual)

TERMINATED AT 7.00 m
Target depth
Soil Logging

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►—	water inflow
—◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

2023_03_16_STANTEC PERTH GEOTECH LIBRARY - UPDATE 2024-03-06.GLB Log STANTEC PERTH HYBRID LOG - 05/03/2024 XBEENUP HYDRO LOGS.GPJ <<DrawingFile>> 30/05/2024 17:00 10.03.00.09 Datgel AGS RTA, Photo, Monitoring Tools

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

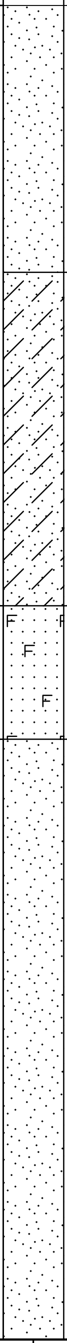
Job No: 304501017

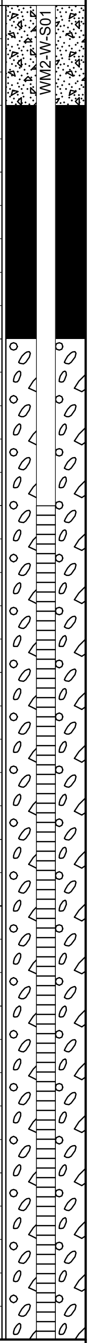
Hole No: WM2-W-S01

Sheet: 1 of 2

Position: E343226.910 N6208201.060 50 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 28.920 m AHD
Rig Type: Geoprobe 7822dt	**Mounting:** Light Vehicle	**Contractor:** National Geotech
Data Started: 13/3/24 **Date Completed:** 13/3/24	**Logged By:** NM	**Checked By:**

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A			0.00	Quaternary Dune Deposits	SAND (SP): fine to medium-grained; sub-rounded to rounded; quartz; grey; trace silt, non-plastic; trace rootlets to 0.1m depth. (Aeolian)	Uc						0.00: Stickup: 0.6m		WM2-W-S01
			28.5	0.5											
				0.80m		Clayey SAND (SC): fine to medium-grained; sub-angular to sub-rounded; quartz; pale brown; trace clayey fines, low plasticity. (Aeolian)									
			28.0	1.0											
			27.5	1.5											
				1.80m	DII Duricrust	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust)									
			27.0	2.0											
				2.20m	Quaternary Dune Deposits	SAND (SP): fine to medium-grained; sub-rounded to rounded; quartz & organics; black; with clay, low-plasticity. (Aeolian)	Wk								
			26.5	2.5											
														▽ Whilst Drilling	
			26.0	3.0											
			25.5	3.5											
			25.0												





DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER	
▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS	
RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY	
PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS	
X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

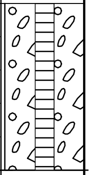
CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

Hole No: WM2-W-S01

Sheet: 2 of 2

Position: E343226.910 N6208201.060 50 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 28.920 m AHD
Rig Type: Geoprobe 7822dt	**Mounting:** Light Vehicle	**Contractor:** National Geotech
Data Started: 13/3/24 **Date Completed:** 13/3/24	**Logged By:** NM	**Checked By:**

Drilling: Method	Casing	Core Run	RL (m AHD)	Depth (m)	Material Description: Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	Defect Description: RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP						4.30m	SAND (SP): fine to medium-grained; sub-rounded to rounded; quartz & organics; black; with clay, low-plasticity. (Aeolian) *(continued)*	Wk								
			24.5	4.5		4.50m	Sandy CLAY (CI): medium plasticity; dark brown to dark grey; sand, fine to medium-grained, sub-rounded to rounded, quartz & organics. (Alluvial).	Uc								
							TERMINATED AT 4.50 m Target Water Contact Soil Logging									
			24.0	5.0												
			23.5	5.5												
			23.0	6.0												
			22.5	6.5												
			22.0	7.0												
			21.5	7.5												
			21.0													

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶—	water inflow
—◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

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CORE BOX - PHOTO SHEET

Hole ID: WM2-W-S01

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM2-W-S01: 0 - 4.5m

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CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

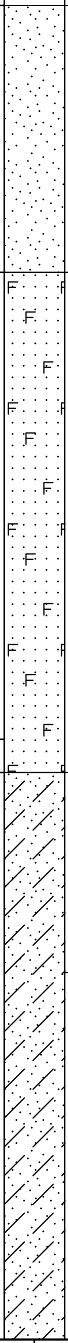
Hole No: WM2-W-S02

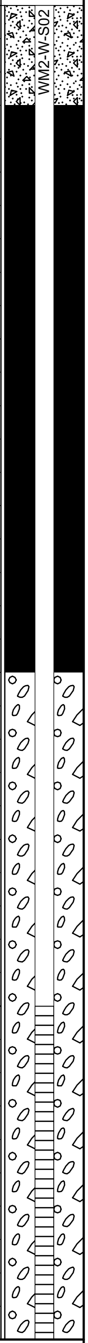
Sheet: 1 of 2

Position: E342827.500 N6208156.170 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 27.450 m AHD
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech
Data Started: 12/3/24
Date Completed: 12/3/24
Logged By: NM
Checked By:

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A			0.00–0.80m	Quaternary Dune Deposits	SAND (SP): fine to medium-grained; sub-rounded to sub-angular; quartz; brown; trace silt, non-plastic; trace rootlets to 0.1m depth. (Aeolian)	Uc						0.00: Stickup: 0.6m		WM2-W-S02
				0.80–2.30m	DII Duricrust	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).									
				2.30–2.90m	Quaternary Dune Deposits	Clayey SAND (SC): fine to medium-grained; sub-rounded to rounded; quartz; mottled white-brown to grey; clay, low plasticity. (Aeolian)	Wk								
				2.90m–		Clayey SAND (SC): fine to medium-grained; sub-rounded to rounded; quartz & organics; dark grey to black; clay, low plasticity. (Aeolian)								Whilst Drilling	

RL (m AHD): 27.0, 26.5, 26.0, 25.5, 25.0, 24.5, 24.0, 23.5
Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5





DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ► water inflow
- ◄ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

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CORE LOG SHEET

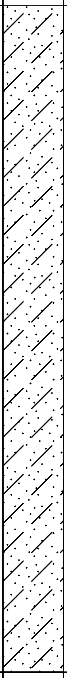
Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

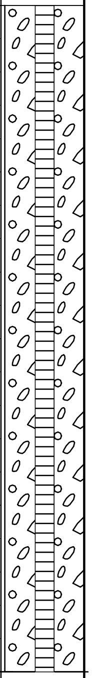
Hole No: WM2-W-S02

Sheet: 2 of 2

Position: E342827.500 N6208156.170 50 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 27.450 m AHD
Rig Type: Geoprobe 7822dt	**Mounting:** Light Vehicle	**Contractor:** National Geotech
Data Started: 12/3/24 **Date Completed:** 12/3/24	**Logged By:** NM	**Checked By:**

Drilling: Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP			23.0 22.5 22.0 21.5	4.5 5.0 5.5 6.0	Quaternary Dune Deposits	6.00m	Clayey SAND (SC): fine to medium-grained; sub-rounded to rounded; quartz & organics; dark grey to black; clay, low plasticity. (Aeolian) *(continued)*	Wk Uc								
			21.0 20.5 20.0 19.5	6.5 7.0 7.5			TERMINATED AT 6.00 m Target depth Soil Logging									





DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- ► water inflow
- ◄ water outflow

ROCK QUALITY DESCRIPTIONS	
RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY	
PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS	
X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM2-W-S02

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM2-W-S02: 0 - 6m

2023_03_16_STANTEC PERTH GEOTECH LIBRARY - UPDATE 2024-03-06.GLB GrfcText CORE BOX PHOTO 2 PHOTOS PER PAGE BEENUP HYDRO LOGS.GPJ <<DrawingFile>> 30/05/2024 15:27

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CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

Hole No: WM3-N-S01

Job No: 304501017
Sheet: 1 of 1

Position: E343246.590 N6211039.500 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 33.840 m AHD

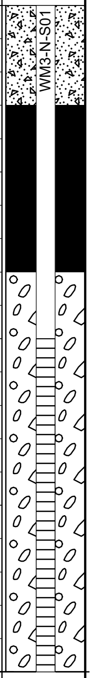
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 14/3/24
Date Completed: 14/3/24
Logged By: NM
Checked By:

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm)	Observations / Description of Defects	Water Level
DPP	N/A			0.00–1.00m	Quaternary Dune Deposits	SAND (SP): fine to medium-grained; sub-angular to rounded; quartz; grey; trace silt, non-plastic; trace rootlets to 0.1m. (Aeolian)	Uc						0.00: Stickup: 0.6m	
				1.00–1.80m		SAND (SP): fine to medium-grained; sub-angular to rounded; quartz; dark brown; with silt/clay, low plasticity. (Aeolian) From 1.4m... mottled orange-brown								
				1.80–2.00m		Clayey SAND (SC): fine to medium-grained, sub-rounded to sub-angular; quartz & organics; black; clay, low plasticity. (Laucustrine)	Wk							Whilst Drilling (2.0)
				2.0		TERMINATED AT 2.00 m Refusal Soil Logging								

RL (m AHD): 33.5, 33.0, 32.5, 32.0, 31.5, 31.0, 30.5, 30.0
Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5
Average Natural Defect Spacing (mm): 20, 60, 200, 600, 2000

Monitoring Well Details



DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
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L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
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HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-N-S01

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

PROJECT NAME: Beenup Wind Farm
PROJECT NUMBER: 304501017
DATE: 14/03/2024
BOREHOLE ID: WM3-N-S01
DEPTH: 0 to 2m

WM3-N-S01: 0 - 2m

Stantec

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

Hole No: WM3-N-S02 (A)
Job No: 304501017
Sheet: 1 of 1

Position: E343265.730 N6211102.080 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 33.710 m AHD

Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 14/3/24
Date Completed: 14/3/24
Logged By: NM
Checked By:

Drilling					Material Description						Defect Description				
Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level
DPP	N/A			0.20m	QDD		SAND (SP): fine to medium grained; sub-angular to sub-rounded; quartz; yellow, mottled orange; trace silt, non-plastic; trace rootlets to 0.1m depth. (Aeolian)	Uc							
			33.5	0.40m	DII	F F	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).							0.40: Well Install	
				0.5			TERMINATED AT 0.40 m Refusal Soil Logging							NO WELL INSTALLATION DEPTH TOO SHALLOW	
			33.0												
				1.0											
			32.5												
				1.5											
			32.0												
				2.0											
			31.5												
				2.5											
			31.0												
				3.0											
			30.5												
				3.5											
			30.0												

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

2023_03_16_STANTEC PERTH GEOTECH LIBRARY - UPDATE 2024-03-06.GLB Log STANTEC PERTH - HYBRID LOG - 05/03/2024 XBEENUP HYDRO LOGS.GPJ <<DrawingFile>> 30/05/2024 17:01 10.03.00.09 Datgel AGS RTA, Photo, Monitoring Tools

CORE BOX - PHOTO SHEET Hole ID: WM3-N-S02 (A)

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-N-S02 (A): 0 - 0.4m

Stantec

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

Hole No: WM3-N-S02 (B)

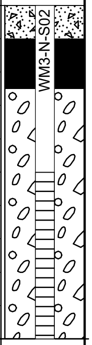
Job No: 304501017 **Sheet:** 1 of 1

Position: E343265.730 N6211102.080 50 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:** 33.710 m AHD

Rig Type: Geoprobe 7822dt **Mounting:** Light Vehicle **Contractor:** National Geotech

Data Started: 14/3/24 **Date Completed:** 14/3/24 **Logged By:** NM **Checked By:**

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm)	Observations / Description of Defects	Water Level
DPP	N/A			0.00–0.30m	QDD	Clayey SAND (SC): fine to medium-grained; sub-rounded to sub-angular; quartz; orange-brown; trace clay, low to medium plasticity. (Aeolian)	Uc						0.00: Stickup: 0.6m	
DPP / AD/V				0.30–1.00m	DI - DII Duricrust	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).								
				1.00m		TERMINATED AT 1.00 m Refusal Soil Logging								



Monitoring Well Details

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET Hole ID: WM3-N-S02 (B)

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

PROJECT NAME: Beenup Wind Farm
PROJECT NUMBER: 304501017
DATE: 14/03/2024
BOREHOLE ID: WM3-N-S02b
DEPTH: 0 to 1m

WM3-N-S02 (B): 0 - 1m

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

Hole No: WM3-N-S03

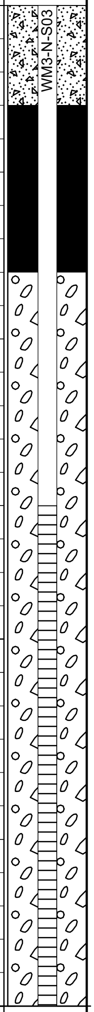
Sheet: 1 of 1

Position: E343304.400 N6211216.990 50 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 34.000 m AHD
Rig Type: Geoprobe 7822dt	**Mounting:** Light Vehicle	**Contractor:** National Geotech
Data Started: 14/3/24 **Date Completed:** 14/3/24	**Logged By:** NM	**Checked By:**

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level
DPP	N/A			0.00–0.50		SAND (SP): medium to fine-grained; sub-angular to sub-rounded; quartz; pale grey to grey; trace silt, non-plastic; trace rootlets to 0.1m. (Aeolian)	Uc						0.00: Stickup: 0.6m	
			33.5	0.50–1.40		SAND (SP): fine to medium-grained; sub-angular to sub-rounded; quartz; pale brown; with clayey fines; low plasticity. (Aeolian)								
				1.40–1.50		Clayey SAND (SC): fine to medium-grained; sub-angular to sub-rounded; quartz; brown to red brown; clay, low to medium plasticity. (Aeolian)								
			32.5	1.50–3.00		Clayey SAND (SC): fine to medium-grained; sub-angular to sub-rounded; quartz & organics; dark brown; clay, medium plasticity. (Aeolian)	Wk							Whilst Drilling
			31.0	3.00		TERMINATED AT 3.00 m Target depth Soil Logging								

33.5 — 0.5; 33.0 — 1.0; 32.5 — 1.5; 32.0 — 2.0; 31.5 — 2.5; 31.0 — 3.0; 30.5 — 3.5

Monitoring Well Details



DRILLING		**WATER**	**ROCK STRENGTH**		**DEFECT TYPE**		**PLANARITY**		**COATING**	
AD/V	Solid flight auger: V-Bit	▽ Water Level on date shown	EH	Extremly High	J	Joint	PL	Planar	CN	Clean
AD/T	Solid flight auger: TC-Bit	▶— water inflow	VH	Very High	P	Parting	IR	Irregular	STN	Stained
HFA	Hollow flight auger	—◀ water outflow	H	High	SM	Seam	CU	Curved	VN	Veneer (thin or patchy)
WB	Washbore drilling		M	Medium	SZ	Sheared zone	DIS	Discontinuous	CT	Coating (up to 1mm)
RR	Rock roller		L	Low	FL	Foliation	ST	Stepped	**INFILL MATERIALS**	
PQ	Rotary core (85mm)	**ROCK QUALITY DESCRIPTIONS**	VL	Very Low	V	Vein	UN	Undulose	X	Carbonaceus
HQ	Rotary core (63.5mm)	RQD Rock Quality Designation (%)	**ROCK WEATHERING**		CSM	Crushed Seam	**ROUGHNESS**		MU	Unidentified minteral
NMLC	Rotary core (51.94mm)	TCR Total Core Recovery (%)	FR	Fresh	FZ	Fracture Zone	VR	Very Rough	MS	Secondary mineral
DT	Diatube concrete coring		SW	Slightly Weathered	HB	Handing Break	RO	Rough	KT	Chlorite
PT	Push tube		MW	Moderately Weathered	DB	Drilling Break	SO	Smooth	CA	Calcite
PS	Percussion sampling		HW	Highly Weathered			SL	Slockensided	Fe	Iron Oxide
SON	Sonic drilling		XW	Extremly Weathered			POL	Polished	Qz	Quartz
AH	Air hammer									

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-N-S03

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-N-S03: 0 - 3m

CORE LOG SHEET

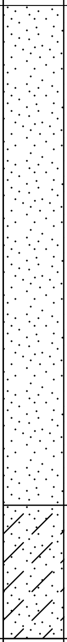
Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

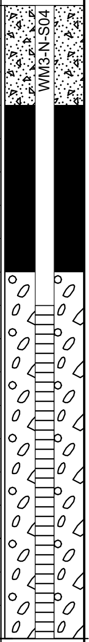
Hole No: WM3-N-S04

Sheet: 1 of 1

Position: E343223.940 N6211480.060 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 34.790 m AHD
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech
Data Started: 14/3/24
Date Completed: 14/3/24
Logged By: NM
Checked By:

Drilling					Material Description						Defect Description					
Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A		34.5 34.0 33.5	0.5 1.0 1.5		1.50m	SAND (SP): fine to medium-grained; sub-rounded to sub-angular; quartz; pale grey; trace silt, non-plastic; trace rootlets to 0.1m depth. (Aeolian)	Uc						0.00: Stickup: 0.6m		WM3-N-S04
			33.0			1.90m	Clayey SAND (SC): fine to medium-grained; sub-rounded to sub-angular; quartz & organics; dark brown; silty/clayey fines, low to medium plasticity. (Aeolian)	Wk							Whilst Drilling	
			32.5 32.0 31.5 31.0	2.0 2.5 3.0 3.5			TERMINATED AT 1.90 m Refusal Soil Logging									





DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-N-S04

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-N-S04: 0 - 1.9m

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

Hole No: WM3-W-S01

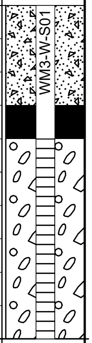
Job No: 304501017
Sheet: 1 of 1

Position: E343118.740 N6210924.010 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 33.670 m AHD

Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 14/3/24
Date Completed: 14/3/24
Logged By: NM
Checked By:

Drilling					Material Description							Defect Description				
Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A			0.00			SAND (SP): fine to medium-grained; sub-rounded to sub-angular; quartz; dark brown to grey; trace silt, non-plastic; trace rootlets to 0.6m depth (Aeolian).	Uc						0.00: Stickup: 0.6m		WM3-W-S01
			33.5													
				0.5												
			33.0													
				0.80m		F F	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).	Wk								
				1.00m			TERMINATED AT 1.00 m Refusal Soil Logging									
			32.5													
				1.5												
			32.0													
				2.0												
			31.5													
				2.5												
			31.0													
				3.0												
			30.5													
				3.5												
			30.0													



DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-W-S01

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

PROJECT NAME: Beenup Wind Farm
PROJECT NUMBER: 304501017
DATE: 14/03/2024
BOREHOLE ID: WM3-W-S01
DEPTH: 0 to 1m

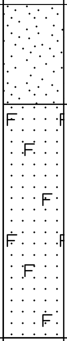
WM3-W-S01: 0 - 1m

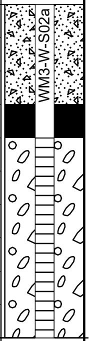
Stantec

CORE LOG SHEET

Client: Synergy RED **Project:** Beenup Wind Farm Project **Location:** Shire of Augusta Margaret River		**Job No: 304501017**	**Hole No: WM3-W-S02 (A)** **Sheet: 1 of 1**
Position: E343059.020 N6210916.440 50 MGA94		**Angle from Horizontal: 90°**	**Surface Elevation: 33.340 m AHD**
Rig Type: Geoprobe 7822dt		**Mounting: Light Vehicle**	**Contractor: National Geotech**
Data Started: 13/3/24	**Date Completed: 13/3/24**	**Logged By: NM**	**Checked By:**

Drilling: Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	Material Description: LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Defect Description: Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A					0.30m	SAND (SP): fine to medium-grained; sub-angular to sub-rounded; quartz and ferricrete fragments; orange-brown. (Aeolian)	Uc						0.00: Stickup: 0.6m		WM3-W-S02a
			33.0	0.5		1.00m	FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).									
			32.5	1.0			TERMINATED AT 1.00 m Target depth Soil Logging									
			32.0	1.5												
			31.5	2.0												
			31.0	2.5												
			30.5	3.0												
			30.0	3.5												
			29.5													





DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶—	water inflow
—◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-W-S02 (A)

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

PROJECT NAME: Beenup Wind Farm
PROJECT NUMBER: 304501017
DATE: 13/03/2024
BOREHOLE ID: WM3 - W - S02(A)
DEPTH: 0m to 1m

WM3-W-S02 (A): 0 - 1m

CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River

Hole No: WM3-W-S02 (B)

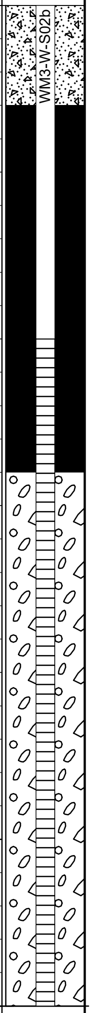
Job No: 304501017

Sheet: 1 of 1

Position: E343058.710 N6210917.830 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 33.350 m AHD

Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 13/3/24
Date Completed: 13/3/24
Logged By: NM
Checked By:



Drilling					Material Description							Defect Description					
Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A		33.0 32.5	0.5 1.0			SAND (SP): fine to medium-grained; sub-angular to sub-rounded; quartz; greay; trace silt, non-plastic; trace rootlets to 0.1m depth. (Aeolian) 1.00m	Uc						0.00: Stickup: 0.6m		
			32.0 31.5 31.0	1.5 2.0 2.5			SAND (SP): fine to medium-grained; sub-angular to rounded; quartz; pale to dark orange-brown; with silty fines, low plasticity. (Aeolian) 2.50m									
			30.5	3.0			Clayey SAND (SC): fine to medium-grained; sub-angular to sub-rounded; quartz; grey; clay, low to medium plasticity. (Aeolian). 3.00m	Wk							▽ Whilst Drilling	
			30.0 29.5	3.5			TERMINATED AT 3.00 m Target depth Soil Logging									

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

2023_03_16_STANTEC PERTH GEOTECH LIBRARY - UPDATE 2024-03-06.GLB Log STANTEC PERTH - HYBRID LOG - 05/03/2024 XBEENUP HYDRO LOGS.GPJ <<DrawingFile>> 30/05/2024 17:01 10.03.00.09 Datgel AGS RTA, Photo, Monitoring Tools

CORE BOX - PHOTO SHEET

Hole ID: WM3-W-S02 (B)

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-W-S02 (B): 0 - 3m

Stantec

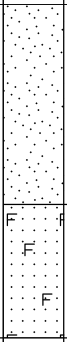
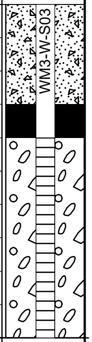
CORE LOG SHEET

Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017
Hole No: WM3-W-S03
Sheet: 1 of 1

Position: E342987.260 N6210892.360 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 33.870 m AHD

Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech

Data Started: 13/3/24
Date Completed: 13/3/24
Logged By: NM
Checked By:

Drilling					Material Description						Defect Description					
Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A			0.60m			SAND (SP): fine to medium-grained; sub-angular to sub-rounded; quartz; greay; trace silt, non-plastic. (Aeolian)	Uc						0.00: Stickup: 0.6m		
				1.00m			FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).									
							TERMINATED AT 1.00 m Target depth Soil Logging									

RL (m AHD)	Depth (m)
33.5	
	0.5
33.0	
	1.0
32.5	
	1.5
32.0	
	2.0
31.5	
	2.5
31.0	
	3.0
30.5	
	3.5
30.0	

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

2023_03_16_STANTEC PERTH GEOTECH LIBRARY - UPDATE 2024-03-06.GLB Log STANTEC PERTH - HYBRID LOG - 05/03/2024 XBEENUP HYDRO LOGS.GPJ <<DrawingFile>> 30/05/2024 17:01 10.03.00.09 Datgel AGS RTA, Photo, Monitoring Tools

0
1
1
2
2
3
3
4
PROJECT NAME: Beenup Wind Farm
PROJECT NUMBER: 304501017
DATE: 13/03/2024
BOREHOLE ID: WM3-W-S03
DEPTH: 0m to 1m

WM3-W-S03: 0 - 1m

Stantec

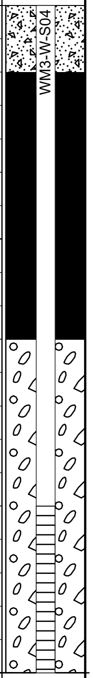
CORE LOG SHEET

Client: Synergy RED	**Hole No: WM3-W-S04**
Project: Beenup Wind Farm Project	
Location: Shire of Augusta Margaret River	**Job No: 304501017** — **Sheet: 1 of 1**
Position: E342901.620 N6210922.540 50 MGA94	**Angle from Horizontal:** 90° — **Surface Elevation:** 33.140 m AHD
Rig Type: Geoprobe 7822dt	**Mounting:** Light Vehicle — **Contractor:** National Geotech
Data Started: 13/3/24 — **Date Completed:** 13/3/24	**Logged By:** NM — **Checked By:**

Drilling: Method	Drilling: Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A		33.0	0.00–0.80m			SAND (SP): fine to medium-grained, sub-rounded to sub-angular, quartz; grey; trace silt, non-plastic; rootlets to 0.1m depth (Aeolian).	Uc						0.00: Stickup: 0.6m	Whilst Drilling	
AD/V			32.5	0.80–1.80m			FERRICRETE: fine to coarse grained; sub-rounded to angular clasts, quartz & iron oxide; red-brown. (Duricrust).									
AD/V			31.5	1.80–2.00m			SAND (SP): fine to medium-grained; sub-rounded to sub-angular, quartz & organics; black; with silt, non-plastic. (Aeolian)	Wk								
			31.0	2.0			TERMINATED AT 2.00 m Target depth Soil Logging									

RL (m AHD): 33.0, 32.5, 32.0, 31.5, 31.0, 30.5, 30.0, 29.5

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5



DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ▶— water inflow
- —◀ water outflow

ROCK QUALITY DESCRIPTIONS	
RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY	
PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS	
X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET

Hole ID: WM3-W-S04

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-W-S04: 0 - 2m

Stantec

CORE LOG SHEET

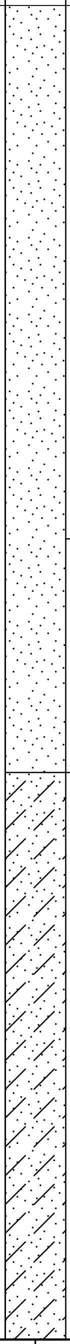
Client: Synergy RED
Project: Beenup Wind Farm Project
Location: Shire of Augusta Margaret River
Job No: 304501017

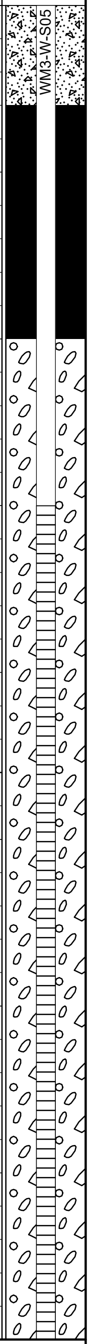
Hole No: WM3-W-S05

Sheet: 1 of 2

Position: E342692.990 N6210889.200 50 MGA94
Angle from Horizontal: 90°
Surface Elevation: 32.500 m AHD
Rig Type: Geoprobe 7822dt
Mounting: Light Vehicle
Contractor: National Geotech
Data Started: 13/3/24
Date Completed: 13/3/24
Logged By: NM
Checked By:

Drilling: Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP	N/A			0.00		SAND (SP): fine to medium-grained, subangular to rounded; quartz; dark brown to grey; trace silt, non-plastic; trace rootlets <0.1m. (Aeolian)	Uc						0.00: Stickup: 0.6m		WM3-W-S05
			32.0	0.5											
			31.5	1.0											
			31.0	1.5											
				1.60m		SAND (SP): fine to medium-grained; sub-angular to rounded; quartz &organics; dark brown-black; with silt and clay, low plasticity. (Aeolian)									
			30.5	2.0											
				2.30m		Clayey SAND (SC): fine to medium-grained, sub-angular to sub-rounded, quartz; brown; trace silt, low to medium plasticity. (Aeolian)	Wk							Whilst Drilling	
			30.0	2.5											
			29.5	3.0											
			29.0	3.5											





DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ▶— water inflow
- —◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

Stantec

CORE LOG SHEET

Client: Synergy RED **Project:** Beenup Wind Farm Project **Location:** Shire of Augusta Margaret River	**Job No: 304501017**	**Hole No: WM3-W-S05** **Sheet: 2 of 2**
Position: E342692.990 N6210889.200 50 MGA94	**Angle from Horizontal: 90°**	**Surface Elevation: 32.500 m AHD**
Rig Type: Geoprobe 7822dt	**Mounting: Light Vehicle**	**Contractor: National Geotech**
Data Started: 13/3/24 **Date Completed: 13/3/24**	**Logged By: NM**	**Checked By:**

Method	Casing	Core Run	RL (m AHD)	Depth (m)	Geology	Graphic Log	LITHOLOGY	Weathering / Cementation	Strength / Density / Consistency	Sample or Field Test	TCR (%)	RQD (%)	Average Natural Defect Spacing (mm) 20 60 200 600 2000	Observations / Description of Defects	Water Level	Monitoring Well Details
DPP						4.30m	Clayey SAND (SC): fine to medium-grained, sub-angular to sub-rounded, quartz; brown; trace silt, low to medium plasticity. (Aeolian) *(continued)*	Wk								
			28.0	4.5		4.50m	SAND (SP): fine to medium-grained, sub-angular to sub-rounded, quartz & organics; dark brown-black; trace silt, non-plastic. (Aeolian)	Uc								
							TERMINATED AT 4.50 m Target Water Contact Soil Logging									
			27.5	5.0												
			27.0	5.5												
			26.5	6.0												
			26.0	6.5												
			25.5	7.0												
			25.0	7.5												

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

Water Level on date shown
► water inflow
◄ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

J	Joint
P	Parting
SM	Seam
SZ	Sheared zone
FL	Foliation
V	Vein
CSM	Crushed Seam
FZ	Fracture Zone
HB	Handing Break
DB	Drilling Break

PLANARITY

PL	Planar
IR	Irregular
CU	Curved
DIS	Discontinuous
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
STN	Stained
VN	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

