

LOCAL STRUCTURE PLAN

LOTS 500 AND 501 NORTH BEACH ROAD **GWELUP**



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RECORD OF ENDORSEMENT

CERTIFIED THAT THIS LOCAL STRUCTURE PLAN WAS ADOPTED BY RESOLUTION AUSTRALIAN PLANNING COMMISSION ON:	OF THE WESTERN
7 November 2014	Date
Signed for and on behalf of the Western Australian Planning Commission	
an officer of the Commission duly authorised by the Commission pursuant to section	n.26 24
of the Planning and Development Act 2005 for that purpose, in the presence of:	
M. Wiedan 18 November 2014	Witness Date
And by	
RESOLUTION OF THE COUNCIL OF THE CITY OF STIRLING ON 16 SEPTEMBER 2014.	Date
And	
PURSUANT TO THE COUNCIL'S RESOLUTION HEREUNTO AFFIXED IN THE PRESENTATION OF STIRLING CITY OF STIRLING	OF STIR
90910 Dange C	
Chief Executive Officer,	MMON SE
CITY OF STIRLING	
6 October 2014.	Date
This Local Structure Plan is prepared under the provisions of the City of Stirling Local Planning Scheme No. 3	

TABLE OF MODIFICATIONS TO LOCAL STRUCTURE PLAN

Modification No.	Description of Modification	Date Endorsed by Council	Date Endorsed by WAPC

EXECUTIVE SUMMARY

The land the subject of this Local Structure Plan ('Structure Plan') is located within the municipality of the City of Stirling. The subject land is situated approximately 10 kilometres north west of the Perth City Centre and approximately 2 kilometres north east of the Karrinyup Shopping Centre.

The Structure Plan Area represents the northern extension of land already developed within the Careniup Swamp Special Control Area on land formerly used for market garden purposes. The eastern part of the site includes a wetland and associated bushland. The Structure Plan proposes public open space and residential development providing medium density housing opportunities. The Structure Plan requires Local Development Plans for all grouped housing lots and lots less than 350m² to guide development.

The provisions, standards and requirements specified under Part 1 of this Structure Plan have the same force and effect as if it were a provision, standard or requirement of the City of Stirling's Local Planning Scheme No. 3 (the 'Scheme'). Parts 2 and 3 of this Structure Plan are for explanatory purposes and to provide a descriptive analysis of the Structure Plan.

In the event of an inconsistency or conflict between the provisions, standards or requirements of the Scheme and the provisions, standards or requirements of this Structure Plan, then the provisions, standards and requirements of the Scheme will prevail to the extent of the inconsistency.

Local Structure Plan Summary Table

Item	Data	Section number referenced in report
Total area covered by the Local Structure Plan	4.0468 hectares	[2] 1.2.2
Area of each land use proposed:		(2) 1.2.2
Residential	2.4406 hectares	
Estimated residential site density	25 dwellings per site hectare	(2) 2.3
Estimated population	170 people*	
Estimated area and % of public open space:		[2] 2.2
Regional Open Space	7,615 hectares, 18.8%	
Estimated number and area of natural area and biodiversity assets	7,615 hectares 1 park	(2) 2.1

^{*} Based on 2011 Australian Bureau of Statistics Census data applicable to the suburb of Gwelup.

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- 2. Regional Location
- 3. Local Location
- 4. Metropolitan Region Scheme Zoning
- 5. Local Planning Scheme Zoning
- **6.** Site Plan

▲TECHNICAL APPENDICES

Appendix Number	Document Title	Nature of Document	Referral/Approv al Agency	Summary of Document Modifications
1.	Certificate(s) of Title	Additional Information	N/A	N/A
2.	Environmental Assessment	Technical Report	City of Stirling	
3.	Local Water Management Strategy	Technical Report	City of Stirling	
4.	Traffic Assessment	Technical Report	City of Stirling	
5.	Infrastructure Report	Technical Report	City of Stirling	
6.	Geotechnical Investigation	Technical Report	City of Stirling	

Part One STATUTORY SECTION



1. Local Structure Plan Area

This Local Structure Plan shall apply to Lots 500 and 501 North Beach Road, Gwelup, being the land contained within the inner edge of the line denoting the Local Structure Plan boundary on the Local Structure Plan map.

The Local Structure Plan map includes an indicative subdivisional lot layout for northern Lot 2 North Beach Road, and southern Lots 600 and 5 North Beach Road. The indicative subdivision layout included is generally in accordance with the Proposed Subdivision Plan for the Careniup Swamp Special Control Area.

Refer Figure 1 – Structure Plan Map.

2. Local Structure Plan Content

This Structure Plan comprises the following:

- ✓ Statutory Section (Part 1);
- Explanatory Section (Part 2); and,
- ✓ Technical Reports (Part 3 Appendices).

Part 1 includes the provisions and requirements that have statutory effect.

Parts 2 and 3 of this Structure Plan justify and clarify the provisions of Part 1 and are used as a reference guide to interpret and implement Part 1.

3. Interpretations and Relationship with the Scheme

Unless otherwise specified in this part, the words and expressions used in this Structure Plan shall have the respective meanings given to them in the City of Stirling Local Planning Scheme No.3 (the 'Scheme') including any amendments gazetted thereto.

The Local Structure Plan map (Figure 1) outlines land use, zones and reserves applicable within the Local Structure Plan Area. The zones and reserves designated under this Structure Plan apply to the land within it as if the zones and reserves were incorporated into the Scheme.

Pursuant to Clause 6A.12.2 of the Scheme:

If a provision of a structure plan is inconsistent with a provision of the Scheme, then the provision of the Scheme prevails to the extent of the inconsistency."

4. Operation

In accordance with Clause 6A.12.1 of the Scheme, the Structure Plan will come into effect:

- ✓ Where the Structure Plan proposes the subdivision of land, on the day on which it is endorsed by the Commission pursuant to Clause 6A.10.2; or,
- On the day on which it is adopted by the Council under Clause 6A.9.1 in all other cases.

5. Land Use and Subdivision

The Local Structure Plan Map outlines land use, zones and reserves applicable within the Structure Plan Area. The zones and reserves designated under this Local Structure Plan apply to the land within it as if the zones and reserves were incorporated into the Scheme.

Land Use Permissibility

Land use permissibility within the Local Structure Plan area shall be in accordance with the corresponding zone or reserve under the Scheme.

5.1 Subdivision of Lots 500 and 501 North Beach Road, Gwelup, is required to be in accordance with this Structure Plan. Subdivision of Lots 500 and 501 is required to provide for further urban growth within the area in accordance with the objectives set out in the City's Draft Local Planning Strategy.

5.2.1 **Dwelling Target**

5.2.1.1 Objective

The subdivision is to provide for a minimum of 1 dwelling per Lot within the Local Structure Plan area.

> 5.2.1.2 Subdivisions are to achieve the following:

Minimum lot sizes shall be consistent with the applicable density code provisions of the Residential Design Codes.

5.2.2 Density

- 5.2.2.1 Plan 1 defines the broad residential density ranges that apply to specific areas within the Local Structure Plan. Lot specific residential densities, within the defined residential density ranges, are to be subsequently assigned in accordance with a Residential Code Plan approved by the WAPC.
- 5.2.2.2 A Residential Code Plan is to be submitted at the time of subdivision to the WAPC and shall indicate the R-Code applicable to each lot within the subdivision and shall be consistent with the Local Structure Plan, and the Residential Density Ranges identified on Plan 1.
- 5.2.2.3 The Residential Code Plan is to include a summary of the proposed dwelling yield of the subdivision.
- 5.2.2.4 Approval of the Residential Code Plan shall be undertaken at the time of determination of the subdivision application by the WAPC. The approved Residential Code Plan shall then form part of the Local Structure Plan and shall be used for the determination of future development applications.
- 5.2.2.5 Variations to the Residential Code Plan will require further approval of the WAPC, with a revised Residential Code Plan submitted generally consistent with the approved plan of subdivision issued by the WAPC. The revised Residential Code Plan shall be consistent with Residential Density ranges identified on Plan 1 and the locational criteria contained in Clause 5.3 and Clause 5.4 of this Structure Plan.
- 5.2.2.6 A revised residential code plan will replace, wholly or partially, the previously approved residential density code plan, and shall then form part of the Local Structure Plan as outlined above.

- 5.2.2.7 Residential Code Plans are not required if the WAPC considers that the subdivision is for one or more of the following:
 - a) the amalgamation of lots;
 - b) consolidation of land for "superlot" purposes to facilitate land assembly for future development;
 - c) the purposes of facilitating the provision of access, services or infrastructure; or
 - d) land which by virtue of its zoning or reservation under the Local Structure Plan cannot be developed for residential purposes.

5.3 Reports / Strategies Required Prior to Subdivision

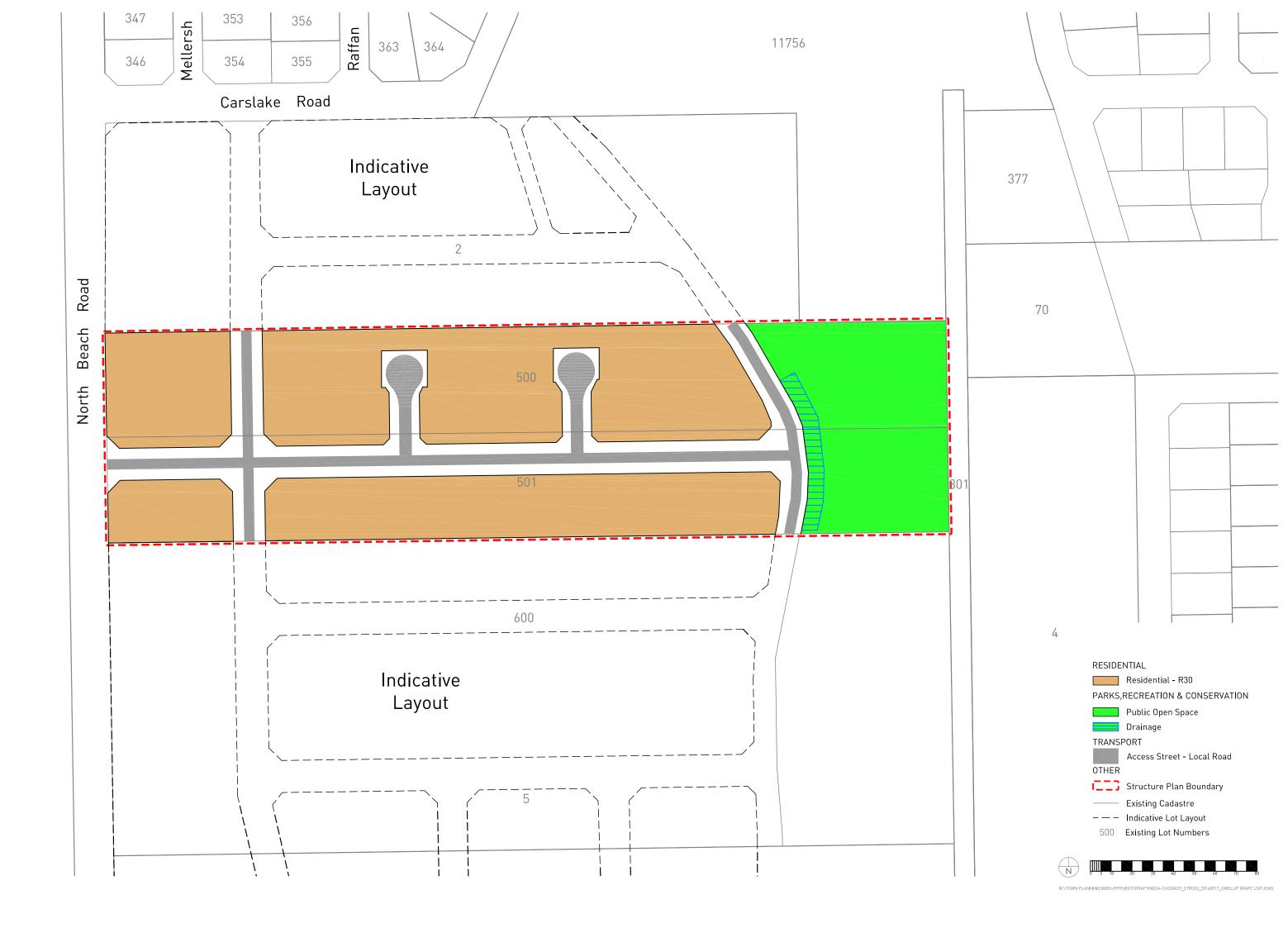
Prior to the lodgement of one or more applications for Subdivision Approval with the Western Australian Planning Commission, the following management plans are to be prepared, as applicable, to the satisfaction of the relevant authority:

- ✓ Fire Management Plan;
- Geotechnical Investigation Report;
- ▲ Local Water Management Strategy;
- Hydrological Investigation Report; and,
- ▲ Environmental Investigation Report.

5.4 Conditions of Subdivision Approval

The following conditions are recommended prior to development of the subject site, including:-

- ▲ Landscape Management Plan (Approval Agency: City of Stirling)
 - The Landscape Management Plan is to be generally in accordance with the requirements of the City of Stirling.
- Bushfire Management Plan (Approval Agency: City of Stirling)
 - Implementation of the endorse Fire Management Plan for Lots 500 and 501 North Beach Road, Gwelup is to be generally in accordance with the requirements of the City of Stirling.
- Urban Water Management Plan (Approval Agency: City of Stirling)
 - The Urban Water Management Plan is to be generally in accordance with the Local Water Management Strategy at Appendix 3.
- ✓ Public Open Space (Approval Agency: City of Stirling)
 - Public Open Space will be ceded free of cost to the Crown, vested to the City of Stirling and the developer responsible for the landscaping and management of the Public Open Space for a two year period.







O1 Planning Background 1.1 Introduction

This Local Structure Plan has been prepared by Rowe Group who acts on behalf of the landowners of Lots 500 and 501 North Beach Road, Gwelup (the 'Subject Site'), as a precursor to subdivision of the subject site.

The purpose of the Structure Plan is to refine the provisions under the district framework and ensure a comprehensive approach to planning and development is undertaken, with input from landowners, government agencies and other key stakeholders.

The Structure Plan is a statutory planning document that will guide future land use and development within the subject area, and provide a framework for more detailed planning at subdivision stage.

For the purposes of the 'Part Two' - Explanatory Section of the Local Structure Plan, this report will primarily focus on the proposed development to the subject site, providing wider contextual information where required.

1 2 Land Description

1.2.1 Location

The land the subject of this Local Structure Plan ('Structure Plan') is located within the metropolitan central sub region, within the municipality of the City of Stirling. The subject land is situated approximately 10 kilometres north west of the Perth City Centre and approximately 2 kilometres north east of the Karrinyup Shopping Centre.

Refer to Figure 2 - Regional Location.

Refer to Figure 3 - Local Location.

1.2.2 Area and Land Use

For the purpose of this document, the Structure Plan Area has been defined as the northern boundary of Lot 500, the eastern and western boundaries of Lots 500 and 501, and the southern boundary of Lot 501, as indicated on Figure 1.

In total, the subject site has a total land area of 4.0468 hectares.

The subject lots are currently used for residential purposes, with a single dwelling located on each of the lots adjacent to North Beach Road. Both lots have been used for market garden purposes in the past, where large rural sheds are currently located at the centre (approx.) of each lot. The rear of both lots contain a 'Resource Enhancement Wetland' and associated bushland.

1.2.3 **Legal Description and Ownership**

The Structure Plan area comprises of two land parcels, legally described as follows:

- ▲ Lot 500 on Deposited Plan 32237, Certificate of Title Volume 740 and Folio 77;
- ▲ Lot 501 on Deposited Plan 32237, Certificate of Title Volume 740 and Folio 76.

Refer Appendix 1 for a copy of the Certificate(s) of Title.

1.3 Planning Framework

1.3.1 **Zoning and Reservations**

The subject site is zoned 'Urban Deferred' under the provisions of the Metropolitan Regional Scheme. Land to the north and south is similarly zoned 'Urban Deferred', land to the east is zoned 'Urban' while land to the east is reserved for 'Private Recreation'.

Refer Figure 4 - Metropolitan Regional Scheme Zoning.

The subject site is zoned 'Development' under the provisions of the City of Stirling Local Planning Scheme No. 3.

Refer Figure 5 - Local Planning Scheme No. 3 Zoning.

Under the 'Development' zone, subdivision and development is to be undertaken generally in accordance with an approved Structure Plan prepared and adopted under Clause 6A.9of the Scheme.

This Structure Plan is consistent with the objectives of the 'Development' zone and allocates land use, identifies environmental constrains, identifies bushfire management controls, and the integration of the subject site into surrounding development.

1.3.2 State Planning Policies and Strategies

Liveable Neighbourhoods 1.3.2.1

The WAPC's Liveable Neighbourhoods guides the sustainable development of Western Australia to 2029, operating as a development control policy facilitating the development of sustainable communities.

A key element of sustainable urban design contained within Liveable Neighbourhoods is the establishment of desired urban densities within new developments. As detailed in Section (2) 2.3, this Structure Plan achieves the residential density targets set under Liveable Neighbourhoods.

Liveable Neighbourhoods identifies that intersections within new developments are required to be located in suitable places to achieve a safe and permeable road layout. The roads contained within this Structure Plan are generally a typical grid pattern, providing points of connection to adjacent North Beach and Carslake Roads. Also, included in the Structure Plan is an indicative road layout for land north and south of the subject site to demonstrate how this area could be developed in the future. The overall road layout is a modified grid pattern that forms the logical extension of residential subdivisions to the south of the Structure Plan Area, whilst providing a legible and permeable network.

As identified within Liveable Neighbourhoods, achieving better residential design outcomes requires a mechanism to enable lot design to be linked to a future building without the building plan being submitted at subdivision. Part 6A.16 of LPS3 sets out the requirements for a Detailed Area Plan and these are to be prepared where required under the Residential Design Codes or for any other relevant purpose.

Liveable Neighbourhoods outlines the approach of restricted and unrestricted Public Open Space provision. The Lots directly abutting the Public Open Space will provide the required passive surveillance promoting the safety of its users. Section (2) 2.2 addresses the public open space contribution of the Structure Plan Area.

As identified within the Local Water Management Strategy (LWMS) (Appendix 3), the Structure Plan provides emphasis to the on-site collection, treatment and use of storm water flows. The LWMS provides methods of storm water collection, detention and use within roadways and individual lots; the LWMS is described in more detail in Section 3.6.

The below table identifies the Design Elements found within Liveable Neighbourhoods, and the corresponding section where its incorporation into the LSP's design is identified.

Liveable Neighbourhoods Element	Report Reference
Element 1 – Community Design	(2) 2.4– Residential
Element 2 – Movement Network	(2) 2.5 – Movement Network
Element 3 – Lot Layout	(1) 6 – Detailed Area Plans
Element 4 – Public Parkland	(2) 2.3 – Open Space
Element 5 – Urban Water Management	(2) 2.6 – Water Management
Element 6 - Utilities	(2) 2.8 – Infrastructure Coordination, Servicing and Staging
Element 7 – Activity Centres and Employment	(2) 2.7 – Activity Centres and Employment
Element 8 - Schools	Not discussed due to LSP's limited area

1.3.2.2 Directions 2031 and Outer Metropolitan Perth and Peel Sub-Regional Strategy

Directions 2031 is a high level spatial and strategic planning framework that establishes a vision for future growth of the Perth Metropolitan and Peel region. It provides a detailed framework guiding the planning and delivery of housing, infrastructure and services required to accommodate a range of growth scenarios.

Directions 2031 seeks a 50% increase to the current average residential density of 10 dwellings per gross urban zoned hectare, setting the target of 15 dwellings per gross urban zoned hectare for land in new development areas. Consistency with this objective is discussed in Section (2) 2.3 (below).

1.3.2.3 State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region - seeks to provide a policy and implementation framework that will ensure bushland protection and management is appropriately addressed and integrated into broader land use planning.

The policy recognises the protection and management of significant bushland areas as a fundamental consideration in the planning process. The Structure Plan has thoroughly addressed the condition, protection and rehabilitation of native bushland present on the subject site (refer Section (2) 1.4).

Site Conditions and Constraints

1.4 Biodiversity and Natural Area Assets

1.4.1 Flora

The Structure Plan Area has historically been used for the purposes of market gardening and residential living and therefore has been predominantly cleared. The eastern third (approx.) of the site which is associated with a Resource Enhancement Wetland retains some remnant vegetation.

Strategen Environmental Consultants undertook a Vegetation and Flora Assessment in March of 2014. The assessment was conducted to determine the condition of vegetation within the Structure Plan Area and can be found at Appendix 2.

The Vegetation and Flora Assessment concluded that:

- ✓ The project area comprises two major areas:
 - Terrestrial area comprising mostly cleared vegetation, with a small number of remnant trees, primarily introduced species; and
 - Swamp area including some native species interspersed with introduced species and weeds.
- ✓ The majority of the Structure Plan Area has been cleared and there has been no regeneration of indigenous vegetation;
- The vegetation present within the Swamp area has been influenced by past land uses.

1.4.2 Fauna

As the majority of the site has been extensively cleared and farmed there is limited remnant vegetation remaining, which has determined that the fauna values of the subject site are limited. Based on the desktop assessment performed by Strategen Environmental Consultants, the open water, paperbark and sedge land are expected to provide habitat for wildlife. The Structure Plan Area protects the majority of remnant vegetation areas on the site and therefore the likely habitat location.

1.5 Landform and Soils

1.5.1 Soil and Topography

The subject site is located on the Swan Coastal Plain within the Spearwood Dune geomorphic system, which is generally described as coastal limestone sparsely overlain by yellow brown sedimentary sands of the Cottesloe soil group. The Cottesloe soil group is described as darker colours sand and Tamala Limestone coated in iron and aluminium oxides, which is generally described as infertile.

The south eastern corner of the subject site, adjacent to North Beach Road, is generally a level of 14m AHD. The site falls toward the wetland area, where the level of the site is generally 7m AHD at the vegetation line. The site remains generally flat continuing east toward the eastern boundary of Careniup Swamp.

1.5.2 Acid Sulphate Soils

As per Western Australian Planning Commission Planning Bulletin No. 64: Acid Sulphate Soils (ASS), the subject site is partially void of any ASS risk. The western half (approx.) of the site has been identified as having a moderate to high risk of ASS occurring within 3 metres of the natural soil surface (or deeper).

As indicated in Section 3.2.1 of the LWMS contained at appendix 3, it is considered unlikely that ASS are present within the development portion of the Structure Plan Area. Given the groundwater levels, as identified in Section 2.3.2 below, it is not expected that any dewatering will occur and therefore is not expected that any ASS will be disturbed by subdivision.

1.6 Groundwater and Surface Water

1.6.1 Wetlands

A Resource Enhancement Wetland ('REW') is mapped as occurring over the east of the subject site and approximately covering one third of the land. The wetland has been further identified as a Sumpland suggesting it is seasonally inundated. The REW requires a 50m buffer to development.

Refer Figure 7 - Wetlands Plan

1.6.2 Groundwater

Groundwater monitoring was undertaken by Hyd2o in February and March of 2014 at 5 bores within the Structure Plan Area and adjacent Lot 2. The maximum recorded groundwater level for the site was 5.6 mAHD, and the lowest recorded groundwater level was 3.44 mAHD.

Tables 3 and 4 of the attached Local Water Management Strategy outlines the details of the average annual maximum groundwater level and maximum groundwater levels for the Structure Plan Areas based on long term Department of Water bore records.

1.7 Stormwater

The subject site does not contain permanent water features. Most stormwater infiltrates the site with any heavy runoff resulting from extreme rainfall flowing in an eastern direction toward Careniup Swamp. On occasions, this runoff tends to flow north onto the neighbouring property where the gradient allows.

1.8 Heritage

A search of the Department of Indigenous Affairs Aboriginal Heritage Inquiry System confirmed that the subject site does not contain any registered Aboriginal Heritage Sites.

No other sites of indigenous or non-indigenous heritage significance were identified within the subject site.

Adjacent Lot 2 North Beach Road has been identified by the Draft City of Stirling Heritage List Review as a place with potential heritage significance. As Lot 2 is not contained within the Structure Plan Area, it is considered that the development of the subject site will not have a substantial impact on Lot 2.

Cand Use and Subdivision Requirements 2.1 Land Use

The eastern one quarter (approx.) of the subject site has been allocated as Public Open Space in order to protect the conservation values of the Resource Enhancement Wetland. The remaining three quarters (approx.) of the site has been designated for Residential development and the associated street network.

2.2 Open space

Under the provisions of Liveable Neighbourhoods, a range of site responsive urban parkland is required which appropriately addresses the needs of residents; urban parkland is to be comprised of a mixture of restricted and unrestricted open space.

The Structure Plan Area will provide POS generally in accordance with Figure 1 and Table 1 (Part 1) along with the implementation of the Landscape Management Plan, as specified under Section 5.4 of Part 1, will satisfy the POS requirements as specified by the City of Stirling.

As previously discussed, POS is provided at the rear of the subject site to conserve and protect the wetland, wetland buffer and the associated bushland.

In accordance with the requirements of Liveable Neighbourhoods, the Structure Plan Area is required to provide 4,046 m² of restricted and unrestricted Public Open Space, being 10% of the Structure Plan Area. Following the guidance of the City, the Structure Plan provides 7,615m2 of Open Space, being approximately 18% of the Structure Plan Area. The Open Space to be provided is not separated into restricted and unrestricted components, as it is to form part of the overall Regional Open Space specified by the City's Scheme.

The City of Stirling has provided guidance regarding the provision of Regional Open Space. It is considered appropriate that the ceding of wetland area satisfies the Open Space requirements prescribed by Liveable Neighbourhoods and the City of Stirling.

2.3 Residential

It is the intention of the Structure Plan to provide a diversity of lot product and housing choices for a diversified residential population. The Structure Plan proposes an R30 density coding for the entire residential portion of the Site (refer Figure 1).

Both Directions 2031 and Liveable Neighbourhoods specify that new urban land is to achieve a target of 15 dwellings per urban zoned hectares, which is achieved within the proposed Structure Plan under the proposed R30 density coding.

Liveable Neighbourhoods further stipulates an average residential density of 22 dwellings per site hectare to be achieved in new urban areas. As noted above, the Structure Plan has the potential to achieve a rounded residential density of 25 dwellings per site hectare based on its potential yield under the R30 density coding. The density proposed is consistent with the locational characteristics of the land and the densities proposed and currently implemented on adjoining properties.

It should also be noted that the eastern one quarter of the subject site comprises wetland and Open Space, meaning that the developable portion of the site is substantially reduced.

2.4 Movement Networks

The western boundary of the Structure Plan Area has frontage to North Beach Road, which intersects with Balcatta Road approximately 220 metres to the north. North Beach Road is a north south dual lane distribution road.

Presently, vehicles enter the Structure Plan Area via two driveway crossovers for the two existing residential dwellings off North Beach Road. Access to North Beach Road from the Structure Plan Area is to be provided via a centrally located east west road connection. The development of the Subject Site in accordance with this Structure Plan will facilitate the removal of one vehicle crossover.

The proposed point of connection to North Beach Road will provide the primary point of connection for further subdivision north and south of the Structure Plan Area. As previously stated, the Structure Plan area employs a modified grid road network providing a high degree of pedestrian and public permeability.

An indicative road pattern for land further north and south has been shown on Figure 1 to demonstrate the manner in which this area could be developed in the future. The indicative road pattern shows the continuation of the north-south roads that extend through the subject site and possible future connections to Carslake Road and existing areas further south.

2.5 Water Management

Stormwater management is proposed to be undertaken consistent with water sensitive design practices specified by the Department of Water. The stormwater management system consists of a series of lot soak wells, road drainage system comprising pipes and a bioretention / infiltration area to provide water quantity and quality treatment for stormwater generated from the proposed development.

The onsite stormwater storage is designed to detain and infiltrate the 1 in 1 year ARI events, with larger events permitted to overflow to Careniup Swamp via an overflow spillway, to be established as an overland flow path.

The development catchment area is sufficient to allow for potential future drainage from development of adjacent Lot 2 to be directed into the Structure Plan Area.

An Urban Water Management Plan will be required as a condition of subdivision approval to refine and implement the objectives of the LWMS.

2.6 Activity Centres and Employment

Located approximately 4 kilometres south of the Structure Plan Area is the Stirling Strategic Metropolitan Centre as identified within Directions 2031. The Strategic Metropolitan Centre provides a full range of economic and community services necessary for the communities within their catchment. It is estimated that the City Centre provides services for between 150,000 and 300,000 people, accessible by rail and frequent bus services.

Located 2 kilometres south west of the site is the Karrinyup Secondary Centre, which provides similar characteristics of larger metropolitan facilities offering a much more extensive range of facilities, services and employment opportunities than smaller Neighbourhood and Local Centres. The Karrinyup Secondary Centre provides its catchment with essential services and employment opportunities. it is expected Karrinyup Secondary Centre will provide the future residents of the subdivision with weekly shopping needs as well as employment opportunities.

Located 1.75 kilometres south east of the Structure Plan Area is the Gwelup Plaza Local Centre. The Local Centre provides for the incidental shopping needs of people within a walkable catchment area, and as such will contribute the a decrease in the daily use of private vehicles. Gwelup Plaza provides an important and highly accessible service to the local community.

Located approximately 1 kilometre east of the Structure Plan Area is the Balcatta Industrial Estate, identified as an 'Existing Industrial Centre' by Directions 2031. Existing Industrial Centres cater for a broad range of manufacturing, fabrication, processing, warehousing and bulk goods handling activities at one end of the scale and provide household needs at the other.

2.7 Infrastructure Coordination, Servicing and Staging

2.7.1 Water and Sewer

A reticulated water supply is currently available to service the Structure Plan Area within the North Beach Road road reserve. It is expected that the Structure Plan Area will connect to the reticulated water supply as subdivision to the north and south is yet to commence.

A pressure sewer main is located within the North Beach Road road reserve adjacent to the Structure Plan Area's western boundary. It is expected that the Structure Plan Area will be connected to the sewerage system following subdivision in accordance with this Structure Plan.

2.7.2 Gas and Electricity

There is an existing gas distribution pipeline running adjacent to the western curb of North Beach Road, owner and operated by Atco Gas. The pipeline is 80mm in diameter, of PCV construction, has a medium pressure and is 1.5 metres from the property line. Although it is not a requirement of subdivision, it is expected the future subdivision will be connected to the gas network.

Power infrastructure is available to service the Structure Plan Area via the North Beach Road reserve. It is expected that the Structure Plan Area will be connected to the power network following subdivision approval in accordance with this Structure Plan.

2.7.3 Telecommunications

Telstra has significant fibre optic infrastructure running along the eastern and western curb lines of North Beach Road. Plans supplied by Telstra indicate that the Structure Plan Area is connected to Telstra services via a 50 mm PVC conduit extending generally east of North Beach Road.

Telecommunication infrastructure is readily available to service the Structure Plan Area via the extension of services from within the North Beach Road road reserve.

2.8 Developer Contribution Arrangements

The Structure Plan Area is not contained within any Developer Contribution Area as identified at Schedule 11 of the Scheme.

There are no additional Development Contribution Arrangements proposed by the Structure Plan.

FIGURES



Planning Design Delivery



REVISIONS

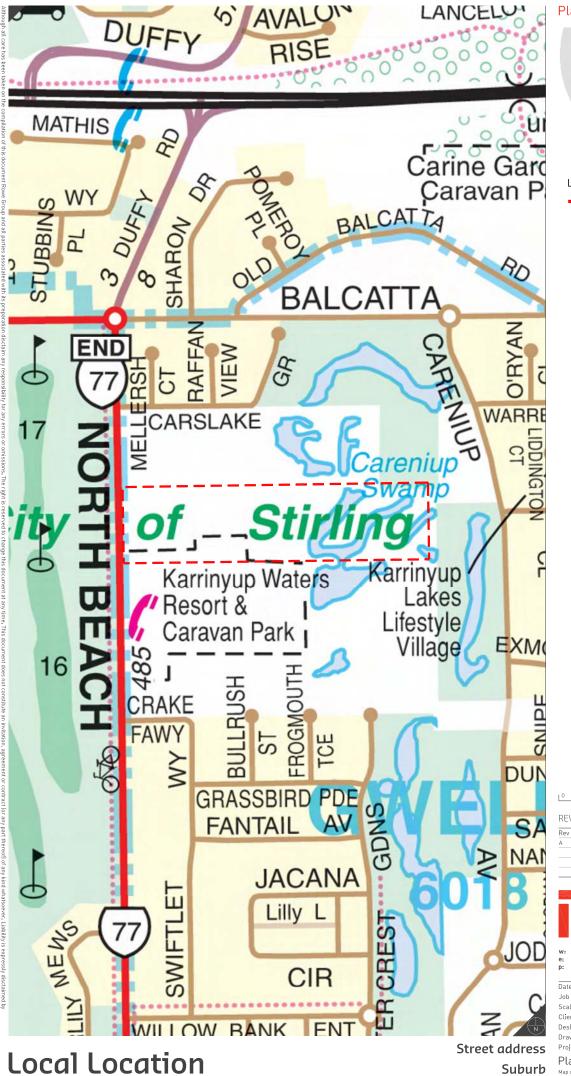


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Job Ref: Scale: Client: Designer: Projection: Plan ID:

2014.03.24 N.T.S. @ A4 R. Neumann D. Hollingworth K. Trenberth MGA50 GDA94 8029-FIG-02-A

Lots 500 & 501 North Beach Road Gwelup



Planning Design Delivery

LEGEND

👅 🥃 Subject Site

125 Metre

REVISIONS

Rev Date Drawn A 2014.03.24 K. Trenberth



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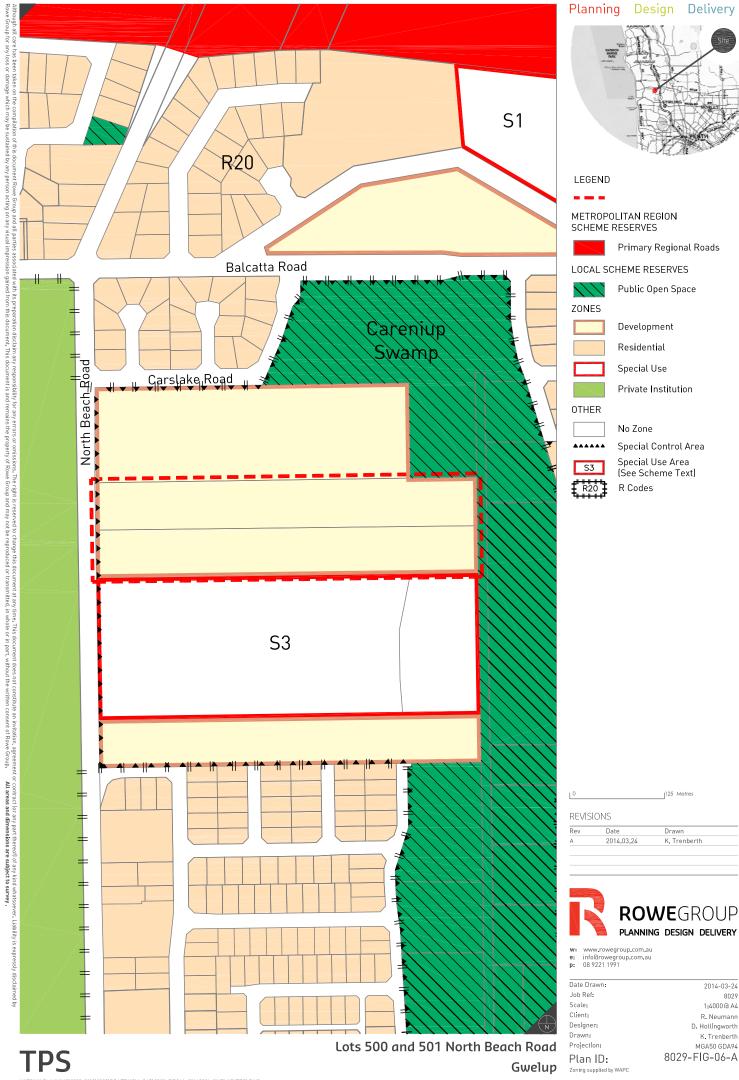
2014-03-24 8029 1:5000 @ A4 R. Neumann D. Hollingworth K. Trenberth MGA50 GDA94 8029-FIG-03-A

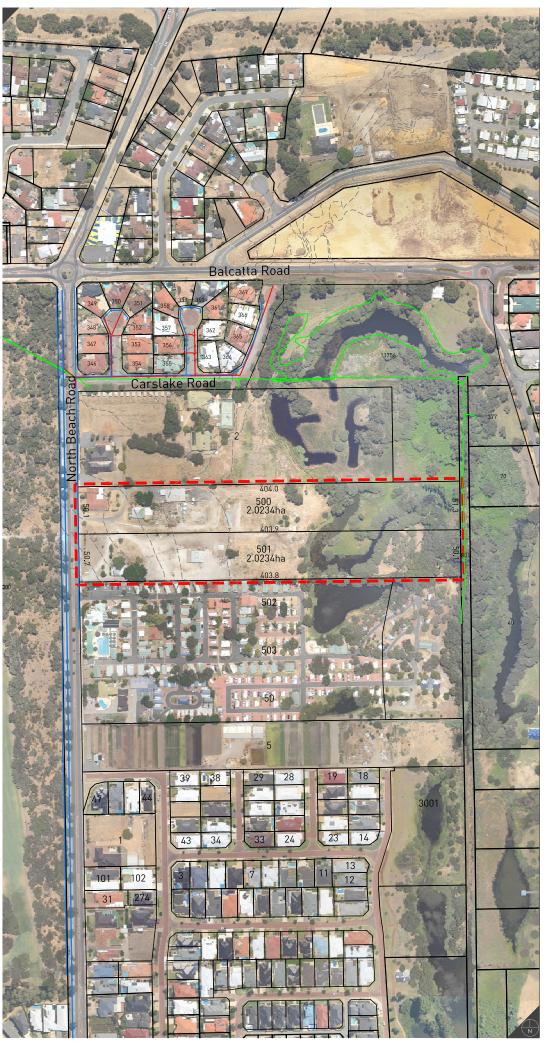


Lots 500 and 501 North Beach Road

Gwelup

K. Trenberth MGA50 GDA94 8029-FIG-05-A Plan ID:





Lots 500 and 501 North Beach Road

Gwelup

Planning Design Delivery



LEGEND

🛌 🕳 Subject Site

___ Contours

500 Existing Lot Numbers

____ Water ____ Sewer

____ Drain

— Existing Boundaries

100 Metre

REVISIONS

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 Drawn

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 2014.03.24
 K. Trenberth



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Date Drawn:
Job Ref:
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Designer:
Drawn:
Projection:
Plan ID:

2014-03-24 8029 1:4000 @ A4 R. Neumann D. Hollingworth K. Trenberth MGA50 GDA94 8029-FIG-04-A







APPENDIX 1 CERTIFICATE(S) OF TITLE







AUSTRALIA

REGISTER NUMBER

500/DP32237

DUPLICATE EDITION

N/A

N/A

N/A

VOLUME

740

FOLIO

77

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and

REGISTRAR OF TITLES

LOT 500 ON DEPOSITED PLAN 32237

REGISTERED PROPRIETOR:

LAND DESCRIPTION:

(FIRST SCHEDULE)

MICHELE TANA
ROSINA TANA
BOTH OF 459B NORTH BEACH ROAD, GWELUP
AS JOINT TENANTS

(T A782022) REGISTERED 8 FEBRUARY 1974

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:

(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.

* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title. Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: DP32237. PREVIOUS TITLE: 636-118.

PROPERTY STREET ADDRESS: 459 NORTH BEACH RD, GWELUP.

LOCAL GOVERNMENT AREA: CITY OF STIRLING.

NOTE 1: A000001A LAND DESCRIPTION AMENDED ON ORIGINAL CERTIFICATE OF TITLE - BUT NOT

SHOWN ON CURRENT EDITION OF THE DUPLICATE.

NOTE 2: SKETCH ON ORIGINAL SUPERSEDED PAPER TITLE AMENDED - BUT NOT SHOWN

ON CURRENT EDITION OF THE DUPLICATE.





AUSTRALIA

REGISTER NUMBER
501/DP32237

DUPLICATE EDITION
N/A
N/A
N/A

VOLUME

740

FOLIO

76

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 501 ON DEPOSITED PLAN 32237

REGISTERED PROPRIETOR:

(FIRST SCHEDULE)

PEK GUAN HA
ANGELINA ANGUS-HA
BOTH OF 96 EDWARD STREET, OSBORNE PARK
BRUCE SYDNEY ROWLEY
PAMELA JANET ROWLEY
BOTH OF BINDOON-MOORA ROAD, MOGUMBER
AS TENANTS IN COMMON IN EQUAL SHARES

(T F581657) REGISTERED 15 JUNE 1994

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS: (SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.

* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.

Lot as described in the land description may be a lot or location.

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SHOWN ON CURRENT EDITION OF THE DUPLICATE.

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ON CURRENT EDITION OF THE DUPLICATE.









Lots 500 & 501 North Beach Road, Gwelup

Environmental Assessment Report

Prepared for Rowe Group by Strategen

April 2014



Lots 500 & 501 North Beach Road, Gwelup

Environmental Assessment Report

Strategen is a trading name of Strategen Environmental Consultants Pty Ltd Level 2, 322 Hay Street Subiaco WA ACN: 056 190 419

April 2014

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consulting Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Rowe Group

Report Version	Revision	Purpose	Strategen author/reviewer	Submitted to Client	
neport version	No.	Fulpose		Form	Date
Draft Report	Α	Client review	K Browne, E Congear / D Walsh	Electronic	28 March 2014
Final Report	В	Submission	E Congear / D Walsh	Electronic	1 April 2014

Filename: ROG14074_01 R001 Rev B - 2 April 2014

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1. Introduction

1.1 Project description

Rowe Group on behalf of Gwelup Land Developments Pty Ltd is preparing a Local Structure Plan (LSP) to facilitate the subdivision of Lots 500 & 501 North Beach Road, Gwelup (the Project) (Figure 1).

The project area (Figure 2) comprises Lots 500 and 501 and occurs within the Careniup Swamp Special Control Area (SCA) of the City of Stirling Town Planning Scheme No. 3 (CoS, 2013). The Careniup Swamp SCA has been subject to extensive environmental investigations in the past which have resulted in identification of the 'Core Area' and specific provisions intended to maintain water quality standards. The Careniup Swamp Area and Core Area are depicted on the Careniup Swamp rehabilitation Plan (Figure 3).

The Structure Plan comprises an area of 4.04 ha, including 2.44 ha for residential development, with 61 lots, comprising an estimated 61 dwellings and 7,615m² for public open space (POS). The Structure Plan required Local Development Plans for all grouped housing lots less than 350 m² to guide development.

1.2 Document purpose and scope

This document provides an environmental assessment for Lots 500 and 501 North Beach Road, Gwelup, including:

- a review of the Careniup Swamp SCA (Clause 6.2 of the City of Stirling Town Planning Scheme No. 3)
- environmental and planning criteria
- a desktop review of available environmental information, including searches of relevant databases.

The above review has been used to identify potential opportunities and constraints for the LSP and Subdivision Plan, including recommendations for additional environmental investigations.

The environmental assessment report will be submitted to the Western Australian Planning Commission (WAPC) as an appendix to the LSP.



2. Opportunities and constraints assessment

An opportunities and constraints assessment of the project area has been undertaken to identify potential development constraints and assist in refining required investigations.

The opportunities and constraints assessment involved a desktop review to provide a preliminary environmental evaluation across a range of environmental factors including:

- land use
- landform and topography
- · geology and soils
- hydrology
- · stormwater flow and on-site drainage
- · bush fire risk
- · vegetation and flora
- fauna
- · weeds and pests
- · cultural heritage.

2.1 Site description

2.1.1 Location

The project area is located approximately 10 km northwest of Perth central business district and 3.5 km inland from North Beach, in the suburb of Gwelup. The project area is situated in the City of Stirling (CoS) and falls within the Careniup Swamp SCA (Figure 1).

