



CARABOODA URBAN PRECINCT DISTRICT STRUCTURE PLAN

Engineering Servicing Report
July 2026

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APPENDIX A - DOUGLAS PARTNERS (NOVEMBER 2023). *REPORT ON DESKTOP GEOTECHNICAL STUDY*

1. EXECUTIVE SUMMARY

This report has been prepared by Cossill & Webley Pty Ltd (CW) for the Carabooda Urban Precinct. It summarises the results of a review of the civil engineering aspects which have informed and support the delivery of the structure plan and are related to the future servicing of the developed land.

This report provides details on each major infrastructure type and a servicing strategy for the implementation required for the development of the District Structure Plan (DSP) area.

The engineering review covers siteworks, earthworks, roadworks, stormwater drainage, sewerage, water supply and utility services.

The site is frontal to major strategic infrastructure which lends itself to a development of this scale leveraging on state government and private assets that have already been funded and either constructed or under construction.

The Mitchell Freeway extension to Romeo Road provides a direct road connection to the site and links to the Alkimos Regional Centre and public transport with the Yanchep rail line and Alkimos Station now operational.

The Alkimos Wastewater Treatment plant is within 5km of the site. The 1500mm diameter Alkimos Main Sewer has been extended under the rail corridor to facilitate sewerage flows from land east of the rail where the site is located. The existing Water Corporation Carabooda Water Tank is located within the DSP area and will provide potable water to the development through the extension DN400 distribution main connected to reticulation mains.

The Alkimos Seawater Desalination Plant (ASDP) was announced in May 2022 with enabling works underway and expected to be operational by 2028. A 1600mm diameter watermain from the ASDP will connect to the Carabooda Tank and then south east to the Wanneroo Reservoir with approximately 6,300m of watermain traversing the site. These works are currently underway.

The Western Power Yanchep zone substation is located adjacent to the site at the corner of Wanneroo Road and Romeo Road and will provide for the early stages of the development. Existing 132kVA and a series of 22kVA transmission and distribution lines traverse the site providing good connectivity to the electricity network. When required, the extension of a 132kV transmission line from the existing Pinjar-Neerabup line will be required and new zone substation located at the eastern boundary of the DSP area.

Major gas and telecommunication's infrastructure exist in Wanneroo Road and are at the doorstep of the site.

The site has favourable geotechnical conditions suitable for development consisting of sand and limestone with significant depth to groundwater providing good infiltration. The site topography lends itself to efficient cut to fill earthworks thereby minimising importation and exportation of fill creating affordable land development and reduced carbon emissions.

A staged approach to earthworks and development in areas of the site mapped as Basic Raw Materials (sand and limestone) and that have mining tenements is to be adopted to allow sequential land use and the appropriate extraction and rehabilitation to be undertaken.

The investigation has found the land is well suited to urban development, with the logical progressive extension of infrastructure and base capacity.

2. INTRODUCTION

Cossill & Webley (CW) has been requested by Acumen to prepare an Engineering Servicing Report for the Carabooda Urban Precinct (the Site). The Site is bound by Carabooda Road to the north, and Wesco Road to the south and is situated between Wanneroo Road to the west and Hopkins Road to the east.

The preparation of the Carabooda Urban Precinct District Structure Plan (DSP) has been carried out by a team of consultants, led by CLE on behalf of Acumen and covers an area of 979 hectares. The DSP Concept Plan is depicted in Figure 1 below.

This report summarises the engineering opportunities and constraints for the potential future urban development of the area.

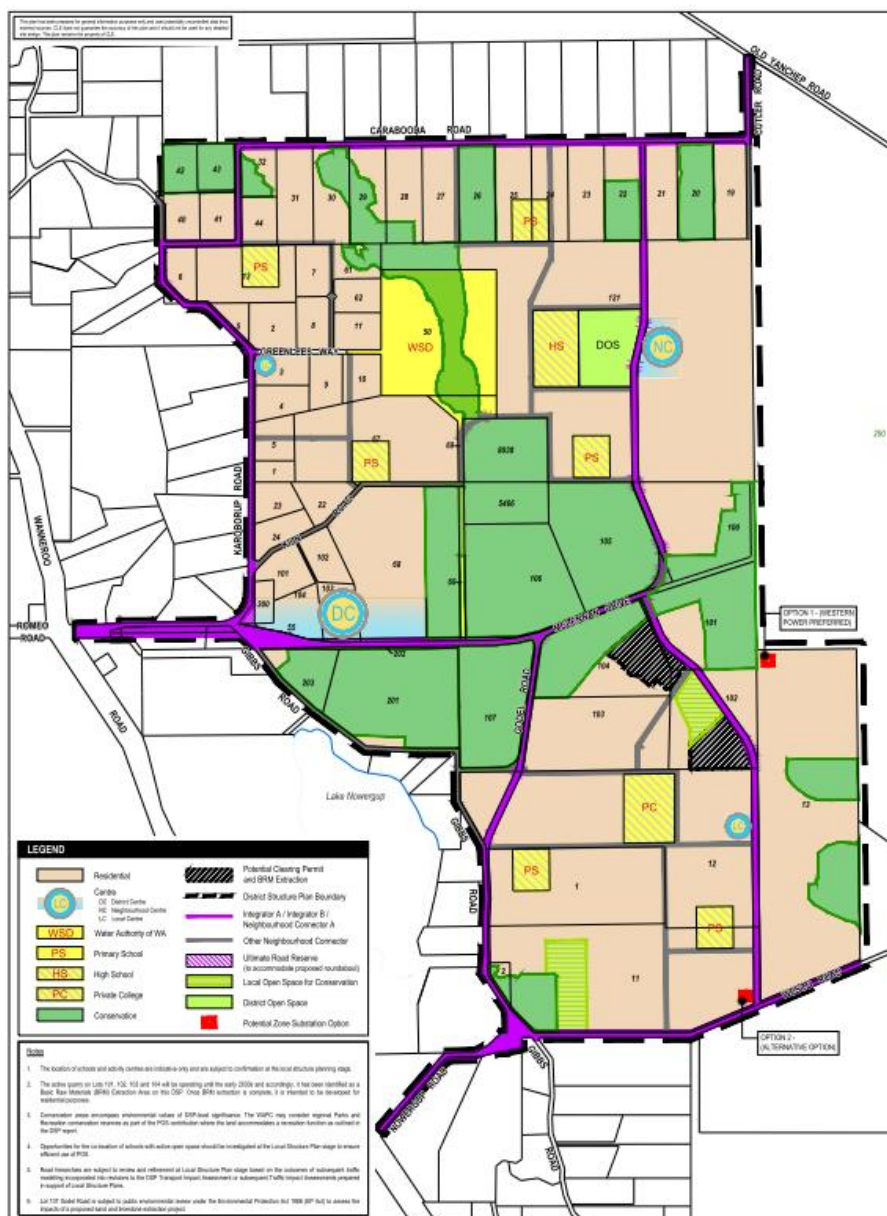


Figure 1: DSP Concept Plan 3742-84L-01 (CLE, 14 July 2026)

3. SITE DESCRIPTION

3.1 Existing Site Uses

The DSP area is situated within the City of Wanneroo, approximately 47 kilometres north-west of the Perth city centre. The Site is predominantly used for agriculture purposes with some areas of the site utilised for extraction of sand and limestone. There is some remnant vegetation across the site, a significant amount of which is retained as shown on the DSP Concept Plan in Figure 1. An aerial view of the site is shown in Figure 2 below.



Figure 2: Aerial Photography (MNG Access)

3.2 Existing Topography

Based on aerial contour data obtained from MNG, the Site generally grades from east to west, ranging in elevation from 74m AHD along the east of the site to 20m AHD along the west of the site, averaging a 2% gradient across the site in an east-west direction. Existing surface contours provided by MNG are presented in Figure 3 below:

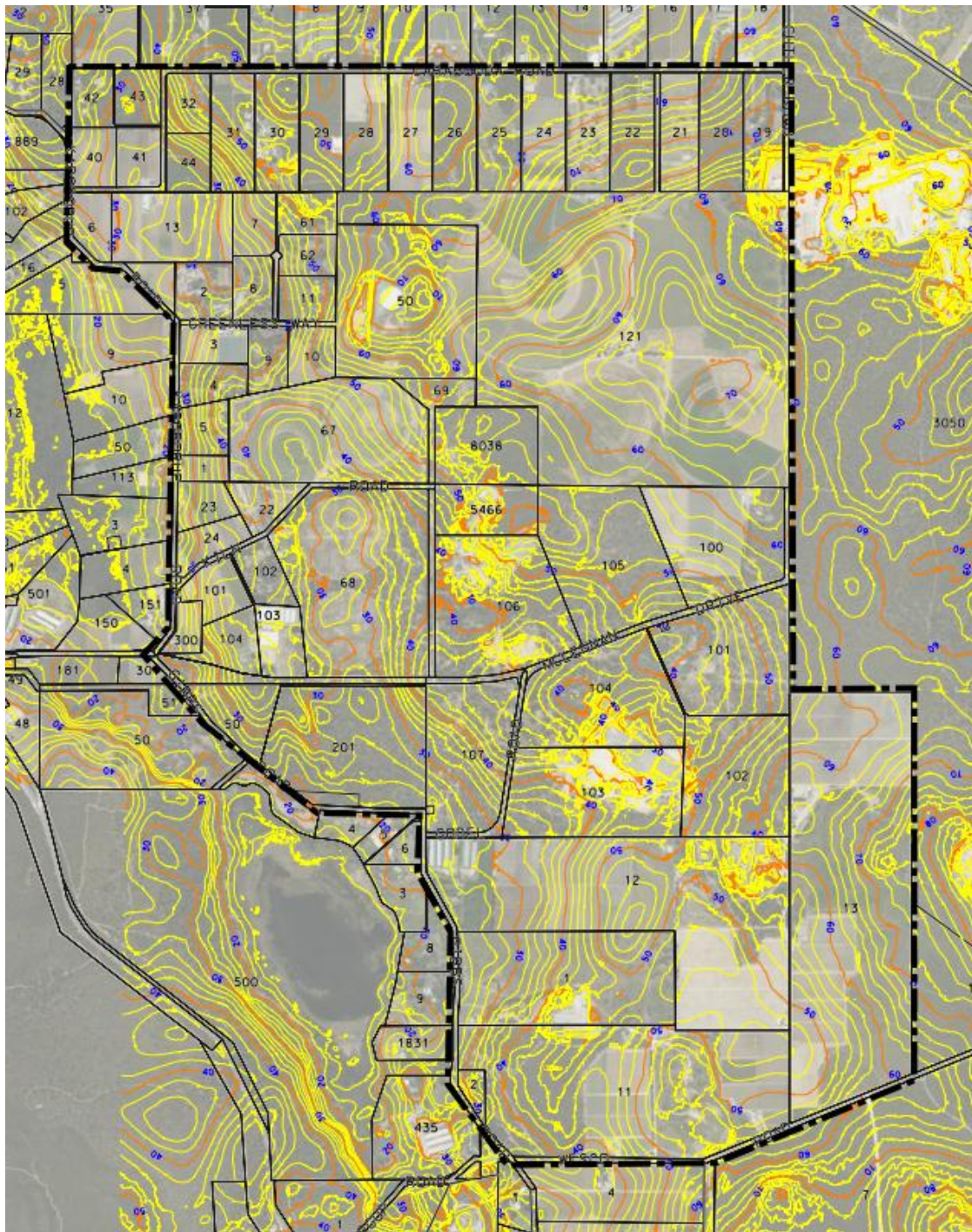


Figure 3: Existing Contours (MNG)

4. SITEWORKS & EARTHWORKS

A desktop Geotechnical Study has been prepared for the Site by Douglas Partners, which confirms the majority of the Site is covered with SAND (S7) and LIMESTONE (LS1 & LS2), which is well suited to urban development, and disposal of runoff via soakage. The report titled *“Carabooda Urban Precinct, District Structure Plan Pre-Lodgement Advice – Report of Desktop Geotechnical Study”* is included in Appendix A.