STANTEC AUSTRALIA PTY LTD

CORE BOX - PHOTO SHEET Hole ID: WM3-W-S05

Client: Synergy Australia
Project: Beenup Wind Farm
Location: Beenup, WM-01

Job No: 304501017

WM3-W-S05: 0 - 4.5m

Appendix C Hydrogeology Figures

Beenup Wind Farm

Preliminary Geotechnical and Baseline Contamination Investigation

Test Location Plan
Project Code: 304501017
Drawn By: Singh, Edvinder, Checked By: BP
Date: (2024-06-21)
Appendix A - Figure 1.1 - Site Plan Overview

Stantec

Legend

▭ Boundary Extents

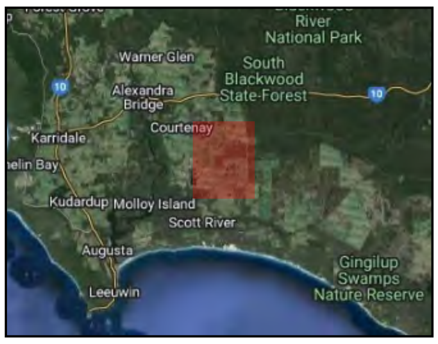
Geotechnical Investigation Type

- ● Geotechnical Boreholes (WM)
- ● Shallow Wells
- ▚ Geotechnical Test Pits (TP)

0 500 1,000 m

Scale at A3: 1:30000

Key Map



Beenup Wind Farm

Preliminary Geotechnical and Baseline Contamination Investigation

Test Location Plan
Project Code: 304501017
Drawn By: Singh, Edvinder, Checked By: BP
Date: (2024-06-21)
Appendix A - Figure 1.2 - WM01 Overview

Stantec

Legend

▭ Boundary Extents

Geotechnical Investigation Type

- ◐ Geotechnical Boreholes (WM)
- ◐ Shallow Wells
- ▚ Geotechnical Test Pits (TP)

0 100 200 m

Scale at A3: 1:10000

Key Map

Beenup Wind Farm

Preliminary Geotechnical and Baseline Contamination Investigation

Test Location Plan
Project Code: 304501017
Drawn By: Singh, Edvinder, Checked By: BP
Date: (2024-06-21)
Appendix A - Figure 1.3 - WM02 Overview

Stantec

Legend

▭ Boundary Extents

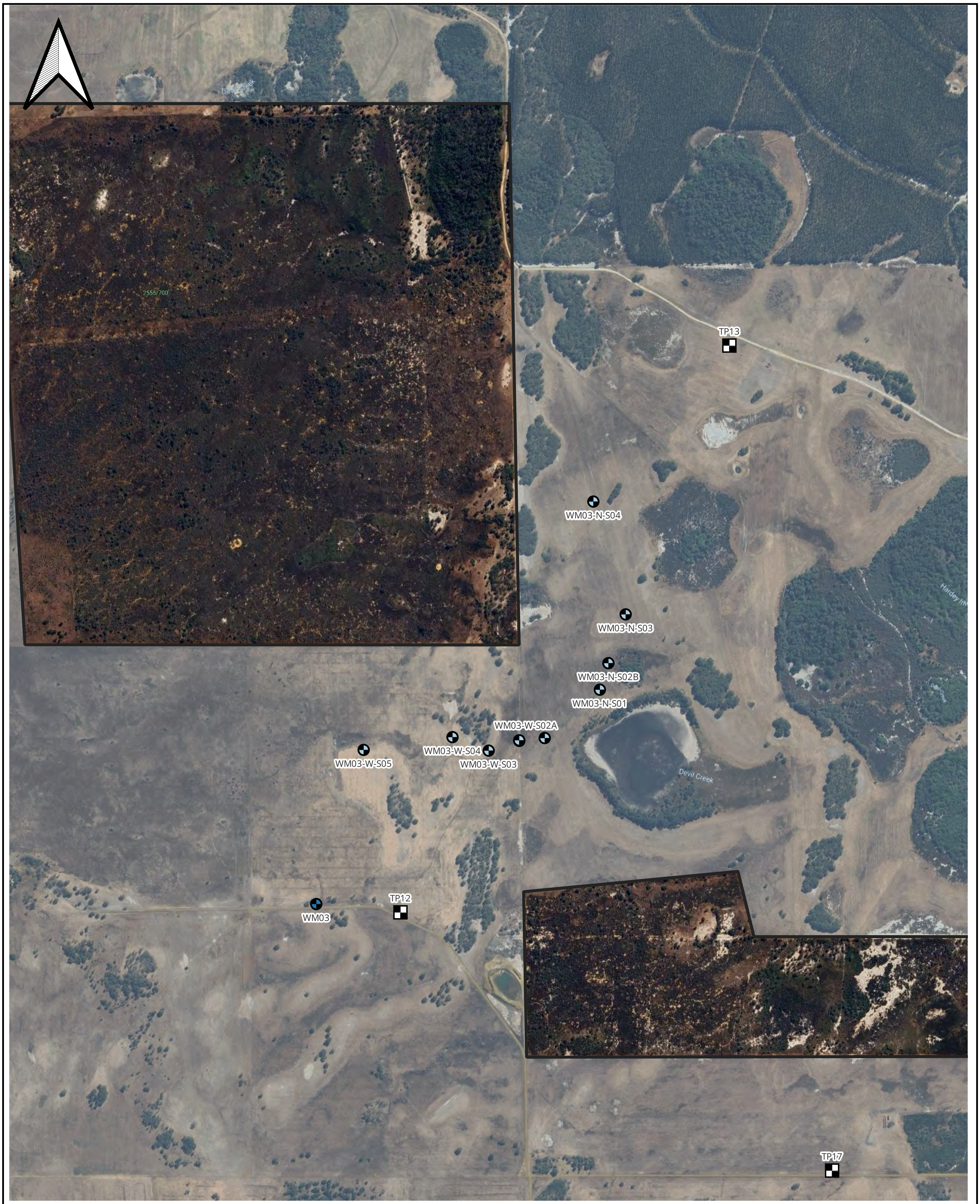
Geotechnical Investigation Type

- ● Geotechnical Boreholes (WM)
- ● Shallow Wells
- ▨ Geotechnical Test Pits (TP)

0 100 200 m

Scale at A3: 1:10000

Key Map



Beenup Wind Farm

Preliminary Geotechnical and Baseline Contamination Investigation

Test Location Plan
Project Code: 304501017
Drawn By: Singh, Edvinder, Checked By: BP
Date: (2024-06-21)
Appendix A - Figure 1.4 - WM03 Overview

Stantec

Legend

▭ Boundary Extents

Geotechnical Investigation Type

- ◐ Geotechnical Boreholes (WM)
- ◐ Shallow Wells
- ▚ Geotechnical Test Pits (TP)

0 100 200 m

Scale at A3: 1:10000

Key Map

Appendix D Hydrogeology Tables

Table E-1: Soil profile chemistry.

ID	Depth (m)	pH (Units)	Chloride (mg/kg)	Sulfate (mg/kg)
TP11	2.0	5.2	51	790
WM01	17.0 - 18.0	5.4	26	810
WM01	22.0 - 23.0	5.1	41	190
WM02	4.5 - 5.0	3.6	34	5,200
WM02	10.0 - 11.0	2.6	20	18,000
WM02	16.0 - 17.0	4.1	54	1100
WM03	4.0 - 5.0	4.0	50	1800
WM03	24.0 - 24.95	5.3	33	110

Table E-2: Test pit excavation profile.

Test Pit ID	Sand (Top - metres)	Sand (Bottom - metres)	Notes
TP01	0.1	2.1	Water encountered
TP02	0.1	0.9	Ferricrete at 0.9m - 1.0m (refusal)
TP03	0.15	2	0.0 to 0.15m gravelly SAND (fill)
TP04	0.15	2	-
TP05	0.1	0.85	Ferricrete at 0.85m - 0.9m (refusal)
TP06	0.1	0.65	Ferricrete at 0.65m - 0.7m (refusal)
TP07	0.1	1.7	Water encountered
TP08	0.1	2	Water encountered
TP09	0.1	1.5	Water encountered
TP10	0.1	1.1	Ferricrete at 1.1m - 1.2m
TP11	0.1	2	-
TP12	0.1	0.15	Ferricrete at 0.15m - 0.2m, refusal at 0.2m
TP13	0.1	2	-
TP14	0.1	0.35	Ferricrete at 0.35m - 0.4m, refusal at 0.4m
TP15	0.1	0.95	Ferricrete at 0.95m - 1.00m, refusal at 1m
TP16	0	0	0m - 0.1m topsoil, 0.1m - 0.15m Ferricrete.
TP17	0.1	0.45	Ferricrete at 0.45m - 0.5m
TP18	0	0	Ferricrete at 0.1m - 0.15m
TP19	0.1	0.55	Ferricrete at 0.55m - 0.6m
TP20	0.1	0.85	Ferricrete at 0.85m - 0.9m

Table E-3: Groundwater monitoring bores and screened aquifer units.

Bore ID	Depth (mbgl)	RL Depth (mAHD)	Screened Interval (mbgl)	Screened Lithology	Aquifer Unit
Stantec 2024					
WM01	24.95	15.05	18.50 – 24.50	Clayey SAND, SAND	Leederville (Warnbro)
WM01-W-S01	7.00	29.0	2.5 – 5.5	Sandy CLAY, Organic CLAY	Superficial Aquifer and Leederville (Warnbro)
WM01-W-S02	7.00	46.0	4.0 – 7.0	Clayey SAND, Sandy CLAY	Superficial Aquifer
WM02	24.95	6.05	12.50 – 24.50	CLAY, SAND	Leederville (Warnbro)
WM02-W-S01	4.50	28.5	1.5 – 4.0	Clayey SAND, Ferricrete, SAND, Sandy CLAY	Superficial Aquifer
WM02-W-S02	6.0	30.0	3.0 – 6.0	Clayey SAND	Superficial and Leederville (Warnbro)
WM03	24.95	7.05	18.50 – 24.50	SAND, Sandy CLAY	Leederville (Warnbro)
WM03-N-S01	2.0	36.0	1.0 – 2.0	SAND, Clayey SAND	Superficial
WM03-N-S03	3.0	31.0	1.5 – 3.0	Clayey SAND	Superficial
WM03-N-S04	1.90	36.1	0.9 – 1.90	SAND, Clayey SAND	Superficial
WM03-W-S01	1.00	37.0	0.4 – 1.00	SAND, Ferricrete	Superficial
WM03-W-S03	1.00	34.0	0.4 – 1.00	SAND, Ferricrete	Superficial
WM03-W-S04	2.00	30.0	1.5 – 2.00	Ferricrete, SAND	Superficial
WM03-W-S05	4.5	32.5	1.5 – 4.5	SAND, Clayey SAND	Superficial
EW17B	3.9		0.9-3.9	SAND/Ferricrete	Superficial
Mohsenzadeh and Diamond (2000)					
SM41	12	-	-	Sand, Clay	Leederville (Warnbro)
SM42	9	-	-	Sand, Clay	Leederville (Warnbro)
SM43	16.4	-	-	Sand, Clay	Leederville (Warnbro)
SM44	0.9	-	-	Sand	Superficial
SM45	2.2	-	-	Sand	Superficial
SM46D	18	-	-	Sand, Clay, Coal	Leederville (Warnbro)
SM46S	3	-	-	Sand	Superficial

Table E-4: Gauging information of deep and shallow groundwater bores.

Bore ID	Date	Surface RL (m AHD)	SWL (mbTOC)	SWL RL (mAHD)	Bore Depth (mbls)	Bore Bottom (mAHD)
Deep Bores						
WM01	16/04/2024	36.04	2.94	33.79	24.95	11.09
	23/07/2024	36.04	2.07	34.66	24.95	11.09
	26/09/2024	36.04	1.22	35.52	24.95	11.09
WM02	16/04/2024	28.57	1.09	28.13	24.95	3.62
	23/07/2024	28.57	0.72	28.50	24.95	3.62
	26/09/2024	28.57	1.20	28.03	24.95	3.62
WM03	17/04/2024	32.43	2.49	30.57	24.95	7.48
	23/07/2024	32.43	0.98	32.09	24.95	7.48
	27/09/2024	32.43	1.22	31.84	24.95	7.48
Shallow Bores						
WM01-W-S01	16/04/2024	35.14	3.43	32.17	7.00	28.14
	23/07/2024	35.14	2.76	32.84	7.00	28.14
	26/09/2024	35.14	1.37	34.23	7.00	28.14
WM01-W-S02	16/04/2024	36.35	3.75	33.2	7.00	29.35
	23/07/2024	36.35	3.43	33.52	7.00	29.35
	26/09/2024	36.35	1.64	35.32	7.00	29.35
WM02-W-S01	16/04/2024	28.92	1.94	27.58	4.50	24.42
	23/07/2024	28.92	0.68	28.84	4.50	24.42
	26/09/2024	28.92	1.27	28.25	4.50	24.42
WM02-W-S02	16/04/2024	27.45	1.84	26.25	6.00	21.45
	23/07/2024	27.45	0.64	27.45	6.00	21.45
	26/09/2024	27.45	1.33	26.76	6.00	21.45
WM03-N-S01	17/04/2024	33.84	2.15	32.38	2.00	31.84
	24/07/2024	33.84	0.78	33.75	2.00	31.84
	26/09/2024	33.84	1.30	33.24	2.00	31.84
WM03-N-S02B	17/04/2024	33.71	1.51	32.87	1.00	32.71
	24/07/2024	33.71	0.97	33.41	1.00	32.71
	26/09/2024	33.71	1.00	33.38	1.00	32.71
WM03-N-S03	17/04/2024	34.00	2.00	32.65	3.00	31.00
	24/07/2024	34.00	0.83	33.82	3.00	31.00
	27/09/2024	34.00	0.95	33.71	3.00	31.00
WM03-N-S04	17/04/2024	34.79	1.98	33.41	1.90	32.89
	24/07/2024	34.79	1.02	34.37	1.90	32.89
	26/09/2024	34.79	1.18	34.21	1.90	32.89

Bore ID	Date	Surface RL (m AHD)	SWL (mbTOC)	SWL RL (mAHD)	Bore Depth (mbls)	Bore Bottom (mAHD)
WM03-W-S01	17/04/2024	33.67	Dry	-	1.00	32.67
	24/07/2024	33.67	0.85	33.52	1.00	32.67
	26/09/2024	33.67	1.38	32.99	1.00	32.67
WM03-W-S02A	17/04/2024	33.34	Dry	-	1.00	32.34
	24/07/2024	33.34	0.59	33.47	1.00	32.34
	25/09/2024	33.34	0.64	33.41	1.00	32.34
WM03-W-S02B	17/04/2024	33.35	1.98	32.04	3.00	30.35
	24/07/2024	33.35	0.56	33.46	3.00	30.35
	25/09/2024	33.35	0.61	33.42	3.00	30.35
WM03-W-S03	17/04/2024	33.87	Dry	-	1.00	32.87
	24/07/2024	33.87	1.12	33.39	1.00	32.87
	25/09/2024	33.87	1.30	33.21	1.00	32.87
WM03-W-S04	17/04/2024	33.14	1.55	32.15	2.00	31.14
	24/07/2024	33.14	0.69	33.70	2.00	31.14
	27/09/2024	33.14	0.79	32.91	2.00	31.14
WM03-W-S05	17/04/2024	32.50	1.77	31.30	4.50	28.00
	24/07/2024	32.50	0.74	32.34	4.50	28.00
	25/09/2024	32.50	1.04	32.03	4.50	28.00

Table E-5: Summary of groundwater field parameters.

Bore ID	Date	Pump Rate (L/min)	Temp. (ºC)	DO (mg/L)	EC (µS/cm)	pH	ORP (mV)
Deep Bores							
WM01	16/04/2024	0.34	19.60	0.06	314.64	5.38	15.12
	23/07/2024	0.1	15.87	0.21	326.50	5.34	106.60
	26/09/2024	0.11	19.40	1.63	341.69	5.67	155.70
WM02	16/04/2024	0.1	20.02	0.10	651.12	6.06	5.58
	23/07/2024	0.107	13.66	0.41	722.24	5.92	19.20
	26/09/2024	0.1	19.20	1.04	700.53	5.86	16.60
WM03	17/04/2024	0.1	21.53	0.22	523.95	6.08	5.55
	23/07/2024	0.105	16.17	2.89	481.62	6.15	70.90
	27/09/2024	0.115	15.76	0.93	461.85	5.79	52.60
Shallow Bores							
WM01-W-S01	16/04/2024	0.1	22.08	1.05	455.14	5.93	-13.98
	23/07/2024	0.1	14.22	0.79	422.81	4.57	284.10
	26/09/2024	0.105	15.51	0.81	372.56	4.61	317.30
WM01-W-S02	16/04/2024	0.05	23.88	0.17	468.75	6.42	-160.74

Bore ID	Date	Pump Rate (L/min)	Temp. (ºC)	DO (mg/L)	EC (µS/cm)	pH	ORP (mV)
	23/07/2024	0.1	14.85	1.03	342.12	5.51	26.90
	26/09/2024	0.11	18.14	0.87	449.12	5.22	47.40
WM02-W-S01	16/04/2024	0.1	24.83	0.11	513.17	6.41	-134.75
	23/07/2024	0.115	12.85	0.22	449.52	5.95	22.50
	26/09/2024	0.112	18.61	0.58	419.83	5.62	70.80
WM02-W-S02	16/04/2024	0.1	21.83	0.11	670.93	6.42	-111.70
	23/07/2024	0.105	14.48	0.37	551.48	5.68	141.20
	26/09/2024	0.112	19.29	0.43	587.25	5.85	48.60
WM03-N-S03	17/04/2024	0.1	25.42	0.86	417.52	5.51	50.53
	24/07/2024	0.096	17.79	0.55	793.12	4.58	264.90
	26/09/2024	0.115	16.45	0.57	983.14	5.87	4.60
WM03-W-S02B	17/04/2024	0.1	27.14	0.31	3050.72	6.08	-39.44
WM03-W-S04	24/07/2024	0.1	20.23	0.25	1034.30	5.63	60.70
	26/09/2024	0.115	16.99	0.49	1291.40	5.52	54.90

Note: all parameters are mg/L, except where shown.

Table E-6: April 2024 groundwater quality results.

		Phosphate total (as P)	Aluminium (filtered)	Arsenic (filtered)	Cadmium (filtered)	Copper (filtered)	Iron (filtered)	Lead (filtered)	Magnesium (filtered)	Potassium (filtered)	Electrical conductivity *(lab)	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrate & Nitrite (as N)	Nitrogen (Total)	Salinity
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	g/kg
EQL		0.01	0.01	0.001	0.0001	0.001	0.01	0.001	0.5	0.5	1	0.1	0.01	0.01	0.01	0.1	0.01
ADWG 2022 Aesthetic						1	0.3										
ADWG 2022 Health				0.01	0.002	2		0.01									
ANZG Freshwater Toxicant DGVs LOSP 80% (July 2023)			0.15		0.0008	0.0025		0.0094									
ANZG Freshwater Toxicant DGVs LOSP 90% (July 2023)			0.08		0.0004	0.0018		0.0056									
ANZG Freshwater Toxicant DGVs LOSP 95% (July 2023)			0.055		0.0002	0.0014		0.0034									
ANZG Freshwater Toxicant DGVs LOSP 99% (July 2023)			0.027		0.00006	0.001		0.001									
NHMRC & NRMMC (2011) ADWG 6. Version 3.4 (2017)													50				
ANZECC 2000 Irrigation - Short-term trigger value			20	2	0.05	5	10	5								25	
ANZECC 2000 Irrigation - Long-term trigger value			5	0.1	0.01	0.2	0.2	2								5	
ANZECC 2000 Livestock drinking water			5	0.5	0.01	0.4		0.1					338.7	9.13			
Managing Risks in Recreational Water 2008 (Health)				0.07	0.02	20		0.1					113	9			
Managing Risks in Recreational Water 2008 (Aesthetic)						1	0.3										
DoH 2014 - Non-Potable Use			0.2	0.1	0.02	20	0.3	0.1					113	9			
Field ID	**Date**																
SW2	**17 Apr 2024**	0.16	<0.01	<0.001	<0.0001	0.002	1.46	<0.001	20	18	903	7.2	0.02	<0.01	0.02	7.2	0.44
WM01	**17 Apr 2024**	0.04	0.02	<0.001	<0.0001	0.004	2.62	<0.001	5	7	266	0.3	<0.01	<0.01	<0.01	0.3	0.12
WM02	**17 Apr 2024**	0.1	0.01	0.002	<0.0001	0.004	11.4	<0.001	9	5	528	0.3	<0.01	<0.01	<0.01	0.3	0.25
WM03	**17 Apr 2024**	0.06	0.05	<0.001	<0.0001	0.003	6.48	<0.001	8	3	450	0.3	<0.01	<0.01	<0.01	0.3	0.22
WM01-W-S01	**17 Apr 2024**	0.93	<0.01	0.003	<0.0001	0.004	7.16	<0.001	8	4	354	2.3	<0.01	<0.01	<0.01	2.3	0.17
WM01-W-S02	**17 Apr 2024**	0.28	0.03	<0.001	<0.0001	0.003	17.8	<0.001	12	6	341	1.1	0.01	<0.01	0.01	1.1	0.16
WM02-W-S01	**17 Apr 2024**	0.04	0.1	<0.001	<0.0001	0.002	22.4	<0.001	7	14	394	2.1	<0.01	<0.01	<0.01	2.1	0.19
WM02-W-S02	**17 Apr 2024**	0.08	0.02	<0.001	<0.0001	0.002	30.2	<0.001	10	9	545	0.6	<0.01	<0.01	<0.01	0.6	0.26
WM03-N-S03	**17 Apr 2024**	0.02	0.34	0.002	<0.0001	0.006	11	<0.001	8	3	376	1.2	0.14	<0.01	0.14	1.3	0.18
WM03-W-S02B	**17 Apr 2024**	0.03	<0.01	<0.001	<0.0001	0.005	17.4	<0.001	54	27	2,740	0.6	0.01	<0.01	0.01	0.6	1.42

Table E-7: July 2024 groundwater metals results.

		Metals																			
		Aluminium (filtered)	Arsenic (filtered)	Barium (filtered)	Boron (filtered)	Cadmium (filtered)	Calcium (filtered)	Chromium (III+VI) (filtered)	Cobalt (filtered)	Copper (filtered)	Iron (filtered)	Lead (filtered)	Magnesium (filtered)	Manganese (filtered)	Mercury (filtered)	Molybdenum (filtered)	Nickel (filtered)	Potassium (filtered)	Selenium (filtered)	Vanadium (filtered)	Zinc (filtered)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL		0.01	0.001	0.001	0.05	0.0001	1	0.001	0.001	0.001	0.05	0.001	1	0.001	0.0001	0.001	0.001	1	0.01	0.01	0.005
ADWG 2022 Aesthetic										1	0.3			0.1							3
ADWG 2022 Health			0.01	2	4	0.002				2		0.01		0.5	0.001	0.05	0.02		0.01		
ANZG Freshwater Toxicant DGVs LOSP 80% (July 2023		0.15			2.5	0.0008				0.0025		0.0094		3.6	0.0054		0.017		0.034		0.031
ANZG Freshwater Toxicant DGVs LOSP 90% (July 2023		0.08			1.5	0.0004				0.0018		0.0056		2.5	0.0019		0.013		0.018		0.015
ANZG Freshwater Toxicant DGVs LOSP 95% (July 2023		0.055			0.94	0.0002				0.0014		0.0034		1.9	0.0006		0.011		0.011		0.008
ANZG Freshwater Toxicant DGVs LOSP 99% (July 2023		0.027			0.34	0.00006				0.001		0.001		1.2	0.00006		0.008		0.005		0.0024
NHMRC & NRMMC (2011) ADWG 6. Version 3.4 (2017)																					
ANZECC 2000 Irrigation - Short-term trigger value		20	2		0.5	0.05		1	0.1	5	10	5		10	0.002	0.05	2		0.05	0.5	5
ANZECC 2000 Irrigation - Long-term trigger value		5	0.1		0.5	0.01		0.1	0.05	0.2	0.2	2		0.2	0.002	0.01	0.2		0.02	0.1	2
ANZECC 2000 Livestock drinking water		5	0.5		5	0.01	1,000	1	1	0.4		0.1			0.002	0.15	1		0.02		20
Managing Risks in Recreational Water 2008 (Health)			0.07	7	40	0.02				20		0.1		5	0.01	0.5	0.2		0.1		
Managing Risks in Recreational Water 2008 (Aesthetic)										1	0.3			0.1							3
DoH 2014 - Non-Potable Use		0.2	0.1	20	40	0.02				20	0.3	0.1		5	0.01	0.5	0.2		0.1		3
Field ID	**Date**																				
Dup01	**23 Jul 2024**	0.04	<0.001	0.078	<0.05	<0.0001	4	<0.001	0.003	0.001	0.09	<0.001	10	0.378	<0.0001	0.002	0.003	3	<0.01	<0.01	0.032
Dup 02	**23 Jul 2024**	0.77	<0.001			<0.0001				0.001	0.13	<0.001	<1					4			
Dup04	**24 Jul 2024**	0.37	0.001			<0.0001				0.002	0.99	<0.001	25					22			
Field Blank 1	**24 Jul 2024**	<0.01	<0.001			<0.0001				<0.001	<0.05	<0.001	<1					<1			
Field Blank 2	**25 Jul 2024**	<0.01	<0.001	<0.001	<0.05	<0.0001	<1	<0.001	<0.001	<0.001	<0.05	<0.001	<1	<0.001	<0.0001	<0.001	<0.001	<1	<0.01	<0.01	<0.005
SW02	**22 Jul 2024**	0.02	<0.001			<0.0001				0.006	2.82	<0.001	21					26			
SW03	**22 Jul 2024**	0.04	<0.001			<0.0001				0.005	0.28	<0.001	9					9			
SW04	**22 Jul 2024**	0.12	<0.001			<0.0001				0.007	0.45	<0.001	8					9			
SW05	**22 Jul 2024**	0.05	0.001			<0.0001				0.006	1.34	<0.001	13					25			
WM01	**23 Jul 2024**	0.03	<0.001	0.143	<0.05	<0.0001	2	<0.001	<0.001	0.004	2.58	<0.001	6	0.087	<0.0001	0.002	0.002	8	<0.01	<0.01	<0.005
WM01 Wetland	**23 Jul 2024**	0.60	<0.001			<0.0001				0.004	0.12	<0.001	<1					4			
WM01-W-S01	**23 Jul 2024**	0.01	<0.001	0.069	<0.05	<0.0001	4	<0.001	0.003	0.005	0.07	<0.001	8	0.324	<0.0001	0.002	0.003	4	<0.01	<0.01	0.030
WM01-W-S02	**25 Jul 2024**	0.07	0.002	0.085	<0.05	<0.0001	1	<0.001	<0.001	0.003	4.19	<0.001	6	0.048	<0.0001	0.002	<0.001	5	<0.01	<0.01	<0.005
WM02	**23 Jul 2024**	<0.01	<0.001	0.093	<0.05	<0.0001	2	<0.001	<0.001	0.004	14.9	<0.001	12	0.195	<0.0001	0.002	<0.001	6	<0.01	<0.01	<0.005
WM02 Wetland	**23 Jul 2024**	0.03	<0.001			<0.0001				0.004	0.16	<0.001	18					12			
WM02-W-S01	**23 Jul 2024**	0.09	<0.001	0.018	<0.05	<0.0001	11	<0.001	<0.001	0.004	6.05	<0.001	8	0.128	<0.0001	0.003	<0.001	14	<0.01	<0.01	<0.005
WM02-W-S02	**25 Jul 2024**	<0.01	<0.001	0.094	<0.05	<0.0001	11	<0.001	<0.001	0.004	0.20	<0.001	11	0.141	<0.0001	0.003	<0.001	12	<0.01	<0.01	<0.005
WM03	**24 Jul 2024**	0.01	<0.001	0.106	<0.05	<0.0001	5	<0.001	0.002	0.005	2.94	<0.001	8	0.607	<0.0001	0.002	0.008	4	<0.01	<0.01	0.013
WM03-N-S03	**24 Jul 2024**	0.36	<0.001	0.016	<0.05	<0.0001	34	<0.001	<0.001	0.002	2.70	<0.001	18	0.045	<0.0001	0.001	<0.001	18	<0.01	<0.01	<0.005
WM03 Wet Land	**24 Jul 2024**	0.36	0.001			<0.0001				0.006	0.93	<0.001	23					22			
WM03-W-S04	**24 Jul 2024**	1.02	<0.001	0.032	0.06	<0.0001	10	0.001	0.004	0.005	17.5	<0.001	18	0.289	<0.0001	0.001	0.002	57	<0.01	<0.01	<0.005

Table E-8: July 2024 groundwater inorganics results.