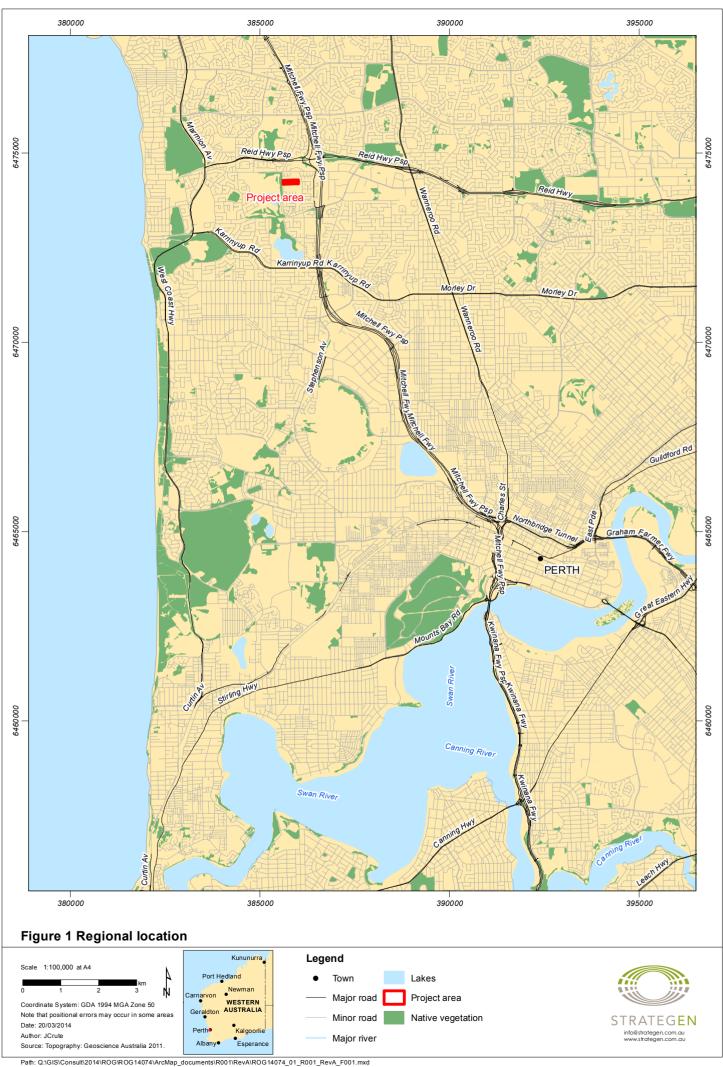
The project area comprises Lots 500 and 501 North Beach Road, Gwelup (Figure 2). Lot details are provided in Table 1.

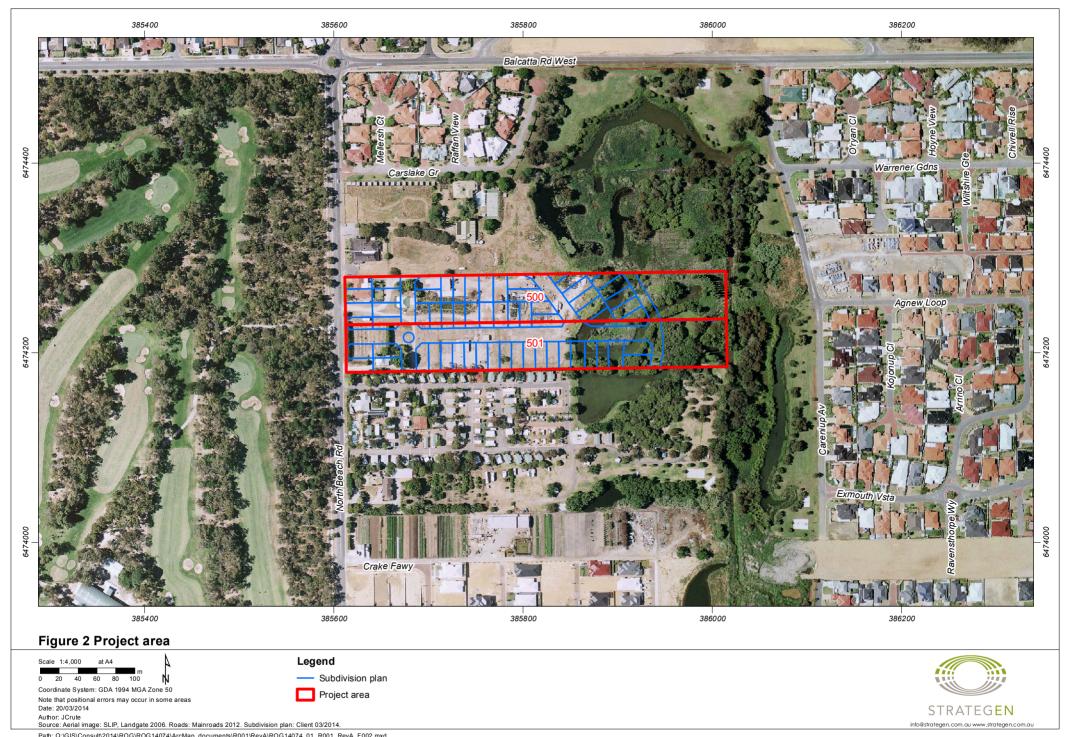
Table 1: Lot details

Lot	Street address	
500	Lot 500 North Beach Road, Gwelup	
501	Lot 500 North Beach Road, Gwelup	

The entire project area sits within the Careniup Swamp SCA and the eastern portion of both lots occurs within the Core Area of the Careniup Swamp SCA, where swamp and open water occur. No lots will be situated in the Core Area as part of the Project; however, some batters and drainage infrastructure may extend into the Core Area.







PLAN 1 - Careniup Swamp Rehabilitation Plan

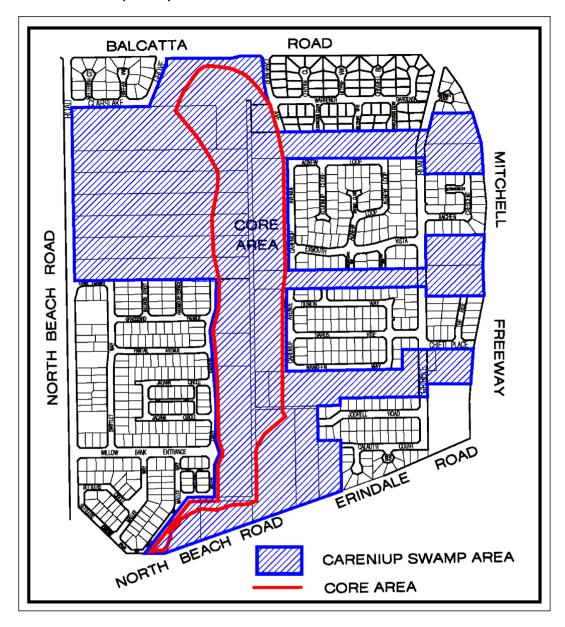


Figure 3 Careniup Swamp Rehabilitation Plan



2.1.2 Zoning and planning context

The project area is currently zoned for development in the City of Stirling Local Planning Scheme No. 3. Objectives have been set for the Development Zone within the City of Stirling Local Planning Scheme No. 3, including:

- 1. To provide for coordinated development through the application of a comprehensive structure plan to guide subdivision and development.
- 2. To avoid the development of land for purposes likely to compromise its future development for purposes, or in a manner likely to detract from the amenity or integrity of the area.

The project area also falls within the Careniup Swamp SCA of the City of Stirling Local Planning Scheme No. 3. Special Control Areas are subject to specific provisions in addition to provisions applying to any underlying zoning or reserve and any general provisions to the scheme.

The Careniup Swamp SCA, in broad terms is bound by Balcatta Road, Mitchell Freeway, Erindale Road and North Beach Road. The SCA has been subject to extensive environmental investigations in the past which have resulted in identification of the 'Core Area' and specific provisions intended to maintain water quality standards within this area (CoS, 2013).

2.1.3 Land use

Current land use

A desktop review was undertaken to determine current land use of the project area; using aerial photography and other relevant literature in relation to the project area. Lot 500 comprises a number of buildings including residential and industrial related materials, vehicles and storage. Lot 501 contains several buildings and storage of various vehicles and other materials. Both lots extend into Careniup Swamp to the east and presently contain areas of open water.

The project area is bound by a vet clinic, an equestrian centre or stables and residential land use to the north. There may have also been some intermittent use of a portion of the lot to the north of the project area for market gardening in the last five years. To the west of the project area, beyond North Beach Road, is the Karrinyup Golf Course, which contains areas of native vegetation. The project area is bound to the east by Careniup Swamp, and is situated within the Careniup Swamp SCA. Immediately to the south of the project area is a caravan park, with market gardens situated further to the south.

Historic land use

A desktop review has been undertaken of a selection of aerial imagery from 1953 to present (Landgate 2014). The aerial imagery shows that the project area and adjacent lots to the north and south were used for market gardening for an extended length of time. In the 1970s the lots to the north and south of the project area transitioned to the equestrian centre/stables and caravan park, respectively. Market gardening (and possibly a commercial nursery from the early 2000s) continued within the project area until around 2006 to 2008 when the gardening was phased out and replaced with storage of various boats, vehicles and other materials.

Historical land use may pose a constraint to the Project as any remaining material from past land uses with the potential to cause localised contamination or redundant infrastructure on the lots will require removal and appropriate treatment (as required) prior to construction. Potential contamination is discussed further in Section 2.2.2.



2.2 Existing environment

2.2.1 Landform and topography

The project area lies on the Swan Coastal Plain, bound by the Darling Scarp in the east. The Swan Coastal Plain consists of a series of distinct landforms, roughly parallel to the coast, including the Dandaragan Plateuas, Pinjarra Plain and Bassendean Dune System.

Careniup Swamp comprises lake deposits within the Spearwood Dune system near the interface of the Karrakatta and Cottesloe associations. There is a prominent limestone outcrop in the north-east of the swamp. Deep peat deposits occur in the lake bed and extent to greater than 3 m in depth (EPA & WAWA 1990).

The Groundwater Atlas (Waters and Rivers Commission Website 2nd Edition) indicates that the natural ground surface level on this site is approximately ranging from 12.0mAHD (Australian Height Datum) on the western boundary to 7.0mAHD (Australian Height Datum) on the eastern boundary (Prompt Engineering 2013).

2.2.2 Geology and soils

Regional

The Swan Coastal Plain comprises two main geological units, the Tamala Limestone and the Safety Bay Sand, both belonging to the early Pleistocene to Holocene Kwinana Group (Playford et al 1976). The Tamala Limestone consists of coarse to medium-grained calcarenite composed mainly of foraminifera and mollusc fragments with some detrital quartz sand (Playford et al 1976). The Tamala Limestone was formed from the cementation of the Spearwood Dune system by calcium carbonate (Playford et al 1976).

The Safety Bay Sand overlies the Tamala Limestone from the Holocene era and comprise of shell fragments with quartz and feldspar. The Safety Bay Sands is divided into a number of units based on physical and mechanical characteristics (Playford et al 1976).

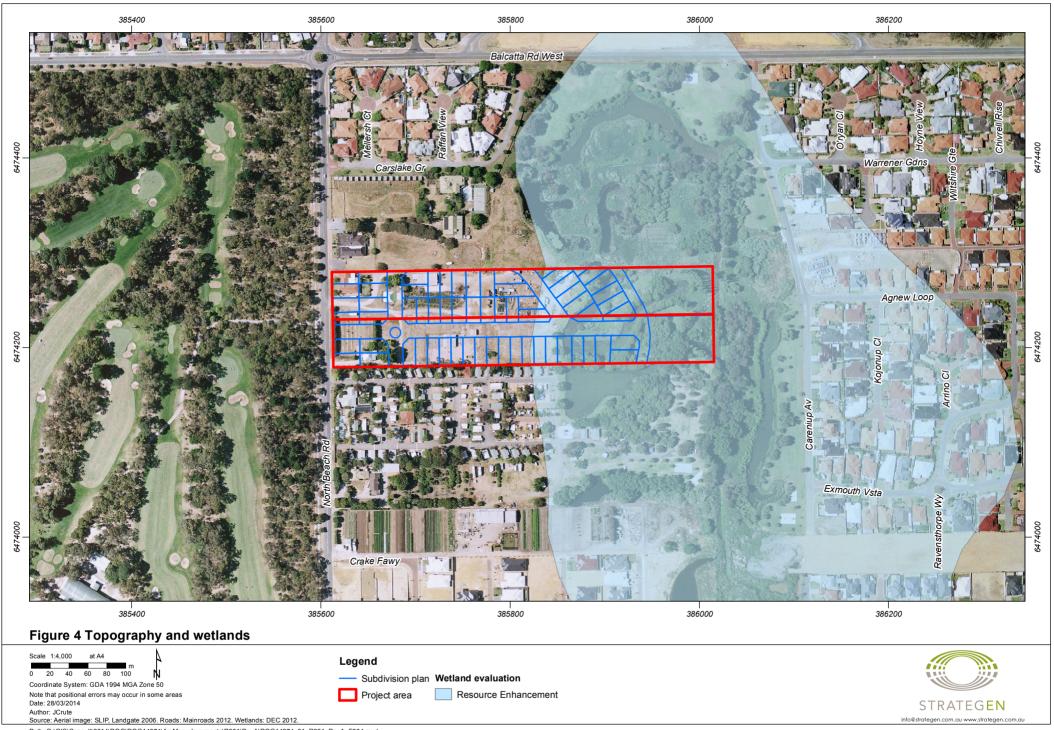
Local

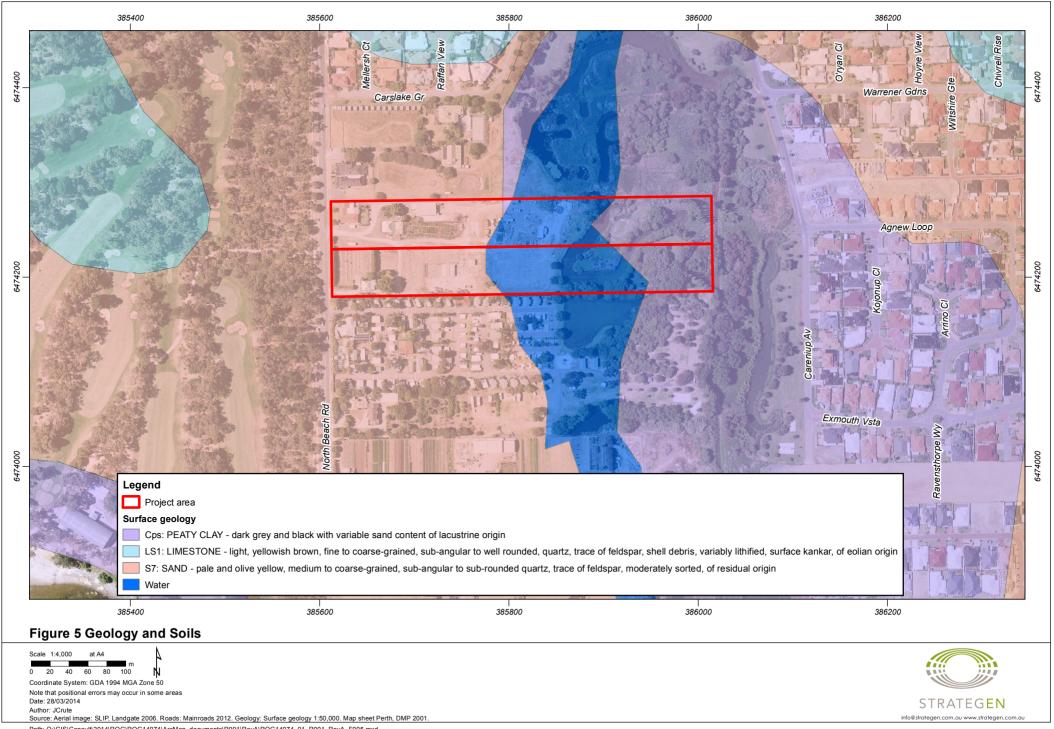
A review of Landgate database (2014) was undertaken to determine the surface geology of the project area. The desktop search found that the western half of the project area comprises pale and olive yellow; medium to coarse-grained sand at the eastern half is dark grey and black peaty clay, associated with the Careniup Swamp (Figure 5).

A geotechnical investigation of the project area was undertaken by Prompt Engineering in November 2013 (Prompt Engineering). The investigation found that subsurface soil profiles are generally consistent with regional geology, comprising natural sand derived from Tamala Limestone. Subsurface soil profiles varied from regional geology at the eastern side of the project area, in close proximity to the swamp, where alluvium and swamp deposits were encountered (Prompt Engineering 2013).

Soil profiles encountered in boreholes are generally overlain by typical sand derived from Tamala Limestone described as sand silty sand; medium to coarse grained, low to non plasticity silt, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, dry, light brown/orange (Prompt Engineering 2013).







Acid sulfate soils

Acid sulfate soils (ASS) are naturally occurring soils and sediments containing iron sulphides, most commonly pyrite. When ASS is exposed to air the iron sulphides in the soil react with oxygen and water to produce a variety of iron compounds and sulphuric acid. Initially a chemical reaction, the process is accelerated by soil bacteria. The resulting acid can release other substances, including heavy metals, from the soil and into the surrounding environment (DEC 2013).

Inappropriate disturbance of these soils can generate large amounts of sulphuric acid, resulting in the leaching of contaminants (heavy metals) naturally occurring in soils. Flushing of acidic leachate to groundwater and surface waters can cause off-site impacts including:

- ecological damage to aquatic and riparian ecosystems
- effects on estuarine fisheries and aquaculture projects
- · contamination of groundwater with arsenic, aluminium and other heavy metals
- reduction in agricultural productivity through contamination of soils (predominantly by aluminium)
- damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets.

The Acid Sulfate Soils (ASS) Guidelines (West Australian Planning Commission [WAPC] and Department of Planning and Infrastructure [DPI] 2008) have been put in place to assist in implementation of the *Contaminated Sites Act 2003* (WA) (CS Act), in relation to potential ASS contamination. The objective of the CS Act is to protect human health, the environment and environmental values by providing for the identification, recording, management and remediation of contaminated sites.

The Environmental Protection Act 1986 (WA) (EP Act) and CS Act require proponents to control the extent and discharge of dewatering and to ensure that soil, groundwater and surface water are of an acceptable standard compatible with the intended land use, and consistent with appropriate criteria, as well as minimising the risk to human and ecological health. This involves the identification, recording, management and remediation of contaminated sites and ASS.

The ASS Guidelines (DPI 2008) state that an ASS investigation is required for activities detailed in Table 2.

Table 2: Activities that may trigger ASS site assessment in Class 1 and Class 2 ASS risk areas

Proposed activity	ASS risk class	ASS site assessment
Soil or sediment disturbance of 100 m3 or more (e.g. construction of	Class 1 (red)	Required
roads, foundations, installation of underground infrastructure, drainage works, land forming works, dams and aquaculture ponds or sand or gravel extraction)	Class 2 (orange)	Not required
Soil or sediment disturbance of 100 m3 or more with excavation	Class 1 (red)	Required
from below the natural watertable	Class 2 (orange)	Required
Lowering of the watertable, whether temporary or permanent (e.g.	Class 1 (red)	Required
for groundwater abstraction, dewatering, installation of new drainage, modification to existing drainage)	Class 2 (orange)	Required
Any dredging operations	Class 1 (red)	Required
	Class 2 (orange)	Required
Extractive industry works (e.g. mineral sand mining), flood mitigation	Class 1 (red)	Required
works, including construction of levees and flood gates	Class 2 (orange)	Required
Earthworks extending to beyond 3 m below the natural ground	Class 1 (red)	Required
surface	Class 2 (orange)	Required
Works within 500 m of a wetland	Class 1 (red)	Required



Additional requirements exist at the subdivision stage for sites where any dewatering or drainage works (either temporary or permanent), or the excavation of 100 cubic metres or more of soil is proposed where:

- land is partially or wholly within an area of 'high to moderate risk of ASS occurring within 3 m of natural soil surface
- site characteristics or local knowledge lead the applicant to form the view that there is a high to moderate risk of disturbing acid sulfate soils at this location (WAPC & DPI 2008).

A search of the WA Atlas ASS Swan Coastal Plain risk map (Landgate 2014) (search conducted 14 March 2014) indicates that the eastern end of both lots is classified Class 1 (High to Moderate risk of ASS occurring within 3 of natural soil surface). Results are indicated in Figure 6.

An assessment of ASS potential as part of the geotechnical investigation was undertaken, using the following criteria; whereby:

- for actual ASS (AASS) a pH_F of less than 4 indicates the presence of AASS
- for potential ASS (PASS):
 - * pH_{FOX} of less than 3
 - * difference between pH_F and pH_{FOX} is greater than 3.

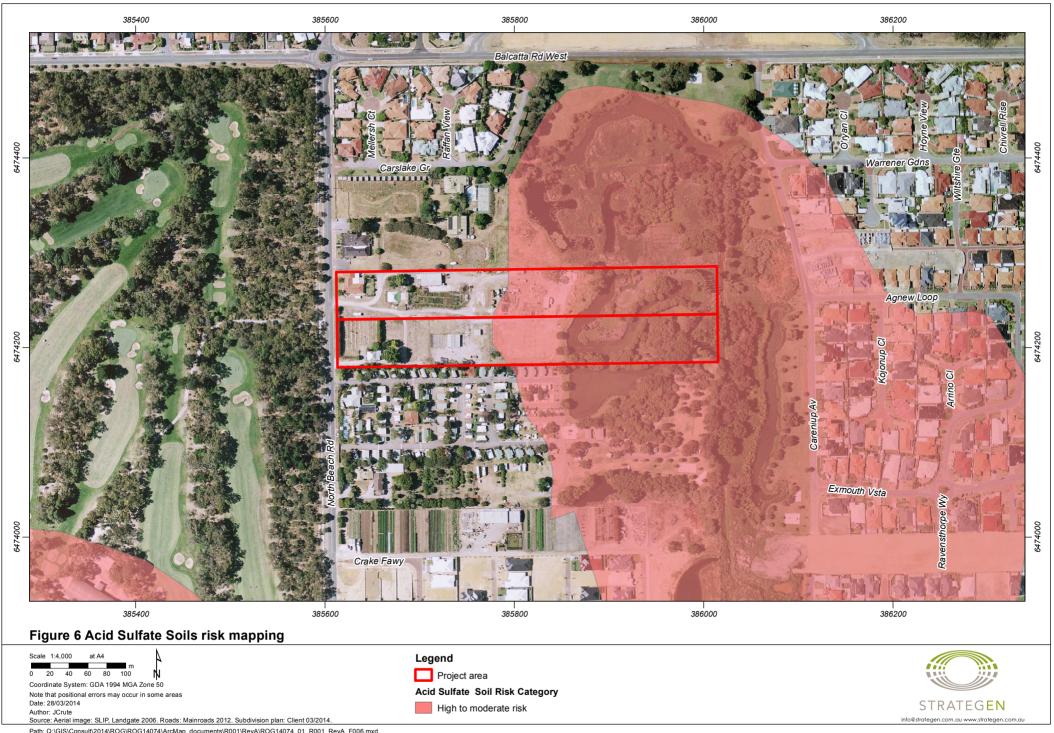
Laboratory testing of the soil samples encountered at the site was undertaken and the following results were found:

- no samples recorded pH_F of less than 4
- no samples recorded a pH_{FOX} of less than 3
- two samples recorded a difference between pH_F and pH_{FOX} of greater than 3.

Results therefore indicated an inferred moderate PASS risk of the two samples (Prompt Engineering 2013).

Based on the findings of the initial desktop and initial evaluation of ASS, it is recommended that a detailed ASS management plan is prepared and implemented during earthworks and construction to manage potential impacts associated with disturbance of ASS materials.





Salinity risk

The groundwater salinity level of the project area was assessed using the WA Atlas as relatively low (500 - 1000 (TDS) (Landgate 2014). Salinity is not expected to pose a constraint to development of the project area.

Contamination

A search of the DER Contaminated Sites Database (DER 2014) (search conducted on 14 March 2014) found no recorded contaminated sites within the project area or adjacent properties. The nearest record is a site that has been remediated for restricted use, located approximately 500 m south-southeast of the project area.

Contamination may be present as a result of the past potentially contaminating activities on the site including:

- market gardening (storage and use of chemicals)
- dumping (potential chemicals and other hazardous materials)
- vehicle/scrap yard (potential hydrocarbon or other contamination).

A Preliminary Site Investigation (PSI) is recommended to investigate the potential presence of contamination in the project area. The PSI would include recommendations for removal and treatment of contaminants if required.

2.2.3 Hydrology

Surface water

The key surface water feature associated with the proposal area is the Careniup Swamp. The Careniup Swamp is a natural swamp area that has been subject to various developments over the past 100 years. Development of the site has incorporated farming, market gardening, some industry and residential development. The Careniup Swamp is used by the Water Corporation as a compensating basin, forming a modified wetland to satisfy drainage and compensation requirements (CoS 2013).

Careniup Swamp also provides an important refuge for wildlife by providing permanent water throughout the area of modified wetland with minimum summer depths sufficient to maintain landscape and water quality (CoS 2013).

Wetlands

The Geomorphic Wetlands Swan Coastal Plain dataset (available in WA Atlas, Landgate 2014) classifies wetlands in the Swan Coastal Plain by type, based on the characteristics of landform and water permanence. The Swan Coastal Plain wetlands have also been evaluated and assigned a management category that is used by the Environmental Protection Authority (EPA) and Department of Planning and Infrastructure (DPI) as a basis to guide planning and decision making. The Careniup Swamp is classed as a Resource Enhancement Wetland (sumpland) (Landgate 2014).

Resource Enhancement Wetlands (REWs) have been modified, but still contain moderate degrees of naturalness and human interest, and opportunities may exist for commercial developments to enhance the conservation value of wetlands in this category.

Wetland buffer

WAPC released a Guideline for the Determination of Wetland Buffer Requirements for public comment in December 2005. The guideline is intended to assist landowners, developers, planners and architects to identify an appropriate buffer between wetlands and land uses that will enhance or maintain the significant attributes and values of the wetland (WAPC 2005).



The process to determine an appropriate buffer between a wetland and an existing or proposed land use requires:

- the systematic consideration of wetland attributes (existing or desired)
- · threatening processes associated with adjacent land use
- the role of the buffer in mitigating these threats so the wetland values, functions and attributes are protected to the extent that separation measures can achieve this practically.

An individual approach is required to determine buffer requirements, rather than a "one size fits all" approach (WAPC 2005). Careniup Swamp is a Resource Enhancement wetland as defined by WAPC 2005.

Recommended separation distances for Resource Enhancement category wetlands are provided in Table 3

Table 3: Category R wetlands: separation and management (WAPC 2005)

Key threatening process	Recommended separation and/or management	Separation area management
Alteration to the water regime Habitat modification	Regulation of groundwater abstraction as catchment management measure • 50 m weed infestation • 50 m avifauna habitat	Area to be vegetated with deep-rooted perennial vegetation. Limited open areas of grass controlled access to wetland (paths)
	6 m firebreak	6 m firebreak minimum, inside fence (if required)
Inappropriate recreational use	10 m - 50 m for improving aesthetics 10 m - 50 m for barrier fence, paths for controlling access	(if required) fence to limit vehicle, stock access clear perimeter outside fence (path, road)
Diminished water quality	drainage inflows eliminated or managed where a proposal may affect wetland water quality, particularity through un-channelised flow, detailed site-specific work should be undertaken to determine the specific separation measures required, including management measures	fire control to minimise hazards and maintain habitat diversity management for water quality outcomes as required

The presence of Careniup Swamp SCA poses a potential constraint to the Project in terms of wetland buffer requirements outlined in Table 4. Discussions with the CoS have determined that the wetland buffer requirements may be subject to negotiations ensuring provisions required under Clause 6 of the Local Planning Scheme (2013) in relation to the Careniup Swamp SCA are met.

Consultation with the City also determined that the Core Area associated with the SCA was endorsed through an agreement between the EPA and the City over 25 years ago. Recent discussions between the CoS and the EPA in relation to a development proposal south of the project area, confirmed the agreement and endorsement of the Core Area.

It is recommended that additional consultation with the CoS be undertaken to determine the requirements for wetland protection.



Careniup Swamp Special Control Area

The entire project area sits within the Careniup Swamp SCA and the eastern portion of both lots occurs within the Core Area of the Careniup Swamp SCA, where swamp and open water occur.

Clause 6.2 of the CoS Local Planning Scheme No. 3 sets out requirements to safeguard the values of the Careniup Swamp. The objectives of the Careniup Swamp SCA are as follows:

- to ensure orderly subdivision of the SCA
- · to ensure the ceding of Public Open Space
- to ensure water quality standards
- to ensure wildlife protection
- · to control filling
- to manage stormwater.

The Careniup Swamp SCA and Core Area are depicted in Figure 3. Requirements of the Local Planning Scheme in relation to the Careniup Swamp SCA (Clause 6.2) that have the potential to impact the Project, specifically the LSP and Subdivision Plan are set out in Table 4.



Table 4: Requirements of clause 6.2

Clause	Outline	Requirement	Potential impact	Recommended action
Implementat	ion of development proposals			
6.2.3(a)	Subdivision and development not in conformity with Clause 6.2 and the Rehabilitation Plan may be carried out with Council approval.	All subdivision and development within the Area shall have regard to the requirements set out in clause 6.2 and the Rehabilitation Plan provided however that any development proposal not in conformity with clause 6.2 may be carried out with the approval of Council. Council may seek input from the Western Australian Planning Commission, Water Corporation and the Department of Environment and Conservation.	Enables development to go ahead if non-conforming to Clause, provided Council approval is obtained. Council may seek input from WAPC, Water Corporation and DPaW.	Subdivision will be undertaken with regard to the Rehabilitation Plan and Rehabilitation Strategy identified for the area. Consider using this clause to resolve any potential non-conformity with Clause 6.2.
6.2.3 (c)	When considering any subdivision, the Council shall inform WAPC of the Rehabilitation Plan and Rehabilitation Strategy.	When considering any application for subdivision or strata subdivision approval within the Area, the Council shall inform the Western Australian Planning Commission of the Rehabilitation Plan and the Rehabilitation Strategy, particularly when determining any POS contribution required as a condition of a subdivision or a strata subdivision approval.	Any rehabilitation activities required to be undertaken by the Council may be required to be implemented by the proponent in areas of POS.	Recommend rehabilitation requirements within any POS areas are discussed with Council.
Ceding of lar	nd and cash payments in lieu			
6.2.4(a)(i)	Land within the Core Area to be ceded to the State for vesting in the City	Where any portion of land is within the Core Area delineated on the Rehabilitation Plan, such portion shall be ceded to the State for vesting in the City by the owner free of costs and without any entitlement on the part of the owner or any other person with any interest therein to be paid compensation pursuant to the Public Works Act	The land within the project area that occurs within the Core Area will be required to be ceded to the State	Cede portion of Lots 500 and 501 that fall within the Core Area in consultation with the Council.
6.2.4 (a)(i)	The owner of land not within the Core Area shall pay to the City a sum equal to 10% of the market value to commence development on such land.	If no portion of the land is within the Core Area delineated by the Rehabilitation Plan, the owner of such land shall pay to the City a sum equal to ten per centum (10%) of the market value of the land calculated as at the date of the gazettal of the amendment, the granting of approval to subdivide such land, or the granting of approval to commence development on such land as the case may be.	The owner is required to pay to the Council a sum equal to 10% of the market value of the land calculated to commence development on such a land.	Determine requirements for payment and/or ceding of land in consultation with the Council.
Water quality	v standards			
6.2.5(b)(i)	Lake design – minimum and maximum water levels	The lake be designed on the basis that the area has a maximum water level of RL 7.0 metres AHD and a minimum water level of RL 6.3 metres AHD	This clause may impact on design of the development where the design has the potential to: • fill or place infrastructure within the lake • discharge stormwater to the lake • reduce recharge to the lake	Undertake consultation with the Water Corporation and CoS in relation to proposed development levels.
6.2.5(c)(ii)	Lake design – moat and lake bed levels referred to in Rehabilitation Plan*	The moat and lake beds referred to in the Rehabilitation Plan shall be constructed to RL 4.1 metres AHD in order to maintain a minimum water depth of 1.0 metre during the summer period	This clause may impact on design of the development where the design has the potential to: • fill or place infrastructure within the lake • discharge stormwater to the lake • reduce recharge to the lake	Undertake consultation with the Water Corporation and CoS in relation to proposed development levels.



Wildlife prot	ection requirements			
6.2.6(b)(i)	Provision for planting of foreshore by Council	Satisfactory provision must be made when it is practical and feasible to do so, for planting of foreshore areas by Council with native vegetation species listed in the Dames & Moore Report "Conceptual Development Plan for the Area within the System 6 Boundary - Careniup Swamp" (November 1987), with particular emphasis on the Paperbark (<i>Melaleuca Raphiophylla</i>) and Flooded Gum (<i>Eucalyptus Rudis</i>)	Impacts on ability to develop the foreshore. However, it could demonstrate that is not practical or feasible to do so, if this is the case.	Consider practicality and feasibility of providing the foreshore for native planting by Council.
Maintenanc	e of the Core Area			
6.2.7(b)(i)	No filling or deposition of any substance in the Core Area except in accordance with approved development plan	No person shall fill or deposit or cause to be filled or deposited any substance in the Core Area delineated in the Rehabilitation Plan except in accordance with a development plan approved by the Council and the Western Australian Planning Commission in consultation with the Water Corporation and the Environmental Protection Authority	This clause may impact on design of the development where that design has the potential to: • fill or place infrastructure within the lake • discharge stormwater to the lake. This clause may impact on the proposed 1 in 1 year basin to be located in the Core Area immediately east of the 11 m road reserve. This clause may similarly impact on the intended battering of earthworks in the Core Area.	Ensure proposed fill options and rehabilitation materials are determined in consultation with the Council. Ensure landscape design incorporates the requirements for stormwater storage.
6.2.7(b)(ii)	Council shall recommend to WAPC that stormwater from subdivision be disposed of onsite.	Council shall recommend to the Western Australian Planning Commission that stormwater from subdivisions should be disposed of onsite to the extent that a one in ten year storm event is retained for three to four days.	Requirement of Council, but with implications for the developer. While the wording suggests that this is not a requirement, non conformance could delay approval.	Consider design of stormwater management to retain a one in ten year storm event for three to four days.
6.2.7(b)(iii)	Subdivision design should be in accordance with Planning and Management Guidelines for Water Sensitive Urban (Residential) Design	Subdivision design should be in accordance with the principles and practices detailed in the "Planning and Management Guidelines for Water Sensitive Urban (Residential) Design", published by the Western Australian Planning Commission in June 1994	Development required to be designed in accordance with guidelines.	Ensure subdivision design incorporates Planning and Management Guidelines for Water Sensitive Urban (Residential) Design.



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Groundwater

The project area is located within the Perth Coastal and Gwelup Underground Water Pollution Control Area (UWPCA), proclaimed in 1973 under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*. The Perth Coastal and Gwelup UWPCA is a Priority 3 source protection area, defined to manage risk of pollution to the water source, and where water supply sources need to co-exist with other land uses such as residential, commercial and light industrial developments (Department of Water, 2009). Priority 3 areas generally include the requirement for best available environmental management practice and connection to deep sewerage (Department of Water, 2009).

Shallow groundwater was encountered and stabilised at approximately 1.5 m below the existing ground level during the geotechnical investigation (Prompt Engineering 2013).

Groundwater levels

A Local Water Management Strategy (LWMS) has been prepared by hyd₂O Hydrology to support the LSP application. As part of the LWMS local groundwater characteristics have been established using data from local and site specific groundwater monitoring bores (hyd₂o 2014). Monitoring found that groundwater has a low gradient, flowing in an east-west direction, with a maximum recorded groundwater level of 5.60 mAHD and lowest recorded groundwater level of 3.44 mAHD (hyd₂o 2014).

The average annual maximum groundwater level (AAMGL) and maximum groundwater levels (MGL) for the site based on long term DoW bore records were estimated to range from 4.38 mAHD to 6.40 m AHD across the site, varying from approximately 0.45 m to 6.69 m below the existing natural surface level (hyd₂o 2014).

Groundwater monitoring will continue over the winter 2014 period and this data will be used to refine groundwater levels to inform the development of the Urban Water Management Plan (UWMP) to support the subdivision application (hyd₂o 2014).

Groundwater quality

Groundwater quality was monitored within the four bores located within the project area; groundwater monitoring found that nutrient levels across the site were generally high; consistent with the historical land use of the site for market gardening. The average pH of groundwater was 6.73; consistent with ANZECC guidelines for Fresh and Marine Water Quality (ANZECC 2000).

Groundwater quality monitoring will continue and be reported in the UWMP (hyd₂o 2014).

Groundwater is not expected to pose a constraint to development as outlined in the LWMS. A UWMP will be prepared to support the subdivision application.

Public Drinking Water Source Areas

The project area is located entirely within a Priority 3 Public Drinking Water Supply Area. Priority 3 areas are declared over land where water supply sources need to coexist with other land uses; these areas are defined to manage the risk of pollution to drinking water sources through adoption of best management practices for land uses in the water reserve (DoW 2009).

The presence of the Priority 3 Public Drinking Water Supply Area poses a minor constraint in that the Project should be considered in line with *Water Quality Protection Note: Land Use Compatibility in Public Drinking Water Source Areas* (DoE 2004).





Stormwater flow and on-site drainage

The fine to medium grained natural sand materials encountered within the project area have high permeability and are suitable for absorption of storm water runoff through the use of soak wells (Prompt Engineering 2013).

2.2.4 Bush fire risk

A Fire Management Plan (FMP) is often requested by Department of Planning (DoP) or Local Government to support an LSP or to address a condition of subdivision. The basis for this requirement is related to the vegetation extent located within and adjacent to the site. If there is an obvious bush fire risk to a development it is an option to pre-empt this requirement and prepare an FMP, rather than waiting for direction from DoP or Local Government.

The presence of vegetation associated with the golf course to the west of the project area, and the Careniup Swamp immediately to the east may pose a bush fire risk and it is recommended that an on the ground assessment of vegetation be undertaken to confirm this, and the potential need for fire management planning.

If deemed to be required, the FMP should be prepared in accordance with the state-adopted Planning for Bush Fire Protection Guidelines Edition 2 (PFBFP Guidelines). This guideline is not a statutory document or driven by any legislation at this stage, but is a general requirement handed down by WAPC for any proposed developments located within 100 m of a bush fire prone area.

The subsequent FMP, if required, will guide future development design early in the planning stages and ensure a suitable and effective bush fire management outcome is achieved for the site. This is generally achieved through implementation of PFBFP Guidelines and Australian Standard AS 3959–2009 Construction of Buildings in Bushfire-prone Areas and meeting performance criteria and acceptable solutions for the following key aspects:

- 1. Development Location.
- 2. Vehicular Access.
- 3. Water Supply.
- 4. Siting of Development.
- 5. Design of Development.

If required, the FMP will include a Bushfire Attack Level (BAL) assessment to confirm the potential level of construction standard that may need to be applied to proposed buildings throughout the development. Bush fire risk assessment is also included as part of the FMP and requires further investigation, which may reveal a potential constraint to development, pending appropriate fire management planning.

2.2.5 Vegetation and flora

Remnant vegetation is protected in Western Australia under the EP Act, and clearing of native vegetation requires a Clearing Permit, unless subject to subdivision approval.

Threatened ecological communities (TECs) can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) and the *Wildlife Conservation Act 1950* (WA) (WC Act), while priority ecological communities (PECs) are listed by DPaW.

Native flora species are protected under the EPBC Act and the WC Act. Flora species protected under the EPBC Act are referred to as Matters of National Environmental Significance (MNES) and include rare, threatened and migratory species. Flora species may also be listed for protection under the WC Act or listed as priorities by DPaW. Listed threatened and priority flora are also considered during the assessment of clearing permit applications.



The project area comprises two major areas; terrestrial land, incorporating the majority of the project area and swamp land, comprising approximately one third of the project area. The terrestrial area comprises mostly cleared vegetation, with a small number of remnant trees, primarily introduced species. The swamp area includes some native species interspersed with introduced species and weeds.

The majority of project area has been cleared and there has been no regeneration of indigenous vegetation. A desktop assessment has confirmed that there are no Bush Forever sites within the project area. The nearest Bush Forever site occurs approximately 1 km south of the project area (Lake Gwelup Reserve).

According to information published in 1937, Careniup swamp was originally covered by a tussock reed that differed botanically from reeds in neighbouring marshes. In 1990, EPA and WAWA reported that the vegetation at the time was influenced by past and present land use and consists of large areas of *Typha orientalis*, which is highly invasive and takes effort to clear. It was also noted that a small area of swamp paperbark was present, no assimilated into the caravan park, flooded gum, and a large area of weeds (EPA and WAWA 1990).

2.2.6 Fauna

Native fauna species are protected under the EPBC Act and WC Act. Fauna species protected under the EPBC Act are referred to as Matters of National Environmental Significance (MNES) and include rare, threatened and migratory species. Fauna species may also be listed for protection under the WC Act or listed as priorities by DPaW. Important fauna habitats are also considered during the assessment of clearing permit applications.

Under the environmental assessment provisions of the EPBC Act, 'actions' (such as this development) that are considered likely to have a significant impact to one or more MNES protected under the EPBC Act are subject to an assessment and approvals process by DotE. 'Actions', including clearing, that may significantly impact upon MNES are required to be referred to DotE. An action that is considered to have a significant impact is deemed a 'controlled action' and will require formal assessment by DotE.

The project area is largely devoid of remnant vegetation, having been previously cleared. It is unlikely that any significant habitat exists for native fauna within the project area, based on the desktop assessment, however the open water, paperbark and sedge land are expected to provide habitat for wildlife (EPA and WAWA 1990).

2.2.7 Cultural Heritage

The Aboriginal Heritage Act 1972 provides automatic protection for all places and objects in Western Australia that are important to Aboriginal people because of connections to their culture. These places and objects are referred to as Aboriginal sites. The Department of Aboriginal Affairs (DAA) maintains a Register of Aboriginal Sites as a record of places and objects of significance to which the Act applies. The presence of an Aboriginal site places restrictions on what can be done to the land. Anyone who wants to use land for research, development or any other cause, must investigate whether there is an Aboriginal heritage site on the land (DAA 2014a).

A search of the Department of Aboriginal Affairs (DAA) *Aboriginal Heritage Inquiry System* (DAA 2014b) (search conducted 19 March 2014) of the suburb of Gwelup found no Registered Sites in the vicinity of the project area.

It is noted that a site of heritage significance occurs within Lot 2 directly north of the project area; however, this feature is not known to extend beyond Lot 2, or affect the project area.

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Cultural Heritage is not expected to pose a constraint to the Project, which includes the development of Lots 500 and 501 North Beach Road.



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3. Preliminary environmental evaluation

This section provides a summary of the key environmental constraints to development determined from the site visit and desktop assessment.

