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TOWN PLANNING
AND URBAN DESIGN

DEVELOPMENT PLAN

LOT 331 HAMILTON ROAD, SOUTH HEDLAND

711-340
MAY 2012

perth
sydney

DOCUMENT CONTROL

Document ID: PLANNING/PG 2011/711-340/Final Documents/Lodged Report/Development Plan Report/711-340 Port Hedland, Hamilton Precinct Development Plan

Issue	Date	Status	Prepared by		Approved by	
			Name	Initials	Name	Initials
1	22.11.11	Final	Eleanor Richards		David Read	
2	16.12.11	Amended Final	Eleanor Richards		David Read	
3	30.03.12	Amended Final	Eleanor Richards		David Read	
4	25.05.12	Amended Final	Eleanor Richards		David Read	

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CERTIFICATION OF DEVELOPMENT PLAN

IT IS HEREBY CERTIFIED THAT THE DEVELOPMENT PLAN FOR LOT 331 HAMILTON ROAD, LOT 2944 NORTH CIRCULAR ROAD, SOUTH HEDLAND WAS ADOPTED BY RESOLUTION OF THE COUNCIL OF THE TOWN OF PORT HEDLAND ON

11 APRIL 2012

DIRECTOR OF PLANNING AND DEVELOPMENT, TOWN OF PORT HEDLAND

AND

ADOPTED BY THE WESTERN AUSTRALIAN PLANNING COMMISSION ON 12 June 2012

BEING AN OFFICER OF THE COMMISSION DULY
AUTHORISED BY THE COMMISSION PURSUANT TO
RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION
SECTION 16 OF THE PLANNING AND DEVELOPMENT ACT 2005

Date of Expiry: **19 October 2035**

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EXECUTIVE SUMMARY

The proposed Development Plan relates to Lot 331 Hamilton Road and Water Corporation reserve on Lot 2944 North Circular Road, South Hedland (the subject site), and will determine the land use and form for urban development within the site.

The subject site is located on the corner of North Circular and Hamilton roads, immediately north of the existing South Hedland townsite. The land is undeveloped, with the exception of two drainage channels in the north-eastern portion of the site. It is proposed to develop the land for residential purposes as a logical extension of the existing South Hedland townsite.

Amendment No. 46, to the Town of Port Hedland Town Planning Scheme No. 5, which rezones the site from its current 'Other Purposes – Infrastructure' reservation to the 'Urban Development' zone was lodged with the Shire, and at the time of writing this report is with the WAPC for their consideration. Amendment 46 will facilitate the sites development for residential purposes. Under the 'Urban Development' zone a Development Plan is required to be prepared and adopted prior to subdivision or development occurring.

Subclause 5.2.1 of the Town of Port Hedland Town Planning Scheme No. 5 (herein called 'the Scheme') prescribes that the Council may prepare, or require the preparation of a Development Plan prior to considering the subdivision or development of, land within the 'South Hedland Entry Precinct' (which incudes the subject site) or the 'Urban Development' zone, which will be the zoning of the site following the gazettal of Amendment 46 to the Scheme.

The proposed Development Plan, the subject of this report, addresses this requirement. The proposed Development Plan will provide for the creation of some 298 residential lots comprising approximately 235 lots at an R20 coding, 35 lots at an R25 coding, 26 lots at an R80 coding and two grouped housing sites at an R160 coding. It is envisaged that the site will ultimately be developed to contain some 440 dwellings.

This Development Plan comprises two parts, being:

- Part 1: Statutory Planning Section
- Part 2: Explanatory Report

Subclause 5.2.2 of the Scheme prescribes that, upon endorsement of a Development Plan, Council shall ensure that they are included in the Town of Port Hedland Local Planning Policy Manual as a policy statement. This requirement is addressed in Part 1 of the Report. Part 2 of this Development Plan is for explanatory purposes only, providing a descriptive analysis of this Development Plan, and comprehensively justifying the development of this land for the extension of the South Hedland townsite and the pattern of residential development proposed.

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CONTENTS

PART 1 – STATUTORY PLANNING SECTION

TITLE

This Development Plan shall have the formal title of the 'Lot 331 Hamilton Road Development Plan' (hereafter referred to as the 'Development Plan').

RELATIONSHIP TO THE TOWN OF PORT HEDLAND TOWN PLANNING SCHEME NO. 5

Unless specified by a specific requirement of this Development Plan, all land uses and development shall occur in accordance with the standards and requirements specified by the Town of Port Hedland Town Planning Scheme No. 5 (TPS5).

DEVELOPMENT PLAN

The Development Plan is attached as Appendix 1 to this Part and comprises Lot 331 Hamilton Road, North Hedland that is 25.462 hectares in area and Water Corporation reserve on the adjoining Lot 2944 North Circular Road.

The objective of the Development Plan is to provide a Master Plan to facilitate the orderly and proper subdivision and development of the land into a conventional residential estate with a variety of lot sizes to provide for a diversity of permanent housing types, including key and service worker accommodation. The Plan also aims to set aside land for public open space and drainage and ensure that a legible road network is created with appropriate access to both Hamilton and North Circular roads whilst also allowing for future access to the north and east.

LAND USE PERMISSIBILITY

The following table now describes the permitted uses pursuant to clause 5.2.10 of the Scheme and replaces the permissibility of uses within the Development Plan area.

Aged of Dependant Persons Dwelling	AA	Ancillary Accommodation	IP
Grouped Dwelling	P	Holiday Home	SA
Home Business	AA	Home Office	P
Multiple Dwelling	P	Residential Building	SA
Serviced Apartment	SA	Short Stay	SA
Single House	P	Transient Workforce Accommodation	SA
Arts and Crafts Centre	SA	Industry – Cottage	SA
Infrastructure	P	Display Home Centre	AA
Mobile Business	P	Community Use	SA
Carpark	IP	Child Care Services	SA
Public Utility	AA	Emergency Services	SA
Public Recreation	AA		

Where:

- 'P' means the development is permitted by the Scheme.
- 'AA' means the development is not permitted unless the local government has granted planning approval.
- 'SA' means the development is not permitted unless the local government has granted planning approval after giving notice in accordance with Clause 4.3 (advertising).
- 'IP' means the development is not permitted unless the use to which it is put is incidental to the predominate use as decided by local government.

All other uses are not permitted.

For that part of the 'Residential R160' portion of the site abutting the public open space as indicated on Development Plan, the permissibility of uses is to be as per the above table, except with the uses below also being permitted as detailed.

Office	SA	Take-away Food Outlet	SA
Restaurant	SA	Consulting Rooms	SA
Shop	SA	Private Recreation	SA

Within the central area of Public Open Space (POS), as indicated on the Development Plan, a 'Restaurant' and 'Take-away Food Outlet' shall be 'AA' uses.

RESIDENTIAL DENSITY CODING

The Development Plan indicates the Residential Density Coding that applies to land zoned 'Residential' and includes the following:

- R20
- R25
- R80
- R160

Residential development shall be in accordance with the Residential Design Codes of Western Australia (R-Codes) as given effect by sub-clause 6.2.3 of TPS5, unless otherwise stated in this part.

The Performance Criteria of the R-Codes are still applicable, however if the provision is detailed on an approved Detailed Area Plan(s) (DAP) the provision identified on the DAP becomes the Acceptable Development Criteria.

DETAILED AREA PLANS

This Development Plan identifies several land parcels for which a Detailed Area Plan (DAP) is required to be prepared.

An approved DAP prepared by the developer, an owner of the land or the Town and approved by the Town shall form the basis for the determination of all affected development applications in the identified land parcels shown on the Development Plan.

The DAP is to enhance, elaborate and expand the details and provisions contained in this Part as well as supplement the provisions of the Scheme and the R-Codes. DAP's are required to address the following:

a) Any non-residential land use, size and location (where applicable);

b) Setbacks;

c) Interfaces with public open space and drainage areas;

d) Vehicular access and parking;

e) The location, orientation and design of buildings and the space between buildings; and

f) Such other information considered relevant by the Town of Port Hedland.

Variations to the provisions of the R-Codes shall be allowed where prescribed on the DAP.

APPENDIX 1

DEVELOPMENT PLAN

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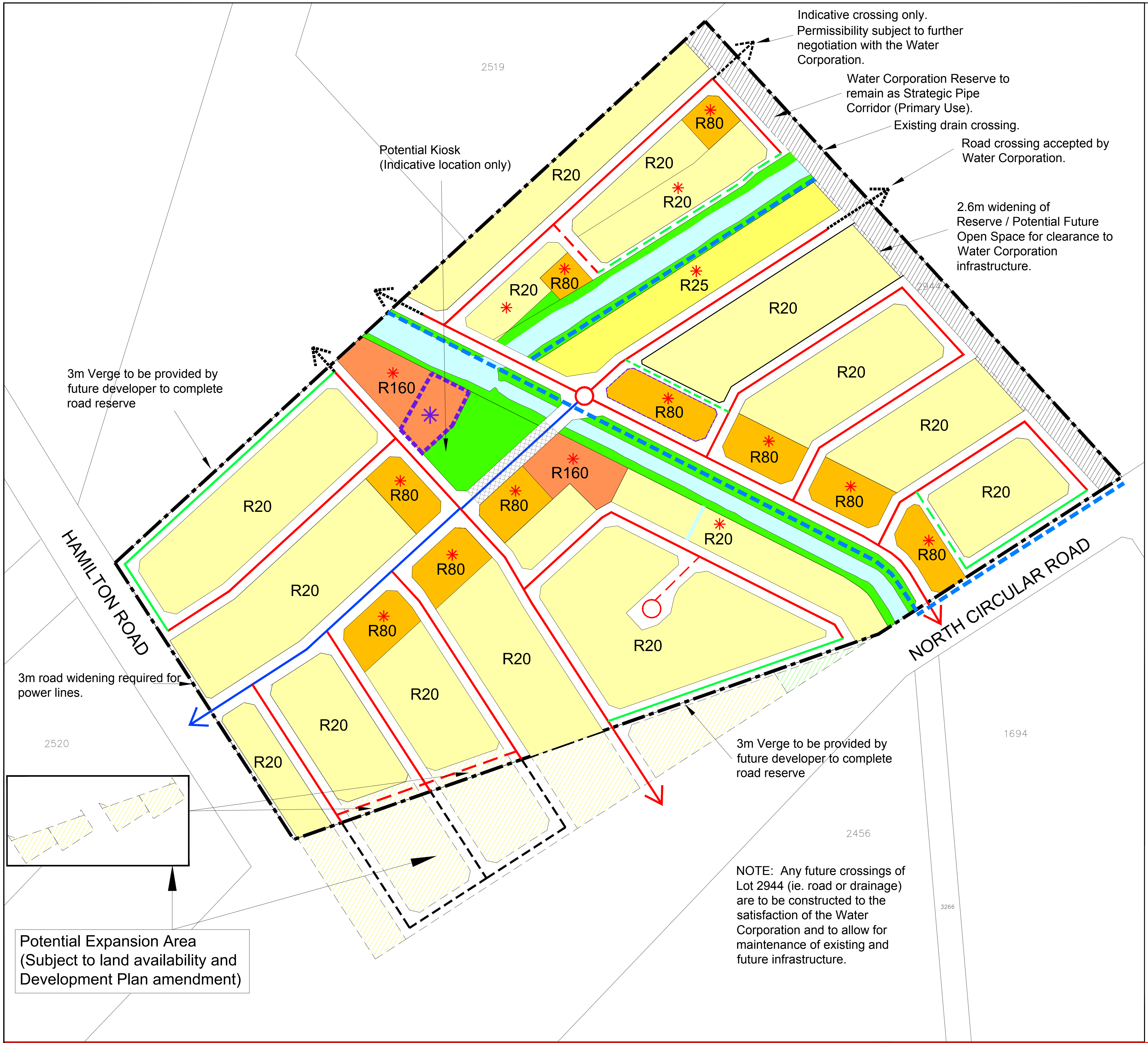

Indicative crossing only. Permissibility subject to further negotiation with the Water Corporation.

Water Corporation Reserve to remain as Strategic Pipe Corridor (Primary Use).

Existing drain crossing.

Road crossing accepted by Water Corporation.

2.6m widening of Reserve / Potential Future Open Space for clearance to Water Corporation infrastructure.

Potential Kiosk (Indicative location only)

3m Verge to be provided by future developer to complete road reserve

3m road widening required for power lines.

3m Verge to be provided by future developer to complete road reserve

Potential Expansion Area (Subject to land availability and Development Plan amendment)

NOTE: Any future crossings of Lot 2944 (ie. road or drainage) are to be constructed to the satisfaction of the Water Corporation and to allow for maintenance of existing and future infrastructure.

DEVELOPMENT PLAN LEGEND

- ▭ Development Plan Area

LAND USE/ DEVELOPMENT YIELD

- 🟩 Public Open Space/ Drainage
- ▭ Drainage
- ▨ Potential Future Open Space
- R20 Residential R20
- R25 Residential R25
- R80 Residential R80
- R160 Residential R160
- ▨ Potential Future Development
- ✳ Detailed Area Plan Required
- ✳ Commercial uses permitted in this area.(Refer to Development Plan text.)

ROADS & TREATMENTS

- ― Access Road 'A' (18m reserve)
- ― Access Road 'B' (15m reserve)
- - - Access Road 'C' (13.7m reserve)
- ― Access Road 'D' (12m reserve)
- - - Laneway 'E' (8m reserve)
- - - Laneway 'F' (6.01m reserve)
- - - 3m Dual Use Path
- → Possible Future Access
- ○ Traffic Roundabout
- ▭ Visitor Parking
- ▨ Brick Paved Carriageway

Hamilton - Development Plan

Date: 24th May 2012 Designer: DR
Scale: 1: 3000 @ A3 Drawn: PR
Drawing No. 711-340 CP1C Development Plan 240512

0 75 m 150 m

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TOWN PLANNING
AND URBAN DESIGN

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PART 2 - EXPLANATORY REPORT

INTRODUCTION

This Development Plan has been prepared by a consultant team headed by NS Projects on behalf of a private client, to facilitate the future residential subdivision and development of Lot 331, formally Lot 330 Hamilton Road, South Hedland (the subject site), and thereby help in addressing the significant shortfall of housing stock in Port Hedland.

This Development Plan has been prepared with input from the following:

- TPG Town Planning & Urban Design – Town Planning
- Pritchard Francis – Engineer
- Hassell – Landscaping
- Aurora – Environmental
- McMullen Nolan – Surveyor
- Arup – Traffic/Transport
- Douglas Partners – Geotechnical

The subject site is currently vacant and unused land with the exception of two drainage channels, which run through the northeast section of the site. The subject site is currently reserved for 'Other Purposes – Infrastructure', but Amendment 46, will amend the current reserve to rezone it to 'Urban Development'. At the time of writing the report Amendment 46 is with the Western Australian Planning Commission (WAPC) for consideration.

This Development Plan has been prepared in anticipation of the gazettal of Amendment 46 and in accordance with the requirements of the Scheme for the 'Urban Development' zone as discussed in detail later in this report.

This report addresses relevant planning requirements, as well as traffic, landscaping, environmental, and engineering matters.

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SUBJECT SITE

SITE LOCATION

The subject site comprises Lot 331 Hamilton Road, South Hedland, as shown on the site plan below. The site is located on the north-eastern corner of the intersection of Hamilton and North Circular roads. Lot 331 has an area of 25.462ha and Lot 2944 an area of 0.9821ha.

REFER TO FIGURE 1 – LOCATION PLAN

REFER TO FIGURE 2 – SITE PLAN

The site is located to the northwest of the South Hedland townsite and development of the site represents the logical extension of the northern residential development front. There are currently no crossovers into the site, however it is understood that access can be provided from both Hamilton and North Circular Roads.

LAND OWNERSHIP AND ENCUMBRANCES

The Certificate of Crown Land Title identifies Lot 331 as Unallocated Crown Land (UCL) and Lot 2944 as a Reserve Under Management Order.

The State of Western Australia is listed as the primary interest holder for Lot 331 with the responsible agency being the Department of Regional Development and Lands. No limitations, interests, encumbrances or notifications are identified on the Title.

For Lot 2944 the Minister for Water Resources is listed as the primary interest holder with the responsible agency being the Water Corporation. The Title identifies that the site is part of a reserve for the purposed of Water Suppy.

The particulars of the Certificates of Title for Lots 331 and 2944 are detailed below.

Lot	Deposited Plan	Volume/ Folio	Street Address	Status Order/ Interest	Primary Interest Holder
331	71514	LR3159/ 965	Hamilton Road, South Hedland	Unallocated	State of WA
2944	181516	LR3013/706	Hamilton Road, South Hedland	Reserve Under Management Order	Minister for Water Resources

Copies of the Ceritificate of Title can be seen in Appendix 1.

CULTURAL HERITAGE

The Australian Heritage Database does not identify any areas of European heritage significance on the site or the surrounding area.

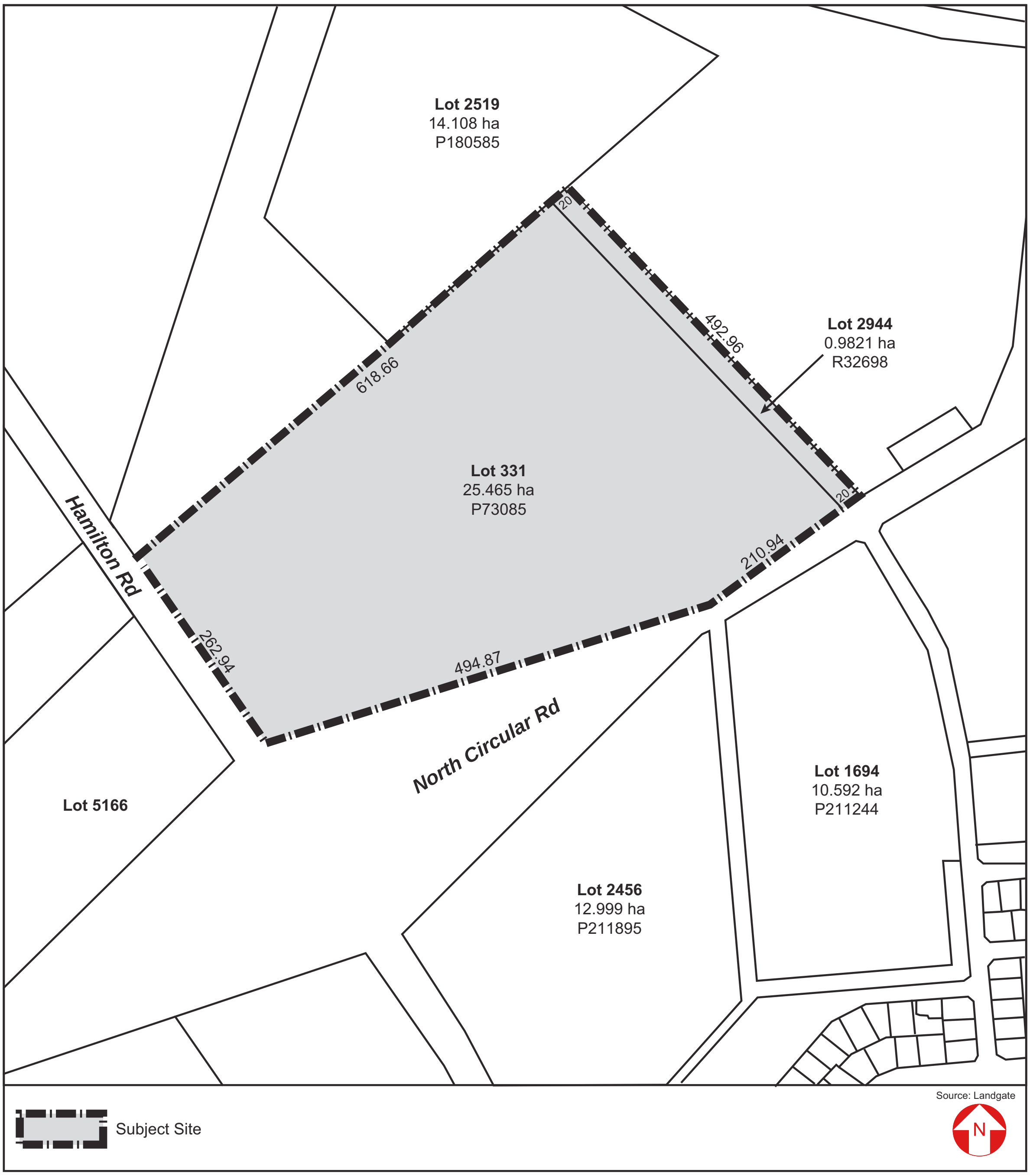
An online search for relevant Aboriginal heritage information was undertaken using the Department of Indigenous Affairs (DIA) Aboriginal Inquiry System that incorporates both the heritage site register and the heritage survey database. The Aboriginal Heritage Site Register is maintained pursuant to Section 38 of the Aboriginal Heritage Act 1972 (AHA) and contains information on over 22,000 listed Aboriginal sites throughout Western Australia.

No Aboriginal heritage sites were found on the Register within the subject site.

Figure 1 – Location Plan

Source: Google Maps

Figure 2 – Site Plan



Source: Landgate

The land is part of the Kariyarra – Pipingarra claim where discussions need to occur with the Yamatji Marlpa Aboriginal Corporation before the land is converted from Unallocated Crown Land (UCL) to a freehold Title.

The Department of Regional Development and Lands have recently entered into an agreement with the relevant indigenous families to enable the removal of native title rights over Lot 331 the land and this will occur as part of the conversion from UCL when it issues a Notice of Intention to Take (NOITT).

A local indigenous representative has walked the land and no locations of heritage significance have been identified.

MINING TENEMENTS (DEPARTMENT OF MINES AND PETROLEUM RESOURCES)

A desktop review of the Department of Mines and Petroleum website indicates that there are no live mining tenements over the subject site.

LAND USE AND TOPOGRAPHY

The subject site is generally flat, with the exception of two drainage channels that intersect on the property. The site levels range from approximately 8.6m (AHD) in the north of the site to 9.6m (AHD) in the south.

There are no improvements within Lot 331 with the exception of the drainage channels, nor evidence that the Lot has been used for any purpose. Lot 2944 contains underground water infrastructure, which runs to the Water Tanks to the north of the site.

REFER TO FIGURE 3 – AERIAL PHOTOGRAPH

LOCAL CONTEXT

To the south of the site the land use is predominantly residential in nature, with the Hedland Senior High School and the Pundulmurra Aboriginal College located directly to the south of the site, across from North Circular Road.

The land to the north and west is generally un-used, with the exception of a water storage tanks located directly to the north of the site, and a railway line which runs south east to north west on the other side of the tanks. To the south west of the site there is the South Hedland Sports Complex and a Fortescue Metals Group (FMG) workers accommodation camp, and further to the south of that another school.

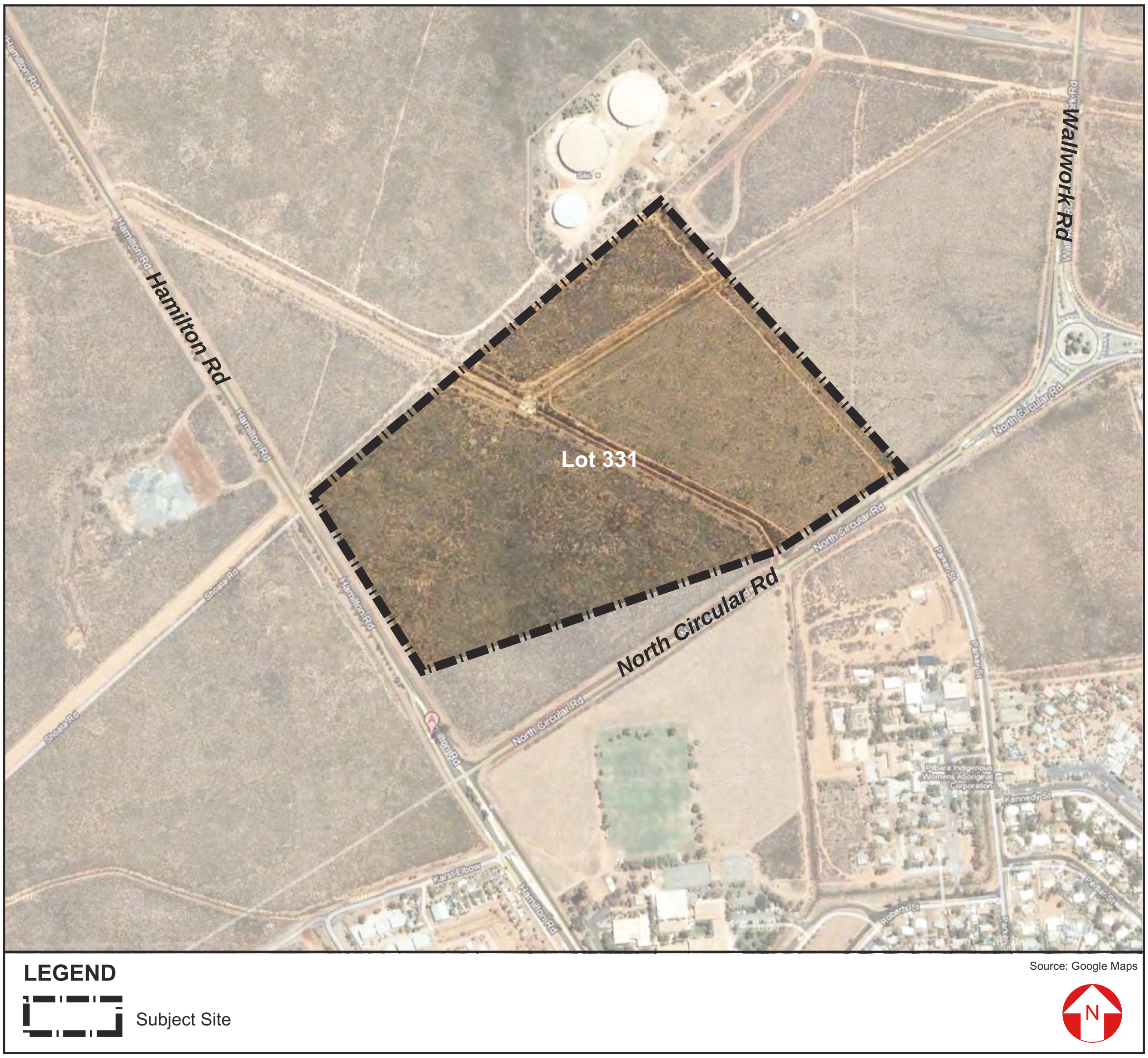
The main commercial area in South Hedland is located approximately 1.5km south of the site, with the remainder of the South Hedland being townsite predominantly residential in nature.

Some 3km south west of the site is a wastewater treatment plant and north of that a race track and golf course. The Wedgefield industrial area is located 2km to the north of the site. The Port Hedland Airport is located approximately 4km to the north east of the site, and well outside of the Airports Australian Noise Exposure Forecast (ANEF) limits for residential development as outlined in the Town's Scheme.

REFER TO FIGURE 4 – CONTEXT PLAN

There are three existing Primary Schools located in South Hedland, the closest of which is South Hedland Primary School located approximately 1km south east of the subject site. The Baler and Cassia Primary Schools are also located to the south east of the site, approximately 2km away. It is also understood, based on information from the Department of Education and Training, that a fourth primary school is proposed as part of the southern extension of the South Hedland town site.

Figure 3 - Aerial Photograph



Source: Google Maps

Figure 4 - Context Plan

SOURCE: WA DEPT PLANNING

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PLANNING FRAMEWORK

STRATEGIC DOCUMENTS

There are a number of strategic documents that are relevant to the planning and development of the subject site. An overview of the documents is provided below.

State Planning Strategy (1997)

The State Planning Strategy provides the basis for long-term State and regional land use planning and coordinates a whole-of government approach to planning. The vision for the Pilbara Region, as identified in the State Planning Strategy, is as follows:

"In the next three decades, the Pilbara Region will be a world leading resource development area focusing on mineral extraction, petroleum exploration and production and the primary stages of downstream processing. The region's population will grow in the future, fuelled by specific resource development projects, the sustainable development of Karratha and Port Hedland and a more diverse economy. A growing tourism industry will have developed based on the region's unique natural environment."

The document identifies a series of strategies to achieve the above vision, which are based on the environment and resources, community, economic and infrastructure principles. The strategies relevant to the proposal include:

- Protecting sensitive environmental and heritage areas;
- Addressing the need for the provision of social facilities;
- Improving town amenity;
- Giving greater emphasis to local recruitment and training of the work-force; and
- Promoting opportunities for economic development.

The Development Plan will allow for the development of high-quality, well planned residential neighbourhood. The detailed planning and development of the site as a conventional residential subdivision will be guided by the above strategies. Environmental, heritage, social and other amenity issues have been considered and addressed in this report.

Pilbara Infrastructure and Planning Framework (Draft)

The draft 'Pilbara Planning and Infrastructure Framework' for the Pilbara region, prepared by the WAPC, defines a strategic direction for the future development of the Pilbara region over the next 25 years. The document sets out a settlement-focused regional development structure for the region providing a framework for public and private sector investment, as well as context for the preparation of local planning strategies and local planning schemes by local authorities. The framework is built on detailed profiles of the region's major settlements in which Port Hedland (comprising both North and South Hedland) is designated as one of two 'Pilbara Cities' (along with Karratha) providing regional facilities and services to Newman, with which it is functionally linked, and the surrounding area.

The framework also incorporates findings from a range of existing Pilbara-wide studies and strategies including the Pilbara Plan document.

The Framework states that the residential population of Port Hedland is to expand from 19,000 to 50,000 by 2035 with a city 'footprint' of 7,000ha. Port Hedland also currently has a fly-in fly-out population of some 2,470 people based on transient accommodation supply. In terms of supplying housing for this growing population, the Framework states that residential development in Port Hedland will change significantly with more townhouses and other forms of medium-density living being made available to consumers. Average densities are likely to increase from R30 to R50 and maximum building heights (in the town centre) to increase to be between 7 and 10 storeys.

In terms of a strategic direction for the town, the Framework states that the Town of Port Hedland has recently commenced work on the Port Hedland City Grown Plan, which will replace the Land Use Master Plan - a local planning strategy discussed later in this report that was endorsed by the WAPC in September 2008.

The proposed Development Plan will facilitate the development of a variety of accommodation types for the growing demand, and will be designed in such a way so as to make a valuable addition to Port Hedland housing stock.

Port Hedland Area Planning Study

The Port Hedland Area Planning Study was prepared by the WAPC in 2003 and addressed all important regional issues as well as setting out a framework to guide State decision-making and detailed planning at the local level over the next 20-25 years. The purpose of the Study was to undertake detailed planning by:

- Ensuring that all current and future land uses are accommodated in an equitable manner;
- Planning for future infrastructure;
- Identifying preferable townsite expansion areas;
- Improving town amenity and promoting regional identity on an ongoing basis;
- Identifying areas of high environmental value;
- Providing direction for development control and protection of the environments; and
- Providing sound natural reserve management, particularly for coastal areas.

The report has two main components – a sub-regional plan and a Port Hedland Structure Plan. The sub-regional plan focuses on regional issues, such as environmental protection and recreation nodes, economic development and regional infrastructure. The Port Hedland Structure Plan outlines the status of existing services and land uses and indicates land use allocations to accommodate development in the townsite area. The Structure Plan identifies the subject site and its surrounds to the west, north and east as requiring further assessment.

PORT HEDLAND REGIONAL HOTSPOTS LAND SUPPLY UPDATE

The Port Hedland Regional Hotspots and Land Supply Update was last updated by the WAPC in April 2011 and is prepared as part of the Urban Development Program. The Urban Development Program (UDP) coordinates and promotes the development of serviced land in a sustainable manner for the guidance of state infrastructure agencies, public utilities, local governments and the private sector. It tracks demand, land supply, development and infrastructure in Western Australia's major urban centres to deliver a more effective use of land, better staging of development and prioritisation of infrastructure investment to support urban growth.

The Regional Hotspots and Land Supply Update states that appropriately zoned land for residential/urban development is currently in short supply, with the Town currently investigating options for re-zoning as part of their preparation of the City Growth Plan (discussed later in this report).

The western portion of the subject site is indicated as 'SH130', with the intended land use identified as 'potential residential'. The purpose of 'SH130' is identified as potential key worker housing, and identifies that a scheme amendment is required to facilitate development. In addition, land assembly issues are identified as a constraint on the development of the site, and are to be resolved though discussions between the Town and the developer.

The eastern portion of the site is identified as SH52 which is 'Potential Mixed Business'. This however, was based on the Port Hedland Land Use Master Plan which is soon to be superseded by the Pilbara's Port City Plan which identifies the whole of the site as Residential.

REFER TO FIGURE 5 – HOTSPOTS LAND SUPPLY UPDATE

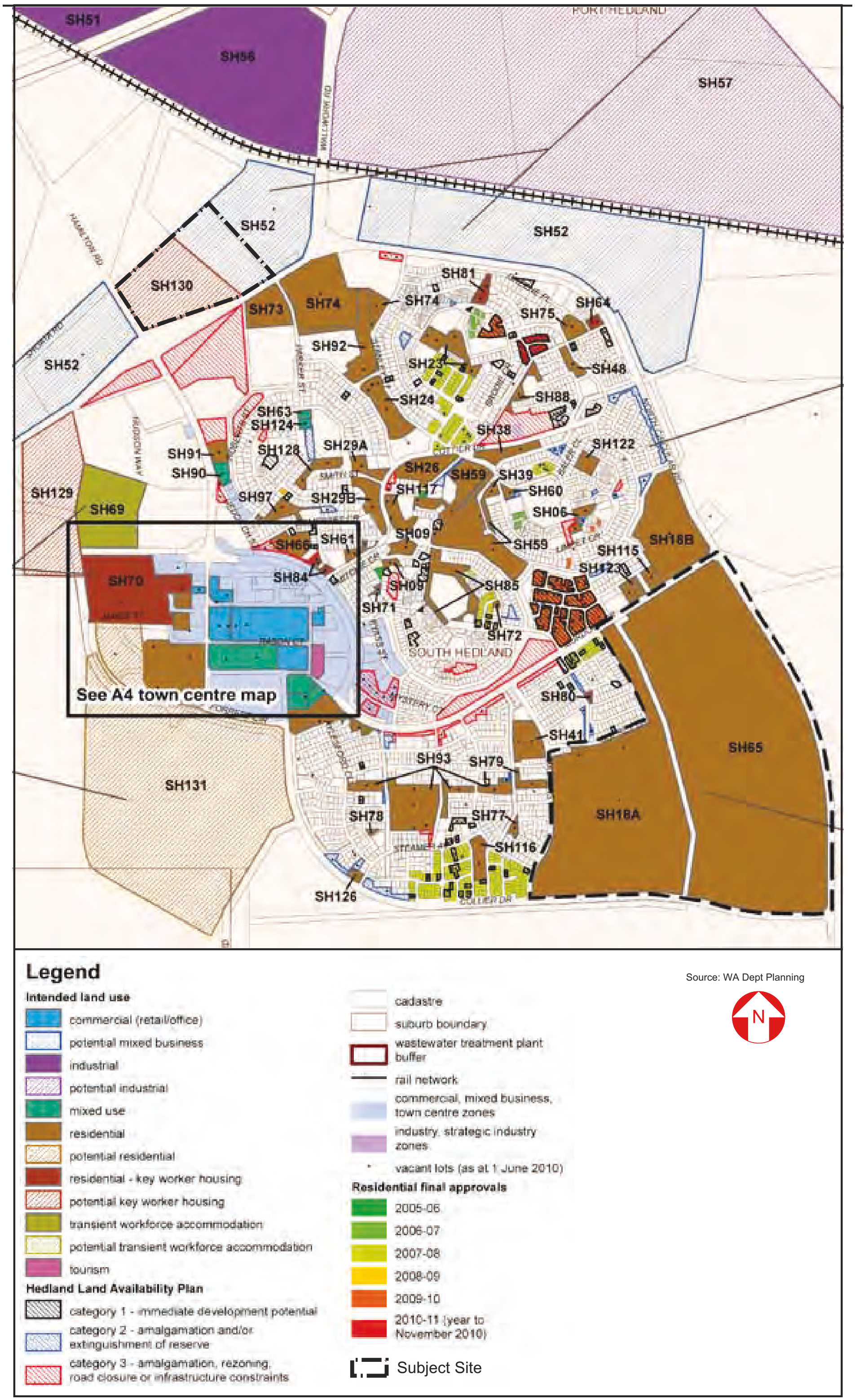
PORT HEDLAND LAND USE MASTER PLAN

The Port Hedland Land Use Master Plan (LUMP) was prepared by the City and endorsed by the WAPC in September 2008. The LUMP was prepared to guide the growth and development of Port Hedland through the next 20-25 years.

As part of the preparation of the LUMP, the following development challenges to be addressed by the Plan were identified:

- Achieving a shared and inclusive long-term vision for the future of Port Hedland;
- Developing in sustainable patterns that diversify and strengthen the local economy, enrich community life, and protect environmental resources;
- Resolving existing land use conflicts between residential and industrial uses, particularly in Wedgefield and the West End;
- Providing a wider range of more affordable housing choices;
- Overcoming the historical fragmentation of Port, South Hedland and Wedgefield and developing them to complement but not compete with each other;

Figure 5 – Hotspots Land Supply Update



Source: WA Dept Planning

- Creating a stronger sense of place and identity for Port Hedland that builds on local history and the unique environment of the region;
- Attracting tourism and other small business opportunities; and
- Developing a richer cultural life and more diverse entertainment options that will encourage people of all ages and interests to make Port Hedland their home.

The LUMP identifies the subject site as being intended for mixed business uses including showrooms, warehouses, car and boat sales yards, and other large-scale retail and service activities that are inappropriate in a town centre.

A draft revision of the LUMP, prepared in 2010 on behalf of the Town and available on their website however, indicates the subject site as 'Urban Development'. The subject rezoning to Urban Development will implement this vision as well as assisting in achieving the above objectives by providing a wider range of more affordable and sustainable housing choices.

Refer to Figure 6 – Draft Port Hedland Land Use Master Plan

Pilbara's Port City Growth Plan (Draft)

The Town of Port Hedland is currently advertising the draft Pilbara's Port City Growth Plan (the Growth Plan), which is a strategic plan to facilitate the future growth of Port Hedland into Pilbara's Port City with a population of up to 50,000 people.

Pilbara's Port City Growth Plan builds on many of the aspirational themes of previous Port Hedland plans which have sought to guide the future structure and form of growth. It incorporates all land within the municipality of Port Hedland, with primary focus on the settlement areas of South and Port Hedland. The Growth Plan's vision for Port Hedland is to be:

"A nationally significant, friendly City, where people want to live and are proud to call home".

The subject site is identified in the draft Growth Plan as being within Precinct 10, being South Hedland West. The Precinct statement for South Hedland West is as follows:

"South Hedland West is South Hedland's newest land release area. It supports immediate and short term land supply, bringing a permanent population catchment to the west of the City. Densities are greatest in proximity to the City Centre, with more traditional home sites provided to the south west and south of the precinct."

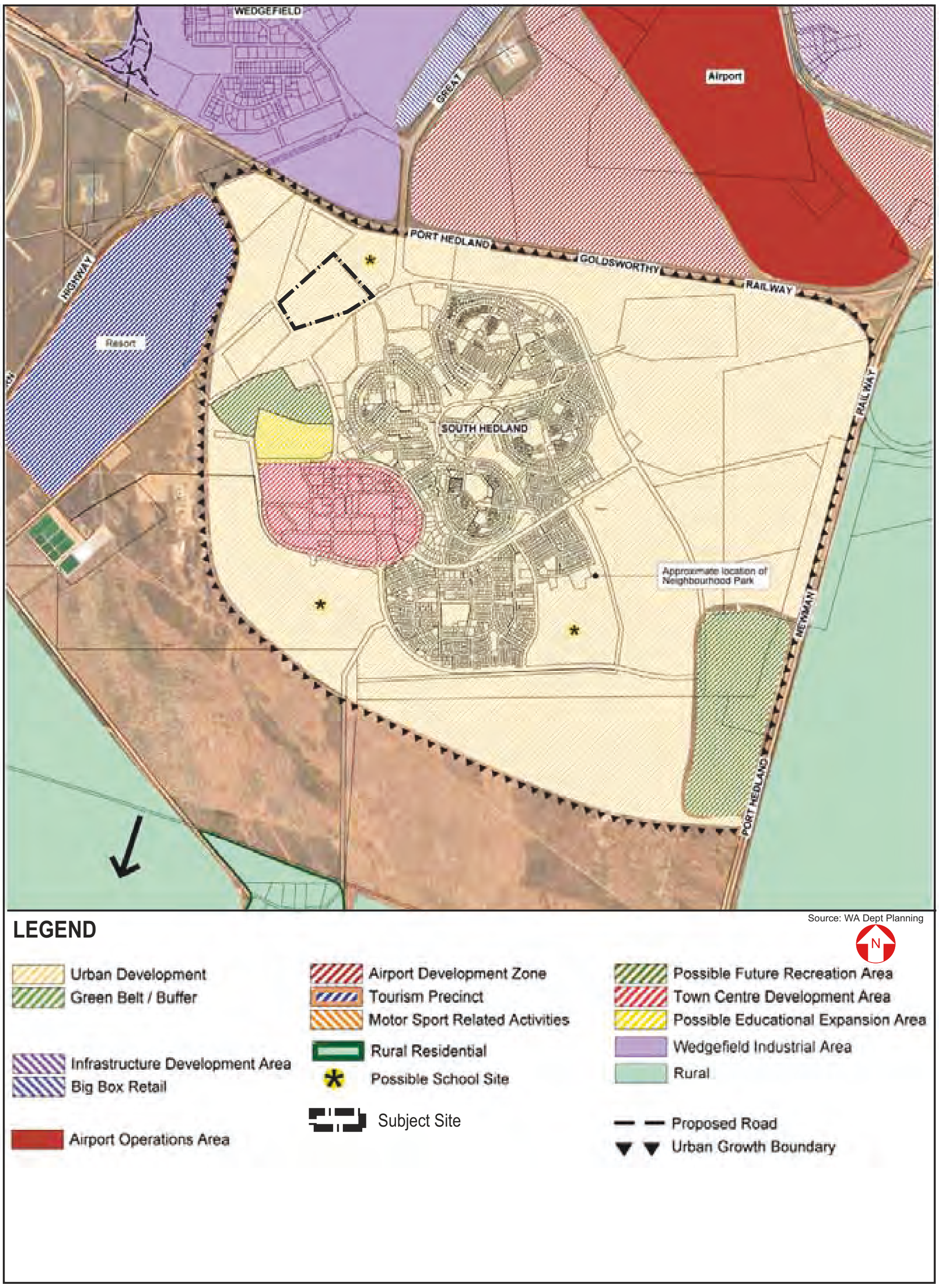
The subject site itself, as well as the land to the north and east is identified for low-density residential development. The proposed Development Plan is considered to be highly consistent with this intention, with the majority of land within the site intended for development as the R20-25 density. The land directly to the north of the subject site is identified for 'Public Purposes', which indicates that the water tanks located directly to the north are not proposed to be relocated.

Refer to Figure 7 - Draft Pilbara's Port City Growth Plan

Liveable Neighbourhoods

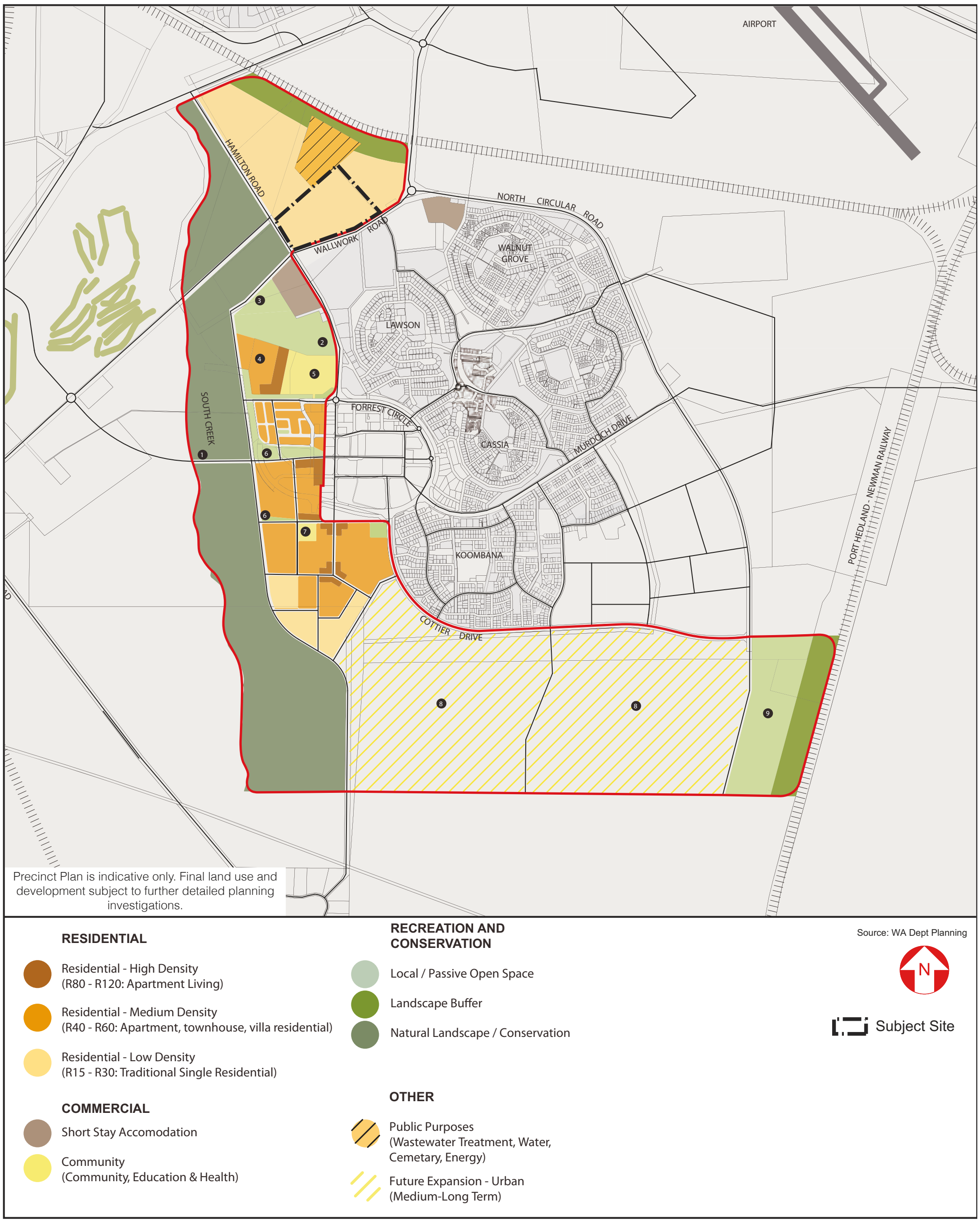
Liveable Neighbourhoods is an operational policy, adopted by the WAPC, for the design and assessment of structure plans and subdivision,

Figure 6 – Draft Port Hedland Land Use Master Plan



Source: WA Dept Planning

Figure 7 – Draft Pilbara's Port City Growth Plan



Precinct Plan is indicative only. Final land use and development subject to further detailed planning investigations.

Source: WA Dept Planning

for new urban (predominantly residential) in the metropolitan area and country centres, on greenfield and large urban infill sites.

The Policy is a performance-based code which advocates the structure of new urban areas be formed by the clustering of compact, walkable neighbourhoods with a central amenities area to provide a community focus. A range of residential densities and a variety of housing types with increased densities where they abut areas with a high level of amenity, and an interconnected street network that provides good access for vehicles, cyclists and pedestrians in a pleasant, efficient and safe manner is also advocated.

Additionally the Policy states the WAPC may accept a minimum of five per cent of the gross subdivisible area for public open space for new development in regional areas subject to the support of the local government, the open space being developed to a minimum standard, for the widest possible use of the community and public open space being readily available in the community.

Planning for the site will need to have due regard to the Policy although care needs to be taken to ensure it is adapted to the local arid environment.

State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (2009)

This Policy is primarily concerned with how the planning system can be used to minimise the adverse impact of transport noise on noise-sensitive development without placing unreasonable restrictions on development or adding unduly to the cost of road and rail infrastructure.

Neither Hamilton Road nor North Circular Road are indicated as a state road or national highway under the Policy.

STATUTORY DOCUMENTS

Town of Port Hedland Town Planning Scheme No. 5

The Town of Port Hedland Town Planning Scheme No. 5 (the Scheme or TPS5) is a land use based statutory Scheme, which was gazetted in 2001.

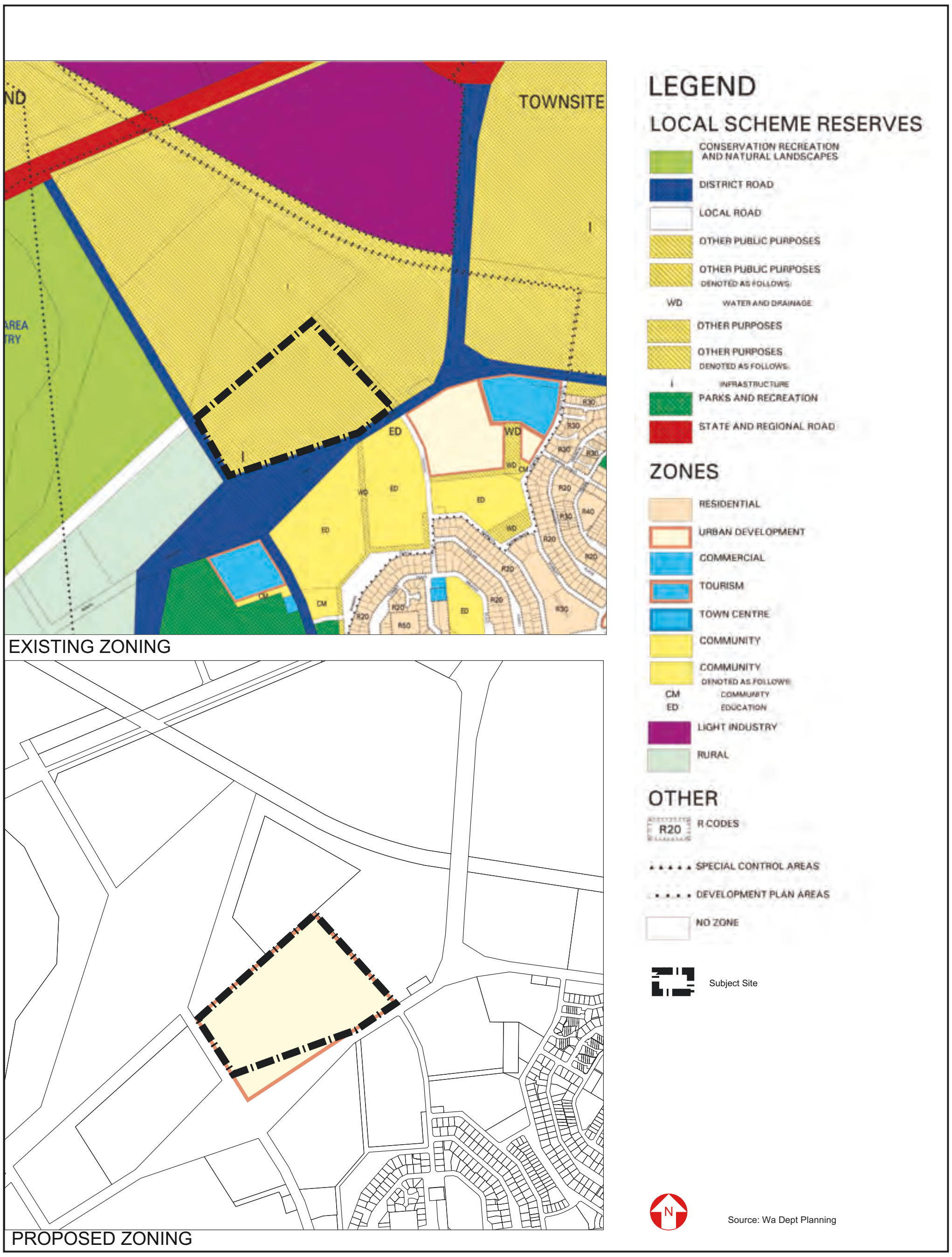
Under the Scheme the subject site, and its surrounds to the north and northeast, are currently reserved for 'Other Purposes – Infrastructure'. However the Town has initiated Amendment No. 46 to its Scheme to rezone Lot 331 and a portion of the adjoining North Circular Road reserve as 'Urban Development'. Hamilton Road and North Circular Road and its reserves are both reserved as 'District Roads'.

Refer to Figure 8 – Town of Port Hedland Town Planning Scheme No.5 (Existing and Proposed)

Section 1.5 of TPS5 states that the general objectives of the Scheme are to:

a) Encourage an appropriate balance between economic and social development,

Figure 8 – Town of Port Hedland Town Planning Scheme No.5 (Existing and Proposed)



Source: Wa Dept Planning

conservation of the natural environment, and improvements in lifestyle and amenity;

b) Implement strategic planning for the municipality, including the recommendations of the State Planning Strategy and relevant regional planning strategies;

c) Reserve certain portions of land required for public purposes;

d) Zone the balance of the land within the Scheme Area for purposes described in the Scheme;

e) Define the uses and types of development to be permitted on land within the Scheme Area; and

f) Control and regulate the development of land, erection and demolition of buildings and the carrying out of works.

TPS5 identifies the site as being within the South Hedland Entry Precinct/Development Plan area which, as identified in Section 5.3.5, has the following objectives:

a) Improve the legibility of the locational and functional relationships between Wedgefield, Boodarie, South Hedland, Port Hedland and the airport;

b) Enhance the visual amenity of entry roads to South Hedland;

c) Give priority to recreation and community uses;

d) Ensure that uses occurring within the Boodarie strategic industrial buffer area place no constraints on industry operations within the Strategic Industry zone;

e) Determine practical functional relationships between land uses as the basis for possible rationalisation of cadastral boundaries within the precinct; and

f) Protect options for future infrastructure within the area reserved for this purpose.

Amendment No. 46 rezoning the site to 'Urban Development' zone will facilitate its development for much needed residential accommodation, and will assist in reinforcing the entry to South Hedland without impacting on the Boodarie Strategic buffer.

Whilst it is noted that Lot 2944 is not included in Amendment 46, the Development Plan proposes only future open space over the lot which is coincided compatible with the site existing reservation particularly as it will continue to be used for infrastructure purposes as the water pipes are to be maintained.

Section 6.4 stipulates the purpose of the Urban Development zone is

"... to identify land where detailed planning and the provision of infrastructure is required prior to the further subdivision and development of land. This planning should be documented in the form of a Development Plan. Although subdivision and development may take place prior to the Scheme maps being amended to reflect the details of Development Plans; the Scheme maps should be amended as soon as practicable following the creation of lots and Crown reserves."

Section 5.2 of the Scheme indicates the procedures and requirements for Development Plans. Clause 5.2.1 states that Council may prepare, or require the preparation of a Development Plan prior to considering subdivision or development proposals for land within the Urban Development zone and Development Plan Precincts identified in Appendix 5 of the Scheme (such as South Hedland Entry Precinct within which the site is located). Section 5.2.10 states that a Development Plan may indicate development categories in the zoning table, which, upon final approval, shall be considered permitted or otherwise by Council in the area of the Plan. These aspects are addressed by this Development Plan.

Appendix 6 of the Scheme provides direction as to matters which are to be addressed by Development Plans which includes:

i) landform, topography, landscape, vegetation and soils of the area,

ii) location, existing roads, land uses an surrounding land uses and features,

iii) legal considerations, ownership, title description, area and encumbrances,

iv) existing and proposed services and infrastructure including reticulated or other potable water supply, sewerage, energy, communications, drainage and catchment considerations,

v) existing places and features of Aboriginal and non-Aboriginal heritage and/or cultural significance, including natural landscapes, flora and fauna in addition to built structures and other modified environments,

vi) road layouts and traffic assessments, communal and incidental parking areas, pedestrian/cycle network/underpasses, including impacts on the surrounding movement network,

vii) public open space and recreation provision, environmental protection areas, and relationships to natural features,

viii) assessment of the impact of the proposal on the natural environment, including management of potential effluent, emissions and other forms of pollution,

ix) comprehensive drainage systems for stormwater runoff and natural drainage lines,

x) the design of the proposal including lot layout, major buildings, roads and landscaping proposals,

xi) the demand for the development in relation to the overall market for similar developments,

xii) the method of carrying out the development including the projected times of completion of each stage,

xiii) provisions, as may be considered appropriate by local government, for inclusion in the Policy Manual, and

xiv) any other information as may be required by local government.

In the Urban Development zone the Development Plan also needs to address:

i) location and density of housing areas, including lot and dwelling yield, population outcomes, net residential density and detailed subdivision standards relating to solar access, efficient use of water resources, design features and density rationale, and

ii) indicate demand for commercial and community facilities, including schools, generated by the proposal and implications for the provision of these within the development area or elsewhere

These matters are all addressed by the subject Development Plan.

There are no special requirements in Appendix 10 of the Scheme which apply to the site.

ENVIRONMENTAL ANALYSIS

CLIMATE

The climate of the Port Hedland region is arid (semi-desert) tropical with a very low and highly variable annual rainfall. The region experiences a typical wet and dry season, with the wet season commencing around December and ending around June.

According to climate data collected from the Port Hedland Airport (located approximately 4km to the east of Lot 331), South Hedland experiences a mean annual rainfall of 312.2mm/annum with 292.7mm being recorded during the wet season (December to June inclusive) and the balance (20.5mm) during the dry season. Most of the rainfall comes from scattered thunderstorms and the occasional tropical cyclone. The mean minimum and maximum temperatures are 19.4°C and 33.2°C respectively with the hottest month being March and the coolest month being July (Weatherzone, 2011). A summary of monthly climate data is provided in Table 1.

Table 1: Port Hedland Airport Long-term Climate Averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	36.4	36.2	36.8	35.2	30.6	27.5	27.1	29.1	32.3	34.8	36.2	36.6	33.2
Mean Min (°C)	25.5	25.4	24.5	21.4	17.2	14.1	12.2	13.1	15.4	18.3	21.3	24.0	19.4
Mean Rain (mm)	58.5	94.3	48.3	23.7	27.6	21.6	10.7	5.1	1.2	0.9	2.6	18.7	312.2
Median Rain (mm)	21.3	75.0	14.0	1.6	9.2	7.0	2.8	0.6	0.4	0.2	0.0	0.5	304.6
Mean Rain Days	4.8	7.0	4.2	1.9	3.0	2.8	1.9	1.1	0.7	0.6	0.5	1.8	30.2

GEOLOGY, SOILS AND LANDFORMS

According to the 1:250,000 geological map sheet for Port Hedland – Bedout Island (Geological Survey of Western Australia (GSWA), 2006a) the site is located within Quaternary age mixed floodplain deposits comprising silt, sand, clay and gravel adjacent to drainage channels. GSWA (2006a) also indicates that the bedrock geology of the area comprises mylonite and that the regolith comprises coastal tide-dominated deposits.

The 1:50,000 Urban Geology map sheet for Port Hedland (GSWA, 2006b) indicates the site consists of Pleistocene age red-brown Silty Sands, (Qps) with Pleistocene-Holocene age alluvium comprising gravel, sand and silts (Qa) in drainage channels (including in Sandy Creek).

Soil logs recorded during test-pitting undertaken at the site on 5 August 2011 indicate that the site soils comprise medium to fine-grained red and brown silty sands grading into clays at depths. As such, mapped surface geology for the site correlates with site observations.

Mapped surface geology at the site is presented in Figure 9. A copy of the geotechnical investigation is presented in Appendix 2.

Refer to Figure 9 – Surface Geology

Refer to Appendix 2 – Geotechnical Report

CONTAMINATION AND ACID SULFATE SOILS (ASS)

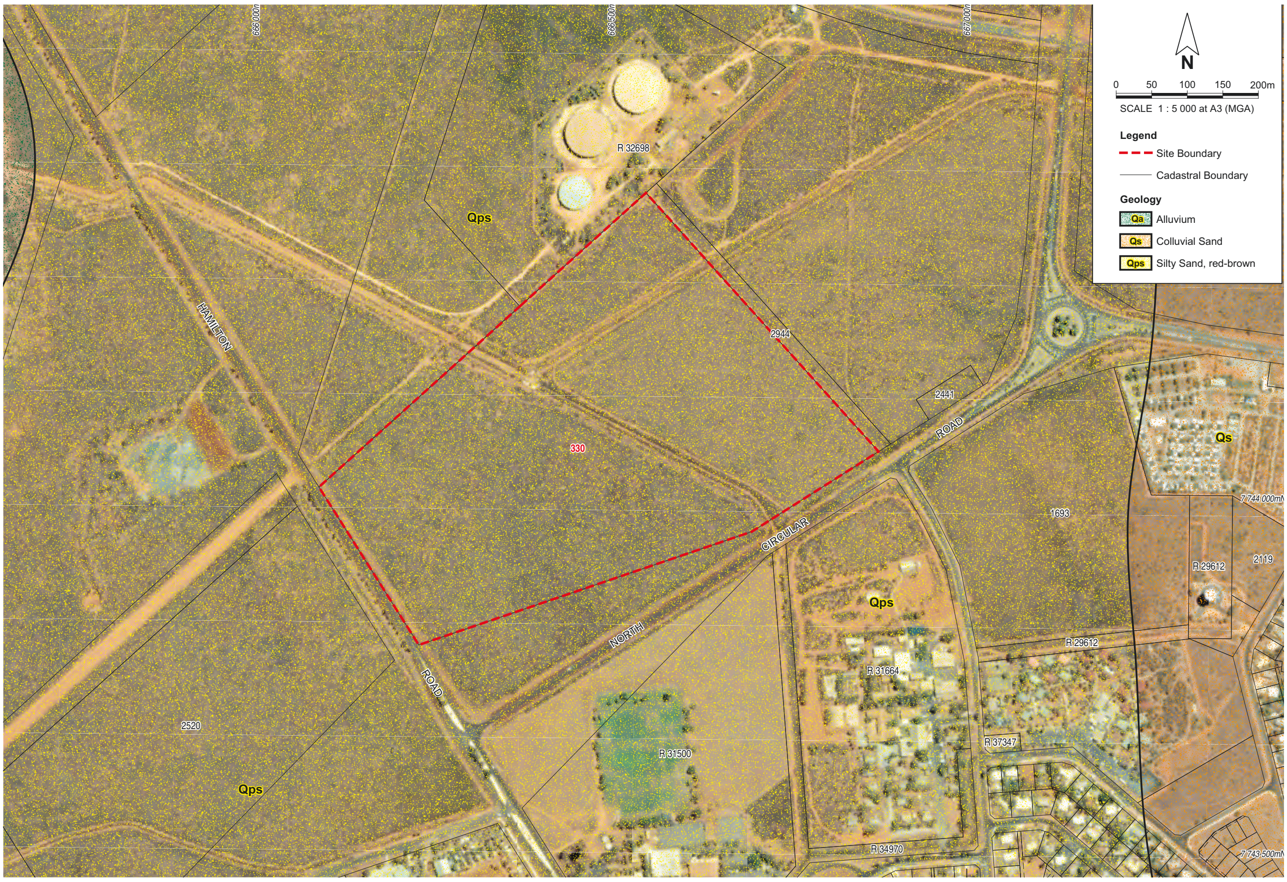
Contamination

The subject site or the immediate surrounds have not been reported as a known or suspected contaminated site within the DEC's Contaminated Sites Database. A desktop study of the site, along with a detailed site inspection and limited sampling program were undertaken by Aurora Environmental (2011) to determine whether contamination is likely to be present at the site.

A review of historical aerial photos (dating back to 1970) and historical title confirmed that the site has historically remained vacant with the exception of the construction of the drainage channels that traverse the site.

Land abutting the northern boundary of the site is currently used for potable water storage as a component of South Hedland's water supply. Other than this use, land to the south consists of a mixture of residential housing and schools and a small quarry exists to the west of the site. Further west is an ephemeral creek system (South Creek) which flows in a south-north direction towards the ocean. Otherwise, surrounding land is general vacant, comprising vegetation.

Figure 9 – Surface Geology



The DEC contaminated sites database was consulted on 29 August 2011. Two classified contaminated sites are present within a 2.5km radius of the site. The first contaminated site is located approximately 2.1km north of the site (6 Trig Street, Wedgefield) and the second contaminated site is located approximately 2.4km north of the site (Lot 6179 on Plan 26719).

A review of the Basic Summary of Records for each site indicates each contaminated site has been impacted by their historical use for fuel storage. The nature and status of contamination can be summarised as follows:

- 6 Trig Street, Wedgefield: Classified as "Contaminated – remediation required" due to Hydrocarbons (such as from petrol, diesel, oil) and metals being present in groundwater. The site is restricted to commercial/industrial use and groundwater abstraction is not permitted.
- Lot 6179 on Plan 26719, Wedgefield: Classified as "Contaminated – remediation required" due to Total Petroleum Hydrocarbons (TPH) and metals being present in groundwater. The site is restricted to commercial/industrial use and groundwater abstraction is not permitted.

Based on the inferred groundwater flow direction, neither of the above two classified contaminated sites would impact the subject site.

The desktop review of environmental information for the site has revealed no areas of environmental concern from a contamination perspective. However, to provide extra confidence in the findings of the desktop review, soil samples were recovered from ten (10) test-pits across the site and groundwater samples were recovered from three (3) groundwater monitor bores installed at the site. All samples were analysed for selected potential contaminants of concern (PCOCs). The findings of the groundwater investigation were not available at the time of preparing this report.

The soil sample results can be summarised as follows:

- No total petroleum hydrocarbons were detected in any of the samples;
- Heavy metals were detected in the majority of samples at the site however no cadmium or mercury was detected. Nickel was detected in excess of Ecological Investigation Levels at one location (at 0.5m BGL) however the detected concentration of 65mg/kg only slightly exceeded the assessment criteria of 60mg/kg. This was the only sample to contain any metal at concentrations over the applicable assessment level; and
- No organochlorine or organophosphorus was detected in any of the samples.

The elevated nickel identified at the one sample location was recovered from 0.5m BGL and given that the findings of the desktop review indicate that the site does not appear to have been disturbed, it is considered to be a function of the region's geology and as such, is considered acceptable and not indicative of a greater issue.

On the basis of the available information it is considered that the site is likely not contaminated and that a full Detailed Site Assessment for soils at the site is not warranted.

Acid Sulfate Soils

Acid Sulfate Soils (ASS) is the name commonly given to naturally occurring soils and sediments that contain iron sulphide (iron pyrite) materials. In their natural state ASS are generally present in waterlogged anoxic conditions and do not present a risk to the environment. ASS can present issues when they are oxidised, producing sulphuric acid, which can impart a range of impacts on the surrounding environment, infrastructure and human health.

Regional mapping produced by the DEC indicates that the site is unlikely to be affected by ASS. Information obtained from the CSIRO's online Australian Soils Resource Information System (ASRIS) confirms that the probability of ASS occurring at the site is extremely low, however due to the lack of information for this region, CSIRO have assigned the data as low confidence.

It was also considered pertinent to ground-truth the CSIRO ASS data, as it had been allocated a low confidence. As such, soil samples from all depths were recovered from half of the test-pits and analysed for ASS characteristics including field tests and the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) suite. ASS samples were assessed against the criteria required in DEC (2009) "Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes".

All ASS samples, except for one, were below the applicable criteria for ASS. One sample had a pHox of 3.3 which was slightly below the assessment criteria of 4. Total potential acidity expressed as sulphur units (sTPA) in this sample was 0.106%S which exceeds the guideline value of 0.03%S. This result is likely due to the presence of organic acids in the soil. This conclusion is supported by the fact that the acidity was not present as sulfur.

Rather than indicating an ASS issue, the single isolated result likely indicates that organic acids were more concentrated at the location than at other locations at the site. Given that DEC (2009) also states that soils that have never been disturbed and which remain permanently dry (i.e. are above the highest seasonal groundwater levels) do not require full acid-base accounting, it is not considered to indicate an ASS issue at the site.

HYDROLOGY

SURFACE WATER

The subject site is located in the Port Hedland Coast Basin which is within the proclaimed Pilbara Surface Water Area. This basin contains several creeks between Turner River Catchment and the De Grey River Catchment that converge at the coast. The dominant watercourses in this basin are Southwest Creek and South Creek.

The subject site is located within the catchment of South Creek which is approximately 8.5km in length and has an estimated catchment of 23km^2. It is a typical Pilbara ephemeral creek system which is dry for most of the year, except during heavy rainfall when sheet run off from adjacent land is generated.

While there are no natural watercourses that traverse the subject site, two constructed drainage channels dissect the site, converging at a junction in the central area of the subject site. The larger of the two drainage channels run in a south-east to north-west direction across the site, and ultimately discharges into South Creek. The drains are approximately 2m to 3m deep and the base width varies between an estimated 2m and 4m. The drains receive run-off from residential areas upstream of the site.

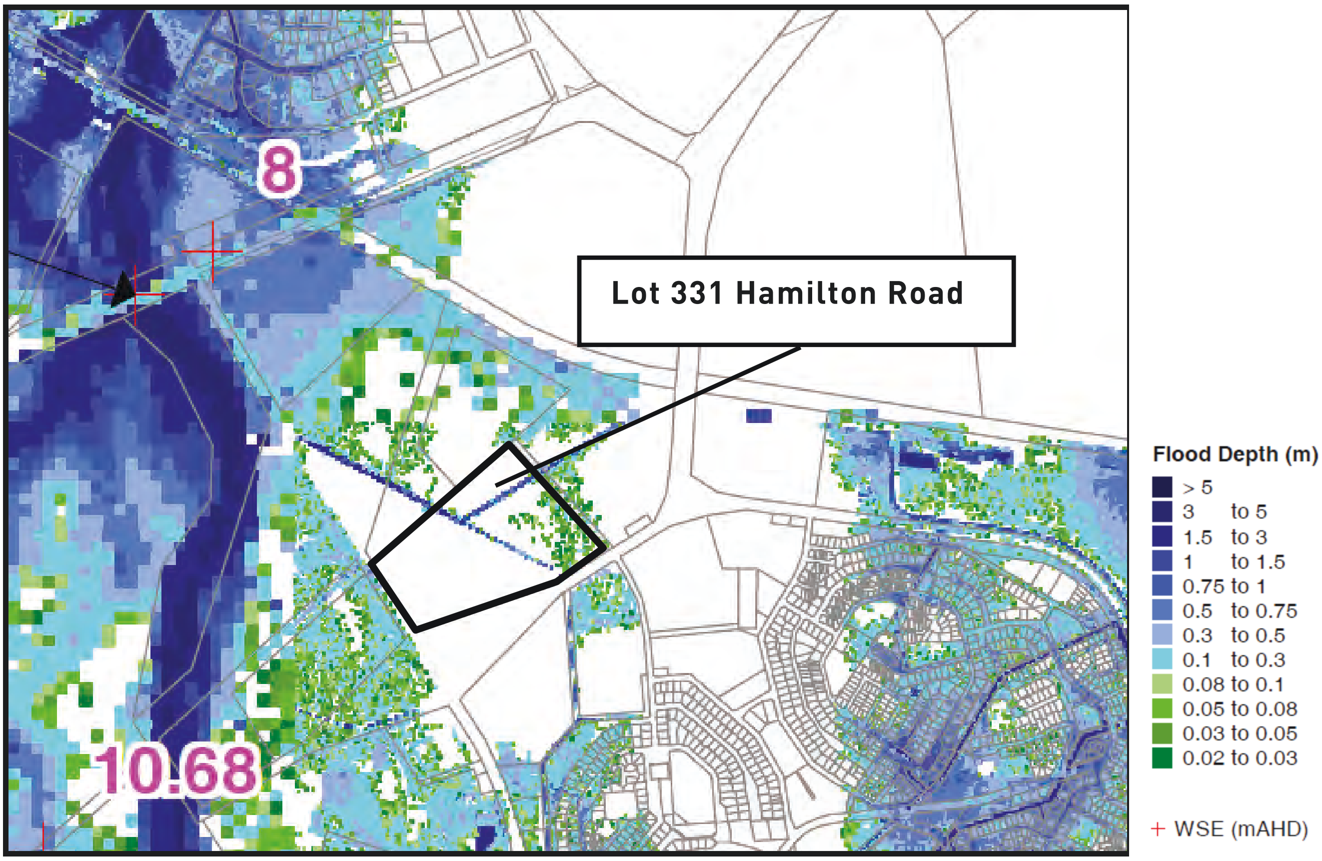
Flood and storm surge mapping of South West Creek has been undertaken by JDA Consultant Hydrologists (2000) and reviewed by MP Rogers and Associates (2008) for a project located to the south of Lot 331.

The mapping for South West Creek suggested inundation levels to be in the order of 13m AHD. However, based on recorded flood levels during certain events, it is apparent that the maximum inundation levels in South Creek are typically 4m lower than South West Creek (MP Rogers and Associates, 2008). Nominally inundation levels of approximately 9m AHD. Based on these levels, it would appear that the subject site would not be impacted by a combined 100 year flood and storm surge. However, recent advice provided by the Town of Port Hedland indicates that a Draft Coastal Vulnerability Analysis for Port Hedland has been completed by Cardno (2011). Based on the information prepared by Cardno (2011) it appears that the site is largely unaffected by 100 year flooding caused by the combined effects of large storm events and coastal storm surge, with the exception of the eastern portion which may be affected by up to 0.1m of flooding.

REFER TO FIGURE 10 – 100 YEAR FLOOD DEPTH

Further modelling will be undertaken to ascertain the flood levels which will determine the requirement for the future development to import fill material to ensure that the finished levels are above the 100 year ARI flood and coastal storm surge inundation levels. These details will be further refined in the UWMP.

FIGURE 10 – 100 YEAR FLOOD DEPTH



GROUNDWATER

Published data regarding groundwater at the site is limited however, the Online Hydrogeological Atlas (DoW, 2011) indicates that groundwater at the site is hosted in the unconfined Pilbara Coastal Saline Aquifer. It also indicates that the unconfined Pilbara Fractured Rock aquifer is located approximately 180m south-east from the site, beneath the South Hedland townsite.

It is anticipated that groundwater at the site flows in a north-westerly direction towards South Creek and towards the coast.

WATER INFORMATION NETWORK (WIN) DATABASE

A review of the DoW WIN database indicated that a registered bore is located adjacent the south-eastern most boundary of the site. However, there is a lack of reliable groundwater information for this monitoring well.

SITE SPECIFIC GROUNDWATER DATA

On 6 August 2011 a geotechnical scientist from Douglas Partners installed three groundwater monitoring wells at the site. The well construction bores and associated soil logs are presented in Appendix 2. During the construction of the bores, it was determined that groundwater at the site is approximately 3.1m BGL.

