Orchard Hills Alspec Industrial Business Park Groundwater Impact Assessment

HB+B Property

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DOCUMENT TRACKING

Project Name	Orchard Hills Alspec Industrial Business Park Groundwater Impact Assessment
Project Number	8648
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Approved by	Richard Cresswell
Status	**Final**
Version Number	**V2**
Last saved on	**22 November 2024**

This report should be cited as 'Eco Logical Australia Click here to enter a year. *Orchard Hills Alspec Industrial Business Park Groundwater Impact Assessment*. Prepared for HB+B Property.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from

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Abbreviations

Abbreviation	Description
AHD	Australian Height Datum
AIP	*NSW Aquifer Interference Policy 2012*
ANZECC	Australia & New Zealand Environment and Conservation Council
ANZG	Australia and New Zealand Guidelines for fresh and marine water quality
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASRIS	Australian Soil Resource Information System
BoM	Bureau of Meteorology
CLM Act	*Contaminated Land Management Act 1997*
CRD	Cumulative Rainfall Departure
DPIE	NSW Department of Planning, Infrastructure and Environment
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environmental Protection Authority
GDE	Groundwater dependent ecosystem
mAHD	metres above height datum
mbgl	metres Below Ground Level
MDB	Murray Darling Basin
NWQMS	National Water Quality Management Strategy
NWQM	National Water Quality Management
PASS	Potential Acid Sulfate Soils
PCT	Plant Community Type
POEO Act	*Protection of Environment Operations Act 1997*
SEARs	Secretary Environmental Assessment Requirements
SRLUP	Strategic Regional Land Use Policy
SWL	Standing Water Level
TDS	Total Dissolved Solids
WM Act	*Water Management Act 2000*
WRP	Water Resource Plan
WRPA	Water Resource Plan Area
WSP	Water Sharing Plan

1. Introduction

Eco Logical Australia Pty Ltd (ELA) was engaged by HB+B Property (HBB), to undertake a Groundwater Impact Assessment for the proposed ALSPEC Industrial business Park (the 'Project'), located at 221-227 and 289-317 Luddenham Road, Orchard hills, New South Wales (NSW) (the 'site') (Figure 1-1). The site is approximately 127 ha and is bordered by Patons Lane to the north, private property to the south and Luddenham Road to the east. The site is currently utilised as rural residential and agricultural land and is proposed to be redeveloped as an industrial subdivision for commercial and industrial land use.

1.1. Scope of Work

ELA has undertaken the following scope of work to address the key groundwater requirements defined within the SEARs (Table 1-1):

- A review of the existing, available hydrogeological data and environmental information to characterise the existing hydrogeological environment at the Project.
- An impact assessment outlining potential impacts from the Project on groundwater resources, including GDEs.
- Recommendations regarding potential management and mitigation strategies to prevent and minimize any potential impacts and contingency requirements to address any residual impacts.

Table 1-1: Secretary's Environmental Assessment Requirements

SEARs Item	Description	Section of this report
Key Issues	Water management	
	a description of groundwater conditions and all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater (both temporary and permanent)	**Section 3** Existing Environment **Section 4** Potential Impacts **Section 5** Management considerations and recommendations
	an assessment of potential groundwater impacts (both quality and quantity) associated with the development, including potential impacts on groundwater, and groundwater-dependent communities nearby in accordance with relevant water quality guidelines and the Department of Climate Change, Energy, the Environment and Water-Water Group (DCCEEW-Water) Groundwater Toolkit	**Throughout**
	details of any groundwater mitigation, management and monitoring activities and methodologies.	**Section 5** Management considerations and recommendations

Figure 1-1: Site location

2. Relevant Legislation

The following legislation and policies have been considered in this assessment:

- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- *Water Management Act 2000* (WM Act)
- Water Sharing Plan for the NSW *Murray Darling Basin Fractured Rock Groundwater Sources 2020*
- Water Resource Plan for the NSW *Murray Darling Basin Fractured Rock Groundwater Sources 2020.*
- NSW Aquifer Interference Policy (AIP) 2012
- Risk Assessment Guidelines for Groundwater Dependent Ecosystems
- National Water Quality Management Strategy (NWQMS) Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ) 2018
- NWQMS Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
- NSW State Groundwater Policy Framework Document
- Environmental Protection Authority (EPA) Guidelines for the Assessment & Management of Groundwater Contamination.

Further details on key legislation are provided below.

2.1. Environmental Planning and Assessment Act 1979

The EP&A Act is the principal planning legislation for NSW, providing a framework for the overall environmental planning and assessment of development proposals. A variety of other legislation and environmental planning instruments, such as the WM Act, which specifies groundwater management requirements, are integrated with the EP&A Act.

2.2. Water Management Act 2000

The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs. The WM Act is administered by WaterNSW and establishes an approval regime for sustainable development of water resources across the State.

The WM Act also recognises the need to allocate and provide water for the environmental health of the State's rivers and groundwater systems, whilst also providing licence holders with more secure access to water and greater opportunities to trade water through the separation of water licences from land. The main tools within the WM Act for managing the State's water resources are Water Sharing Plans (WSPs), which establish rules for sharing water between different water uses such as town supply, rural domestic supply, stock watering, industry and irrigation and ensure that water is provided for the health of the system.

2.2.1. Water Sharing Plans (WSP)

The project is situated with the Greater Metropolitan Region, with surface waters covered by the Greater Metropolitan Region Unregulated River Water Sources Sharing Plan 2023 and specifically rules relating to the Upper Wianamatta-South Creek Management Zone (Rule summary sheets for the Greater Metropolitan Region Unregulated River Water Sources 2023 (nsw.gov.au)) and groundwater managed through rules relating to the Sydney Basin Central Groundwater Source of the Greater Metropolitan Region Groundwater Sources 2023 Water Sharing Plan (sl-2023-328 (nsw.gov.au)) (DPIE Water, 2023).

2.2.2. Aquifer Interference Policy

The *Aquifer Interference Policy 2012* (AIP, 2012) was established under the WM Act to define the assessment process for development applications in terms of their potential impacts on aquifers, to clarify the requirements for obtaining water licenses for aquifer interference activities and to define the considerations for assessing potential impacts on key water-dependent assets. The AIP focuses on activities that remove water from aquifers for non-water supply purposes.

The WM Act defines an aquifer interference activity as that which involves any of the following:

- *The penetration of an aquifer*
- *The interference with water in an aquifer*
- *The obstruction of the flow of water in an aquifer*
- *The taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations*
- *The disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations*.

The AIP clarifies water licensing requirements and details how these potential interference activities will be assessed under relevant planning and approvals processes. The policy provides ‘minimal impact considerations’ to evaluate potential impacts on groundwater levels, pressures, and quality for different categories of groundwater sources. The policy also includes provisions for water to take from a source following the cessation of the aquifer interference activity.

The ‘minimal impact considerations’ provided in the AIP have been developed for impacts on groundwater sources, connected water sources and their dependent ecosystems, culturally significant sites and water users. These considerations are defined for ‘highly productive’ and ‘less productive’ groundwater sources, both of which are further grouped into categories according to aquifer type (e.g., alluvial, coastal sands, fractured rock, etc.). Two levels of ‘minimal impact considerations’ are provided, and if the predicted impacts are less than the Level 1 impact considerations, the impacts from the Project would then be considered acceptable. If the predicted impacts are greater than the Level 1 considerations, studies would be required to fully assess these impacts and potentially apply mitigation measures which may include provision of water access licencing or make-good actions.

There is the possibility that construction and operation works on site may involve the penetration of an aquifer, the interference with water in an aquifer and/or the obstruction of the flow of water in an aquifer. This report considers whether the minimal impact considerations under the WM Act are exceeded and whether a full assessment of the activity is required.

3. Existing Environment

3.1. Topography and hydrology

The Site is located within the broader Wianamatta-South Creek catchment. The Water Sharing Plan acknowledges that this catchment is the most degraded catchment in the Hawkesbury-Nepean River system due to historical vegetation clearing, agriculture and urbanisation. Increased urbanisation will further degrade the waterways if stormwater and flooding regimes are not managed through an integrated approach (BMT Commercial Australia, 2022).

Site elevation ranges from approximately 38 m relative Australian Height Datum (mAHD) in the northern portion of the site adjacent to Patons Lane to 54 mAHD in the southern portion of the site (Figure 3-1). The topography indicates a gentle slope to the north/north-west towards an unnamed drainage line and west towards Wianamatta-South Creek.

A review of the local drainage lines (NSW MinView, accessed 24 May 2024) indicates the primary surface water features relevant to the site, classified using the Strahler stream order classification system, are:

- An unnamed fourth order stream that borders the north-west boundary of the site for approximately 500 m.
- Cosgroves Creek, a fourth order stream located approximately 300 m to the south-east of site, flowing north, and discharging into Wianamatta-South Creek.
- Wianamatta-South Creek, a sixth order stream, located approximately 170 m to the west of the site, which flows north subsequently flows into the Hawkesbury River, classified as a ninth order stream, approximately 25.7 km north of the site.