Table 5: Preliminary environmental evaluation

Factor	Potential constraint to development	Justification	Potential management measures and further work required
Conflict with current land uses	No	The project area and surrounds currently incorporates primarily residential development areas. The project area is zoned for 'Development' in the Local Planning Scheme; therefore residential development is not considered to be at variance to existing land use in the area.	Consideration will need to be given to current land users, which will require sufficient notification and liaison to be undertaken by the landowner during key stages of development, such as construction.
Landform and topography	Yes	Swamp land areas of the project area may pose constraints to development. The Careniup Swamp is part of the Careniup Swamp SCA subject to a number of special provisions under the Local Planning Scheme. Careniup Swamp is also identified as a Resource Enhancement wetland.	The LSP requires the development of lots in accordance with provisions set out in Clause 2 of the Local Planning Scheme, where development will impact on the 'Core Area'. The project may have some minor impacts on the Core Area where battering for road construction takes place. It is unlikely that impacts to the Core Area will result in delays to the LSP and subdivision process. It is recommended that additional consultation with the CoS is undertaken to determine the requirements for wetland protection. Any wetland buffer requirements have the potential to impact the LSP and subdivision process.
Geology and soils	No	A geotechnical investigation found that geology and soils of the project area are not likely to pose a constraint to development.	N/A
Acid sulfate soils	Yes	As identified in the DEC ASS risk maps, the project area has a medium to high risk of ASS occurring. Potential ASS may be present as a result of low land areas associated with the Careniup Swamp. An investigation of ASS potential as part of the geotechnical investigation was undertaken. Results of the ASS investigation inferred moderate PASS risk of the samples.	It is recommended that a detailed ASS management plan is prepared and implemented during earthworks and construction to manage potential impacts associated with disturbance of ASS materials.
Salinity risk	No	The groundwater salinity level of the project area was assessed using the WA Atlas as relatively low (500 – 1000 (TDS) (Landgate 2014). Salinity is not expected to pose a constraint to development of the project area.	N/A



Factor	Potential constraint to development	Justification	Potential management measures and further work required
Contaminated sites	Yes	Historical and current land use of the site has included market gardening and storage of vehicles, which may have resulted in some form of contamination through the use of chemicals, pesticides etc.	To determine the likely status of contamination of the project area, it is recommended that a preliminary site investigation (PSI) is undertaken to assess the presence of contaminants. Groundwater quality sampling undertaken as part of the LWMS can be used to inform this assessment. The PSI would include recommendations for removal and treatment of contaminants if required.
Surface water / wetlands	Yes	The presence of the Careniup Swamp SCA and Resource Enhancement category are the most significant constraints to development. Consultation with the City also determined that the Core Area associated with the SCA was endorsed through an agreement between the EPA and the City over 25 years ago. Recent discussions between the CoS and the EPA in relation to a development proposal south of the project area, confirmed the agreement and endorsement of the Core Area.	The Careniup Swamp poses constraints for the actual development of the site (filling; battering; drainage basin) and from an approvals perspective. Provisions of the SCA as identified in Clause 6 of the Local Planning Scheme are unlikely to significantly impact the LSP process. It is considered that relevant clauses in the Local Planning Scheme can be met through implementation of environmental best practice and consultation with the CoS. It is recommended that further consultation is undertaken with the CoS to confirm requirements for wetland protection.
Groundwater	No	A LWMS has been prepared to support the LSP.	Groundwater is not anticipated to pose a constraint to development as outlined in the LWMS. An UWMP will be prepared to support the subdivision application.
PDWSA & UWPCA	No	The project area is located within the Gwelup UWPCA and PDWSA advice states that the land comprising the project area is to be managed in accordance with a P3 classification.	Protection of P3 areas is mainly achieved through guided or regulated environmental risk management for land use, where land uses considered to have significant pollution potential are nonetheless opposed or constrained. Where the risk of potential contamination is greater more stringent conditions and management measures will need to be implemented. It is unlikely that the proposed development will impact on water managed under provisions of the
Stormwater flow and onsite drainage	No	Stormwater flow and on-site drainage does not pose a constraint to development.	PDWSA and UWPCA. N/A
Bush fire risk	No	The project is not considered to be located within an extreme bush fire risk area.	Bush fire is not considered to be a significant risk to development; however it is recommended that a Bush fire Management Plan is prepared to support the subdivision application.

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Factor	Potential constraint to development	Justification	Potential management measures and further work required
Vegetation and flora	No	The project area comprises two major areas; terrestrial land, incorporating the majority of the project area and swamp land, comprising approximately one third of the project area. The terrestrial area comprises mostly cleared vegetation, with a small number of remnant trees, primarily introduced species. The swamp area includes some native species interspersed with introduced species and weeds.	Given the lack of native species within the project area and the weedy areas associated with the wetland it is unlikely that a flora and vegetation survey is required. Strategen recommends that a site walkover is undertaken to confirm these conclusions identified in the desktop assessment.
Fauna and fauna habitat	No	The project area is largely devoid of remnant vegetation, having been previously cleared. It is unlikely that any significant habitat exists for native fauna within the project area, based on the desktop assessment, however the open water, paperbark and sedge land are expected to provide habitat for wildlife	It is unlikely that significant fauna habitat occurs within the swamp area; however Strategen recommends that a site walkover is undertaken to confirm habitat values identified in the desktop assessment.
Infrastructure and servicing		No additional investigations into infrastructure are required.	
Cultural heritage	No	There are no sites of Aboriginal heritage significance occurring in the project area.	No additional investigations into heritage are required.

4. Recommendations

4.1 Site summary

A preliminary opportunities and constraints assessment was undertaken for Lots 500 and 501 North Beach Road, Gwelup. Existing environmental characteristics of the project area have been described and environmental factors with the potential to constrain proposed development of the site were identified as detailed in the following sections.

4.2 Constraints

Potential development constraints were identified throughout the project area, including:

- The Careniup Swamp is part of the Careniup Swamp SCA subject to a number of special provisions under the Local Planning Scheme. Careniup Swamp is also identified as a Resource Enhancement wetland.
- · Results of the ASS investigation inferred moderate PASS risk of the samples.
- Historical and current land use of the site has included market gardening and storage of vehicles, which may have resulted in some form of contamination through the use of chemicals, pesticides etc.
- The presence of the Careniup Swamp with its SCA provisions and Resource Enhancement
 category is the most significant constraint to development. The presence of the Careniup Swamp
 poses constraints for the actual development of the site (filling; battering; drainage basin) and
 from an approvals perspective, with more consultation regarding wetland protection requirements
 with the CoS potentially required.

4.3 Recommendations

The project has the potential to impact on a number of environmental factors; however it is unlikely that the proposed development will result in significant impacts to any factors. Based on the above constraints and other aspects noted in the assessment, it is recommended that the following additional investigations/management measures are implemented:

- Consultation with adjacent landowners to be undertaken by the landowner during key stages of development, such as construction.
- The LSP requires the development of the lots in accordance with provisions set out in Clause 2 of the Local Planning Scheme, where development will impact on the 'Core Area'. The project may have some minor impacts on the Core Area where battering for road construction takes place. Management of the Core Area will incorporate requirements of Clause 6 as detailed in Table 4.
- To facilitate development of the wetland areas, it is recommended that additional consultation with the CoS be undertaken to determine the requirements for wetland protection and any potential buffer requirements with the DoW and DPaW.
- It is recommended that a detailed ASS management plan is prepared and implemented during earthworks and construction to manage potential impacts associated with disturbance of ASS materials.
- Management of P3 water areas in accordance with best practice water management measures in line with the CoS requirements.
- To determine the likely status of contamination of the project area, it is recommended that a PSI is undertaken including soil and groundwater sampling to assess the presence of contaminants.
 Groundwater quality sampling undertaken as part of the LWMS can be used to inform this assessment.
- Bush fire is not considered to be a significant risk to development; however it is recommended that a Bush fire Management Plan is prepared to support the subdivision application.



- Strategen recommends that a site walkover is undertaken to confirm the presence of flora and vegetation and fauna habitat on site to accurately assess anticipated impacts of subdivision.
- Weed management measures should be implemented throughout project development, with an emphasis on clearing and construction activities.



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APPENDIX 3

LOCAL WATER MANAGEMENT STRATEGY





Lots 500 & 501 North Beach Road Gwelup

Local Water Management Strategy

March 2014



Client: Gwelup Land Developments Pty Ltd



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- 11. Implementation, Roles and Responsibilities



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Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

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Executive Summary

Hyd2o was commissioned by Gwelup Land Developments Pty Ltd to prepare this Local Water Management Strategy (LWMS) to support the proposed subdivision development of Lots 500 and 501 North Beach Road within the suburb of Gwelup.

The site is located approximately 12 km north west of Perth City Centre within the City of Stirling. The site has an approximate area of 4.0 ha and consists of two individual lots bound by Carslake Grove to the north, Karrinyup Waters Resort Caravan Park to the south, North Beach Rd to the west and Careniup Swamp to the east.

The proposed development consists of 61 residential lots <500m² each and one POS reserve located adjacent to Careniup Swamp. The development area represents approximately 3.2 ha of the site and has been developed in accordance with the City of Stirling Local Planning Scheme (LPS) No. 3 and associated Careniup Swamp Rehabilitation Plan.

The site is largely cleared and contains several existing residential dwellings. Careniup Swamp located to the east, is mapped as a resource enhancement wetland, with a smaller portion mapped as an EPP lake. The swamp forms part of the Water Corporations Main Drainage system, which services the adjacent residential area.

Topography of the site slopes from approximately 14 mAHD at the south western corner to 6 mAHD at the eastern boundary. Elevated areas along the western boundary of the site are located well above the groundwater table, with the water table expressing itself at natural surface in the east.

The proposed stormwater management system will retain and infiltrate the 1 in 1 year average recurrence interval (ARI) event on site, with events greater than 1 year ARI overflowing to Careniup Swamp in accordance with Water Corporation overarching drainage planning for the area.

This LWMS has been prepared in accordance with the principles, objectives, and key criteria of Better Urban Water Management (Western Australian Planning Commission, 2008). In excess of 40 years of groundwater and wetland water quality and level data from nearby Department of Water (DoW) bores, and onsite measurements by Hyd2o on February and March 2014, have been use to inform the development of this LWMS.

Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of Urban Water Management Plans for individual stages of development within the site.



Local Water Management Strategy Summary

Strategy Elements	LWMS Method & Approach
Water Use Sustainability	
Water Efficiency	 5 Star Building Standards (water efficient fixtures and fittings). Use of native plantings in POS / wetland area. Maximise infiltration of stormwater at source.
Water Supply	 Water Corporation IWSS for lots with rainwater tanks optional. No long term irrigation of Public Open Space / wetland area.
Wastewater	Water Corporation reticulated sewerage
Stormwater	
Flood Protection	 No development within wetland core area. 100 year overflow to Careniup Swamp . Establish minimum habitable floor levels at 0.5m above the 100 year ARI flood level. Provide flood paths for overland flows which exceed the capacity of piped drainage. Provision of flow paths for future development area to north
Serviceability	 Road drainage system designed so roads will be passable in the 1 in 5 year event. 5 year overflow to Careniup Swamp
Ecological Protection	 1 year 1 hour storm event to be retained on site. Use of soakwells at lots scale Total storage volume of 217 m³ and area of 0.059 ha required to manage flood events up to 1 year ARI, representing approximately 1.5% of total site area. Design accommodates future potential drainage contribution from area to north of the site Bioretention area established at 2% of connected impervious area within 1 year storage area. Wetland boundary established in accordance with the Careniup Swamp Rehabilitation Plan contained in City of Stirling (2013), Implement non-structural controls.
Groundwater	
Fill & Subsoil Drainage	 A combination of fill and subsoil drainage will be utilised to achieve clearance to groundwater. Subsoil will be free draining and receive appropriate treatment prior to discharge.
ASS & Contamination	ASS to be investigated as a separate process and reported in UWMP.



1. Introduction

Hyd2o was commissioned by Gwelup Land Developments Pty Ltd to prepare this Local Water Management Strategy (LWMS) to support the proposed subdivision development of Lots 500 and 501 North Beach Road within the suburb of Gwelup (herein referred to as the site).

The site is located approximately 12 km north west of Perth City Centre within the City of Stirling (Figure 1). The site has an approximate area of 4.0 ha and consists of two individual lots bound by Carslake Gr to the north, Karrinyup Waters Resort Caravan Park to the south, North Beach Rd to the west and Careniup Swamp to the east.

This LWMS provides a total water cycle management approach to development and has been prepared consistent with the overarching City of Stirling Local Planning Scheme No. 3 and Better Urban Water Management (Western Australian Planning Commission (WAPC, 2008). This document provides the outcomes of site specific analysis relating to groundwater and surface water and provides a clear vision in terms of adopting best management practises to achieve water sensitive design.

LWMS Checklists are contained as Appendix A.

1.1 Planning Background

The site is located within the City of Stirling Local Planning Scheme (LPS) No. 3 area and is identified as a development zone (City of Stirling, 2013). The proposed residential development complies with the LPS.

It is located within the zone identified as the Careniup Swamp Special Control Area, and the LPS scheme text provides special provisions for this area (City of Stirling, 2013).

The LPS scheme text details a Careniup Swamp Rehabilitation Plan, which defines the core area of the wetland for retention with development. The boundary of the wetland core area identified in the LPS has been used as the basis of structure planning for areas adjacent to the swamp.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Document and Status
Local	Local Structure Plan Lots 500 & 501 North Beach Rd Gwelup	Lots 500 & 501 North Beach Rd Gwelup Local Water Management Strategy THIS DOCUMENT
Subdivision	Subdivision Application	Urban Water Management Plan (for individual subdivision applications) FUTURE PREPARATION



1.2 Key Documents and Previous Studies

This LWMS uses the following key documents to define its principles, criteria, and objectives:

- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (Department of Water, 2007)
- Decision Process for Stormwater Management in WA (Department of Water, 2009a)
- City of Stirling Local Planning Scheme No. 3 (City of Stirling, 2013)
- Karrinyup Gwelup Local Area Plan (City of Stirling 2010)



2 Proposed Development

The structure plan for the site is shown in Figure 2.

Consideration of the predevelopment environment of the site and existing constraints have guided the development of this plan. The proposed development consists of 61 residential lots <500m² each and one POS reserve located adjacent to the Careniup Swamp.

The development area represents approximately 3.2 ha of the site.

The extent of the development area has been established in accordance with the City of Stirling Local Planning Scheme (LPS) No. 3 and associated Careniup Swamp Rehabilitation Plan.



3 Pre-Development Environment

3.1 Site Conditions

The site is largely cleared and contains several existing residential dwellings (Figure 3). A caravan park is located south of the site, with existing residential development to the north and the Careniup Swamp to the east.

Topography of the site slopes from approximately 14 mAHD at the south western corner to 7 mAHD at the eastern boundary (Figure 3).

Historical aerial imagery shows that the project area and adjacent lots to the north and south were previously used for market gardening for an extended length of time.

The project area is located within the Perth Coastal and Gwelup Underground Water Pollution Control Area (UWPCA), which is a Priority 3 source protection area. Land uses such as residential, commercial and light industrial developments are permissible in P3 areas and coexist with public water supply sources in these areas.

3.2 Geotechnical

Environmental geology mapping on the Perth Metropolitan Regional Sheet 2034 II and part 2034 III and 2134 III (Gozzard, 1986) is shown in Figure 4, indicating the site is characterised by areas of:

- Cps PEATY CLAY dark grey to black at surface with variable sand content of lacustrine origin. This is located in the eastern portion of the site in vicinity of the Careniup Swamp.
- S7 SAND Pale grey to white medium grained well sorted sub angular quartz. This is located in the western portion of the site covering the majority of the development area.

Pre-development monitoring involved the installation of four groundwater bores within the site (Section 3.5) (Figure 4) by Hyd2o on 18 February 2014 to maximum depths of between 5.25 m and 11.25 m. The logs indicated that the subsurface profile is generally sandy, with areas of peaty clay in close vicinity to the swamp. Lithological logs taken by Hyd2o at the time of bore installation are attached as Appendix B. In summary, the findings from lithological logs are consistent with surface geology characteristics identified by Gozzard (1986), with the exception of site GW3 which encountered a mostly fill-like soil suggesting that the area may be reclaimed land and not the original geological profile.

A geotechnical investigation of the site was undertaken by Prompt Engineering in November 2013 (Prompt Engineering, 2013). Results from the investigation, showing subsoil profiles consisting of sands derived from Tamala Limestone and swampy deposits in close proximity to the Careniup Swamp, are consistent with those of Gozzard (1986) and Hyd2o.

The geotechnical report is included as Appendix C.



3.2.1 Acid Sulphate Soils

According to Western Australian Planning Commission (2003), the eastern portion of the site has a moderate to high level risk of acid sulphate spoil disturbance occurring within 3m of natural soil surface (Figure 4).

3.2.2 Contaminated Sites

A search of the Department of Environment and Conservation's Contaminated Sites Database determined that there are no known contaminated areas within the site.

3.3 Wetlands

According to the DEC's Geomorphic Wetlands of the Swan Coastal Plain dataset, Careniup Swamp is classified as a sumpland, resource enhancement wetland (Figure 5). EPA's Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 also identifies part of the wetland as an EPP Lake (Government of Western Australia, 1992) (Figure 5).

As previously discussed in Section 1.1, Careniup Swamp is zoned as a Special Control Area allowing for development to occur consistent with the detailed Careniup Swamp Rehabilitation Plan contained in City of Stirling (2013), which defines the core area of the wetland for retention following development.

The boundary of the wetland core area is shown in Figure 5 and an extract from the City of Stirling Local Planning Scheme No. 3 regarding the provisions in place for the Careniup Swamp Special Control Area included as Appendix D.

The boundary of the wetland core area in the LPS is used to define development boundaries adjacent to the wetland (Bruce Gardner, Senior Strategic Planning Officer City of Stirling, pers comm).

Many existing and recent residential developments adjacent to Careniup Swamp intersect the mapped wetland boundaries.

3.4 Surface Water Hydrology

The site drains from west to east toward Careniup Swamp, via overland flow. There are currently no defined drainage flow paths within the site and it has no external catchments contributing flow into the site.

Careniup Swamp is part of the Water Corporation Main Drainage system, and is a compensating basin receiving stormwater runoff from adjacent residential development areas. City of Stirling (2013) outlined the need to maintain 26,000m³ of capacity within the wetland core area for drainage purposes following development of the adjacent areas.

Development was also required consider a maximum water level of 7 mAHD and minimum operating water levels of 6.3 mAHD for the wetland (City of Stirling 2013). Recent discussions with the Water Corporation (James Wegener pers comm) however have indicated a maximum top water level for Careniup Swam of 6.6 mAHD (100 year ARI) to be used for design purposes. Hyd2o understand this advice is based on the Water



Corporation's latest modelling of the drainage system in the area and this advice supersedes the previous 7 mAHD level contained in City of Stirling (2013).

Further details regarding provisions for the Careniup Swamp Special Control Area are included in Appendix D.

3.5 Groundwater Hydrology

3.5.1 Groundwater Levels

Local groundwater characteristics have been established using data obtained from local and site specific groundwater bores. All monitoring bores associated with these investigations (Hyd2o and DoW bores) are shown in Figure 6.

Long-term groundwater monitoring data, measured between July 1974 and October 2013, was obtained from the Department of Water (DoW) for four bore sites, GM4, GM8, GM9 and GM33, located between approximately 500 m and 1 km from the site.. Water level monitoring data is included as Appendix E and hydrographs for all four DoW bores are included in Appendix F.

Groundwater level monitoring was undertaken by Hyd2o at four site bores, GW1, GW2, GW3 and GW4, on 20/02/2014 and 24/03/2014, and DoW bores on 24/03/2014 (Table 2).

Groundwater has a low gradient, flowing in an east-west direction. The maximum recorded groundwater level for the site was 5.60 mAHD at site GW3 and the DoW staff gauge on 20/03/2014 and the lowest recorded groundwater level for the site was 3.44 mAHD at site GW4 (see Table 2).

Tables 3 and 4 outline the details of the average annual maximum groundwater level (AAMGL) and maximum groundwater levels (MGL) for the site based on long term DoW bore records. The AAMGL is estimated to range from 4.38 mAHD to 6.40 mAHD across the site, which varies from approximately 0.45 m to 6.69 m below the existing natural surface level (Figure 7).

This calculation is considered likely to provide a conservative groundwater level estimate as Water Corporation infrastructure at Carenuip Swamp is likely to control groundwater level rise in areas immediately adjacent to the wetland.

The estimated MGL level for the site in the area adjacent to Careniup Swamp is generally consistent with the maximum recorded groundwater level contours detailed in DoW's online Perth Groundwater Atlas (2014b). Hyd2o maximum groundwater levels adjacent to North Beach Rd are lower than DoW (2014b) estimates, possibly due to irrigation impacts of the Lake Karrinyup Country Club golf course.

Further groundwater level monitoring is currently being undertaken by Hyd2o and will extend over the winter 2014 period. This data will be used to refine groundwater levels to inform the development of the Urban Water Management Plan (UWMP) for the site.



Table 2: Pre Development Groundwater Levels

	Hyd2o Monitoring Bores DoW Monitoring Bores				DoW Staff Gauge				
	GW1	GW2	GW3	GW4	GM4	GM8	GM9	GM33	-
Bore Details									
Easting (m)	38586	38576	38584	38564	385811	385417	386423	386844	385813
Northing (m)	647427	647428	647420	647423	6474995	6473276	6474049	6474310	6474394
Groundwate	er Level (m	nAHD)							
20/02/2014	5.53	4.81	5.60	3.70	-	-	-	-	5.60
24/03/2014	5.37	4.58	5.46	3.44	4.47	3.67	7.85	8.96	5.50

Table 3: DoW Bore AAMGLs and MGLs

Bore	Period of Record	AAMGL (mAHD)	24/3/2014 Correction to AAMGL (m)	MGL (mAHD)	24/3/2014 Correction to MGL (m)
GM4	1974 - 2013	5.75	1.28	6.80	2.33
GM8	1974 - 2013	5.16	1.49	6.33	2.66
GM9	1974 - 2013	8.24	0.39	8.78	0.93
GM33	1984 - 2013	9.57	0.61	10.46	1.50
Average C	Correction Factor (a	I DoW bores)	0.94		1.86

Table 4: Estimated Site AAMGLs and MGLs

Bore	Natural Surface (mAHD)	AAMGL (mAHD)	Depth to AAMGL (m)	MGL (mAHD)	Depth to MGL (m)
GW1	6.76	6.31	0.45	6.76 *	0.00
GW2	7.97	5.52	2.45	6.44	1.53
GW3	7.12	6.40	0.72	7.12 *	0.00
GW4	11.07	4.38	6.69	5.30	5.77

^{*} Corrected to natural surface



3.5.2 Groundwater Quality

The four site groundwater bores were sampled for groundwater quality on 24/03/2014 using low-flow groundwater sampling techniques.

Physical parameters (temperature, electrical conductivity, pH) were measured in situ. Samples were sent to a NATA approved laboratory for analysis of total suspended solids, total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, filterable reactive phosphorus, and heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, and zinc).

Groundwater quality sampling results are outlined in Table 5, with full results contained in Appendix E and lab reports in Appendix G. Results are summarised below:

- pH in groundwater across all readings ranged from 6.53 to 6.92. The average across all bores was 6.73 suggesting the groundwater fits within the ANZECC (2000) guideline range of 6.5-8 pH.
- EC ranged from 512 μ s/cm to 1835 μ s/cm across all groundwater samples, with an average of 1050 μ s/cm.
- Across all sampling locations, values for total nitrogen (TN) ranged from 2.4 mg/L to 18 mg/L. The average value across all bores was 11.6 mg/L, which is above the ANZECC (2000) guideline value of 1.2 mg/L. The highest nutrient values were recorded at the eastern sites adjacent to Careniup Swamp.
- Total phosphorous ranged from <0.05 to 0.57 mg/L across all bores, with an average of 0.23 mg/L, which exceeds the ANZECC (2000) value of 0.065 mg/L.
- With respect to metals, Cadmium, Lead, and Mercury were below detectable limits for all samples, Arsenic, Nickel and Chromium within a 99% level of protection, and Copper and Zinc within a 90% level of protection.

The high nutrient levels are consistent with the site historical land use as a market garden.

Groundwater quality monitoring is continuing and will be further reported in the UWMP for the site. This data will be correlated to the ongoing monitoring programs of Careniup Swamp conducted by the City of Stirling.



Table 5: Groundwater Quality

Parameter		ANZECC			
	GW1	GW2	GW3	GW4	
Ec (μS/cm)	878	977	1835	512	120-300
рН	6.77	6.53	6.71	6.92	6.5-8.0
TSS (mg/L)	390	29	190	8	-
TN (mg/L)	17.0	2.4	18.0	9.0	1.2
TKN (mg/L)	17.0	2.0	18.0	0.9	n/a
Ammonia (mg/L)	11.0	1.1	15.0	0.05	0.08
Phosphate (mg/L)	0.34	<0.005	<0.005	0.009	-
Nox as N (mg/L)	<0.005	0.33	0.2	8.1	n/a
TP (mg/L)	0.57	0.06	0.28	<0.05	0.065



4 Design Criteria

Key design criteria for the site are shown in Table 6 and have been established consistent with criteria specified in the key reference documents previously detailed in Section 1.3

These design criteria are used in Sections 5, 6 and 7 together with the identified constraints and opportunities of the predevelopment environment (Section 3) to establish the water management strategy for the site.

Table 6: Design Criteria

Strategy Elements	Criteria	
Water Use Sustainability		
Water Efficiency	 Reduce consumptive use through adoption of waterwise practices. 	
Water Supply	 Develop "fit for purpose" water supply strategy, and minimise potable water use where drinking quality water is not essential. 	
Wastewater	 Provide a wastewater system which meets agency requirements. 	
Stormwater		
Flood Protection	 100 year overflow to Careniup Swamp Establish minimum habitable floor levels at 0.5m above the 100 year ARI flood levels. Provide flood paths for overland flows which exceed the capacity of piped drainage. 	
Serviceability	 Road drainage system to be designed so that roads will be passable in the 1 in 5 year event. 5 year overflow to Careniup Swamp 	
Ecological Protection	 1 year 1 hour storm event to be retained on site. Bioretention areas established at 2% of connected impervious areas. Wetland boundary established in accordance with the Careniup Swamp Rehabilitation Plan contained in City of Stirling (2013). Implement non-structural controls. 	
Groundwater		
Fill Requirement & Subsoil Drainage	 Establish development levels with acceptable clearance above post development groundwater levels. Provide subsoil drainage to control any post development groundwater rise. 	
Acid Sulphate Soils & Contamination	 Management of Acid Sulphate Soils to be handled as a separate process to LWMS consistent with DoE (2004b) requirements. 	



5 Water Use Sustainability Initiatives

5.1 Water Efficiency Measures

Development of the site will lead to an increased demand of potable water for residential use and irrigation of gardens and POS areas. Water conservation measures will be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria including:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets, rainwater tanks, waterwise landscaping).
- All houses to be built to 5 star building standards.
- Use of native plants in POS and wetland area.
- Maximising on site retention of stormwater (where practicable).

5.2 Water Supply

Potable water supply to future homes in the site will be via the Water Corporation Integrated Water Supply System (IWSS).

With respect to the Public Open Space / wetland area, no long term irrigation is proposed. Some short term irrigation water supply may be required for establishment purposes.

The site is located within the Gwelup groundwater management area (GMA) and Gwelup groundwater subarea. Table 7 summarises the current quotas and allocation according to the Department of Water's online Water Register (2014b), indicating both the Superficial and Mirrabooka aquifers as being fully allocated. Any short term temporary irrigation will therefore be via scheme water.

Rainwater tanks have been identified as a non-potable source to be integrated as part of the domestic water supply scheme to assist in reducing stormwater generation and minimise scheme water importation. Further details of rainwater tank implementation will be provided at UWMP stage.

Table 7: Groundwater Resource and Licenced Allocation

Groundwater Area	Subarea	Aquifer	Allocation Limit	Water Availability
Gwelup	Gwelup	Superficial	7.95 GL	Fully allocated
		Mirrabooka	3.60 GL	Fully allocated

5.3 Wastewater Management

Wastewater will be deep sewerage (reticulated) with management by the Water Corporation.



6 Stormwater Management Strategy

Stormwater management is proposed to be undertaken consistent with DoW water sensitive design practices. The system will consist of a series of lot soakwells, road drainage system comprising pipes, and a bioretention/infiltration area to provide water quantity and quality treatment for stormwater generated from the proposed development.

6.1 Stormwater Modelling

Stormwater modelling for the site was performed using XP-Storm to determine flood storage requirements and provide an assessment of local structure plan areas required for drainage purposes.

The post development catchment area for the flood storage is shown in Figure 8. This catchment area allows for the connection of potential future drainage from development of Lot 2 located immediately north of the site.

The storage is designed to detain and infiltrate the 1 in 1 year ARI event, with larger events permitted to overflow to Careniup Swamp, via an overflow spillway which will be established as an overland flow path.

The proposed runoff rate for the 1 in 1 year ARI event has assumed the use of soakwells within lots, with only road reserve runoff contributing to storage requirements. For events greater than 1 in 1 year ARI, a runoff coefficient of 20% has been adopted from lots.

The design storms modelled by XP-Storm were calculated internally by the model with reference to the methodology in Australian Rainfall & Runoff (AR&R) (Institution of Engineers, Australia, 2000) and the Bureau of Meteorology Computerised Design IFD Rainfall System. The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 60 minutes to 72 hours.

Modelling results are shown in Table 8 and Figure 8. The storage shape shown in Figure 8 is indicative only for determination of area requirements. Note the location of the 1 year storage area has been established outside the development area and within the area required to be graded to Careniup Swamp.

The final storage area configuration (side slopes etc), location, and elevation will be documented in the UWMP and will be dependent on final earthworks, drainage, and road design levels for the development.

Minor refinements to catchment areas shown in this report may occur as detailed design proceeds, and stormwater modelling will be updated accordingly if required during the UWMP process.

All building floor levels will comply with Water Corporation requirements for a 0.5 m clearance above the Careniup Swamp 100 year ARI flood level of 6.6 mAHD (James Wegener, Water Corporation, pers comm).



Table 8: Stormwater Storage Sizing

Catchment Details	
Contributing Lot Area (Ultimate) (ha)	4.44
Contributing Road Reserve Area (ha)	1.53
Roads (% runoff)	90%
Lots (for events >1 year ARI) (% runoff)	20%
1 in 1 Year ARI EIA (Roads) (ha)	1.38
>1 Year ARI EIA (Roads and Lots) (ha)	2.27
Storage Parameters	
Base Area (m²)	310
Side Slopes	1:6
Approximate Base Invert	7.0
Bioretention Area	
Required Area (m²) (2% of EIA)	276
1 Year ARI Event	
Flood Rise (m)	0.49
Volume (m³)	217
TWL Surface Area (m²)	586
TWL (mAHD)	7.49
5 Year ARI Event	
Peak Overflow (m³/s) to wetland via spillway	0.19
100 Year ARI Event	
Peak Overflow(m³/s) to wetland via spillway	0.46

6.2 BMP Water Quality Performance

Bioretention areas are calculated as 2% of the effective impervious area (EIA) (Table 8), and provide a guide for storage requirements and areas for water quality treatment consistent with DoW requirements (DoW, 2009a).

The area required for bioretention will be approximately similar to the area required for 1 year ARI event storage.

Table 9 details a summary from DoW's Stormwater Management Manual for Western Australia (2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria. While DoW (2007) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach using a combination of the non-structural and structural measures will therefore achieve the design objectives for water quality as detailed in Better Urban Water Management (WAPC, 2008).



Table 9: BMP Water Quality Performance

Parameter	Design Criteria via BUWM (WAPC,2008)	Structural Controls Nutrient Output Reduction 1		
	(required removal as compared to a development with no WSUD)	Vegetated Swales/ Bioretention Systems	Detention/ Retention Storages	
Total Suspended Solids	80%	60-80%	65-99%	
Total Phosphorus	60%	30-50%	40-80%	
Total Nitrogen	45%	25-40%	50-70%	
Gross Pollutants	70%	-	>90%	

^{1.} Typical Performance Efficiencies via DoW (2007)

6.3 Non-Structural Controls

This LWMS proposes a treatment train approach to water quality management which will include non-structural as well as structural controls:

Non-Structural Controls

Planning: POS and storage location/configuration Landscape: Native plantings, WSUD integration

Maintenance: wetland and storage areas, street sweeping, manhole education

Monitoring: Pre and post development program and review

Structural Controls

Soakwells at lot scale to minimise runoff Bioretention storage and 1 year treatment area Overland flow path to wetland for major events

Measures adopted represent known best management practice as detailed in the DoW's Stormwater Management Manual for Western Australia (2007).



7 Groundwater Management Strategy

7.1 Fill and Subsoil Drainage

Development levels in the site will be largely dominated by fill requirements to achieve adequate separation to groundwater, rather than clearance above the Careniup Swamp 100 year flood level.

Minimum separation between building floor levels for development and groundwater will be achieved by a combination of fill and subsoil drainage to provide protection against any post development groundwater rise.

Subsoil drainage is likely to be confined to the eastern portion of the development area. All subsoil drainage is proposed to be located at the AAMGL as a control groundwater level, with lots provided with a minimum 1.5 m clearance above the invert of the subsoil drains.

The extent of the subsoil area will be identified at UWMP stage. All subsoil drainage will be free draining in accordance with DoW requirements and treated for water quality prior to discharge.

Finished lot levels and fill requirements are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP and will be ultimately submitted for council approval at that stage.

7.2 Acid Sulphate Soils

Management of Acid Sulphate Soils (ASS) will be addressed as a separate study to this LWMS. Details regarding the outcomes of this study will be included as part of the Urban Water Management Plan (UWMP).

All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series Identification and Investigation of Acid Sulphate Soils (DoE, 2004b).



8 Urban Water Management Plans

Consistent with processes defined in WAPC (2008), an Urban Water Management Plan (UWMP's) will be developed and submitted to support a subdivision application for the site.

The UWMP will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of the City of Stirling and DoW.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating major and minor flood management capability.
- Management of groundwater levels including proposed cut/fill level, and any subsoil drainage inverts (if/where required).
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed ongoing management arrangements.
- Management of subdivisional works
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken consistent with the monitoring program defined in the LWMS.
- Contingency plans (where necessary).

More detail on stormwater storage integration will be provided during the development of the UWMP, including refinement of stormwater modelling, preparation of landscape plans (species selection and treatments), and detailed engineering design drawings.

Preparation of the UWMP will be the responsibility of the developer.



9 Monitoring

9.1 Predevelopment

Based on the extensive amount of monitoring data already available in proximity to the site, DoW have endorsed a shorter pre-development monitoring program than the typical 18 month period. Hyd2o's letter report detailing the LWMS pre-development monitoring program, and the DoW's letter of acceptance are included in Appendix H.

Pre-development monitoring for the site is currently continuing with the programme estimated for completion at the end of winter 2014.

Results collected to date have been reported in Section 3.5 and Appendix E and have been used to inform this LWMS.

Where applicable, additional data collected from this programme will be used to inform the development of the urban water management plan (UWMP).

9.2 Post Development

Post-development groundwater monitoring is proposed in one of the pre-development groundwater monitoring bores located near the eastern development area boundary adjacent to the wetland. The following frequency of monitoring is proposed:

- Monthly groundwater level measurements.
- Quarterly groundwater quality measurements.

Groundwater quality will be monitoring quarterly (typically January, April, July, October) for physical parameters (pH, electrical conductivity), nutrients (total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, and filterable reactive phosphorus) and heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, aluminium, manganese, arsenic and lead).

All samples will be analysed at a NATA approved laboratory.

The groundwater monitoring schedule will be undertaken for a two year period. An annual report will be prepared summarising the results of the program.

Table 10: Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
	Water Level (m AHD)	1 bore within development area and 2 DoW bores	Electrical depth probe or similar	Quarterly
Groundwater				
	pH, EC, nutrients, metals	1 bores within development area adjacent to wetland	Pumped bore sample	Quarterly (Jan, Apr, Jul & Oct)



10 Implementation

Table 11 details the roles, responsibilities and funding to implement the LWMS.

Predevelopment monitoring outcomes will be used in a continual improvement capacity to inform later stages of planning for the development. Any modification required to the LWMS would be identified through the review process of monitoring data and would require the agreement of all parties (DoW, City of Stirling, and developer).

Details of construction and maintenance responsibilities will be appropriately detailed at UWMP stage.

Operation and maintenance of the stormwater management system will initially be the developer's responsibility, ultimately reverting to the City following handover. Details of maintenance responsibilities will be further outlined at UWMP stage. The schedule for maintenance works will be consistent with typical requirements of the City of Stirling.

Table 11: Implementation Roles & Responsibilities

			Responsibility & Fu	nding
LWMS Section	Implementation Action	Developer	City of Stirling	DoW
Urban Wa	ter Management Plan			
8	Preparation of a UWMP	Ø		
8	Review & Approval of UWMP		☑	☑
Monitoring	g Program			
9	Pre Development Monitoring Program	Ø		
9	Post Development Monitoring Program	Ø		
Stormwate	er System			
-	Construction of system	Ø		
	Operation & Maintenance			
-	a) Prior to Handover	\square		
	b) Following Handover		☑	



11 References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000), National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

City of Stirling (2010), Karrinyup Gwelup Local Area Plan, February 2010

City of Stirling (2013), City of Stirling Local Planning Scheme No. 3, May 2013

Department of Environment (2004a) Acid Sulphate Soil Guideline Series Identification and Investigation of Acid Sulphate Soils, Perth, Western Australia

Department of Environment (2004b) Perth Groundwater Atlas, Second Edition. Department of Environment, December 2004.

Department of Water (2007), Stormwater Management Manual for Western Australia.

Department of Water (2009a), Decision Process for Stormwater Management in WA

Department of Water (2009b), Gnangara Groundwater Areas Allocation Plan.

Department of Water (2014a), Perth Groundwater Atlas (online)

Department of Water (2014b), The Water Register: Licence and Water Availability Information (online)

Environmental Protection Authority and Water Authority of WA (1990), Jenny Arnold's Perth Wetlands Resource Book, Bulletin 266 December 1990

Gozzard (1986), Perth, Sheet 2034 II and Part 2034 III and 2134 III. Perth Metropolitan Regional Environmental Geology Series, Geological Survey of Western Australia.

Institution of Engineers Australia (2006), Australian Rainfall Quality

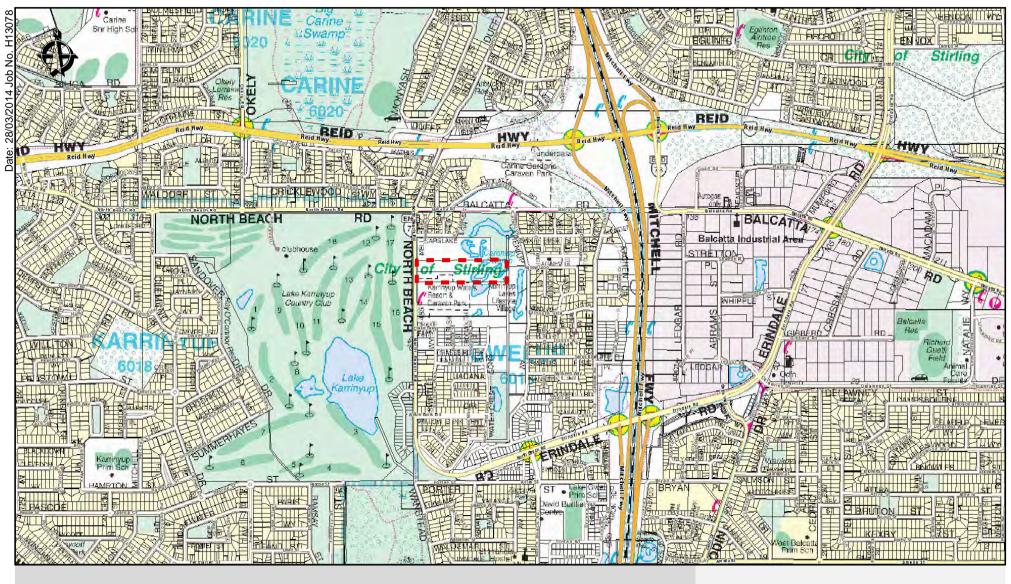
Institution of Engineers Australia (2000), Australian Rainfall & Runoff

Prompt Engineering 2013, Site Investigation: Lots 500 and 501 #459 and #463 North Beach Road, Gwelup, Western Australia, report prepared for Attest Pty Ltd, November 2013.

Strategen (2014), Lot 500 & 501 North Beach Rd Gwelup Environmental Assessment Report, Draft March 2014

Western Australian Planning Commission, (2003). Planning Bulleting No. 64: Acid Sulphate Soils. Western Australian Planning Commission, November 2003.