The first round of groundwater sampling at the site was undertaken by Aurora Environmental on 31 August 2011. The initial sampling round recorded groundwater levels at the three monitoring wells, the results are provided in Table 2. Groundwater level loggers have been installed in each monitoring well to improve the resolution of groundwater data for the site. Site visits are currently planned on a quarterly basis with data to be downloaded from each logger prior to re-setting and activating the logger.

TABLE 2: GROUNDWATER LEVELS BENEATH LOT 331 HAMILTON ROAD SOUTH HEDLAND

Date	Depth to Groundwater (m BGL)		
	MB41	MB42	MB45
6 August 2011	3.14	3.16	3.13
31 August 2011	4.43	3.80	3.94

Survey data for the site and the bores is not yet available and as such, it is not yet possible to conclusively ascertain the actual groundwater flow directions beneath the site. However, based on the preliminary results provided in Table 2 it would appear that groundwater flow direction is towards the north-west.

The initial sampling round also involved the collection of groundwater samples from the site for the purposes of establishing the baseline groundwater quality. The following analytes were being tested in the first round of sampling:

- Organochlorines (OCs) and organophosphorus (OPs) pesticides;

- Total petroleum hydrocarbons;
- Suite of eight heavy metals (Arsenic, Mercury, Lead, Nickel, Aluminium, etc);
- Nutrients (Total Nitrogen, Total Kjeldahl Nitrogen, Ammonia, Nitrate/Nitrite, Total Phosphorus and Filterable Reactive Phosphorus); and
- Total Dissolved Solids.

Subsequent rounds will not test for heavy metals or OCs/OPs. At the time of preparing this LWMS, the groundwater quality results were not available.

VEGETATION AND FLORA

The site is mapped as Beard's vegetation association Abydos Plain 647. This association comprises a low shrubland of Acacia translucens over open hummock grassland of Soft Spinifex (Triodia pungens).

A vegetation and flora survey undertaken by Woodman Environmental Consulting (2011) for Aurora Environmental of Lot 331 and the land to the east of Lot 331 identified two plant vegetation associations on the site, these were:

- G1 – Tall Closed Hummock Grassland of Triodia schinzii over Low Open Shrubland of Acacia stellaticeps on red-brown sandy loam; and
- S1 – Tall Isolated Clumps of Shrubs of Acacia trachycarpa and Acacia tumida over Low Open Shrubland of *Stylosanthes hamata and Acacia stellaticeps over Mid Tussock Grassland of *Cenchrus ciliaris on red sand.

Vegetation association G1 occurs across the entire site with occasional tall shrubs of Acacia trachycarpa/pyrifolia/Codonocarpus cotinifolius emergent. The S1 vegetation association was restricted to along the drainage line that traverses the site along a south-east/north-west alignment and contained species typical of wet habitats.

The vegetation associations recorded are common on the sand plain and drainage areas in the Port Hedland region and are not considered to represent any known threatened (or priority) communities.

The vegetation condition was variable, ranging from Poor-Very Poor to Very Good-Excellent. The majority of the site was Very Good-Excellent with the vegetation structure intact, and a low to absent weed occurrence. Areas mapped as Poor-Very Poor, Good-Poor, Good or Good-Very Good were typically along road verges and drainage lines. Areas assigned a lower condition rating generally displayed higher levels of weed infestation (in particular Cenchrus ciliaris - Buffel Grass) and an absence of native vegetation/structure due to anthropogenic disturbances.

A search of relevant DEC databases revealed that no threatened (declared) flora priority classes 1, 2, 3, or 4 occur within the site. Similarly, there have been no previous records of threatened or priority ecological communities as occurring on the site or in close proximity to the site.

Woodman Environmental Consulting (2011) recorded a total of 114 taxa (which included 7 introduced species) from the survey area (note that the survey area extended beyond the boundaries of Lot 331). Two Priority 3 taxa were identified during the survey. Eragrostis crateriformis, was recorded along the drain on Lot 331 and Tephrosia bidwilliia was recorded opportunistically while Lot 331 was being grid searched. Any impacts on the conservation significance on these species at a local and regional distribution level is likely to be negligible given that both species have been recorded in the general area previously (Woodman Environmental Consulting (2011).

FAUNA

A level 1 fauna assessment of the site was undertaken by Coffey Environments (2011). Coffey Environments (2011) identified a total of two fauna habitats on Lot 331, these being:

- Spinifex on Sandy Plain; and
- Drainage Lines.

Spinifex on Sandy Plain dominated Lot 331 with two narrow drainage lines traversing the central areas. All fauna habitats were in good condition, reflecting some impact of anthropogenic activities. There were no significant features or specific habitat within Lot 331 that would indicate it possesses ecological function values that are significantly different to many other areas surrounding it.

Eleven of the conservation significant fauna species listed under Commonwealth or State legislation are possible visitors to Lot 331. Of these species, four were migratory bird species (Barn Swallow, Rainbow Bee-eater, Oriental Plover and Fork-tailed Swift), four were mammals (Crest-tailed Mulgara, Orange Leaf-nosed bat, Brush-tailed Mulgara, Ghost Bat), one was a reptile (Woma) and the remaining two species were birds (Australian Bustard, Peregrine Falcon). None of these species are anticipated to be significantly affected by the proposed vegetation clearing of Lot 331. It is Coffey Environments' (2011) view that the proposed clearing is unlikely to substantially modify, destroy or isolate an area of important habitat for these species, or seriously disrupt the life cycle of an ecologically significant proportion of the population of any of these species.

TRAFFIC AND TRANSPORT

ROAD ACCESS

The site is located north east of the priority-controlled 'T' intersection of North Circular Road (east-west, minor leg) and Hamilton Road (north-south, major leg). Site access will be provided from both of these roads in the future. The current southeast lot boundary is set back from North Circular Road allowing for the possible future realignment of the road. As the site is currently undeveloped, there are no formal internal roads.

North Circular Road is classified as a District Distributor by the Town of Port Hedland while Main Roads WA's Functional Road Hierarchy (FRH) classes it as a Local Distributor (Neighbourhood Connector in Liveable Neighbourhoods). According to traffic modelling undertaken in 2010, North Circular Road east of Hamilton Road carried in the range of 3,000 - 7,000 vehicles per day, commensurate with a classification of Local Distributor. The road is a single, undivided carriageway with a posted speed limit of 80km per hour adjacent to the site. North Circular Road provides access to Wallwork Road to the east via a roundabout-controlled intersection, which in turn provides access northwards to Great Northern Highway and the town site of Port Hedland.

Hamilton Road is classified by the Town of Port Hedland as a Primary Distributor north of North Circular Road and District Distributor to the south of North Circular Road. Main Roads WA's FRH classifies both sections as Local Distributor. The road is primarily single, undivided carriageway; a limited stretch of median has been constructed from the TAFE site past North Circular Road to facilitate turning movements and queuing. The posted speed limit is 60km per hour to the south of the site, increasing to 80km per hour approximately 250 metres north of North Circular Road. Based on 2011 traffic count data, Hamilton Road south of North Circular Road carries about 10,000 vehicles per day. According to the traffic modeling undertaken in 2010, traffic on Hamilton Road north of North Circular Road reduces to a range of 3,000-7,000 vehicles per day.

Both North Circular Road and Hamilton Road are under the care and control of the Town of Port Hedland. Neither is part of Main Roads WA's Restricted Access Vehicles (heavy freight vehicle) network. Great Northern Highway is the principal freight route and bypasses the site to the north.

The Town of Port Hedland has advised that there are no current plans for other new developments in the vicinity of the subject site. However, the Town is currently looking at upgrading the at-grade crossing of the BHP rail line on Wallwork Road (about 360 metres north of the intersection of Wallwork Road and North Circular Road). This upgrade would likely involve grade separation on the basis of traffic demand and safety considerations. As part of the needs assessment, the Town has advised that they are considering traffic volume-based trigger points. This has been addressed in the Traffic Report appended to this document.

Refer to Appendix 3 – Traffic Report

NON-CAR TRANSPORT

In 2008, consultants Transplan Pty Ltd prepared a Cycle Plan for the Town of Port Hedland. A draft of the Plan is currently available on the Town's website although no network maps are included. The intention of the Plan is "to make cycling and walking within the Town of Port Hedland safer, more convenient and hence an attractive alternative means of transport and form of recreation". The Plan articulates objectives in relation to network development, provision of end-of-trip facilities and 'way-finding'.

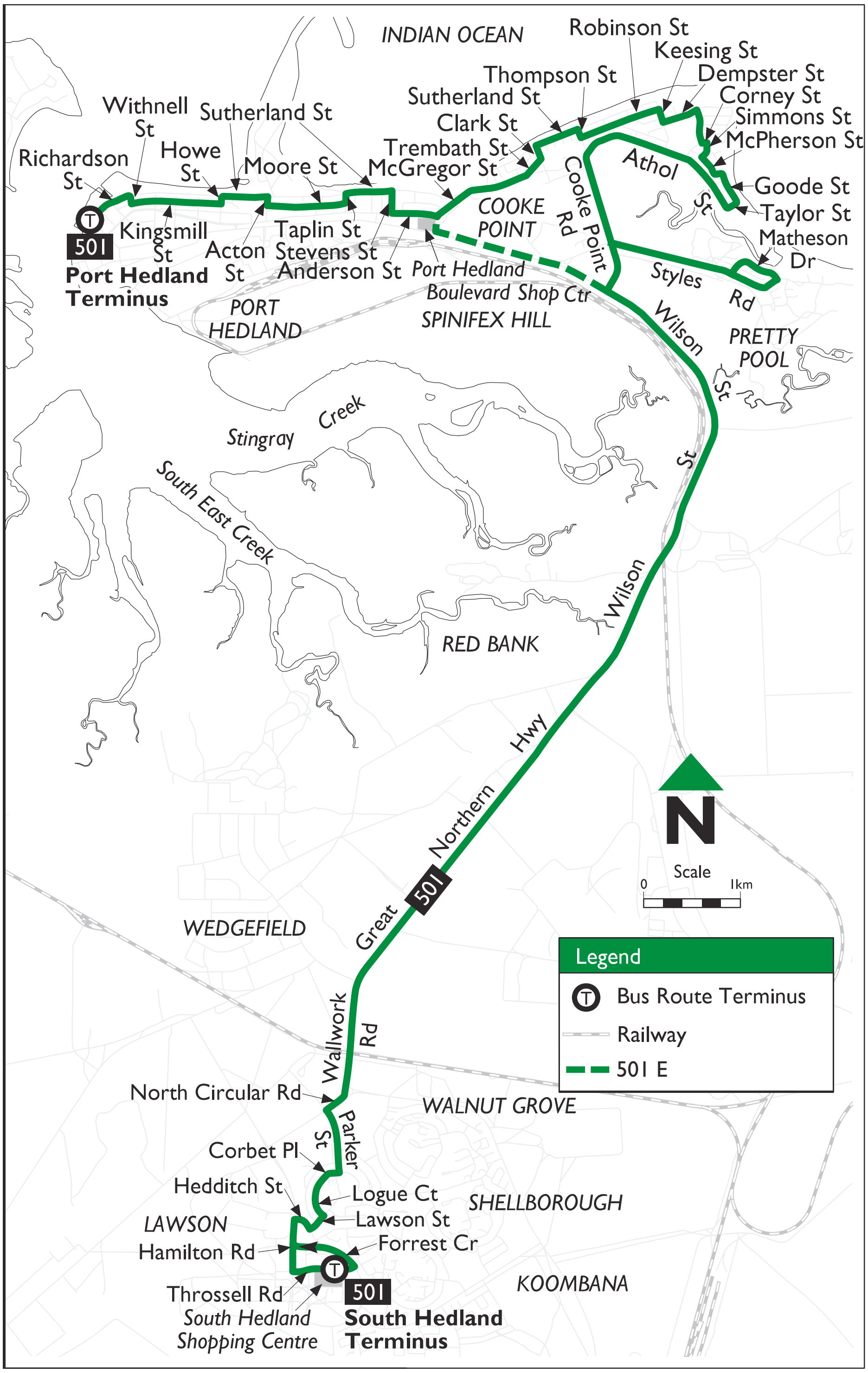
There is very little existing cycling infrastructure in the vicinity of the subject site. There are no sealed paths on either side of either Hamilton Road or North Circular Road. A sealed path is provided along Hamilton Road within the verge but only as far north as Karst Elbow, about 120m south of North Circular Road.

Based on the Town's draft Cycle Plan, the Town intends to develop a link (potentially a shared path) between South Hedland and Port Hedland via Wallwork Road. However, there do not appear to be any plans for additional infrastructure along North Circular Road to the west of Wallwork Road. Accordingly, any proposed cycling infrastructure within the Development Plan area should be augmented by investment by the Town in cycling provisions along Hamilton Road and North Circular Road to help create a legible, connected cycling network. This is also true for walking infrastructure.

The Public Transport Authority (PTA), operates three bus services, the 301, 401 and 501, which service South Hedland, and will soon be implementing some small changes to routing to better connect with the new hospital. The current network map for the 301 and 401 services is included below as Figure 11. The 501 operates between South Hedland and Port Hedland via Parker Street and Wallwork Road. Bus services operate infrequently – service headways are 1-2 hours and buses only operate between 8:15am and 7:40pm on weekdays – and there are no services on Sundays or public holidays. None of these services currently operate within walking distance (e.g. a 400m or five minute walk), of the subject site. The PTA has advised that there are no plans to extend public transport services to the subject site.

Refer to Figure 11 – Current Public Transport Service Map for South Hedland

Figure 11 – Current Public Transport Service Map for South Hedland



(Source: Public Transport Authority, August 2011)

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THE DEVELOPMENT PLAN

The following section of this report provides a description of the Development Plan, its design rationale and objectives, land uses, estimated population and residential densities, movement networks, servicing considerations and built form design considerations.

PROJECT OBJECTIVES

The residential centre of South Hedland is some 10km inland from Port Hedland, the largest port and the major centre for Western Australia's iron ore industry in the Pilbara. The economic growth has fuelled a demand for both short term and permanent, affordable accommodation for key workers and resource sector employees.

As stated above, the Town of Port Hedland's 'Pilbara's Port City Growth Plan', which is currently being advertised, is a high level strategic plan which aims to transform Port and South Hedland into:

"A nationally significant, friendly City, where people want to live and are proud to call home."

The strategic plan outlines that the population of Port Hedland will grow to 40,000 people by 2025, approximately 2/3rds of whom will live in South Hedland, and approximately 1/3rd in Port Hedland.

The Development Plan will provide approximately 440 dwellings, to help accommodate Port Hedland's growing population, including accommodation for key workers and community housing.

The desired architecture of buildings will be innovative, functional, energy efficient and capture the spirit of the Pilbara. Housing will be affordable with a diversity of styles.

The main objectives for the Development Plan are to:

- Address the need for permanent and affordable and key worker accommodation;
- Generate an attractive urban outcome that will attract people to Port Hedland;
- Provide permanent long term accommodation;
- Deliver accommodation in a speedy and efficient manner;
- Incorporate public amenity through appropriately located and landscaped public open space; and
- Meet the provisions of a Development Plan required in accordance with the Town of Port Hedland Town Planning Scheme No 5.

DEVELOPMENT PLAN DESIGN RATIONALE

The design of the Development Plan is based around the provision of an interconnected street grid network that provides good permeability and access around the drainage channels which traverse the site. The design of the Development Plan also provides the option for future development to extend into what is currently part of the North Circular Road reservation to the south of the site should it be surplus to road requirements as well as facilitating possible future connections with future development to the northeast and northwest.

Refer to Figure 12– Development Plan

FIGURE 12– DEVELOPMENT PLAN

DEVELOPMENT PLAN LEGEND

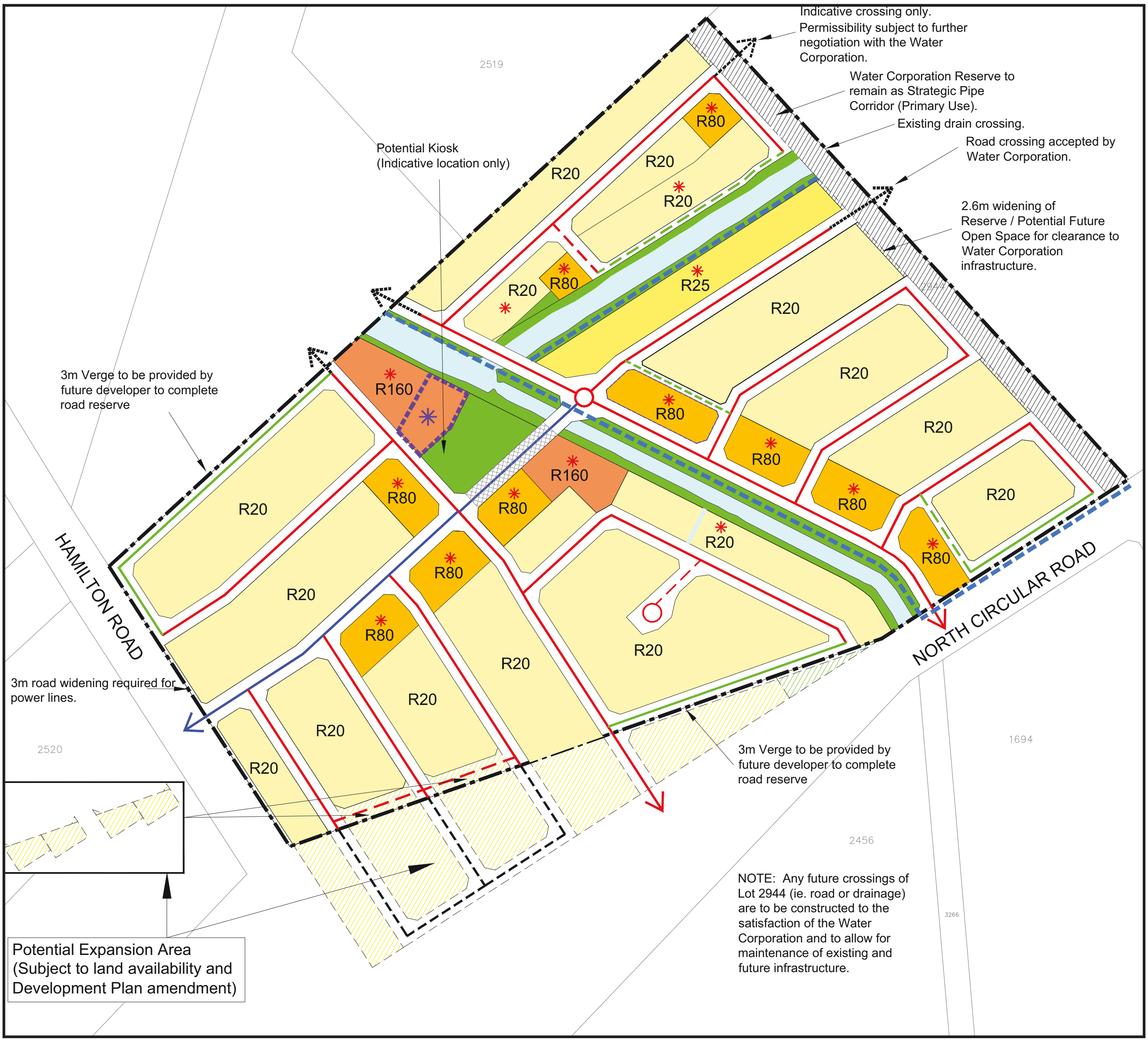
▭	Development Plan Area

LAND USE/ DEVELOPMENT YIELD

🟩	Public Open Space/ Drainage
🟦	Drainage
▨	Potential Future Open Space
R20	Residential R20
R25	Residential R25
R80	Residential R80
R160	Residential R160
▨	Potential Future Development
✳	Detailed Area Plan Required
✳	Commercial uses permitted in this area.(Refer to Development Plan text.)

ROADS & TREATMENTS

—	Access Road 'A' (18m reserve)
—	Access Road 'B' (15m reserve)
- - -	Access Road 'C' (13.7m reserve)
—	Access Road 'D' (12m reserve)
- - -	Laneway 'E' (8m reserve)
- - -	Laneway 'F' (6.01m reserve)
- - -	3m Dual Use Path
➜	Possible Future Access
⊗	Traffic Roundabout
▭	Visitor Parking
▨	Brick Paved Carriageway
☒	Bin Pads



Indicative crossing only. Permissibility subject to further negotiation with the Water Corporation.

Water Corporation Reserve to remain as Strategic Pipe Corridor (Primary Use).

Existing drain crossing.

Road crossing accepted by Water Corporation.

2.6m widening of Reserve / Potential Future Open Space for clearance to Water Corporation infrastructure.

Potential Kiosk (Indicative location only)

3m Verge to be provided by future developer to complete road reserve

3m road widening required for power lines.

3m Verge to be provided by future developer to complete road reserve

Potential Expansion Area (Subject to land availability and Development Plan amendment)

NOTE: Any future crossings of Lot 2944 (ie. road or drainage) are to be constructed to the satisfaction of the Water Corporation and to allow for maintenance of existing and future infrastructure.

COMMUNITY DESIGN

The Development Plan will facilitate the provision of a sustainable, coherent and attractive neighbourhood, offering a wide choice of housing, local identity and sense of place and the opportunity for recreational activities. The Plan predominantly provides single lot residential development, with the exception of two large grouped housing sites located abutting public open space, and a number of 'four-pack' lots, generally with rear access, capable of providing four multiple dwellings on each lot (further discussed below).

The Development Plan will also facilitate sustainable urban development by providing well designed housing using passive solar design principles including maximising the number of east-west blocks to allow for maximum solar efficiency (as advocated in arid environments). Whilst the shape of the site and the existing drainage lines are not conducive to all lots having an east-west orientation, climate responsive design principles will be incorporated into housing designs (as detailed in the Dwelling Typology section later in this report). Climate responsive design principles will also be incorporated into Detailed Area Plans, which will promote energy efficient built form.

The Plan provides for a range of accommodation and living options through the provision of a mix of lot types, residential densities and housing types. Areas of higher density residential development, potentially incorporating apartments within low-rise development, have been located around high amenity areas including the parkland and drainage channels.

Legibility and sense of place is also provided via an integrated movement network comprising a clear street hierarchy and shared path network which will facilitate safe and efficient movement for pedestrians, cyclists and vehicles. The design of the movement network ensures good internal connectivity, within the limitations the site's drainage channels impose. The street network also allows for potential future connections to North Circular Road and also to the land to the northeast and northwest.

POPULATION AND RESIDENTIAL DENSITIES

The Development Plan provides for a diversity of residential living options within residential development ranging from R20 to R160. The distribution of residential density has been based on the provision of higher densities around the park and landscaped drainage channels.

The range of residential densities will assist with meeting current and future market demand for residential housing. Approximately 50% of the Development Plan area is identified for development at the R20 density code, and 3% for development at the R25 code, densities which are generally consistent with the existing housing stock in Port Hedland. A further 10% of the Plan is identified for development at higher densities with 7% identified for development at the R80 density and 3% at the R160 density. Lots identified for lower densities are to be developed as single residential dwellings, facilitating a range of lot sizes to cater for large family homes. Land subject to higher density codings are envisaged to comprise predominantly multiple dwelling developments facilitating apartment style residential living for single persons, couple households or two unrelated persons sharing.

Tables 3 and 4 below summarise the estimated development yields and population generated by the future subdivision under the Development Plan.

TABLE 3: DEVELOPMENT AREAS SUMMARY

Land Use	Land Area	Percentage of Future Subdivision Area
Single Residential		
Residential R20	12.7814 ha	50.2%
Residential R25	7757 m^2	3.0%
Residential R80	1.8057 ha	7.1%
Residential R160	7260 m^2	2.9%
Public Open Space	1.4190 ha	5.6%
Drainage	1.1201 ha	4.4%
Water Corp Reserve	525m^2	0.2%
Access Easement	1,735m^2	0.7%
PAN	120m^2	0
Road	6.5991 ha	27.0%
Total	25.465 ha	100%
Potential Future Open Space	9321 m^2	-

TABLE 4: ESTIMATED DWELLING YIELD AND POPULATION

Residential Type	Estimated No. Dwellings	Estimated Population[1]
Residential R20	254	711
Residential R25	16	45
Residential R80	104	291
Residential R160	66	185
Total	440 dwellings	1232 persons

[1] Based on an average household size for a normalised Pilbara city of "2.8 persons".

SCHOOLS

It is understood that there is pressure on existing schools within South Hedland to accommodate the town's current population. Given the Development Plan proposes the development of residential housing, it will add to this pressure.

Given the site's size and constraints in the form of the drainage channels, it is not proposed to accommodate a school within the Development Plan area. Discussions with the Department of Education and Training revealed that it agrees a school is not required in the subject site.

The Department of Education and Training are likely to develop and implement expansion programmes which reflect the future population forecast within the draft Pilbara's Port City Growth Plan.

COMMUNITY FACILITIES

As stated above the Development Plan area is located in proximity to a number of community facilities such as the South Hedland Sports Complex to the south west of the site as well as the fields associated with the Hedland Senior High School located directly to the south. The South Hedland Sports Complex not only caters for sporting events but also incorporates club rooms and various function rooms which is presumed can be utilised as community meeting rooms. The main commercial centre of South Hedland is located approximately 1.5km south of the site and the Port Hedland race track and golf course some 3km south west of the site. It is therefore considered that the development does not give rise for the need for any additional community facilities.

LOT LAYOUT AND DEVELOPMENT TYPOLOGIES

The Development Plan provides diverse residential lot types and sizes to cater for a range of household types and lifestyles, through the majority are single residential lots to accommodate families. Higher density lots have been provided in proximity to the public open space (POS) and the drainage channels where they benefit from the higher amenity provided.

The design of the Development Plan ensures lots will front onto and overlook public realm areas, facilitating a high level of passive surveillance and assist in creating a safe and attractive environments.

Generally each street block is provided with a minimum depth of 60m to provide a minimum lot depth of 30m, however due to the constraints imposed by the sites drainage channels some less regular lots were required. The following table identifies the lot sizes envisaged under each density code for single residential lot development thus demonstrating compliance with the R-Codes.

This indicative subdivision plan is subject to further review and refinement during the design process while the development principles will be retained, the lot layout and form may be modified to suit design responses.

TABLE 5: PROPOSED SINGLE RESIDENTIAL LOT CONFIGURATIONS

Density	Minimum Lot Size m^2	Area (average) m^2
Residential R20	450	503
Residential R25	480	485

REFER TO FIGURE 13 - INDICATIVE SUBDIVISION PLAN & YIELDS

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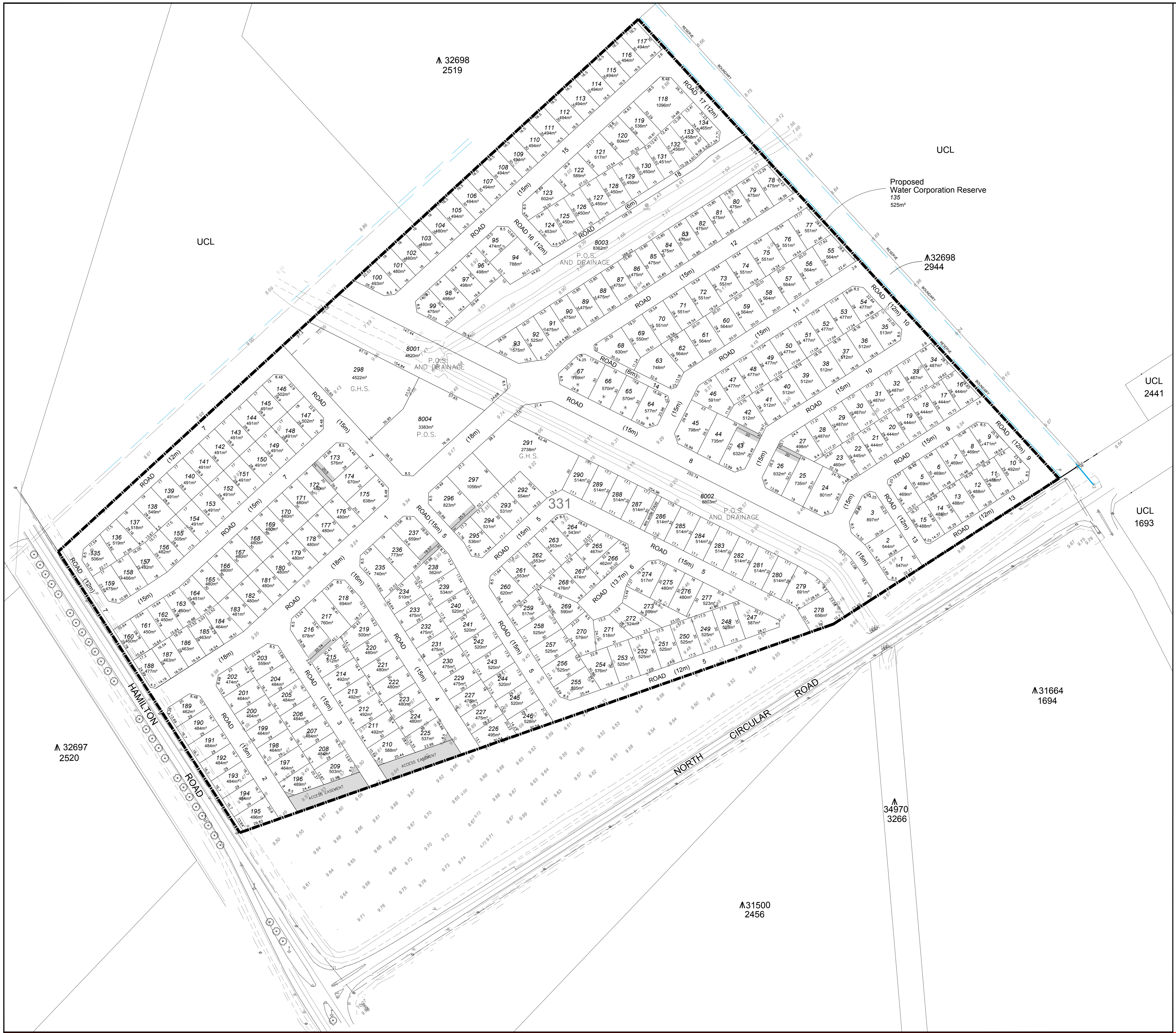

LEGEND

- AREA SUBJECT OF APPLICATION FOR SUBDIVISION
- EXISTING CADASTRE
- PROPOSED LOT
- ACCESS EASEMENT
- CONTOURS (0.25M INTERVAL)
- SURVEY CONTROL
- 9.00 SPOT HEIGHT
- 9.00 INVERT LEVEL
- EXISTING LIGHT POLE
- EXISTING POWER POLE
- EXISTING STEEL WIRE ANCHOR
- EXISTING SIGN
- BORE EXISTING MONITORING BORE
- EXISTING WATER MAIN MARKER
- EXISTING TREE 0.3 - 1.0m
- EXISTING ROAD KERB
- EXISTING ROAD CENTRE LINE
- EXISTING EDGE OF BITUMEN
- EXISTING ROAD SHOULDER
- EXISTING RIDGE LINE
- EXISTING TOP OF EMBANKMENT
- EXISTING BOTTOM OF EMBANKMENT
- EXISTING OVERHEAD POWER LINE
- EXISTING U/G WATER PIPE
- EXISTING U/G TELSTRA CABLES

DEVELOPMENT SUMMARY

LOT TYPE	LAND AREA	AVERAGE	NO. LOTS
Residential R20	12.7814ha	503m²	254 lots
Residential R25	7757m²	485m²	16 lots
Residential R80	1.8057ha	694m²	26 lots
Residential R160	7260m²	-	2 lots
Total Residential	16.0888ha		298 lots
Public Open Space	1.4190ha		
Roads	6.5991ha		
Drainage	1.1201ha		
Water Corp reserve	525m²		1 lot
Access Easements	1735m²		2 lots
P. A. W.	120m²		1 lot
Development Total	25.465ha		

NOTES:

- Original area of lot 331 - 25.465ha
- Number of original lots - 1
- Number of proposed lots - 298
- Land is vacant
- All dimensions and areas are subject to survey

Proposed Subdivision Plan
Lot 331 Hamilton Road
South Hedland

Date: 15th May 2012 Designer: DR
Scale: 1:3000 @ A3 Drawn: PR
Drawing No. 711- 340 SU1D - (A3) 150512.pdf

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TOWN PLANNING
AND URBAN DESIGN

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Dwelling Typologies

The Development Plan provides for a diversity of housing options through a range of single and multiple dwelling sites (both private and public development). Indicative development typologies have been prepared to illustrate site planning principles and the potential for development on each of the lot types facilitated by the Development Plan.

REFER TO APPENDIX 4 – DWELLING TYPOLOGIES

Single Residential Typologies

The Development Plan will facilitate a subdivision pattern predominantly comprised of traditional front loaded lots. At the northern corner of the site an irregular pocket of land formed by the existing east-west traversing "Drain/POS" (POS) facilitates the introduction of laneway lots abutting and with outlook over the POS. Throughout the site it is anticipated that the POS will be activated through pedestrian connection points to each lot and with passive surveillance facilitated by the location of outdoor living areas and low or visually permeable fencing.

A range of dwelling sizes is catered for as follows:

Front Loaded Lots

Dwelling type:	Approx lot size
3 bed x 2 bath	455m^2 – 498m^2
4 bed x 2 bath	500m^2 – 589m^2
5 bed x 2 bath	588m^2 – 745m^2

Laneway Lots

Dwelling type	Approx lot size
3 bed x 2 bath	476m^2 – 497 m^2
4 bed x 2 bath	1 off at 546m^2
5 bed x 2 bath	599m^2 – 630m^2

Multiple Dwelling Lots

The plan incorporates a range of multiple dwelling sites which add an additional level of diversity over that provided by the single residential typologies. These are comprised of two strategically located key development sites supported by a series of smaller '4 Pack' lots designed to accommodate four, zero lot line apartments on each lot, with two above and two below. This housing style will therefore create a two storey urban edge along the main entry roads to the development. Vehicle access will be via the rear of the lots, either off a secondary street frontage or a battle-axe connection for internal lots, with the primary street frontage kept clear of crossovers.

Multiple dwelling sites are generally located on primary roads or take advantage of significant elements of amenity. The two key development sites both abut Public Open Space while the majority of '4 Pack' sites enjoy POS outlook across a street.

Indicative development plans for both the key development sites and the '4 Packs', together with a photographic streetscape example of the style of development which could potentially be achieved on the on the R160 site in the north of the site are provided in Appendix 5.

REFER TO APPENDIX 5 - LARGE MULTIPLE DWELLING DEVELOPMENT CONCEPTS

Approximate dwelling yields and design features proposed for the key multiple dwelling sites are as follows:

- Central R160 site:
  - 10x1 Bed and 8x2 Bed multiple dwellings;
  - 2 storey development addressing the road and the POS opposite; and
  - Parking accessed via the rear.
- Northern R160:
  - Approximately 48 3 bedroom multiple dwellings;
  - Average 3 storey maximum height development located approximately 1.5m above road level addressing the street and both areas of POS (note - feature elements up to 4 storeys are suitable and encouraged);
  - Semi-basement residents parking located approximately 1.5m below road level; and
  - Visitors parking located on the "ground floor" residential deck, and on street.

PUBLIC PARKLAND AND PUBLIC OPEN SPACE

The provision of public open space (POS) within the development has been informed by the principles of Liveable Neighbourhoods and taking into consideration the sites existing drainage channels and the need to ensure effective open space is provided. The POS is provided in the form of a park located in the northern portion of the Development Plan area, located abutting the drainage channel and the large grouped dwelling site.

The public open space area(s) will be landscaped to provide for opportunities for passive recreation opportunities within easy reach of residents and available for day or night use. The central park has been designed and located to act as focal points within the development, enhancing local amenity and sense of place. The drainage channels through the site will be landscaped to provide visual interest.

Refer to Figure 14 - Central Public Open Space Area

The Development Plan proposes to provided 1.207ha of the site as open space, representing 5% of the developable area. The following table summaries the open space contribution for the site.

Table 6 – Schedule of Public Open Space Contributions

Public Open Space Schedule	Area (Ha)
Site Area (lot 331)	25.462
Deductions	
Drainage	1.313
Gross Subdivisional Area	24.149
Public Open Space @5% (as per Element 4, R34)	1.207
Total Public Open Space Provided	1.207
Percentage of Gross Subdivisional Area	5%

Refer to Figure 15 - Public Open Space Areas

FIGURE 14 - CENTRAL PUBLIC OPEN SPACE AREA

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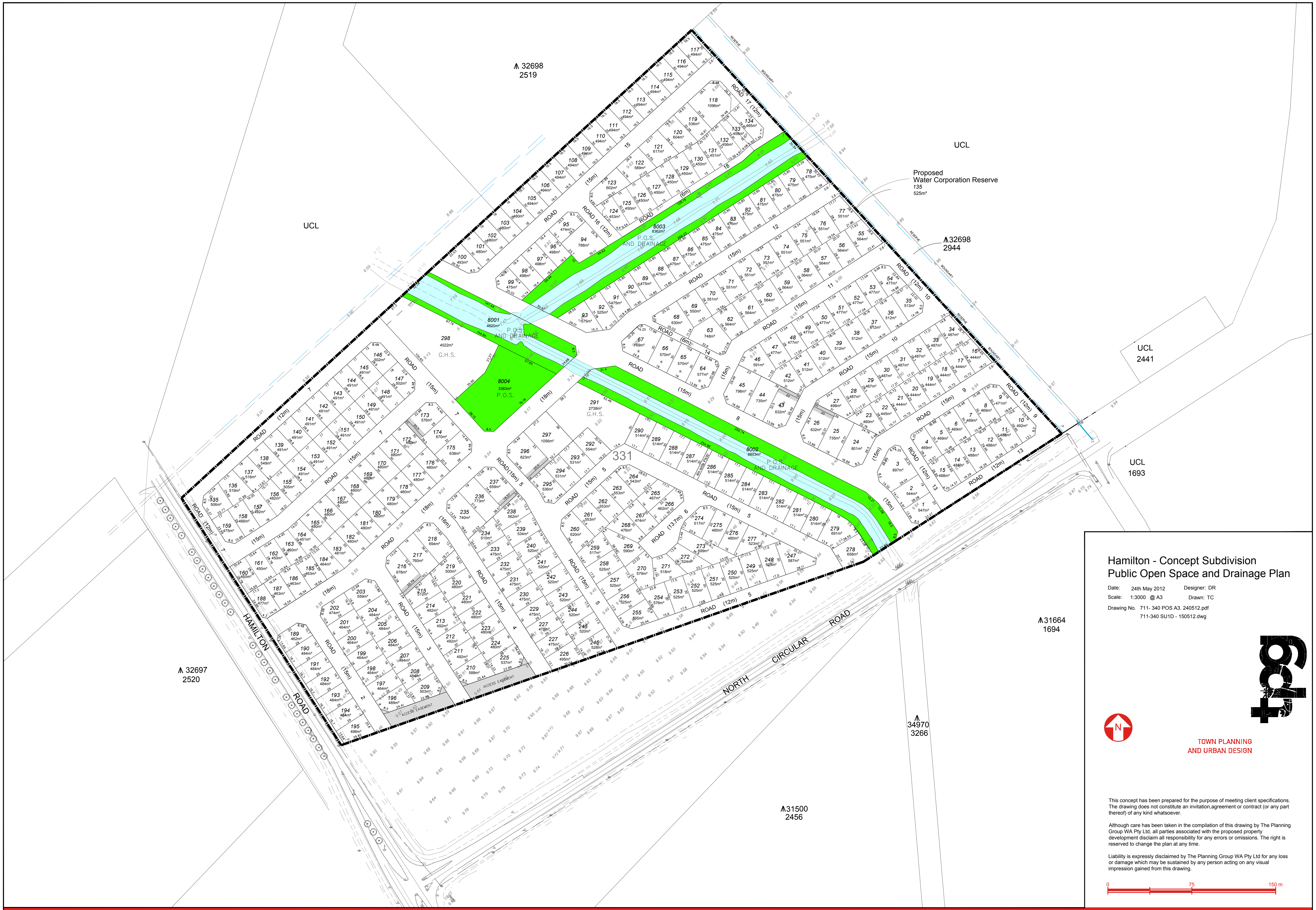

Hamilton - Concept Subdivision
Public Open Space and Drainage Plan

Date: 24th May 2012 Designer: DR
Scale: 1:3000 @ A3 Drawn: TC
Drawing No. 711- 340 POS A3. 240512.pdf
711-340 SU1D - 150512.dwg

TOWN PLANNING
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This concept has been prepared for the purpose of meeting client specifications. The drawing does not constitute an invitation,agreement or contract (or any part thereof) of any kind whatsoever.

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Liability is expressly disclaimed by The Planning Group WA Pty Ltd for any loss or damage which may be sustained by any person acting on any visual impression gained from this drawing.

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Public open space within the Development Plan is in accordance with Element 4, R34 of Liveable Neighbourhoods which allows for a minimum POS contribution of 5% of the gross subdivisible area for regional areas as:

- The POS is designed, developed and located for the widest possible use of the community, readily available for day and night use and developed to a quality standard in accordance with the landscaping plans as discussed below;
- Adequate areas are provided elsewhere for drainage with a large drainage channel provided to accommodate stormwater. Whilst landscaped drainage swales are located on the fringe of the main drainage channel, recreational pathways are provided which provide a year round recreational use, which is considered the most appropriate given the limited width of the land and climate; and
- The public open space does not contain any restricted uses.

The public open space contribution provided under the Development Plan has been devised in conjunction with the Town and is considered suitable for the following reasons:

- The total public open space contribution comprises 5% of the gross subdivisible area;
- The main POS area is to be well developed and includes an active recreation area suitable for all ages as discussed below;
- There are significant areas of open space provided in close proximity to the proposed development including a large park associated with the high school directly south of North Circular Road (suitable for organised activity) and the South Hedland Sports Centre located to the south of the site which provides significant opportunities for active recreation; and
- The provision of additional areas of POS would add a significant maintenance burden on the Town.

Landscape and Open Space Strategy

The Hamilton Precinct landscape strategy is aimed at the creation of safe, attractive and comfortable settings for future residents, suitable for the social and recreational demands of the precinct and responsive to the local climate and environment. The existing regional drainage function will be maintained within the public open space and regenerated through a series of landscape and engineering measures.

Refer to Figure 16 – Landscaping Plan

Refer to Figure 17 – Channel Cross Sections

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LEGEND

1	Central public open space
2	Footbridge
3	Resting points with seating
4	2m footpaths along local streets
5	Linear drainage parkway
6	On street embayment parking
7	Private pedestrian access to lots
8	Recreation path
9	2m local circuit path (share use)
10	Trafficable paving

Hamilton Development_South Hedland

Master plan

24 May 2012

Scale 1:1000 @ A1

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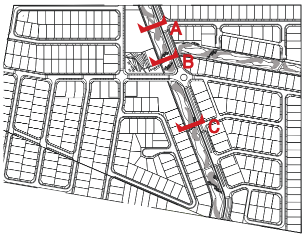
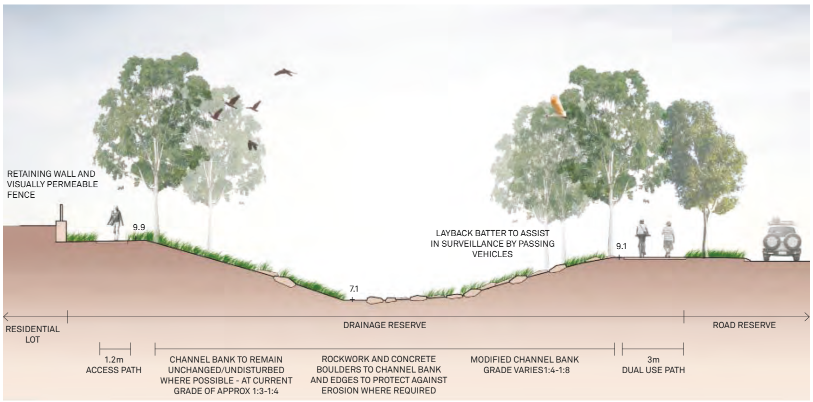
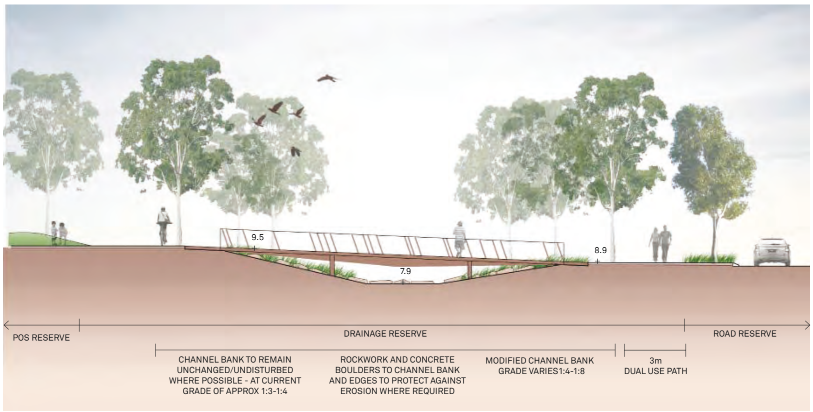
FIGURE 17 – CHANNEL CROSS SECTIONS

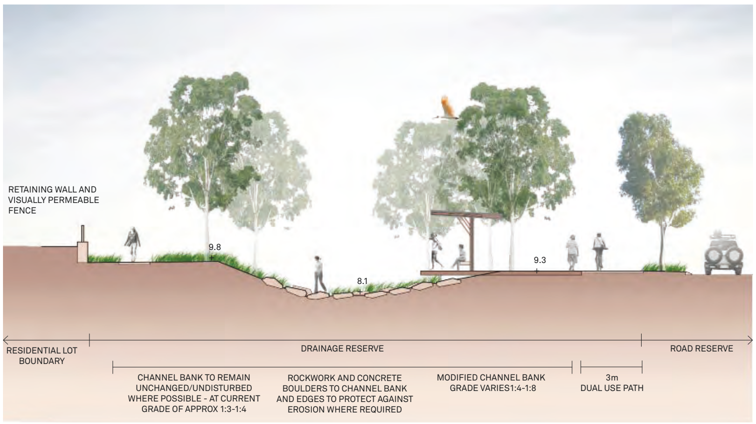




SECTION A_TYPICAL



SECTION B_PUBLIC OPEN SPACE CROSSING



SECTION C_RESTING POINT

Central Public Open Space

The central public open space (approximately 3,400m^2) will provide local neighbourhood park features, including a large open grassed 'kickabout' area, an all ages playground, future water play area, barbeque shelters, and a seasonal kiosk platform.

The park will provide a mix of partly shaded open active recreation spaces and heavily shaded social and play areas, through tree planting and the provision of permanent shade structures.

The park will be shaped and planted in a manner reminiscent in character and materiality of the Pilbara's natural environment, with pockets of richer more detailed garden interspersed throughout larger areas of dry land planting. Species selection and irrigation will be arranged on the principles of hydrozoning to maximise water efficiency.

Robust materials and structures will be selected and designed to withstand the rigours of the local climate. Lighting will be provided throughout the park to encourage outdoor use in the cooler nights.

Linear Parkways

One of the key strategies in the development of the Hamilton Precinct is to activate the existing drainage corridors as integral components of the landscape public open space network and in doing so celebrate these unique elements of the North West Australian landscape. It is hoped that in the future these linear parkways will form a network of green corridors across the area linking communities, facilities and areas of public open space.

The activation of the drainage channels will be achieved through improved grading, planting, visual surveillance and circulation. The existing banks will be reshaped and planted with more gradual slopes where possible. Footpaths running along the top level will be linked across the channel by foot bridges to complete pedestrian circulation loops within the precinct, and increase visual permeability and safety generally.

The footpaths will provide links to the surrounding street and open space network, including the provision for a wider share use path catering for cyclists. Pedestrian pole top lighting will be provided along key pathways to encourage safe night time use.

Streetscapes

Streetscapes through the residential areas will be defined and shaded through street tree planting, comprising local and some exotic species assigned to different road types to assist orientation within the development.

Informal visitor parking will be provided adjacent to each single residential lot through gravel mulched verges. Formalised on street parking is proposed only where directly adjoining the parks and high density residential lots.

The footpath hierarchy across the site will be based on three footpath sizes, a 3m wide recreational path, a 2m wide typical footpath and a 1.2m wide pedestrian access path. The 3m wide recreational path is proposed to form part of the regional cycle path network, linking parks and community destinations within the precinct and future surrounding developments.

Local streets will have a 2m wide footpath which is a generous size to allow for local cyclists, prams and wheelchairs if necessary. The 1.2m footpath will provide residential access to some high density residential lots and to many of the lots facing into the drainage channel.

The footpath and dual use paths will be located to anticipate connections to future developments, public transport routes and community facilities.

Proposed Planting List

Planting and tree species will be selected from the following list, subject to availability and further discussion with Town of Port Hedland.

STREETSCAPE	
Trees	
Acacia stenophylla	Shoestring Acacia
Corymbia flavescens (E. flavescens)	White Gum
Delonix regia	Poinciana
Eucalyptus victrix	Smooth-Barked coolabah
Tipuana tipu	Rosewood
Ulmus parvifolia	Chinese Elm
Understorey	
Convolulus cneorum	Silver bush
Dianella ‘Breeze’	Flax Lily
Dianella revoluta	Black Anther Flax Lily
Eremophila glabra ‘Kalbarri Carpet’	Emu Bush
Gomphrena canescens	Pink Billy buttons
Grevillea ‘Gin Gin Gem’	Grevillea
Hardenbergia comptoniana	Native wisteria
Lomandra Tanika	Matt rush
Myoporum parvifolium	Creeping Boobiala
Poa labillardierii ‘Eskdale’	Bluegrass
Scaevola crassifolia	Thick leaf fan flower
Scaevola parvifolia	Camel weed
Westringia Mundii	Native rosemary
POS	
Trees	
Acacia aneura	Mulga
Acacia stenophylla	Shoestring Acacia
Brachychiton acuminatus	Burrup Kurrajong
Casuarina equisetifolia	Coastal sheoak
Corymbia aspera (E. aspera)	Brittle Bloodwood
Corymbia flavescens (E. flavescens)	White Gum
Eremophila glabra	Emu bush
Eucalyptus camaldulensis	River Red Gum
Eucalyptus victrix	Smooth-Barked coolabah
Ficus hillii	Hill’s Fig
Hibiscus tileaceous rubra	Cottonwood
Melaleuca leucadendra	Weeping paperbark
Pulmeria obtusa	Frangipani
Understorey	
Acacia gregorii	Gregory’s Wattle
Acalypha Wilkeslana	Acalypha
Alyogyne hakeifolia	Native Hibiscus
Bougainvillea Sp	Bougainvillea
Convolulus cneorum	Silver bush
Carrisa grandiflora	Natal Plum
Dianella ‘Breeze’	Flax Lily
Dianella revoluta	Black Anther Flax Lily
Eremophila glabra ‘Kalbarri Carpet’	Emu Bush
Eremophila maculata	Native fuchsia
Ficinia nodosa	Noddy Clubrush
Gomphrena canescens	Pink Billy buttons
Ixora coccinea	Jungle Geranium
Lomandra Nyalla	Matt rush
Lomandra Tanika	Matt rush
Murraya paniculata	Orange Jessamine
Poa labillardierii ‘Eskdale’	Bluegrass
Ptilotus exaltatus	Pink mulla mulla
Russelia equisetifomis	Firecracker Plant
Scaevola crassifolia	Thick leaf fan flower
Trioda wiseana	Lime spinifex
Westringia Mundii	Native rosemary
Olearia ‘Little Smokie’	Daisy Bush
DRAIN REVEGETATION	
Trees	
Acacia aneura Mulga	Mulga
Acacia coriacea	Wiry Wattle
Corymbia aspera (E. aspera)	Burrup Kurrajong
Corymbia flavescens (E. flavescens)	White Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus victrix	Smooth-Barked coolabah
Casuarina equisetifolia	Coastal sheoak

Understorey	
Eremophila longifolia	Native fuchsia
Eremophila maculata	Native fuchsia
Ptilotus exaltatus	Pink mulla mulla
Scaevola parvifolia	Camel weed
Spinifex longiflorus	Beach spinifex
Trioda pungens	Soft Spinifex
Triodia schinzii	Spinifex
Lomandra longifolia	Matt Rush
Juncus krausii	Sea Rush
Juncus pallidus	Pale Rush
Lepidosperma gladiatum	Coast Sword Sedge

Irrigation and Maintenance

Based on preliminary discussions with the Town it is envisaged that the landscaping will be irrigated using recycled waste water treated near the South Hedland Sports Complex. This water currently irrigates nearby school ovals and ports and it is believed there is additional capacity to extend the network to irrigate the landscaping proposed.

In terms of maintenance it is understood that the developer will be responsible for the maintenance of the open space for an 18 month period to allow for establishment of the landscaping prior to care and management being handed to the Town.

MOVEMENT NETWORK

Proposed Street Network

The Development Plan provides for an interconnected street network that helps to facilitate safe and effective internal connectivity and access to the surrounding area for vehicles, cyclists and pedestrians. All streets are intended to function as local access streets. However, in future, when the development is connected to new adjacent subdivisions, the internal spine routes (Roads 1 and 8) have sufficient carriageway width to function, if required, as Neighbourhood Connectors. These roads have also been designed to accommodate a future bus service with 7.2m carriageway, proposed. There are three external connection points proposed for the development with two of these being provided at ultimate development and one anticipated at some later point:

- Three-way intersection at Hamilton Road/Road 1 (by ultimate development);
- Three-way intersection at North Circular Road/ Road 8 (by ultimate development); and
- Three-way intersection at North Circular Road/ Road 3 (in the future, following realignment of North Circular Road or extension of the Hamilton Precinct southwards.

As the traffic volumes anticipated to use these intersections at ultimate development are low, they should function adequately under priority control with all movements permitted (see below). The intersection of Hamilton Road/ Road 1 (refer to Figure 13) would be offset from the three-way intersection of Hamilton Road/

Shoata Road. The stagger (approximately 80 metres from centreline to centreline) is considered sufficient on the basis that there is low demand for access to/ from Shoata Road (unsealed) and likely to be few movements across Hamilton Road. The Development Plan also makes provision for future connections with adjacent development to the northwest and northeast.

The proposed street hierarchy is depicted in Figure 18.

REFER TO FIGURE 18 – PROPOSED ROAD HIERARCHY

Indicating street cross sections for the above road types have been provided in Figure 19.

REFER TO FIGURE 19 – INDICATIVE STREET CROSS SECTIONS

TRAFFIC MODELLING AND ANALYSIS

Trip generation rates for the subdivision have been calculated based on first principles and reference to relevant data from other locations. The basic assumptions were also discussed and agreed with the Town of Port Hedland.

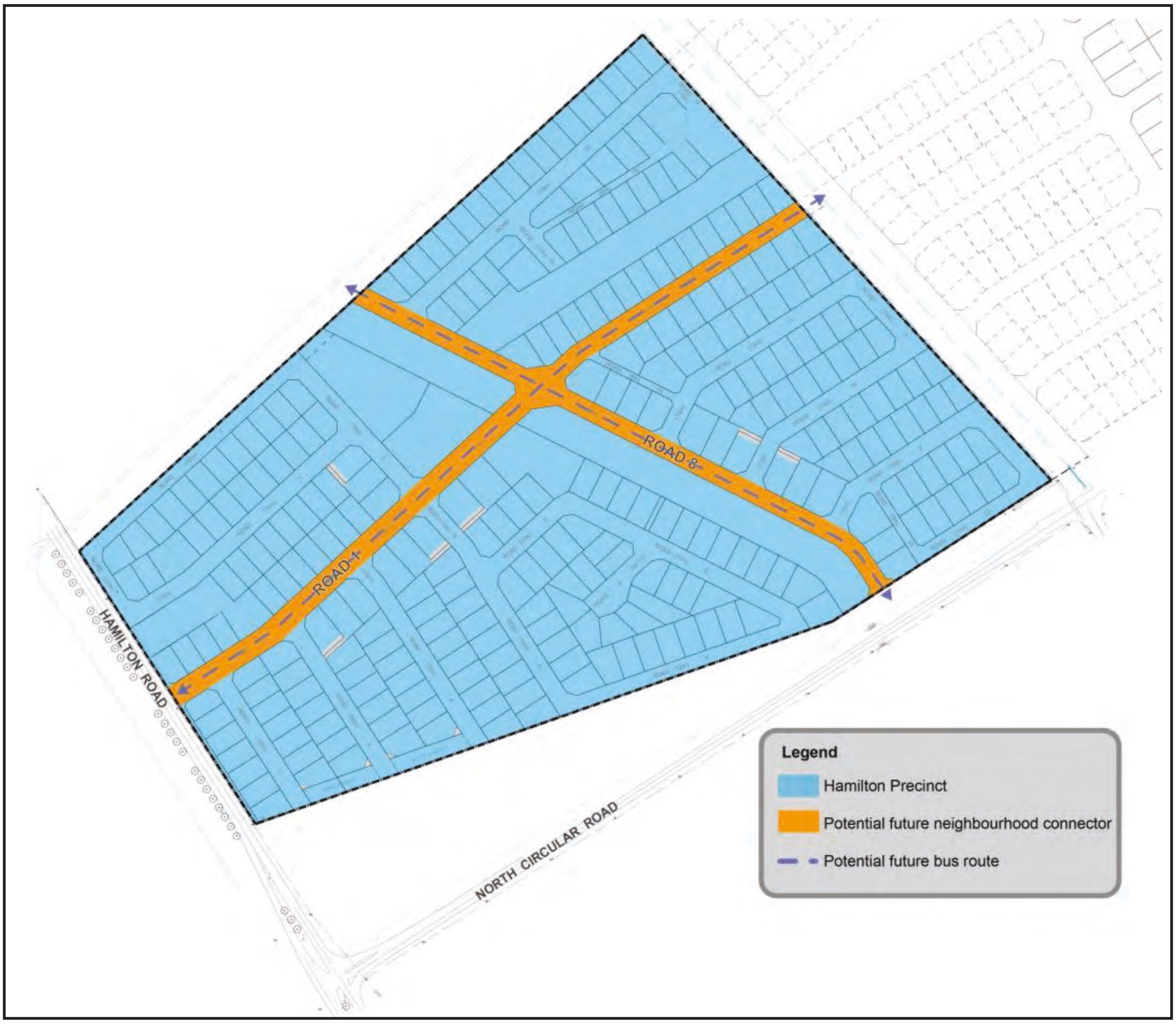
Factors used in calculating the trip generation rate are as follows:

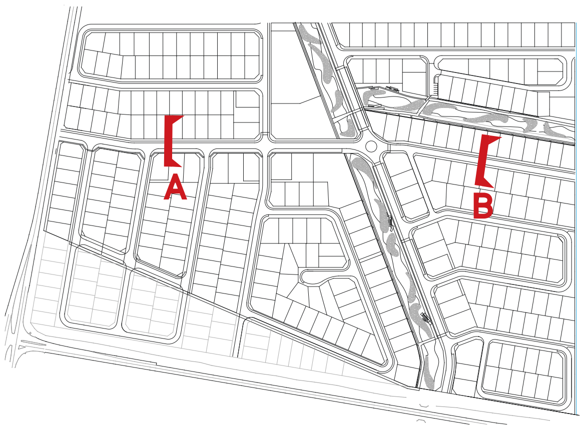
- Dwelling yield: 440 (66 of which are apartments and 104 are on four-pack lots)
- Occupancy: 2.8 residents per unit
- Total trips per person (all modes): 3.5 trips per day
- Visitor trips (e.g. people visiting residential premises in the development): 15% additional trips
- Car driver mode split: 77%

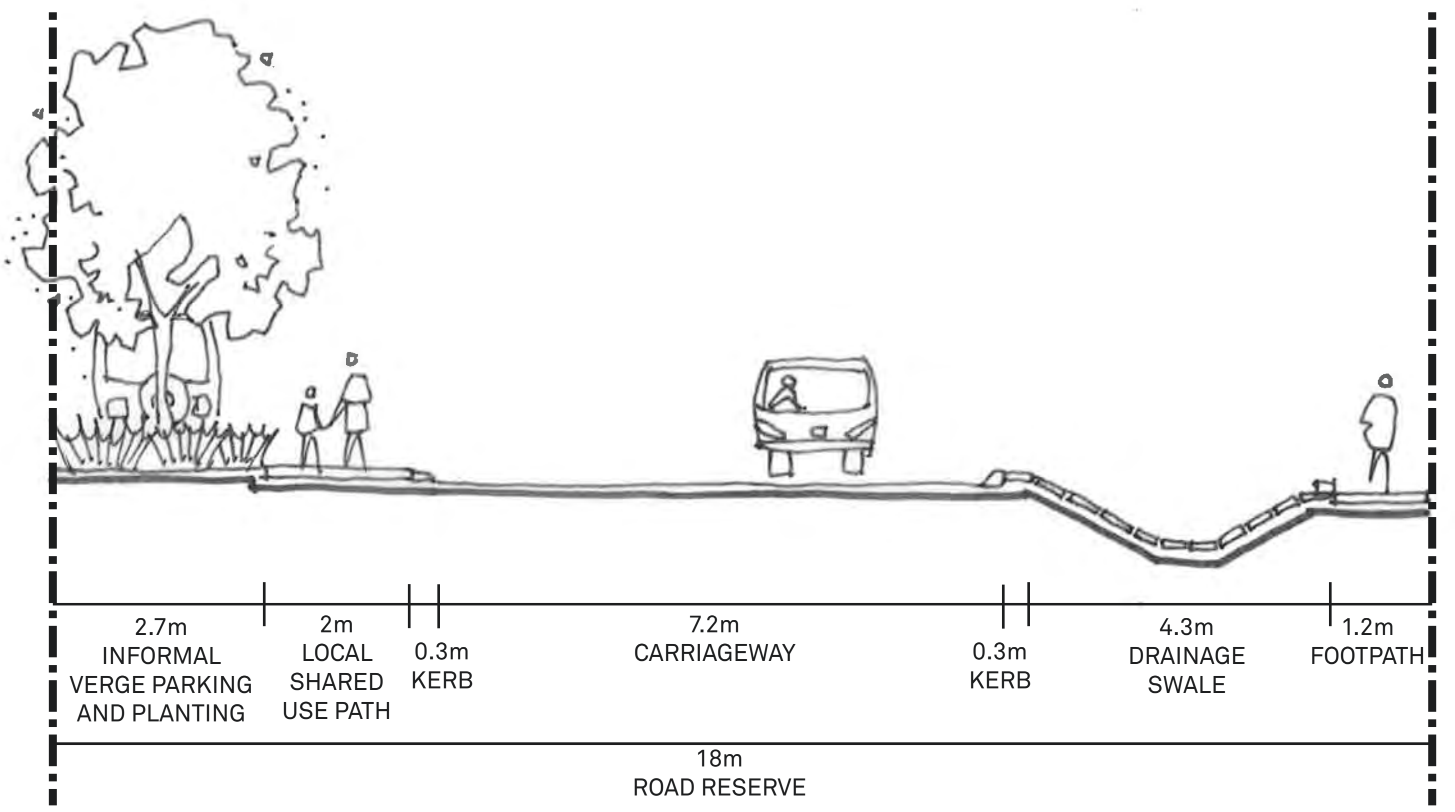
Based on the aforementioned factors, the trip generation rate applied to the development is 2.8 x 3.5 x 1.15 x 0.77 = 8.7 trips per unit per day. For a 440 dwelling development, this trip generation rate equates to 3,854 forecast vehicle trips per day and 385 vehicles in the PM peak hour assuming the peak hour to be 10% of the daily total, which is reasonable for a residential development.

In the AM peak hour, vehicle trip generation may be assumed to be about 8% of the daily total. This corresponds to about 308 trips. The reduced percentage of trips compared to the PM peak hour reflects that residential trips undertaken in the morning are generally limited to non-discretionary trips (e.g. trips for work or education purposes). In the afternoon/ evening a relatively high number of non-discretionary trips also occur but additional discretionary trips are more likely, too (e.g. shopping trips).

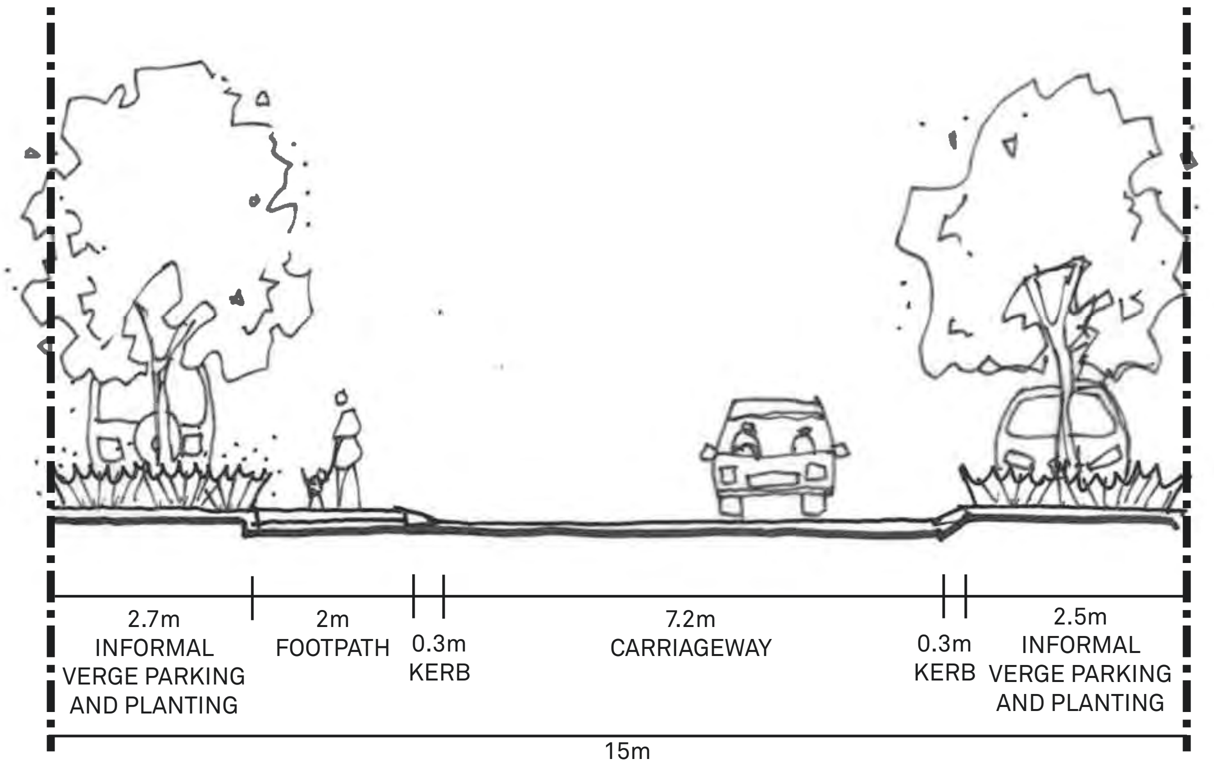
Figure 18 – Proposed Road Hierarchy







ROAD 1_SECTION A



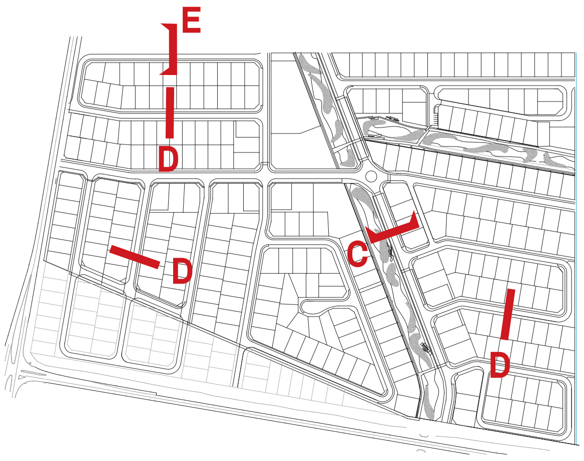
ROAD 12_SECTION B

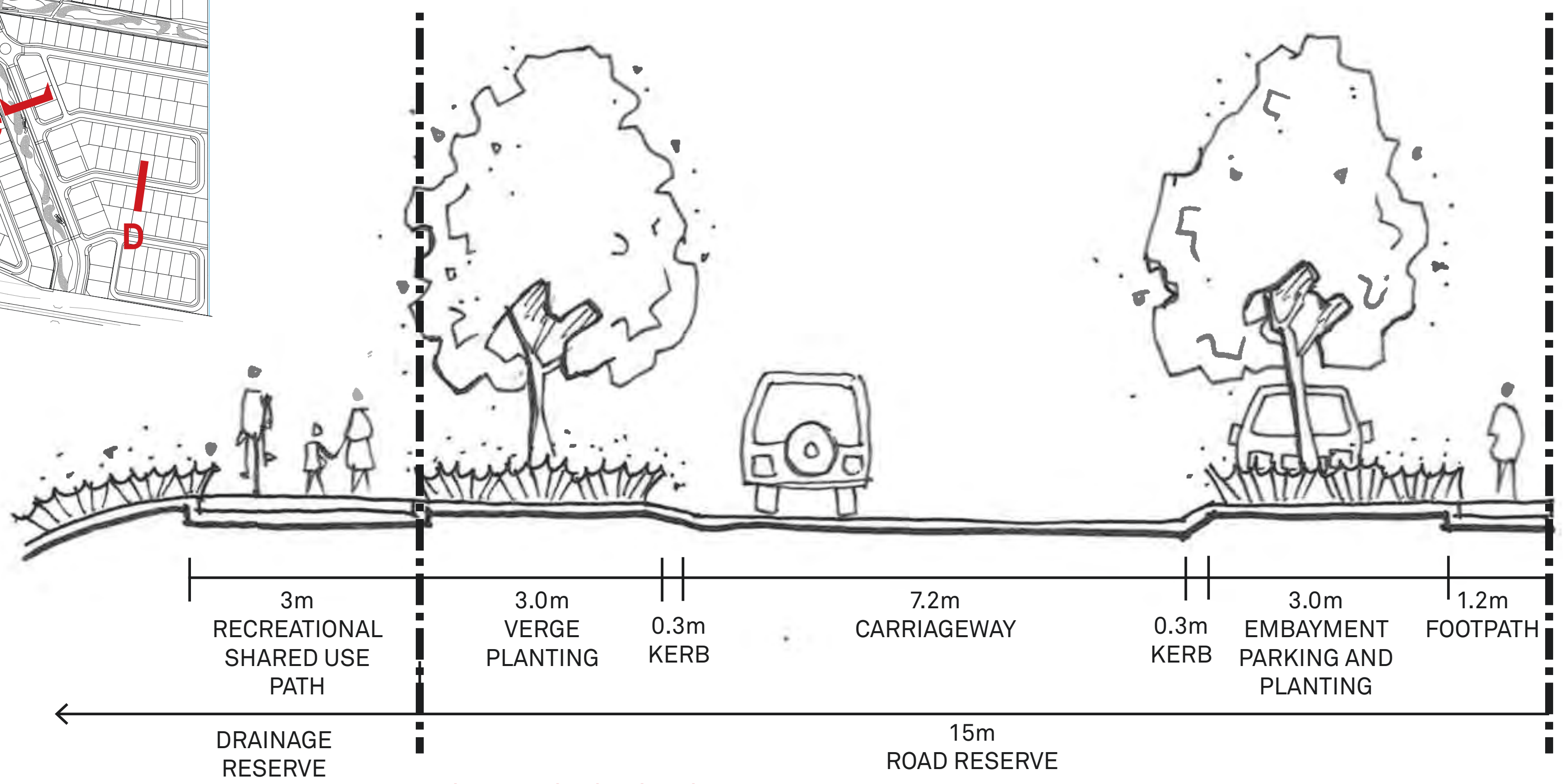
STREETSCAPE SECTIONS

0 .5 2 4m

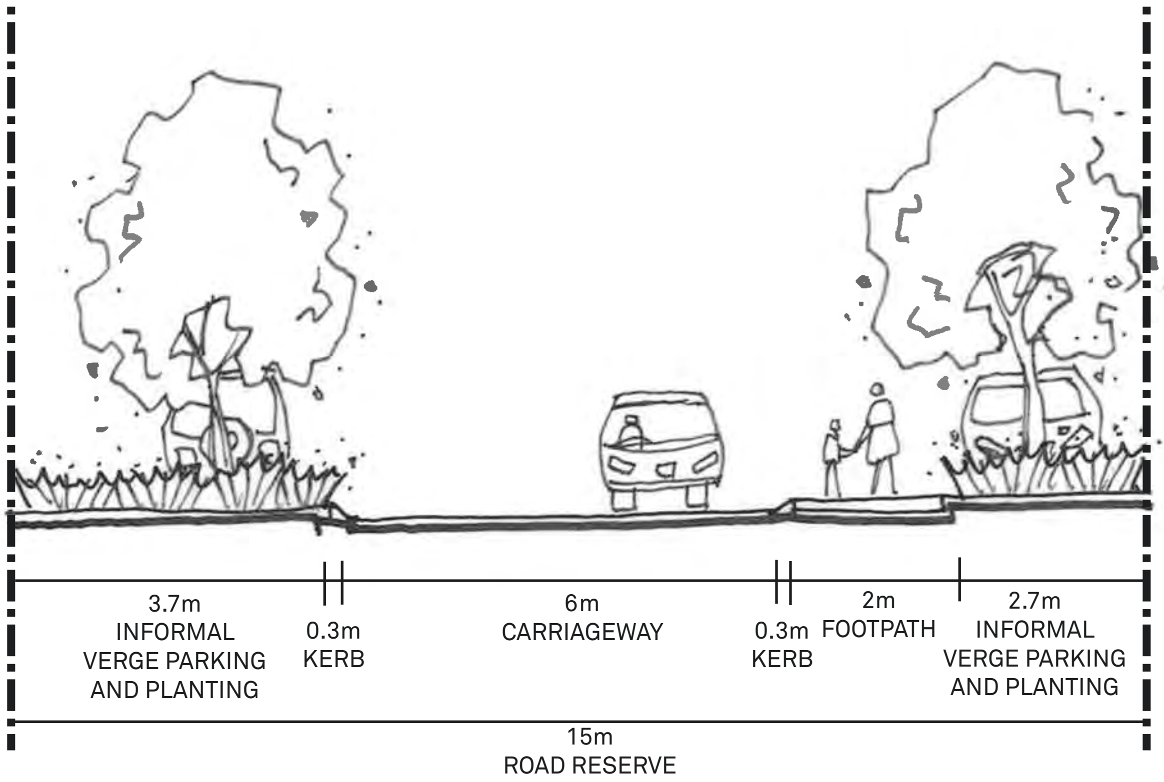
Revision	Date	Scale	Client	Project Name	Drawing
I, Preliminary	27-March2012	1:100@A3 1:50@A1	NS Projects	Hamilton Development South Hedland	SK02 Road Sections

HASSELL

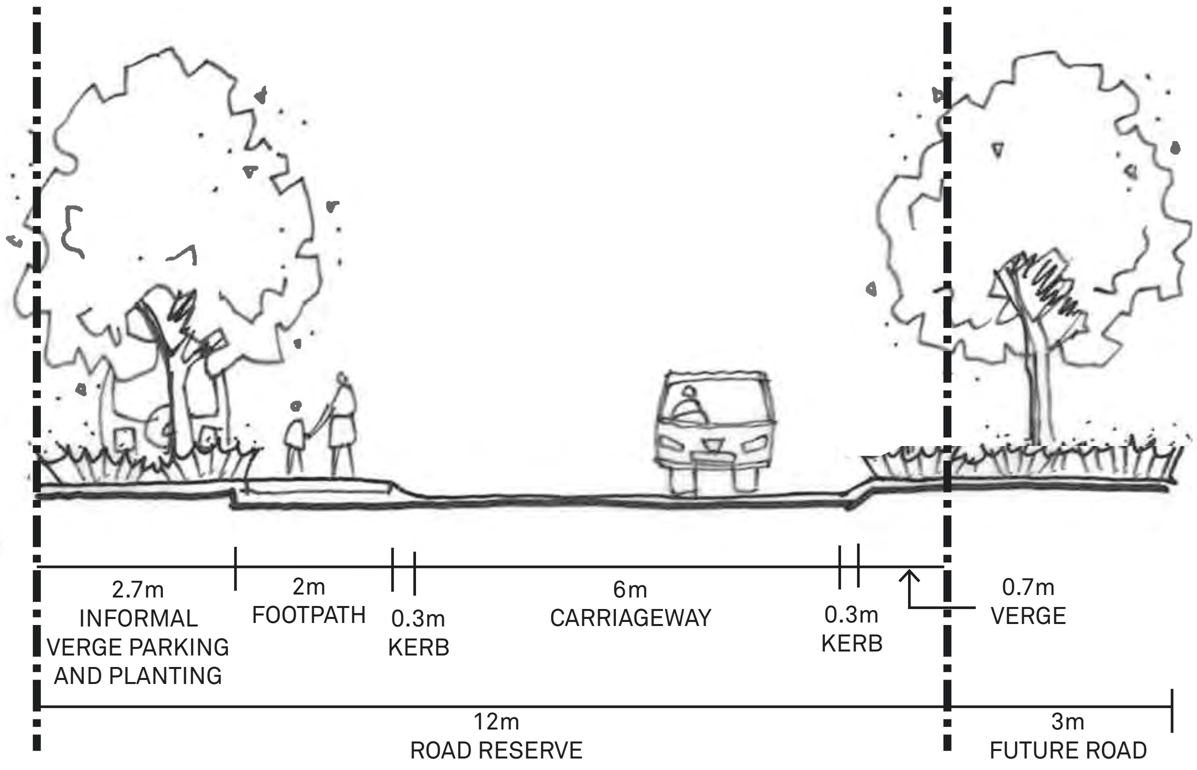




ROAD 8_SECTION C



TYPICAL 15m ROAD_SECTION D



TYPICAL 12m ROAD_SECTION E

STREETSCAPE SECTIONS

0 .5 2 4m

Revision	Date	Scale	Client	Project Name	Drawing
I, Preliminary	27-March2012	1:100@A3 1:50@A1	NS Projects	Hamilton Development South Hedland	SK03 Road Sections

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Intersection Analysis and Treatments

The analysis shows that all intersections are likely to operate within acceptable parameters assuming the forecast growth in baseline traffic plus development traffic. This is providing suitable intersection geometry and controls are adopted.