The sand and limestone is expected to form a suitable structural fill material, and as such could be considered for re-use as a fill source within this site or could be exported to other development sites.

Douglas Partners has confirmed that a site classification of ‘Class A’ should be appropriate for new residential lots within the areas of the site underlain by sand and rock, in accordance with AS 2870-2011 “Residential Slab Footings”.

Groundwater levels grade from RL24m AHD along the eastern boundary of the Site to RL12m AHD along the western boundary. The site has significant clearance to groundwater levels, well suited to affordable land development as a result of efficient cut-to-fill earthworks and assisting with the disposal of stormwater runoff generated from roads and lots on-site.

The area is mapped as having no known risk of actual or potential Acid Sulfate Soils being present at depths up to 3 metres below natural surface levels, again confirming the ease of development and reduced civil construction costs when compared with other parcels east and south of the Perth metropolitan region.

We anticipate future earthworks would comprise:

- Stripping of all vegetation, topsoil and deleterious materials beneath development areas;
- Excavation and export of basic raw materials sand and limestone to other development sites;
- Compaction of natural subgrade soils;
- Cut and fill of sand soils to achieve appropriate design levels; and
- Compaction of all development areas in preparation for future built form construction.

4.1 Karst Risk

The majority of the site is within a low karst risk area as mapped on Figure 1 of the City of Wanneroo Local Planning Policy 4.13, an excerpt of which is presented below in Figure 4.

An area long the western edge of the Site is mapped as medium risk with a small area to the south west of the site and north west of the site mapped as high risk. The management of karst risk is outlined in Douglas Partners report included in Appendix A.

Douglas Partners has confirmed that based on the available desktop information, the risk of damage to proposed residential houses from ground subsidence due to karst features is considered to be low across the vast majority of the site, albeit some medium and high risk areas are noted in the available mapping of the site.

As planning progresses, more detailed karst risk geotechnical investigations will be undertaken to identify the actual karst risk across the Site. If any significant cavities are identified during further geotechnical investigations, this would need to be considered with the design of the overall development possibly incorporating these in POS areas.

Prior to commencement of earthworks, a karstic features management plan would be prepared which identifies karst risk areas, and provides monitoring and mitigation measures during the works.

During bulk earthworks construction, additional geotechnical investigations would be undertaken to de-risk the future development.

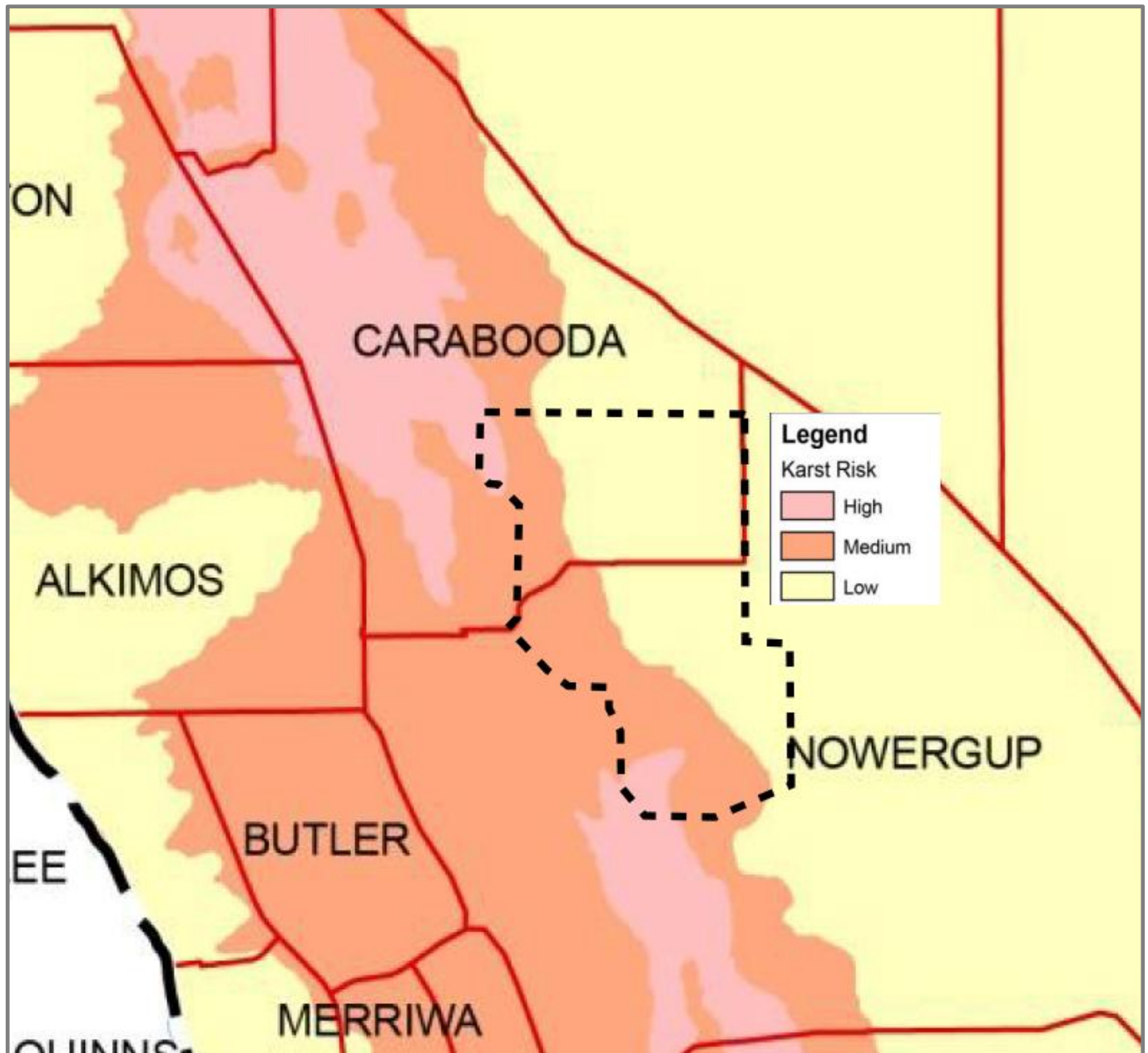


Figure 4: Karstic Features Risk Zones in the City of Wanneroo Excerpt (City of Wanneroo)

4.2 Basic Raw Material

State Planning Policy 2.4 – Planning for Basic Raw Materials has identified the area as a high priority for the extraction of high grade sand and limestone. An excerpt of the Basic Raw Materials mapping is presented below in Figure 5.

A review of the Site confirms that some areas of the limestone deposits depicted below have previously been mined for limestone.

At future stages of the planning process, we intend to liaise with the Department of Mines, Industry Regulation and Safety to develop a staged approach to extraction of the sand and limestone resource ahead of future land development. This strategy has been successfully implemented in a number of regions within the Perth Metropolitan Region and ensures the finite BRM resource is capitalised, whilst developing efficient earthworks strategies to support future urban development.

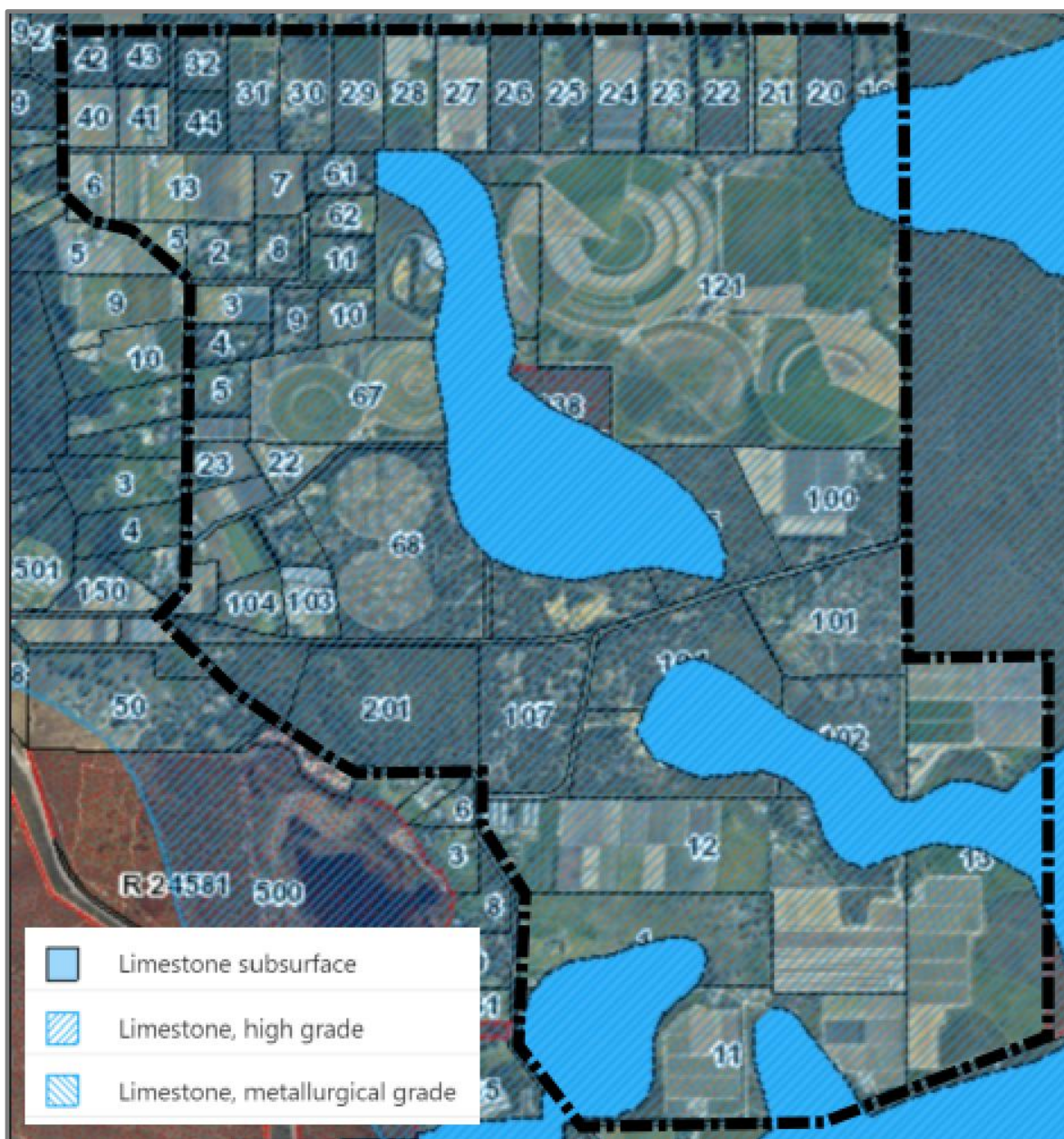


Figure 5: Basic Raw Materials (Geological Survey of WA)

4.3 Mining Tenements

Figure 6 below depicts one existing mining tenement within the planning area. Licence P70/1731 is a prospecting licence lodged in January 2019 for Limestone and Sand Prospecting. This licence is still pending.

As per Section 3.2 of this report, we recognise State significance of the limestone and sand BRM present on-site. We intend to liaise with the existing tenement holder to understand how the BRM extraction can be staged to support sequential urban development.

There are a number of areas in Perth where we have worked with DMIRS to develop finished design levels that support the extraction of BRM, whilst also preparing the site for future urban development.