In addition to identified drainage line features, up to eight earthen surface water storage dams are present within the site boundary. It is assumed that the existing dam features will be appropriately dewatered and infilled or managed as part of the Project construction activities in accordance with relevant dewatering management and construction environmental management plans.

Surface water quality modelling has not been undertaken as part of this assessment however, an eWater MUSIC water quality model is concurrently being developed by Henry & Hymas.

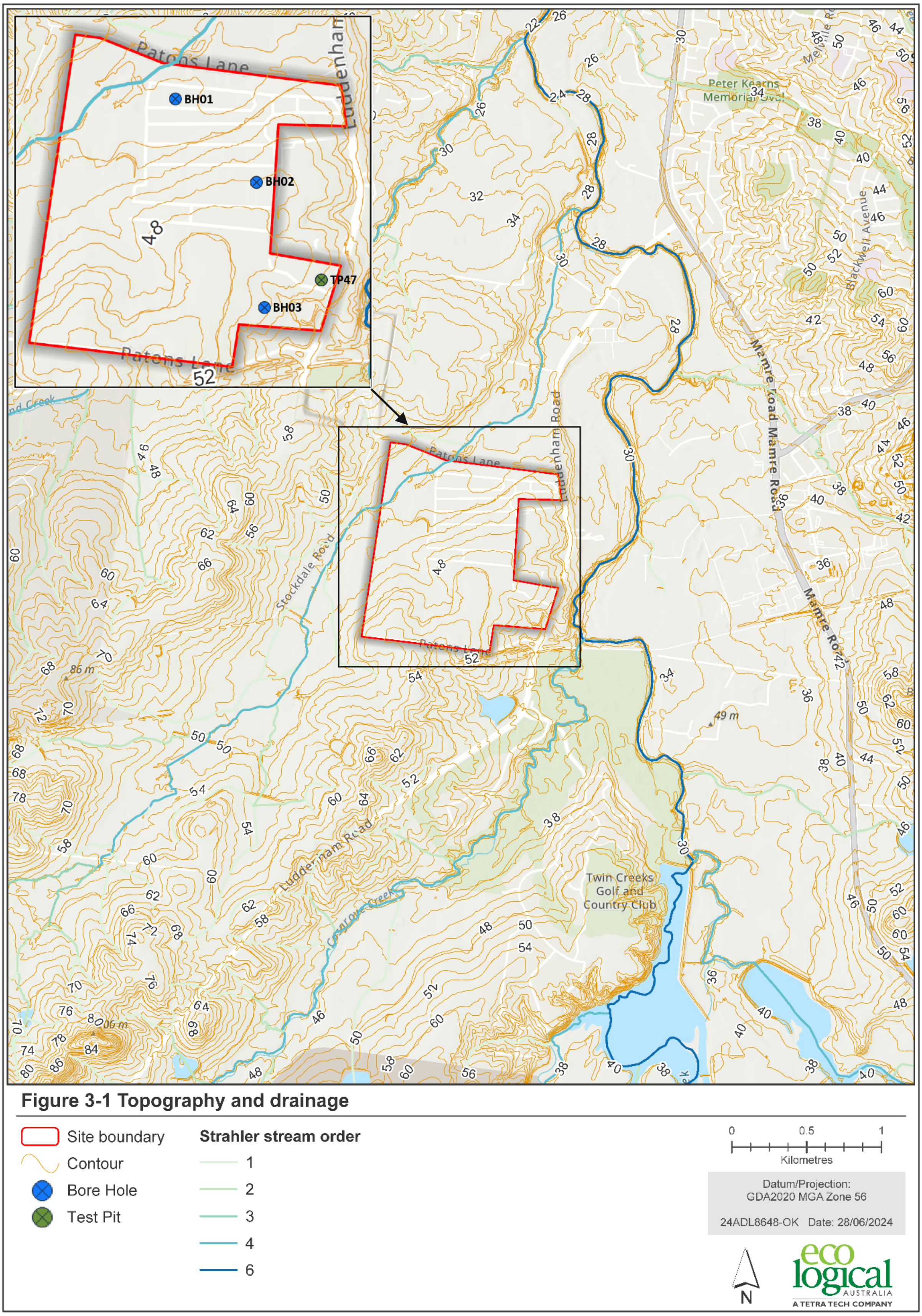

Figure 3-1 Topography and drainage

3.1.1. Streamflow

Observed streamflow information was available for South Creek at Elizabeth Drive (gauge number 212320), located approximately 5.4 km south of the Project site. Data was sourced from the WaterNSW Realtime Water database from 1 June 1970 to 15 May 2024 as shown in Figure 3-2.

Additional streamflow information was available for South Creek at Great Western Highway (gauge number 212048), located approximately 3.9 km downgradient of the Project site to the north, noting observed streamflows at this location are likely higher than those at the Site due to a larger contributing catchment area. Data sourced from the WaterNSW Realtime Water database from 25 February 1986 to 13 May 2024 is shown in Figure 3-3.

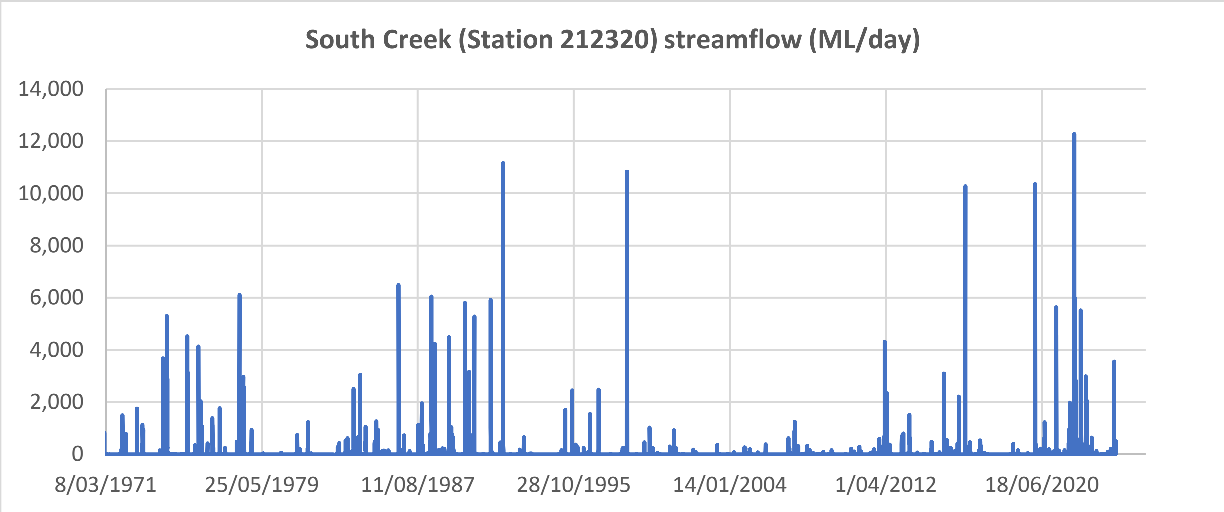

Figure 3-2 South Creek at Elizabeth Drive (212320) gauged streamflow

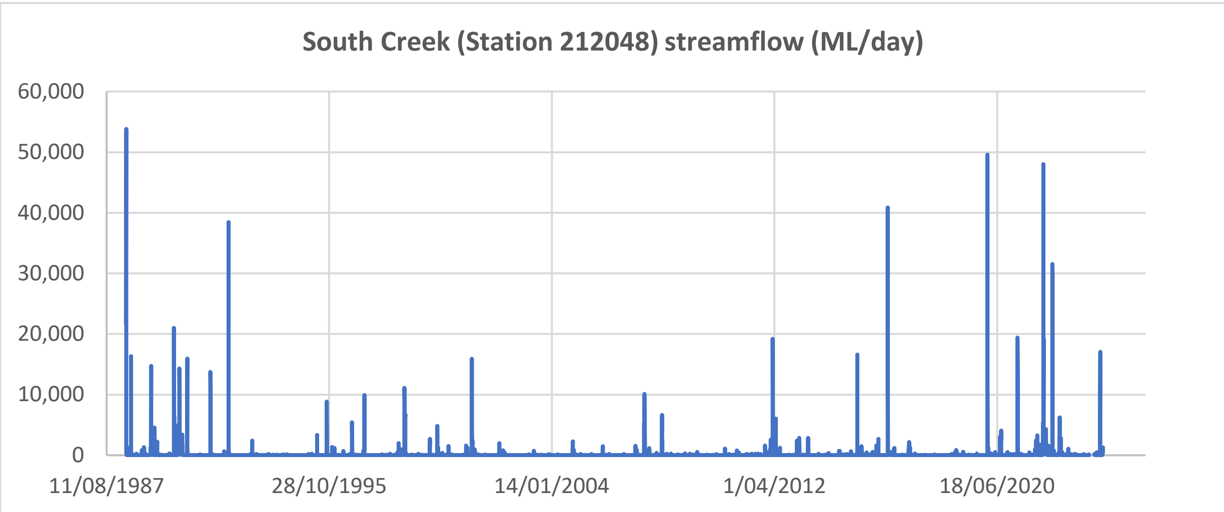

Figure 3-3 South Creek at Great Western Highway (212048) gauged streamflow

3.2. Climate

Based on average climate data from the nearest weather station at Penrith Lakes AWS (BOM station 067113), the average maximum temperature since 1995 near the project range between 18.1°C (July) to 30.8°C (January) (BoM, 2024).