		Inorganics																								
		Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)_	Phosphate total (as P)	Reactive Phosphorus as P (Orthophosphate as P)	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Ammonia as N	Anions Total	Cations Total	Chloride	Electrical Conductivity (Lab)	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Nitrogen (Total)	pH (Lab)	Salinity	Silicon as SiO2 (filtered)	Sodium (filtered)	Sulphur as S (filtered)	Total Dissolved Solids (Lab)	Turbidity (Lab)	Sulfate as SO4 - Turbidimetric (filtered)
		mg/L	MG/L	MG/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	µS/cm	%	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units	g/kg	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
EQL		1	1	0.01	0.01	1	1	0.01	0.01	0.01	1	1	0.01	0.1	0.01	0.01	0.01	0.1	0.01	0.01	0.1	1	1	10	0.1	1
ADWG 2022 Aesthetic											250								6.5-8.5			180		600	5	
ADWG 2022 Health																										
ANZG Freshwater Toxicant DGVs LOSP 80% (July 2023)								2.3																		
ANZG Freshwater Toxicant DGVs LOSP 90% (July 2023)								1.43																		
ANZG Freshwater Toxicant DGVs LOSP 95% (July 2023)								0.9																		
ANZG Freshwater Toxicant DGVs LOSP 99% (July 2023)								0.32																		
NHMRC & NRMMC (2011) ADWG 6. Version 3.4 (2017)															50											500
ANZECC 2000 Irrigation - Short-term trigger value																		25								
ANZECC 2000 Irrigation - Long-term trigger value																		5								
ANZECC 2000 Livestock drinking water															338.7	9.13								3,000		
Managing Risks in Recreational Water 2008 (Health)															113	9			6.5-8.5							
Managing Risks in Recreational Water 2008 (Aesthetic)								0.4			250											180				
DoH 2014 - Non-Potable Use								0.4			250				113	9			6.5-8.5			180		600		
Field ID	**Date**																									
Dup01	**23 Jul 2024**	<1	<1	<0.01	<0.01	<1	<1	<0.01	3.52	3.36	93	360	2.29	0.2	0.05	<0.01	0.05	0.2	5.14		17.2	52	16	238	38.0	43
Dup 02	**23 Jul 2024**			0.30								83		2.8	0.04	<0.01	0.04	2.8		0.04						
Dup04	**24 Jul 2024**			1.71								1,190		3.8	0.09	0.01	0.10	3.9		0.59						
Field Blank 1	**24 Jul 2024**			<0.01								<1		<0.1	<0.01	<0.01	<0.01	<0.1		<0.01						
Field Blank 2	**25 Jul 2024**	<1	<1	<0.01	<0.01	<1	<1	<0.01	<0.01	<0.01	<1	1	<0.01	<0.1	<0.01	<0.01	<0.01	<0.1	5.46		<0.1	<1	<1	<10	0.2	<1
SW02	**22 Jul 2024**			0.23								919		6.0	0.64	0.07	0.71	6.7		0.45						
SW03	**22 Jul 2024**			0.06								504		1.3	0.02	<0.01	0.02	1.3		0.24						
SW04	**22 Jul 2024**			0.10								483		2.2	<0.01	<0.01	<0.01	2.2		0.23						
SW05	**22 Jul 2024**			0.22								731		3.8	0.76	0.47	1.23	5.0		0.36						
WM01	**23 Jul 2024**	11	<1	0.03	<0.01	<1	11	0.15	2.71	2.67	84	295	0.85	0.6	<0.01	<0.01	<0.01	0.6	5.90		22.9	43	2	185	12.0	6
WM01 Wetland	**23 Jul 2024**			0.43								85		3.5	0.03	<0.01	0.03	3.5		0.04						
WM01-W-S01	**23 Jul 2024**	<1	<1	<0.01	<0.01	<1	<1	<0.01	3.48	3.26	93	370	3.13	0.2	0.04	<0.01	0.04	0.2	5.00		17.5	53	16	245	45.0	41
WM01-W-S02	**25 Jul 2024**	5	<1	1.06	<0.01	<1	5	0.08	2.78	2.67	92	296	1.94	2.8	<0.01	<0.01	<0.01	2.8	5.30		16.4	46	1	688	7,000	4
WM02	**23 Jul 2024**	16	<1	0.04	<0.01	<1	16	0.11	6.33	6.26	202	623	0.56	0.2	<0.01	<0.01	<0.01	0.2	6.12		10.7	97	4	332	90.0	15
WM02 Wetland	**23 Jul 2024**			0.17								832		2.7	0.04	<0.01	0.04	2.7		0.41						
WM02-W-S01	**23 Jul 2024**	24	<1	0.03	<0.01	<1	24	0.85	3.75	3.57	91	390	2.57	1.6	0.02	<0.01	0.02	1.6	6.42		2.8	46	13	230	70.0	34
WM02-W-S02	**25 Jul 2024**	24	<1	0.02	<0.01	<1	24	0.25	4.91	4.59	135	506	3.41	0.6	0.11	0.02	0.13	0.7	6.29		7.0	65	12	283	400	30
WM03	**24 Jul 2024**	30	<1	0.01	<0.01	<1	30	0.17	4.40	3.97	128	434	5.13	0.4	0.09	<0.01	0.09	0.5	6.56		10.7	68	3	234	21.0	9
WM03-N-S03	**24 Jul 2024**	<1	<1	0.04	<0.01	<1	<1	0.70	6.87	6.68	180	747	1.36	3.0	5.95	0.02	5.97	9.0	4.18		4.8	70	28	442	80.0	86
WM03 Wet Land	**24 Jul 2024**			1.75								1,220		3.8	0.10	0.01	0.11	3.9		0.60						
WM03-W-S04	**24 Jul 2024**	4	<1	0.16	0.05	<1	4	0.51	9.49	9.55	287	943	0.35	4.6	<0.01	<0.01	<0.01	4.6	5.43		5.6	119	24	714	65.0	63

Table E-9: September 2024 groundwater metals results.

		Metals																			
		Aluminium (filtered)	Arsenic (filtered)	Barium (filtered)	Boron (filtered)	Cadmium (filtered)	Calcium (filtered)	Chromium (III+VI) (filtered)	Cobalt (filtered)	Copper (filtered)	Iron (filtered)	Lead (filtered)	Magnesium (filtered)	Manganese (filtered)	Mercury (filtered)	Molybdenum (filtered)	Nickel (filtered)	Potassium (filtered)	Selenium (filtered)	Vanadium (filtered)	Zinc (filtered)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL		0.01	0.001	0.001	0.05	0.0001	1	0.001	0.001	0.001	0.05	0.001	1	0.001	0.0001	0.001	0.001	1	0.01	0.01	0.005
ADWG 2022 Aesthetic										1	0.3			0.1							3
ADWG 2022 Health			0.01	2	4	0.002				2	[#1]	0.01		0.5	0.001	0.05	0.02		0.01		[#1]
ANZG Freshwater Toxicant DGVs LOSP 80% (July 2023		0.15[#3]			2.5[#4]	0.0008[#4]				0.0025[#4]		0.0094[#5]		3.6[#5]	0.0054[#6]		0.017[#6]		0.034[#6]		0.031[#7]
ANZG Freshwater Toxicant DGVs LOSP 90% (July 2023		0.08[#3]			1.5[#4]	0.0004[#9]				0.0018[#4]		0.0056[#3]		2.5[#5]	0.0019[#6]		0.013[#6]		0.018[#6]		0.015[#7]
ANZG Freshwater Toxicant DGVs LOSP 95% (July 2023		0.055[#3]			0.94[#11]	0.0002[#9]				0.0014[#9]		0.0034[#3]		1.9[#5]	0.0006[#6]		0.011[#6]		0.011[#6]		0.008[#7]
ANZG Freshwater Toxicant DGVs LOSP 99% (July 2023		0.027[#3]			0.34[#9]	0.00006[#9]				0.001[#9]		0.001[#3]		1.2[#3]	0.00006[#6]		0.008[#6]		0.005[#6]		0.0024[#7]
NHMRC & NRMMC (2011) ADWG 6. Version 3.4 (2017)																					
ANZECC 2000 Irrigation - Short-term trigger value		20[#15]	2[#15]		0.5[#16]	0.05[#15]		1[#15]	0.1[#15]	5[#15]	10[#15]	5[#15]		10[#15]	0.002[#15]	0.05[#15]	2[#15]		0.05[#15]	0.5[#15]	5[#15]
ANZECC 2000 Irrigation - Long-term trigger value		5[#18]	0.1[#18]		0.5[#18]	0.01[#18]		0.1[#18]	0.05[#18]	0.2[#18]	0.2[#18]	2[#18]		0.2[#18]	0.002[#18]	0.01[#18]	0.2[#18]		0.02[#18]	0.1[#18]	2[#18]
ANZECC 2000 Livestock drinking water		5	0.5		5	0.01	1,000[#19]	1	1	0.4[#20]		0.1			0.002	0.15	1		0.02		20
Managing Risks in Recreational Water 2008 (Health)			0.07[#22]	7[#22]	40[#22]	0.02[#22]				20[#22]		0.1[#22]		5[#22]	0.01[#22]	0.5[#22]	0.2[#22]		0.1[#22]		
Managing Risks in Recreational Water 2008 (Aesthetic)										1	0.3			0.1							3
DoH 2014 - Non-Potable Use		0.2[#24]	0.1	20	40	0.02				20	0.3	0.1		5	0.01	0.5	0.2		0.1		3
Field ID	Date																				
Dup02	26 Sep 2024	<0.01	<0.001	0.058	<0.05	<0.0001	4	<0.001	0.002	<0.001	<0.05	<0.001	7	0.206	<0.0001	<0.001	0.002	3	<0.01	<0.01	0.024
DUP01	25 Sep 2024	<0.01	<0.001	0.012	<0.05	<0.0001	45	<0.001	<0.001	<0.001	1.12	<0.001	24	0.157	<0.0001	<0.001	0.001	18	<0.01	<0.01	0.006
FB2	27 Sep 2024	<0.01	<0.001	<0.001	0.38	<0.0001	<1	<0.001	<0.001	<0.001	<0.05	<0.001	<1	<0.001	<0.0001	<0.001	<0.001	<1	<0.01	<0.01	<0.005
Field Blank 1	26 Sep 2024	<0.01	<0.001	<0.001	0.38	<0.0001	<1	<0.001	<0.001	<0.001	<0.05	<0.001	<1	<0.001	<0.0001	<0.001	<0.001	<1	<0.01	<0.01	<0.005
SW01	25 Sep 2024	0.06	<0.001	0.008	<0.05	<0.0001	58	<0.001	<0.001	<0.001	2.03	<0.001	11	<0.001	<0.0001	<0.001	<0.001	3	<0.01	<0.01	<0.005
SW02	25 Sep 2024	<0.01	<0.001	0.013	<0.05	<0.0001	46	<0.001	<0.001	<0.001	0.98	<0.001	24	0.141	<0.0001	<0.001	<0.001	18	<0.01	<0.01	<0.005
SW03	25 Sep 2024	0.07	<0.001	0.013	<0.05	<0.0001	38	<0.001	<0.001	<0.001	1.39	<0.001	10	0.002	<0.0001	<0.001	<0.001	16	<0.01	<0.01	<0.005
SW04	25 Sep 2024	0.14	<0.001	0.013	<0.05	<0.0001	27	<0.001	<0.001	<0.001	8.63	<0.001	10	0.011	<0.0001	<0.001	<0.001	4	<0.01	<0.01	<0.005
SW05	25 Sep 2024	0.01	0.001	0.006	<0.05	<0.0001	44	<0.001	<0.001	<0.001	2.20	<0.001	15	0.177	<0.0001	<0.001	<0.001	42	<0.01	<0.01	<0.005
WM01	26 Sep 2024	<0.01	<0.001	0.203	<0.05	<0.0001	8	<0.001	<0.001	0.002	0.06	<0.001	6	0.061	<0.0001	<0.001	0.005	7	<0.01	<0.01	0.009
WM01 Wetland	26 Sep 2024	0.76	<0.001	0.001	<0.05	<0.0001	4	0.001	<0.001	<0.001	0.34	<0.001	5	0.022	<0.0001	<0.001	<0.001	8	<0.01	<0.01	<0.005
WM01-W-S01	26 Sep 2024	<0.01	<0.001	0.061	<0.05	<0.0001	4	<0.001	0.001	<0.001	<0.05	<0.001	7	0.209	<0.0001	<0.001	0.002	3	<0.01	<0.01	0.021
WM1-W-S02	26 Sep 2024	0.04	<0.001	0.104	<0.05	<0.0001	4	<0.001	<0.001	<0.001	0.58	<0.001	11	0.052	<0.0001	<0.001	<0.001	4	<0.01	<0.01	<0.005
WM02	26 Sep 2024	<0.01	<0.001	0.098	<0.05	<0.0001	3	<0.001	<0.001	<0.001	3.11	<0.001	12	0.222	<0.0001	<0.001	<0.001	6	<0.01	<0.01	<0.005
WM 02 Wetland	26 Sep 2024	0.06	<0.001	0.003	<0.05	<0.0001	24	<0.001	<0.001	<0.001	2.07	<0.001	10	0.023	<0.0001	<0.001	<0.001	7	<0.01	<0.01	<0.005
WM02-W-S02	26 Sep 2024	<0.01	<0.001	0.105	<0.05	<0.0001	9	<0.001	<0.001	<0.001	<0.05	<0.001	12	0.245	<0.0001	<0.001	<0.001	8	<0.01	<0.01	<0.005
WM02-W-S02	26 Sep 2024	0.04	<0.001	0.013	<0.05	<0.0001	14	<0.001	<0.001	<0.001	0.23	<0.001	8	0.038	<0.0001	<0.001	<0.001	12	<0.01	<0.01	<0.005
WM03	27 Sep 2024	<0.01	<0.001	0.078	<0.05	<0.0001	3	<0.001	<0.001	<0.001	6.76	<0.001	8	0.334	<0.0001	<0.001	0.004	3	<0.01	<0.01	0.008
WM03-N-S03	27 Sep 2024	2.24	0.006	0.014	<0.05	<0.0001	18	0.004	0.002	0.006	15.3	<0.001	10	0.119	<0.0001	<0.001	0.002	36	<0.01	<0.01	<0.005
WM03 Wetland	27 Sep 2024	0.31	<0.001	0.001	<0.05	<0.0001	8	<0.001	<0.001	<0.001	0.86	<0.001	18	0.009	<0.0001	<0.001	<0.001	11	<0.01	<0.01	<0.005
WM03-W-S04	27 Sep 2024	0.78	<0.001	0.023	0.06	<0.0001	12	<0.001	0.004	<0.001	13.0	<0.001	24	0.186	<0.0001	<0.001	0.001	79	<0.01	<0.01	<0.005

Table E-10: September 2024 groundwater inorganics results.

		Inorganics																							
		Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)_	Phosphate total (as P)	Reactive Phosphorus as P (Orthophosphate as P)	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Ammonia as N	Anions Total	Cations Total	Chloride	Electrical Conductivity (Lab)	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Nitrogen (Total)	pH (Lab)	Silicon as SiO2 (filtered)	Sodium (filtered)	Sulphur as S (filtered)	Total Dissolved Solids (Lab)	Turbidity (Lab)	Sulfate as SO4 - Turbidimetric (filtered)
		mg/L	MG/L	MG/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	µS/cm	%	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
EQL		1	1	0.01	0.01	1	1	0.01	0.01	0.01	1	1	0.01	0.1	0.01	0.01	0.01	0.1	0.01	0.1	1	1	10	0.1	1
ADWG 2022 Aesthetic											250								6.5-8.5		180		600	5	
ADWG 2022 Health											#1								#1		#2		#2	#1	
ANZG Freshwater Toxicant DGVs LOSP 80% (July 2023)								2.3[#8]																	
ANZG Freshwater Toxicant DGVs LOSP 90% (July 2023)								1.43[#10]																	
ANZG Freshwater Toxicant DGVs LOSP 95% (July 2023)								0.9[#10]																	
ANZG Freshwater Toxicant DGVs LOSP 99% (July 2023)								0.32[#12]																	
NHMRC & NRMMC (2011) ADWG 6. Version 3.4 (2017)															50[#13]										500[#14]
ANZECC 2000 Irrigation - Short-term trigger value																		25[#17]							
ANZECC 2000 Irrigation - Long-term trigger value																		5[#18]							
ANZECC 2000 Livestock drinking water															338.7	9.13							3,000[#21]		
Managing Risks in Recreational Water 2008 (Health)															113[#22]	9[#22]			6.5-8.5[#23]						
Managing Risks in Recreational Water 2008 (Aesthetic)								0.4			250										180				
DoH 2014 - Non-Potable Use								0.4			250				113	9			6.5-8.5		180		600		
Field ID	Date																								
Dup02	26 Sep 2024	<1	<1	<0.01	<0.01	<1	<1	<0.01	3.40	2.90	89	342	7.94	0.1	<0.01	<0.01	<0.01	0.1	4.82	14.2	47	16	199	1.7	43
DUP01	25 Sep 2024	103	<1	0.49	0.06	<1	103	3.85	12.1	10.6	322	1,100	6.70	8.5	0.12	0.10	0.22	8.7	7.11	1.4	136	17	660	50.0	47
FB2	27 Sep 2024	1	<1	<0.01	<0.01	<1	1	<0.01	0.08	0.09	2	7	6.48	<0.1	<0.01	<0.01	<0.01	<0.1	6.14	1.1	2	<1	<10	0.4	<1
Field Blank 1	26 Sep 2024	1	<1	<0.01	<0.01	<1	1	<0.01	0.08	0.09	2	7	6.48	<0.1	<0.01	<0.01	<0.01	<0.1	6.13	1.1	2	<1	<10	0.3	<1
SW01	25 Sep 2024	175	<1	0.06	0.01	<1	175	0.01	5.08	4.83	56	402	2.45	1.6	0.01	<0.01	0.01	1.6	7.83	4.8	22	1	269	34.0	<5
SW02	25 Sep 2024	100	<1	0.50	0.04	<1	100	3.83	12.0	10.7	320	1,100	5.58	8.4	0.13	0.07	0.20	8.6	7.05	1.6	138	18	686	65.0	47
SW03	25 Sep 2024	72	<1	0.68	0.02	<1	72	0.04	7.78	6.70	190	667	7.47	6.0	0.01	0.01	0.02	6.0	6.91	1.5	82	10	440	110	47
SW04	25 Sep 2024	55	<1	0.54	0.33	<1	55	0.03	5.44	5.27	145	486	1.54	3.2	<0.01	<0.01	<0.01	3.2	7.07	2.1	58	5	367	21.0	12
SW05	25 Sep 2024	165	<1	6.23	0.09	<1	165	0.37	9.64	8.72	207	864	4.97	12.6	0.01	<0.01	0.01	12.6	7.04	2.8	97	8	570	180	24
WM01	26 Sep 2024	24	<1	<0.01	<0.01	<1	24	<0.01	3.40	2.95	100	317	7.20	0.1	0.18	<0.01	0.18	0.3	6.46	23.2	43	2	189	7.0	5
WM01 Wetland	26 Sep 2024	17	<1	0.31	0.15	<1	17	0.50	2.76	2.47	86	272	5.67	3.6	0.01	<0.01	0.01	3.6	6.69	1.8	38	2	214	18.0	<10
WM01-W-S01	26 Sep 2024	<1	<1	<0.01	<0.01	<1	<1	<0.01	3.46	2.90	91	323	8.89	0.1	<0.01	<0.01	<0.01	0.1	4.90	14.2	47	16	186	2.5	43
WM1-W-S02	26 Sep 2024	<1	<1	<0.01	<0.01	<1	<1	0.15	4.22	3.46	123	413	9.84	0.4	<0.01	<0.01	<0.01	0.4	4.59	6.8	51	12	234	60.0	36
WM02	26 Sep 2024	17	<1	0.03	<0.01	<1	17	0.08	6.12	5.56	197	617	4.84	0.2	<0.01	<0.01	<0.01	0.2	6.31	11.6	94	4	322	110	11
WM 02 Wetland	26 Sep 2024	60	<1	0.59	0.09	<1	60	0.03	4.25	4.16	103	416	1.11	8.0	<0.01	<0.01	<0.01	8.0	7.37	<0.1	45	5	266	55.0	7
WM02-W-S02	26 Sep 2024	34	<1	0.02	<0.01	<1	34	0.11	5.67	4.91	166	543	7.20	0.3	0.01	<0.01	0.01	0.3	6.65	10.4	75	5	280	55.0	15
WM02-W-S02	26 Sep 2024	17	<1	<0.01	<0.01	<1	17	1.15	4.00	3.46	104	395	7.26	1.7	<0.01	<0.01	<0.01	1.7	6.38	2.5	39	12	212	24.0	35
WM03	27 Sep 2024	26	<1	<0.01	<0.01	<1	26	0.15	4.84	3.97	148	419	9.91	0.3	<0.01	<0.01	<0.01	0.3	6.28	9.3	62	2	225	11.0	7
WM03-N-S03	27 Sep 2024	59	<1	0.28	0.12	<1	59	35.1	8.62	9.14	209	892	2.94	41.9	0.07	<0.02	0.07	42.0	6.23	4.4	67	27	618	28.0	74
WM03 Wetland	27 Sep 2024	29	<1	2.14	2.15	<1	29	0.04	8.22	7.56	242	808	4.20	3.1	0.02	<0.01	0.02	3.1	6.65	0.2	124	14	560	2.1	39
WM03-W-S04	27 Sep 2024	10	<1	0.68	0.32	<1	10	0.44	11.5	10.6	320	1,200	4.27	5.3	0.02	<0.02	0.02	5.3	5.52	6.3	137	39	822	37.0	109

Appendix E Groundwater Hydrographs

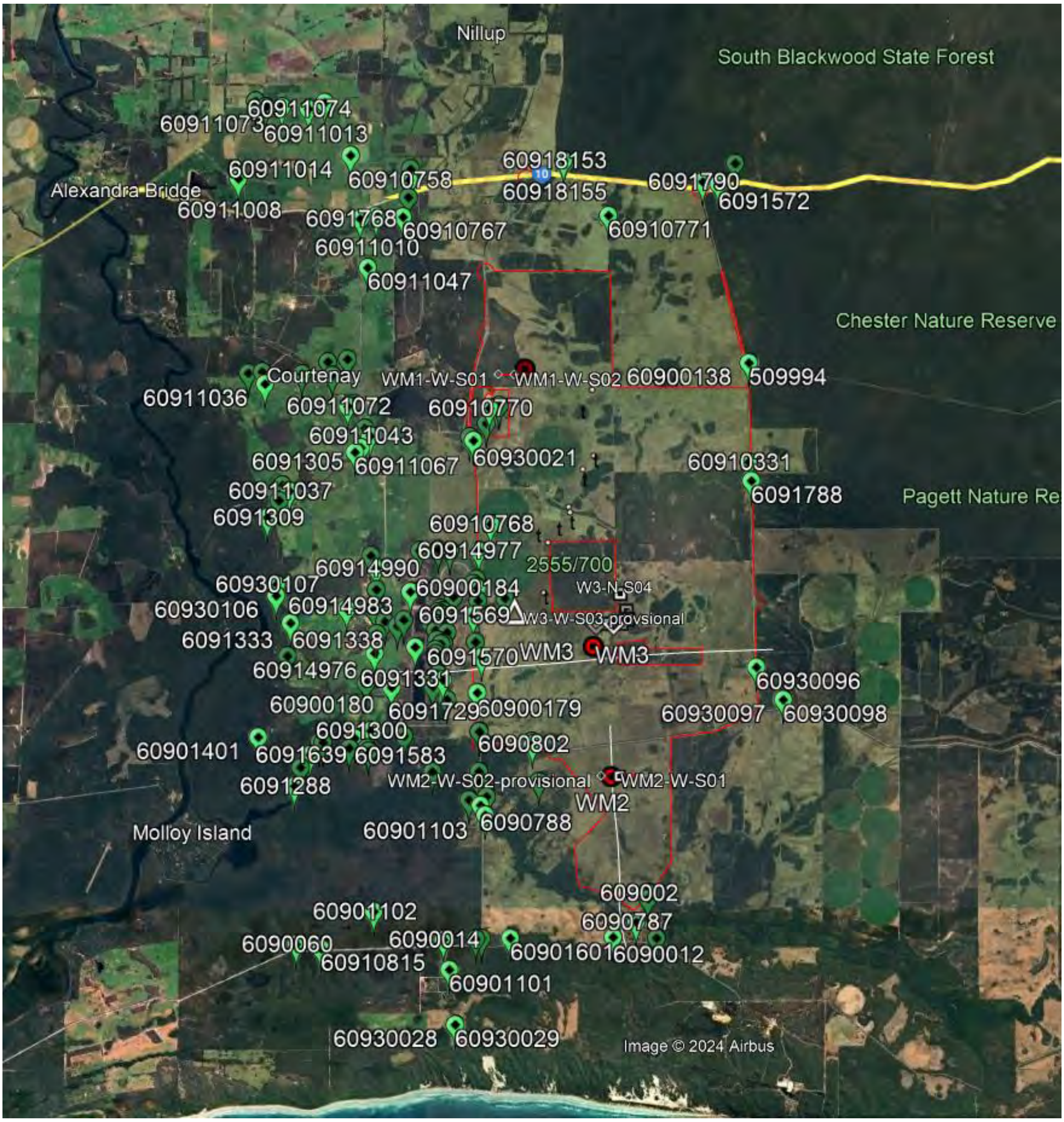


Figure F-1: WMIS Registered Bores (Study Area indicated by red polygon).

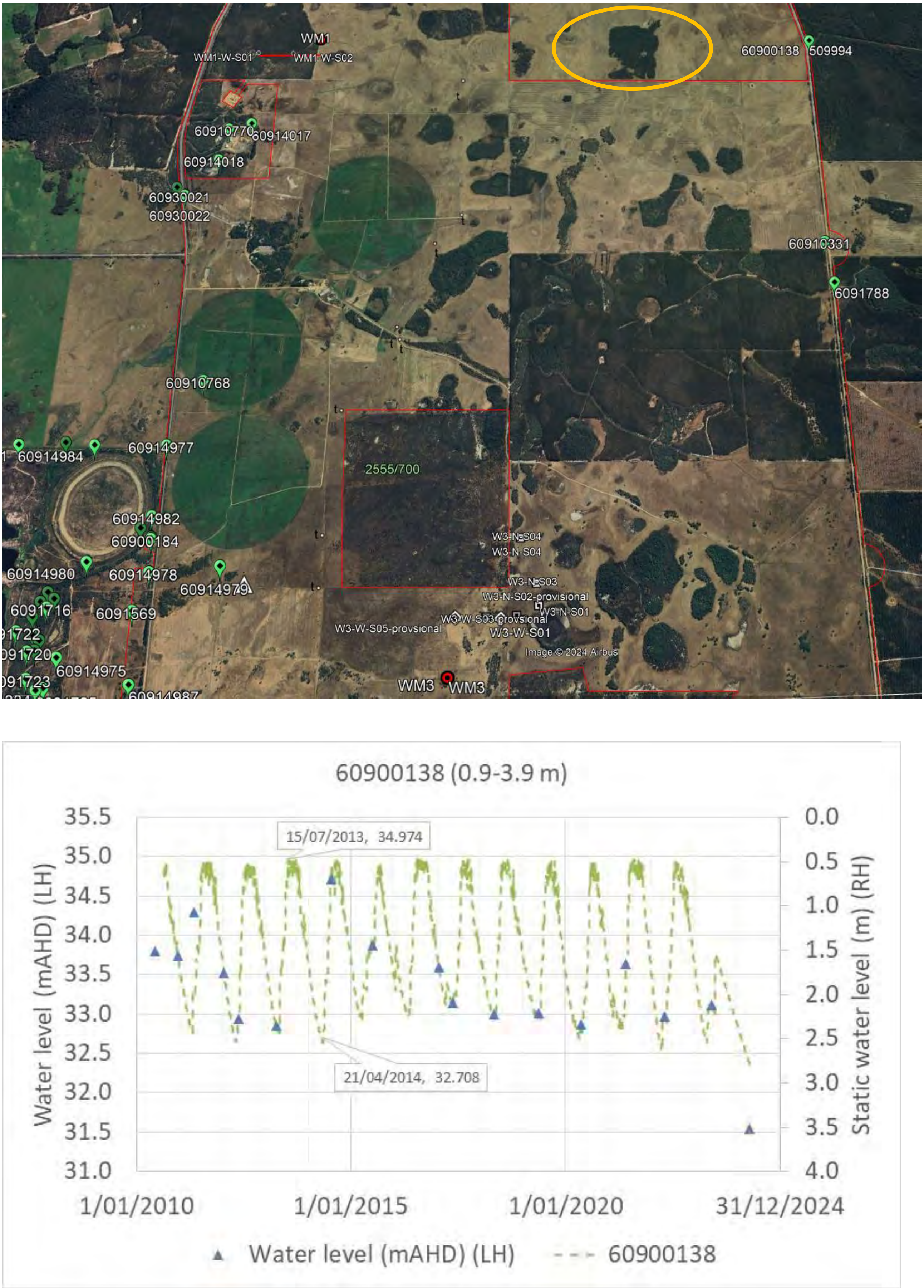


Figure F-2: Bore 60900138 Hydrograph (east boundary east of WM01)

SITE_ID	60900139
LATITUDE	-34.2834
LONGITUDE	115.269
SITE_NAME	Scott Coastal Plain - EW18A
SITE_SHORTNAME	EW18A
ZONE	50
EASTING	340706
NORTHING	6.20506e+06
SPHEROID	GDA2020