Western Australian Planning Commission. (2008), Better Urban Water Management, October 2008







hyd₂O Lot 500, 501 North Beach Rd Gwelup LWMS

Location Plan

Figure 1



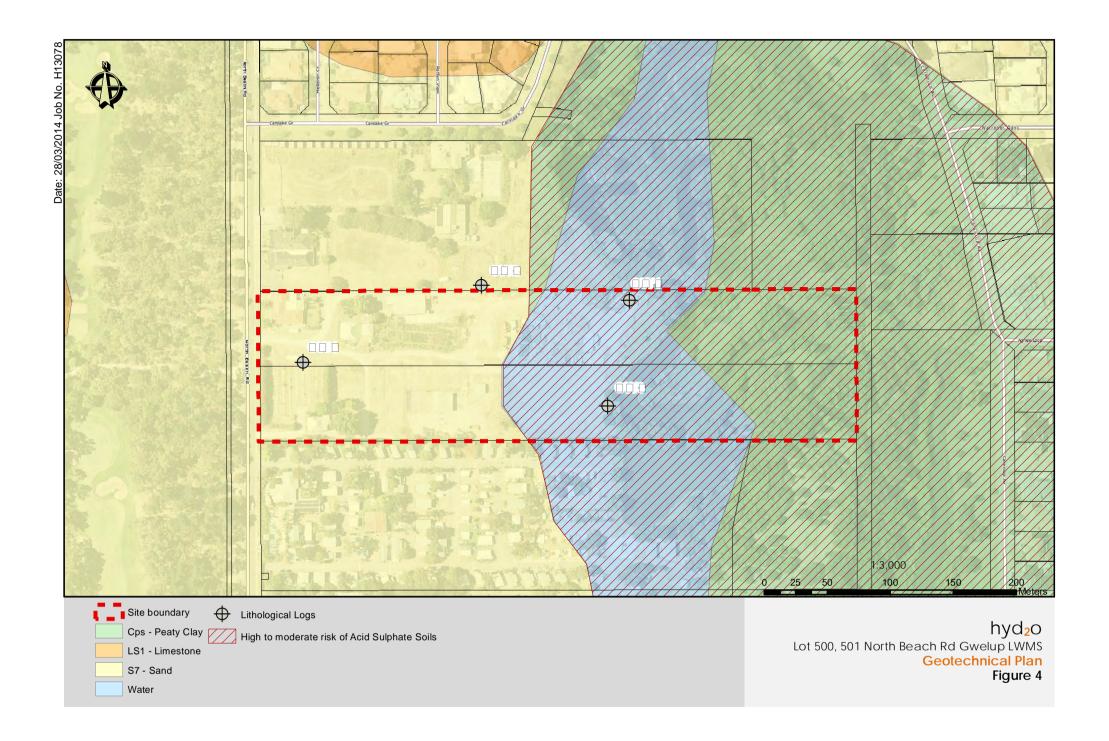
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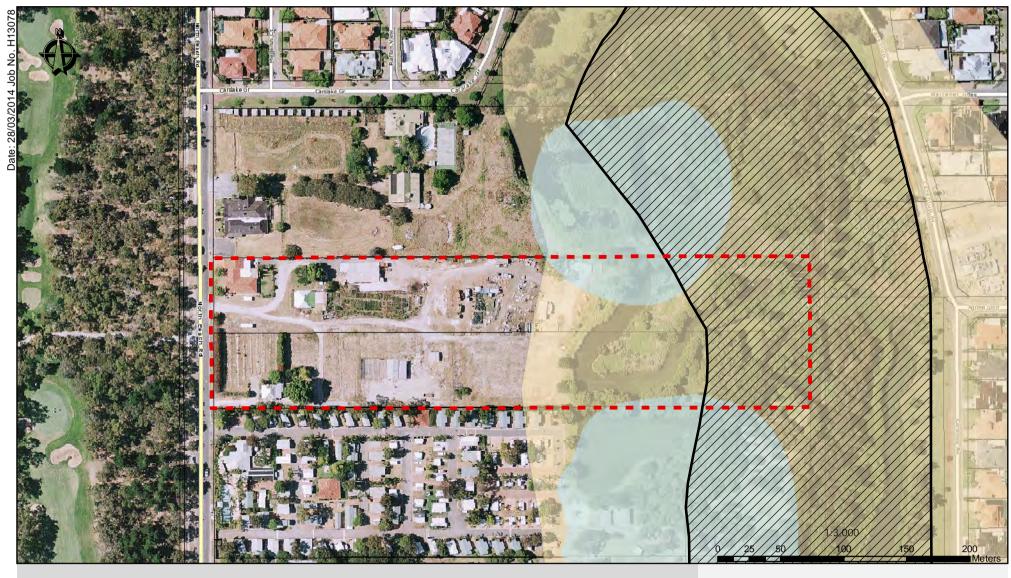
Lot 2, 501, 502 North Beach Rd Gwelup LWMS

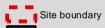
Structure Plan Figure 2











Careniup Swamp Core Area (City of Stirling, 2013)

EPP Lake

Resource Enhancement Wetland

hyd₂O Lot 500, 501 North Beach Rd Gwelup LWMS Wetland Plan Figure 5





Hyd2o Monitoring Bores

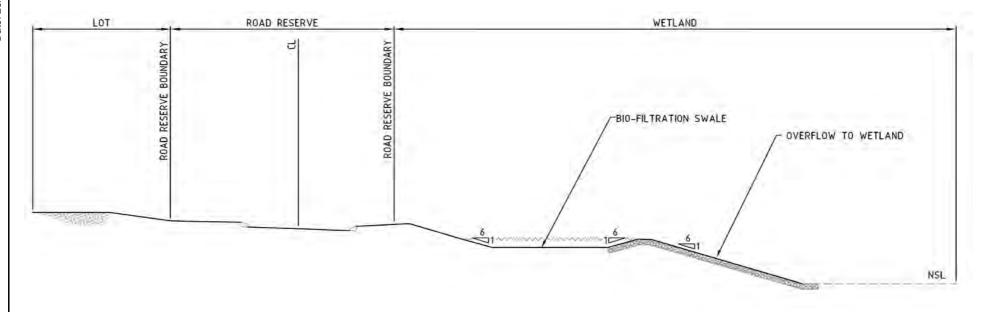
DoW Monitoring Bores

DoW Staff Guage

hyd₂O Lot 500, 501 North Beach Rd Gwelup LWMS Groundwater Monitoring Locations Figure 6







Source: TABEC (2014)

hyd₂o

Lot 500, 501 North Beach Rd Gwelup LWMS

1 Year ARI Stormwater Cross-Section

Figure 9

APPENDIX A

LWMS Checklist





LOCAL WATER MANAGEMENT STRATEGY DOCUMENT SUBMISSION CHECKLIST

Document title: Lot 500, 501 North Beach Rd **Gwelup LWMS** Version number: 1 Development stage: 1 Number of stages: 1 Associated developments (if relevant): None Structure plan reference: Include structure plan as an appendix Lots within subject area: 500, 501 Suburb: Gwelup Local Government Authority: City of Stirling **REQUIRED CHECK BOX** 1 x Hardcopy X 1 x Electronic copy (CD preferably affixed within CD slip to inside back cover of hard copy) X Revised document to include cover letter identifying amendments in relation to comments) Provide and comply with LWMS Guidelines checklist Х Referred to Local Government Authority X Referred to Department of Parks and Wildlife (if relevant) Other relevant referrals (list): Water Corporation X i.e. Swan River Trust, Water Corporation, Dept. Environment & Regulation etc. Compiled by (Consultancy): Hyd2o Hydrology Contact person: Sasha Martens Email: sasha@hyd2o.com.au Contact number: 9382 8683 Postal address: Suite 6b Rokeby Rd Subiaco WA 6008 Project reference number: H13078 Compiled on behalf of (Developer) Gwelup Land Developments Pty Ltd Contact person: Ross Neumann Email: neumann.ross@gmail.com Contact number: 0418644196 Postal address: 5/12 Eric St Como WA 6192

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P Stage and informed to inform POS ter Availability
to inform POS
and F

		,					
Local Water Management Strategy Item	Deliverable	V	Comments				
Groundwater management strategy							
Post development groundwater levels, fill requirements	Groundwater/subsoil Plan		Section 7.1				
(including existing and likely final surface levels), outlet controls,		$\overline{\checkmark}$					
and subsoil areas/exclusion zones							
Actions to adress acid sulphate soils or contamination		\checkmark	Section 7.2, Figure 4				
The next stage - subdivision and urban water management plan	s						
Content and coverage of future urban water management plans			Section 8				
to be completed at subdivision. Include areas where further		$\overline{\checkmark}$					
investigations are required prior to detailed design							
Monitoring							
Recommended future monitoring plan including timing,			Section 9, Table 10				
frequency, locations and parameters, together with		$\overline{\checkmark}$					
arrangements for ongoing actions							
Implementation							
Developer commitments		\checkmark	Chapter 10, Table 11				
Roles, responsibilities, funding for implementation		$\overline{\checkmark}$	Chapter 10, Table 11				
Review		$\overline{\mathbf{V}}$	Chapter 10, Table 11				

APPENDIX B

Hyd2o Lithological Logs

Lithological Log



Hyd2o Suite 6B 103 Rokeby Rd Subiaco, WA 6008

PO Box 1055 Subiaco WA 6904

Client: Ross Neuman Project: Gwelup LWMS 385861 Easting Northing 6474276

MGA Zone 50, GDA 94 Datum: Drill Rig Hollow Auger Drill type:

Hole diameter:

Job Number: H13078 Start Hole : 7.00am End Hole: 7.30am

Logged by: Michael Fifield Total Depth: 3.75m

RL Top of Casing: RL Nat Surface :

Bore Name

GW₁

					Soil Characteristics					
+	backfill	water	Slot /	Darath	Soil Characteristics					
support			Screen Depth	Depth (metres)	Colour	Particle Size	Texture	Organic Content	Moisture	Comment
(Class 9)	PVC (Class 9)			<u>-</u>	Light Grey Solid	Fine	Limestone	Low	Dry	
PVC				1.0 m	Medium grey Solid	Medium	Sand			Stones <30mm
					Wediom grey solid			Medium	High	
				2.0 m	Dark Grey Solid	Fine	Sandy Peat	· High		50% Peaty Soils
				_ _ _	Black Solid		Peat			
				3.0 m	Dark Grey Solid		Sandy Peat		Saturated	Mixture of organics
				_	Medium Grey Solid		Silty Clay	Low		
				4.0 m						End of hole
				_						
				5.0 m						
				_ _						
				6.0 m						
				_ _ _						
				7.0 m						
				_ _						
				8.0 m						
				9.0 m						
				_ _						
				10.0 m						

COLOUR:

Black, White, Biege Dark/Medium/Light: Brown, Red, Orange, Yellow, Grey, Blue Composition: Solid, Blemish, Mottle

PARTICLE SIZE: Fine, Medium, Course

TEXTURE: Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clayey Loam

Clay, Sandy Clay

ORGANICS: High, Medium, Low

MOISTURE: Dry, Slightly Moist, Moist, Saturated Static Water Level

18/02/2014

Stickup above NS (m) 0.5 Water Level bTOC (m) 1.84 Water Level bNS (m)

Date

Lithological Log



Hyd2o Suite 6B 103 Rokeby Rd Subiaco, WA 6008

PO Box 1055 Subiaco WA 6904

Client: Ross Neuman Project: Gwelup LWMS 385761 Easting Northing 6474285

MGA Zone 50, GDA 94 Datum: Drill type: Drill Rig Hollow Auger

Hole diameter:

Job Number: H13078 Start Hole : 7.45am

End Hole: 8.15am Logged by: Michael Fifield Total Depth: 5.25m

RL Top of Casing: RL Nat Surface :

Bore Name

GW₂

noie diameter. 75 mm Rt. Nat Surface .															
	backfill		Slot /		Soil Characteristics										
support		water	Screen Depth	Depth (metres)	Colour Particle Size		Texture	Organic Content	Moisture	Comment					
PVC (Class 9)	PVC (Class 9) Gravel			1.0 m	Medium Brown Solid	Fine		Low	Low	Stones <30mm					
				_ _ _ _ 2.0 m	Light Brown Solid		Sand	2011	23	33.13					
					Dark Brown Solid		Sand/Organics	Medium	Medium						
				3.0 m	Black Solid	Medium	Sandy Peat	High	High						
				4.0 m	Dark Brown Solid		Sand/Organics	Medium	Medium	Stones <10mm					
				- - -	Dark Grey Solid	Fine	Suria/Organics		Saturated						
				5.0 m	Medium Grey Solid		Sandy Clay	Low							
				6.0 m						End of hole					
				7.0 m											
				8.0 m											
				9.0 m											
				- - 10.0 m											

Black, White, Biege COLOUR:

Dark/Medium/Light: Brown, Red, Orange, Yellow, Grey, Blue Composition: Solid, Blemish, Mottle

PARTICLE SIZE: Fine, Medium, Course

TEXTURE: Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clayey Loam

Clay, Sandy Clay High, Medium, Low

ORGANICS: MOISTURE: Dry, Slightly Moist, Moist, Saturated Static Water Level

Date 18/02/2014 Stickup above NS (m) 0.55

Water Level bTOC (m) 3.75 Water Level bNS (m)

Lithological Log



Hyd2o Suite 6B 103 Rokeby Rd Subiaco, WA 6008

PO Box 1055 Subiaco WA 6904

Client: Ross Neuman Project: Gwelup LWMS 385847 Easting Northing 6474205

MGA Zone 50, GDA 94 Datum: Drill Rig Hollow Auger Drill type:

Hole diameter: 75 mm Job Number: H13078 Start Hole : 8.30am End Hole: 9.00am Logged by: Michael Fifield

Total Depth: 3.75 RL Top of Casing: RL Nat Surface :

Bore Name

GW3

	diameter:		75 mm												
					Soil Characteristics										
support	backfill	water	Slot / Screen Depth	Depth (metres)	Colour	Particle Size	Texture	Organic Content	Moisture	Comment					
PVC (Class 9)	Gravel			1.0 m	Light Brown Solid	Fine		Low	Low High	Stones <20mm and concrete possible pieces					
				2.0 m	Medium Brown Solid		Sand	LOW		Encountered hard substance likely to be remnant fill					
				3.0 m		Medium			Saturated	Stones <10mm					
					Medium Grey Solid			Medium							
				4.0 m 						End of hole					
				5.0 m	Note: There is a hig	gh chance t	his area is reclaime	ed land and n	ot the original s	oil profile					
				6.0 m											
				7.0 m											
				8.0 m											
				9.0 m											
				- - 10.0 m											

COLOUR:

Black, White, Biege Dark/Medium/Light: Brown, Red, Orange, Yellow, Grey, Blue Composition: Solid, Blemish, Mottle

PARTICLE SIZE: Fine, Medium, Course

TEXTURE: Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clayey Loam

Clay, Sandy Clay

ORGANICS: High, Medium, Low MOISTURE: Dry, Slightly Moist, Moist, Saturated Static Water Level

Date 18/02/2014 Stickup above NS (m) 0.5 Water Level bTOC (m) 2.19 Water Level bNS (m)

Lithological Log



Hyd2o Suite 6B 103 Rokeby Rd Subiaco, WA 6008

PO Box 1055 Subiaco WA 6904

Client: Ross Neuman Project: Gwelup LWMS 385641 Easting Northing 6474232

MGA Zone 50, GDA 94 Datum: Drill Rig Hollow Auger Drill type:

Hole diameter:

H13078 Job Number: Start Hole : 9.15am End Hole: 10.15am Logged by: Michael Fifield

11.25m

RL Top of Casing: RL Nat Surface :

Total Depth:

Bore Name

GW4

ноіе	diameter		75 mm		RL Nat Surface :									
					Soil Characteristics									
support	backfill	water	Slot / Screen Depth	Depth (metres)	Colour	Particle Size	Texture	Organic Content	Moisture	Comment				
PVC (Class 9)				-	Dark Brown									
PVC	-			1.0 m					Low					
	Gravel			2.0 m	· Medium Brown									
				3.0 m										
				4.0 m						Classic Spearwood Sand with a few chunks of Limestone at the bottom end				
				5.0 m		Medium	Sand	Low	Medium					
				6.0 m	Medium Brown Yellow									
				7.0 m										
				8.0 m	Medium Brown Yellow Mottled Dark Brown									
				9.0 m	Creamy Grey Creamy Grey Mottled Dark Brown				High					
				11.0 m	Medium Brown Mottled Dark Brown									

COLOUR: Black, White, Biege

Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE: Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clayey Loam

Clay, Sandy Clay

ORGANICS: High, Medium, Low

MOISTURE: Dry, Slightly Moist, Moist, Saturated Static Water Level

Date 18/02/2014 Stickup above NS (m) 0.47 Water Level bTOC (m) 8 Water Level bNS (m)

APPENDIX C

Geotechnical Report (Prompt Engineering, 2013)

prompt engineering

CIVIL, STRUCTURAL & GEOTECHNICAL







SITE INVESTIGATION

Lots 500 & 501, #459 & #463 North Beach Road, Gwelup, Western Australia.



Submitted to: ATTEST PTY LTD

15 November 2013

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1.0 Introduction

This report presents the results of a *preliminary site investigation* carried out by Prompt Engineering for the proposed residential subdivision development located at Lots 500 & 501, #459 & #463 North Beach Road, Gwelup, Western Australia. The work was authorised by *Attest Pty Ltd*. The proposed site consists of two lots with a typical rectangular shaped. It is bounded by residential lot to the north, by North Beach Road to the west, by Lake Careniup to the east, and by residential lot with existing residence to the south as shown on the site plan. There are existing houses, sheds, storage and other facilities within the site property. Most of the area is partially vegetated with small to medium trees. The topography of the whole site is slightly sloping from the west boundary (North Beach Road) for some distance towards the east direction, and then generally flat for some distance towards the rear boundary (Lake Careniup). We understand that the existing houses, sheds and other facilities are to be demolished and removed, and the whole site is to be developed for mixed use residential development purposes.

2.0 Objectives

The main objectives of the site investigation were to:

- Identify subsurface soil condition, and identify the approximate extent and thickness of the peaty soils;
- · Provide recommendations on suitable footing systems; and
- Provide site classification in accordance with AS 2870-2011 "Residential Slabs and Footings";

3.0 Fieldwork

Fieldwork for the site investigations were carried out on 5th, 8th and 11th of November, 2013, under the full time presence of a geotechnical engineer, and consisted of the following:

- Drilling of 11 boreholes to a depth of 2.5m for visual and tactile investigation of the subsoil layers and soil profiling and sampling for acid sulphate contamination testing.
- 9 Perth Sand Penetrometer Test (PSP) to a depth of approximately 2.0m for evaluation of relative densities and compressibility of the upper layers, and
- 4 Electric Friction Cone Penetrometer Test (EFCPT) to a depth up to 8.0m to investigate the subsoil layers, soil profiling and also to determine relative density and ground compressibility of the deep layers.
- Seismic survey including HVSR testing for deep soil profiling and subsurface cross-section.

All boreholes were visually logged and classified according to the Unified Soil Classification System. Boreholes, CPT, PSP and HVSR test locations are shown on the attached site plan.

4.0 Site Conditions

4.1 Geological Setting

The *Perth* 1:50,000 Environmental Geology Series Sheet Part Sheet 2003 I and 2133 IV, prepared by the Geological Survey of Western Australia, indicate that the site is underlain with:

- SAND derived from Tamala Limestone (S7); pale and olive yellow, medium to coarse grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin on the east half section of the site property, and
- Swamp Deposits (Cps); PEATY CLAY; dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin on the west half section of the site property.

4.2 Ground Elevation & Ground Water

- The Groundwater Atlas (Waters and Rivers Commission Website 2nd Edition) indicates that the natural ground surface level on this site is approximately ranging from 12.0mAHD (Australian Height Datum) on the western boundary to 7.0mAHD (Australian Height Datum) on the eastern boundary.
- The May 2003 maximum-recorded groundwater level at this site is 5.0m AHD (Australian Height Datum). The ground water levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

4.3 Results of Investigations

4.3.1 Soil Profile

Based on the results of site investigations, the subsurface profiles encountered on the site generally concurs with the regional geology for the area and comprises of natural SAND derived from Tamala Limestone with the exception occurred at the eastern side close to the lake where alluvium and swamp deposits were encountered.

The soil profiles encountered in the boreholes and CPTs is generally overlain with typical sand (with variable densities) derived from Tamala Limesotone, which can be described as following: SAND / Silty SAND; medium to coarse grained, low to non plasticity silt, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, dry, light brown/orange. Fill materials were encountered up to 3.0m below the existing ground level (E.G.L.).

Detailed descriptions of the subsurface soil conditions encountered from boreholes, CPTs and PSP readings are also attached in this report.

4.3.2 Groundwater

Shallow groundwater was encountered and stabilized at approximately 1.5m below the existing ground level.

4.3.3 Acid Sulphate Testing

The main purpose of ASS testing is to provide an *initial evaluation* of potential (high, medium and low) for each soil sample collected to be ASS. The following criteria are used to evaluate the soil samples for either Actual ASS (AASS) or Potential ASS (PASS).

For actual Acid Sulfate Soil (AASS), a pH_F of less than 4.0 indicates the presence of AASS.

For Potential Acid Sulfate Soil (PASS):

- pH_{FOX} of less than 3.0.
- Difference between pH_F and pH_{FOX} is greater than 3.0.

ALS Group was commissioned by Prompt Engineering to carry out laboratory testing of the natural soil samples encountered within the site. The results of the laboratory testing are attached in this report and summarized below:

- No samples recorded a pH_F of less than 4.0.
- No samples recorded a pH_{FOX} of less than 3.0.
- Two samples recorded a difference between pH_F and pH_{FOX} of greater than 3.0.
- · An inferred moderate PASS risk for the two samples.

5.0 Geotechnical Assessment & Recommendation

5.1 Site Classification

AS2870: 2011, Residential Slabs and Footings-Construction provides guidance on site classification for residential slabs and footing design based on the expected level of site movements as follows:

	Table 3: AS2870:2011- General Definition of Site Classes								
Class	Foundation								
Α	Most sand and rock sites with little or no ground movement from moisture changes								
S	Slightly reactive clay sites with only slight ground movement from moisture changes (y₅≤20mm)								
М	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes (20 <y₅≤40mm)< td=""></y₅≤40mm)<>								
H1	Highly reactive clay site, which can experience high ground movement from moisture changes (40 <y₅≤60mm)< td=""></y₅≤60mm)<>								
H2	Highly reactive clay site, which can experience very high ground movement from moisture changes (60 <y₅≤75mm)< td=""></y₅≤75mm)<>								
E	Extreme reactive sites, which can experience extreme ground movement from moisture changes (y _s >75mm)								
Р	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.								

Based on the results of the investigation, a site classification **P** is appropriate for the existing site condition. However, the whole site can be classified as Class **A** to Class **S-M** to Class **H** in accordance to *AS2870*: 2011, Residential Slabs and Footings" subject to additional and final site investigation and sitework preparations.

5.4 Stormwater Drainage

The fine to medium grained natural sand materials encountered within the site have high permeability and are suitable for absorption of storm water runoff through the use of soak wells.

5.5 Shallow Footings

Shallow footings are suitable for the proposed residential development subject to ground improvement to achieve Class A to Class S-M to Class H as shown on the site plan.

Peaty soil was present along the eastern section of the site property. This peaty soil is highly compressible, organic material and consolidates over time, and potentially contaminated (Potential Acid Sulfate Soil).

6.0 References

- WRC (2004) Perth Ground Water Atlas Perth, Western Australia
- PhotoMaps by Nearmap.com
- AS 1170.4-2007 Structural Design Actions-Earthquake Actions in Australia
- AS 1289 6.3.3 1997 Soil Strength and Consolidation Tests
- AS 1726-1993 Geotechnical Site Investigations
- AS 2870-2011 Residential Slabs and Footings
- AS 3798-2007 Earthworks for Residential and Commercial Developments
- AS 4055-2006 Wind Loads for Housing
- Geology Survey of Western Australia 1:50 000 Environmental Geology Series PERTH (Sheets 2033 I and Parts 2133 IV, 1986)

7.0 Closures

We trust that this information satisfies your present requirements. Should you require clarification of any issues please do not hesitate to contact this office. We thank you for the opportunity of assisting you with this project.

Yours faithfully

PROMPT ENGINEERING

Sentigo alway

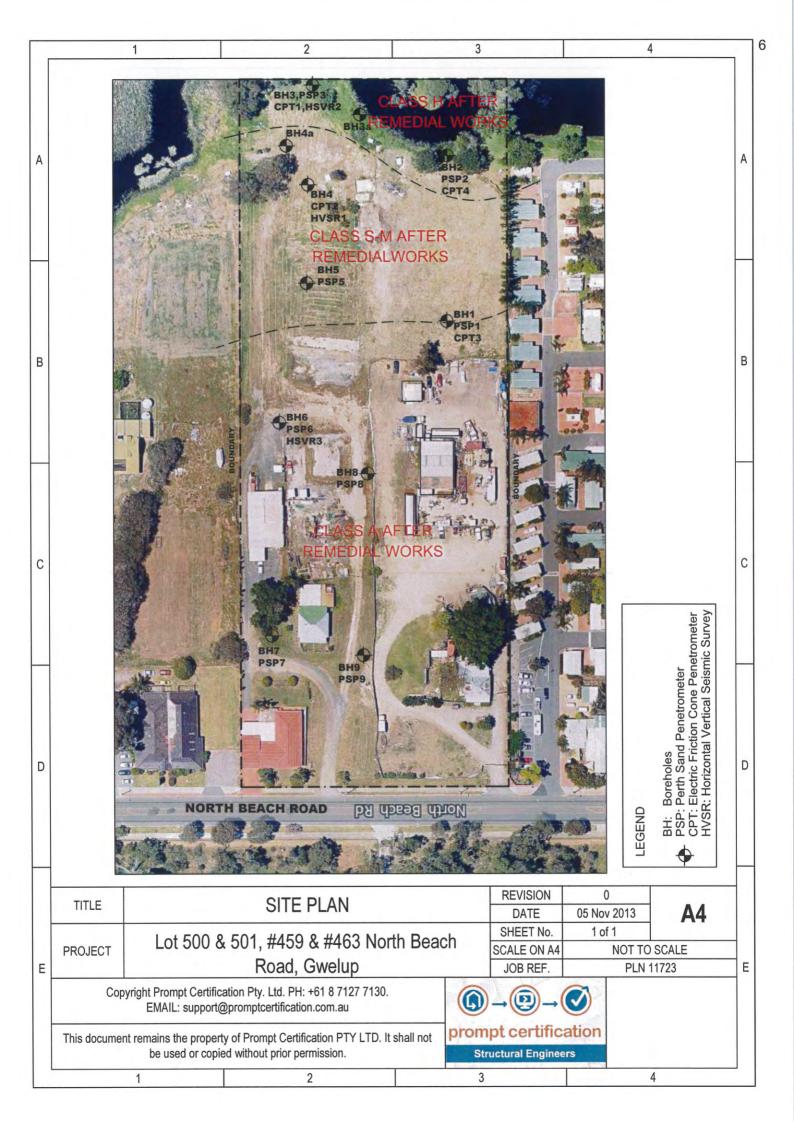
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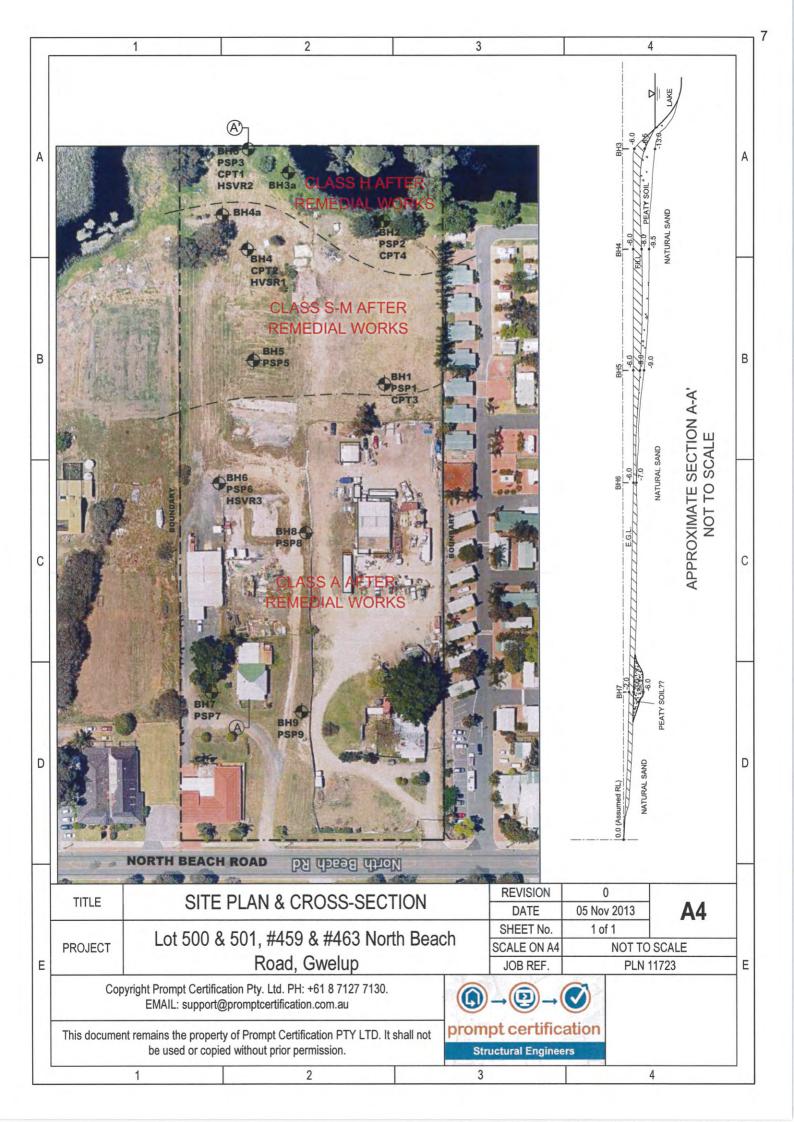
STRUCTURAL ENGINEERING & GEOTECHNICAL SERVICES

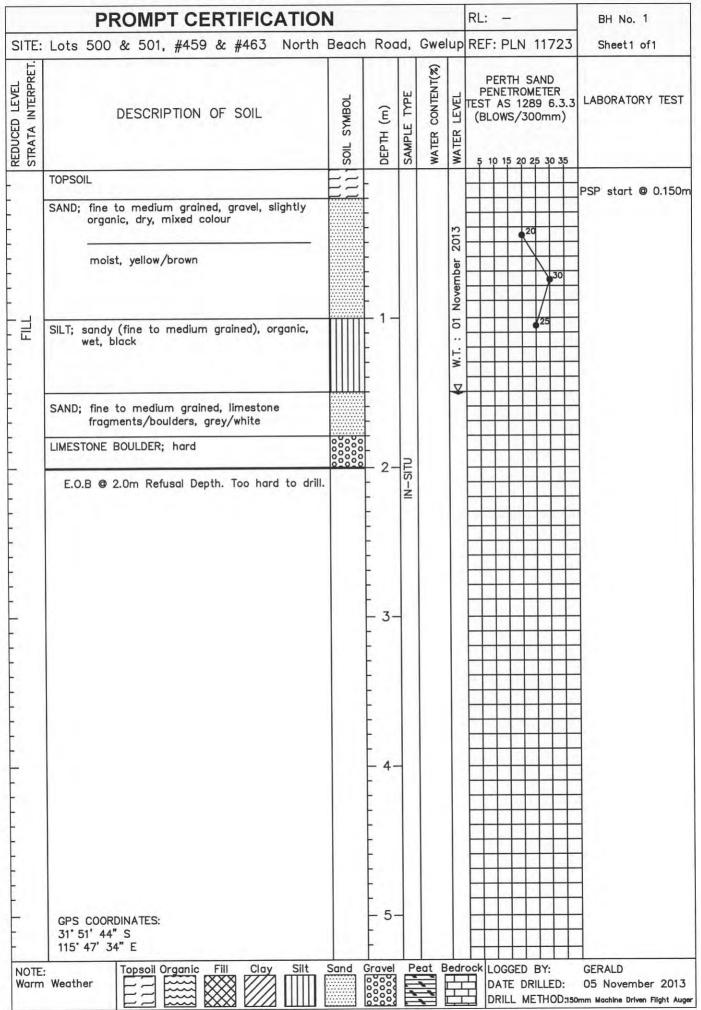


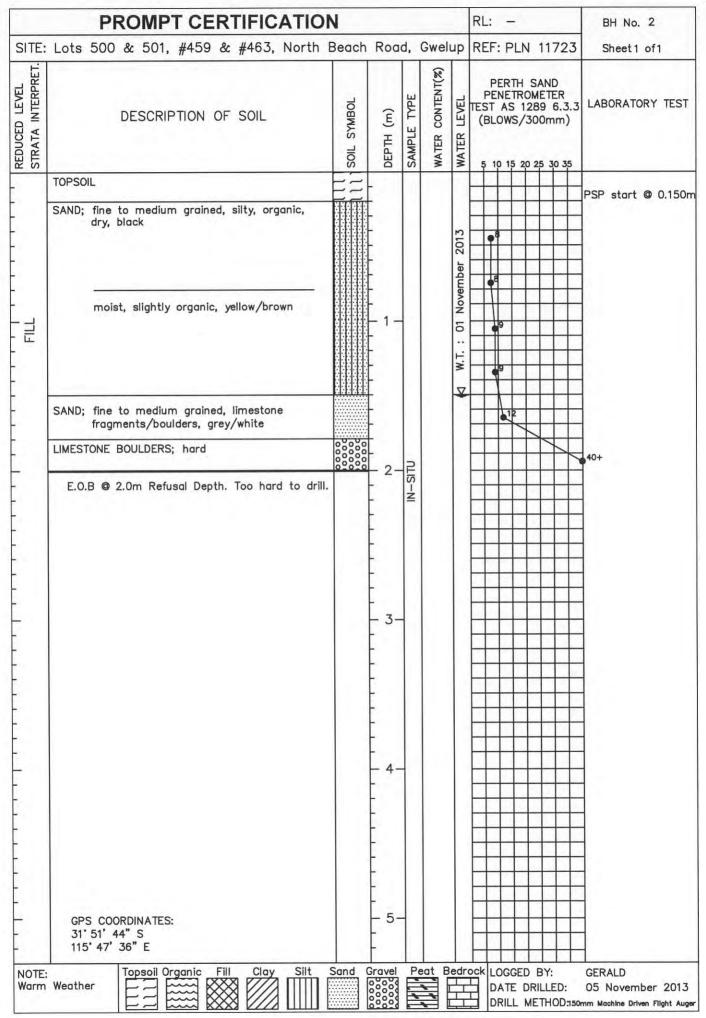
APPENDIX A-LIMITATIONS

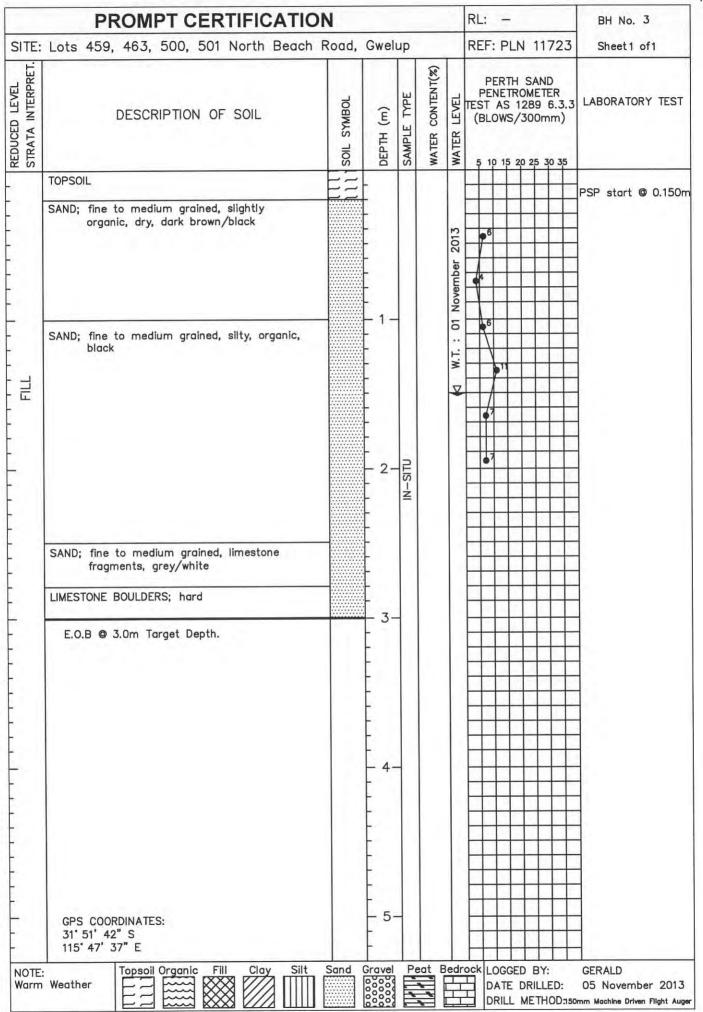
- 1. The conclusions and recommendations given in this geotechnical investigation report are based on the information supplied by the client regarding the proposed development in conjunction with the findings of the site investigation. Any change in construction type, building location or omission in the client supplied information, may require additional testing and/or make the conclusions and recommendations invalid.
- 2. The recommendations herein may identify target soil stratum into which the building foundations should be founded at the time of site investigation. Any cutting or filling works and any surface erosion or deposits subsequent to the site investigation, will alter the measured location of the stratum relative to the ground surface. Where required, this office should be notified in such cases to confirm the location of the target stratum.
- 3. Every reasonable effort has been made to locate the test sites so that the boreholes profiles are representative of the soil conditions within the area investigated. The client should be made aware however, that site exploration is limited by time available. In some cases soil conditions can be change dramatically over short distances, therefore even careful exploration programs may not locate all the variations.
- 4. If soil conditions encountered are significantly different from those shown in this report and on which the conclusions and recommendations were based, then this office must be notified immediately.
- 5. This report may not be reproduced except in full. The information and site plans shall only be used and will only be applicable for the developments shown on the clientsupplied information provided for this site.
- 6. Any dimensions, contours, trees locations, slope directions and magnitudes shown on the site plan shall not be used for any construction or costing calculations. The purpose of the site plan is to show approximate location of field tests only.
- 7. Any changes made to this report by persons unauthorised by this office will legally be interpreted at that person assuming the responsibility for the long-term performance of the proposed development.
- 8. Removal of water bores, underground services, and trees from a site before site investigation can cause significant shrinking or swelling of the clayey soil over large areas. The removal of trees from the proposed site during development is rarely picked up during the investigation phase and is generally outside the scope of AS2870:2011. However, sites affected by large trees are often classified as "P". If, during the excavation, it is noted that there are soils with varying moisture contents, or evidence of large trees having been removed, then this office should be notified immediately.

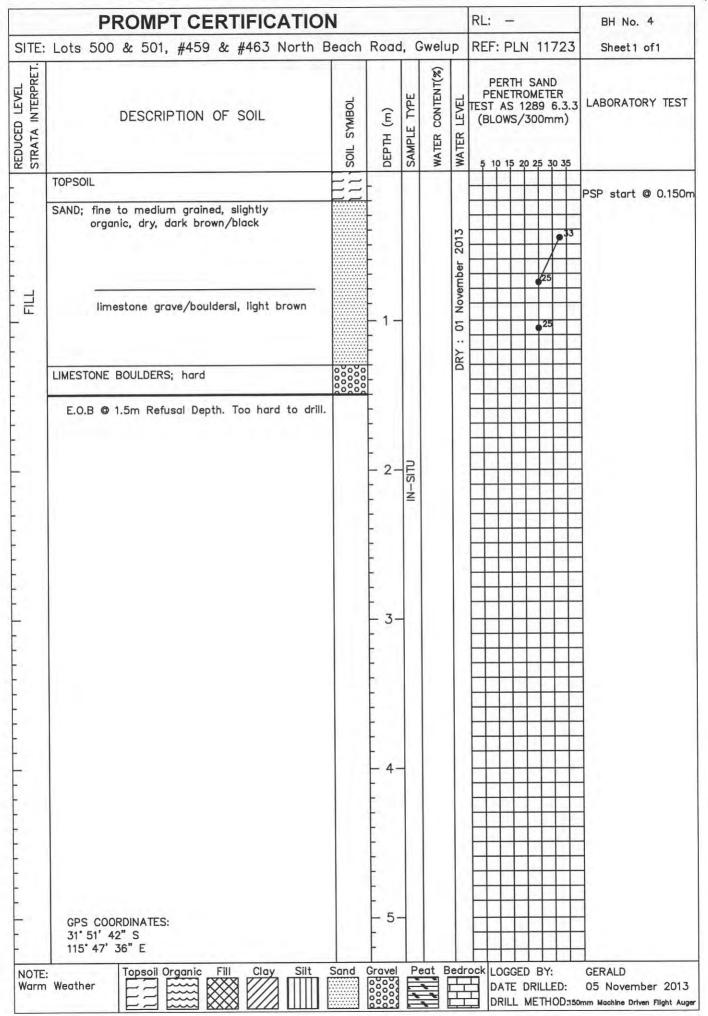


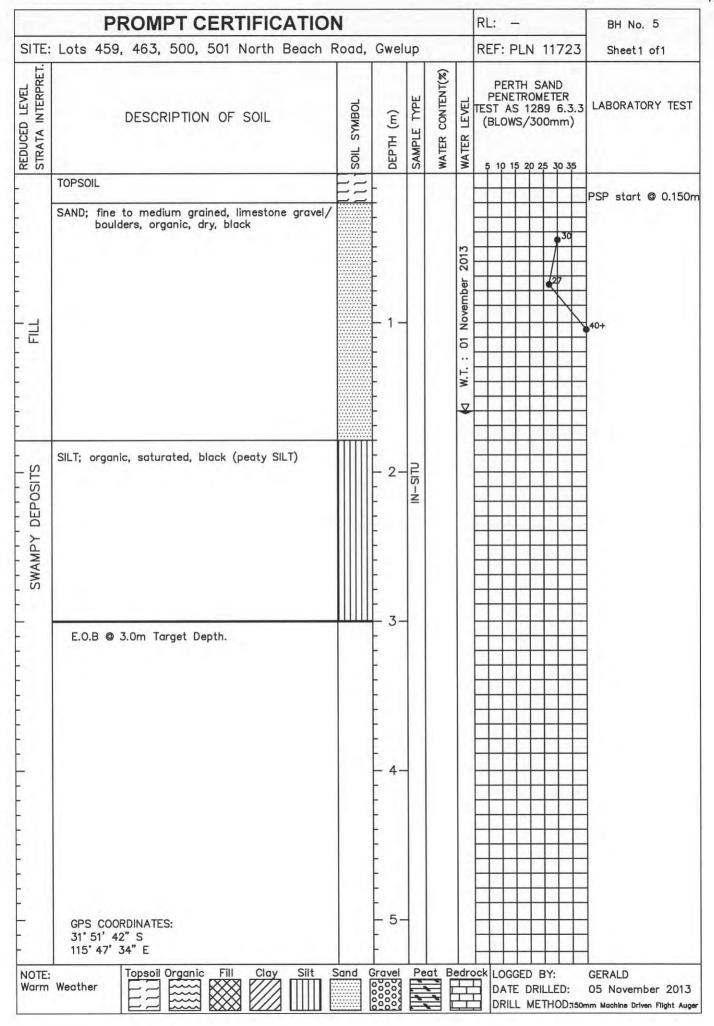


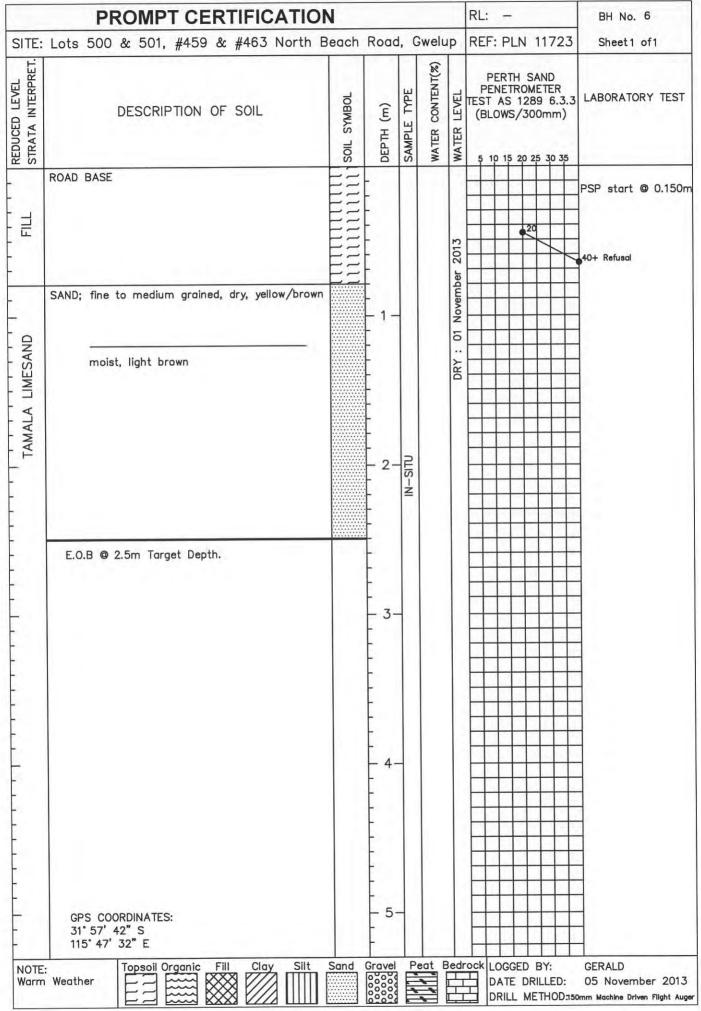


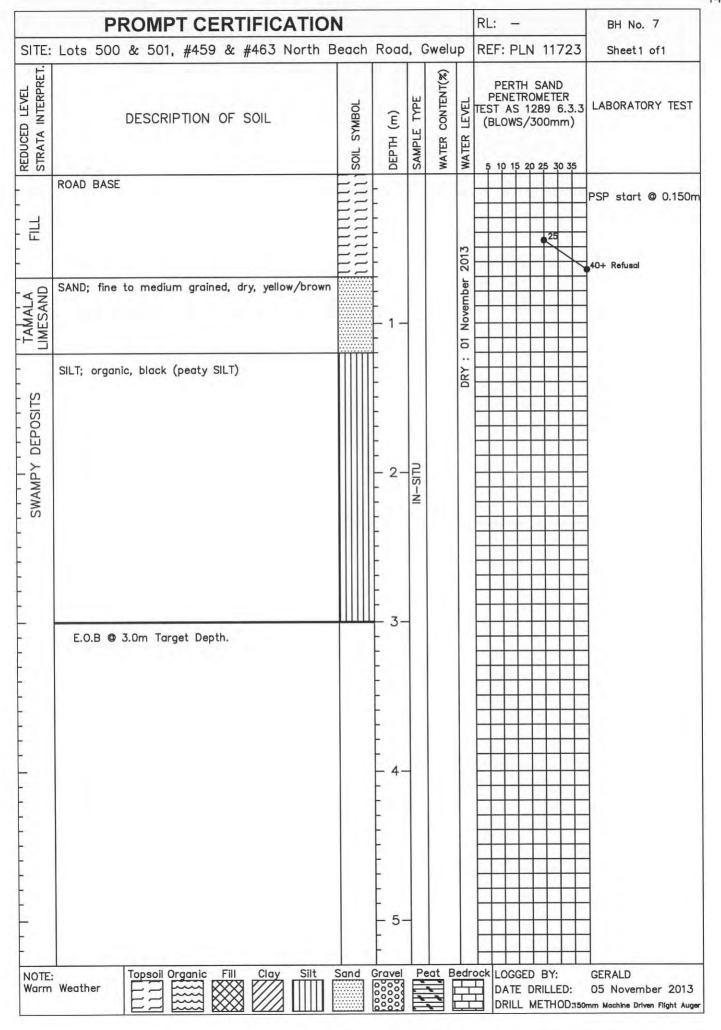


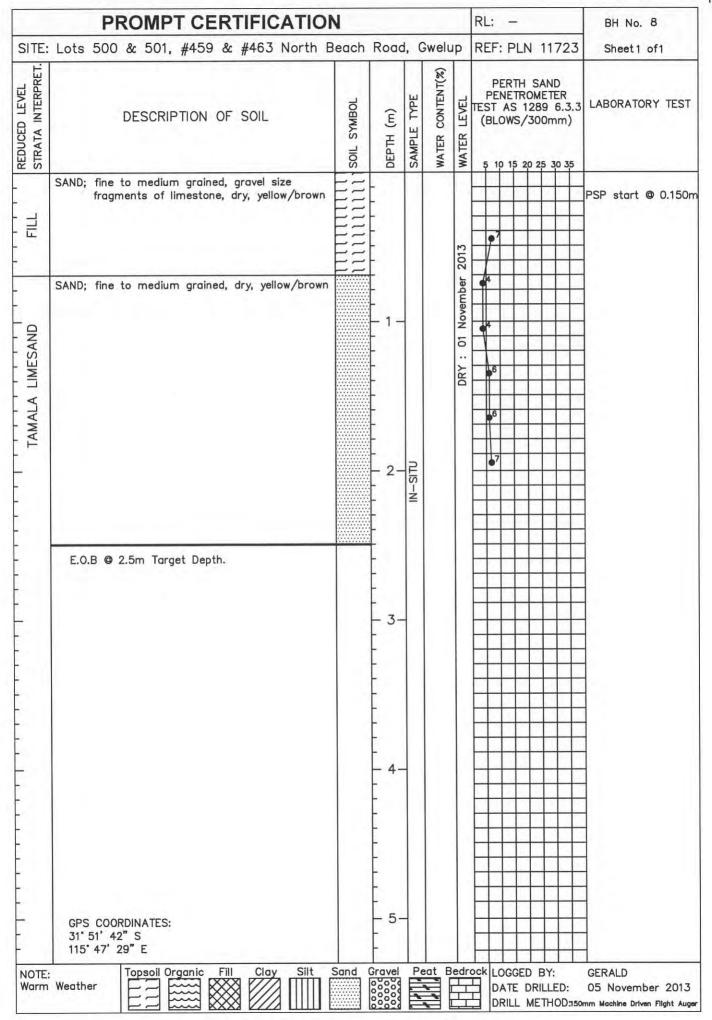












PROMPT CERTIFICATION RL:											BH No. 9
SITE:	Lots 500 & 501, #459 & #463 North B	each Road, Gwelup					REF:	PLN	1 11	723	Sheet1 of1
REDUCED LEVEL STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEРТН (m)	SAMPLE TYPE	WATER CONTENT(%)	WATER LEVEL	PENI TEST A (BLO)	ETRO S 1: WS/:	289 300r	ER 6.3.3 nm)	3 LABORATORY TEST
FILL	SAND; fine to medium grained, gravel size fragments of limestone, dry, light grey	11111111	-				•8				PSP start @ 0.150m
TAMALA LIMESAND	SAND; fine to medium grained, dry, yellow/brown		- - - - - - - - - - - - - - - -			DRY: 01 November 2013	31 31 31				
- T	E.O.B @ 2.5m Target Depth.		2-	UN-SITU							
			- - - 3- - -								
	GPS COORDINATES: 31° 51' 43" S 115° 47' 29" E		- 4-								

CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development

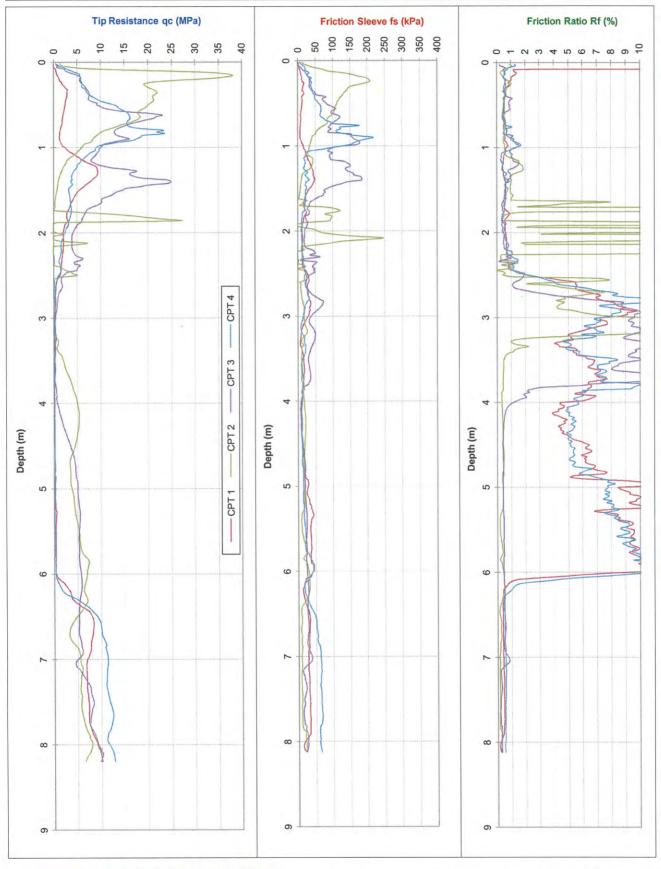
LOCATION: 459-463 North Beach Road, Gwelup

Date: Mon, Nov 11, 2013

Probe No.: All Data

Job Number: PLN 11723

Co-ordinates:





Water (m):

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development

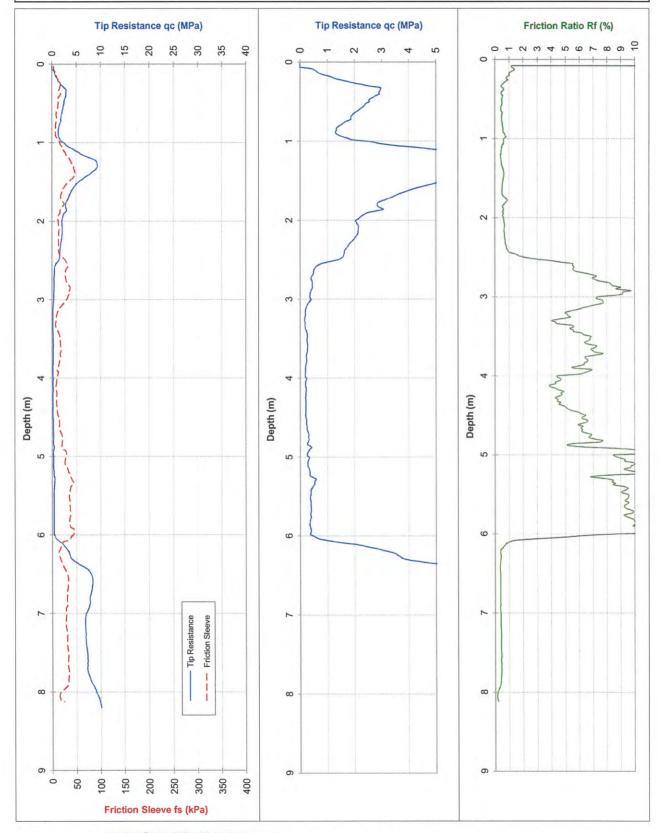
LOCATION: 459-463 North Beach Road, Gwelup

Date: Mon, Nov 11, 2013

Probe No.: CPT 1

Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.0

Refusal:

Cone I.D.: EC145

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: PR0020M

Dummy probe to (m):

CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development

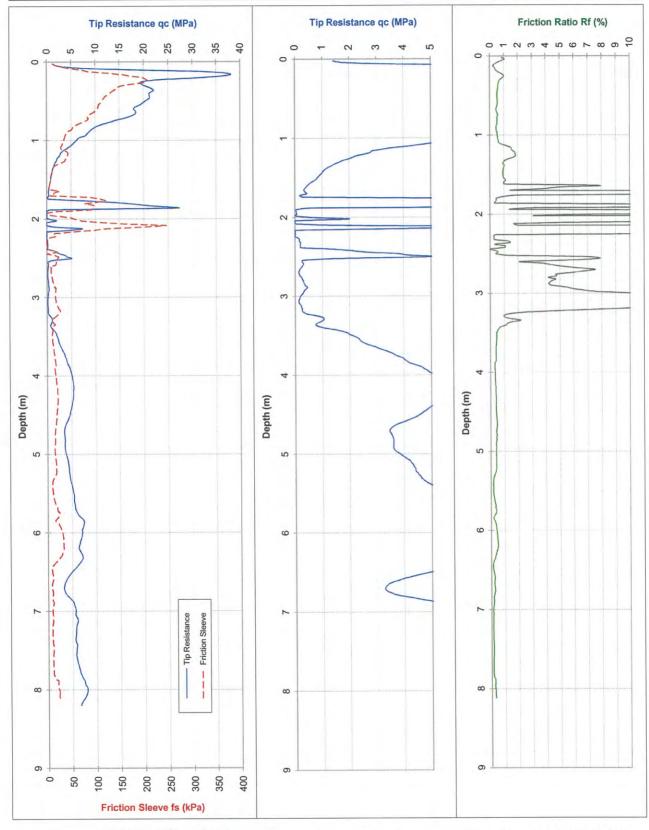
LOCATION: 459-463 North Beach Road, Gwelup

Date: Mon, Nov 11, 2013

Probe No.: CPT 2

Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.3

Refusal:

Cone I.D.: EC145

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: PR0021M

Dummy probe to (m):

CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development

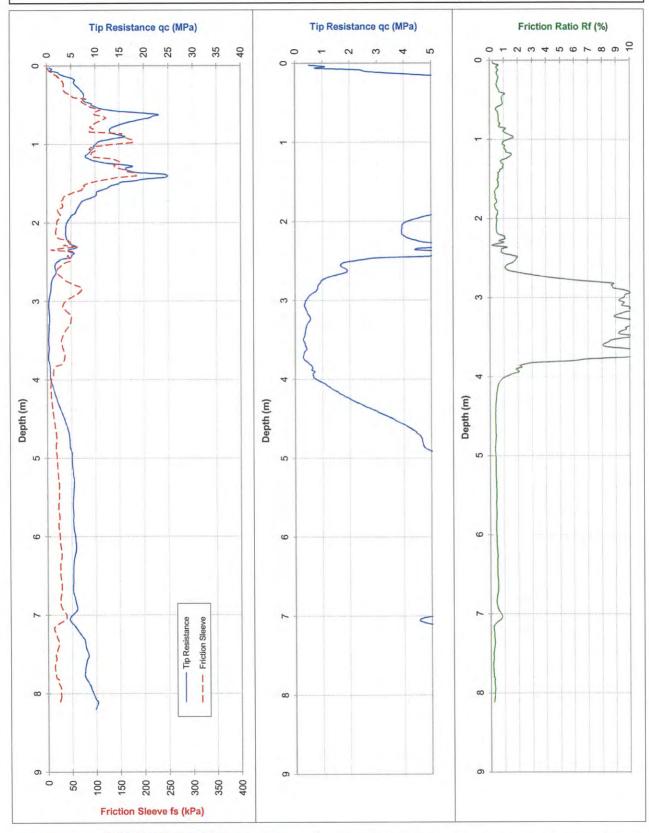
LOCATION: 459-463 North Beach Road, Gwelup

Date: Mon, Nov 11, 2013

Probe No.: CPT 3

Job Number: PLN 11723

Co-ordinates:



Water (m): Dry to 1.2

Refusal:

Cone I.D.: EC145

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development

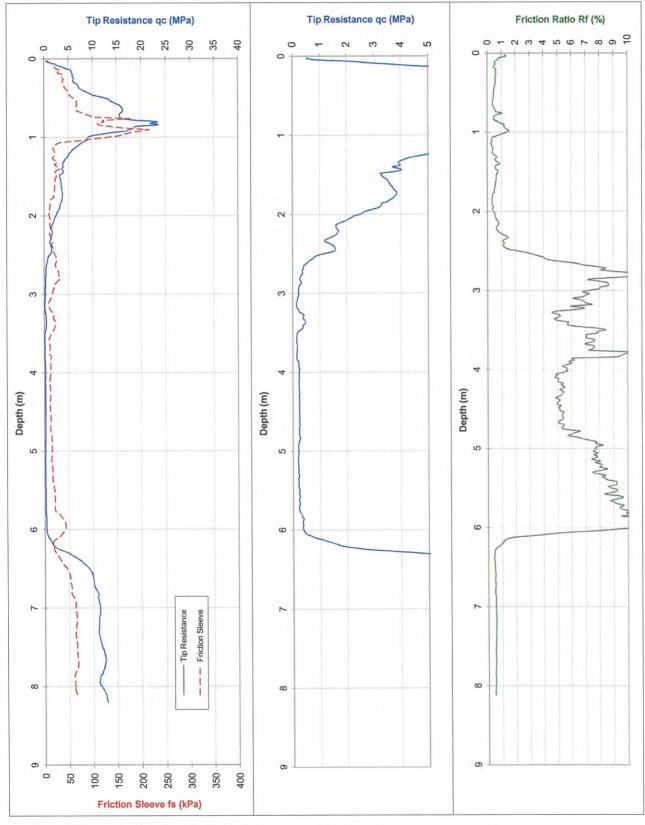
LOCATION: 459-463 North Beach Road, Gwelup

Date: Mon, Nov 11, 2013

Probe No.: CPT 4

Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: PR0023M

Dummy probe to (m):

Cone I.D.: EC145



HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

Theoretical aspects

The HVSR method: an overview

The HVSR technique relies on the measurement of the horizontal and vertical spectra of ambient vibrations, which are ubiquitous in the Earth surface. The components of ambient vibrations linked to natural atmospheric sources generally occur in the low frequency range (below 1 Hz), while the anthropogenic noises will generally include components of higher frequencies (over 1 Hz). It is noted that induced tremors form these noises consist in very small vibrations, much smaller than those experienced during perceptible earthquakes.

Microtremor studies pioneered by Aki (1957) and Kanai (1957) paved the way for development of present day techniques for inferring the dynamic site characteristics and associated subsurface soil structure at an observation point. In the early days, the techniques were developed for the primary purpose if identifying the fundamental resonance frequency of a site. The renewed interest in the horizontal to vertical spectral ratio (HVSR) technique is attributed to Nakamura (1989), who proposed that the fundamental resonance frequency be defined as the frequency of the predominant peak of the ratio of the H/V Fourier amplitude spectra.

The HVSR technique is unique among array based surface wave methods. This is because unlike other multichannel methods, it does not attempt to utilise the phase velocity dispersion curve of Rayleigh waves, but instead seeks to obtain and exploit the HVSR curve of the microtremor of a site. Although this technique has the utmost advantage of being far quicker and less invasive than other SWM, it can provide only relative stratigraphic information, thus it always needs some form of restrain to be operated correctly in terms of uses other than fundamental frequency assessment.

Acquisition procedures

The HVSR curves, in accordance with SESAME guidelines (2004), should be obtained by elaborating a continuous 3C microtremor measurement in the frequency range of 0,1 - 100 Hz. Then the HVSR should be calculated by averaging the H/V ratios obtained after dividing the signals into non-overlapping windows. The extent of such windows varies according to the minimum frequency to be inferred. Each window should then be detrended, tapered, padded, FF transformed and finally smoothed.



HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

The geometric average should be used to combine the two horizontal components (EW and NS) of the ambient noise in a single horizontal spectrum. The HVSR should therefore be evaluated as:

$$HVSR = \frac{\sqrt{H_{EW} \cdot H_{NS}}}{V}$$

Forward modelling of HVSR

The forward modelling utilised in this study was proposed by Lunedei and Albarello (2009) and it is based on a theoretical model of Rayleigh and Love waves propagation in multi layered, visco-elastic media. The ambient vibrations in the ground are assumed to have resulted from randomly distributed independent noise sources, including vertical and horizontal harmonic point forces. The point sources are assumed to be located outside a source-free circular area from the observation point so that only effects of surface waves are needed to be considered in this approach. It is noted that, due to the stochastic random nature of the noise sources, the theoretical HVSR at a given angular frequency, which is taken as the ratio of average power components in the horizontal and vertical directions, is expressed in terms of variance of the corresponding vibrations:

$$HVSR_s(\omega) = \sqrt{\frac{V_H(\omega)}{V_V(\omega)}}$$

The V_s profile is inferred by matching the theoretical HVSR of the forward model (as described above) to the measured HVSR.

The general methodology to infer the shear wave velocity profile involves a trial-anderror to model the theoretical HVSR curve. Generally only the first fundamental mode of both Rayleigh waves and Love waves is considered in the synthetic response, while superior modes can be considered in particular cases.

As mentioned before, the HVSR needs restrains to provide univocal solution to the inversion problem. Therefore, in the specific case studied herein, restrains are provided in the form of 2 CPT tests (with particular emphasis on the upper compressible layer shown in the provided CPT logs).

HVSR TESTING REPORT
PCERT22-2013 - 14 Nov 2013
(Final report)

Experimental results

Survey's outline

The surveying campaign was articulated with 3 measuring spots, located on the proposed development area as shown below



Tests location on proposed development area

positioning should be verified according to the provided GPS coordinates of the tests.

Summary of experimental results

The experimental results obtained from the 3 tests carried out during the planned survey showed a sharp distinction between the "wetland" zone (HVSR 1 and HVSR 2) and the inner part of the lot (HVSR 3). The first portion of the lot is characterized by a very slow level (peat layer) at an average depth of 1.8 m b.g.l. and with an average thickness of 2.7 m. This level is included in a homogeneous layer with S-wave velocity of 190-200 m/s (typical of silty sands and/or loose sands). Moving away from the

M AUSGeotech

459 North Beach Rd Client: PCERT HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

wetland zone, the seismic stratigraphy becomes less chaotic, with an homogeneous layer (220-245 m/s, e.g. loose to medium sand) characterizing the whole first seismostratus.

At depth the whole area is characterized by the presence of a rather fast alteration level (340-410 m/s) overlaying the seismic bedrock (700 m/s). The depth of the seismic bedrock increases while moving towards point 1 and 2.

Analysis criteria

The HVSR inversion procedure has been carried out using two CPT test logs as restraints for shallow stratigraphy. In particular the superficial peat layer encountered in HVSR 1 and HVSR 2 has been adequately constrained in thickness with CPT tests. Having no direct evidence of the first major positive contrast of impedance (not reached by the CPTs), the reader must be aware that deep structures interpretations (namely structures deeper than 40-50 m) may be affected by increased error in terms of absolute depth and velocity.

Analysis outputs

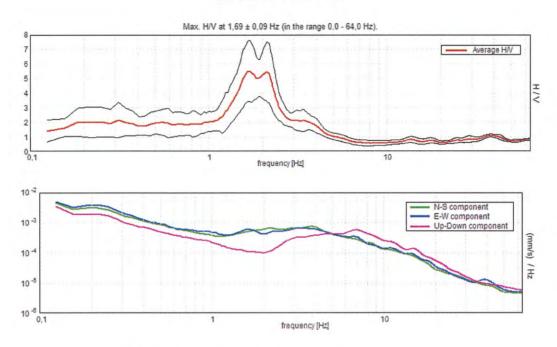
With the awareness of what stated above in terms of method's capabilities and limitations, the following analysis outputs can be delivered as for the 3 surveyed locations.

(Results follow in the next pages)

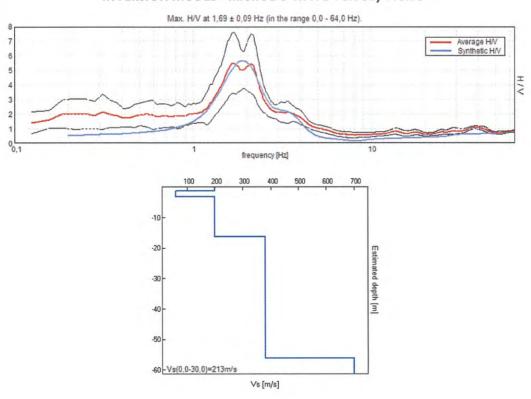


HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

HVSR TEST 1



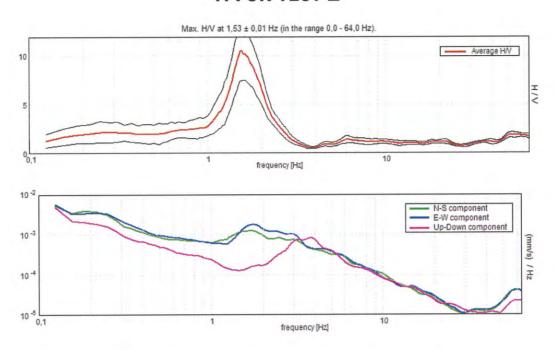
INVERSION MODEL - Inferred S-WAVE Velocity Profile



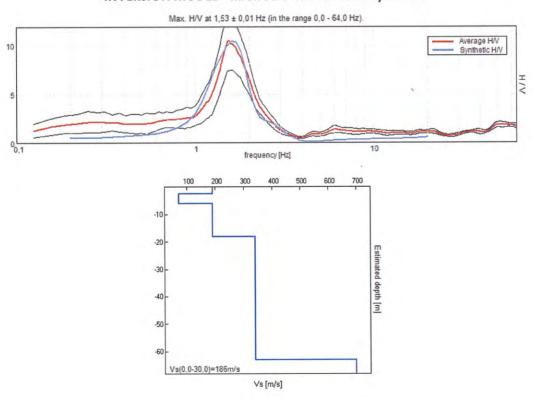


HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

HVSR TEST 2



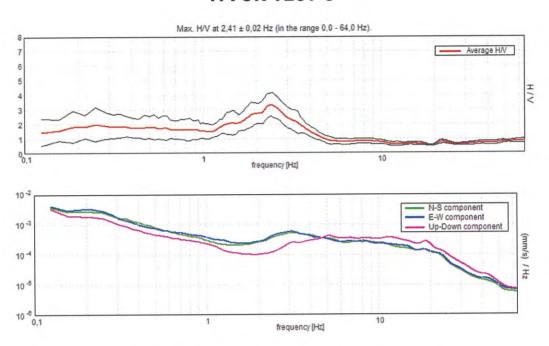
INVERSION MODEL - Inferred S-WAVE Velocity Profile



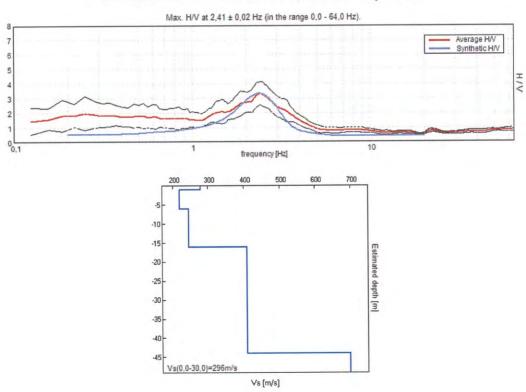


HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

HVSR TEST 3



INVERSION MODEL - Inferred S-WAVE Velocity Profile





HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

Conclusions

As anticipated in the latter paragraphs, the HVSR survey carried out on 3 tests spots showed a fundamental difference between the "wetland" zone (HVSR 1 and HVSR 2) and the inner part of the area (HVSR 3).

The slow (e.g. peat) layer observed in HVSR 1 and HVSR 2 appears to be limited to the eastern part of the lot, and this very zone is characterized by lower S-wave velocity values for the upper seismic layer either (190 - 200 m/s). The second zone (HVSR 3) is less chaotic and is characterized by a uniform layer with estimated (higher) S-wave velocity of 220 - 245 m/s.

Due to the strong non-uniformity of the area, no linear interpolation plot has been provided on the virtual line linking the 3 HVSR tests. This is motivated by the fact that linear interpolation cannot adequately resolve sharp discontinuity (as the one provoked by the peat layer), unless further testing is carried out between HVSR 1 and HVSR 3. Hence relying on linear interpolation with insufficient resolution in this case might lead to severe interpretation errors.



HVSR TESTING REPORT PCERT22-2013 - 14 Nov 2013 (Final report)

ANNEX 1

HVSR Tests geographical coordinates

TEST 1:

Latitude : -31.86164 Longitude : 115.79327

Accuracy of signal: 3.0 m

TEST 2:

Latitude: -31.86174

Longitude: 115.79366

Accuracy of signal: 3.0 m

TEST 3:

Latitude: -31.86161

Longitude: 115.79366

Accuracy of signal: 3.0 m

				Acid Sulfate Soil Indicative Guideline	Soil Indicative	e Guideline			
				<4=ASS	violi i-c/	vladi i-s>	AASS=Acti	AASS=Actual Acid Sulfate Soil	ate Soil
				4-5.5=Acidic Soil	PASS	PASS	PASS=Pot	PASS=Potential Acid Sulfate	ulfate
							PAS	PASS RISK RATING	NG
Borehole	Soil Description	Moisture	Depth (m, B.G.L.)	₽H₽	рНгох	pHF-pHF0X	HIGH	MEDIUM	LOW
BH7	Silty SAND black	31 50%	2.0-2.5	8.9	7.1	1.80			×
בומ	Silty SAND black	%02 20	2.0-2.5	9.8	7.6	2.20			×
RH3a	Silty SAND black	61.20%	2.0-2.5	8.2	3.1	5.1		×	
BH43	Silky SAND black	21.80%	2.0-2.5	7.1	3.3	3.80		×	



CERTIFICATE OF ANALYSIS

Work Order	: EP1308553	Page	:10f4
Client	PROMPT CERTIFICATION PTY LTD	Laboratory	: Environmental Division Perth
Contact	: SANTIAGO ABUEVA	Contact	: Scott James
Address	: Unit 1/73 Buckingham Drive	Address	: 10 Hod Way Malaga WA Australia 6090
	Wangara Western Australia 6065		
E-mail	: santiago@promptcertification.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 7324 7130	Telephone	: +61-8-9209 7655
Facsimile	Ţ	Facsimile	: +61-8-9209 7600
Project	1.	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number			
C-O-C number		Date Samples Received	: 11-NOV-2013
Sampler		Issue Date	: 18-NOV-2013
Site	: 459-463 NORTH BEACH RD, GWELUP		
		No. of samples received	4:
Quote number	: EP/389/13	No. of samples analysed	4:

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825 Signal

This dc
Accredited for compliance with carried or
ISO/IEC 17025. Signatoria

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been Accreditation Category Perth Inorganics Perth Inorganics Perth ASS Acid Sulfate Soils Supervisor Senior Inorganic Chemist carried out in compliance with procedures specified in 21 CFR Part 11. Metals Chemist Position Benjamin Nicholson Signatories Leanne Carey Chas Tucker Signatories

Address 10 Hod Way Malaga WA Australia 6090 | PHONE +61-4-9209 7685 | Facsimile +61-8-9209 7600
Environmental Division Perth ABN 84 009 936 029 Part of the ALS Group An ALS Limited Company
WWW.A ISO Dall.COM







General Comments

Client

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society. LOR = Limit of reporting Key:

^ = This result is computed from individual analyte detections at or above the level of reporting

- non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for
- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5



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Work Order

Project Client Page

Analytical Results

-1 11 1 1 1 1 1 1 11 1 11-NOV-2013 10:20 EP1308553-004 BH5 2.0-2.50 <0.005 9000 529 0.85 0.19 0.03 0.007 529 0.85 0.20 1.00 0.30 148 0.24 0.02 0.008 2 7.1 3.3 2 121 1 11-NOV-2013 10:20 EP1308553-003 BH4 2.50-3.0 <0.005 <0.005 <0.005 0.83 0.14 98.0 0.84 0.02 <5 0.03 8.2 87 0.14 0.02 522 0.08 18 3.1 2 87 1 8.1 11-NOV-2013 10:20 EP1308553-002 BH2 2.0-2.50 <0.005 <0.005 <0.005 <0.005 0.03 0.02 0.02 1.23 1.02 0.03 3.05 0.01 208 0.81 0.03 2 7.9 8.6 7.6 27 2 4 20 11-NOV-2013 10:20 EP1308553-001 BH1 2.0-2.50 <0.005 <0.005 <0.005 90000 80.0 09.0 60000 0.02 0.09 0.94 0.48 0.01 1.25 27 297 8.1 8.9 7.1 2 2 53 10 mole H+/t Client sample ID mole H+/t mole H+/t % pyrite S mole H+/t Client sampling date / time % pyrite S mole H+/t % CaC03 % pyrite S mole H+/t pH Unit pH Unit pH Unit % Ca % Ca % Ca % Mg % Mg % Mg s % s % s % s % s% Unit LOR 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.02 0.005 0.1 0.1 0.1 7 7 2 2 2 2 1 1 1 CAS Number 1 111 111 1 1 EA029-F: Excess Acid Neutralising Capacity sulfidic - Titratable Sulfidic Acidity (s-23H) Acidity - Acid Reacted Magnesium (a-23U) sulfidic - Titratable Actual Acidity (s-23F) Excess Acid Neutralising Capacity (23Q) sulfidic - Acid Reacted Calcium (s-23X) acidity - Acid Reacted Calcium (a-23X) sulfidic - Titratable Peroxide Acidity KCI Extractable Magnesium (23Sm) acidity - Peroxide Oxidisable Sulfur sulfidic - Acid Reacted Magnesium Peroxide Oxidisable Sulfur (23E) Titratable Peroxide Acidity (23G) Titratable Sulfidic Acidity (23H) KCI Extractable Calcium (23Vh) EA029-E: Magnesium Values Acid Reacted Magnesium (23U) EA029-A: pH Measurements Titratable Actual Acidity (23F) KCI Extractable Sulfur (23Ce) Sub-Matrix: SOIL (Matrix: SOIL) Peroxide Magnesium (23Tm) EA029-D: Calcium Values Acid Reacted Calcium (23X) Peroxide Calcium (23Wh) EA029-B: Acidity Trail EA029-C: Sulfur Trail Peroxide Sulfur (23De) EA002: pH (Soils) pH KCI (23A) pH OX (23B) (s-23G) (s-23U) Compound pH Value



Page Work Order Client

: 4 of 4 : EP1308553 : PROMPT CERTIFICATION PTY LTD

Project Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)		Ö	Client sample ID	BH1 2.0-2.50	BH2 2.0-2.50	BH4 2.50-3.0	BH5 2.0-2.50	
	Cli	ent sampl	Client sampling date / time	11-NOV-2013 10:20	11-NOV-2013 10:20	11-NOV-2013 10:20	11-NOV-2013 10:20	1
Compound	CAS Number	LOR	Unit	EP1308553-001	EP1308553-002	EP1308553-003	EP1308553-004	
EA029-F: Excess Acid Neutralising Capacity - Continued	acity - Continued						The second second	
acidity - Excess Acid Neutralising Capacity (a-23Q)	-	10	mole H+/t	251	610			
sulfidic - Excess Acid Neutralising Capacity (s-23Q)		0.02	s %	0.40	0.98	_		
EA029-H: Acid Base Accounting								
ANC Fineness Factor	1	0.5	-	1.5	1.5	1.5	1.5	
Net Acidity (sulfur units)		0.02	8%	<0.02	<0.02	0.37	0.63	-
Net Acidity (acidity units)	1	10	mole H+/t	<10	<10	232	393	-
Liming Rate	-	-	kg CaCO3/t		>	17	29	
Net Acidity excluding ANC (sulfur units)	-	0.02	8%	0.08	0.02	0.84	0.19	1
Net Acidity excluding ANC (acidity units)	I	10	mole H+/t	53	14	522	121	1
Liming Rate excluding ANC	1	-	kg CaCO3/t	4	1	39	6	
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	31.5	22.2	61.2	21.8	
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	820	290	2210	640	
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	30	100	069	20	
	AND	-	- Easternament and the second and th	with incontinuous highway industries soled the feature of the continue of the	of the constitution of the contract of the con		Control of the Contro	Annual Sales and



QUALITY CONTROL REPORT

Work Order	: EP1308553	Page	: 1 of 6
Client Contact Address	: PROMPT CERTIFICATION PTY LTD : SANTIAGO ABUEVA : Unit 1/73 Buckingham Drive Wangara Western Australia 6065	Laboratory Contact Address	: Environmental Division Perth : Scott James : 10 Hod Way Malaga WA Australia 6090
E-mail Telephone Facsimile	santiago@promptcertification.com.au : +61 08 7324 7130	E-mail Telephone Facsimile	: perth.enviro.services@alsglobal.com : +61-8-9209 7655 : +61-8-9209 7600
Project	1	QC Level	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site C-O-C number Sampler	: 459-463 NORTH BEACH RD, GWELUP :	Date Samples Received Issue Date	: 11-NOV-2013 : 18-NOV-2013
Order number	: : EP/389/13	No. of samples received No. of samples analysed	4 4

approved for This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
 - Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



NATA Accredited Laboratory 825

compliance with ISO/IEC 17025. Accredited for

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out ir compliance with procedures specified in 21 CFR Part 11. Position Signatories Signatories

Acid Sulfate Soils Supervisor Senior Inorganic Chemist Metals Chemist Benjamin Nicholson Leanne Carey Chas Tucker

Perth Inorganics Perth Inorganics Perth ASS

Accreditation Category

Address 10 Hod Way Malaga WA Australia 6090 | PHOME +61-8-9209 7665 | Facsimile +61-8-9209 7600 Environmental Division Perth ABN 84 009 936 029 Part of the ALS Group An ALS Limited Company





: 2 of 6 : EP1308553 : PROMPT CERTIFICATION PTY LTD Work Order Project Client

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key:

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society. Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC



: 3 of 6 : EP1308553 : PROMPT CERTIFICATION PTY LTD : —

Page Work Order

Project Client

Laboratory Duplicate (DUP) Report

e ID						Laboratory L	Laboratory Duplicate (DUP) Report		
EA002: pH (Soils) (QC Lot	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
	(QC Lot: 3154075)								
EP1308553-001 BH1 2	BH1 2.0-2.50	EA002: pH Value	1	0.1	pH Unit	8.1	7.9	1.8	0% - 20%
EA029-A: pH Measurements (QC Lot: 3153604)	6 (QC Lot: 315360)								
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: pH KCI (23A)	Ī	0.1	pH Unit	8.9	8.9	0.0	0% - 20%
		EA029: pH OX (23B)		0.1	pH Unit	7.1	7.1	0.0	0% - 20%
EA029-B: Acidity Trail (QC Lot: 3153604)	Lot: 3153604)								
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: sulfidic - Titratable Actual Acidity (s-23F)	1	0.005	% pyrite S	<0.005	<0.005	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)		0.005	% pyrite S	<0.005	<0.005	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	I	0.005	% pyrite S	<0.005	<0.005	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	1	2	mole H+/t	<2	<2	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)		2	mole H+/t	<2	<2	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	I	2	mole H+/t	<2	<2	0.0	No Limit
EA029-C: Sulfur Trail (QC Lot: 3153604)	.ot: 3153604)								
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: KCI Extractable Sulfur (23Ce)	1	0.005	S %	900.0	0.007	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	The state of the s	0.005	s%	0.09	0.09	0.0	0% - 50%
		EA029: Peroxide Oxidisable Sulfur (23E)		0.005	8 %	0.08	0.08	0.0	%05 - %0
		EA029: acidity - Peroxide Oxidisable Sulfur	1	2	mole H+/t	53	52	2.7	%09 - %0
		(a-23E)							
EA029-D: Calcium Values (QC Lot: 3153604)	QC Lot: 3153604)								
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: KCI Extractable Calcium (23Vh)	1	0.005	% Ca	0.35	0.36	0.0	0% - 20%
		EA029: Peroxide Calcium (23Wh)	1	0.005	% Ca	0.94	0.91	3.7	0% - 20%
		EA029: Acid Reacted Calcium (23X)	1	0.005	% Ca	09.0	0.56	7.1	0% - 20%
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	I	0.005	8 %	0.48	0.44	7.1	0% - 20%
		EA029: acidity - Acid Reacted Calcium (a-23X)	I	5	mole H+/t	297	277	7.1	0% - 20%
EA029-E: Magnesium Values (QC Lot: 3153604)	s (QC Lot: 315360	04)							
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: KCI Extractable Magnesium (23Sm)	1	0.005	% Mg	0.009	0.01	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	1	0.005	% Mg	0.02	0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	1	0.005	% Mg	0.01	0.01	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium		0.005	S %	0.02	0.01	0.0	No Limit
		(s-23U)		At month of management of management of the state of the					
		EA029; Acidity - Acid Reacted Magnesium (a-23U)		വ	mole H+ / t	10	_∞	12.7	No Limit
EA029-F: Excess Acid Neutralising Capacity (QC Lot: 3153604)	ralising Capacity	(QC Lot: 3153604)							
EP1308553-001 BH1 2	BH1 2.0-2.50	EA029: Excess Acid Neutralising Capacity (23Q)	T	0.02	% CaCO3	1.25	1.27	1.1	0% - 20%

ALS

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Work Order

Client

Recovery Limits (%) No Limit 0% - 20% 0% - 20% No Limit 0% - 20% No Limit No Limit No Limit No Limit No Limit No Limit RPD (%) 13.0 0.0 0.0 0.0 0.0 1.9 0.0 7. 4.8 0.0 Laboratory Duplicate (DUP) Report Original Result Duplicate Result <0.02 0.08 <10 0.41 930 254 v 4 30 <0.02 0.08 4 <10 31.5 0.40 820 251 V 53 30 kg CaCO3/t mole H+/t mole H+/t kg CaCO3/t mole H+/t mg/kg 8 % s % mg/kg Unit 8 % % 0.02 0.02 0.02 1.0 100 LOR - 6 6 10 9 16887-00-6 14808-79-8 CAS Number EA029: Net Acidity excluding ANC (acidity units) EA029: Net Acidity excluding ANC (sulfur units) EA055-103: Moisture Content (dried @ 103°C) EA029: sulfidic - Excess Acid Neutralising EA029: acidity - Excess Acid Neutralising EA029: Liming Rate excluding ANC EA029: Net Acidity (acidity units) EA029: Net Acidity (sulfur units) EA029-F: Excess Acid Neutralising Capacity (QC Lot: 3153604) - continued EP1308553-001 BH1 2.0-2.50 EA029: sulfidic - Excess Acid N EA029: ANC Fineness Factor ED040T: Sulfate as SO4 2-Capacity (s-23Q) Capacity (a-23Q) EA029: Liming Rate ED045G: Chloride ED045G: Chloride by Discrete Analyser (QC Lot: 3154076) ED040T : Total Sulfate by ICPAES (QC Lot: 3154085) EA029-H: Acid Base Accounting (QC Lot: 3153604) EA055: Moisture Content (QC Lot: 3153683) Client sample ID BH1 2.0-2.50 BH1 2.0-2.50 BH1 2.0-2.50 BH1 2.0-2.50 Laboratory sample ID EP1308553-001 EP1308553-001 EP1308553-001 EP1308553-001 Sub-Matrix: SOIL



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Method Blank (MB) and Laboratory Control Spike (LCS) Report

parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC 130 High 130 130 130 126 130 11 30 111 1 1 Recovery Limits (%) LOW 1 11 2 2 1 20 2 2 III202 1 20 1 11 82 202 Laboratory Control Spike (LCS) Report Spike Recovery (%) SO7 95.2 92.6 98.1 analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS. 105 99.1 00 9 9 119 111 1 1 1 11 ١ 73.0756 mole H+ / t 73.7217 mole H+ / t Concentration 7.00 pH Unit 0523 % Mg 5000 mg/kg 2554 % Ca 3301 % Ca 0499 % Mg 0215 % S 0506 % S 7 pH Unit 7 pH Unit Spike 1 1 1 Method Blank (MB) Result <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 <0.005 Report <100 <10 <5 2 1 -0 0 <5 mole H+/t % pyrite S mole H+/t mole H+/t % pyrite S % pyrite S mole H+/t mole H+/1 pH Unit pH Unit pH Unit mg/kg mg/kg 8 % % Ca % Ca % Ca % Mg % Mg % Mg s% 8 % s % S Unit 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 LOR 2 100 10 0.1 0.1 0.1 7 2 2 CAS Number 1 11 1... 111 1 111 14808-79-8 16887-00-6 1 ED045G: Chloride by Discrete Analyser (QCLot: 3154076) ED040T : Total Sulfate by ICPAES (QCLot: 3154085) EA029-E: Magnesium Values (QCLot: 3153604) EA029-A: pH Measurements (QCLot: 3153604) EA029: sulfidic - Titratable Peroxide Acidity (s-23G) EA029: acidity - Peroxide Oxidisable Sulfur (a-23E) EA029-D: Calcium Values (QCLot: 3153604) EA029: Acidity - Acid Reacted Magnesium (a-23U) EA029: sulfidic - Acid Reacted Magnesium (s-23U) EA029: sulfidic - Titratable Sulfidic Acidity (s-23H) EA029: sulfidic - Titratable Actual Acidity (s-23F) EA029-B: Acidity Trail (QCLot: 3153604) EA029: sulfidic - Acid Reacted Calcium (s-23X) EA029: acidity - Acid Reacted Calcium (a-23X) EA029-C; Sulfur Trail (QCLot; 3153604) EA029: KCI Extractable Magnesium (23Sm) EA002: pH (Soils) (QCLot: 3154075) EA029: Titratable Peroxide Acidity (23G) EA029: Peroxide Oxidisable Sulfur (23E) EA029: KCI Extractable Calcium (23Vh) EA029: Acid Reacted Magnesium (23U) EA029: KCI Extractable Sulfur (23Ce) EA029: Titratable Actual Acidity (23F) EA029: Peroxide Magnesium (23Tm) EA029: Acid Reacted Calcium (23X) EA029: Peroxide Calcium (23Wh) EA029: Peroxide Sulfur (23De) ED040T: Sulfate as SO4 2-EA029: pH KCI (23A) EA029: pH OX (23B) ED045G: Chloride EA002: pH Value Sub-Matrix: SOIL



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Project Client

Sub-Matrix: SOIL

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on Matrix Spike (MS) Report analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

				Spike	Spikerecovery(%)	Recovery	Junts (%)
Laboratory sample ID Client sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride	ED045G: Chloride by Discrete Analyser (QCLot: 3154076)						
EP1308553-002 BH2 2.0-2.50	BH2 2.0-2.50	ED045G: Chloride	16887-00-6	5000 mg/kg	101	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: SOIL					Matrix Spike (MS	latrix Spike (MS) and Matrix Spike Duplicate (MSD) Repon	ike Duplicate	(MSD) Report		
				Spike	Spike Recovery (%)		Recovery Limits (%)	Limits (%)		RPDs (%)
Laboratory sample ID Client sample ID	Client sample ID	Method: Compound	CAS Number	CAS Number Concentration	MS	MSD	Low	High	Value	Value Control Limit
ED045G: Chloride	ED045G: Chloride by Discrete Analyser (QCLot: 3154076)				turing and the second	100000000000000000000000000000000000000	A constitution of the cons	100000000000000000000000000000000000000		
EP1308553-002 BH2 2.0-2.50	BH2 2.0-2.50	ED045G: Chloride	16887-00-6 5000 mg/kg	5000 mg/kg	101	-	70	130	1	1
Sansatautoscinistras de transmissa de la compresenta de la contraction del contraction de la contraction de la contraction de la contracti										



PROMPT CERTIFICATION

Borelog Explanation Notes SOILS

	Consist	ency Terms	s (Coh	esive Soils)			Relative	Density	(Non-	cohesive	Soils)	
Log	Term	Undrained Strength		Field A	ssessment	Term	N Value (SPT)	PSP (blows)	DCP (blows)	qc (MPa)	(,) à,	RD
VS	Very Soft	<12	Exudes	between fi ed	ingers when	Very Loose	0<6	0-3	0-1	0-2.5	25	<20
S	Soft	12-25	Can b	e moulded re	by light	Loose	6-9	3-6	2-4	2.5-7.5	25-30	20-33
F	Firm	25-50		e moulded pressure	by strong	Medium Dense	10-29	7-9	5-14	7.5–14	30-35	33-66
St	Stiff	50-100	Can't Can be	be moulded e indented l	I by fingers. by thumb	Dense	30-50	10-20	15-25	14-24	35-40	66-90
Vst	Very Stiff	100-200	Can b	e indented	by thumb	Very Dense	>50	>20	>25	>24	>40	90-100
Н	Hard	>200		e indented vith difficult		PSP: N DCP: N	o. of bow o. of blow	s per 30 vs per 10	0mm p	enetratio enetratio	n n	
	Se	ensitivity (C	Cohesiv	e Soils)				D	ilatancy	,		
	Term	S	Shear St Rat	trength = Ui	ndisturbed emoulded		Reaction varies fro		ng (silts	s & fine	sands)	
Inse	ensitive, nor	mal		>2			Non-dilat	ant - n	o react	ion		
Mod	lerately Sen	sitive		2 - 4				to				
Sen	sitive			4 - 8			Highly dil	atant -	rapid a	ppearance	e of wat	er
Extr	a Sensitive			8 -16			and comp	olete loss				
Quid	ck			>16	- 4		tillough	iiigers.				
	Soil Syr	nbols				SAMPL	ING AND	TESTIN	G			
Letter	Graphs				Bag Sample				-	- Water	level in	borehole
F		FILL		0	Core Sample				l w		mpletion re Conte	nt %
TS	\$7.754.78 -374.474 \$7.774.78	TOPSOIL		Ueo	Thin Wall Tu	ihe Samn	le (undist	urbed)	P	Bulk D	ensity ki	N/m³
PT	त मृत्य मृत्य मृत्य मृत्य मृत्य मृत्य	PEAT			man nam	DO GUITP	io (analoc	ui Douy	CON	NS Consol	idation T	est
CL	F-3	CLAY		SPT	Standard Pe	enetration	Test Sar	nple	PSI) Particl	e Size D	istribution
SI	×××	SILT	- 1						C, 8	d' Effecti	ve Stress	s (triaxial
SN	× × ×	SAND		3/6/9 N=15	3,6 and 9 rependent penetration. after the in	N=15 is	the sum	of blows	UCS	S Uncon Stress		npression
GR	040	GRAVEL		3/6/9 blow for 20mm	s		blows per		DC	P Penetr	ometer 289 6.3.2	
		Combinati e.g. Clay, Sl. sandy	ions silty,	penetration. N>15	penetratio	on at whi	ch point p tion occur	practical	PS	Perth P Penetr	Sand ometer	Test
SM,SC				DS	Disturbed so	ample			qq		289 6.3.3 Tip Resi	
SM,SC	A A A	TUFF			. 6	e shear t	est Resul	t expres		MPa	Th Ites	sturice,
		Bedrock		S=50kPa	In—situ vand as peak und						e Densit	y, %

Careniup Swamp Special Control Area extract (City of Stirling, 2010)

6.2 Careniup Swamp Special Control Area

Note: In addition to the following provisions, the provisions of Clause 6A and Schedule 10 also apply to the Careniup Swamp Special Control Area

6.2.1 Objectives

- a) To ensure orderly subdivision of the Special Control Area;
- b) To ensure the ceding of Public Open Space;
- c) To ensure water quality standards;
- d) To ensure wildlife protection;
- e) To control filling; and
- f) To manage stormwater.