3.2.1. Rainfall

The average rainfall is 782.8 mm/year, with an average of 78.3 days a year experiencing more than 1 mm of rainfall (Figure 3-4). Typically, the highest rainfall is during late summer and early autumn (January-March) while late winter early spring are typically the dry (July-September) (BoM, 2024).

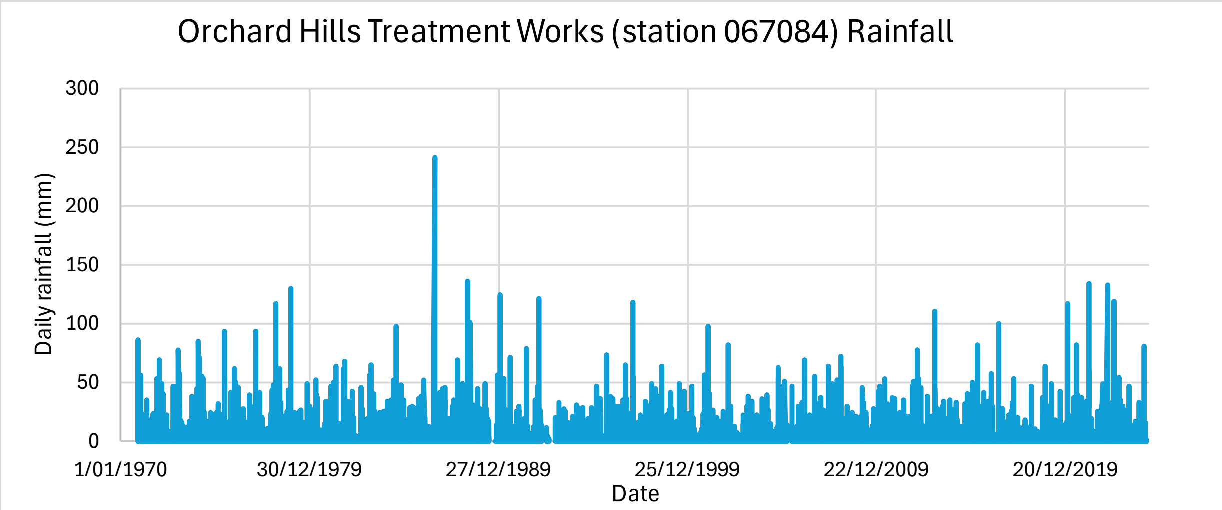

Figure 3-4 Orchard Hill Treatment Works precipitation (BOM station 067084)

3.2.2. Potential Evapotranspiration (PET) / Evaporation

Daily evaporation and average monthly PET were required for the water quality (MUSIC) modelling, respectively. Evaporation data was sourced from the Prospect Reservoir (67019) (Government, 2024) gauge roughly 13 km to the northeast and is considered applicable for catchment modelling. For the purposes of the MUSIC modelling Evaporation may be considered equivalent to evapotranspiration.

The daily and monthly evaporation can be seen in Figure 3-5 and Figure 3-6 respectively and gives an average annual evaporation of 1314 mm/year.

The Project Site water balance (Section 5) assessed both Actual and Potential evapotranspiration data, which were sourced from the TERN (2022) ecosystem research infrastructure actual evapotranspiration (AET) explorer web portal and the Queensland government's SILO (2001) database for potential evapotranspiration (PET) data. These data sources reflect evapotranspiration data from as close as possible to the Project Site.

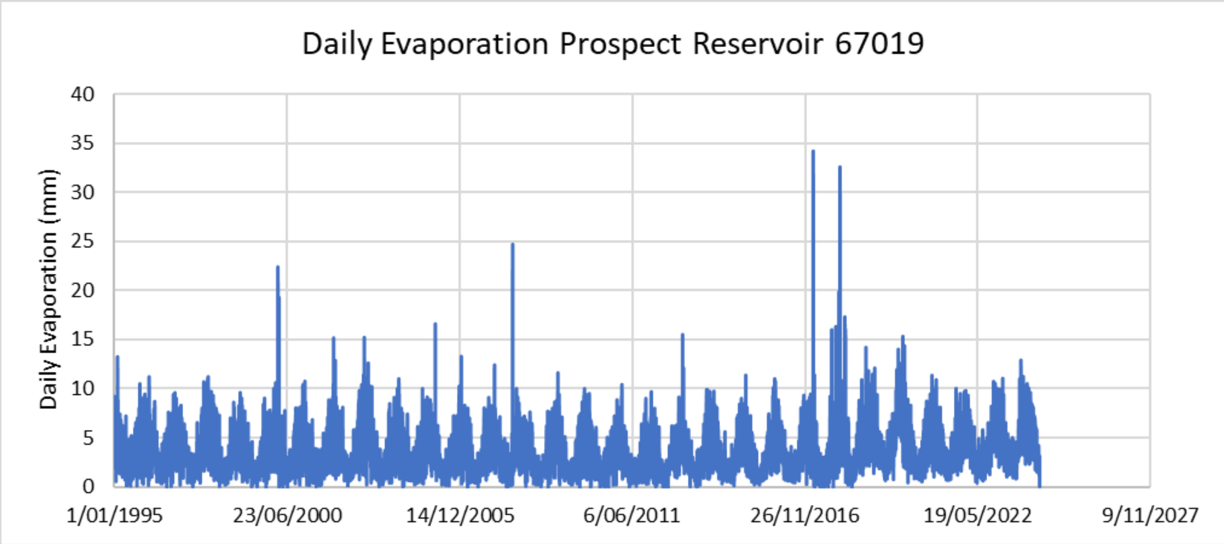

Figure 3-5 Average Daily Evaporation, Prospect Reservoir

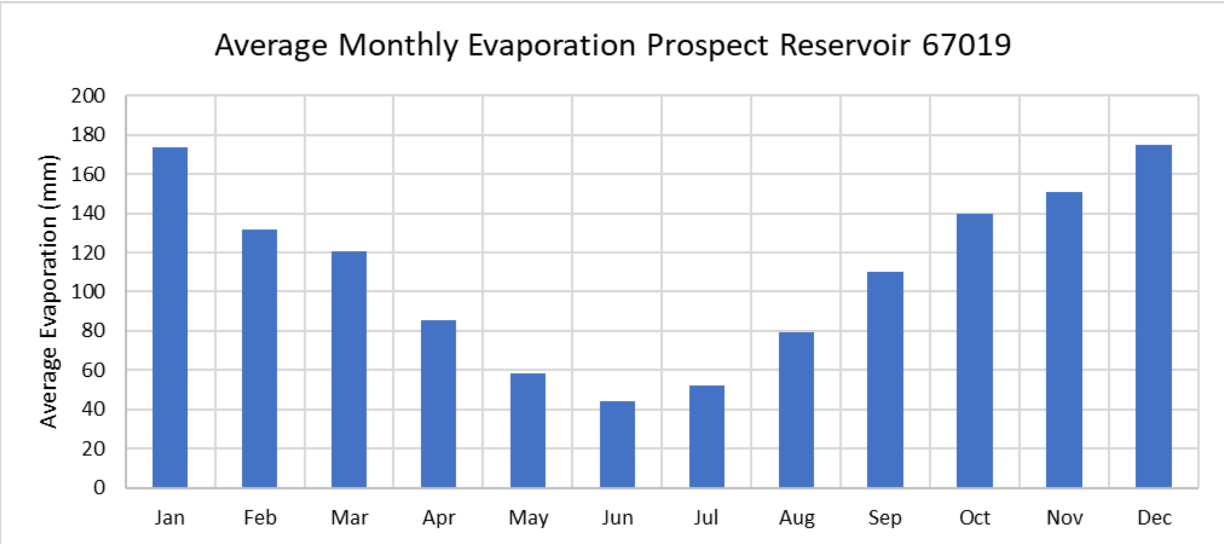

Figure 3-6 Average Monthly Evaporation, Prospect Reservoir

3.3. Soils

The Soil Landscapes of the Penrith 1:100,000 scale sheet suggests that the soils at the Project site are mostly classified as Blacktown Soil Landscape, which is associated with gently undulating rises on Wianamatta Group shales with soils here typically being shallow to moderately deep (<100 cm) (SEED, 2010). A portion of the project site to the north-west is classified as South Creek Soil Landscape, which Is associated with floodplains, valley flats and drainage depressions of the channels of the Cumberland Plain. This soil is described as very deep layered sediments over bedrock or relict soils (SEED, 2010).

