PENTIUM WATER

# SITE AND SOIL EVALUATION

## Stage 1, Town Centre,
## Lot 601 Brockman Street, Gingin

PW_HCPBROK_01_R001_Rev0
13/10/2023

# Document Status

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# Approval for Issue

| Name | Signature | Date |
|---|---|---|
| Simon Hewitt | | 13/10/23 |

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# Executive Summary

Westerly Developments Pty Ltd (herein referred to as “Westerly Developments”) proposes to develop and use the southern portion of Lot 601 Brockman Street, Gingin (herein referred to as “the site”), the extension of the Town Centre and associated Public Open Space (POS) with a total development area of approximately 22,700 m².

It has been requested that more details be provided for the section of the development relating to the Town Centre and POS. This is area now referred to as the Town Centre – Stage 1 which comprises the southern portion of Lot 601 . This report is focused on this section of the development, with the wastewater management of domestic wastewater being handled at an individual lot scale for the balance of Lot 601. The Town Centre expansion area and associated POS comprises an area of approximately 22,700 m².

This SSE report is an expansion on the work completed by Structerre (2022a and b) that more thoroughly addresses the human health and environmental risks raised in accordance with the Government Sewerage Policy 2019 (GSP) and AS/NZS 1547:2012 *On-site domestic wastewater management* (AS 1547) (Standards Australia and New Zealand, 2012) to support an updated Western Australian Planning Commission (WAPC) submission for the development. The infiltration test results presented within this report supersede the previously submitted results in the Geotechnical report (Structerre 2022a) and the Site and Soil Evaluation report (Structerre 2022b).

Stage 1 is zoned as a combination of “Town Centre” and “Parks and Recreation” under the Shire of Gingin’ Local Planning Scheme (LSP) No. 9.

The site is bounded by Brockman Street to north and east and Weld Street to the west. The southern boundary of the site adjoins the Shire of Gingin offices and town centre. Existing residential areas of the townsite are present adjacent to the north and the east of the site with the Gingin Brook located approximately 250 m to the south. The site is located approximately 66 km north-northeast of Perth central business district (CBD) within the Shire of Gingin (SoG)

The site is in a Sewerage Sensitive Area (SSA) as it is located within 1 km of a significant wetland.

The lots within SSAs have a minimum lot size of 1 hectare, and this stage of the development complies with this limit. However, it is confirmed that the Land Application Area (LAA) can be achieved, and environmental impacts are considered acceptable.

As the site is not anticipated to impact on any wetlands in proximity to the site (due to the nature of surface and groundwater flow), and the LAA can be achieved, the development design is not considered to pose an environmental or human health risk.

Post-development earthwork and stormwater management of the site has been designed to prevent the accumulation and infiltration of surface water run-off that was observed during pre-development investigations in August 2022.

Results of the site and soil assessment indicate the soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW). Compliance with the required clearance to groundwater of 1.5m will be achieved through earthwork design of the Stage 1 area.

This SSE demonstrates the site can accommodate a suitable wastewater management system through having sufficient area to accommodate the LAA and through being able to achieve the required groundwater clearance through importation of fill during the construction of individual LAA’s.

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# 1. Introduction

## 1.1. Background

Westerly Development Pty Ltd (herein referred to as “Westerly Development”) proposes to develop and use the southern portion Lot 601 Brockman Street, Gingin (herein referred to as “the site”). This Town Centre expansion will be staged (likely two stages), with the initial stage 1 development being the extension of the Town Centre being adjacent to Weld St. The entire town centre expansion area is approximately 22,880 m²

Stage 1 is bounded by Brockman Street to north and east and Weld Street to the west. The southern boundary of the site adjoins the Shire of Gingin offices and town centre. Existing residential areas of the townsite are present to the north and the east of the site with the Gingin Brook located approximately 250 m to the south. The site is located approximately 66 km north-northeast of Perth central business district (CBD) within the Shire of Gingin (SoG). The location of the stage 1 development of the site is shown in Figure 1.


**Figure 1: Site location**

## 1.2. Planning context

Stage 1 is zoned a combination of “Town Centre” and “Parks and Recreation” under the Shire of Gingin’ Local Planning Scheme (LSP) No. 9.

## 1.3. Proposed development

The development consists of an extension of the town centre in the southern portion of Lot 601 with an area of approximately 2.28 ha. The detailed site layout is presented in Figure 15.

## 1.4. Purpose of this report

This SSE report has been prepared to expand on the work previously completed SSE report for Lot 601 by Pentium Water (2023) which addressed the urban development areas of Lot 601. Structerre that more thoroughly addresses the human health and environmental risks raised in accordance with the Government Sewerage Policy 2019 (GSP) and AS/NZS 1547:2012 *On-site domestic wastewater management* (AS 1547) (Standards Australia and New Zealand, 2012) to support an updated Western Australian Planning Commission (WAPC) submission for the development. The previous SSE report (Pentium Water, 2023) has been provided in Appendix A, and details the methodology and results of the previously conducted site investigations.

## 1.5. Previous site reports and investigations

Several geotechnical field programs and associated reporting have been previously undertaken to support the development of the Urban Water Management Plan (UWMP) (Hyd2o hydrology, 2023) and have been utilised to inform this SSE, these supporting reports are:

- Urban Water Management Plan – Lot 601 Brockman Street, Gingin (Hyd2o, 2022): An Urban Water Management Plan (UWMP) was prepared by Hyd2o hydrology in 2022 as required for subdivision submission and approval. The document covers the entire development and details the drainage management plan for the subdivision of the subject site.

- Structerre (2022a) – Geotechnical Investigation: Proposed Residential Subdivision – Lot 601 Brockman St, Gingin WA, May 2022.
    - This report included site specific geotechnical investigations to support the development design including earthworks, road networks and the stormwater drainage design.

- Structerre (2022b). Site and Soil Evaluation for Onsite Sewage Management – Lot 601 Brockman Street, Gingin WA, September 2022.
    - This report was prepare to demonstrate the site's suitability to accommodate the disposal of treated wastewater (TWW) in accordance with the Government Sewerage Policy (GSP) (2019).

- Pentium Water (2023). Site and Soil Evaluation: Lot 601 Brockman Street, Gingin.
    - This report presented the results of the Structerre site investigations and detailed the wastewater management measures for the site to ensure compliance with the Government Sewerage Policy 2019 (GSP) and AS/NZS 1547:2012 *On-site domestic wastewater management* (AS 1547) (Standards Australia and New Zealand, 2012) to support an updated Western Australian Planning Commission (WAPC) submission for the development.

It should be noted that although the site infiltration tests (falling head infiltration test) as conducted for the above two Structerre reports was suitable for the design requirements of the UWMP, it was not a supported methodology by the GSP (2019). As such additional site investigation was undertaken which included the completion of 26 constant head infiltration tests across the development site in accordance with the GSP (2019).

This report presents and discusses the results of the additional constant head infiltration tests to demonstrate the site's compliance with the GSP (2019).

# 2. Existing environment

## 2.1. Climate

The nearest Bureau of Meteorology (BoM) weather station to the site is Gingin (Station Number 9018), located approximately 0.5 km to the southwest of the site. Based on the rainfall data collected from 1891 to 2022 at this station, the local area experiences an average of 737.7 mm rainfall annually.

Other climate data has been taken from Gingin Aero (station number 9178) with evaporation data from Perth Airport (Station Number 9021) located approximately 65 km to the south of the site as this is the closest BoM recording weather station with this data. Based on climate data collected from 1968 to 2022, the local area experiences a mean maximum temperature of 33.2° C and a mean minimum temperature of 6.5℃ (BoM 2022). The monthly mean climatic data for rainfall and temperature is summarised in Table 1 below, with monthly rainfall data for the previous few years presented in Figure 2.

**Table 1: BoM Weather Stations No. 9018 (rainfall 1891-2023), 9178 (Gingin Aero) temperature and 9021 (Perth Airport) evaporation (1986 to 2023)**

| Statistic | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean rainfall** | 10.2 | 13.6 | 17.9 | 33.3 | 97.3 | 140.2 | 145.6 | 113.3 | 69.2 | 46.4 | 20.0 | 10.8 | 737.7 |
| **Mean max temp** | 33.2 | 33.1 | 30.8 | 26.8 | 22.7 | 19.7 | 18.4 | 19.1 | 20.9 | 24.3 | 28.0 | 31.0 | 25.7 |
| **Mean min temp** | 16.4 | 17.1 | 15.4 | 12.0 | 8.9 | 7.2 | 6.5 | 6.6 | 7.4 | 9.1 | 11.9 | 14.5 | 11.1 |
| **Mean evaporation (mm)** | 316.2 | 268.8 | 238.7 | 150 | 93 | 66 | 65.1 | 80.6 | 111 | 167.4 | 228 | 282.1 | 2080.5 |

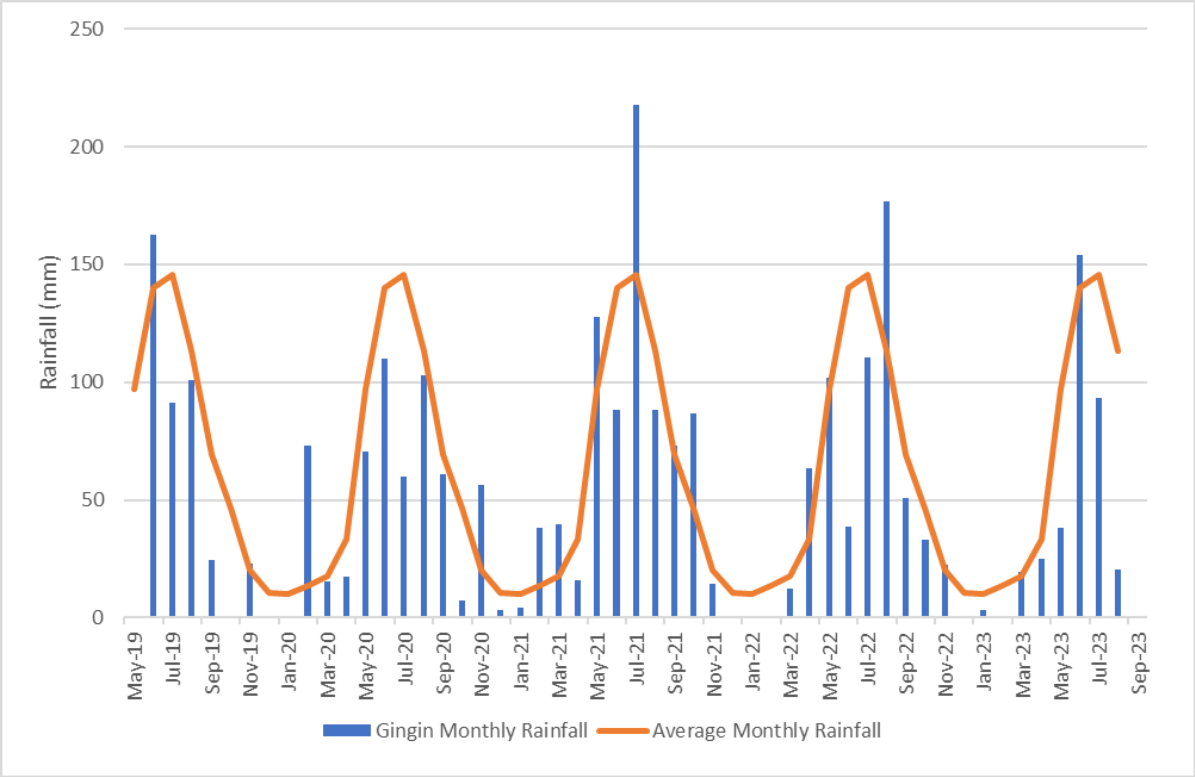


**Figure 2: Monthly rainfall data - Gingin Station (BoM site 9018)**

As shown in Figure 1, rainfall recorded for August of 2022 exceeded the average monthly rainfall for this site. Further analysis indicates 254.4 mm of rainfall was recorded in the four weeks between 17th July 2022 and 17th August 2022 64% of the mean winter rainfall between 1st June – 31st August. This rainfall preceded the field investigations completed by Structerre.

Evaporation data estimated from The Department of Agriculture and Food (1987) data indicates that evaporation generally exceeds rainfall annually at the site. On average there are four months of the year (May to August) where the rainfall exceeds the evaporation at the site.

## 2.2. Topography

The regional topographic contours show that the site slopes in a south / south-easterly direction with elevations across the site ranging from approximately 130 m Australian Height Datum (m AHD) in the northern portion of the site to 98 m AHD in the south. The surface gradient of the site varies between 5 and 10% with an average slope of approximately 7%. Regional topographic contours are presented in Figure 3.

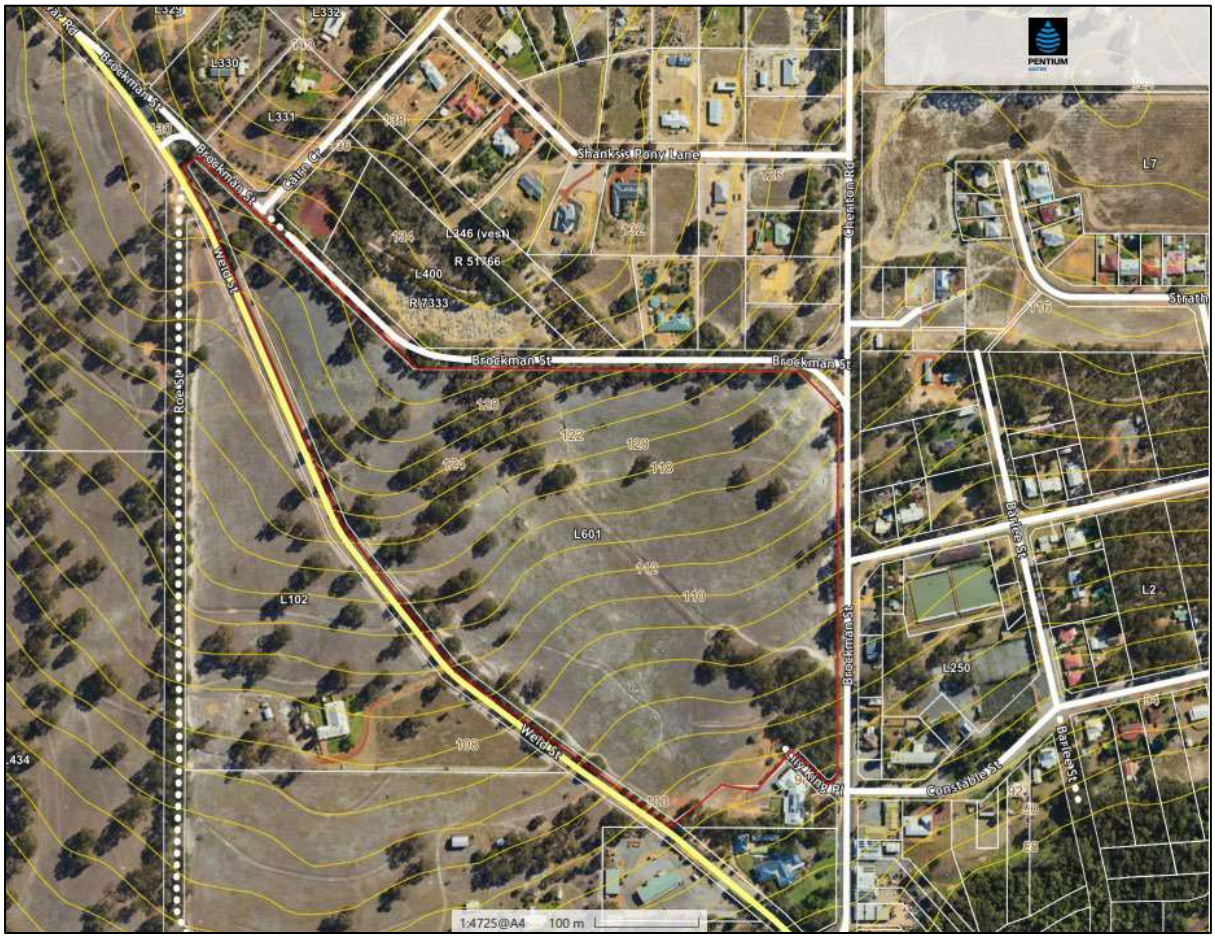


**Figure 3: Site topography**

## 2.3. Regional landforms and soils

The Gingin sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by predominantly colluvium soil and undifferentiated sand.

Structerre's site geotechnical investigations conducted during May 2022 (13 bore holes) and August 2022 (30 boreholes) provided additional detail to the site geological conditions. The reported soil conditions broadly align with regional conditions. Three main soil profiles were identified across the site which are summarized below:

- **Profile 1**:
    - Topsoil – grey, fine to medium grained - 0.1 – 0.2 m
    - Silty sand – fine to medium – 0.2 – 1.2 m
    - Sand – grey, fine to medium grained, with clay and gravel inclusions – 1.2 – 2.5m
- **Profile 2:**
    - Topsoil – grey, fine to medium grained - 0.1 – 0.2 m
    - Silty sand – fine to medium – 0.2 – 0.65 m
    - Clay / sandy clay – high plasticity, trace sands and gravels – 0.65 – 2.5m
- **Profile 3:**
    - Topsoil – grey, fine to medium grained - 0 – 0.1 m
    - Clay / sandy clay, medium to fine grained, high plasticity with trace sands and gravels 0.1 – 2.5 m

The location of the bore holes on the proposed stage 1 development conducted as part of the overall site geotechnical investigations is presented in Figure 4.


**Figure 4: Investigation borehole locations (green)**

## 2.4. Acid sulfate soils

The (then) Department of Environmental Regulation (DER, now Department of Water and Environmental Regulation, DWER) mapped the site not having and acid sulphate soil risk within the site (refer Figure 5).

## 2.5. Public drinking water source areas

The site is not located within a public drinking water source area (PDWSA) and is located approximately 250 m southwest (down hydraulic gradient) of P2 public drinking water source area associated with the Gingin Water Reserve Area.

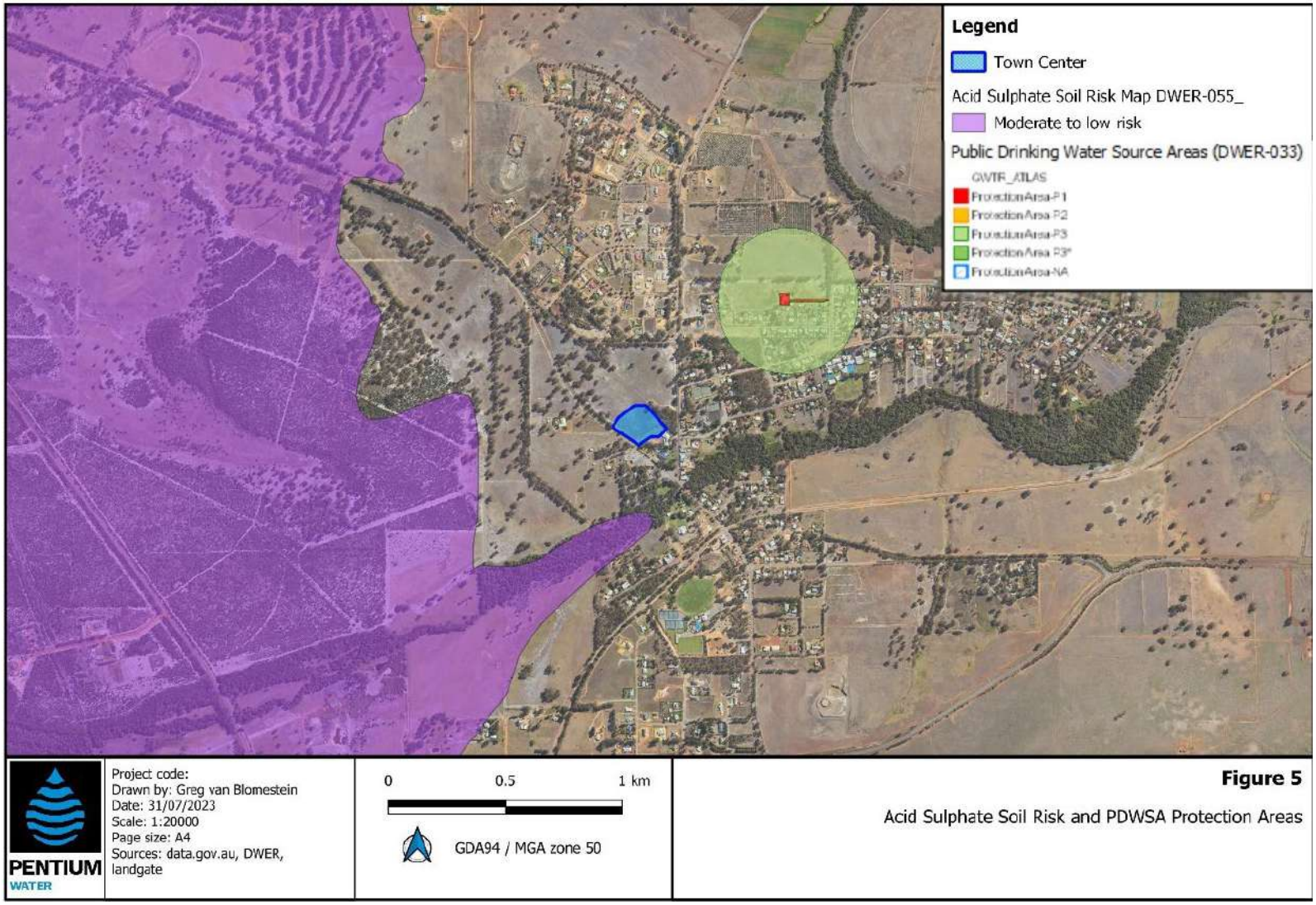


**Figure 5: Acid sulfate soil mapping and PDWSA.**

## 2.6. Groundwater

The site is located within the Gingin Townsite subarea of the Gingin Groundwater Management Area. Department of Water and Environmental Regulation (DWER) groundwater contours are not available for the site, however according to the Perth Groundwater Map (DWER, 2022), contours starting approximately 3.5 km to the south of the site and indicate regional groundwater flows generally east to west.

It is acknowledged that localised groundwater flow directions may generally align with topography. As such groundwater may potentially flow in a southerly direction within the site towards the Gingin Brook before trending west in line with regional groundwater flow.

Depth to groundwater information is not available from DWER's Perth Groundwater Atlas and the Water Information Reporting online database only provides groundwater data for a single site approximately 500m to the south of the site. Data from this bore (WIN bore 61710528) indicates a maximum groundwater elevation of approximately 81.4 m Australian Height Data (mAHD) in 2008. Groundwater elevations have declined since at this location by approximately 1.5 m since 2008.

Information on the regional groundwater resources obtained from the DWER's online databases indicates that the site is underlain by a dual-layered aquifer system comprised of the following resources:

- Perth – Superficial Swan
- Perth – Leederville (confined)

Groundwater levels were measured across the site during geotechnical investigations conducted on the 16th and 17th August 2022 via a series of 26 bore holes across the development site, but this investigation is limited to the Stage 1 Town centre area where there are only three sites within the development boundary (Figure 4). The site investigations are described in detail in Section 3.0.

During the August 2022 site investigations, groundwater was encountered within all three of the bores (BH 7, BH8, and BH 13) which are located on the Stage 1 development of the Town Centre expansion area. At all these locations, groundwater level was at found at the ground surface level.

It should be noted that the rainfall recorded for August of 2022 exceeded the average monthly rainfall for this site. Further analysis indicates 254.4 mm of rainfall was recorded in the four weeks between 17th July 2022 and 17th August 2022 64% of the mean winter rainfall between 1st June – 31st August.

### 2.6.1. Additional groundwater monitoring

Subsequent groundwater monitoring post submission of the Lot 601 SSE (Pentium Water 2023) was completed by Hydr20 (Figure X). This monitoring included the installation of four groundwater bores across the site to further clarify the presence of groundwater at the site. These bores were constructed to depths ranging from 1.5 (shallow bores) to 8 meters below ground level (mbgl) (for the deeper groundwater bore. The results to date indicate:

- Shallow bores have not had any measurable groundwater:
    - Indicating that previous groundwater encountered on site was likely perched due to infiltration of surface water run-off from wider catchment.
- Deeper groundwater encountered at a depth of approximately 6 mbgl.


**Figure 6: Groundwater monitoring bore locations**

### 2.6.2. Groundwater and surface water licences

There are no groundwater licences associated with the site. A review of DWER's online Groundwater Register (DWER 2023) indicate that there are a number groundwater and surface water licences within 500m of the site. A summary of the nearby water allocation licences is provided in Table 2 below.

Majority of the licences are located up- or cross-hydraulic gradient of the site, with those located down-hydraulic gradient or significantly close to the site discussed further below.

Most of the groundwater licences in close proximity to the site are within the confined Leederville aquifer. The only superficial groundwater licence is located up-hydraulic gradient of the site.

It is noted that a number of surface water drawpoints are identified on the Groundwater Register (DWER 2023), however at the time of writing no associated licence details were not available – this does not preclude the existence of surface water licences being present in close proximity to the site.

Given the above, and proposed wastewater treatment systems (refer Section 5.2). It is therefore unlikely that site development and related wastewater management will pose any risk to these licences.

**Table 2: Surrounding groundwater licence holders (within 500 m of the site)**

| Licence number | Type | Owner | Resource | Volume (kL/yr) | Comment |
|---|---|---|---|---|---|
| 157187 | Groundwater | Slater, Geoffrey, Alan, Slater Annette Frances | Perth – Superficial Swan | 154,000 | Located 200 m north-west of site (up hydraulic gradient) |
| 174201 | Groundwater | Shire of Gingin | Perth – Leederville - Parmelia | 22,950 | Two sites – adjacent to the south of the site. Likely POS irrigation water. |
| 65089 | Groundwater | Water Corporation | Perth – Leederville - Parmelia | 210,000 kL | Two sites – 500 m to the east of the site. Likely abstraction bores associated with the Gingin PDWSA |
| 179971 | Surface Water | Shire of Gingin | Gingin Brook 3 | 2,250 kL | Unknown use. 150 m east of the site |
| 151889 | Surface water | Greville, Maxine Carole | Gingin Brook 3 | 1,500 kL | Unknown use, 500 m south-west |

## 2.7. Drainage

### 2.7.1. Pre-development

Surface water flows are anticipated to flow south overland towards the southern boundary of the site. A cut-off drain within the site and a shallow open drain following the fence-line have been constructed to direct flows to the east and west respectively and around the shire buildings to the south.