We understand there will be a need to provide suitable buffers to mining extraction, which we intend to deal with through the development of a staging plan that responds to these buffers.



Figure 6: Existing Mining Tenement (MNG Access)

5. TRANSPORT

5.1 Traffic and Transportation

An assessment of the traffic and transport planning for the DSP has been undertaken by PJA.

The results of this assessment include a recommended hierarchy for the roads within the DSP and the future subdivision development together with recommendations for public transport services, pedestrian and cyclist facilities.

In all cases the engineering review has taken account of the recommendations outlined in the PJA report and they will be incorporated into future detailed subdivision planning and design.

5.2 Regional Roads

The Site is strategically located near high level transport infrastructure depicted in Figure 7 below and summarised as follows:

- The Site is two kilometres east of the Mitchell Freeway alignment. The Freeway has recently been extended to Romeo Road with a western link to Marmion Avenue and eastern link to Wanneroo Road.
- There are existing road connections to Wanneroo Road located approximately one kilometre west of the Site via Karaborup Road and Nowergup Road.
- State road infrastructure planning depicts the future alignment of the Whiteman Yanchep Highway east of the Site which will provide good regional linkages from the Site to the broader Perth Metropolitan region and beyond.
- The Alkimos Town Centre and Railway Station is approximately five kilometres west of the Site. This recently completed rail link provides a connection to the Perth CBD and Yanchep to the north.

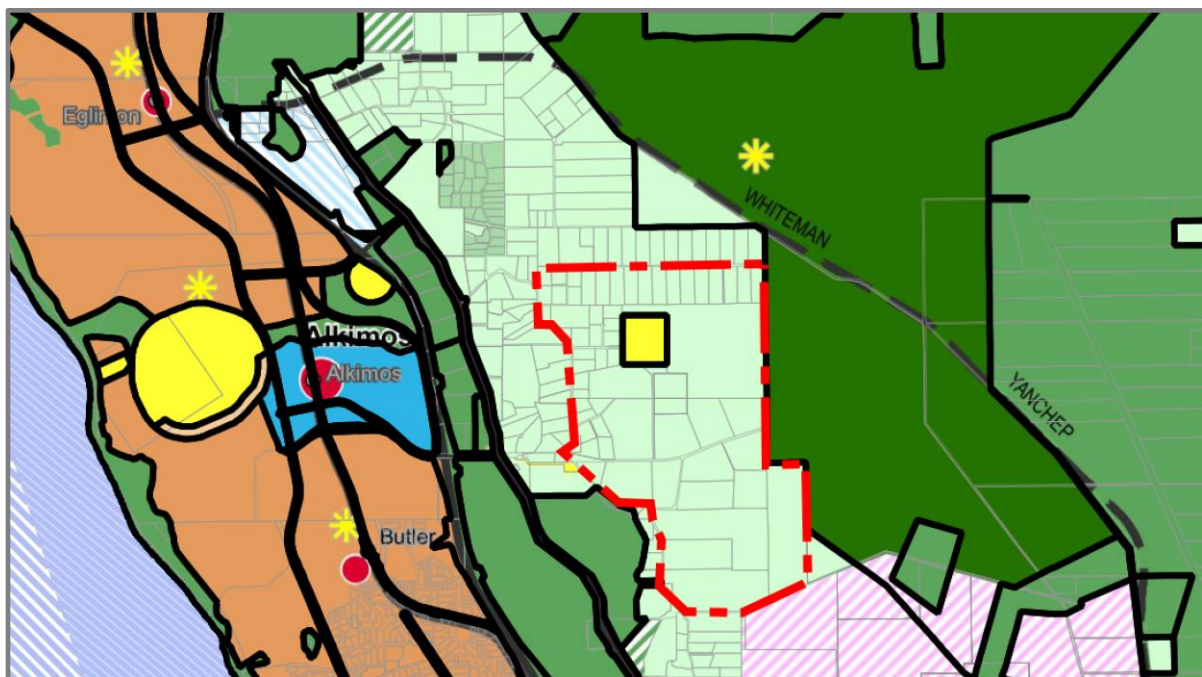


Figure 7: Sub Regional Framework (DPLH, 2018)

5.3 Development Roads

The DSP comprises a network of development roads including Integrator A, Integrator B and Neighbourhood Connectors running north to south and west to east, and local access roads as shown in Figure 1.

In all cases the road cross-sections will be designed to cater for utility services, on standard verge alignments, street trees, parking embayment's where appropriate, off-street and on-street cycling lanes in accordance with the overall pedestrian and cycling network.

The engineering design of roads will be carried out to comply with the Department of Planning's Liveable Neighbourhoods recommendations for design speeds and sight distances and with the requirements of the City of Swan. Roadworks will generally consist of kerbed and asphalted pavements.

5.4 Path Network

Footpaths will be provided in accordance with Liveable Neighbourhoods and the City of Wanneroo standards and will consist of one path on every road, and dual use paths on Integrator Roads and Neighbourhood Connector roads.

5.5 Public Transport

The State Government's METRONET included an extension of the Yanchep Rail Extension from Butler Station to Yanchep Station and included a train station at Alkimos within 4km of the Site. It is envisaged bus services will run from Alkimos Station to the DSP area as the area is occupied by residents and demand justifies the service.

6. DRAINAGE STRATEGY

6.1 Urban Water Management

A District Water Management Plan will be prepared as a basis for ongoing development to ensure that appropriate allowances are made for total water management including the minimisation of scheme water use and the maximisation of recharge of stormwater runoff.

It is anticipated that runoff within future residential allotments will be contained on-site. Stormwater disposal will be via soakwells or other infiltration facilities which form part of the building and private open space development.

Drainage from public roads and lanes can be managed in a number of ways using a Water Sensitive Urban Design (WSUD) approach. The Site has permeable soils with good infiltration properties and therefore infiltration at source via swales within or adjacent to road reserves, via gully pits with permeable bases and tree pits is favourable.

Runoff from storms up to 1 in 5 years ARI would be conveyed via an underground pipe system to low point infiltration basins consistent with the requirements of the City of Wanneroo. The dispersion of stormwater disposal will maximise the area of recharge down through the soil profile to the shallow aquifer, thereby, maximising the potential for nutrient stripping and water quality improvements.

7. WASTEWATER

The Site is located within the Water Corporation licensed area for operating sewerage services. At full development, it is anticipated the wastewater flow from the entire DSP area will be in the order of 124 L/s GSDF.

A strategy for servicing of the entire DSP was developed by CW and tabled with Water Corporation. Based on the preliminary earthworks across the DSP area and site constraints, a total of six wastewater pumping stations are required for full development. It is anticipated that these pumping stations would be delivered under the Water Corporation's capital works program via the typical Developer Constructed Works Agreement (DCWA) process subject to Government first allocating funding for headworks infrastructure.

The wastewater pumpstation at the western edge of the Carabooda DSP will transfer all flows in a western direction ultimately discharging to the Alkimos Main Sewer (AMS) that has already been constructed under the Yanchep rail. Water Corporation confirmed that Lot 204 Gibbs Road is owned by Water Corporation and would be the site of the wastewater pumping station that would receive all wastewater flows from the Carabooda DSP. The available lot area of approximately 1.5ha is shown in Figure 6 below.

This site is planned by Water Corporation to cater for the ultimate Carabooda Type 500 transfer wastewater pumping station which will service the greater Carabooda area and surrounds.



Figure 8: Water Corporation Site Lot 204 Gibbs Road (MNG Access, 2026)

The pumped flows from the Carabooda DSP area will discharge to the existing 1500mm diameter AMS that has been constructed just east of the Yanchep Rail line as part of the Alkimos Town Centre development. In discussions with Water Corporation, the discharge will be via a vortex chamber that will be located offline to the main sewer.

The AMS has been constructed beneath the Yanchep rail line and Marmion Avenue and terminates in the Water Corporation Wastewater Treatment Plant Buffer. As part of the Alkimos Town Centre works by DevelopmentWA they will be funding a Type 40 wastewater pumping station as the western end of the AMS to then pump flows into an existing 375mm gravity sewer that transfers flows to the Quinns Main Sewer. Figure 9 below shows this arrangement.

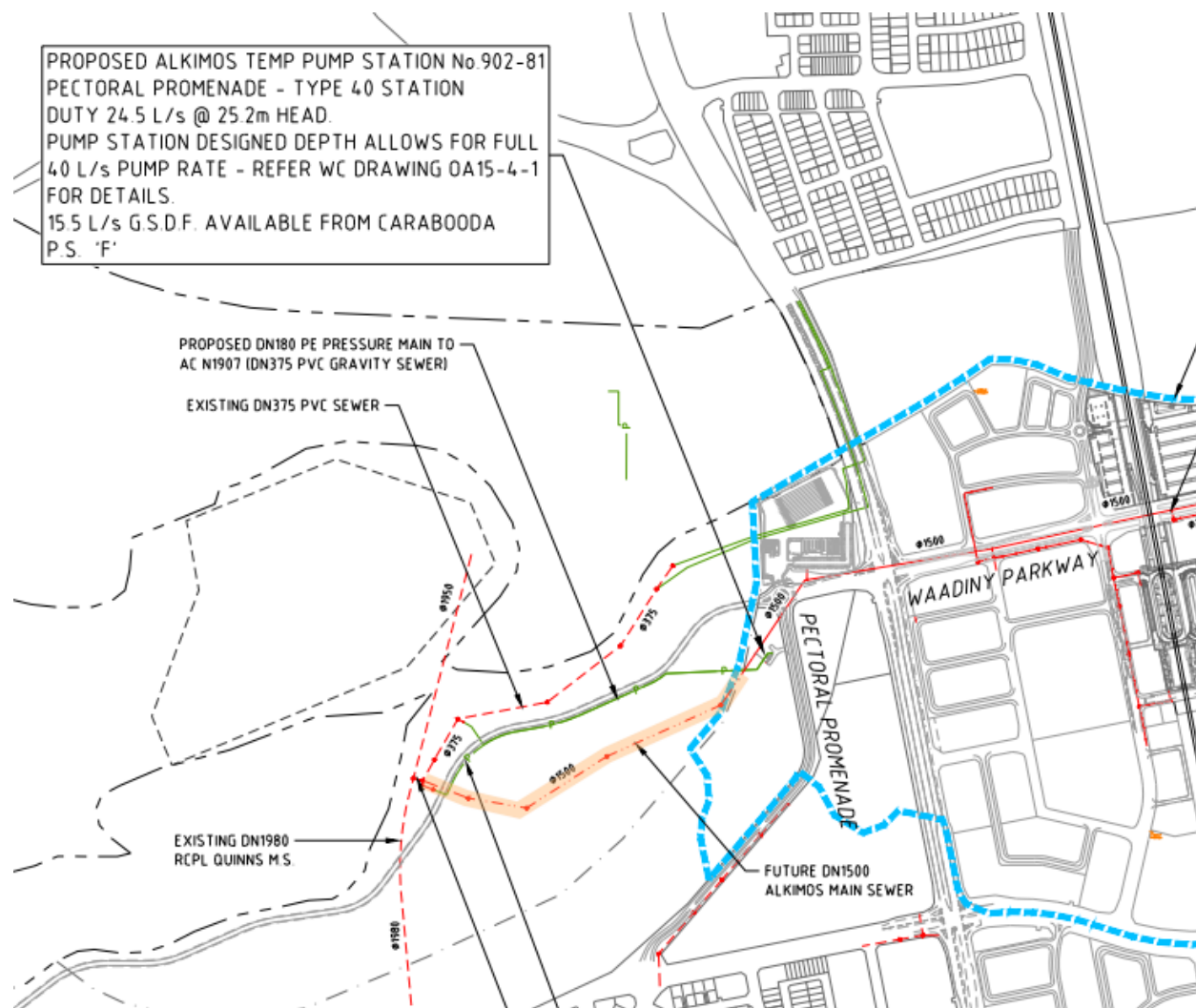


Figure 9: Wastewater Infrastructure in WWTP Buffer (Cossill and Webley, 2026)

The Type 40 wastewater pumping station will have capacity to cater for the early stages of the Carabooda DSP area. Once the capacity of the Type 40 wastewater pump station has been reached, the AMS (Section 2) would need to be extended to the Quinns Main Sewer. This is part of the Water Corporation's long term strategy and development in the Carabooda DSP area may bring forward the need for this infrastructure.