AustRoads Guide to Road Design Part 4A – Unsignalised and Signalised Intersections (2009) provides guidance on intersection treatments befitting semi-rural/ fringe urban locations. Typically, given moderate traffic flows on the major road, which oppose right turning movements in and out of the minor road, it is appropriate to consider provision of auxiliary turning lanes or channelization. Generally, the latter provides a higher level of safety than the former.

Based on the forecast traffic flows and reference to the AustRoads guide, it is recommended that provision of short right turn channels and left turn auxiliary lanes on the major roads at the intersections of Hamilton Road/Road 1 and North Circular Road/Road 8 be provided. Single rather than twin stand-up lanes are recommended on the minor approach. Twin stand-up lanes are not required from a capacity point of view and may reduce safety because of right blocking the view of left turning vehicles. It is noted that the traffic volumes forecast at the intersection of Hamilton Road/Road 1 are approaching the recommended threshold for provision of left turn channels on the major road. However, it is proposed that they are not required because of the excellent, unimpeded sight distance in this location.

The operation of the intersections of Hamilton Road/Road 1 and North Circular Road/Road 8 has also been tested assuming the higher opposing flows along the major roads calculated for the PM peak hour and the higher outbound traffic movements from the development likely to occur in the AM peak hour. This analysis shows that the right hand turn out of Road 1 would operate at level of service C with a degree of saturation of 0.34 and average delay of about 17 seconds. The right hand turn out of Road 8 would operate at level of service B with a degree of saturation of 0.22 and average delay of about 11 seconds. This assessment underscores the robust of the overall transport analysis.

The intersection of Hamilton Road and North Circular Road is forecast to operate well within capacity with the average delay for the right-hand turn from North Circular to Hamilton Road forecast to be 32 seconds in the peak hour. Both the forecast 95th percentile right turn queues (North Circular Road right on to Hamilton Road and vice versa), could easily be accommodated within the existing right turn pockets. On this basis, no intersection upgrades are forecast to be required. In practice, any extended delays to right turning (i.e. from North Circular Road on to Hamilton Road) development traffic at this location is likely to encourage vehicles to distribute northwards to exit via Road 1, which has spare capacity.

By 2013, our analysis indicates that the intersection of North Circular Road and Parker Street, which currently has a basic left turn/ right turn design, will likely require some channelization for the right turn from North Circular Road on to Parker Street. To improve capacity and safety, provision of a left turn auxiliary lane on North Circular Road (westbound) is also recommend. The contribution of the Hamilton precinct to turning movements, which help trigger the upgrade requirements, will be minimal and accordingly, the Town may wish to look at an upgrade in this location as part of routine public works.

The forecast high ongoing rate of growth in background traffic in Hedland, much of which is likely to be associated with other developments that are at the concept stage of planning, is likely to trigger requirements for upgrades of external intersections sometime after the completion of the Hamilton Precinct. In all likelihood, roundabout control at the intersection of Hamilton Road and North Circular Road is likely to be required sometime before 2021 even without the Hamilton Precinct development.

Results of PM peak hour SIDRA intersection analysis are provided in Table 7.

TABLE 7 - SIDRA INTERSECTION ANALYSIS

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.13	N/ A	2.6m
Road 1	0.11	C	2.7m
Hamilton Road north	0.23	N/ A	0.0m
Overall performance	0.23	N/ A	2.7m
North Circular Road/ Road 8			
North Circular Road east	0.19	N/ A	3.7m
Road 8	0.07	B	1.6m
North Circular Road west	0.22	N/ A	0.0m
Overall performance	0.22	N/ A	3.7m
Hamilton Road/ North Circular Road			
Hamilton Road south	0.47	N/ A	21.7m
North Circular Road	0.52	C	23.8m
Hamilton Road north	0.13	N/ A	0.0m
Overall performance	0.47	N/ A	22.1m
North Circular Road/ Parker Street			
Parker Street	0.16	C	4.0m
North Circular Road east	0.29	N/ A	0.0
North Circular Road west	0.27	N/ A	17.3m
Overall performance	0.29	N/ A	17.3m

Two longer-term traffic scenarios were also tested in relation to external network access points to the Hamilton Precinct: e.g. the intersections of Road 4/ Hamilton Road and Road 8/ North Circular Road. Analysis of the intersections at build out of the Hamilton Precinct plus five years (e.g. 2018), demonstrates that the recommended intersection treatments should function adequately. AECOM's background traffic growth factors have been applied to demonstrate a conservative traffic scenario. Results derived from SIDRA testing are shown in Table 8.

A simulation of conservative traffic conditions in the AM peak hour demonstrated that the critical exiting movements (e.g. right turn from Road 1 on to Hamilton Road and Road 8 on to North Circular Road) would operate satisfactorily. The right turn out of Road 1 would operate at LoS C and DoS 0.42 with the average delay about 21 seconds and 95th percentile back of queue about 14 metres. The right turn out of Road 8 would operate at LoS B and DoS 0.25 with the average delay about 12 seconds and 95th percentile back of queue about 7 metres.

It is recommended that at some stage prior to 2018, the posted speed limit on North Circular Road is revised downwards from 80 to 60 kilometres per hour, which would be more befitting the change in character of the area from rural to urban fringe. This should also increase the safety of turning movements into and out of the Hamilton Precinct.

Table 8 – Results of SIDRA Analysis (PM Peak Hour, Year 2018)

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.16	N/ A	2.9m
Road 1	0.14	C	3.3m
Hamilton Road north	0.28	N/ A	0.0m
Overall performance	0.28	N/ A	3.3m
North Circular Road/ Road 8			
North Circular Road east	0.23	N/ A	4.0m
Road 8	0.07	B	1.8m
North Circular Road west	0.26	N/ A	0.0m
Overall performance	0.26	N/ A	4.0m

Analysis of the intersections of Road 1/ Hamilton Road and Road 8/ North Circular Road at build out of the Hamilton Precinct plus eight years (e.g. 2021), demonstrates that the recommended intersection treatments should continue to function adequately. Results derived from SIDRA testing are shown in Table 9.

A simulation of conservative traffic conditions in the AM peak hour demonstrated that the critical exiting movements (e.g. right turn from Road 1 on to Hamilton Road and Road 8 on to North Circular Road) would also operate satisfactorily. The right turn out of Road 1 would operate at LoS D and DoS 0.42 with the average delay about 25 seconds and 95th percentile back of queue about 20 metres. The right turn out of Road 8 would operate at LoS B and DoS 0.29 with the average delay about 14 seconds and 95th percentile back of queue about 9 metres.

TABLE 9 – RESULTS OF SIDRA ANALYSIS (PM PEAK HOUR, YEAR 2021)

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.19	N/ A	3.3m
Road 1	0.19	D	4.4m
Hamilton Road north	0.34	N/ A	0.0m
Overall performance	0.34	N/ A	4.4m
North Circular Road/ Road 8			
North Circular Road east	0.28	N/ A	4.4m
Road 8	0.09	B	2.1m
North Circular Road west	0.31	N/ A	0.0m
Overall performance	0.31	N/ A	4.4m

Overall, the assessment described in this section of the Plan is likely to represent worst-case traffic conditions. This is because the per annum growth factor applied to baseline traffic assumes added residential development in South Hedland over time. Some degree of double-counting of traffic is therefore likely when baseline and development traffic are combined.

Internal Network Performance

The estimated traffic volume likely to utilise the internal network is about 3,850 vehicles per day. Ahead of development on adjacent lots (i.e. to the north and east), there is likely to be a negligible amount of through traffic. Non-development traffic is relatively unlikely to cut through the development to avoid the intersection of North Circular Road and Hamilton Road because of the collective time penalty of turning right on to Road 8, turning left on to Road 1 and then right on to Hamilton Road.

The main east-west and north-south internal roads (i.e. Roads 1 and 8) are likely to carry less than about 2,000 vehicles per day at their busiest points. Other internal roads are likely to carry less than 1,000 vehicles per day. The carrying capacity of an access street as per Liveable Neighbourhoods is 3,000 vehicles per day assuming single traffic lanes in both directions and preferably, traffic speeds less than 50kph. The forecast traffic volumes are therefore well within the capacity of an internal street network planned for local access with single carriageway.

In the longer term, if development eventuates to the north and east, Roads 1 and 8 will have sufficient capacity to carry additional traffic and potentially function as Neighbourhood Connectors, with a practical upper limit of about 5,000 vehicles per day (based on the lack of facility for protected reversing manoeuvres from driveways on to the street).

An exercise circuit comprising a 3m wide path is proposed, which will also act as a primary pedestrian link from the centre development to the schools to the South of the site. The proposed network is shown on Figure 19.

REFER TO FIGURE 20 - FOOTPATH HIERARCHY

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Legend

- 🟦 _Min 1.2m Pedestrian Access Path
- 🟨 _Min 2m Footpath
- 🟧 _Min 2m Local Shared Use Path (Circuit Path)
- 🟥 _Min 3m Recreational Path (Shared Use)
- ▮▮▮▮▮▮▮▮▮ _Preliminary Pedestrian Crossing Location

FOOTPATH HIERARCHY

Revision	Date	Scale	Client	Project Name	Drawing
F, Preliminary	25-May2012	1:1000@A1 1:2000@A3	NS Projects	Hamilton Development South Hedland	SK06 Footpath Hierarchy

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PEDESTRIAN AND CYCLIST NETWORK

When integrated with compatible land uses, a high-quality walking and cycling network can:

- Mitigate car dependency for residents;
- Reduce adverse environmental impacts of transport; and
- Facilitate improved personal health and fitness.

Basic infrastructure provisions are proposed within the Hamilton Precinct with emphasis on efficient use of road reserves. Excepting laneways, all streets are proposed with a footpath on at least one side with a minimum width of 2 metres on most streets.

Possible features that could be included to improve pedestrian and cyclist comfort include:

- Regularly spaced, well-designed street crossing points;
- Ample shade to reduce the effects of South Hedland's harsh climate;
- Ramped kerbs at crossing points for wheelchairs and prams; and
- Appropriate street lighting.

The spine routes (Roads 1 and 8) are proposed to incorporate 2.0 metre minimum shared paths on one side to support off street cycling by less confident cyclists. These will be particularly important post ultimate development when new subdivisions are completed to the northeast and northwest, and more traffic utilises these roads.

Arup recommends that the ToPH consider further investment in the South Hedland shared path network as part of its public works programme, which could incorporate connections to/ from the Hamilton Precinct. These infrastructure provisions are not articulated in but could be added to the ToPH's draft Cycle Plan.

Public works should also incorporate crossing provisions at the intersection of North Circular Road and Hamilton Road where there are none currently.

PUBLIC TRANSPORT

There are few public transport services currently operating in Hedland and these are not easily accessed from the Hamilton Precinct. The Public Transport Authority has advised that there are no plans to extend services to the precinct. Thus, the public transport mode share for residents of the Hamilton Precinct is forecast to be close to zero for the foreseeable future.

However, to future-proof the development, Roads 1 and 8 are being designed with a seven metre carriageway, which is sufficient to accommodate buses.

URBAN WATER MANAGEMENT

A Local Water Management Strategy (LWMS) has been prepared by Aurora Environmental and is attached as Appendix 6.

Refer to Appendix 6 - Local Water Management Strategy (LWMS)

The LWMS has been developed consistent with the framework and process detailed in the WAPC's better Urban Water Management Guidelines (2008).

The document includes the principles, objectives and requirements of total water cycle management and a detailed description of the environmental conditions of the site. The capacity of the site to sustain development, including consideration of acid sulphate soils, impacts from groundwater and surface water, impacts on ecosystems and biodiversity and impacts on existing infrastructure is also examined.

Groundwater investigations are currently being undertaken on Lot 331 by Aurora Environmental. To date, the information obtained indicates that groundwater levels are between 3.1m and 4.4m below ground level. A complete suite of pre-development groundwater quality data was not yet available at the time of preparing this report, but will be reported in the urban water management plan (UWMP).

Recent investigations by Cardno (2011) suggest that the site is largely unaffected by 100 year flooding caused by the combined effects of large storm events and coastal storm surge, with the exception of the eastern portion of Lot 331. Further modelling will be undertaken to ascertain the flood levels which will determine the requirement for the future development to import fill material to ensure that the finished levels are above the 100 year ARI flood and coastal storm surge inundation levels. These details will be further refined in the UWMP.

The following strategies are proposed in this LWMS for implementation on Lot 331:

Water Conservation and Efficiency Measures

- Ensure that future dwellings are fitted out with waterwise fittings and fixtures to minimise the use of potable water;
- Retain native vegetation in POS areas as a preference;
- Apply waterwise landscaping measures in landscaped areas; and
- Restrict irrigation during daytime hours (between 9am and 6pm).

Wastewater Management

- Wastewater disposal via reticulated sewer.

STORMWATER MANAGEMENT

1 year ARI event

- Lots will drain into road gutters; and
- Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin.

5 year ARI event

- Lots will drain into road gutters;
- Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin; and
- The capacity of the site to treat the 5 year ARI event will be reviewed at the detailed design stage.

100 year ARI event

- Run-off conveyed by overland flow paths in the road reserve to the swale which will then overtop into the existing drainage channels
- Finished floor levels of lots set higher than peak flood levels
- Road reserves will be used as flood routes to direct flood waters to the main drains.

All floodway treatments will be designed in accordance with the principles identified in the GHD (2011) flood assessment report for the South Hedland area.

GROUNDWATER MANAGEMENT

Due to the low permeability of the in situ soils and the depth to groundwater beneath the site, it is anticipated that there will be little interaction with groundwater. Therefore, groundwater level management for the development is not required.

IMPLEMENTATION

Implementation of the LWMS will be undertaken through the preparation of a detailed Urban Water Management Plan (UWMP) under relevant conditions of subdivision. The UWMP will be submitted by the developer to the Department of Water and the Town of Port Hedland as required and will address:

- Detailed stormwater management design including the size, location and design of drainage swales:
- The finished floor level heights for the development to ensure protection from peak flood levels;
- Proposed landscaping arrangements for POS areas including the proposed drainage swales, as irrigation requirements and an irrigation water source;
- Measures to achieve water conservation and efficiencies of use including sources of water for non-potable uses and detailed designs, controls, management and operation of any proposed system(s); and
- Operational and maintenance responsibilities for the proposed stormwater management system.

SERVICING

UTILITIES

Sewer Reticulation

Preliminary planning information from the Water Corporation's Mid-West office indicates that there is the requirement for a permanent type 90 wastewater pumping station and rising main to service the subject site. The final planning requirements will come from ongoing liaison with the Water Corporation's land development branch in Perth. As the subject land is distant from existing developments, existing Water Corporation sewer mains cannot be extended to service the proposed development.

Water Reticulation

On the north western side of the land are two existing 375 mm water mains that are feeder pipes from the Yule Bore Fields and supply the main water supply tanks. The Water Corporation has advised that these mains cannot be used to supply water reticulation to the Hamilton site.

On the north eastern side Lot 331 within Lot 2944 are two existing water distribution mains that service the South Hedland area (600 mm diameter and 250 mm diameter pipes). These mains service existing infrastructure to the north east and further information has been requested from the Water Corporation to confirm if a connection can be made to one of these mains to service the Hamilton Development or whether additional infrastructure will be required to service the site. During preliminary discussions, Water Corporation has highlighted a water supply shortage for Port and South Hedland area exists. The most likely outcome is that a mains extension will be required to service the site but this needs to be confirmed by the Water Corporation.

Whilst one future access point over this reserve, to future development to the east has been approved by the Water Corporation, negotiations are ongoing to secure a second future access point. Due to the proximity of Water Corporation infrastructure the Development Plan indicates a 2.6m setback for any proposed lots abutting Lot 2944, as requested by the Water Corporation.

Electrical Supply

From preliminary discussions with Horizon Power, it is understood that in order to service the Hamilton site, a main power feeder will need to be installed from either the Wedgefield or Murdoch Drive zone substation sites, with an upgrading of the substations needed as part of the work. Preliminary investigations indicate that it is more likely that the feeder will need to come from the Wedgefield site. Installation of the feeder cable will be at the developers cost, whereas upgrading of the zone substation may be a Horizon Power expense.

There are existing aerials servicing the Wedgefield and South Hedland precincts. It is understood Horizon Power have already programmed for the overhead power lines to be placed underground as part of the Pilbara Underground Power Program (PUPP) upgrade. If this hasn't occurred by the time the development is constructed Horizon Power may request the developer to carry out this work when installing feeder cable.

The existing network may have the capacity to supply the proposed development, but until a formal request is lodged with Horizon Power they will not confirm this or advise on what is required for network reinforcement.

There are no existing transformers in the vicinity of the site so as part of the power servicing it is anticipated that there will be a requirement to supply and install eight to ten transformers and approximately five switchgear units. This would be finalised as part of the detailed power design and actual locations finalised as part of the process and it will be critical to integrate these locations into the final subdivision plan. It is estimated the power requirement for the precinct to be in the order of 3-5 MVA.

An existing aerial pole in Hamilton Road will also need to be relocated as it clashes with the proposed road intersection. This will be initiated with Horizon Power.

Gas Supply

WA Gas currently has no gas reticulation infrastructure in Port Hedland. The Port and South Hedland residential areas are serviced using twin consumer tank arrangements. It is not common for residential lots in Hedland to be serviced with a shared underground pipe system and we believe the subject site to be no different. Therefore, if a gas supply is required, other options including bottled gas will need to be investigated.

Telecommunication

Preliminary discussions with NBNCo indicate they have distribution infrastructure in the Port Hedland area, however this does not extend to the South Hedland area. The subject site is not within NBNCo's current fibre rollout footprint. If feasible, NBNCo will install an infrastructure connection to the Development Plan area but an application will need to be made to NBNCo.

Preliminary advice from Telstra indicates there is an existing service network in the vicinity of South Hedland but no services have been extended to the subject site. Telstra do not have a fibre network in the area but have provided advice that a connection will be needed from the existing Wedgefield exchange provided the exchange has sufficient capacity to service the new development. This will be at the developers cost and will likely have to go through NBNCo.

As part of subdivisional works, pits and pipes will be installed. New communication cable will then need to be installed by NBNCo after the pit and pipe is handed over.

An alternative that could be investigated would be to provide remote service to the area.

Site Works, Earthworks and Drainage

Earthworks

A Geotechnical Report has been completed by Douglas Partners and ground conditions are summarised below:

The ground surface level across the site is generally flat, although dipping slightly to the north, with levels of approximately RL 10.0m AHD in the south falling to RL 8.6m in the north. The site is undeveloped land covered with minor vegetation such as grass, shrubs and small trees. The natural soil conditions beneath the site comprises of:

- Sand – medium dense, brown and red-brown, slightly silty sand, extending from depth to 1.8 m, underlain by
- Clayey Sand – medium dense, red-brown, clayey sand underlying the sand to termination depth in the test pits, and to depths of between 5.5m and 6.8m within boreholes.
- Clayey Gravelly Sand – medium dense, red brown mottled brown and grey, clayey gravelly sand from 2.3m to termination depth at TP5.
- Sandy Clay – stiff, red-brown, low to medium plasticity sandy clay within the boreholes from depths of 5.5m and 6.8m to termination depth as of up to 10.2m depth.

This soil unit described above is locally identified as 'pindan sand'. Pindan sand is typically known to have soil collapse potential. Collapsible soils are weakly cemented soils that are subject to large settlements under load as a result of degradation by water on the cementing agent between soil particles. Weakly cemented soils with collapsing potential were not identified at the site during the field investigation.

It is believed the site is likely to be raised using imported structural filling to achieve a suitable clearance above flood levels. Based on present information, comments have been provided advising:

- Areas underlain by pindan sand can generally by classified as 'Class A' or 'Class S' if not identified has having a collapsing potential. In this case the subject site has been given a classification of 'Class S'.
- Also the site will need to be reclassified following completion of bulk earthworks as the imported fill may be reactive and may change soil characteristics. No information regarding likely filling material is currently available.

In order to place the imported fill on site, stripping of all vegetation, topsoil and deleterious materials beneath development areas will be required, followed by removal of unsuitable material prior to placement of any filling. The site will then need to be compacted using a medium to heavy (minimum of 14 tonne) vibrating smooth drum roller.

In the event that collapsing soils are identified beneath the site, additional specific ground improvement measures may need to be recommended and will be dependent on the severity of the collapse potential.

Once the subsurface is signed off, imported fill material can be placed, compacted and signed off in readiness for house builders and pavement construction.

Floodway Assessment

The site is within the South Creek Catchment Area that has an approximate catchment area of 23km^2 and is approximately 8.5km in length.

There are two watercourses that traverse the Hamilton site that are constructed drainage channels. These drains dissect the site and meet at a junction in the centre of the subject land. The larger western drain discharges into South Creek to the west of the site. These are typical Pilbara drains that are dry for most of the year and mainly only run in heavy rain events.

The two existing drains/creeks traversing through the proposed development site will need to be maintained and upgraded as part of the development works. The integrity of the drains will need to be maintained as far as practicable and sizing will be confirmed as part of the detailed flow modelling. A detailed floodway assessment is currently being undertaken to determine the final size, shape and flood areas that will impact this development.

Stormwater Drainage

The development will be designed in accordance with the principles of Australian Rainfall and Runoff, Town of Port Hedland guidelines by using a 1 in 5 year part piped system in association with overland flow routes that will direct stormwater run-off to strategic points and Water Sensitive Urban Design principles.

Overland flow for minor and major flood events will be channelled via road reserves towards swales where the water will gravitate towards the existing main drainage system.

It is intended that the discharge from the site be limited to existing flow. With this in mind the stormwater drainage system will incorporate on site compensation of stormwater, and where possible infiltration, before allowing water to discharge into the two existing main drains (this is in line with the principles for water sensitive urban design). It is proposed to contain the post development stormwater run-off in shallow, vegetated, swale drains located adjacent the main open drains and in the POS areas.

All floodway treatments will need to be in accordance with principles identified in the GHD flood assessment report for the South Hedland area. Along with this any works to the main drainage channels will be in line with the South Hedland guidelines for Drainage Reserves and Public Access Ways – Development and Management guidelines – Nov 2007. It is recognised that areas of bank used for public access will require reshaping in part. It is recommended that existing vegetation be left on banks where possible to limit erosion changes to the existing flood patterns.

Visual Amenity and Surveillance

A part of the guiding principles for drainage reserves in South Hedland is the ability to survey the drains to provide a space that is safe and secure. In accordance with this principle, lot levels and road levels will be designed to allow direct line of sight from either bank of the drain. This will be possible by elevating and retaining lots adjacent to the drain, which will be needed from a flood level requirement, and providing an accessible bank adjacent to road reserves that will typically adopt a 1 in 6 gradient. Again, in order to minimise erosion, existing vegetation will be left on the banks where possible.

Road Construction

Internal road networks will be designed in accordance with Liveable Neighbourhoods Community Codes, Austroads and the Town of Port Hedland development guidelines. They will also be designed to cater for major storm events. Intersection connections to existing roads will be discussed and final layouts agreed with relevant authorities and traffic consultant to minimise traffic congestion at entry and exit points to the development.

Roadwork will generally consist of traditional kerbed and asphalted pavements, with integrated stormwater infrastructure to cater for 1 in 5 year storm events.

PLANNING ASSESSMENT

ORDERLY AND PROPER PLANNING

The proposed Development Plan represents the logical, orderly and proper development of land that is consistent with the current strategic vision prescribed by Shire's Pilbara's Port City Growth Plan which is currently being advertised. The Town's proposed planning framework and other State level strategic documents identify the site for urban purposes and generally as a future development area.

At a strategic level, the proposed Development Plan will facilitate the implementation of the objectives the Shire's Pilbara's Port City Growth Plan, which highlights that the site is to be developed for low-density residential development, which the proposed Plan generally provides with the exception of some areas of higher density in close proximity to areas of high amenity. The site is also the logical northern extension of the South Hedland townsite and will provide a good level of housing diversity, including the provision of some 100 dwellings for the Department of Housing.

The Development Plan will assist in minimising the need for FIFO workers by providing additional accommodation. This is a key objective of the a number of state and local planning documents such as the Scheme, State Planning Strategy, Port Hedland Area Planning Strategy and the Shire's Pilbara's Port City Growth Plan. The Development Plan is located in close proximity to the South Hedland town centre so as to provide ample opportunities for residents to support the local economy and contribute to the town. The type of development being proposed, being generally single residential lots, is in high demand in Port Hedland. Through the provision of a variety of lot types the Development Plan will also enable variation in housing styles, providing accommodation for a wide range of people.

From a statutory viewpoint, a Development Plan is required to be prepared to facilitate the development of land zoned 'Urban Development' and has been prepared in accordance with clause 5.2 and Appendix 6 of the Scheme. As stated previously in this report, the subject site is currently in the process of being rezoned to the 'Urban Development' zone by Amendment 46, which has been adopted by the Town of Port Hedland and is soon to be with the WAPC for approval. To assist in expediting the development approval process, given the significant demand for housing in Port Hedland, it is considered appropriate and in line with the principles of orderly and proper planning that the Development Plan be lodged at this stage. It is not envisaged that the Development Plan will be approved until Amendment 46 is gazetted.

The design is responsive to the site providing a neighbourhood that is walkable with a high level of pedestrian permeability, especially to the central public open space area, considering the constraints placed on the site in terms of drainage. The Development Plan also allows for the future extension of development into what is now the North Circular Road reservation, should it not be required for widening in the future, and land to the north and east of the site.

Two potential connections are provided to the north, with one on either side of both drains which allows for a high level of connectivity. Another two potential connections are also provided through to the east, and the Development Plan design does allow for additional connections eastward in future if desired.

The Development Plan, and particularly the roundabout located in the centre of the Plan, has also been designed in such a way as to allow for a bus route to run through the site if required in the future.

SITE SUITABILITY AND RELATIONSHIP TO ADJOINING DEVELOPMENT

The Development Plan is consistent with surrounding land uses, being the logical northern extension of South Hedland, and representing the most efficient use of land. The site is surrounded by and within proximity to a range of services and facilities including open space, educational facilities, recreational sporting facilities, and commercial and employment centres.

The Development Plan will provide an increased residential base, which will support these surrounding services and facilities and contribute economic growth of South Hedland. The gradation of higher density residential development around areas of high amenity and local neighbourhood centres ensures appropriate interfaces to surrounding areas achieved. The development is also earmarked for residential development in a number of strategic documents (as detailed above) indicating that the site is suitable for the style of development proposed by this Development Plan.

The provision of road linkages onto North Circular Road have been designed to enable the development to link effectively with existing development to the east, with the internal roads designed to allow future linkages to the north and east.

As identified previously in this report the site is considered to be ideally suited to accommodate a residential subdivision, being flat and geotechnically sound, and provided with suitable amenity and able to be connected to all essential services.

In terms of adjoining development, no buffers are required to the water tanks to the north of the site and the site is located outside of the buffers to surrounding industrial areas as indicated on the Scheme maps.

ACCESS TO EXISTING SERVICES AND COMMUNITY INFRASTRUCTURE

All standard essential residential services and infrastructure are capable of being extended to the Development Plan area as detained in the Servicing section of this report.

Also as identified previously, the site is within proximity and easy access to a variety of existing community facilities which will cater for the local needs of future residents. These include a number of primary schools located within South Hedland, the South Hedland High School located to the south of the site, as well as the Hedland Sports Complex to the south.

The South Hedland central retail area is located only approximately 1km from site, and includes the Post Office, Police Station and other services as well as the main shopping centre which includes the supermarket. Additional services are available in the Port Hedland townsite some 10 km north of the site.

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IMPLEMENTATION AND STAGING

INDICATIVE STAGING AND TIMING

A staged approach to development is envisaged for the Hamilton Precinct based on starting in the north eastern section of the site, developing land to the east of the north/south drain and then moving to the western side of the drain and then heading south. The main access road and the Central Public Open Space Area will be developed as part of Stage 1 earth works.

Refer to Figure 21 – Indicative Staging Plan

APPLICATION FOR SUBDIVISION

Given lead times associated with the Town's and the Commission's consideration of the Development Plan as well as the preparation, consideration and approval of detailed subdivision plans, normally the initial stages of development within a Development Plan area would not proceed within 6-12 months following lodgement of a Development Plan.

Due to the demand for the housing within Port Hedland, applications for subdivision will be lodged with the Commission as soon as possible in order to achieve the necessary approvals and ensure lots are available for in a timely manner.

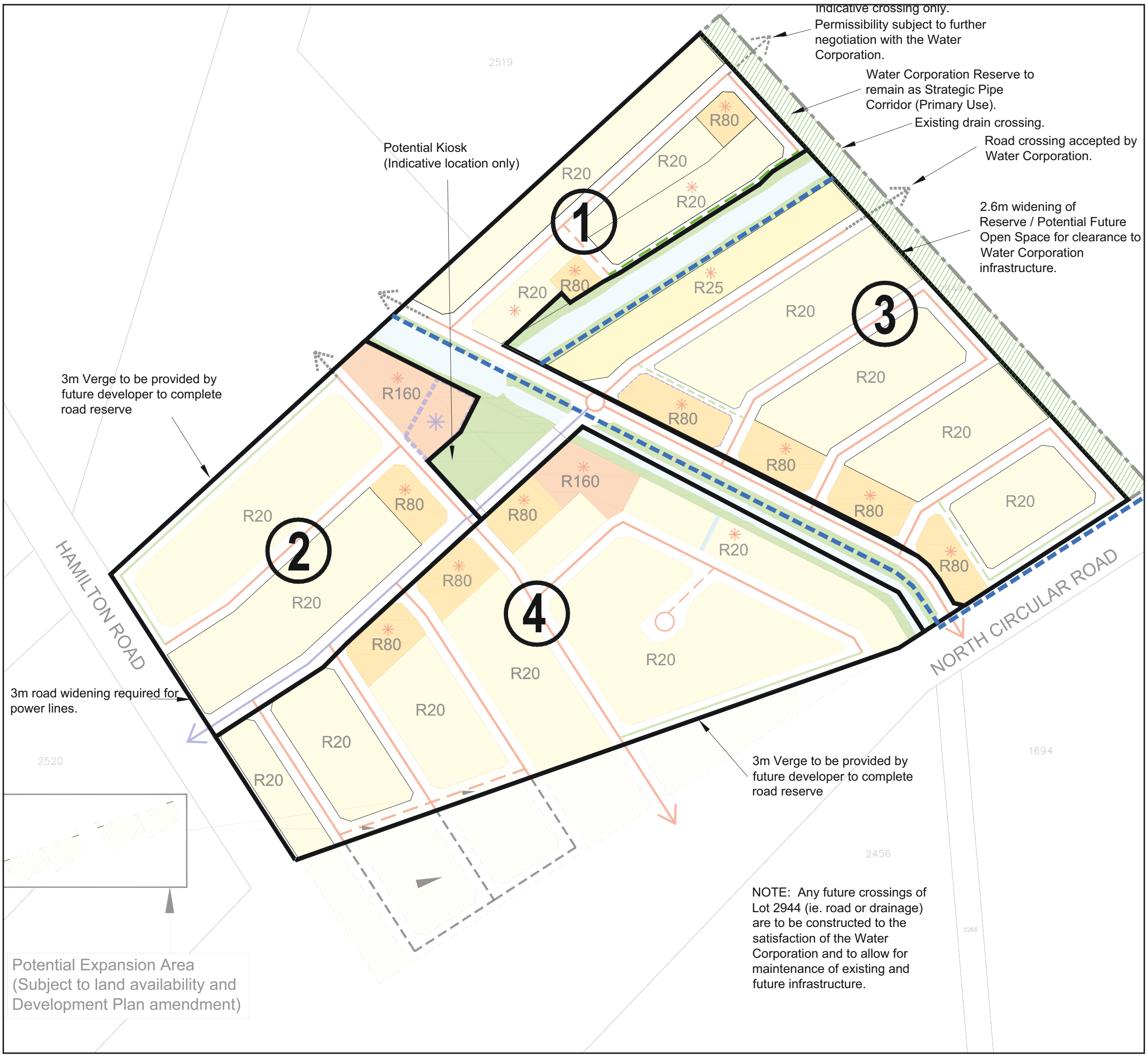
To further assist this process a Development Application for site works and clearing is also likely to be lodged with the Town shortly.

DETAILED AREA PLANS

To assist in creating a sustainable, visually interesting and attractive place, Detailed Area Plans (DAPs) will be prepared at a future date to control the detailed design and development of the grouped housing sites within the Development Plan area.

It is envisaged that DAPs will build upon the planning and urban design principles identified in this report and incorporate the use of climate responsive design principles. DAPs will play a particularly important role in ensuring a high level of passive surveillance is maintained over the POS and drainage areas within the site.

REFER TO FIGURE 21 – INDICATIVE STAGING PLAN



Indicative crossing only. Permissibility subject to further negotiation with the Water Corporation.

Water Corporation Reserve to remain as Strategic Pipe Corridor (Primary Use).

Existing drain crossing.

Road crossing accepted by Water Corporation.

2.6m widening of Reserve / Potential Future Open Space for clearance to Water Corporation infrastructure.

Potential Kiosk (Indicative location only)

3m Verge to be provided by future developer to complete road reserve

3m road widening required for power lines.

3m Verge to be provided by future developer to complete road reserve

Potential Expansion Area (Subject to land availability and Development Plan amendment)

NOTE: Any future crossings of Lot 2944 (ie. road or drainage) are to be constructed to the satisfaction of the Water Corporation and to allow for maintenance of existing and future infrastructure.

CONCLUSION

This Development Plan has been prepared in order to facilitate the orderly future subdivision, land use and development of Lots 331 and 2944 Hamilton Road, South Hedland. The Development Plan and this supporting report demonstrate how the proposed development is in accordance with State and Local Government Vision for the site in particular the Draft City Growth Plan and Proposed Amendment No. 46.

The development of the site for the proposed purposes will provide much needed permanent housing to South Hedland, including the provision of dwellings, which are to be used for key workers accommodation and community housing.

The style of housing which the Development Plan will facilitate is generally consistent with the existing housing stock within South Hedland, except some higher density sites have been provided to provide a greater level of housing diversity.

The proposed residential land use with a variety of densities and housing types represents the highest and best use for the property and the design and layout is based on sound design intent. An application for subdivision is to be lodged with the WAPC shortly, to facilitate the timely development of the site, considering the strong demand for residences in Port Hedland.

Based on the consistency of the Development Plan with the agreed vision for the site and that the design represents the optimal development outcome for the site, it is requested that the Town and the WAPC approve the Development Plan at their earliest convenience to enable subdivision and development to occur.

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APPENDIX 1

CERTIFICATE OF TITLE

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REGISTER NUMBER	
331/DP73085	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	**N/A**

WESTERN AUSTRALIA

VOLUME **LR3162** FOLIO **104**

RECORD OF CERTIFICATE OF CROWN LAND TITLE

UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997

NO DUPLICATE CREATED

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 331 ON DEPOSITED PLAN 73085

STATUS ORDER AND PRIMARY INTEREST HOLDER:

(FIRST SCHEDULE)

STATUS ORDER/INTEREST: UNALLOCATED CROWN LAND

PRIMARY INTEREST HOLDER: STATE OF WESTERN AUSTRALIA

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:

(SECOND SCHEDULE)

1.	L842205	AUTHORISATION ORDER FOR THE TAKING OF INTERESTS. REGISTERED 25.1.2012.
2.	L842206	NOTICE OF INTENTION TO TAKE FOR THE DESIGNATED PURPOSE OF RESIDENTIAL DEVELOPMENT, EASEMENT, SALE AND FORMALISATION OF ROADS. REGISTERED 25.1.2012.

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

--END OF CERTIFICATE OF CROWN LAND 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:	DP73085 [SHEET 1].
PREVIOUS TITLE:	LR3159-965.
PROPERTY STREET ADDRESS:	LOT 331 HAMILTON RD, SOUTH HEDLAND.
LOCAL GOVERNMENT AREA:	TOWN OF PORT HEDLAND.
RESPONSIBLE AGENCY:	DEPARTMENT OF REGIONAL DEVELOPMENT AND LANDS (SLSD).

NOTE 1: L871802 CORRESPONDENCE FILE 00602-2010-06RO.

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APPENDIX 2

GEOTECHNICAL REPORT

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Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Proposed Residential Development
Hamilton Precinct
South Hedland, WA

Prepared for
Pritchard Francis Pty Ltd

Project 76250
September 2011

Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

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Document status and review

Revision	Prepared by	Reviewed by	Date issued
1	D. Reaveley	M.J. Thom	8 September 2011

Distribution of copies

Revision	Electronic	Paper	Issued to
1	1	1	Cory Johnson, Pritchard Francis
1	1	0	Damian Fasher, NS Projects

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

	Signature	Date
Author		8-9-2011
Reviewer	P.P.	8-9-2011

NCS INTERNATIONAL
CERTIFIED
QUALITY
MANAGEMENT SYSTEM

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Table of Contents

Report on Geotechnical Investigation
Proposed Residential Development
Hamilton Precinct, South Hedland, Western Australia

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed residential development at the Hamilton Precinct in South Hedland, WA. The investigation was commissioned in a letter received from Cory Johnson of Pritchard Francis Pty Ltd, on 26 July 2011 and was undertaken in accordance with Douglas Partners' proposal dated 18 July 2011.

The aim of the investigation was to assess the sub-surface soil and groundwater conditions across the site and thus:

- Provide a description of the sub-soil conditions including identification of areas of unsuitable soils for building requirements, if encountered.
- Assess the depth to rock, if encountered.
- Assess the potential for collapsing soils beneath the site.
- Determine the suitability of the site to support the proposed development.
- Provide the appropriate classification of the site in accordance with the requirements of AS 2870-2011.
- Provide recommendations on site preparation.
- Provide parameters for pavement design, including a suitable California bearing ratio (CBR) for the subgrade encountered at the site and provide comments on road construction.
- Assess the permeability of the shallow soils and provide comments on site drainage.
- Measure the groundwater level beneath the site at the time of the field work, if encountered.

The investigation included the excavation of 40 test pits, the drilling of three geotechnical boreholes, the installation of three groundwater monitoring wells, permeability testing at four locations and laboratory testing of selected samples. The details of the field work and laboratory testing are presented in this report, together with preliminary comments and recommendations on the issues listed above.

2. Site Description

The site comprises an irregular shaped area of approximately 25 hectares and lies immediately to the north of the existing South Hedland development in Western Australia. It is bounded by Hamilton Road to the west, North Circular Road to the south and has bushland to the east and north (Refer to Drawing 1, Appendix A).

At the time of the field work, the site was covered in medium length grasses, small bushes and some isolated small trees. The site is transected by two large open drains. Surficial soils, where exposed, comprise brown and red-brown sand. The ground surface level across the site is generally flat, although dipping slightly to the north, with levels of approximately RL 10.0 m (AHD) in the south falling to RL 9.0 m in the north.

The Port Hedland 1:50 000 Urban Geology Map Sheet indicates that the site is underlain by sand and silt from alluvial and aeolian origin (locally termed Pindan Sand).

Pindan Sands are known to possibly exhibit collapsing potential. Collapsing soil is a weakly cemented material that is subject to large settlement upon wetting under load, and this could possibly have an impact on the proposed houses.

3. Field Work Methods

Field work was carried out between 4 and 8 August 2011 and comprised:

- The excavation of 40 test pits (TP1 to TP40).
- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- The drilling of three geotechnical boreholes (MB42, BH43 and BH44).
- The construction of three groundwater monitoring wells (MB41, MB42 and MB45).
- Four in situ permeability tests.

The test pits were excavated to a maximum depth of 3.25 m using a 5 tonne Kubota excavator equipped with a 450 mm wide, toothed bucket. PSP tests were carried out adjacent to the test pit locations in accordance with AS1289.6.3.3 to assess the in-situ density of the shallow soils.

The boreholes were drilled to depths of between 7.3 m and 10.2 m, by Edge Drilling using an Explorer 50 drilling rig. The boreholes were advanced using hollow stem auger drilling techniques. Boreholes (MB42, BH43 and BH44) were drilled within the vicinity of three possible locations for the proposed Waste Water Pumping Station for the development. Standard penetration testing (SPT) was carried out at regular depth intervals of 1.5 m within these boreholes. Groundwater monitoring wells were installed at locations MB41, MB42 and MB45, for sampling by others.

Each test location was logged in general accordance with AS 1726–1993 by a suitably experienced representative from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

Permeability testing was carried out at a depth of 0.5 m adjacent to test locations TP1, TP16, TP23 and TP30 using the falling head method.

Test locations were determined using a GPS and are marked on Drawing 1. Surface elevations at each test location were interpolated from a survey plan produced by McMullen Nolan and provided by the client. Levels are quoted relative to the Australian Height Datum (AHD) on the test pit and borehole logs in Appendix A.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix A, together with notes defining descriptive terms and classification methods. A summary of the ground conditions encountered is:

- **Sand** – medium dense, brown and red-brown, slightly silty sand extending from surface to depths of between 1.8 m and termination depth in the test pits and to depths of between 3.0 m and 4.0 m in the boreholes. Rootlets were generally encountered to depths of between 0.2 m and 0.3 m within the test pits.
- **Clayey Sand** – medium dense, red-brown, clayey sand underlying the sand to termination depth in the test pits, and to depths of between 5.5 m and 6.8 m within the boreholes.
- **Clayey Gravelly Sand** – medium dense, red brown mottled brown and grey, clayey gravelly sand from 2.3 m to termination depth at TP5.
- **Sandy Clay** – stiff, red-brown, low to medium plasticity sandy clay within the boreholes from depths of 5.5 m and 6.8 m to termination depths of up to 10.2 m depth.

Weakly cemented soils with collapsing potential were not identified at the site during the field investigation.

4.2 Groundwater

No free groundwater was observed within any of the test pits excavated on 4, 5 and 8 August 2011 to depths of up to 3.25 m below surface level (RL 5.75 m at TP18, lowest test pit level). The test pits were immediately backfilled following the investigation, which precluded longer-term monitoring of groundwater levels. Groundwater levels encountered at each of the boreholes is displayed in Table 1.

Table 1: Summary of Groundwater Levels

Test Location	Date of Drilling	Interpolated Surface Level* [1] (m AHD)	Groundwater Depth (m)	Date of Groundwater Measurement	Groundwater Level [2]* (m AHD)
MB41	06/08/2011	10.0	3.135	07/08/2011	6.9
MB42	06/08/2011	9.2	3.155	07/08/2011	6.0
BH43	06/08/2011	9.3	3.080	07/08/2011	6.2
BH43	07/08//2011	9.2	2.820	08/08/2011	6.4
MB45	07/08/2011	9.3	3.130	08/08/2011	6.2

Notes for Table 1 - [1]: Surface level interpolated from survey plan provided by the client.
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.
* : At time of reporting, the levels of the wells were being surveyed by the project surveyor. Detailed surface level and groundwater levels will be provided once available.

4.3 In Situ Permeability Testing

Four in situ permeability tests using the falling head method were carried out at a depth of 0.5 m at selected locations across the site. A field permeability value was estimated using the Horslev method (1951). Results of the permeability analysis are summarised in Table 2.

Table 2: Summary of the In-Situ Permeability Testing and Derived Values

Test Location	Depth (m)	Measured Permeability (m/s)	Material
TP1	0.5	7.0×10^{-6}	Slightly Silty Sand
TP16	0.5	5.1×10^{-6}	Slightly Silty Sand
TP23	0.5	1.2×10^{-5}	Slightly Silty Sand
TP30	0.5	2.6×10^{-6}	Slightly Silty Sand

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- The particle size distribution of 16 samples.
- Atterberg limits and linear shrinkage of ten samples.
- California bearing ratio (CBR) and modified maximum dry density (MMDD) of four samples.

Detailed test report sheets are given in Appendix B and the results are summarised in Table 3 (following page).

Table 3: Results of Laboratory Testing

Pit	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI	LS (%)	OMC (%)	MMDD (t/m^3)	CBR (%)	Material
TP1	0.5	17	0.0135	0.4	-	-	-	-	-	-	-	Slightly Silty Sand
TP2	0.25	14	0.029	0.41	NP	NP	NP	NP	7.5	1.981	45	Slightly Silty Sand
TP2	1.9	34	<0.0135	0.32	39	14	25	9.5	-	-	-	Clayey Sand, some silt and trace gravel
TP2	2.5	32	<0.0135	0.31	32	13	19	5.0	-	-	-	Clayey Sand, some silt and trace gravel
TP12	0.3	17	0.014	0.4	-	-	-	-	7.3	2.034	60	Slightly Silty Sand
TP16	0.5	15	0.02	0.43	-	-	-	-	-	-	-	Slightly Silty Sand
TP21	0.6	20	<0.0135	0.39	18	14	4	1.0	-	-	-	Slightly Silty Sand, trace clay
TP21	2.5	32	<0.0135	0.37	36	13	23	7.0	-	-	-	Clayey sand, some silt
TP23	0.5	13	0.029	0.49	-	-	-	-	-	-	-	Slightly Silty Sand
TP28	0.4	18	<0.0135	0.39	17	15	2	1.0	7.9	2.050	70	Slightly Silty Sand
TP30	0.5	15	0.026	0.425	-	-	-	-	-	-	-	Slightly Silty Sand
TP33	0.3	11	0.05	0.49	-	-	-	-	9.6	1.965	50	Sand, some silt
TP33	2.1	29	<0.0135	0.39	28	13	15	7.0	-	-	-	Slightly Clayey, some silt
MB42	6-6.45	39	<0.0135	0.23	35	15	20	7.0	-	-	-	Clayey Sand, some silt
BH43	4.5-4.95	38	<0.0135	0.31	39	13	26	10.5	-	-	-	Clayey Sand, some silt
BH44	6-6.45	29	<0.0135	0.32	33	13	20	7.5	-	-	-	Clayey Sand, some silt

Notes on Table 3:

- The % fines is the amount of particles smaller than 75 µm
- A d_{10} of 0.17 mm means that 10% of the sample particles are finer than 0.17 mm
- A d_{60} of 0.23 mm means that 60% of the sample particles are finer than 0.23 mm
- LL: liquid limit
- PL: plastic limit
- PI: plasticity Index
- LS: linear shrinkage
- MMDD: modified maximum dry density
- CBR: California bearing ratio
- OMC: optimum moisture content.
- NP: non plastic fines
- '-' means 'Not Tested'

6. Proposed Development

It is understood that the proposed development includes the construction of a residential development with associated roads and public open space. The site is likely to be raised with imported filling to mitigate inundation by flooding.

A waste water pumping station with a wet well with depth of approximately 6 m below existing surface level will also be constructed. The proposed construction method of the wet well is not known at time of writing.

7. Comments

7.1 Ground Conditions and Collapsing Soils

The results of the investigation indicate that there is little lateral variation in the shallow ground conditions across the site, which generally consist of slightly silty sand, overlying clayey sand in turn overlying sandy clay. This soil profile is typical of Pindan Sand, a geological soil unit found throughout the north-west of Western Australia and known to have a collapse potential.

Undisturbed samples were collected with the view to testing their collapse potential, although, no soils were discovered on site that exhibited signs of having collapse potential. Even so, it is considered prudent to undertake suitable site preparation measures, as indicated in Section 7.3, to minimise any potential impacts of collapsing soils, should they exist at locations other than those investigated at the site.

7.2 Site Classification

The shallow ground conditions beneath the site generally comprise slightly silty sand overlying slightly reactive low plasticity clayey sand and sandy clay. Current classification of the site in accordance with AS 2870-2011 was determined using the results of the field work and subsequent laboratory testing. The method presented in Kay (1990) was used to calculate the characteristic free surface movement (ys) for the site, based on procedures outlined in AS 2870-2011, the typical soil profiles revealed in the test pits, the results of laboratory testing and on a design depth of suction change of 4 m, as proposed by McManus et al (2004) for semi arid flood prone sites.

Based on the results of the assessment, the site should be classified as ‘Class S’ in accordance with AS 2870-2011.

7.3 Site Preparation

It is recommended that site preparation is supervised by a suitably experienced geotechnical engineer. Prior to excavation of foundations and/or placement of fill, all deleterious material including topsoil and vegetation should be stripped from building envelopes and pavement areas and removed from site or reused for landscaping purposes, if applicable. Rootlets occurred within the upper soil profile to a depth of 0.3 m. It is considered that the top 0.1 m of this profile should be stripped from the site prior to any filling.

Tree roots remaining from any clearing operations within the proposed building envelopes and pavement areas, should be completely removed.

Following removal of unsuitable material and prior to any filling, to minimise the risk of damage to structures and roads due to possible soil collapse, it is recommended that the following preparation is undertaken across each building envelope and pavement area:

- Flood the site with water and allow to drain; then
- Compact the site using several overlapping passes of a heavy vibrating roller (minimum 18 tonne).

Following the site preparation suggested above, filling should be placed within 2% of its optimum moisture content, in layers not exceeding 200 mm thickness and each layer compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. Care should be taken not to operate heavy plant adjacent to existing structures or services.

With the exception of the top 0.1 m layer of surfical soil containing rootlets, the natural materials across the site are generally suitable for re-use as filling material for support of structures. This material should be placed as detailed above.

The base of all footing excavations should be compacted prior to placement of reinforcement and casting of concrete. The use of a vertical rammer is considered to be suitable equipment for this task.

Compaction control of sand could be carried out using a Perth sand penetrometer in accordance with test method AS 1289.6.3.3. It is recommended that all areas within building and pavement envelopes be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration when tested in accordance with the above test method. Compaction control of clayey materials should be carried out using a nuclear surface moisture-density gauge, in accordance with test method AS 1289.5.8.1.

7.4 Earth Retaining Structures

Design of temporary and permanent retaining structures can be based on a bulk unit weight for the retained material of 20 kN/m^2 and an active earth pressure coefficient Ka of 0.33 in sand assuming level backfill and adequate drainage. In addition to the soil pressure, wall design should also allow for external loads such as buildings and live loads.

7.5 Foundation Design

7.5.1 Residential Structures

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support residential structures. Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of the appropriate site classification detailed in Section 7.2.

AS 2870-2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. For buildings not covered by AS 2870-2011, a presumptive allowable bearing pressure of 150 kPa is suggested for foundation design of strip and pad footings founded at a minimum depth of 0.5 m following suitable preparation detailed above. This should ensure that total settlements are less than about 20 mm.

7.5.2 WWPS Wet Well

Detailed information for the proposed wet well to be constructed at the WWPS is not available at time of writing, however it is understood that the footing at the base of the well is likely to be approximately 6 m below existing surface level. Boreholes MB42, BH43 and BH44 were drilled in the vicinity of potential locations for the WWPS, as nominated by Pritchard Francis. The material encountered at the proposed base of the wet well at each of these locations consists of medium dense clayey sand underlain by stiff sandy clay. A preliminary allowable bearing capacity of 250 kPa is suggested for the design of the wet well footing in the material encountered at the foundation depth at these locations.

The wet well should also be designed to resist hydrostatic pressure (uplift). To calculate the shaft resistance to uplift, the following parameters are provided in Table 4.

Table 4: Soil Parameters for Shaft Resistance to Uplift at Proposed WWPS Locations

Soil Unit Weight Above Water γ (kN/m^3)	Drained Angle of Friction for Sand Φ' (Degrees)	Friction Angle between Sand and Pre-cast Concrete δ (Degrees)	Coefficient of Earth Pressure – at Rest K_0
18	32	17 - 22	0.5

7.6 Pavement Design Parameters and Road Construction

As noted in Section 4.1 the shallow soils across the site comprise slightly silty sand. This material may constitute the subgrade for the proposed pavements across the site.

Laboratory testing results detailed in Section 5 indicate CBR values between 45% and 60% for 4-day soaked samples compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and tested under a confining surcharge of 4.5 kg for silty sand subgrade. Based on observations made in the field and a review of the available laboratory testing results, a subgrade CBR design value of 10% is suggested for the design of pavement on the silty sand material, provided the subgrade is prepared in accordance with Section 7.3, compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and suitably drained.

7.7 Site Drainage

Results of the permeability analysis are summarised in Table 2 and indicate a permeability values in the order of between 1 x 10 $^{-5}$ and 3 x 10 $^{-6}$ m/s for the slightly silty sand encountered beneath the site.

Given the high fines content of the soils at the site, which is generally increasing with depth, it is considered that stormwater disposal via soakwells is unsuitable. An alternative method of stormwater disposal, such as directing water to retention basins or similar should be considered. The implementation of a suitable drainage strategy is suggested to control water collecting on the site surface during the large rain events which seasonally occur in the Pilbara region.

The typical approach for ensuring amenity of sites such as this in regional areas includes grading of the lots to allow surface water to flow into roadside drains, and on towards a subsequent suitable outflow.

8. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings

9. Limitations

Douglas Partners (DP) has prepared this report for a residential development at the Hamilton Precinct in South Hedland, WA in accordance with DP's proposal dated 18 July 2011 and acceptance received from Cory Johnson of Pritchard Francis Pty Ltd on 26 July 2011. This report is provided for the exclusive use of Pritchard Francis for this project only and for the purposes described in the report. It should not be used by or relied upon for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About this Report
Drawings
Results of Field Work

About this Report

Douglas Partners

Introduction

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

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

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Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

■ Asphalt


Road base

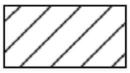

Concrete


Filling

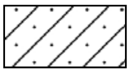
Soils


Topsoil

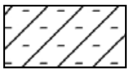

Peat


Clay

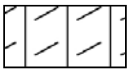

Silty clay

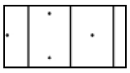

Sandy clay

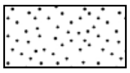

Gravelly clay

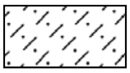

Shaly clay

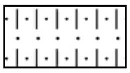

Silt


Clayey silt

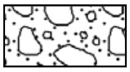

Sandy silt


Sand


Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

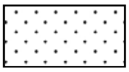

Talus

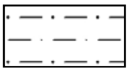
Sedimentary Rocks

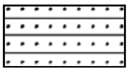

Boulder conglomerate

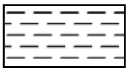

Conglomerate


Conglomeratic sandstone

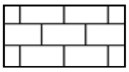

Sandstone


Siltstone

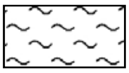

Laminite

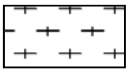

Mudstone, claystone, shale

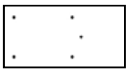
■ Coal


Limestone

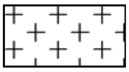
Metamorphic Rocks

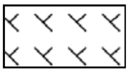

Slate, phyllite, schist

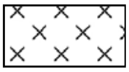

Gneiss


Quartzite

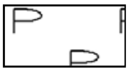
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Pritchard Francis Pty Ltd

OFFICE: Perth

DRAWN BY: B. Divilly

SCALE: As shown

DATE: 10 Aug 2011

TITLE:

Location of Tests
Hamilton Precinct
South Hedland, WA

MGA

PROJECT No.: 76250

DRAWING No.: 1

REVISION: A

76250-d01.dgn
PINPOINT CARTOGRAPHICS (08) 9562 7136

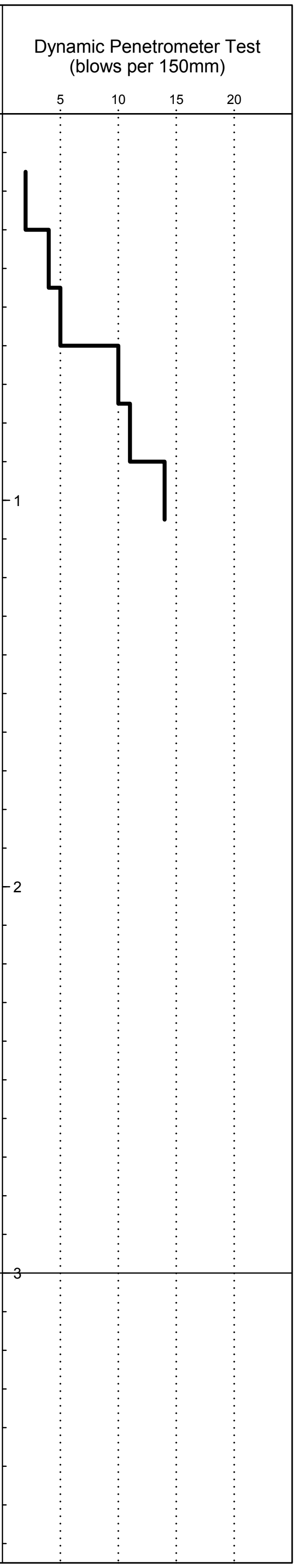
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666133
NORTHING: 7744009
DIP/AZIMUTH: 90°/--

PIT No: TP 1
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.						
9		- with a trace of rootlets to 0.3 m. - becoming red-brown from 0.35 m. - becoming dry to moist from 0.4 m. - becoming slightly silty sand from 0.5 m.		D	0.5			
		- becoming dense from 0.6 m.						
	1							
8		- with some clay from 1.4 m. - becoming moist and mottled light brown from 1.5 m. - clay content increasing with depth.						
		- becoming slightly clayey sand with some fine to medium sized gravel from 1.8 m. - becoming light brown mottled red-brown and black from 1.9 m.						
	2							
7				D	2.3			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

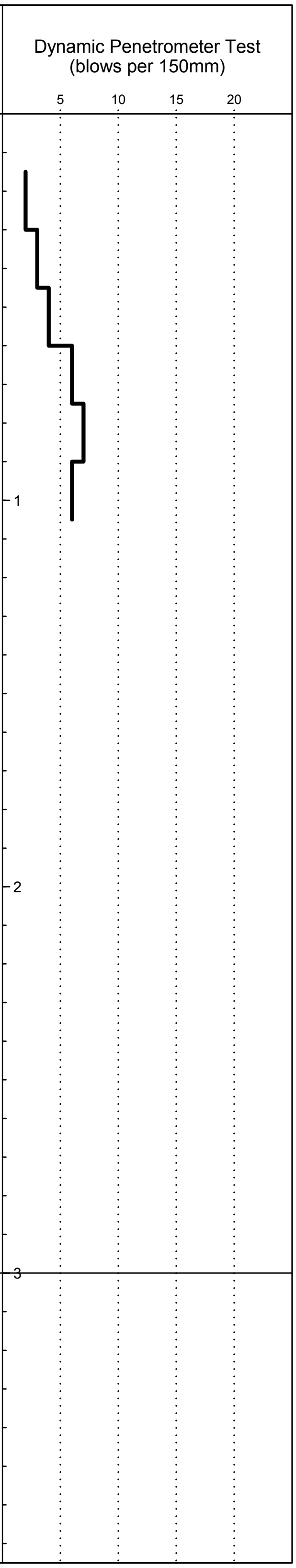
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666185
NORTHING: 7743949
DIP/AZIMUTH: 90°/--

PIT No: TP 2
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with some rootlets to 0.2 m. - becoming red-brown from 0.2 m.		B	0.25			
		- becoming dry to moist from 0.8 m.						
		- with a trace of clay from 0.9 m.						
	1	- clay content increasing with depth.						
8								
				D	1.4			
		- with some clay and mottled light brown from 1.5 m.						
	1.8	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with some silt and a trace of fine sized gravel, moist.		D	1.9			
	2							
7								
				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

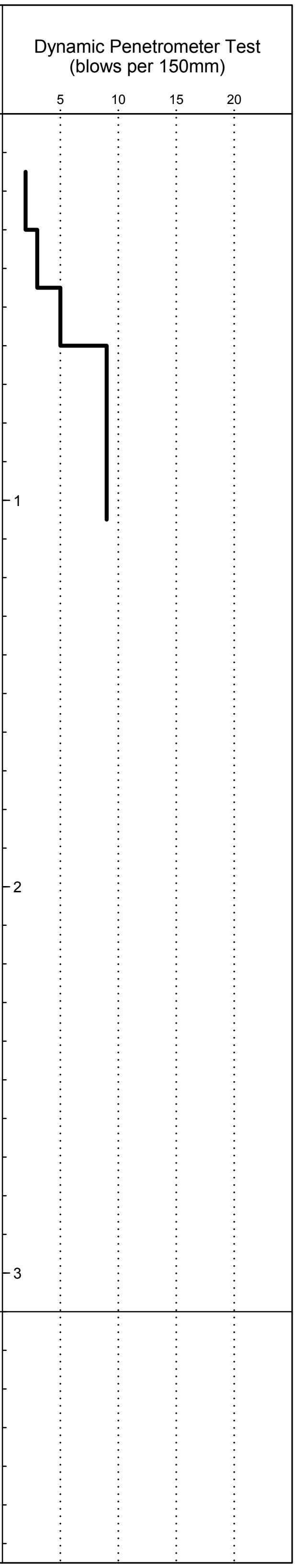
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666237
NORTHING: 7743887
DIP/AZIMUTH: 90°/--

PIT No: TP 3
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- becoming red-brown from 0.3 m.						
9								
		- becoming dense from 0.6 m.						
				D	0.7			
		- becoming dry to moist from 0.9 m.						
	1	- becoming light brown from 1.0 m.						
8								
					1.5			
		- becoming light brown mottled red-brown and black, slightly clayey sand with some silt and fine sized gravel, moist from 1.5 m.		U_{150}				
					1.7			
	2							
7					2.4			
		- becoming red-brown mottled light grey 2.5 m.		U_{150}				
				D	2.6			
	3							
	3.1	Pit discontinued at 3.1m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

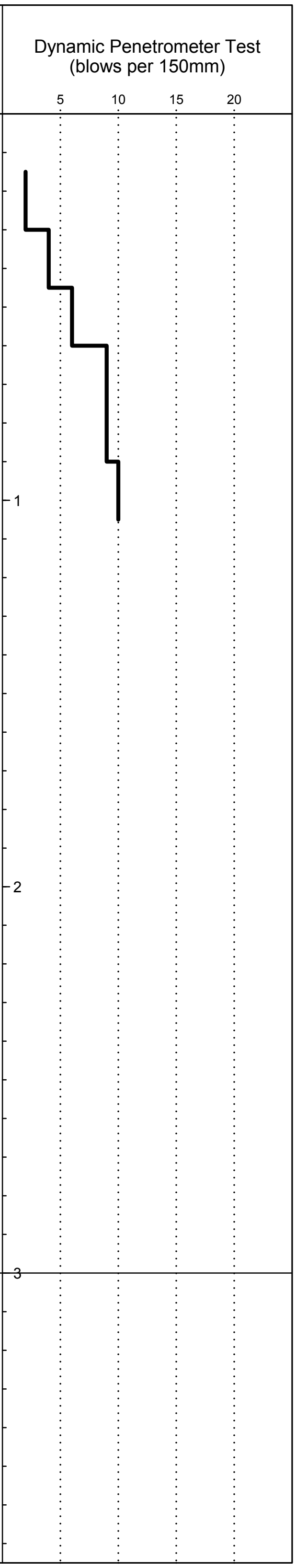
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666294
NORTHING: 7743831
DIP/AZIMUTH: 90°/--

PIT No: TP 4
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with trace of rootlets to 0.3 m. - becoming red-brown from 0.3 m.						
9		- becoming dry to moist from 0.6 m. - becoming dense from 0.6 m.		D	0.7			
	1							
		- with a trace of clay from 1.2 m. - clay content increasing with depth.						
8		- becoming light brown mottled red-brown with a trace of fine sized gravel from 1.5 m. - with some clay from 1.6 m.						
	2	- becoming mottled black, slightly clayey sand with some silt from 1.9 m.						
		- weakly cemented in pockets from 2.2 m.		D	2.3			
7		- gravel size increasing to fine to medium sized from 2.6 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

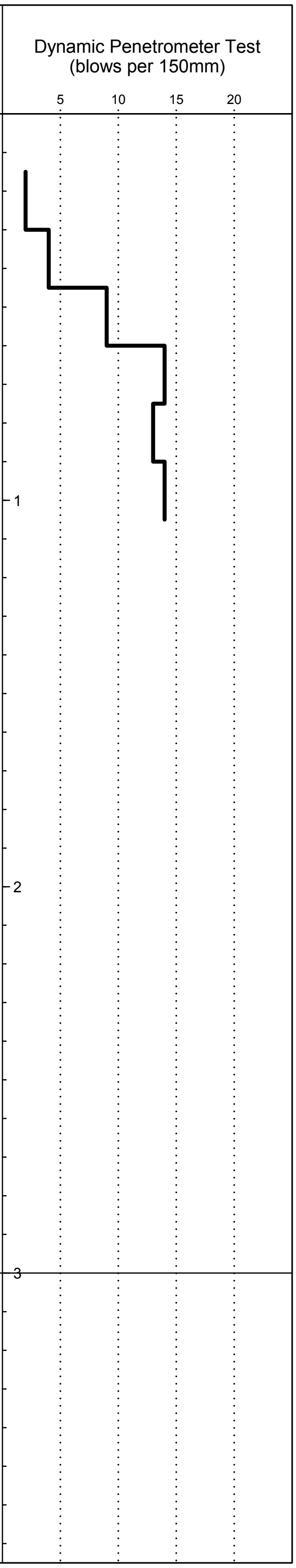
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666347
NORTHING: 7743882
DIP/AZIMUTH: 90°/--

PIT No: TP 5
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.2 m.						
		- becoming dry to moist from 0.35 m.						
		- becoming dense from 0.45 m.						
		- with a trace of clay from 0.5 m.						
9								
		- clay content increasing with depth.						
				D	0.9			
	1							
		- with some clay from 1.1 m.						
		- becoming light brown mottled red-brown from 1.4 m.						
8								
	2	- becoming slightly clayey sand with some silt from 1.9 m.		D	2.0			
	2.3	CLAYEY GRAVELLY SAND - medium dense, red-brown mottled brown and grey, fine to medium grained clayey gravelly sand. Gravel is fine to medium sized. Moist.		D	2.4			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

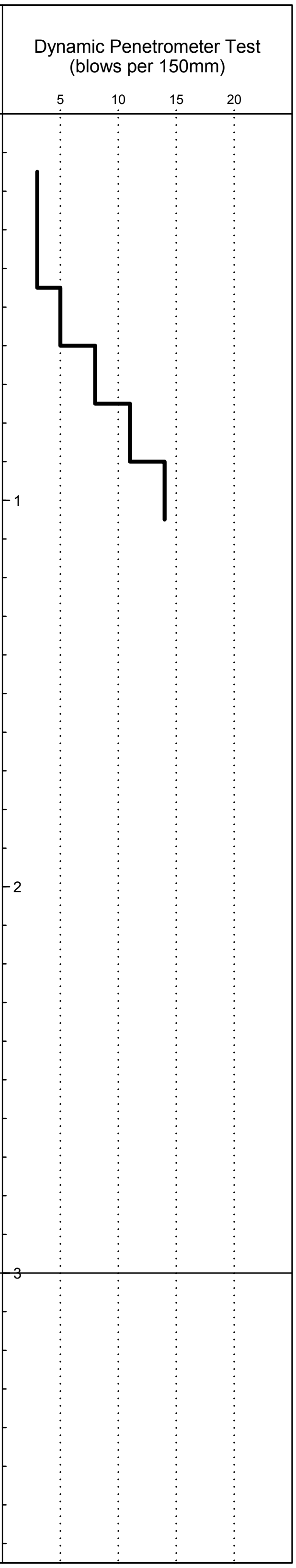
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666295
NORTHING: 7743945
DIP/AZIMUTH: 90°/--

PIT No: TP 6
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- trace of rootlets to 0.25 m.						
		- becoming red-brown from 0.3 m.						
9		- becoming dry to moist from 0.4 m.						
		- becoming dense from 0.6 m.						
		- with a trace of clay from 0.9 m.						
	1	- clay content increasing with depth.		D	1.0			
8		- becoming mottled light brown with some clay from 1.3 m.						
		- becoming red brown mottled black and light brown and slightly clayey sand with some silt from 1.5 m.						
		- with a trace of fine sized gravel from 1.6 m.		D	1.7			
	2							
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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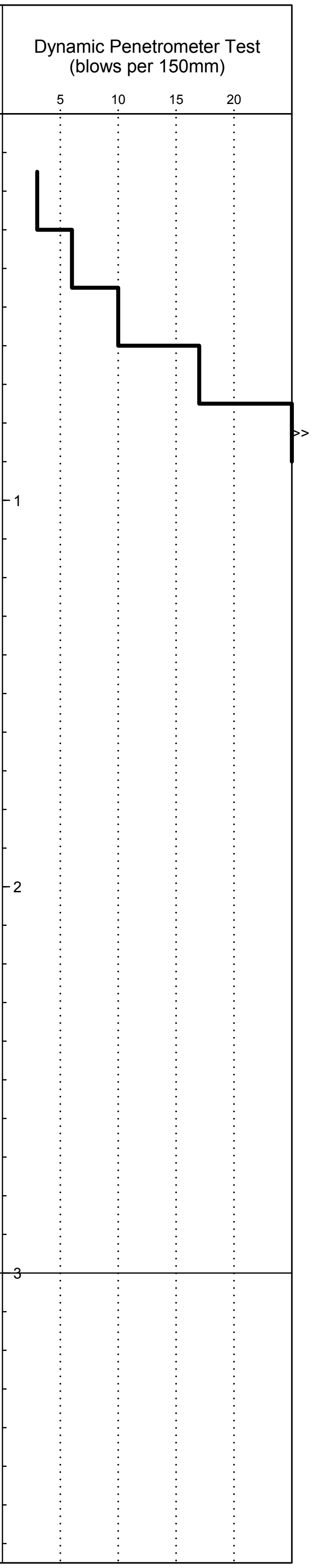
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666244
NORTHING: 7744006
DIP/AZIMUTH: 90°/--

PIT No: TP 7
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with some rootlets and a trace of roots to 0.25 m. - becoming light brown from 0.3 m.						
		- becoming dry to moist from 0.6 m. - weakly cemented in pockets from 0.6 m.						
	1			D	1.0			
8								
	2	- becoming red-brown mottled light brown with some clay from 1.9 m. - with some fine sized gravel from 2.0 m. - clay content increasing with depth.		D	2.1			
7		- becoming slightly clayey sand with some silt and moist from 2.3 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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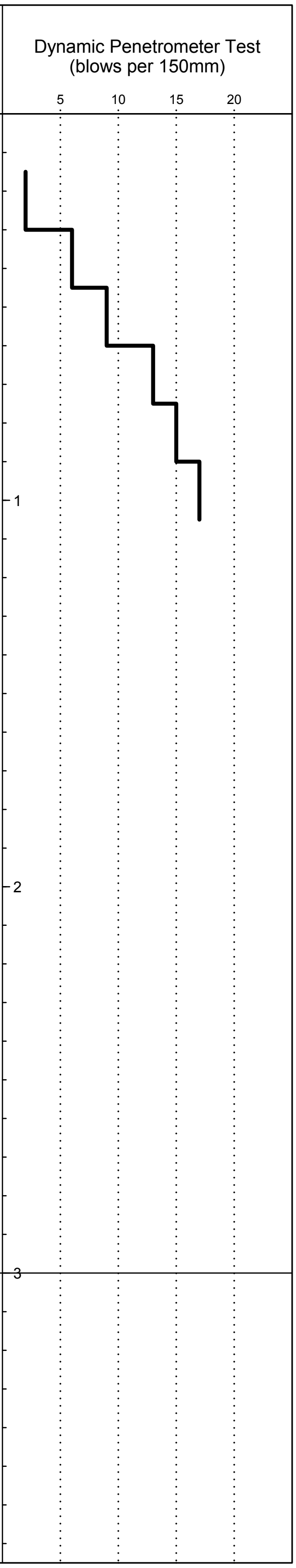
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666186
NORTHING: 7744061
DIP/AZIMUTH: 90°/--