There are two minor catchments in the north of the site. One catchment in the northwest portion of the site drains to an external catchment through the site to culverts under Weld

St, then flowing south-east through the downstream property to Roe St. The other small catchment in the north-eastern corner of the site is in the Robinson St drainage system catchment.

All flows generated from the site that enter the drainage system are then conveyed to the Gingin Brook located approximately 250 m to the south of the site (Figure 7).


**Figure 7: Surface water catchments and drainage**

### 2.7.2. Post-development

Post-development drainage for the site will include the retention and infiltration of the first 15 mm of rainfall. Larger events and direct rainfall on the internal roads of the development will be conveyed via a piped road drainage network.

In addition, the road network drainage systems throughout Lot 601 and to the north of the Stage 1 Town Centre expansion area will capture and convey any surface water run-off from the site. Which will prevent perched water (as indicated in *Section 2.6*) to occur within the Stage 1 Town Centre expansion area.

The town centre will manage all stormwater generation within the town centre area through conveyance too, and retention/infiltration within a stormwater basin. This basin will also be vegetated to promote nutrient removal from stormwater.

## 2.8. Vegetation and exposure

The site has been extensively cleared for rural use purposes and consists of pasture except for spares trees and a remnant gathering of trees in the south-east corner. The site is predominantly comprised of open paddocks.

It is anticipated that any remnant trees retrained post-development will not impact LAA's.

## 2.9. Wetlands

A review of the Geomorphic Wetlands, Swan Coastal Plain (DBCA 2020) dataset indicates that are no geomorphic wetlands present within the site

There are also a few mapped wetlands in close vicinity of the site, as shown in Figure 8. The wetlands are located cross and down-hydraulic gradient of the site and include:

- UFI 15107 – Palusplain – Conservation Category Wetland (CCW) located approximately 300m south of the site associated with the Gingin Brook.
- UFI 11122 – Palusplain – Multiple use (MU) located approximately 320m south of the site associated with the Gingin Brook.
- UFI 13450 – Palusplain – Multiple use (MU) located approximately 600m south-west of the site associated with the Gingin Brook.
- UFI 11130 – Palusplain – Multiple use (MU) located approximately 950m south-west of the site associated with the Gingin Brook.
- UFI 11221 – Palusplain – Conservation Category Wetland (CCW) located approximately 1.5 km west of the site.
- UFI 11121 – Palusplain – Multiple use (MU) located approximately 950m north-east of the site associated with the Gingin Brook.

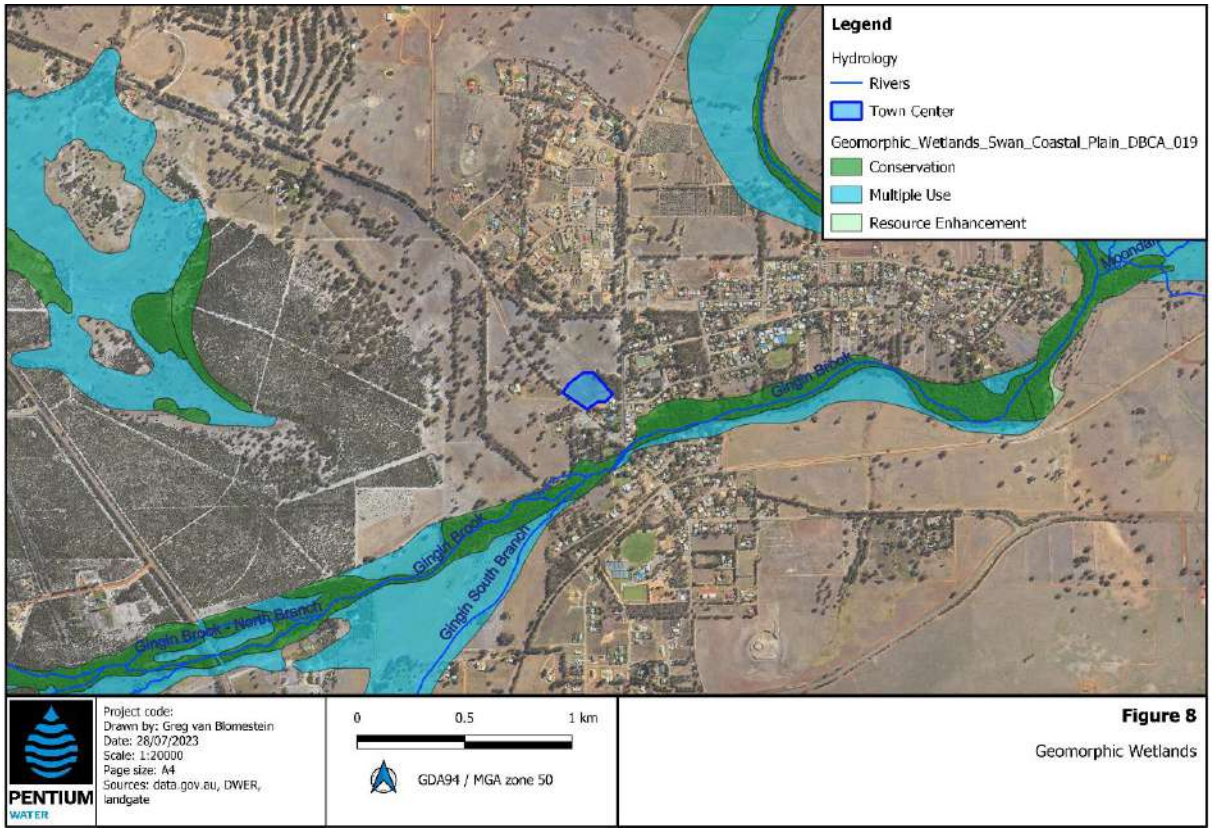


**Figure 8: Geomorphic wetlands**

## 2.10. Sewage sensitive areas

Sewage sensitive areas (SSAs) are proclaimed under the *Government Sewerage Policy* (GSP) (DPLH 2019) to protect groundwater and surface water systems. A review of the GSP online data set (National Map 2023) maps the site as being within a SSA as it is located within 1 km of significant wetlands (refer Figure 8).

The GSP (2019) requires that the lots within SSAs have a minimum lot size of 1 hectare. The stage 1 development will comply with this as the lot size is significantly larger than this. The minimum LAA can thus be achieved, and environmental impacts are considered acceptable as the LAA sizing requirements will be met (as discussed in Section 4.4) and given the treatment requirements (ATU with nutrient striping) is not considered to pose an environmental or human health risk.

## 2.11. Bush Forever

There are no Bush Forever areas mapped within or near the site.

## 2.12. Existing and historic land use

The site has been historically used for rural purposes, with historical aerial photographs indicating that in 1960 the site had been extensively cleared.

## 2.13. Surrounding land use

Immediately to the north, east and south of the site lies the township of Gingin, comprising mainly of residential dwellings and a town centre. Further to the south (approx. 320m) lies the Gingin Brook and beyond that the remainder of the Gingin townsite. The west of the site lies pastoral properties including remnant vegetation, with the Brand highway located approximately 2 km to the west of the site.

# 3. Site and Soil Assessment

## 3.1. Site assessment

To assess the site's ability to accommodate the disposal of treated wastewater site investigations were completed by Structerre on the 16th and 17th August and again on the 7th of December. These investigations were completed in accordance with AS 1547 and superseded the previous site investigations completed as part of the Structerre 2022a and 2022b reports. The additional investigations comprised of:

- a site walkover including inspection of the site features relevant to AS1547-2012.
- drilling of boreholes at 26 locations, extending to depths of up to 2.5m unless refusal encountered prior.
- 8 x dynamic cone penetrometer (DCP) tests in accordance with AS 1289.6.3.2 (1997) to a depth of 1m for the evaluation of relative densities in the upper lithological profile.
- constant head infiltration testing at 26 locations of which 4 are found on the stage 1 site; and
- collection of representative soil samples for laboratory testing.

Sampling locations relevant to this SSE are presented in Figure 4.

A geotechnical engineer from Structerre conducted the walkover survey, selected and located the test positions, drilling the push core boreholes, logged the materials encountered in the boreholes, conducted the constant head infiltration testing, and collected representative samples for laboratory testing.

The test locations were positioned using a handheld GPS typically accurate to within ± 5 m in the horizontal plane. The approximate test locations are shown on Figure 4.

Details of the tests and individual site results are presented in Structerre (2022c) in Appendix A of Appendix A.

The following sections discuss the results obtained.

### 3.1.1. Boreholes

Boreholes were drilled using a sample retrieval probes. Borehole reports, including a photograph of the spoil are presented in Appendix C, Borehole and Test Pit Reports (Structerre, 2022c).

### 3.1.2. Dynamic Cone Penetrator Tests

Dynamic cone penetrometer (DCP) tests were carried out adjacent to each test pit. Results of the DCP testing are presented in Appendix D, Dynamic Cone Penetrometer Test Results (Structerre, 2022c). The tests were carried out in accordance with AS 1289.6.3.2.

#### 3.1.2.1. Soil lithology

The soil profiles encountered onsite for all bore holes typically comprised clay, sandy clay and silty clays with the presence of gravels towards the surface with an overlying layer of topsoil. Many boreholes reported refusal due to still clays and hard gravels at depths typically around the 1.3 mbgl where encountered. The lithology closely corresponds with the regional landform descriptions outlined in Section 2.3. It should be noted that all clayey materials encountered and logged on site had a high plasticity – rather than being described as a stiff clay. This indicates that these clays contain water and although lower than the overlying topsoil and sands, would have a reasonable ability to infiltrate water. Section 3.1.5 provides the measured infiltration rates across the entire soil profile recorded across the site.

#### 3.1.2.2. Particle size analysis

Particle size analysis was undertaken at one site BH01, located in the greater development envelope, north of the stage 1 development, with results presented in Appendix E (Structure 2022c). This site is considered acceptable to cover the stage 1 area as it was designed for the original full development.

Analyses have been reviewed against Table 5.1 of the *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand, 2012). Based on visual-tactile assessment undertaken during the site walkover, laboratory and infiltration

testing, the site soils have been determined to be soil Category 2 and Category 3 soils (AS 1547) with a hydraulic capacity of ranging from 2.6 – 5m/day.

### 3.1.3. Design loading rates

Based on Table 5.2 of AS 1547, the following design loading rates (DLRs) are considered applicable for treated effluent in trenches and beds as shown in Table 3, to provide a conservative approach, the DLR for Category 3 soils has been adopted.

**Table 3: Design loading rates (mm/day)**

| Trenches and Beds | | | |
|---|---|---|---|
| **Secondary Treated Effluent (Conservative Rate)** | **Secondary Treated Effluent (Maximum Rate)** | **Secondary Treated Effluent (ETA/ETS beds and trenches)** | **Secondary Treated Effluent (Spray or LPED irrigation)** |
| 30 | 50 | Not recommended | 3.5 |

Notes:

1. The irrigation system has a depth of 100 – 150 mm in good quality topsoil, or 250 mm for LPED irrigation

2. A suitably qualified and experienced design of effluent disposal systems should confirm the above design loading rates and suitable land application systems

### 3.1.4. Soil components analysis

Laboratory testing was carried out by Western Geotechnical and Laboratory Services in their NATA accredited laboratory and comprised the determination of:

- particle size distribution on 1 sample site for encountered soil profiles (BH01).
- Atterberg limits and linear shrinkage on 1 site for encountered soil profiles (BH01)
- dry density-moisture content relationship using modified compactive effort on 2 samples (BH13, BH14); and
- California bearing ratio (CBR) on 2 samples (BH13, BH14).

Laboratory results along with the test methods followed are presented in Structerre 2022a, and are summarised in Table 4.

**Table 4: Summary of geotechnical laboratory test results**

| Test Location | Sample Depth (m) | Sieve analysis – % passing sieve size (mm) | | | | LL (%) | PI (%) | LS (%) |
|---|---|---|---|---|---|---|---|---|
| | | 0.075 | 0.425 | 2.39 | 19 | | | |
| BH01 | 1.0–1.6 | 90 | 96 | 98 | 100 | 70 | 42 | 14.5 |
| BH01 | 1.3–1.9 | 56 | 80 | 98 | 100 | 55 | 34 | 13 |

Note:
LL – Liquid Limit
PI – Plasticity Index
LS – Linear Shrinkage

| Test Location | Sample Depth (m) | MMDD (t/m$^3$) | OMC (%) | CBR (%) | CBR Swell (%) |
|---|---|---|---|---|---|
| BH13 | 0.2-0.5 | 1.83 | 10 | 12 @5mm | 0 |
| BH14 | 0.2-0.5 | 1.99 | 10 | 40 @5mm | 0 |

Note:
MMDD – Maximum Modified Dry Density
OMC – Optimum Moisture Content
CBR – California Bearing Ratio (sample compacted to 95% MMDD, saturated, 4.5 kg surcharge)

#### 3.1.4.1. Observed groundwater levels.

Groundwater level observations were conducted during the fieldwork conducted over the 16th and 17th of August 2022. Groundwater water was encountered at 3 of the bore holes drilled on the stage 1 development site. Groundwater was encountered at surface for BH07, BH08, and BH 13 within the Town Centre expansion area.

As previously discussed, Hyd2o has installed groundwater monitoring bores across Lot 601 to confirm ongoing groundwater levels across the site. This monitoring commenced in June 2023 and is ongoing. However, results have indicated that groundwater has not been encountered within 1.5 m of the current ground surface. This supports the theory that the shallow groundwater / saturation observed in 2022 was as a result of surface water flows from the broader site accumulating and infiltrating in the southern area of the site.

This is not anticipated to occur in the future once development is completed as the additional lot scale and road network drainage systems will prevent the accumulation of surface run-off through interception and conveyance to the POS area of the site.

As such, the groundwater levels beneath the pre-developed town-centre are understood to be greater than 1.5 mbgl. The post-development finished earthworks levels across the town-centre site and in particular the location of the proposed TWW disposal area has increased by approximately 2m above natural surface – thereby creating additional vertical separation to groundwater.

### 3.1.5. Infiltration testing

Additional infiltration testing has been conducted across the site beyond the investigations presented in the previous Structerre (2022a and b) reports due to the previous methods (falling head infiltration tests) not being supported by the GSP (2019) and AS 1547. As such, constant head infiltration tests were conducted using a constant head permeameter. The tests were generally conducted in accordance with Appendix G of AS 1547 (2012) "On-site domestic wastewater management". The tests were conducted across the entire soil profiled of each bore hole and as such represents an average infiltration across the soil profiles encountered. The results of the testing as provided in Structerre (2022c) are summarised in Table 6.

**Table 5: Constant head infiltration test results**

| Test | Test Location (Lot) | Test Depth (m) | Soil Type | K[1] (m/day) | Soil Category[2] |
|---|---|---|---|---|---|
| BH 7 | TC | 0 – 1.4 | Sand to sandy clay – trace gravel | 5.0 | 2 |
| BH 8 | TC | 0 – 1.5 | Sand to sandy clay – trace gravel | 3.3 | 2 |
| BH 13 | TC | 0 – 1.4 | Sand to sandy clay – trace gravel | 2.6 | 3 |

Notes:

1. K-saturated hydraulic conductivity

2. Soil category in accordance with Table 5.1 and L1 of AS1547-2012.

### 3.1.6. Site soils summary

The soil profiles encountered closely correspond with the regional landform descriptions outlined in Section 2.3. Based on the soil descriptions across the site, and the physical performance of the soil profile as demonstrated by the constant head infiltration tests, the soil has been determined to at worst Category 3 classification as per the AS 1547 classification. As such, all design recommendations will be based on Category 3 soils as a conservative approach.

Groundwater was encountered at ground surface across the three sites in the stage 1 development area during August 2022. Based on the timing of the investigations (end of winter, end of August) coupled with the increased rainfall received during the 2022 winter months, this groundwater level is considered to represent the maximum groundwater level at this site. However, based on preliminary groundwater level results from ongoing monitoring and the impact that future drainage infrastructure will have on the site these

groundwater levels are not anticipated to occur in the future once development is completed.

The constant head infiltration tests indicate the site soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW). Clearance to groundwater will be managed through earthwork design at the site which will increase the ground surface elevation above the pre-development levels (and above the previously observed groundwater). This separation will also be managed by implementation of appropriate TWW systems and design of adequate LAA (area and elevation).

Given the relatively high occurrence of clayey sands and sandy clays across the site, the site soils are anticipated to have a very high P retention rate. It is recommended that fill be imported to the site to establish the LAA, where the re-use of in-situ is not available i.e., earthwork costs to high or insufficient volumes. Sands with a PRI of 10 are the recommended import fill option and would assist to retain phosphorus within the site's soils. Significant phosphorus retention is expected on site regardless of fill choice.

# 4. Land capability

## 4.1. Determination of soil-terrain units

Although a specific feature survey of the site has not been conducted and based on topographic mapping available and observations from the site visit, although relatively uniform, the site has been estimated to have an overall slope of approximately between 5 and 10% from the north to the south.

The maximum slope suitable for on-site sewage systems is dependent upon the type of system proposed and ranges from 10% to 30% (Standards Australia and Standards New Zealand 2012), noting that the surface application systems are more sensitive to slope. Although the slope ranges from 5-10%, the slope is relatively uniform across the site and as such, topographical units are not distinguished as part of this assessments.

Soil investigations (Section 3.1) align with the regional geological mapping and show the site can be generally categorised as sandy clay.

## 4.2. Sand soil-terrain unit

In accordance with Table 5.2 of the AS 1547, based on the soil descriptions across the site and the constant head infiltration test results, the soil has been determined to be either a soil Category 3 classification as per the AS 1547 classification (Standards Australia and Standards New Zealand, 2012). The results of the constant head infiltration test results, which have been conducted across the entire soil profile at each bore location are the primary driver of the adopted soil category as they provide an actual measure of the soil's physical ability to infiltrate TWW.

## 4.3. Additional site considerations

### 4.3.1. Flood-prone areas and erosion potential

The GSP (2019) outlines that on-site systems are not to be in areas that are subject to inundation and/or flooding in a 10% AEP rainfall event. As outlined in Section 2.7, it is expected that rainfall that the first 15 mm of rainfall events would be infiltrated locally, whilst larger events would be conveyed to a drainage network. Given the high permeability of the site soils, the generation of surface flows and erosion is considered a low risk.

The (then) Department of Water (now DWER) maps the site as not being within the flood level for the 1 in 10 (10%) annual exceedance probability (AEP).

#### 4.3.1.1. Site inundation potential

The GSP (2019) outlines that the location of any LAA should not be in an area that becomes inundated during a 10% AEP event. According to the Bureau of Meteorology Design Rainfall Data System (2016), a 24 hr 10% AEP rainfall event for the site is 87.4 mm. The infiltration rate across the site has been measured as having a minimum infiltration rate (constant head infiltration) of 2.6 m/day or 2,600 mm/day. As such, site inundation is not anticipated to occur within the site due to the high infiltration rates, it acknowledged that clayey sands and sandy clays are present at the site, however they have been demonstrated to have a reasonable capacity for infiltration. Any surface water flows generated by any larger events will be directed to the drainage network to a stormwater basin which will prevent inundation occurring (The stage 1 town centre layout is provided in Appendix B).

### 4.3.2. Drainage system and significant wetland separation

The GSP (2019) stipulates that on-site sewerage systems should not be located within 100m of a drainage system that discharges directly into a waterway or significant wetland without treatment. It should be noted that the drainage basin within the Stage 1 site is located within approximately 20m of the TWW disposal area. The basin is predominantly designed to retain and infiltrate stormwater, however during large events >10% ARI it will discharge into the Lily King Road drainage network. This roadside drainage network ultimately conveys stormwater to the Gingin Brook.

Although this basin is located within 100 m of the TWW disposal area it is not considered to present a risk due to the following:

- The stormwater basin has been designed so that it does not intersect groundwater. i.e., the invert of the basin is above groundwater.
- The stormwater basin is located approximately 20m up-hydraulic gradient of the TWW disposal area and as such is will not receive any inputs from infiltrated TWW.
- As part of the earthworks, an underground bund comprised of low-permeability material (in-situ clay) will be constructed between the infiltration area and the stormwater basin to create a hydraulic barrier between the two systems to ensure that infiltrated TWW cannot physically flow into the stormwater basin.
- The stormwater basin will be vegetated to promote additional removal of nutrients.

#### 4.3.2.1. Weld Street road-side swale

The weld street roadside swale is located adjacent to the western boundary of the site (Figure 7). The proposed LAA for Stage 1 of the Town Centre Expansion does not comply with the 100m setback as they are currently proposed to have an approximate 40 m setback.

This setback is considered to be acceptable. The Weld Street roadside swale is poorly defined and due to the drainage management proposed for the site it will not receive surface water discharge from the site, nor does it receive groundwater inflows. The roadside swale is extremely shallow, approx. <0.15m below ground level at its deepest and as such does not receive groundwater inflows. Groundwater levels (recorded in 18th August 2022) in the bore holes adjacent to the Weld Street drain indicated that the maximum groundwater level was recorded in BH06 at 0.6 mbgl (adjacent to location of Photo 1). This groundwater level is below the invert level of the Weld Street roadside swale.

Figures 9 to 14 are site photographs of the Weld Street roadside swale demonstrating the very shallow depth of this feature taken 15th March 2023. Subsequent groundwater monitoring during winter of 2023 which did not record any groundwater within 1.5m of the groundwater surface further corroborate that the Weld St roadside swale does not received groundwater inflows.


**Figure 9: Weld Street roadside swale photo locations**

**Figure 10: Weld Street roadside swale Photo 1**


**Figure 11: Weld Street roadside swale Photo 2**

**Figure 12: Weld Street roadside swale Photo 3**

**Figure 13: Weld Street roadside swale Photo 4**

**Figure 14: Weld Street roadside swale Photo 5**

### 4.3.3. Groundwater separation and site inundation potential

The groundwater clearance has been determined through monitoring that has occurred across the site during the 2023 winter months, commencing in June. Three shallow groundwater bores were installed across the site to a depth of 1.5 mbgl (Figure 6). Monitoring of these bores to date has not encountered any groundwater. A single deeper groundwater bore, installed to 8 mbgl, encountered groundwater at a depth of 6 mbgl.

#### 4.3.3.1. Previous site saturation

As previously outlined in Section 3.1.4.1 ground saturation at the site was observed during August 2022 field investigation resulting in groundwater effectively being at ground surface. The inundation observed during the August 2022 fieldwork program in these lower reaches of the site is anticipated to be a result of surface water runoff from the upper areas of the site accumulating in the southern portion of the site due to the significant rainfall received in the preceding 4 weeks. Post-development this will no longer occur as all surface run-off will be intercepted and managed through the road drainage network. In addition, the civil works of Stage 1 of the Town Centre will result in the finished levels for the LAA to be approximately 2 m above the natural ground surface. The stormwater management design for the Town Centre will also prevent inundation as all stormwater will be conveyed to a drainage basin prior to infiltration.

### 4.3.4. Rainfall run-off and seepage

The UWMP (Hyd2o 2023) details the stormwater design strategy to manage stormwater post-development. The strategy includes the implementation of:

- Detention of the first rainfall on lots (likely through soak wells)
- Treatment of the first 15 mm of road run-off in biofiltration areas or swales
- Piped road drainage network sized to ensure roads are passable during 20% AEP event.
- Road reserves are capable of conveying up to and including the 1% AEP event.
- Flood detention areas to detain up to the 1% AEP event on-site
- 10% and 1% AEP flows to be maintained within pre-development flow rates.

### 4.3.5. Other setbacks

Other setback distances required for leach drain systems will be in accordance with AS 1547.

## 4.4. Available Land Application Area (LAA)

Table 8 outlines the length of leach drain requirements based on AS/NSZ 1547.2012 methodology and associated soil classification design loading rates (DLR). The use of irrigation as the disposal method is not recommended as it would require a larger LAA.

The calculation of the minimum trench length required to discharge wastewater (based on trench design) is described in AS 1547 using the following methodology:

L = Q / (DLR x W)

Where:

L = length in meters

Q = designed daily flow L/day (6,290 based on Department of Health – wastewater loading rates))

DLR = designed loading rate in mm/day (30 mm/day as per AS 1547 for category 3 soils

W = width in m (Aquarius Wastewater leach drain (AqwaCell 16 is 2 m)

**Table 6: Land application areas for Stage 1 Town Centre (estimated loading 6,290 L/day (GSP, 2019)**

| Soil category | Soil texture | Land application area ($m^2$) | |
|---|---|---|---|
| | | Leach Drain | |
| | | Design loading rate (secondary treatment) | Length of trench(m)[1,2] |
| 1 | Gravels and sands | 50 | 62.9 |
| 2 | Sandy loams | 50 | 62.9 |
| 3 | Loams | 30-50 | 62.9 - 105 |
| 4 | Clay loams | 10-30 | 105 – 314.5 |
| 5 | Light clays | 8-12 | –262 - 393 |
| 6 | Medium to heavy clays | Special design | Special design |

Note: 1 – based on Aquarius AqwaCell 16 leach drain design with 2m width.

2 – AS 1547.2012 details leach drain length requirement determined by Q /(DRL x width of drain)

#### 4.4.1.1. Town Centre

As the site has been classified as having Category 3 soils and leach drain width of 2m, the minimum leach drain length is 105 m based on a leach drain width. The detailed site development plans are shown in Figure 15 below. From these plans and advice from the developer on expected occupancy numbers the volumes of waste water generated were be estimated.

The hydraulic loading for the site is summarised in Table 8. The hydraulic loading assessment results in a total hydraulic loading of 6,290 L/day and is in accordance with AS/NSZ 1547.2012 and Supplement to Regulation 29 Health (treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974.