6.2.2 Special Control Area

The Careniup Swamp Special Control Area ("the Area") is all that land delineated on the Scheme Maps. In broad terms it is bounded by Balcatta Road, Mitchell Freeway, Erindale Road and North Beach Road.

6.2.3 <u>Implementation of Development Proposals</u>

- a) All subdivision and development within the Area shall have regard to the requirements set out in clause 6.2 and the Rehabilitation Plan provided however that any development proposal not in conformity with clause 6.2 may be carried out with the approval of Council. Council may seek input from the Western Australian Planning Commission, Water Corporation and the Department of Environment and Conservation.
- b) When considering any application for approval to commence development, subdivision, strata subdivision or the amendment of the Scheme within the Area, the Council and the applicant shall have due regard to the provisions contained within clause 6.2.
- c) When considering any application for subdivision or strata subdivision approval within the Area, the Council shall inform the Western Australian Planning Commission of the Rehabilitation Plan and the Rehabilitation Strategy, particularly when determining any public open space contribution required as a condition of a subdivision or a strata subdivision approval.

6.2.4 Ceding of Land & Cash Payments in Lieu

- a) Upon any amendment of the Scheme in respect of land within the Area, or the granting of approval to subdivide any land within the Area, whichever shall first occur, the following provisions shall take effect:
 - i) Where any portion of land is within the Core Area delineated on the Rehabilitation Plan, such portion shall be ceded to the State for vesting in the City by the owner free of costs and without any entitlement on the part of the owner or any other person with any interest therein to be paid compensation pursuant to the Public Works Act otherwise;
 - ii) If no portion of the land is within the Core Area delineated by the Rehabilitation Plan, the owner of such land shall pay to the City a sum equal to ten per centum (10%) of the market value of the land calculated as at the date of the gazettal of the amendment, the granting of approval to subdivide such land, or the granting of approval to commence development on such land as the case may be.

6.2.5 Water Quality Standards

a) Objectives

The Careniup Swamp and adjacent area is utilised by the Water Corporation as a compensating basin and it is important to maintain sufficient capacity of not less than 26,000 cubic metres within the Core Area as a modified wetland to satisfy drainage and compensation requirements. It is also vital for wildlife retention to retain permanent water throughout the Area of modified wetland, with minimum summer depths being sufficient to maintain landscape and water quality.

b) Development and Subdivision Criteria

In order to satisfy the objectives set out in the preceding sub-clause hereof, development shall conform with the following criteria and Council will recommend to the Commission in responding to a subdivision application that:

- i) The lake be designed on the basis that the area has a maximum water level of RL 7.0 metres AHD and a minimum water level of RL 6.3 metres AHD; and
- ii) The moat and lake beds referred to in the Rehabilitation Plan shall be constructed to RL 4.1 metres AHD in order to maintain a minimum water depth of 1.0 metre during the summer period.

6.2.6 Wildlife Protection Requirements

a) Objectives

Although the number and diversity of wildlife habitats has declined in past years in the Area due to filling of the Careniup Swamp at the margin, it is considered essential to reverse this trend and maximise the length of vegetated wetland foreshore, establish a system of islands within the modified wetland of the Core Area, maximise shading of water surfaces and conversely limit the extent of unshaded open water, control access to the wildlife/bird habitat areas and maximise habitat availability for water and roosting birds (with particular preference to perching and wading birds rather than swimming birds).

- b) In order to satisfy the objectives set out in the preceding sub-clause hereof, the following criteria or requirements shall apply:
 - i) Satisfactory provision must be made when it is practical and feasible to do so, for planting of foreshore areas by Council with native vegetation species listed in the Dames & Moore Report "Conceptual Development Plan for the Area within the System 6 Boundary Careniup Swamp" (November 1987), with particular emphasis on the Paperbark (Melaleuca Raphiophylla) and Flooded Gum (Eucalyptus Rudis); and
 - ii) Four islands specified in the Rehabilitation Plan shall, when it is practical and feasible to do so, be constructed by Council and planted with native vegetation species as determined in the Design and Management Plan.

iii) The timing of the aforementioned works shall be specified in the Design and Management Plan.

Note: The Design and Management Plan is to be prepared and adopted by Council to outline the location of the islands, plantings, and other relevant works in accordance with clause 6.2.8 (b).

6.2.7 <u>Maintenance of The Core Area</u>

a) Objectives

In order to satisfy the objectives set out in the two preceding clauses hereof, the Core Area delineated in the Rehabilitation Plan must not be the subject of indiscriminate filling and infiltration of nutrients and the integrity of the Core Area as a whole must be maintained.

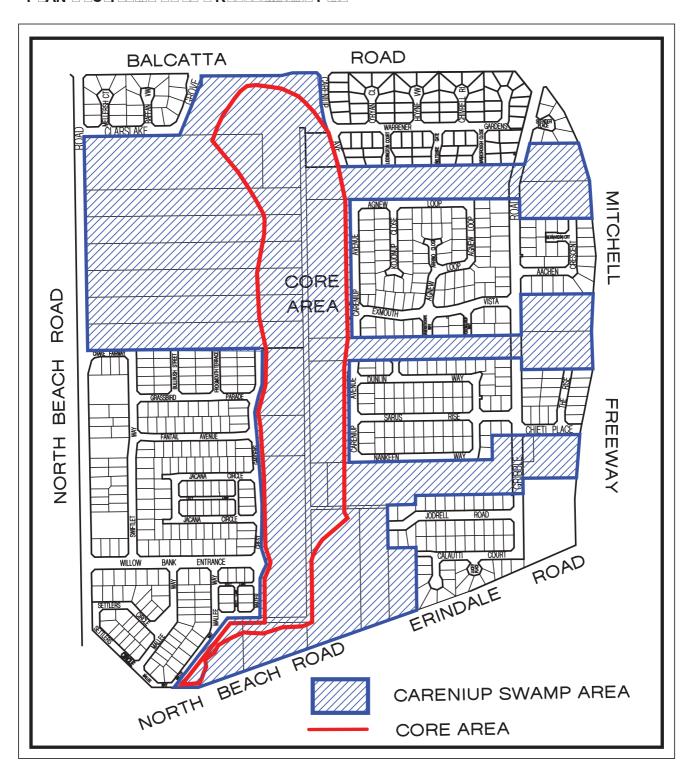
- b) In order to satisfy the objectives set out in the preceding sub-clause hereof, the following criteria or requirements shall apply in respect of development within the Area:
 - No person shall fill or deposit or cause to be filled or deposited any substance in the Core Area delineated in the Rehabilitation Plan except in accordance with a development plan approved by the Council and the Western Australian Planning Commission in consultation with the Water Corporation and the Environmental Protection Authority;
 - ii) Council shall recommend to the Western Australian Planning Commission that stormwater from subdivisions should be disposed of on site to the extent that a one in ten year storm event is retained for three to four days;
 - iii) Subdivision design should be in accordance with the principles and practices detailed in the "Planning and Management Guidelines for Water Sensitive Urban (Residential) Design", published by the Western Australian Planning Commission in June 1994.

6.2.8 Rehabilitation Programme

a) Objectives

The Core Area delineated in the Rehabilitation Plan is proposed to ultimately be vested in the Council, which intends to rehabilitate it in an orderly and comprehensive manner in accordance with the Rehabilitation Plan. A Design and Management Plan for the entire Core Area is to be prepared by the Council addressing issues such as midge and mosquito control, moat depth profiles, peat removal for housing and stormwater drainage prior to commencement of rehabilitation works.

- b) The Design and Management Plan shall be prepared when sufficient land in the Core Area has been ceded to the Crown and vested in the Council to enable rehabilitation to commence in an orderly manner or at such earlier time as determined by Council.
- c) In respect of those portions of the Core Area ultimately vested in the Council, it shall be the responsibility of the Council to carry out over time the rehabilitation of the Core Area referred to in the Rehabilitation Plan.



APPENDIX E

Hyd2o Groundwater Monitoring Results

H13078 Gwelup LWMS Groundwater Monitoring



Water Level m((AHD)																	
	GW1	7.36	GW2	8.57	GW3	7.72	GW4	11.67	GM4	11.23	GM8	12.41	GM9	14.34	GM33	15.15	SW Gaug	je
	m BTOC	m AHD	m BTOC	m AHD														
20/02/2014	1.83	5.53	3.76	4.81	2.17	5.55	8.00	3.67										5.6
24/03/2014	1.985	5.372	3.99	4.576	2.26	5.461	8.23	3.437	7.56	3.67	4.56	7.85	9.87	4.47	6.19	8.96		5.5

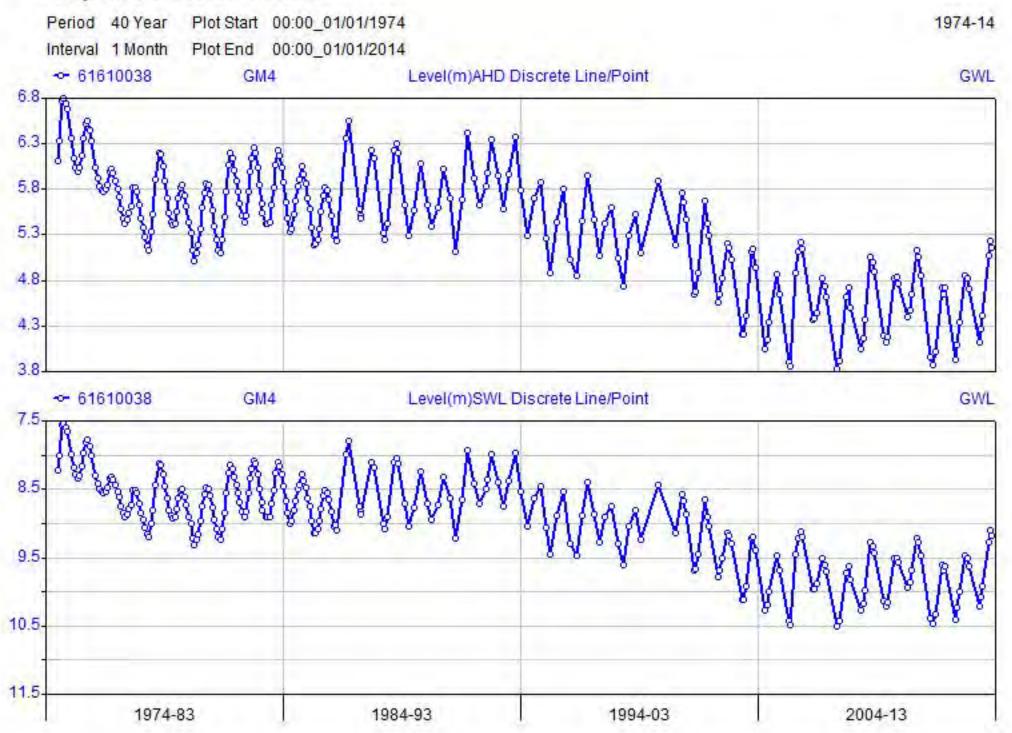
H13078 Gwelup LWMS Groundwater Monitoring

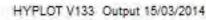


GW1						mg/L															
	WL	E	CμS	рН	Temp	TSS	TN		TKN	Ammonia	Nox as N	TP	Phosphate as P	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
24/03/2014		1.99	878	6.7	7 26.6	3	90	17	1	7 11	< 0.005	0.57	0.34	0.019	< 0.0001	0.001	0.001	0.004	< 0.001	<0.00005	0.038
GW2						mg/L															
	WL	E	CμS	рН	Temp	TSS	TN		TKN	Ammonia	Nox as N	TP	Phosphate as P	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
24/03/2014		3.99	977	6.5	30.8		29	2.4		2 1.1	0.33	0.06	< 0.005	0.004	< 0.0001	0.001	0.005	0.002	< 0.001	<0.00005	0.014
GW3						mg/L															
	WL	E	CμS	рН	Temp	TSS	TN		TKN	Ammonia	Nox as N	TP	Phosphate as P	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
24/03/2014		2.26	1835	6.7	1 30.9	1	90	18	18	15	0.2	0.28	< 0.005	0.007	< 0.0001	< 0.001	< 0.001	0.001	< 0.001	<0.00005	0.01
GW4						mg/L															
	WL	E	CμS	рН	Temp	TSS	TN		TKN	Ammonia	Nox as N	TP	Phosphate as P	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
24/03/2014		8.23	512	6.92	2 29.7		8	9	0.0	0.05	8.1	< 0.05	0.009	0.002	< 0.0001	< 0.001	0.003	0.001	< 0.001	<0.00005	0.003

DoW Groundwater Bore Hydrographs (Department of Water, 2014)

Department of Water



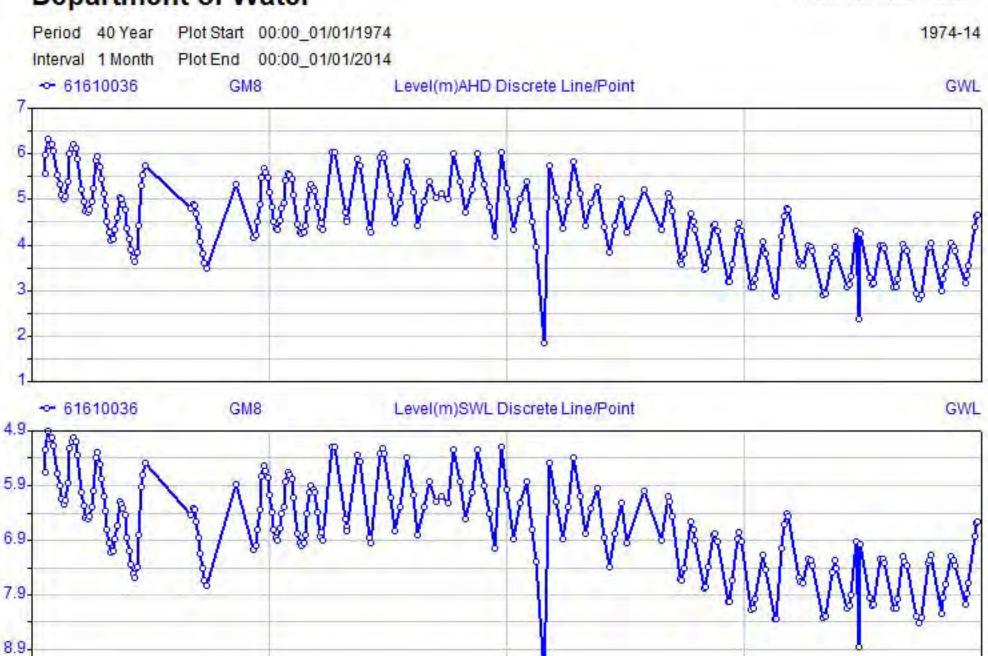


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Department of Water

9.9

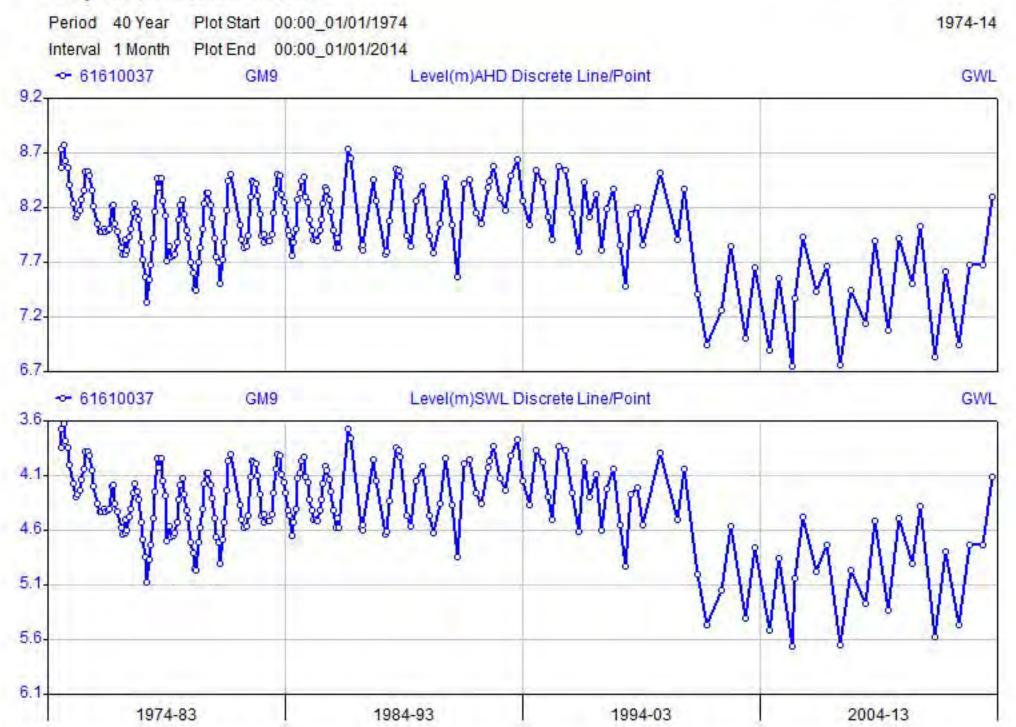
1974-83



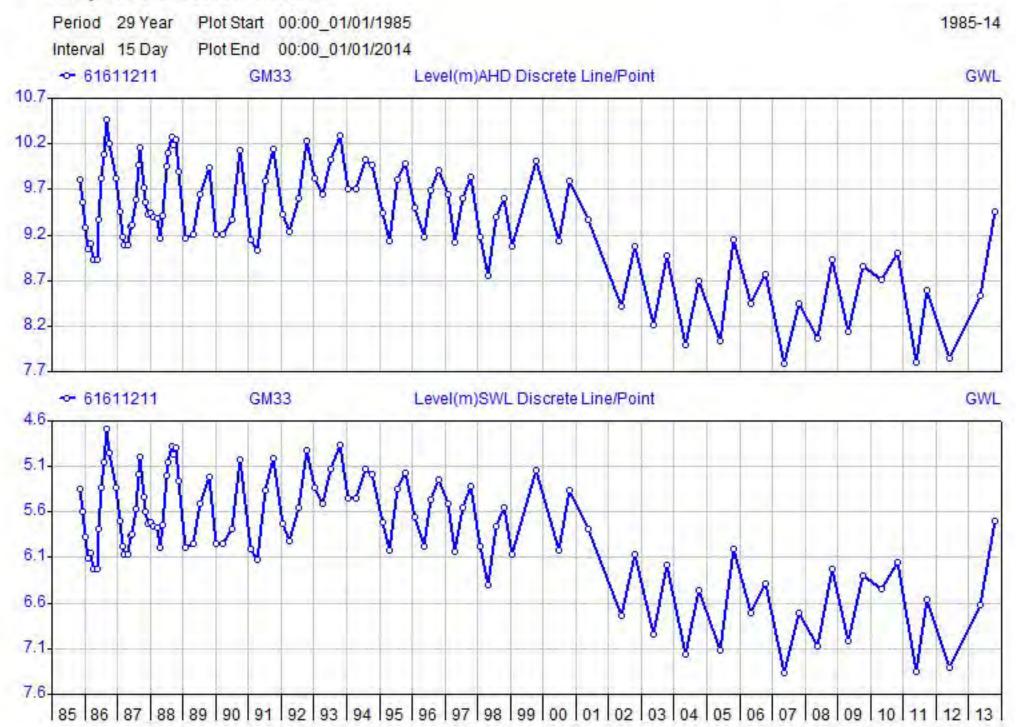
1994-03

1984-93

Department of Water



Department of Water



APPENDIX G

Groundwater Quality Lab Report







16 - 18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
Tel: +61 8 9317 2505 / Fax: +61 8 9317 4163
email: laboratory@mpl.com.au
www.envirolabservices.com.au
Envirolab Services (WA) Pty Ltd ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 148170

Client:

Hyd2O

Suite 6B, 103 Rokeby Rd

Subiaco

WA 6008

Attention: Renee Blandin

Sample log in details:

Your Reference: 13078 Gwelup LWMS

No. of samples: 4 Water
Date samples received: 24/3/14
Date completed instructions received: 24/3/14

Location:

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: 28/03/14
Date of Preliminary Report: not issued Issue Date: 28/03/14

NATA accreditation number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025.

Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim Operations Manager



Miscellaneous Inorganics					
Our Reference:	UNITS	148170-1	148170-2	148170-3	148170-4
Your Reference		H13078 GW1	H13078 GW2	H13078 GW3	H13078 GW4
Date Sampled		24/03/2014	24/03/2014	24/03/2014	24/03/2014
Type of sample		Water	Water	Water	Water
Time Sampled		14:00	14:00	14:00	14:00
Date prepared	-	26/3/14	26/3/14	26/3/14	26/3/14
Date analysed	-	26/3/14	26/3/14	26/3/14	26/3/14
Total Suspended Solids	mg/L	390	29	190	8
Total Nitrogen (Total N)	mg/L	17	2.4	18	9.0
Total Phosphorus (Total P)	mg/L	0.57	0.06	0.28	<0.05
TKN by Discrete Analyser	mg/L	17	2.0	18	0.9
Ammonia as N	mg/L	11	1.1	15	0.050
Phosphate as P	mg/L	0.34	<0.005	<0.005	0.009
NOx as N	mg/L	<0.005	0.33	0.20	8.1



Metals in Water - Low Level					
Our Reference:	UNITS	148170-1	148170-2	148170-3	148170-4
Your Reference		H13078 GW1	H13078 GW2	H13078 GW3	H13078 GW4
Date Sampled		24/03/2014	24/03/2014	24/03/2014	24/03/2014
Type of sample Time Sampled		Water 14:00	Water 14:00	Water 14:00	Water 14:00
Date prepared	-	26/3/14	26/3/14	26/3/14	26/3/14
Date analysed	-	26/3/14	26/3/14	26/3/14	26/3/14
Arsenic-Dissolved	mg/L	0.019	0.004	0.007	0.002
Cadmium-Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.005	<0.001	0.003
Lead-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005	<0.00005
Nickel-Dissolved	mg/L	0.004	0.002	0.001	0.001
Zinc-Dissolved	mg/L	0.038	0.014	0.01	0.003



Method ID	Methodology Summary						
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample, in accordance with APHA 22nd ED, 2540 D. The samples are dried at 104+/-5oC.						
INORG-055	Total Nitrogen by colourimetric analysis in accordance with APHA 4500-P J, 4500-NO3 F.						
METALS-020	Metals in soil and water by ICP-OES.						
INORG-062	TKN by calculation fromTotal Nitrogen and NOx using APHA methodology.						
INORG-057	Ammonia by colourimetric analysis in accordance with APHA 22nd ED 4500-NH3 F.						
INORG-060	Phosphate by colourimetric analysis in accordance with APHA 22nd ED 4500-P E.						
INORG-055	NOx by colourimetric analysis and calculation.						
Metals-022 ICP-MS	Determination of various metals by ICP-MS.						
Metals-021 CV- AAS	Determination of Mercury by Cold Vapour AAS.						



Client Reference: 13078 Gwelup LWMS										
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery		
Miscellaneous Inorganics						Base II Duplicate II %RPD				
Date prepared	-			26/3/14	[NT]	[NT]	LCS	26/3/14		
Date analysed	-			26/3/14	[NT]	[NT]	LCS	26/3/14		
Total Suspended Solids	mg/L	5	INORG-019	<5	[NT]	[NT]	LCS	101%		
Total Nitrogen (Total N)	mg/L	0.1	INORG-055	<0.1	[NT]	[NT]	LCS	92%		
Total Phosphorus (Total P)	mg/L	0.05	METALS- 020	<0.05	[NT]	[NT]	LCS	101%		
TKN by Discrete Analyser	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NR]	[NR]		
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	LCS	100%		
Phosphate as P	mg/L	0.005	INORG-060	<0.005	[NT]	[NT]	LCS	99%		
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS	97%		
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike %		
Metals in Water - Low Level						Base II Duplicate II %RPD		Recovery		
Date prepared	-			26/3/14	[NT]	[NT]	LCS	26/3/14		
Date analysed	-			26/3/14	[NT]	[NT]	LCS	26/3/14		
Arsenic-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	102%		
Cadmium-Dissolved	mg/L	0.0001	Metals-022 ICP-MS	<0.000 1	[NT]	[NT]	LCS	95%		
Chromium-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	99%		
Copper-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	101%		
Lead-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	99%		
Mercury-Dissolved	mg/L	0.0000 5	Metals-021 CV-AAS	<0.000 05	[NT]	[NT]	[NR]	[NR]		
Nickel-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	103%		
Zinc-Dissolved	mg/L	0.001	Metals-022 ICP-MS	<0.001	[NT]	[NT]	LCS	99%		



Report Comments:

INS: Insufficient sample for this test; NT: Not tested; PQL: Practical Quantitation Limit; <: Less than; >: Greater than

RPD: Relative Percent Difference; NA: Test not required; LCS: Laboratory Control Sample;

NS: Not specified; NEPM: National Environmental Protection Measure

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however were analysed at a frequency to meet of exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD a matrix spike recoveries for the sample batch were within laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable

For VOCs in water samples, three vials are required for duplicate or spike analysis

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spike and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics;

10-140% for SVOC and Speciated Phenols; and 40-120% for low level organics is acceptable.

Surrogates: 60-140% is acceptable for general organics and 10-140% for SVOC and Speciated Phenols.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.



APPENDIX H

Pre-Development Monitoring Program and DoW Approval



5 February 2014 Your Ref:

Our Ref: H13078av2

Department of Water Swan Avon Region 7 Ellam Street Victoria Park WA 6100

ATTENTION: James Mackintosh

Dear James,

VARIOUS LANDHOLDINGS GWELUP, LOCAL WATER MANAGEMENT STRATEGY PROPOSED MONITORING PROGRAM

Hyd2o are scoping urban water management studies required to support the subdivision development of approximately 100 lots at Lots 2, 500 and 501 North Beach Road within the suburb of Gwelup (Figure 1). The site is approximately 7.5 ha in size.

As you are aware, we previously sought preliminary advice from the Department of Water (DoW) regarding the level of monitoring program that would be required to support the preparation of a Local Water Management Strategy (LWMS) for the site. An 18 month period (inclusive of two winters) was recommended.

Since this advice, we have received additional information regarding available historical monitoring data (including DoW bores) and the previous planning background for the site. We believe the additional monitoring data provides sufficient detail to inform the preparation of an LWMS for the site and reduce the predevelopment monitoring requirement.

This letter is therefore submitted seeking formal DoW support for a reduced predevelopment monitoring program for the site. The recommended program, based on our review of the considerable data available, is for 10 months over winter 2014.

This letter report provides additional detail regarding site characteristics, previous planning history, and ongoing long term water monitoring data and programs in support of this request.

1. SITE CHARACTERISTICS

Site characteristics are shown in Figure 1. The 7.5 ha site is located in the suburb of Gwelup in the City of Stirling. It is bound to the west by North Beach Rd and to the east by Careniup Swamp. The site is bound to the north by existing residential development and to the south by a Caravan Park and future residential.



The site slopes from approximately 14 mAHD at its south western corner to 7 mAHD at its eastern boundary. It is largely cleared and contains several existing residential dwellings.

The DoW's Perth Groundwater Atlas indicates the maximum historical groundwater level at the site to range between 6.7 mAHD and 7.5 mAHD with groundwater flow in a north westerly direction (Figure 1). At the south western corner of the site the depth to groundwater would be in excess of 7 m.

The Department of Water Perth Groundwater Atlas May 2003 groundwater contours (representative of a summer minimum) indicate levels across the site from 5.5 mAHD to 4.3 mAHD.

Careniup Swamp is mapped as a resource enhancement (RE) wetland, with a much smaller portion mapped as an EPP lake. The wetland boundary is shown on Figure 1. The mapped wetland boundaries (both EPP and RE) extend over existing residential development including recent development areas adjacent to Erindale Rd.

Development adjacent to the wetland in the area has been occurring consistent with the City of Stirling Local Planning Scheme (LPS) No. 3. This is discussed in further detail in Section 2.

Careniup Swamp is part of the Water Corporation Main Drainage system, and is a compensating basin receiving stormwater runoff from residential development areas.

2. PLANNING BACKGROUND

The site is located within the City of Stirling Local Planning Scheme (LPS) No. 3 area (Figure 2). The LPS identifies the site as a development zone. The proposed residential development complies with the LPS.

It is located within a zone identified as the Careniup Swamp Special Control Area, and the LPS scheme text provides special provisions for this area (City of Stirling, 2012).

The LPS scheme text details a Careniup Swamp Rehabilitation Plan (Figure 2), which defines the core area of the wetland for retention with development. The boundary of the wetland core area in the LPS is used to guide development boundaries adjacent to the wetland (Bruce Gardner, Senior Strategic Planning Officer City of Stirling, pers comm).

This boundary has formed the basis of the initial planning for the site however this will be ultimately reviewed and negotiated with the various agencies in due course as part of the structure planning process.

The LPS scheme text also defines key design information for the wetland, including maximum (7 mAHD) and minimum operating levels (6.3 mAHD). The maximum level is likely to have been established based on Water Corporation Main Drain requirements and defines a known key criteria for the establishment of future development levels for the site.



3. EXISTING SURFACE AND GROUNDWATER MONITORING DATA & PROGRAMS

A large amount of monitoring data in the immediate vicinity of the site has previously been collected by various government agencies. A summary of this data is presented in Table 1 with monitoring sites shown in Figure 3.

With respect to groundwater levels, there are four long term DoW bores located in close proximity to the site. Three of these bores have monitored water level data dating back to 1974. The groundwater gradient in the area is low and the amount of water level data available is considered sufficient to provide confidence in groundwater levels at the site and inform the preparation of an LWMS. There is also some water quality data from these sites available including physical parameters, nutrients and metals.

With respect to water quality of Careniup Swamp, the City of Stirling undertake an ongoing monitoring program of lakes in the City. Careniup Swamp is monitored at four locations, one of which is adjacent to the site. Data for the monitoring period since 2012 has been provided to Hyd2o by the City, however further historical data is available on request. The monitoring program commenced in 2006 and is ongoing.

Environmental Protection Authority Bulletin 266 (EPA, 1990) also provides longer term monitoring data from Careniup Swamp based on data from the then Water Authority of WA (now Water Corporation) for the period 1970-1984. This data includes water levels, nutrients, and metals.

Further monitoring data is also likely to be available from adjacent development areas. During the LWMS preparation and local structure planning process, this data will be requested from the City of Stirling if required.

In summary, the site and its surrounds have long term groundwater and wetland water quality and level data for a period in excess of 40 years. This amount of information far exceeds that which is normally available to inform the development of an LWMS.

Table 1: Existing Monitoring Data

Agency	Site	Parameter	Data	Status
DoW	GM9 61610037	Physical, Nutrients, Metals Water Levels	1981-2005 (11 readings) 1974-2014 (666 readings)	Ongoing
DoW	GM8 61610036	Physical Water Levels	1990-2014 (12 readings) 1974-2014 (687 readings)	Ongoing
DoW	GM33 61611211	Physical Water Levels	1987-2014 (15 readings) 1985-2014 (312 readings)	Ongoing
DoW	GM4 61610038	Physical, Nutrients, Metals Water Levels	1981-2014 (88 readings) 1974-2014 (834 readings)	Ongoing
City of Stirling	Careniup Swamp (STA10, STA11, STA13, STA14)	Physical, Nutrients, Metals	2006-2014	Ongoing
EPA/Water Authority	Careniup Swamp	Physical, Nutrients, Metals Water Levels	1975-1984 (15 samples) 1970-1984 (unknown)	-

^{1.} Data from 2012-2013 provided to Hyd2o. Further long term data available on request via City of Stirling

H13078av2 | 5 February, 2014



4. PROPOSED PREDEVELOPMENT MONITORING PROGRAM

Notwithstanding the large volume of existing monitoring data, it is appreciated that some additional site specific data will be required to supplement this information and assist structure planning and engineering design.

Based on review of the existing data and site characteristics, a proposed predevelopment monitoring program is detailed in Table 2. Hyd2o recommend the installation of 4 groundwater monitoring bores across the site. These are to be installed via drill rig and constructed suitable for water quality monitoring. Logging of soil profiles and survey to AHD will be completed for each bore installed. Based on the expected depth to groundwater, the depth of bore installation will range from approximately 6 - 8 m.

Monitoring will be undertaken over a 10 month period, inclusive of the 2014 winter. Bores will be installed in February 2014, with monitoring to occur from February 2014 to November 2014.

Each installed bore is to be monitored monthly for groundwater levels (total 10 occasions), with groundwater quality sampling to be undertaken quarterly (total four occasions). Nearby long term DoW bores will also be monitored for groundwater levels on a monthly basis.

Water quality samples will be measured in situ for physical parameters (temperature, electrical conductivity, pH), with samples sent to a NATA approved laboratory for analysis of nutrients and heavy metals. The following parameters will be analysed: total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, filterable reactive phosphorus, and metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, and zinc).

Table 2: Proposed Predevelopment Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater Level	Water Level (m AHD)	4 bores within site area and 3 DoW bores	Electrical depth probe or similar	Monthly (10 occasions) Feb 2014-Nov 2014
Groundwater Quality	Physical, Nutrients, Metals	4 bores within the site area	Pumped bore sample	Quarterly (4 occasions) (Feb 2014, May 2014, Aug 2014, Nov 2014)

5. URBAN WATER MANAGEMENT PROCESS

Consistent with the processes defined in WAPC (2008), an LWMS and UWMP will be developed and submitted to support the planning processes for the site.

Based on review of the existing monitoring data available, Hyd2o consider an LWMS can be prepared on the basis of an initial set of data collected from the above monitoring program, with the further data used to inform the Urban Water Management Plan (UWMP) in due course.



6. REFERENCES

City of Stirling (2010), Karrinyup Gwelup Local Area Plan, February 2010

City of Stirling (2012), City of Stirling Local Planning Scheme No 3, May 2012

Department of Water (2014a), Perth Groundwater Atlas (online)

Department of Water (2014b), Water Information Reporting (online)

Environmental Protection Authority and Water Authority of WA (1990), Jenny Arnold's Perth Wetlands Resource Book, Bulletin 266 December 1990

Western Australian Planning Commission (2008), Better Urban Water Management

We seek DoW's agreement and support of the monitoring program detailed in this letter to enable structure planning to proceed. A formal response is requested to enable us to proceed with certainty within the planning process and advise the City of Stirling accordingly.

Your earliest possible consideration of this proposed monitoring program and urban water management implementation process is appreciated.

Should you have any queries regarding this report, please do not hesitate to contact Sasha Martens or Suzanne Smart of this office.

Yours sincerely,

Sasha Martens

Managing Director, Hyd2o

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents.

Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

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Source: Landgate, DoW Perth Groundwater Atlas

Site

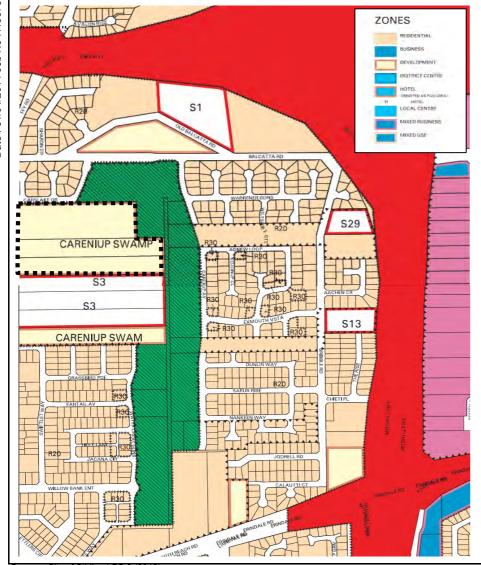
Resource Enhancement Wetland Mapping

EPP Wetland Mapping

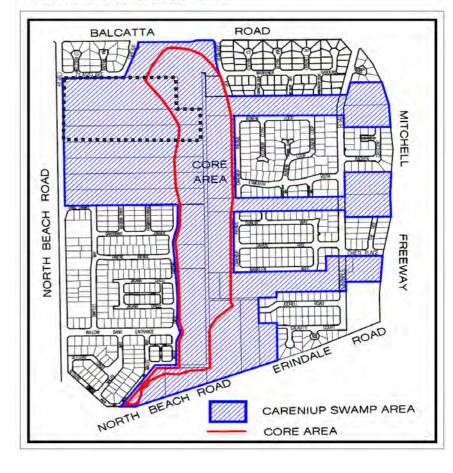
DoW May 2003 Groundwater Contours

DoW Maximum Historical Groundwater Contours

Figure 1



PLAN 1 - Careniup Swamp Rehabilitation Plan



Source: City of Stirling LPS 3 (2012)

Site

hyd₂o Gwelup LWMS Monitoring Program City of Stirling LPS 3



Government of Western Australia Department of Water



looking after all our water needs

Your ref: H13078av2

File ref

RF44-24

SRS: 35750

Enquiries:

Bree Lyons

Tel:

6250 8035

Hyd2o Hydrology PO Box 1055 SUBIACO WA 6904

Dear Mr Martens,

Re: Various Landholdings Gwelup - Local Water Management Strategy - Proposed Monitoring Program

Thank you for the above referral dated 5 February 2014. The Department of Water (DoW) has assessed the proposed monitoring program and supports the monitoring program to support the Local Water Management Strategy and Urban Water Management Plan.

If you wish to discuss the matter further, please contact Briony Lyons on 6250 8035 or briony.lyons@water.wa.gov.au.

Yours sincerely,

James Mackintosh Program Manager Land Use Planning Department of Water

17 February 2014



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APPENDIX 4 TRAFFIC ASSESSMENT





Proposed Residential Subdivision Lots 500 & 501 North Beach Road, Gwelup

Transport Statement

PREPARED FOR:
Gwelup Land Developments Pty
Ltd

March 2014

Document history and status

Author	Revision	Approved by	Date approved	Revision type
Vladimir Baltic	r01	R White	28/03/2014	Final

File name: t14.049.vb.r01.docx

Author: Vladimir Baltic

Project manager: Behnam Bordbar

Client: Gwelup Land Developments Pty Ltd

Project: Lots 500 & 501 North Beach Road, Gwelup

Document revision: r01

Project number: t14.049

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CARAVAN PARK

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1.0 Introduction

This Transport Statement has been prepared by Transcore on behalf of Gwelup Land Developments Pty Ltd with regard to a proposed subdivision comprising 61residential lots, to be located at Lot 500 & 501 North Beach Road in Gwelup, City of Stirling (subject site).

The Transport Assessment Guidelines for Developments (WAPC, Vol 3 – Subdivisions, August 2006) states: "A Transport Statement is required for those subdivisions that would be likely to generate moderate volumes of traffic¹ and therefore would have a moderate overall impact on the surrounding land uses and transport networks". Section 6.0 of Transcore's report provides details of the estimated trip generation for the proposed development. Accordingly, as the total peak hour vehicular trips are estimated to be less than 100 trips per hour, a Transport Statement is deemed appropriate for this development.

The subject site is located immediately opposite of the Karrinyup Country Club and approximately 210m south of North Beach Road/Balcatta Road intersection in Gwelup as shown in **Figure 1**.



Figure 1: Location of the subject site

¹ Between 10 and 100 vehicular trips per hour

The site is bounded by North Beach Road to the west, existing caravan park to the south, a vet clinic with ancillary uses to the north and Lake Careniup nature reserve to the east. Vehicle access to the site is proposed from North Beach Road via a single full-movement access intersection located near the southern site perimeter.

The subject site is located within a predominantly residential area. The site is currently partially occupied by several single-storey buildings.

2.0 Proposed Subdivision

The site is zoned "Development" under the provisions of the City of Stirling Local Planning Scheme No.3 with a combined total area of approximately 4.1ha. The subject site is also zoned "Urban Deferred" in the WAPC Metropolitan Region Scheme. The subject site is also located within the Careniup Swamp Special Control Area of the City of Stirling Local Planning Scheme No.3

The proposed subdivision forms part of a wider structure plan prepared in 2003 (by Chappell & Lambert) as part of the proposed Karrinyup Waters Caravan Park redevelopment. Refer **Appendix B** for more details. However, at present there is no endorsed LSP covering the subject site.

The development proposal for the subject site entails 61 residential lots ranging in size from $322m^2$ to $534m^2$ and with associated internal subdivision road system. The area east of the eastern perimeter road would be retained as a nature reserve.

The internal road system is designed to integrate seamlessly with the future subdivisions to the north (Lot 2) and south (Lots 502 and 503). However, in the initial stage the future road links to the north and south are likely to be cul-desacked.

Refer to **Appendix A** for proposed subdivision concept plan.

3.0 Vehicle Access and Parking

The proposed residential subdivision will be served by a single full-movement vehicular access on North Beach Road, as shown on the proposed subdivision plan in **Appendix A** of this report. The access intersection is located approximately 30m north of the southern site perimeter.

The internal subdivision road system is designed to integrate seamlessly with the future subdivisions to the north (Lot 2) and south (Lots 502 and 503). A perimeter road with a road reservation of 11.0m is proposed to skirt around the eastern subdivision perimeter while three internal subdivision roads with road reserve of 15.4m would be distributing the traffic within the development. The 15.4m east-west subdivision road will form an access intersection with North Beach Road near the southern end of the subject site.