PIT No: TP 8
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.25 m. - becoming red-brown from 0.3 m. - becoming dry to moist from 0.4 m.						
	1							
8				D	1.1			
		- with some clay from 1.5 m. - clay content increasing with depth. - becoming light brown mottled red-brown with trace of fine sized gravel from 1.7 m. - becoming red-brown mottled light brown, slightly clayey sand with some silt and fine sized gravel from 1.9 m.						
	2			D	2.0			
7								
		- becoming mottled grey from 2.7 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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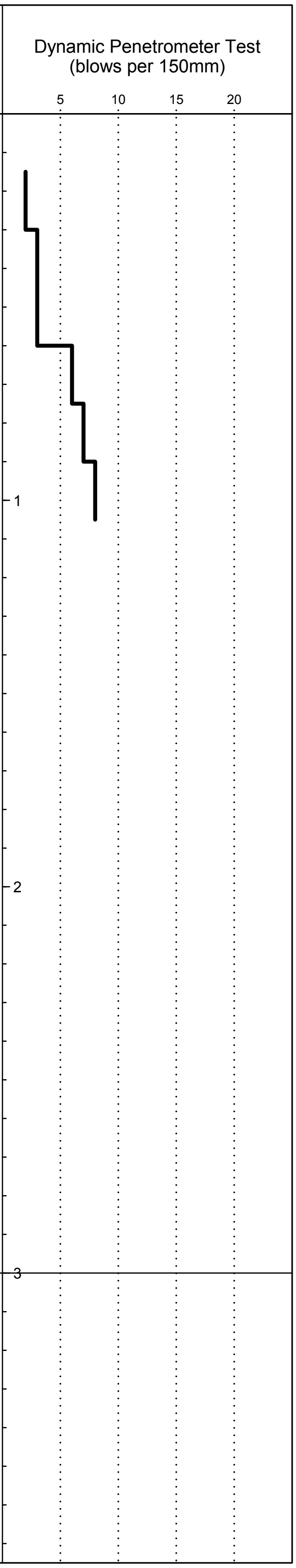
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666247
NORTHING: 7744115
DIP/AZIMUTH: 90°/--

PIT No: TP 9
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.25 m. - becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.5 m.						
	1	- becoming light brown mottled red-brown with trace of clay from 1.0 m.						
8				D	1.2			
		- with some clay and fine sized gravel from 1.5 m. - becoming moist from 1.5 m. - weakly cemented in pockets to 1.5 m.						
		- becoming mottled black, slightly clayey sand with some silt from 1.8 m.						
	2							
7								
				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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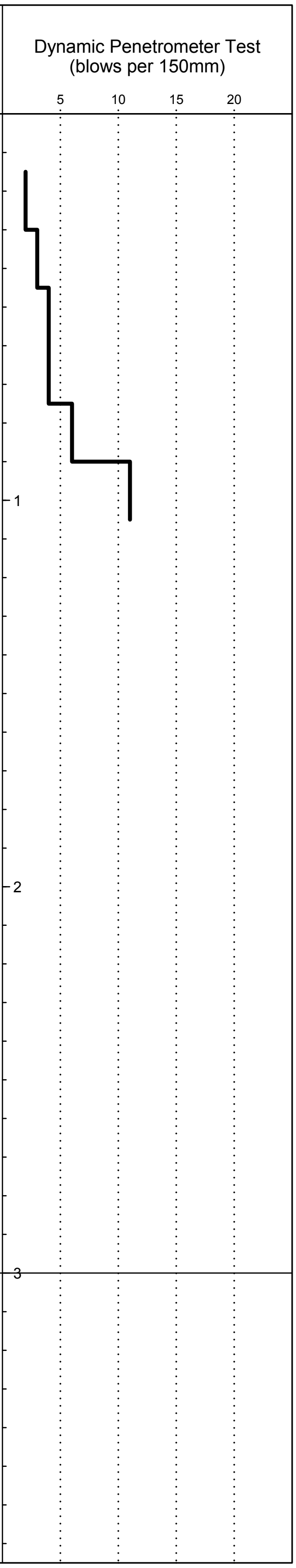
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666299
NORTHING: 7744059
DIP/AZIMUTH: 90°/--

PIT No: TP 10
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.4 m.		B	0.4			
	1							
8								
		- with some clay from 1.3 m.						
		- becoming mottled light brown, slightly clayey sand with some silt from 1.7 m.						
				D	1.9			
	2							
7								
				D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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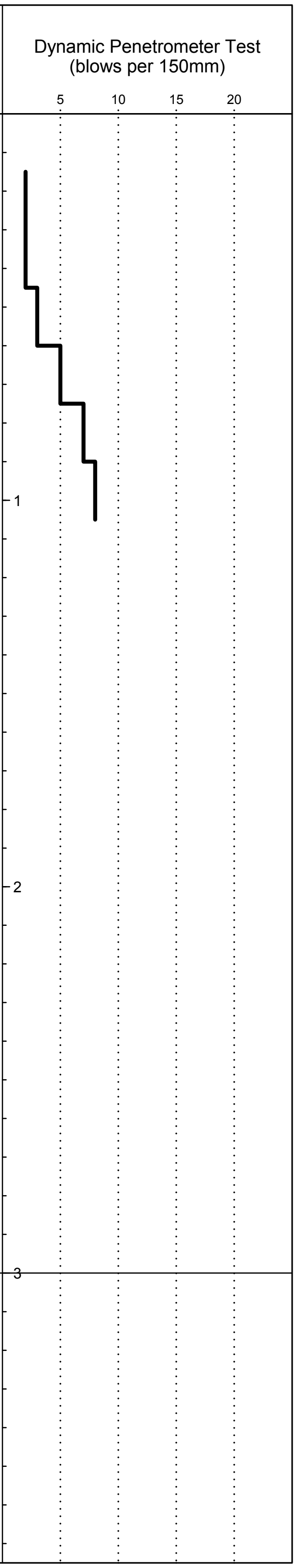
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666355
NORTHING: 7743996
DIP/AZIMUTH: 90°/--

PIT No: TP 11
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- becoming red-brown from 0.3 m. - with a trace of roots and rootlets to 0.3 m.						
	1	- with a trace of clay from 0.9 m. - clay content increasing with depth.						
8								
		- becoming light brown mottled red-brown from 1.5 m.						
		- becoming slightly clayey sand with some silt, a trace of fine sized gravel and moist from 1.8 m.						
	2	- becoming mottled black from 2.0 m.						
7		- with some fine sized gravel from 2.3 m.						
				D	2.4			
	2.8	CLAYEY SAND - medium dense, red-brown mottled light brown and black, fine to medium grained clayey sand with some silt and fine to medium sized gravel, moist.		D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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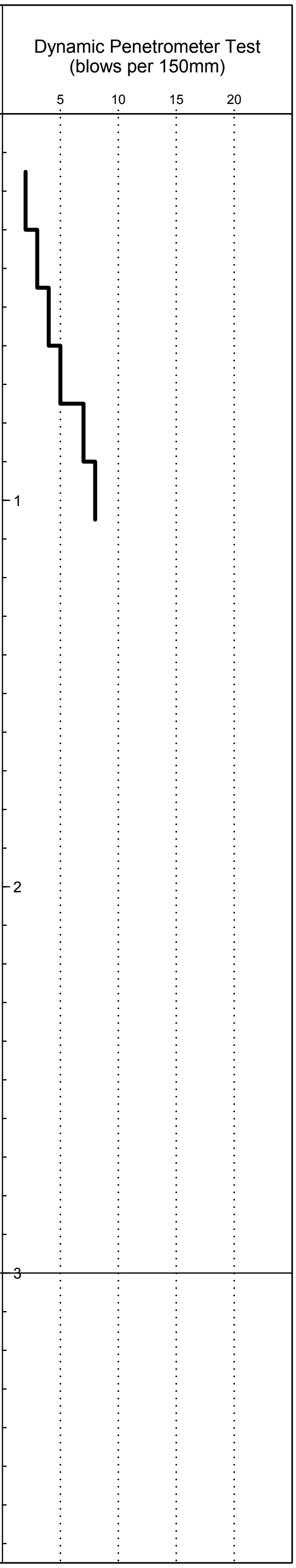
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666405
NORTHING: 7743938
DIP/AZIMUTH: 90°/--

PIT No: TP 12
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.25 m.		B	0.3			
9		- becoming dry to moist from 0.5 m.						
	1							
		- with some clay from 1.1 m.		D	1.2			
8		- becoming mottled light brown from 1.5 m.						
		- becoming mottled light brown and black, slightly clayey sand with some silt and trace fine sized gravel from 1.8 m.						
	2			D	2.0			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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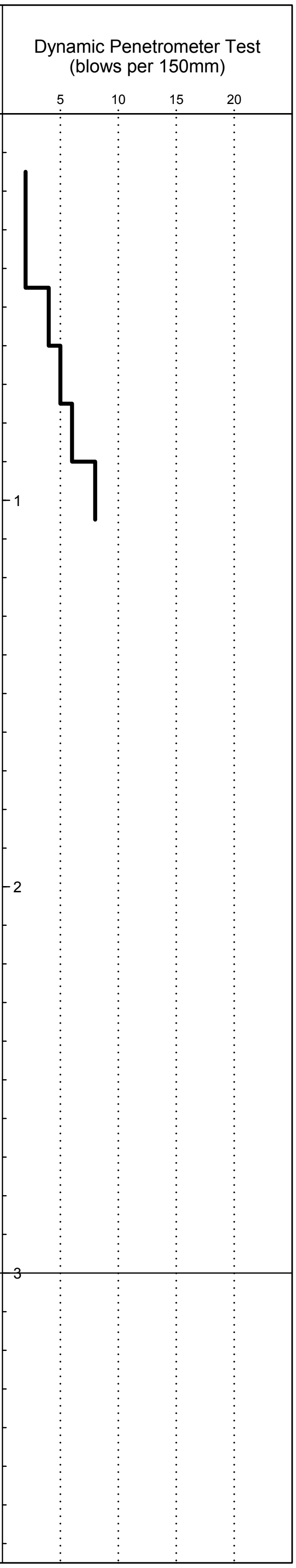
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666526
NORTHING: 7743931
DIP/AZIMUTH: 90°/--

PIT No: TP 13
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- becoming red-brown from 0.25 m.						
		- with a trace of rootlets to 0.35 m.						
9								
		- weakly cemented in pockets to 0.6 m.						
	1			D	1.0			
		- with some clay from 1.2 m.						
		- clay content increasing with depth.						
8								
		- becoming mottled light brown and slightly clayey sand with some silt from 1.8 m.						
	2							
		- with a trace of fine sized gravel from 2.2 m.						
				D	2.4			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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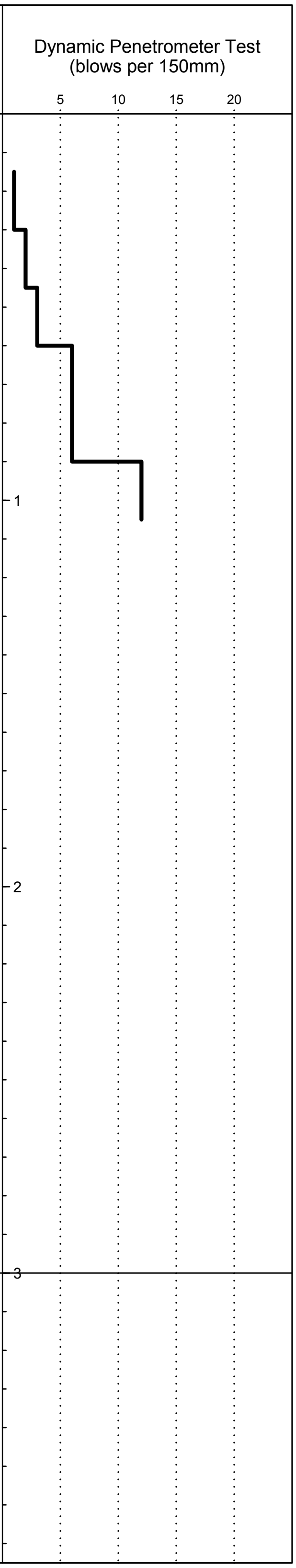
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666475
NORTHING: 7743996
DIP/AZIMUTH: 90°/--

PIT No: TP 14
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.0	SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with some rootlets to 0.35 m. - becoming red-brown and dry to moist from 0.4 m. - with a trace of clay from 0.8 m. - becoming dense from 0.9 m. - clay content increasing with depth.	D	1.0			
	- becoming mottled light brown and moist from 1.7 m. - becoming slightly clayey sand with some silt from 2.0 m.	D	2.2			
	- becoming mottled black, with a trace of fine sized gravel from 2.6 m.					
2.7	CLAYEY SAND - medium dense, red-brown mottled light brown and black, fine to medium grained clayey sand with trace of fine sized gravel, moist.	D	2.9			
3.0	Pit discontinued at 3.0m (Target)					



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

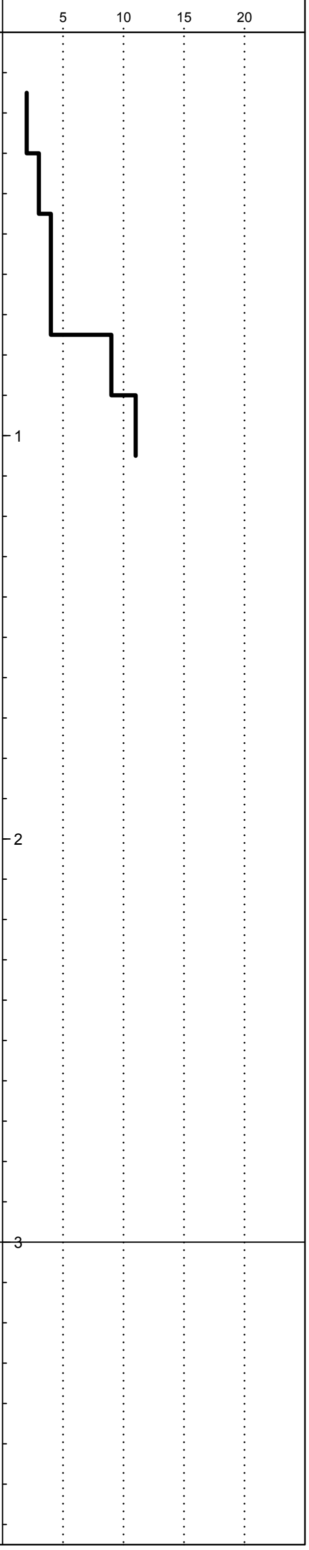
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666417
NORTHING: 7744052
DIP/AZIMUTH: 90°/--

PIT No: TP 15
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry.					
	- with some rootlets and trace of roots to 0.3 m.					
	- becoming dry to moist from 0.5 m.					
		D	0.7			
	- becoming dense from 0.75 m.					
	- with some clay from 1.4 m.					
		D	1.6			
	- becoming mottled light brown and moist from 1.7 m.					
	- becoming slightly clayey sand with some silt from 2.0 m.					
		D	2.4			
3.0	Pit discontinued at 3.0m (Target)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

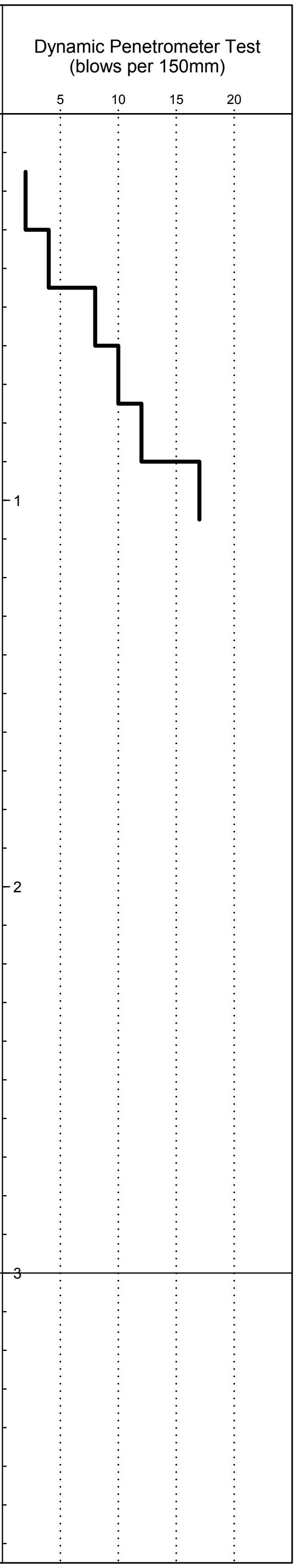
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666363
NORTHING: 7744112
DIP/AZIMUTH: 90°/--

PIT No: TP 16
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9								
		- with some rootlets from 0.25 m. - becoming red-brown from 0.25 m.						
		- becoming dense from 0.45 m. - becoming dry to moist from 0.5 m.		D	0.5			
	1							
8		- with some clay from 1.2 m.						
		- becoming red-brown mottled light brown slightly clayey sand with some silt, moist from 1.7 m.		D	1.8			
	2							
7								
		- with some fine sized gravel from 2.8 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

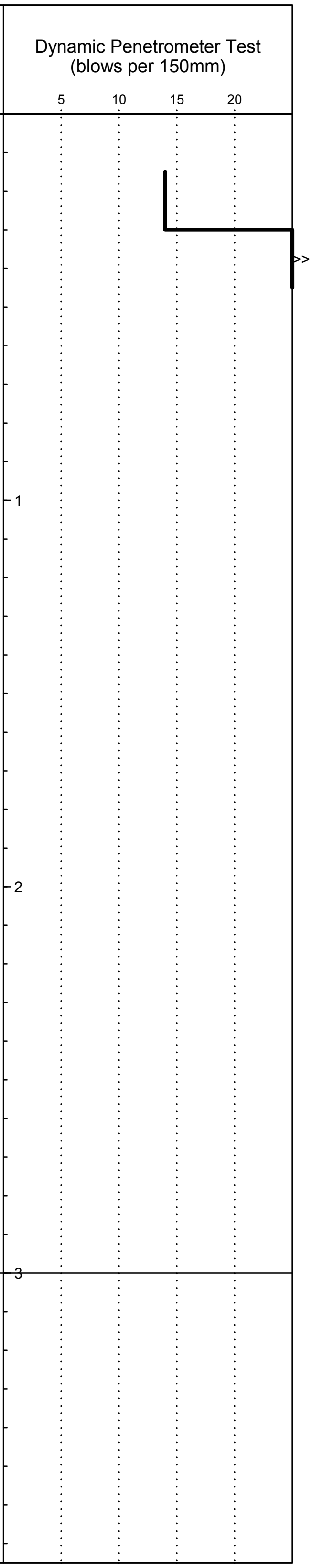
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.7 m AHD*
EASTING: 666314
NORTHING: 7744169
DIP/AZIMUTH: 90°/--

PIT No: TP 17
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - very dense, red-brown, fine to medium grained slightly silty sand, dry. - with some rootlets to 0.2 m. - becoming dry to moist from 0.5 m. - weakly cemented in pockets to 0.5 m.		D	0.6			
9								
	1	- with some clay from 1.2 m. - clay content increasing with depth.		D	1.4			
		- becoming mottled light brown and moist from 1.5 m.						
8		- becoming slightly clayey sand with some silt from 1.8 m.						
	2			D	2.3			
	2.5	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand with some silt, moist.		D	2.6			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

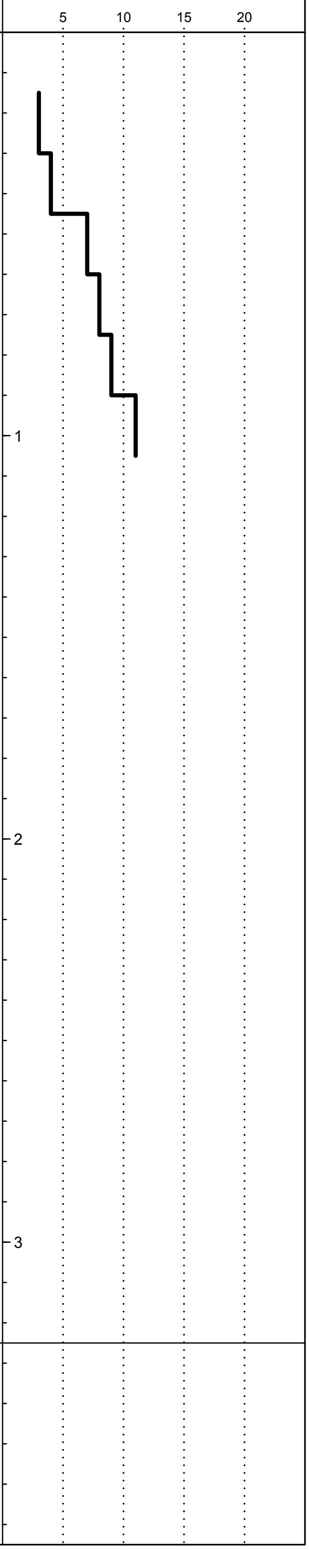
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666365
NORTHING: 7744225
DIP/AZIMUTH: 90°/--

PIT No: TP 18
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- trace of roots and rootlets to 0.2 m.						
		- becoming red-brown and dry to moist from 0.25 m.						
		- becoming dense from 0.45 m.						
8	1							
		- with a trace of clay from 1.2 m.						
		- clay content increasing with depth.						
		- with some clay from 1.5 m.		D	1.5			
		- becoming mottled light brown from 1.8 m.						
					1.9			
7	2	- becoming slightly clayey sand with some silt from 1.9 m.		U_{150}				
					2.1			
		- becoming moist from 2.1 m.						
					2.6			
				U_{150}				
					2.8			
6	3	- becoming moist to wet from 3.0 m.						
	3.1	CLAYEY SAND - medium dense, red-brown, fine to medium clayey sand, moist to wet.		D	3.2			
	3.25	Pit discontinued at 3.25m (Target)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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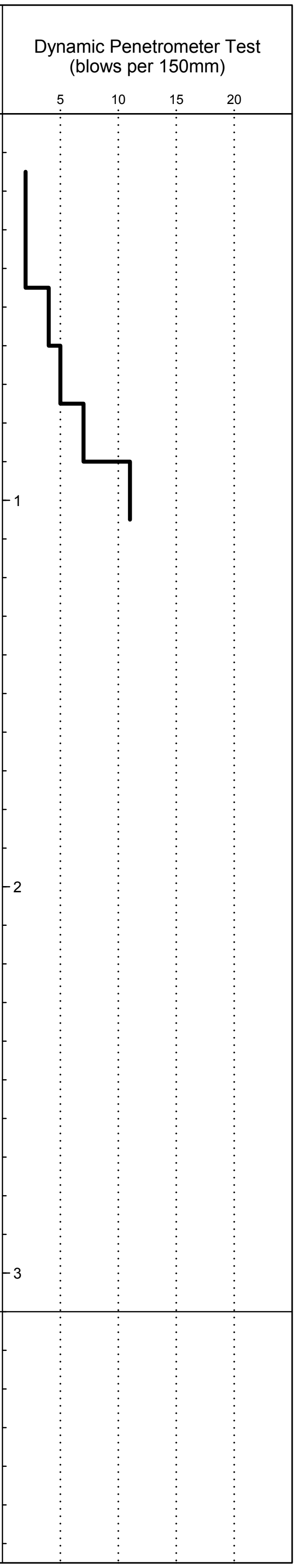
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.9 m AHD*
EASTING: 666430
NORTHING: 7744163
DIP/AZIMUTH: 90°/--

PIT No: TP 19
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- with some rootlets to 0.25 m.					
		- becoming red-brown from 0.25 m.					
		- becoming dry to moist from 0.5 m.					
		- becoming dense from 0.75 m.					
		- with a trace of clay from 0.8 m.					
8		- clay content increasing with depth.					
	1						
		- with some clay from 1.2 m.					
		- becoming slightly clayey sand with some silt, a trace of fine sized gravel and moist from 1.5 m.	D	1.6			
7							
	2						
			D	2.7			
		- becoming moist to wet from 2.8 m.					
6							
	3						
	3.1	Pit discontinued at 3.1m (Target)					



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

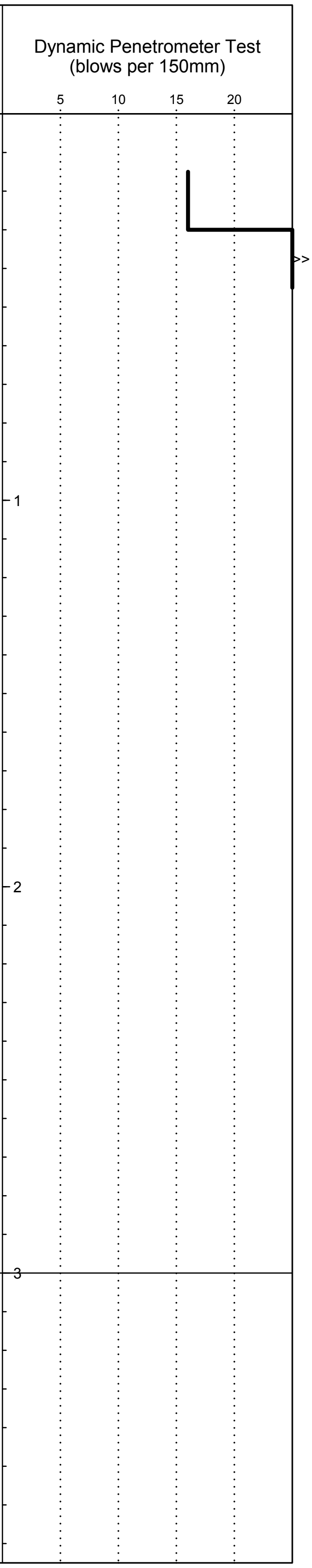
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666473
NORTHING: 7744101
DIP/AZIMUTH: 90°/--

PIT No: TP 20
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - very dense, red-brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.25 m.						
				D	0.4			
		- becoming dry to moist from 0.5 m.						
9								
	1							
8		- with some clay from 1.6 m.						
		- becoming moist from 1.8 m.						
	2							
		- becoming mottled light brown with some fine to medium sized gravel from 2.1 m.		D	2.2			
		- becoming slightly clayey sand with some silt from 2.4 m.						
7				D	2.6			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket) **LOGGED:** BD **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

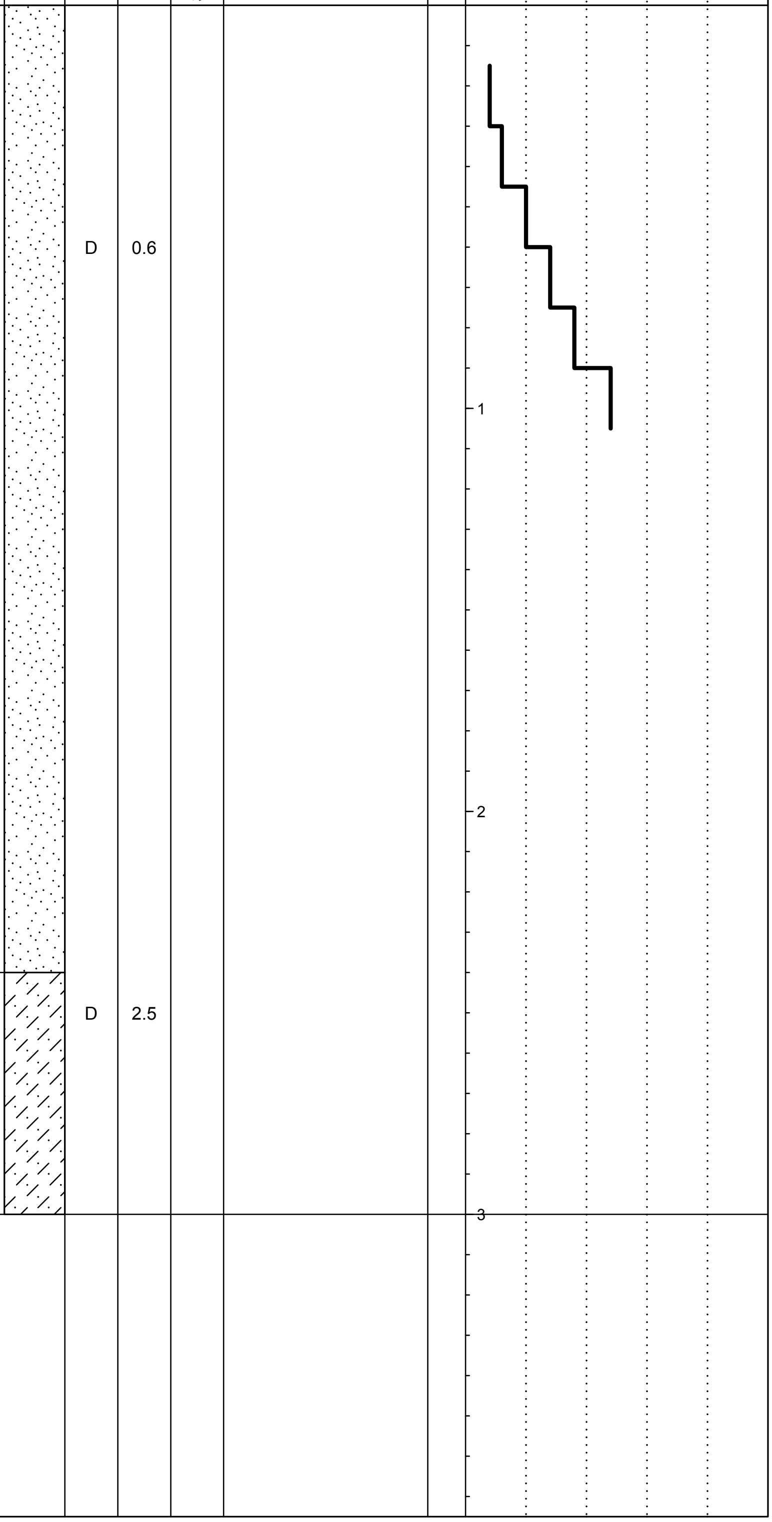
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666528
NORTHING: 7744046
DIP/AZIMUTH: 90°/--

PIT No: TP 21
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 **OF** 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- becoming red-brown from 0.3 m. - with a trace of rootlets to 0.3 m.					
9		- with a trace of clay and becoming moist from 0.5 m.					
		- becoming dense from 0.6 m.	D	0.6			
	1						
8							
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.					
	2						
	2.4	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand with some silt, moist.					
7			D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)					
6							



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

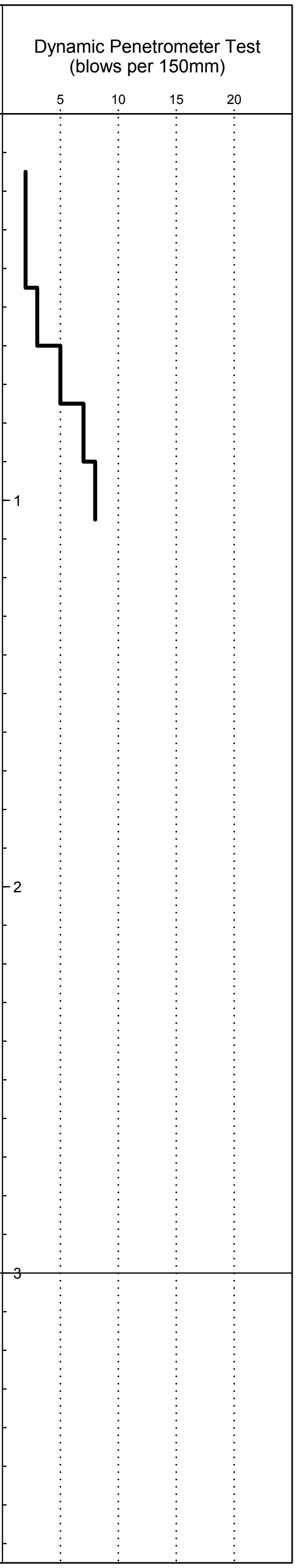
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666585
NORTHING: 7743984
DIP/AZIMUTH: 90°/--

PIT No: TP 22
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9 8 7	1 2 2.8	SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - becoming red-brown from 0.2 m. - with a trace of rootlets to 0.2 m. - with a trace of clay from 1.0 m. - clay content increasing with depth. - becoming mottled light brown and moist from 1.8 m. - becoming slightly clayey sand with some silt from 1.9 m. - with a trace of fine sized gravel from 2.0 m.		D	1.6			
	3 3.0	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand with a trace of silt, moist to wet.		D	2.9			
6		Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94
WATER OBSERVATIONS: No free groundwater observed
REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

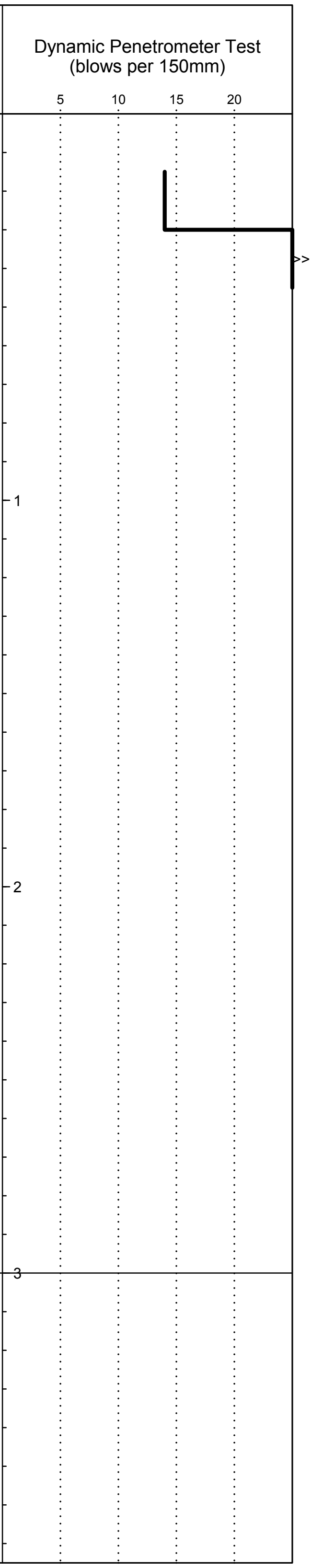
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 10.0 m AHD*
EASTING: 666697
NORTHING: 7743969
DIP/AZIMUTH: 90°/--

PIT No: TP 23
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
10		SAND - very dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.15 m. - becoming red-brown from 0.2 m.						
		- weakly cemented in pockets to 0.5 m. - becoming dry to moist from 0.5 m.		D	0.5			
		- with a trace of clay from 0.7 m.						
				D	0.8			
		- clay content increasing with depth.						
9	1							
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.		D	1.9			
8	2							
7	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

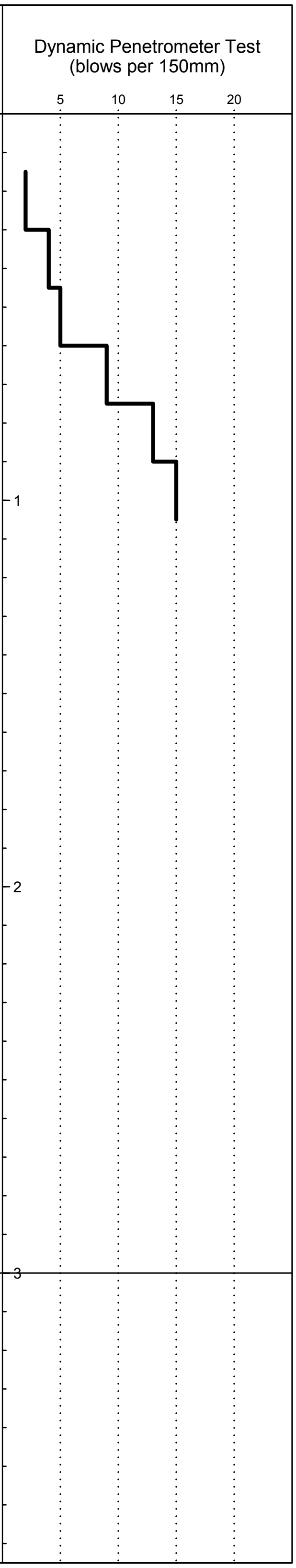
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666637
NORTHING: 7744044
DIP/AZIMUTH: 90°/--

PIT No: TP 24
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.15 m. - becoming red-brown, with a trace of clay and dry to moist from 0.2 m. - clay content increasing with depth. - weakly cemented in pockets.						
9		- becoming dense from 0.6 m.		D	0.6			
	1							
8				D	1.6			
		- becoming mottled light brown from 1.8 m.						
	2							
		- becoming slightly clayey sand with some silt from 2.2 m. - becoming moist from 2.3 m.						
7				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

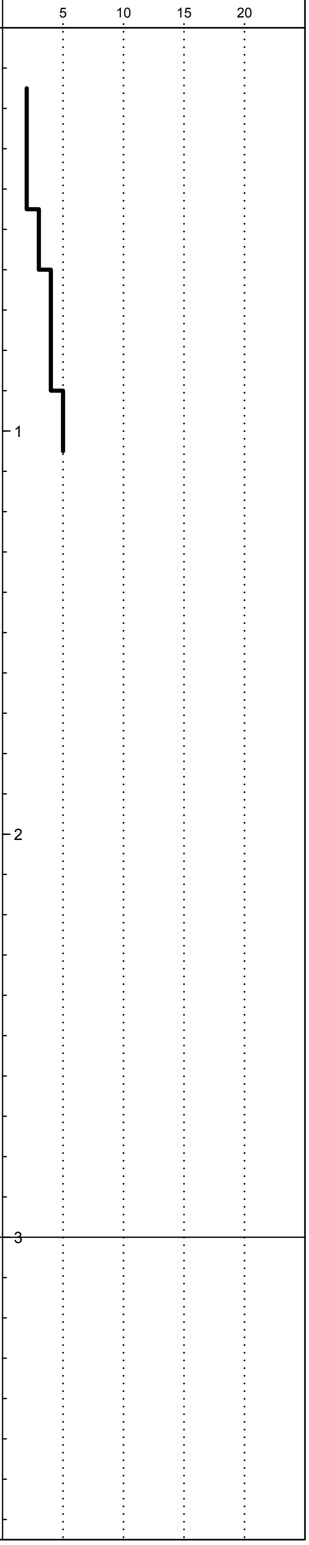
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666587
NORTHING: 7744098
DIP/AZIMUTH: 90°/--

PIT No: TP 25
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.25 m. - becoming red-brown, with a trace of clay from 0.3 m.						
9		- clay content increasing with depth.		D	0.4			
	1			U_{150}	1.0 1.2			
8		- becoming mottled light brown and moist from 1.5 m.		D	1.6			
	2	- becoming slightly clayey sand with some silt from 2.2 m.		U_{150}	2.1 2.3			
7				D	2.7			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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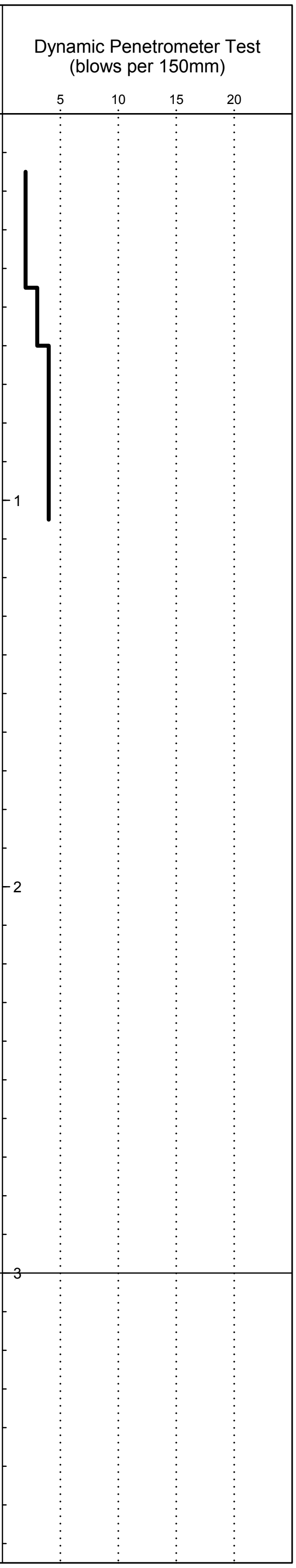
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666538
NORTHING: 7744157
DIP/AZIMUTH: 90°/--

PIT No: TP 26
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9								
		- with a trace of rootlets to 0.25 m. - becoming red-brown from 0.3 m.						
				D	0.4			
				D	0.8			
	1	- becoming dry to moist from 1.5 m.						
8								
		- becoming slightly clayey sand with some silt and moist from 1.5 m.						
				D	1.8			
	2							
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								


Dynamic Penetrometer Test (blows per 150mm)

RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

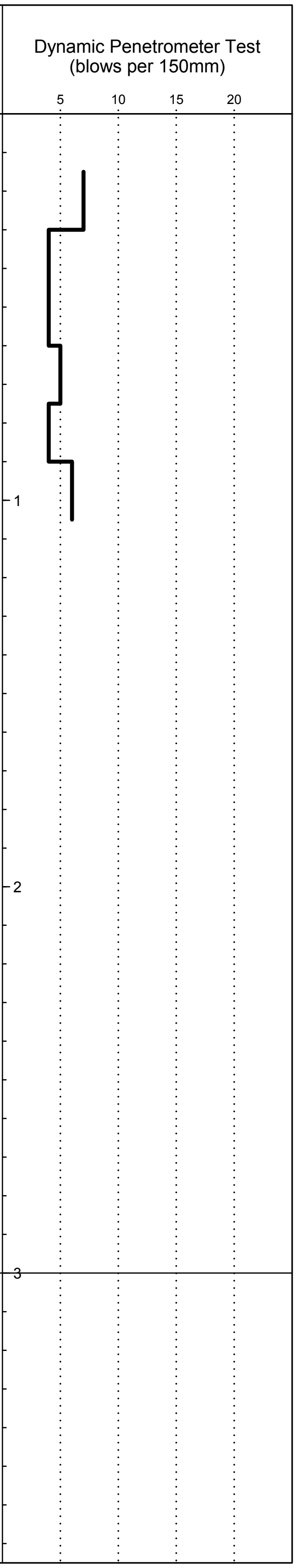
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.8 m AHD*
EASTING: 666484
NORTHING: 7744212
DIP/AZIMUTH: 90°/--

PIT No: TP 27
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - dense, brown, fine to medium grained sand with some silt, dry.						
		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.25 m.						
		- becoming medium dense from 0.45 m.						
		- becoming dry to moist from 0.3 m.						
		- with a trace of clay from 0.5 m.						
		- clay content increasing with depth.						
8				D	0.8			
	1							
		- with some clay and becoming moist from 1.2 m.						
		- becoming mottled light brown from 1.5 m.						
				D	1.6			
7								
	2	- becoming slightly clayey sand with some silt from 2.0 m.						
				D	2.2			
				D	2.7			
6								
	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

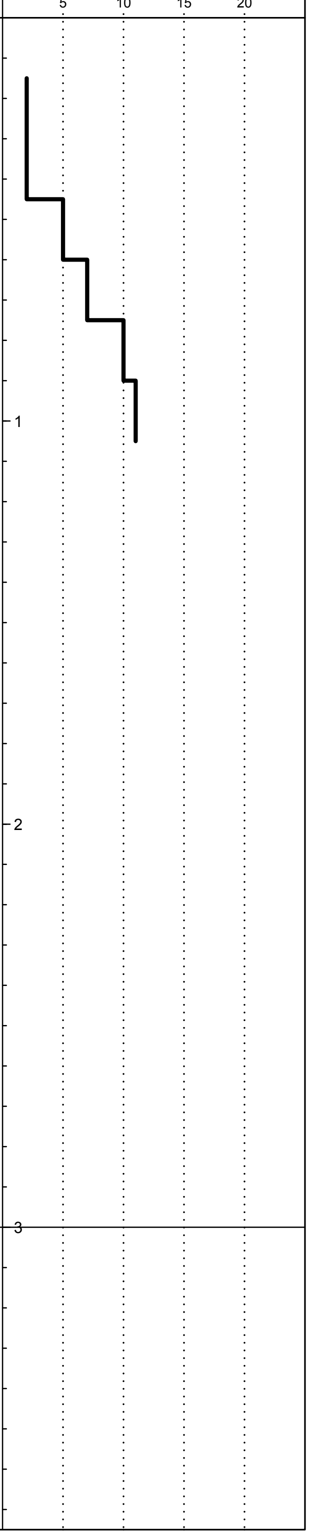
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666434
NORTHING: 7744282
DIP/AZIMUTH: 90°/--

PIT No: TP 28
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- with a trace of rootlets to 0.2 m. - becoming red-brown from 0.2 m.					
			B	0.4			
		- becoming dense from 0.45 m.					
		- becoming dry to moist from 0.8 m. - with a trace of clay from 0.8 m.					
8	1	- clay content increasing with depth.					
		- with some clay from 1.2 m.					
			D	1.5			
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.					
7	2						
			D	2.2			
6	3 3.0	Pit discontinued at 3.0m (Target)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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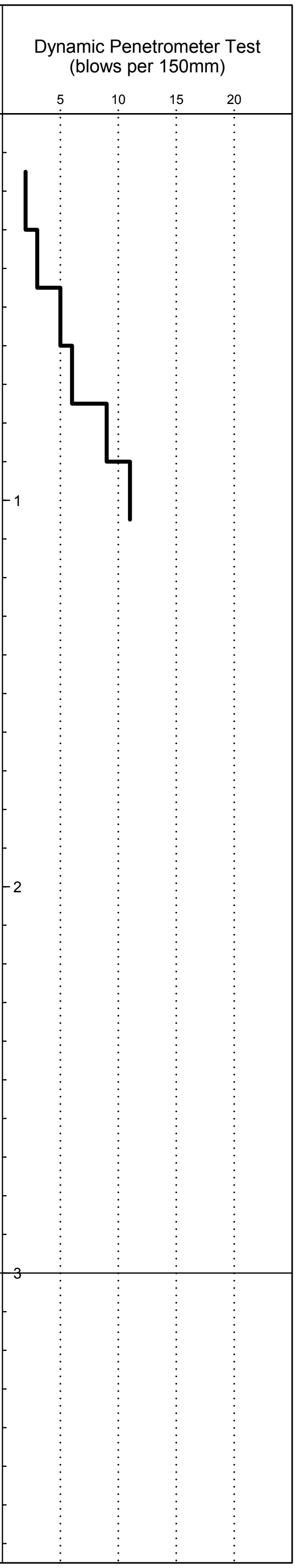
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666487
NORTHING: 7744328
DIP/AZIMUTH: 90°/--

PIT No: TP 29
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with some rootlets to 0.25 m. - becoming red-brown from 0.3 m. - becoming dry to moist from 0.4 m. - becoming dense from 0.75 m. - with a trace of clay from 0.8 m.					
8	1	- clay content increasing with depth. - with some clay from 1.5 m.	D	1.5			
7	2	- becoming mottled light brown, slightly clayey sand with some silt, fine sized gravel and moist from 1.9 m.					
	2.6	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with a trace of fine sized gravel, moist.	D	2.7			
6	3 3.0	Pit discontinued at 3.0m (Target)					



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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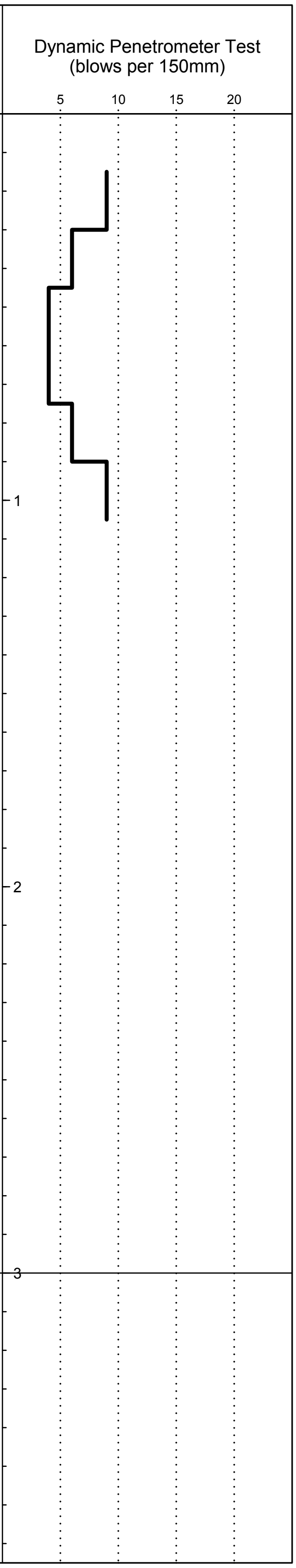
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666536
NORTHING: 7744274
DIP/AZIMUTH: 90°/--

PIT No: TP 30
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - dense, brown, fine to medium grained slightly silty sand, dry.						
9		- becoming red-brown from 0.25 m.						
		- becoming medium dense from 0.45 m.		D	0.5			
		- becoming dry to moist from 0.6 m.						
		- with a trace of clay from 0.7 m.						
		- clay content increasing with depth.						
	1							
8								
		- with some clay from 1.5 m.						
				D	1.7			
	2							
7		- becoming mottled light brown and moist from 2.3 m.						
		- becoming slightly clayey sand with some silt from 2.4 m.		D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

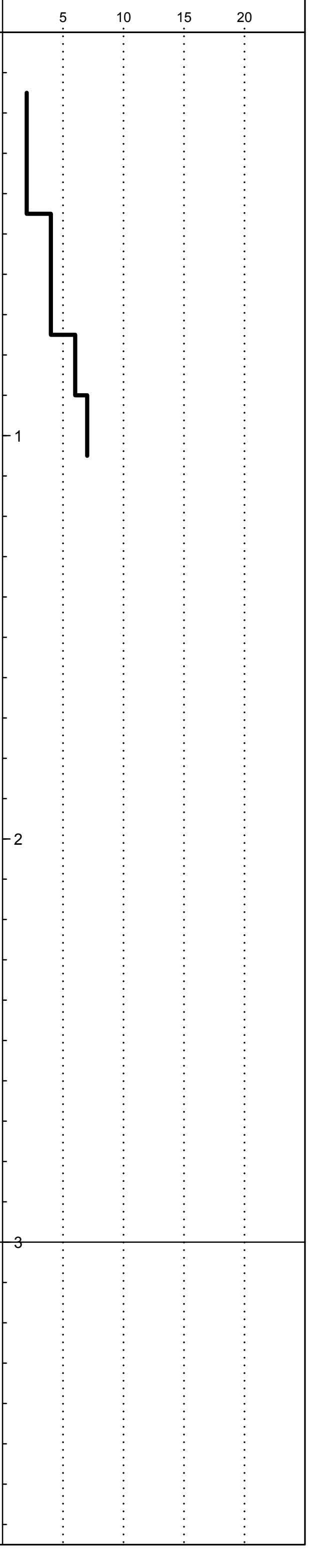
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666597
NORTHING: 7744213
DIP/AZIMUTH: 90°/--

PIT No: TP 31
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.25 m.						
		- with a trace of clay from 0.3 m.						
		- clay content increasing with depth.						
				D	0.6			
		- becoming dry to moist from 0.8 m.						
	1							
8								
				D	1.4			
		- becoming mottled light brown from 1.5 m.						
		- with some clay from 1.6 m.						
	2							
		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.0 m.		D	2.1			
7								
		- becoming moist to wet from 2.8 m.						
				D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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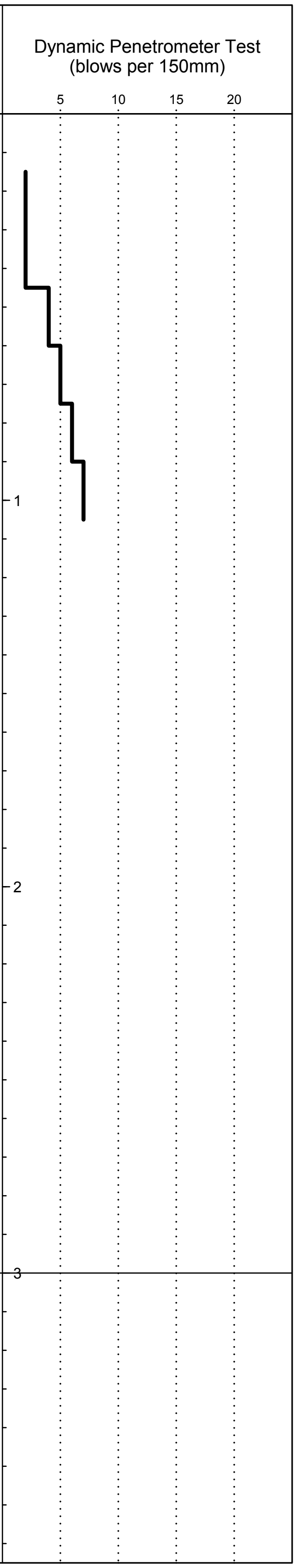
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666649
NORTHING: 7744150
DIP/AZIMUTH: 90°/--

PIT No: TP 32
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.6 m.						
	1	- with a trace of clay from 1.0 m.						
8		- clay content increasing with depth.						
		- becoming mottled light brown, with some clay and moist from 1.4 m.						
	2	- with some fine sized gravel from 2.0 m.						
7		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.2 m.		D	2.3			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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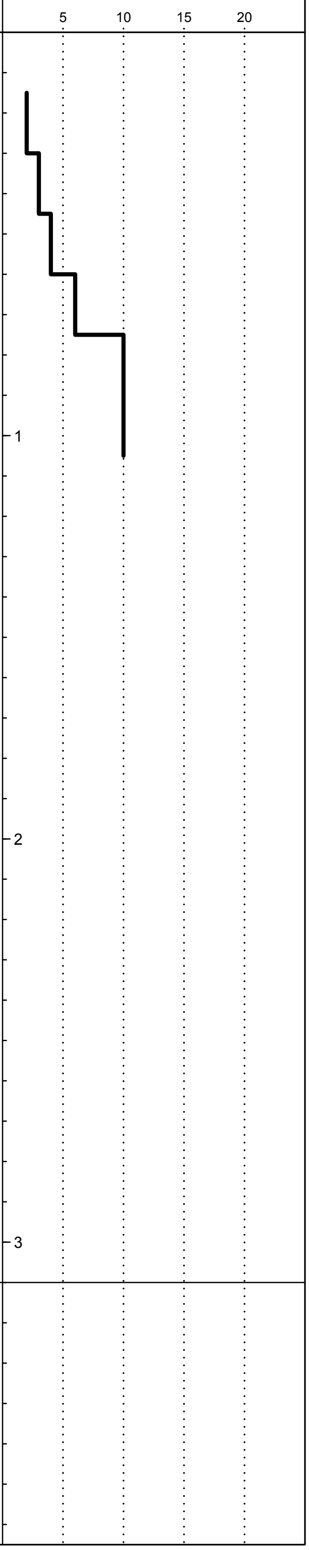
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666701
NORTHING: 7744095
DIP/AZIMUTH: 90°/--

PIT No: TP 33
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.							
		- becoming red-brown and dry to moist from 0.2 m.							
		- with a trace of rootlets to 0.25 m.		B	0.3				
		- weakly cemented in pockets.							
9									
		- becoming slightly silty sand with a trace of clay from 0.5 m.							
		- becoming dense from 0.75 m.							
	1								
				D	1.2				
8									
		- with some clay from 1.6 m.							
		- becoming mottled light brown from 1.9 m.							
	2								
		- becoming slightly clayey sand with some silt from 2.0 m.		D	2.1				
7									
	2.8	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, moist.		D	2.95				
	3								
	3.1	Pit discontinued at 3.1m (Target)							
6									



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

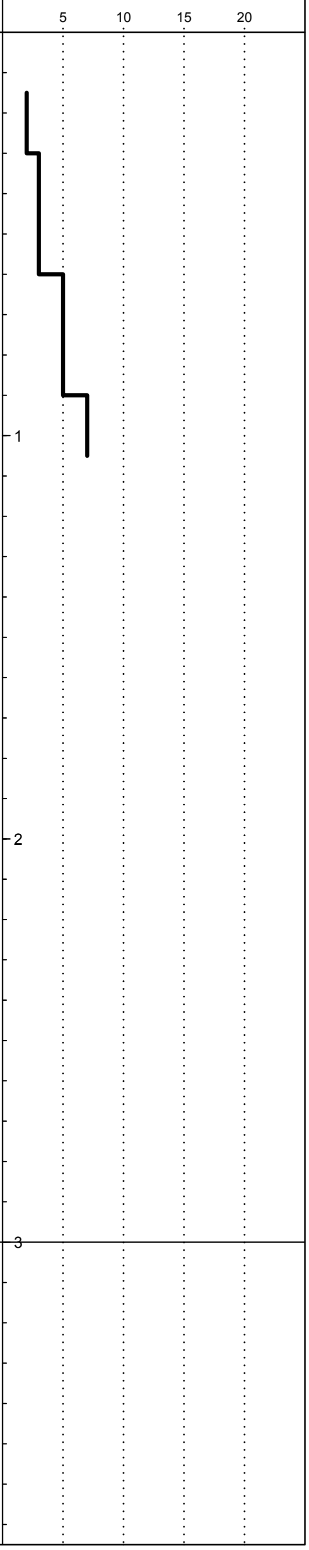
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666755
NORTHING: 7744037
DIP/AZIMUTH: 90°/--

PIT No: TP 34
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- weakly cemented in pockets.					
		- becoming red-brown and dry to moist from 0.2 m.					
		- with a trace of rootlets to 0.25 m.					
		- with some clay from 0.4 m.	D	0.4			
9		- clay content increasing with depth.					
	1		D	1.2			
8		- becoming slightly clayey sand with some silt from 1.5 m.					
	2	- becoming mottled brown from 2.0 m.					
			D	2.4			
7	2.8	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, moist.	D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)					
6							

Dynamic Penetrometer Test
(blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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TEST PIT LOG

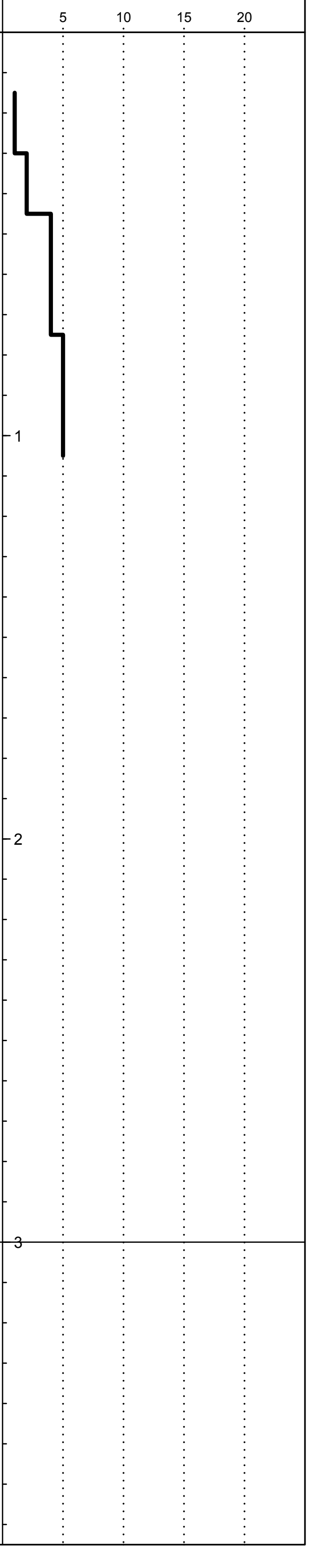
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666817
NORTHING: 7744088
DIP/AZIMUTH: 90°/--

PIT No: TP 35
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.						
		- with some rootlets to 0.3 m.						
9		- becoming red-brown and slightly silty sand from 0.4 m.						
		- becoming dry to moist from 0.5 m.						
	1	- with a trace of clay from 1.0 m.						
		- clay content increasing with depth.						
8		- with some clay and becoming moist from 1.5 m.						
				D	1.8			
	2	- becoming mottled brown from 2.0 m.						
7		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.5 m.						
				D	2.7			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test
(blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

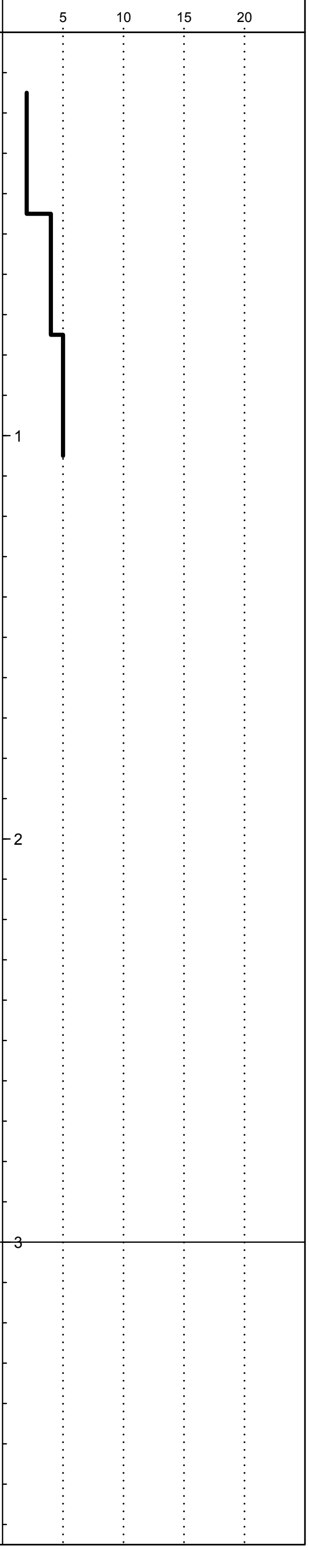
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666759
NORTHING: 7744147
DIP/AZIMUTH: 90°/--

PIT No: TP 36
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained sand with some silt, dry. - with a trace of rootlets to 0.2 m. - with a trace of clay and becoming red-brown and dry to moist from 0.25 m. - clay content increasing with depth.						
				D	0.7			
8	1	- with some clay from 1.0 m.						
		- becoming moist from 1.6 m. - becoming mottled light brown from 1.8 m.						
7	2	- becoming slightly clayey sand with some silt from 2.0 m.						
				D	2.2			
	2.7	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, moist to wet.		D	2.9			
6	3 3.0	Pit discontinued at 3.0m (Target)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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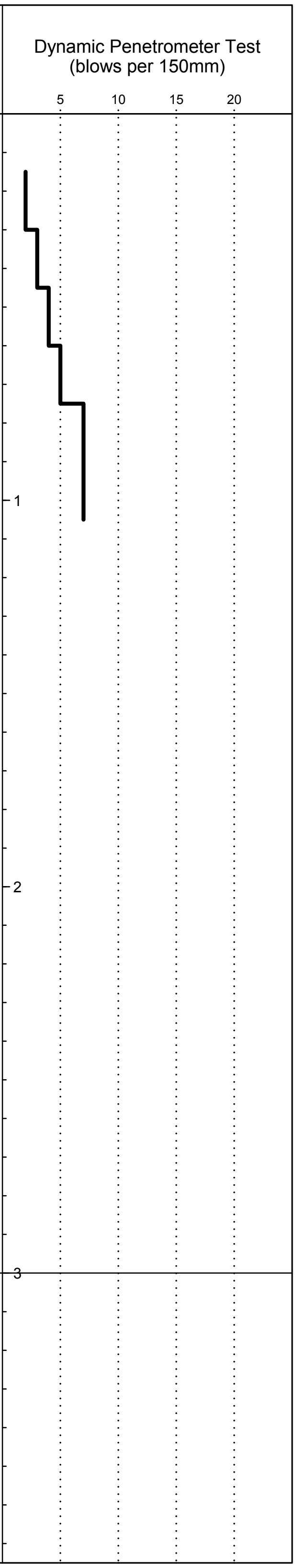
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666711
NORTHING: 7744206
DIP/AZIMUTH: 90°/--

PIT No: TP 37
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.25 m. - with a trace of clay and becoming red-brown and dry to moist from 0.25 m. - clay content increasing with depth.						
				D	0.7			
	1							
8								
		- becoming moist from 1.4 m.		D	1.4			
		- becoming mottled light brown from 1.8 m.						
	2			D	2.0			
7								
		- becoming slightly clayey sand with some silt from 2.2 m.						
				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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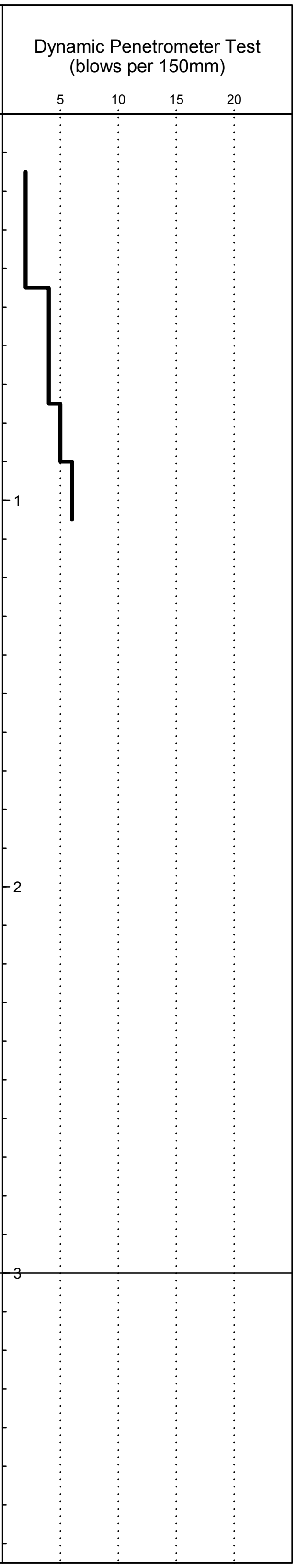
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666654
NORTHING: 7744266
DIP/AZIMUTH: 90°/--

PIT No: TP 38
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets and a trace of roots to 0.3 m.						
		- becoming red-brown from 0.35 m.						
		- becoming dry to moist from 0.5 m.						
8	1	- with a trace of clay from 1.0 m.						
		- becoming mottled light brown from 1.8 m.						
7	2	- becoming slightly clayey sand with some silt from 2.0 m.						
				D	2.1			
				D	2.8			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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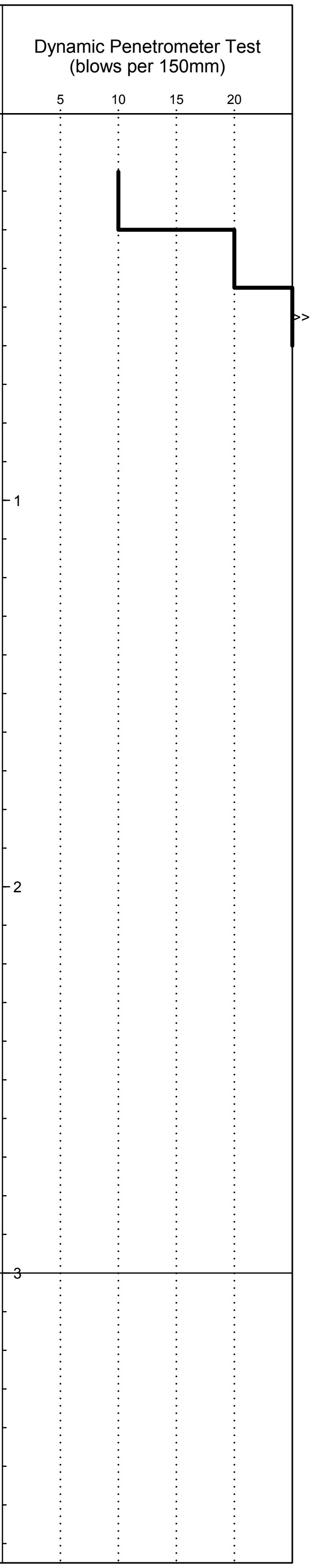
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666599
NORTHING: 7744320
DIP/AZIMUTH: 90°/--

PIT No: TP 39
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.1 m.						
		- weakly cemented in pockets to 0.5 m. - becoming dry to moist from 0.5 m.						
		- with a trace of clay from 0.8 m.		D	0.9			
8	1	- clay content increasing with depth.						
7	2	- becoming mottled light brown and black, slightly clayey sand with some silt and a trace of fine sized gravel from 2.0 m.		D	2.1			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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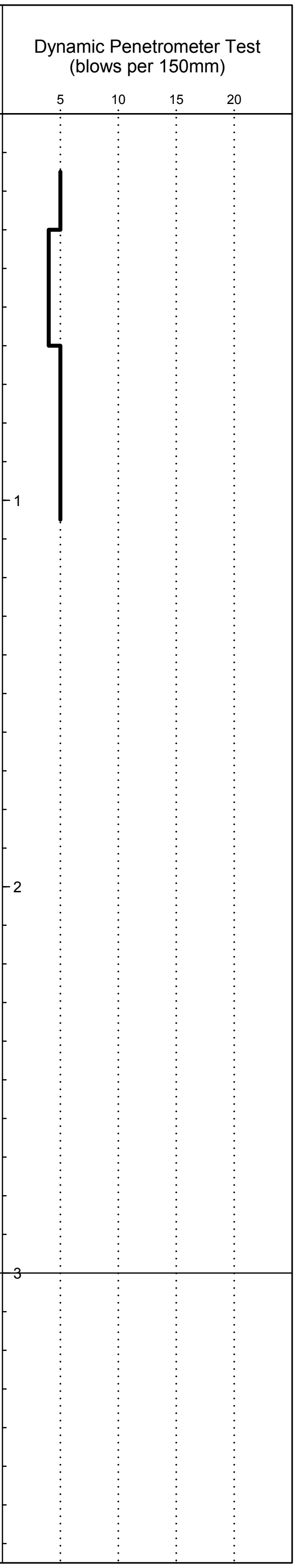
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.9 m AHD*
EASTING: 666550
NORTHING: 7744378
DIP/AZIMUTH: 90°/--

PIT No: TP 40
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.25 m.						
		- becoming dry to moist from 0.4 m.		D	0.4			
		- with a trace of clay from 0.5 m.						
		- clay content increasing with depth.						
8								
	1							
		- becoming moist from 1.2 m.						
		- with some clay and a trace of fine sized gravel from 1.3 m.		D	1.4			
7								
	2	- becoming mottled light brown from 2.1 m.						
		- becoming slightly clayey sand with some silt from 2.2 m.						
				D	2.5			
		- becoming moist to wet from 2.8 m.						
6								
	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

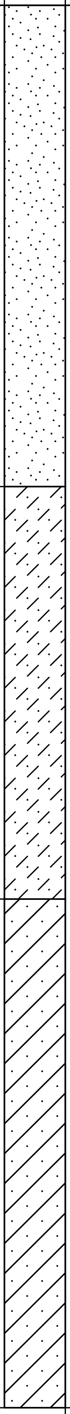
BOREHOLE LOG

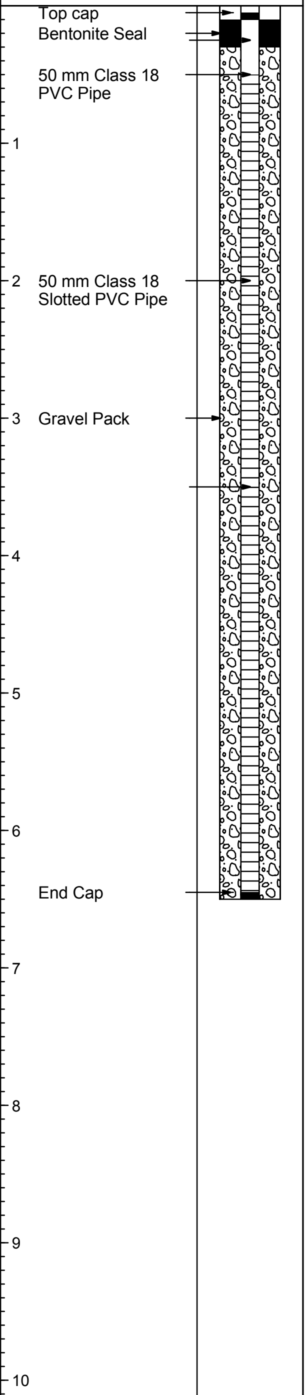
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 10 m AHD*
EASTING: 666701
NORTHING: 7743966
DIP/AZIMUTH: 90°/--

BORE No: MB 41
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
10		SAND - red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to moist from 0.5 m. - with some clay and becoming moist from 1.5 m. - becoming slightly clayey sand with some silt from 2.0 m.					07-08-11	Top cap Bentonite Seal 50 mm Class 18 PVC Pipe 2 50 mm Class 18 Slotted PVC Pipe 3 Gravel Pack
	3.5	CLAYEY SAND - red-brown, fine to medium grained clayey sand, with some silt, moist. - with some medium sized white gravel at 0.55 m. - possible small lens of rock.						
	6.5	SANDY CLAY - red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist. - possible thin rock layer at 8.0 m.						End Cap
0	10.2	Bore discontinued at 10.2m (Target)						





RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.135 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

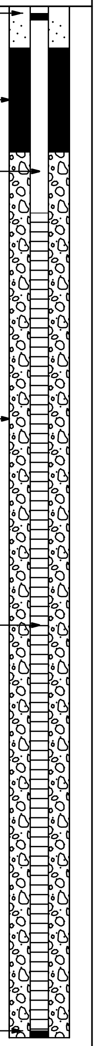
BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666116
NORTHING: 7744014
DIP/AZIMUTH: 90°/--

BORE No: MB 42
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
9		SAND - medium dense, red-brown, fine to medium grained, slightly silty sand, dry.							Top cap
		- becoming dry to moist from 0.5 m.							Bentonite Seal
8	1	- becoming moist from 1.0 m.							50 mm Class 18 PVC Pipe
		- becoming mottled light brown, slightly clayey sand with some silt from 1.5 m.		S	1.5 1.95		9,8,8 N = 16		
7	2								
6	3			S	3.0 3.45		5,7,10 N = 17	▼ 07-08-11	Gravel Pack
		- with some fine sized gravel from 3.5 m.							
5	4.0	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with some silt and a trace of fine sized gravel, dry to moist.							
				S	4.5 4.95		7,10,12 N = 22		50 mm Class 18 Slotted PVC Pipe
4	5								
3	6			S	6.0 6.45		7,10,9 N = 19		
2	6.8	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Dry to moist.							
				S	7.5 7.95		8,16,22 N = 38		End Cap
1	7.95	Bore discontinued at 7.95m (Target)							
0	9								
-1	10								



RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.155 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666179
NORTHING: 7743903
DIP/AZIMUTH: 90°/--

BORE No: BH 43
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry. - becoming dry to moist from 0.4 m. - with some clay from 1.5 m. - becoming slightly clayey sand with some silt and moist from 1.8 m.		S	1.5 1.95		6,7,11 N = 18		
	3.0	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt and fine to medium sized gravel, moist.		S	3.0 3.45		4,6,8 N = 14	07-08-11	
				S	4.5 4.95		6,6,12 N = 18		
				S	6.0 6.45		7,12,14 N = 26		
	6.5	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist.		S	7.5 7.95		9,13,23 N = 36		
	7.95	Bore discontinued at 7.95m (Target)							

RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.080 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666389
NORTHING: 7744129
DIP/AZIMUTH: 90°/--

BORE No: BH 44
PROJECT No: 76250
DATE: 7/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		SAND - medium dense, red-brown, fine to medium grained, slightly silty sand, dry.							
		- becoming dry to moist from 0.4 m.							
		- with some clay from 0.8 m.							
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.6 m.		S	1.5 1.95		3,5,8 N = 13		
								▼ 08-08-11	
				S	3.0 3.45		3,5,6 N = 11		
	3.5	CLAYEY SAND - dense to medium dense, red-brown mottled light grey, fine to medium grained clayey sand, with some silt, moist.							
		- with a trace of fine sized gravel from 4.5 m.		S	4.5 4.95		10,16,23 N = 39		
				S	6.0 6.45		7,10,13 N = 23		
	6.5	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Dry to moist.		S	7.5 7.8		18,R refusal 34 blows for 145 mm penetation		
	7.795	Bore discontinued at 7.8m (Target)							

RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 2.820 m on 8/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

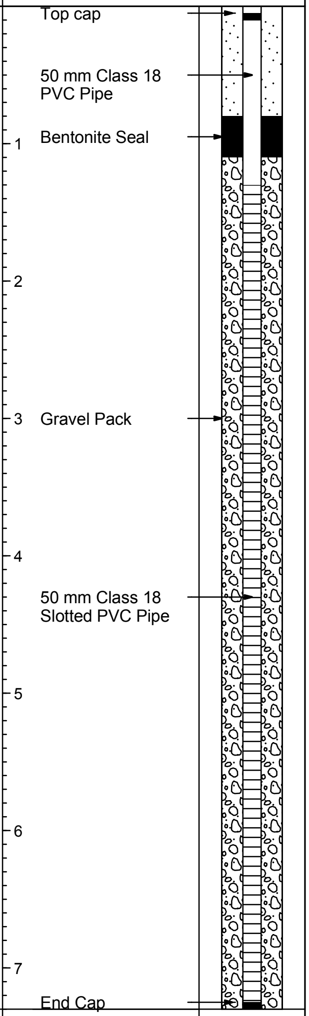
BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666553
NORTHING: 7744284
DIP/AZIMUTH: 90°/--

BORE No: MB 45
PROJECT No: 76250
DATE: 7/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.0	SAND - red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to most from 0.5 m. - with some clay from 1.2 m. - becoming slightly clayey sand with some silt from 2.2 m.					▼ 08-08-11 (3.13)
3.3	CLAYEY SAND - red-brown, fine to medium grained clayey sand, moist.					
5.5	SANDY CLAY - red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist.					
7.3	Bore discontinued at 7.3m (Target)					



RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.130 m on 8/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix B

Geotechnical Laboratory Testing

Sheet No: 1 of 1

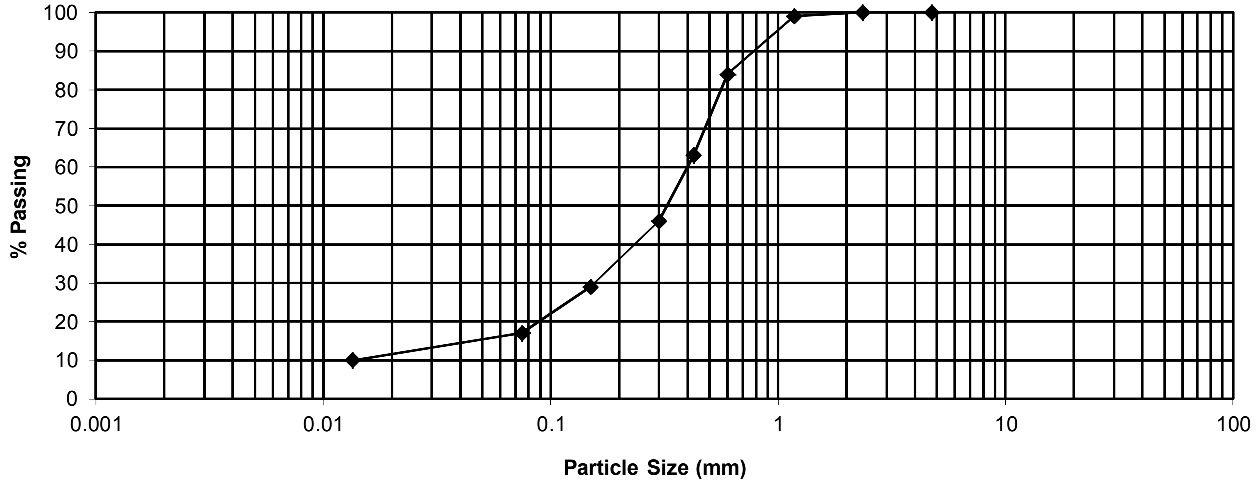
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2663
Sample No: P11/2663
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 1**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	84
0.425	63
0.300	46
0.150	29
0.075	17
0.0135	10

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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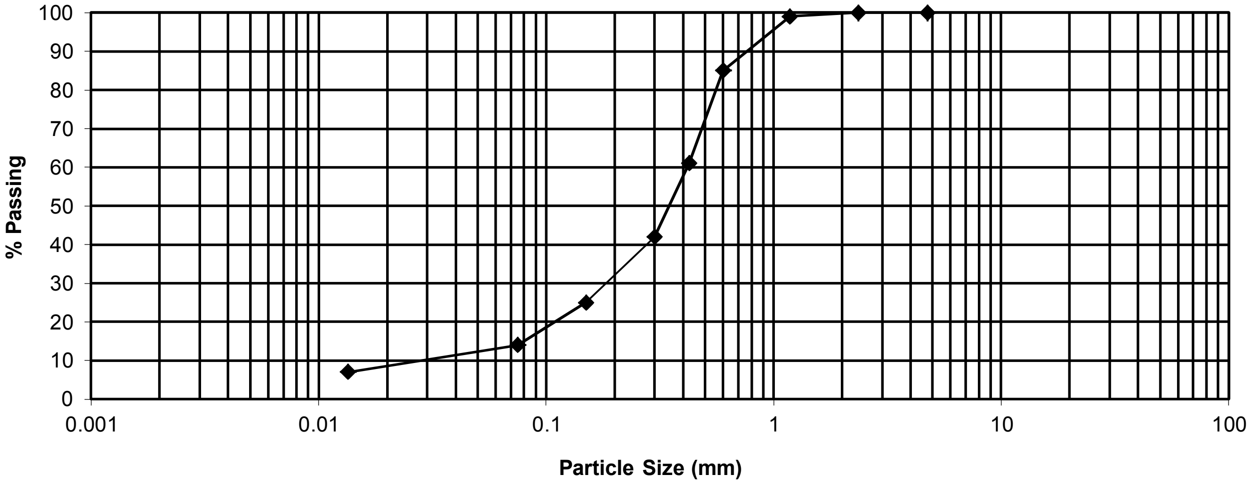
Kevin M Jones

Particle Size Distribution & Plasticity Index tests

Mining &
Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2664**
Sample No:	**P11/2664**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 2**
Project:	**Hamilton Precinct**	Depth (m):	**0.25**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	85
0.425	61
0.300	42
0.150	25
0.075	14
0.0135	7

SIC = Slipped in cup
NP = Non Plastic
***Non standard test as liquid limit was not determined.**
Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	SIC	%
Plastic limit 3.2.1	NP	%
Plasticity index 3.3.1	NP	%
Linear shrinkage 3.4.1	0.0*	%
Cracked	☐	
Curled	☐	

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

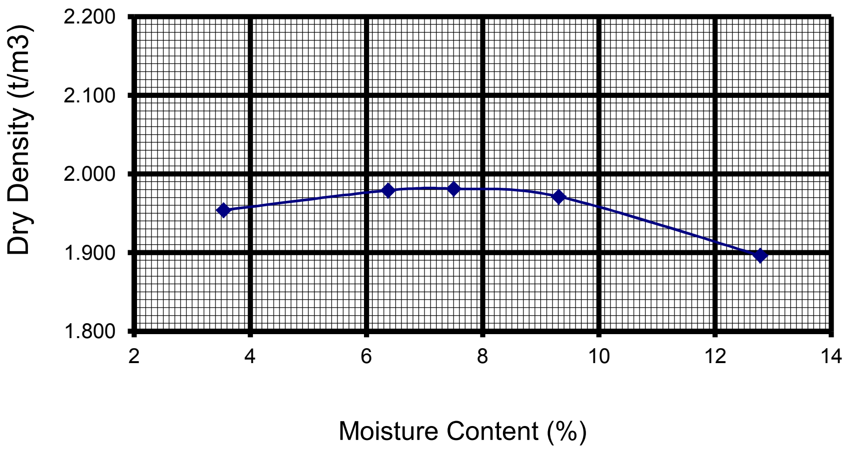
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) 9414 8022
Fax (08)9414 8011
Email kevin@mcgeotest.com.au

Sheet 2 of 2

Certificate No:	60017-P11/2664	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2664	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 2, 0.25m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.981	**Conditions at Test**	
Optimum Moisture Content %:	7.5	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	11.1
Mass of hammer kg	4.9	Entire Moisture Ratio %	148.1
Number of layers	5	Top 30mm Moisture Content %	10.6
Number of blows/layer	29	Top 30mm Moisture Ratio %	140.6
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.883	C.B.R. at 2.5 mm Penetration %	45
Moisture Content %	7.4	**Conditions after Soaking**	
Density Ratio %	95.1	Dry Density t/m^3	1.881
Moisture Ratio %	99.1	Moisture Content %	11.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	94.9
		Moisture Ratio %	151.9

Comments:



Client address: 36 O'Malley St, Osborne Park

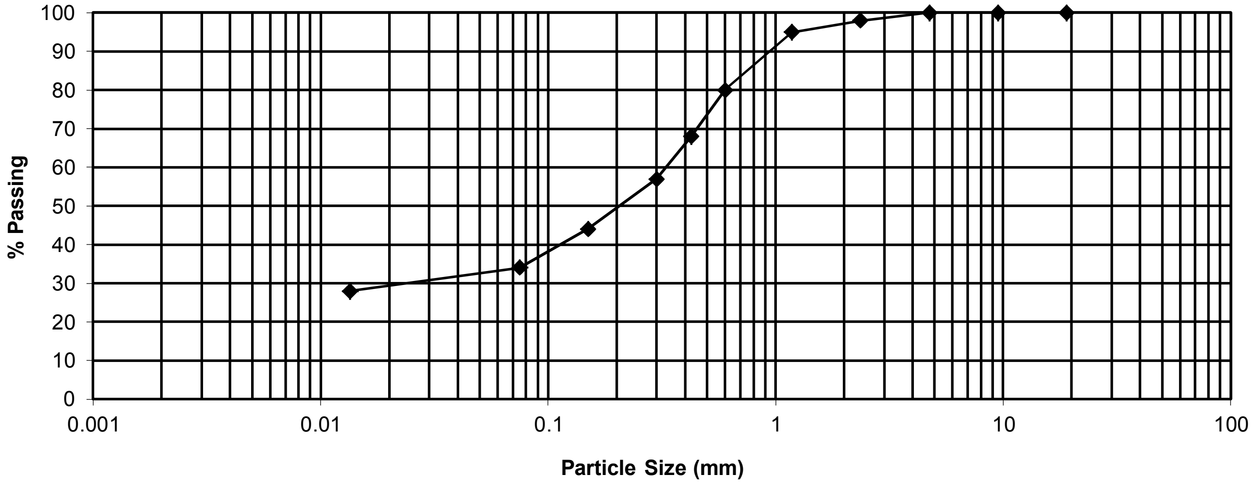
Approved Signature Kevin M Jones

Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2665**
Sample No:	**P11/2665**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 2**
Project:	**Hamilton Precinct**	Depth (m):	**1.9**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	98
1.18	95
0.600	80
0.425	68
0.300	57
0.150	44
0.075	34
0.0135	28

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	39	%
Plastic limit 3.2.1	14	%
Plasticity index 3.3.1	25	%
Linear shrinkage 3.4.1	9.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature

Kevin M Jones

Particle Size Distribution & Plasticity Index tests

**Mining &
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Geotest Pty Ltd**
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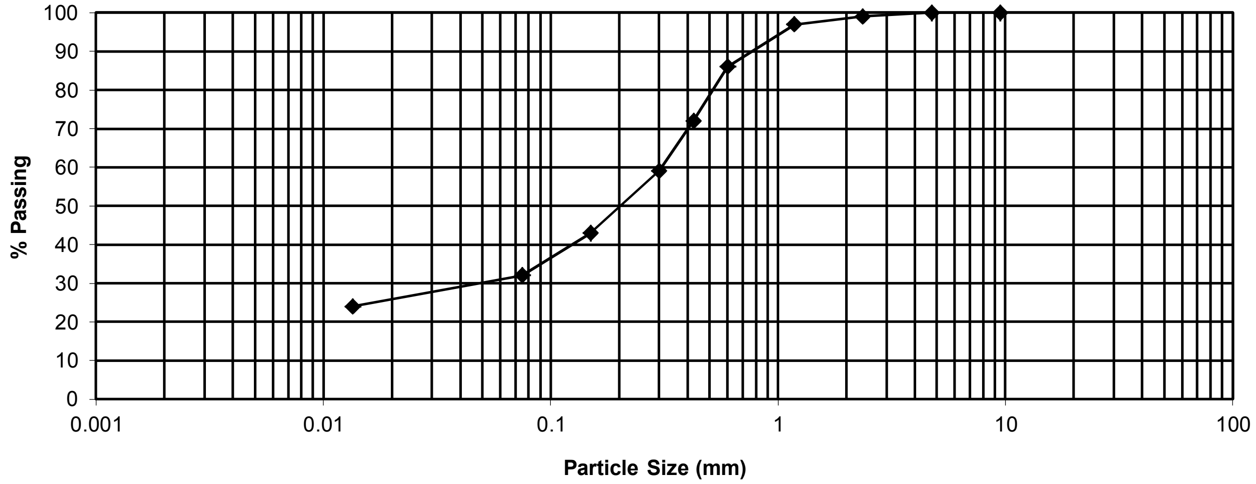
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2666**
Sample No:	**P11/2666**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 2**
Project:	**Hamilton Precinct**	Depth (m):	**2.5**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	97
0.600	86
0.425	72
0.300	59
0.150	43
0.075	32
0.0135	24

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	32	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	19	%
Linear shrinkage 3.4.1	5.0	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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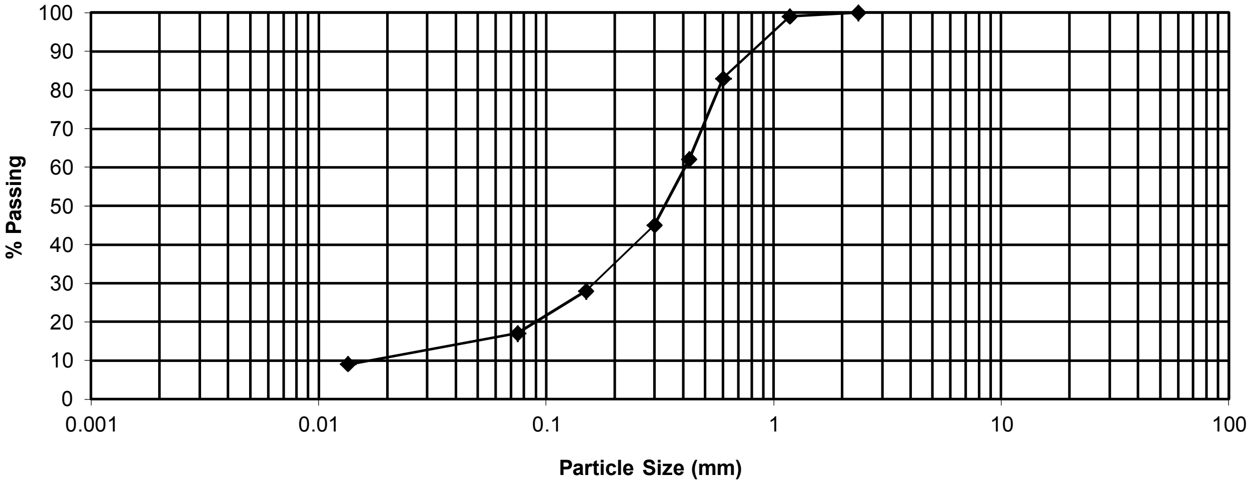
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2667
Sample No: P11/2667
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **TP 12**
Depth (m): **0.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	99
0.600	83
0.425	62
0.300	45
0.150	28
0.075	17
0.0135	9

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Mining &
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Geotest Pty Ltd

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

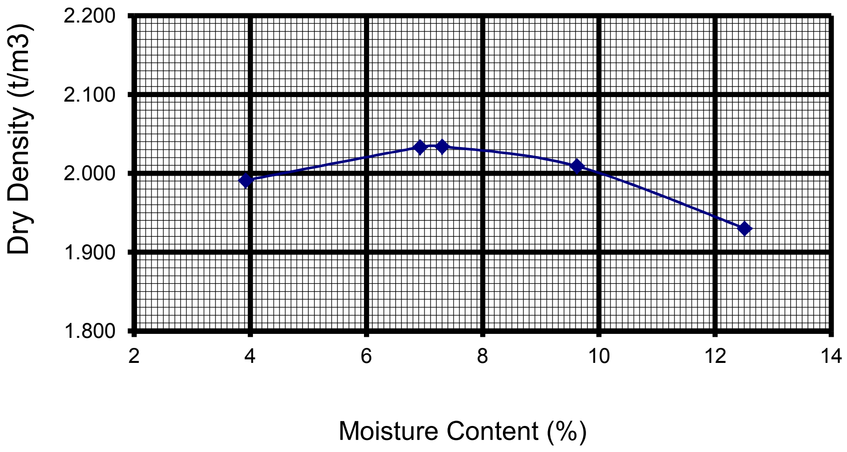
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) 9414 8022
Fax (08)9414 8011
Email kevin@mcgeotest.com.au

Sheet 2 of 2

Certificate No:	60017-P11/2667	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2667	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 12, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	2.034	**Conditions at Test**	
Optimum Moisture Content %:	7.3	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	9.8
Mass of hammer kg	4.9	Entire Moisture Ratio %	133.6
Number of layers	5	Top 30mm Moisture Content %	9.9
Number of blows/layer	30	Top 30mm Moisture Ratio %	135.9
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.937	C.B.R. at 2.5 mm Penetration %	60
Moisture Content %	7.2	**Conditions after Soaking**	
Density Ratio %	95.2	Dry Density t/m^3	1.936
Moisture Ratio %	98.8	Moisture Content %	10.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.2
		Moisture Ratio %	142.5

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

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Sheet No: 1 of 1

Particle Size Distribution & Plasticity Index tests

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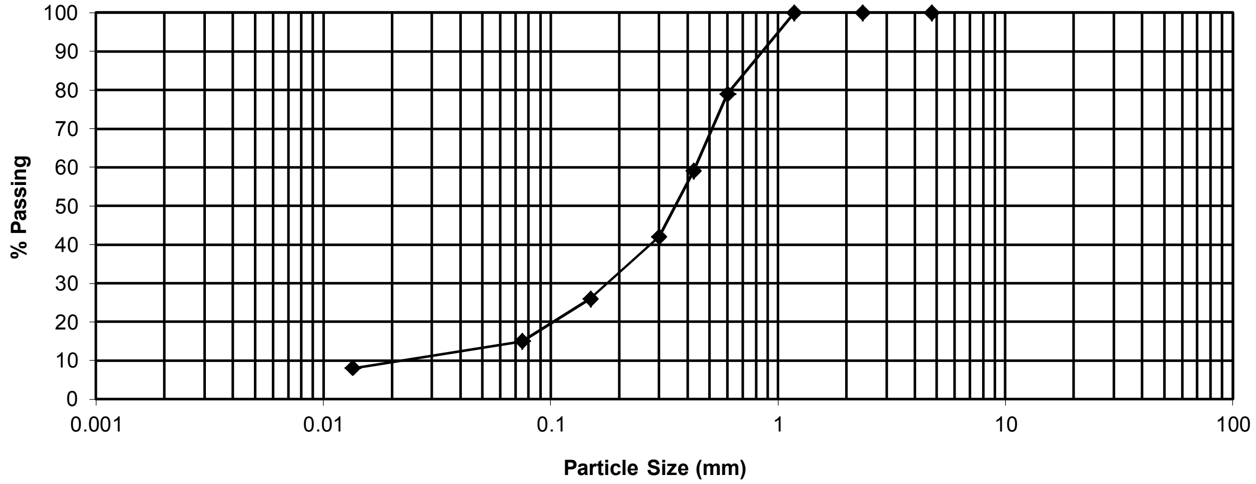
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: **60017**
Report No: **60017-P11/2668**
Sample No: **P11/2668**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **TP 16**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	79
0.425	59
0.300	42
0.150	26
0.075	15
0.0135	8

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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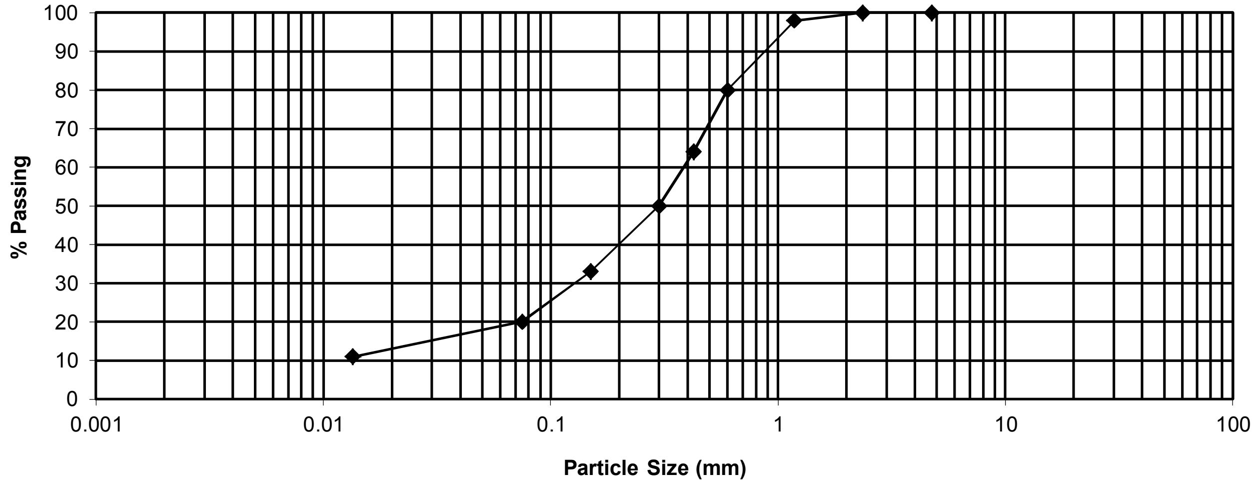
Email: kevin@mcgeotest.com.au

Job No: **60017**
Report No: **60017-P11/2669**
Sample No: **P11/2669**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 21**
Depth (m): **0.6**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	98
0.600	80
0.425	64
0.300	50
0.150	33
0.075	20
0.0135	11

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	18	%
Plastic limit 3.2.1	14	%
Plasticity index 3.3.1	4	%
Linear shrinkage 3.4.1	1.0	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature

Kevin M Jones

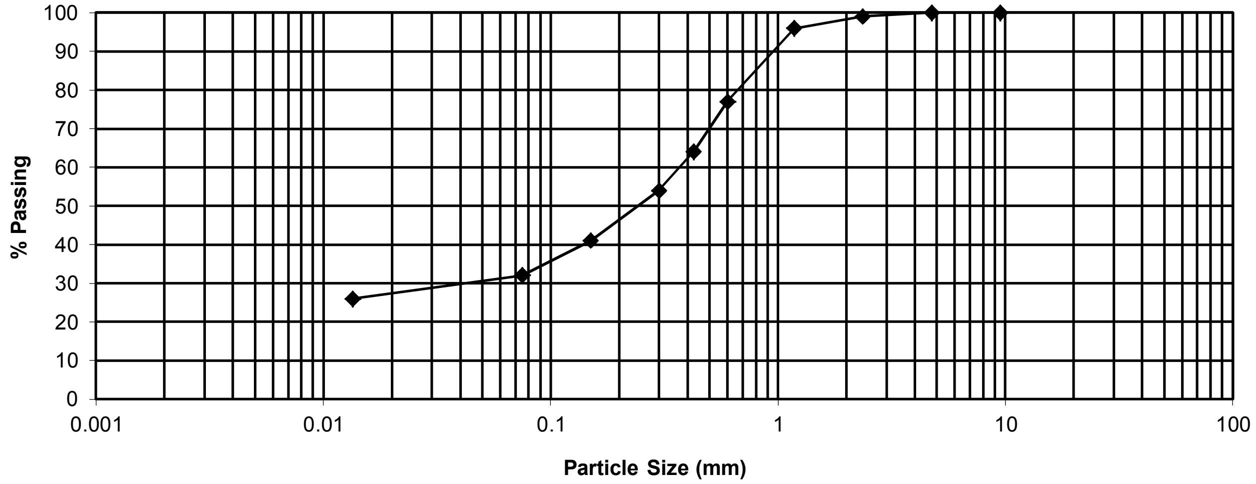
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2670
Sample No: P11/2670
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 21**
Depth (m): **2.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	96
0.600	77
0.425	64
0.300	54
0.150	41
0.075	32
0.0135	26

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	36	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	23	%
Linear shrinkage 3.4.1	7.0	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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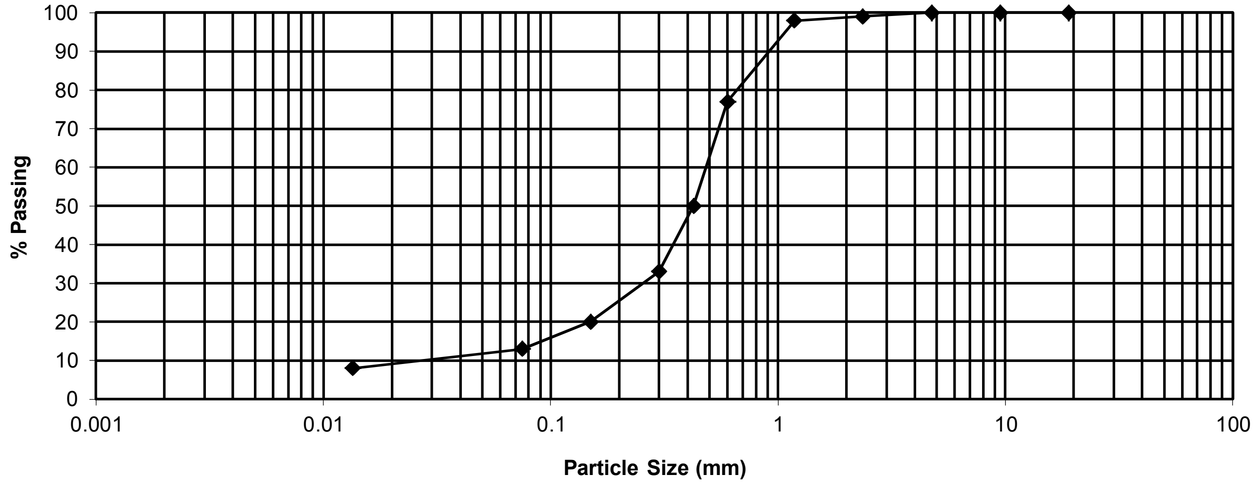
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2671
Sample No: P11/2671
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 23**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	99
1.18	98
0.600	77
0.425	50
0.300	33
0.150	20
0.075	13
0.0135	8

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Kevin M Jones

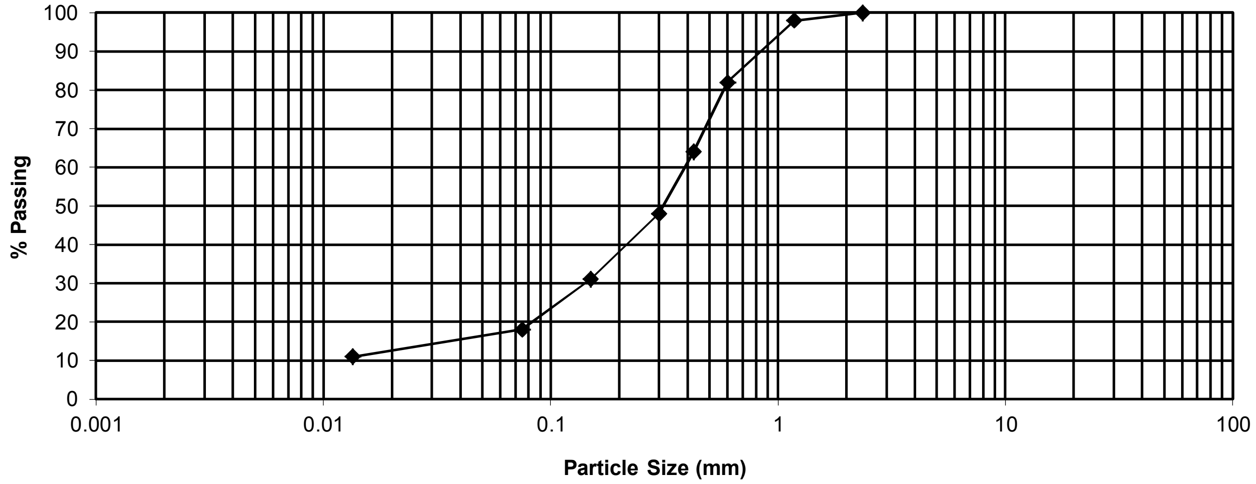
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2672**
Sample No:	**P11/2672**
Issue Date:	**24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 28**
Depth (m): **0.4**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	82
0.425	64
0.300	48
0.150	31
0.075	18
0.0135	11

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	17	%
Plastic limit 3.2.1	15	%
Plasticity index 3.3.1	2	%
Linear shrinkage 3.4.1	1.0	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Mining &
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Maximum Dry Density (AS 1289.5.2.1) &
California Bearing Ratio (AS 1289.6.1.1)
Test Report

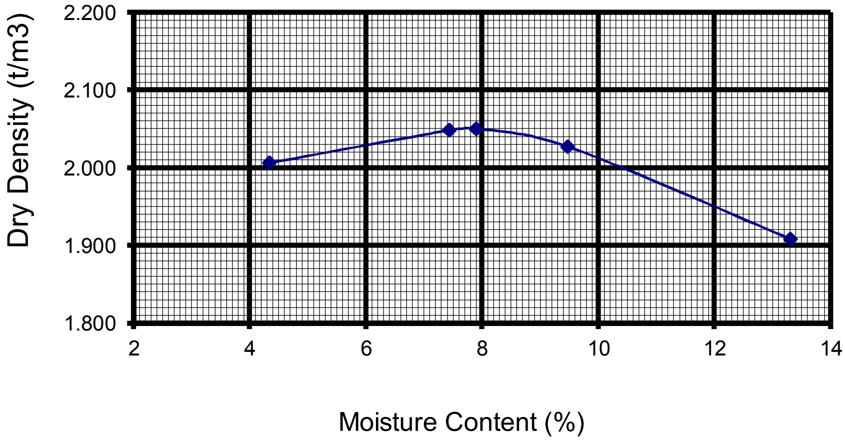
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) 9414 8022
Fax (08)9414 8011
Email kevin@mcgeotest.com.au

Sheet 2 of 2

Certificate No:	60017-P11/2672	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2672	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 28, 0.4m	**Job No:**	60017

Maximum Dry Density t/m^3:	2.050	**Conditions at Test**	
Optimum Moisture Content %:	7.9	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	9.0
Mass of hammer kg	4.9	Entire Moisture Ratio %	114.4
Number of layers	5	Top 30mm Moisture Content %	8.8
Number of blows/layer	25	Top 30mm Moisture Ratio %	111.7
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.951	C.B.R. at 5.0 mm Penetration %	70
Moisture Content %	7.8	**Conditions after Soaking**	
Density Ratio %	95.2	Dry Density t/m^3	1.950
Moisture Ratio %	98.4	Moisture Content %	10.3
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.1
		Moisture Ratio %	130.4

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

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Particle Size Distribution & Plasticity Index tests

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unit1/1 Pusey Road, Jandakot, WA 6164
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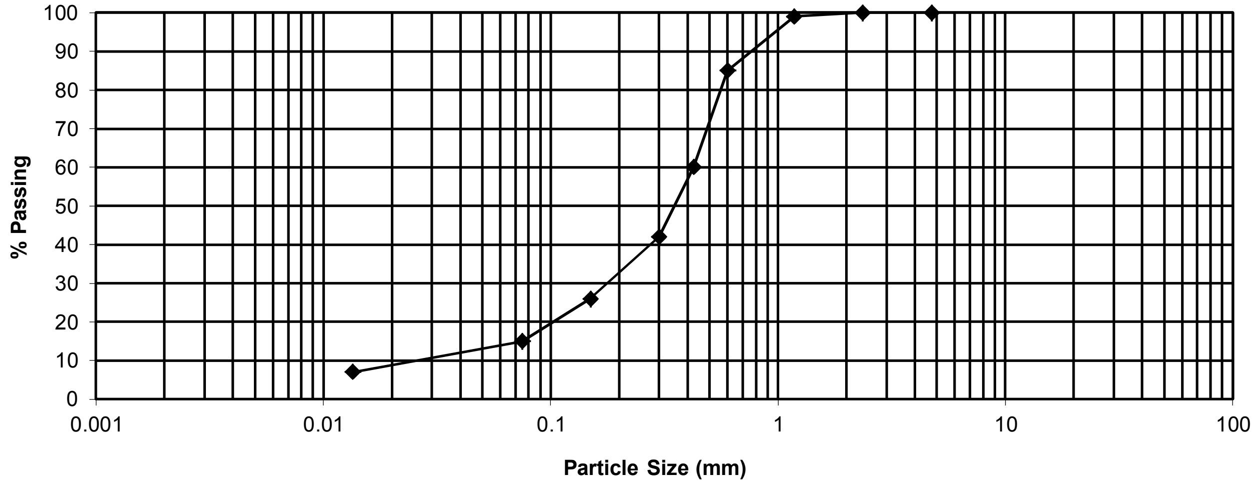
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2673**
Sample No:	**P11/2673**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 30**
Project:	**Hamilton Precinct**	Depth (m):	**0.5**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	85
0.425	60
0.300	42
0.150	26
0.075	15
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

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Kevin M Jones

Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
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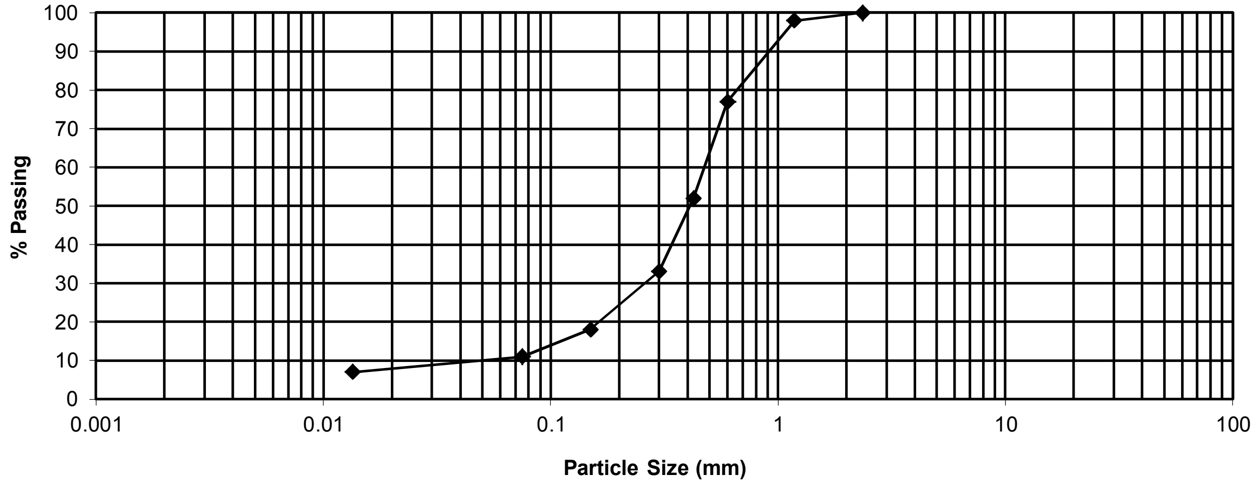
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2674**
Sample No:	**P11/2674**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 33**
Project:	**Hamilton Precinct**	Depth (m):	**0.3**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	77
0.425	52
0.300	33
0.150	18
0.075	11
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Kevin M Jones

Mining &
Civil
Geotest Pty Ltd

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

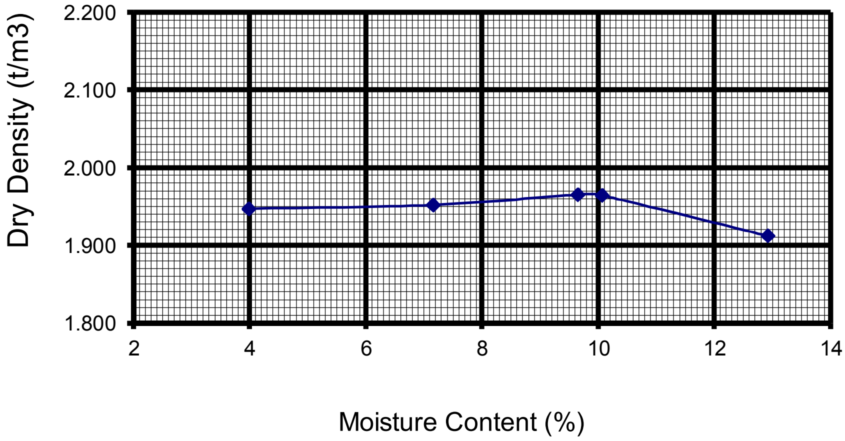
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) 9414 8022
Fax (08)9414 8011
Email kevin@mcgeotest.com.au

Sheet 2 of 2

Certificate No:	60017-P11/2674	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2674	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 33, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.965	**Conditions at Test**	
Optimum Moisture Content %:	9.6	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	10.8
Mass of hammer kg	4.9	Entire Moisture Ratio %	112.5
Number of layers	5	Top 30mm Moisture Content %	10.2
Number of blows/layer	26	Top 30mm Moisture Ratio %	105.7
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.864	C.B.R. at 5.0 mm Penetration %	50
Moisture Content %	9.3	**Conditions after Soaking**	
Density Ratio %	94.9	Dry Density t/m^3	1.863
Moisture Ratio %	96.7	Moisture Content %	11.7
Soaked / Unsoaked	Soaked	Dry Density Ratio %	94.8
		Moisture Ratio %	121.4

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

Approved Signature Kevin M Jones

Sheet No: 1 of 1

Particle Size Distribution & Plasticity Index tests

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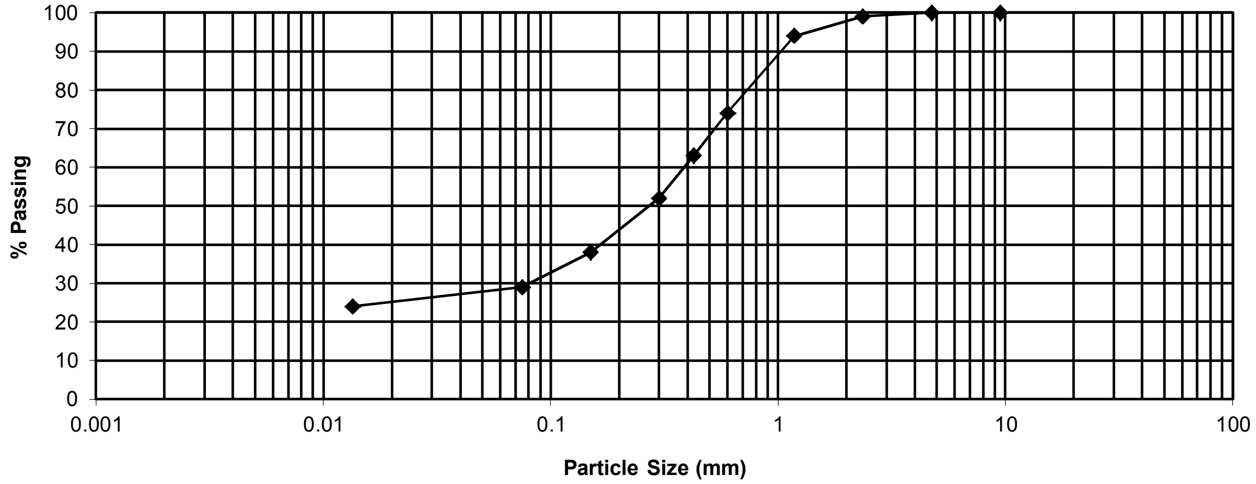
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2675**
Sample No:	**P11/2675**
Issue Date:	**29 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 33**
Project:	**Hamilton Precinct**	Depth (m):	**2.1**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	94
0.600	74
0.425	63
0.300	52
0.150	38
0.075	29
0.0135	24

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	28	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	15	%
Linear shrinkage 3.4.1	7.0	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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WA PSD PI April 2009

Particle Size Distribution & Plasticity Index tests

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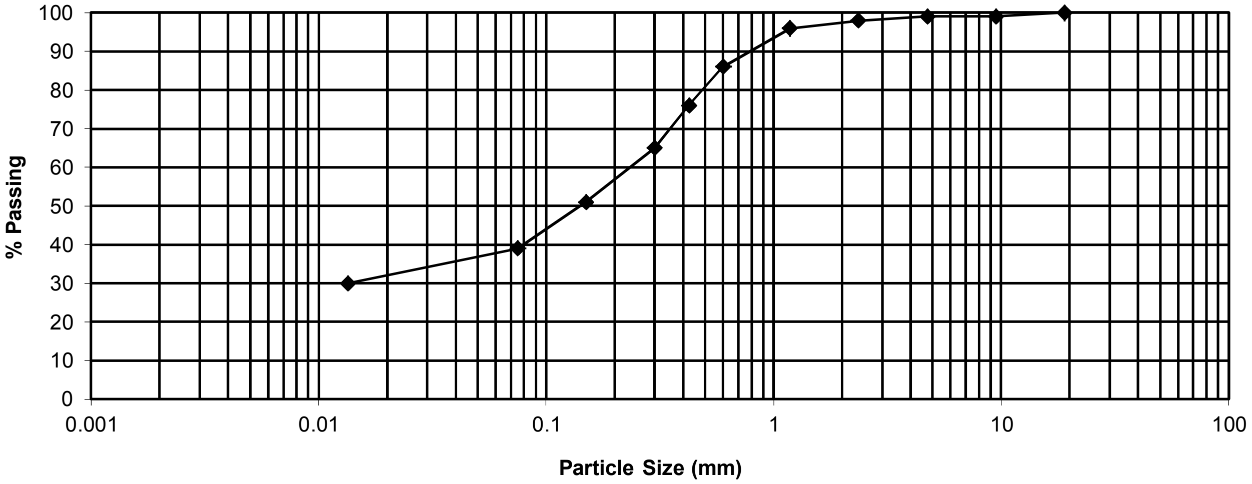
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2676**
Sample No:	**P11/2676**
Issue Date:	**29 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **MB 42**
Depth (m): **6.00 - 6.45**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	98
1.18	96
0.600	86
0.425	76
0.300	65
0.150	51
0.075	39
0.0135	30

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	35	%
Plastic limit 3.2.1	15	%
Plasticity index 3.3.1	20	%
Linear shrinkage 3.4.1	7.0	%

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Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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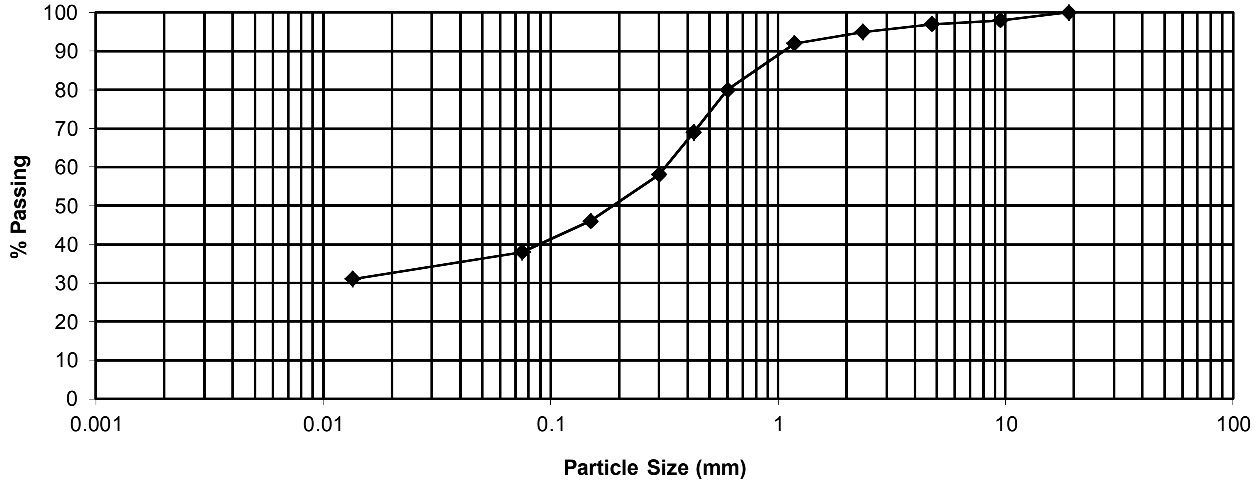
Job No: 60017
Report No: 60017-P11/2677
Sample No: P11/2677
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **BH 43**
Depth (m): **4.50 - 4.95**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	97
2.36	95
1.18	92
0.600	80
0.425	69
0.300	58
0.150	46
0.075	38
0.0135	31

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	39	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	26	%
Linear shrinkage 3.4.1	10.5	%
Cracked	☐	
Curled	☑	

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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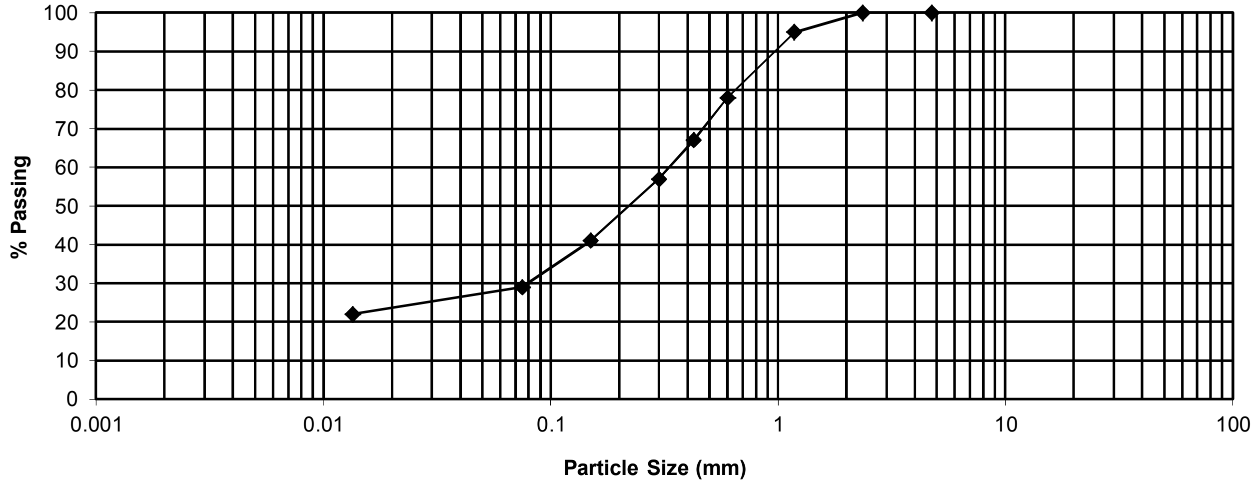
Job No: **60017**
Report No: **60017-P11/2678**
Sample No: **P11/2678**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **BH 44**
Depth (m): **6.00 - 6.45**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	95
0.600	78
0.425	67
0.300	57
0.150	41
0.075	29
0.0135	22

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	33	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	20	%
Linear shrinkage 3.4.1	7.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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APPENDIX 3

TRAFFIC REPORT

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NS Projects

Hamilton Precinct, South Hedland

Transport Assessment

222098-00

Final v3 | March 2012

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
11 Harvest Terrace
West Perth
WA 6005
Australia
arup.com.au

Job number 222098-00

ARUP

Document Verification

ARUP

Job title	Hamilton Precinct, South Hedland	Job number 222098-00	
Document title	Transport Assessment	File reference	
Document ref	222098-00		

Revision	Date	Filename	0001Report_Hamilton Precinct Transport Assessment_DRAFT		
Draft 1	03/11/11	Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Christie McKinnon/ Ryan Falconer	Darryl Patterson	Allan Mason
		Signature			
Final Draft	17/11/11	Filename	0002Report_Hamilton Precinct Transport Assessment_FINAL DRAFT		
		Description	Final draft		
			Prepared by	Checked by	Approved by
		Name	Christie McKinnon/ Ryan Falconer	Darryl Patterson	Allan Mason
		Signature			
Final	18/11/11	Filename	0003Report_Hamilton Precinct Transport Assessment_FINAL		
		Description	Final		
			Prepared by	Checked by	Approved by
		Name	Christie McKinnon/ Ryan Falconer	Darryl Patterson	Allan Mason
		Signature			
Final v2	02/02/12	Filename	0004Report_Hamilton Precinct Transport Assessment_FINALv2		
		Description	Final (minor revisions)		
			Prepared by	Checked by	Approved by
		Name	Ryan Falconer		
		Signature			
Final v3	28/03/12	Filename	0005Report_Hamilton Precinct Transport Assessment_FINALv3		
		Description	Final (minor revisions)		
			Prepared by	Checked by	Approved by
		Name	Ryan Falconer		

		Signature			

Issue Document Verification with Document ☑

Contents

Executive Summary

This Transport Assessment Report has been prepared to assess the traffic and transport implications of a 440 dwelling subdivision in South Hedland, Western Australia. This development, hereafter referred to as the 'Hamilton Precinct', is to occur on unallocated crown land abutting to North Circular Road and Hamilton Road, and undeveloped land to the north. The development is proposed to be completed by the fourth quarter of 2013.

The key assumptions applied in and findings of the Report are as follows:

- Traffic generation for the site has been determined using first principles and engineering judgement and validated through a comparison with recent (relevant) residential traffic count data. Assumptions regarding dwelling yield and occupancy has been provided by other members of the project team
- The forecast traffic generation from the 440 dwelling development is expected to be approximately 3,828 vehicles per day. Approximately 10% of development traffic is forecast to be generated in the PM peak hour and about 8% in the AM peak hour, corresponding to 383 and 306 trips, respectively
- Traffic was assigned to the internal and external network by applying assumptions regarding external distribution and using a basic spreadsheet assignment model
- Background traffic volumes on the existing external network (specifically Hamilton Road and North Circular Road) are forecast to grow by 25% between 2011 and 2016. Arup has derived a *per annum* growth rate and applied this to spot count data collected at key locations during the PM peak hour. Background traffic was also forecast for 2018 and 2021 based on growth assumptions provided by AECOM
- The assessment of key intersections using SIDRA software related to the PM peak hour on the basis that background traffic is about 30% higher in the PM compared to the AM peak hour. This means that opposing flows on external streets will be highest in the PM peak hour. Some additional sensitivity testing was conducted applying the higher oppositional flows on the external network expected in the PM peak hour and the higher outbound flows anticipated in the AM peak hour compared to the PM peak. This was to make sure that sufficient (and safe) turning capacity out of the development, via Roads 1 and 8, is being provided
- All intersections tested are anticipated to function adequately under priority control at build out of the Hamilton Precinct. The Report recommends provision of right turn pockets (e.g. channelization) and left turn auxiliary lanes at the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 to aid efficient traffic movement and for safety purposes. External intersection upgrades may be required by the ToPH to suit future town growth out to 2021. These could be completed as part of its standard public works programme.
- An integrated internal network of footpaths is being constructed to support walking, particularly for leisure purposes. In addition, a shared path network is proposed, aligned along Roads 1 and 8, and the main drainage corridors. Other internal roads are likely to support on-street cycling. The Report

recommends that the ToPH considers investment in the external shared path network to provide better connections between development on the northern fringe of South Hedland and key destinations like schools

- Public transport services do not currently operate within walking distance (400 metres) of the Hamilton Precinct and the Public Transport Authority has no current plans to modify their operating schedule. However, Roads 1 and 8 within the proposed development are being future proofed to accommodate services should they be introduced in the future
- Parking for residents is generally to be supplied on individual lots. Some provisions for visitor parking are being made on the spine routes (e.g. Roads 1 and 8) while some verge parking is likely to occur elsewhere

It can be concluded that the development will incorporate sufficient transport provisions to support efficient access and is future-proofed to enable development of adjoining land to the northwest and northeast.

1 Introduction

1.1 Purpose of this report

This Transport Assessment (TA) has been prepared by Arup for NS Projects to report on the traffic and transport implications of the proposed 304 lot (440 dwelling) residential 'Hamilton Precinct' subdivision in South Hedland.

The Western Australian Planning Commission's draft *Transport Assessment Guidelines for Developments Volume 3* requires the preparation of a TA to support a subdivision, which is anticipated to have a 'high' level of impact on the transport network. This is defined by the subdivision being forecast to generate more than 100 vehicle trips in the peak hour.

A TA Report has objectives to:

- *Assess the proposed internal transport networks with respect to accessibility, circulation and safety for all modes, i.e. vehicle, public transport, pedestrian and cyclist;*
- *Assess the level of transport integration between the subdivision area and the surrounding land uses;*
- *Determine the impacts of the traffic generated by the subdivision area on the surrounding land uses; and*
- *Determine the impacts of the traffic generated by the subdivision area on the surrounding transport networks.*

The TA report has been developed to a level of detail suitable for the scale of the development and its likely level of impact on the transport network.

1.2 Relevant plans and schemes

Planning studies and documentation that has been referred to in the preparation of this TA include:

- Town of Port Hedland, undated, *Design Standards for New Residential Developments (Engineering Services)*
- Porter Consulting Engineers, 2010, *Traffic Study for Town of Port Hedland*
- Transplan Pty Ltd, 2008, *Town of Port Hedland Cycling Plan*
- Sinclair Knight Merz, 2011, *Wedgefield Industrial Estate Expansion – traffic management plan*
- Sinclair Knight Merz, 2011, *Great Northern Highway Bypass, Port Hedland, Traffic Assessment*
- Institute of Public Works Engineering Australia, 2009, *Local Government Guidelines for Subdivisional Development Ed. 2*

Public transport servicing information provided by the Public Transport Authority (PTA) was also referred to (see Sections 2 and 7).

1.3 Summary of consultation

This report has been prepared in consultation with the Town of Port Hedland (ToPH). A meeting was held with the ToPH in August 2011 to discuss and agree on traffic management and trip generation associated with the development. Additionally, basic transport inputs were agreed as were intersections to be included in the analysis. A copy of the finalised meeting notes are attached as Appendix A. It is noted that there has been further discussion and agreement between NS Projects and the ToPH since this meeting was held. In particular, some deviations from the Town's *Design Standards for New Residential Developments* were agreed to subject to justification in this report. These are discussed in Section 4.

During dialogue with the ToPH, Arup was advised that AECOM has been undertaking some high level spreadsheet traffic modelling for South Hedland. Having spoken with AECOM's project lead, we understand that the modelling incorporates some projections for 2016, 2021 and 2031 assuming new development in various precincts in South Hedland and general growth in background traffic on the road network. The implications of this modelling are discussed further in Section 5.

Arup consulted with the Public Transport Authority (PTA) in relation to current and planned bus services in Hedland. As noted above, the advice received is discussed in more detail in Sections 2 and 7.

Main Roads Western Australia (MRWA) was not consulted in the preparation of this study as the impacts of the development on MRWA roads (i.e. Great Northern Highway) is considered to be minor. MRWA should be contacted regarding lining and signing requirements associated with the development once structure plan approval is issued by the Western Australian Planning Commission.

2 Existing Context

2.1 Forecast growth in Hedland

In their *Great Northern Highway Bypass, Port Hedland, Traffic Assessment* report, Sinclair Knight Merz's (2011) outlines population growth projections for South Hedland. From 2011 to 2025, the population is forecast to grow from 20,000 to 40,000 people with two thirds living in South Hedland. The Hamilton Precinct will therefore have an important role to play in providing new housing for an increasing local population.

2.2 Site location and characteristics

The development site is located approximately 20 kilometres inland from Port Hedland and 1.5 kilometres north of the South Hedland town centre. It is approximately 24.5 hectares in size and located northeast of the priority-controlled T intersection of North Circular Road (east-west, minor leg) and Hamilton Road (north-south, major leg). Site access would be provided from both of these roads in the future. The current lot boundary is set back from North Circular Road allowing for the possible future realignment of the road or expansion of the Hamilton Precinct.

The site encompasses unallocated crown land and is intersected by a large drainage channel running from the southeast to the north. It is bounded by greenfield sites to both the northeast and northwest, and located within close proximity to Hedland Senior High School, which is south of North Circular Road and west of Parker Street.

As the site is currently undeveloped, there are no formal internal roads. The site location can be seen in Figure 1.

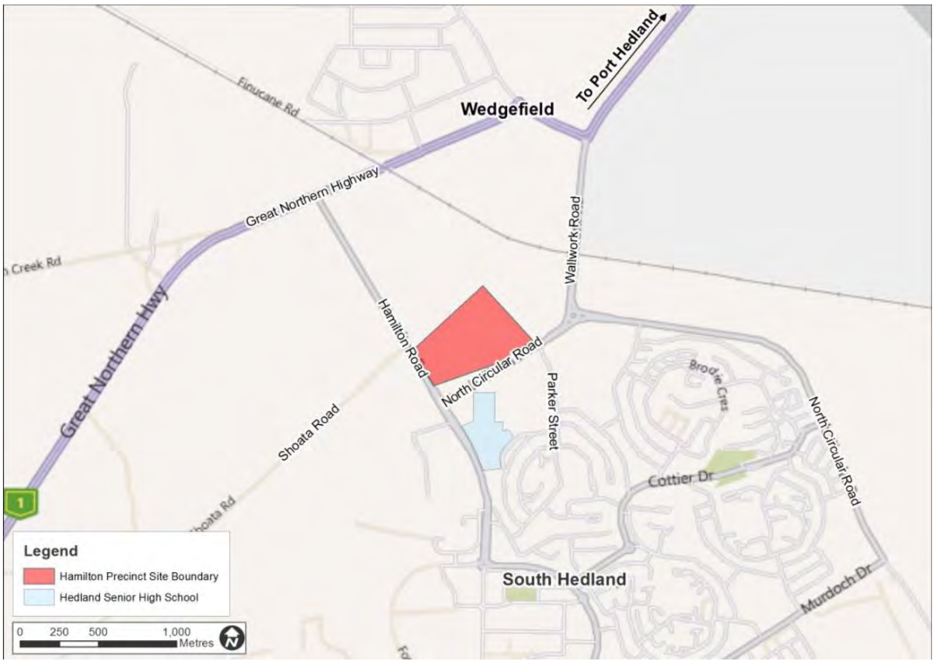


Figure 1 site location

2.3 Existing road network

Given the site is currently undeveloped there are no existing formalised internal roads. North Circular Road is classified as a District Distributor by the ToPH while it is classed as a Local Distributor (Neighbourhood Connector in Liveable Neighbourhoods parlance) in MRWA's Functional Road Hierarchy (FRH).

According to a traffic study conducted in 2010 by Porter Consulting Engineers, North Circular Road east of Hamilton Road carried in the range of 3,000-7,000 vehicles per day (more specific recent traffic count data is not available). This volume range is commensurate with a classification of Local Distributor, all else being equal. The road is a single, undivided carriageway with a posted speed limit of 80 kilometres per hour adjacent to the site. North Circular Road provides access to Wallwork Road to the east via a roundabout-controlled intersection, which in turn provides access northwards to Great Northern Highway and Port Hedland. North Circular Road facing northeast can be seen in Figure 2.

Hamilton Road is classified by the ToPH as a Primary Distributor north of North Circular Road and District Distributor to the south. It is classed as a Local Distributor in MWRA's FRH. The road has single, undivided carriageway excepting where a limited stretch of median (about 440 metres long) has been constructed from the TAFE site to the south to a point about 125 metres north of the intersection with North Circular Road. This has been constructed to facilitate turning movements and queuing.

The posted speed limit is 60 kilometres per hour to the south of the site, increasing to 80 kilometres per hour approximately 250 metres north of North Circular Road. Based on 2011 traffic count data, Hamilton Road south of North Circular Road carries about 10,000 vehicles per day. This reduces to about 4,580 vehicles per day north of North Circular Road (according to 2010 traffic count data). Hamilton Road can be seen in Figure 3.

Figure 2 North Circular Road, facing northeast (taken adjacent to the site)

Figure 3 Hamilton Road, facing southeast (taken from its intersection with North Circular Road)

Both North Circular Road and Hamilton Road are under the care and control of the ToPH. Neither is part of MRWA's Restricted Access Vehicles (heavy freight vehicle) network. Great Northern Highway is currently the principal freight route and is about 1.5 kilometres to the north.

2.4 Spot count data

In August 2011, PM peak hour spot counts were conducted at the following intersections:

- Hamilton Road and Shoata Road;
- Hamilton Road and North Circular Road; and
- North Circular Road and Parker Street.

These counts were conducted for 15 minute periods and then extrapolated to generate an estimation of peak hour volumes. A summary of the peak hour count data is provided in Figures 4 to 6. Data was collected for the PM peak hour, as this represents the daily peak period (confirmed through reference to traffic count data provided by the ToPH).

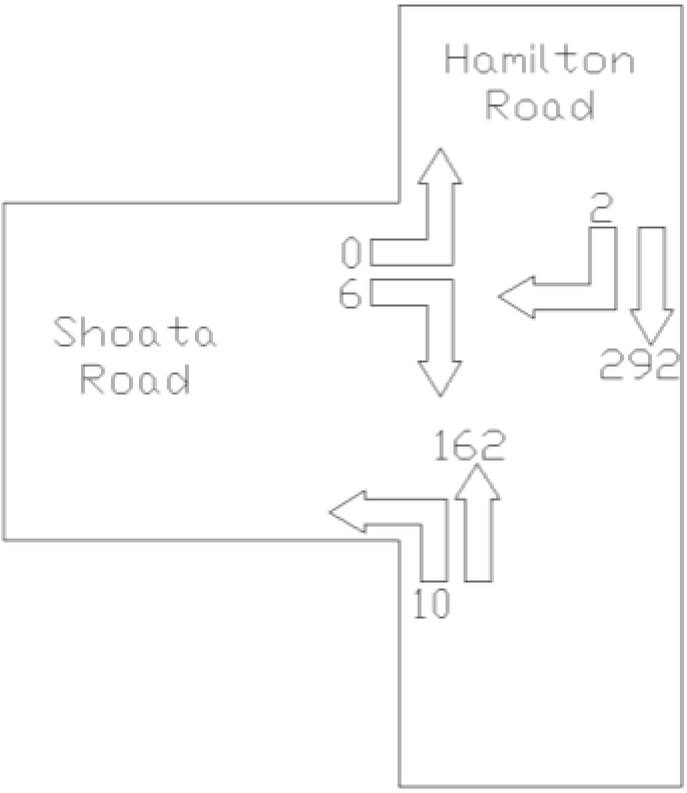


Figure 4 PM peak hour spot counts (2011) – intersection of Hamilton Road and Shoata Road

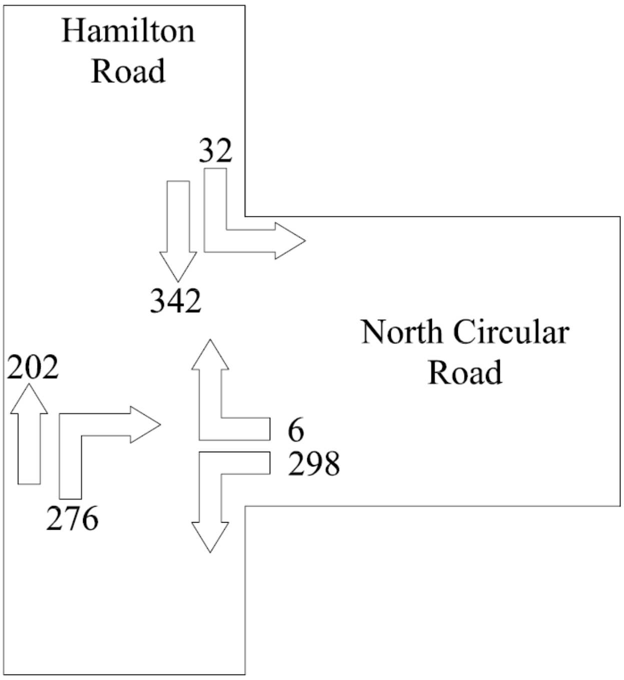


Figure 5 PM peak hour spot counts (2011) intersection of Hamilton Road and North Circular Road

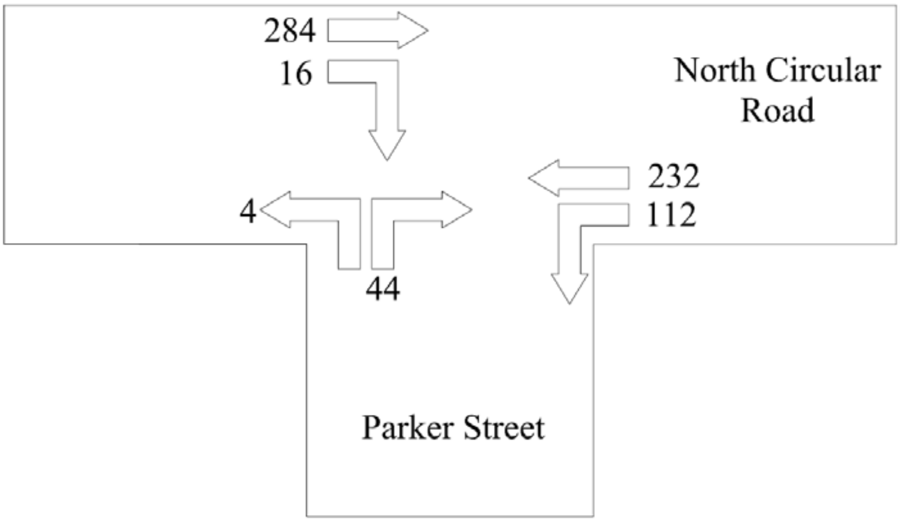


Figure 6 PM peak hour spot counts (2011) - intersection of North Circular Road and Parker Street

2.5 Public transport network

A limited public transport service schedule currently operates in Port Hedland and South Hedland. The PTA operates three services, the 301, 401 and 501, and will soon be implementing some small changes to routing to better connect with the new hospital in South Hedland. The current network map for the 301 and 401 services is shown in Figure 7.

The 501 operates between South Hedland and Port Hedland via Parker Street and Wallwork Road. Bus services operate infrequently – service headways are 1-2 hours and buses only operate between 8:15am and 7:40pm on weekdays – and there are no services on Sundays or public holidays. None of these services currently operate within walking distance (e.g. a 400 metre or five minute walk), of the subject site. The PTA has advised that there are no plans to extend public transport services to the subject site.

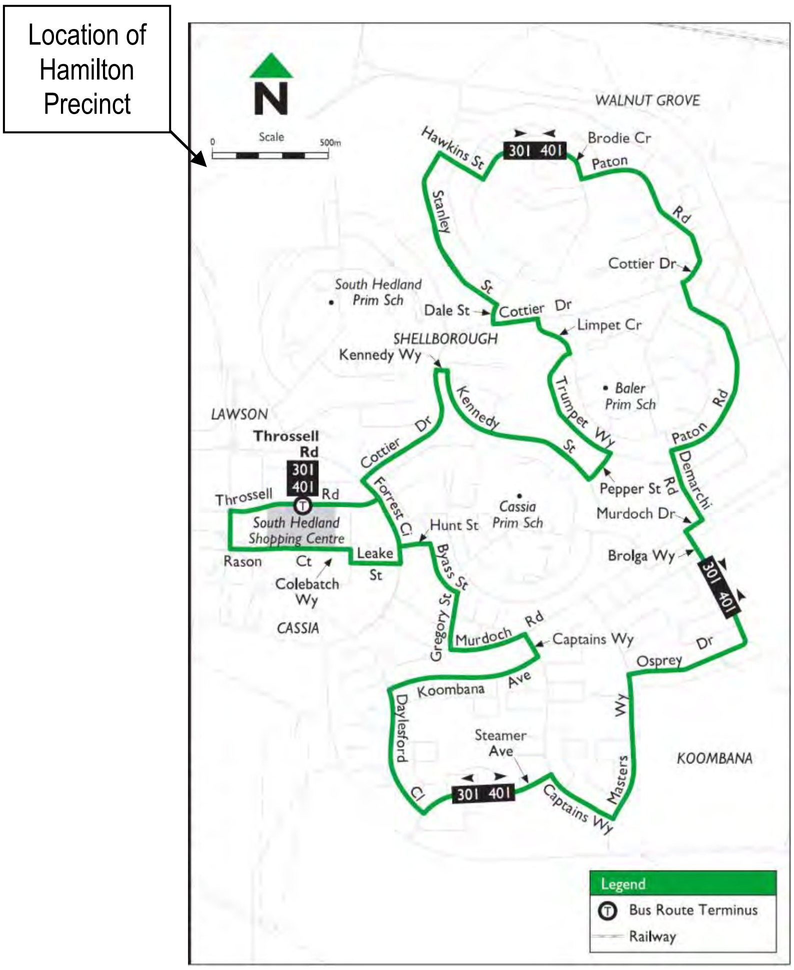


Figure 7 current public transport service map (301 and 401 services) for South Hedland (Source: Public Transport Authority, August 2011)

2.6 Walking and cycling network

Due to the arid climate and limited shade in South Hedland, walking and cycling are relatively uncomfortable. Moreover, the relatively low densities in Hedland, agglomeration of industry/ jobs outside of the townsite in industrial estates and at minesites, and historical Radburn-style layout of residential cells discourages utilitarian active transport. The terrain in South Hedland is relatively flat and suitable for cycling; however, extreme temperatures in summer can act as a deterrent as do occasional tropical storm/ cyclone events.

In 2008, consultants prepared a Cycle Plan for the ToPH. The intention of the plan is “to make cycling and walking within the ToPH safer, more convenient and hence an attractive alternative means of transport and form of recreation”. The plan articulates objectives in relation to network development, provision of end-of-trip facilities and way-finding.

There is very little existing cycling infrastructure in the vicinity of the development site. There are neither specific provisions on Hamilton Road nor North Circular Road. A path is provided along Hamilton Road within the verge but only as far north as Karst Elbow, about 120 metres south of North Circular Road.

Based on the Town's draft Cycle Plan, the Town intends to develop a link (potentially a shared path) between South Hedland and Port Hedland via Wallwork Road. However, there appear to be no plans for infrastructure along North Circular Road to the west of Wallwork Road. Accordingly, it is recommended that any proposed infrastructure internal to the Hamilton development should be augmented by investment by the ToPH in cycling provisions along Hamilton Road and North Circular Road to help create a legible, connected cycling network. The same should be provided in relation to walking infrastructure.

3 External Transport Infrastructure

The ToPH is currently coordinating the planning and design for a grade-separated rail crossing on Wallwork Road to the northeast of the site on the basis of traffic demand and safety considerations. There is an existing crossing in this location provided at grade. As part of the needs assessment, the Town has advised that they are considering traffic volume-based trigger points. The work is approaching the 85% design stage and a contractor is to be engaged shortly to deliver the infrastructure.

Various State proponents are undertaking or have recently undertaken traffic studies in relation to proposed major transport infrastructure upgrades. While these are unlikely to be impacted on by or directly impact the development of the Hamilton Precinct, these include:

- Development of the Wedgefield Industrial Estate north of Great Northern Highway including various key internal and external connections
- Development of the Airport Site east of existing Great Northern Highway including various key internal and external connections
- Construction of the Great Northern Highway Bypass

Major infrastructure projects are shown on Figure 8.

Figure 8 Major transport infrastructure (planned and committed)

4 Internal Road Network

4.1 Overview

The proposed internal street network is shown on the following Subdivision Plan (Figure 9). Proposed external connections are indicated. All streets are intended to function as local access streets. However, in future, when the development is connected to new adjacent subdivisions, the internal spine routes (Roads 1 and 8) have sufficient carriageway width to function, if required, both as Neighbourhood Connectors and bus routes.

Road 5 may be connected to North Circular Road and northwards into new adjoining development sometime in the future. However, it is envisaged to be a high order access street rather than a Neighbourhood Connector and has been designed appropriately (see below).

Figure 9 Proposed subdivision plan

(Source: TPG/ Arup, March 2012)

4.2 Street typologies

Arup has been advised that the proposed cross sections and street network layout have been presented to the Town by the project team and the Council has ratified them.

Most streets within the network are designed and will function as local access streets with undivided 6 metre carriageway. Liveable Neighbourhoods notes that 5.5 metre carriageway (excluding car parking) is sufficient to support the design intent for local access streets while still enabling two vehicles to pass each other. This is also articulated in the Institute of Public Works Engineering Australia's (2009) *Local Government Guidelines for Subdivisional Development*. The ToPH's technical services personnel have advised that 6 metre carriageway is preferred given the preponderance of larger vehicles in Hedland.

Two main spine routes are proposed through the development – Roads 1 and 8 – which will have 7.2 metre carriageway. This is sufficient to accommodate future bus services. This would be on the basis that the PTA reroutes an existing or creates a new bus service that operates through the Hamilton Precinct and potentially into future adjoining subdivisions. However, based on Arup's discussions with the PTA, there are no plans for buses to operate in the Hamilton Precinct in the short term.