Based on loading rates, soil category DLR's and prescribed LAA conversion factors the LAA required for the Town Centre is as follows:

- Total leach drain trench length required – 105 m ( comprised of 5 individual leach drains)

The total occupancy numbers for Stage 2 of the Town Centre expansion are currently unknown. However, provision will be made for the duplication of the treated wastewater disposal requirements within Stage 2 i.e., will be a separate system to Stage 1. It is acknowledged that a separate approval will be required for Stage 2.

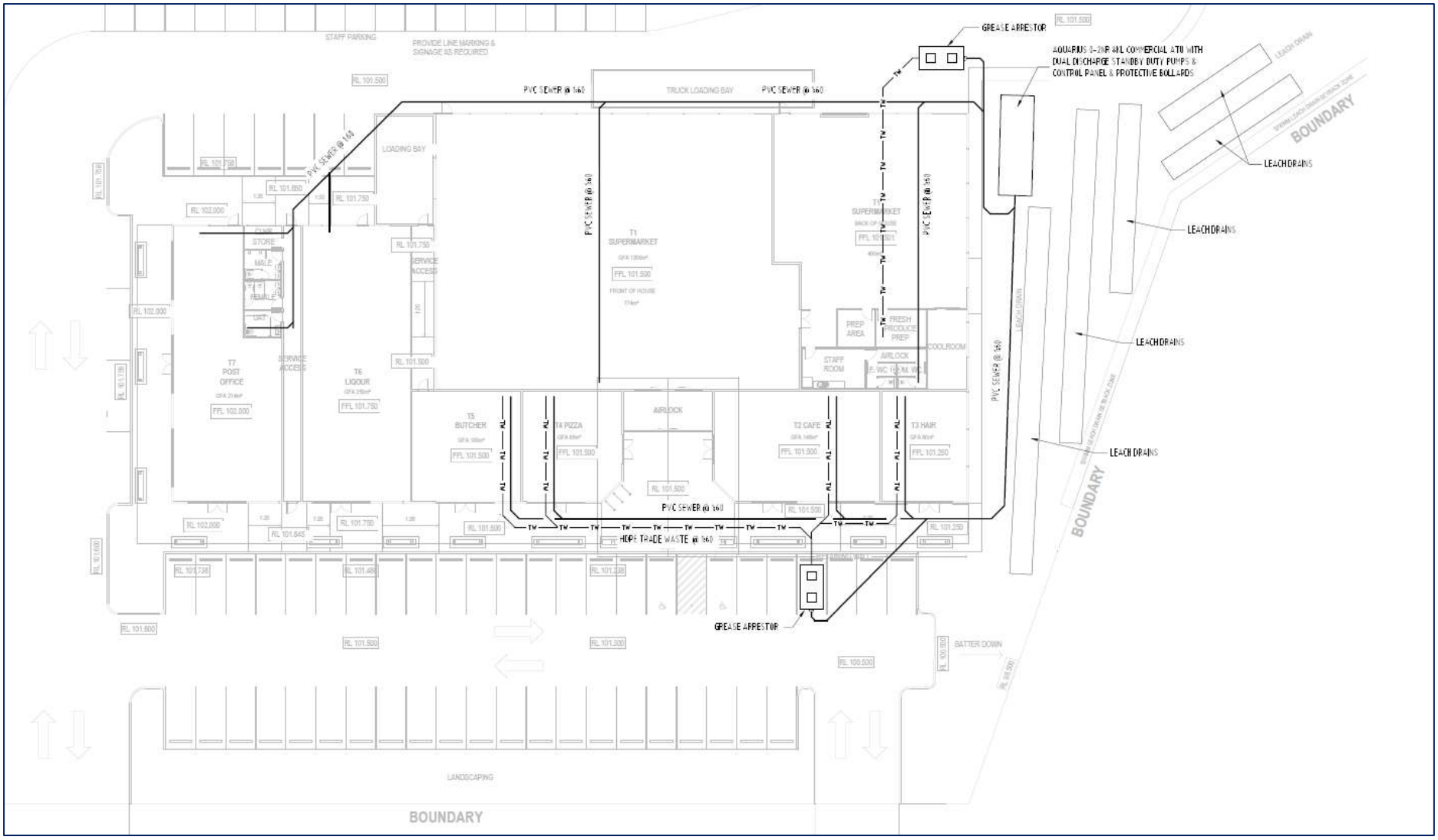


**Figure 15: Detailed Town Centre Expansion Development Plan**

**Table 7: Stage 1 Town Centre Expansion Area Hydraulic Loading Estimates**

| Stage 1 | | | | |
|---|---|---|---|---|
| **Premises Type** | **User Type** | **Number of persons** | **Combined Flow (L/person/day)** | **Total Wastewater Generated (L/day)** |
| **Supermarket** | Staff (non-showering) | 5 staff x 2 shifts Total - 10 | 30 | **300** |
| | Customers (using the on-site toilet facility) | 150 | 10 | **1,500** |
| **Hair Dresser** | Staff | 3 | 70 | **210** |
| | Customer (allowance for hair wash / shampoo) | 40 | 15 | **600** |
| | Allowance for cleaning of equipment | | | **200** |
| **Café** | Café staff | 4 | 70 | **280** |
| | Sit in customer | 50 | 30 | **1,500** |
| | Allowance for food preparation and cleaning | | | **300** |
| **Pizza shop** | Staff | 4 | 70 | **280** |
| | Allowance for food preparation and cleaning | | | **300** |
| **Butcher** | Staff | 3 | 70 | **210** |
| | Allowance for food preparation and cleaning | | | **400** |
| **Liquor Store** | Staff (non-showering) | 2 staff x 2 shifts Total = 4 | 30 | **120** |
| **Post Office** | Staff (non-showering) | 3 | 30 | **90** |
| **Total** | | | | **6,290 L/day** |

## 4.5. Results

The soil-terrain unit determined for the site can accommodate on-site sewage treatment and disposal.

Based on the above assessment, and through the special design of the treatment system to address the achievable setbacks as previously described, the site is considered suitable for on-site sewage treatment and disposal. This will be achieved in lines with the GSP (2019) and AS 1547.

# 5. Wastewater management

## 5.1. Site requirements

The GSP outlines the minimum site requirements for onsite sewerage disposal to protect public health and the environment. An onsite sewage system is not to be located within:

- a wellhead protection zone or on Crown land within a reservoir protection zone
- 30 metres of a private bore used for household/ drinking water purposes.
- 100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer.
- 100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment
- any area subject to inundation and/or flooding in a 10% AEP rainfall event.
- 1.5 metres above the highest groundwater level (in sewerage sensitive area)

Additional setbacks to structures which impact the sizing and location of the available land application areas include:

- 1.2 metres between treatment tanks to buildings, property boundaries, driveways,
- paths, and other tanks
- 1.2 metres between tranches, beds and soak wells to trafficable areas
- 1.8 metres between tranches, beds and soak wells to boundary, building, tanks and other land application systems
- Sub surface dripper to
  - Boundaries, building, treatment tanks, driveways 0.5 m
  - Open drain 3.0 m
  - Garden bore 10 m.

This SSE has demonstrated that the site is able to achieve all the necessary buffers needed to protect public health and the environment.

## 5.2. Proposed treatment systems

The treatment systems must be designed and installed in accordance with AS 1547 and the DoH. Disposal and treatment systems approved by the DoH must be used. Due to the size of the lot, and the site being in a Sewerage Sensitive Area (proximity to sensitive wetlands), the site will be required to install a secondary treatment system (STS) (such as aerobic treatment unit) with nutrient removal capabilities. This will maximise the useability of the lot as secondary treated effluent requires a smaller LAA.

Primary treatment systems, including septic tanks are not suitable at this site due to its location within an SSA, as per ASNZ1547-2012.

STS, with nutrient removal capabilities can produce treated effluent of secondary standard, that is

- ≤20 mg/L of Biochemical Oxygen Demand (BOD),
- ≤ 30 mg/L of Total Suspended Solids (TSS) and
- ≤ 10 cfu/100 mL of *Escherichia (E) coli*.

In addition, the levels of nitrogen and phosphorus must be reduced to:

- <10 mg/L nitrogen
- <1 mg/L phosphorus.

## 5.3. Discharge loading rates

The hydraulic loading volume for Town Centre has been summarised in Table 8.

This results in a total hydraulic loading of 6,290 L/day and is in accordance with AS/NSZ 1547.2012 and Supplement to Regulation 29 Health (treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974.

The discharge loading rate adopted from Table 5.1 and L1 from AS/NZS 1547.2012 is 30mm/day which is the lower limit recommended for soil Category 3 soils and as such provides a conservative approach to the LAA design.

## 5.4. Land application system and disposal area

The treated wastewater is required to be disposed to land within the Stage 1 boundary. Based upon the land area requirements for the various disposal systems and the available land, leach drains will be used to dispose of the treated wastewater.

In addition, leach drains are recommended for this site as they result in a reduced human health risk through reducing potential contact with wastewater.

## 5.5. Land application area

### 5.5.1. Clearance to groundwater

2023 groundwater monitoring has demonstrated that groundwater clearance from the natural ground surface is at least 1.5 m – likely to be approximately 6mbgl. In addition, the civil works will result in the final land form being approximately 2 m higher than the pre-development land surface. As such the clearance to groundwater will be greater than the minimum requirement of 1.5 m.

### 5.5.2. Land application area

As detailed in Section 4.4, a leach drain system has been designed to accommodate a hydraulic load of 6,290 L/day. The disposal area complies will all setbacks other than being 100 m away from drains that flow directly into a sensitive environmental receptor – that being the Weld St road-side swale and the Brockman Street drainage system. However, as previously discussed both drainage systems do not receive groundwater inflows and as such will not receive any inflows from the TWW disposal system.

# 6. Summary

The development consists of an expansion of the Town Centre. The Town Centre expansion has an area of approximately 22,800 m². The site is in a Sewerage Sensitive Area (SSA) as it is located within 1 km of a sensitive wetland: CCW associated with the Gingin Brook. The site will be developed in a staged approach, each having separate wastewater disposal systems. The Stage 1 site has sufficient area to achieve the required LAA and environmental impacts are considered acceptable, the development is not anticipated to impact the nearby wetland due the treatment proposed, nor is it considered to pose an environmental or human health risk.

Results of the site and soil assessment indicate the soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW). Groundwater clearance of 1.5 m has been demonstrated through groundwater monitoring across the site during winter of 2023 indicating groundwater across the site is deeper that 1.5 m below the natural surface. In addition, the civil works for Stage 1 of the town centre will result in the disposal area being raised by approximately 2 m above the existing ground surface.

Previous inundation of the southern portion of Lot 601 will be controlled through the stormwater management systems (road drainage etc) within the urban area to the north. This will prevent inundation of the site which was previously observed in 2022. The 2023 groundwater monitoring conducted indicates that previous groundwater levels recorded in the southern portion of Lot 601 were as a result of the accumulation and infiltration of surface run-off from the upper catchment of the site. This will no longer occur post construction due to the stormwater controls that will be implemented.

Site soils are anticipated to have a very high P retention due to the clayey nature of the underlying geology.

It is recommended that if appropriate in-situ fill is unavailable, fill be imported to the site to complete the civil works to establish the LAA. Sands with a PRI of 10 are the recommended fill option and would provide additional phosphorus retention benefits. Significant phosphorus retention is expected on site regardless of fill choice.

Section 5.2.2 of the Government Sewerage Policy (2019) relating to the extent of seasonal inundation has been addressed by the following:

- Recent groundwater monitoring (winter 2023) has demonstrated groundwater to be a depth greater than 1.5 m below ground level.
- The proposed earthworks design of the Town Centre Expansion area and road drainage network of the remainder of the development have modified the sites hydrological regime to prevent the accumulation of surface run-off from the upper catchment area in the stage 1 portion of the site. This will prevent the accumulation and infiltration of surface runoff occurring as was observed during the August 2022 field investigations.
- Civil works within the Town Centre will result in the LAA being approximately 2m above the pre-development ground surface level.

LAA fill requirements have been provided based on achieving clearance to the observed maximum groundwater level (as per 2022 monitoring) in accordance with the GSP (2019).

This SSE demonstrates the site can accommodate a suitable wastewater management system.

# 7. Conclusion

The sewage management strategy for the site, as outlined in this report, has been developed to be consistent with the approach and requirement details in the *Government Sewerage Policy* (DPLH, 2019) and *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand 2012), and includes:

- Earthwork and stormwater drainage design to prevent accumulation of surface run-off and inundation in the site and associated LAA.
- Utilising secondary treatment systems with additional nutrient removal
- Appropriate sizing of the land application area / trench sizes based on the geotechnical investigations and classification of the soil classification of the site.
- Ensuring there is sufficient disposal area within the site.
- Special design of the treatment system to reduce the risk of groundwater pollution in accordance with AS 1547.
- Utilising ameliorated existing site soils or the importation of suitable soil (both with higher nutrient retention than the existing site soils) to comply with the disposal outlet height and minimum groundwater clearance requirement of 1.5 m. This soil will be assessed prior to the installation of the secondary treatment system to ensure the soil category and compliance with the design detailed within this document.
- Ensuring appropriate installation, monitoring and maintenance of the systems is conducted.

It is considered that the above investigations and management demonstrate that the site can accommodate the on-site treatment and disposal of sewage within the site and that this can be achieved in a way that mitigates the potential risk to the environmental and human receptors.

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Structerre (2022b): Site and Soil Evaluation Report – Lot 601 Brockman Street, Gingin.

Structerre (2022c): General Site and Soil Evaluation Report – Lot 601 Brockman Street, Gingin. Unsubmitted report.

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# Appendix A: Lot 601 Site and Soil Evaluation (Pentium Water 2023)

PENTIUM WATER

# SITE AND SOIL EVALUATION

## Lot 601 Brockman Street, Gingin

ACUGING_01

20/03/2023

# Document Status

| Version | Purpose of document | Authored by | Reviewed by | Review Date |
|---|---|---|---|---|
| Draft A | Draft for Review | S. Hewitt | | |
| Rev 0 | Final for Issue | S. Hewitt | S. McSweeney | 10/02/23 |
| Rev 1 | Final for Issue | S. Hewitt | S. McSweeney | 20/03/2023 |
| | | | | |
| | | | | |

# Approval for Issue

| Name | Signature | Date |
|---|---|---|
| Shane McSweeney |  | 20/03/23 |

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# Executive Summary

Acumen Development Solutions (herein referred to as “Acumen”) proposes to develop and use Lot 601 Brockman Street, Gingin (herein referred to as “the site”), for residential lots, the extension of the Town Centre and associated Public Open Space (POS) with a total development area of approximately 17.6 hectares (ha). Individual lot sizes will range between approximately 980 and 2,600 m² with the Town Centre expansion area and associated POS comprising an area of approximately 22,700 m².

This SSE report has been prepared to expand on the work previously completed by Structerre (2022a and b) that more thoroughly addresses the human health and environmental risks raised in accordance with the Government Sewerage Policy 2019 (GSP) and AS/NZS 1547:2012 *On-site domestic wastewater management* (AS 1547) (Standards Australia and New Zealand, 2012) to support an updated Western Australian Planning Commission (WAPC) submission for the development. The infiltration test results presented within this report supersede the previously submitted results in the Geotechnical report (Structerre 2022a) and the Site and Soil Evaluation report (Structerre 2022b).

The site is zoned predominantly as “Residential” under the Shire of Gingin’ Local Planning Scheme (LSP) No. 9 with the southern portion of the site be classified as a combination of “Town Centre” and “Parks and Recreation”. The site is bounded by Brockman Street to north and east and Weld Street to the west. The southern boundary of the site adjoins the Shire of Gingin offices and town centre. Existing residential areas of the townsite are present adjacent to the north and the east of the site with the Gingin Brook located approximately 250 m to the south. The site is located approximately 66 km north-northeast of Perth central business district (CBD) within the Shire of Gingin (SoG)

The site is in a Sewerage Sensitive Area (SSA) as it is located within 1 km of a significant wetland. The GSP (2019) requires that the subdivided lots within SSAs have a minimum lot size of 1 hectare. It has been noted that the site has previously been provided with lot zoning within a regional structure plan and therefore possible these minimum lot sizes are not required provided that the minimum Land Application Area (LAA) can be achieved, and environmental impacts are considered acceptable. As the site is not anticipated to impact on any wetlands in proximity to the site (due to the nature of surface and groundwater flow), and the minimum LAA can be achieved, the development design with 980 – 2,600 $m^2$ lots is not considered to pose an environmental or human health risk.

Post-development earthwork and stormwater management of the development has been designed to prevent the accumulation and infiltration of surface water run-off that was observed during pre-development investigations in August 2022.

Results of the site and soil assessment indicate the soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW), however achieving the required clearance to groundwater 1.5m across was not achieved in a number of areas across the site. This will be managed through stormwater management, implementation of appropriate TWW systems and disposal design and adequate LAA design and construction. Site soils are anticipated to have a very high P retention due to the clayey nature of the underlying geology.

It is recommended that if appropriate in-situ fill is unavailable, fill be imported to the site to establish the LAA and an appropriate level above the natural ground surface to achieve the required groundwater clearances across the site. Sands with a PRI of 10 are the recommended fill option and would provide additional phosphorus retention benefits. Significant phosphorus retention is expected on site regardless of fill choice.

A proposed setback of 20m to the Weld Street roadside swale has been proposed. This poorly defined drainage feature, due to its shallow nature and the proposed ‘rear of lot’ drainage system will not receive groundwater or surface water inflows from the site.

This SSE demonstrates the site can accommodate a suitable wastewater management system through having sufficient area to accommodate the LAA and through being able to achieve the required groundwater clearance through importation of fill during the construction of individual LAA’s.

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# 1. Introduction

## 1.1. Background

Acumen Development Solutions (herein referred to as “Acumen”) proposes to develop and use Lot 601 Brockman Street, Gingin (herein referred to as “the site”), for residential lots, the extension of the Town Centre and associated Public Open Space (POS) with a total development area of approximately 17.6 hectares (ha). Individual lot sizes will range between approximately 980 and 2,600 m² with the Town Centre expansion area and associated POS comprising an area of approximately 31,808 m². The site is bounded by Brockman Street to north and east and Weld Street to the west. The southern boundary of the site adjoins the Shire of Gingin offices and town centre. Existing residential areas of the townsite are present adjacent to the north and the east of the site with the Gingin Brook located approximately 250 m to the south. The site is located approximately 66 km north-northeast of Perth central business district (CBD) within the Shire of Gingin (SoG). The location of the site is shown in Figure 1.


**Figure 1: Site locations**

## 1.2. Planning context

The site is zoned predominantly as “Residential” under the Shire of Gingin’ Local Planning Scheme (LSP) No. 9 with the southern portion of the site be classified as a combination of “Town Centre” and “Parks and Recreation”.

## 1.3. Proposed development

The development consists of R5 and R10/R30 lots (a total of 99 lots) comprising an area of 17.6 ha and an extension of the town centre in the southern portion of Lot 601 with an are of approximately 2.47 ha.

### 1.3.1. Lot zoning

Plate 1 below, which has been taken from the Shire of Gingin Council Minutes 6th December 2022 (available here: https://www.gingin.wa.gov.au/council-meetings/past/2022), details the recognition by the SoG that the site was previously zoned as R5 and R10/R20 density. In addition, it was acknowledged that deep sewer is cost prohibitive, and that onsite secondary treatment of wastewater is required.

Plate 2 demonstrates compliance of the subdivision proposed lots with the previously zoned lot densities.

The Government Sewerage Policy states:

*Land in a sewerage sensitive area that is already zoned for urban use with a residential density coding of R2 to R10 under a local planning scheme or structure plan endorsed by the Western Australian Planning Commission, may be subdivided in accordance with the existing density coding. Where R10 subdivision is proposed, it should be demonstrated that the density coding was assigned with the understanding that reticulated sewerage would not be provided.*

The land has been earmarked for these purposes for some considerable time, prior to the Government Sewage Policy being introduced. Various investigations into the viability of deep sewer provision have proved it to be cost prohibitive. Given the circumstances, the officer is of the view that a secondary treatment unit servicing each lot is appropriate and the documentation provided in support of the subdivision adequately demonstrates the ability of the land to dispose of effluent.

The suggested conditions require a notification to be placed on the land titles to alert prospective purchasers that deep sewer is not available and that a secondary level treatment system is required.

The officer notes that the Department of Health with provide the WAPC with separate comments in this regard, as will the Department of Water and Environmental Regulation (DWER) in relation to water management.

**Plate 1: Extract from Shire of Gingin minutes 6th December 2022**

Design

The table below provides an overview of the proposed residential lot sizes:

| | Required | Proposed |
|---|---|---|
| R5<br>minimum lot size | 2000m$^2$ | 2,025m$^2$ - compliant |
| R10<br>minimum lot size<br>Average lot size | 875m$^2$<br>1,000m$^2$ | 980m$^2$ - compliant<br>1,123m$^2$ - compliant |

**Plate 2: demonstration of proposed lots compliance with previously assigned residential density coding.**

## 1.4. Purpose of this report

This SSE report has been prepared to expand on the work previously completed by Structerre that more thoroughly addresses the human health and environmental risks raised in accordance with the Government Sewerage Policy 2019 (GSP) and AS/NZS 1547:2012 *On-site domestic wastewater management* (AS 1547) (Standards Australia and New Zealand, 2012) to support an updated Western Australian Planning Commission (WAPC) submission for the development. The site investigations and a draft and previously unsubmitted General Site and Soil Evaluation report prepared by Structerre (2022c) is provided in Appendix A.

## 1.5. Previous Reports

A number of geotechnical field programs and associated reporting have been previously undertaken to support the development of the Urban Water Management Plan (UWMP) (Hyd2o hydrology, 2023), these supporting reports are:

- Structerre (2022a) – Geotechnical Investigation: Proposed Residential Subdivision – Lot 601 Brockman St, Gingin WA, May 2022.
    - This report included site specific geotechnical investigations to support the development design including earthworks, road networks and the stormwater drainage design.

- Structerre (2022b). Site and Soil Evaluation for Onsite Sewage Management – Lot 601 Brockman Street, Gingin WA, September 2022.
    - This report was prepare to demonstrate the site's suitability to accommodate the disposal of treated wastewater (TWW) in accordance with the Government Sewerage Policy (GSP) (2019).

It should be noted that although the site infiltration tests (falling head infiltration test) as conducted for the above two reports was suitable for the design requirements of the UWMP, it was not a supported methodology by the GSP (2019). As such additional site investigation was undertaken which included the completion of 26 constant head infiltration tests across the development site in accordance with the GSP (2019).

This report presents and discusses the results of the additional constant head infiltration tests to demonstrate the site's compliance with the GSP (2019)

## 1.6. Previous site reports and investigations

Reports that have previously been prepared for the site and utilised to inform the development of the SSE are discussed below.

- Urban Water Management Plan – Lot 601 Brockman Street, Gingin (Hyd2o, 2022): An Urban Water Management Plan (UWMP) was prepared by Hyd2o hydrology in 2022 as required for subdivision submission and approval. The document covers the entire development and details the drainage management plan for the subdivision of the subject site.

# 2. Existing environment

## 2.1. Climate

The nearest Bureau of Meteorology (BoM) weather station to the site is Gingin (Station Number 9018), located approximately 0.5 km to the southwest of the site. Based on the rainfall data collected from 1891 to 2022 at this station, the local area experiences an average of 737.7 mm rainfall annually.

Other climate data has been taken from Gingin Aero (station number 9178) with evaporation data from Perth Airport (Station Number 9021) located approximately 65 km to the south of the site as this is the closest BoM recording weather station with this data. Based on climate data collected from 1968 to 2022, the local area experiences a mean maximum temperature of 33.2° C and a mean minimum temperature of 6.5℃ (BoM 2022). The monthly mean climatic data for rainfall and temperature is summarised in Table 1 below, with monthly rainfall data for the previous few years presented in Figure 2.

**Table 1: BoM Weather Stations No. 9018 (rainfall 1891-2022), 9178 (temperature) and 9021 (Perth Airport) evaporation (1986 to 2022)**

| Statistic | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean rainfall** | 10.2 | 13.6 | 17.9 | 33.3 | 97.3 | 140.2 | 145.6 | 113.3 | 69.2 | 46.4 | 20.0 | 10.8 | 737.7 |
| **Mean max temp** | 33.2 | 33.1 | 30.8 | 26.8 | 22.7 | 19.7 | 18.4 | 19.1 | 20.9 | 24.3 | 28.0 | 31.0 | 25.7 |
| **Mean min temp** | 16.4 | 17.1 | 15.4 | 12.0 | 8.9 | 7.2 | 6.5 | 6.6 | 7.4 | 9.1 | 11.9 | 14.5 | 11.1 |
| **Mean evaporation (mm)** | 316.2 | 268.8 | 238.7 | 150 | 93 | 66 | 65.1 | 80.6 | 111 | 167.4 | 228 | 282.1 | 2080.5 |

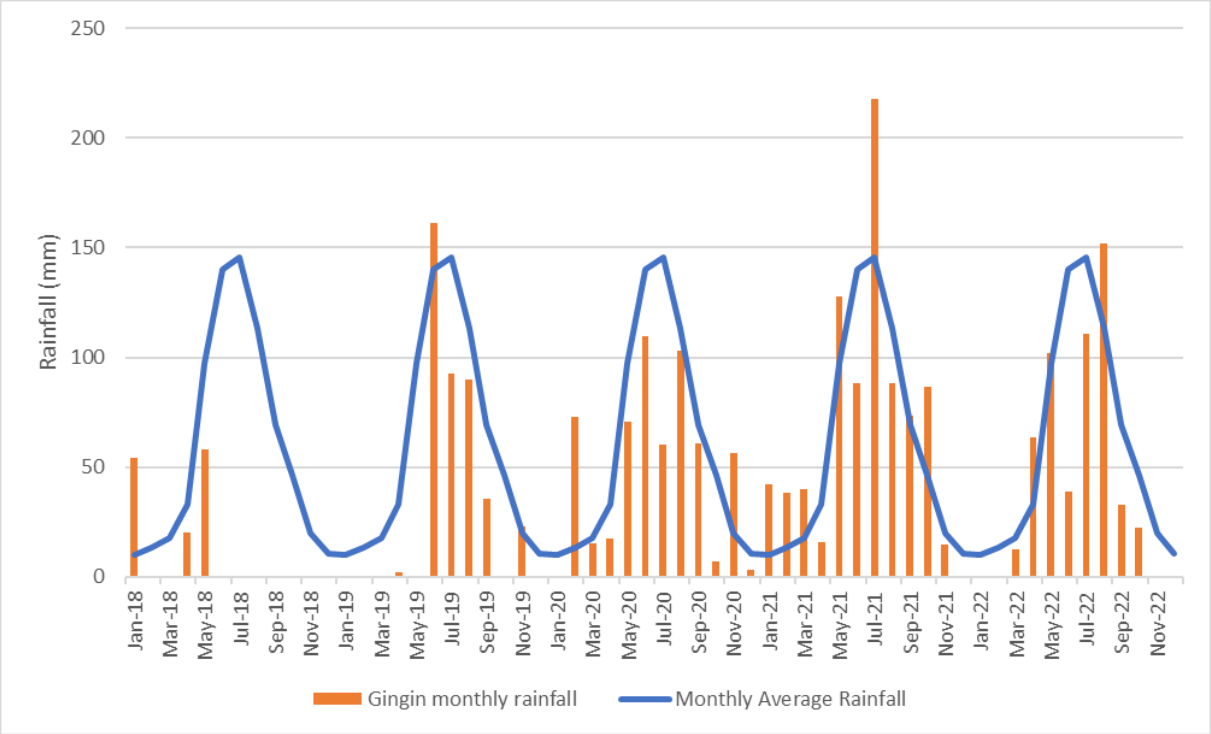


**Figure 2: Monthly rainfall data - Gingin Station (BoM site 9018)**

As shown in Figure 1, rainfall recorded for August of 2022 exceeded the average monthly rainfall for this site. Further analysis indicates 254.4 mm of rainfall was recorded in the four weeks between 17th July 2022 and 17th August 2022 64% of the mean winter rainfall between 1st June – 31st August.