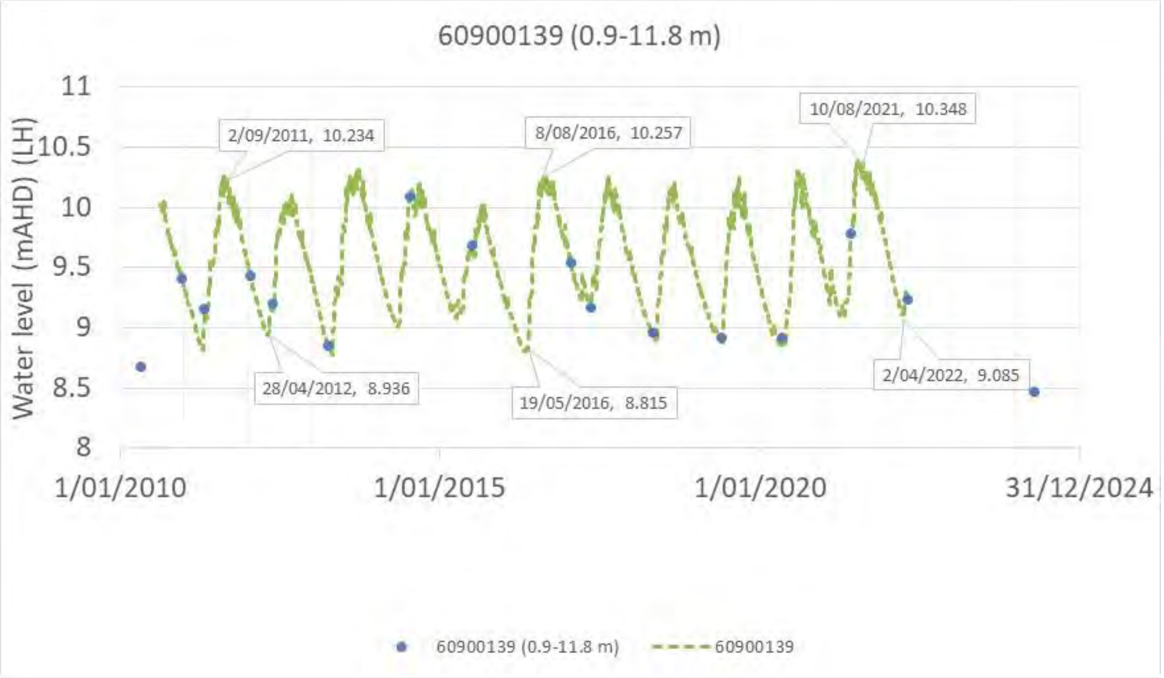
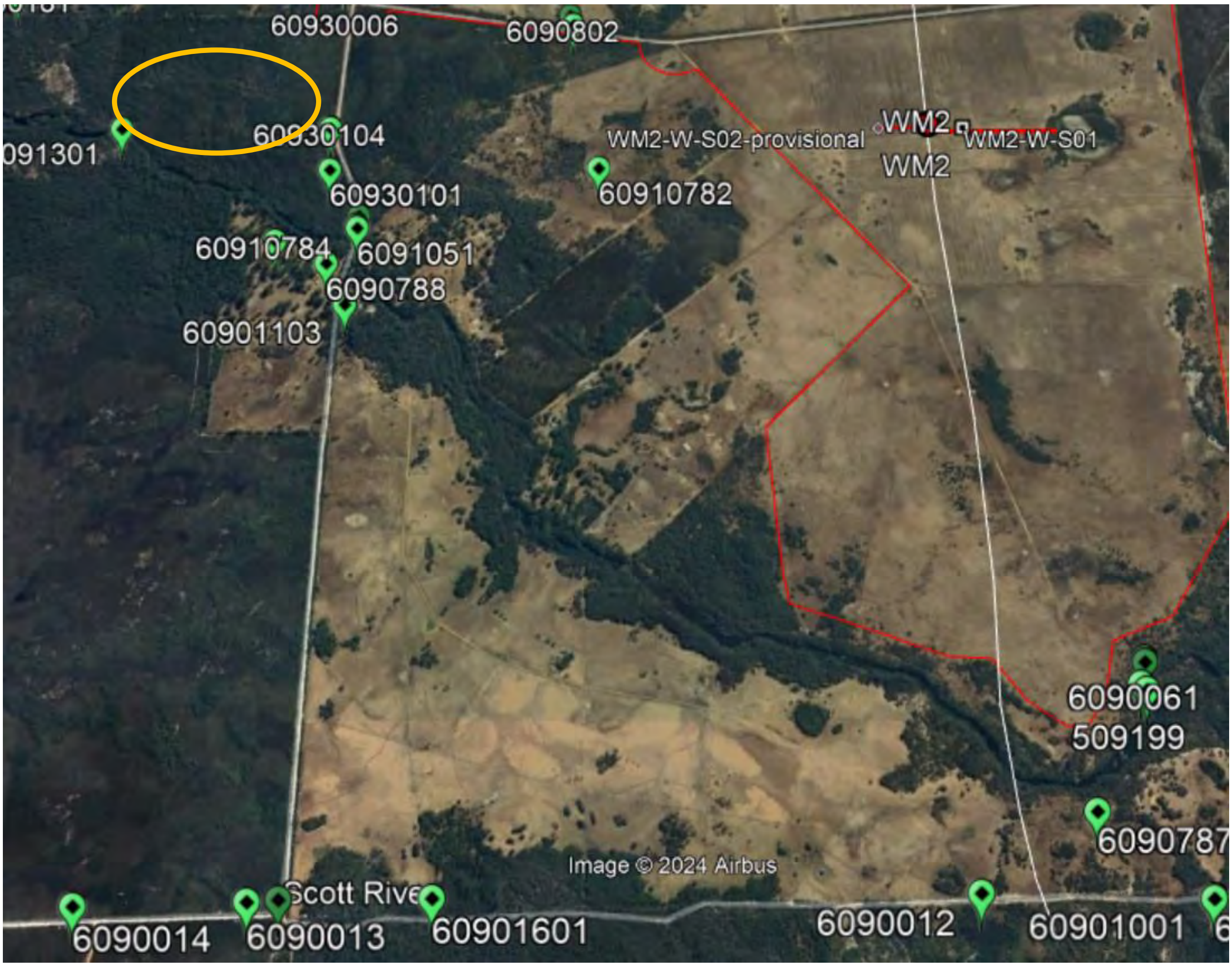


Figure F-3: Bore 60900139 Hydrograph (southwest of WM02)



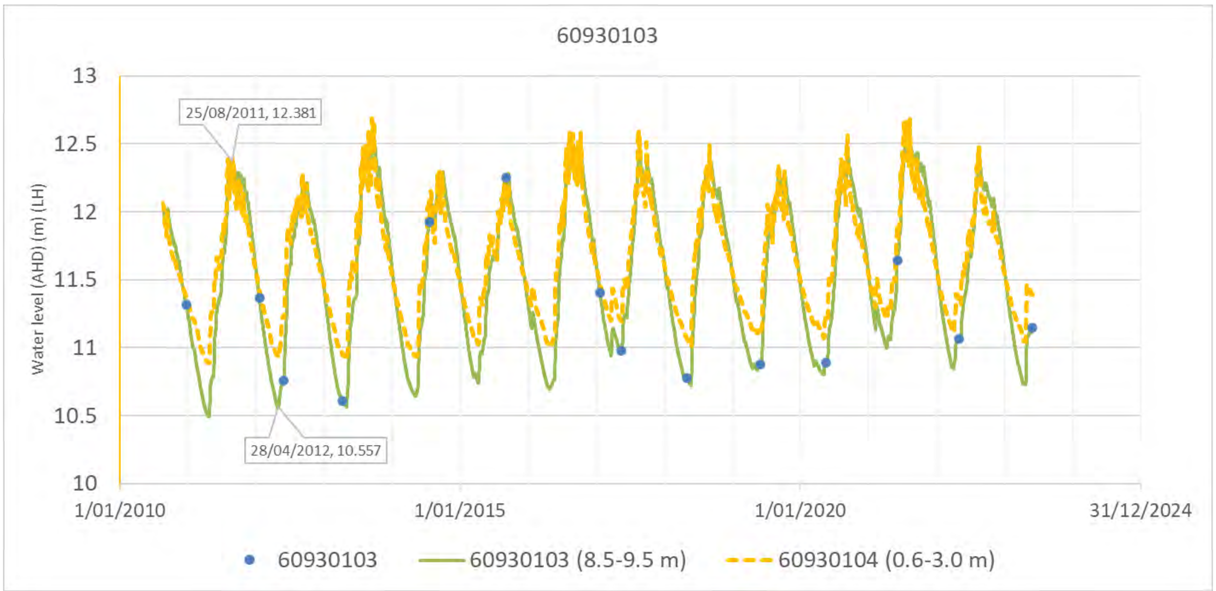
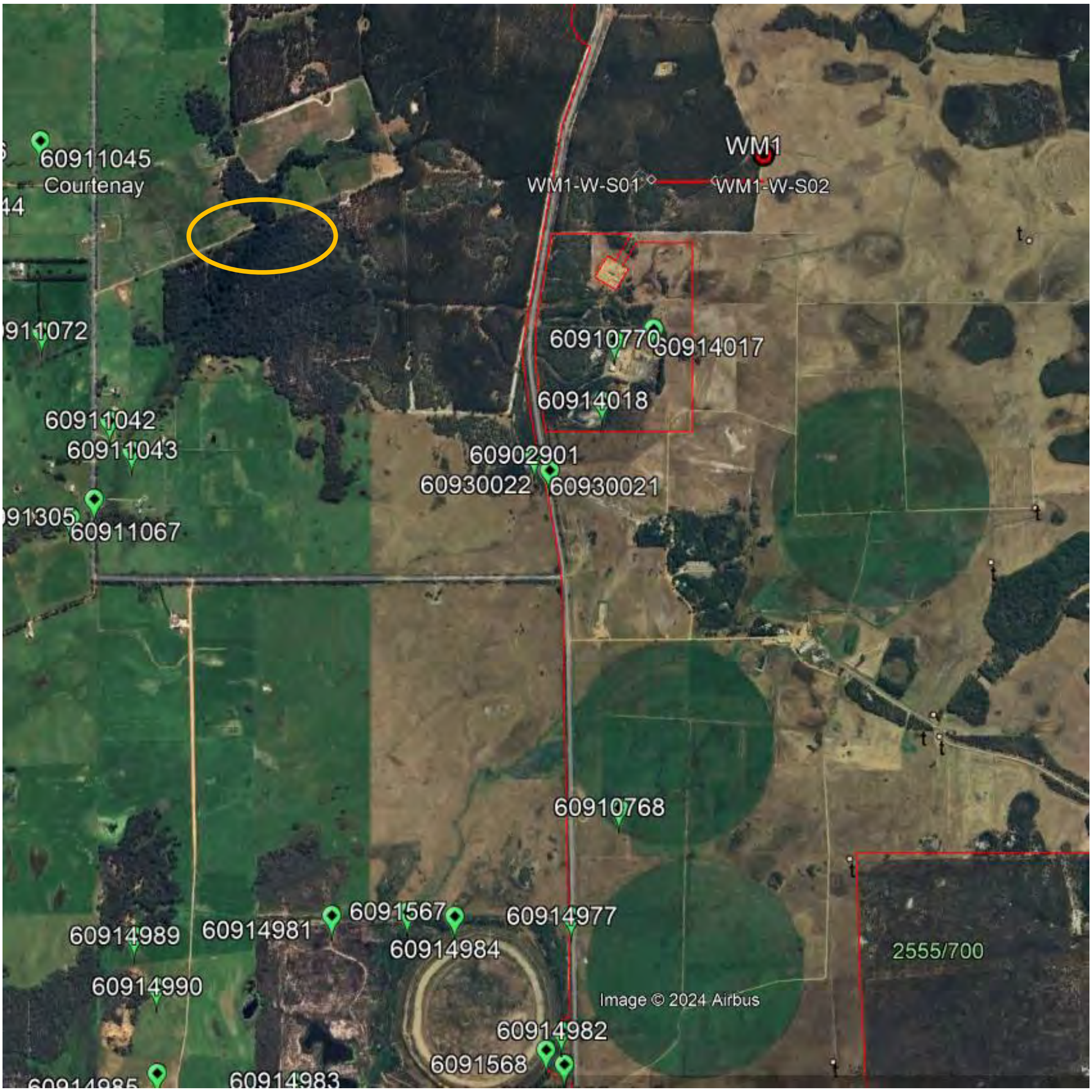


Figure F-4: Bores 60930103 & 60930104 Hydrographs (west of WM02)


60911045
Courtenay
44
WM1
WM1-W-S01
WM1-W-S02
911072
60910770
60914017
60914018
60911042
60911043
60902901
60930022
60930021
91305
60911067
60910768
6091567
60914977
60914989
60914981
60914984
2555/700
60914990
Image © 2024 Airbus
60914982
6091568
60914985
60914983

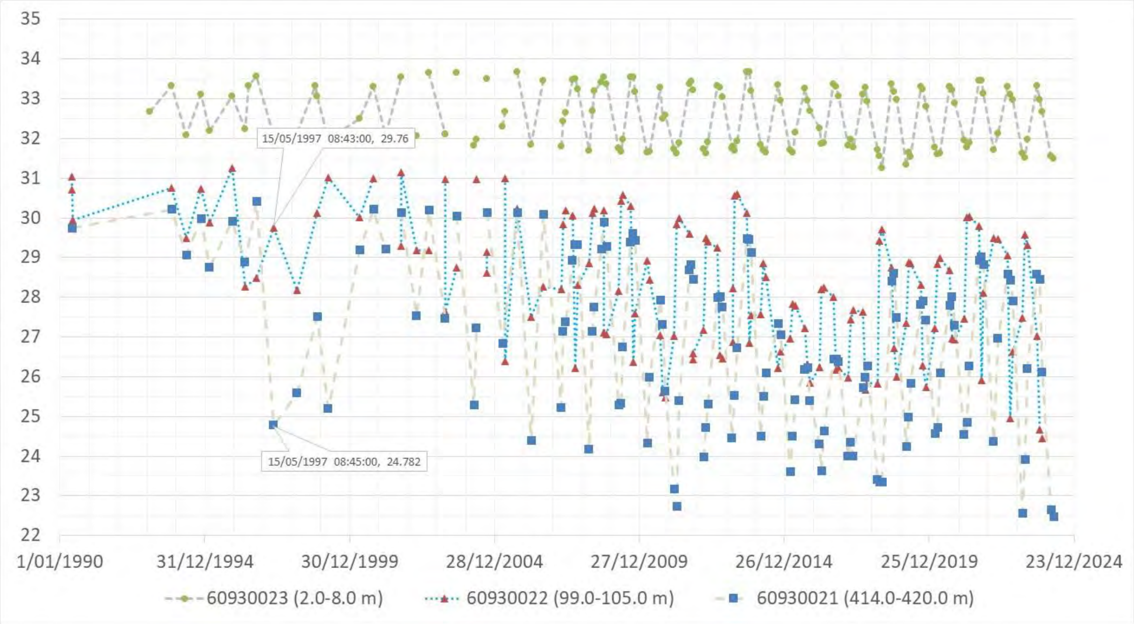


Figure F-5: Bore 60930021, 60930022, and 60930023 Hydrographs (west of WM01).

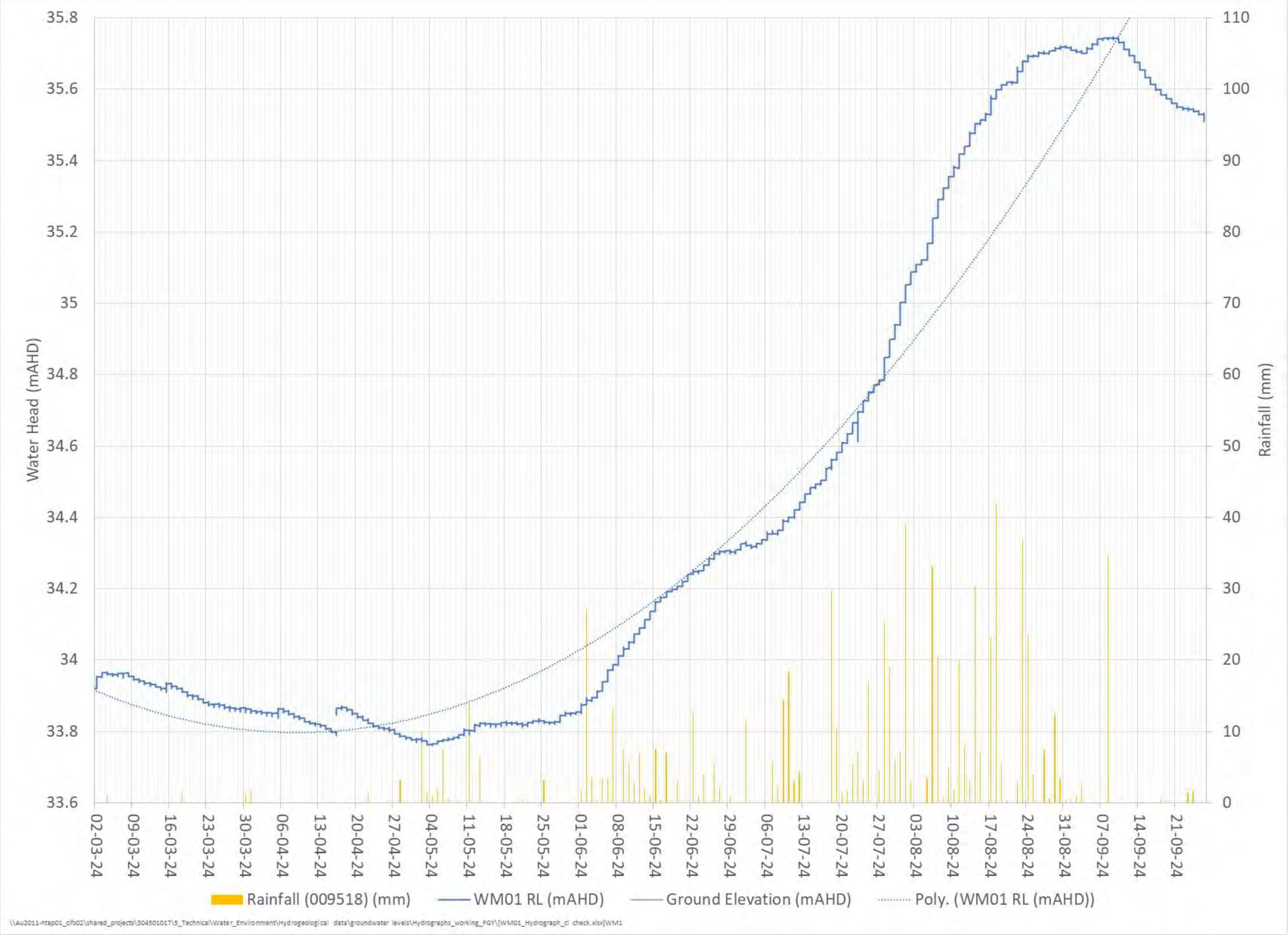
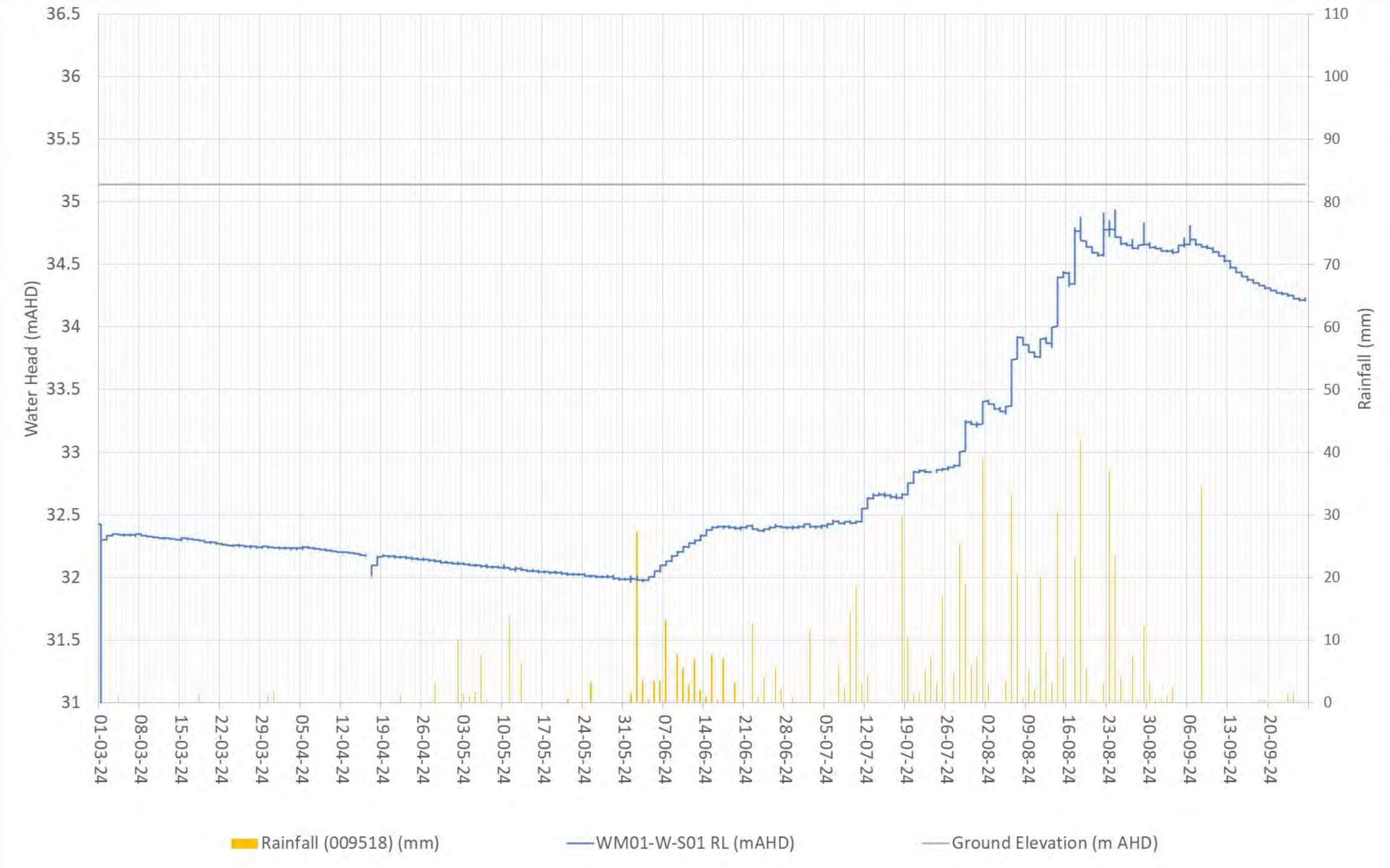
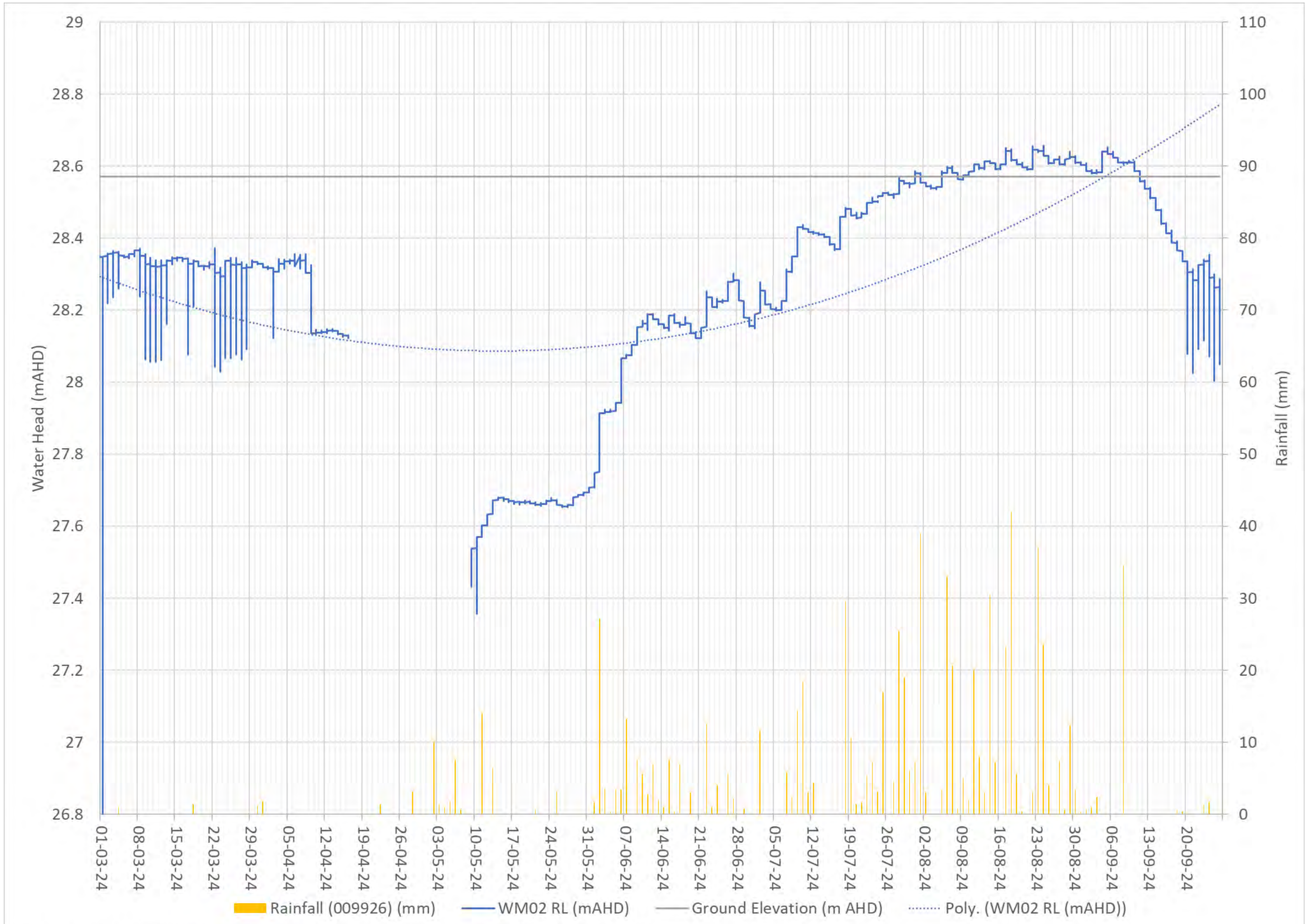


Figure F-6: Bore WM01 Hydrograph.



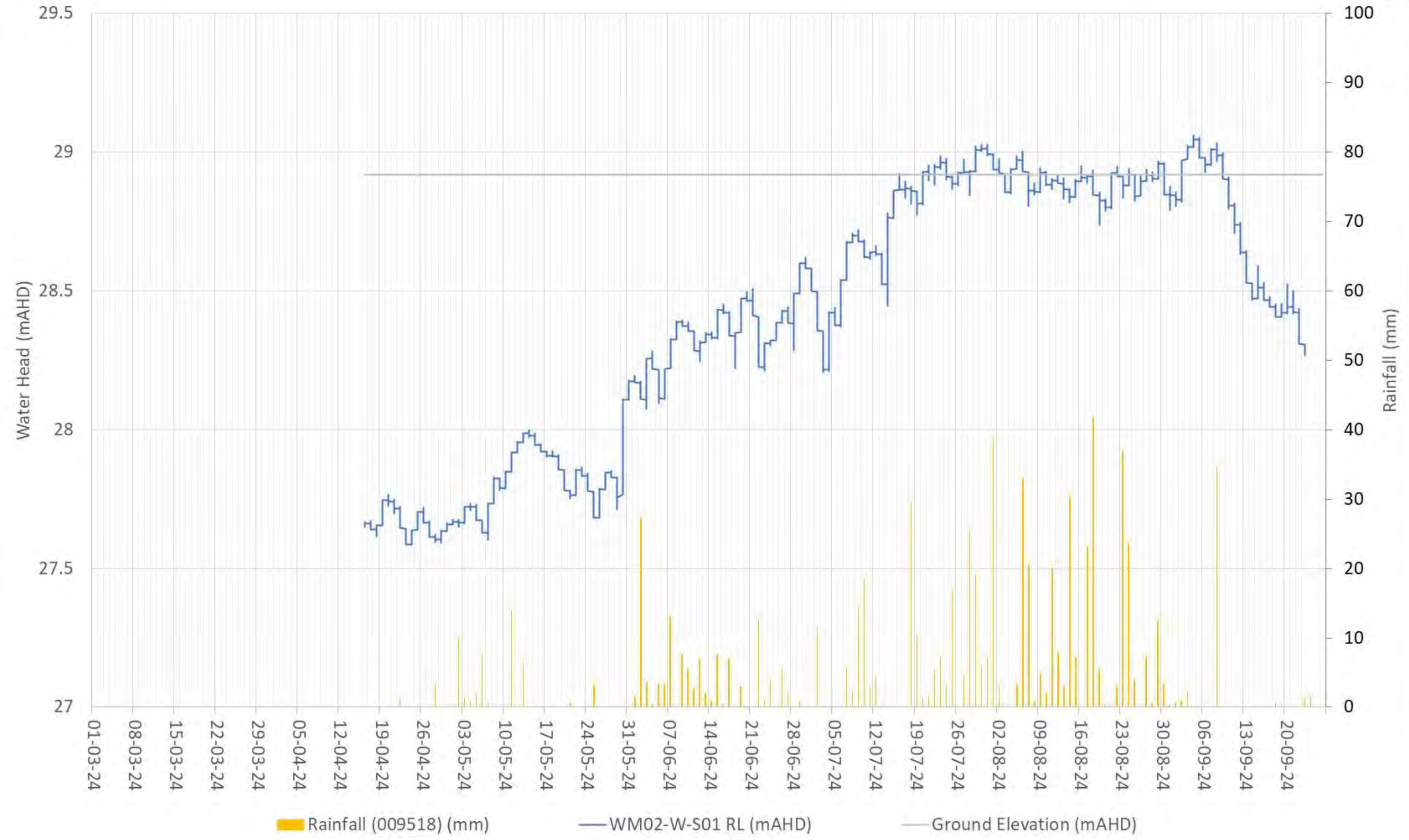
\\Au2011-ntap01_cifs02\shared_projects\304501017\5_Technical\Water_Environment\Hydrogeological data\groundwater levels\Hydrographs_working_FGY\[WM01-W-S01_Hydrograph.xlsx]WM01-W-S01

Figure F-7: Bore WM01-S01 Hydrograph



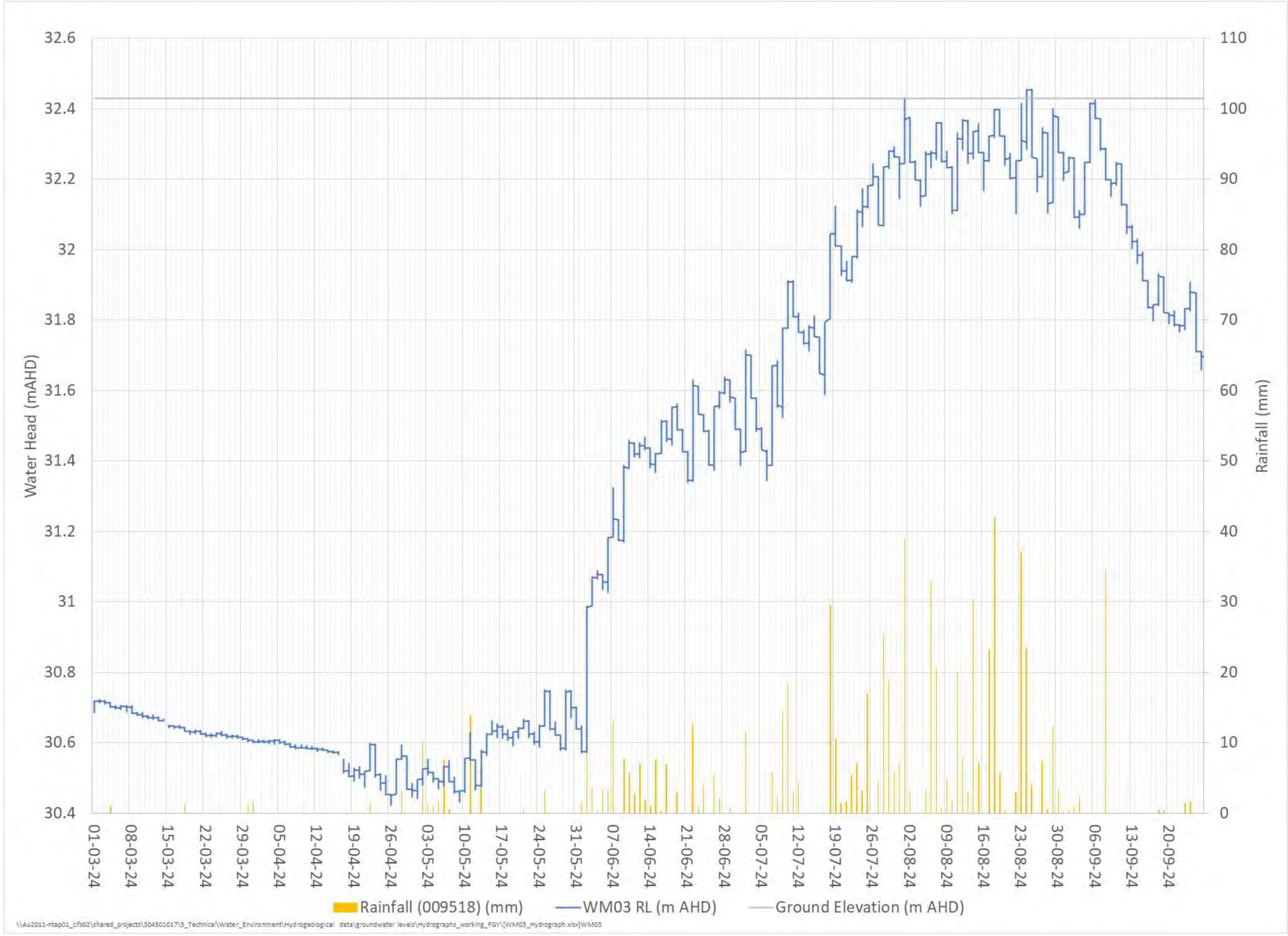
\\Au2011-ntap01_cifs02\shared_projects\304501017\5_Technical\Water_Environment\Hydrogeological data\groundwater levels\Hydrographs_working_FGY\[WM02_Hydrograph_(Bore_Reconstructed).xlsx]WM2

Figure F-8: Bore WM02 Hydrograph



\\Au2011-ntap01_cifs02\shared_projects\304501017\5_Technical\Water_Environment\Hydrogeological data\groundwater levels\Hydrographs_working_FGY\[WM02-W-S01_Hydrograph.xlsx]WM02-W-S01

Figure F-9: Bore WM02-W-S01 Hydrograph



\\Au2011-ntap01_cifs02\shared_projects\304501017\5_Technical\Water_Environment\Hydrogeological data\groundwater levels\Hydrographs_working_FGY\[WM03_Hydrograph.xlsx]WM03

Figure F-10: Bore WM03 Hydrograph

Appendix F Hydrological Details

Table B-1: Sub-catchment E, H, and I outlet and ponding areas results.