3.4. Geology

The Penrith 1:100,000 Geological series sheet map (Geoscience NSW, 1991) suggest that the surface geology underlying the project site is dominated by the Triassic age Bringelly Shale (Rwb) of the

Wianamatta Group. The Bringelly Shale is described as shale and carbonaceous claystone, claystone, laminate, fine- to medium-grained lithic sandstone, rare coal and tuff. The north-west portion of the Site is underlain by Quaternary Alluvial sediments associated with an unnamed tributary of South Creek.

3.5. Hydrogeology

The Site is primarily located within the Upper South Creek Hydrogeological Landscape (HGL) and the Shale Plains HGL along the northwestern side of the site. These two HGLs are share similar groundwater properties characterised by low groundwater gradients and extensive shallow saline groundwaters. High base flow Electrical Conductivity (EC) and Chloride-dominant high EC (>4.8 ds/m) are common features of these HGLs (NSW Government Environment and Heritage, 2024a) and (NSW Government Environment and Heritage, 2024c). The aquifer properties of these two HGLs are very similar and are presented in Table 3-1. The primary difference between the two HGLs being the Upper South Creek HGL has more undulating hills, steeper slope, absence of alluvial plains and receives slightly less rainfall than the Shale Plains HGL.

Table 3-1: Hydrogeological Landscape general aquifer properties

Aquifer property	Shale Plains	Upper South Creek
Aquifer type	Unconfined in unconsolidated alluvial sediments Unconfined to semi-confined in fractured rock along structures Vertical and lateral flow components Local perching above clay-rich layers (seasonal)	Unconfined to semi-confined in fractured rock along structures Vertical and lateral flow components Local perching above clay-rich layers (seasonal)
Hydraulic conductivity	Moderate Range: 10^{-2}–10 m/day	Moderate Range: <10^{-2} – 10m/day
Transmissivity	Low to moderate Range: <2-20 m^2/day	Low to moderate Range: <2-20 m^2/day
Specific yield	Moderate Range: 5–15%	Low to moderate Range: <5-15%
Salinity	Brackish to saline Range: >4.8 dS/m	Brackish to saline Range: >4.8 dS/m
Depth to water table	Intermediate Range: 2–6 m	Intermediate Range: 2–6 m

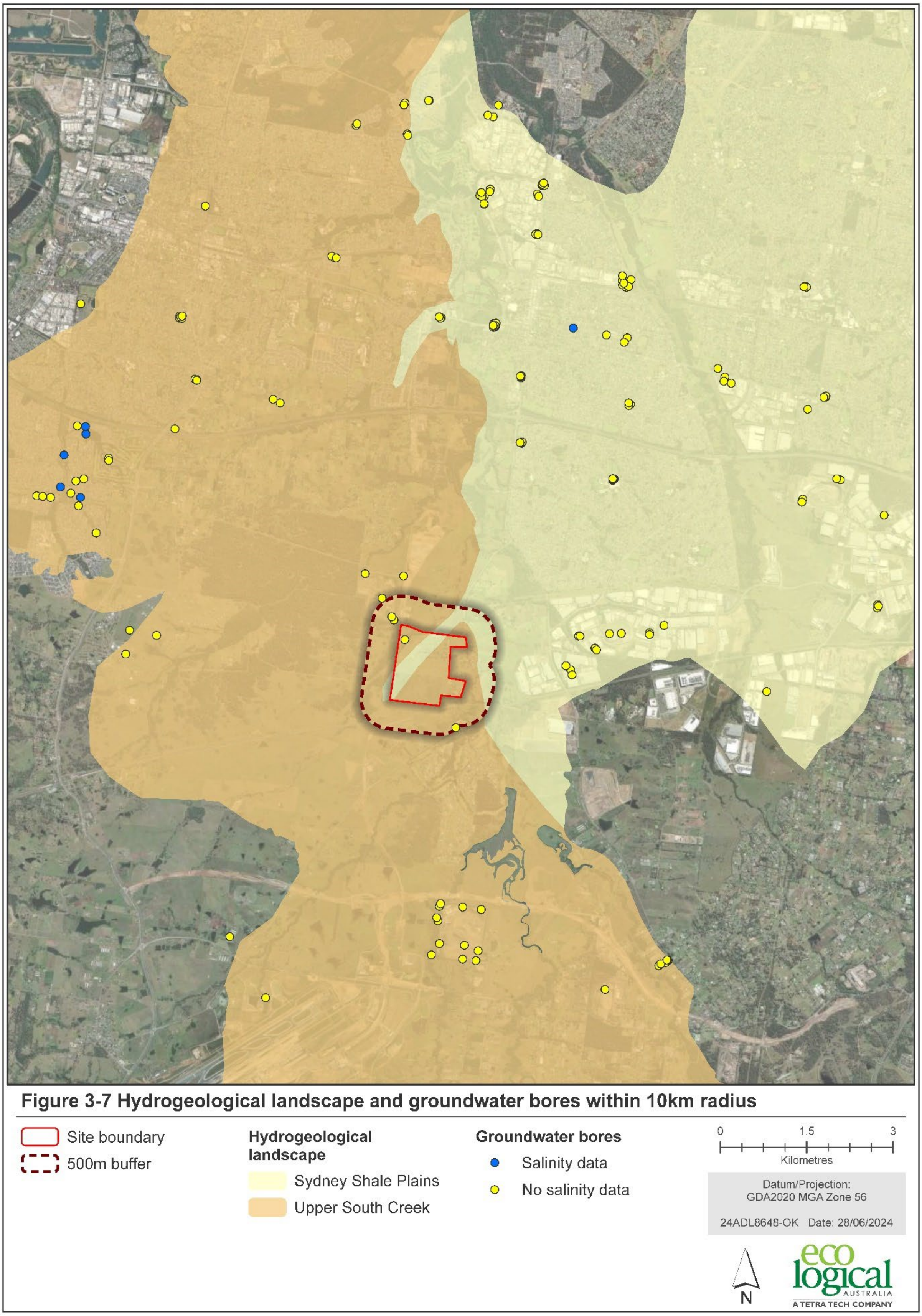

Figure 3-7 Hydrogeological landscape and groundwater bores

3.5.1. Regional groundwater

Regionally, groundwater level was extracted from the BoM Australian Groundwater Explorer online database using data from 370 registered bores within a 10 km radius of the site (Figure 3-7). Only thirteen of the identified bores, however, had standing water levels (SWL) recorded. Table 3-2 presents the available groundwater data for the bores.

Regional groundwater levels are variable, extending from 7.2 to 58.6 m AHD, and largely reflect the surface topography. The data variability and proximity of bores does not enable accurate extrapolation of groundwater levels at the ALSPEC site.

3.5.2. Local groundwater

Shallow groundwater sources found within Alluvial sediments of the Upper South Creek and Shale Plains HGL's are dominated by clay rich soils, that are noted as cause for seasonal waterlogging. Alluvial sediments of the HGL's have a lack of sandy or gravel sediments, resulting in compartmentalised shallow groundwater lenses, with limited lateral extents.

Evidence from geotechnical drill hole BH03 and test pit TP47 (Figure 3-1) suggest that shallow groundwater observed within the Alluvial sediments is hosted within Clay and Clayey silt respectively, indicating point source/localised waterlogging of the clay rather than an extensive shallow groundwater lens.

Alluvial hosted groundwater was encountered during geotechnical investigations at:

- Drill hole BH03, with a recorded groundwater depth of 3.5 m bgl (43.6 m AHD) within alluvial clay.
- Test Pit TP47, with a recorded groundwater depth of 0.5 m bgl (42.9 m AHD), with increased inflows at 0.95 m bgl and 1.5 m bgl within Clayey silt and Clay.

Geotechnical staff recorded groundwater depths during site visit 24th June 2024 of:

- Drill hole BH01 groundwater depth of 2.24 m bgl (36.2 m AHD).
- Drill hole BH02 groundwater depth of 3.2 m bgl (42.9 m AHD).
- Drill hole BH03 groundwater depth of 2.31 m bgl (44.8 m AHD).

Fractured Rock groundwater sources within fractured rock of the Upper South Creek and Shale Plains HGL's are predominantly found within lateral shale layers, vertical interbedded shale/sandstone fracturing or at the shale/sandstone interface. Aquifers within the fractured rock are considered poor due to being localised (occur over limited extents) and are brackish to saline.

Evidence from geotechnical bore holes and test pits did not encounter groundwater within the Fractured Rock.