Traffic on both Roads 1 and 8 will have priority excepting where they intersect; this intersection will be roundabout-controlled. Given the long stretches of road with uninterrupted priority, it is recommended that some basic midblock speed mitigation treatments are considered; these may also be applied at intersections of these roads with minor roads. These treatments may incorporate:

- Small added landscaping nibs (e.g. 100 mm on each side of the carriageway, effectively reducing the carriageway to 7 metres in specific locations)
- Differential colouring treatments on the road surface
- Localised paving treatments in lieu of bitumen
- Low platform treatments at intersections with minor streets

Sections of three roads – Road 5, Road 7 and Road 13 – are designed to have 12 metre cross sections and function as low order local access streets (e.g. Access Street C or D). The access easement shown along the southwest boundary of the site would function similarly. Laneways are proposed in some locations with a minimum 6.01 metre cross section generally in accordance with Liveable Neighbourhoods.

The project team has developed indicative cross sections for the streets within the development. Key (location) maps are shown in Figures 10 and 11 and the cross sections themselves in Figures 12 to 17. All sections have been reviewed by the project team's civil engineers and landscape architects to make sure that appropriate provisions for services and landscaping have been incorporated.

Arup recommends that local access streets have a posted speed limit of 30 or 40 kilometres per hour, subject to approval by MRWA. Reduced speed limits should be supported by minimisation of kerb radii and building truncations in general accordance with the Liveable Neighbourhoods Design Code. Direct property access is permitted along each street (based on capacity). However, sight lines should be preserved as part of detailed design.

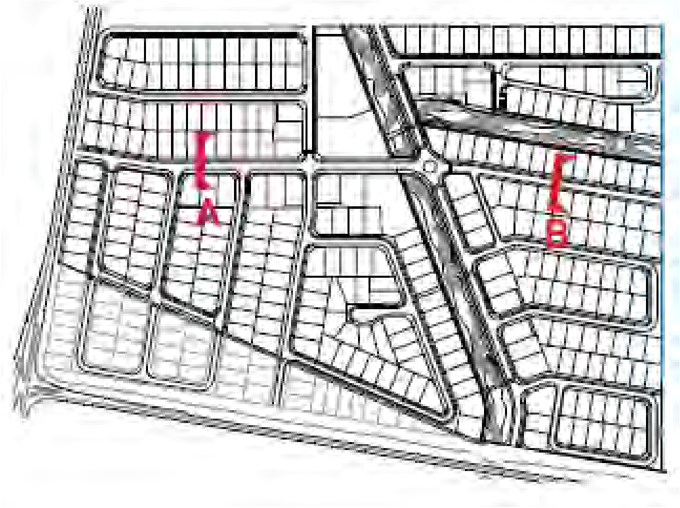


Figure 10 Key map [sections (A)-(B)]

(Source: Hassell, March 2012)

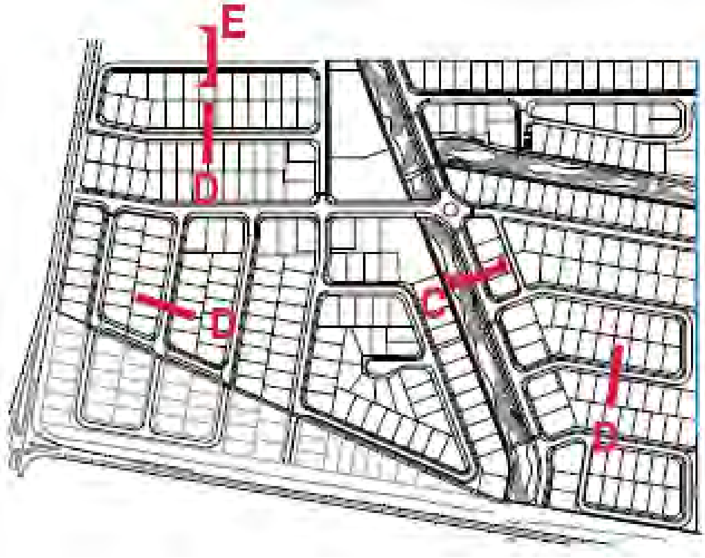


Figure 11 Key map [sections (C)-(E)]

(Source: Hassell, March 2012)

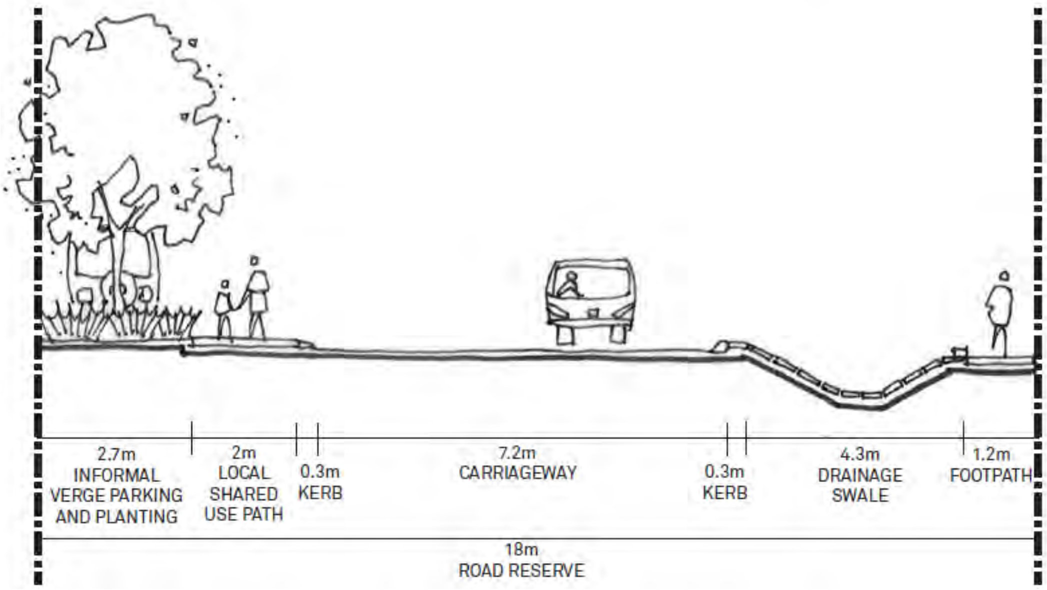


Figure 12 Road 1, 18 metre cross section west of Road 8 [Section (A)]

(Source: Hassell, March 2012)

The 18 metre section incorporates 7.2 metre carriageway, informal verge parking on the northern side and a drainage swale on the southern side. The ToPH has advised that a (shared) path should only be provided on one side. Accordingly, a local shared path is provided on the northern side (2 metre width) and a 1.2 metre footpath on the southern side.

This section is suitable as an Access Street A/ B that is forecast to carry 1,000-2,000 vehicles per day. However, it has the practical capacity to carry a bus service in the future and traffic volumes of 3,000-5,000 vehicles per day, if required.

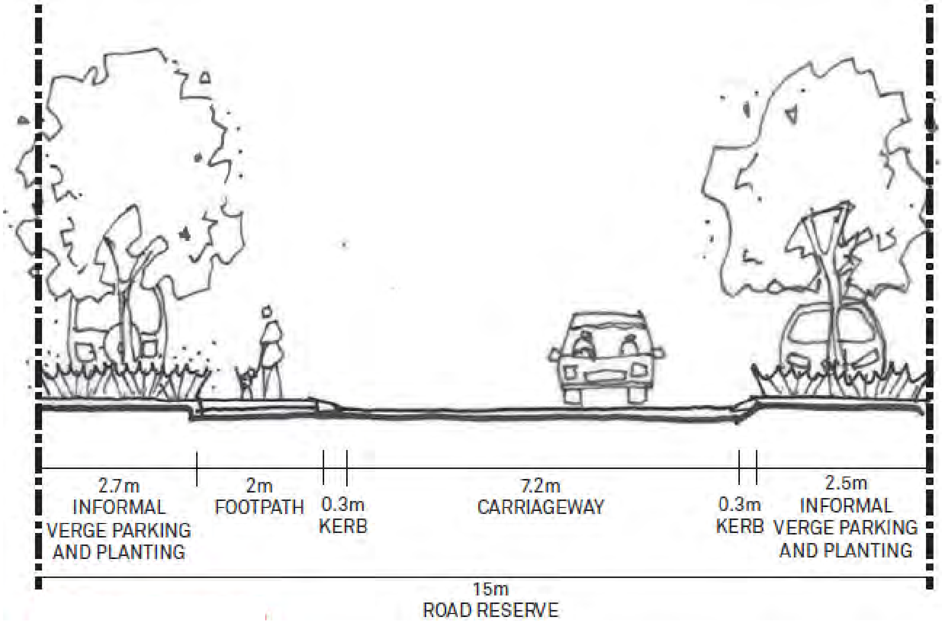


Figure 13 Road 1, 15 metre cross section east of Road 8 [Section (B)]

(Source: Hassell, February 2012)

The 15 metre cross section applicable to Road 1 east of Road 8 incorporates 7.2 metre carriageway, informal verge parking on both sides and a 2 metre wide footpath on the northern side. The shared path continues south on Road 8 at its intersection with Road 1 and discontinues eastwards. There is an east-west shared path through the drainage corridor a short distance to the north.

This section is suitable as an Access Street A/ B that is forecast to carry 1,000-2,000 vehicles per day with practical capacity to carry a bus service in the future and traffic volumes of 3,000-5,000 vehicles per day, if required.

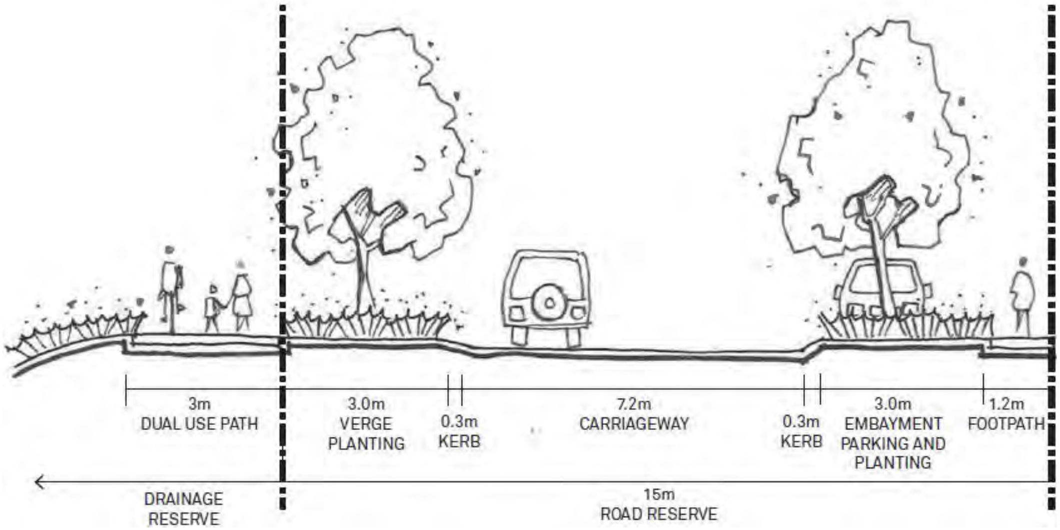


Figure 14 Road 8, Typical 15 metre cross section [Section (C)]

(Source: Hassell, February 2012)

The typical 15 metre section for Road 8 incorporates 7.2 metre carriageway, embayed parking and a 1.2 metre wide footpath (intended to facilitate pedestrian access to adjoining dwellings), on the east side and verge planting on the west side. The 3 metre shared path is proposed to be located within the adjacent drainage reserve, where it will be required to have a low pitch and minimal cross-fall.

This section is suitable as an Access Street A/ B that is forecast to carry 1,000-2,000 vehicles per day with practical capacity to carry a bus service in the future and traffic volumes of 3,000-5,000 vehicles per day, if required.

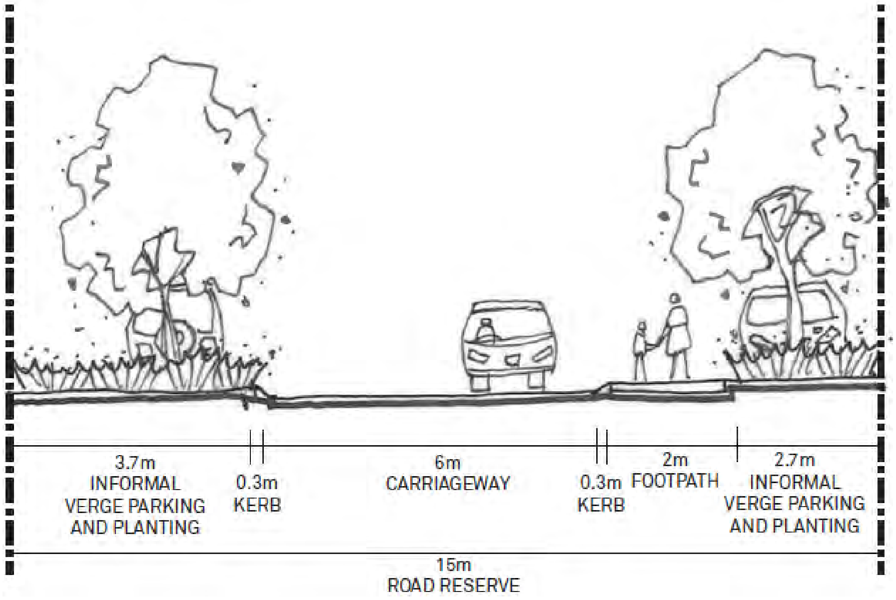


Figure 15 Typical 15 metre cross section [Section (D)]

(Source: Hassell, February 2012)

Most roads within the development will be constructed with the typical 15 metre cross section shown in Figure 15. This section incorporates 6 metre carriageway, a 2 metre wide footpath on one side, and intermittent verge parking space/ landscaping on both sides.

This section is suitable for Access Streets B/ C that are forecast to carry up to about 1,000 vehicles per day in some instances. However, most internal roads with this section are likely to carry up to about 300 vehicles per day. The section has the practical capacity to carry 1,000-3,000 vehicles per day and will support on-street cycling.

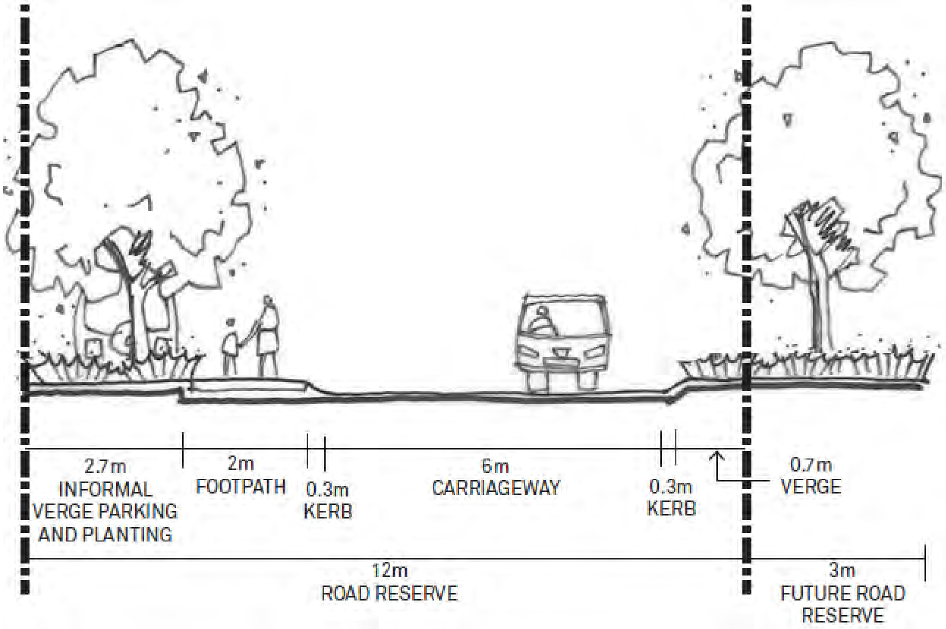


Figure 16 Typical 12 metre street cross section [Section (E)]

(Source: Hassell, February 2012)

Road 7 will abut to the northwest boundary of the site. In the future, new adjacent development would likely front to this road and the reserve could be widened, if needed. The current section incorporates 6 metre carriageway, a 2 metre wide footpath and intermittent verge parking space/ landscaping on the southeast side, and a narrow strip of verge on the northwest side.

Road 5 would abut to the proposed 3 metre shared path circuit rather than future road reserve. Road 13 will abut to North Circular Road. If, in the future, development occurs to the south of Road 5, the 3 metre shared path would likely be removed and the reserve would be widened. Provision for this has been identified on both the Subdivision and Development Plans.

This section is suitable for an Access Street C that is forecast to carry less than 300 vehicles per day.

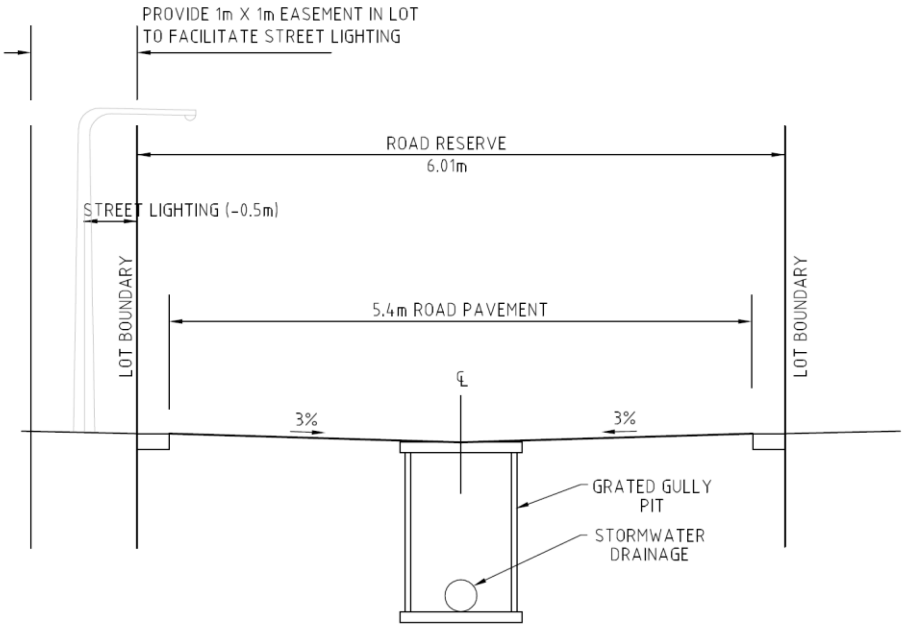


Figure 17 Typical 6.01m laneway cross section

(Source: Pritchard Francis, August 2011)

The 5.4 metre pavement proposed will enable most vehicles to pass at very low speeds suitable for laneways. In some instances, drivers may have to yield at the entrance to laneways when there are oncoming vehicles. This is acceptable within a low speed low traffic volume residential environment. Part of Road 13 is proposed to be constructed as an 8 metre laneway with wider pavement that will facilitate two-way flow. Laneways are generally likely to carry less than 100 vehicles per day but could support up to about 300 vehicles per day.

4.3 External connections

Proposed connections between the development and the existing external network are illustrated in Figure 18. There are three external connection points proposed for the development with two of these being provided at ultimate development and one anticipated at some later point:

- Three-way intersection at Hamilton Road/ Road 1 (by ultimate development);

- Three-way intersection at North Circular Road/ Road 8 (by ultimate development); and
- Three-way intersection at North Circular Road/ Road 5 (in the future, following the potential use of land between North Circular Road and the Hamilton Precinct).

As the traffic volumes anticipated to use these intersections at ultimate development are low, they should function adequately under priority control with all movements permitted (see Section 5). Moreover, there are unlikely to be capacity issues at North Circular Road/ Road 8 and Hamilton Road/ Road 1 that trigger a need for provision of the third access via Road 5. This connection would be more likely established to improve external connectivity.

The intersection of Hamilton Road/ Road 1 would be offset from the three-way intersection of Hamilton Road/ Shoata Road. The stagger (approximately 80 metres from centreline to centreline) is considered sufficient on the basis that there is low demand for access to/ from Shoata Road (unsealed) and likely to be few movements across Hamilton Road. Any future development to the west, which may utilise Shoata Road as an external access, will need to take into account the development of the Hamilton Precinct in an associated transport impact assessment and any proposed intersection upgrades.

The development plan makes provision for future connections with adjacent development to the northwest and northeast. These are shown in Figure 18.

Figure 18 Potential future external connections and key internal intersection control

(Source: TPG, March 2012)

4.4 Internal intersection controls

Proposed key internal intersection controls are shown above in Figure 18. Intersection threshold treatments and low platforms/ differential paving/ differential colouring are recommended at internal intersections and on minor approaches to external intersections to provide drivers with added cues as to the need to slow down/ stop. Three by three metre truncations would generally be supported as articulated in Liveable Neighbourhoods.

Three-way intersections are proposed to operate as standard T-intersections with give way control on the minor approach; these are not specifically shown in Figure 18. Two internal four-way intersections are proposed. The intersection of Roads 1 and 8 would be subject to roundabout control, which befits their status as internal spine routes. Moreover, they are being designed to accommodate buses and are likely to link with adjoining development in the future. Under these conditions, they may ultimately function as Neighbourhood Connectors (see Figure 19).

The four-way intersection of Roads 1 and 5 is planned to be subject to priority control, both at the ultimate development of the Hamilton Precinct and into the future. While Road 3 may provide an additional connection to North Circular Road and/ or future adjoining development to the northwest, it would not operate as a bus route. It is also anticipated to terminate in a T intersection across the boundary in the adjoining development. Thus, future traffic flows on Road 5 should warrant retention of priority control at the intersection of Road 5 and Road 1 (Road 1 being the major link).

Figure 19 Potential future Neighbourhood Connectors/ bus routes

5 Traffic Generation, Distribution and Impacts

5.1 Subdivision generated traffic

Trip generation rates for the subdivision have been calculated based on first principles and reference to relevant data from other locations. The basic assumptions were also discussed and agreed with the ToPH. Factors used in calculating the trip generation rate are as follows:

- Dwelling yield: 440 (66 of which are group housing units or apartments and 104 are on four-pack lots)
- Occupancy: 2.8 residents per unit
- Total trips per person (all modes): 3.5 trips per day
- Visitor trips (e.g. people visiting residential premises in the development): 15% additional trips
- Car driver mode split: 77%

The household occupancy forecast is high; however, planning advice to Arup is that a high proportion of housing in the Hamilton Precinct is likely to be shared and this will increase the average occupancy rate.

Given limited opportunities to walk, cycle or use public transport, South Hedland has a high vehicle mode split. Census data from the Australian Bureau of Statistics (2006) for commuter trips in South Hedland reports a car driver mode split of approximately 77 percent. Tube counter data collected in mid 2011 for an existing residential cell in Karratha, a comparable township in the north of Western Australia, found similarly.

Increases in mining activity may have increased the overall mode share of car passengers (and in turn decreased car driver mode split), which would also stand to reason assuming a moderate-high proportion of shared housing. In addition, some non-work trips may be expected to be via non-car modes (e.g. walking and cycling), for example for education and leisure purposes. Very few commute trips may be anticipated to be by walking and cycling. A conservative driver mode split of 77 percent has been adopted for this study, which reflects the data available.

Based on the aforementioned factors, the trip generation rate applied to the development is 2.8 x 3.5 x 1.15 x 0.77 = 8.7 trips per unit per day. For a 440 dwelling development, this trip generation rate equates to 3,828 forecast vehicle trips per day and 383 vehicles in the PM peak hour assuming the peak hour to be 10% of the daily total, which is reasonable for a residential development.

In the AM peak hour, vehicle trip generation may be assumed to be about 8% of the daily total. This corresponds to about 306 trips. The reduced percentage of trips compared to the PM peak hour reflects that residential trips undertaken in the morning are generally limited to non-discretionary trips (e.g. trips for work or education purposes). In the afternoon/ evening a relatively high number of non-discretionary trips also occur but additional discretionary trips are more likely, too (e.g. shopping trips).

5.2 Traffic assignment and distribution

The following trip distributions were calculated using spreadsheet analysis, accounting for lot layouts, provision of the two external access points anticipated at ultimate development, an understanding of trip attractors in surrounding areas and likely desire lines. A very low percentage of vehicle trips are anticipated to originate and end in the development (i.e. trips internal to the site) and there is likely to be a very low number of through trips as the internal network does not provide attractive through routes. The assumed external trip distribution is as follows:

- North (via Hamilton Road) 24%
- South (via Hamilton Road) 29%
- East (via North Circular Road) 38%
- West (via North Circular Road) 9%

The intersection analysis in the following section is for the PM peak hour with some sensitivity testing for critical AM peak hour vehicle movements. This assessment period was selected because traffic data shows that baseline traffic is about 30% higher in the PM peak compared to the AM peak. Moreover, the PM peak hour represents when there will be greatest demand for turning movements into the development and therefore the ultimate requirements for provision of auxiliary lanes and/ or channelization.

The directional distribution of residential traffic in the PM peak hour is assumed to be:

- 80% inbound traffic
- 20% outbound traffic

The most significant trip generators in South and Port Hedland with regards to PM peak hour trips are expected to be centres of employment. These are anticipated to include mine sites and industry, particularly north in and around Wedgefield and Port Hedland (particularly in the longer term: i.e. after 2013). Access to these locations will be via Hamilton Road (northwest) or North Circular Road/ Wallwork Road, with the attraction of both routes being roughly equal. Some residents are also anticipated to access employment in South Hedland, accessible by Hamilton Road (south), North Circular Road (southeast of Wallwork Road) and Parker Road.

Non-work peak hour trips (e.g. shopping trips) are likely to be associated with trip generators in South Hedland rather than Port Hedland, given proximity.

In the AM peak hour, the directional distribution of trips may be assumed to be :

- 10% inbound traffic
- 90% outbound traffic

This directional split is representative of the high demand for trips to work.

5.3 Analysis of key intersections

5.3.1 Overview

Industry standard computer modelling software (SIDRA) was used to assess the impact of the generated traffic from the residential development on the surrounding road network during the PM peak hour. To make sure of sufficient provisions for vehicles exiting the development in the morning peak hour (identified as 6-7am based on traffic count data), Arup undertook some sensitivity testing of external intersections assuming the higher baseline traffic volumes experienced in the PM peak hour (e.g. when the maximum oppositional flows occur).

External intersections warranting analysis are as follows (as per discussion and agreement with the ToPH):

- Hamilton Road and Road 1 (assuming three-way priority control); and
- North Circular Road and Road 8 (assuming three-way priority control).

Arup has also considered impacts on the intersection of North Circular Road and Parker Street (three-way priority control), and North Circular Road and Hamilton Road during the PM peak hour at build-out of the Hamilton Precinct (2013). This latter intersection is of interest because it is currently a relatively busy intersection under priority control. However, we note that traffic is more likely to use Road 1 to access Hamilton Road to travel south and north, and Road 8 to access North Circular Road to travel east rather than performing turning movements at the intersection of North Circular Road and Hamilton Road, particularly during busier periods.

To assist with the interpretation of the SIDRA output, the Degree of Saturation (DoS) is defined as the ratio of demand flow to intersection capacity. A DoS of 0.85 for a particular turning movement is generally understood to represent practical capacity having been reached. While a DoS this high is unusual at intersections in regional Western Australia, it is being forecast to occur more frequently into the future during peak periods as mine site and resources operations expand and regional town sites grow.

The Level of Service (LoS) is a less continuous measure than DoS that describes the quality of traffic service generally in the form of delay. LoS is defined from A-F with LoS A representing the best operating condition – with conditions at or close to free flow – while LoS F represents the worst, most congested, conditions.

Traffic volumes inputted into SIDRA have been calculated by combining baseline and forecast development traffic. Baseline traffic was calculated by applying a growth factor to traffic volumes recorded during the spot count. The growth factor was determined following discussions with AECOM, who is currently developing a spreadsheet model for South Hedland.

5.3.2 Year 2013

Based on AECOM's modelling, baseline traffic on North Circular Road and Hamilton Road is expected to increase by 25 percent between the year 2011 and 2016. A per annum growth rate was back-cast and applied to current traffic count data to provide a context for assessment of the ultimate development year (e.g. 2013). Forecast PM peak hour traffic movements are summarised in Figures 20 to 23.

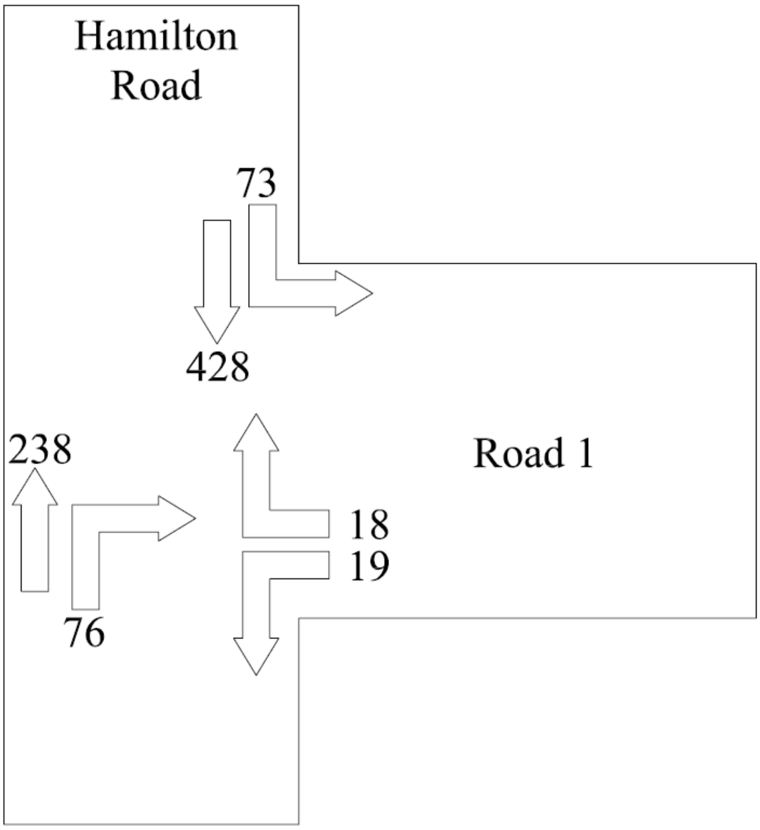


Figure 20 Forecast (year 2013) traffic volumes at intersection of Hamilton Road and Road 1 (PM peak hour)

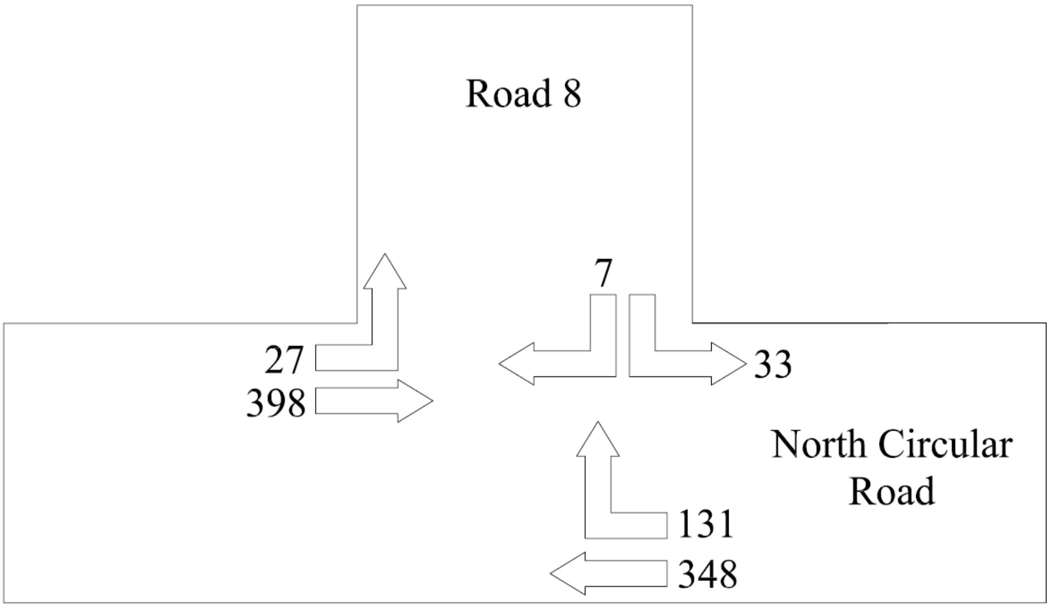


Figure 21 Forecast (year 2013) traffic volumes at intersection of North Circular Road and Road 8 (PM peak hour)

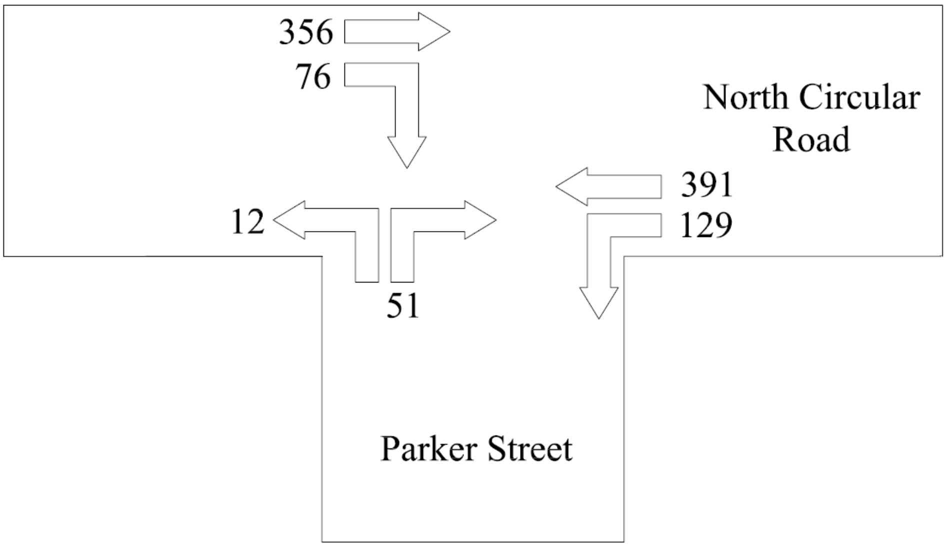


Figure 22 Forecast (year 2013) traffic volumes at intersection of North Circular Road and Parker Street (PM peak hour)

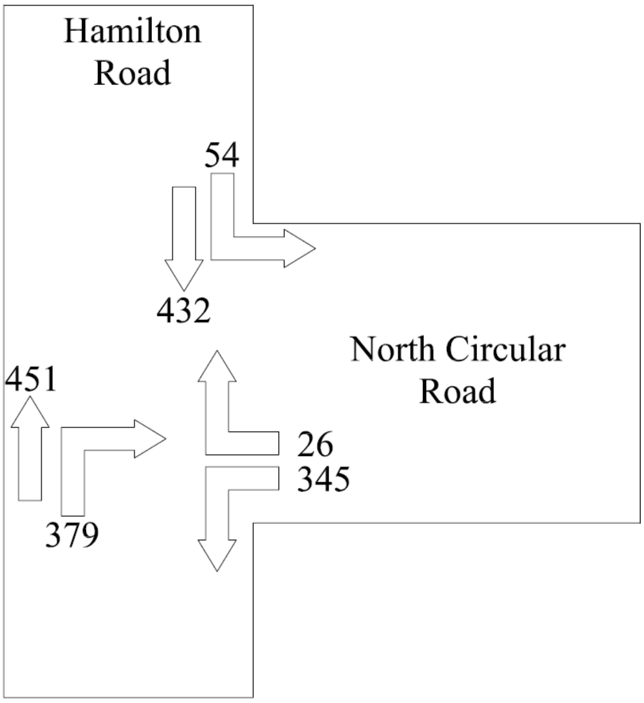


Figure 23 Forecast (year 2013) traffic volumes at intersection of North Circular Road and Hamilton Road (PM peak hour)

The initial intersection layouts tested in SIDRA are shown in Figures 24 to 27, with the results of the analysis presented in Table 1. Full results are included in Appendix B.

The preliminary geometry of the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 incorporates no auxiliary turning lanes or channelization. These intersection designs are referred to as BAL/ R configurations. This preliminary geometry was applied to test capacity.

The configuration of the intersections of Hamilton Road/ North Circular Road and North Circular Road/ Parker Street are as existing. The fourth, diagonal leg shown in the former is included in SIDRA to account for the current ‘seagull’ design, which permits a two-stage right-hand turn from North Circular Road on to Hamilton Road.

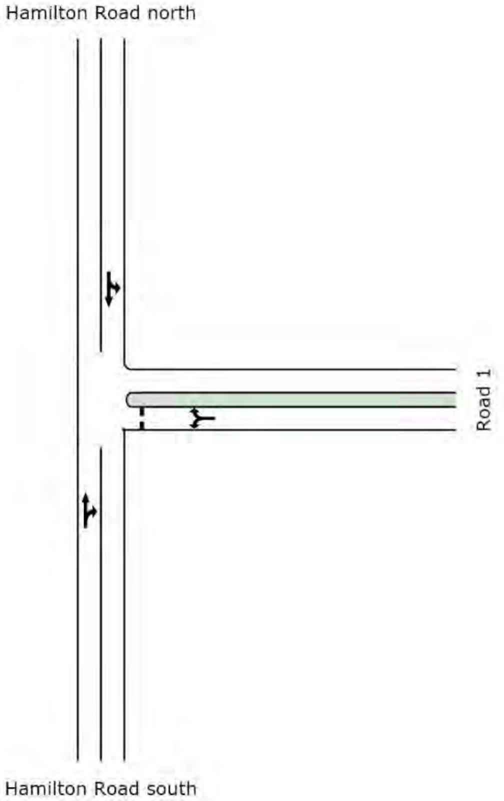


Figure 24 SIDRA intersection layout (Hamilton Road and Road 1)

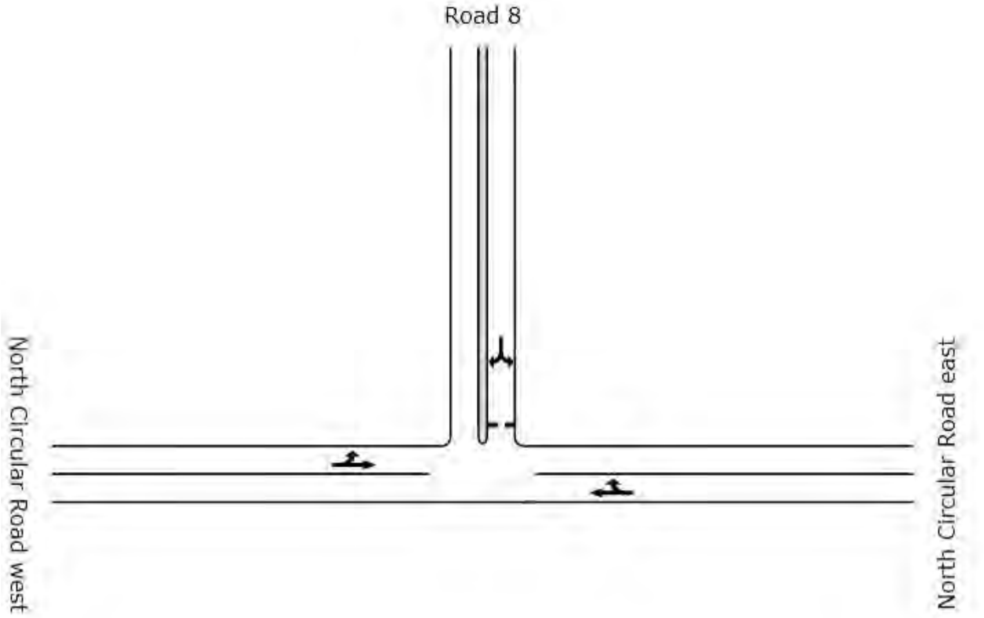


Figure 25 SIDRA intersection layout (North Circular Road and Road 8)

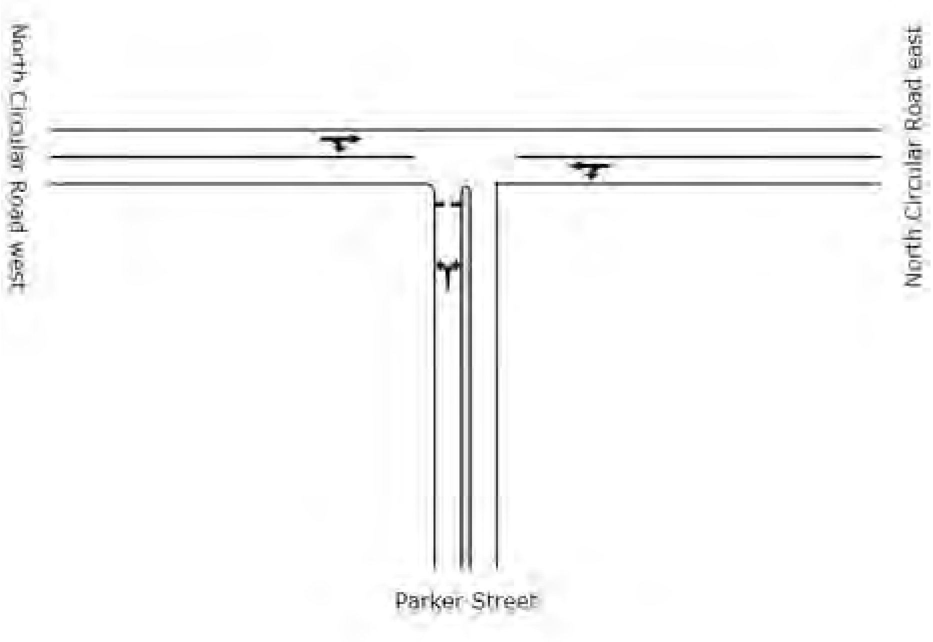


Figure 26 SIDRA intersection layout (North Circular Road and Parker Street)

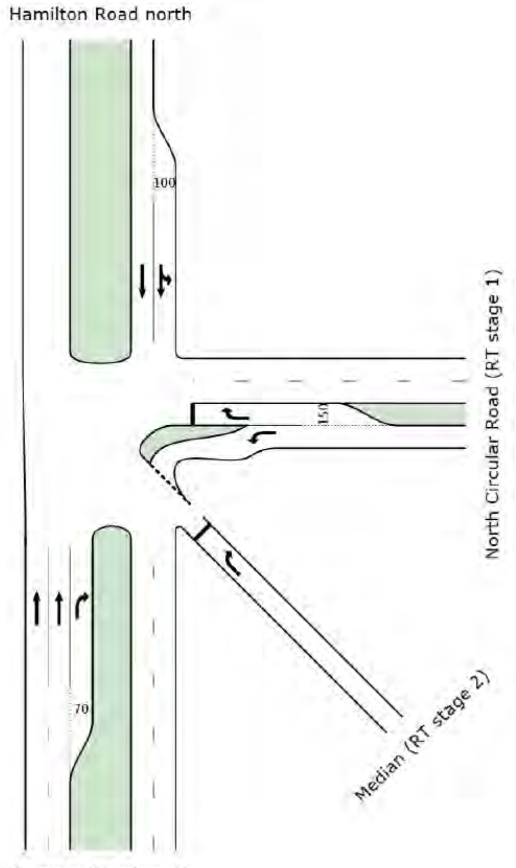


Figure 27 SIDRA intersection layout (North Circular Road and Hamilton Road)

Table 1 Intersection assessment (PM peak hour, year 2013)

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.23	N/ A	13.4m
Road 1	0.12	C	2.9m
Hamilton Road north	0.28	N/ A	0.0m
Overall performance	0.28	N/ A	13.4m
North Circular Road/ Road 8			
North Circular Road east	0.31	N/ A	18.3m
Road 8	0.07	B	1.7m
North Circular Road west	0.23	N/ A	0.0m
Overall performance	0.31	N/ A	18.3m
Hamilton Road/ North Circular Road			
Hamilton Road south	0.47	N/ A	21.7m
North Circular Road	0.52	C	23.8m
Hamilton Road north	0.13	N/ A	0.0m
Overall performance	0.47	N/ A	22.1m
North Circular Road/ Parker Street			
Parker Street	0.16	C	4.0m
North Circular Road east	0.29	N/ A	0.0
North Circular Road west	0.27	N/ A	17.3m
Overall performance	0.29	N/ A	17.3m

The analysis shows that all intersections are likely to operate within acceptable parameters – based on capacity - given the forecast growth in baseline traffic plus development traffic assuming the layouts as shown in Figures 23 to 26. However, in the interests of safety, performance and future-proofing, it is desirable to eliminate queues that may form during peak periods of vehicles wanting to turn right from Hamilton Road and North Circular Road into the Hamilton Precinct.

AustRoads Guide to Road Design Part 4A – Unsignalised and Signalised Intersections (2009) provides guidance on intersection treatments befitting semi-rural/ fringe urban locations. Typically, given moderate traffic flows on the major road, which oppose right turning movements in and out of the minor road, it is appropriate to consider provision of auxiliary turning lanes or channelization. Generally, the latter provides a higher level of safety than the former.

Based on the forecast traffic flows and reference to the AustRoads guide, we recommend intersection designs incorporating short left turn auxiliary lanes and right turn channels on the major roads at the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8. We note the excellent, unimpeded sight distance in this location.

The amended configurations (see Figures 28 and 29) have been tested in SIDRA. The results of this analysis are in Table 2. Assuming these treatments, the performance of the intersections increases and the queues caused by right turning vehicles are virtually eliminated.

Single rather than twin stand-up lanes are recommended on the minor approach. Twin stand-up lanes are not required from a capacity point of view and may reduce safety because of right blocking the view of left turning vehicles.

The sensitivity testing of the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 to simulate conservative traffic conditions in the AM peak hour demonstrated that the critical exiting movements (e.g. right turn from Road 1 on to Hamilton Road and Road 8 on to North Circular Road) would operate satisfactorily. This is on the basis that one stand-up lane is constructed in both cases; no channelization is provided.

The right turn out of Road 1 would operate at LoS C and DoS 0.34 with the average delay about 17 seconds and 95th percentile back of queue about two vehicle lengths. The right turn out of Road 8 would operate at LoS B and DoS 0.22 with the average delay about 11 seconds and 95th percentile back of queue about one vehicle length.

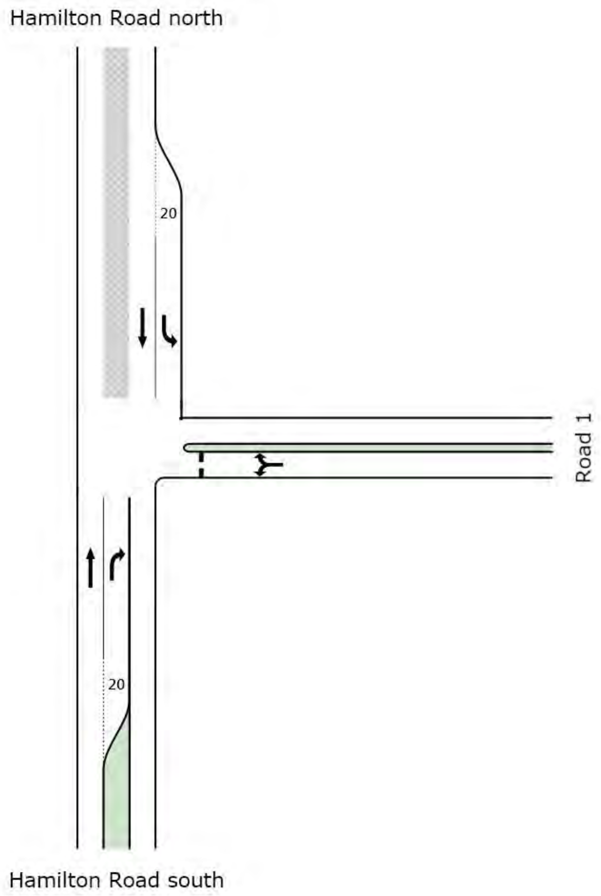


Figure 28 Preferred intersection layout (Hamilton Road and Road 1)

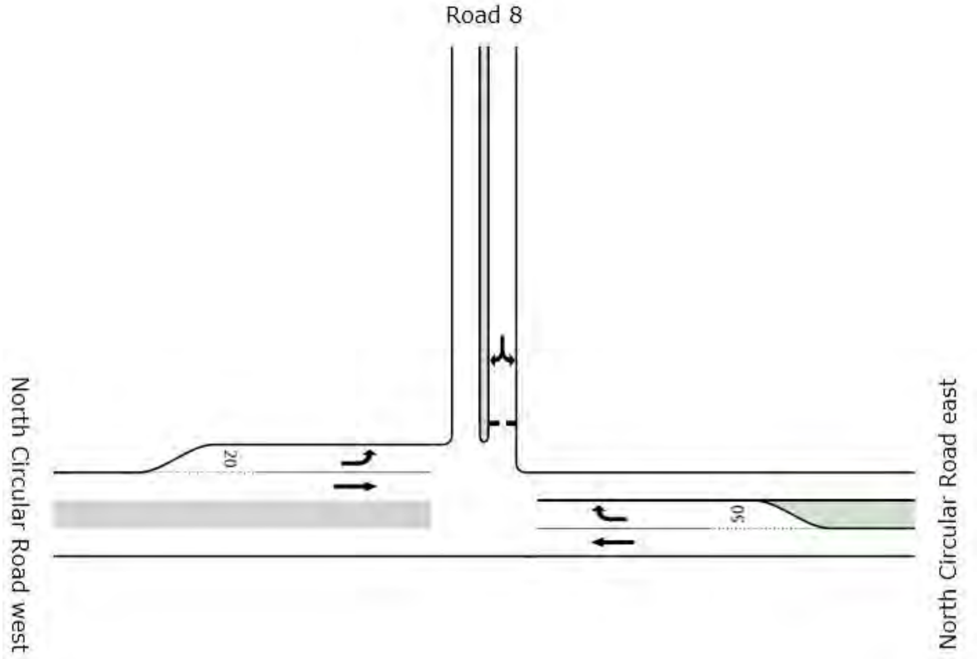


Figure 29 Preferred intersection layout (North Circular Road and Road 8)

The intersection of Hamilton Road and North Circular Road is forecast to operate well within capacity with the average delay for the right-hand turn from North Circular to Hamilton Road forecast to be 32 seconds in the peak hour (being the sum of the two stages of movement). Both the forecast 95th percentile right turn queues (North Circular Road right on to Hamilton Road and *vice versa*), could easily be accommodated within the existing right turn pockets (see Figure 27). On this basis, no intersection upgrades are forecast to be required by the forecast completion of development.

In practice, any extended delays to right turning (i.e. from North Circular Road on to Hamilton Road) development traffic at this location is likely to encourage vehicles to distribute northwards to exit via Road 1, which has spare capacity.

The final scenario that we tested was assuming all development-generated traffic wishing to distribute northwards would use Road 1 given a lower level of service at the intersection of Hamilton Road/ North Circular Road during the PM peak hour. The results relating to the right turn movement on the minor approach (being the worst performing movement), are presented in Table 3. The findings are intuitive, demonstrating that a lower DoS and higher LoS may be expected than in the outcomes of the sensitivity testing (i.e. which assumes higher outbound vehicle movements again, given the directional split anticipated in the AM peak hour).

By 2013, our analysis indicates that the intersection of North Circular Road and Parker Street, which currently has a basic BAL/ BAR design, will likely require some channelization for the right turn from North Circular Road on to Parker Street. To improve capacity and safety, provision of a left turn auxiliary lane on North Circular Road (westbound) is also recommend. The contribution of the Hamilton precinct to turning movements, which help trigger the upgrade requirements, will be minimal and accordingly, the Town may wish to look at an upgrade in this location as part of routine public works.

Overall, the assessment described in this section of the report is likely to represent worst-case traffic conditions. This is because the *per annum* growth factor applied to baseline traffic assumes added residential development in South Hedland over time. Some degree of double-counting of traffic is therefore likely when baseline and development traffic are combined.

Table 2 Comparative performance of right turning movements on to minor leg – Hamilton Road/ Road 1; North Circular Road/ Road 8 (PM peak hour, year 2013)

Intersection	No right turn pocket			Right turn pocket		
	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1	0.23	B	13.4m	0.11	C	2.7m
North Circular Road/ Road 8	0.31	B	18.3m	0.12	B	3.7m

Table 3 Performance of right turning movements on minor approach assuming reassignment – Hamilton Road/ Road 1 and Hamilton Road/ North Circular Road (PM peak hour, year 2013)

Intersection	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1	0.20	C	5.1m
Hamilton Road/ North Circular Road	0.01	C	0.3m

5.3.3 External impacts post build out of the Hamilton Precinct

The analysis demonstrates that the impacts of the development on the existing transport network are likely to manageable and no specific upgrades other than the construction of the new intersections to the specified standard will be required by build out of the Hamilton Precinct. The analysis also shows that there is likely to be residual capacity at the subject intersections; particularly Hamilton Road/ Road 1 and North Circular Road/ Road 8, where the impacts of the development traffic will be most material. This is likely to future-proof the infrastructure proposed for some years.

The forecast high ongoing rate of growth in background traffic in Hedland, much of which is likely to be associated with other developments that are at the concept stage of planning, is likely to trigger requirements for upgrades of external intersections sometime after the completion of the Hamilton Precinct. In all likelihood, roundabout control at the intersection of Hamilton Road and North Circular Road is likely to be required sometime before 2021 even without the Hamilton Precinct development.

5.3.4 Year 2018 – external connections to the Hamilton Precinct

Analysis of the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 at build out of the Hamilton Precinct plus five years demonstrates that the recommended intersection treatments should function adequately. Forecast traffic movements at the two intersections are shown in Figure 30 and 31, respectively. Once more, AECOM's background traffic growth factors have been applied to demonstrate a conservative traffic scenario. Results derived from SIDRA testing are shown in Table 4. Full movement summaries are provided in Appendix B.

A simulation of conservative traffic conditions in the AM peak hour demonstrated that the critical exiting movements (e.g. right turn from Road 1 on to Hamilton Road and Road 8 on to North Circular Road) would operate satisfactorily.

The right turn out of Road 1 would operate at LoS C and DoS 0.42 with the average delay about 21 seconds and 95th percentile back of queue about 14 metres. The right turn out of Road 8 would operate at LoS B and DoS 0.25 with the average delay about 12 seconds and 95th percentile back of queue about 7 metres.

It is recommended that at some stage prior to 2018, the posted speed limit on North Circular Road is revised downwards from 80 to 60 kilometres per hour, which would be more befitting the change in character of the area from rural to urban fringe. This should also increase the safety of turning movements into and out of the Hamilton Precinct.

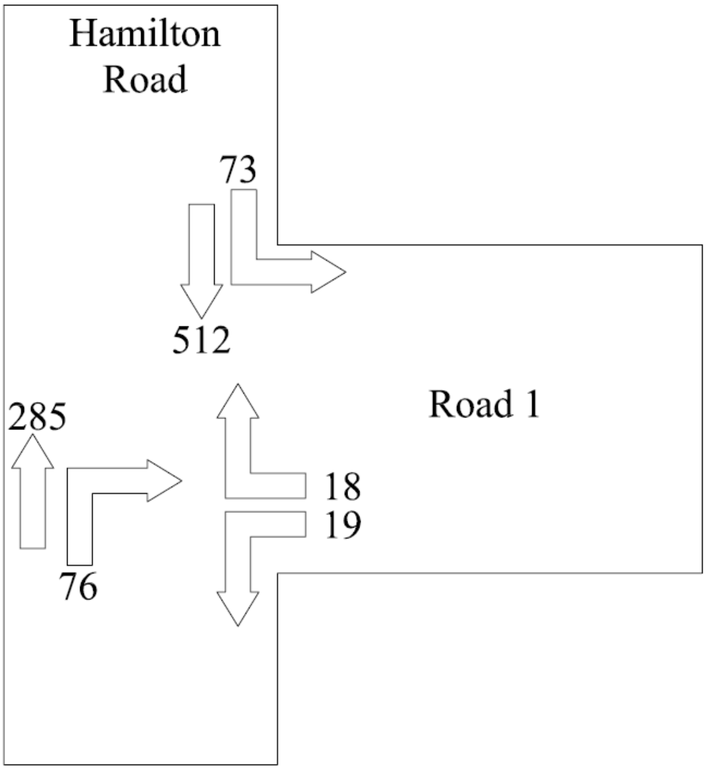


Figure 30 Forecast (year 2018) traffic volumes at intersection of Hamilton Road and Road 1 (PM peak hour)

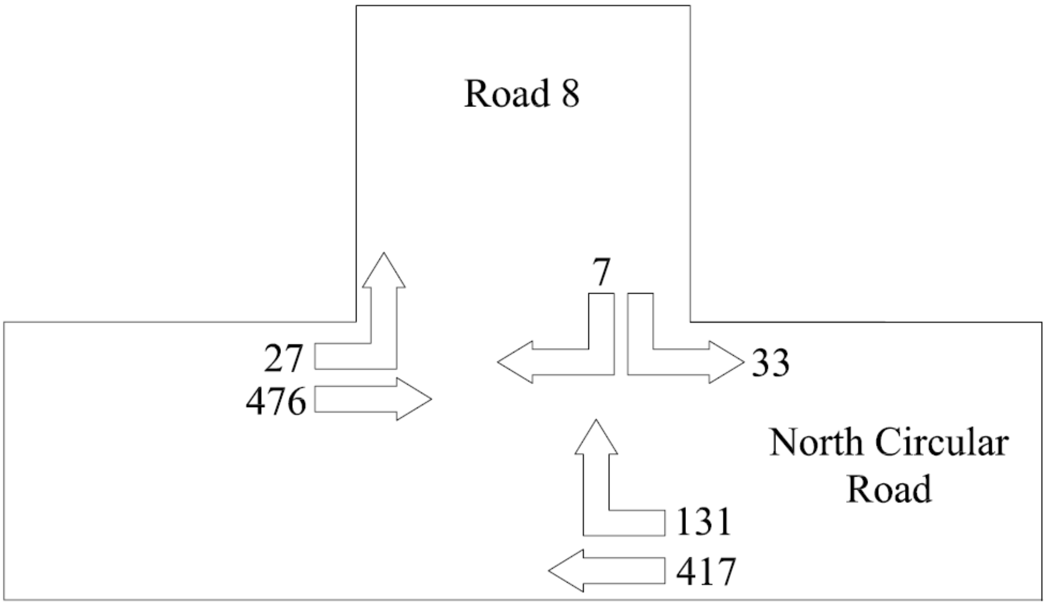


Figure 31 Forecast (year 2018) traffic volumes at intersection of North Circular Road and Road 8 (PM peak hour)

Table 4 Intersection assessment (PM peak hour, year 2018)

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.16	N/ A	2.9m
Road 1	0.14	C	3.3m
Hamilton Road north	0.28	N/ A	0.0m
Overall performance	0.28	N/ A	3.3m
North Circular Road/ Road 8			
North Circular Road east	0.23	N/ A	4.0m
Road 8	0.07	B	1.8m
North Circular Road west	0.26	N/ A	0.0m
Overall performance	0.26	N/ A	4.0m

5.3.5 Year 2021 – external connections to the Hamilton Precinct

Analysis of the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 at build out of the Hamilton Precinct plus eight years demonstrates that the recommended intersection treatments should continue to function adequately. Forecast traffic movements at the two intersections are shown in Figures 32 and 33, respectively. Results derived from SIDRA testing are shown in Table 5. Full movement summaries are provided in Appendix B.

A simulation of conservative traffic conditions in the AM peak hour demonstrated that the critical exiting movements (e.g. right turn from Road 1 on to Hamilton Road and Road 8 on to North Circular Road) would also operate satisfactorily.

The right turn out of Road 1 would operate at LoS D and DoS 0.42 with the average delay about 25 seconds and 95th percentile back of queue about 20 metres. The right turn out of Road 8 would operate at LoS B and DoS 0.29 with the average delay about 14 seconds and 95th percentile back of queue about 9 metres.

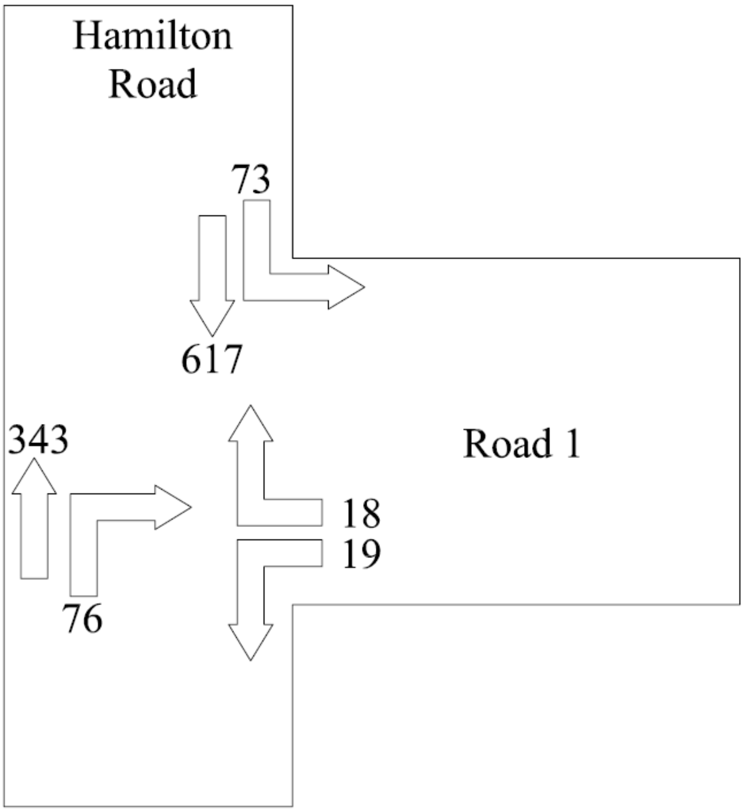


Figure 32 Forecast (year 2021) traffic volumes at intersection of Hamilton Road and Road 1 (PM peak hour)

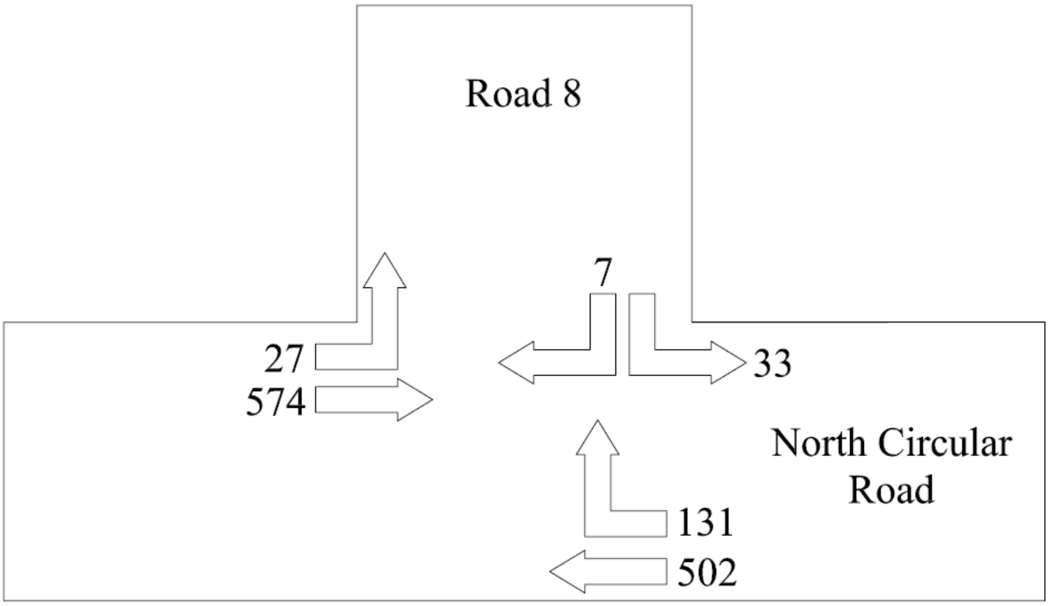


Figure 33 Forecast (year 2021) traffic volumes at intersection of North Circular Road and Road 8 (PM peak hour)

Table 5 Intersection assessment (PM peak hour, year 2021)

Approach	Degree of Saturation	Level of Service	95th Percentile Queue Length (m)
Hamilton Road/ Road 1			
Hamilton Road south	0.19	N/ A	3.3m
Road 1	0.19	D	4.4m
Hamilton Road north	0.34	N/ A	0.0m
Overall performance	0.34	N/ A	4.4m
North Circular Road/ Road 8			
North Circular Road east	0.28	N/ A	4.4m
Road 8	0.09	B	2.1m
North Circular Road west	0.31	N/ A	0.0m
Overall performance	0.31	N/ A	4.4m

5.4 Performance of the internal street network

Total daily forecast traffic likely to distribute across the internal network is about 3,850 vehicles per day (maximum). Ahead of development on adjacent lots (i.e. to the northwest and northeast), there is likely to be negligible through traffic. Non-development traffic is relatively unlikely to cut through the development to avoid the intersection of North Circular Road and Hamilton Road because of the collective time penalty of turning right on to Road 8, turning left on to Road 1 and then right on to Hamilton Road.

The main east-west and north-south internal roads (i.e. Roads 1 and 8) are likely to carry less than about 2,000 vehicles per day at their busiest points. Other internal roads are likely to carry less than 1,000 vehicles per day. The carrying capacity of an access street as per Liveable Neighbourhoods is 3,000 vehicles per day assuming single traffic lanes in both directions and preferably, traffic speeds less than 50 kph. The forecast traffic volumes are therefore well within the capacity of an internal street network planned for local access with single carriageway.

In the longer term, if development eventuates to the north and east, Roads 1 and 8 will have sufficient capacity to carry additional traffic and potentially function as Neighbourhood Connectors, with a practical upper limit of about 5,000 vehicles per day (based on the lack of facility for protected reversing manoeuvres from driveways on to the street). Road 5 is also likely to attract more traffic and assuming it is treated as a lower order road than Roads 1 and 8, to may eventually carry about 1,000-2,000 vehicles per day.

5.5 Impacts of other developments

The ToPH has advised Arup that there are plans for two other new developments in the vicinity of the subject site. These include a mining camp behind the existing TAFE and a proposal to increase the size of the FMG hotel on Hamilton Road. The ToPH was unable to furnish any specific traffic planning information in relation to these (see Appendix A).

However, the annual traffic growth factor supplied by AECOM, which is applied in the earlier traffic analysis assumes new development in various precincts in South Hedland prior to 2013. It is likely that this makes some allowance for these projects. Accordingly, taking any specific traffic forecasts into consideration, if they were available for these two projects, may result in double-counting and therefore an overly conservative traffic scenario.

6 Walking and Cycling

6.1 Proposed internal network and external connections

When integrated with compatible land uses, a high-quality walking and cycling network can:

- Mitigate car dependency for residents;
- Reduce adverse environmental impacts of transport; and
- Facilitate improved personal health and fitness.

Basic infrastructure provisions are proposed within the Hamilton Precinct with emphasis on efficient use of road reserves and legible internal connections, which may be connected with external networks in the future. Excepting laneways, all streets are proposed with a footpath on at least one side with most being 2 metres wide.

Internal shared paths are proposed, which will provide external connections to Hamilton Road and North Circular Road and in the future, to new development to the north and east. The shared paths aligned via the main internal drainage corridors are proposed to be 3 metres in width and are intended to form part of the Town of Port Hedland's strategic shared path network. Other shared paths – particularly the path along Road 1 – are intended to function more as local shared paths. The shared path network will provide off-street cycling facilities for less confident cyclists. This will be particularly important in the future if/ when buses operate along and traffic from new adjoining developments use Roads 1 and 8. On-street cycling is otherwise anticipated, which is appropriate for a local access street network.

The proposed internal walking and cycling network is shown in Figure 34.

As part of detailed design, it is recommended that the following design elements are incorporated:

- Regularly spaced street crossing points (generally, provisions for street crossings will be suitable at intersections rather than midblock, excepting adjacent to public open space);
- Ramped kerbs at crossing points for wheelchairs and prams;
- Grab rails at crossing points to assist the elderly and mobility impaired persons;
- Ample shade to reduce the effects of South Hedland's harsh climate; and
- Regular street lighting.

Arup recommends that the ToPH consider further investment in the South Hedland shared path network as part of its public works programme, which could incorporate connections to/ from the Hamilton Precinct. These infrastructure provisions are not articulated in but could be added to the ToPH's draft Cycle Plan.

Public works should also incorporate crossing provisions at the intersection of North Circular Road and Hamilton Road where there are none currently.

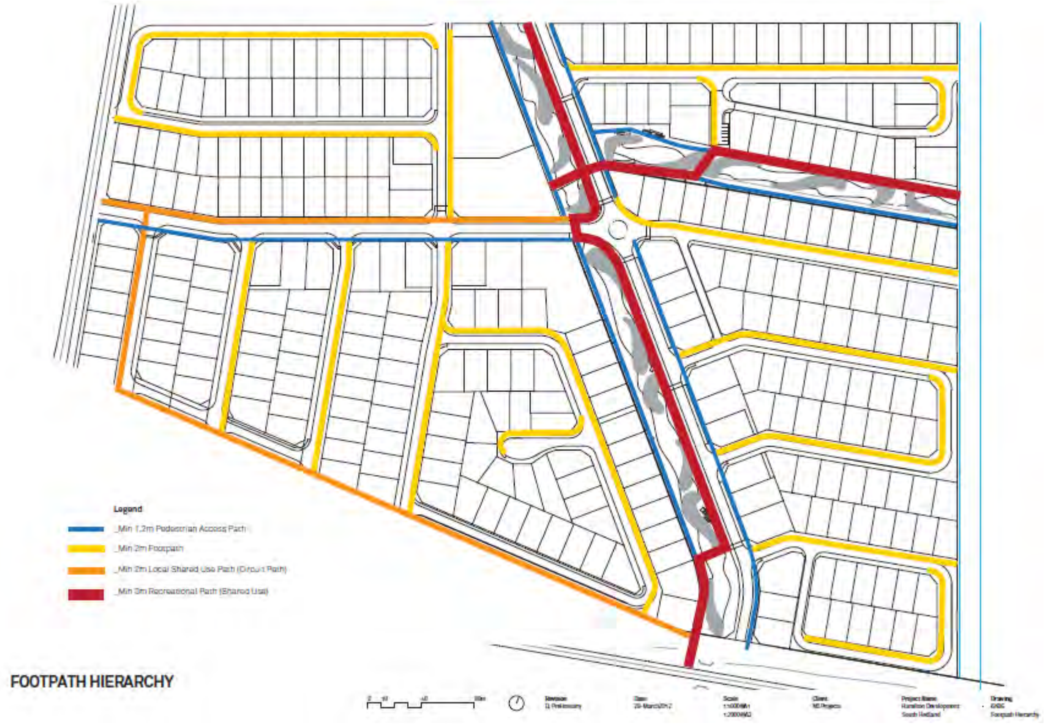


Figure 34 Proposed internal walking and cycling network
(Source: Hassell, March 2012)

6.2 Safe routes to school

Hedland Senior High School is located to the south of the site on the opposite side of North Circular Road. South Hedland Primary School is located further south and is accessible via Parker Street (over a distance of about 1.2 kilometres via the road network).

Given the lack of any shared paths or footpaths along both Hamilton Road and North Circular Road, walking and cycling access to the schools is generally unsafe and unattractive.

7 Public Transport

There are few public transport services currently operating in Hedland and these are not easily accessed from the Hamilton Precinct. The PTA has advised that there are no plans to extend services to the precinct. Thus, the public transport mode share for residents of the Hamilton Precinct is forecast to be close to zero for the foreseeable future. However, to future-proof the development, Roads 1 and 8 are being designed with 7.2 metre carriageway, which is more than sufficient to accommodate buses.

8 Car Parking

Parking for residents should be provided on individual lots as per the stipulations of the *Residential Design Codes*. On-street visitor car parking is considered the most efficient and appropriate method for provision of visitor car parking for residential access streets. The ToPH has indicated that on-street parking should only be provided on the spine routes (e.g. Roads 1 and 8) and verge parking catered for on other internal streets as the preferred alternative.

9 Conclusions

Arup has prepared this Transport Assessment Report to outline the transport access and circulation provisions associated with the proposed Hamilton Precinct subdivision in South Hedland. We have also considered the likely vehicle trip generation associated with the development, the assignment of traffic to the internal and external road networks, and the likely impacts on key intersections.