Evaporation data estimated from The Department of Agriculture and Food (1987) data indicates that evaporation generally exceeds rainfall annually at the site. On average there are four months of the year (May to August) where the rainfall exceeds the evaporation at the site.

## 2.2. Topography

The regional topographic contours show that the site slopes in a south / south-easterly direction with elevations across the site ranging from approximately 130 m Australian Height Datum (m AHD) in the northern portion of the site to 98 m AHD in the south. The surface gradient of the site varies between 5 and 10% with an average slope of approximately 7%. Regional topographic contours are presented in Figure 3.


**Figure 3: Site topography**

## 2.3. Regional landforms and soils

The Gingin sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by predominantly colluvium soil and undifferentiated sand.

Structerre's site geotechnical investigations conducted during May 2022 (13 bore holes) and August 2022 (30 boreholes) provided additional detail to the site geological conditions. The reported soil conditions broadly align with regional conditions. Three main soil profiles were identified across the site which are summarized below:

- **Profile 1**:
    - Topsoil – grey, fine to medium grained - 0.1 – 0.2 m
    - Silty sand – fine to medium – 0.2 – 1.2 m
    - Sand – grey, fine to medium grained, with clay and gravel inclusions – 1.2 – 2.5m
- **Profile 2:**
    - Topsoil – grey, fine to medium grained - 0.1 – 0.2 m
    - Silty sand – fine to medium – 0.2 – 0.65 m
    - Clay / sandy clay – high plasticity, trace sands and gravels – 0.65 – 2.5m
- **Profile 3:**
    - Topsoil – grey, fine to medium grained - 0 – 0.1 m
    - Clay / sandy clay, medium to fine grained, high plasticity with trace sands and gravels 0.1 – 2.5 m

The location of the bore holes conducted as part of the geotechnical investigations is presented in Figure 4.

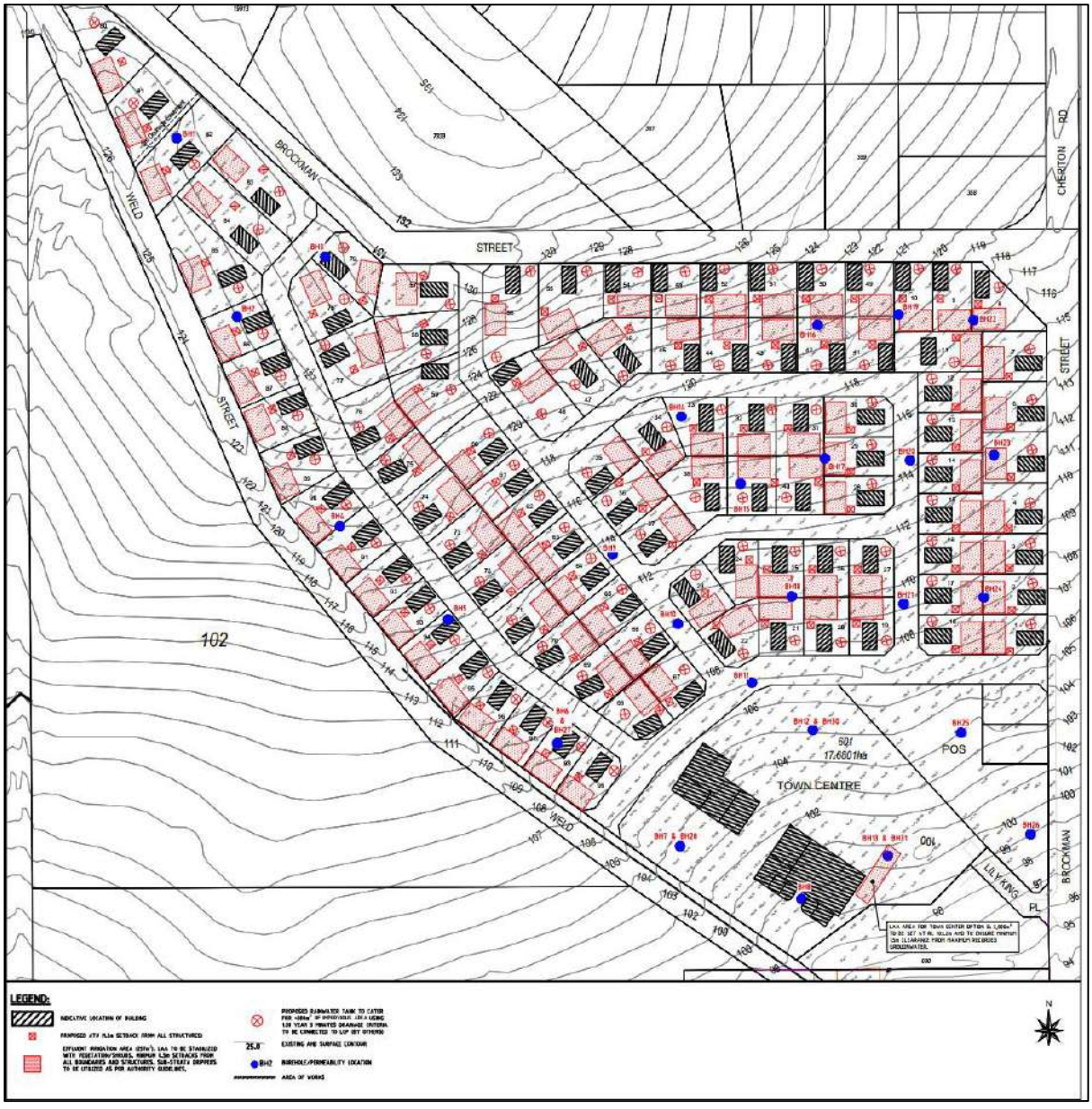


**Figure 4: Investigation borehole locations (blue)**

## 2.4. Acid sulfate soils

The (then) Department of Environmental Regulation (DER, now Department of Water and Environmental Regulation, DWER) mapped the site not having and acid sulphate soil risk within the site (refer Figure 5).

## 2.5. Public drinking water source areas

The site is not located within a public drinking water source area (PDWSA) and is located approximately 250 m southwest (down hydraulic gradient) of P2 public drinking water source area associated with the Gingin Water Reserve Area.


**Figure 5: Acid sulfate soil mapping and PDWSA.**

## 2.6. Groundwater

The site is located within the Gingin Townsite subarea of the Gingin Groundwater Management Area.

Department of Water and Environmental Regulation (DWER) groundwater contours are not available for the site, however according to the Perth Groundwater Map (DWER, 2022), contours starting approximately 3.5 km to the south of the site and indicate regional groundwater flows generally east to west. It is acknowledged that localised groundwater flow directions may generally align with topography. As such groundwater may potentially flow in a southerly direction within the site towards the Gingin Brook before trending west in line with regional groundwater flow.

Depth to groundwater information is not available from DWER's Perth Groundwater Atlas and the Water Information Reporting online database only provides groundwater data for a single site approximately 500m to the south of the site. Data from this bore (WIN bore 61710528) indicates a maximum groundwater elevation of approximately 81.4 m Australian

Height Data (mAHD) in 2008. Groundwater elevations have declined since at this location by approximately 1.5 m since 2008.

Information on the regional groundwater resources obtained from the DWER's online databases indicates that the site is underlain by a dual-layered aquifer system comprised of the following resources:

- Perth – Superficial Swan
- Perth – Leederville (confined)

Groundwater levels were measured across the site during geotechnical investigations conducted on the 16th and 17th August 2022 via a series of 26 bore holes across the site (Figure 4). The site investigations are described in detail in Section 3.0. During the August 2022 site investigations, groundwater was only encountered within five of the 26 bore holes (BH6, BH 7, BH8, BH 12 and BH 13) which are all located in the southern area of the site and predominantly the Town Centre expansion area. At these locations, groundwater was encountered at 0.6 metres below ground level (mbgl) at BH6 and at the ground surface at all other locations where groundwater was encountered.

It is noted that 13 bore holes where groundwater was not encountered did not extend past 1.5 mbgl. As such, these locations will be addressed on a site by site basis to ensure adequate groundwater clearance is achieved; this is further detailed in *Section 4.3.3.*

It should be noted that the rainfall recorded for August of 2022 exceeded the average monthly rainfall for this site. Further analysis indicates 254.4 mm of rainfall was recorded in the four weeks between 17th July 2022 and 17th August 2022 64% of the mean winter rainfall between 1st June – 31st August.

### 2.6.1. Groundwater and surface water licences

A review of DWER's online Groundwater Register (DWER 2023) indicate that there are a number groundwater and surface water licences within 500m of the site. A summary of the nearby water allocation licences is provided in Table 2 below.

Majority of the licences are located up- or cross-hydraulic gradient of the site, with those located down-hydraulic gradient or significantly close to the site discussed further below.

The majority of the groundwater licences in close proximity to the site are within the confined Leederville aquifer. The only superficial groundwater licence is located up-hydraulic gradient of the site.

It is noted that a number of surface water drawpoints are identified on the Groundwater Register (DWER 2023), however at the time of writing no associated licence details were not available – this does not preclude the existence of surface water licences being present in close proximity to the site.

Given the above, and proposed wastewater treatment systems (refer Section 5.2). It is therefore unlikely that site development and related wastewater management will pose any risk to these licences.

There are no groundwater licences associated with the site. However there are a number of groundwater and surface water licences within a 500 m radius of the site. These are summarised in Table 2 below.

**Table 2: Surrounding groundwater licence holders (within 500 m of the site)**

| Licence number | Type | Owner | Resource | Volume (kL/yr) | Comment |
|---|---|---|---|---|---|
| 157187 | Groundwater | Slater, Geoffrey, Alan, Slater Annette Frances | Perth – Superficial Swan | 154,000 | Located 200 m north-west of site (up hydraulic gradient) |
| 174201 | Groundwater | Shire of Gingin | Perth – Leederville - Parmelia | 22,950 | Two sites – adjacent to the south of the site. Likely POS irrigation water. |
| 65089 | Groundwater | Water Corporation | Perth – Leederville - Parmelia | 210,000 kL | Two sites – 500 m to the east of the site. Likely abstraction bores associated with the Gingin PDWSA |
| 179971 | Surface Water | Shire of Gingin | Gingin Brook 3 | 2,250 kL | Unknown use. 150 m east of the site |
| 151889 | Surface water | Greville, Maxine Carole | Gingin Brook 3 | 1,500 kL | Unknown use, 500 m south-west |

## 2.7. Drainage

### 2.7.1. Pre-development

Surface water flows are anticipated to flow south overland towards the southern boundary of the site. A cut-off drain within the site and a shallow open drain following the fence-line have been constructed to direct flows to the east and west respectively and around the shire buildings to the south.

There are two minor catchments in the north of the site. One catchment in the northwest portion of the site drains to an external catchment through the site to culverts under Weld St, then flowing south-east through the downstream property to Roe St. The other small catchment in the north-eastern corner of the site is located in the Robinson St drainage system catchment.

All flows generated from the site that enter the drainage system are then conveyed to the Gingin Brook located approximately 250 m to the south of the site (Figure 6).


**Figure 6: Surface water catchments and drainage**

### 2.7.2. Post-development

Post-development drainage for the site will include the retention and infiltration of the first 15 mm of rainfall within individual lots. Larger events and direct rainfall on the internal roads of the development will be conveyed via a piped road drainage network.

Individual lot owners will be responsible for ensuring that all land application areas (LAA) are protected from surface flows generated within individual lots i.e. via spoon drains connected to soak wells etc. to prevent the flow of surface water impacting the LAA.

#### 2.7.2.1. Additional rear of lot drainage

To protect lots that do not naturally grade towards the internal road and associated drainage network a lot drainage system has been proposed to capture any potential surface water flows that would potentially flow into adjacent downhill lots and the Weld Street road side swale (Figure 7). This system utilises drainage collection risers to capture any overflow from

the lot storage and any potentially generated surface runoff within the lot. Appendix B, provides the complete proposed 'rear of lot' drainage design. This drainage system does not preclude the lots from the requirement to retain the 15 mm rainfall event, but rather to manage any potential surface water flows generated from the pervious areas within the lot. Surface run-off generation potential is discussed in Section 4.3.1.1.


**Figure 7: 'Rear of Lot" drainage network layout (dark blue lines)**

## 2.8. Vegetation and exposure

The site has been extensively cleared for rural use purposes and consists of pasture with the exception of spares trees and a remnant gathering of trees in the south-east corner. The site is predominantly comprised of open paddocks.

It is anticipated that any remnant trees retrained post-development will not impact LAA's.

## 2.9. Wetlands

A review of the Geomorphic Wetlands, Swan Coastal Plain (DBCA 2020) dataset indicates that are no geomorphic wetlands present within the site

There are also a number of mapped wetlands in close vicinity of the site, as shown in Figure 8. The wetlands are located cross and down-hydraulic gradient of the site and include:

- UFI 15107 – Palusplain – Conservation Category Wetland (CCW) located approximately 300m south of the site associated with the Gingin Brook.
- UFI 11122 – Palusplain – Multiple use (MU) located approximately 320m south of the site associated with the Gingin Brook.

- UFI 13450 – Palusplain – Multiple use (MU) located approximately 600m south-west of the site associated with the Gingin Brook.
- UFI 11130 – Palusplain – Multiple use (MU) located approximately 950m south-west of the site associated with the Gingin Brook.
- UFI 11221 – Palusplain – Conservation Category Wetland (CCW) located approximately 1.5 km west of the site.
- UFI 11121 – Palusplain – Multiple use (MU) located approximately 950m north-east of the site associated with the Gingin Brook.

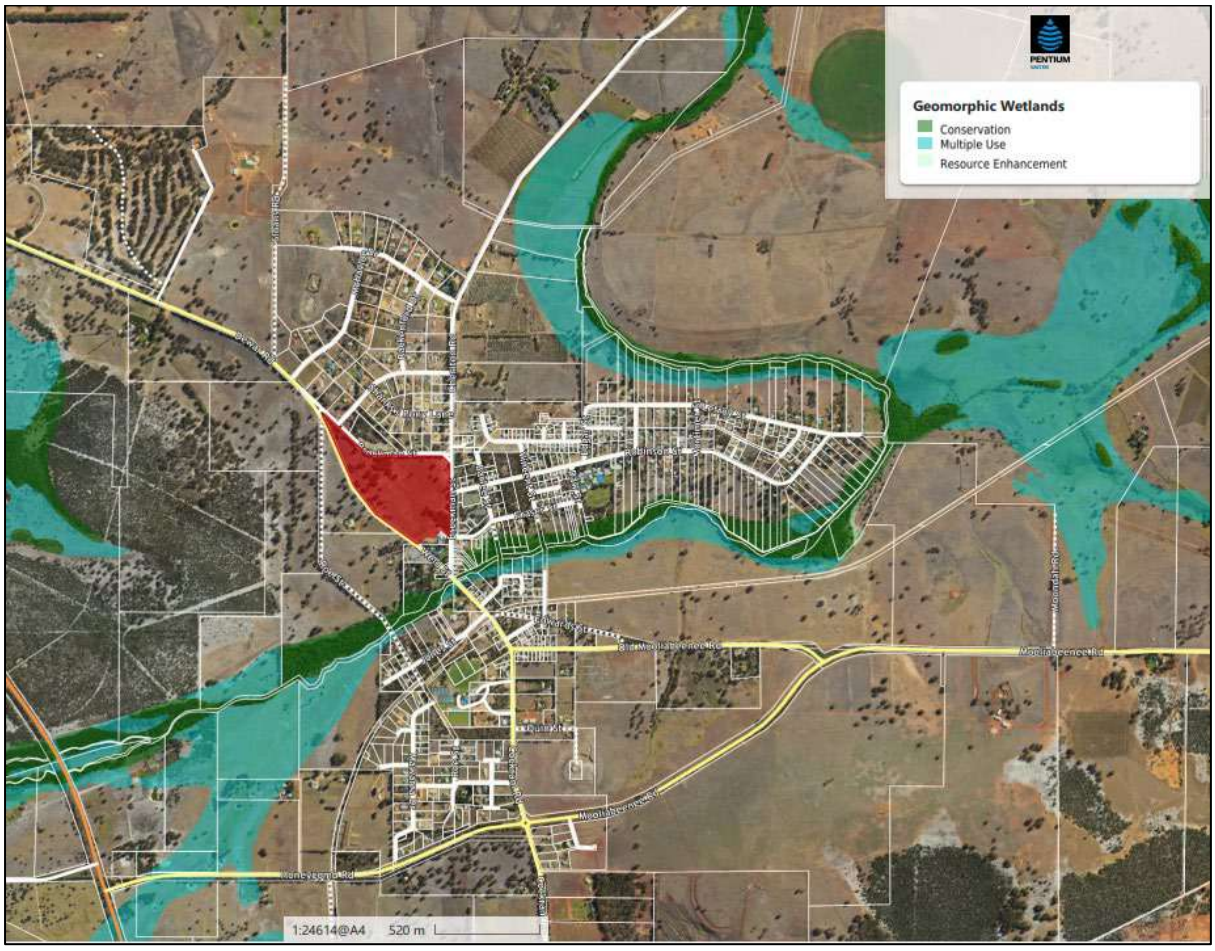


**Figure 8: Geomorphic wetlands**

## 2.10. Sewage sensitive areas

Sewage sensitive areas (SSAs) are proclaimed under the *Government Sewerage Policy* (GSP) (DPLH 2019) to protect groundwater and surface water systems. A review of the GSP online data set (National Map 2022) maps the site as being within a SSA as it is located within the Estuary catchments on the Swan Coastal Plain and within 1 km of significant wetlands (refer Figure 78.

The GSP (2019) requires that the subdivided lots within SSAs have a minimum lot size of 1 hectare. It has been noted that the site has previously been provided with lot zoning within a regional structure plan and therefore possible these minimum lot sizes are not required provided that the minimum LAA can be achieved, and environmental impacts are considered acceptable.

Although the lot sizes range from 980 – 2,600 m², they are large enough to adequately achieve the minimum LAA sizing requirements (as discussed in Section 4.4) and given the

treatment requirements (ATU with nutrient striping) is not considered to pose an environmental or human health risk.

## 2.11. Bush Forever

There are no Bush Forever areas mapped within or in close proximity to the site.

## 2.12. Existing and historic land use

The site has been historically used for rural purposes, with historical aerial photographs indicating that in 1960 the site had been extensively cleared.

## 2.13. Surrounding land use

Immediately to the north, east and south of the site lies the township of Gingin, comprising mainly of residential dwellings and a town centre. Further to the south (approx. 320m) lies the Gingin Brook and beyond that the remainder of the Gingin townsite. The west of the site lies pastoral properties including remnant vegetation, with the Brand highway located approximately 2 km to the west of the site.

# 3. Site and Soil Assessment

## 3.1. Site assessment

To assess the site's ability to accommodate the disposal of treated wastewater site additional investigations were completed by Structerre on the 16th and 17th August and again on the 7th of December. This investigation was completed in accordance with AS 1547 and supersedes the previous site investigations completed as part of the Structerre 2022a and 2022b reports. The additional investigations comprised of:

- a site walkover including inspection of the site features relevant to AS1547-2012.
- drilling of boreholes at 26 locations, extending to depths of up to 2.5m unless refusal encountered prior.
- 8 x dynamic cone penetrometer (DCP) tests in accordance with AS 1289.6.3.2 (1997) to a depth of 1m for the evaluation of relative densities in the upper lithological profile.
- constant head infiltration testing at 26 locations; and
- collection of representative soil samples for laboratory testing.

Sampling locations are presented in Figure 4.

A geotechnical engineer from Structerre conducted the walkover survey, selected and located the test positions, drilling the push core boreholes, logged the materials encountered in the boreholes, conducted the constant head infiltration testing, and collected representative samples for laboratory testing.

The test locations were positioned using a handheld GPS typically accurate to within ± 5 m in the horizontal plane. The approximate test locations are shown on Figure 1, Site and Location Plan..

Details of the tests and individual site results are presented in Structerre (2022c) in appendix A.

Perched water at the natural ground surface was observed on site, however, was only briefly noted in the report, with the specific whereabouts not mentioned.

The following sections discuss the results obtained.

### 3.1.1. Boreholes

Boreholes were drilled using a sample retrieval probes.. Borehole reports, including a photograph of the spoil are presented in Appendix C, Borehole and Test Pit Reports (Structerre, 2022c).

### 3.1.2. Dynamic Cone Penetrator Tests

Dynamic cone penetrometer (DCP) tests were carried out adjacent to each test pit. Results of the DCP testing are presented in Appendix D, Dynamic Cone Penetrometer Test Results (Structerre, 2022c). The tests were carried out in accordance with AS 1289.6.3.2.

#### 3.1.2.1. Soil lithology

The soil profiles encountered onsite for all bore holes typically comprised clay, sandy clay and silty clays with the presence of gravels towards the surface with an overlying layer of topsoil. Many boreholes reported refusal due to still clays and hard gravels at depths typically around the 1.3 mbgl where encountered. The lithology closely corresponds with the regional landform descriptions outlined in Section 2.3. It should be noted that all clayey materials encountered and logged on site had a high plasticity – rather than being described as a stiff clay. This indicates that these clays contain water and although lower than the overlying topsoil and sands, would have a reasonable ability to infiltrate water. Section 3.1.5 provides the measured infiltration rates across the entire soil profile recorded across the site.

#### 3.1.2.2. Particle size analysis

Particle size analysis was undertaken at two sites, with results presented in Appendix E (Structure 2022c).

Analyses have been reviewed against Table 5.1 of the *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand, 2012). Based on

visual-tactile assessment undertaken during the site walkover, laboratory and infiltration testing, the site soils have been determined to be soil Category 2 and Category 3 soils (AS 1547) with a hydraulic capacity of ranging from 2.6 – 8.1 m/day.

### 3.1.3. Design loading rates

Based on Table 5.2 of AS 1547, the following design loading rates (DLRs) are considered applicable for treated effluent in trenches and beds as shown in Table 3, to provide a conservative approach, the DLR for Category 3 soils has been adopted.

**Table 3: Design loading rates (mm/day)**

| Trenches and Beds | | | |
|---|---|---|---|
| **Secondary Treated Effluent (Conservative Rate)** | **Secondary Treated Effluent (Maximum Rate)** | **Secondary Treated Effluent (ETA/ETS beds and trenches)** | **Secondary Treated Effluent (Spray or LPED irrigation)** |
| 30 | 50 | Not recommended | 3.5 |

Notes:

1. The irrigation system has a depth of 100 – 150 mm in good quality topsoil, or 250 mm for LPED irrigation

2. A suitably qualified and experienced design of effluent disposal systems should confirm the above design loading rates and suitable land application systems

### 3.1.4. Soil components analysis

Laboratory testing was carried out by Western Geotechnical and Laboratory Services in their NATA accredited laboratory and comprised the determination of:

- particle size distribution on 11 samples.
- Atterberg limits and linear shrinkage on 11 samples.
- dry density-moisture content relationship using modified compactive effort on 3 samples; and
- California bearing ratio (CBR) on 3 samples.

Laboratory results along with the test methods followed are presented in Appendix F (Structerre 2022a), Laboratory Test Results – Geotechnical (Galt, 2022) and are summarised in Table 4.

**Table 4: Summary of geotechnical laboratory test results**

| Test Location | Sample Depth (m) | Sieve analysis – % passing sieve size (mm) | | | | LL (%) | PI (%) | LS (%) | MMDD (t/m$^3$) | OMC (%) | CBR (%) | CBR Swell (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.075 | 0.425 | 2.39 | 19 | | | | | | | |
| BH01 | 1.0–1.6 | 90 | 96 | 98 | 100 | 70 | 42 | 14.5 | 1.83 | 10 | 12 | 0 |
| BH02 | 1.3–1.9 | 56 | 80 | 98 | 100 | 55 | 34 | 13 | 1.83 | 10 | 40 | 0 |

Note:

LL – Liquid Limit

PI – Plasticity Index

LS – Linear Shrinkage

MMDD – Maximum Modified Dry Density

OMC – Optimum Moisture Content

CBR – California Bearing Ratio (sample compacted to 95% MMDD, saturated, 4.5 kg surcharge)

#### 3.1.4.1. Observed groundwater levels

Groundwater level observations were conducted during the fieldwork conducted over the 16th and 17th of August 2022. Groundwater water was not encountered at 21 of the 26 bore

holes drilled on the site. Groundwater was however, encountered at a depth of 0.6 m at BH06 which is located in the south west corner of the residential area (Lot 98) and at ground level at BH07, BH08, BH12 and BH 13 which are all located in the Town Centre expansion area.