Table 3-2 Groundwater bore data

Bore ID	Latitude	Longitude	Drilled depth (m)	Drilled date	Purpose	Elevation (m AHD)	SWL (mbgl)	SWL (m AHD)	SWL date	Salinity (µS/cm)	Sample date
GW075098.2.2	-33.78423	150.68984	na	19/11/2008	Monitoring	38.4	15.28	23.11	7/12/2022	-	na
GW075078.1.1	-33.7729	150.7912	8	26/05/1999	Monitoring	40.5	-0.1	40.6	2/06/2003	-	na
GW075098.3.3	-33.78423	150.68984	250	19/11/2008	Monitoring	38.4	14.53	23.8	7/12/2022	-	na
GW075077.1.1	-33.7717	150.7879	12.5	26/05/1999	Monitoring	43.6	1.54	42.06	6/02/2003	-	na
GW075074.1.1	-33.8009	150.6914	6	14/08/2001	Monitoring	60.1	1.43	58.67	21/01/2009	-	na
GW075075.1.1	-33.7953	150.6886	2.5	14/08/2001	Monitoring	53.4	2.26	51.14	6/02/2003	2438	7/07/2003
GW075070.1.1	-33.7854	150.6899	4	13/08/2001	Monitoring	41	3.62	37.38	6/02/2003	37248	5/02/2003
GW075069.1.1	-33.7841	150.6883	5	13/08/2001	Monitoring	8.2	0.99	7.21	18/12/2001	-	na
GW075076.1.1	-33.7705	150.7817	13.5	26/05/1999	Monitoring	54	2.23	51.77	6/02/2003	2026	5/02/2003
GW075073.1.1	-33.7966	150.6882	6.5	14/08/2001	Monitoring	51.1	1.52	49.58	24/07/2009	-	na
GW075098.1.1	-33.78423	150.68984	na	19/11/2008	Monitoring	38.4	0.7	37.7	7/12/2022	30200	11/11/2008
GW075072.1.1	-33.7936	150.6849	6.5	13/08/2001	Monitoring	45.8	2.59	43.21	21/01/2009	19425	5/02/2003
GW075071.1.1	-33.7886	150.6857	7.2	13/08/2001	Monitoring	42	3.57	38.43	24/07/2009	12761	5/02/2003
TP47	-33.82632	150.75913	1.5	5/05/2020	Geotechnical Test Pit	**43.401*	0.5	42.901	5/05/2020	-	na
BH03 – Drilling	-33.82681	150.75606	8	1/05/2024	Geotechnical Drill Hole	**47.121*	3.5	43.621	1/05/2024	-	na
BH01 - June	-33.81888	150.753	8	1/05/2024	Geotechnical Drill Hole	**38.444*	2.24	36.204	24/06/2024	-	na
BH02 - June	-33.82198	150.75677	8	1/05/2024	Geotechnical Drill Hole	**46.111*	3.2	42.911	24/06/2024	-	na
BH03 - June	-33.82681	150.75606	8	1/05/2024	Geotechnical Drill Hole	**47.121*	2.31	44.811	24/06/2024	-	na

**Elevation data sourced from NSW Gov Spatial Services 1m DEM*

3.5.3. Groundwater Dependent Ecosystems

Policy design in NSW aims at balancing the safeguarding of GDEs in WSPs with licensed water users' needs, focusing largely on high priority GDEs. GDEs may include:

- Aquifer ecosystems (stygofauna)
- Cave and karst systems (which may contain aquatic and terrestrial GDEs)
- Base flow stream ecosystems
- Terrestrial vegetation
- Groundwater dependent wetlands
- Great Artesian Basin springs
- Estuarine and marine ecosystems.

Current guidance for identification of individual GDEs in NSW recommends assessment of the high ecological value aquatic ecosystem (HEVAE) GDE score data, publicly available through the NSW SEED portal *HEVAE Vegetation Groundwater Dependent Ecosystems Value in NSW map* (NSW DPE, 2023b). The HEVAE GDE score is calculated using the probability of groundwater dependence, based on vegetation species and depth to groundwater and a further assessment of the communities with a “high or very high” GDE probability based on the community’s diversity and ecological importance.

The resulting HEVAE GDE scores classify the ecological value of groundwater dependent vegetation communities, ranging from very low to very high. GDEs with very high and high value are given high priority in Water Sharing Plans (WSP). The identified very high and high value GDEs within 500 m of the site boundary and their HEVAE categories are shown in (Figure 3-8).

The Bom GDE atlas identified South Creek as the only high potential Aquatic GDE in the surrounding area, situated 170 m to the east of the southeastern boundary of site as shown in Figure 3-9.

Within the northwest portion of the site a portion of Cumberland River Flat Forrest is identified as a high potential Terrestrial GDE (Figure 3-10).

There are additional GDE sites identified using the HEVAE but none have been categorised as high or very high importance.

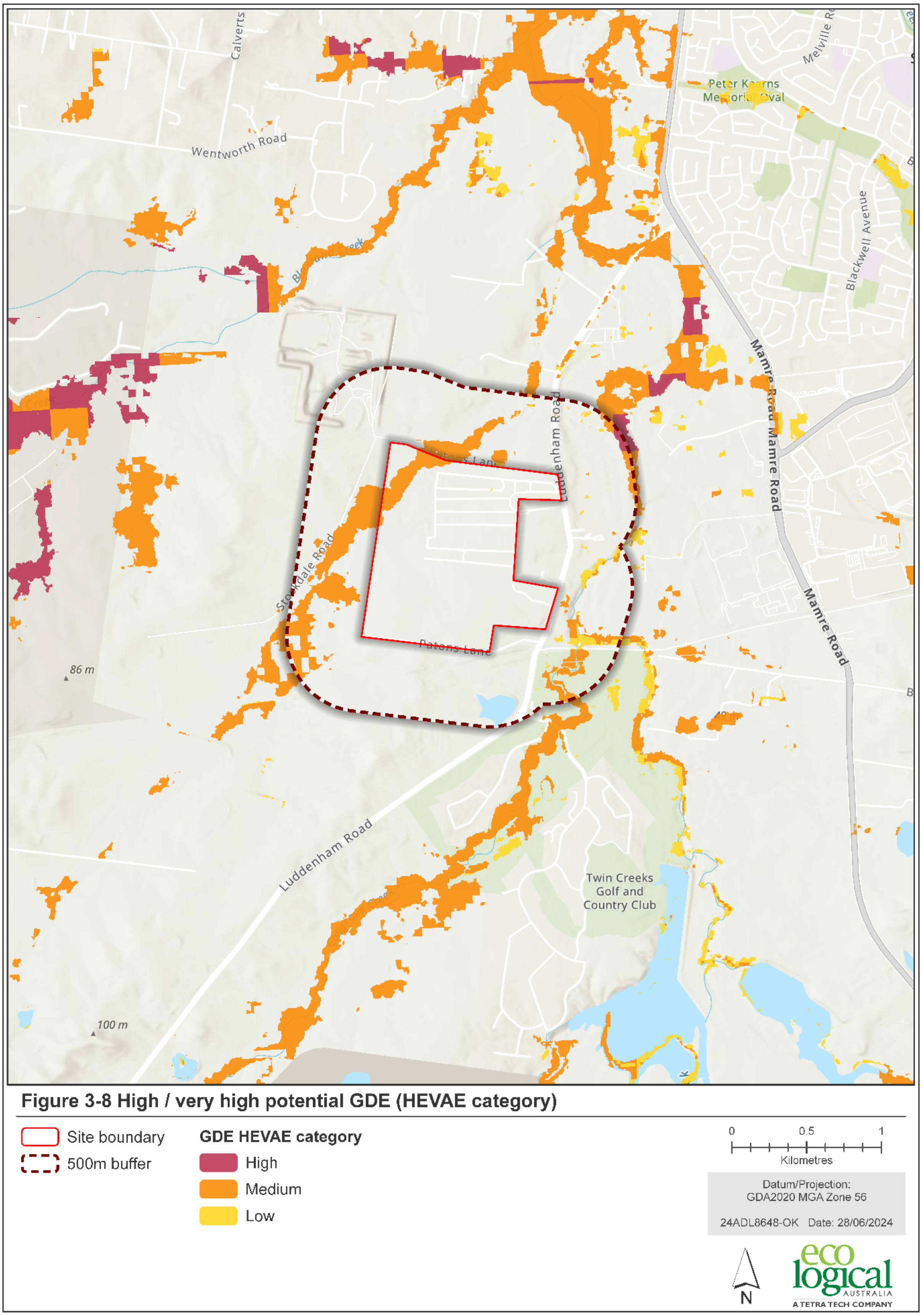

Figure 3-8 High / very high potential GDE (HEVAE category)