All lots are designed to accommodate residents' parking within the site with access driveways to be located away from subdivision intersections.

4.0 Provision for Service Vehicles

It is anticipated that the internal subdivision road network will be designed to accommodate a typical service vehicle.

The waste collection is likely to be organised weekly on designated dates when the rubbish bins shall be wheeled out for kerbside/driveway collection.

5.0 Daily Traffic Volumes and Vehicle Types

The traffic volumes likely to be generated by the proposed residential subdivision have been estimated in accordance with the RTA NSW "Guide to Traffic Generating Developments" document, which provides daily and peak hour trip rates for relevant land uses. This document outlines a series of trip generation rates for different types of residential dwellings which range from 3 to 9 trips per dwelling per day. However, in order to provide for a robust assessment a daily trip rate of 8 trips per dwelling and peak hour trip rate of 0.8 trips per dwelling was adopted for the proposed subdivision.

5.1 Subdivision Trip Generation and Distribution

Accordingly, it is estimated that the proposed residential subdivision would generate approximately **490** daily vehicle trips, with approximately **49** trips during each peak hour. These trips include both inbound and outbound vehicle movements. It is anticipated that most of the vehicle types would be passenger cars.

The traffic distribution detailed in **Table 1** was based on the following directional split assumptions:

- ♣ Morning (AM) peak split estimated at 25%/75% inbound/outbound;
- ♣ Afternoon (PM) peak split estimated at 66%/34% inbound/outbound

Time period	Direction	Total Peak Hour Trips				
-		Split	Total			
AM	Inbound	12	40			
Peak	Outbound	37	49			
PM	Inbound	32	49			
Peak	Outbound	17	49			

Table 1: Peak hour trips for the proposed development

With respect to the location of the development and the layout of the surrounding road network it is assumed that directional AM, PM and total daliy inbound/outbound traffic would be split 60%/40% between North Beach Road south and North Beach Road north directions, respectively.

The directional morning, afternoon and total daily trip distribution of the development-generated traffic is illustrated in **Figure 2.** The assessment year for the post-development stage is assumed to be five years from present (year 2019) at which stage the subdivision would be fully developed and activated. The AM and PM peak hour traffic for North Beach Road was estimated based on 2012 Main

Roads WA traffic counts which have been adjusted for a default 2.0% traffic growth per annum to approximate the year 2019 traffic.



Figure 2. Estimated traffic movements for the subject development – morning/ afternoon peak/total daily trips (post-development stage)

The estimation of traffic volumes at the subdivision's North Beach Road access intersection was also undertaken for the "ultimate stage" which involves full development of the locality which encompasses Lots 2, 50, 502 and 503. The structure plan prepared in 2003 (by Chappell & Lambert) as part of the proposed Karrinyup Waters Caravan Park redevelopment was used as a rough guide for estimation of lot yield and access system for the subject area.

The assessment year for the ultimate stage has been assumed as 2024 at which stage it is anticipated that the subject locality will be fully developed and populated. The estimated AM and PM peak hour traffic volumes at the North Beach Road access intersection, including the estimated North Beach Road traffic, has been illustrated in **Figure 3**.

It is anticipated that a portion of Lot 2, 50, 502 and 503 generated traffic would utilise the subject North Beach Road access intersection due to convenience and would filter through the structure plan area to access future dwellings within the lots adjacent to the subject site. This additional traffic is included in **Figure 3**.



Figure 3. Estimated traffic movements for the subject development – morning/ afternoon peak/total daily trips (ultimate stage)

5.2 Capacity Assessment of Intersections

Capacity analysis of the North Beach Road access intersection for post-development (year 2019) and ultimate stages (year 2024) were undertaken using the SIDRA computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation** is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).

- **Average Delay** is the average of all travel time delays for vehicles through the intersection.
- **95**% **Queue** is the queue length below which 95% of all observed queue lengths fall.

The results of the post-development and ultimate stages of SIDRA analysis for the AM and PM peak hours for North Beach Road access intersection are detailed in **Table 2** and **Table 3**.

Table 2: SIDRA results for the North Beach Road access intersection – AM peak hour (post development stage)

		Demand		Deg.	Average		95% Back	of Queue		Effective	Average
Mov ID					Delay	Service	Vehicles	Distance	Queued	Stop Rate	
		veh/h	%	v/c	sec		veh	m		perveh	km/h
South: I	North Bea	ach Road Soutl	า								
2	T	279	3.5	0.162	9.3	LOSA	2.5	18.3	0.89	0.00	44.5
3	R	7	2.0	0.162	20.5	LOSC	2.5	18.3	0.89	0.98	40.6
Approach		286	3.5	0.162	9.6	NA	2.5	18.3	0.89	0.02	44.5
East: A	ccess Roa	ad East									
4	L	22	2.0	0.183	19.1	LOSC	0.6	4.0	0.86	0.92	14.4
6	R	15	2.0	0.183	19.4	LOSC	0.6	4.0	0.86	0.93	14.2
Approa	ch	37	2.0	0.183	19.2	LOSC	0.6	4.0	0.86	0.92	14.3
North: N	North Bea	ch Road North									
7	L	5	2.0	0,537	10.8	LOSB	0.0	0.0	0.00	0.74	50.8
8	Т	1018	3.5	0.537	0.0	LOSA	0.0	0.0	0.00	0.00	60.0
Approa	ch	1023	3.5	0.537	0.1	NA	0.0	0.0	0.00	0.00	60.0
All Vehi	ides	1346	3.4	0.537	2.6	NA	2.5	18.3	0.21	0.03	54.7

Table 3: SIDRA results for the North Beach Road access intersection – PM peak hour (post development stage)

74		Demand		Deg.	Average		95% Back			Effective	Average
Mov ID					Delay	Service	Vehicles	Distance	Queued	Stop Rate	
South:	North Boo	veh/h ach Road Sout	%	v/c	sec		veh	m		per veh	km/h
2	T T	606	3.5	0.332	1.4	LOSA	2.7	19.3	0.50	0.00	51.3
3	R	19	2.0	0.332	12.6	LOSB	2.7	19.3	0.50	0.75	48.5
Approa		625	3.5	0.332	1.8	NA	2.7	19.3	0.50	0.02	51.2
East: A	ccess Roa	ad East									
4	L	10	2.0	0.033	6.6	LOSA	01	0.8	0.48	0.45	23.1
6	R	7	2.0	0.033	6.8	LOSA	0.1	0.8	0.48	0.67	22.8
Approa	ch	17	2.0	0.033	6.7	LOSA	0.1	0.8	0.48	0.54	23.0
North: N	North Bea	ch Road North	ļ								
7	L	13	2.0	0.151	10.8	LOSB	0.0	0.0	0.00	0.74	50.8
8	Т	274	3.5	0.151	0.0	LOSA	0.0	0.0	0.00	0.00	60.0
Approa	ch	287	3.4	0.151	0.5	NA	0.0	0.0	0.00	0.03	59.6
All Vehi	icles	929	3.4	0.332	1.5	NA	2.7	19.3	0.35	0.04	53.3

The results of the SIDRA analysis of the North Beach Road access intersection for the morning and afternoon peak hour period indicate that this intersection operates with an acceptable overall level of service.

The longest delays and queuing are anticipated in the AM peak hour with about 20sec delays for right-turn movements into the subdivision and outbound traffic from the subdivision. The queues in the northbound direction are estimated to be in order of three vehicles; however, it is anticipated that the stationary vehicles waiting to turn right into the site would queue within the existing median of North Beach Road allowing the northbound traffic to safely bypass them. As such, it is anticipated that the practical impact on the northbound traffic would be minimal. North Beach Road southbound traffic will experience minimal delays as traffic turning left into the subject site will not be impeded. As such it is concluded that the subdivision traffic would have moderate impact on the traffic operations of North Beach Road.

Importantly, the North Beach Road access intersection retains a sufficient level of spare capacity during both peak hours in the post-development stage.

The capacity assessments of the North Beach Road access intersection for the AM and PM peak hours in the ultimate stage (year 2024) are presented in **Tables 4** and **5**.

The capacity assessment of the North Beach Road access intersection for the ultimate stage shows moderate and proportional increases in delays and queues on all but northern approaches to the intersection. The longest delays of up to 33sec are anticipated on the Access Road approach; however, queues on this approach would seldom exceed two vehicles.

The access intersection will continue to operate in a similar manner in year 2024.

Table 4: SIDRA results for the North Beach Road access intersection – PM peak hour (ultimate stage)

Moven	nent Per	formance - V	ehicles								
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back Vehicles veh	of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South: I	North Bea	ich Road South		1000,000,000							
2	T	308	3.5	0.190	13.4	LOSB	3.8	27.1	1.00	0.00	40.8
3	R	10	2.0	0.190	24.5	LOSC	3.8	27.1	1.00	1.02	37.4
Approa	ch	318	3.5	0.190	13.7	NA	3.8	27.1	1.00	0.03	40.7
East: A	ccess Roa	ad East									
4	L	30	2.0	0.400	33.1	LOSD	1.3	9.3	0.92	1.07	10.2
6	R	26	2.0	0.400	33.3	LOSD	1.3	9.3	0.92	1.07	10.0
Approa	ch	56	2.0	0.400	33.2	LOSD	1.3	9.3	0.92	1.07	10.1
North: N	North Bea	ch Road North									
7	L	9	2.0	0.594	10.8	LOSB	0.0	0.0	0.00	0.74	50.8
8	T	1124	3.5	0.594	0.0	LOSA	0.0	0.0	0.00	0.00	60.0
Approa	ch	1133	3.5	0.594	0.1	NA	0.0	0.0	0.00	0.01	59.9
All Vehi	des	1507	3.4	0.594	4.2	NA	3.8	27.1	0.24	0.05	52.4

Table 5: SIDRA results for the North Beach Road access intersection – PM peak hour (ultimate stage)

		Demand		Deg.	Average		95% Back	of Queue	Prop.	Effective	Average
Mov ID					Delay		Vehicles	Distance	Queued	Stop Rate	
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South:	North Bea	ich Road South	1								
2	T	669	3.5	0.371	1.8	LOSA	3.3	24.1	0.56	0.00	50.4
3	R	26	2.0	0.371	13.0	LOSB	3.3	24.1	0.56	0.78	48.2
Approach		695	3.4	0.371	2.3	NA	3.3	24.1	0.56	0.03	50.3
East: A	ccess Roa	nd East									
4	L	14	2.0	0.062	8.4	LOSA	0.2	1.4	0.54	0.51	21.2
6	R	12	2.0	0.062	8.6	LOSA	0.2	1.4	0.54	0.71	20.9
Approa	ich	26	2.0	0.062	8.5	LOSA	0.2	1.4	0.54	0.60	21.1
North: 1	North Bea	ch Road North									
7	L	23	2.0	0.171	10.8	LOSB	0.0	0.0	0.00	0.74	50.8
8	T	302	3.5	0.171	0.0	LOSA	0.0	0.0	0.00	0.00	60.0
Approa	ich	325	3.4	0.171	0.8	NA	0.0	0.0	0.00	0.05	59.3
All Vehi	ides	1046	3.4	0.371	2.0	NA	3.3	24.1	0.39	0.05	52.4

6.0 Traffic Management on the Frontage Streets

North Beach Road, is 11m wide, boulevard-style road with one lane in each direction and a 2.5m wide combined painted and raised median. It entails a shared path along the western side and pedestrian footpath becoming a shared path south of the site on the eastern side of the road. Refer **Figure 4** for more details.



Figure 4. Southbound view along North Beach Road in the vicinity of the future access intersection

In the vicinity of the subject site North Beach Road operates under a sign-posted speed limit of 60km/h.

According to the Main Roads WA Metropolitan Functional Road Hierarchy, North Beach Road is classified as a Distributor B road.

Based on the latest traffic count information available from Main Roads WA, North Beach Road (south of Balcatta Road) carried about 8,550 vehicles per day in August 2012. The morning peak hour (8:00 – 9:00AM) recorded 1,128vph while the afternoon peak hour (4:00 – 5:00PM) recorded 765vph.



Figure 5. Northbound view along North Beach Road in the vicinity of the future access intersection

7.0 Public Transport Access

The subject site has limited exposure to public transport facilities. Bus route 424 was until recently operating along North Beach Road; however, due to a recently developed residential subdivision of substantial size immediately east of Careniup reserve (east of Careniup Avenue) route 424 was diverted to pass through this subdivision in lieu of the former route. However, route 424 still operates along Balcatta Road with nearest bus stops approximately 300m walking distance from the subject site.

This bus service provides connection to Stirling Train Station (Clarkson rail line) and Karrinyup Bus Station thus facilitating even wider connectivity to the greater metropolitan area. Details of the local bus services are illustrated in **Figure 6**.



Figure 6: Local public transport service map (Transperth Maps)

8.0 Pedestrian Access

Pedestrian access to the proposed development would be facilitated directly from the existing shared paths and footpaths along North Beach Road.

Pedestrian crossing opportunities are located on North Beach Road (145m north and 40m south of the site) including the North Beach Road/Balcatta Road roundabout intersection (approximately 210m to the north of the site) enabling access to the nearby bus stops.

9.0 Cycle Access

The Perth Bicycle Network Map (see **Figure 7**) indicates relatively good pedestrian and cyclist connectivity to the subject site. A shared path is in place along North Beach Road, Balcatta Road and Erindale Road connecting to the Principal Shared Paths along Mitchell Freeway and Reid Highway further to the east and north, respectively. Another recreational shared path is in place around Gwelup Lake to the southwest of the subdivision. The existing shared path system also provides connectivity to the nearby Lake Gwelup Primary School.



Figure 7: Extract from Perth Bicycle Network (Department of Transport)

10.0 Site Specific Issues

No particular site specific issues have been identified for the proposed residential development.

11.0 Safety Issues

A preliminary assessment of potential sight lines at the proposed access intersection on North Beach Road was undertaken as part of the site inspection process. This assessment was undertaken for the approximate location of the access intersection as shown in the proposed subdivision plan.

The preliminary assessment indicates that the required 141m safe intersection sight distance for a 60km/h road (design speed of 70km/h), measured from the minimum setback distance of 3m back from the edge of the traffic lane is met. Refer **Figure 8** for more details.



Figure 8: Sight distance at proposed access intersection on North Beach Road

The following photos are taken from the approximate location of the proposed access intersection on North Beach Road and are for illustration purpose only. Refer **Figure 9** and **Figure 10**.



Figure 9: Northbound view along North Beach Road from approximate location of the proposed subdivision access



Figure 10: Southbound view along North Beach Road from approximate location of the proposed subdivision access

No other safety issues were identified for the proposed residential development.

12.0 Conclusions

This transport statement provides information on a proposed residential subdivision yielding 61 residential lots, located on Lots 500 & 501 North Beach Road in Gwelup, City of Stirling.

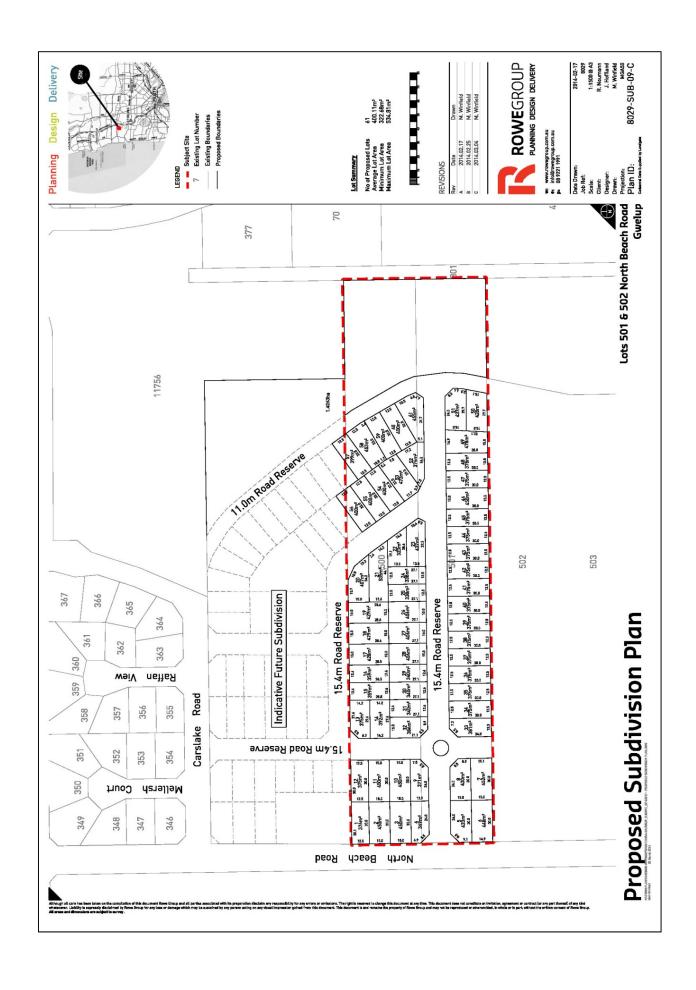
The internal subdivision road system is designed to integrate seamlessly with the future residential subdivisions to the immediate north and south. The subject subdivision is proposed to be served by a single full-movement access intersection on North Beach Road. Capacity analysis of the access intersection confirms satisfactorily operation both in the post-development period as well as for the full locality development scenario.

The site has very good accessibility by the existing road, pedestrian and cyclist network and has good public transport coverage through nearby bus service.

Accordingly, traffic issues should not form an impediment for the approval of the proposed subdivision.

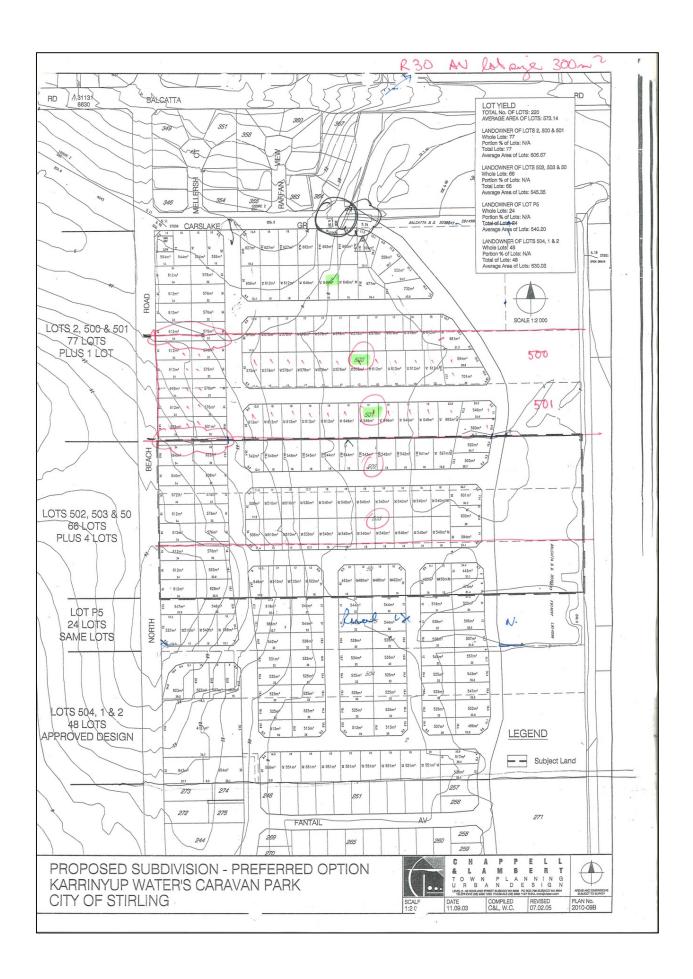
Appendix A

LOTS 500 & 501 SUBDIVISON PLAN



Appendix B

PROPOSED SUBDIVISION (PREFERRED OPTION) KARRINYUP WATERS CARAVAN PARK



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CLIENT: GWELUP LAND DEVELOPMENTS Pty Ltd

PROJECT: LOTS 500 and 501, NORTH BEACH ROAD, GWELUP TITLE: PRELIMINARY ENGINEERING INFRASTRUCTURE REPORT

DOCUMENT REVIEW					
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1 INTRODUCTION

This report has been prepared by TABEC Pty Ltd to provide broad servicing and infrastructure advice for the proposed subdivision of Lots 500 and 501, North Beach Road in Gwelup. The site is in the City of Stirling.

This report has been based on the civil engineering aspects of residential related land uses and summarises the availability of existing infrastructure assets in proximity to the landholding and the potential engineering infrastructure requirements to support urban development within the study area.

The investigation and preparation of the report are largely based on preliminary advice from the various service authorities. The information is current as of March 2014 and is subject to change as the development process proceeds and more information becomes available from the various authorities.

2 THE STUDY AREA

The proposed development site is approximately 4.1 hectares and is located on North Beach Road. The site is bounded by Lot 2 and Carslake Grove to the north and Lake Careniup to the east. To the south of the proposed development site is an existing caravan park. The site is approximately 400 metres in depth and 100 metres in width fronting North Beach Road.

Currently on site there are existing houses, sheds and other storage facilities. The site has generally been cleared however there remains some trees and scattered vegetation. There are similar site conditions to the immediate north on Lot 2, however surrounding areas have previously been subdivided and developed. On the opposite side of North Beach Road is the Karrinyup Golf Course.

The Proposed Subdivision Plan is included in Figure 1 and provides the basis for preliminary development assessment. This plan may be refined further as the planning detail is progressed.

2.1. Topography

From the preliminary survey information available, it can be seen that the site generally grades toward the eastern boundary, where the existing Lake Careniup and wetland area is located. The existing levels along North Beach Road vary between approximately 14m to 11m AHD, with the trapped low point in North Beach Road near the boundary of Lot 2. The site falls away from North Beach Road at grades of approximately 5%. The site then levels and the central areas are at approximately 8m AHD. Along the eastern boundary the site falls away further toward Lake Careniup and levels of about 7m AHD exist.

The fall across the site in the easterly direction appears consistent with the developed levels within the caravan park to the immediate south.

2.2. Acid Sulphate Soils

The Perth Groundwater Atlas indicates that the majority of the site has no known risk of any acid sulphate soils occurring. However, the eastern portion as it falls away into Lake Careniup is identified as being at high to moderate risk of encountering acid sulphate soils.

Based on the site testing completed by Prompt Engineering in November 2013, the preliminary evaluation of acid sulphate soil testing indicates there is an inferred moderate risk of potential acid sulphate soils from the samples taken.

The Water Corporation has advised the 100 year top water level in Lake Careniup is predicted to be at 6.6m AHD. From the borehole testing completed on site, the groundwater level appeared to vary between



approximately 6.0 and 6.5m AHD however this will need to be evaluated further to confirm the contours of the Annual Average Maximum Groundwater Levels (AAMGL) which will determine the minimum development elevation.

It is expected that during subdivision works and services installation, the groundwater table will be intersected. Therefore, the risk of encountering acid sulphate soils should be investigated further. It is also expected that dewatering licenses will also be required for this purpose.

2.3. General

Site works for urban development comprises the clearing of existing vegetation, demolition of the existing house, sheds and other facilities on site and earth working of existing ground surfaces to facilitate a required form of development.

Earth working of the site, particularly lot areas and road reserves will be required to ensure the positive drainage of the lots to the road reserves.

3 EARTHWORKS

Ground conditions vary across the site and a significant earthworks program will be required to adequately prepare the site to support residential development. Preliminary geotechnical investigations have been carried out by Prompt Engineering.

Earthworks will involve initially stripping approximately 250mm of topsoil. Part of this material may require disposal off site, however there may be some opportunity to undertake blending operations and bury at depth. Further investigations would be required to assess this option.

The western portion of the site is predominately sand and silty sand at medium to course grained with the material derived from Tamala Limestone. In the eastern portion, where the site falls into the wetland area, peaty clay materials were found.

The majority of the site in the sand areas will achieve Class A however the wetland area at the eastern portion of the site requires significant ground improvement to achieve Class M to Class S lots.

Given the peat material is compressible only and is not reactive like clays we are advised the material will not expand and the peat may remain on site under appropriate site preparation procedures.

The recommended ground improvement requirements in the locations where peaty clay is found are described in the geotechnical report which details how the natural peaty soils may remain in place. The material should be compacted through high impact energy dynamic compaction techniques. It is understood that this methodology is effective up to a maximum depth of 4 metres.

The peat material will then be covered with a tensar grid and brought up to finished design level with structurally suitable sand. Tensar sheets shall be applied between every 1.0 metre of sand fill.

We are advised that to achieve Class S in the locations of peat materials, at least 1.8 metres of sand fill will be necessary. Based on the estimated ground contours on site, the wetland areas may require up to 3m of sand. The resulting site classification in the wetland/peaty area will only be determined post earthworks upon CPT and load bearing testing by the geotechnical engineer.

It is noted the peaty area must be well defined and the boundary between Class A and the Class M-S areas for site preparation requirements must be clearly documented through more detailed geotechnical investigations.

Dilapidation surveys will be necessary given the proximity to neighbouring structures and services.



3.1. Retaining Walls

Due to the significant volume of imported fill required, particularly in the eastern portion of the site to adequately elevate development levels above ground water and flood levels, it is anticipated that retaining wall construction to manage the level differences will be necessary. This will also apply along the western boundaries where grades of up to 5% currently exist.

Development is proposed along the southern boundary with filling required in an existing lake. Significant site remediation will be necessary and the interface to the caravan park on the immediate south will require either an earth batter, or a significant wall. Negotiations should be undertaken with the adjoining landowner to ensure the proposed level differences are managed to the satisfaction of all parties.

Similarly where the site falls toward towards Lake Careniup where it is anticipated that an earth batter, or a combination of retaining walls and batters will be necessary to provide an interface to match the natural levels. The extent of works in this area is anticipated to extend substantially beyond the road reserve boundary as it is indicated on the Proposed Subdivision Plan in Figure 1.

It is proposed that any retaining walls would be constructed from reconstituted limestone as is common industry practise.

4 ROADWORKS

Access to Lots 500 and 501 is proposed to be provided via a single road connection onto North Beach Road. It is proposed that six residential lots would front onto North Beach road, with all remaining lots served from newly constructed internal roads. The current subdivision plan shows 5 lots fronting onto Lot 2 and an access agreement suitable to the City of Stirling would need to be established if these lots were created prior to the subdivision of Lot 2.

North Beach Road currently exists with a divided median and single lane traffic in each direction. Traffic islands are located at various locations along North Beach Road and it is expected that modifications would be required to facilitate the new intersection construction. A 4-way intersection and roundabout is proposed inside the development, which would serve ultimate traffic movements associated with the greater structure plan.

The proposed internal subdivision roads within Lots 500 and 501 would be paved with asphalt and kerbed in accordance with relevant City of Stirling guidelines. Alternative treatments such as brick paving and coloured asphalt may be incorporated which will be resolved at the design stage. It is anticipated the road reserves will also include pedestrian and dual use path networks.

5 STORMWATER DRAINAGE

Due to the sandy nature of soils and the elevated nature of the western portion of the site, good drainage through soak wells within subdivided lots should be available. While peaty materials are known to exist in the eastern areas, it is expected that at least 2 metres of clean sand fill will elevate the development levels above peaty clay material. Therefore, it is expected that soak wells would be adequate in these areas of residential development also.

The site will generally be graded in an easterly direction following the natural contours on site. A Stormwater Catchment Plan has been prepared which is included in Figure 2, showing the road reserve areas and Lot 2 is



also identified given a future subdivision on this land is likely to direct storm water flows toward the eastern boundaries and possibly through Lot 500 as well.

A Local Water Management Strategy (LWMS) is separately being prepared which will address the design flows in each of the major storm events with intended treatment detailed for this purpose.

AAMGL levels will also be confirmed with onsite monitoring which is currently ongoing with groundwater bores which have previously been installed on site. The earthworks design will ensure that finished development levels are preferably 1.5m above AAMGL and suitably elevated above flood levels in Lake Careniup also.

The detailed drainage management measures will ultimately be defined and implemented through an Urban Water Management Plan (UWMP) under both Department of Water and City's approval. It is expected that a UWMP will be a Western Australian Planning Commission (WAPC) condition of subdivision.

The piped stormwater system would be designed and constructed according to City of Stirling guidelines and specifications to capture and direct flows for the 1 in 5 year storm event. Events greater than the 1 in 5 will be directed through overland flood paths to appropriate drainage facilities.

It is intended that the 1 in 1 year storm event will be treated in a swale facility along the eastern boundary of the development. Events greater than the 1 year may overflow into the wetland area however this will be detailed and reviewed through LWMS reporting.

Provision will also be made for the Water Corporation's main drain facility and it is noted that a required minimum volume be maintained in the wetland area. Earthworks designs will need to consider and ensure this design requirement is met.

6 WASTEWATER

Lots 500 and 501 fall into two separate catchments on Water Corporation's broad waste water servicing strategy. The existing catchment plan for the site is included in Figure 3. The ultimate scheme planning to serve the proposed subdivision involves the extension of existing waste water services located approximately 200 metres south of the site in Water Crest Gardens and Swiftlet Way. Between these existing assets and the development site is a vacant property and also an existing caravan park and therefore connections to these services may prove problematic.

The opportunity to construct waste water services in accordance with Water Corporation's ultimate planning will be investigated through negotiations with the existing land owners to assess the viability of waste water construction that suits ultimate planning.

There is an existing waste water pump station opposite Lot 2 on Careniup Ave, identified as Balcatta PS 9 which has an estimated long term pump rate of 14.4L/s. This pump station is served via gravity sewer mains in Carslake Grove and also in Careniup Avenue. The existing services in Careniup Ave are approximately 170m to the immediate east of the site.

It would be unfeasible to grade the site toward gravity waste water mains in Carslake Grove due to the limited cover however another possible design solution may involve a bored connection under Careniup Lake to Careniup Avenue. Investigations should be undertaken to assess the potential for reduced development levels by grading internal waste water services to the eastern boundary, with a bored connection to Careniup Ave. One benefit of this design option would be a more compatible interface on the project boundaries with the reduced level differences to the south where the caravan park is located.

A copy of Water Corporation's existing waste water assets is included in Figure 4 showing existing services surrounding the development site.



Within the subdivision of Lots 500 and 501, the development would be served via a gravity fed network designed in accordance with the Water Corporations specifications. Additional fill beyond the naturally occurring levels to facilitate waste water design will be necessary as a controlling aspect of civil design. Standard Water Corporation headwork's contributions are expected to apply to the project.

7 WATER SUPPLY

Currently there is an existing 300mm diameter water main and also a 100mm reticulation water main in the western and eastern North Beach Road verges respectively. There is also a 100mm main in Carslake Grove providing services to existing residential development to the north of the site. The existing network surrounding the site has adequate capacity to support the development proposal.

Water Corporation's scheme planning indicates that the subdivision of Lots 500 and 501 may be served through a 150mm water main connection through the entry road. A bored connection under North Beach Road will be necessary to provide a water main connection to the existing 300mm asset due to required demand flows. The subdivision would be served internally through 100mm reticulation mains.

The internal water main construction would extend to the development boundaries to cater for future main extensions.

The existing water reticulation infrastructure plan is shown in Figure 5. It is advised that standard Water Corporation head works contributions are expected to apply.

8 POWER SUPPLY

There is existing high and low voltage overhead power cables on North Beach Road fronting Lots 500 and 501. The overhead power will need to be removed and relocated underground and existing power connections to properties affected converted to underground supplies. The commercial property on Lot 2 on the immediate north may require a supply greater than 100amps which will need to be considered and detailed. There is also a re-closer on an existing pole which will need to be relocated and Western Power will cost these items into their quote during detailed design stages.

Category V3 according to the Australian Standard for street lighting will be required along North Beach Road where the overhead power cables are removed. These street lights will be either 10.5 or 12.5 metre Western Power standard galvanised streetlights unless specified otherwise.

There is an unmetered supply pit on North Beach Road, near the corner of Carslake Grove supplying Telstra equipment. This equipment may also require relocation if necessary.

A high voltage concept plan will be required for the overall structure plan and it is likely that a transformer will be required near the entrance off North Beach Road. A switchgear unit will also be required in the same location.

Works within the subdivision boundary would be designed with consideration to the surrounding proposed development areas. Therefore, the standard high voltage pool and subdivision policies will apply. Street lights would be required as per the City of Stirling policy.

The effects of any earth potential rise (EPR) issues will need to be investigated, however if any high pressure steel Water Corporation or gas pipelines are in the vicinity extra investigation and reporting would be required.



The details in this report are only indicative. Further in-depth study and analysis can only be required to determine the exact requirement of any (if required) reinforcement works once a formal application to Western Power has been lodged.

Western Power will neither reserve capacity nor guarantee supply to this development without a formal request being lodged.

9 TELECOMMUNICATIONS

NBN Co is responsible for the installation of fibre in all broad acre developments of 100 or more premises within the long term optic fibre footprint. For this purpose, a developer agreement will be necessary prior to any construction works commencing. However, as Lots 500 and 501 are unlikely to qualify independently, it may be possible to create a developer agreement based on the greater surrounding areas in view of the surrounding demand, and potential to include the future subdivision of Lot 2 to achieve the 100 lot criteria.

In any case, communications pit and pipe designs are required to be 'fibre ready' and the developer is responsible for providing infrastructure throughout the subdivision to meet this design requirement. Should a developer agreement not be reached with NBN Co then it is likely that Telstra would install copper through the NBN ready, pit and pipe network.

It is noted the communications design may require the inclusion of Fibre Distribution Hub (FDH) within a road reserve which is an unpowered, street side cabinets used to provide an optical connection point between the distribution and local network. Given the likely hood of Telstra installing copper in the interim for this subdivision, this may be resolved at a later date.

10 GAS SUPPLY

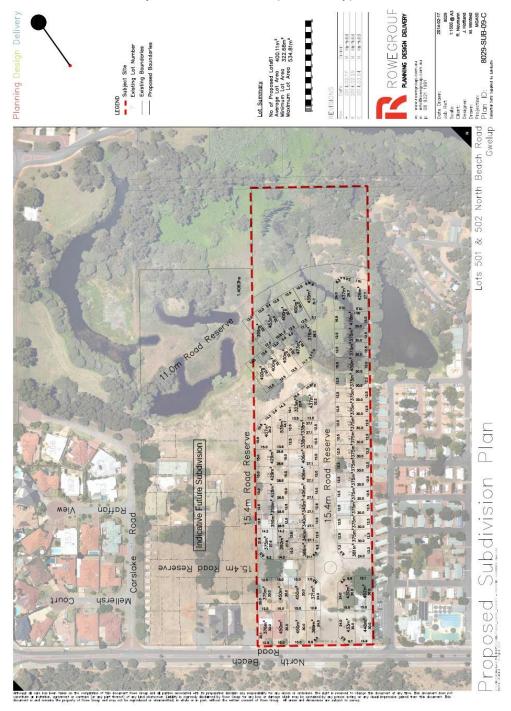
There are existing gas mains in North Beach Road as shown in Figure 6 which includes a 155mm medium pressure PVC line in the western verge and an 80mm medium pressure PVC line in the eastern verge of North Beach Road. These existing assets provide reticulated gas services to existing residents in the surrounding areas.

It is expected that connections and extensions of these gas mains could be provided to serve the development of Lots 500 and 501. Internal gas supply will be provided to each lot through common trenching at no additional cost to the project. There may be a requirement to provide a bored connection under North Beach Road to allow a service connection to the larger gas main. Works off site outside of normal common trenching may carry a cost component.



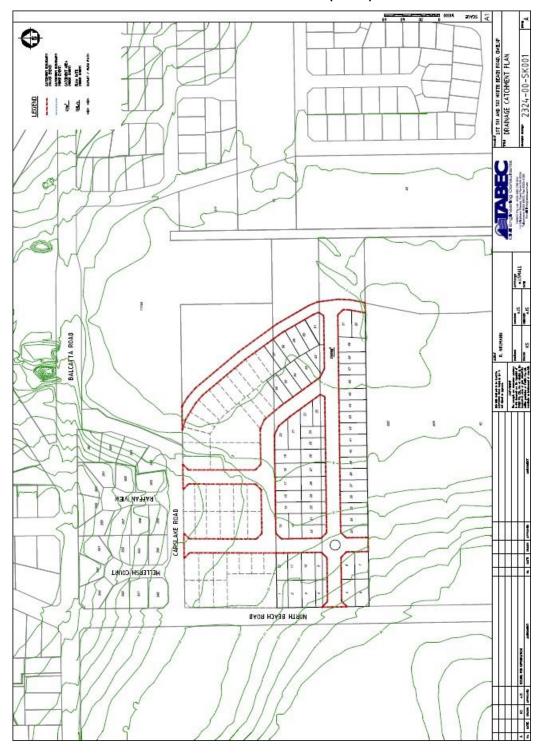
FIGURE 1

Proposed Subdivision Plan (Rowe Group)

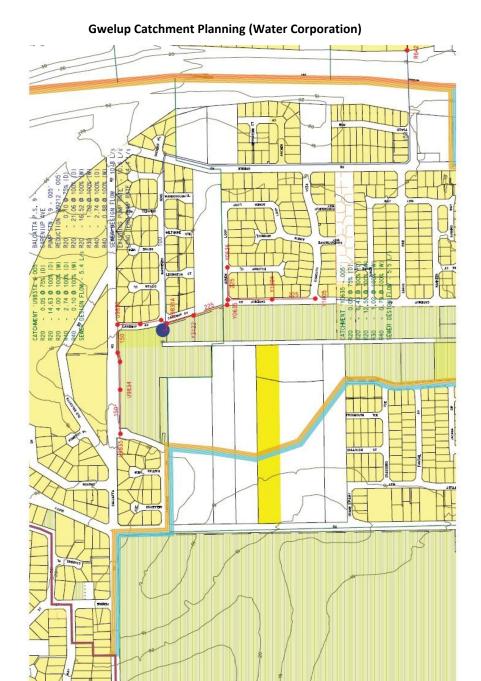




Stormwater Catchment Plan (TABEC)

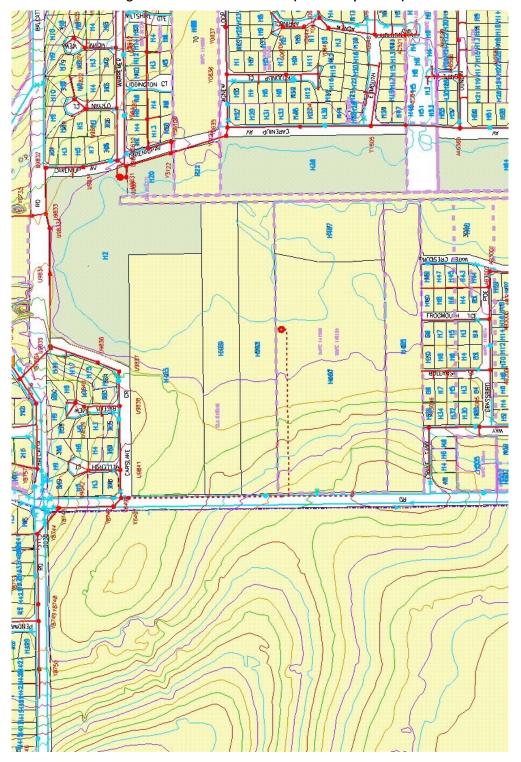






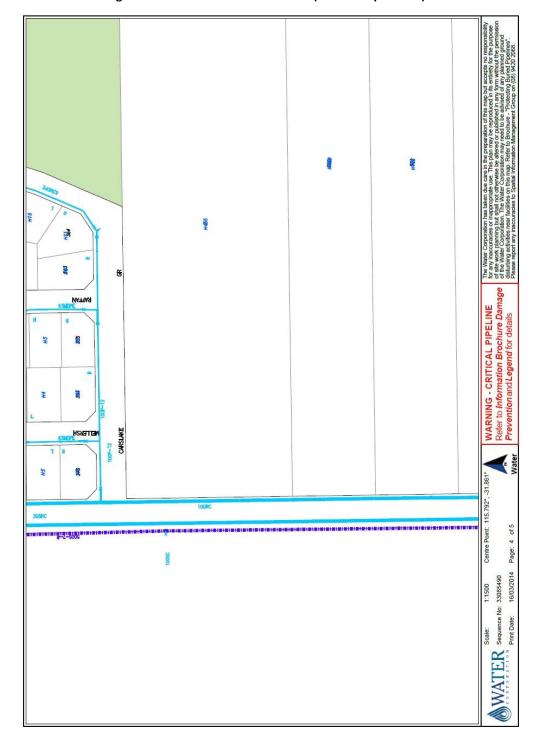


Existing Waste Water Infrastructure (Water Corporation)



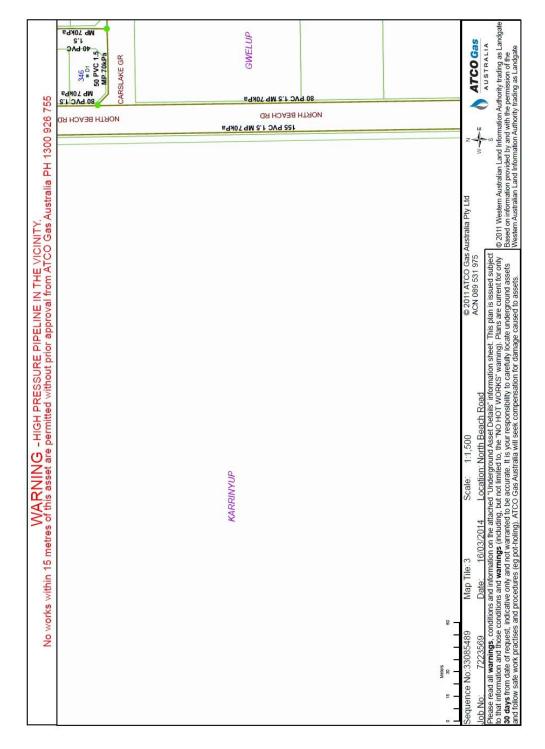


Existing Water Reticulation Infrastructure (Water Corporation)





Existing Gas Mains (ATCO Gas, March 2014)











CIVIL, STRUCTURAL & GEOTECHNICAL







SITE INVESTIGATION

Lots 500 & 501, #459 & #463 North Beach Road, Gwelup, Western Australia.



Submitted to: ATTEST PTY LTD

15 November 2013

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1.0 Introduction

This report presents the results of a *preliminary site investigation* carried out by Prompt Engineering for the proposed residential subdivision development located at Lots 500 & 501, #459 & #463 North Beach Road, Gwelup, Western Australia. The work was authorised by *Attest Pty Ltd*. The proposed site consists of two lots with a typical rectangular shaped. It is bounded by residential lot to the north, by North Beach Road to the west, by Lake Careniup to the east, and by residential lot with existing residence to the south as shown on the site plan. There are existing houses, sheds, storage and other facilities within the site property. Most of the area is partially vegetated with small to medium trees. The topography of the whole site is slightly sloping from the west boundary (North Beach Road) for some distance towards the east direction, and then generally flat for some distance towards the rear boundary (Lake Careniup). We understand that the existing houses, sheds and other facilities are to be demolished and removed, and the whole site is to be developed for mixed use residential development purposes.

2.0 Objectives

The main objectives of the site investigation were to:

- Identify subsurface soil condition, and identify the approximate extent and thickness of the peaty soils:
- Provide recommendations on suitable footing systems; and
- Provide site classification in accordance with AS 2870-2011 "Residential Slabs and Footings";

3.0 Fieldwork

Fieldwork for the site investigations were carried out on 5th, 8th and 11th of November, 2013, under the full time presence of a geotechnical engineer, and consisted of the following:

- Drilling of 11 boreholes to a depth of 2.5m for visual and tactile investigation of the subsoil layers and soil profiling and sampling for acid sulphate contamination testing.
- 9 Perth Sand Penetrometer Test (PSP) to a depth of approximately 2.0m for evaluation of relative densities and compressibility of the upper layers, and
- 4 Electric Friction Cone Penetrometer Test (EFCPT) to a depth up to 8.0m to investigate the subsoil layers, soil profiling and also to determine relative density and ground compressibility of the deep layers.
- Seismic survey including HVSR testing for deep soil profiling and subsurface cross-section.

All boreholes were visually logged and classified according to the Unified Soil Classification System. Boreholes, CPT, PSP and HVSR test locations are shown on the attached site plan.