It is also noted that a number of the boreholes did not reach the target depths of 1.5 mbgl or greater due to refusal on hard clays or hard gravels. As such, a 1.5 m clearance to groundwater could not been confirmed. In these instances, the total drilled depth has been adopted as the maximum groundwater level for the purposes of determining the LAA deign datums.

Table 5 below presents the bore hole depths, observed groundwater levels and adopted groundwater levels for the site from August 2022 site investigations. Where clearance to groundwater was not confirmed to be 1.5 m or greater, clearance requirements will be managed through the importation of fill to ensure LAA compliance with GSP (2019). Further details on the LAA design are provided in *Section 5.5*.

**Table 5: Observed groundwater levels**

| Test ID | Associated lot | Bore hole depth (mbgl) | Groundwater depth (mbgl) | Minimum Groundwater Clearance (mbgl) | Additional fill requirement (m)[2] |
|---|---|---|---|---|---|
| BH 1 | 82 | 1.9 | GNE | 1.9 | 0 |
| BH 2 | 86 | 1.3 | GNE | 1.3 | 0.2 |
| BH 3 | 79 | 2.5 | GNE | 2.5 | 0 |
| BH 4 | 90/91 | 1.3 | GNE | 1.3 | 0.2 |
| BH 5 | 95 | 1.2 | GNE | 1.2 | 0.2 |
| BH 6 / 27 | 98 | 2.5 | 0.6 | 0.6 | 0.9 |
| BH 7 / 28 | TC | 1.4 | 0 (at ground level) | 0 | 1.5 |
| BH 8 / 29 | TC | 1.5 | 0 (at ground level) | 0 | 1.5 |
| BH 9 | 64 | 2.5 | GNE | 2.5 | 0 |
| BH 10 | 23/68 | 2.5 | GNE | 2.5 | 0 |
| BH 11 | 22 / road | 1.5 | GNE | 1.5 | 0 |
| BH 12 / 30 | TC | 1.9 | 0 (at ground level) | 0 | 1.5 |
| BH 13 / 31 | TC | 1.4 | 0 (at ground level) | 0 | 1.5 |
| BH 14 | 33 | 1.8 | GNE | 1.8 | 0 |
| BH 15 | 39 | 1.3 | GNE | 1.3 | 0.2 |
| BH 16 | 42 | 1.1 | GNE | 1.1 | 0.4 |
| BH 17 | 29 | 1.6 | GNE | 1.6 | 0 |
| BH 18 | 21/25 | 1.1 | GNE | 1.1 | 0.5 |
| BH 19 | 10 | 1.3 | GNE | 1.3 | 0.2 |
| BH 20 | 14 | 1.1 | GNE | 1.1 | 0.4 |
| BH 21 | 19 | 1.1 | GNE | 1.1 | 0.4 |
| BH 22 | 8 | 1.5 | GNE | 1.5 | 0 |
| BH 23 | 5 | 1.3 | GNE | 1.3 | 0.2 |
| BH 24 | 2 | 1.3 | GNE | 1.3 | 0.2 |
| BH 25 | TC POS | 0.8 | GNE | 0.8 | 0.7 |
| BH 26 | TC POS | 0.8 | GNE | 0.8 | 0.7 |

Notes: 1. GNE – Groundwater Not Encountered

2. additional fill required to achieve the LAA base level with 1.5 m groundwater separation. Does not include fill requirements for the installation of leach drains

### 3.1.5. Infiltration testing

Additional infiltration testing has been conducted across the site beyond the investigations presented in the previous Structerre (2022a and b) reports due to the previous methods (falling head infiltration tests) not being supported by the GSP (2019) and AS 1547. As such, constant head infiltration tests were conducted using a constant head permeameter. The tests were generally conducted in accordance with Appendix G of AS 1547 (2012) "On-site domestic wastewater management". The tests were conducted across the entire soil profiled of each bore hole and as such represents an average infiltration across the soil profiles encountered. The results of the testing as provided in Structerre (2022c) are summarised in Table 6.

**Table 6: Constant head infiltration test results**

| Test | Test Location (Lot) | Test Depth (m) | Soil Type | K[1] (m/day) | Soil Category[2] |
|---|---|---|---|---|---|
| BH 1 | 82 | 0 – 1.9 | Sand to clay – trace gravel | 7.2 | 2 |
| BH 2 | 86 | 0 – 1.3 | Sand to sandy clay – trace gravel | 5.7 | 2 |
| BH 3 | 79 | 0 – 1.2 | Silty sand to sand – trace gravel | 5.6 | 2 |
| BH 4 | 90/91 | 0 – 1.3 | Sand to sandy clay – trace gravel | 5.4 | 2 |
| BH 5 | 95 | 0 – 1.2 | Sand to sandy clay – trace gravel | 7.7 | 2 |
| BH 6 / 27 | 98 | 0 – 2.5 | Sand to sandy clay – trace gravel | 5.4 | 2 |
| BH 7 / 28 | TC | 0 – 1.4 | Sand to sandy clay – trace gravel | 5.0 | 2 |
| BH 8 / 29 | TC | 0 – 1.5 | Sand to sandy clay – trace gravel | 3.3 | 2 |
| BH 9 | 64 | 0 – 2.5 | Silty sand to sandy clay – trace gravel | 6.2 | 2 |
| BH 10 | 23/68 | 0 – 2.5 | Sand to sandy clay – trace gravel | 6.5 | 2 |
| BH 11 | 22 / road | 0 – 1.5 | Sandy clary with gravel | 4.7 | 2 |
| BH 12 / 30 | TC | 0 – 1.9 | Sand to sandy clay – trace gravel | 3.2 | 3 |
| BH 13 / 31 | TC | 0 – 1.4 | Sand to sandy clay – trace gravel | 2.6 | 3 |
| BH 14 | 33 | 0 – 1.8 | Silty sand to sandy clay – trace gravel | 4.6 | 2 |
| BH 15 | 39 | 0 – 1.3 | Silty sand to sandy clay – trace gravel | 5.0 | 2 |
| BH 16 | 42 | 0 – 1.1 | Silty sand to sandy clay – trace gravel | 3.1 | 3 |
| BH 17 | 29 | 0 – 1.6 | Silty sand to sandy clay – trace gravel | 4.9 | 2 |
| BH 18 | 21/25 | 0 – 1.1 | Silty sand to sandy clay – trace gravel | 4.6 | 2 |
| BH 19 | 10 | 0 – 1.3 | Silty sand to sandy clay – trace gravel | 3.4 | 3 |
| BH 20 | 14 | 0 – 1.1 | Silty sand to sandy clay – trace gravel | 3.4 | 3 |
| BH 21 | 19 | 0 – 1.1 | Sandy clay with gravel | 3.6 | 3 |
| BH 22 | 8 | 0 – 1.5 | Silty sand to sandy clay – trace gravel | 5.1 | 2 |
| BH 23 | 5 | 0 – 1.3 | Sand to sandy clay – trace gravel | 6.0 | 2 |
| BH 24 | 2 | 0 – 1.3 | Sand to sandy clay – trace gravel | 8.1 | 2 |
| BH 25 | TC POS | 0 – 0.8 | Gravelly sand with clay | 5.3 | 2 |
| BH 26 | TC POS | 0 – 0.8 | Gravelly sand with clay | 6.6 | 2 |

Notes:

1. K-saturated hydraulic conductivity

2. Soil category in accordance with Table 5.1 and L1 of AS1547-2012.

### 3.1.6. Site soils summary

The soil profiles encountered closely correspond with the regional landform descriptions outlined in Section 2.3. Based on the soil descriptions across the site, and the physical performance of the soil profile as demonstrated by the constant head infiltration tests, the soil has been determined to predominantly be soil Category 2 classification as per the AS 1547 classification. However, there are areas where a classification of soil Category 3 is

appropriate due to the recorded infiltration rates. As such, all design recommendations will be based on Category 3 soils as a conservative approach. It is acknowledged that Structerre (2022b) reported that the site soils are Category 4 based upon infiltration testing results. It should be noted this recommendation was based upon results from a falling head infiltration test method which is not supported by the GSP (2019) and as such these results have be superseded by the results reported in this report.

Groundwater was encountered between ground surface and 0.6 mbgl across five bore holes in the south-west of the site during August 2022. Based on the timing of the investigations (end of winter, end of August) coupled with the increased rainfall received during the 2022 winter months, this groundwater level is considered to represent the maximum groundwater level at this site.

For borehole locations that did not extend to >1.5mbgl, the maximum groundwater level at the depth of refusal has been adopted and is considered to be a conservative approach.

The constant head infiltration tests indicate the site soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW). However, areas of the site have not demonstrated a groundwater separation distance of at least 1.5m, this will be managed implementation of appropriate TWW systems and design of adequate LAA (area and elevation).

Given the relatively high occurrence of clayey sands and sandy clays across the site, the site soils are anticipated to have a very high P retention rates. It is nevertheless recommended that fill be imported to the site to establish the LAA, where the re-use of in-situ is not available i.e., earthwork costs to high or insufficient volumes. Sands with a PRI of 10 are the recommended import fill option and would assist to retain phosphorus within the site's soils. Significant phosphorus retention is expected on site regardless of fill choice.

# 4. Land capability

## 4.1. Determination of soil-terrain units

Although a specific feature survey of the site has not been conducted, and based on topographic mapping available and observations from the site visit, although relatively uniform, the site has been estimated to have an overall slope of approximately between 5 and 10% from the north to the south.

The maximum slope suitable for on-site sewage systems is dependent upon the type of system proposed and ranges from 10% to 30% (Standards Australia and Standards New Zealand 2012), noting that the surface application systems are more sensitive to slope. Although the slope ranges from 5-10%, the slope is relatively uniform across the site and as such, topographical units are not distinguished as part of this assessments.

Soil investigations (Section 3.1) align with the regional geological mapping and show the site can be generally categorised as sandy clay.

## 4.2. Sand soil-terrain unit

In accordance with Table 5.2 of the AS 1547, based on the soil descriptions across the site and the constant head infiltration test results, the soil has been determined to be either a soil Category 2 or Category 3 classification as per the AS 1547 classification (Standards Australia and Standards New Zealand, 2012). Th results of the constant head infiltration test results, which have been conducted across the entire soil profile at each bore location are the primary driver of the adopted soil category as they provide an actual measure of the soil's physical ability to infiltrate TWW.

## 4.3. Additional site considerations

### 4.3.1. Flood-prone areas and erosion potential

The GSP (2019) outlines that on-site systems are not to be located in areas that are subject to inundation and/or flooding in a 10% AEP rainfall event. As outlined in Section 2.7, it is expected that rainfall that the first 15 mm of rainfall events would be infiltrated locally, whilst larger events would be conveyed to a road piped network. Given the high permeability of the site soils, the generation of surface flows and erosion is considered to be a low risk.

The (then) Department of Water (now DWER) maps the site as not being within the flood level for the 1 in 10 (10%) annual exceedance probability (AEP).

#### 4.3.1.1. Site inundation potential

The GSP (2019) outlines that the location of any LAA should not be in an area that becomes inundated during a 10% AEP event. According to the Bureau of Meteorology Design Rainfall Data System (2016), a 24 hr 10% AEP rainfall event for the site is 87.4 mm. The infiltration rate across the site has been measured as having a minimum infiltration rate (constant head infiltration) of 2.6 m/day or 2,600 mm/day. As such, site inundation is not anticipated to occur within the lots due to the high infiltration rates, it acknowledged that clayey sands and sandy clays are present at the site, however they have been demonstrated to have a reasonable capacity for infiltration. Any surface water flows generated by any larger events will be directed to the 'rear of lot' drainage network (Figure 7) which will prevent inundation at a lot level occurring (complete design layout is provided in Appendix B).

### 4.3.2. Drainage system and significant wetland separation

The GSP (2019) stipulates that on-site sewerage systems should not be located within 100 m of a drainage system that discharges directly into a waterway or significant wetland without treatment. Although there are a number of lots that are within 100 m of a drainage system that will discharge directly into the Gingin Brook, all lots will have ATU systems with nutrient stripping as per the GSP (2019).

As outlined in Section 2.9 the site maintains the 100 m setback from the down-gradient CCW's associated with the Gingin Brook, as shown in Figure 8.

#### 4.3.2.1. Weld Street road-side swale

The weld street roadside swale is located adjacent to the western boundary of the site (Figure 6). This proposed LAA for the lots along the western boundary of the site do not comply with the 100m setback as they are currently proposed to have an approximate 20 m setback.

This setback is considered to be acceptable. The Weld Street roadside swale is poorly defined and due to the drainage management proposed for the site ('rear of lot' drainage) it will not receive surface water discharge from the site, nor does it receive groundwater inflows. The roadside swale is extremely shallow, approx. <0.15m below ground level at its deepest and as such does not receive groundwater inflows. Groundwater levels (recorded in 18th August 2022) in the bore holes adjacent to the Weld Street drain indicated that the maximum groundwater level was recorded in BH06 at 0.6 mbgl (adjacent to location of Photo 1). This groundwater level is below the invert level of the Weld Street roadside swale.

Figures 9 to 14 are site photographs of the Weld Street roadside swale demonstrating the very shallow depth of this feature taken 15th March 2023.


**Figure 9: Weld Street roadside swale photo locations**

**Figure 10: Weld Street roadside swale Photo 1**


**Figure 11: Weld Street roadside swale Photo 2**

**Figure 12: Weld Street roadside swale Photo 3**

**Figure 13: Weld Street roadside swale Photo 4**

**Figure 14: Weld Street roadside swale Photo 5**

#### 4.3.2.2. Brockman Street Drain

The Brockman St drain (Figure 6) is located approximately 60m to the east of the LAA proposed for the eastern most lots of the development. This is considered acceptable as this drain is a piped system and does not receive surface water flows from the site, nor does it receive groundwater inputs.

### 4.3.3. Groundwater separation and site inundation potential

The groundwater clearance has been determined during observations made during the August 2022 field investigations. Groundwater was only encountered in five of the 26 bore holes conducted across the site and clustered in the south-western portion of the site. Groundwater in this area was measured as ranging from being present at the surface to 0.6 mbgl. Although the remaining bore holes did not encounter groundwater, a number of these bore holes did not extend to 1.5 mbgl or greater (Refer Table 5). As such where bore holes did not extend to >1.5mbgl, the end of the bore hole has been adopted as the maximum groundwater level for the site as a conservative approach.

Additional testing of any imported fill that underlays the disposal area will be required to determine and confirm the soil category of the introduced fill/soil mixture as per AS 1547 and ensure the capacity of the soil to accommodate sewage disposal.

#### 4.3.3.1. Previous site saturation

As previously outlined in Section 3.1.4.1 ground saturation in the southern area of the site was observed during August 2022 field investigation resulting in groundwater effectively being at ground surface. The inundation observed during the August 2022 fieldwork program in these lower reaches of the site is anticipated to be a result of surface water runoff from the upper areas of the site accumulating in the southern portion of the site due to the significant rainfall received in the preceding 4 weeks. Post-development this will no longer occur as all surface run-off will be intercepted and managed through the 'rear of lot' and road drainage network as well as through the earthworks design for the town centre.

#### 4.3.3.2. Residential lots

Based on the field observations and the depths of the bore holes conducted during the August 2022 fieldworks, recommended additional fill above the natural ground surface has been proposed for the LAA. The proposed additional fill depths in the vicinity of individual bore holes has been outlined previously in Table 5 and summarised in Table 7 below. Figure 15 below presents the proposed additional fill depths for the LAA across the site to achieve a minimum of 1.5 m clearance above the adopted maximum groundwater level for the site.

As such, the wastewater treatment and disposal system design datum has been proposed for each site as detailed in Table 8 that achieves a groundwater separation distance of 1.5m as per GSP (2019).

**Table 7: Proposed wastewater treatment system LAA fill requirements above natural surface.**

| Lot number | LAA additional fill requirements (m) |
|---|---|
| 6-9, 11-19, 27-30, 33-37, 57-67, 78-58 | 0 |
| 31, 32, 38, 40, 72-77 | 0.1 |
| 1-5 ,10 ,20 ,2 2,24 ,26 ,41 ,43 ,49 ,51 ,70 ,71 , 86-94 | 0.2 |
| 42, 50, 95 | 0.4 |
| 96 | 0.6 |
| 97 | 0.8 |
| 98, 99 | 0.9 |


**Figure 15: LAA fill requirements above natural surface (adopted maximum groundwater levels in blue)**

#### 4.3.3.3. Town Centre

It was observed during the August 2022 site investigations that groundwater was encountered at the ground surface and as such would require the LAA to be raised by at least 1.5m above natural ground surface to achieve the required groundwater separation distance. The proposed earthworks design indicate that the Town Centre will be graded to increase the surface elevation approximately 3 m above the existing natural surface in the south-eastern portion of the site. This would raise the LAA by approximately 3 m above the existing natural surface and provide adequate groundwater separation distance. A proposed cut and fill plan for the Town Centre has been included in Appendix C. In addition, the post development 'rear of lot' and road drainage networks will prevent future surface run-off to accumulate in this southern portion of the site which will prevent groundwater from rising to this pre-development level.

### 4.3.4. Rainfall run-off and seepage

The UWMP (Hyd2o 2023) details the stormwater design strategy to manage stormwater post-development. The strategy includes the implementation of:

- Detention of the first rainfall on lots (likely through soak wells)
- Treatment of the first 15 mm of road run-off in biofiltration areas or swales
- Piped road drainage network sized to ensure roads are passable during 20% AEP event.
- Road reserves are capable of conveying up to and including the 1% AEP event.
- Flood detention areas to detain up to the 1% AEP event on-site
- 10% and 1% AEP flows to be maintained within pre-development flow rates.
- 'rear of lot' drainage system to manage any surface water run-off from pervious areas for lots that don't naturally drain towards the internal road network

As previously mentioned in Section 4.3.1.1 due to the measured site infiltration rates and the 'rear of lot' drainage network, it is considered unlikely that surface water flows within individual lots will occur. The installation of stormwater diversion drains i.e., open swale should be considered to assist in the prevention of erosion occurring from around the LAA.

### 4.3.5. Other setbacks

Other setback distances required for leach drain systems will be in accordance with AS 1547.

## 4.4. Available Land Application Area (LAA)

As outlined in Table 8, the minimum LAA for secondary treatment (excluding setbacks) is 225 $m^2$ (GSP, 2019) for soil category 3 soils. This minimum LAA (as presented in GSP (2019) has been determined using the design loading rates for drip irrigation as presented in Table 5.2 and L1 of AS/NZS 1547.2012. Table 8 also presents the length of leach drain requirements based on AS/NSZ 1547.2012 methodology. The use of irrigation as the disposal method is not recommended as it would require a larger LAA which may be difficult to accommodate within the individual lots.

The calculation of the minimum trench length required to discharge wastewater (based on trench design) is described in AS 1547 using the following methodology:

L = Q / (DLR x W)

Where:

L = length in meters

Q = designed daily flow L/day (900 L/day as per household design in GSP (2019))

DLR = designed loading rate in mm/day (30 mm/day as per AS 1547 for category 3 soils

W = width in m (Aquarius Wastewater leach drain (AqwaCell 16 is 2.5 m)

**Table 8: Land application areas for a single house (occupancy of 6 persons in a 5-bedroom house (900L/day)) (GSP, 2019)**

| Soil category | Soil texture | Land application area ($m^2$) | | | |
|---|---|---|---|---|---|
| | | Drip and Spray Irrigation | | Leach Drain | |
| | | Design loading Rate | Secondary treatment (excludes setback) | Design loading rate (secondary treatment) | Length of trench(m)[1,2] |
| 1 | Gravels and sands | 5 | 180 | 50 | 7.2 |

| Soil category | Soil texture | Land application area ($m^2$) | | | |
|---|---|---|---|---|---|
| | | Drip and Spray Irrigation | | Leach Drain | |
| | | Design loading Rate | Secondary treatment (excludes setback) | Design loading rate (secondary treatment) | Length of trench(m)[1,2] |
| 2 | Sandy loams | 5 | 180 | 50 | 7.2 |
| 3 | Loams | 4 | 225 | 30-50 | 7.2 - 12 |
| 4 | Clay loams | 3.5 | 257 | 10-30 | 12 - 36 |
| 5 | Light clays | 3 | 300 | 8-12 | 30 - 45 |
| 6 | Medium to heavy clays | 2 | 450 | Special design | Special design |

Note: 1 – based on Aquarius AqwaCell 16 leach drain design with 2.5m width.

2 – AS 1547.2012 details leach drain length requirement determined by Q /(DRL x width of drain)

The final design of the LAA will be the responsibility of the individual land owners. However, the LAA requirements for drip and spray irrigation can be adequately met within the urban development.

#### 4.4.1.1. Town Centre

The hydraulic loading volume for Town Centre has been estimated based on the following:

- 33 staff @ 30L/day = 990 L/day
- 200 patrons/diners (3 course meal) @ 30L/day = 6,000L/day

This results in a total hydraulic loading of 6,990 L/day and is in accordance with AS/NSZ 1547.2012 and Supplement to Regulation 29 Health (treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974.

Based on aforementioned loading rates, soil category DLR's and prescribed LAA conversion factors the LAA required for the Town Centre is as follows:

- Surface Drippers – 2,000m²
- Total leach drain trench length required – 93.2 m (maximum trench length to be 21.5 m)
    - 5 x 20 m trenches with 1 m spacing is approximately 410 m².

The total occupancy numbers once the Town Centre Expansion area is completed is currently unknown due to the unknown future uses proposed for this area. Additional LAA will be set aside to allow for a potential future duplication of the proposed disposal system above and will provide sufficient disposal area for a total of 66 staff and 400 patrons.

The individual lot owner will be responsible for the final selection and approval of the secondary treatment system to be installed.

## 4.5. Results

The soil-terrain unit determined for the site is capable of accommodating on-site sewage treatment and disposal. However, considerations (such as achievable LAA and stormwater management) are needed due to the size of the lots and the ground surface gradients across the site. This will be achieved through special design of the sewage treatment system as per the recommendations of AS 1547 (further discussed in Section 5).

Based on the above assessment, and through the special design of the treatment system to address the achievable setbacks as previously described, the site is considered suitable for on-site sewage treatment and disposal. This will be achieved in lines with the GSP (2019) and AS 1547.

# 5. Wastewater management

## 5.1. Site requirements

The GSP outlines the minimum site requirements for onsite sewerage disposal to protect public health and the environment. An onsite sewage system is not to be located within:

- a wellhead protection zone or on Crown land within a reservoir protection zone
- 30 metres of a private bore used for household/ drinking water purposes.
- 100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer.
- 100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment
- any area subject to inundation and/or flooding in a 10% AEP rainfall event.
- 1.5 metres above the highest groundwater level (in sewerage sensitive area)

Additional setbacks to structures which impact the sizing and location of the available land application areas include:

- 1.2 metres between treatment tanks to buildings, property boundaries, driveways,
- paths, and other tanks
- 1.2 metres between tranches, beds and soak wells to trafficable areas
- 1.8 metres between tranches, beds and soak wells to boundary, building, tanks and other land application systems
- Sub surface dripper to
  - Boundaries, building, treatment tanks, driveways 0.5 m
  - Open drain 3.0 m
  - Garden bore 10 m.

This SSE has demonstrated that the site is able to achieve all the necessary buffers needed to protect public health and the environment. However, it is proposed that the setback from the LAA on the western boundary of the property to the Weld Street roadside swale is 20m. Due to the poorly defined nature of the roadside swale and the proposed 'rear of lot' drainage network neither groundwater nor surface water runoff from the site is anticipated to enter this roadside swale.

## 5.2. Proposed treatment systems

The treatment systems must be designed and installed in accordance with AS 1547 and the DoH. Disposal and treatment systems approved by the DoH must be used. Due to the size of the proposed lots, and the site being in a Sewerage Sensitive Area (proximity to sensitive wetlands), each lot will be required to install a secondary treatment system (STS) (such as aerobic treatment unit) with nutrient removal capabilities. This will maximise the useability of each lot as secondary treated effluent required a smaller LAA.

Primary treatment systems, including septic tanks are not suitable at this site due to its location within an SSA, as per ASNZ1547-2012.

STS, with nutrient removal capabilities can produce treated effluent of secondary standard, that is

- ≤20 mg/L of Biochemical Oxygen Demand (BOD),
- ≤ 30 mg/L of Total Suspended Solids (TSS) and
- ≤ 10 cfu/100 mL of *Escherichia (E) coli*.

In addition, the levels of nitrogen and phosphorus must be reduced to:

- <10 mg/L nitrogen
- <1 mg/L phosphorus.

## 5.3. Discharge loading rates

The hydraulic loading is based on 6 persons occupying a 5-bedroom house on a sewage design flow of 150 L/person/day, resulting in a hydraulic loading of 900 L/day per household. The discharge loading rate adopted from Table 5.1 and L1 from AS/NZS 1547.2012 is 30mm/day which is the lower limit recommended for soil Category 3 soils and as such provides a conservative approach to the LAA design.

## 5.4. Land application system and disposal area

The treated wastewater is required to be disposed to land within the lot. The recommended land application systems for Category 3 soils include:

- Trenches and beds (leach drains)
- mounds (inverted leach drains)
- irrigation systems – requires 150 – 250 mm of good quality topsoil to slow down soakage and assist in nutrient reduction.

Leach drains are recommended for this site as they require less LAA and result in a reduced human health risk through reducing potential contact with wastewater.