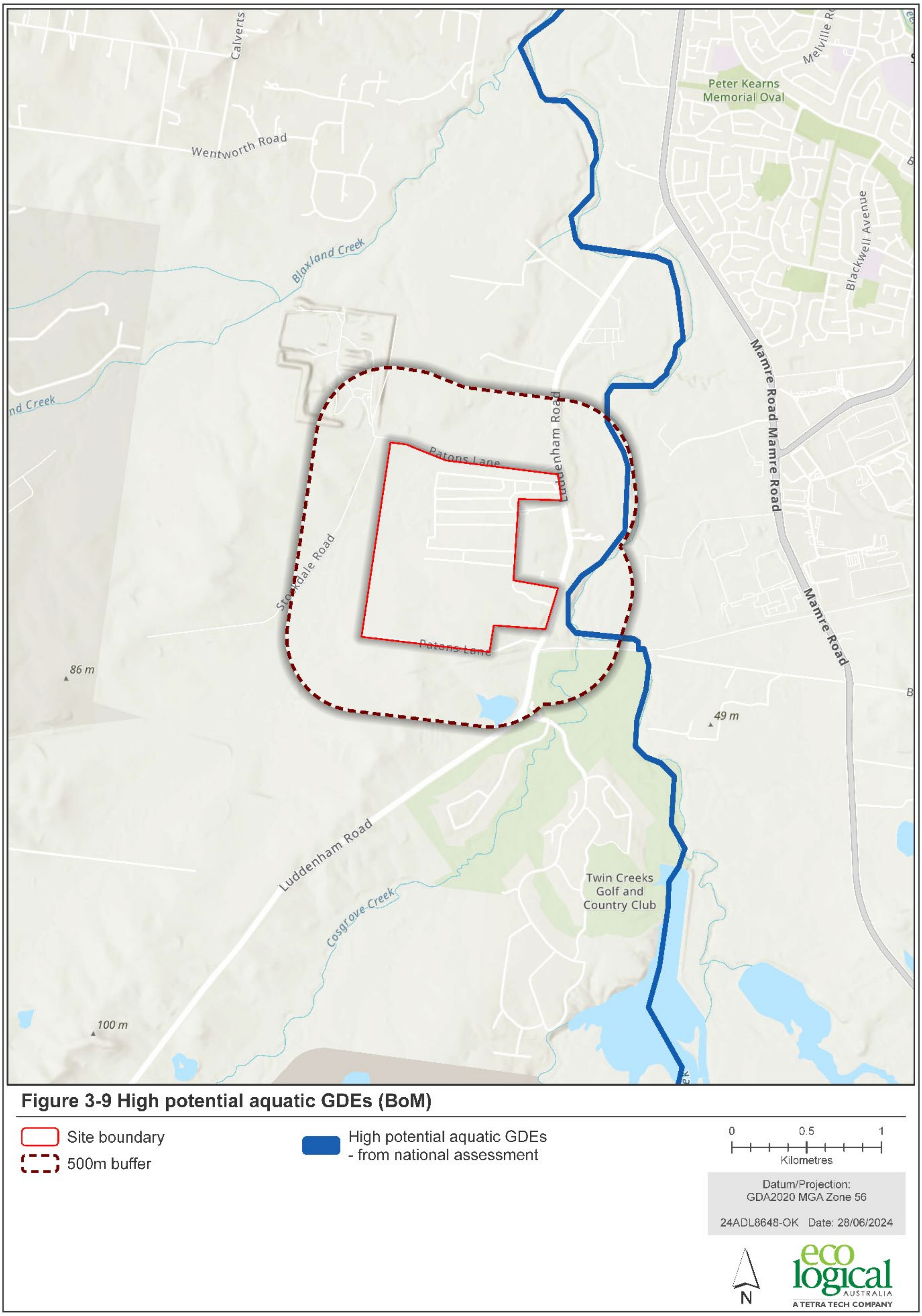

Figure 3-9 High potential aquatic GDEs (BoM)

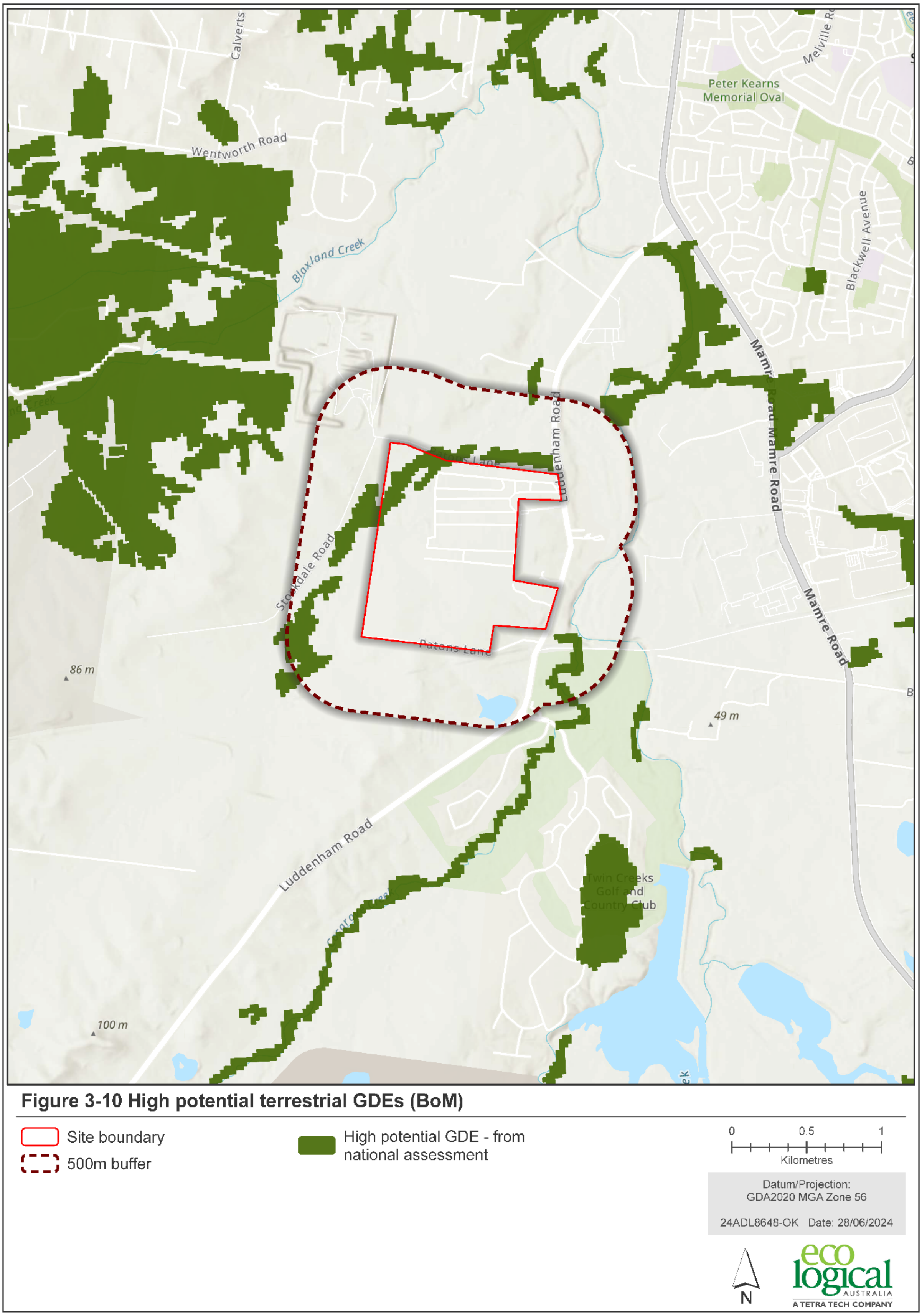

Figure 3-10 High potential terrestrial GDEs (BoM)

4. Groundwater Impact Assessment

A groundwater impact assessment has been based on information and data derived from available public data records and information acquired during this desktop review. Potential impacts have been assessed against the AIP Level 1 Minimal Consideration Criteria which were summarised in Table 4-1 and expended below.

The following potential environmental receptors have been identified:

- Water Table / Groundwater level.
- Disturbance to potential terrestrial and aquatic GDEs.
- Groundwater contamination.

Table 4-1 Potential groundwater impacts

Management issue	Potential receptor	Potential exposure pathway/impact	Preliminary risk assessment level and Management Strategies
GW1	Third party bore users	Human, livestock and/or domestic source users of impacted groundwater resulting in illness or death	Low – unlikely due to condition of local groundwater and current groundwater use. Management strategies will include mitigation measures and water quality monitoring will include comparison to relevant drinking water guidelines.
GW2	Terrestrial GDEs along the streamlines.	Deterioration in the health of GDE communities due to reduction in groundwater levels or quality.	Low – due to alluvial groundwater intercepts representing localised waterlogging of clay rather than extensive shallow groundwater lenses, and proximity to Terrestrial GDEs along the Unnamed creek within the northwest of site. Management strategies will include mitigation measures and water quality monitoring will include comparison to relevant recreational guideline values.
GW3	Water Table	Reduction in water table level due to changes in connected surface water flows, infiltration rates or water take	Low- existing recharge due to infiltration is likely to be minor across the site. Dewatering limited to localised waterlogging of clay. Treated stormwater will be directed to existing drainage where possible to limit changes in stream bed infiltration
GW4	Water Pressure	Reduction in the water pressure due to changes in connected surface water flows, infiltration rates or water take	Low- existing recharge due to infiltration is likely to be minor across the site. Treated stormwater will be directed to existing drainage where possible to limit changes in stream bed infiltration
GW5	Water Quality	Reduction in the water quality due to changes in connected surface water flows, infiltration rates, water take or leaching of saline soils	Moderate – due to proximity to Terrestrial GDEs along the Unnamed creek within the northwest of site. Management strategies will include mitigation measures and water quality monitoring will include comparison to relevant recreational guideline values.