Catchment E			Catchment H			Catchment I		
Maximum Depth (m)								
ID	50% AEP	1% AEP	ID	50% AEP	1% AEP	ID	50% AEP	1% AEP
E1	0.98	2.01	H1	0.11	0.36		-	-
E2	0.11	0.37		-	-		-	-
E3	0.20	0.63		-	-		-	-
Maximum Flow (m^3/s)								
E4	0.3	20.1	H2	0.2	1.9	I1	0.23	2.13
E5	0.3	20.6	H3	0.2	2.8		-	-

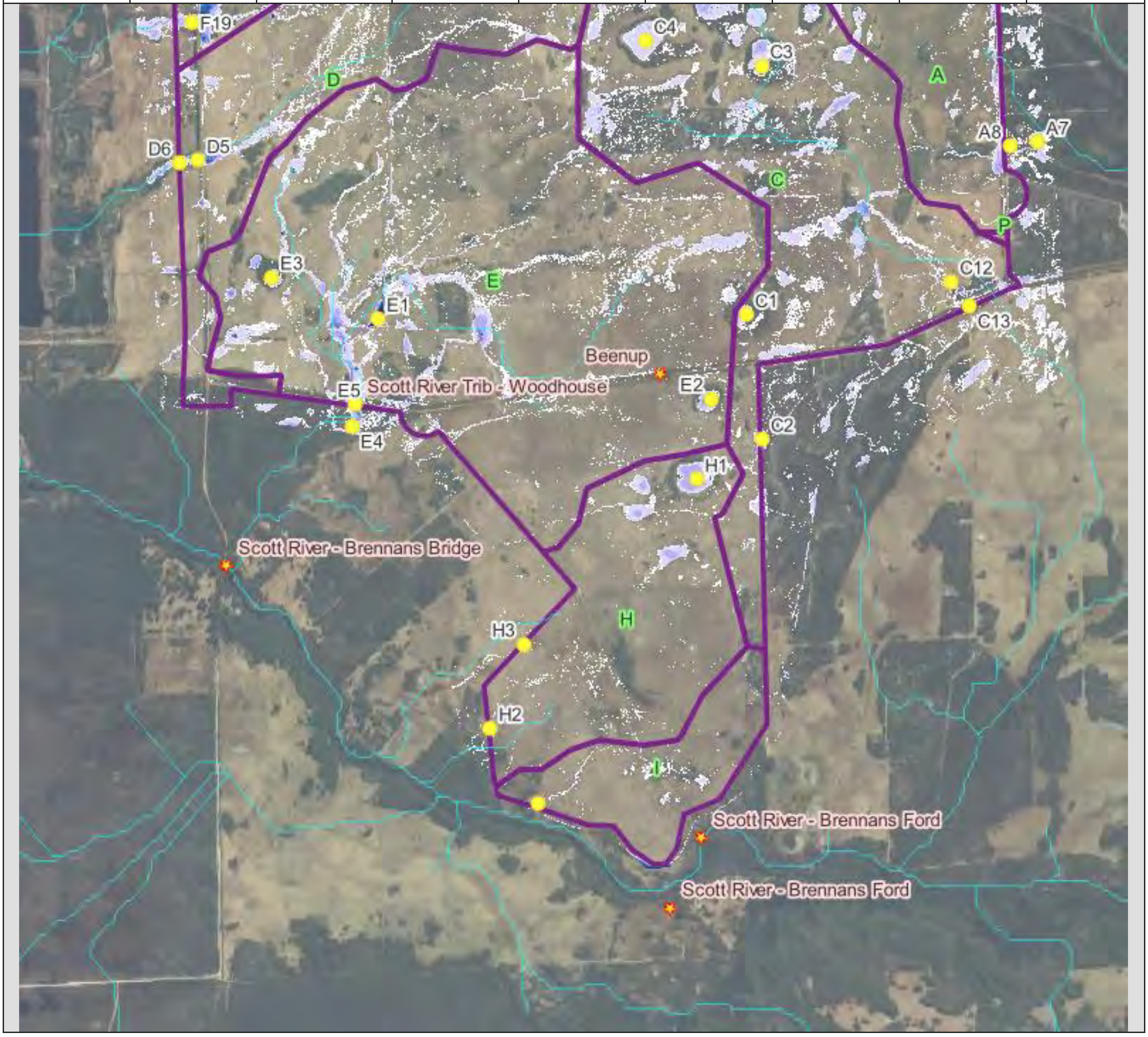


Table B-2: Sub-catchment A and C outlet and ponding areas results.

Catchment A			Catchment C		
Maximum Depth (m)					
ID	50% AEP	1% AEP	ID	50% AEP	1% AEP
A1	0.13	0.65	C1		0.36
A2	0.07	0.15	C2	0.13	0.55
A3	0.11	0.76	C3	0.18	0.55
A4	0.20	0.54	C4	-	0.11
A5	0.18	0.59	C5	-	0.24
A6	0.10	0.20	C6	0.09	0.28
	-	-	C7	-	0.15
	-	-	C8	-	1.13
	-	-	C9	-	0.08
	-	-	C10	0.15	0.31
	-	-	C11	-	0.42
Maximum Flow (m^3/s)					
A7	0.20	4	C12	0.31	3.02
A8	0.28	3.65	C13	0.39	5.8
	0.46	7.96		-	-
	0.41	7.81		-	-

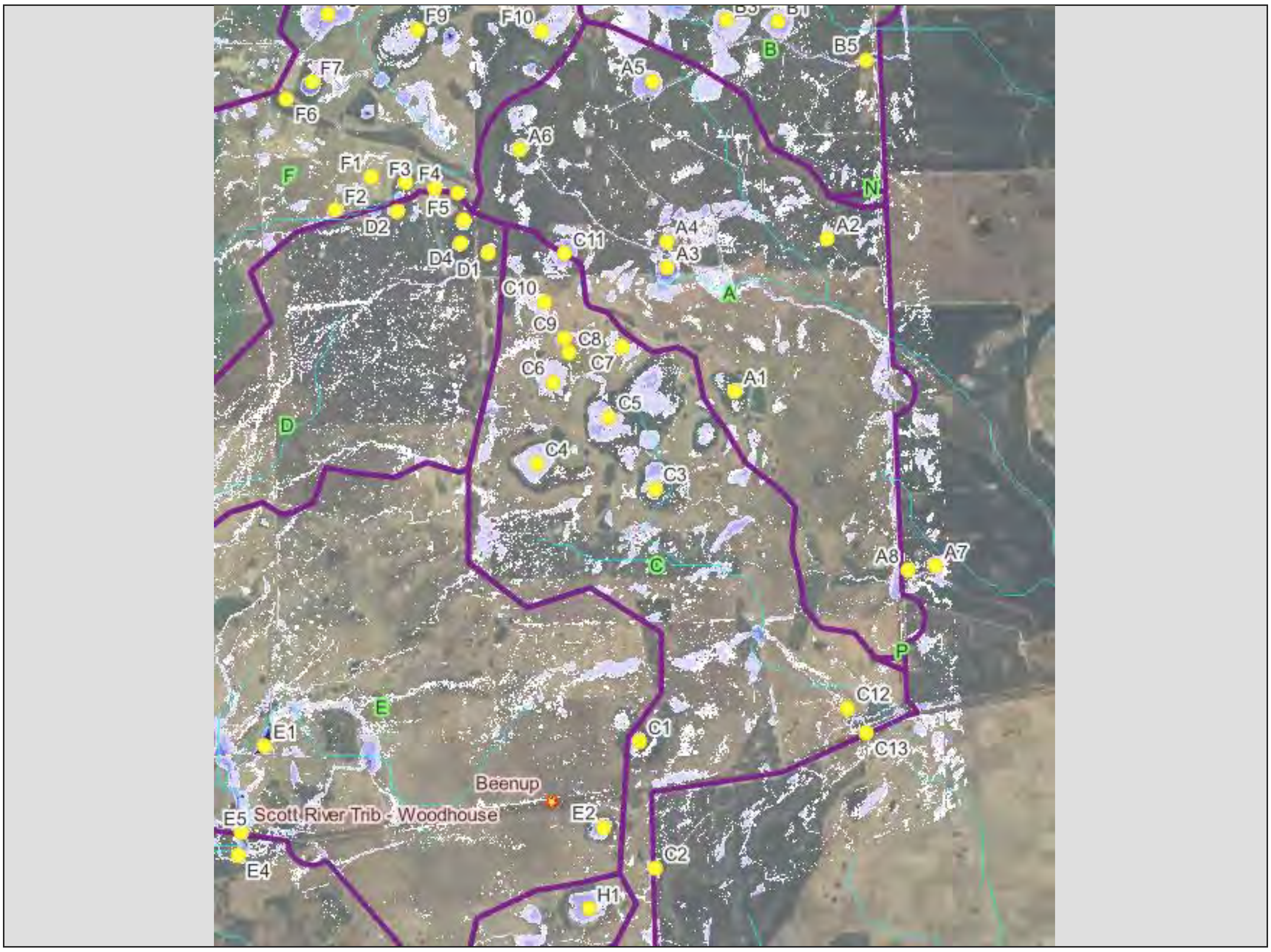

F9
F10
B3
B1
F7
B
B5
A5
F6
A6
F
F1
F3
F4
F2
F5
D2
N
A4
A2
C11
D4
A3
D1
A
C10
C9
C8
C7
C6
A1
C5
D
C4
C3
A8
A7
C
P
C12
E
C1
E1
C13
Beenup
E5
Scott River Trib - Woodhouse
E2
C2
E4
H1

Table B-3: Sub-catchment K, J and G outlet and ponding areas results.

Catchment K			Catchment J			Catchment G		
Maximum Depth (m)								
ID	50% AEP	1% AEP	ID	50% AEP	1% AEP	ID	50% AEP	1% AEP
K1	0.19	0.56		-	-	G1	-	0.95
K2	0.14	0.81		-	-	G2	0.064	0.34
K3	0.35	1.30		-	-		-	-
k4	0.09	1.12		-	-		-	-
K5	0.16	0.82		-	-		-	-
K6	0.46	2.82		-	-		-	-
K7	0.14	1.00		-	-		-	-
K8	0.27	1.89		-	-		-	-
K9	0.26	0.72		-	-		-	-
K10	0.30	0.70		-	-		-	-
K11	0.18	0.64		-	-		-	-
K12	0.24	0.62		-	-		-	-
K12	0.22	0.64		-	-		-	-
Maximum Flow (m^3/s)								
K14	0.11	1.59	J1	0.05	1.8	G3	0.06	0.8
	-	-		-	-	G4	0.38	11.6

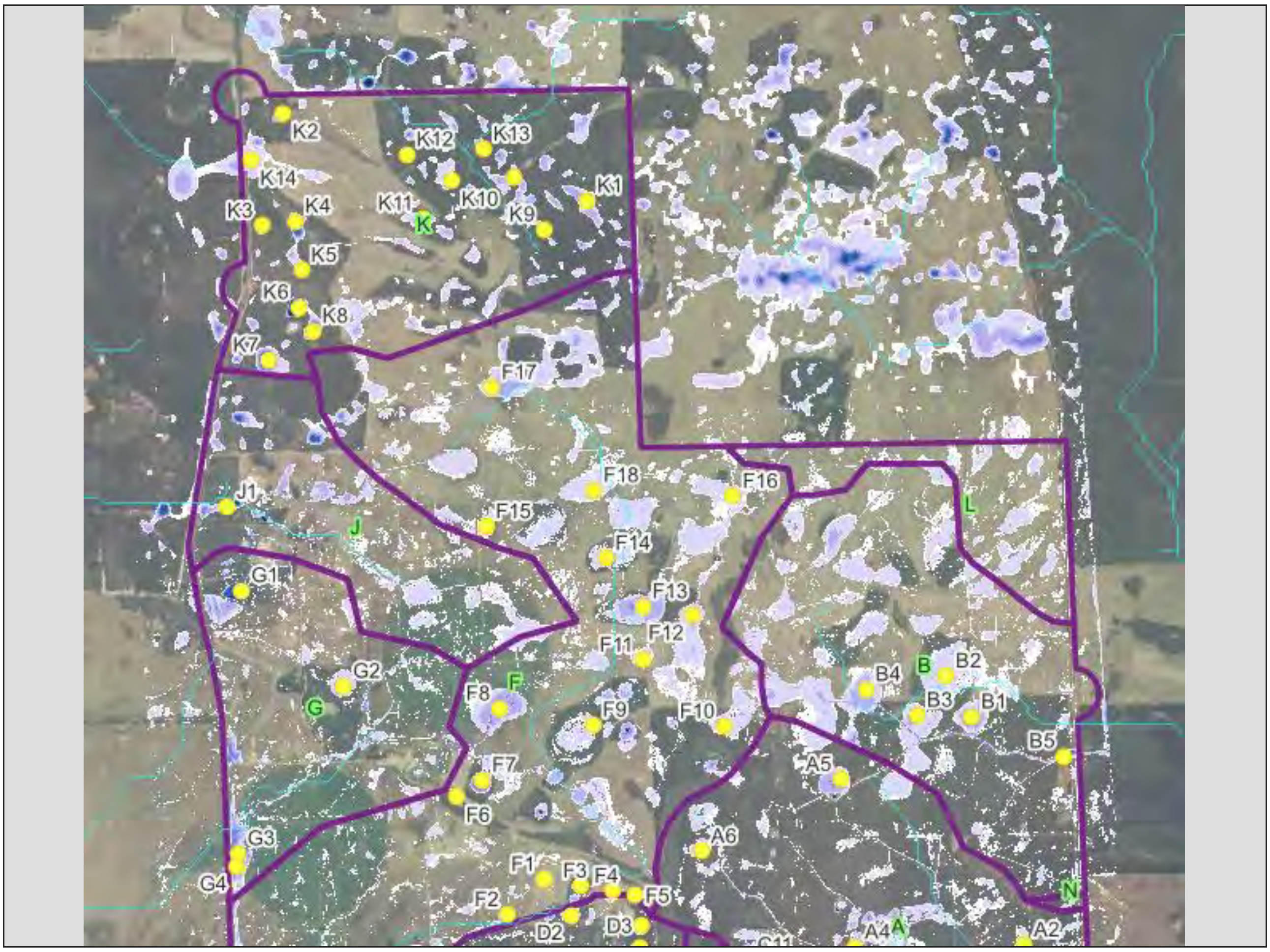
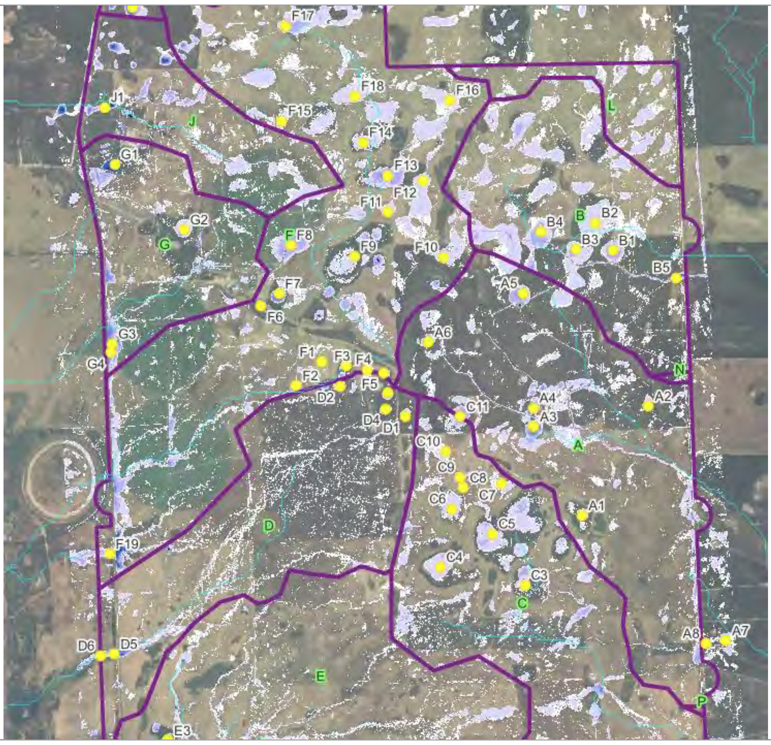
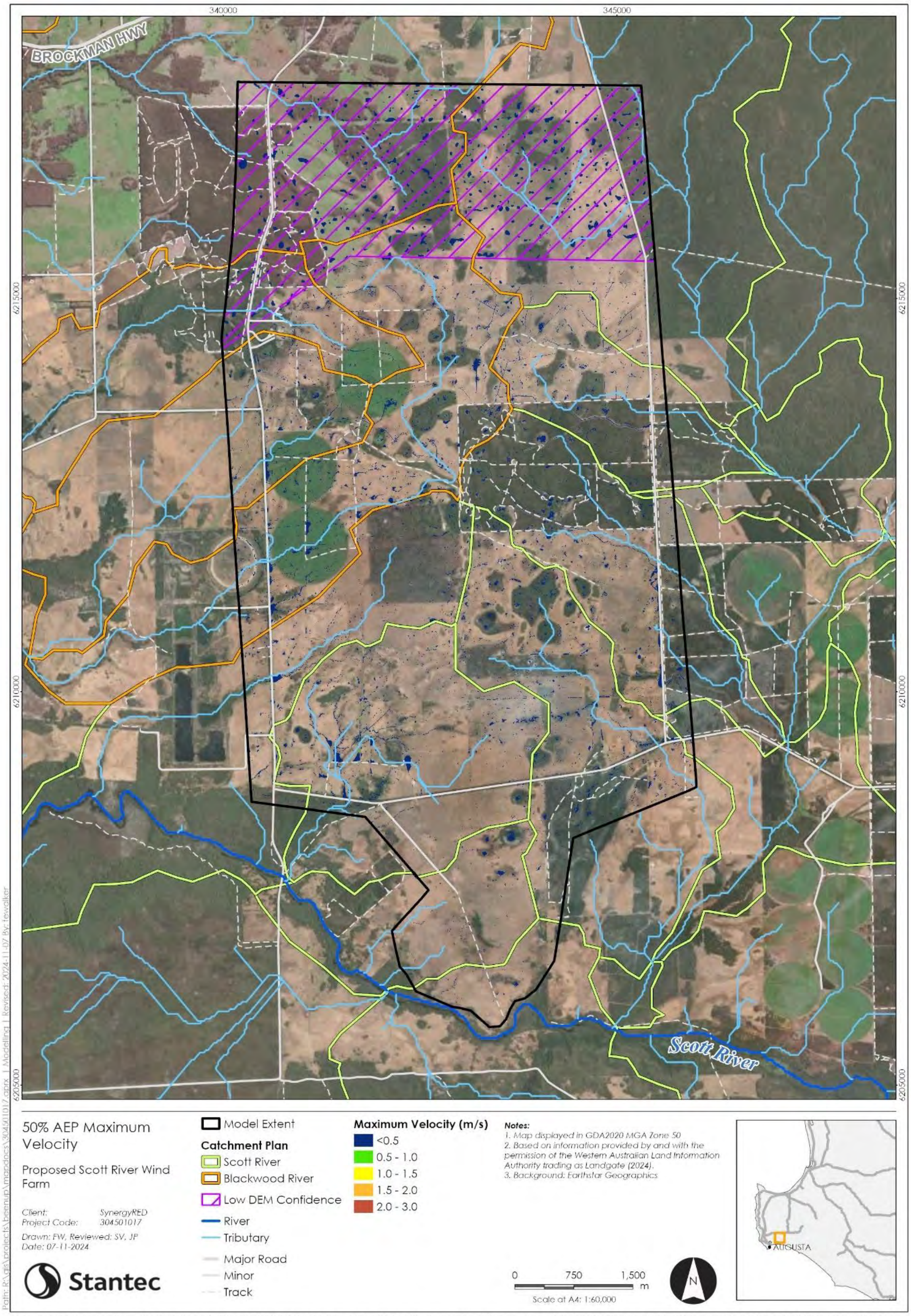

K2
K12
K13
K14
K1
K3
K4
K11
K10
K9
K
K5
K6
K8
K7
F17
F18
F16
J1
L
J
F15
F14
G1
F13
F12
F11
G2
B4
B
B2
G
F8
F
F9
F10
B3
B1
B5
A5
F7
F6
G3
A6
F1
F3
F4
G4
F2
F5
N
D2
D3
A4
A
A2

Table B-4: Sub-catchment B, F and D outlet and ponding areas results.

Catchment B			Catchment F			Catchment D		
Maximum Depth (m)								
ID	50% AEP	1% AEP	ID	50% AEP	1% AEP	ID	50% AEP	1% AEP
B1	-	0.35	F1	0.49	1.16	D1	0.18	0.26
B2	-	0.30	F2	0.14	0.74	D2	0.13	0.60
B3	-	0.48	F3	0.08	0.56	D3	0.17	0.54
B4	-	0.34	F4	0.07	0.18	D4	0.03	0.26
	-	-	F5	0.06	0.29		-	-
	-	-	F6	0.17	0.68		-	-
	-	-	F7	-	0.62		-	-
	-	-	F8	0.11	0.53		-	-
	-	-	F9	0.04	0.21		-	-
	-	-	F10	0.20	0.45		-	-
	-	-	F11	-	0.17		-	-
	-	-	F12	0.35	0.56		-	-
	-	-	F13	-	0.33		-	-
	-	-	F14	0.06	0.31		-	-
	-	-	F15	0.14	0.32		-	-
	-	-	F16	0.07	0.18		-	-
	-	-	F17	0.16	0.32		-	-
	-	-	F118	0.19	0.57		-	-
Maximum Flow (m3/s)								
B5	0.12	1.99	F19	0.02	11.87	D5	0.21	7.57
	-	-		-	-		0.21	7.89


F17
F18
F16
J1
F15
J
L
F14
G1
F13
F12
F11
B
B2
B4
B3
B1
G2
F
F8
F9
F10
G
B5
F7
A5
F6
G3
A6
G4
F1
F3
F4
N
F2
F5
D2
A4
A2
C11
D4
D1
A3
C10
A
C9
C8
C7
C6
A1
C5
D
F19
C4
C3
C
A8
A7
D6
D5
E
P
E3

Appendix G Flood Result Figures



50% AEP Maximum Velocity

Proposed Scott River Wind Farm

Client: SynergyRED
Project Code: 304501017
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Stantec

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

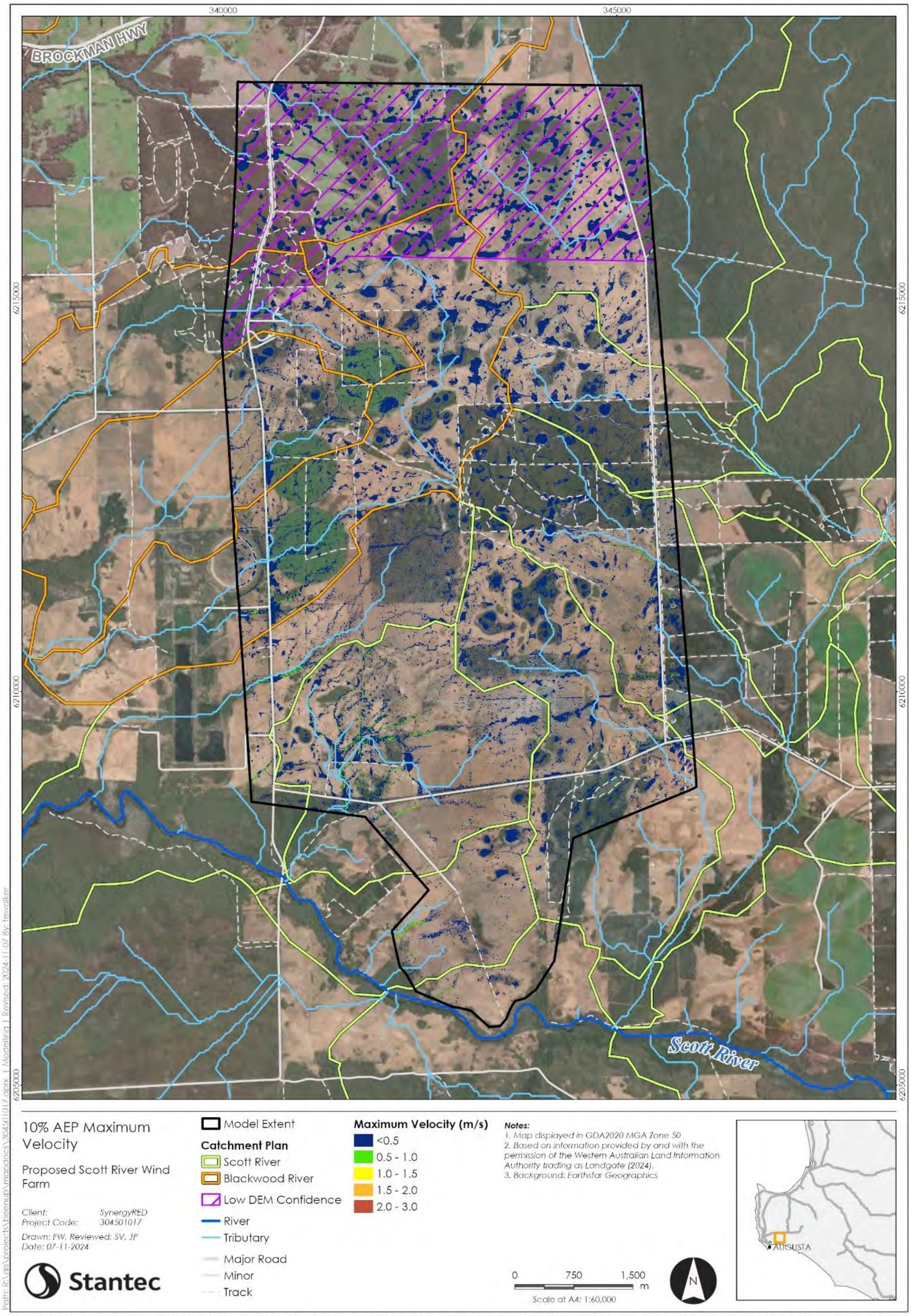
50% AEP Maximum Depth

Proposed Scott River Wind Farm

Client: *SynergyRED*
Project Code: *304501017*
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. *Map displayed in GDA2020 MGA Zone 50*
2. *Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).*
3. *Background: Earthstar Geographics*

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker



10% AEP Maximum Velocity

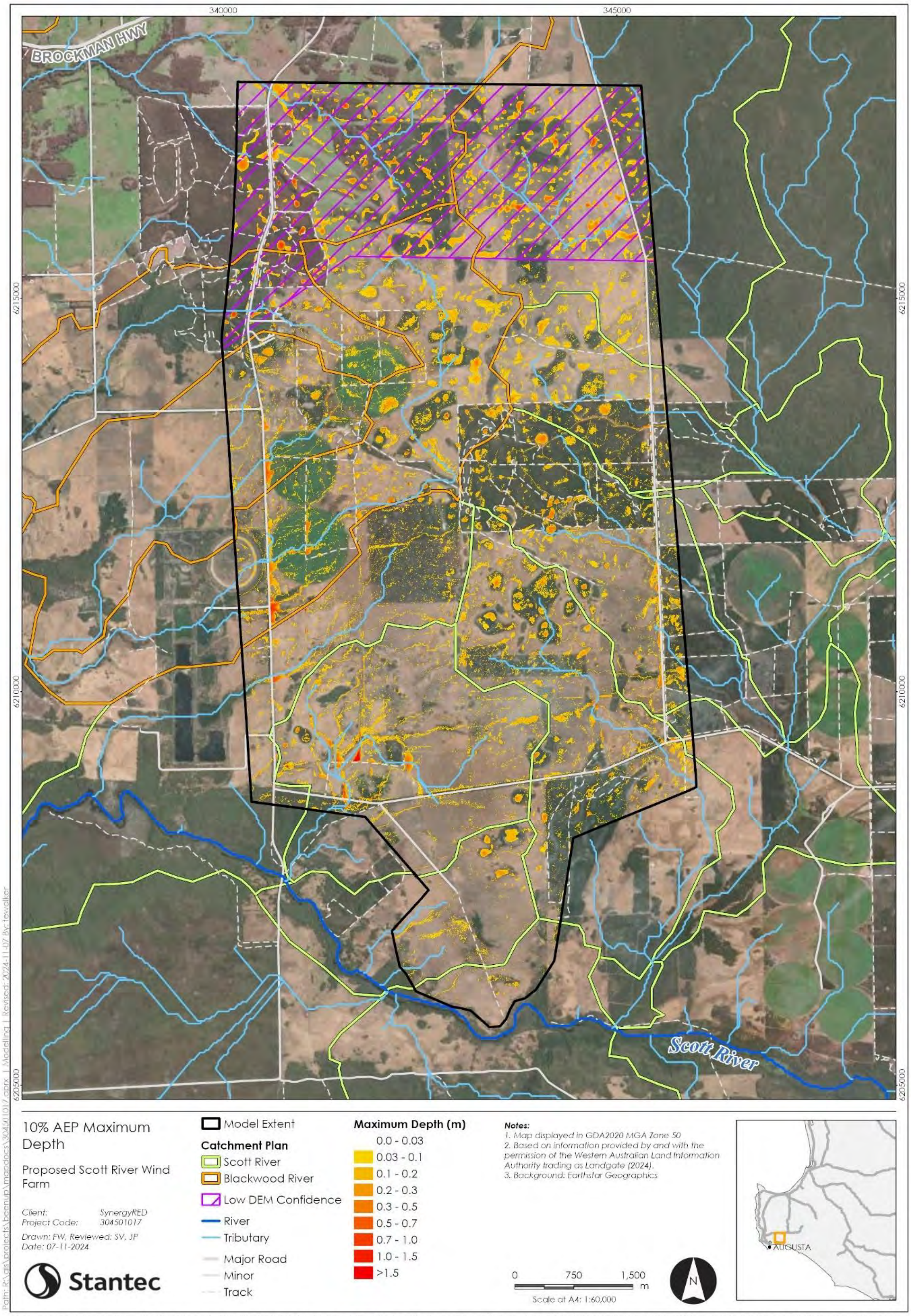
Proposed Scott River Wind Farm

Client: *SynergyRED*
Project Code: *304501017*

Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker



10% AEP Maximum Depth

Proposed Scott River Wind Farm

Client: SynergyRED
Project Code: 304501017
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Stantec