The extension of the existing 1500mm diameter AMS in an eastern direction towards the Mitchell Freeway will occur as orderly development of the Alkimos Town centre occurs. The AMS capacity is approximately 1400L/s and is intended to cater for regional flows that are being transferred from future development areas to the east. The Carabooda flows will make up less than 10% of the capacity of the AMS.

8. WATER SUPPLY

The Site is located within the Water Corporation licensed area for provision of a potable water supply.

There is an existing 60ML water storage tank (Carabooda Reservoir) on Lot 50 located within Water Corporation Public Purpose Reserve and an associated 1200mm diameter water pipeline from this tank site to Butler to assist with distribution of water supply to the land west of the Mitchell Freeway. The tank has a top water level of 81.60m AHD.

Figure 10 below depicts the alignment of the existing 1200mm diameter watermain and Greenlees Way water tank.

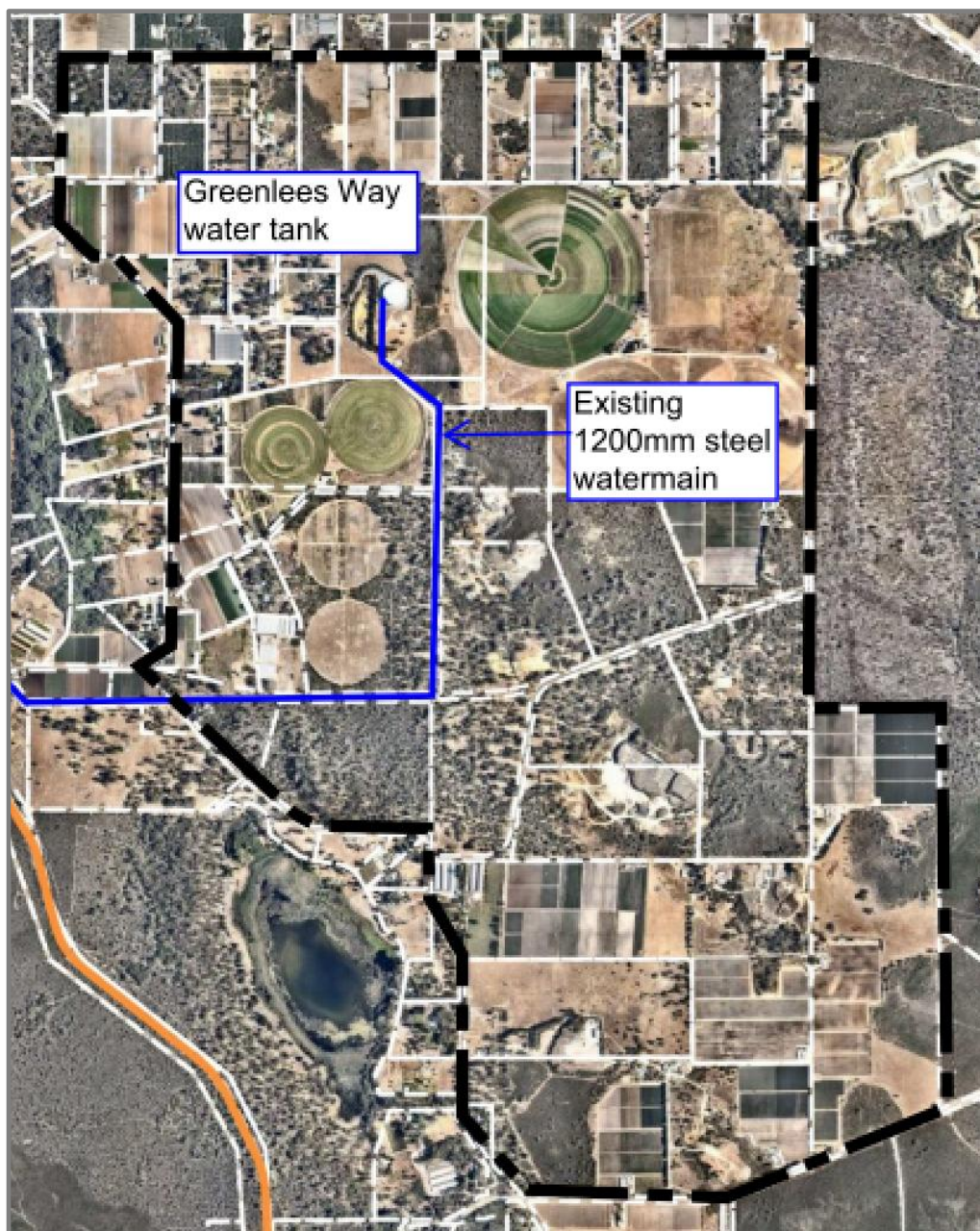


Figure 10: Existing Water Infrastructure (MNG Access)

Existing ground levels across the Site vary substantially. There are elevated regions in the north and south-east of the Site, reaching approximately RL 70m AHD, grading to a low of approximately RL25m AHD at the north-west end as depicted below.

Water Corporation has confirmed the Carabooda DSP area can be serviced by a 400mm diameter water distribution main that is fed from the existing Greenlees Way water tank. The construction of the distribution main will occur to coincide with each stage of development. The water distribution main is large enough that is classified as 'headworks' and therefore it is anticipated that the watermain would be delivered under the Water Corporation's capital works program via the typical Developer Constructed Works Agreement (DCWA) process subject to Government first allocating funding.

Part of the eastern section of the DSP area are beyond the maximum elevation that the existing Greenlees Way water tank can service. Water Corporation has advised that these areas will require a high-level tank to ensure adequate pressure is achieved. Water Corporation long term planning is to duplicate the existing Greenlees Way water tank to service the greater regional area as development increases.

9. ELECTRICAL POWER SUPPLY

The existing Yanchep Zone Substation located on the corner of Wanneroo Road and Romeo Road currently services land east and west of the Site. In discussions with Western Power, the Yanchep Zone Substation is currently being upgraded with an additional transformer being added.

There are 132kVA overhead power lines located along the western and northern edge of the Site as depicted below in Figure 11. There are also a series of 22kV overhead and underground power lines traversing the Site as depicted below.

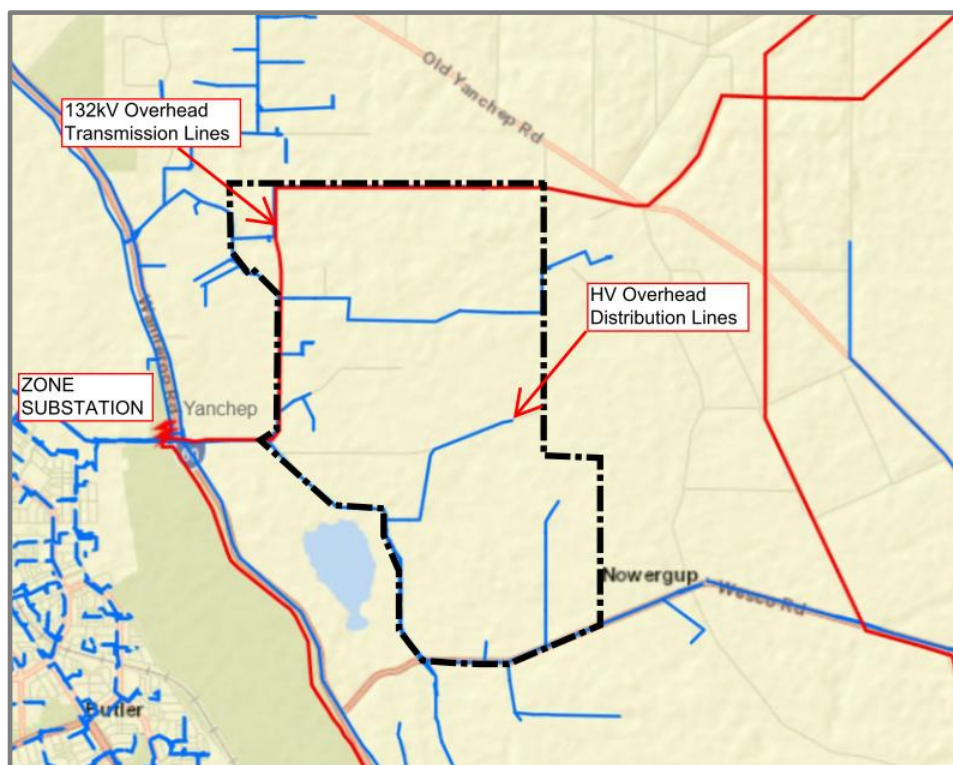


Figure 11: Overhead Power Lines and Zone Substation (Western Power Network Mapping Tool, 2026)

From discussions with Western Power, the first stages of development will be serviced from the existing Yanchep Zone Substation with an extension of a 22kV feeder cable. The installation of HV cabling, transformer and switchgear required to service the development will be constructed progressively with each stage of development with the Developer funding the works and receiving HV refunds through the Western Power HV Pool mechanism subject to Government first allocating funding.

Medium to Long term development of the Carabooda DSP area will require a zone substation to be installed. A 132kV transmission line will need to be extended from the existing Pinjar-Neerabup line to service the zone substation. The area for the zone substation site is to be 1.8ha. The zone substation will have sufficient capacity to service the entire Carabooda DSP area.

There are two potential zone substation sites identified in the DSP Concept Plan which are shown below in Figure 12 and finalising site selection and tenure is an immediate priority. Depending on which site is agreed upon, the transmission line length varies from 2.1km to 3.1km as shown below. Exact routes for the transmission lines will be subject to site survey to optimise the design and minimise clearing works.