## 5.5. Land application area

### 5.5.1. Clearance to groundwater

Through the importation of fill to the LAA for each lot and the Town Centre expansion area, the site will be able to achieve a groundwater clearance of 1.5 m from the lowest point of the leach drain system. The site soils are anticipated to have a high PRI, and where possible in-situ soils will be utilised to create the appropriate LAA. However if imported soil is required, it is recommended to have a PRI of 10 and will need additional testing to confirm the soil category aligns with what has been used in this document to ensure appropriately sized LAA.

### 5.5.2. Land application area

The land application area is the area where the treated sewage from a treatment system (in this case secondary treatment with additional nutrient removal) is applied into or onto the ground. Land-application systems typically either discharge treated sewage via soil absorption systems (e.g., leach drains) or irrigation systems (e.g., sub-surface irrigation or surface irrigation). The method by which sewerage is dispersed to the land is determined based on the site conditions and may influence the land area required for disposal.

The proposed land application method, as mentioned above, is via leach drains, however the LAA has also been sized to provide provisions for surface drip irrigation should individual land owners choose to do so.

The GSP states that the land application area required for secondary treatment systems in soil category 3 soils is 225 $m^2$ which is based on the below calculation.

Land Application Area (LAA) for sub surface irrigation ($m^2$) =

$$hydraulic\ load\ (L/day) x\ conversion\ factor\ for\ the\ soil\ texture$$

The conversion factor for secondary treated effluent for heavy clays is 0.25 (as per Table 2 of GSP, 2019).

$$900\ L/day \times\ 0.25 = 225\ m^2$$

It should be noted the LAA conversion rates provided in GSP (2019) are equivalent to the drip irrigation design loading rates (DLR) as presented in Tables 5.2 and L1 of AS/NZS 1547.2012.

The calculation of the minimum trench length required to discharge wastewater (based on trench design) is described in AS 1547 using the following methodology:

L = Q / (DLR x W)

Where:

L = length in meters

Q = designed daily flow L/day (900 L/day as per household design in GSP (2019))

DLR = designed loading rate in mm/day (30 mm/day as per AS 1547 for category 3 soils

W = width in m (Aquarius Wastewater leach drain (AqwaCell 16 is 2.5 m)

The trench length calculations estimate that individual lots require a minimum of trench length of 12 m, whilst the Town Centre will require a trench length of 93.5 m (of 5 x 20m trenches). It should be noted that this is estimated using a width of 2.5 m which is the width of an Aquarius AqwaCell16; a DoH approved, non-concrete leach drain. Should the width of the drain adopted for each site be less, this will result in additional overall length requirements and should be considered as part of the design.

An application to *Construct or Install an Apparatus for the Treatment of Sewerage* will be submitted to the SoG by the lot owners following detailed design to specify the final design and wastewater management systems to be installed.

# 6. Summary

The development consists of 99 residential lots and an expansion of the Town Centre. Lots range between approximately 980 – 2,600 m² and the Town Centre expansion has an area of approximately 24,700 m². The site is in a Sewerage Sensitive Area (SSA) as it is located within 1 km of a sensitive wetland: CCW associated with the Gingin Brook. The GSP (2019) requires that the subdivided lots within SSAs have a minimum lot size of 1 hectare. It has been noted that the site has previously been provided with lot zoning within a regional structure plan and therefore possible these minimum lot sizes are not required provided that the minimum LAA can be achieved, and environmental impacts are considered acceptable. As is not anticipated to be any impact to the nearby wetland due the treatment proposed), and the minimum LAA can be achieved, the development design with 980-2,600m$^2$ lots is not considered to pose an environmental or human health risk.

Results of the site and soil assessment indicate the soils have high infiltration capacity to accommodate the infiltration of stormwater and Treated Wastewater (TWW), however achieving the required clearance to groundwater 1.5m across was not achieved in a number of areas across the site. This will be managed through stormwater management, implementation of appropriate TWW systems and disposal design and adequate LAA design and construction. Site soils are anticipated to have a very high P retention due to the clayey nature of the underlying geology.

It is recommended that if appropriate in-situ fill is unavailable, fill be imported to the site to establish the LAA to achieve the required groundwater clearances across the site. Sands with a PRI of 10 are the recommended fill option and would provide additional phosphorus retention benefits. Significant phosphorus retention is expected on site regardless of fill choice.

August 2022 field investigations. Groundwater was only encountered in five of the 26 bore holes conducted across the site and clustered in the south-western portion of the site. Groundwater in this area was measured as ranging from being present at the surface to 0.6 mbgl. Although the remaining bore holes did not encounter groundwater, a number of these bore holes did not extend to 1.5 mbgl or greater (Refer Table 5). As such where bore holes did not extend to >1.5mbgl, the end of the bore hole has been adopted as the maximum groundwater level for the site as a conservative approach.

Section 5.2.2 of the Government Sewerage Policy (2019) relating to the extent of seasonal inundation has been addressed by the following:

- The proposed earthworks design of the Town Centre Expansion area and 'rear of lot' and road drainage network of the remainder of the development have modified the sites hydrological regime to prevent the accumulation of surface run-off from the upper catchment area in the southern portion of the site. This will prevent the accumulation and infiltration of surface runoff occurring as was observed during the August 2022 field investigations.
- Use of in-situ of importation of fill to create LAA that achieve the required 1.5 m clearance to the groundwater levels observed in August 2022.
- Recommendation to install stormwater diversion drains (shallow swales) at the boundary of all LAAs to prevent localised impacts (i.e., erosion/scouring of LAA) from rain generated surface run-off.

LAA fill requirements have been provided based on achieving clearance to the observed maximum groundwater level (as per 2022 monitoring) in accordance with the GSP (2019).

The proposed LAA in the lots on the western boundary of the site are proposing a setback of 20m from the Weld Street roadside swale, as opposed to the 100 m setback outlined in GSP (2019). The Weld Street roadside swale is a very shallow and poorly defined feature. Due to the recorded depth to groundwater recorded across the site and the post-development stormwater drainage design, neither groundwater nor surface water inflows to the Weld Street roadside swale will occur.

This SSE demonstrates the site can accommodate a suitable wastewater management system.

# 7. Conclusion

The sewage management strategy for the site, as outlined in this report, has been developed to be consistent with the approach and requirement details in the *Government Sewerage Policy* (DPLH, 2019) and *AS/NZS 1547 On-site domestic wastewater management* (Standards Australia and Standards New Zealand 2012), and includes:

- Earthwork and stormwater drainage design to prevent accumulation of surface run-off and inundation in the southern portion of the site and associated LAA.
- 'rear of lot' drainage network to manage any surface water flows generated within individual lots and to prevent surface water inundation and/or run-off to the adjacent Weld Street roadside swale to support a reduction in proposed setback.
- Utilising secondary treatment systems with additional nutrient removal
- Appropriate sizing of the land application area / trench sizes based on the geotechnical investigations and classification of the soil classification of the site.
- Ensuring there is sufficient disposal area within the site.
- Special design of the treatment system to reduce the risk of groundwater pollution in accordance with AS 1547.
- Setting the disposal outlet point/base of leach drain systems at a lot specific elevation to achieve groundwater clearance in accordance with GSP (2019) This will be achieved through the importation of fill to individual lot LAA in increase their surface elevations above the natural surface levels.
- Utilising ameliorated existing site soils or the importation of suitable soil (both with higher nutrient retention than the existing site soils) to comply with the disposal outlet height and minimum groundwater clearance requirement of 1.5 m. This soil will be assessed prior to the installation of the secondary treatment system to ensure the soil category and compliance with the design detailed within this document.
- Ensuring appropriate installation, monitoring and maintenance of the systems is conducted.

It is considered that the above investigations and management demonstrate that the site is able to accommodate the on-site treatment and disposal of sewage within the site and that this can be achieved in a way that mitigates the potential risk to the environmental and human receptors.

# 8. References

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Standards Australia and Standards New Zealand, 2012. AS/NZS 1547:2012 On-site Domestic Wastewater Management, Sydney, New South Wales. 2012.

Structerre (2022a): Geotechnical Investigation Report – Lot 601 Brockman Street, Gingin.

Structerre (2022b): Site and Soil Evaluation Report – Lot 601 Brockman Street, Gingin.

Structerre (2022c): General Site and Soil Evaluation Report – Lot 601 Brockman Street, Gingin. Unsubmitted report.

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# Appendix A: S Structerre General Site and Soil Evaluation (unsubmitted)

Doc GE2.1.2

# GEOTECHNICAL INVESTIGATION

**For:** Tabec Pty Ltd

**Project Address:** Proposed Residential Subdivision –
Lot 601 Brockman Street, Gingin WA

**Project Number:** D294537

**Job Number:** J409671

**Revision Number:** 0

**Date:** 31/5/2022

Structerre Consulting
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# TABLE OF CONTENTS





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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

# 1. PROJECT DETAILS

## 1.1. Introduction

At the request of Tabec Pty Ltd, Structerre Consulting (Structerre) have conducted a Geotechnical Investigation at Proposed Residential Subdivision – Lot 601 Brockman Street, Gingin. The purpose of the investigation was to provide the following for residential subdivision purposes:

- An assessment of subsurface soil profile and groundwater conditions across the proposed area of development;
- Site classification in accordance with AS 2870-2011 Residential Slabs and Footings;
- Wind Classification in accordance with AS 4055-2012 Wind Loads for Housing;
- Recommendations for stormwater drainage design;
- Recommendations on earthworks and site preparation; and
- Provision of a footing detail considering anticipated surface movement and sand pad thickness.

Terms of reference for this investigation were presented in a Structerre Consulting proposal reference Q95958 (dated 5 May 2022), which was submitted to and accepted by Tabec Pty Ltd.

## 1.2. Site Description

The site is located at Lot 601 Brockman Street, Gingin, Shire of Gingin. Brockman Street lies to the north of the site, Weld Street to the west, Cheriton Road to the east and Shire of Gingin and Gingin Community Resource & Visitor Centre to the south.

The site slopes up towards the northern boundary. At the time of the field investigation, the site was vacant and covered in vegetation with small to medium sized trees.

## 1.3. Field Investigation – Scope of Works

The field investigation was carried out on 12 May 2022 and comprised:

- 13 x Sample Retrieval Probes (SRP) to a depth of 2.0m (refusal) over the site for material assessment and soil profiling;
- 12 x In-situ percolation tests to determine the permeability of the materials within the upper 2.0m; and
- 8 x Dynamic Cone Penetrometer (DCP) tests in accordance with AS 1289.6.3.2 (1997) to a depth of 1.0m for evaluation of relative densities of the upper layers.

The borehole test locations are shown on the attached site plan in Appendix 1.

Suitably qualified geotechnical personnel from Structerre supervised the fieldwork and all fieldwork, interpretation and terminology used in this report are in accordance with the guidelines presented in AS1726-2017 Geotechnical Site Investigations.

# 2. DESK STUDY

## 2.1. Geological Setting

The Perth sheet 1: 50,000 Environmental Geology Series (Part Sheets 2034 III and 2134 III, 1986) prepared by the Geological Survey of Western Australia indicates that the following geological layers underlie the site:

- Colluvium – Colluvium soil and undifferentiated sand (Qpo)

## 2.2. Ground Surface and Groundwater Level

The Landgate website indicates the ground surface level at this site was approximately 120.0m – 135.0m Australian Height Datum (AHD).

No published groundwater information available for the site.

## 2.3. Earthquake Coefficient

In accordance with AS 1170.4-2007 Structural Design Actions the site is located within an area with an earthquake acceleration coefficient of 0.10.

## 2.4. Wind Classification

In accordance with AS 4055-2012 Wind Loads for Housing, wind classification of this site falls within the non-cyclonic “N2” –“N3” category.

# 3. RESULTS OF THE INVESTIGATION

## 3.1. Subsurface Soil Profile

The subsurface soil profile presented below was determined from the ground conditions encountered within the boreholes:

**Table 1 – Subsurface Soil Profile**

| Borehole | Topsoil | Gravelly SAND with clay | SAND with clay, with gravel | Sandy CLAY trace gravel | CLAY trace sand, trace gravel |
|---|---|---|---|---|---|
| | Depth to Base of Strata (m) | | | | |
| BH1 | 0.1 | - | 0.7 | 2.0 | 1.3 |
| BH2 | 0.1 | - | 0.8 | - | - |
| BH3 | 0.1 | 0.4 | - | 1.5 | - |
| BH4 | 0.1 | 0.3 | - | 1.0 | - |
| BH5 | 0.1 | 0.3 | - | 1.2 | - |
| BH6 | 0.1 | 0.2 | - | 0.7 | - |
| BH7 | 0.1 | 0.3 | - | 1.5 | - |
| BH8 | 0.1 | 0.2 | - | 0.7 | - |
| BH9 | 0.1 | 0.2 | - | 0.7 | - |
| BH10 | 0.1 | 1.5 | 1.1 | - | - |
| BH11 | 0.1 | 1.1 | 0.9 | 1.9 | - |
| BH12 | 0.1 | 1.0 | 0.7 | 1.2 | - |
| BH13 | 0.2 | - | 0.5 | - | - |
| **Average** | **0.1** | **0.6** | **0.8** | **1.2** | **1.3** |

The soils encountered are consistent with the expected site conditions as predicted from the Environmental Geology Map. It is important to note that there may be pockets of fill on site that are deeper than that encountered by the investigation boreholes. The subsurface soil conditions encountered are presented in the bore logs, within Appendix 3.

## 3.2. Groundwater

Groundwater was not encountered in any of the boreholes during or immediately after drilling. However, the groundwater is expected to be encountered approximately 0.2m below the existing ground level above the more cohesive materials.

### 3.3. Percolation Testing

Percolation testing of the in-situ soils was undertaken in twelve locations. Results of the testing are summarised below:

**Table 2 – In Situ Percolation Test Results**

| Test Location | Testing Depth | Soil Type | Permeability |
|---|---|---|---|
| BH1 | 0.0 - 2.0m | SAND to CLAY trace sand trace gravel | 0.1/day |
| BH2 | 0.0 – 0.8m | SAND | 1.7m/day |
| BH3 | 0.0 - 1.5m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.7m/day |
| BH4 | 0.0 - 1.0m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.5m/day |
| BH5 | 0.0 - 1.2m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.3m/day |
| BH6 | 0.0 – 0.7m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.5m/day |
| BH7 | 0.0 - 1.5m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.9m/day |
| BH8 | 0.0 – 0.8m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.6m/day |
| BH9 | 0.0 – 0.7m | Gravelly SAND with clay to Sandy CLAY with gravel | 0.8m/day |
| BH10 | 0.0 - 1.5m | SAND | 2.6/day |
| BH11 | 0.0 - 1.9m | SAND to Gravelly SAND with clay | 1.4m/day |
| BH12 | 0.0 - 2.0m | SAND to Gravelly SAND with clay | 0.9m/day |

## 3.4. Laboratory Test Results

Selected soil samples were tested for Atterberg Limits.

### 3.4.1. Atterberg Limits

Atterberg Limits were tested by Structerre's in-house NATA accredited laboratory. Results of the testing are summarised below:

**Table 3 – Atterberg Limit Test Results**

| Sample | Test Hole | Depth (m) | Soil Description | Liquid Limit % AS1289 3.1.2 | Plastic Limit % AS1289 3.2.1 | Plasticity Index % AS1289 3.3.1 | Linear Shrinkage % AS1289 3.4.1 |
|---|---|---|---|---|---|---|---|
| 1 | BH1 | 1.0-1.6 | CLAY trace gravel, trace sand | 70 | 28 | 42 | 14.5 |
| 2 | BH1 | 1.3-1.9 | Sandy CLAY trace gravel | 55 | 21 | 34 | 13 |

Test results indicate that the natural CLAY has moderate to high shrink swell capacity or degree of expansion. A copy of the results are presented in Appendix 4.

### 3.4.2. California Bearing Ratio (CBR)

Representative samples were tested by Structerre's in-house NATA accredited laboratory in accordance with AS1289.5.2.1 (2003). The test certificates are presented in Appendix 4 and are summarised in Table 4.

**Table 4 – Soaked CBR Test Results**

| Test Hole | Depth (m) | Soil Description | Optimum Moisture Content % | Maximum Dry Density t/m3 | Swell (%) | CBR @ Penetration (%) |
|---|---|---|---|---|---|---|
| BH13 | 0.2 – 0.5 | SAND | 10 | 1.83 | 0 | 12 @5.0mm |
| BH14 | 0.2 – 0.5 | SAND | 10 | 1.99 | 0 | 40 @5.0mm |

Note: CBR samples were remoulded to 95% Modified maximum dry density in accordance with AS1289 5.2.1 prior to soaking for four (4) days. Based on the above results a conservative soaked CBR of 10% would be recommended for pavement design. Copies of the laboratory results are included in Appendix 4 of this report.

Where the placement of 0.5m or greater of sand fill placed and compacted to 95% of (Modified) MDD above the existing clay soils, an improved subgrade CBR of 12% can be used in pavement design.

# 4. GEOTECHNICAL CONSTRUCTION CONSIDERATIONS

## 4.1. Site Classification

AS 2870-2011 Residential Slabs and Footings provides guidance on site classification for residential slabs and footing design based on the expected ground surface movement and depth of expected moisture changes.

**Table 5 – Classification Based on Site Reactivity**

| AS 2870-2011 Residential Slabs and Footings - Clause 2.1.2 Table 2.1 | |
|---|---|
| **Class** | **Foundation** |
| A | Most sand and rock sites with little or no ground movement from moisture changes |
| S | Slightly reactive clay sites, which may experience only slight ground movement from moisture changes (0<ys≤20mm) |
| M | Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes (20<ys≤40mm) |
| H1 | Highly reactive clay sites, which may experience high ground movement from moisture changes (40<ys≤60mm) |
| H2 | Highly reactive clay sites, which may experience very high ground movement from moisture changes (60<ys≤75mm) |
| E | Extremely reactive sites, which may experience extreme ground movement from moisture changes (ys>75mm) |
| **Clause 2.1.3 Classification of other Sites** | |
| P | Sites which include soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions and site that cannot be classified in accordance to Table 2.1 |

The site in its current condition is classified as Class “M” to “H”. Based on results of this investigation the site can be upgraded to a Class “S” in accordance with AS 2870-2011 provided that all unsuitable materials are removed and replaced with engineer-controlled sand fill materials in accordance with the earthwork recommendations outlined in Section 4.3 of this report.

Footings suitable for this site should be adopted to accommodate expected ground surface movements of approximately $y_s$ = 20mm associated with the presence of moderately to highly reactive CLAY deposits within the building site.

## 4.2. Drainage

The existing ground conditions are not suitable for on-site disposal of stormwater runoff through the use of soakwells.

The design of the drainage system is unknown at this time, but may include:

- Rainwater Tanks;
- Dams / Compensation basin;
- Overland flow paths; and
- Soakwells, if permeable cover and / or stormwater designs are appropriate.

Sub soil drainage may be required to control groundwater perching in the upper soil layers within the building footprint.

## 4.3. Earthworks

All earthworks shall be undertaken in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments and are to include the following:

- All unsuitable materials to be stripped and removed from the site. Unsuitable materials include topsoil, deleterious and organic materials.
- It is considered that the near surface sand material requires improvement. Therefore, it is proposed to excavate and stockpile the materials for reuse, provided it is free from clay/silt (i.e. <5%), deleterious and organic materials. The depth of excavation may vary depending on conditions encountered and is subject to inspection.
- Excavation should not be greater than 2.0m and/or undermine any surrounding structures. A 1V: 1.5H slope should be maintained for temporary excavations. If excavation is required closer than the 1V: 1.5H slope would allow or deeper, it is recommended that this office be contacted for retaining system design.
- Proof compact the exposed base. The compaction requirements are set out in the table below, as per AS 3798-2007:

**Table 6 – Compaction Requirements**

| Item | Application | Minimum relative compaction, % | |
|---|---|---|---|
| | | Minimum density ratio (Standard Compaction Effort) (Cohesive soils) | Minimum density index (Cohesionless soils) |
| 1 | Residential - lot, fill, house, sites | 95 | 70 |

- After excavation and proof compaction, the excavated base is to be inspected and approved by a representative from this office prior to backfilling. At this stage it can be assessed whether any further materials need to be removed or whether further compaction of the base is required.

- A minimum of 1.0m sand cover is to be placed or maintained above the reactive (clay) material in order to achieve a Class "S" site with $y_s$ = 20mm.
- The ground level for residential construction should be built up to design levels with the stockpiled sand FILL and imported fill, if required. The imported fill should consist of free draining sand with not more than 5% passing a 75µm sieve and be free of organic matter and other deleterious materials. The fill materials should be placed in layers not exceeding 300mm loose thickness and compacted to achieve a minimum 8 PSP blows over the interval
  150 – 450mm, 9 PSP blows over the interval 450 – 750mm and 11 PSP blows over the interval 750 -1050mm.
- After remedial earthworks have been completed, the earthworks should be inspected and approved by a representative from this office.

## 5. CONCLUSIONS

A site investigation has been carried out at the site of the proposed residential development to assess the geotechnical conditions. Parameter and design recommendations are incorporated in the body of the report. The following conclusions have been drawn from the site investigation:

- The average subsurface soil profile encountered comprised topsoil to 0.1m, gravelly sand with clay to 0.6m, sand with clay, with gravel to 0.8m, sandy clay trace gravel to 1.2m and underlain by clay trace sand, trace gravel to the investigated depth of 2.0m.
- Groundwater or perched water was not encountered across the site to the depth of 2.0m.
- It is considered that the site is not suitable for on-site drainage.
- The site can be classified as Class "S" in accordance with AS 2870-2011 due to presence of moderately to highly reactive CLAY deposits within the building site, provided that the recommended earthworks are undertaken.
- The full scope of the recommended earthworks is presented in Section 4.3, but generally comprises:
  - Stripping of topsoil and unsuitable materials
  - Proof compaction of the base
  - Placement of sand fill to required level
  - Compaction to final level

## 6. LIMITATION OF FIELD INVESTIGATIONS

This report has been prepared in accordance with generally accepted consulting practice for Tabec Pty Ltd using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

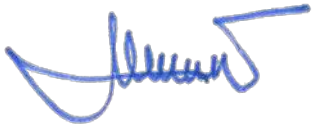
The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions.

If ground conditions encountered during construction are different to that described in this report, this office should be notified immediately.