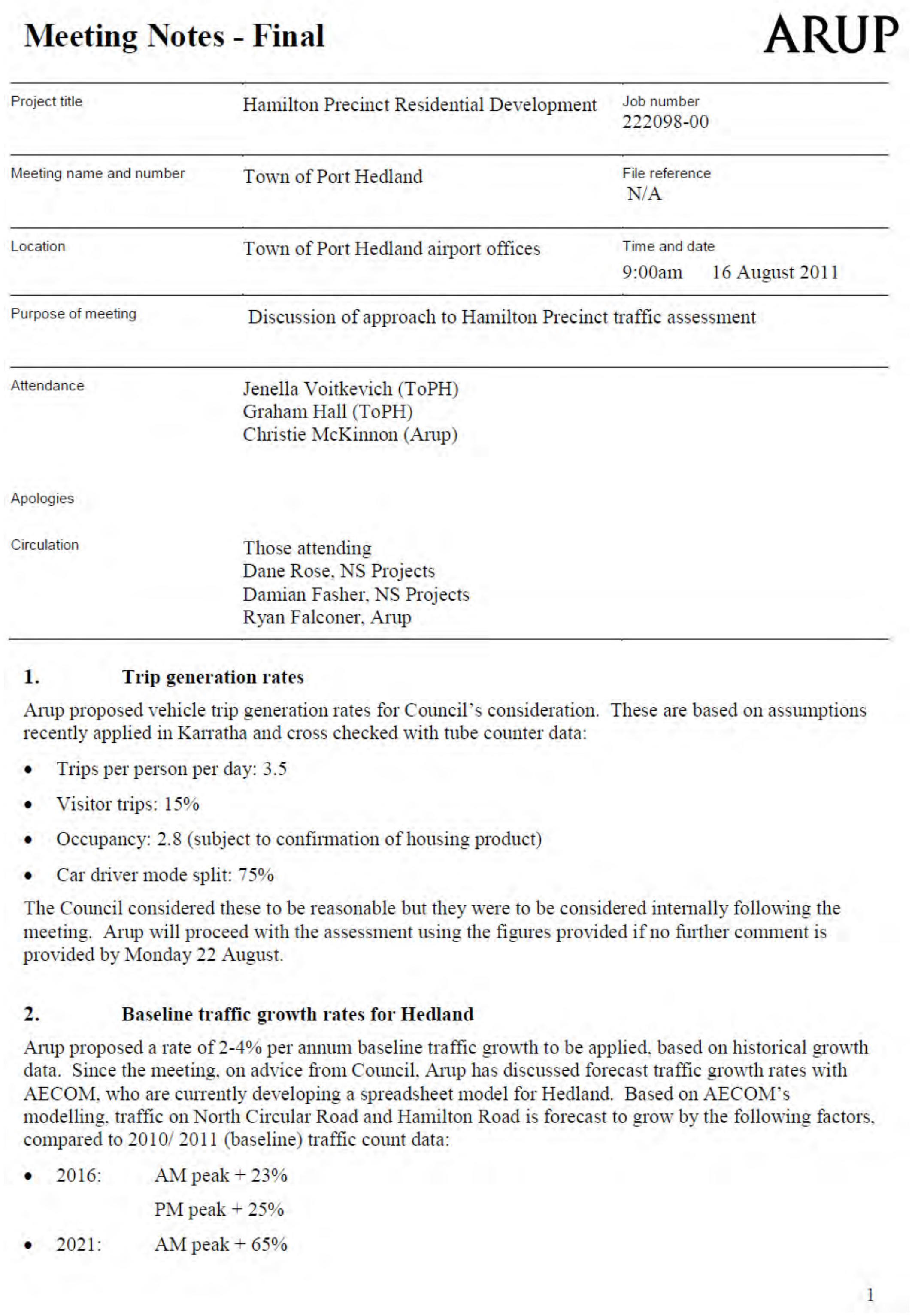
The key assumptions applied in and findings of the Report are as follows:

- The ultimate development year is 2013
- Traffic generation for the site has been determined using first principles and engineering judgement and validated through a comparison with recent (relevant) residential traffic count data. Assumptions regarding dwelling yield and occupancy has been provided by other members of the project team
- The forecast traffic generation from the 440 dwelling development is expected to be approximately 3,828 vehicles per day. Approximately 10% of development traffic is forecast to be generated in the PM peak hour and about 8% in the AM peak hour, corresponding to 383 and 306 trips, respectively
- Traffic was assigned to the internal and external network by applying assumptions regarding external distribution and using a basic spreadsheet assignment model
- Background traffic volumes on the existing external network (specifically Hamilton Road and North Circular Road) are forecast to grow by 25% between 2011 and 2016. Arup has derived a *per annum* growth rate and applied this to spot count data collected at key locations during the PM peak hour. Background traffic was also forecast for 2018 and 2021 based on growth assumptions provided by AECOM
- The assessment of key intersections using SIDRA software related to the PM peak hour on the basis that background traffic is about 30% higher in the PM compared to the AM peak hour. This means that opposing flows on external streets will be highest in the PM peak hour. Some additional sensitivity testing was conducted applying the higher oppositional flows on the external network expected in the PM peak hour and the higher outbound flows anticipated in the AM peak hour compared to the PM peak. This was to make sure that sufficient (and safe) turning capacity out of the development, via Roads 1 and 8, is being provided
- All intersections tested are anticipated to function adequately under priority control at build out of the Hamilton Precinct. The Report recommends provision of right turn pockets (e.g. channelization) and left turn auxiliary lanes at the intersections of Hamilton Road/ Road 1 and North Circular Road/ Road 8 to aid efficient traffic movement and for safety purposes. Some other external intersection upgrades are recommended for the ToPH to consider as part of its public works programme
- An integrated internal network of footpaths is being constructed to support walking, particularly for leisure purposes. In addition, a shared path network is proposed, aligned along Roads 1 and 8, and the main drainage corridors. Other internal roads are likely to support on-street cycling.

- Public transport services do not currently operate within walking distance (400 metres) of the Hamilton Precinct and the PTA has no current plans to modify their operating schedule. However, Roads 1 and 8 within the proposed development are being future proofed to accommodate services should they be introduced in the future
- Parking for residents is generally to be supplied on individual lots. Some provisions for visitor parking are being made on the spine routes (e.g. Roads 1 and 8) while some verge parking is likely to occur elsewhere

It can be concluded that the development will incorporate sufficient transport provisions to support efficient access and is future-proofed to enable development of adjoining land to the northwest and northeast.

Appendix A – Finalised notes from meeting with the Town of Port Hedland



Meeting Notes - Final

ARUP

Project title	Hamilton Precinct Residential Development	Job number 222098-00
Meeting name and number	Town of Port Hedland	File reference N/A
Location	Town of Port Hedland airport offices	Time and date 9:00am 16 August 2011
Purpose of meeting	Discussion of approach to Hamilton Precinct traffic assessment	
Attendance	Jenella Voitkevich (ToPH) Graham Hall (ToPH) Christie McKinnon (Arup)	
Apologies		
Circulation	Those attending Dane Rose, NS Projects Damian Fasher, NS Projects Ryan Falconer, Arup	

1. Trip generation rates

Arup proposed vehicle trip generation rates for Council's consideration. These are based on assumptions recently applied in Karratha and cross checked with tube counter data:

- Trips per person per day: 3.5
- Visitor trips: 15%
- Occupancy: 2.8 (subject to confirmation of housing product)
- Car driver mode split: 75%

The Council considered these to be reasonable but they were to be considered internally following the meeting. Arup will proceed with the assessment using the figures provided if no further comment is provided by Monday 22 August.

2. Baseline traffic growth rates for Hedland

Arup proposed a rate of 2-4% per annum baseline traffic growth to be applied, based on historical growth data. Since the meeting, on advice from Council, Arup has discussed forecast traffic growth rates with AECOM, who are currently developing a spreadsheet model for Hedland. Based on AECOM's modelling, traffic on North Circular Road and Hamilton Road is forecast to grow by the following factors, compared to 2010/ 2011 (baseline) traffic count data:

- 2016: AM peak + 23%
  PM peak + 25%
- 2021: AM peak + 65%

1

PM peak + 65%

- 2031: AM peak + 108%
  PM peak + 115%

NB: A per annum rate of growth may be back-cast from this information and then applied to current traffic count data to provide a context for assessment of the ultimate development year. The traffic assessment is likely to be conservative because there will be some double counting of vehicle trips generated by the Hamilton Precinct.

3. Intersections to be analysed

Arup proposed that the intersections of North Circular Road and the South Development Access, and Hamilton Road and the West Development Access be included in the traffic assessment. Other external intersections are not considered to be greatly impacted by the development. This approach was agreed with Council.

It is noted that the second southern access, on the western side of the drain, is not likely to be constructed as part of the current scoped works.

4. Intersection treatments for connections to Council roads

Arup proposed that a rural channelised treatment is likely to be appropriate for the two external intersections. Council advised that this would be acceptable and appropriate left and right turning lanes should be provided.

Arup believes that this is appropriate, subject to assessment of intersection operation. It is noted that in the longer term, when the character of the area changes and more urban development unfolds, it is likely to be appropriate for the intersections to be upgraded to reflect the urban character although this is not anticipated as part of the current works.

5. Cross-sections

Arup discussed the current concept subdivision plan and outlined the development intent (e.g. to create a permeable residential community). Council raised concerns with the proposed road reserves and noted that road reserve widths of less than 15m for standard residential roads will not be accepted, as per the Design Standards for New Residential Developments issued to the project team on 2 August.

Arup queried the rationale behind the minimum road reserve requirement, noting the likely low forecast traffic volumes. Council identified that they require a minimum road pavement width of 6m to allow for the large vehicles that are common in Hedland. In addition, 4.5m will be required for verge on each side of the road to allow for services. Arup notes that this minimum pavement requirement does not allow for any internal streets to function as yield streets on the basis that on-street parking is not favoured (see below).

Arup notes that these are considered standard verge requirements. Comment will be required from the project civil engineers on the actual minimum requirement for the project so that this may then be taken into account by Council.

The 6m laneways for rear access lots were discussed. The proposed laneway widths would be considered appropriate by Council providing services can gain access as necessary.

Meeting Notes - Final

The 17m road reserves would be acceptable to Council assuming a 7.2m pavement is provided to potentially provide bus access in the future. Arup notes that the Public Transport Authority accepts 3.5m lanes on greenfields sites and therefore a reduction to 7m should be acceptable.

The possibility was discussed with Council of other deviations to the road reserve widths as presented in the Design Standards for New Residential Developments. Council identified that road reserve widths may be altered alongside the public open space (POS) to less than 15m. However, carriageways must remain at a 6m minimum. The Council will require at least a 2m verge adjacent to the drain POS to provide for services. However, a path can be within POS as long as it does not encroach on the drain itself.

Council noted that footpaths should not be provided on both sides of roads. Council's position is that this reduces maintenance requirements. Arup considers that paths should be considered on both sides of the wider, central streets (e.g. 17m reserves).

Council also noted that on-street parking is not preferred. Instead, allowances should be made for informal verge parking. Intermittent parking between landscaping nibs was suggested as an option. However, this is considered to increase construction and maintenance costs. In general, it is Council's view that specific parking provisions should only be necessary in the vicinity of the proposed retail. It is Arup's view, that where cross sections allow, on-street parking could be considered as it can provide for visitor parking and assist with speed management appropriate in a new residential development.

NB: On Friday 19 August, Ryan Falconer (Arup) discussed these requirements with the ToPH in a follow up conversation. Council reiterated its position that verge widths of 4.5m are standard practice in the Town to meet infrastructure requirements and deviations are not generally accepted. Specifically, ample width must be retained for informal verge parking as on-street parking is not accepted outside of mixed use/ commercial precincts. Council is prepared to consider a standard road reserve width of 15m (excepting the potential future bus route), on the basis that a suitable argument regarding capacity can be articulated. Council also noted that they had already reviewed a draft subdivision plan that shows reserve widths at 15m. Arup noted that the project team would be considering reduced development setbacks to offset the widening of road reserves required based on the current development plan. It was agreed that this would be a matter for consideration by Council's planning staff.

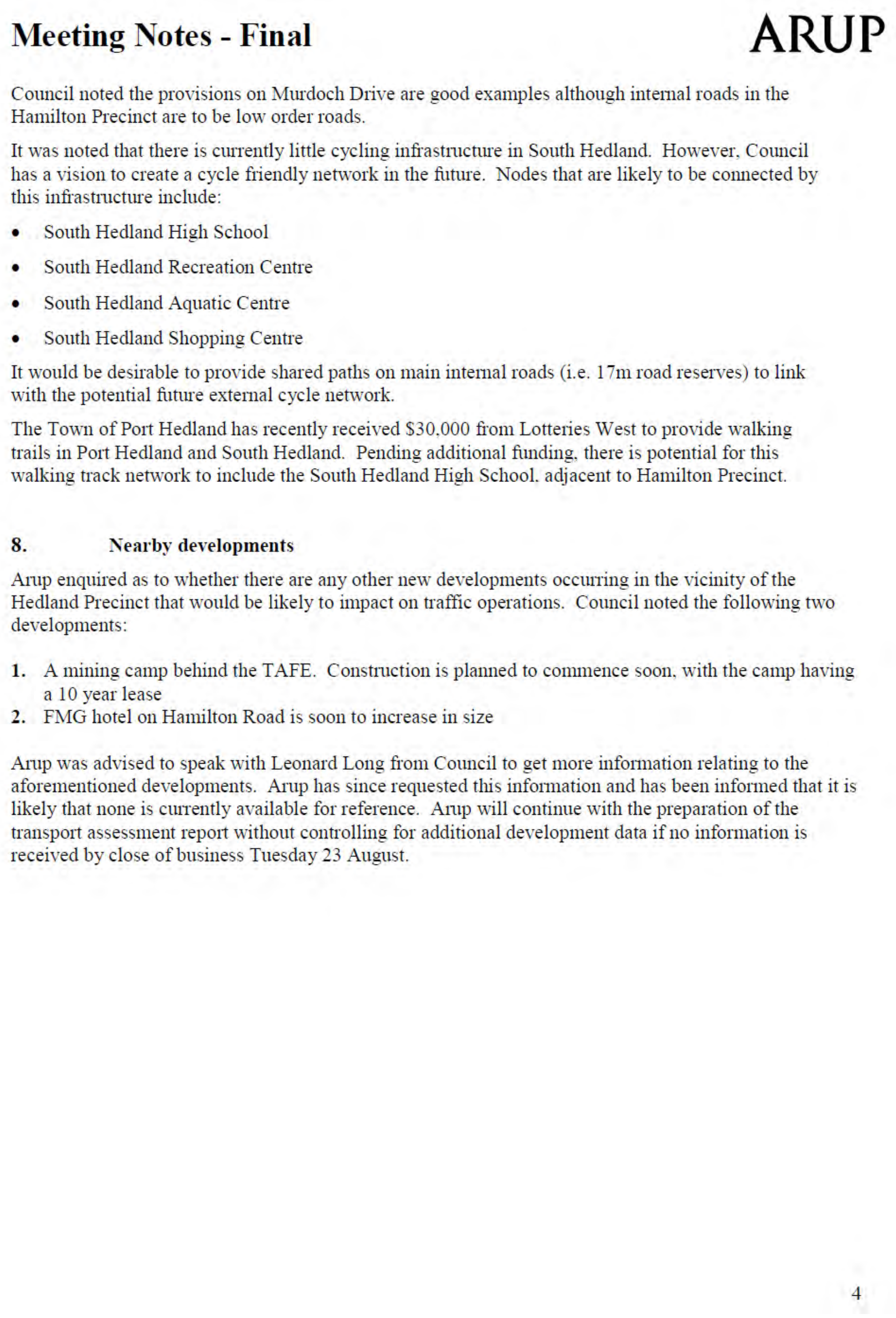
6. Internal road network

Arup requested any general comments on the internal street network and provision of external links. Council noted that a public access easement at the southwest of the site is not considered acceptable. They would prefer either culs-de-sac treatments or a formal road reserve for access.

Council also specified that the access road at the northeast corner of the site will need to be designed as a cul-de-sac to allow service vehicles (i.e. rubbish trucks) to turn around. Arup notes that this would be one option with allowance for a future connection to the east in this location an alternative.

7. Current and future cycle/ pedestrian network infrastructure

Arup discussed internal provisions for pedestrians and cyclists and outlined the intent for the development to link with external provisions in Council's Bike Plan and potential future infrastructure. Council noted that shared paths for cyclist are preferred over on-street cycle paths and that ideally these would have a width of three metres. Arup notes that 2.5m would be adequate for shared paths in this location, which is consistent with the Liveable Neighbourhoods Design Guidelines. However, in the follow up conversation on 19 August, Council noted that the intent with provision of new shared paths is to create consistency in the Town and 3m is the typical width for these.



Council noted the provisions on Murdoch Drive are good examples although internal roads in the Hamilton Precinct are to be low order roads.

It was noted that there is currently little cycling infrastructure in South Hedland. However, Council has a vision to create a cycle friendly network in the future. Nodes that are likely to be connected by this infrastructure include:

- South Hedland High School
- South Hedland Recreation Centre
- South Hedland Aquatic Centre
- South Hedland Shopping Centre

It would be desirable to provide shared paths on main internal roads (i.e. 17m road reserves) to link with the potential future external cycle network.

The Town of Port Hedland has recently received $30,000 from Lotteries West to provide walking trails in Port Hedland and South Hedland. Pending additional funding, there is potential for this walking track network to include the South Hedland High School, adjacent to Hamilton Precinct.

8. Nearby developments

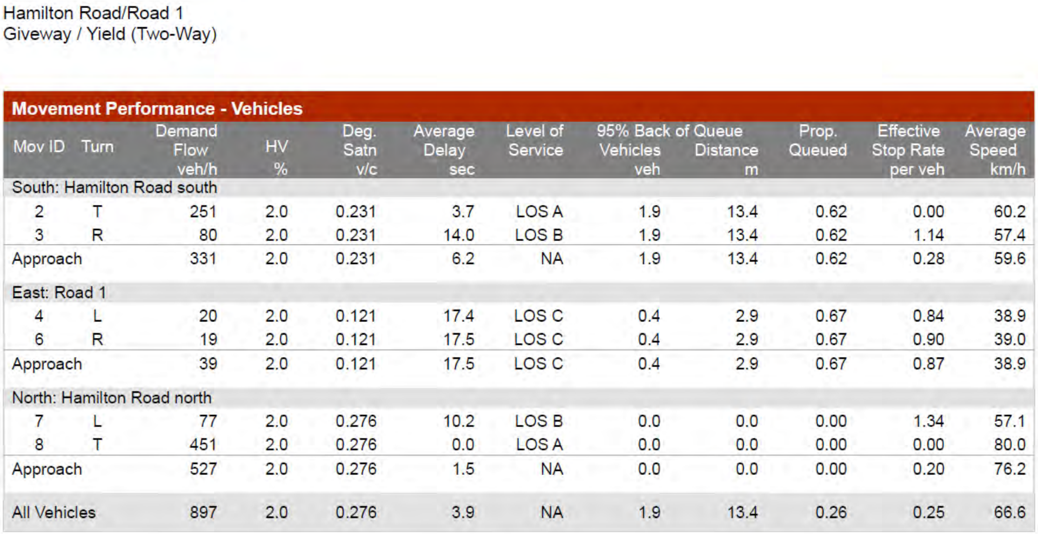
Arup enquired as to whether there are any other new developments occurring in the vicinity of the Hedland Precinct that would be likely to impact on traffic operations. Council noted the following two developments:

1. A mining camp behind the TAFE. Construction is planned to commence soon, with the camp having a 10 year lease
2. FMG hotel on Hamilton Road is soon to increase in size

Arup was advised to speak with Leonard Long from Council to get more information relating to the aforementioned developments. Arup has since requested this information and has been informed that it is likely that none is currently available for reference. Arup will continue with the preparation of the transport assessment report without controlling for additional development data if no information is received by close of business Tuesday 23 August.

Appendix B – SIDRA analysis: movement summaries

B1 – Hamilton Road/ Road 1 (BAR/ BAL) (year 2013, PM peak hour)

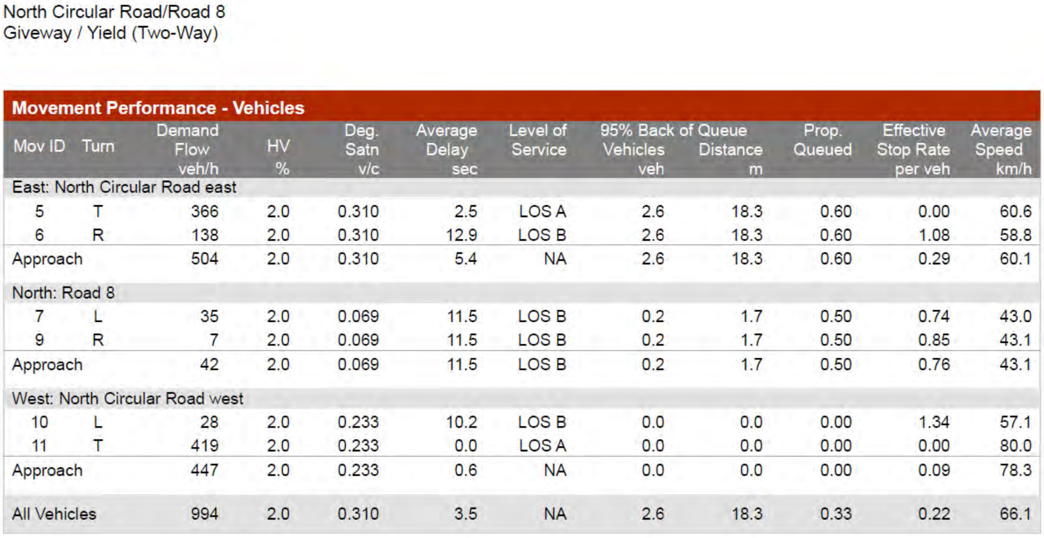


Hamilton Road/Road 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	251	2.0	0.231	3.7	LOS A	1.9	13.4	0.62	0.00	60.2
3	R	80	2.0	0.231	14.0	LOS B	1.9	13.4	0.62	1.14	57.4
Approach		331	2.0	0.231	6.2	NA	1.9	13.4	0.62	0.28	59.6
East: Road 1											
4	L	20	2.0	0.121	17.4	LOS C	0.4	2.9	0.67	0.84	38.9
6	R	19	2.0	0.121	17.5	LOS C	0.4	2.9	0.67	0.90	39.0
Approach		39	2.0	0.121	17.5	LOS C	0.4	2.9	0.67	0.87	38.9
North: Hamilton Road north											
7	L	77	2.0	0.276	10.2	LOS B	0.0	0.0	0.00	1.34	57.1
8	T	451	2.0	0.276	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		527	2.0	0.276	1.5	NA	0.0	0.0	0.00	0.20	76.2
All Vehicles		897	2.0	0.276	3.9	NA	1.9	13.4	0.26	0.25	66.6

B2 – North Circular Road/ Road 8 (BAR/ BAL) (year 2013, PM peak hour)

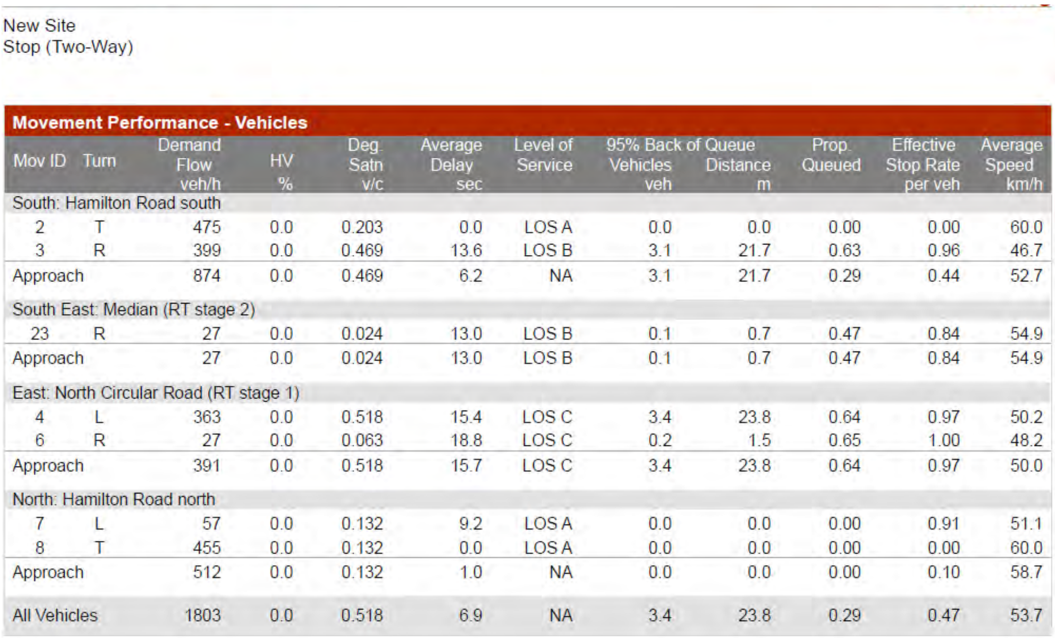


North Circular Road/Road 8
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: North Circular Road east											
5	T	366	2.0	0.310	2.5	LOS A	2.6	18.3	0.60	0.00	60.6
6	R	138	2.0	0.310	12.9	LOS B	2.6	18.3	0.60	1.08	58.8
Approach		504	2.0	0.310	5.4	NA	2.6	18.3	0.60	0.29	60.1
North: Road 8											
7	L	35	2.0	0.069	11.5	LOS B	0.2	1.7	0.50	0.74	43.0
9	R	7	2.0	0.069	11.5	LOS B	0.2	1.7	0.50	0.85	43.1
Approach		42	2.0	0.069	11.5	LOS B	0.2	1.7	0.50	0.76	43.1
West: North Circular Road west											
10	L	28	2.0	0.233	10.2	LOS B	0.0	0.0	0.00	1.34	57.1
11	T	419	2.0	0.233	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		447	2.0	0.233	0.6	NA	0.0	0.0	0.00	0.09	78.3
All Vehicles		994	2.0	0.310	3.5	NA	2.6	18.3	0.33	0.22	66.1

B3 – Hamilton Road/ North Circular Road (development traffic) (year 2013, PM peak hour)

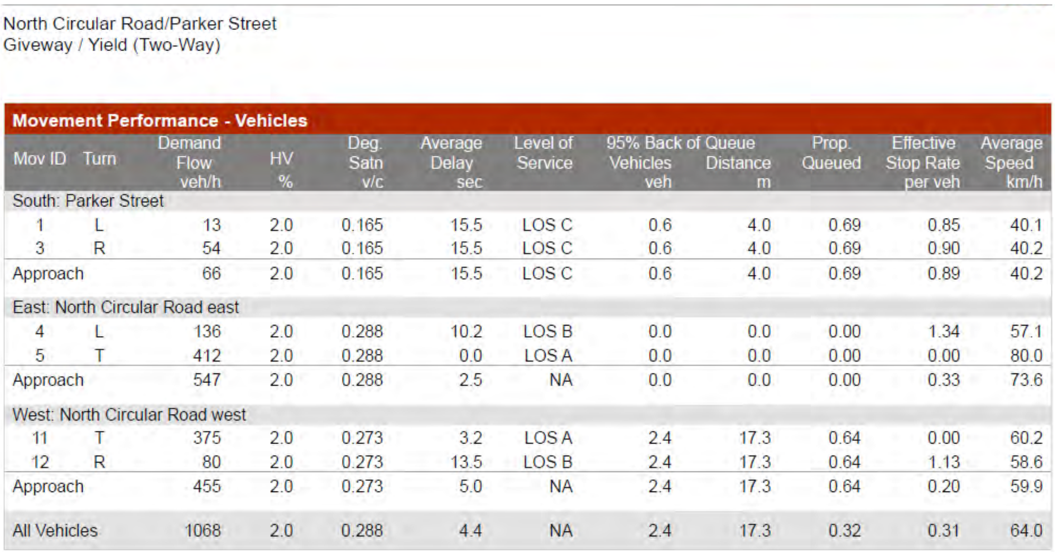


New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	475	0.0	0.203	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R	399	0.0	0.469	13.6	LOS B	3.1	21.7	0.63	0.96	46.7
Approach		874	0.0	0.469	6.2	NA	3.1	21.7	0.29	0.44	52.7
South East: Median (RT stage 2)											
23	R	27	0.0	0.024	13.0	LOS B	0.1	0.7	0.47	0.84	54.9
Approach		27	0.0	0.024	13.0	LOS B	0.1	0.7	0.47	0.84	54.9
East: North Circular Road (RT stage 1)											
4	L	363	0.0	0.518	15.4	LOS C	3.4	23.8	0.64	0.97	50.2
6	R	27	0.0	0.063	18.8	LOS C	0.2	1.5	0.65	1.00	48.2
Approach		391	0.0	0.518	15.7	LOS C	3.4	23.8	0.64	0.97	50.0
North: Hamilton Road north											
7	L	57	0.0	0.132	9.2	LOS A	0.0	0.0	0.00	0.91	51.1
8	T	455	0.0	0.132	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		512	0.0	0.132	1.0	NA	0.0	0.0	0.00	0.10	58.7
All Vehicles		1803	0.0	0.518	6.9	NA	3.4	23.8	0.29	0.47	53.7

B4 – North Circular Road / Parker Street (development traffic) (year 2013, PM peak hour)

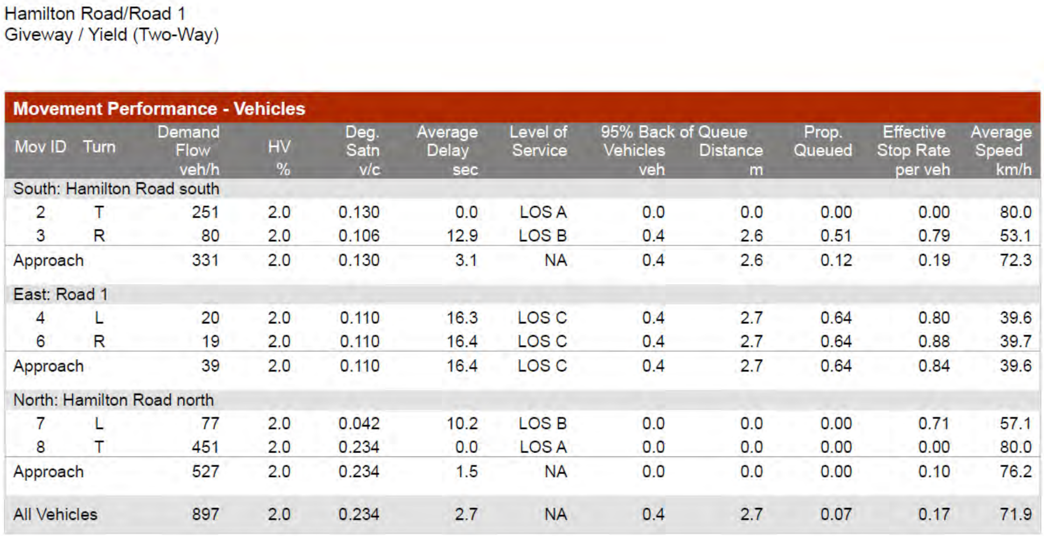


North Circular Road/Parker Street
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Parker Street											
1	L	13	2.0	0.165	15.5	LOS C	0.6	4.0	0.69	0.85	40.1
3	R	54	2.0	0.165	15.5	LOS C	0.6	4.0	0.69	0.90	40.2
Approach		66	2.0	0.165	15.5	LOS C	0.6	4.0	0.69	0.89	40.2
East: North Circular Road east											
4	L	136	2.0	0.288	10.2	LOS B	0.0	0.0	0.00	1.34	57.1
5	T	412	2.0	0.288	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		547	2.0	0.288	2.5	NA	0.0	0.0	0.00	0.33	73.6
West: North Circular Road west											
11	T	375	2.0	0.273	3.2	LOS A	2.4	17.3	0.64	0.00	60.2
12	R	80	2.0	0.273	13.5	LOS B	2.4	17.3	0.64	1.13	58.6
Approach		455	2.0	0.273	5.0	NA	2.4	17.3	0.64	0.20	59.9
All Vehicles		1068	2.0	0.288	4.4	NA	2.4	17.3	0.32	0.31	64.0

B5 – Hamilton Road/ Road 1 [CHR/ AUL(S)] (year 2013, PM peak hour)

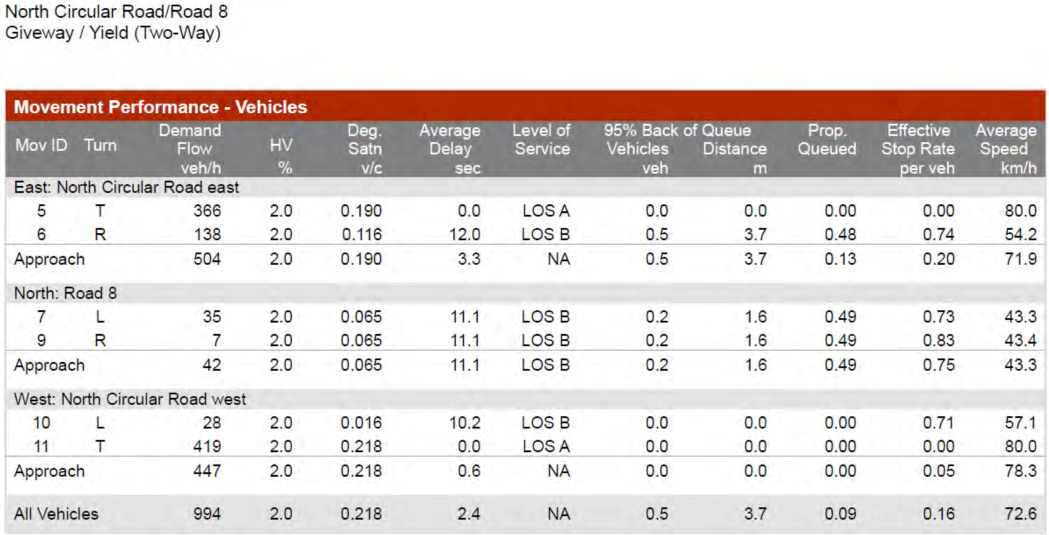


Hamilton Road/Road 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	251	2.0	0.130	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	80	2.0	0.106	12.9	LOS B	0.4	2.6	0.51	0.79	53.1
Approach		331	2.0	0.130	3.1	NA	0.4	2.6	0.12	0.19	72.3
East: Road 1											
4	L	20	2.0	0.110	16.3	LOS C	0.4	2.7	0.64	0.80	39.6
6	R	19	2.0	0.110	16.4	LOS C	0.4	2.7	0.64	0.88	39.7
Approach		39	2.0	0.110	16.4	LOS C	0.4	2.7	0.64	0.84	39.6
North: Hamilton Road north											
7	L	77	2.0	0.042	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
8	T	451	2.0	0.234	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		527	2.0	0.234	1.5	NA	0.0	0.0	0.00	0.10	76.2
All Vehicles		897	2.0	0.234	2.7	NA	0.4	2.7	0.07	0.17	71.9

B6 – North Circular Road/ Road 8 [CHR/ AUL(S)] (year 2013, PM peak hour)

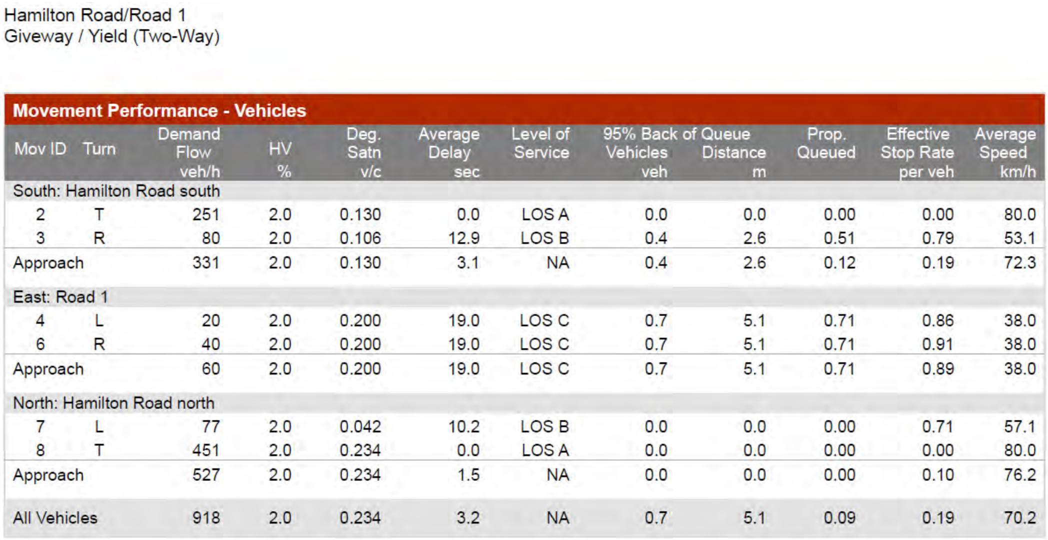


North Circular Road/Road 8
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: North Circular Road east											
5	T	366	2.0	0.190	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
6	R	138	2.0	0.116	12.0	LOS B	0.5	3.7	0.48	0.74	54.2
Approach		504	2.0	0.190	3.3	NA	0.5	3.7	0.13	0.20	71.9
North: Road 8											
7	L	35	2.0	0.065	11.1	LOS B	0.2	1.6	0.49	0.73	43.3
9	R	7	2.0	0.065	11.1	LOS B	0.2	1.6	0.49	0.83	43.4
Approach		42	2.0	0.065	11.1	LOS B	0.2	1.6	0.49	0.75	43.3
West: North Circular Road west											
10	L	28	2.0	0.016	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
11	T	419	2.0	0.218	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		447	2.0	0.218	0.6	NA	0.0	0.0	0.00	0.05	78.3
All Vehicles		994	2.0	0.218	2.4	NA	0.5	3.7	0.09	0.16	72.6

B7 – Hamilton Road/ Road 1 (redistribution of traffic) (year 2013, PM peak hour)

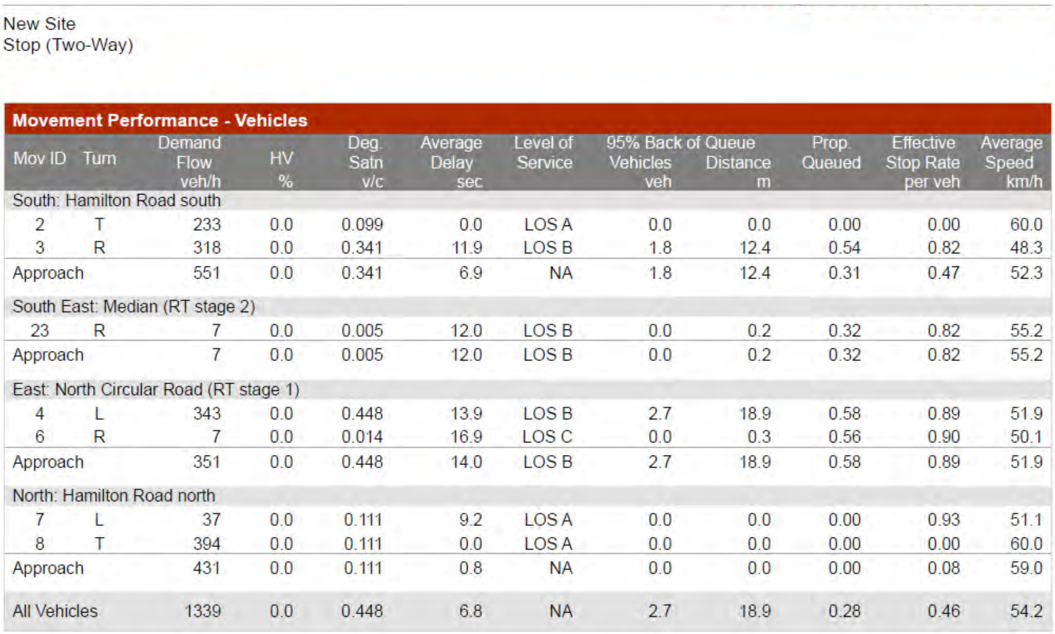


Hamilton Road/Road 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	251	2.0	0.130	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	80	2.0	0.106	12.9	LOS B	0.4	2.6	0.51	0.79	53.1
Approach		331	2.0	0.130	3.1	NA	0.4	2.6	0.12	0.19	72.3
East: Road 1											
4	L	20	2.0	0.200	19.0	LOS C	0.7	5.1	0.71	0.86	38.0
6	R	40	2.0	0.200	19.0	LOS C	0.7	5.1	0.71	0.91	38.0
Approach		60	2.0	0.200	19.0	LOS C	0.7	5.1	0.71	0.89	38.0
North: Hamilton Road north											
7	L	77	2.0	0.042	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
8	T	451	2.0	0.234	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		527	2.0	0.234	1.5	NA	0.0	0.0	0.00	0.10	76.2
All Vehicles		918	2.0	0.234	3.2	NA	0.7	5.1	0.09	0.19	70.2

B8 – Hamilton Road/ North Circular Road (redistribution of traffic) (year 2013, PM peak hour)

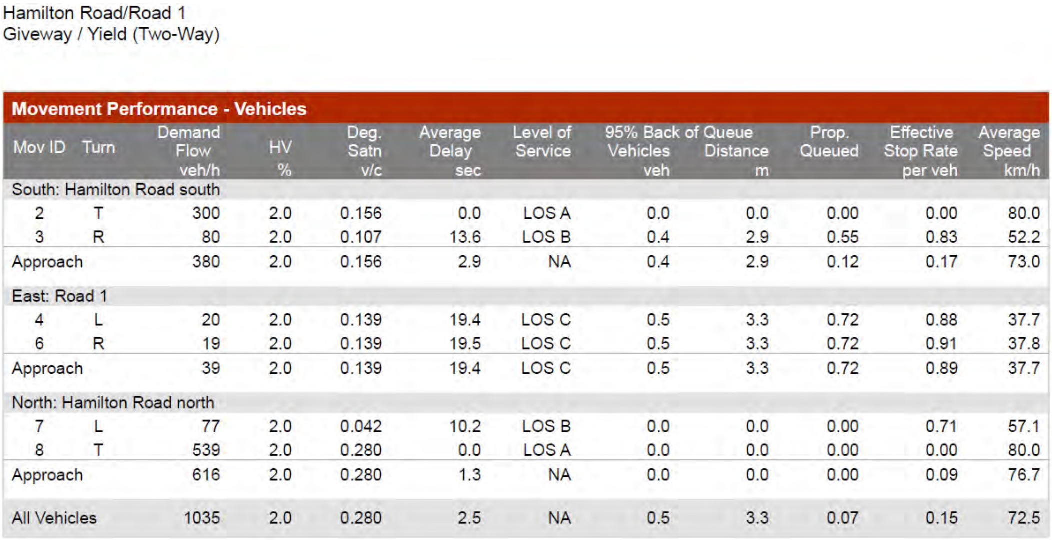


New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	233	0.0	0.099	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R	318	0.0	0.341	11.9	LOS B	1.8	12.4	0.54	0.82	48.3
Approach		551	0.0	0.341	6.9	NA	1.8	12.4	0.31	0.47	52.3
South East: Median (RT stage 2)											
23	R	7	0.0	0.005	12.0	LOS B	0.0	0.2	0.32	0.82	55.2
Approach		7	0.0	0.005	12.0	LOS B	0.0	0.2	0.32	0.82	55.2
East: North Circular Road (RT stage 1)											
4	L	343	0.0	0.448	13.9	LOS B	2.7	18.9	0.58	0.89	51.9
6	R	7	0.0	0.014	16.9	LOS C	0.0	0.3	0.56	0.90	50.1
Approach		351	0.0	0.448	14.0	LOS B	2.7	18.9	0.58	0.89	51.9
North: Hamilton Road north											
7	L	37	0.0	0.111	9.2	LOS A	0.0	0.0	0.00	0.93	51.1
8	T	394	0.0	0.111	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		431	0.0	0.111	0.8	NA	0.0	0.0	0.00	0.08	59.0
All Vehicles		1339	0.0	0.448	6.8	NA	2.7	18.9	0.28	0.46	54.2

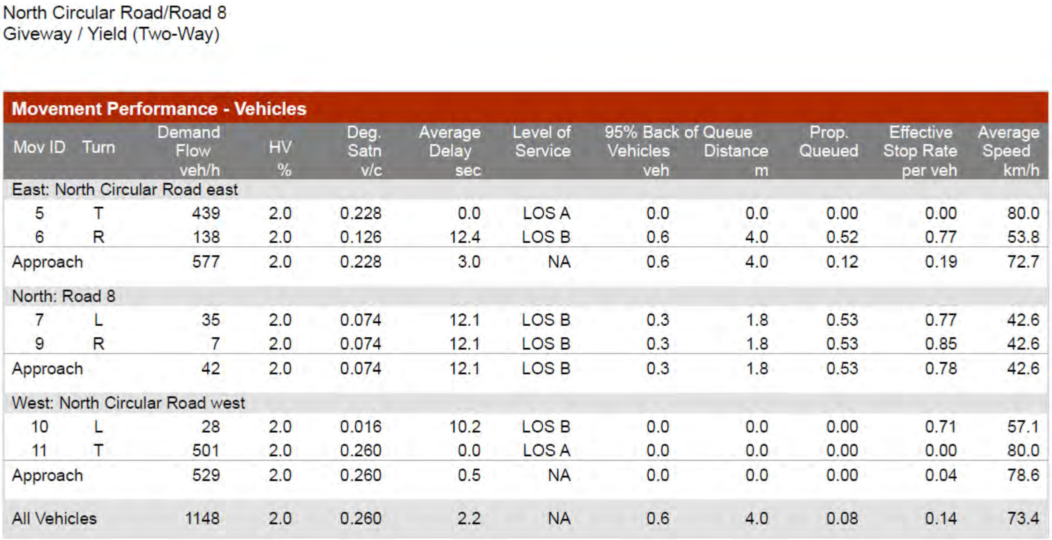
B9 – Hamilton Road/ Road 1 (year 2018, PM peak hour)


Hamilton Road/Road 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	300	2.0	0.156	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	80	2.0	0.107	13.6	LOS B	0.4	2.9	0.55	0.83	52.2
Approach		380	2.0	0.156	2.9	NA	0.4	2.9	0.12	0.17	73.0
East: Road 1											
4	L	20	2.0	0.139	19.4	LOS C	0.5	3.3	0.72	0.88	37.7
6	R	19	2.0	0.139	19.5	LOS C	0.5	3.3	0.72	0.91	37.8
Approach		39	2.0	0.139	19.4	LOS C	0.5	3.3	0.72	0.89	37.7
North: Hamilton Road north											
7	L	77	2.0	0.042	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
8	T	539	2.0	0.280	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		616	2.0	0.280	1.3	NA	0.0	0.0	0.00	0.09	76.7
All Vehicles		1035	2.0	0.280	2.5	NA	0.5	3.3	0.07	0.15	72.5

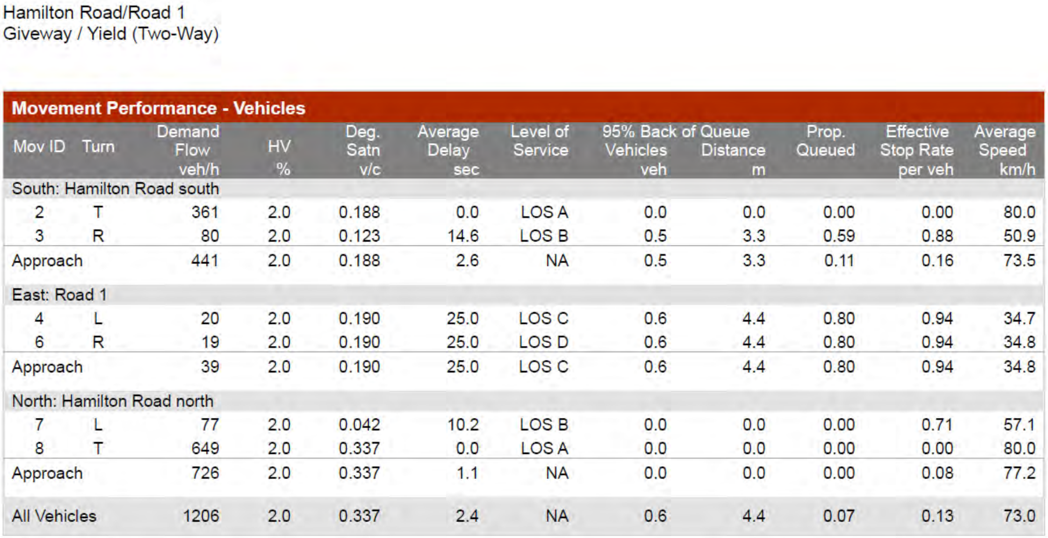
B10 – North Circular Road/ Road 8 (year 2018, PM peak hour)


North Circular Road/Road 8
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: North Circular Road east											
5	T	439	2.0	0.228	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
6	R	138	2.0	0.126	12.4	LOS B	0.6	4.0	0.52	0.77	53.8
Approach		577	2.0	0.228	3.0	NA	0.6	4.0	0.12	0.19	72.7
North: Road 8											
7	L	35	2.0	0.074	12.1	LOS B	0.3	1.8	0.53	0.77	42.6
9	R	7	2.0	0.074	12.1	LOS B	0.3	1.8	0.53	0.85	42.6
Approach		42	2.0	0.074	12.1	LOS B	0.3	1.8	0.53	0.78	42.6
West: North Circular Road west											
10	L	28	2.0	0.016	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
11	T	501	2.0	0.260	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		529	2.0	0.260	0.5	NA	0.0	0.0	0.00	0.04	78.6
All Vehicles		1148	2.0	0.260	2.2	NA	0.6	4.0	0.08	0.14	73.4

B11 –Hamilton Road/ Road 1 (year 2021, PM peak hour)

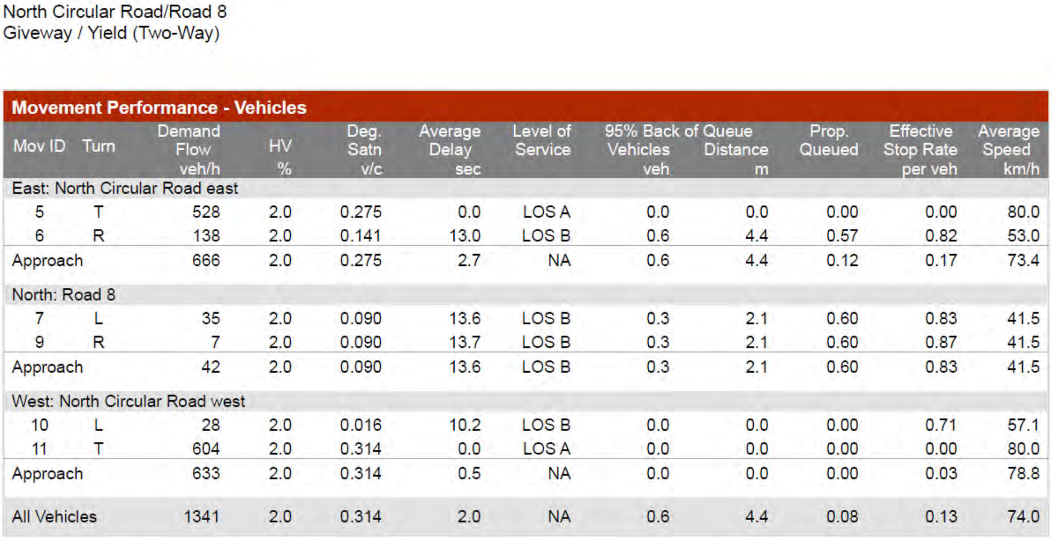


Hamilton Road/Road 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hamilton Road south											
2	T	361	2.0	0.188	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	80	2.0	0.123	14.6	LOS B	0.5	3.3	0.59	0.88	50.9
Approach		441	2.0	0.188	2.6	NA	0.5	3.3	0.11	0.16	73.5
East: Road 1											
4	L	20	2.0	0.190	25.0	LOS C	0.6	4.4	0.80	0.94	34.7
6	R	19	2.0	0.190	25.0	LOS D	0.6	4.4	0.80	0.94	34.8
Approach		39	2.0	0.190	25.0	LOS C	0.6	4.4	0.80	0.94	34.8
North: Hamilton Road north											
7	L	77	2.0	0.042	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
8	T	649	2.0	0.337	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		726	2.0	0.337	1.1	NA	0.0	0.0	0.00	0.08	77.2
All Vehicles		1206	2.0	0.337	2.4	NA	0.6	4.4	0.07	0.13	73.0

B12 –Hamilton Road/ Road 8 (year 2021, PM peak hour)



North Circular Road/Road 8
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: North Circular Road east											
5	T	528	2.0	0.275	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
6	R	138	2.0	0.141	13.0	LOS B	0.6	4.4	0.57	0.82	53.0
Approach		666	2.0	0.275	2.7	NA	0.6	4.4	0.12	0.17	73.4
North: Road 8											
7	L	35	2.0	0.090	13.6	LOS B	0.3	2.1	0.60	0.83	41.5
9	R	7	2.0	0.090	13.7	LOS B	0.3	2.1	0.60	0.87	41.5
Approach		42	2.0	0.090	13.6	LOS B	0.3	2.1	0.60	0.83	41.5
West: North Circular Road west											
10	L	28	2.0	0.016	10.2	LOS B	0.0	0.0	0.00	0.71	57.1
11	T	604	2.0	0.314	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		633	2.0	0.314	0.5	NA	0.0	0.0	0.00	0.03	78.8
All Vehicles		1341	2.0	0.314	2.0	NA	0.6	4.4	0.08	0.13	74.0

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APPENDIX 4

DWELLING TYPOLOGIES

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HAMILTON SOUTH HEDLAND: HOUSING TYPOLOGIES

INDICATIVE DEVELOPMENT PLAN

3x2 FRONT LOADED DWELLINGS:
FRONTAGE: 16m - 17m Approx.

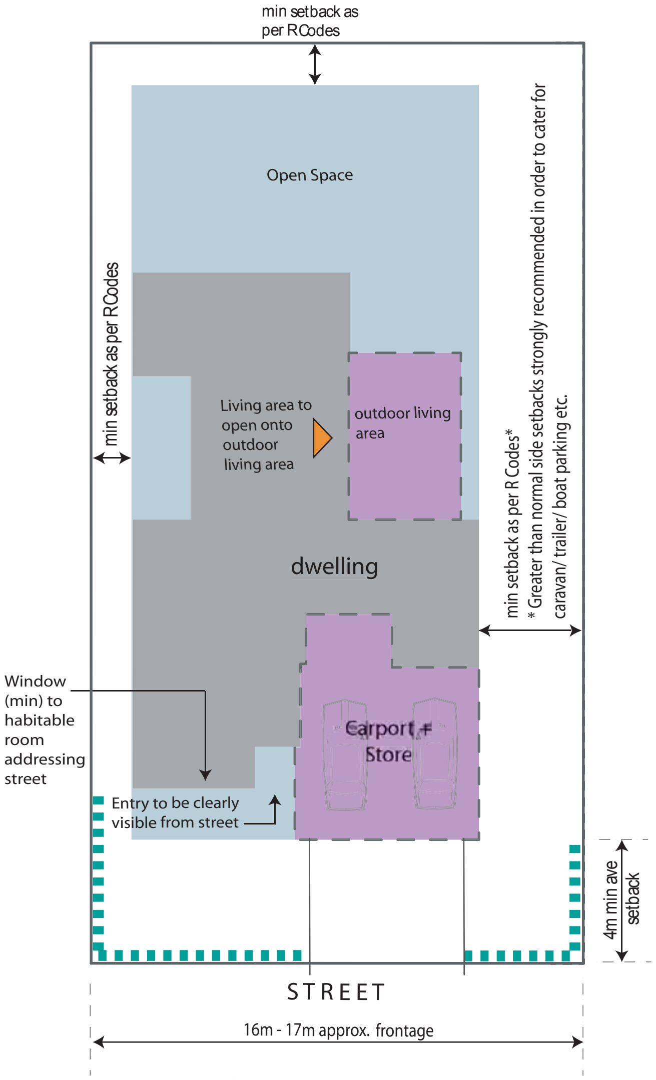
Setbacks	**min**
Front	4m ave
Side	As per R Codes
Rear	As per R Codes
Secondary Street	1.5m

Accommodation:

3 bed
2 bath
Living/dining

Indicative Areas:

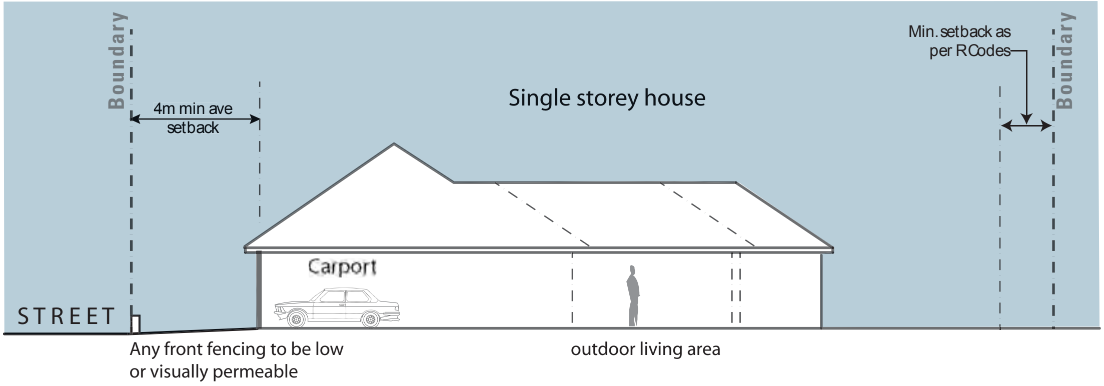
Lot Area	480m² to 510m²
Dwelling Footprint	120m²
Carport + Store	40m²
TOTAL	160m²
Approximate Open Space	320m² (67%) to 350m² (73%)



INDICATIVE PLAN Not to Scale

Legend

▨ Building Envelope
■ Indicative Building Footprint
▪▪▪ Any fencing forward of the building line to be low or visually permeable
▨ Indicative carport/store and outdoor living



INDICATIVE SECTION Not to Scale

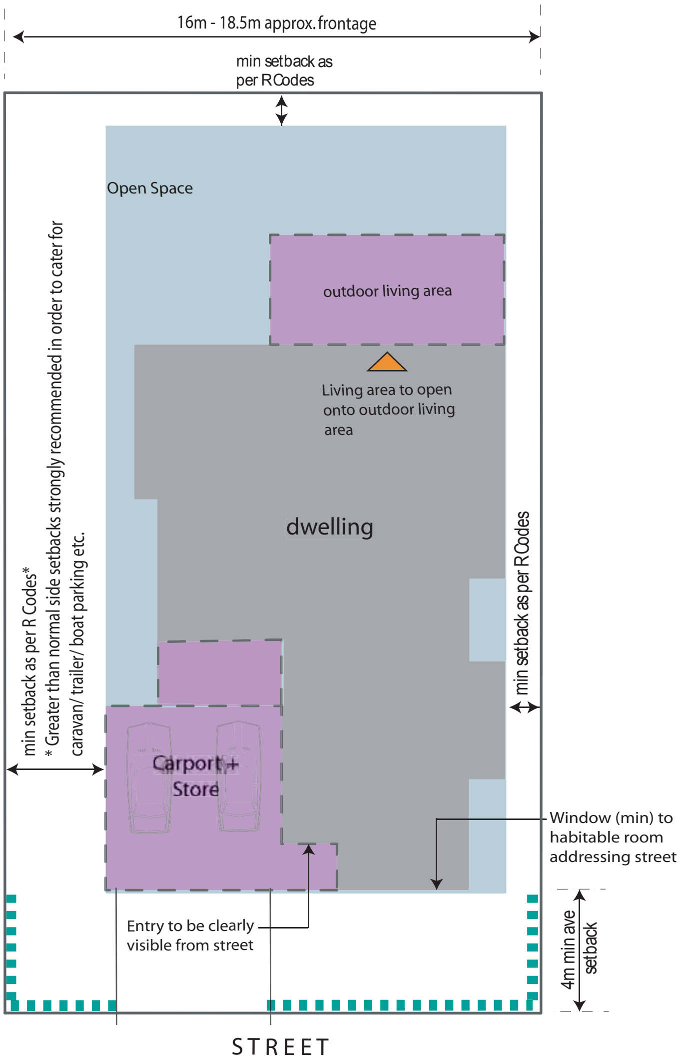
4x2 FRONT LOADED DWELLINGS
FRONTAGE: 16m - 18.5m Approx.

Setbacks	**min**
Front	4m ave
Side	As per R Codes
Rear	As per R Codes
Secondary Street	1.5m

Accommodation:
4 bed
2 bath
Living/dining

Indicative Areas:

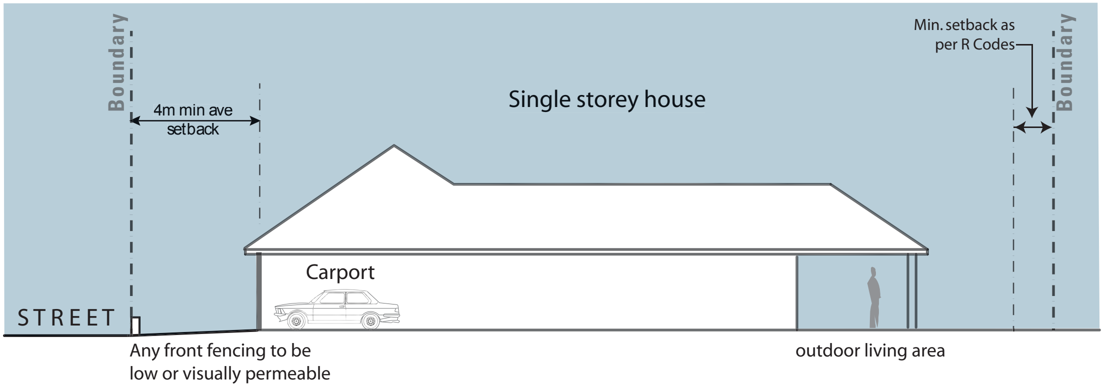
Lot Area		480m² to 555m²
Dwelling Footprint	160m²	
Carport + Store	40m²	
TOTAL		200m²
Approximate Open Space		280m² (58%) to 355m² (64%)



INDICATIVE PLAN Not to Scale

Legend

🟦	Building Envelope
⬛	Indicative Building Footprint
▪ ▪ ▪	Any fencing forward of the building line to be low or visually permeable
🟪	Indicative carport/store and outdoor living



INDICATIVE SECTION Not to Scale

5x2 REAR LOADED DWELLINGS: LOTS 195 - 198
FRONTAGE: VARIABLE (Generally > 20m)

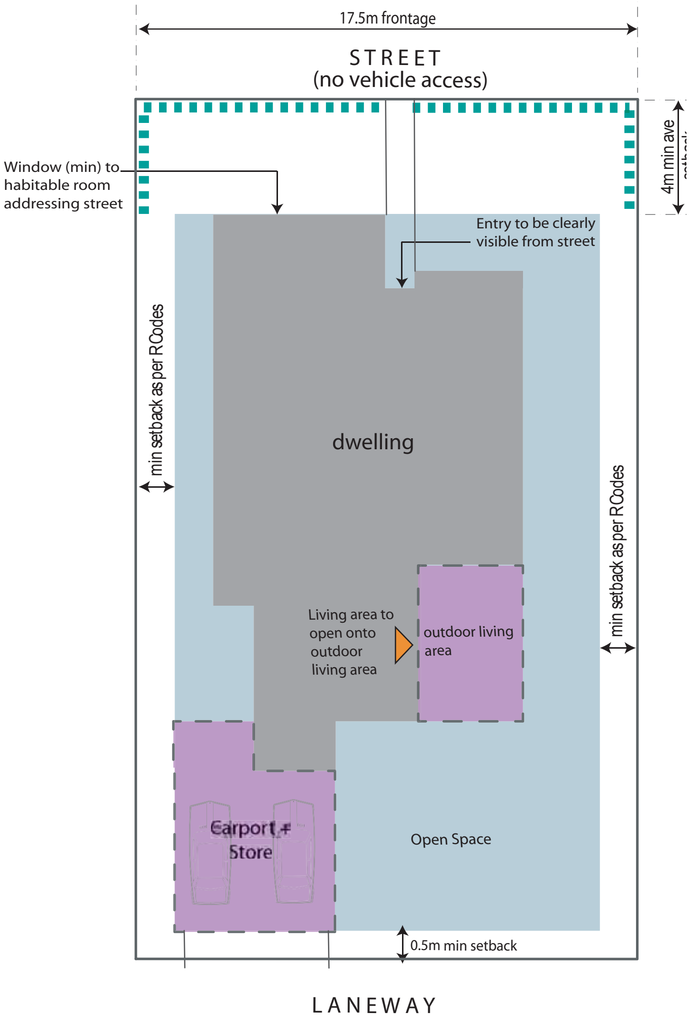
Setbacks	**min**
Front	4m ave
Side	As per R Codes
Secondary Street	As per R Codes
Rear Laneway	0.5m

Accommodation:

5 bed
2 bath
Living/ dining

Indicative Areas:

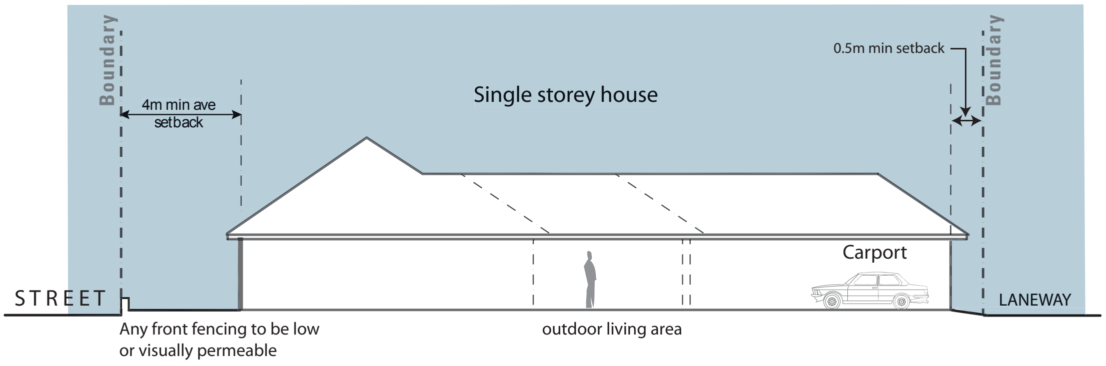
Lot Area		620m² (ave)
Dwelling Footprint	190m²	
Carport + Store	40m²	
TOTAL		230m²
Approximate Open Space		390m² (63%)



INDICATIVE PLAN Not to Scale

Legend

▨ Building Envelope
■ Indicative Building Footprint
▪▪▪ Any fencing forward of the building line to be low or visually permeable
▨ Indicative carport/store and outdoor living



INDICATIVE SECTION Not to Scale

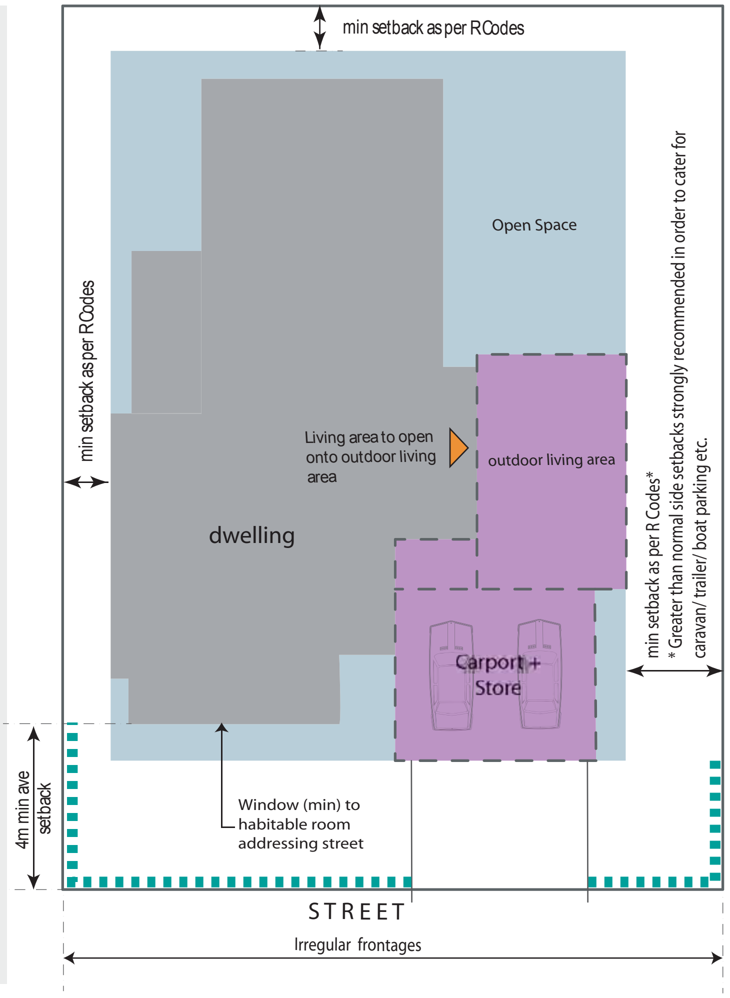
5x2 FRONT LOADED DWELLINGS: IRREGULAR FRONTAGE: VARIABLE

Setbacks	**min**
Front	4m ave
Side	As per R Codes
Rear	As per R Codes
Secondary Street	1.5m

Accommodation:
- 5 bed
- 2 bath
- Living/dining
- Sitting/play area

Indicative Areas:

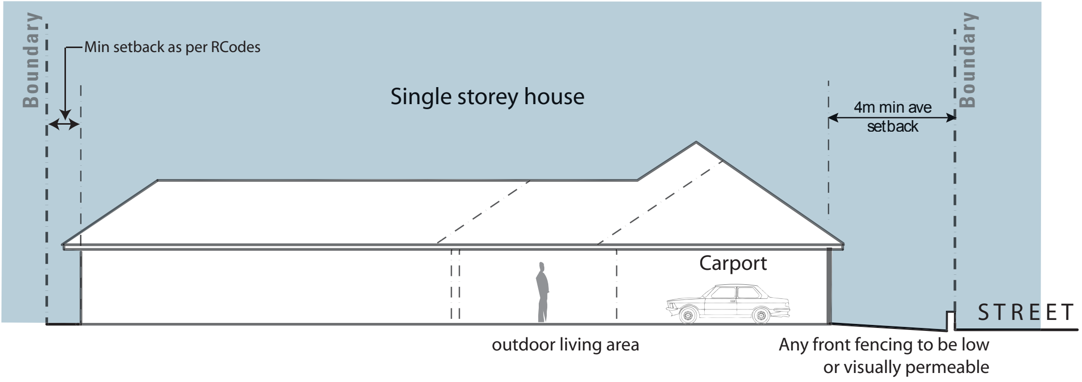
Lot Area		620m² (ave)
Dwelling Footprint	190m²	
Carport + Store	40m²	
TOTAL		230m²
Approximate Open Space		390m² (63%)



INDICATIVE PLAN Not to Scale

Legend

- ▨ Building Envelope
- ■ Indicative Building Footprint
- ▪▪▪ Any fencing forward of the building line to be low or visually permeable
- ▨ Indicative carport/store and outdoor living



INDICATIVE SECTION Not to Scale

REAR LOADED “4 PACK”: FOUR OFF 2-3 BED MULTIPLE DWELLINGS OVER 2 STOREYS
FRONTAGE: VARIABLE 19m - 25m Approx.

Setbacks	**min**
Front	4m ave
Side	Nil
Rear	6.0m

Accommodation:

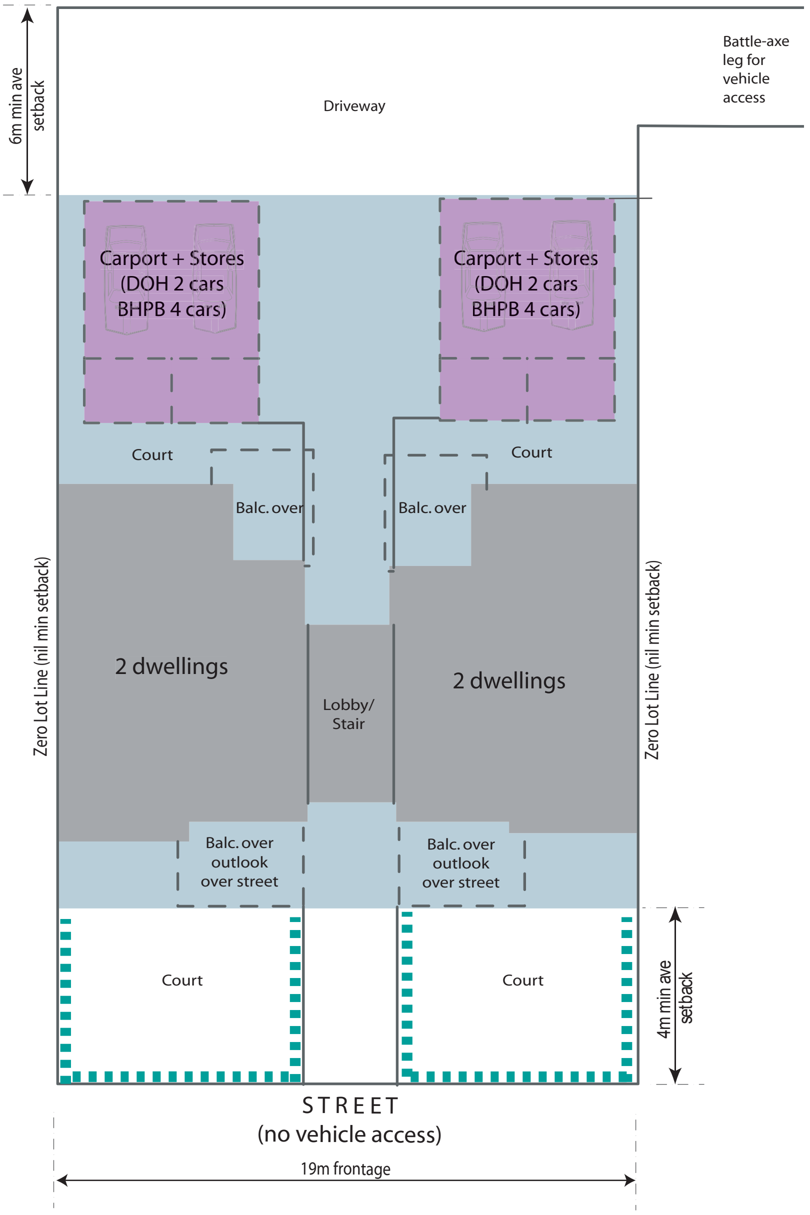
DOH		BHPB	
4 x	2 bed	4 x	3 bed
	1 bath		2 baths
	Living/ dining		Living/ dining

Indicative Areas:

Lot Area		600m^2 (ave)
Dwelling Footprint	85m^2 x 2 =	170m^2
Lobby	20m^2	
Carport + Store	45m^2 x 2 =	90m^2
TOTAL		280m^2
Approximate Open Space		320m^2 (53%)

Legend

▨	Building Envelope
■	Indicative Building Footprint
▪ ▪ ▪	Any fencing forward of the building line to be low or visually permeable
▨	Indicative carport/store and outdoor living



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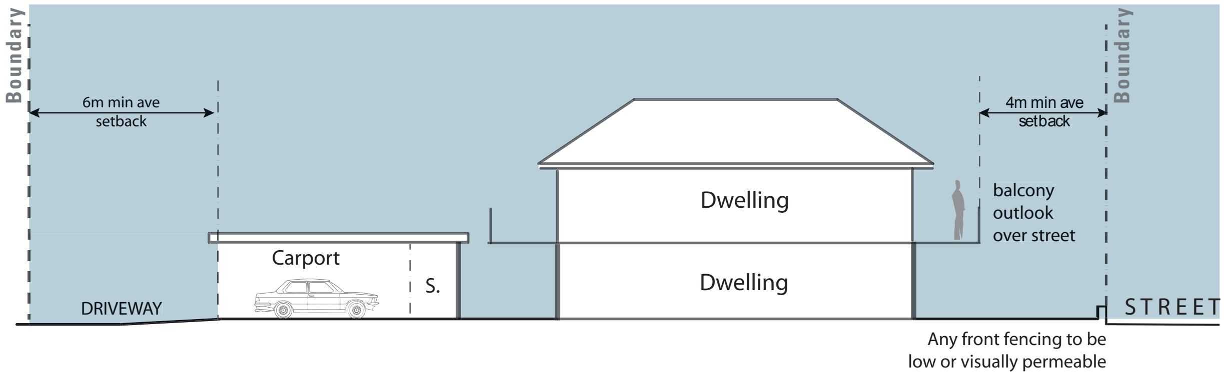


INDICATIVE SECTION Not to Scale

LANEWAY LOADED "4 PACK": FOUR OFF 2-3 BED MULTIPLE DWELLINGS OVER 2 STOREYS

FRONTAGE: 19m - 20m Approx.