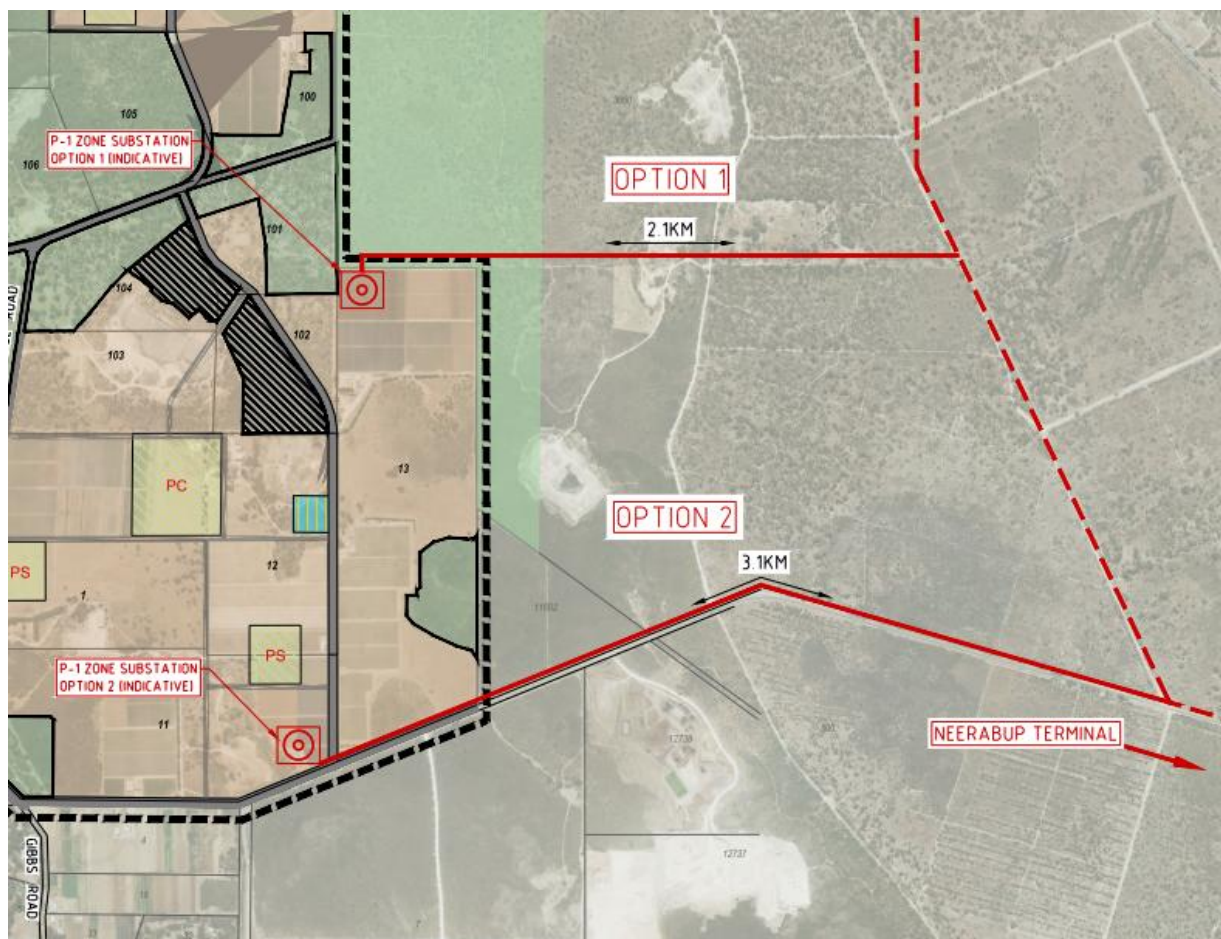


Figure 12: Potential Zone Substation Sites and Transmission Line Routes (Cossill and Webley, 2026)

10. GAS SUPPLY

Atco Gas has a high pressure gas network in the vicinity of the site. Therefore, we do not anticipate there will be any gas supply capacity issues. Some extension from the existing network will be required to bring gas to the Site.

11. TELECOMMUNICATIONS

The telecommunications reticulation in close proximity to the development and can be readily extended from the existing network in Wanneroo Road.

12. CONCLUSION

Based on our assessment of the existing services in the vicinity of the Site and following discussions with the various servicing agencies, we consider that infrastructure could readily be extended to service the development. There are no engineering impediments to the development, and co-ordination and co-operation with the relevant Service Authorities will be undertaken in further detail as the development progresses.

APPENDIX A

Carabooda Urban Precinct, District Structure Plan
Pre-Lodgement Advice - Report on Desktop
Geotechnical Study, Douglas Partners (November
2023)



Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Desktop Geotechnical Study

Carabooda Urban Precinct
District Structure Plan Pre-Lodgement Advice

Carabooda, WA

Prepared for
Carabooda Landowners Pty Ltd

Project 219549.00
November 2023

Integrated Practical Solutions



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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Desktop Geotechnical Study

Carabooda Urban Precinct, District Structure Plan Pre-Lodgement Advice

Carabooda, WA

1. Introduction

This report presents the results of a desktop geotechnical study undertaken for the Carabooda Urban Precinct project, to provide advice for the District Structure Plan Lodgement. The geotechnical desktop study was commissioned in an email dated 21 December 2022 by Nick Perrignon of Acumen Project Management Pty Ltd on behalf of Carabooda Landowners Pty Ltd, and was undertaken in accordance with Douglas Partners' proposal P219549 dated 29 November 2022.

With reference to the CLE plan in Appendix A, it is understood that the proposed study site comprises an approximate area of 944 ha as indicated by the 'Indicative Urban Investigation Boundary', within which a land parcel of 660 ha consists of the 'Carabooda Urban Precinct'.

The objectives of the desktop study were to assess relevant existing information and subsequently provide some preliminary comments relating to geotechnical matters, including:

- the geology and anticipated soil conditions;
- geotechnical opportunities and constraints, with a recommendation on the suitability of the site to support urban development;
- the likely site classification based on AS 2870-2011, which should be achievable for new residential lots at the site;
- a desktop assessment of karst risk, and if there is karst potential, how the risks can be assessed and managed at the engineering design and construction stages;
- suitability of existing limestone and sand present on-site for use as structural fill for future development or export from site; and
- the suitability of in-situ soils within the site for disposal of stormwater runoff from roads and lots.

The scope of work undertaken for this geotechnical desktop study included:

- a review of published information on regional geology and groundwater;
- a review of previous geotechnical investigation reports and other associated information held by Douglas Partners on nearby sites;
- an examination of a selection of historical aerial photographs of the area available from the Department of Land Administration (Landgate); and
- a site inspection by an experienced geotechnical engineer.

2. Review of Desktop Information

2.1 Existing Published Geological Information

An extract of the Yanchep 1:50 000 Environmental Geology sheet is presented as Drawing 1, Appendix C. The geological sheet indicates that shallow sub surface conditions across the site consist of the following units:

- SAND (S7) -** Sand derived from Tamala Limestone (Qts), pale and olive yellow, medium to coarse grained, sub-angular quartz with a trace of feldspar, moderately sorted, of residual origin. Indicated to be present across approximately 83% of the site.
- LIMESTONE (LS1) -** light yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin. Indicated to be present across approximately 13% of the site.
- LIMESTONE (LS2) -** light yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin, abundant karsts. Indicated to be present across less than 4% of the site.

On the northern boundary of the site, an isolated area of Swamp Deposits (Cps) comprising PEATY CLAY is indicated to occur, with similar materials identified beyond the west and south of the site boundaries. The peaty clay is an organic soil, described as dark grey and black with variable sand content, of lacustrine origin.

The ground conditions within boreholes drilled within, and in close proximity to the site, as displayed on the 1:50,000 Geology map sheet, indicate that the Sand unit (S7) to be between approximately 5 m depth and over 40 m depth, at the borehole locations.

2.2 Existing Groundwater Information

Information available from the Perth Groundwater Atlas indicates that the regional groundwater level at the site in May 2003 (i.e. near seasonal low levels) varied between approximately RL 12 m AHD on the western boundary of the site to approximately RL 24 m AHD on the eastern boundary. The Atlas also provides some estimated maximum groundwater levels, which suggest maximum levels of approximately RL 16 m AHD on the western boundary of the site to approximately RL 29 m AHD on the eastern boundary. LiDAR data provided for the project indicates existing ground surface elevations of approximately RL 20 m AHD near the western site boundary, generally increasing in elevation to the east, with high points of approximately RL 50 m to RL 60 m AHD.

The above published information is shown as light blue contours in Drawing 2, Appendix C, for the seasonally low groundwater levels, overlain on the LiDAR surface level contours.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

2.3 Acid Sulfate Soil (ASS) Risk Mapping

Published acid sulfate risk mapping indicates that the majority of the site (99.7%) is mapped as 'no known risk of acid sulphate soils occurring within 3 m of natural soil surface' – depicted as green shading in Drawing 3, Appendix C. An isolated zone of 'high to moderate risk of acid sulphate soils occurring within 3 m of natural soil surface' is indicated to occur on the northern boundary of the Urban Investigation Area – depicted as the red area in Drawing 3, and covering approximately 0.3% of the site area. This high to moderate risk area coincides with the area of swamp deposits noted in Section 2.1, above.

2.4 Karst Features

Karst features are erosional landforms occurring within calcareous rock (limestone), and may include caves, dolines and shallow holes. The features form over long periods of time by the dissolution of the carbonate minerals of the limestone by acidic groundwater movement and percolating surface water. Major cavities generally form at or near the water table level (which may have varied over geological times).

As outlined in Section 2.1, the Yanchep 1:50 000 Environmental Geology sheet indicates that the development area is underlain by Tamala Limestone and associated residual sand ('sand derived from Tamala Limestone'). The geological sheet identifies two units of Tamala Limestone on this site, consisting of the LS1 and LS2 units. The LS1 unit is described as including common, but small-scale solution cavities and fissures. The LS2 unit is associated with abundant karst features including caves, dolines and swallows. With reference to Drawing 1, the geological mapping indicates the presence of the LS2 unit covering less than 4% of the site in the south-west corner, and the north-west corner.

The City of Wanneroo Local Planning Policy 4.13 provides a map with an indication of karstic feature risk zones. An excerpt from this map (Drawing 4, Appendix C) indicates that the majority of the project site (approximately 69% by area) is within an area of low karst risk, with an area of approximately 28% in the western part of the site identified as medium risk. High risk areas are located in the south-western corner and on the north-western site boundary, are associated with the mapped LS2 limestone unit discussed previously, and covers less than 4% of the total site area.

2.5 Historical Aerial Photography

An examination of a selection of historical aerial photographs of the area available from the Department of Land Administration (Landgate) and provided for the project by MNG has been undertaken to determine changes in land use and other observable features. Extracts of the aerial photographs provided by MNG included in the review are provided in Appendix D.

Table 1: Summary of Historical Aerial Photographs

Year	Site Features
1965	The site mostly comprises areas of undisturbed bushland and partially cleared land, likely for pastoral use. Cleared areas with possible market garden crops are evident along the western site boundary in the southern and western parts of the site. Two structures, inferred to be houses, are

Year	Site Features
	present in south-western corner of site. An area of possible ground disturbance in the central part of site.
1975	Further clearing has occurred across the site, with tracks and fence lines marking several lot boundaries. Crops present in southern and north-eastern part of site. Small scale farming and structures along northern site boundary. Ground disturbance in central area of site.
1985	Some expansion of farming/cropping activities. Additional isolated structures present across site. Expansion of a disturbed area in the central part of the site, likely material extraction/quarry. Ground disturbance in north-eastern site corner, possible material extraction/quarry. McLennan Drive visible and possibly including a sealed surface. Several unsealed roads evident across the site.
1995	Expansion of market garden areas. Large scale turf farming with pivot type irrigation in north-eastern part of site. Numerous structures associated with farming activities and semi-rural residential properties. Several material extraction sites in the central, south-east and north-east. Pockets of bushland remain. Several sealed roads.
2005	Expansion of material extraction/quarry sites. Slight expansion of farming areas, in particular into south-eastern part of site. Large lot in western part of site stripped to bare soils. Further sealing of roads.
2015	Expansion of turf farming land-use, into western part of site. Slight expansion of small scale farming areas. Large water tank and sealed access road, in central-northern part of site.
2022	No significant changes from 2015.

2.6 Previous Geotechnical Investigations

Douglas Partners has undertaken several investigations in the general area and within the same geological units within which the site lies, as indicated in Drawing 5, Appendix C. Our experience largely confirms the geological mapping in the general area, with previous investigations typically encountering sand and limestone at shallow depths, overlain by a thin layer of sandy topsoil.

The results of the numerous geotechnical investigations in the region, and within the same geological units have typically determined that the ground conditions such as evident across the subject site are suitable for urban development.

Furthermore, Douglas Partners has carried out geotechnical inspection services during earthworks construction of residential developments within the vicinity of the site, where ground conditions similarly comprised sand and limestone. Based on this experience, it is considered that the ground conditions are readily developable for urban land-use, with several earthworks contractors within the local industry highly experienced in cut and fill earthworks for typical sand and limestone ground conditions.