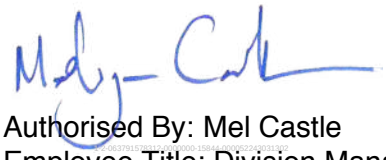
For and behalf of

STRUCTERRE CONSULTING



Margie Mortera
Geotechnical Assistant

Checked By: David Harding
Employee Title: Geotechnical Supervisor



Authorised By: Mel Castle
Employee Title: Division Manager - Geotechnical

Disclaimer
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| Job # | Revision | Authored | Checked | Authorised |
|---|---|---|---|---|
| J409671 | 0 | MM | DH | MC |
| | | | | |

## 7. REFERENCES

Department of Water – Perth Groundwater Atlas

Landgate Map Viewer

Geological Survey of Western Australia 1:50,000 Environmental Geology Series

AS 1170.4-2007 Structural design actions – Earthquake actions in Australia

AS 1289.3.1.2-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the liquid limit of a soil

AS 1289.3.2.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the plastic limit of a soil

AS 1289.3.3.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Calculation of the plasticity index of a soil

AS 1289.3.4.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the linear shrinkage of a soil

AS 1289.3.6.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the particle size distribution of a soil – Standard method of analysis by sieving

AS 1289.5.2.1-2009 Soil compaction and density tests – Soil classification tests – Determination of the dry density/moisture content relation of a soil using modified compactive effort

AS 1289.6.1.1-2009 Soil strength and consolidation tests – Soil classification tests – Determination of the California Bearing Ratio of a soil

AS 1289.6.3.2-1997 Methods of testing soils for engineering purposes – Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9kg dynamic cone penetrometer test

AS 1726-2017 Geotechnical site investigation

AS 2870-2011 Residential slabs and footings

AS 3798-2007 Guidelines on earthworks for commercial and residential developments

AS 4055-2012 Wind loads for housing

# APPENDIX 1 – SITE LOCATION MAP


Note: Showing approximate test locations only

Google Map 2022

## LEGEND

BH Borehole


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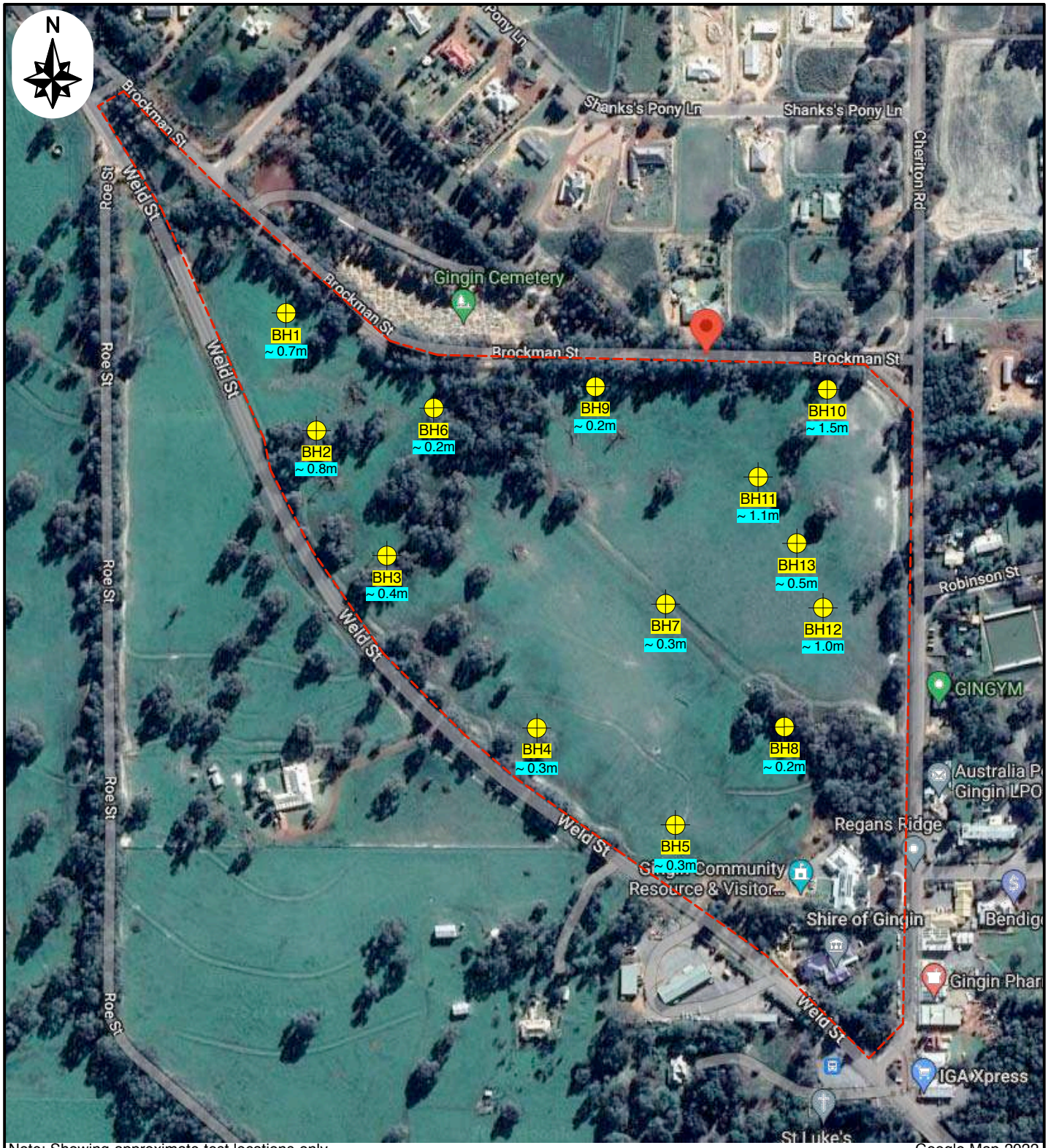
| | |
|---|---|
| PROJECT: | Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin |
| PROJECT #: | D294537 |
| JOB #: | J409671 |
| CLIENT: | **Tabec Pty Ltd** |
| SCALE: | NTS |
| TITLE: | Geotechnical Investigation Site Plan |
| DATE: | 12 May '22 |
| DRAWN BY: | MM |
| CHECKED BY: | DH |

DOC: GE:3.001




Note: Showing approximate test locations only

Google Map 2022

## LEGEND

BH Borehole

Depths of Non-reactive Material

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PROJECT: Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

PROJECT #: D294537

JOB #: J409671

CLIENT: **Tabec Pty Ltd**

SCALE: NTS

TITLE: Geotechnical Investigation Site Plan

DATE: 12 May '22

DRAWN BY: MM

CHECKED BY: DH

DOC: GE:3.001

# APPENDIX 2 – SITE PHOTOS

PHOTO 1

PHOTO 2

STRUCterre consulting

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| PROJECT: | Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin |
| PROJECT #: D294537 | CLIENT: **Tabec Pty Ltd** |
| JOB #: J409671 | |
| SCALE: NTS | TITLE: Site Photographs |
| DATE: 12 May '22 | DRAWN BY: MM / CHECKED BY: DH |


PHOTO 3 - Sample taken at BH2


PHOTO 4 - Sample taken at BH8

STRUCterre consulting

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|---|---|
| PROJECT: | Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin |
| PROJECT #: D294537 | CLIENT: **Tabec Pty Ltd** |
| JOB #: J409671 | |
| SCALE: NTS | TITLE: Site Photographs |
| DATE: 12 May '22 | DRAWN BY: MM / CHECKED BY: DH |

# APPENDIX 3 – BORELOGS

STRUCterre consulting engineers

**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH01**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395281 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531989 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | D - VD | | | | W | |
| | | SP: SAND: fine to medium grained, non-plastic, with gravel, with clay, grey/brown (Colluvium) | | | | | | |
| 1 | | CH: CLAY: fine to medium grained, high plasticity, trace sand, trace gravel, red/grey | | | | | D to M | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel | | | | | | |
| 2 | | Terminated at 2.00 m | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84



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STRUCterre consulting engineers

**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH02**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395349 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531845 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | SP: SAND: medium to coarse grained, non-plastic to low plasticity, with gravel, trace clay, brown (Colluvium) | D - VD | | | | W | |
| | | | | | | | M | |
| | | Terminated at 0.80 m | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on dense gravel
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH03**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395403 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531729 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | L - MD | | | | W | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, brown | F | | | | D to M | |
| 1 | | | | | | | | |
| | | Terminated at 1.50 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH04**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395498 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531633 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | VL - L | | | | W | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, brown | St - VSt | | | | D to M | |
| 1 | | Terminated at 1.00 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH05**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395611 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531549 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | VL - L | | | | W | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, brown | St - VSt | | | | D to M | |
| 1 | | | | | | | | |
| | | Terminated at 1.20 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH06**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395493 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531866 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| 0 | | Topsoil: | | | | | W | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | | | | | | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, with gravel, brown | | | | | D to M | |
| | | Terminated at 0.70 m | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH07**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 3955974 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531716 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | L | | | | W | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, brown | S - F | | | | D to M | |
| | | | F - St | | | | | |
| 1 | | | VSt | | | | | |
| | | Terminated at 1.50 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH08**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395714 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531616 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | W | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | | | | | | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, with gravel, brown | | | | | D to M | |
| | | Terminated at 0.70 m | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH09**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395594 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531896 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | W | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown (Colluvium) | | | | | | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, brown | | | | | D to M | |
| | | Terminated at 0.70 m | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH10**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395765 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531884 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| 0 | | Topsoil: | | | | | | |
| | | SP: SAND: fine to medium grained, non-plastic, grey (Colluvium) | VL - L | | | | W | |
| 1 | | | | | | | M | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown | | | | | | |
| | | Terminated at 1.50 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on dense gravel
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH11**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395755 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531783 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | SP: SAND: fine to medium grained, non-plastic, grey (Colluvium) | | | | | W | |
| | | | | | | | M | |
| 1 | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown | | | | | | |
| | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, red/grey | | | | | D to M | |
| | | Terminated at 1.90 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH12**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395760 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531671 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | | |
| | | SP: SAND: fine to medium grained, non-plastic, grey (Colluvium) | VL - L | | | | W | |
| | | GP: Gravelly SAND: medium to coarse grained, non-plastic, with clay, brown | D - VD | | | | M | |
| 1 | | CH: Sandy CLAY: fine to medium grained, high plasticity, trace gravel, red/grey | | | | | D to M | |
| | | Terminated at 1.20 m | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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**Project** Proposed Residential Subdivision - Lot 601 Brockman Street, Gingin

**Client** Tabec Pty Ltd

Test No. **BH13**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project No.** | D294537 | **Logged By** | Tony Broadway | **Machine** | Soil Retrieval Probe | **Easting** | 395778 |
| **Job No.** | J409671 | **Date** | 12/05/2022 | **Hole Dia.** | 65mm | **Northing** | 6531790 |

| Depth | Graphic | Stratum Description | Consistency | DCP Blows/150mm (5 10 15 20) | Samples Depth | Samples Type | Moisture | Water Level |
|---|---|---|---|---|---|---|---|---|
| | | Topsoil: | | | | | W | |
| | | SP: SAND: fine to medium grained, non-plastic, yellow/ brown (Colluvium) | | | | | M | |
| | | Terminated at 0.50 m | | | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

**Remarks**

1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84



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# APPENDIX 4 – LABORATORY TEST RESULTS

| | | | |
|---|---|---|---|
| **Sample No.** | **36527** | **Client** | Geotechnical |
| **Job No.** | J409671 | **Project** | Lot 601 BROCKMAN ST, GINGIN |

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

## SAMPLE DETAILS

| | | | |
|---|---|---|---|
| BH No. / Depth | BH1 1.0-1.6 | Sampling Method | Client |
| Sample History | 50°C Oven Dried | Sample Preparation | AS 1289 1.1 |

## ATTERBERG LIMITS

| Description | Method | Result (%) |
|---|---|---|
| Liquid Limit | AS 1289.3.1.2 | 70 |
| Plastic Limit | AS 1289.3.2.1 | 28 |
| Plasticity Index | AS 1289.3.3.1 | 42 |
| Linear Shrinkage | AS 1289.3.4.1 | 14.5 |
| Nature of Shrinkage | | Flat |

## PARTICLE SIZE DISTRIBUTION

**Method:** AS 1289.3.6.1
**Description:** Particle size distribution by sieve analysis

| Sieve Size (mm) | % Passing |
|---|---|
| 19.0 | 100 |
| 2.36 | 98 |
| 0.425 | 96 |
| 0.075 | 90 |

**AS 1726:2017 Clause 6.1**
**Material Description:** CLAY trace gravel, trace sand
**AS Group Symbol:** CH or OH

Accredited for compliance with ISO/IEC 17025
NATA
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Jacob Pritchard
Senior Laboratory Technician

**Date:** 27-May-22



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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

| | | | |
|---|---|---|---|
| **Sample No.** | **36528** | **Client** | Geotechnical |
| **Job No.** | J409671 | **Project** | Lot 601 Brockman st, gingin |

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

## SAMPLE DETAILS

| | | | |
|---|---|---|---|
| BH No. / Depth | BH1 1.3-1.9 | Sampling Method | Client |
| Sample History | 50°C Oven Dried | Sample Preparation | AS 1289 1.1 |

## ATTERBERG LIMITS

| Description | Method | Result (%) |
|---|---|---|
| Liquid Limit | AS 1289.3.1.2 | 55 |
| Plastic Limit | AS 1289.3.2.1 | 21 |
| Plasticity Index | AS 1289.3.3.1 | 34 |
| Linear Shrinkage | AS 1289.3.4.1 | 13 |
| Nature of Shrinkage | | Flat |

## PARTICLE SIZE DISTRIBUTION

**Method:** AS 1289.3.6.1
**Description:** Particle size distribution by sieve analysis

| Sieve Size (mm) | % Passing |
|---|---|
| 19.0 | 100 |
| 2.36 | 98 |
| 0.425 | 80 |
| 0.075 | 56 |

**AS 1726:2017 Clause 6.1**
**Material Description:** Sandy CLAY trace gravel
**AS Group Symbol:** CH or OH

Accredited for compliance with ISO/IEC 17025
NATA
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Jacob Pritchard
Senior Laboratory Technician

**Date:** 27-May-22



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Website: www.structerre.com.au
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# California Bearing Ratio Test Report

**Report Number: CBR:22S-03682**
**Date of Issue01/06/2022**
**Issue Number: 1**

| | |
|---|---|
| **Client:** | Tabec Pty Ltd |
| **Client Address:** | Level 2, 54-58 Havelock St West Perth WA 6005 |
| **Project:** | Proposed Residential Subdivision - Lot 601 Brockman St, Gingin |
| **Project No:** | D294537 |

Accreditation Number 18742

NATA WORLD RECOGNISED ACCREDITATION

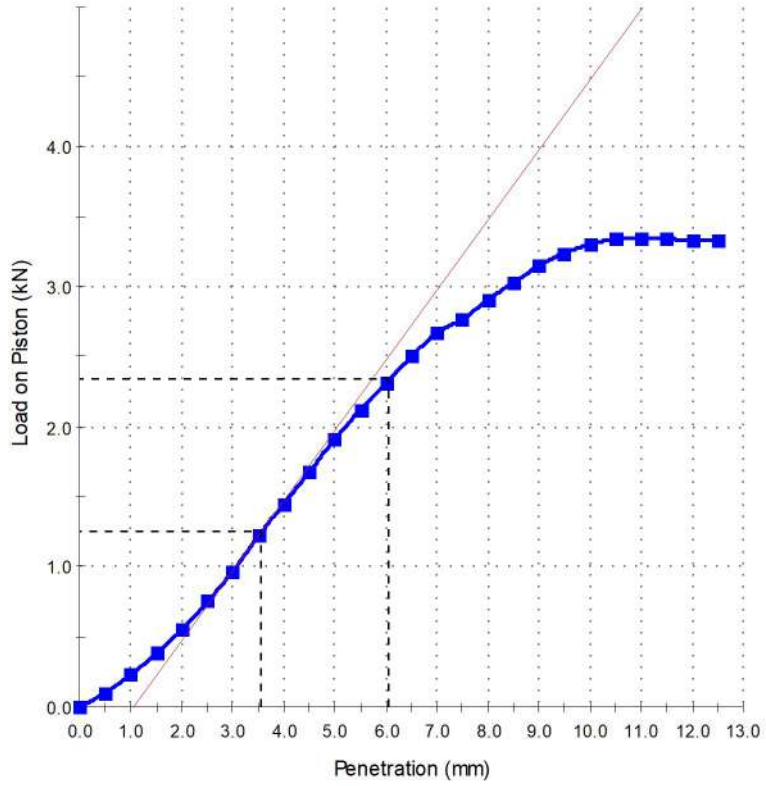
Approved Signatory: Aaron Nicholas

Accredited for compliance with ISO/IEC 17025

## Sample Details

| | | | |
|---|---|---|---|
| **Sample ID:** | Proposed Subdivision | **Field Sample ID:** | BH13 |
| **Date Tested:** | 27/05/2022 | **Date Sampled:** | 24/05/2022 |
| **Soil Description:** | Sand | **Proposed Use:** | Fill |
| **Depth of Test:** | 200-500mm | **Depth of Layer:** | 300 |
| **Sampling Method:** | Sampled by Client | **TRN:** | - |
| **Work Order ID:** | W22-01312 | | |

## Load vs Penetration




## Test Results

AS 1289.6.1.1

| | |
|---|---|
| **CBR at 5.0mm (%):** | **12** |
| Dry Density before Soaking (t/m³): | 1.73 |
| Density Ratio before Soaking (%): | 95.0 |
| Moisture Content before Soaking (%): | 9.9 |
| Moisture Ratio before Soaking (%): | 101.5 |
| Dry Density after Soaking (t/m³): | 1.74 |
| Density Ratio after Soaking (%): | 95.0 |
| Swell (%): | 0.0 |
| Moisture Content of Top 30mm (%): | 14.4 |
| Moisture Content of Remaining Depth (%): | 14.3 |
| Compaction Hammer Used: | Modified AS 1289.5.2.1 |
| Surcharge Mass (kg): | 4.50 |
| Period of Soaking (Days): | 4 |
| Retained on 19 mm Sieve (%): | 0 |
| CBR Moisture Content Method: | AS 1289.2.1.1 |
| Sample Curing Time (h): | 24 |

## Comments

**Malaga Laboratory**
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Ph : (08) 9205 4500
Email: wageotechlab@structerre.com.au
Website: www.structerre.com.au
ABN: 71 349 772 837 / ACN: 008 966 283

# Maximum Dry Density Report

**Report Number: MDD:22S-03682**
**Date of Issue01/06/2022**
**Issue Number: 1**

| | |
|---|---|
| **Client:** | Tabec Pty Ltd |
| **Client Address:** | Level 2, 54-58 Havelock St West Perth WA 6005 |
| **Project:** | Proposed Residential Subdivision - Lot 601 Brockman St, Gingin |
| **Project No:** | D294537 |

Accreditation Number 18742

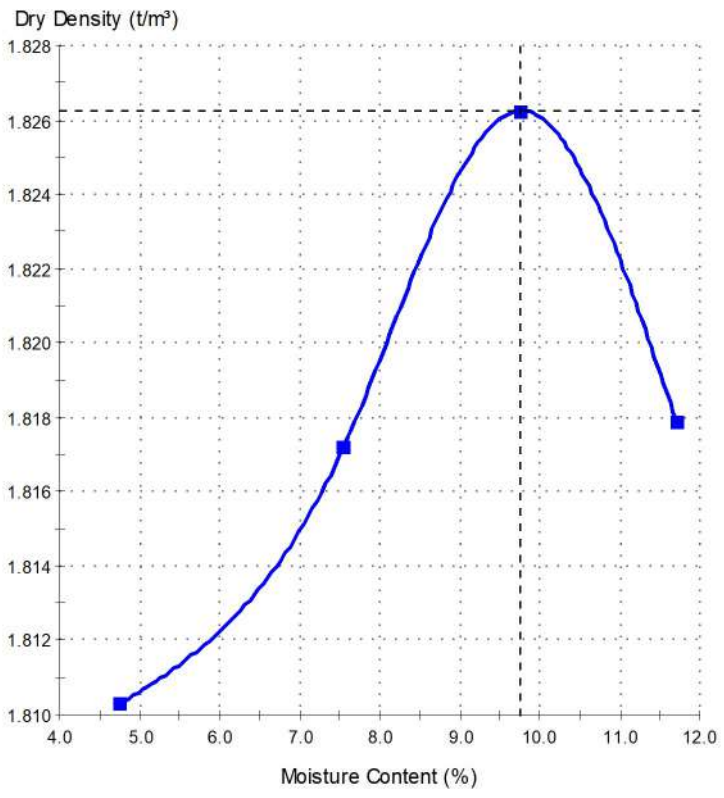
Approved Signatory: Aaron Nicholas

Accredited for compliance with ISO/IEC 17025

## Sample Details

| | | | |
|---|---|---|---|
| **Sample ID:** | Proposed Subdivision | **Field Sample ID:** | BH13 |
| **Date Tested:** | 24/05/2022 | **Date Sampled:** | 24/05/2022 |
| **Soil Description:** | Sand | **Proposed Use:** | Fill |
| **Depth of Test:** | 200-500mm | **Depth of Layer:** | 300 |
| **Sampling Method:** | Sampled by Client | **TRN:** | - |
| **Work Order ID:** | W22-01312 | | |

## Dry Density - Moisture Content Relationship




## Test Results

AS 1289.5.2.1

| | |
|---|---|
| **Modified MDD (t/m³):** | **1.83** |
| **Modified OMC (%):** | **10.0** |
| Retained Sieve (mm): | 19.0 |
| Oversize Material (%): | 0 |
| Curing Time (h): | 2 |
| LL Method: | Visual / Tactile |

## Comments

**Malaga Laboratory**
44 Crocker Drive, Malaga, WA 6090
Post: PO Box 792, Balcatta WA 6914
Ph : (08) 9205 4500
Email: wageotechlab@structerre.com.au
Website: www.structerre.com.au
ABN: 71 349 772 837 / ACN: 008 966 283

# California Bearing Ratio Test Report

**Report Number: CBR:22S-03683**
**Date of Issue01/06/2022**
**Issue Number: 1**

| | |
|---|---|
| **Client:** | Tabec Pty Ltd |
| **Client Address:** | Level 2, 54-58 Havelock St West Perth WA 6005 |
| **Project:** | Proposed Residential Subdivision - Lot 601 Brockman St, Gingin |
| **Project No:** | D294537 |

Accreditation Number 18742

NATA WORLD RECOGNISED ACCREDITATION

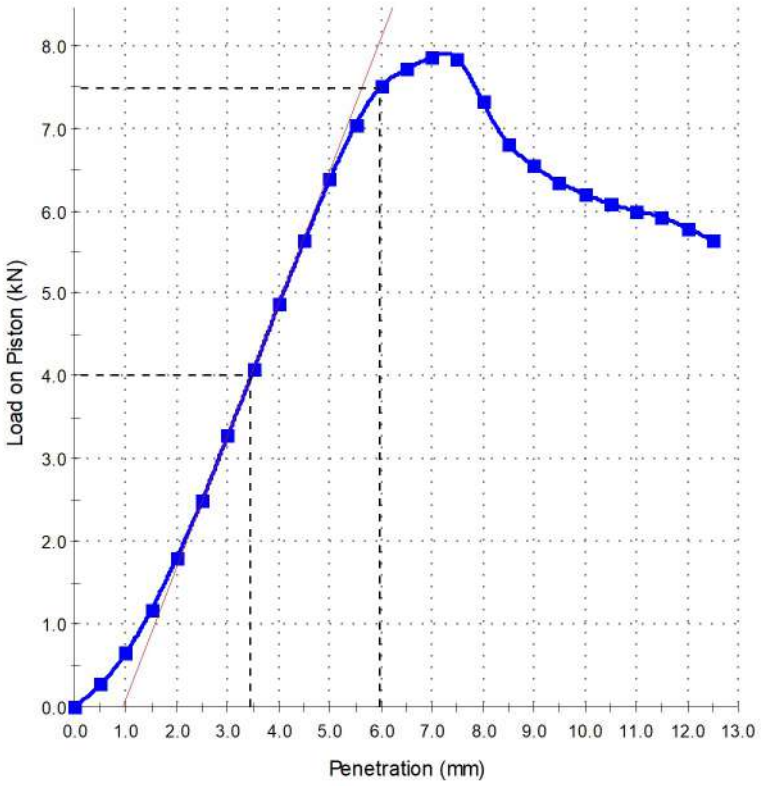
Approved Signatory: Aaron Nicholas

Accredited for compliance with ISO/IEC 17025

## Sample Details

| | | | |
|---|---|---|---|
| **Sample ID:** | Proposed Subdivision | **Field Sample ID:** | BH14 |
| **Date Tested:** | 27/05/2022 | **Date Sampled:** | 24/05/2022 |
| **Soil Description:** | Sand | **Proposed Use:** | Fill |
| **Depth of Test:** | 200-500mm | **Depth of Layer:** | 300 |
| **Sampling Method:** | Sampled by Client | **TRN:** | - |
| **Work Order ID:** | W22-01312 | | |

## Load vs Penetration




## Test Results

AS 1289.6.1.1

| | |
|---|---|
| **CBR at 5.0mm (%):** | **40** |
| Dry Density before Soaking (t/m³): | 1.89 |
| Density Ratio before Soaking (%): | 95.0 |
| Moisture Content before Soaking (%): | 10.0 |
| Moisture Ratio before Soaking (%): | 101.5 |
| Dry Density after Soaking (t/m³): | 1.89 |
| Density Ratio after Soaking (%): | 95.0 |
| Swell (%): | 0.0 |
| Moisture Content of Top 30mm (%): | 11.2 |
| Moisture Content of Remaining Depth (%): | 10.8 |
| Compaction Hammer Used: | Modified AS 1289.5.2.1 |
| Surcharge Mass (kg): | 4.50 |
| Period of Soaking (Days): | 4 |
| Retained on 19 mm Sieve (%): | 1 |
| CBR Moisture Content Method: | AS 1289.2.1.1 |
| Sample Curing Time (h): | 24 |

## Comments

**Malaga Laboratory**
44 Crocker Drive, Malaga, WA 6090
Post: PO Box 792, Balcatta WA 6914
Ph : (08) 9205 4500
Email: wageotechlab@structerre.com.au
Website: www.structerre.com.au
ABN: 71 349 772 837 / ACN: 008 966 283

# Maximum Dry Density Report

**Report Number: MDD:22S-03683**
**Date of Issue01/06/2022**
**Issue Number: 1**

| | |
|---|---|
| **Client:** | Tabec Pty Ltd |
| **Client Address:** | Level 2, 54-58 Havelock St West Perth WA 6005 |
| **Project:** | Proposed Residential Subdivision - Lot 601 Brockman St, Gingin |
| **Project No:** | D294537 |

Accreditation Number 18742

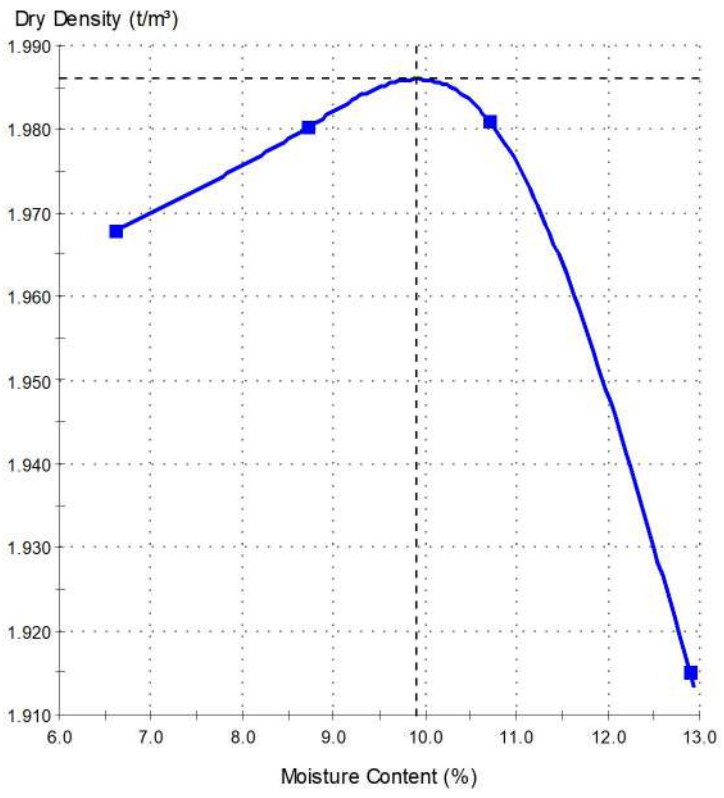
Approved Signatory: Aaron Nicholas

Accredited for compliance with ISO/IEC 17025

## Sample Details

| | | | |
|---|---|---|---|
| **Sample ID:** | Proposed Subdivision | **Field Sample ID:** | BH14 |
| **Date Tested:** | 24/05/2022 | **Date Sampled:** | 24/05/2022 |
| **Soil Description:** | Sand | **Proposed Use:** | Fill |
| **Depth of Test:** | 200-500mm | **Depth of Layer:** | 300 |
| **Sampling Method:** | Sampled by Client | **TRN:** | - |
| **Work Order ID:** | W22-01312 | | |

## Dry Density - Moisture Content Relationship




## Test Results

AS 1289.5.2.1

| | |
|---|---|
| **Modified MDD (t/m³):** | **1.99** |
| **Modified OMC (%):** | **10.0** |
| Retained Sieve (mm): | 19.0 |
| Oversize Material (%): | 1 |
| Curing Time (h): | 2 |
| LL Method: | Visual / Tactile |