4.1. Potential Impacts to Water Table / Groundwater Level

The Project Site topography consists of undulating terrain, general gentle slope toward the south and a vegetated valley within the northwest portion of the site. Registered groundwater bores within 10 km of the Project Site predominately located at lower elevations, within valleys and along creek/river lines or within developed or developing industrial land.

During onsite geotechnical works, groundwater levels were encountered within the 3.5 m of the existing land surface only twice. Groundwater was observed at 0.5 meters below ground level (m bgl) at TP47, and at 3.5 m bgl at BH03. These locations are situated toward the lowest elevation of the site, within the southeast catchment as defined by pre-development catchment plan (Henry & Hymas drawing 19221_D2_C250 rev3).

Geotechnical staff recorded groundwater depths during site visit 24th June 2024 of 2.24 m bgl (36.2 m AHD) at BH01, 3.2 m bgl (42.9 m AHD) at BH02 and 2.31 m bgl (44.8 m AHD) at BH01. The June groundwater levels approximate groundwater level observed within BH03 and TP47 of 42.9 – 43.6 m AHD, possibly extending the lower and upper range slightly (to 36.2 – 44.8 m AHD). Additional monitoring may be warranted to confirm seasonality of groundwater level.

Regional water table levels from water bores within a 10 km radius indicate values ranging from 15.28 to 0.7 m bgl (23.11 to 37.7 m AHD).

The Henry & Hymas Bulk Earthworks cut and fill plan (drawing 19221_D2_BE01 rev3) estimates a cut depth of approximately 2 – 4 m at the locations of BH03 and TP47. These estimated earthworks cut depths are likely to result in excavations intersecting groundwater at 42.9 – 43.6 m AHD.

Stormwater sediment basin in the vicinity of TP47 (approximately 1.5 m depth 19221_D2_SE03 rev2) is likely to intersecting groundwater at 0.5 m bgl (42.9 m AHD).

Excavation impact on groundwater within the vicinity of BH03 and TP47 are assessed as low due to the limited nature of the groundwater observed within the Alluvial sediments, indicating point source/localised waterlogging of the clay rather than an extensive shallow groundwater lens.

4.2. Potential Impacts to Terrestrial and Aquatic GDEs

Based purely on the locations of identified potential GDEs (Figure 3-10), there is a moderate risk (surface water quality) that Project-related infrastructure may impact the high potential Cumberland River Flat Forrest Terrestrial GDE within the northwest portion of the site.

As previously discussed in Section 4.1, however, it is unlikely, based on known groundwater data, that there will be any aquifer interference during construction. Therefore, groundwater-related impacts to the high potential terrestrial GDEs, are not anticipated.

Aquatic GDE risks are assessed as low due to alluvial groundwater intercepts representing localised waterlogging of clay rather than extensive shallow groundwater lenses.

4.3. Potential Groundwater Contamination

Fuels and lubricants will be used on site during construction activities and pose a potential risk of contamination to groundwater in the event of a spill. Contaminants in the soil may also be mobilised during rainfall events and may potentially enter the groundwater system, potentially impacting groundwater quality for third party groundwater users, GDEs and/or aquatic habitats.

Management of temporary sewage systems established onsite for the duration of the Project also pose a risk to surface water quality should spills occur.

It is important that Industry Standard spill minimisation and response procedures are followed, which will reduce and minimize any potential groundwater contamination during construction.

4.4. AIP Level 1 Minimal Impact Consideration Criteria

Our assessment concludes that potential impacts to groundwater will not exceed the Level 1 impact considerations under the AIP as defined in Table 4-1 for 'less productive' alluvial aquifers. That is, the Project areas pose less than a minimal impact to groundwater resources and associated dependencies and any potential impacts are therefore acceptable under the AIP and does not trigger referral under the WM Act.

The only interactions in the vicinity of the alluvial aquifers will involve cut and fill within the vicinity of geotechnical bore hole BH03 and test pit TP47. Any temporary impacts during construction will be managed through sound practice and monitored through the CEMP. No significant impacts are expected at these sites.

5. Irrigation and Site Water Balance Considerations

Consequences to the water cycle of the proposed development has been considered with respect to local climate, planned irrigation and the potential consequential impacts on groundwater.

5.1. Climate

Available salinity, geotechnical, planned irrigation and climate data was reviewed for the Project Site.

5.1.1. Rainfall

Rainfall from for the Project Site is summarised within Section 3.2, with annual average recorded as 782.8 mm/year at the Orchard Hills Treatment Works (BOM station 067084).

5.1.2. Evaporation and Transpiration

Evapotranspiration data was sourced from the TERN ecosystem research infrastructure actual evapotranspiration (AET) explorer web portal, which utilises a CSIRO MODIS Re-Scaled Evapo-Transpiration (CMRSET) algorithm to display a continuous, high-resolution and high-frequency AET dataset. The resultant average AET value for the Project Site reflects climate and pasture landcover over the last 10-years (2015 to 2024) which has averaged 700.1 mm/year. AET is assumed to represent the current state evapotranspiration.

Potential evapotranspiration (PET) data was extracted from the Queensland government's SILO database, utilising the Penman-Monteith (FA056) potential evapotranspiration formula. PET is considered to represent the maximum potential evapotranspiration. The nearest SILO centroid (5 km x 5 km grid) is 2 km north of the Project Site boundary (Lat -33.80, Long 150.75) and estimates potential evapotranspiration from the last 10-years to be 1209.9 mm/year.

The variance between AET and PET, reflects the potential ability of the site to utilise a greater water volume assuming the planted 'crop' can utilise all available water. Actual transpiration from plant species across the Project Site will critically depend on landscaping selections and may result in variability in the overall AET. Quantification of the magnitude change is not quantifiable without detailed landscaping plan and knowledge of plant selections. The use of native species is encouraged, though we note that published transpiration data on native grasses, in particular, are scarce.

Native grasses are commonly utilised for rain gardens and bio-filtration beds as they are commonly deep-rooting and have tolerance for extreme wet/dry climates. Potential species include *Carex appressa* (tall sedge), *Ficinia nodosa* (club rush) and *Juncus flavidus* (Rush).

Actual choice of vegetation at each site should consider the following attributes:

- Vegetation should be perennial
- Vegetation should be deep-rooted
- Vegetation should exhibit a high seasonally wet and dry climate tolerance
- Vegetation should be chosen to reflect the site's aspect (e.g. full sun exposure or consideration for shade tolerance beneath the proposed future Orbital)
- Species should be readily available.

5.2. Irrigation

Irrigation rates for the Project Site are reported against three catchments (Figure 5-1) as outlined within the Henry & Hymas Integrated Water Cycle Management Report (2024 rev. 4). Excerpts from Henry & Hymas (2024) are provided below:

North-Western Catchment

- Includes 1,300kL of rainwater storage for north-west lots, that will be reused for irrigation in landscaping areas at a rate of 0.4kL/m^2/year to achieve 91% reuse.
- Stormwater storage basin (13,400 m^3) with an estimated reuse of 62,400kL/year (based on an irrigation area of 10.4 ha at a rate of 600mm/year). Drawing C260 (Henry & Hymas, 2024) shows the proposed irrigation area.

North-Eastern Catchment

- Includes 100kL of rainwater storage for the north-east lot, that will be reused for irrigation in landscaping areas at a rate of 0.4kL/m^2/year to achieve 84% reuse.
- Stormwater storage basin (400 m^3) with an estimated reuse of 3,653kL/year (based on irrigation area of 0.609 ha at a rate of 600mm/year). Reticulation design and details will be provided at the detailed design phase.

South-Eastern Catchment

- Includes 300kL of rainwater storage for the south-east lot, that will be reused for irrigation in landscaping areas at a rate of 0.4kL/m^2/year to achieve 90% reuse.
- Stormwater storage basin (2,000 m^3) with an estimated reuse of 13,709kL/year (based on irrigation area of 2.285 ha at a rate of 600mm/year). The landscaped area within the southern portion of the subject site will be irrigated. Reticulation design and details will be provided at the detailed design phase.