3. Site Visit

An inspection of the site was undertaken by an experienced Douglas Partners geotechnical engineer on 5 December 2022 and 22 February 2023. During the visit, a walk-over survey of several areas within the site was undertaken, with particular emphasis on each of the various geological units indicated to be present in Section 2.1, and areas of differing karst risk as indicated in Section 2.4. The survey-walk over allowed observations of the surficial ground conditions and general site features, as outlined below.

The site comprises a gently undulating landform with low hills and ridges, and includes area of bushland, market gardens, turf farming, limestone quarries and rural residential properties, as indicated in Photos 1 to 3 below.



Photo 1: Remnant bushland

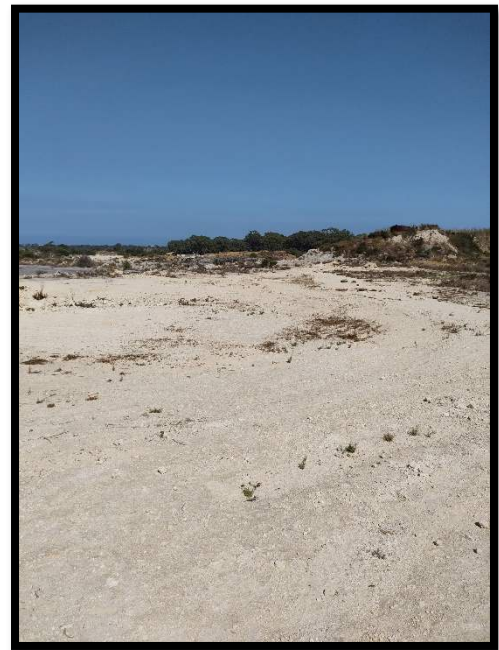


Photo 2: Limestone quarry



Photo 3: Market gardens

The ground conditions visible at surface during the visit generally corroborate the geological mapping and Douglas Partners' expectations for the site. Limestone outcropping was observed in the south-western corner of the site, which is mapped as the Limestone unit (LS2), as evident in Photo 4, below. Karst features such as caves which can occur within this unit, were not observed during the site visit, although the nature of the limestone outcrops in this area of the site are indicative of the landforms in which karst features may be present.



Photo 4: Limestone outcrops

Photos 5 and 6 indicate the presence of limestone in a quarry area in the central part of the site, which is mapped as Limestone unit (LS1). The exposed limestone faces were estimated to be of low to medium strength, and the rock in this area has apparently been utilised for limestone block cutting.



Photos 5 and 6: Exposed limestone

The surficial soils across the majority of the site comprise pale grey and light brown sand, as typical for the Sand unit (S7), indicated to be present in the geological mapping. Photos 7 to 9 indicate the sand conditions observed within the site. Limestone boulders and cobbles were highly prevalent across the surface of the site, and were observed near surface in shallow cuts across the site, as present in the centre of Photo 8. These observations across the sandy parts of the site indicate the presence of shallow limestone in some areas.



Photo 7: Sand soils



Photo 8: Sand soils with limestone

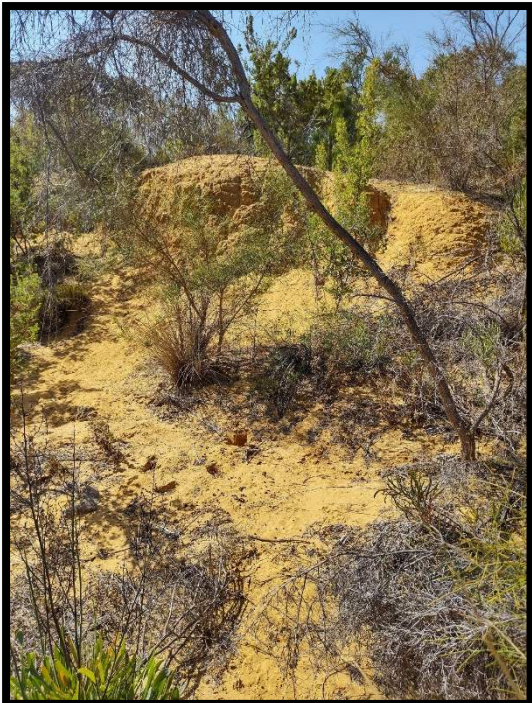


Photo 9: Sand soils near limestone quarry

4. Site Suitability and Geotechnical Comments

The results of the desktop study indicate that from a geotechnical perspective, the site is considered suitable for urban development, with the geological conditions suitable to support housing. The following opportunities and constraints should be considered:

- The vast majority of the site is anticipated to be underlain by sandy soils and limestone rock, which should form a suitable foundation material for urban development, subject to typical site preparation during earthworks, as outlined further below.
- The suitability of the available materials at this site forms a significant opportunity to assist with the site development. The sand and limestone is expected to form a suitable structural fill material, and as such could be considered for re-use as a fill source within this site or for other development sites, following some verification assessment. The site should be readily suitable for urban development, following the conclusion of material extraction activities.
- It is anticipated that a site classification of 'Class A' should be appropriate for new residential lots within the areas of the site underlain by sand and rock, in accordance with AS 2870-2011.
- It is noted that large parts of the site have been historically cleared of bushland and trees, thus excluding the requirement and management of vegetation clearing during earthworks in those areas. In present farming areas including turf farms and former market garden zones, it is possible that the upper zone of the shallow soils has been disturbed and contains a slightly elevated organic content, requiring some specific consideration during design and construction phases. However, such ground conditions are typically readily managed during civil design and earthworks for residential developments, and therefore should be considered to form at worst a possible minor constraint.
- The occurrence and distribution of peaty soils and other organic soils associated with swamp deposits may pose some geotechnical constraint on development of these areas, noting these areas are anticipated to be few, if any, and small (approximately 0.3% of the site area) within the boundaries of the site (geological unit 'Cps' on Drawing 1 above). Where present, peaty and organic soils are unlikely to form a suitable foundation for residential development and will require removal (to achieve a site classification 'A'), or consolidation by surcharging (possibly resulting in a site classification 'S' for these areas). Peaty soils requiring excavation may require management and control of acid sulfate soils. The distribution and management of peaty soils should be undertaken during geotechnical investigations of the site.
- Where natural sandy soils are present, free from organic soils and with a suitable separation from groundwater, well drained conditions can be anticipated. Therefore, stormwater disposal from lots and roads should be readily achievable for the ground conditions at this site via infiltration in soakwells and drainage sumps.
- The regional superficial aquifer is indicated to be generally lower than 4 m of the existing ground surface elevation in the lowest parts of the site. It is suggested that a hydrogeology study is undertaken during the design phase of the development, to allow accurate assessment of maximum groundwater levels to be expected at the site.
- Conventional earthmoving equipment should generally be suitable for excavations within sand across the site. Dozers and rock breaking equipment will be required to penetrate the limestone. Such equipment is common for earthworks in this part of the Perth coastal plain.
- The minimum site preparation requirements prior to construction of buildings for a site such as this are likely to include:

- Stripping of all vegetation, topsoil and deleterious materials beneath development areas. This may include peaty or other organic soils, and possibly areas of uncontrolled fill, where they exist;
- Compaction of natural subgrade soils;
- Cut and fill of sand soils to achieve appropriate design levels; and
- Compaction of all development areas and the base of foundation excavations to achieve at least medium dense material.

Management of Karst Risk

Based on the available desktop information, the areas deemed as high risk cover an area of less than 4% of the total site area, and the areas mapped as medium risk cover approximately 28% of the total site. It should be noted that significant urban development currently occurs over areas mapped as medium risk within the north-west corridor development zone of the Perth metropolitan area. In light of the available desktop information, it is considered that the damage to proposed residential houses from ground subsidence due to karst features is considered to be low across the vast majority of the site.

The possible presence of karst features should be considered at this site and their potential influence and management with regards to the proposed development should be assessed during subsequent phases of geotechnical investigation and during earthworks. It is recommended that karst risk at this site is managed during the future subdivision planning stages of urban development, and includes:

- Detailed geotechnical investigation of proposed urban development areas, with specific assessment for the detection of karst features, to provide confirmation of the actual karst risk at the site. Investigations are suggested to be undertaken on a phased approach across the site, and should consider:
 - Walk-over survey inspections by experienced geotechnical engineers to allow identification and mapping of features visible at ground surface.
 - Excavation of test pits across the medium and high karst risk zones to further assess the location of near surface limestone and possibly define the area for drilling and geophysical testing.
 - Investigate the extent of identified karst features using rock coring boreholes and/or geophysical testing such as ground penetrating radar (GPR).
- Geotechnical supervision during the bulk earthworks including:
 - Inspections following site clearing, limestone exposed in excavations and sewer trenches.
 - The reporting of abnormal ground conditions, ground subsidence or soft spots encountered during earthworks to a geotechnical engineer for further investigation.
- Preparation of a karstic features management plan for identified features, in accordance with the City of Wanneroo Local Planning Policy 4.13.

It should be noted that the City of Wanneroo policy objectives are to:

1. Conserve caves and significant karstic features for their geological, cultural and environmental values; and
2. Minimise risks to people and property in karst hazard areas.

It is anticipated that significant cavities, if any, may need to be assessed for possible incorporation within the design of the proposed development, for instance by integrating them into public open space areas.

Therefore, early consideration of the karst risk assessment in the design phase of the urban development is recommended.

5. References

Acid Sulfate Soil Risk Mapping. (2006). WA Department of Environment and Conservation, digital dataset.

AS 2870. (2011). *Residential Slabs and Footings*. Standards Australia.

City of Wanneroo. (2018). *Planning and Sustainability, Local Planning Policy Framework, Local Planning Policy 4.13: Caves and Karstic Features*,. PS02-10/18, 16 October 2018 : City of Wanneroo.

Department of Environment. (2004). *Perth Groundwater Atlas, Second Edition, Dec 2004*.

The Geology of the Yanchep 1:50,000 Sheet, first edition. (1986). Geological Survey of Western Australia.

6. Limitations

Douglas Partners (DP) has prepared this report for this project at Gibbs Road, Carabooda, WA in accordance with DP's proposal P219549 dated 29 November 2022 and acceptance received from Acumen Project Management Pty Ltd on behalf of Carabooda Landowners Pty Ltd dated 22 December 2022. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Carabooda Landowners Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in