## Comments

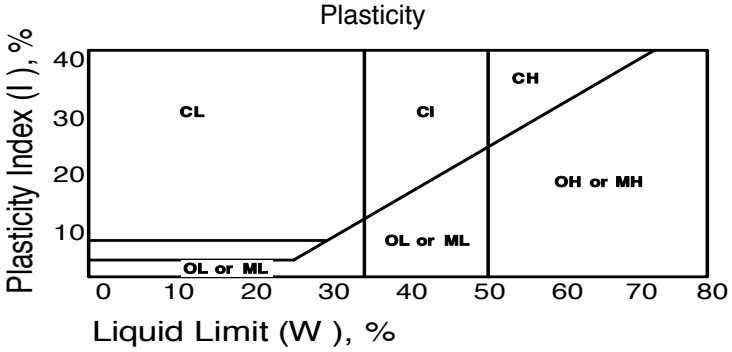
# APPENDIX 5 – BORELOG TERMINOLOGY

# BOREHOLE TERMINOLOGY

## Particle Size Distribution

| Major Division | Subdivision | Size |
|---|---|---|
| Boulders | | >200mm |
| Cobbles | | 200 - 63mm |
| Gravel | Coarse | 63 - 20mm |
| | Medium | 20- 6mm |
| | Fine | 6 - 2.36mm |
| Sand | Coarse | 2.36 - 0.6mm |
| | Medium | 0.6 - 0.2mm |
| | Fine | 0.2 - 0.075mm |

## Plasticity




## Consistency of Cohesive Soils

| Term | Undrained Strength Su (kPa) | Field Guide |
|---|---|---|
| Very Soft | < 12 | Exudes between the fingers when squeezed in hand |
| Soft | 12 - 25 | Can be moulded by light finger pressure |
| Firm | 25 - 50 | Can be moulded by strong finger pressure |
| Stiff | 50 - 100 | Cannot be moulded by Fingers. Can be indented by thumb. |
| Very Stiff | 100 - 200 | Can be indented by thumb nail |
| Hard | > 200 | Can be indented with difficulty by thumb nail. |
| Friable | - | Crumbles or powders when scraped by thumbnail |

## Consistency/Density of Non-Cohesive Soils

| Term | Density Index (%) | SPT "N" Value Comparison |
|---|---|---|
| Very Loose | < 15 | 0 - 4 |
| Loose | 15 - 35 | 4 - 10 |
| Medium Dense | 35 - 65 | 10 - 30 |
| Dense | 65 - 85 | 30 - 50 |
| Very Dense | > 85 | > 50 |

## Moisture Content

| | |
|---|---|
| D | Dry |
| M | Moist |
| W | Wet |
| S | Saturated |

## Minor Components

| Term | Assessment Guide | Proportion of Minor Component In: |
|---|---|---|
| Trace | Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component | Coarse grained soils: < 5 %<br>Fine grained soils: <15% |
| With | Presence easily detected by feel or eye, soil properties little different to general properties of primary component | Coarse grained soils: 5 - 12 %<br>Fine grained soils: 15 - 30% |

## Soil Legend

| | | | |
|---|---|---|---|
| FILL | CLAY | GRAVEL | CONCRETE |
| TOPSOIL | SILT | LIMESTONE | COMBINATIONS |
| PEAT | SAND | BEDROCK | eg: Clay, Silty, Sandy |

## USCS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| GW | Well graded gravel | SC | Clayey sand | OL | Organic low plasticity silt | CL | Low plasticity clay |
| GP | Poorly graded gravel | SM | Silty sand | ML | Low plasticity silt | CI | Intermediate plasticity clay |
| SW | Well graded sand | | | MH | High plasticity silt | CH | High plasticity clay |
| SP | Poorly graded sand | | | OH | Organic high plasticity silt | PT | Peat |

DOC:GE:3.003

WA | QLD | NSW | VIC

1 Erindale Road, Balcatta, Western Australia 6021 | PO Box 792, Balcatta, Western Australia 6914

Phone (+618) 9205 4500 | Fax (+618) 9205 4501 | Email wageotecheng@structerre.com.au | Web www.structerre.com.au

ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

# Appendix B: Rear of Lot drainage system

Note: Lot drainage is shown where lots grade front to rear. System collects overflow from lot soakwells / storage only. Pipe layout indicative and is subject to detailed design.

Legend:

- Proposed lot drainage pipework
- Proposed lot drainage connection point
- Landgate Contours
- Existing Trees (Feature Survey) - To be retained
- Existing Trees (Feature Survey) - To be removed
- Existing Fence (Feature Survey)
- Index Contours (Feature Survey)
- Proposed Commercial Lots

# PROPOSED LOT DRAINAGE NETWORK

LOT 601 BROCKMAN STREET
GINGIN



Urban Development Institute of Australia WESTERN AUSTRALIA

PIA Planning Institute Australia

CPP CERTIFIED PRACTISING PLANNER

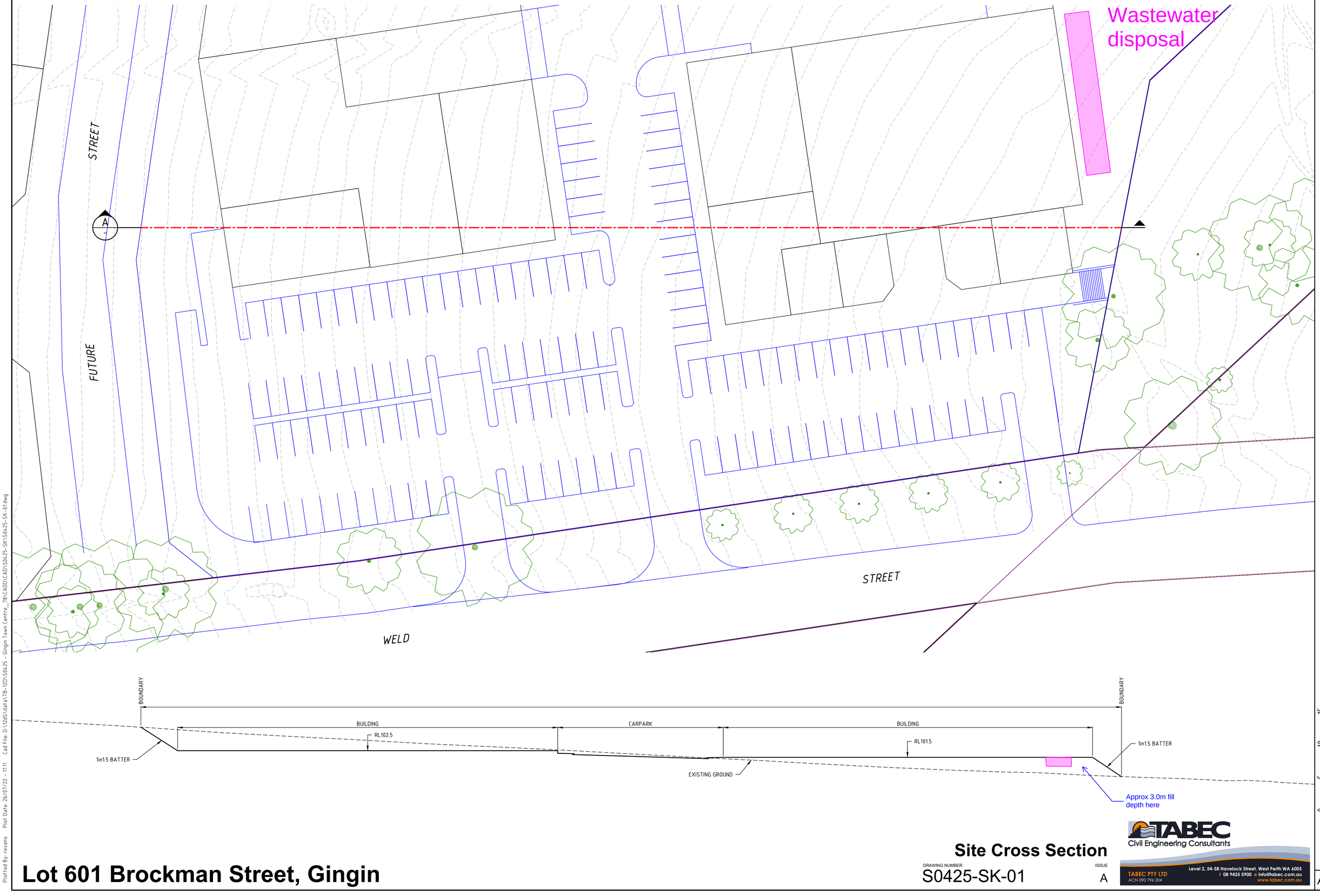
SCALE: 1:2500 @ A3
DATE: 15th SEPTEMBER 2022
FILE: 1508_15.09.2022.dwg
DRAW: - SB
CHECKED: -

DYNAMIC PLANNING AND DEVELOPMENTS
E: admin@dynamicplanning.net.au
T: (08) 9275 4433
W: www.dynamicplanning.net.au
SUITE 15, 29 COLLIER ROAD
MORLEY WA 6062
ABN: 99 169 411 705



N W E S

# Appendix C: Draft Town Centre Cut and Fill Plan




# Lot 601 Brockman Street, Gingin

## Site Cross Section

DRAWING NUMBER S0425-SK-01

ISSUE A

SCALE 1:250

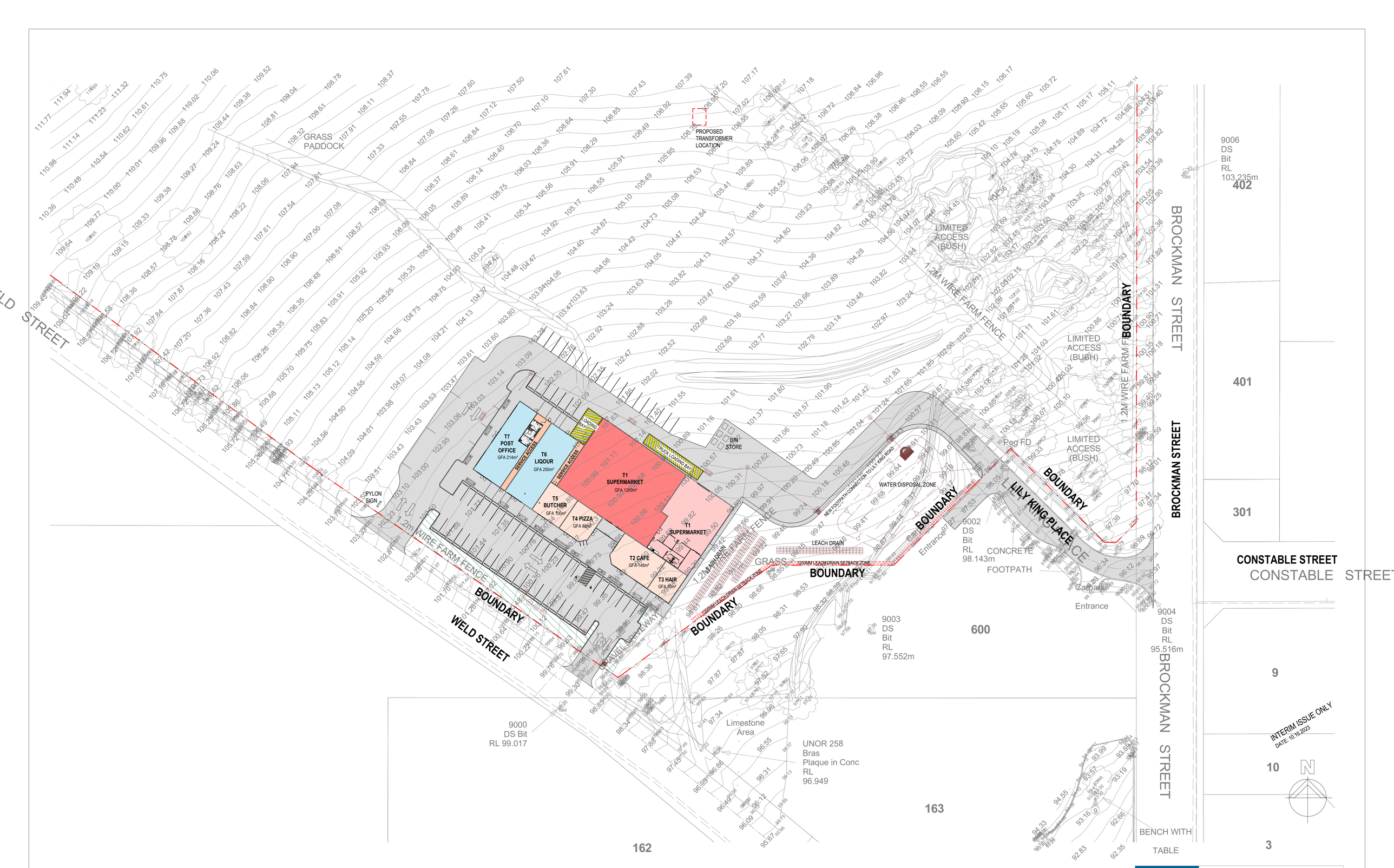
0 5 10 15

A1

TABEC Civil Engineering Consultants
TABEC PTY LTD ACN 090 796 204
Level 2, 54-58 Havelock Street, West Perth WA 6005
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

Plotted By: revans Plot Date: 26/01/22 - 11:11 Cad File: D:\T2dS\data\TB-12D\S04\25 - Gingin Town Centre_78\CADD\CAD\S0425-SK\S0425-SK-01.dwg

# Appendix B: Stage 1 Town Centre Expansion Design Layout




PROPOSED SITE PLAN

DA02

PROPOSED GINGIN COMMERCIAL - STAGE 1

LOT 601 BROCKMAN STREET, GINGIN

REVISION H PROJECT NO. 64.22 DATE 10.10.2023

Hodge Collard Preston ARCHITECTS

# Appendix C: Draft Town Centre Cut and Fill Plan

## NOTES

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DRAWINGS AND SPECIFICATION.
2. ORIGINAL SURVEY CONTOURS PROVIDED BY MNG.
   2.1. ALL FINISHED LEVELS ARE IN METRES TO AHD.
   2.2. HORIZONTAL DATUM IS PCG2020.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. CONTRACTOR TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORKS ON SITE.
5. PRIOR TO CUTTING OR FILLING, THE SITE AREAS SHALL BE CLEARED AND TOPSOIL MANAGED IN ACCORDANCE WITH THE FOLLOWING:
   5.1. EXTENT OF CLEARING TO BE LIMITED TO THE BOUNDARY UNLESS AGREED WITH THE SUPERINTENDENT.
   5.2. VEGETATION WHERE NOTED FOR PROTECTION SHALL BE FENCED PRIOR TO CLEARING SURROUNDING AREA. THE CONTRACTOR TO PROTECT THE "VEGETATION PROTECTION AREAS" FROM ANY DAMAGE.
   5.3. PROPOSED CLEARING AREAS TO BE FLAGGED TO ENABLE FAUNA SURVEY TO BE UNDERTAKEN AHEAD OF CLEARING WORKS COMMENCING.
   5.4. ALL UNSUITABLE MATERIAL TO BE REMOVED BY THE CONTRACTOR TO APPROVED TIPPING SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION. ALL FEES TO BE PAID BY THE CONTRACTOR.
   5.5. ALL CLEARED MATERIAL TO BE MULCHED AND STOCKPILED ON SITE AS DIRECTED BY THE SUPERINTENDENT.
   5.6. TOPSOIL TO BE DIRECT BLENDED WITH CLEAN SAND FILL AS DIRECTED BY THE SUPERINTENDENT.
6. CLEARING OF VEGETATION SHALL NOT COMMENCE UNTIL THE SUPERINTENDENT HAS INSPECTED THE FLAGGED WORKS BOUNDARY AND FAUNA SURVEY HAS BEEN COMPLETED.
7. PLACING OF FILL SHALL NOT COMMENCE UNTIL THE SUPERINTENDENT HAS INSPECTED THE WORKS.
8. IN-SITU ROCK TO BE OVER EXCAVATED 600mm BELOW THE FINISHED SURFACE LEVEL. EXCAVATED ROCK CAN BE PLACED IN AREAS OF DEEP FILL TO WITHIN 600mm OF THE FINISHED SURFACE LEVEL. EXCESS ROCK TO BE STOCKPILED ON SITE AS DIRECTED BY THE SUPERINTENDENT.
9. ALL LEVELS SHOWN ARE FINISHED LEVELS AFTER FINAL WORKS. ALL ROADS SHALL BE BOXED AS SHOWN ON THE TYPICAL BOXOUT SECTION.
10. EARTHWORKS SHALL INTERFACE TO SURROUNDING EXISTING GROUND LEVELS WITH 1in3 BATTERS UNLESS NOTED OTHERWISE.
11. CONTRACTOR TO FACILITATE INDEPENDENT CERTIFICATION BY PRINCIPALS GEOTECHNICAL ENGINEER THAT EARTHWORKS HAVE BEEN CONSTRUCTED IN ACCORDANCE WITH THE DRAWINGS AND THE SPECIFICATION.
12. ALL EARTHWORKED AREAS ARE TO BE STABILISED USING HYDROMULCH.
13. THE CONTRACTOR SHALL PROVIDE THE SUPERINTENDENT AN AS-CONSTRUCTED SURVEY OF FINISHED DEVELOPMENT LEVELS WITHIN THE EXTENT OF WORKS BOUNDARY. THE LEVELS SHOULD ACCURATELY DEFINE BATTERS, CHANGES IN GRADE AND RETAINING WALLS. THE AS-CONSTRUCTED SURVEY SHALL BE SUPPLIED IN DIGITAL FORMAT (CAD AND PDF).

## LEGEND

- EXTENT OF EARTHWORKS
- EXISTING SURFACE CONTOUR
- PROPOSED SURFACE CONTOUR (0.5m)
- PROPOSED FINISHED FLOOR LEVEL
- PROPOSED RETAINING WALLS
- FUTURE RETAINING WALLS (NOT INCLUDED IN THESE WORKS)
- EXISTING RETAINING WALLS
- EXISTING DRAINAGE
- EXISTING WATER MAIN
- EXISTING COMMUNICATIONS
- EXISTING UNDERGROUND POWER HIGH VOLTAGE POWER
- EXISTING OVERHEAD POWER
- EXISTING TREE TO REMAIN

PROPOSED TRANSFORMER LOCATION. PROVIDE LEVEL PAD AT RL 106.50mAHD

1:3 BATTER TO EXISTING

1:4 BATTER

1:2 BATTER TO RL 98.50

1:2 BATTER TO EXISTING

1:2 BATTER TO EXISTING (0.5m OFFSET FROM BOUNDARY)

DRAINAGE BASIN

LILY KING PLACE

BROCKMAN STREET

SCALE 1:500 (0 10 20 30)

A1

BEFORE YOU DIG www.byda.com.au

| No. | DATE | DRAWN | APPROVED | AMENDMENT |
|---|---|---|---|---|
| A | 13.10.23 | DWP | CCB | ISSUED FOR DA SUBMISSION |



CLIENT: JOHN YOUNG

| DESIGNED | CHECKED | APPROVED |
|---|---|---|
| DWP | CCB | C.C. BITMEAD |
| DRAWN: DWP | CHECKED: CCB | DATE: 13.10.2023 |

TABEC Civil Engineering Consultants
TABEC PTY LTD ACN 090 796 204
Level 2, 54-58 Havelock Street, West Perth WA 6005
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

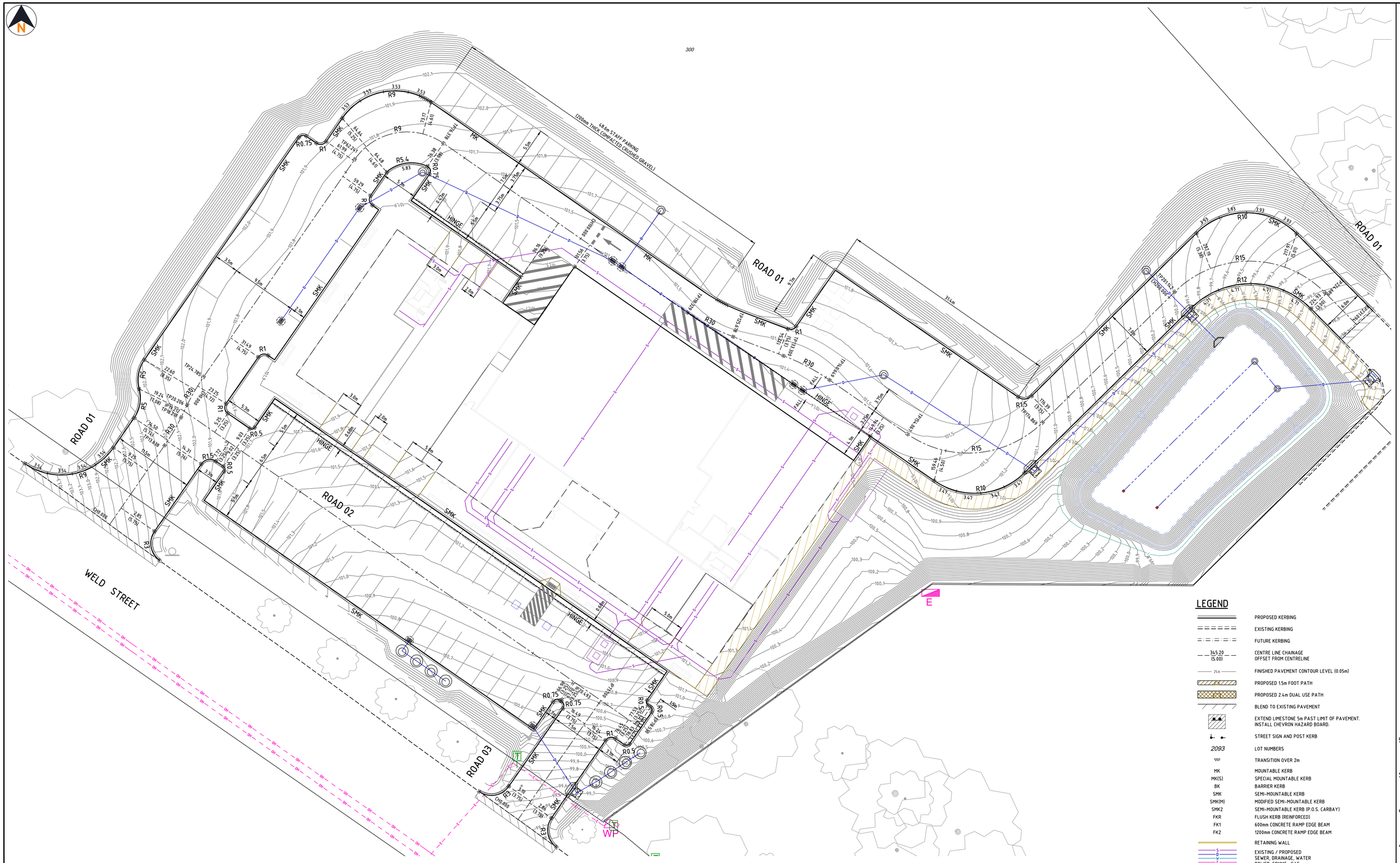
PROJECT: GINGIN LOCAL CENTRE - STAGE 1

TITLE: EARTHWORKS PLAN

DRAWING NUMBER: 2537-01-100

ISSUE: A

Plotted By: dpratt Plot Date: 13/10/23 - 11:14 Cad File: C:\TABEC\Data\TB-JOBS\2537 - Gingin Local Centre_120\LADD\CAD\2537-01\2537-01-100.dwg




## LEGEND

- PROPOSED KERBING
- EXISTING KERBING
- FUTURE KERBING
- 345.20 (5.00) — CENTRE LINE CHAINAGE OFFSET FROM CENTRELINE
- 25.6 — FINISHED PAVEMENT CONTOUR LEVEL (0.05m)
- PROPOSED 1.5m FOOT PATH
- PROPOSED 2.4m DUAL USE PATH
- BLEND TO EXISTING PAVEMENT
- EXTEND LIMESTONE 5m PAST LIMIT OF PAVEMENT. INSTALL CHEVRON HAZARD BOARD.
- STREET SIGN AND POST KERB
- 2093 — LOT NUMBERS
- TW — TRANSITION OVER 2m
- MK — MOUNTABLE KERB
- MK(S) — SPECIAL MOUNTABLE KERB
- BK — BARRIER KERB
- SMK — SEMI-MOUNTABLE KERB
- SMK(M) — MODIFIED SEMI-MOUNTABLE KERB
- SMK2 — SEMI-MOUNTABLE KERB (P.O.S. CARBAY)
- FKR — FLUSH KERB (REINFORCED)
- FK1 — 600mm CONCRETE RAMP EDGE BEAM
- FK2 — 1200mm CONCRETE RAMP EDGE BEAM
- RETAINING WALL
- S D W E T G — EXISTING / PROPOSED SEWER, DRAINAGE, WATER POWER, COMMS, GAS
- DUAL LIGHT POLE / LIGHT POLE / PILLAR / PIT SHOWN FOR INFORMATION ONLY.

SCALE 1:250 (0, 5, 10, 15)

A1

BEFORE YOU DIG www.byda.com.au

| No. | DATE | DRAWN | APPROVED | AMENDMENT |
|---|---|---|---|---|
| A | 13.10.23 | DWP | CCB | ISSUED FOR DA SUBMISSION |

This plan shall not to be used for construction unless issued as rev 0 and signed as approved.



CLIENT: JOHN YOUNG

| DESIGNED | CHECKED | APPROVED |
|---|---|---|
| DWP | CCB | C.C. BITMEAD |
| DRAWN | CHECKED | DATE |
| DWP | CCB | 13.10.2023 |

TABEC Civil Engineering Consultants
TABEC PTY LTD ACN 090 796 204
Level 2, 54-58 Havelock Street, West Perth WA 6005
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

PROJECT: GINGIN LOCAL CENTRE - STAGE 1

TITLE: CIVIL GRADING PLAN

DRAWING NUMBER: 2537-01-320

ISSUE: A

Plotted By: dpratt Plot Date: 13/10/23 - 11:36 Cad File: C:\12d\Data\TB-12D\2537 - Gingin Local Centre_12D\LADD\CAD\2537-01\2537-01-320.dwg