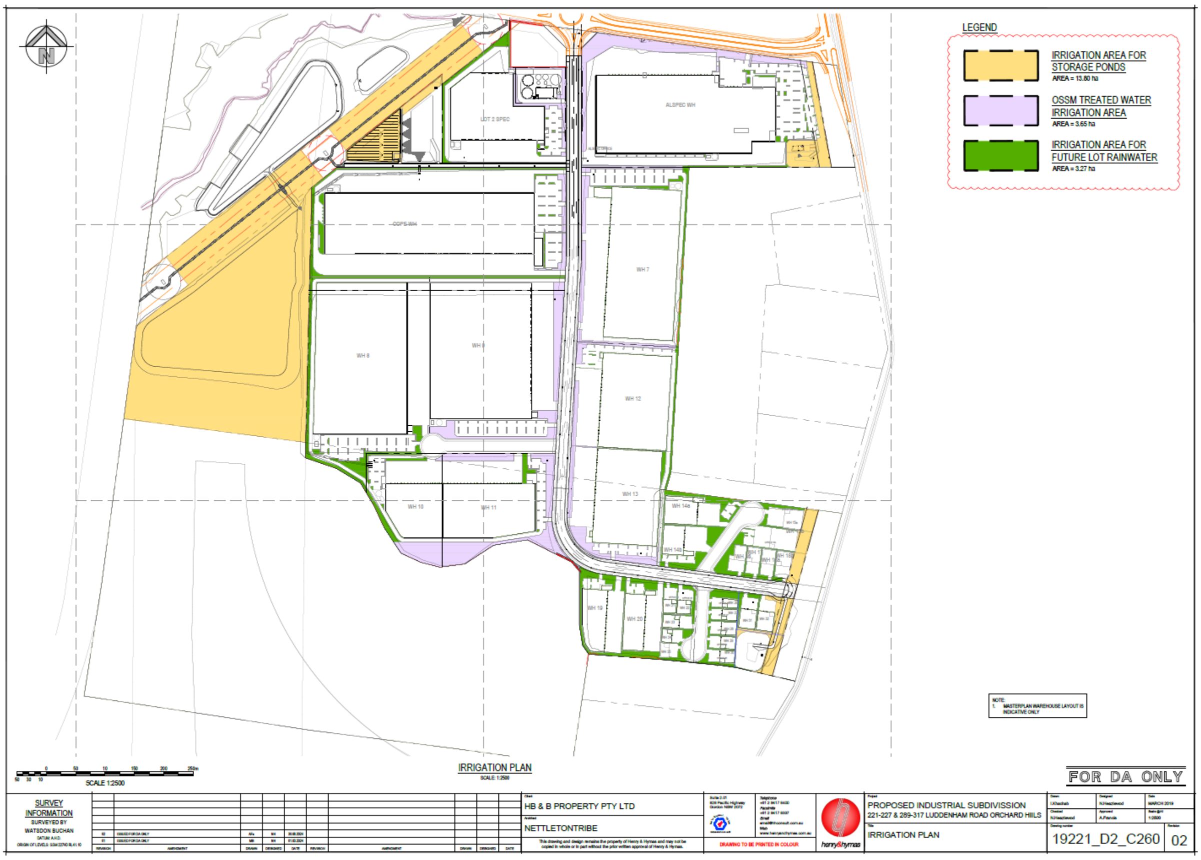

Figure 5-1: ALSPEC Irrigated Area Plan (Henry & Hymas, 2024)

5.2.1. Infiltration

Infiltration across the Project Site was estimated based on the geotechnical United States Department of Agriculture (USDA, 2007) classification of soil type (Core Geotech CG24-0297-A Rev 0, 2024), which designates the local soil hydraulic group as 'D'.

The USDA (2007) details soils within 'group D' have an infiltration rate of 0 to 1.27mm/hour (0 to 13,350.24 mm/year). A median value of 0.635 mm/hour (6,672.12 mm/year) has been adopted for calculations in this report.

The bulk earthwork plan for the Project Site irrigated areas indicates that these areas will remain primarily at current ground levels, with the exception of the flood basin, and this is assumed for all calculations. Notwithstanding, any cut and/or fill placed on top of the natural surface may alter the infiltration rate of the soil and modify the outcomes of the water balance estimate.

Geotechnical drilling and test pits within the location of the flood basin did not intersect groundwater. The underlying soils have a higher clay content, lending themselves to the storage basin development. The higher clay content will somewhat restrict infiltration within the flood basin area, however the water balance (Section 5.3) for the whole site indicates that infiltration rates are below the overall site capacity. Subsoil drains will be installed at the low point of the flood basin to prevent surface ponding and a stormwater pipe will be installed connecting the southern flood basin to the northern flood basin to allow for natural drainage to the north.

The flood storage basin is within the footprint of the Outer Sydney Orbital (OSO) corridor and has been designed to accommodate future development of the OSO as to not negatively impact flood storage capacity. Changes to the Project Site as a result of the OSO development will have minimal impact to the viability of irrigation beneath any future OSO design or to the overall site water balance.

Groundwater was not encountered within geotechnical drillholes or test pits directly underlying areas for irrigation from stormwater. The nearest groundwater encountered occurred within geotechnical drill hole BH01 with a groundwater depth of 2.24 m bgl (36.2 m AHD). Groundwater depth of 36.2 m AHD corresponds to the level of the unnamed fourth order stream that borders the north-west boundary of the site, which may, therefore, act as a natural drain for that part of the site.

Infiltration of rainfall and irrigated stormwater along the north-western irrigated area may also increase the presence of superficial groundwater lenses within the underlying soil profile. Water utilisation by planned landscape plantings, together with discharge through natural processes to the adjacent unnamed fourth order stream to the north-west are considered more likely to maintain groundwater levels, rather than substantially increase them.

5.3. Water Balance

A Project Site water balance was established using data outlined above and is collated in Table 5-1.

Table 5-1: ALSPEC Project Site Water Balance

Water Element	Current Estimated (mm/y)	Upper Estimate (mm/y)
Rainfall (input)	783	783
Evapotranspiration (output)	-700.1 (AET)	-1,206.9 (PET)
Available Irrigation (input)	600	600
Potential Infiltration (output)*	-683	-175
Balance	**0**	**0**

**Note – Potential Infiltration is significantly below the estimated site potential maximum infiltration of 6,672.12 mm/y.*

The water balance (Table 5-1) indicates that while irrigation will be required across the sites (particularly during the vegetation establishment stages), long-term rainfall is likely to be sufficient to support the selected vegetation if chosen appropriately. As potential infiltration rates are relatively high for these sites, however, care needs to be taken to restrict irrigation during wet periods to reduce the potential impact to groundwater levels.

5.4. Irrigation water supply

Henry & Hymas (2024) developed a MUSIC model to help satisfy the water quality requirements of Council.). The described treatment train and water quality outcomes include a stormwater storage basin that will store sufficient and suitable water for irrigation across 13.294 ha of irrigated area. Additional water stored in rainwater tanks across the three catchments will be suitable for irrigation across a total of 3 ha within future lots. Storage across the Project site is therefore adequate for the projected irrigation needs.

6. Management Considerations and Recommended Actions

Potential risk/impacts to groundwater quantity and aquatic GDEs are assessed as low, with a high level of confidence due to available geotechnical bore and test pit results on Site and point source/localised waterlogging of the clay rather than an extensive shallow groundwater lens.

Potential risk/impacts to groundwater quality are also assessed as low, with the exception of the proximity to Terrestrial GDEs along the Unnamed creek to the northwest of site, which results in a moderate classification for this area. Management strategies will include mitigation measures and water quality monitoring will include comparison to relevant recreational guideline values.

It is recommended that the extent and location of potential terrestrial and aquatic GDEs should be confirmed and verified during field-based vegetation surveys. Any confirmed GDEs should be re-assessed for potential impacts, and these should be mitigated at detailed design following approval (if granted).

A summary of groundwater management considerations is provided in Table 6-1.

Table 6-1: Groundwater management actions

Management Issue	Description	Management action
GW01	Impacts to groundwater levels	Monitor for groundwater during site excavations, with specific focus on geotechnical investigation sites BH03 & TP47. Potential impacts at geotechnical investigation sites BH03 & TP47 to be managed through site-specific CEMP.
GW02	Impacts to groundwater quality	Management of temporary sewage systems established onsite for the duration of the Project also pose a risk to surface water quality should spills occur. It is important that Industry Standard spill minimisation and response procedures are followed, which will reduce and minimize any potential groundwater contamination during construction.
GW03	Impacts to groundwater dependent ecosystems	Monitor for groundwater during site excavations within the northwest portion of site, due to impact the high potential Cumberland River Flat Forrest Terrestrial GDE. Potential impacts to be managed through site-specific CEMP.
Irrigation Area	Water balance consideration	Select native grasses that are commonly utilised for rain gardens and bio-filtration beds as they are commonly deep-rooting and have tolerance for extreme wet/dry climates.

7. References

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