▢	Model Extent

Catchment Plan

🟩	Scott River
🟧	Blackwood River
▨	Low DEM Confidence
—	River
—	Tributary
—	Major Road
—	Minor
- -	Track

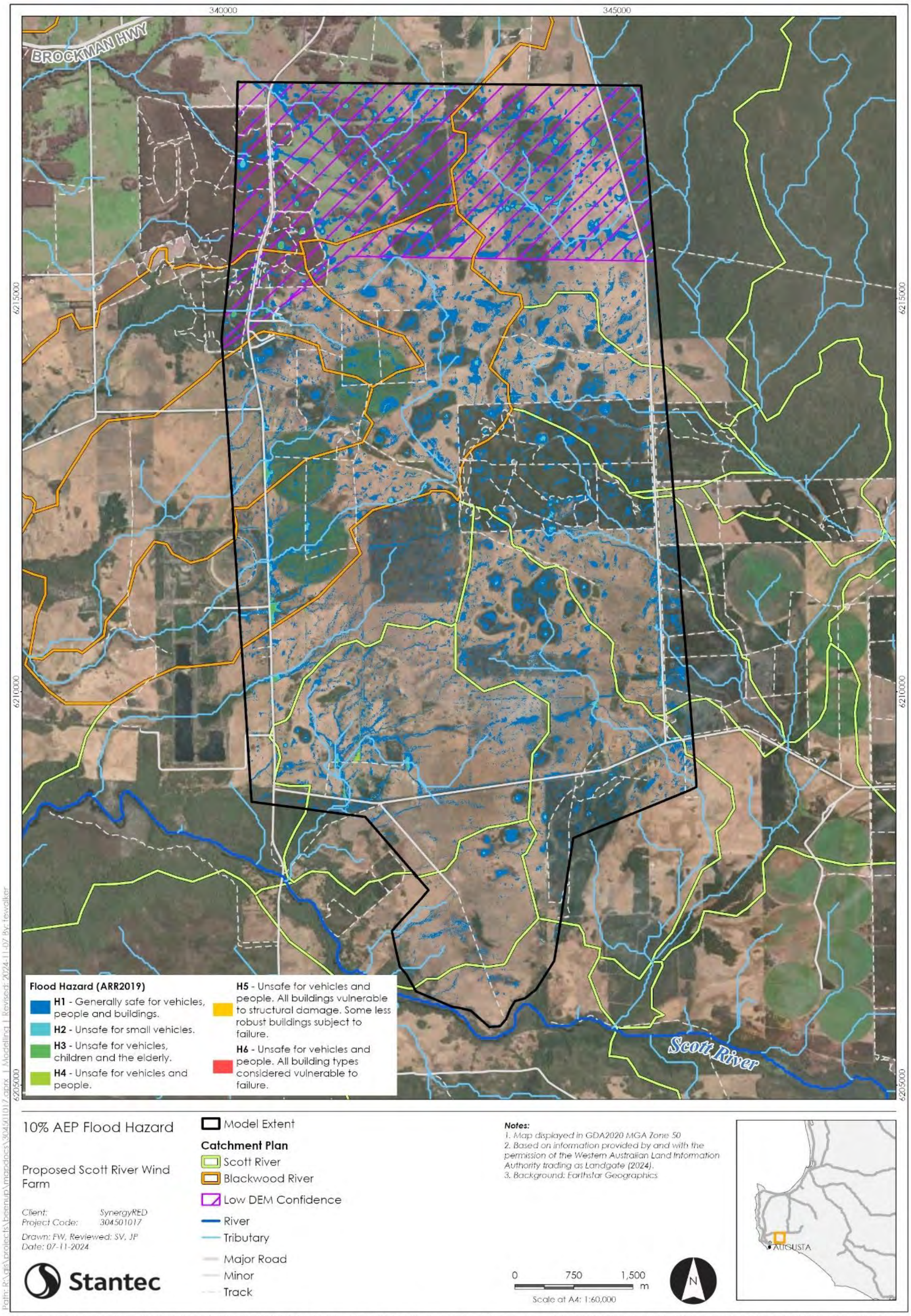
Maximum Depth (m)

	0.0 - 0.03
🟨	0.03 - 0.1
🟨	0.1 - 0.2
🟧	0.2 - 0.3
🟧	0.3 - 0.5
🟧	0.5 - 0.7
🟥	0.7 - 1.0
🟥	1.0 - 1.5
🟥	>1.5

Notes:
1. *Map displayed in GDA2020 MGA Zone 50*
2. *Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).*
3. *Background: Earthstar Geographics*

Scale at A4: 1:60,000

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker



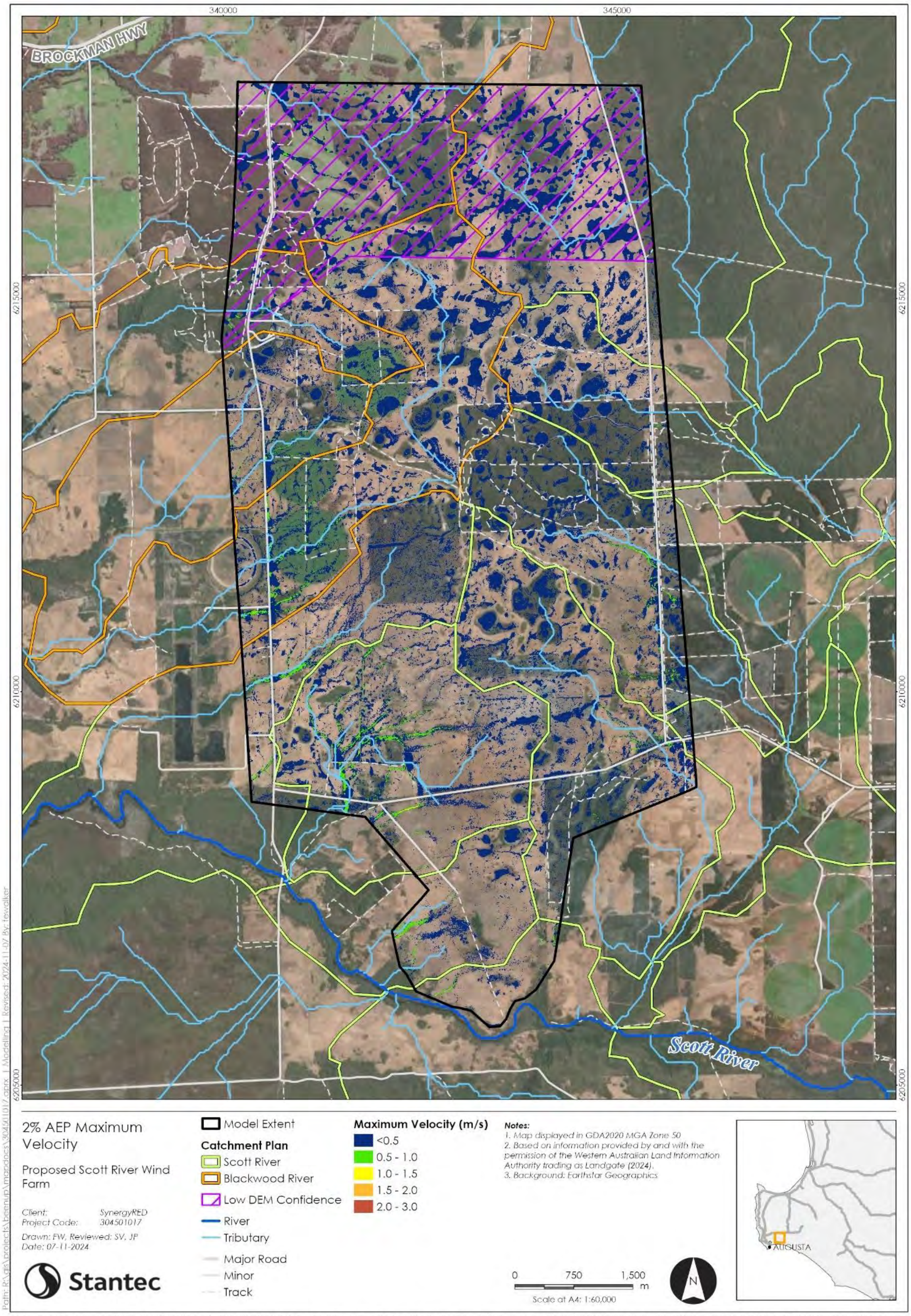
10% AEP Flood Hazard

Proposed Scott River Wind Farm

Client: *SynergyRED*
Project Code: *304501017*

Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics



2% AEP Maximum Velocity

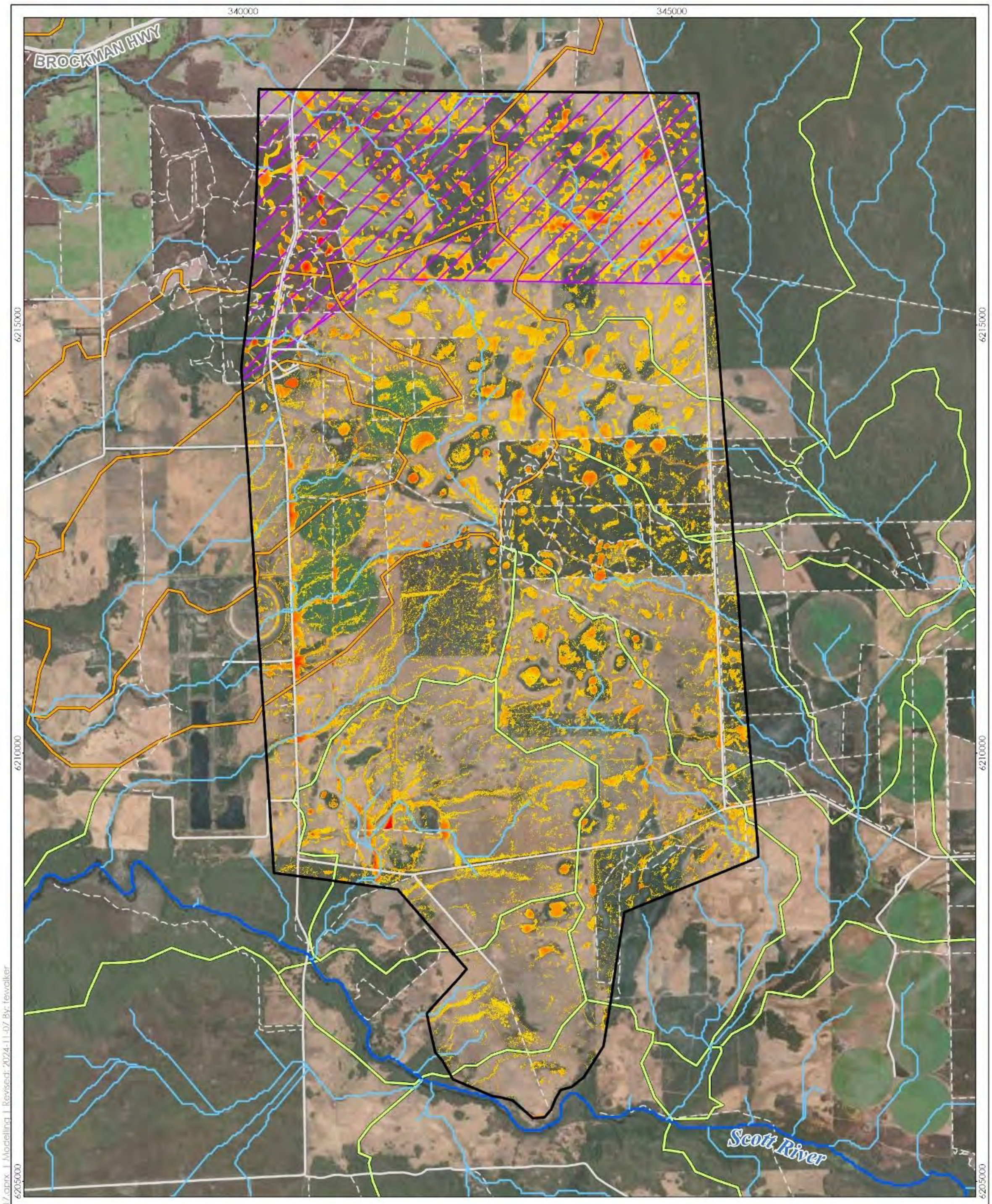
Proposed Scott River Wind Farm

Client:	*SynergyRED*
Project Code:	*304501017*

Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker



2% AEP Maximum Depth

Proposed Scott River Wind Farm

Client: *SynergyRED*
Project Code: *304501017*
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

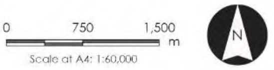
Stantec

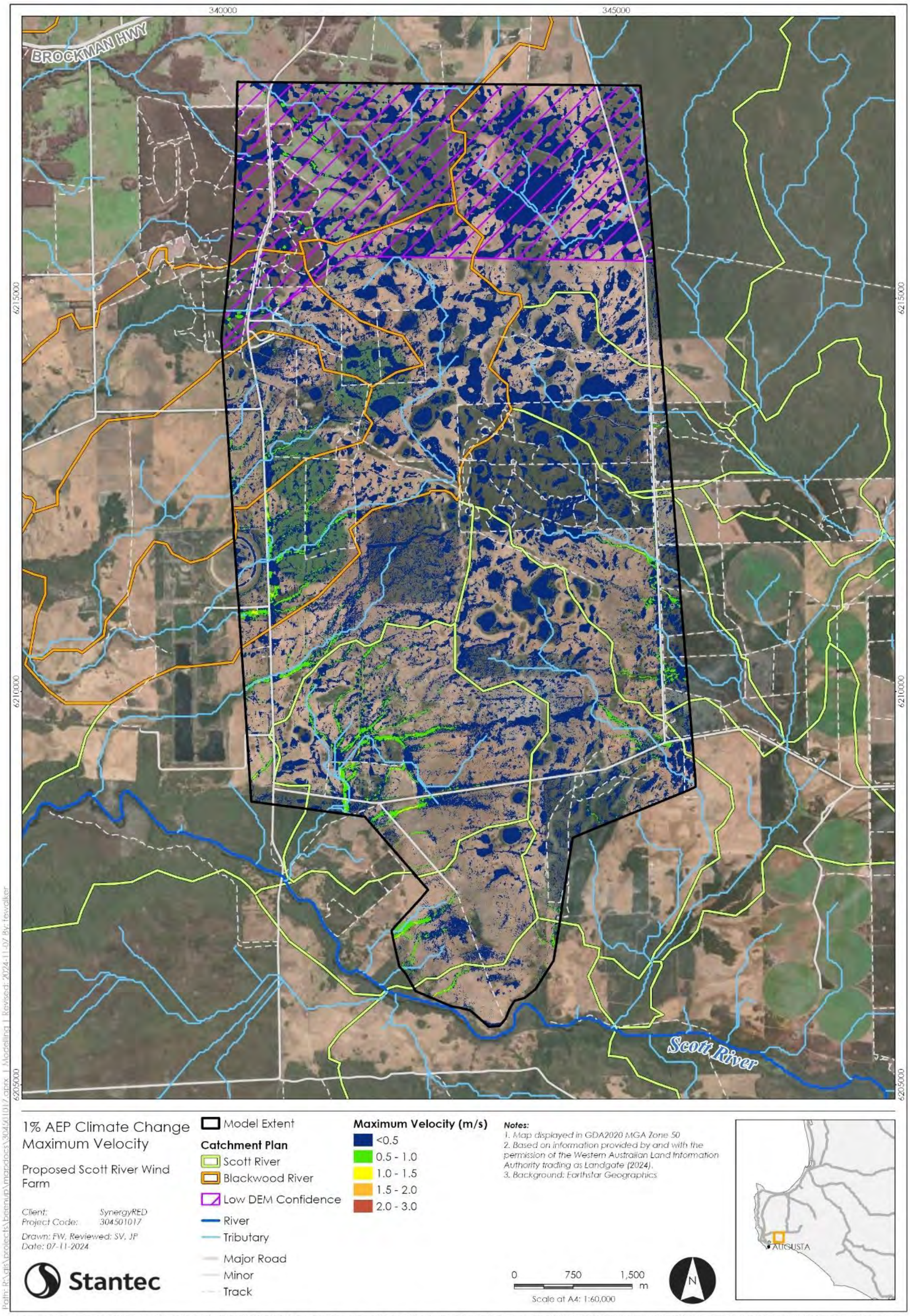
▭ Model Extent

Catchment Plan
- ▭ Scott River
- ▭ Blackwood River
- ▨ Low DEM Confidence
- — River
- — Tributary
- — Major Road
- — Minor
- - - Track

Maximum Depth (m)
- 0.0 - 0.03
- 🟨 0.03 - 0.1
- 🟨 0.1 - 0.2
- 🟧 0.2 - 0.3
- 🟧 0.3 - 0.5
- 🟧 0.5 - 0.7
- 🟥 0.7 - 1.0
- 🟥 1.0 - 1.5
- 🟥 >1.5

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics





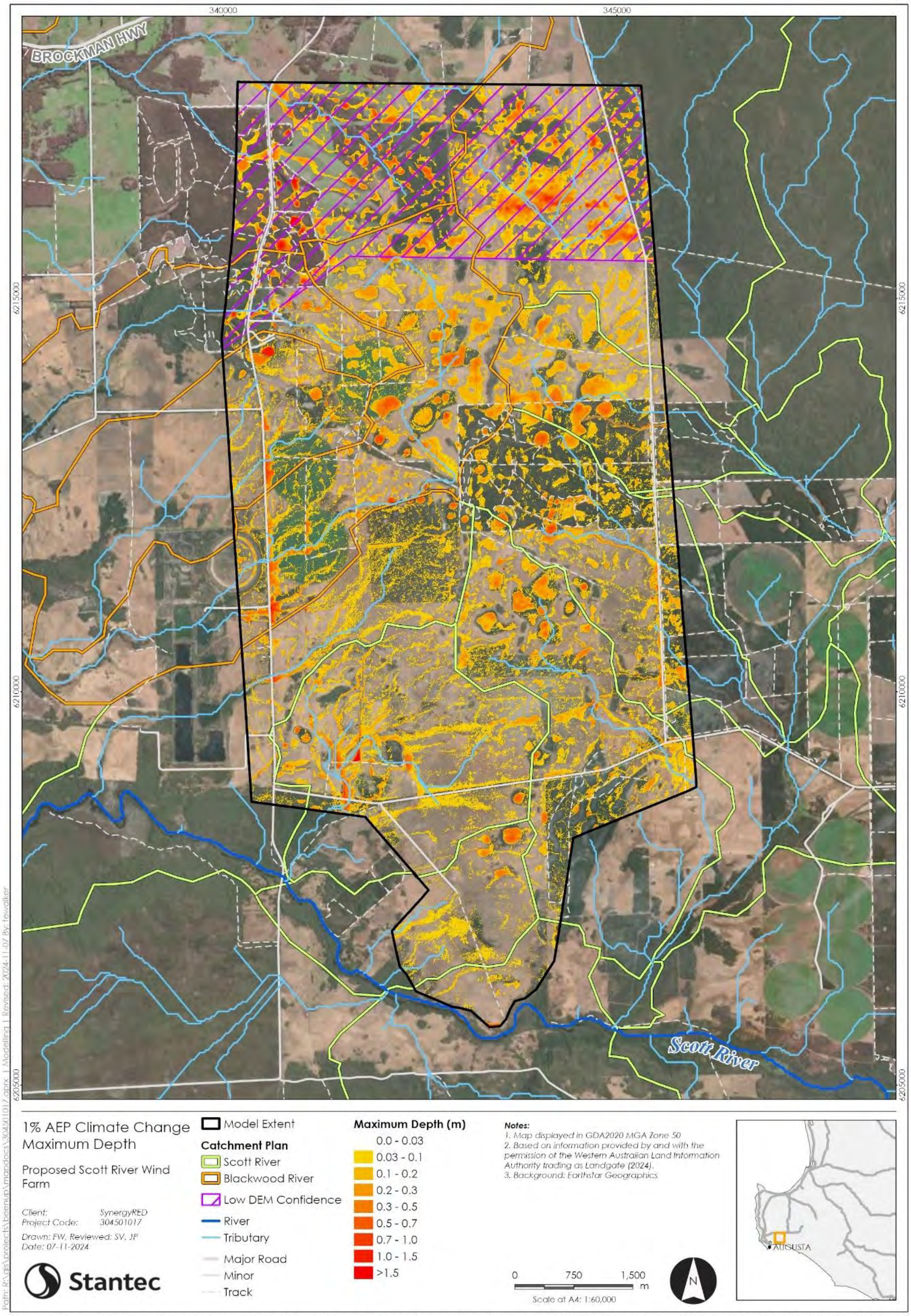
1% AEP Climate Change Maximum Velocity

Proposed Scott River Wind Farm

Client: SynergyRED
Project Code: 304501017
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker



1% AEP Climate Change Maximum Depth

Proposed Scott River Wind Farm

Client: *SynergyRED*
Project Code: *304501017*
Drawn: FW, Reviewed: SV, JP
Date: 07-11-2024

Notes:
1. Map displayed in GDA2020 MGA Zone 50
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2024).
3. Background: Earthstar Geographics

Path: R:\gis\projects\beenup\mapdocs\304501017.aprx | Modelling | Revised: 2024-11-07 By: fewalker

Appendix H Hydrogeology Model Inputs and Outputs

Should

Transient Inflow Modelling (Cooper-Jacob Model) for Transmission Towers and Central \ Southern Turbines (Kh = 10 m/d)

5) Cooper Jacob (Time-variant unconfined aquifer)

(Based on Theis equation)

$$Q = \frac{4\pi Ts}{2.3\log\left(\frac{2.25Tt}{r^2S}\right)}$$

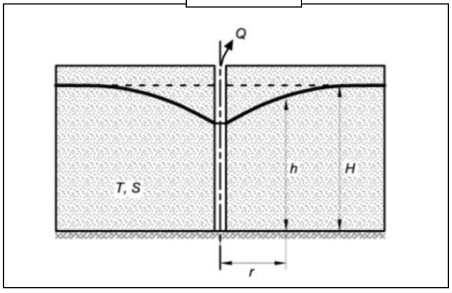
$$s_c = \left(1 - \frac{s_a}{2b}\right)s_a$$

$$u = \frac{r^2S}{4Tt}$$

Essential input
Optional input
Calculated

For assessing drawdown, s, at a distance, r, from a pumping well and a time, t

		expected		min	max	
Transmissivity of aquifer	T	400	m^2/d			m^2/d
Time from start of abstraction	t	5	d			
Storage coefficient	S	0.2				
To find Q if s is known						
Height of water table at radius of influence	H	20	m			m
Height of water table at radius r	h	12.6	m			m
Measured drawdown = (H-h_r)	s_a	7.4	m	7.4	7.4	m
Original saturated thickness of aquifer	b	20	m			
Corrected drawdown	s_c	6.0	m	6.0	6.0	m
Distance from centre of well at r	r	13.82	m			
Use well function to determine if equation is valid	u	0.00477		0.00477	0.00477	
Is equation valid ?		Yes		Yes	Yes	
Total discharge from well	Q	6363.75	m^3/d	6363.75	6363.75	m^3/d



The following assumptions apply to this equation

- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the water removed from storage is discharged instantaneously with decline of head
- the diameter of the well is small, i.e. the storage in the well can be ignored
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer

(from Kruseman & de Ridder, 1994)

To find s if Q is known

$$s = \frac{2.3Q}{4\prod T}\log\frac{2.25Tt}{r^2S}$$

Total discharge from well	Q	3491.92	m3/d
Distance from centre of well at r	r	90.00	m
Drawdown at distance r			
Calculated drawdown	s_c	0.7	m
Actual drawdown	s_a	0.7	m

Note: To check validity of this arrangement of equation, enter value for r in cell C19 as well

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Data sources (to complete an audit trail)		
Height of water table at radius of influence	H	Assume water table at ground surface
Height of water table at radius r	h	Turbine/tower foundation 5 m deep, dewater to 6 m
Transmissivity of aquifer	T	K=10 m/d to 20 m/d (sand); b = 28 m
Time from start of abstraction	t	5 days to lower to target drawdown then 28 days of dew
Storage coefficient	S	Estimated based on SAND geology
Original saturated thickness of aquifer	b	8 m saturated thickness of dune sands in WM02
Distance from centre of well at r	r	r for drawdown extent at 2, 1, 0.5-m drawdown
Total discharge from well	Q	From total discharge from well (m3/d)

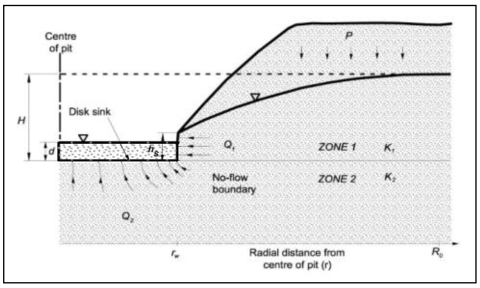
Radius of Influence Calculation for Transmission Towers and Central \ Southern Turbines

19) Radius of influence (Niccoli et al, 1998) - Method to estimate radius of influence if other parameters can be estimated with reasonable accuracy

$$H=\sqrt{h_s^2+\frac{P}{K_{h1}}\left[R_0^2\ln\left(\frac{R_0}{r_w}\right)-\frac{R_0^2-r_w^2}{2}\right]}$$

🟨 Essential input
🟨 Optional input
🟩 Calculated

Height of water table at radius of influence	H	6.1	m	6.1	6.1	m
Saturated thickness to seepage face	h_s	0.1	m	0.1	0.1	m
Drawdown = ($H-h_p$)	s	6	m	6	6	m
Layer 1 horizontal hydraulic conductivity	K_{h1}	20	m/d	0.1	100	m/d
Recharge	P	0.00079	m/d	0.00079	0.00079	m/d
Radius of quarry	r_w	13.82	m			
Effective radius	R_0	545.06		65.94	1102.63	



The following assumptions apply to this equation

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- the static water table is horizontal
- groundwater flow is horizontal
- groundwater flow to the pit is axially symmetric

(Niccoli et al, 1998)

Data sources (to complete an audit trail)

Height of water table at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Saturated thickness to seepage face	h_s	Nominal 0.1 m high face in excavation
Layer 1 horizontal hydraulic conductivity	K_{h1}	SAND: 10 m/d assumed.
Recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Me
Radius of quarry	r_w	20 m by 20 m excavation ~5 m deep for 6-m dewatered

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Steady-state Inflow Modelling (Marinelli and Niccoli Model) for Transmission Towers and Central \ Southern Turbines

20) Flow to a pit (Marinelli and Niccoli, 1998)

$$Q_1 = P\pi\left(R_0^{\ 2} - r_w^{\ 2}\right)$$

$$Q_2 = 4\left(\frac{K_{h2}}{m_2}\right) r_w (H-d)$$

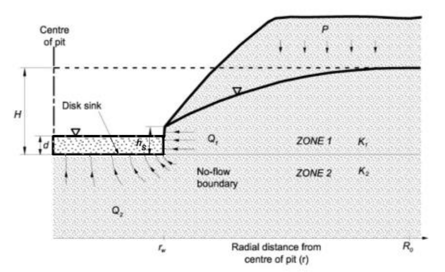
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

Essential input
Optional input
Calculated

Flow into a pit using separate solutions for the sides and the base.