design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

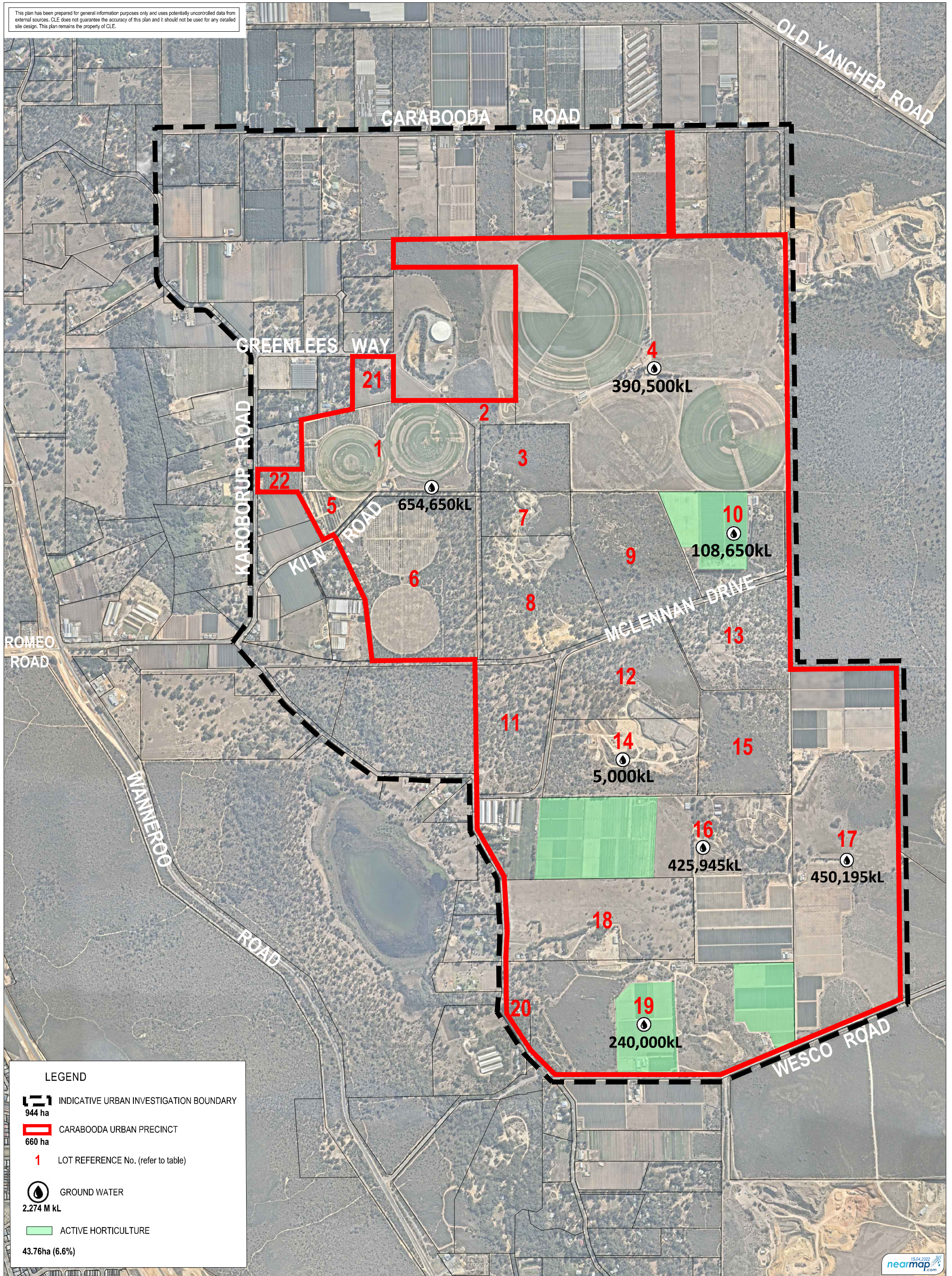
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

CLE Development PPlan

This plan has been prepared for general information purposes only and uses potentially uncontrolled data from external sources. CLE does not guarantee the accuracy of this plan and it should not be used for any detailed site design. This plan remains the property of CLE.

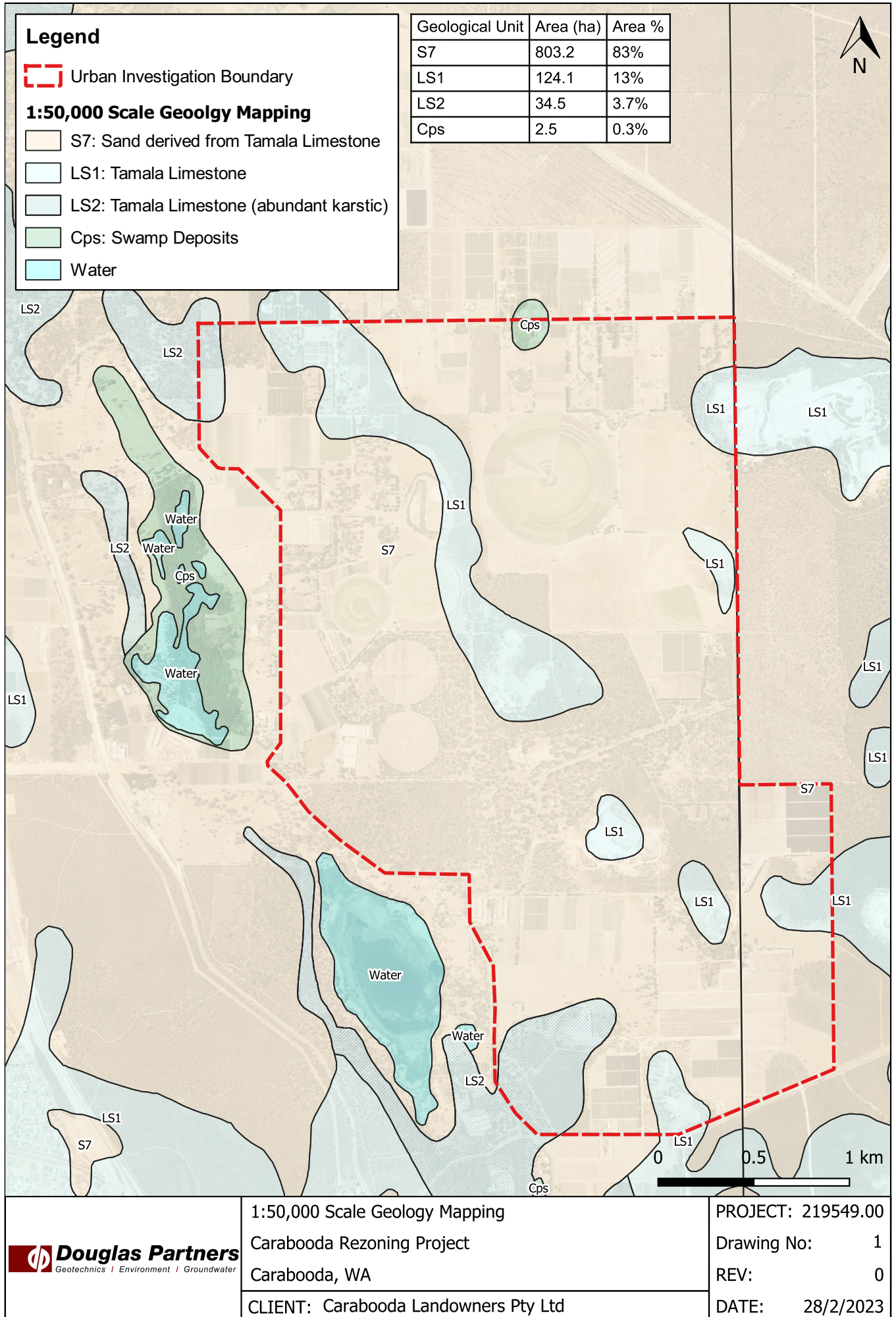


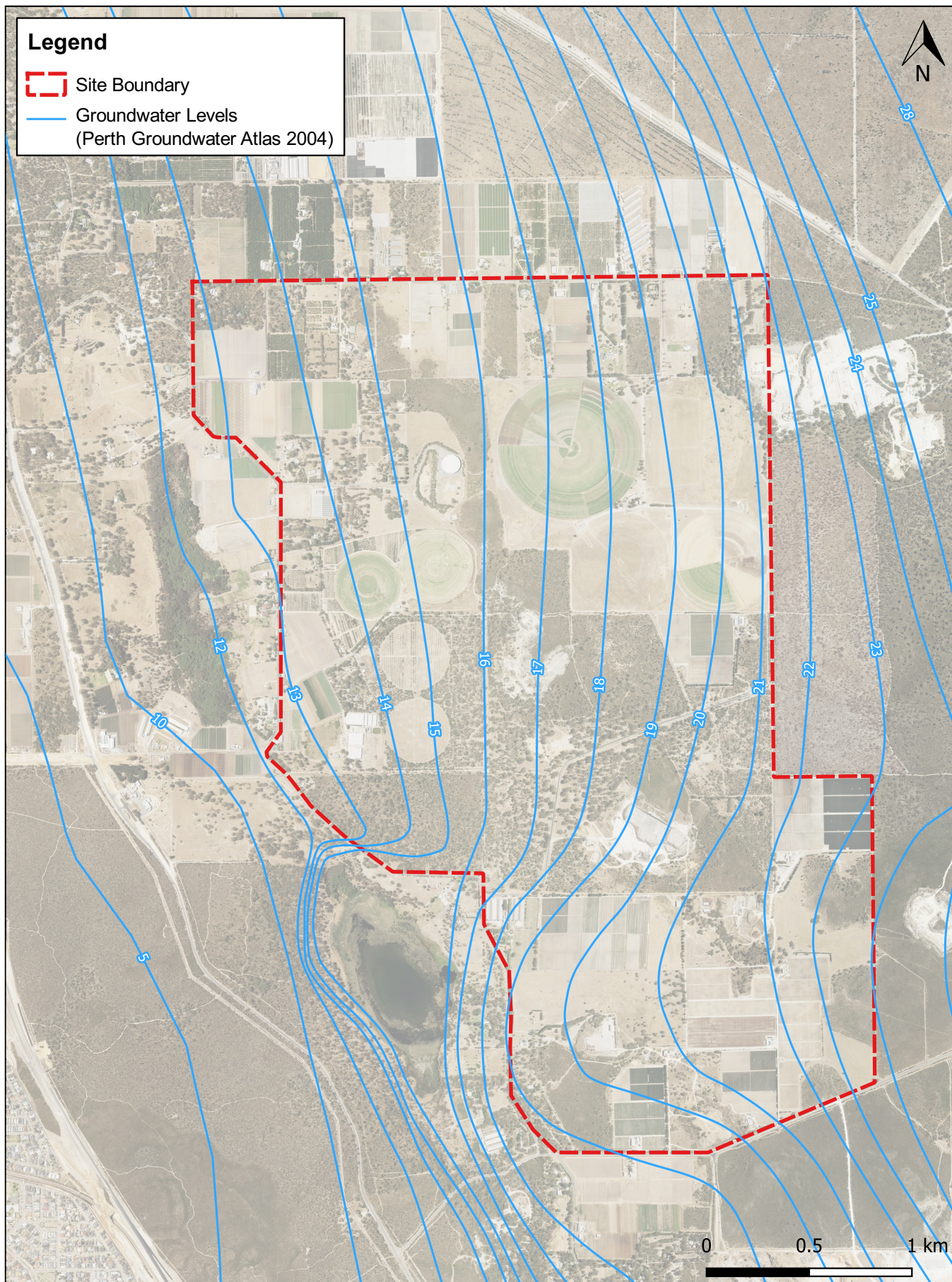
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Appendix C