4.0 Site Conditions

4.1 Geological Setting

The *Perth* 1:50,000 Environmental Geology Series Sheet Part Sheet 2003 I and 2133 IV, prepared by the Geological Survey of Western Australia, indicate that the site is underlain with:

- SAND derived from Tamala Limestone (S7); pale and olive yellow, medium to coarse grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin on the east half section of the site property, and
- Swamp Deposits (Cps); PEATY CLAY; dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin on the west half section of the site property.

4.2 Ground Elevation & Ground Water

- The Groundwater Atlas (Waters and Rivers Commission Website 2nd Edition) indicates that the natural ground surface level on this site is approximately ranging from 12.0mAHD (Australian Height Datum) on the western boundary to 7.0mAHD (Australian Height Datum) on the eastern boundary.
- The May 2003 maximum-recorded groundwater level at this site is 5.0m AHD (Australian Height Datum). The ground water levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

4.3 Results of Investigations

4.3.1 Soil Profile

Based on the results of site investigations, the subsurface profiles encountered on the site generally concurs with the regional geology for the area and comprises of natural SAND derived from Tamala Limestone with the exception occurred at the eastern side close to the lake where alluvium and swamp deposits were encountered.

The soil profiles encountered in the boreholes and CPTs is generally overlain with typical sand (with variable densities) derived from Tamala Limesotone, which can be described as following: SAND / Silty SAND; medium to coarse grained, low to non plasticity silt, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, dry, light brown/orange. Fill materials were encountered up to 3.0m below the existing ground level (E.G.L.).

Detailed descriptions of the subsurface soil conditions encountered from boreholes, CPTs and PSP readings are also attached in this report.

4.3.2 Groundwater

Shallow groundwater was encountered and stabilized at approximately 1.5m below the existing ground level.

4.3.3 Acid Sulphate Testing

The main purpose of ASS testing is to provide an *initial evaluation* of potential (high, medium and low) for each soil sample collected to be ASS. The following criteria are used to evaluate the soil samples for either Actual ASS (AASS) or Potential ASS (PASS).

For actual Acid Sulfate Soil (AASS), a pH_F of less than 4.0 indicates the presence of AASS.

For Potential Acid Sulfate Soil (PASS);

- pH_{FOX} of less than 3.0.
- Difference between pH_F and pH_{FOX} is greater than 3.0.

ALS Group was commissioned by Prompt Engineering to carry out laboratory testing of the natural soil samples encountered within the site. The results of the laboratory testing are attached in this report and summarized below:

- No samples recorded a pH_F of less than 4.0.
- No samples recorded a pH_{FOX} of less than 3.0.
- Two samples recorded a difference between pH_F and pH_{FOX} of greater than 3.0.
- An inferred moderate PASS risk for the two samples.

5.0 Geotechnical Assessment & Recommendation

5.1 Site Classification

AS2870: 2011, Residential Slabs and Footings-Construction provides guidance on site classification for residential slabs and footing design based on the expected level of site movements as follows:

Table 3: AS2870:2011- General Definition of Site Classes				
Class	Foundation			
А	Most sand and rock sites with little or no ground movement from moisture changes			
S	Slightly reactive clay sites with only slight ground movement from moisture changes $(y_s \le 20 \text{mm})$			
М	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes (20 <y₅≤40mm)< td=""></y₅≤40mm)<>			
H1	Highly reactive clay site, which can experience high ground movement from moisture changes (40 <y₅≤60mm)< td=""></y₅≤60mm)<>			
H2	Highly reactive clay site, which can experience very high ground movement from moisture changes (60 <y₅≤75mm)< td=""></y₅≤75mm)<>			
E	Extreme reactive sites, which can experience extreme ground movement from moisture changes (y _s >75mm)			
Р	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.			

Based on the results of the investigation, a site classification **P** is appropriate for the existing site condition. However, the whole site can be classified as Class **A** to Class **S-M** to Class H in accordance to *AS2870:* 2011, Residential Slabs and Footings" subject to additional and final site investigation and sitework preparations.

5.4 Stormwater Drainage

The fine to medium grained natural sand materials encountered within the site have high permeability and are suitable for absorption of storm water runoff through the use of soak wells.

5.5 Shallow Footings

Shallow footings are suitable for the proposed residential development subject to ground improvement to achieve Class A to Class S-M to Class H as shown on the site plan.

Peaty soil was present along the eastern section of the site property. This peaty soil is highly compressible, organic material and consolidates over time, and potentially contaminated (Potential Acid Sulfate Soil).

6.0 References

- WRC (2004) Perth Ground Water Atlas Perth, Western Australia
- PhotoMaps by Nearmap.com
- AS 1170.4-2007
 Structural Design Actions-Earthquake Actions in Australia
- AS 1289 6.3.3 1997 Soil Strength and Consolidation Tests
- AS 1726-1993 Geotechnical Site Investigations
- AS 2870-2011 Residential Slabs and Footings
- AS 3798-2007 Earthworks for Residential and Commercial Developments
- AS 4055-2006 Wind Loads for Housing
- Geology Survey of Western Australia 1:50 000 Environmental Geology Series PERTH (Sheets 2033 I and Parts 2133 IV, 1986)

7.0 Closures

We trust that this information satisfies your present requirements. Should you require clarification of any issues please do not hesitate to contact this office. We thank you for the opportunity of assisting you with this project.

Yours faithfully

PROMPT ENGINEERING

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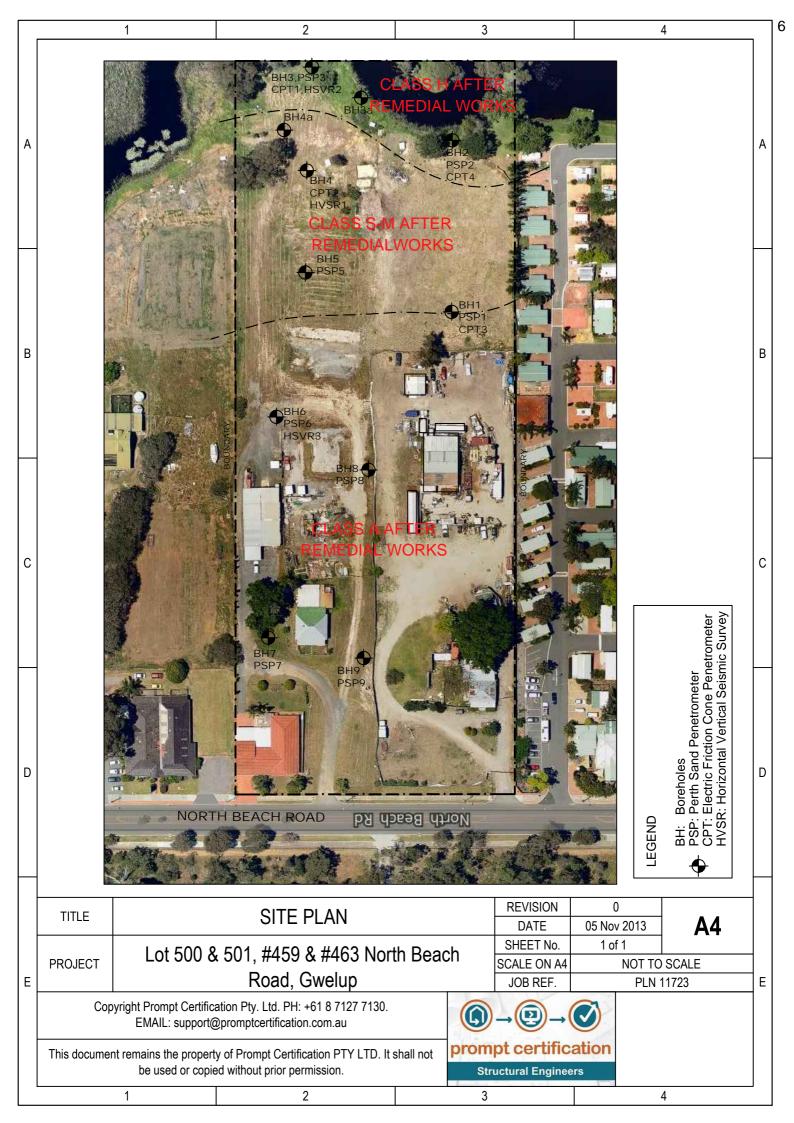
prompt certification

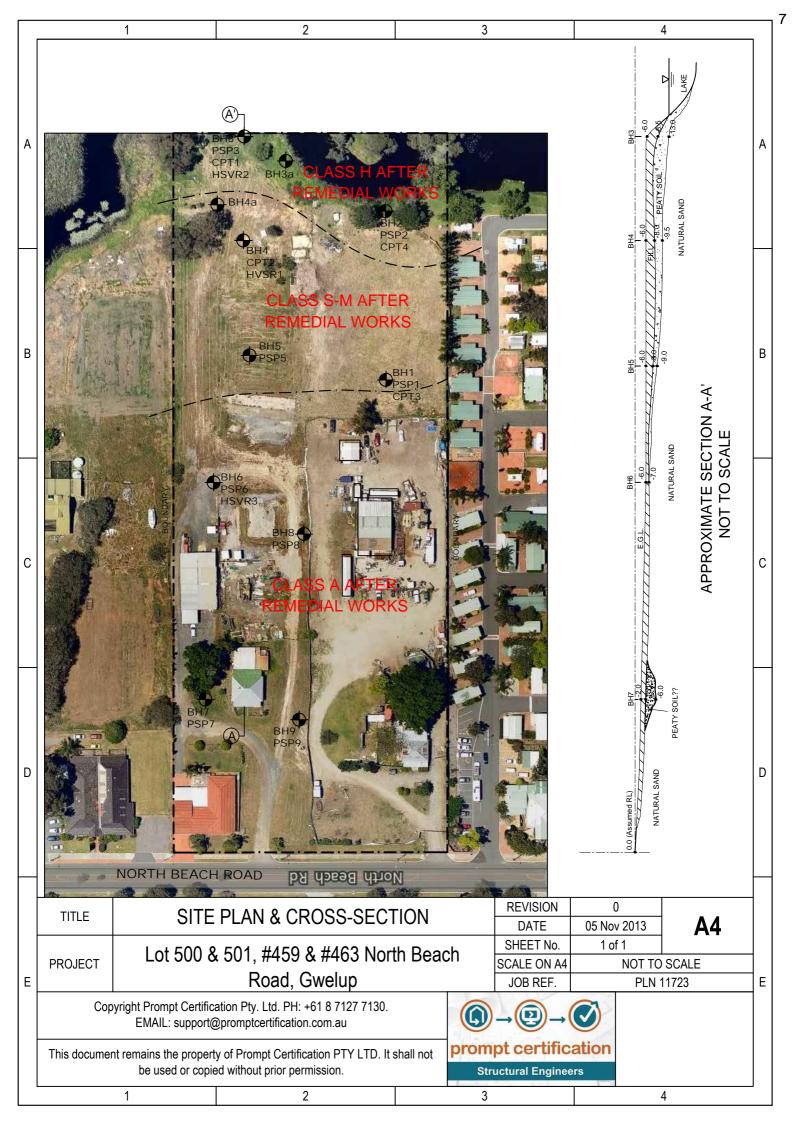
STRUCTURAL ENGINEERING & **GEOTECHNICAL SERVICES**

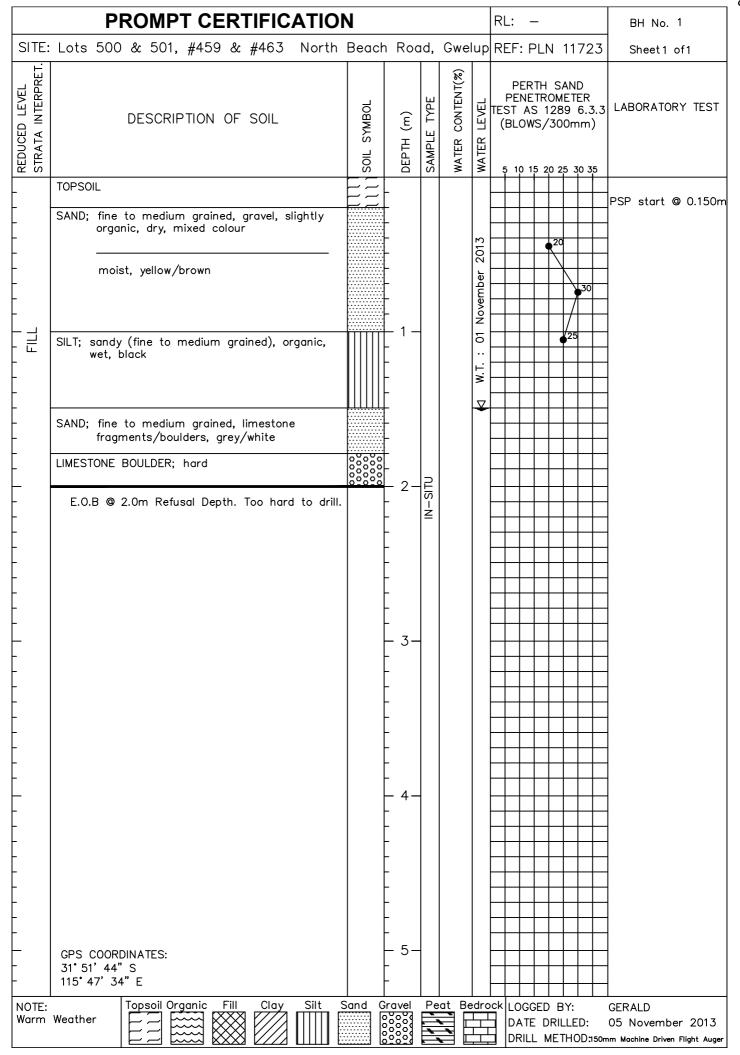


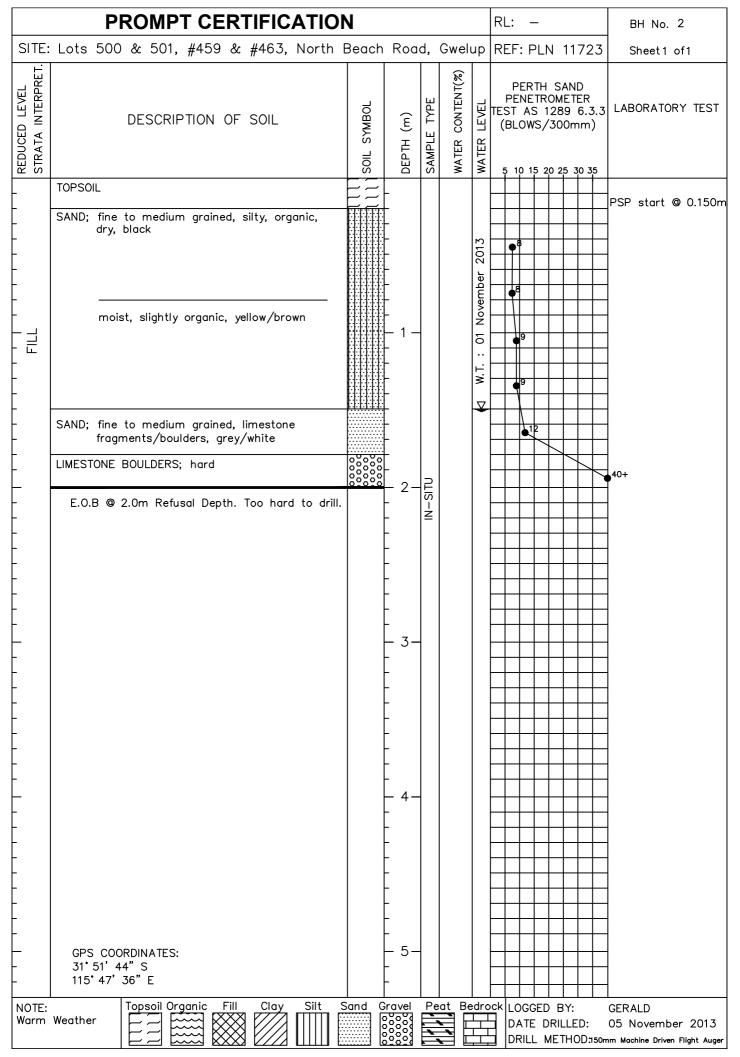
APPENDIX A-LIMITATIONS

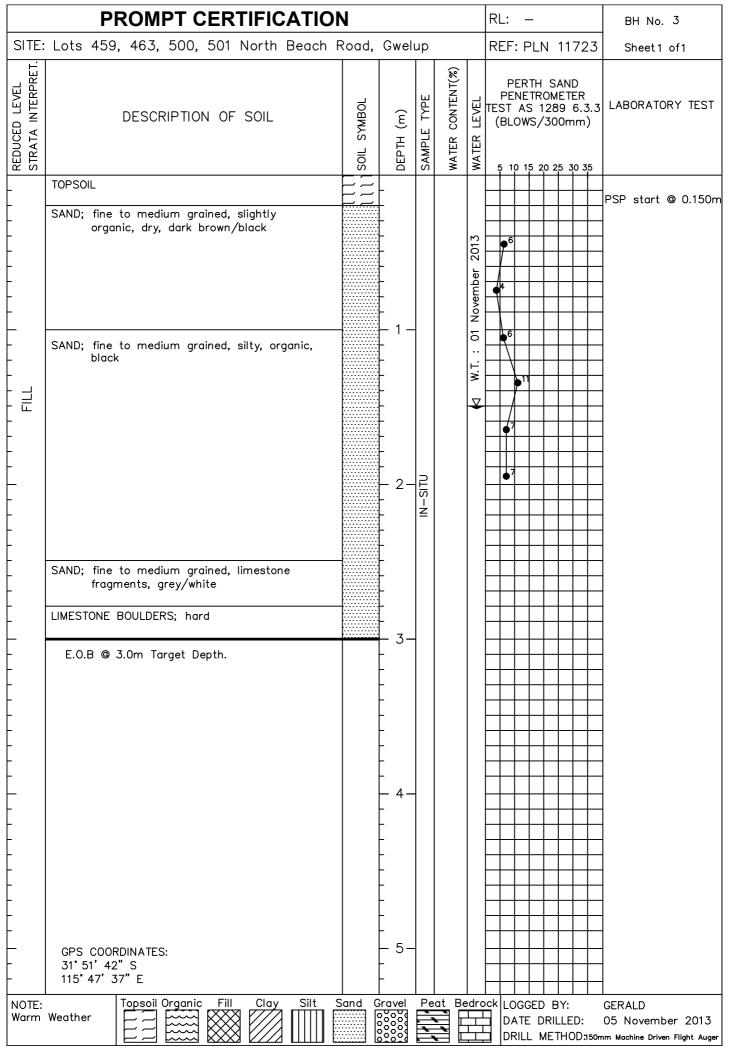
- 1. The conclusions and recommendations given in this geotechnical investigation report are based on the information supplied by the client regarding the proposed development in conjunction with the findings of the site investigation. Any change in construction type, building location or omission in the client supplied information, may require additional testing and/or make the conclusions and recommendations invalid.
- 2. The recommendations herein may identify target soil stratum into which the building foundations should be founded at the time of site investigation. Any cutting or filling works and any surface erosion or deposits subsequent to the site investigation, will alter the measured location of the stratum relative to the ground surface. Where required, this office should be notified in such cases to confirm the location of the target stratum.
- 3. Every reasonable effort has been made to locate the test sites so that the boreholes profiles are representative of the soil conditions within the area investigated. The client should be made aware however, that site exploration is limited by time available. In some cases soil conditions can be change dramatically over short distances, therefore even careful exploration programs may not locate all the variations
- 4. If soil conditions encountered are significantly different from those shown in this report and on which the conclusions and recommendations were based, then this office must be notified immediately.
- 5. This report may not be reproduced except in full. The information and site plans shall only be used and will only be applicable for the developments shown on the clientsupplied information provided for this site.
- 6. Any dimensions, contours, trees locations, slope directions and magnitudes shown on the site plan shall not be used for any construction or costing calculations. The purpose of the site plan is to show approximate location of field tests only.
- 7. Any changes made to this report by persons unauthorised by this office will legally be interpreted at that person assuming the responsibility for the long-term performance of the proposed development.
- 8. Removal of water bores, underground services, and trees from a site before site investigation can cause significant shrinking or swelling of the clayey soil over large areas. The removal of trees from the proposed site during development is rarely picked up during the investigation phase and is generally outside the scope of AS2870:2011. However, sites affected by large trees are often classified as "P". If, during the excavation, it is noted that there are soils with varying moisture contents, or evidence of large trees having been removed, then this office should be notified immediately.

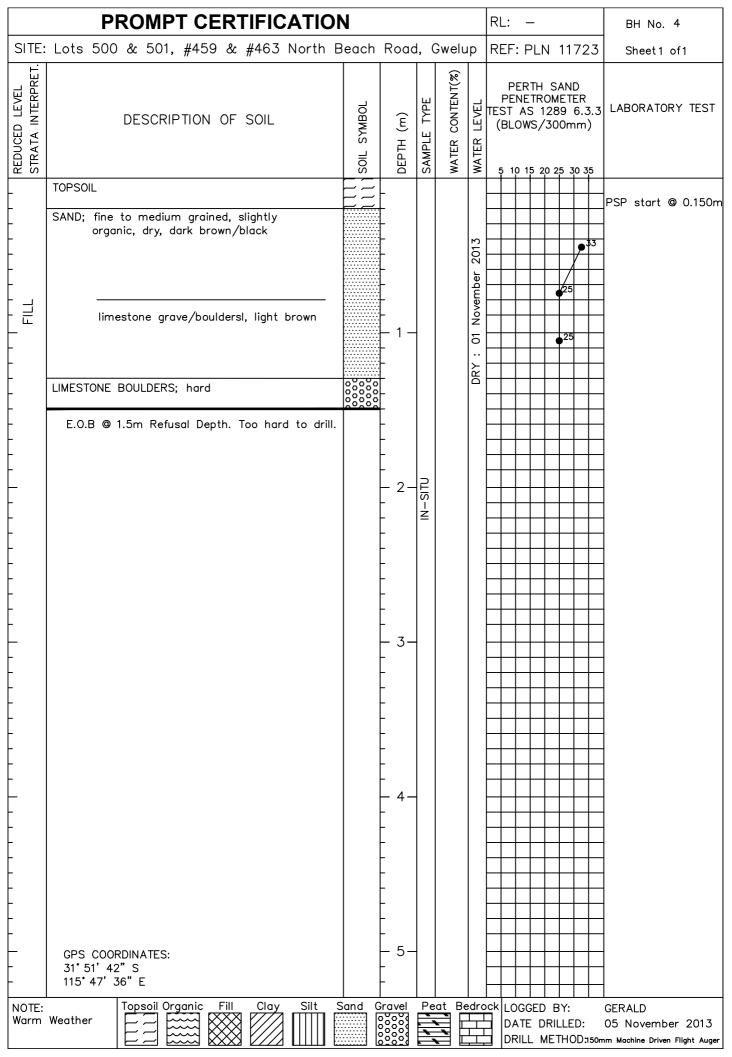


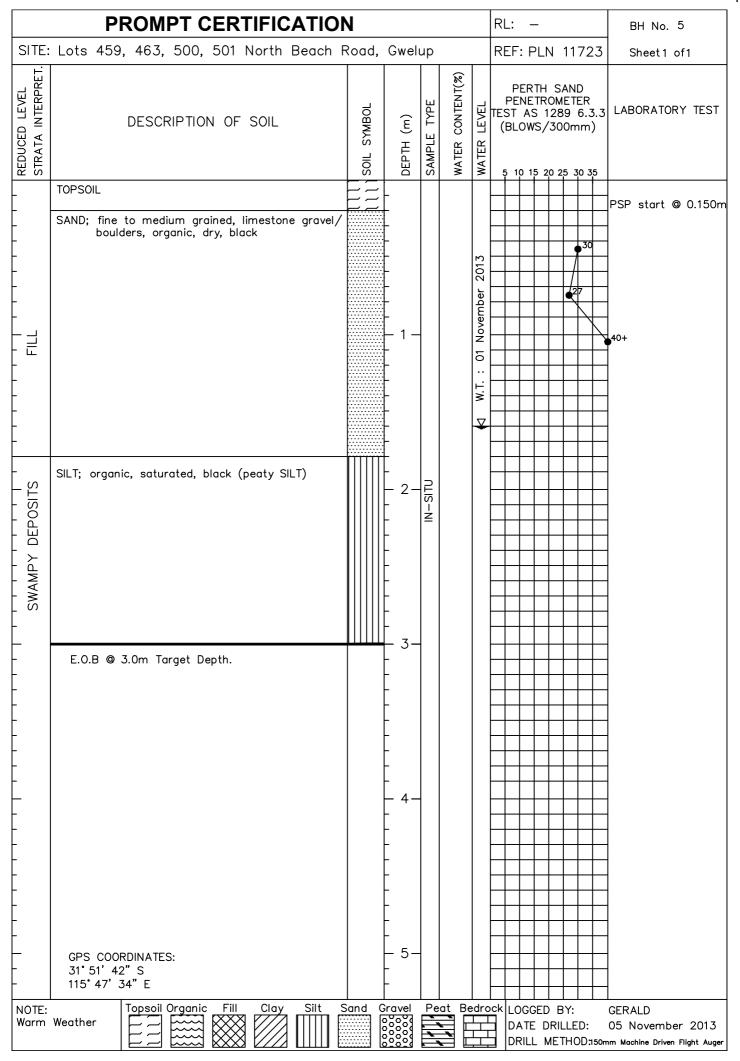


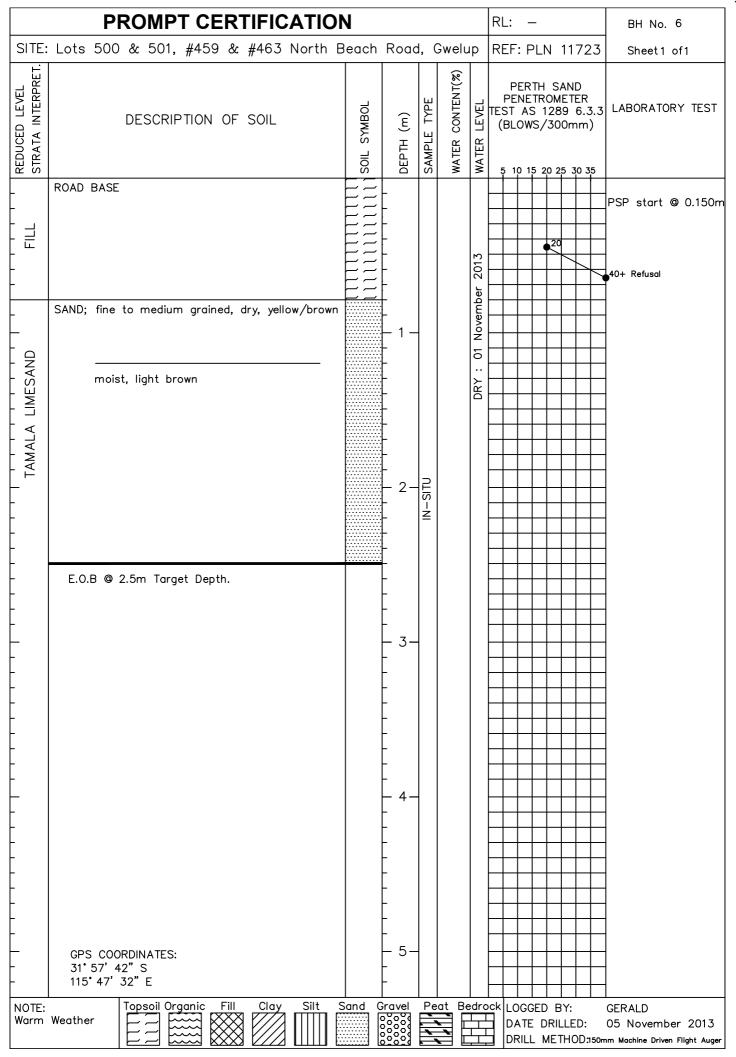


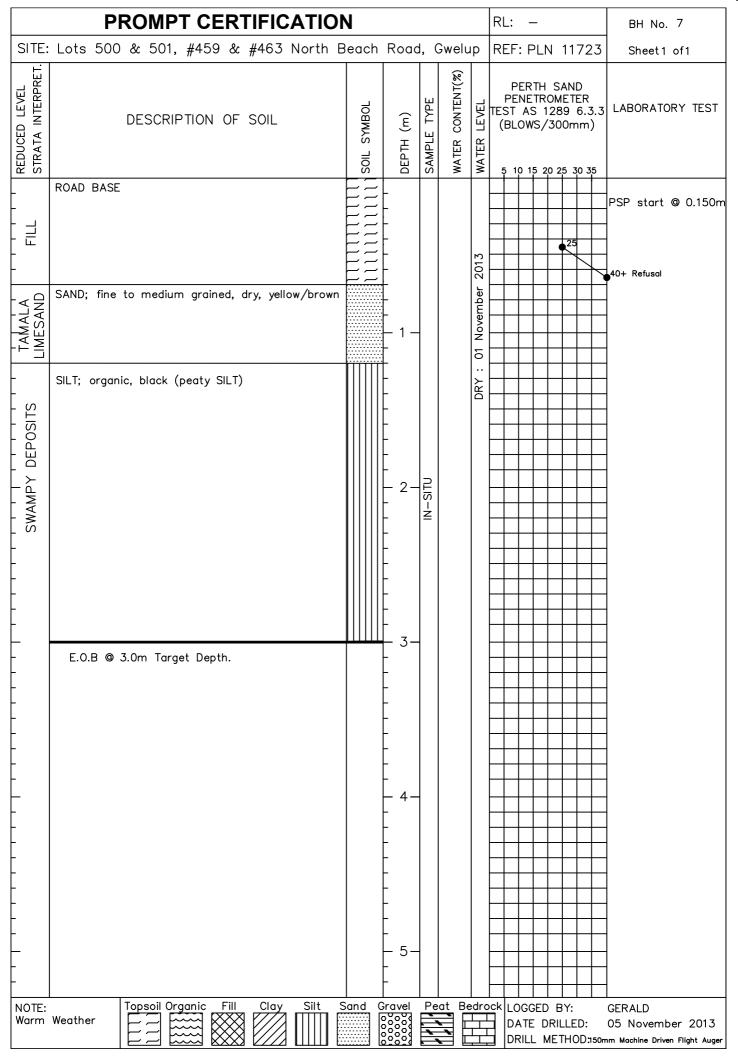


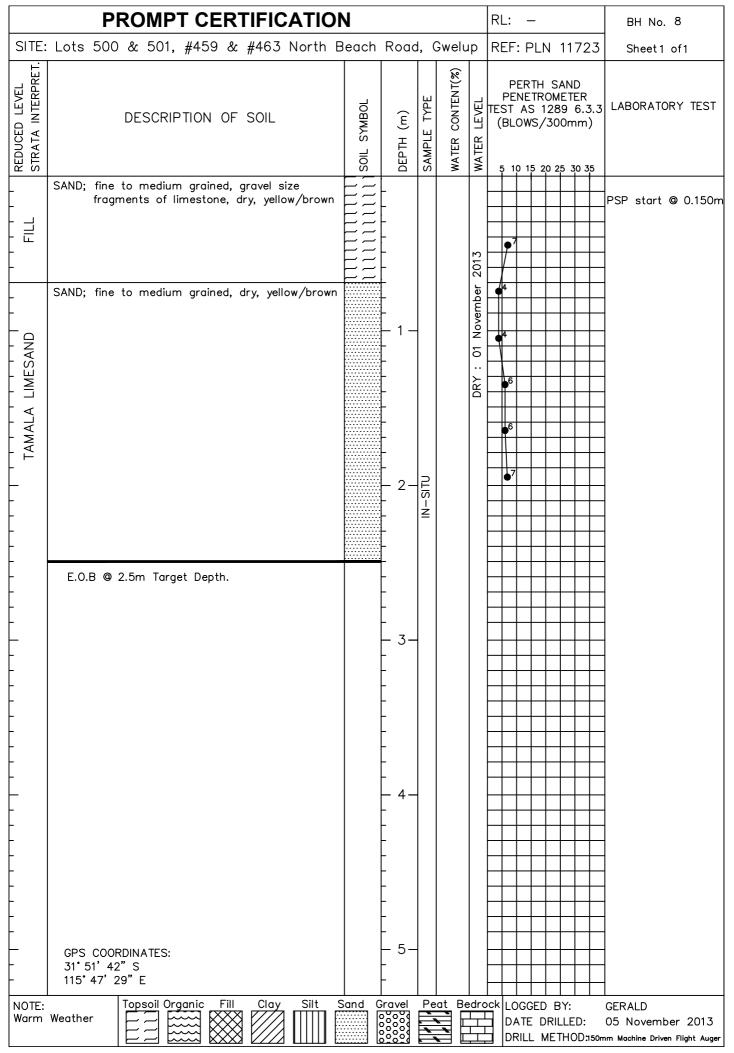


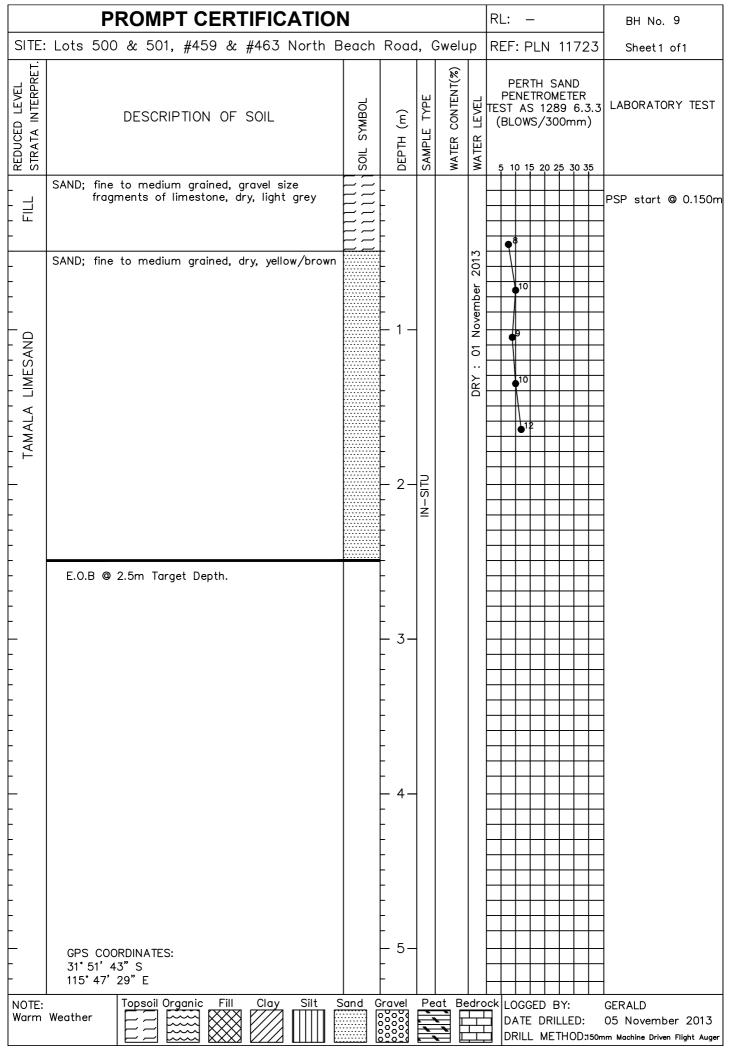












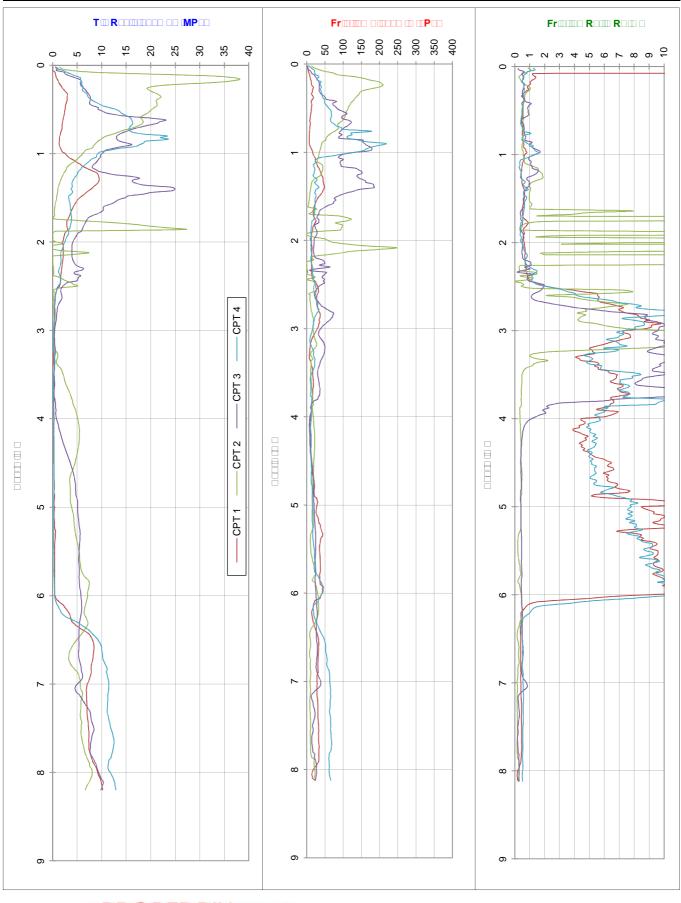
CLIENT: Ross Neumann Property

PROJECT: Proposed Residential Development Probe No.: All Data

LOCATION: 459-463 North Beach Road, Gwelup Job Number: PLN 11723

Co-ordinates:

Date: Mon, Nov 11, 2013





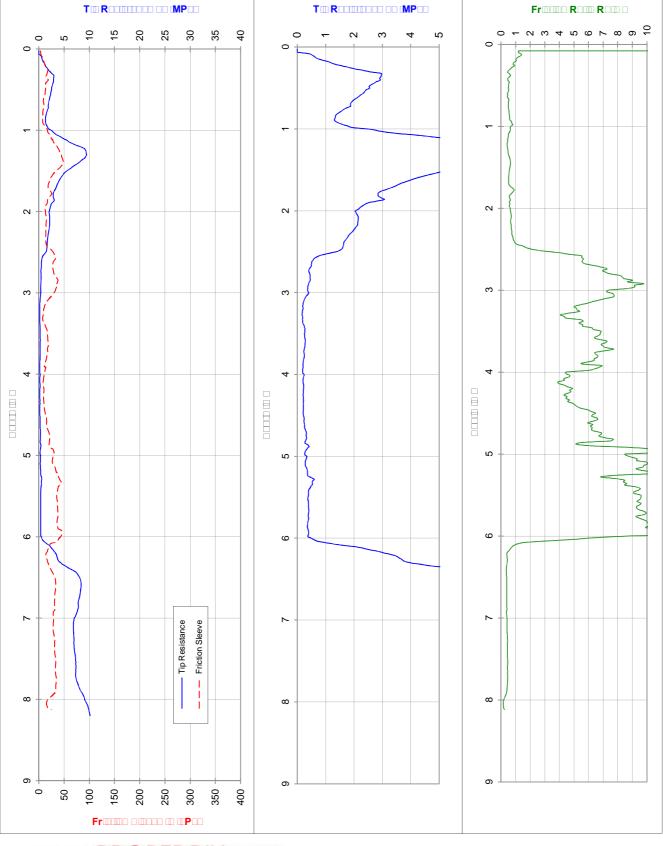
Water (m): Refusal: Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

CLIENT: Ross Neumann Property Date: Mon, Nov 11, 2013

PROJECT: Proposed Residential Development Probe No.: CPT 1

LOCATION: 459-463 North Beach Road, Gwelup Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

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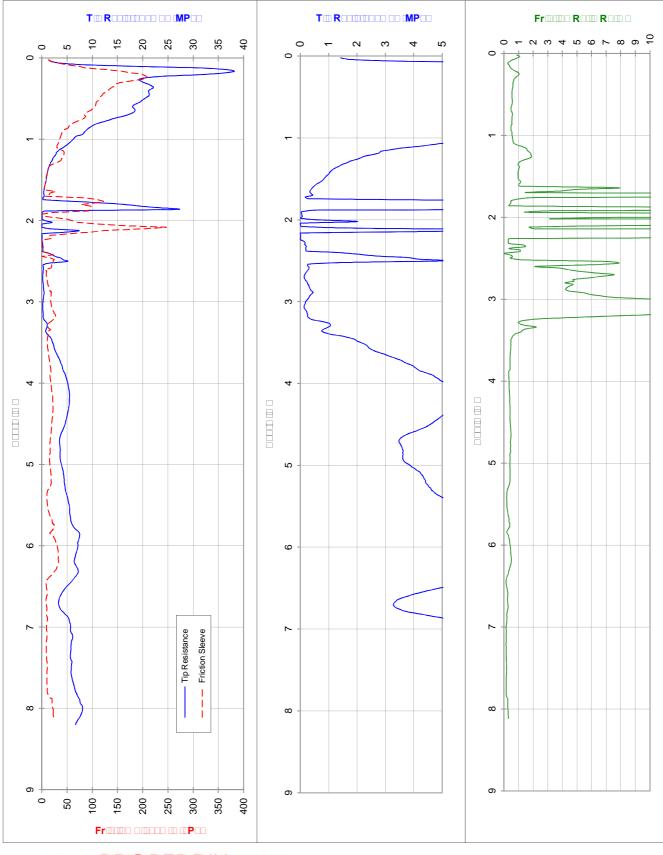
12 tonne track mounted CPT Rig (M1)

CLIENT: Ross Neumann Property Date: Mon, Nov 11, 2013

PROJECT: Proposed Residential Development Probe No.: CPT 2

LOCATION: 459-463 North Beach Road, Gwelup Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.3

Refusal:

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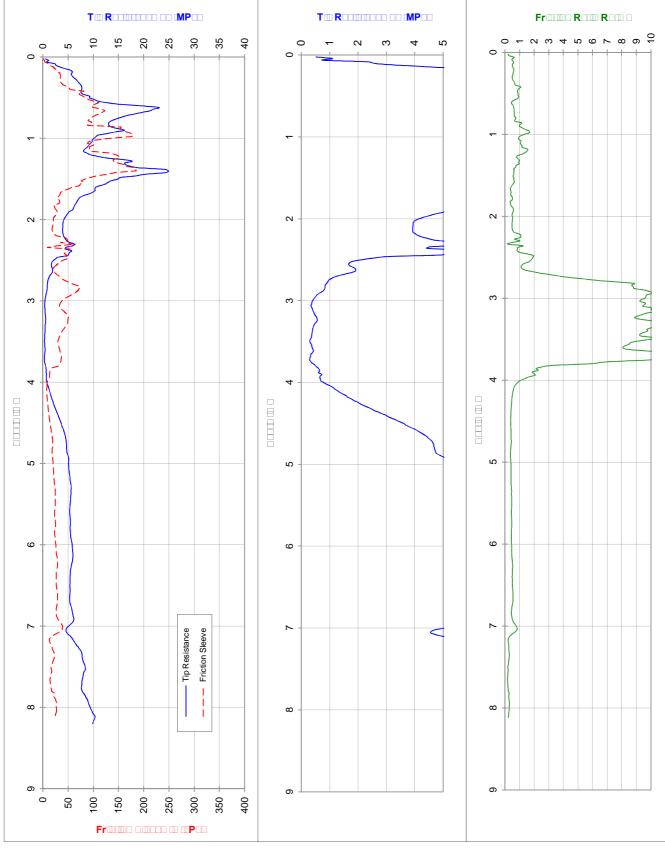
12 tonne track mounted CPT Rig (M1)

CLIENT: Ross Neumann Property Date: Mon, Nov 11, 2013

PROJECT: Proposed Residential Development Probe No.: CPT 3

LOCATION: 459-463 North Beach Road, Gwelup Job Number: PLN 11723

Co-ordinates:





Water (m): Dry to 1.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: PR0022M Dummy probe to (m):

Cone I.D.: EC145 12 tonne track mounted CPT Rig (M1)