(Follow on from ROI spreadsheet 19. To find Radius of influence for this procedure)

Head		expected		min	max	
Height of wt at radius of influence	H	6.1	m	6.1	6.1	m
Depth of Ponded Area	d	0.1	m	0.1	0.1	m
Layer 2						
Horizontal Conductivity	K_{h2}	2.31E-04	m/s	2.31E-06	2.31E-03	m/s
		2.0E+01	m/d	0.2	200	m/d
Vertical Conductivity	K_{v2}	1.16E-04	m/s	1.16E-06	1.16E-03	m/s
Anistropy	m_2	1.4		0.0	44.7	
Distributed recharge	P	9.13E-09	m/s	9.13E-09	9.13E-09	m/s
		7.9E-04	m^3/d	0.00079	0.0007887	m/d
Radius of quarry	r_w	13.8	m			
Radius of influence	R_o	545.1	m	65.94	1102.63	m
Can be taken from ROI worksheet or other sources						
Inflow						
Inflow through Seepage Face	Q_1	8.51E-03	m^3/s	1.19E-04	3.49E-02	m^3/s
		(735.7	m^3/d)	10.301	3012.013	m^3/d
Inflow through Mine base	Q_2	5.43E-02	m^3/s	1.72E-05	1.72E+01	m^3/s
		(4690.6	m^3/d)	1.5	1483292.9	m^3/d
Total Inflow	**Qt**	**0.063**	**m^3/s**	0.000	17.203	m^3/s
		(5426.3	m^3/d)	11.8	1486304.9	m^3/d



The following assumptions apply to this equation

- There is no groundwater flow between zones 1 and 2

Zone 1

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- initial static water table and groundwater flow are both horizontal
- groundwater flow to the pit is axially symmetric

Zone 2

- steady state flow to one side of a circular disk sink of constant and uniform drawdown
- hydraulic head is initially uniform throughout Zone 2.
- initial head is equal to the elevation of the initial water table in Zone 1
- disk sink has a constant hydraulic head equal to the elevation of the pit lake water surface
- flow to the disk sink is three-dimensional and axially symmetric
- materials are anisotropic, prinicipal directions for K are horizontal and vertical

(Marinelli & Niccoli, 1998)

Data sources (to complete an audit trail)		
Height of wt at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Depth of Ponded Area	d	Nominal 0.1 m high face in excavation
Layer 2 Horizontal Conductivity	K_{h2}	SAND: 20 m/d from PSD hydrosieve Excel file.
Layer 2 Vertical Conductivity	K_{v2}	SAND: 10 m/d assumed.
Distributed recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Mean 959.6 mr
Radius of quarry	r_w	20 m by 30 m excavation ~5 m deep for 6-m dewatered
Radius of influence	R_o	From cell content at: 19.Radius of influence N (UC)'!C20

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Steady-state Inflow Modelling (Thiem-Dupuit Model) for Transmission Towers and Central \ Southern Turbines

2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2{}^2 - h_1{}^2)}{2.3\log(\frac{r_2}{r_1})}$$

Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	14	m			m
Distance to observation well 1	r_1	13.82	m			
Height of water table at observation well 2	h_2	20	m	28	32	m
Distance to observation well 2	r_2	545.06	m			
Hydraulic conductivity of aquifer	K	20	m/d			m/d
Total discharge from well	Q	3491.92	m^3/d	3491.92	#######	m^3/d

To find the drawdown at a given radius

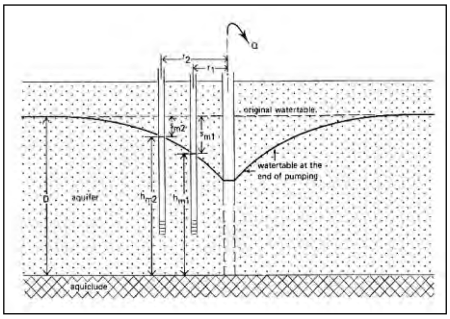
$$h_2 = \sqrt{\frac{2.3Q\log\left(r_2/r_1\right)}{\pi K} + h_1{}^2}$$

Discharge	Q	3491.92	m^3/d
Radius of interest	r_2	138	m
WT height at radius of interest	h	18.0	m
Drawdown at radius r	s_r	2.0	m

To find the radius of a specific water level

$$r_2 = r_1 10 \wedge \left[\frac{\pi K(h_2{}^2 - h_1{}^2)}{2.3Q}\right]$$

Discharge	Q	3491.92	m^3/d
WT height at radius of interest	h_2	18	m
Radius of required drawdown	r_2	138.6	m



(Figure taken from Kruseman & de Ridder, 1994)

The following assumptions apply to this equation

- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	
Distance to observation well 1	r_1	
Height of water table at observation well 2	h_2	
Distance to observation well 2	r_2	
Hydraulic conductivity of aquifer	K	

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Transient Inflow Modelling (Cooper-Jacob Model) for Northern Turbines (Kh = 0.5 m/d)

5) Cooper Jacob (Time-variant unconfined aquifer)

(Based on Theis equation)

$$Q = \frac{4\pi Ts}{2.3\log\left(\frac{2.25Tt}{r^2S}\right)}$$

$$s_c = \left(1 - \frac{s_a}{2b}\right)s_a$$

$$u = \frac{r^2S}{4Tt}$$

- Essential input
- Optional input
- Calculated

For assessing drawdown, s, at a distance, r, from a pumping well and a time, t

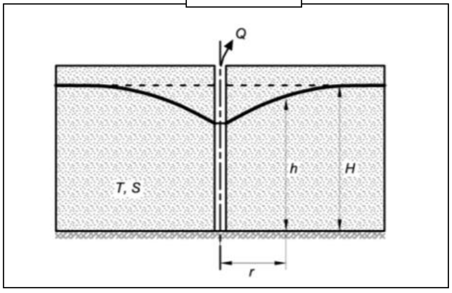
		expected		min	max	
Transmissivity of aquifer	T	10	m^2/d			m^2/d
Time from start of abstraction	t	28	d			
Storage coefficient	S	0.05				
To find Q if s is known						
Height of water table at radius of influence	H	20	m			m
Height of water table at radius r	h	12.6	m			m
Measured drawdown = $(H\text{-}h_r)$	s_a	7.4	m	7.4	7.4	m
Original saturated thickness of aquifer	b	20	m			
Corrected drawdown	s_c	6.0	m	6.0	6.0	m
Distance from centre of well at r	r	13.82	m			
Use well function to determine if equation is valid	u	0.00853		0.00853	0.00853	
Is equation valid ?		Yes		Yes	Yes	
Total discharge from well	Q	181.11	m^3/d	181.11	181.11	m^3/d

To find s if Q is known

$$s = \frac{2.3Q}{4\prod T}\log\frac{2.25Tt}{r^2S}$$

Total discharge from well	Q	148.91	m3/d
Distance from centre of well at r	r	90.00	m
Drawdown at distance r			
Calculated drawdown	s_c	0.5	m
Actual drawdown	s_a	0.5	m

Note: To check validity of this arrangement of equation, enter value for r in cell C19 as well



The following assumptions apply to this equation

- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the water removed from storage is discharged instantaneously with decline of head
- the diameter of the well is small, i.e. the storage in the well can be ignored
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer

(from Kruseman & de Ridder, 1994)

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Data sources (to complete an audit trail)		
Height of water table at radius of influence	H	Assume water table at ground surface (DD=20-12.6 mbls
Height of water table at radius r	h	Turbine foundation 5 m deep, dewater to 6 m
Transmissivity of aquifer	T	K=0.5 m/d (clayey sand); b = 20 m
Time from start of abstraction	t	28 days to lower to target drawdown
Storage coefficient	S	Estimated based on clayey SAND geology
Original saturated thickness of aquifer	b	8 m saturated thickness of dune sands in WM02
Distance from centre of well at r	r	For assessment of 0.1 m drawdown extent
Total discharge from well	Q	From total discharge from well (m3/d) '23.Effective radius

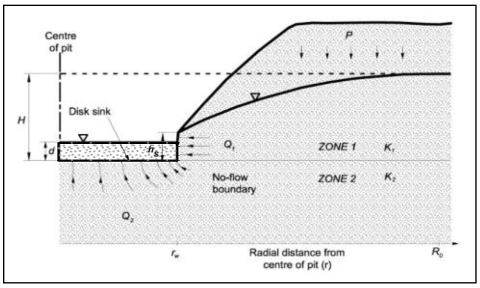
Radius of Influence Calculation Northern Turbines (Kh = 0.5 m/d)

19) Radius of influence (Niccoli et al, 1998) - Method to estimate radius of influence if other parameters can be estimated with reasonable accuracy

$$H = \sqrt{h_s^2 + \frac{P}{K_{h1}}\left[R_0^2 \ln\left(\frac{R_0}{r_w}\right) - \frac{R_0^2 - r_w^2}{2}\right]}$$

- 🟨 Essential input
- Optional input
- 🟩 Calculated

Height of water table at radius of influence	H	6.1	m	6.1	6.1	m
Saturated thickness to seepage face	h_s	0.1	m	0.1	0.1	m
Drawdown = ($H-h_p$)	s	6	m	6	6	m
Layer 1 horizontal hydraulic conductivity	K_{h1}	0.5	m/d	0.1	100	m/d
Recharge	P	0.00079	m/d	0.00079	0.00079	m/d
Radius of quarry	r_w	13.82	m			
Effective radius	R_0	119.15		65.94	1102.63	



The following assumptions apply to this equation

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- the static water table is horizontal
- groundwater flow is horizontal
- groundwater flow to the pit is axially symmetric

(Niccoli et al, 1998)

Data sources (to complete an audit trail)		
Height of water table at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Saturated thickness to seepage face	h_s	Nominal 0.1 m high face in excavation
Layer 1 horizontal hydraulic conductivity	K_{h1}	SAND: 10 m/d assumed.
Recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Me
Radius of quarry	r_w	20 m by 20 m excavation ~5 m deep for 6-m dewatered

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Steady-state Inflow Modelling (Marinelli and Niccoli Model) Northern Turbines (Kh = 0.5 m/d)

20) Flow to a pit (Marinelli and Niccoli, 1998)

$$Q_1 = P\pi\left(R_0{}^2 - r_w{}^2\right)$$

$$Q_2 = 4\left(\frac{K_{h2}}{m_2}\right)r_w(H-d)$$

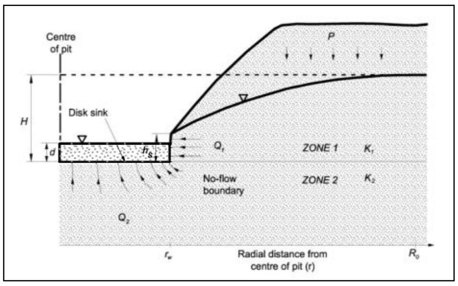
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

🟨 Essential input
Optional input
🟩 Calculated

Flow into a pit using separate solutions for the sides and the base.

(Follow on from ROI spreadsheet 19. To find Radius of influence for this procedure)

		expected		min	max	
Head						
Height of wt at radius of influence	H	6.1	m	6.1	6.1	m
Depth of Ponded Area	d	0.1	m	0.1	0.1	m
Layer 2						
Horizontal Conductivity	K_{h2}	5.79E-06	m/s	5.79E-08	5.79E-05	m/s
		5.0E-01	m/d	0.005	5	m/d
Vertical Conductivity	K_{v2}	2.89E-06	m/s	2.89E-08	2.89E-05	m/s
Anistropy	m_2	1.4		0.0	44.7	
Distributed recharge	P	9.13E-09	m/s	9.13E-09	9.13E-09	m/s
		7.9E-04	m^3/d	0.00079	0.0007887	m/d
Radius of quarry	r_w	13.8	m			
Radius of influence	R_o	119.2	m	65.94	1102.63	m
Can be taken from ROI worksheet or other sources						
Inflow						
Inflow through Seepage Face	Q_1	4.02E-04	m^3/s	1.19E-04	3.49E-02	m^3/s
		(34.7	m^3/d)	10.301	3012.013	m^3/d
Inflow through Mine base	Q_2	1.36E-03	m^3/s	4.29E-07	4.29E-01	m^3/s
		(117.3	m^3/d)	0.0	37082.3	m^3/d
Total Inflow	**Qt**	**0.002**	**m^3/s**	0.000	0.464	m^3/s
		(152.0	m^3/d)	10.3	40094.3	m^3/d



The following assumptions apply to this equation

- There is no groundwater flow between zones 1 and 2

Zone 1

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- initial static water table and groundwater flow are both horizontal
- groundwater flow to the pit is axially symmetric

Zone 2

- steady state flow to one side of a circular disk sink of constant and uniform drawdown
- hydraulic head is initially uniform throughout Zone 2.
- initial head is equal to the elevation of the initial water table in Zone 1
- disk sink has a constant hydraulic head equal to the elevation of the pit lake water surface
- flow to the disk sink is three-dimensional and axially symmetric
- materials are anisotropic, principal directions for K are horizontal and vertical

(Marinelli & Niccoli, 1998)

Data sources (to complete an audit trail)		
Height of wt at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Depth of Ponded Area	d	Nominal 0.1 m high face in excavation
Layer 2 Horizontal Conductivity	K_{h2}	SAND: 20 m/d from PSD hydrosieve Excel file.
Layer 2 Vertical Conductivity	K_{v2}	SAND: 10 m/d assumed.
Distributed recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Mean 959.6 mr
Radius of quarry	r_w	20 m by 30 m excavation ~5 m deep for 6-m dewatered
Radius of influence	R_o	From cell content at: 19.Radius of influence N (UC)'!C20

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Steady-state Inflow Modelling (Thiem-Dupuit Model) for Northern Turbines (Kh = 0.5 m/d)

2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Duput)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^2 - h_1^2)}{2.3\log(\frac{r_2}{r_1})}$$

🟨 Essential input
🟨 Optional input
🟩 Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	14	m			m
Distance to observation well 1	r_1	13.82	m			
Height of water table at observation well 2	h_2	20	m	28	32	m
Distance to observation well 2	r_2	119.15	m			
Hydraulic conductivity of aquifer	K	0.5	m/d			m/d
Total discharge from well	Q	148.91	m^3/d	148.91	604.41	m^3/d

To find the drawdown at a given radius

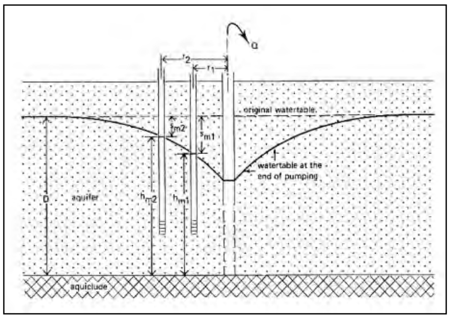
Discharge	Q	148.91	m^3/d
Radius of interest	r_2	95	m
WT height at radius of interest	h	19.5	m
Drawdown at radius r	s_r	0.5	m

$$h_2 = \sqrt{\frac{2.3Q\log\left(r_2/r_1\right)}{\pi K} + h_1^2}$$

To find the radius of a specific water level

Discharge	Q	148.91	m^3/d
WT height at radius of interest	h_2	18	m
Radius of required drawdown	r_2	53.4	m

$$r_2 = r_1 10^\wedge\left[\frac{\pi K(h_2^2 - h_1^2)}{2.3Q}\right]$$



(Figure taken from Kruseman & de Ridder, 1994)

The following assumptions apply to this equation

- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	
Distance to observation well 1	r_1	
Height of water table at observation well 2	h_2	
Distance to observation well 2	r_2	
Hydraulic conductivity of aquifer	K	

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Transient Inflow Modelling (Cooper-Jacob Model) for Transmission Poles (Kh = 10 m/d)

5) Cooper Jacob (Time-variant unconfined aquifer)

(Based on Theis equation)

$$Q = \frac{4\pi Ts}{2.3\log\left(\frac{2.25Tt}{r^2 S}\right)}$$

$$s_c = \left(1 - \frac{s_a}{2b}\right)s_a$$

$$u = \frac{r^2 S}{4Tt}$$

Essential input
Optional input
Calculated

For assessing drawdown, s, at a distance, r, from a pumping well and a time, t

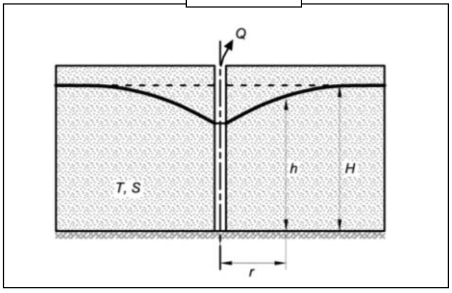
		expected		min	max	
Transmissivity of aquifer	T	200	m^2/d			m^2/d
Time from start of abstraction	t	5	d			
Storage coefficient	S	0.2				
To find Q if s is known						
Height of water table at radius of influence	H	20	m			m
Height of water table at radius r	h	13.4	m			m
Measured drawdown = ($H-h_r$)	s_a	6.6	m	6.6	6.6	m
Original saturated thickness of aquifer	b	20	m			
Corrected drawdown	s_c	5.5	m	5.5	5.5	m
Distance from centre of well at r	r	0.56	m			
Use well function to determine if equation is valid	u	1.6E-05		1.6E-05	1.6E-05	
Is equation valid ?		Yes		Yes	Yes	
Total discharge from well	Q	1324.02	m^3/d	1324.02	1324.02	m^3/d

To find s if Q is known

$$s = \frac{2.3Q}{4\prod T}\log\frac{2.25Tt}{r^2 S}$$

Total discharge from well	Q	1324.02	m3/d
Distance from centre of well at r	r	1	m
Drawdown at distance r			
Calculated drawdown	s_c	4.9	m
Actual drawdown	s_a	5.7	m

Note: To check validity of this arrangement of equation, enter value for r in cell C19 as well



The following assumptions apply to this equation

- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the water removed from storage is discharged instantaneously with decline of head
- the diameter of the well is small, i.e. the storage in the well can be ignored
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer

(from Kruseman & de Ridder, 1994)

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Data sources (to complete an audit trail)		
Height of water table at radius of influence	H	Assume water table at ground surface
Height of water table at radius r	h	Transmiss. tower foundation 4.5m deep, dewater to 5.5m
Transmissivity of aquifer	T	K=10 m/d (sand); b = 20 m
Time from start of abstraction	t	5 days of initial dewatering to attain target drawdown
Storage coefficient	S	Estimated based on SAND geology
Original saturated thickness of aquifer	b	General saturated thickness of MW02-MW03
Distance from centre of well at r	r	For assessment of distance versus drawdown
Total discharge from well	Q	From total discharge from well (m3/d)

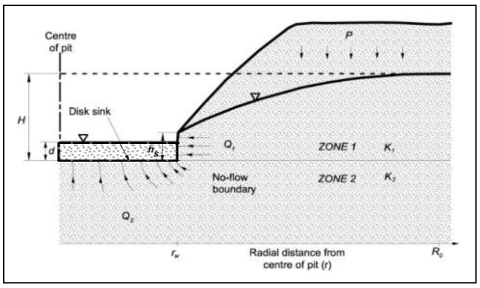
Radius of Influence Calculation for Transmission Poles (Kh = 10 m/d)

19) Radius of influence (Niccoli et al, 1998) - Method to estimate radius of influence if other parameters can be estimated with reasonable accuracy

$$H = \sqrt{h_s^{\,2} + \frac{P}{K_{h1}}\left[R_0^{\,2}\ln\left(\frac{R_0}{r_w}\right) - \frac{R_0^{\,2} - r_w^{\,2}}{2}\right]}$$

Essential input
Optional input
Calculated

Height of water table at radius of influence	H	5.6	m	4.1	4.1	m
Saturated thickness to seepage face	h_s	0.1	m	0.1	0.1	m
Drawdown = (H-h_p)	s	5.5	m	4	5.5	m
Layer 1 horizontal hydraulic conductivity	K_{h1}	10	m/d	0.1	100	m/d
Recharge	P	0.00079	m/d	0.00079	0.00079	m/d
Radius of quarry	r_w	0.56	m			
Effective radius	R_0	265.17		25.38	769.22	



The following assumptions apply to this equation
- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- the static water table is horizontal
- groundwater flow is horizontal
- groundwater flow to the pit is axially symmetric

(Niccoli et al, 1998)

Data sources (to complete an audit trail)		
Height of water table at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Saturated thickness to seepage face	h_s	Nominal 0.1 m high face in excavation
Layer 1 horizontal hydraulic conductivity	K_{h1}	SAND: 10 m/d assumed.
Recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Me
Radius of quarry	r_w	1 m diameter excavation ~4.5 m deep for 5.5-m dewatered

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Steady-state Inflow Modelling (Marinelli and Niccoli Model) for Transmission Poles (Kh = 10 m/d)

20) Flow to a pit (Marinelli and Niccoli, 1998)

$$Q_1 = P\pi\left(R_0^{\ 2} - r_w^{\ 2}\right)$$

$$Q_2 = 4\left(\frac{K_{h2}}{m_2}\right)r_w(H-d)$$

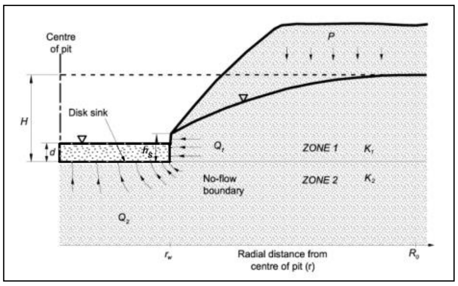
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

Essential input
Optional input
Calculated

Flow into a pit using separate solutions for the sides and the base.

(Follow on from ROI spreadsheet 19. To find Radius of influence for this procedure)

		expected		min	max	
Head						
Height of wt at radius of influence	H	5.6	m	4.1	4.1	m
Depth of Ponded Area	d	0.1	m	0.1	0.1	m
Layer 2						
Horizontal Conductivity	K_{h2}	1.16E-04	m/s	1.16E-06	1.16E-03	m/s
		1.0E+01	m/d	0.1	100	m/d
Vertical Conductivity	K_{v2}	5.79E-05	m/s	5.79E-07	5.79E-04	m/s
Anistropy	m_2	1.4		0.0	44.7	
Distributed recharge	P	9.13E-09	m/s	9.13E-09	9.13E-09	m/s
		7.9E-04	m^3/d	0.00079	0.0007887	m/d
Radius of quarry	r_w	0.6	m			
Radius of influence	R_o	265.2	m	25.38	769.22	m
Can be taken from ROI worksheet or other sources						
Inflow						
Inflow through Seepage Face	Q_1	2.02E-03	m^3/s	1.85E-05	1.70E-02	m^3/s
		(174.2	m^3/d)	1.595	1466.102	m^3/d
Inflow through Mine base	Q_2	1.02E-03	m^3/s	2.34E-07	3.21E-01	m^3/s
		(87.8	m^3/d)	0.0	27754.5	m^3/d
Total Inflow	**Qt**	**0.003**	**m^3/s**	0.000	0.338	m^3/s
		(262.0	m^3/d)	1.6	29220.6	m^3/d



The following assumptions apply to this equation

- There is no groundwater flow between zones 1 and 2

Zone 1

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- initial static water table and groundwater flow are both horizontal
- groundwater flow to the pit is axially symmetric

Zone 2

- steady state flow to one side of a circular disk sink of constant and uniform drawdown
- hydraulic head is initially uniform throughout Zone 2.
- initial head is equal to the elevation of the initial water table in Zone 1
- disk sink has a constant hydraulic head equal to the elevation of the pit lake water surface
- flow to the disk sink is three-dimensional and axially symmetric
- materials are anisotropic, principal directions for K are horizontal and vertical

(Marinelli & Niccoli, 1998)

Data sources (to complete an audit trail)		
Height of wt at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Depth of Ponded Area	d	Nominal 0.1 m high face in excavation
Layer 2 Horizontal Conductivity	K_{h2}	SAND: 10 m/d assumed.
Layer 2 Vertical Conductivity	K_{v2}	SAND: 10 m/d/2 assumed.
Distributed recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Mean 959.6 mr
Radius of quarry	r_w	1 m diameter excavation ~4.5 m deep for 5.5-m dewatered
Radius of influence	R_o	Niccoli et al (1998) = 265.2 m

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Steady-state Inflow Modelling (Thiem-Dupuit Model) for Transmission Poles (Kh = 10 m/d)

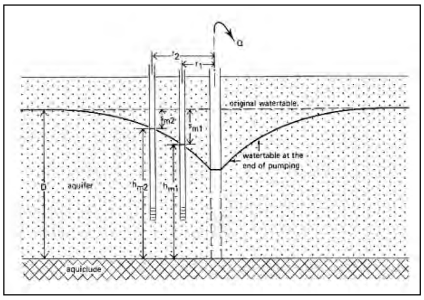
2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2{}^2 - h_1{}^2)}{2.3\log(\frac{r_2}{r_1})}$$

Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	14.5	m			m
Distance to observation well 1	r_1	0.56	m			
Height of water table at observation well 2	h_2	20	m	28	32	m
Distance to observation well 2	r_2	265.17	m			
Hydraulic conductivity of aquifer	K	10	m/d			m/d
Total discharge from well	Q	969.95	m^3/d	969.95	4159.68	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

Discharge	Q	969.95	m^3/d
Radius of interest	r_2	140	m
WT height at radius of interest	h	19.5	m
Drawdown at radius r	s_r	0.5	m

$$h_2 = \sqrt{\frac{2.3Q\log\left({}^{r_2}\!/\!_{r_1}\right)}{\pi K} + h_1{}^2}$$

To find the radius of a specific water level

Discharge	Q	969.95	m^3/d
WT height at radius of interest	h_2	20	m
Radius of required drawdown	r_2	265.2	m

$$r_2 = r_1 10 \wedge \left[\frac{\pi K(h_2{}^2 - h_1{}^2)}{2.3Q}\right]$$

The following assumptions apply to this equation

- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	
Distance to observation well 1	r_1	
Height of water table at observation well 2	h_2	
Distance to observation well 2	r_2	
Hydraulic conductivity of aquifer	K	

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Transient Inflow Modelling (Cooper-Jacob Model) for Meteorological Tower (Kh = 10 m/d)

5) Cooper Jacob (Time-variant unconfined aquifer)

(Based on Theis equation)

$$Q = \frac{4\pi Ts}{2.3\log\left(\frac{2.25Tt}{r^2 S}\right)}$$

$$s_c = \left(1 - \frac{s_a}{2b}\right) s_a$$

$$u = \frac{r^2 S}{4Tt}$$

- 🟨 Essential input
- 🟨 Optional input
- 🟩 Calculated

For assessing drawdown, s, at a distance, r, from a pumping well and a time, t

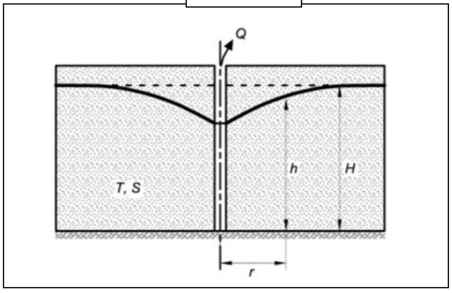
		expected		min	max	
Transmissivity of aquifer	T	200	m^2/d			m^2/d
Time from start of abstraction	t	5	d			
Storage coefficient	S	0.2				
To find Q if s is known						
Height of water table at radius of influence	H	20	m			m
Height of water table at radius r	h	15.5	m			m
Measured drawdown = (H-h$_r$)	s_a	4.5	m	4.5	4.5	m
Original saturated thickness of aquifer	b	20	m			
Corrected drawdown	s_c	4.0	m	4.0	4.0	m
Distance from centre of well at r	r	1.24	m			
Use well function to determine if equation is valid	u	7.7E-05		7.7E-05	7.7E-05	
Is equation valid ?		Yes		Yes	Yes	
Total discharge from well	Q	1129.58	m^3/d	1129.58	1129.58	m^3/d

To find s if Q is known

$$s = \frac{2.3Q}{4\prod T}\log\frac{2.25Tt}{r^2 S}$$

Total discharge from well	Q	1129.58	m3/d
Distance from centre of well at r	r	1	m
Drawdown at distance r			
Calculated drawdown	s_c	4.2	m
Actual drawdown	s_a	4.8	m

Note: To check validity of this arrangement of equation, enter value for r in cell C19 as well



The following assumptions apply to this equation

- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the water removed from storage is discharged instantaneously with decline of head
- the diameter of the well is small, i.e. the storage in the well can be ignored
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer

(from Kruseman & de Ridder, 1994)

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Data sources (to complete an audit trail)

Height of water table at radius of influence	H	Assume water table at ground surface
Height of water table at radius r	h	Met mast foundation 3.0 m deep, dewater to at least 4 m
Transmissivity of aquifer	T	K=10 m/d (sand); b = 20 m
Time from start of abstraction	t	5 days of initial dewatering to attain target drawdown
Storage coefficient	S	Estimated based on SAND geology
Original saturated thickness of aquifer	b	General saturated thickness of MW02-MW03
Distance from centre of well at r	r	For assessment of distance versus drawdown
Total discharge from well	Q	From total discharge from well (m3/d)

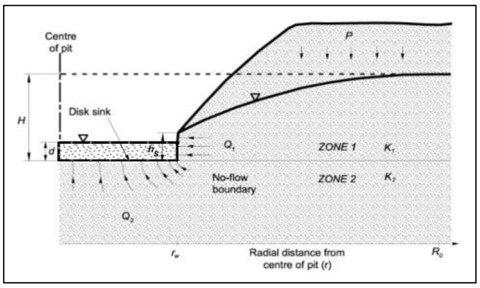
Radius of Influence Calculation for Meteorological Tower (Kh = 10 m/d)

19) Radius of influence (Niccoli et al, 1998) - Method to estimate radius of influence if other parameters can be estimated with reasonable accuracy

$$H=\sqrt{h_s^{\,2}+\frac{P}{K_{h1}}\left[R_0^{\,2}\ln\left(\frac{R_0}{r_w}\right)-\frac{R_0^{\,2}-r_w^{\,2}}{2}\right]}$$

Essential input
Optional input
Calculated

Height of water table at radius of influence	H	4.1	m	4.1	4.1	m
Saturated thickness to seepage face	h_s	0.1	m	0.1	0.1	m
Drawdown = ($H-h_p$)	s	4	m	4	4	m
Layer 1 horizontal hydraulic conductivity	K_{h1}	10	m/d	0.1	100	m/d
Recharge	P	0.00079	m/d	0.00079	0.00079	m/d
Radius of quarry	r_w	1.24	m			
Effective radius	R_0	214.03		28.44	611.33	



The following assumptions apply to this equation

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- the static water table is horizontal
- groundwater flow is horizontal
- groundwater flow to the pit is axially symmetric

(Niccoli et al, 1998)

Data sources (to complete an audit trail)

Height of water table at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Saturated thickness to seepage face	h_s	Nominal 0.1 m high face in excavation
Layer 1 horizontal hydraulic conductivity	K_{h1}	SAND: 10 m/d assumed.
Recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Me
Radius of quarry	r_w	1 m diameter excavation ~4.5 m deep for 5.5-m dewatered

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Steady-state Inflow Modelling (Marinelli and Niccoli Model) for Meteorological Tower (Kh = 10 m/d)

20) Flow to a pit (Marinelli and Niccoli, 1998)

$$Q_1 = P\pi\left(R_0^{\,2} - r_w^{\,2}\right)$$

$$Q_2 = 4\left(\frac{K_{h2}}{m_2}\right) r_w (H-d)$$

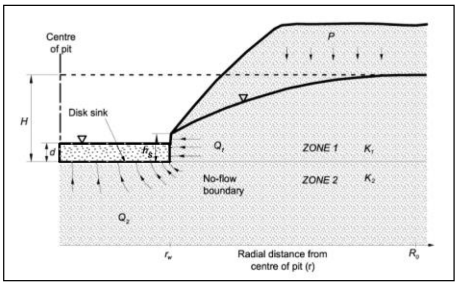
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

Essential input
Optional input
Calculated

Flow into a pit using separate solutions for the sides and the base.