Drawings 1 to 5

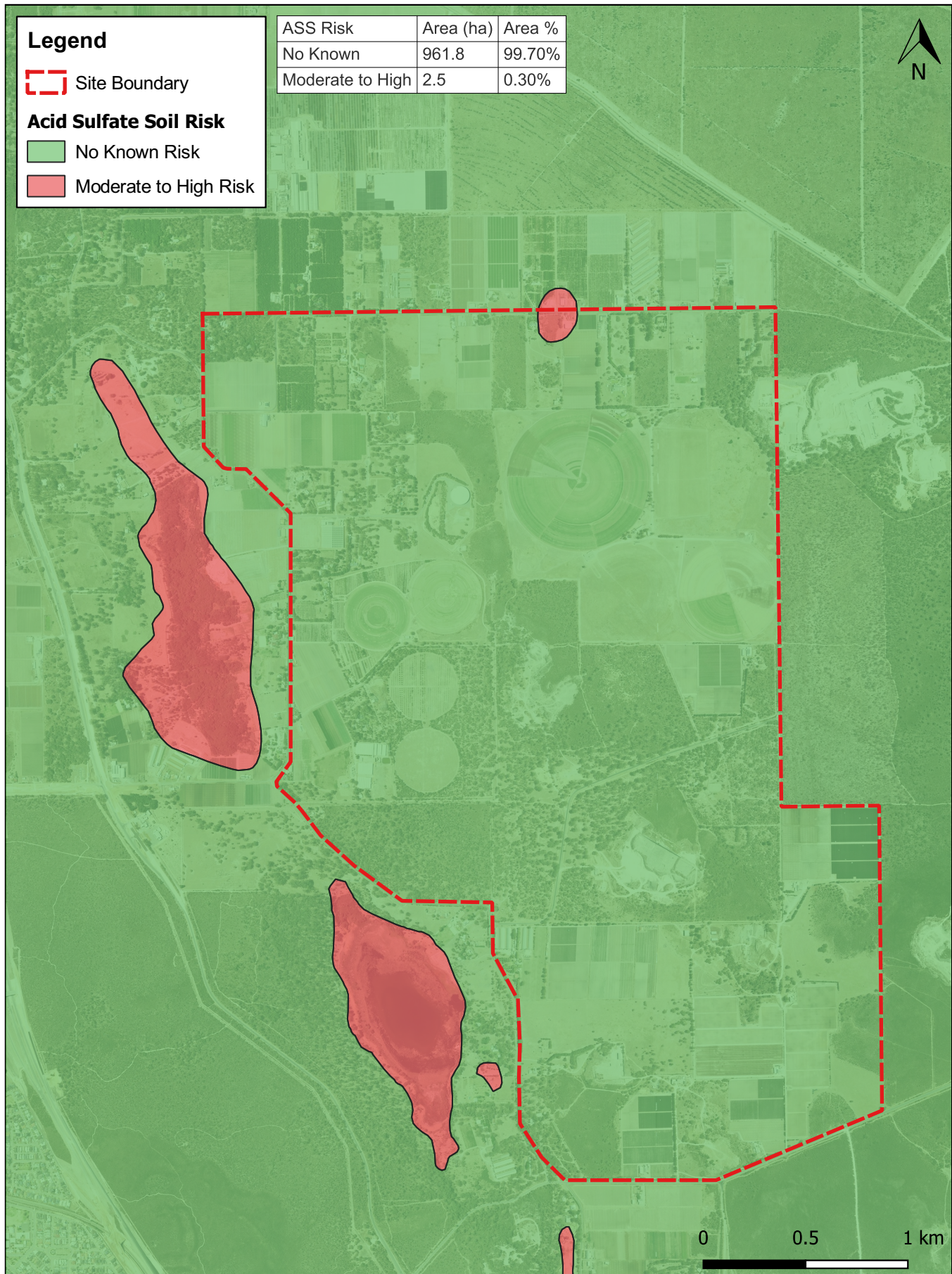




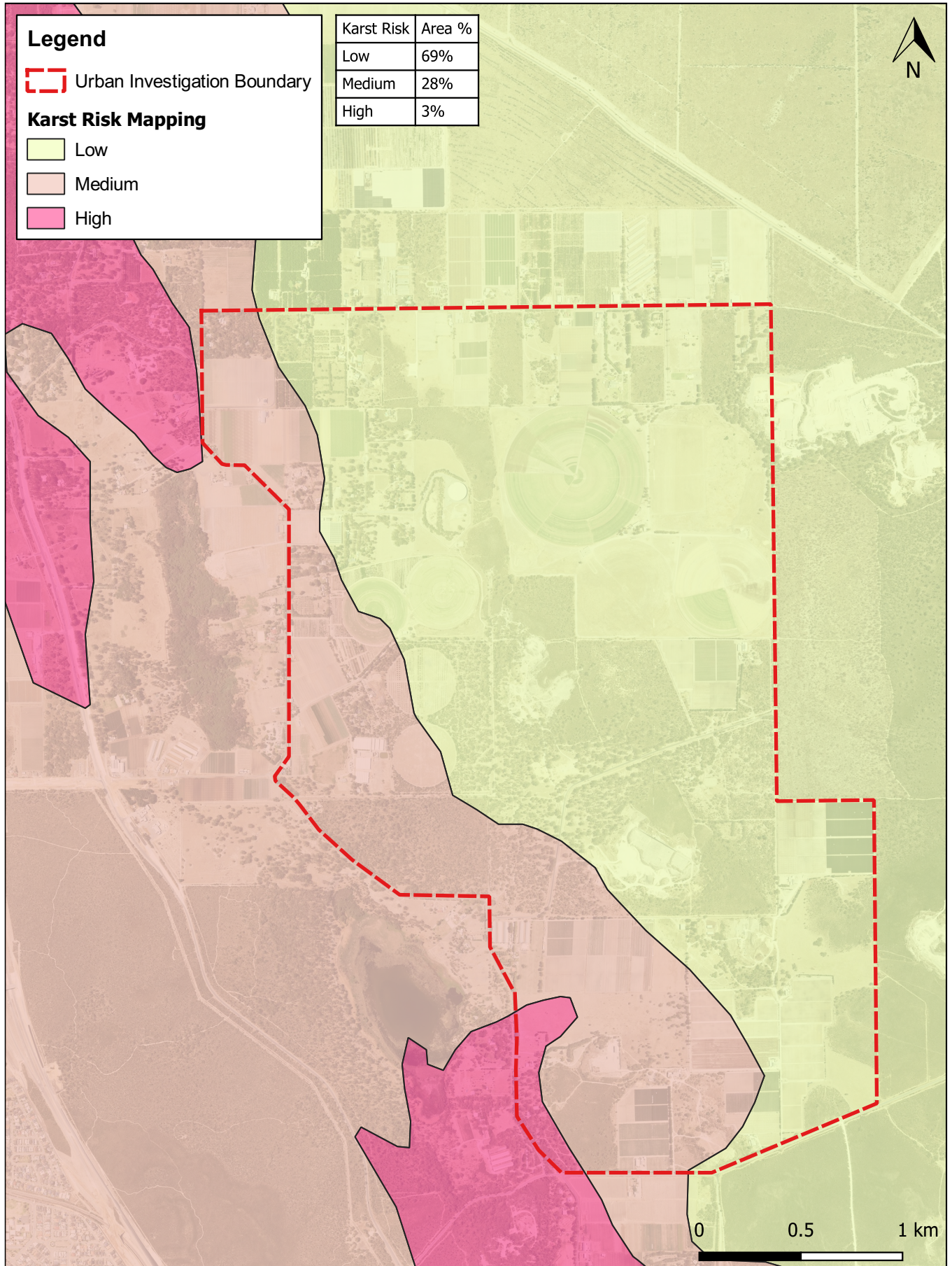
Site Boundary

Groundwater Levels
(Perth Groundwater Atlas 2004)

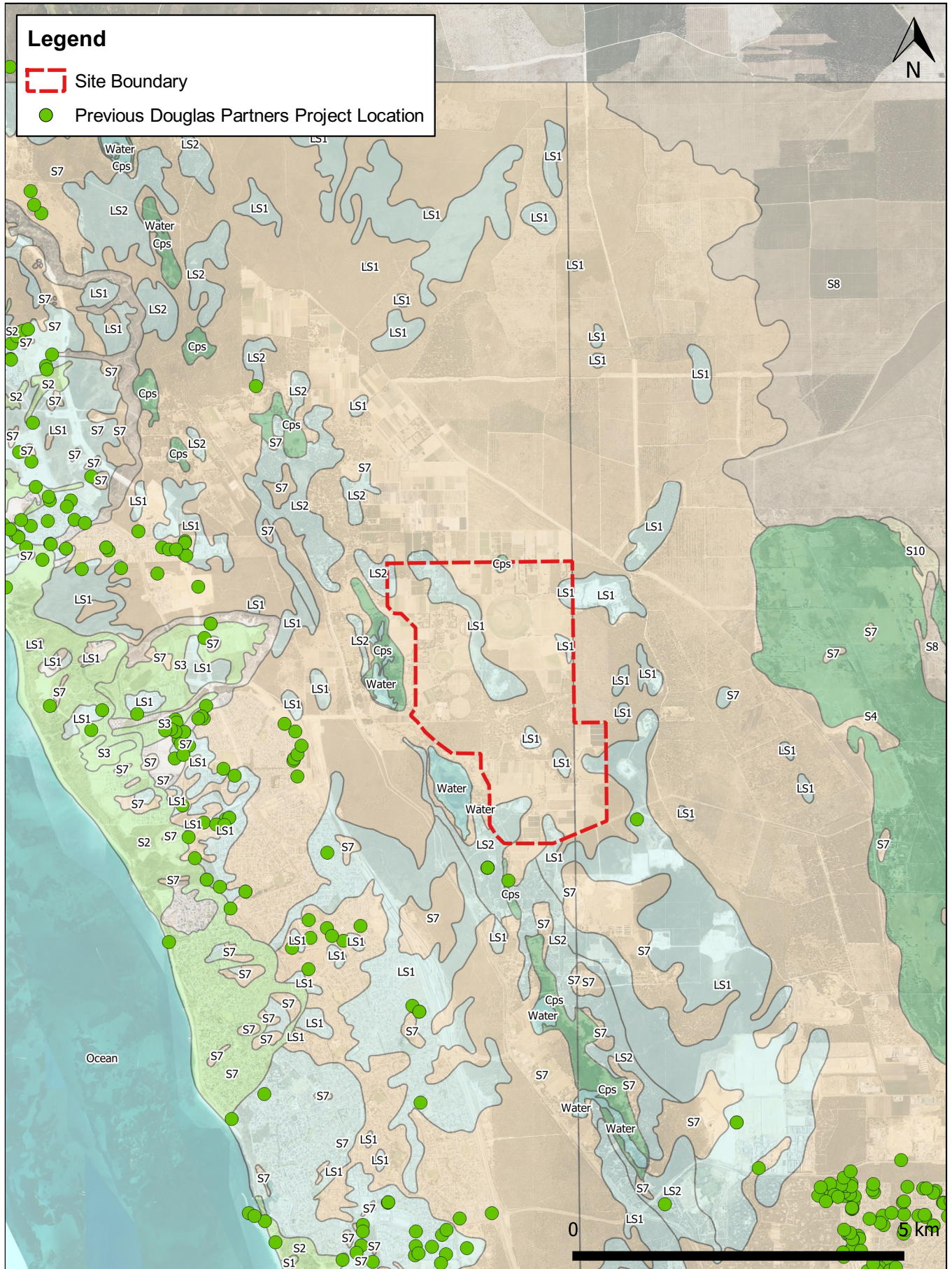
 Douglas Partners <i>Geotechnics Environment Groundwater</i>	Groundwater Levels: Perth Groundwater Atlas 2004	PROJECT:	219549.00
	Carabooda Rezoning Project	Drawing No:	2
	Carabooda, WA	REV:	0
	CLIENT: Carabooda Landowners Pty Ltd	DATE:	20/2/2023



 Douglas Partners Geotechnics Environment Groundwater	Acid Sulfate Soil Risk Mapping		PROJECT: 219549.00
	Carabooda Rezoning Project		Drawing No: 3
	Carabooda, WA		REV: 0
CLIENT: Carabooda Landowners Pty Ltd			DATE: 20/2/2023



 Douglas Partners Geotechnics Environment Groundwater	City of Wanneroo Karst Risk Mapping	PROJECT: 219549.00
	Carabooda Rezoning Project	Drawing No: 4
	Carabooda, WA	REV: 0
	CLIENT: Carabooda Landowners Pty Ltd	DATE: 28/2/2023



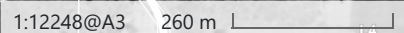
 Douglas Partners Geotechnics Environment Groundwater	Previous Douglas Partners Project Locations		PROJECT: 219549.00
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	Carabooda, WA		REV: 0
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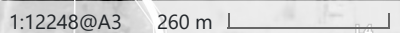
Appendix D

Historical Aerial Photo Extracts



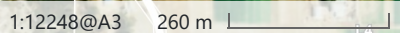
MNG.





1985





2005

MNG



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260 m



2015