(Follow on from ROI spreadsheet 19. To find Radius of influence for this procedure)

Head		expected		min	max	
Height of wt at radius of influence	H	4.1	m	4.1	4.1	m
Depth of Ponded Area	d	0.1	m	0.1	0.1	m
Layer 2						
Horizontal Conductivity	K_{h2}	1.16E-04	m/s	1.16E-06	1.16E-03	m/s
		1.0E+01	m/d	0.1	100	m/d
Vertical Conductivity	K_{v2}	5.79E-05	m/s	5.79E-07	5.79E-04	m/s
Anistropy	m_2	1.4		0.0	44.7	
Distributed recharge	P	9.13E-09	m/s	9.13E-09	9.13E-09	m/s
		7.9E-04	m^3/d	0.00079	0.0007887	m/d
Radius of quarry	r_w	1.2	m			
Radius of influence	R_o	214.0	m	28.44	611.33	m
Can be taken from ROI worksheet or other sources						
Inflow						
Inflow through Seepage Face	Q_1	1.31E-03	m^3/s	2.32E-05	1.07E-02	m^3/s
		(113.5	m^3/d)	2.001	926.013	m^3/d
Inflow through Mine base	Q_2	1.63E-03	m^3/s	5.14E-07	5.14E-01	m^3/s
		(140.4	m^3/d)	0.0	44407.1	m^3/d
Total Inflow	**Qt**	**0.003**	**m^3/s**	0.000	0.525	m^3/s
		(253.9	m^3/d)	2.0	45333.1	m^3/d



The following assumptions apply to this equation

- There is no groundwater flow between zones 1 and 2

Zone 1

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- initial static water table and groundwater flow are both horizontal
- groundwater flow to the pit is axially symmetric

Zone 2

- steady state flow to one side of a circular disk sink of constant and uniform drawdown
- hydraulic head is initially uniform throughout Zone 2.
- initial head is equal to the elevation of the initial water table in Zone 1
- disk sink has a constant hydraulic head equal to the elevation of the pit lake water surface
- flow to the disk sink is three-dimensional and axially symmetric
- materials are anisotropic, prinicipal directions for K are horizontal and vertical

(Marinelli & Niccoli, 1998)

Data sources (to complete an audit trail)		
Height of wt at radius of influence	H	WM02/MW03 area: GW ~34.0 mAHD (WM01-W-S02)
Depth of Ponded Area	d	Nominal 0.1 m high face in excavation
Layer 2 Horizontal Conductivity	K_{h2}	SAND: 10 m/d assumed.
Layer 2 Vertical Conductivity	K_{v2}	SAND: (10 m/d)/2 assumed.
Distributed recharge	P	30% of Scott River BOM 9926: Median Annual 933 mm; Mean 959.6 mr
Radius of quarry	r_w	1 m diameter excavation ~4.5 m deep for 5.5-m dewatered
Radius of influence	R_o	Niccoli et al (1998) = 265.2 m

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Steady-state Inflow Modelling (Thiem-Dupuit Model) for Meteorological Tower (Kh = 10 m/d)

2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2{}^2 - h_1{}^2)}{2.3\log(\frac{r_2}{r_1})}$$

Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	16	m			m
Distance to observation well 1	r_1	1.24	m			
Height of water table at observation well 2	h_2	20	m	28	32	m
Distance to observation well 2	r_2	214.03	m			
Hydraulic conductivity of aquifer	K	10	m/d			m/d
Total discharge from well	Q	879.41	m^3/d	879.41	4690.20	m^3/d

To find the drawdown at a given radius

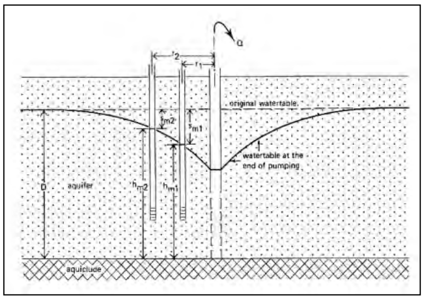
Discharge	Q	879.41	m^3/d
Radius of interest	r_2	180	m
WT height at radius of interest	h	19.9	m
Drawdown at radius r	s_r	0.1	m

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1{}^2}$$

To find the radius of a specific water level

Discharge	Q	879.41	m^3/d
WT height at radius of interest	h_2	31	m
Radius of required drawdown	r_2	#######	m

$$r_2 = r_1 10\wedge\left[\frac{\pi K(h_2{}^2 - h_1{}^2)}{2.3Q}\right]$$



(Figure taken from Kruseman & de Ridder, 1994)

The following assumptions apply to this equation

- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	
Distance to observation well 1	r_1	
Height of water table at observation well 2	h_2	
Distance to observation well 2	r_2	
Hydraulic conductivity of aquifer	K	

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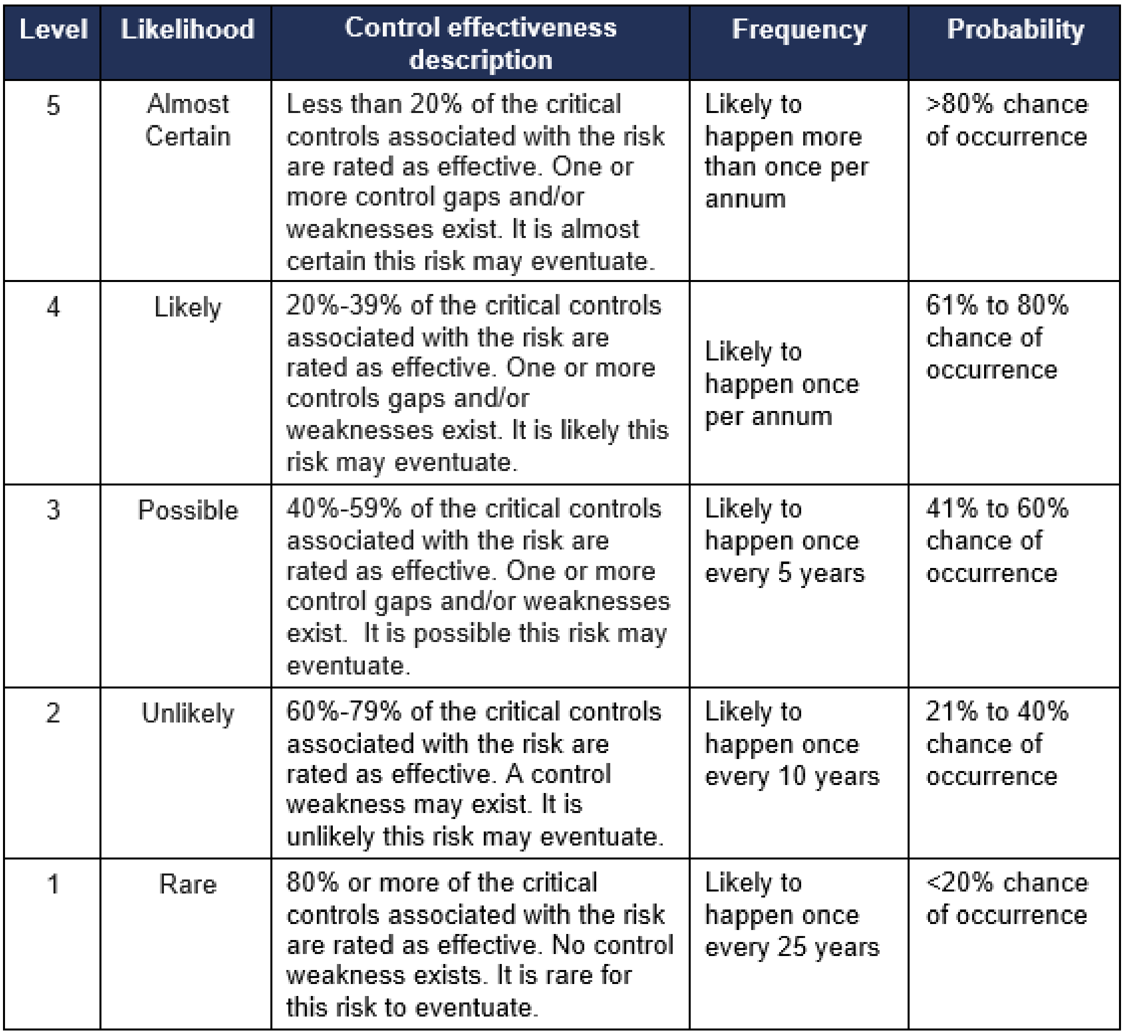
Appendix I SynergyRED Risk Assessment Framework

SynergyRED risk assessment framework likelihood matrix.



Level	Likelihood	Control effectiveness description	Frequency	Probability
5	Almost Certain	Less than 20% of the critical controls associated with the risk are rated as effective. One or more control gaps and/or weaknesses exist. It is almost certain this risk may eventuate.	Likely to happen more than once per annum	>80% chance of occurrence
4	Likely	20%-39% of the critical controls associated with the risk are rated as effective. One or more controls gaps and/or weaknesses exist. It is likely this risk may eventuate.	Likely to happen once per annum	61% to 80% chance of occurrence
3	Possible	40%-59% of the critical controls associated with the risk are rated as effective. One or more control gaps and/or weaknesses exist. It is possible this risk may eventuate.	Likely to happen once every 5 years	41% to 60% chance of occurrence
2	Unlikely	60%-79% of the critical controls associated with the risk are rated as effective. A control weakness may exist. It is unlikely this risk may eventuate.	Likely to happen once every 10 years	21% to 40% chance of occurrence
1	Rare	80% or more of the critical controls associated with the risk are rated as effective. No control weakness exists. It is rare for this risk to eventuate.	Likely to happen once every 25 years	<20% chance of occurrence

SynergyRED risk assessment framework risk matrix.

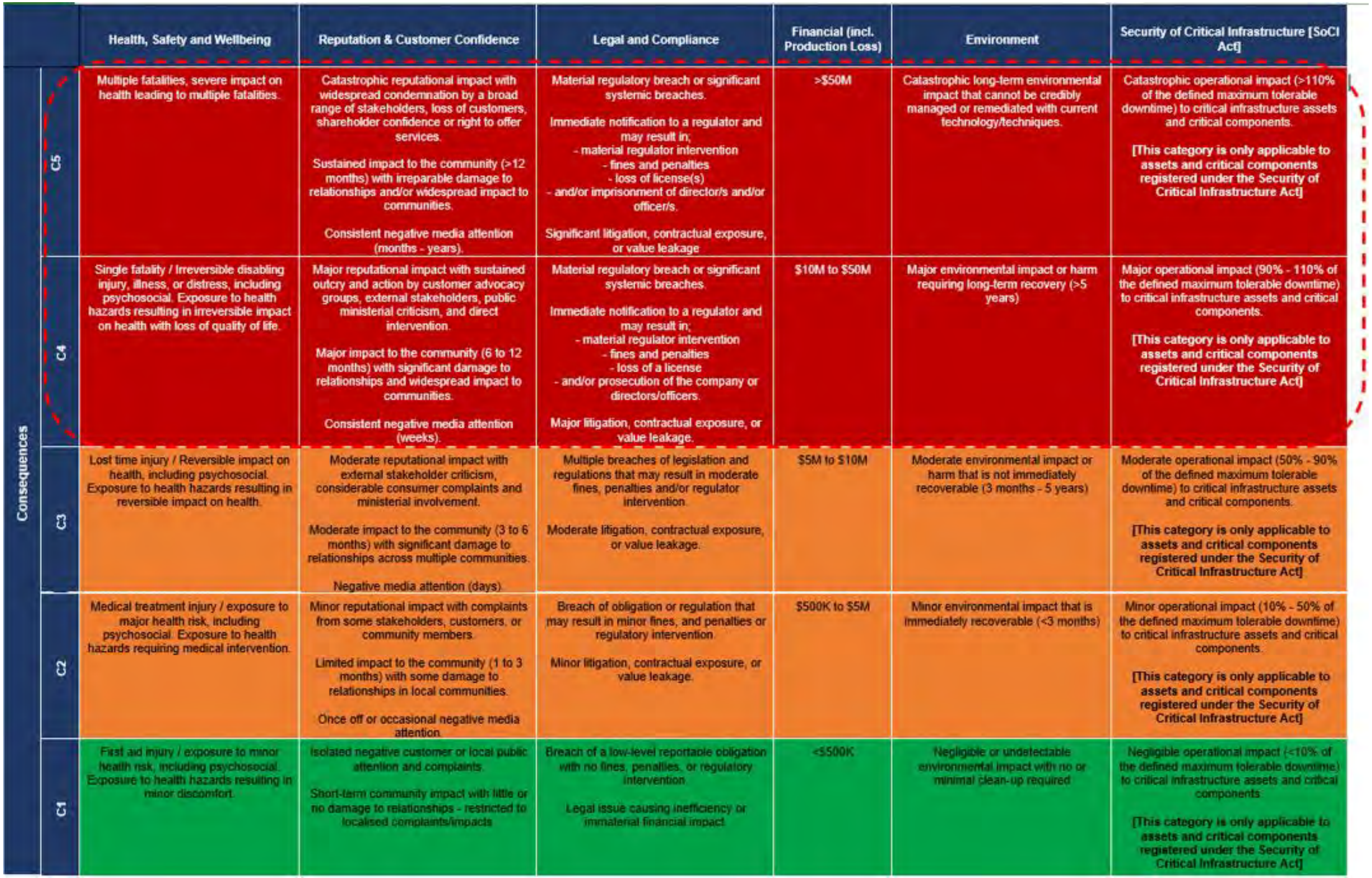
Risk Matrix

Consequences

Likelihood	LEVEL	C1	C2	C3	C4	C5
	L5 Almost certain	15	19	22	24	25
	L4 Likely	10	14	18	21	23
	L3 Possible	6	9	13	17	20
	L2 Unlikely	3	5	8	12	16
	L1 Rare	1	2	4	7	11

Key to risk matrix colour scheme: Red = High, Orange = Moderate, Green = Low, Blue = Negligible.

SynergeyRED risk assessment framework consequence table.



		Health, Safety and Wellbeing	Reputation & Customer Confidence	Legal and Compliance	Financial (incl. Production Loss)	Environment	Security of Critical Infrastructure [SoCI Act]
Consequences	C5	Multiple fatalities, severe impact on health leading to multiple fatalities.	Catastrophic reputational impact with widespread condemnation by a broad range of stakeholders, loss of customers, shareholder confidence or right to offer services. Sustained impact to the community (>12 months) with irreparable damage to relationships and/or widespread impact to communities. Consistent negative media attention (months - years).	Material regulatory breach or significant systemic breaches. Immediate notification to a regulator and may result in; - material regulator intervention - fines and penalties - loss of license(s) - and/or imprisonment of director/s and/or officer/s. Significant litigation, contractual exposure, or value leakage	>$50M	Catastrophic long-term environmental impact that cannot be credibly managed or remediated with current technology/techniques.	Catastrophic operational impact (>110% of the defined maximum tolerable downtime) to critical infrastructure assets and critical components. **[This category is only applicable to assets and critical components registered under the Security of Critical Infrastructure Act]**
	C4	Single fatality / Irreversible disabling injury, illness, or distress, including psychosocial. Exposure to health hazards resulting in irreversible impact on health with loss of quality of life.	Major reputational impact with sustained outcry and action by customer advocacy groups, external stakeholders, public ministerial criticism, and direct intervention. Major impact to the community (6 to 12 months) with significant damage to relationships and widespread impact to communities. Consistent negative media attention (weeks).	Material regulatory breach or significant systemic breaches. Immediate notification to a regulator and may result in; - material regulator intervention - fines and penalties - loss of a license - and/or prosecution of the company or directors/officers. Major litigation, contractual exposure, or value leakage.	$10M to $50M	Major environmental impact or harm requiring long-term recovery (>5 years)	Major operational impact (90% - 110% of the defined maximum tolerable downtime) to critical infrastructure assets and critical components. **[This category is only applicable to assets and critical components registered under the Security of Critical Infrastructure Act]**
	C3	Lost time injury / Reversible impact on health, including psychosocial. Exposure to health hazards resulting in reversible impact on health.	Moderate reputational impact with external stakeholder criticism, considerable consumer complaints and ministerial involvement. Moderate impact to the community (3 to 6 months) with significant damage to relationships across multiple communities. Negative media attention (days).	Multiple breaches of legislation and regulations that may result in moderate fines, penalties and/or regulator intervention. Moderate litigation, contractual exposure, or value leakage.	$5M to $10M	Moderate environmental impact or harm that is not immediately recoverable (3 months - 5 years)	Moderate operational impact (50% - 90% of the defined maximum tolerable downtime) to critical infrastructure assets and critical components. **[This category is only applicable to assets and critical components registered under the Security of Critical Infrastructure Act]**
	C2	Medical treatment injury / exposure to major health risk, including psychosocial. Exposure to health hazards requiring medical intervention.	Minor reputational impact with complaints from some stakeholders, customers, or community members. Limited impact to the community (1 to 3 months) with some damage to relationships in local communities. Once off or occasional negative media attention.	Breach of obligation or regulation that may result in minor fines, and penalties or regulatory intervention. Minor litigation, contractual exposure, or value leakage.	$500K to $5M	Minor environmental impact that is immediately recoverable (<3 months)	Minor operational impact (10% - 50% of the defined maximum tolerable downtime) to critical infrastructure assets and critical components. **[This category is only applicable to assets and critical components registered under the Security of Critical Infrastructure Act]**
	C1	First aid injury / exposure to minor health risk, including psychosocial. Exposure to health hazards resulting in minor discomfort.	Isolated negative customer or local public attention and complaints. Short-term community impact with little or no damage to relationships - restricted to localised complaints/impacts	Breach of a low-level reportable obligation with no fines, penalties, or regulatory intervention. Legal issue causing inefficiency or immaterial financial impact	<$500K	Negligible or undetectable environmental impact with no or minimal clean-up required	Negligible operational impact (<10% of the defined maximum tolerable downtime) to critical infrastructure assets and critical components. **[This category is only applicable to assets and critical components registered under the Security of Critical Infrastructure Act]**

Appendix J Mitigation Measures and Proposal Specifications

This document contains a comprehensive list of mitigation and management actions derived from the Synergy Environment and Heritage Management Standard for Contractors (SYN-STD-ENV-0001, Revision 2 July 2024) which specifies SynergyRED's minimum mandatory expectations for contractors for managing environmental and cultural heritage risk. Contractors must prepare an Environmental Management Plan (EMP), aligning with these mitigation and management strategies. For the Proposal, this will comprise the preparation of a Construction and Environment Management Plan (CEMP), and associated Groundwater and ASS Management Plan.

Management strategies and mitigation measures will be driven by the EPA mitigation hierarchy (avoid, minimise and rehabilitate) and applicable regulatory guidance.

J.1.1 Ground Disturbance, Native Vegetation Clearing and Fauna Disturbance

- No clearing or ground disturbance will occur without an active SynergyRED ground disturbance permit (SYN-PRT-ENV-0001), requiring clearly pegged and demarked clearance areas by a qualified surveyor to minimise the risk of disturbance outside the designated area.

J.1.2 Soil Reuse and Stockpile Management

- Topsoil stockpiling sites will consider locations that are not going to be disturbed in future operations, are remote from weed hygiene occurrences, do not lie in areas likely to receive surface water flow, have surrounding vegetation that is consistent with the original vegetation from the stripped area (where practical) and are as close as practicable to the area of final use.
- All topsoil stockpiles will have windrows placed around the base. This will be of sufficient height to prevent erosion and loss of the stockpile during heavy rainfall.
- Topsoil stockpiles will be inspected regularly and maintained to prevent weed establishment, soil erosion and dust emissions.

J.1.3 Biosecurity

- Where declared weeds or known dieback infestations exist on a project site a Weed and/or Dieback Management Plan will be developed. Access to affected locations will be strictly managed to minimise spread, including the completion of the vehicle-machinery hygiene checklist (SYN-FRM-ENV-0002), or similar contractor hygiene checklist for all vehicles, equipment and machinery.
- Clean down points located at each access point will be established in accordance with the Arrive Clean, Leave Clean Guidelines (Department of Environment, 2015).

J.1.4 Excavation, Trenching and Dewatering

- Works will be undertaken in accordance with an approved work permit and excavations/trenches backfilled overnight if possible. Excavated materials will be stockpiled in a stable location such that they remain within the construction footprint, and do not erode or wash away into drainage or vegetation, in line with the Stockpile Management actions above.
- Where water is likely to be encountered, or is unexpectedly encountered during excavation or trenching works, no dewatering will proceed without written approval from SynergyRED's project environmental advisor and will be undertaken in compliance with WQPN-13 Dewatering of Soils at Construction Sites (DWER, 2012) and will be subject to licensing under the *Rights in Water and Irrigation Act 1914 (WA).*
- In the event demolition or excavation works encounter unexpected and suspected contaminated materials, excavation works will be stopped, reported to the SynergyRED contract representative and advice sought from a qualified subject matter expert. If required, the suspected contamination will be sampled and analysed to determine the appropriate remediation and disposal.

J.1.5 Dust, Erosion and Sedimentation Control

- Driving will be restricted to designated access tracks to prevent and minimise dust and erosion. All access tracks will be stabilised and wet down to prevent dust. Internal speed limits will be enforced where required to minimise the production of dust.
- Dust will be minimised through staged clearing to minimise exposed ground and wetting down/compacting of soils. Where required stabilisation additives may also be applied to exposed surfaces or stockpiles, and/or sediment fences or geofabric may be used to prevent sedimentation of waterways and directing runoff into controlled/treated onsite drainage.
- If sedimentation or erosion does occur immediate action will be taken to prevent further damage occurring, all eroded material will be recovered, and accessways/drains cleaned and returned to service and remaining exposed ground and stockpiles will be assessed.

- At all stages of construction, contractors will ensure exposed soils and stockpiles are maintained to prevent windblown dust, erosion and sedimentation into drainage, remnant vegetation or outside the construction footprint.

J.1.6 Stormwater and Waterway Protection

- Drainage systems will be established as early as possible. Water will be conveyed at appropriate velocities by implementing drainage stabilisation, for example lining drains or creating rock check dams to prevent scouring. Proposal specific risk conditions and requirements are outlined below.
- Land next to waterbodies will remain undisturbed for as long as possible, at least until the installation of culverts and drainage controls or if required sediment barriers and silt curtains will be used to prevent sedimentation into drainage systems.
- Any potentially contaminated water will be treated on-site before being discharged into stormwater drainage or contained and removed as contaminated waste if treatment is unavailable. All potentially contaminated water will be tested and reported to SynergyRED to verify the disposal option is suitable. Contaminated water including stormwater collected in storage bunds and water used in concrete washout, will be managed as controlled waste in accordance with relevant legislation.

J.1.7 Wet Weather

- Contractors will ensure that an inspection is undertaken at the site prior to and post inclement weather events. The inspection checks for any potential hazards and that materials are stowed away, secured and protected from stormwater and high winds.
- All drainage systems, trenching and chemical storage bunding will be inspected post heavy rainfall to ensure the integrity of these systems and assess where stormwater or contaminated water may need to be removed. The site boundary will be inspected to ensure any impacts to the surrounding environment external to the project footprint are identified and able to be responded to.

J.1.8 Hazardous Material, Contaminant and Emissions Containment

- Contractors will have a hazardous substances and dangerous goods process onsite that includes pre-authorisation of chemicals, maintenance of a hazardous substances register, dangerous goods manifest and safety data sheets (SDS).
- Where possible, chemicals will be stored in shaded locations protected from inclement weather, with liquid chemicals stored in impermeable bunds with a capacity of 110% the largest container stored. Bunding, chemical and fuel containing facilities will be inspected regularly for evidence of leaks or spills and be kept clean and free of residue, litter and stormwater.
- Hazardous substances and dangerous good inventories will be maintained such that only the minimum necessary quantities are maintained on-site. Spill response equipment suitable for the type, volume of chemicals and site conditions will be available and accessible at the storage and use locations.
- Work areas for painting and coating works will be established and appropriately contained so that no dust/fugitive paint escapes from the work area, in line with the *Environmental Protection (Metal Coating) Regulations 2001 (WA)*. Materials for abrasive blasting will be scrutinised prior to the activity commencing to identify possible contaminants from the activity.
- Contractors will undertake daily prestart inspections and regular maintenance of all vehicles, plant and equipment.
- Contractors will undertake refuelling at fuel stations or at designated refuelling locations on-site wherever practicable with spill containment measures in place throughout the activity, in addition to having a hydrocarbon spill kit available. No refuelling or servicing will occur within 50 m of a watercourse or wetland.
- All liquid fuel containing equipment such as generators, lighting towers, compressors and pumps will be bunded (or self-bunded), with hoses and connections that contain hydrocarbons being contained with bunding or double skinned with breakaway couplings/one-way valves. All mobile equipment with hydraulic hoses (e.g. cranes, elevated work platforms, bulldozers, excavators, drill rigs) will have a mobile spill kit onboard.
- No plant or vehicle servicing is to occur onsite unless unavoidable. Where unavoidable servicing on-site will be done in an area protected from stormwater ingress, with appropriate hydrocarbon containment, disposal and spill response equipment in place.
- If a spill were to occur on soil or other permeable surface, the contractor will remediate the site and provide evidence of adequate remediation, including photographs of clean up, soil analysis certificates by a NATA accredited laboratory of the removed soil and soil validation sampling and analysis.

J.2 Proposal Specifications

SynergyRED will implement the following design criteria and specifications to mitigate impacts on surface water and groundwater in relation to the construction and operation of the Proposal.

J.2.1 Construction Timing

- Construction, specifically early civils and dewatering activities will be scheduled to take place during the dry season (e.g between November to February and potentially through to April depending on conditions), where practicable. This is to minimise potential runoff, dewatering volumes and associated sediment control and vehicle access track requirements that accompany wet weather site management.

J.2.2 Stormwater Diversions

- There will be no diversion of key tributaries that currently flow through the Study Area and discharge to Scott River or Blackwood River (Figure 3-9).
- Stormwater flows will be diverted around the substation, office and concrete batching areas. Internal stormwater captured within these facilities will be directed to an on-site retention basin to intercept sediment before infiltrating internally and/or controlled discharge through the stormwater overflow designed to manage sediment removal and reduce stormwater velocity. This will ensure that surface water quality is not significantly impacted by construction or operational activities specific to the Proposal.

J.2.3 Civil and Drainage Design

- Alignment and design of access roads from public road to wind farm substation, turbines and other infrastructure will work to utilise existing tracks as much as possible and will be optimised with consideration for areas of inundation and key streams to limit hydrological impacts and potential road closure.
- Civil infrastructure will be located and designed to ensure specific risk-based flood vulnerability requirements have been addressed. Works within the 1% AEP flood extent filtered to 50 mm will be avoided where practicable. Where practicable, key infrastructure (substations, office buildings) to be located outside 1% AEP inundation area and have finished floor levels at least 300 mm above the 1% AEP flood level. Where any infrastructure (roads, buildings, substations) intercepts the flood extent, civil design will ensure predevelopment flow rates are maintained. Areas with flood depths exceeding 0.3 m are categorised as being of likely risk to infrastructure and public safety and will be considered as part of infrastructure resilience planning (Section 5.5.3).
- Drainage control structures (e.g., drains and culverts) will be appropriately located, designed, constructed and maintained to maintain the existing hydrological regime and minimise erosion.
- Velocities will be maintained below 2 m/s for areas upstream and downstream of disturbance areas, including at culvert inlet and outlets. Suitable erosion protection is to be installed in line with Austroads culvert apron sizing and stream stabilisation methodologies, as well as the recommended erosion threshold limits in Section 5.5.2. Where practicable, exposed soils are to be stabilised through suitable vegetation cover or protected using engineered erosion control measures where flow velocities exceed 1 m/s.” Any temporary works during construction are to follow the Construction Environmental Management Plan.
- Design and construction works will ensure that local grading and excavation areas do not create areas of pooling water adjacent to constructed infrastructure that may lead to stagnation or eutrophication, including localised grading of access tracks and pads.
- Evacuation routes to vulnerable infrastructure such as substations and offices will be designed such that flooding over roads does not exceed a depth times velocity (D x V) of 0.6 (i.e. less than 0.5m flood depth and 2m/s velocity).
- Modification of existing drainage structures that contain or control the movement of soil or water (i.e. drains/levees/weirs/dam walls) will be avoided unless the proposed modification will improve drainage and not lead to any detrimental impacts to downstream receptors.
- Suitable erosion protection will be installed in line with Austroads culvert apron sizing and stream stabilisation methodologies, as well as the recommended erosion threshold limits.

J.2.4 Waterway Protection Works

- Concrete batching areas, as well as areas for agitator washout and vehicle/plant washdown will be bunded and captured to prevent contamination of runoff to streams. No concrete slurry will be dumped on site or placed anywhere other than explicitly specified as part of the infrastructure development plan. Local stormwater runoff diversions to onsite retention basins will be implemented as above. Any liquid admixtures are to be stored as per Hazardous Material Containment specifications outlined in the section above.

- Location of any gravel borrow pits will avoid key streams, native vegetation and wetlands. Sediment barriers, silt curtains and geofabrics are to be installed to prevent exposed soils or gravel from being transported to key streams. Rehabilitation plans for the borrow pits are to be in line with the CEMP.
- The electrical substation and switchyard, operation and maintenance building and workshop, concrete batching area will be situated at least 50 m from known and potential GDE.

J.2.5 ASS & Dewatering Management

Any dewatering and/or acid sulfate management will be managed by the Acid Sulfate Soils and Dewatering Management Plan (ASSDMP), outlining suitable mitigation measures. This plan is expected to be in line with the relevant regulatory guidelines and objectives

- Synergy will adopt an alternative foundation design that requires shallower foundation supported by ground improvement via controlled modulus columns, these are installed using piling technology reducing the depth of dewatering from 5-6 m to 1-2 m.
- Synergy will infiltrate dewater as close to the source as possible, to limit drawdown.
- Synergy will not discharge any dewatered groundwater directly or indirectly to local waterways/wetlands.

J.2.6 Environmental and cultural heritage

- The constructionAdhere to the relevant SynergyRED mandatory environment and cultural heritage management measures to maintain surface and groundwater regimes (SYN-STD-ENV-0001 Rev. 2 July 2024).
- Develop, implement, and adhere to the appropriate Construction and Environmental Management Plan (CEMP), outlining suitable mitigation measures to reduce environmental harm during construction.

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