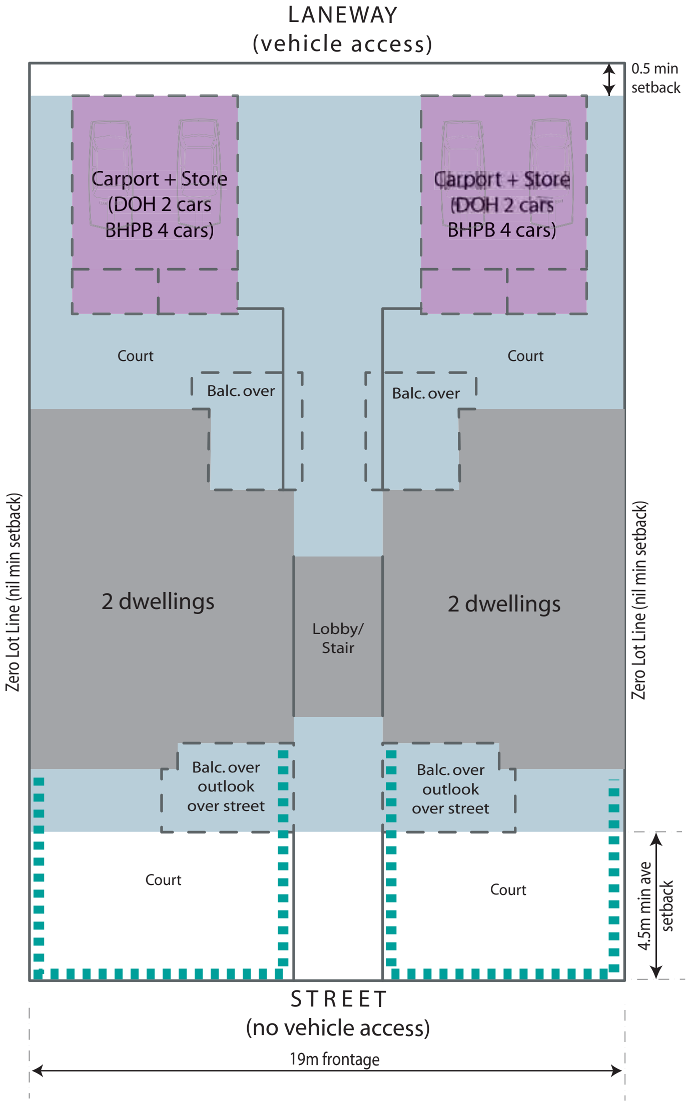
Setbacks	**min**
Front	4.5m ave
Side	Nil
Rear	0.5m

Accommodation:

DOH		BHPB	
4 x	2 bed	4 x	3 bed
	1 bath		2 baths
	Living/ dining		Living/ dining

Indicative Areas:

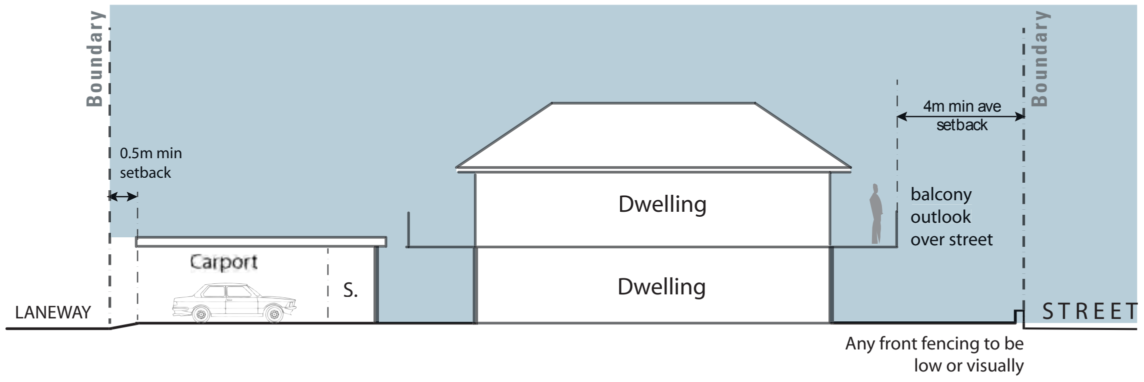
Lot Area		570m² (ave)
Dwelling Footprint	85m² x 2 =	170m²
Lobby	20m²	
Carport + Store	45m² x 2 =	90m²
TOTAL		280m²
Approximate Open Space		290m² (51%)



INDICATIVE PLAN Not to Scale

Legend

- 🟦 Building Envelope
- ⬛ Indicative Building Footprint
- ▪▪▪ Any fencing forward of the building line to be low or visually permeable
- 🟪 Indicative carport/store and outdoor living



INDICATIVE SECTION Not to Scale

APPENDIX 5

LARGE MULTIPLE DWELLING DEVELOPMENT CONCEPTS

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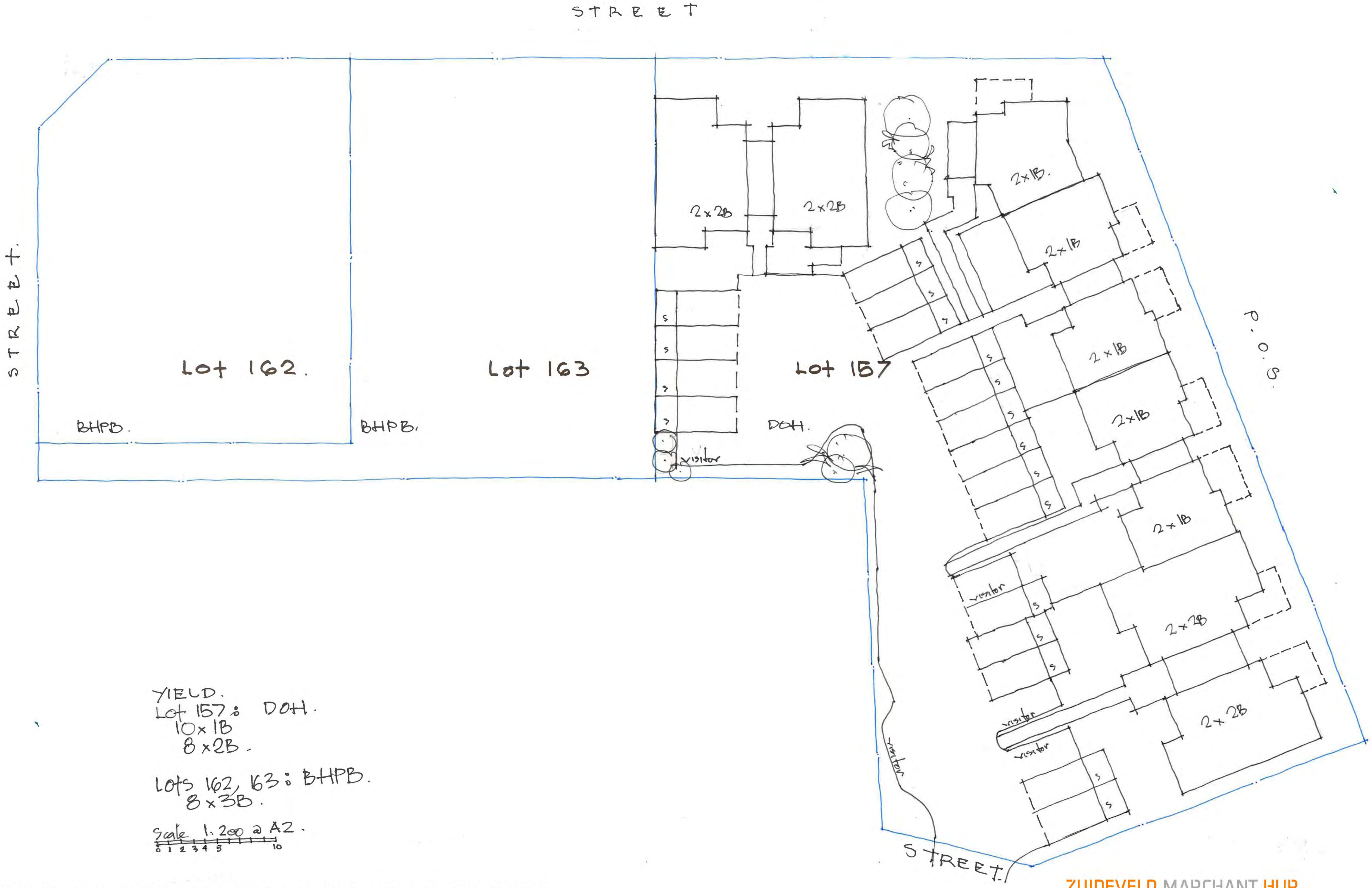


YIELD.
Lot 157: DOH.
10×1B
8×2B.

Lots 162, 163: BHPB.
8×3B.

Scale 1:200 @ A2.

HAMILTON PRECINCT: LOT 157 DEVELOPMENT SCENARIO

LOTS 157, 162, 163
SOUTH HEDLAND

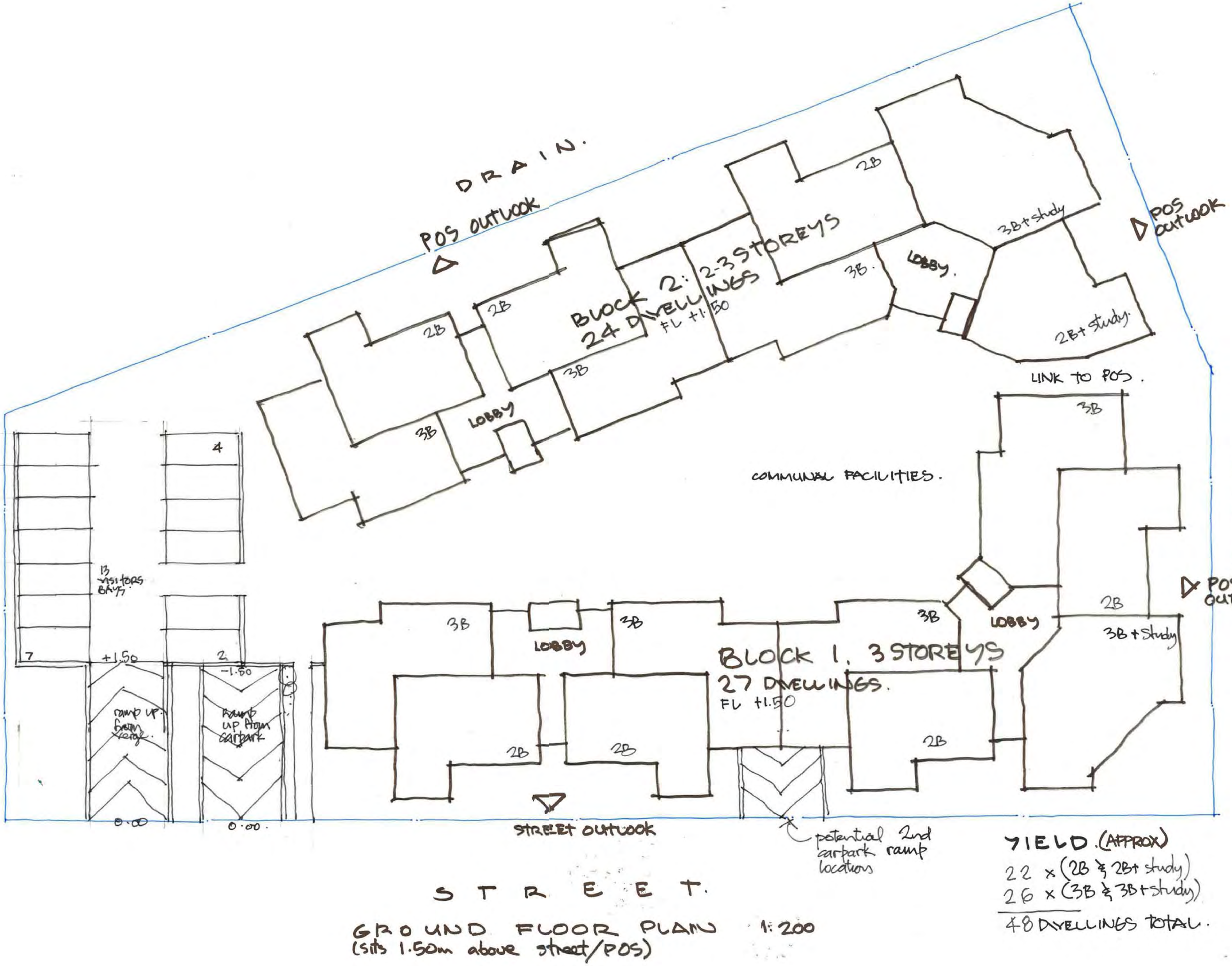
REV	DATE	AMENDMENTS

ZUIDEVELD MARCHANT HUR
ARCHITECTURE PLANNING INTERIOR DESIGN

64 Fitzgerald Street
PO Box 110
Northbridge
Western Australia 6865

T 61 8 9227 0900
F 61 8 9227 0600

DATE 19/10/11
DWG NO. 1874 SK1.01
SCALE 1:200
DRAWN RM
REV. 0



YIELD (APPROX)
22 × (2B & 2B+ study)
26 × (3B & 3B+study)
48 DWELLINGS TOTAL.

GROUND FLOOR PLAN 1:200
(sits 1.50m above street/POS)

HAMILTON PRECINCT: SOUTH HEDLAND

LOT 164 Indicative Development Scenario: ALTERNATIVE 2   48 DWELLINGS   scale 1:200
(SEMI-BASEMENT PARKING) 2.7m WIDE BAYS.

ZUIDEVELD MARCHANT HUR

APPENDIX 6

LOCAL WATER MANAGEMENT STRATEGY (LWMS)

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LOCAL WATER MANAGEMENT STRATEGY

LOT 330 HAMILTON ROAD, SOUTH HEDLAND

Prepared For:	NS Projects Suite 4, Level 1 437 Roberts Rd SUBIACO WA 6008
Report Number:	AE2011-035
Report Version:	V4
Report Date:	7 December 2011

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Document No: NSP2011-001-Report-002_pz_V4

Report No: AE2011-035, V4

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	Partner / Associate Environmental Scientist	Signature	Date
Reviewed by:	Dr Greg Milner		7 December 2011
	Partner / Principal Environmental Consultant	Signature	Date

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LIST OF ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARI	Average Recurrence Interval
ASS	Acid Sulfate Soils
BCA	Building Codes of Australia
BGL	Below Ground Level
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DoW	Department of Water
EPA	Environmental Protection Authority
ha	Hectare
km	Kilometre
LWMS	Local Water Management Strategy
m	Metre
mm	Millimetre
OCs	Organochlorines
OPs	Organophosphorus
PCOCs	Potential Contaminants Of Concern
POS	Public Open Space
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfur
sTPA	Total potential acidity expressed as sulfur units
TPH	Total Petroleum Hydrocarbons
TPS	Town Planning Scheme
UCL	Unallocated Crown Land
UWMP	Urban Water Management Plan
WAPC	Western Australian Planning Commission
WSUD	Water Sensitive Urban Design

EXECUTIVE SUMMARY

This Local Water Management Strategy (LWMS) has been prepared to support a Development Plan for Lot 330 Hamilton Road, South Hedland in accordance with *Better Urban Water Management Guidelines* (WAPC, 2008).

The subject site is located on the corner of North Circular and Hamilton Roads, immediately north of the existing South Hedland town site. The land is undeveloped, with the exception of two drainage channels in the north-eastern portion of the site and is proposed to be developed for residential purposes as a logical extension of the existing town site. Implementation of the Development Plan will result in the creation of approximately 440 new dwellings, multiple new roads and public open space areas.

Groundwater investigations are currently being undertaken on Lot 330 by Aurora Environmental. To date, the information obtained indicates that groundwater levels are between 3.1m and 4.4m below ground level. A complete suite of pre-development groundwater quality data was not yet available at the time of preparing this report, but will be reported in the urban water management plan (UWMP).

Recent investigations by Cardno (2011) suggest that the site would largely be unaffected by 100 year flooding events caused by the combined effects of large storm events and coastal storm surge, with the exception of the eastern portion of Lot 330. Further modelling will be undertaken to ascertain the flood levels which will determine the requirement for the future development to import fill material to ensure that the finished levels are above the 100 year ARI flood and coastal storm surge inundation levels. These details will be further refined in the UWMP.

The following strategies are proposed in this LWMS for implementation on Lot 330:

WATER CONSERVATION AND EFFICIENCY MEASURES

- Ensure that future dwellings are fitted out with waterwise fittings and fixtures to minimise the use of potable water;
- Retain native vegetation in POS areas as a preference;
- Apply waterwise landscaping measures in landscaped areas;
- Restrict irrigation during daytime hours (between 9am and 6pm); and
- Investigate opportunities for alternative water sources for fit-for-purpose use e.g. reuse of treated wastewater, etc.

WASTEWATER MANAGEMENT

- Wastewater disposal via reticulated sewer.

STORMWATER MANAGEMENT

1 year ARI event

- Lots will drain into road gutters; and
- Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin.

5 year ARI event

- Lots will drain into road gutters;
- Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin; and
- The capacity of the site to treat the 5 year ARI event will be reviewed at the detailed design stage.

100 year ARI event

- Run-off conveyed by overland flow paths in the road reserve to the swale which will then overtop into the existing drainage channels;
- Finished floor levels of lots set higher than peak flood levels; and
- Road reserves will be used as flood routes to direct flood waters to the main drains.

All floodway treatments will be designed in accordance with the principles identified in the GHD (2011) flood assessment report for the South Hedland area.

GROUNDWATER MANAGEMENT

Due to the low permeability of the in situ soils and the depth to groundwater beneath the site, it is anticipated that there will be little interaction with groundwater. Therefore, post-development groundwater level management is not required.

Temporary dewatering may be required during construction for the installation of sewerage infrastructure. A licence to abstract groundwater, if required, will be obtained from the Department of Water prior to the commencement of dewatering activities.

THE NEXT STAGE

The UWMP will need to address the following:

- Demonstrate that the objectives and criteria stated in the LWMS can be achieved;
- Detailed stormwater management design including the size, location and design of drainage swales;
- Confirm finished floor level heights for the development to ensure protection from peak flood levels;
- Detailed landscape design for POS areas, expanding upon the Concept Plans provided in Appendix 4, including the proposed drainage swales;
- Determine irrigation requirements for POS areas, and secure an irrigation water source;
- Agreed or approved measures to achieve water conservation and efficiencies of use including sources of water for non-potable uses and detailed designs, controls, management and operation of any proposed system(s); and
- Operational and maintenance responsibilities for the proposed stormwater management system.

MONITORING

Monitoring of the three groundwater monitoring wells on Lot 330 will continue on a quarterly basis. Groundwater level loggers have been installed in each monitoring well. Data will be downloaded on each quarterly basis.

1. INTRODUCTION

1.1 Background

Land supply in Port Hedland and South Hedland is limited with only 115 hectares (ha) of undeveloped residential/urban development zoned land currently available, with the majority of this land located in South Hedland (109ha) (WAPC, 2011). Additional areas of land are being investigated for future development as party of the Town of Port Hedland's City Growth Plan.

Although the demand for housing in South Hedland and Port Hedland is heavily influenced by the economic cycles of the mining industry (WAPC, 2011), in recent years the demand has far exceeded supply and as a consequence the weekly rental value on properties has increased significantly, as has the median house price.

To alleviate some of the current accommodation pressures in the Port Hedland region, NS Projects is advancing the development of Lot 330 Hamilton Road, South Hedland (the site) for residential purposes.

Lot 330 Hamilton Road is located to the north of the existing South Hedland townsite which is approximately 1,700km north of Perth (Figure 1). The site is bounded by Hamilton Road to the west, North Circular Road to the south, a road reserve to the east (providing access to the town's potable water storage tanks) and UCL to the north (Figure 2).

Aurora Environmental has been commissioned to prepare a Local Water Management Strategy (LWMS) for the proposed development.

1.2 Purpose and Scope

The purpose of this LWMS is to provide information relating to potable and non-potable water use, as well as an overview of the proposed approach to managing surface water and groundwater resources on Lot 330. To achieve this, the LWMS:

- Describes the pre-development environmental conditions;
- Describes the proposed development;
- Considers the potential alterations to the site water balance;
- Provides strategies for avoiding or managing impacts to groundwater or surface water resources from the proposed development;
- Summarises the key responsibilities for the implementation of the LWMS;
- Identifies any further investigations that may be needed; and
- Recommends a framework for an Urban Water Management Plan (UWMP) to be prepared at subdivision stage.

1.3 Total Water Cycle Management

Total water cycle management, also referred to as integrated water cycle management, 'recognises that water supply, stormwater and sewage services are interrelated components of catchment systems and therefore must be dealt with using a holistic water management approach that reflects the principles of ecological sustainability' (DoW 2004-2007, *Stormwater Management Manual for Western Australia*).

The *State Planning Policy 2.9: Water Resources* (WAPC, 2006) outlines the key principles of integrated water cycle management as:

- Consideration of all water resources, including wastewater in water planning;
- Integration of water and land use planning;
- The sustainable and equitable use of all water sources, having consideration of the needs of all water users, including the community, industry and the environment;
- Integration of human water use and natural water processes; and
- A whole of catchment integration of natural resource use and management.

The principles and objectives for managing urban water as stated in *the Stormwater Manual for Western Australia* (DoW, 2004-2007) are as follows:

- Water Quality: to maintain or improve the surface and groundwater quality within the Development Areas relative to predevelopment conditions.
- Water Quantity: to maintain the total water cycle balance within the Development Areas relative to the pre-development conditions.
- Water Conservation: to maximise the reuse of stormwater.
- Ecosystem Health: to retain natural drainage systems and protect ecosystem health.
- Economic Viability: to implement stormwater management systems that are economically viable in the long term.
- Public Health: to minimise the public risk, including risk from injury or loss of life, to the community.
- Protection of Property: to protect the built environment from flooding and waterlogging.
- Social Values: to ensure that social, aesthetic and cultural values are recognised and maintained when managing stormwater.
- Development: to ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

1.4 Planning Background

The site is located within the municipality of the Town of Port Hedland (the Town) and is therefore, subject to the requirements of the Town of Port Hedland Town Planning Scheme (TPS) No. 5 (the Scheme). The site is currently zoned 'Other Purposes – Infrastructure' under the TPS, where residential development is not permitted. However, a scheme amendment has been initiated to rezone the site and a portion of the adjoining North Circular Road reserve to 'Urban Development'. The scheme amendment was referred to the Environmental Protection Authority (EPA) who determined that the amendment would not be formally assessed.

In accordance with Section 5.4 of the TPS, the rezoning will allow for a Development Plan to be prepared to guide the subdivision and development of the site. The Development Plan (structure plan) will designate, amongst other matters, the location of access points, roads, open space, residential densities and the way in which access is provided over the drainage channels. The Development Plan is to be lodged with the Town and approved by both the Town and the Western Australian Planning Commission (WAPC). An application for subdivision will then need to be lodged with the WAPC, which can be determined concurrently with the Development Plan.

The orderly processes for the development of the land is rezone the site, prepare and gain approval to the Development Plan, and then subdivide the site before obtaining planning approval for the buildings. These processes can however, be done concurrently and 'fast tracked' in order to expedite development.

The links between the planning framework for land and water planning is illustrated in Plate 1 with the appropriate stage of the process for Lot 330 circled.

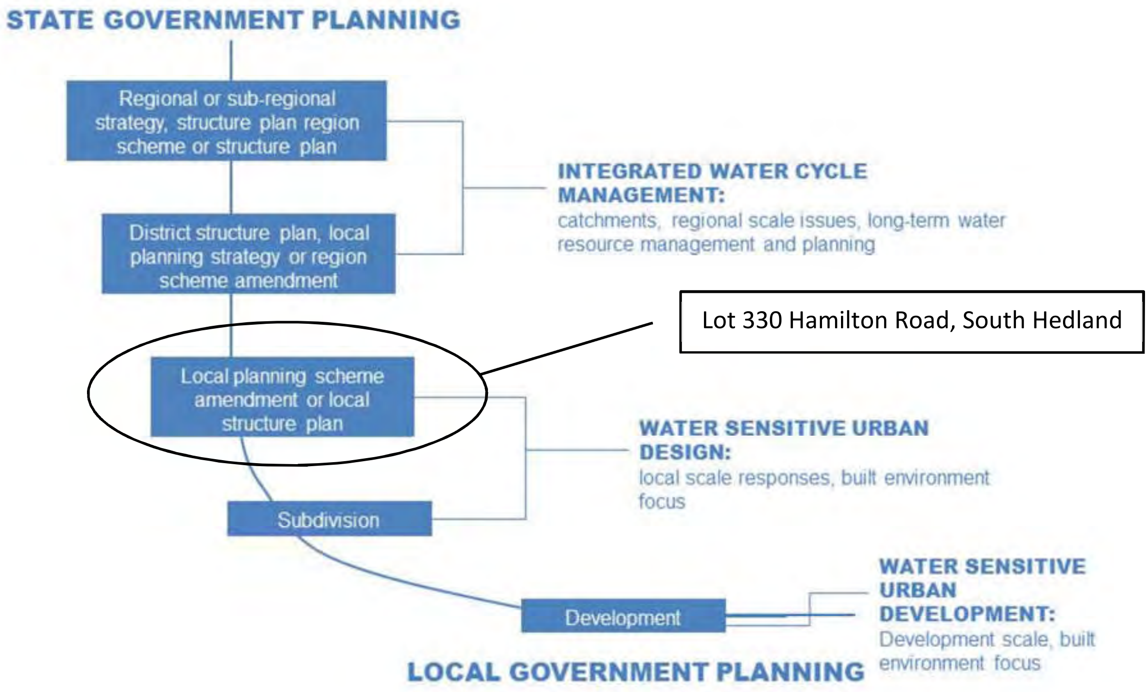

Plate 1: The Western Australian Planning System and Linkages to Water Sensitive Urban Design Terms

Source: Better Urban Water Management (WAPC, 2008)

1.5 Previous Studies

The following investigations have been drawn upon in the creation of this LWMS:

- *Geotechnical Investigation, Lot 330 Hamilton Road, South Hedland,* Douglas Partners (2011). This report provides a description of the existing geotechnical conditions at the site.
- *Preliminary Site Investigation, Hamilton Precinct, South Hedland*, Aurora Environmental (2011). This report provides an analysis of the site contamination risk.
- *Town of Port Hedland, Report for South Hedland Flood Study,* GHD (2011). This report was commissioned as a flood study to examine opportunities and constraints in regards to the

drainage network in South Hedland and to develop a 5 year plan for upgrades and maintenance of drainage infrastructure.

- *[Draft] Port Hedland Coastal Vulnerability Study,* Cardno (2011). This report compiles the findings of a coastal vulnerability study for the Port Hedland region. It considered, amongst other things, the potential flooding impacts associated with coastal storm surge combined with catchment flooding.

2. PRE-DEVELOPMENT ENVIRONMENT

2.1 Climate

The climate of the Port Hedland region is arid (semi-desert) tropical with a very low and highly variable annual rainfall. The region experiences a typical wet and dry season, with the wet season commencing around December and ending around June.

According to climate data collected from the Port Hedland Airport (located approximately 4km to the east of Lot 330), South Hedland experiences a mean annual rainfall of 312.2mm/annum with 292.7mm being recorded during the wet season (December to June inclusive) and the balance (20.5mm) during the dry season. Most of the rainfall comes from scattered thunderstorms and the occasional tropical cyclone. The mean minimum and maximum temperatures are 19.4°C and 33.2°C respectively with the hottest month being March and the coolest month being July (Weatherzone, 2011). A summary of monthly climate data is provided in Table 1.

TABLE 1
PORT HEDLAND AIRPORT LONG-TERM CLIMATE AVERAGES

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	36.4	36.2	36.8	35.2	30.6	27.5	27.1	29.1	32.3	34.8	36.2	36.6	***33.2***
Mean Min (°C)	25.5	25.4	24.5	21.4	17.2	14.1	12.2	13.1	15.4	18.3	21.3	24.0	***19.4***
Mean Rain (mm)	58.5	94.3	48.3	23.7	27.6	21.6	10.7	5.1	1.2	0.9	2.6	18.7	***312.2***
Median Rain (mm)	21.3	75.0	14.0	1.6	9.2	7.0	2.8	0.6	0.4	0.2	0.0	0.5	***304.6***
Mean Rain Days	4.8	7.0	4.2	1.9	3.0	2.8	1.9	1.1	0.7	0.6	0.5	1.8	***30.2***

Source: Weatherzone (2011)

2.2 Topography

The subject site is generally flat, with the exception of two drainage channels that intersect on the property. The site levels range from approximately 8.6m Australian Height Datum in the north of the site to 9.6m AHD in the south. Field observations suggest the drainage channels are approximately 2m to 3m deep (Plate 2).

Plate 2:
Lot 330 Existing Drainage Channel

2.3 Geology and Soils

According to the 1:250,000 geological map sheet for Port Hedland - Bedout Island (Geological Survey of Western Australia (GSWA), 2006a) the site is located within Quaternary age mixed floodplain deposits comprising silt, sand, clay and gravel adjacent to drainage channels. GSWA (2006a) also indicates that the bedrock geology of the area comprises mylonite and that the regolith comprises coastal tide-dominated deposits.

The 1:50,000 Urban Geology map sheet for Port Hedland (GSWA, 2006b) indicates the site consists of Pleistocene age red-brown Silty Sands, (Qps) with Pleistocene-Holocene age alluvium comprising gravel, sand and silts (Qa) in drainage channels (including in Sandy Creek).

Soil logs recorded during test-pitting undertaken at the site on 5 August 2011 indicate that the site soils comprise medium to fine-grained red and brown silty sands grading into clays at depths. As such, mapped surface geology for the site correlates with site observations.

Mapped surface geology at the site is presented in Figure 3. A copy of the geotechnical investigation is presented in Appendix 1.

2.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) is the name commonly given to naturally occurring soils and sediments that contain iron sulphide (iron pyrite) materials. In their natural state ASS are generally present in waterlogged anoxic conditions and do not present a risk to the environment. ASS can present issues when they are oxidised, producing sulphuric acid, which can impart a range of impacts on the surrounding environment, infrastructure and human health.

Regional mapping produced by the DEC indicates that the site is unlikely to be affected by ASS. Information obtained from the CSIRO's online Australian Soils Resource Information System (ASRIS) confirms that the probability of ASS occurring at the site is extremely low, however due to the lack of information for this region, CSIRO have assigned the data as low confidence.

It was also considered pertinent to ground-truth the CSIRO ASS data, as it had been allocated a low confidence. As such, soil samples from depths of 0-0.15, 0.5, 1 and 2 m BGL were recovered from half of the test-pits and analysed for ASS characteristics including field tests and the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) suite. ASS samples were assessed against the criteria required in DEC (2009) *"Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes"*.

All ASS samples, except for one, were below the applicable criteria for ASS. One sample had a pHox of 3.3 which was slightly below the assessment criterion of 4. Total potential acidity expressed as sulfur units (sTPA) in this sample was 0.106%S which exceeds the guideline value of 0.03%S. This result is likely due to the presence of organic acids in the soil. This conclusion is supported by the fact that the acidity was not present as sulfur.

Rather than indicating an ASS issue, the single isolated result likely indicates that organic acids were more concentrated at the location than at other locations at the site. Given that DEC (2009) also states that soils that have never been disturbed and which remain permanently dry (i.e. are above the highest seasonal groundwater levels) do not require full acid-base accounting, it is not considered to indicate an ASS issue at the site.

2.5 Contamination

The subject site or the immediate surrounds have not been reported as a known or suspected contaminated site within the DEC's Contaminated Sites Database. A desktop study of the site, along with a detailed site inspection and limited sampling program were undertaken by Aurora Environmental (2011) to determine whether contamination is likely to be present at the site.

A review of historical aerial photos (dating back to 1970) and historical title confirmed that the site has historically remained vacant with the exception of the construction of the drainage channels that traverse the site. Refer to Appendix 2 for historical aerial photos.

Land abutting the northern boundary of the site is currently used for potable water storage as a component of South Hedland's water supply. Other than this use, land to the south consists of a mixture of residential housing and schools and a small quarry exists to the west of the site. Further west is an ephemeral creek system (South Creek) which flows in a south-north direction towards the ocean. Otherwise, surrounding land is general vacant, comprising vegetation.

The DEC contaminated sites database was consulted on 29 August 2011. Two classified contaminated sites are present within a 2.5km radius of the site. The first contaminated site is located approximately 2.1km north of the site (6 Trig Street, Wedgefield) and the second contaminated site is located approximately 2.4km north of the site (Lot 6179 on Plan 26719).

A review of the Basic Summary of Records for each site indicates each contaminated site has been impacted by their historical use for fuel storage. The nature and status of contamination can be summarised as follows:

- 6 Trig Street, Wedgefield: Classified as "Contaminated – remediation required" due to Hydrocarbons (such as from petrol, diesel, oil) and metals being present in groundwater. The site is restricted to commercial/industrial use and groundwater abstraction is not permitted.

- Lot 6179 on Plan 26719, Wedgefield: Classified as "Contaminated – remediation required" due to Total Petroleum Hydrocarbons (TPH) and metals being present in groundwater. The site is restricted to commercial/industrial use and groundwater abstraction is not permitted.

Based on the inferred groundwater flow direction, neither of the above two classified contaminated sites would impact the subject site.

The desktop review of environmental information for the site has revealed no areas of environmental concern from a contamination perspective. However, to provide extra confidence in the findings of the desktop review, soil samples were recovered from ten (10) test-pits across the site and groundwater samples were recovered from three (3) groundwater monitor bores installed at the site. All samples were analysed for selected potential contaminants of concern (PCOCs). The findings of the groundwater investigation were not available at the time of preparing this report.

The soil sample results can be summarised as follows:

- No total petroleum hydrocarbons were detected in any of the samples;
- Heavy metals were detected in the majority of samples at the site however no cadmium or mercury was detected. Nickel was detected in excess of Ecological Investigation Levels at one location (at 0.5m BGL) however the detected concentration of 65mg/kg only slightly exceeded the assessment criteria of 60mg/kg. This was the only sample to contain any metal at concentrations over the applicable assessment level; and
- No organochlorine or organophosphorus was detected in any of the samples.

The elevated nickel identified at the one sample location was recovered from 0.5m BGL and given that the findings of the desktop review indicate that the site does not appear to have been disturbed, it is considered to be a function of the region's geology and as such, is considered acceptable and not indicative of a greater issue.

On the basis of the available information it is considered that the site is likely not contaminated and that a full Detailed Site Assessment for soils at the site is not warranted.

2.6 Surface Water

The subject site is located in the Port Hedland Coast Basin which is within the proclaimed Pilbara Surface Water Area. This basin contains several creeks between Turner River Catchment and the De Grey River Catchment that converge at the coast. The dominant watercourses in this basin are Southwest Creek and South Creek.

The subject site is located within the catchment of South Creek which is approximately 8.5km in length and has an estimated catchment of 23km^2. It is a typical Pilbara ephemeral creek system which is dry for most of the year, except during heavy rainfall when sheet run off from adjacent land is generated.

While there are no natural watercourses that traverse the subject site, two constructed drainage channels dissect the site, converging at a junction in the central portion of the subject site (Figure 2). The larger of the two drainage channels run in a south-east to north-west direction across the site, and ultimately discharges into South Creek. The drains are approximately 2m to 3m deep and the base width varies between an estimated 2m and 4m. The drains receive run-off from residential areas upstream of the site.

Flood and storm surge mapping of South West Creek has been undertaken by JDA Consultant Hydrologists (2000) and reviewed by MP Rogers and Associates (2008) for a project located to the south of Lot 330. The mapping for South West Creek suggested inundation levels to be in the order of 13mAHD. However, based on recorded flood levels during certain events, it is apparent that the maximum inundation levels in South Creek are typically 4m lower than South West Creek (MP Rogers and Associates, 2008). Nominally inundation levels of approximately 9m AHD. Based on these levels, it would appear that the subject site would not be impacted by a combined 100 year flood and storm surge. However, recent advice provided by the Town of Port Hedland indicates that a Draft Coastal Vulnerability Analysis for Port Hedland has been completed by Cardno (2011). Based on the information prepared by Cardno (2011) it appears that the site is largely unaffected by 100 year flooding caused by the combined effects of large storm events and coastal storm surge, with the exception of the eastern portion which may be affected by up to 0.1m of flooding (Plate 3).

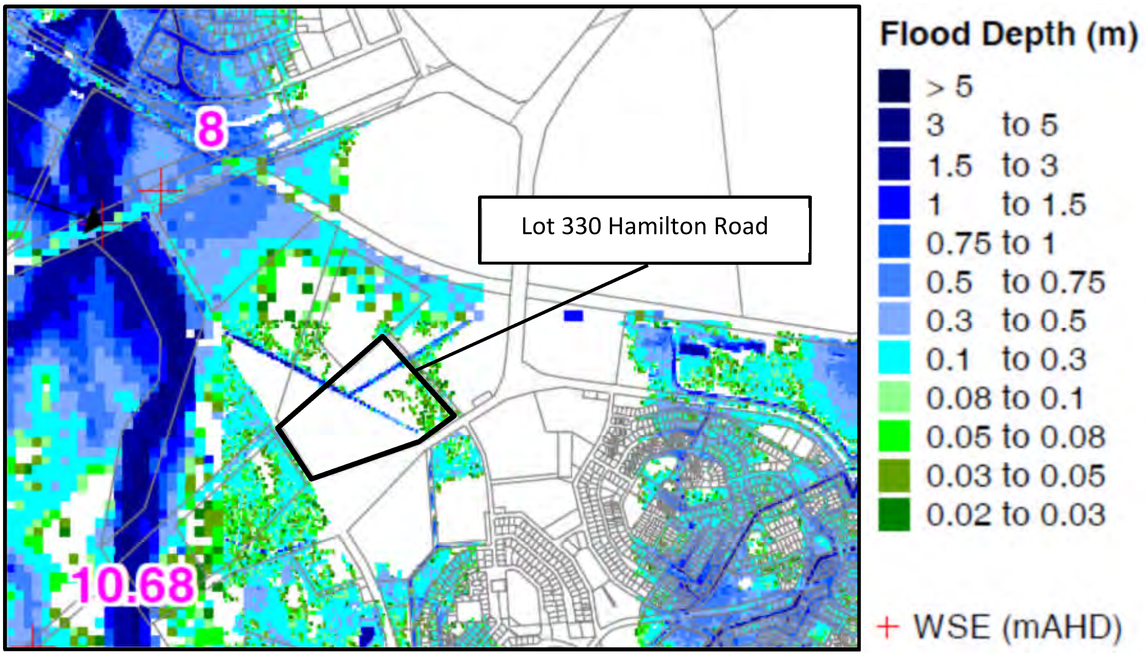

Plate 3:
100 Year Flood Depth – Existing Conditions
100-year Catchment Flow and 20-year Ocean Water Level (Cardno, 2011)

Further modelling will be undertaken to ascertain the flood levels which will determine the requirement for the future development to import fill material to ensure that the finished levels are above the 100 year ARI flood and coastal storm surge inundation levels. These details will be further refined in the UWMP.

2.7 Groundwater

2.7.1 Published Data

Published data regarding groundwater at the site is limited however, the *Online Hydrogeological Atlas* (DoW, 2011) indicates that groundwater at the site is hosted in the unconfined Pilbara Coastal Saline Aquifer. It also indicates that the unconfined Pilbara Fractured Rock aquifer is located approximately 180m south-east from the site, beneath the South Hedland townsite.

It is anticipated that groundwater at the site flows in a north-westerly direction towards South Creek and towards the coast.

2.7.2 Water Information Network (WIN) Database

A review of the DoW WIN database indicated that a registered bore is located adjacent the south-eastern most boundary of the site. However, there is a lack of reliable groundwater information for this monitoring well. The WIN database information is presented in Appendix 3.

2.7.3 Site Specific Groundwater Data

On 6 August 2011 a geotechnical scientist from Douglas Partners installed three groundwater monitoring wells at the site (Figure 2). The well construction bores and associated soil logs are presented in Appendix 1. During the construction of the bores, it was determined that groundwater at the site is approximately 3.1m BGL.

The first round of groundwater sampling at the site was undertaken by Aurora Environmental on 31 August 2011. The initial sampling round recorded groundwater levels at the three monitoring wells, the results are provided in Table 2. Groundwater level loggers have since been installed in each monitoring well to improve the resolution of groundwater data for the site. Site visits are currently planned on a quarterly basis with data to be downloaded from each logger prior to re-setting and activating the logger.

TABLE 2
GROUNDWATER LEVELS BENEATH LOT 330 HAMILTON ROAD SOUTH HEDLAND

Date	Depth to Groundwater (m BGL)		
	MB41	MB42	MB45
6 August 2011	3.14	3.16	3.13
31 August 2011	4.43	3.80	3.94

Survey data for the site and the bores is not yet available and as such, it is not yet possible to conclusively express the ground levels in mAHD and ascertain the actual groundwater flow directions beneath the site. However, based on the preliminary results provided in Table 2 it would appear that groundwater flow direction is towards the north-west.

The initial sampling round also involved the collection of groundwater samples from the site for the purposes of establishing the baseline groundwater quality. The following analytes were being tested in the first round of sampling:

- Organochlorines (OCs) and organophosphorus (OPs) pesticides;
- Total petroleum hydrocarbons;
- Suite of eight heavy metals (Arsenic, Mercury, Lead, Nickel, Aluminium, etc.);
- Nutrients (Total Nitrogen, Total Kjeldahl Nitrogen, Ammonia, Nitrate/Nitrite, Total Phosphorus and Filterable Reactive Phosphorus); and
- Total Dissolved Solids.

Subsequent rounds will not test for heavy metals or OCs/OPs. At the time of preparing this LWMS, the groundwater quality results were not available.

2.8 Vegetation and Flora

The site is mapped as Beard's vegetation association Abydos Plain 647. This association comprises a low shrubland of *Acacia translucens* over open hummock grassland of Soft Spinifex (*Triodia pungens*).

A vegetation and flora survey undertaken by Woodman Environmental Consulting (2011) for Aurora Environmental of Lot 330 and the land to the east of Lot 330 identified two plant vegetation associations on the site, these were:

- **G1** – Tall Closed Hummock Grassland of *Triodia schinzii* over Low Open Shrubland of *Acacia stellaticeps* on red-brown sandy loam; and
- **S1** – Tall Isolated Clumps of Shrubs of *Acacia trachycarpa* and *Acacia tumida* over Low Open Shrubland of **Stylosanthes hamata* and *Acacia stellaticeps* over Mid Tussock Grassland of **Cenchrus ciliaris* on red sand.

Vegetation association G1 occurs across the entire site with occasional tall shrubs of *Acacia trachycarpa/pyrifolia/Codonocarpus cotinifolius* emergent. The S1 vegetation association was restricted to along the drainage line that traverses the site along a south-east/north-west alignment and contained species typical of wet habitats.

The vegetation associations recorded are common on the sand plain and drainage areas in the Port Hedland region and are not considered to represent any known threatened (or priority) communities.

The vegetation condition was variable, ranging from Poor-Very Poor to Very Good-Excellent. The majority of the site was Very Good-Excellent with the vegetation structure intact, and a low to absent weed occurrence. Areas mapped as Poor-Very Poor, Good-Poor, Good or Good-Very Good were typically along road verges and drainage lines. Areas assigned a lower condition rating generally displayed higher levels of weed infestation (in particular *Cenchrus ciliaris - Buffel Grass*) and an absence of native vegetation/structure due to anthropogenic disturbances.

A search of relevant DEC databases revealed that no threatened (declared) flora priority classes 1, 2, 3, or 4 occur within the site. Similarly, there have been no previous records of threatened or priority ecological communities as occurring on the site or in close proximity to the site.

Woodman Environmental Consulting (2011) recorded a total of 114 taxa (which included 7 introduced species) from the survey area[1]. Two Priority 3 taxa were identified during the survey. *Eragrostis crateriformis*, was recorded along the drain on Lot 330 and *Tephrosia? bidwilliia* was recorded opportunistically while Lot 330 was being grid searched. Any impacts on the conservation significance on these species at a local and regional distribution level is likely to be negligible given that both species have been recorded in the general area previously (Woodman Environmental Consulting (2011)).

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[1] Note that the survey area extended beyond the boundaries of Lot 330.

2.9 Fauna

Aurora Environmental commissioned Coffey Environments to undertake a level 1 fauna assessment of the site. Coffey Environments (2011) identified a total of two fauna habitats on Lot 330, these being:

- Spinifex on Sandy Plain; and
- Drainage Lines.

Spinifex on Sandy Plain dominated Lot 330 with two narrow Drainage Lines traversing the central areas. All fauna habitats were in good condition, reflecting some impact of anthropogenic activities. There were no significant features or specific habitat within Lot 330 that would indicate it possesses ecological function values that are significantly different to many other areas surrounding it.

Eleven of the conservation significant fauna species listed under Commonwealth or State legislation are possible visitors to Lot 330. Of these species, four were migratory bird species (Barn Swallow, Rainbow Bee-eater, Oriental Plover and Fork-tailed Swift), four were mammals (Crest-tailed Mulgara, Orange Leaf-nosed bat, Brush-tailed Mulgara, Ghost Bat), one was a reptile (Woma) and the remaining two species were birds (Australian Bustard, Peregrine Falcon). None of these species are anticipated to be significantly affected by the proposed vegetation clearing of Lot 330. It is Coffey Environments' (2011) view that the proposed clearing is unlikely to substantially modify, destroy or isolate an area of important habitat for these species, or seriously disrupt the life cycle of an ecologically significant proportion of the population of any of these species.

2.10 Heritage

2.10.1 Aboriginal Heritage

A search of the Department of Indigenous Affairs' (DIA) Aboriginal Heritage Inquiry System conducted on 8 September 2011 by Aurora Environmental confirmed that no Aboriginal heritage sites have been previously recorded on Lot 330 or in the immediate vicinity of the site.

There are three registered sites (Site ID 23548, 23606 and 23611) located approximately 2km north-west of the site. All three sites were artefact scatters or middens.

2.10.2 European Heritage

Aurora Environmental reviewed the Gray's (2007) review of the Town of Port Hedland's Municipal Inventory of Heritage Places to identify whether there are any recognized heritage values associated with Lot 330. According to Gray (2007) there are no registered heritage sites on Lot 330. Only two listings exist for South Hedland these being the Planning Concept of South Hedland (Place No. 48), and the second being the town's water tank (Place No. 49). The former is listed as a category four site (i.e. a site without built features, but of some cultural heritage significance to the Town of Port Hedland) and the latter is a category three site (i.e. a place of some cultural heritage significance to the Town of Port Hedland). Neither category represents a constraint to future development. Neither listing will be impacted by development of Lot 330.

2.11 Surrounding Land Use

Land use within the surrounding area is presented on Figure 2 and can be described as following:

North:	Three potable water storage tanks and associated buildings. Approximately 500m north of the site, and on the northern side of the water storage tanks, the railway tracks run in a north-west to east-south-east direction.
North East:	South Creek, an ephemeral waterway that flows in a north-south direction towards the ocean, is located approximately 500m from the site at its closest point.
East:	North Circular Road and vegetated, undeveloped land.
South:	A mixture of residential housing and schools (Hedland Senior High School and the Pundulmurra Aboriginal College).
South-West:	South Hedland Sports Complex and Fortescue Metals Group workers accommodation camp.
West:	Quarry and vegetated, undeveloped land.

3. PROPOSED DEVELOPMENT

3.1 Land Use

The rezoning and subsequent development will result in the site being utilized for residential purposes. Some open space areas, predominantly along the existing drains will be provided.

3.2 Development Plan

Development of Lot 330 will result in the creation of approximately 440 dwellings (a portion of which will house key and service workers) to help accommodate Port Hedland's growing population.

The main objectives for the Development Plan are to:

- Address the need for permanent and affordable key worker and service accommodation;
- Generate an attractive urban outcome that will attract people to Port Hedland;
- Provide permanent long term accommodation;
- Deliver accommodation in a speedy and efficient manner;
- Incorporate public amenity through appropriately located and landscaped public open space; and
- Meet the provisions of a Development Plan required in accordance with the Town of Port Hedland Town Planning Scheme No 5.

The Development Plan for the site will ultimately deliver (approximate numbers):

- 15.96ha of residential housing;
- 6.04ha of road reserve;
- 1.45ha of POS; and
- 1.11ha of drainage reserve.

The design of the Development Plan (Figure 4) is based around the provision of an interconnected street grid network that provides good permeability and access around the drainage channels which traverse the site. The design of the Development Plan also provides the option for future development to extend into what is currently part of the North Circular Road reservation to the south of the site should it be surplus to road requirements as well as facilitating possible future connections onto North Circular Road.

The Plan predominantly provides single lot residential development, with the exception of two large apartment sites located adjacent/opposite public open space, and a number of 'four-pack' lots, generally with rear access, capable of providing four multiple dwellings on each lot.

The Development Plan provides for a diversity of residential living options within residential development ranging from R20 to R160. The distribution of residential density has been based on the provision of higher densities around the park and along the main spine roads.

The provision of POS within the development has been informed by the principles of Liveable Neighbourhoods and taking into consideration the sites existing drainage channels and the need to ensure effective open space is provided. The POS is provided in the form of a large park located in the northern portion of the Development Plan area, together with additional areas abutting the drainage channels (Figure 4).

The POS will be landscaped to provide for opportunities for passive recreation opportunities within easy reach of residents and available for day or night use (refer to Appendix 4 for Concept Landscape Master Plan). Species selection and irrigation will be arranged on the principles of hydro-zoning to maximise water efficiency.

4. KEY DESIGN PRINCIPLES, OBJECTIVES AND CRITERIA

4.1 Design Principles and Objectives

The key design principles and objectives applicable to the LWMS for Lot 330 are based on the following:

- State Planning Policy No. 2.9 – Water Resources (WAPC, 2006);
- Stormwater Management Manual for Western Australia (DoW, 2004-2007);
- Better Urban Water Management (WAPC, 2008);
- Advice from the Department of Water; and
- Advice from the Town of Port Hedland.

The key overall guiding principles for the management of water resources relevant to Lot 330 include:

- Facilitation of sustainable best practice water management as it relates to the Pilbara region;
- Minimising public risk, including risk of injury or loss of life;
- Protecting infrastructure from flooding and waterlogging; and
- Encourage environmentally responsible development.

This LWMS has been prepared with regard to the following guidance:

- Open drains are to be used as a preference to piped drainage due to the high rainfall intensities and run-off rates;
- Existing drains are retained as far as possible;
- Flood risk is the main issue from surface water, however groundwater levels need to be considered;
- Management of erosion and sedimentation transport in overland flow paths is important;
- Pre-development groundwater monitoring should be undertaken if time permits to provide ‘proof of concept’;
- The LWMS checklist contained in *Better Urban Water Management* (WAPC, 2008) should still be used.

4.2 Design Criteria

The following design criteria have been adapted for implementation in the design and construction of the stormwater management system for Lot 330.

Water Conservation:

- Minimise the use of potable water where drinking water quality is not essential including the investigation of fit-for-purpose options, particularly for ex-building use;
- Apply waterwise landscaping measures in all landscaped public areas including proposed swales to reduce the requirement for irrigation; and

- Retain native vegetation in public open space areas where practicable to reduce the requirement for irrigation.

Water Quantity Management:

- Convey flood waters off-site in a safe and controlled manner via overland flow paths;
- Use open drains/swales throughout the development to disperse flows with the aim to minimise velocities; and
- Open drains/swales to be designed to cater for the 5 year ARI event, with larger events flowing along road reserves.

Groundwater Levels:

- Protect the development from waterlogging.

Water Quality Management:

- Manage run off to ensure that erosion and sedimentation is managed in the overland flow paths.

5. WATER USE SUSTAINABILITY INITIATIVES

5.1 Water Conservation and Efficiency Measures

5.1.1 Buildings

The development is subject to the mandatory requirements for water efficiency in new buildings under the Building Code of Australia (BCA) and Western Australia's "5-Star Plus Stage 1" supplement (Appendix 5).

5.1.2 Public Open Space

The POS allocation has been kept to a minimum within the Development Plan. The bulk of the POS will be provided within the proposed drainage reserves that cover the existing drainage channels. Wherever practical, the existing native vegetation will be retained in the open space areas to minimise the requirements for irrigation.

Where landscaping is required (e.g. in POS or street trees), water requirements will influence plant selection and POS design. Newly landscaped areas will be watered during establishment. Irrigation will be restricted during the daytime (9am and 6pm) to avoid the time of day when evaporation rates are at their maximum.

An acceptable source of water for irrigation purposes will need to be identified. Fit-for-purposes options will be investigated and reported in the UWMP.

5.2 Water Supply – Fit for Purpose

5.2.1 Scheme Water Supply

Scheme water will be available to the development through an expansion of the existing Water Corporation water supply network.

5.2.2 Groundwater

The quality and yield of groundwater from local aquifers at the site is unknown. On this basis, and considering the availability of scheme water, direct groundwater abstraction for use at this site has not been considered as a water source except for possible use for dust suppression during the construction phase. An application to abstract groundwater from the superficial aquifer will be lodged with the DoW. However, alternative sources such as treated wastewater effluent for dust suppression will also be investigated.

With the above in mind, landscaped areas will be designed with low water use as a driving factor.

5.2.3 Stormwater Harvesting and Reuse

Generally, houses constructed in the Pilbara region do not have gutters and downpipes. Therefore the capture and reuse of stormwater is not considered a viable option for supplementing water supply for non-potable uses.

5.2.4 Wastewater Reuse

Wastewater reuse will be further investigated in collaboration with the Water Corporation to determine whether any options for fit-for-purpose reuse (e.g. dust suppression, irrigation etc.) can be implemented as part of the development. At the time of preparing the report a preferred option had not been selected. Investigations into the various options (e.g. third pipe for treated wastewater for irrigation of POS and street trees, grey water capture and reuse etc.) will be undertaken and reported in the UWMP.

5.3 Wastewater Management

Wastewater disposal will be available to the development through connection to the existing sewer reticulation network. A sewer connection is not currently available at the site. Preliminary advice from the Water Corporation indicates that a permanent wastewater pumping station to service Lot 330 will be required. The cost of providing this infrastructure will be funded by the developer of the site.

6. STORMWATER MANAGEMENT STRATEGY

6.1 Surface Water Management

On-site capture and infiltration of stormwater generated within Lot 330 is not a feasible approach to managing water quality due to the existing site soil conditions. In situ permeability testing using the falling head method indicated permeability values in the order of 1 x 10^{-5} and 3 x 10^{-6}m/s for the slightly silty sand encountered beneath the site (Douglas Partners, 2011).

The ideal drainage network is characterised by the use of kerbed roads as the initial conveyor of stormwater, with kerb breaks located at topographic low points discharging stormwater to large open channels to safely convey stormwater away from the urban zone (GHD, 2011). With this in mind the stormwater drainage system will include on site compensation of stormwater for minor flows, before allowing water to discharge into the two existing main drains. It is proposed to contain the post development stormwater run-off in shallow, vegetated, swale drains located adjacent the main open drains and in the POS areas.

The approach to surface water management on Lot 330 will be consistent with the strategy outlined in Table 3.

TABLE 3
STORMWATER MANAGEMENT STRATEGY FOR LOT 330 HAMILTON ROAD SOUTH HEDLAND

Event	Approach
1 year ARI	Lots will drain into road gutters
	Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin
5 year ARI	Lots will drain into road gutters
	Run-off will be conveyed by overland flow paths in the road reserve to drainage swales which will act as a compensating basin. The capacity of the compensating basins to treat the 5 year ARI event will be confirmed at the detailed design stage.
100 year ARI	Run-off conveyed by overland flow paths in the road reserve to the swale which will then overtop into the existing drainage channels
	Finished floor levels of lots set higher than peak flood levels
	Road reserves will be used as flood routes to direct flood waters to the main drains

Appendix 6 provides an overview of the proposed post-development catchments, 100 year ARI flood routes and indicative locations of drainage swales designed to accommodate the 5 year ARI event.

Any works to the main drainage channels will be undertaken in accordance with the South Hedland Guidelines for Drainage Reserves and Public Access Ways - Development and Management Guidelines (MNLA, 2007). It is recognised that areas of bank used for public access will require reshaping in part. It is recommended that existing vegetation be left on banks where possible to limit erosion changes to the existing flood patterns. The extent and shape of the channel will be in accordance with recommendations from flood modelling for the site currently underway.

6.2 Surface Water Quality Management

Landscaped and vegetated drainage swales will allow for the capture and settling of sediments for events up to the 5 year ARI event. This approach will address the majority of pollutant loads which are typically transported in the smaller, more frequent storm events. Appendix 6 provides indicative locations for the drainage swales. The capacity of the compensating basins will be confirmed at the detailed design stage and reported in the UWMP.

6.3 Disease Vector Management

No permanent water bodies are being created as part of the development. Therefore no specific disease vector management measures are required.

7. GROUNDWATER MANAGEMENT STRATEGY

7.1 Groundwater Levels

Based on the available information at the time of preparing this report, no groundwater level management is proposed for the development due to the depth to groundwater.

It is anticipated that approximately 600mm of fill will be imported, placed and compacted on the site which will further increase groundwater separation between finished floor levels and the highest known groundwater levels. However, the requirement for fill is largely related to geotechnical and flood requirements rather than groundwater levels.

Dewatering may be required during the construction phase and is addressed in Section 8 of this report.

8. CONSTRUCTION MANAGEMENT

The potential presence of groundwater may require management during construction, particularly where deep excavation is required, e.g. sewer services and the construction of a wastewater pumping station.

If dewatering is required, the volume and duration of abstraction is likely to be only for a limited period of time. On this basis the overall impact on the aquifer will be minimal.

Prior to the commencement of dewatering, the construction contractor will prepare a Dewatering Management Plan consistent with the DoW's Water Quality Protection No 13 (DoW, 2006) and apply for a 'Licence to Take Water'. All dewatering will need to be undertaken in accordance with the conditions of the licence and the management plan.

A source of water for dust suppression is currently being investigated. An application to construct abstraction bores and an application to take groundwater will be prepared and lodged with the DoW. In parallel, investigations relating to potential opportunities for use of alternative water supplies (e.g. treated wastewater) for dust suppression will be undertaken prior to the UWMP.

9. SUBDIVISION AND URBAN WATER MANAGEMENT PLANS

The next stage of subdivision planning will require the development of an UWMP. This will include progressing conceptual designs to detailed designs. Specifically, the following issues will need to be addressed within the UWMP:

- Demonstrate that the objectives and criteria stated in the LWMS can be achieved;
- Undertake detailed stormwater management design to confirm the location, size and design of the proposed drainage swales;
- Confirm the finished floor level heights for the development to ensure protection from peak flood levels;
- Undertake detailed landscape design for POS areas, expanding upon the Concept Plans provided in Appendix 4, including the proposed drainage swales;
- Determine irrigation requirements for POS areas, and secure an irrigation water source;
- Identify measures to achieve water conservation and efficiencies of use including sources of water for non-potable uses and detailed designs, controls, management and operation of any proposed system(s); and
- Outline the operational and maintenance responsibilities for the proposed stormwater management system.

10. MONITORING

10.1 Surface Water Monitoring

Since there are no existing natural surface water features on the site, no surface water monitoring is proposed.

10.2 Groundwater Monitoring

Three monitoring wells have been installed on the site. An initial sampling round was undertaken on 31 August 2011 by Aurora Environmental. During this round, groundwater level loggers were installed in each monitoring well to provide a greater resolution of water level information for the site.

Sampling and analysis of the following water quality parameters is planned on a quarterly basis where practicable:

- Total Nitrogen;
- Total Kjeldahl Nitrogen;
- Nitrite/nitrate (NOx-N);
- Ammonia;
- Total Phosphorus;
- Reactive Phosphorus;
- Total dissolved solids;
- pH; and
- Conductivity.

Groundwater level information will be downloaded from each logger on a quarterly basis. The loggers will be re-set and activated.

The data collected from the groundwater monitoring program will be compiled and reported in the UWMP.

11. IMPLEMENTATION

11.1 Roles and Responsibilities

Table 4 outlines the roles and responsibilities to implement this LWMS.

TABLE 4
IMPLEMENTATION STRATEGY

Implementation	**Responsibility**		
Action	**Developer**	**Town of Port Hedland**	**Department of Water**
Prepare UWMP	✓		
Approval of UWMP		✓	✓
Construct stormwater management system	✓		
Operate and maintain stormwater management system	✓ (initially)	✓ (after hand over)	

12. REFERENCES

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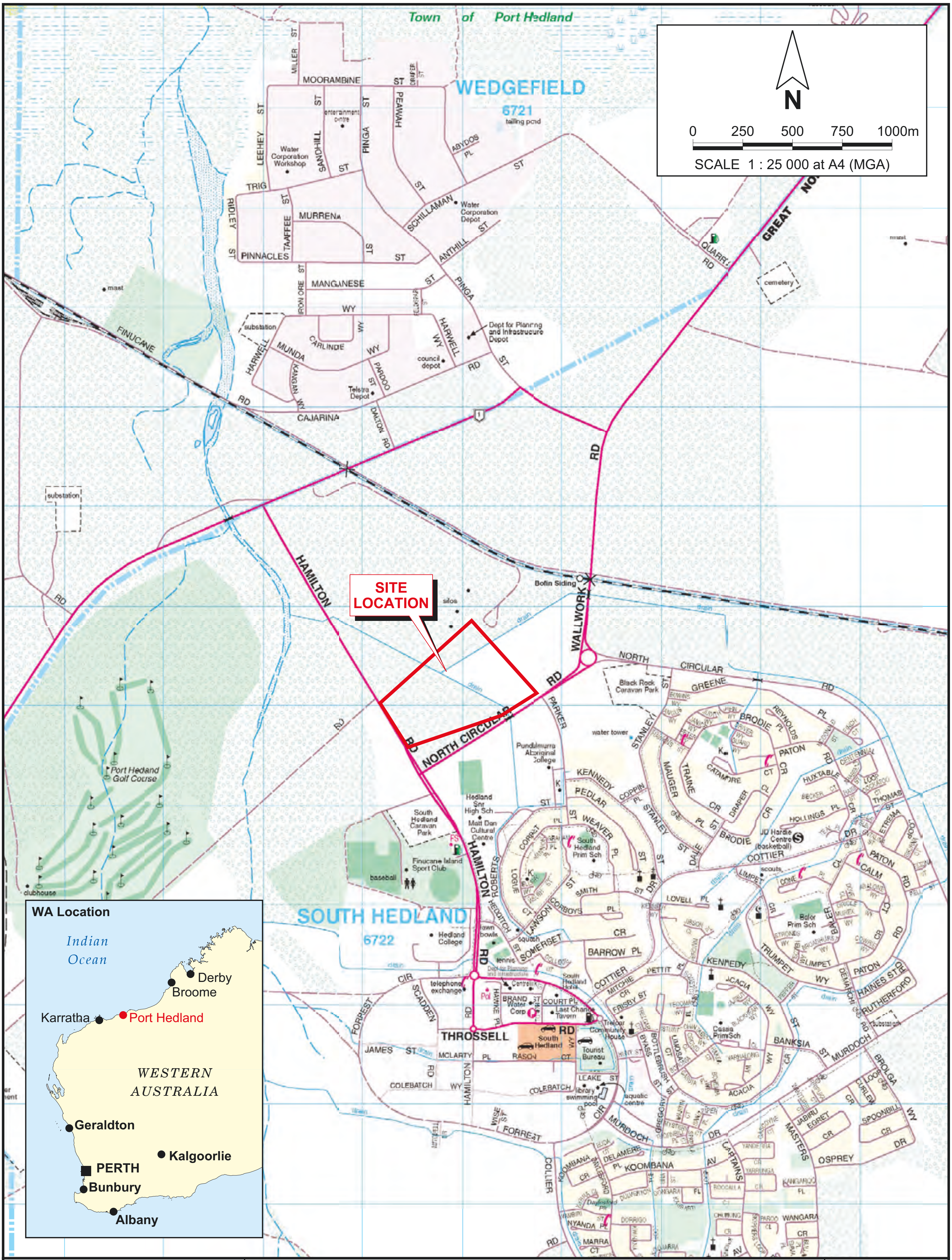
FIGURES



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LOCAL WATER MANAGEMENT STRATEGY
LOT 330 HAMILTON ROAD, SOUTH HEDLAND

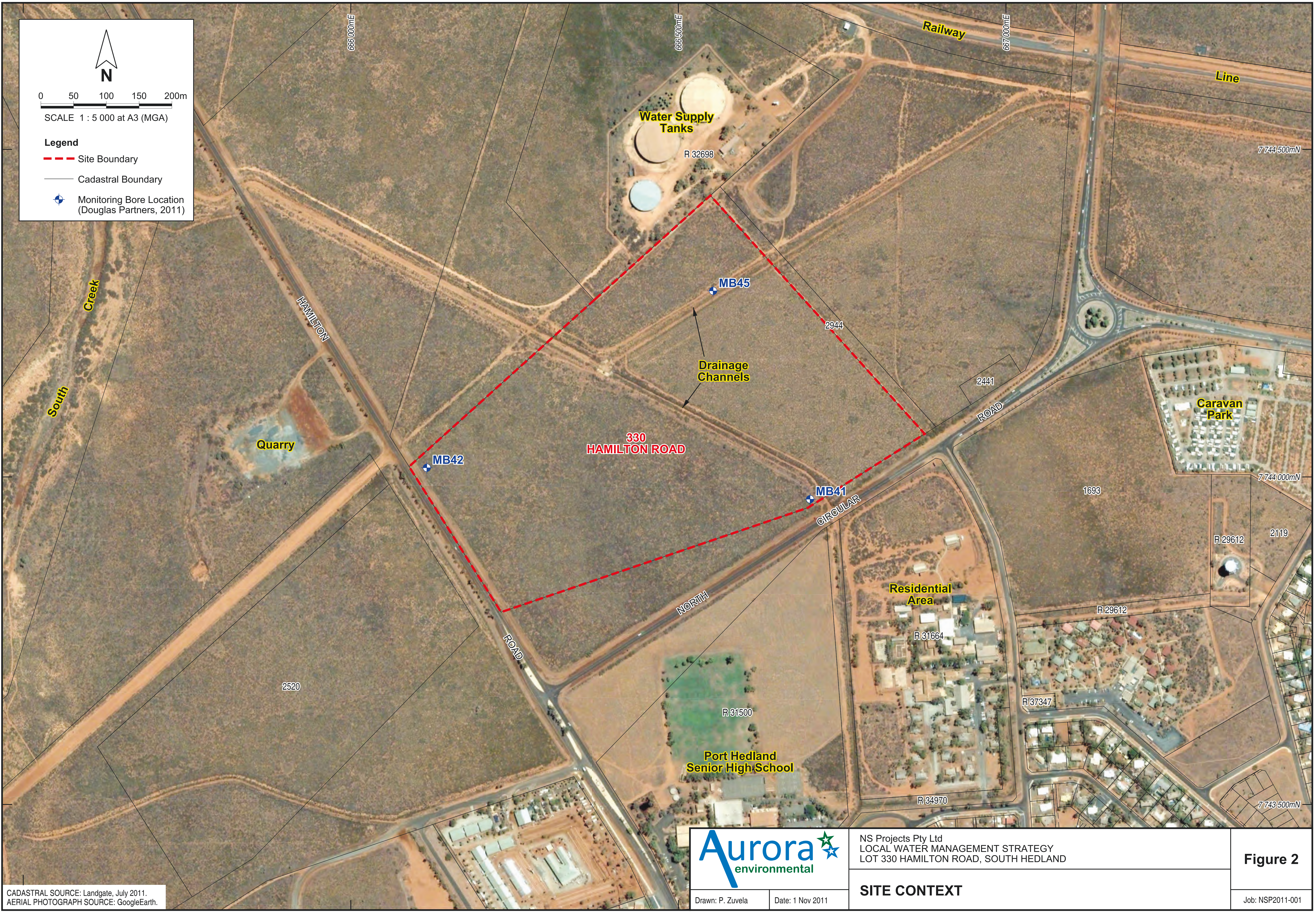
Figure 1

REGIONAL LOCATION

Drawn: P. Zuvela

Date: 1 Nov 2011

Job: NSP2011-001



CADASTRAL SOURCE: Landgate, July 2011.
AERIAL PHOTOGRAPH SOURCE: GoogleEarth.

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LOCAL WATER MANAGEMENT STRATEGY
LOT 330 HAMILTON ROAD, SOUTH HEDLAND

Figure 2

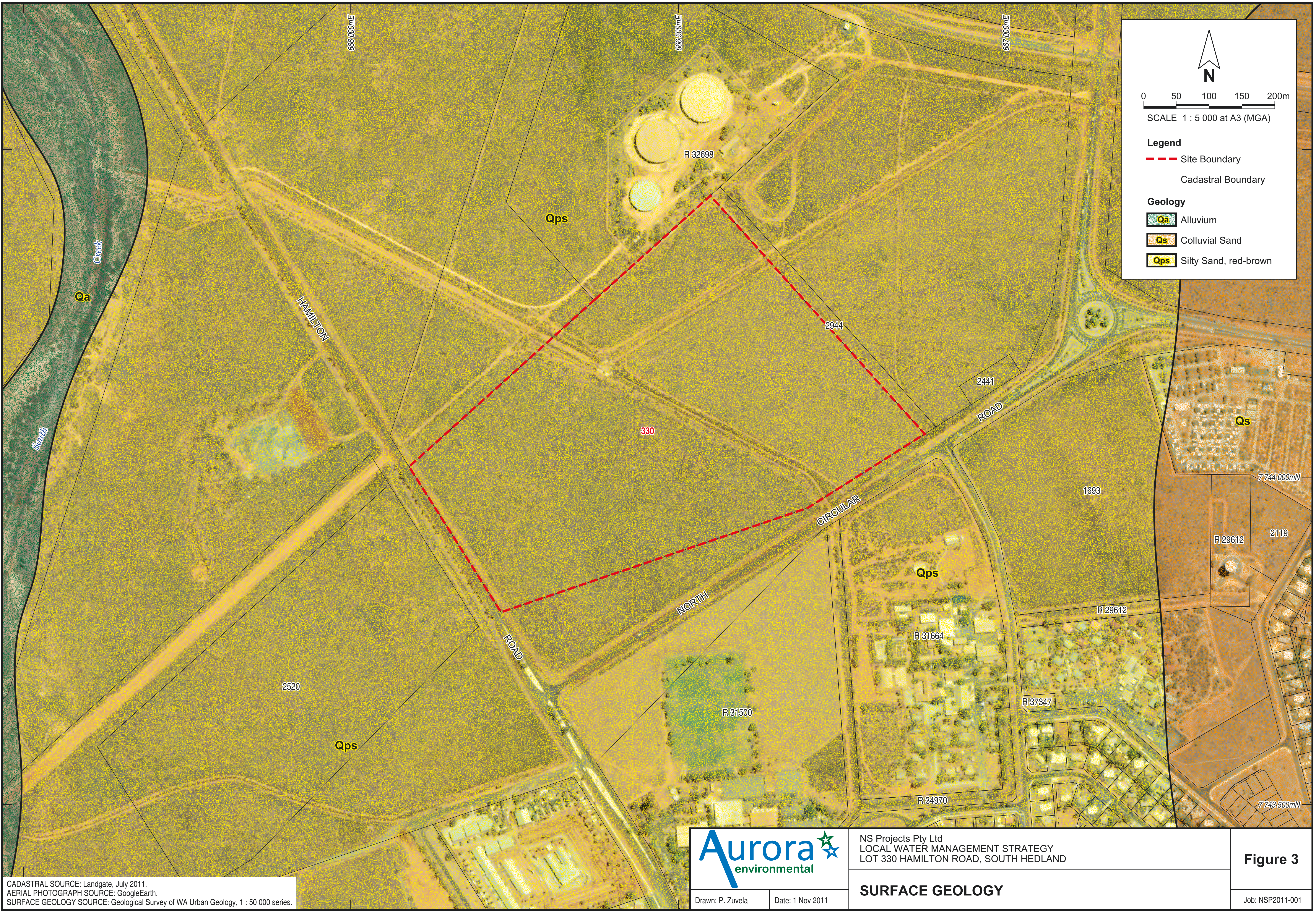
SITE CONTEXT

Drawn: P. Zuvela

Date: 1 Nov 2011

Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136 NSP2011-001-Reporting-002_pz-f02.dgn



CADASTRAL SOURCE: Landgate, July 2011.
AERIAL PHOTOGRAPH SOURCE: GoogleEarth.
SURFACE GEOLOGY SOURCE: Geological Survey of WA Urban Geology, 1 : 50 000 series.

Aurora environmental

NS Projects Pty Ltd
LOCAL WATER MANAGEMENT STRATEGY
LOT 330 HAMILTON ROAD, SOUTH HEDLAND

Figure 3

Drawn: P. Zuvela
Date: 1 Nov 2011

SURFACE GEOLOGY

Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136
NSP2011-001-Reporting-002_pz-f03.dgn

SOURCE: TPG, Job No. 711-340, 03-11-11.

NSP2011-001-Reporting-002_pz-f04.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

Aurora environmental

NS Projects Pty Ltd
LOCAL WATER MANAGEMENT STRATEGY
LOT 330 HAMILTON ROAD, SOUTH HEDLAND

Figure 4

Drawn: P. Zuvela
Date: 10 Nov 2011

DEVELOPMENT PLAN

Job: NSP2011-001

APPENDIX 1

Geotechnical Investigation (Douglas Partners, 2011)

Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Proposed Residential Development
Hamilton Precinct
South Hedland, WA

Prepared for
Pritchard Francis Pty Ltd

Project 76250
September 2011

Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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1	1	1	Cory Johnson, Pritchard Francis
1	1	0	Damian Fasher, NS Projects

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

	Signature	Date
Author		8-9-2011
Reviewer	P.P.	8-9-2011

NCS INTERNATIONAL
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Table of Contents

Report on Geotechnical Investigation
Proposed Residential Development
Hamilton Precinct, South Hedland, Western Australia

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed residential development at the Hamilton Precinct in South Hedland, WA. The investigation was commissioned in a letter received from Cory Johnson of Pritchard Francis Pty Ltd, on 26 July 2011 and was undertaken in accordance with Douglas Partners' proposal dated 18 July 2011.

The aim of the investigation was to assess the sub-surface soil and groundwater conditions across the site and thus:

- Provide a description of the sub-soil conditions including identification of areas of unsuitable soils for building requirements, if encountered.
- Assess the depth to rock, if encountered.
- Assess the potential for collapsing soils beneath the site.
- Determine the suitability of the site to support the proposed development.
- Provide the appropriate classification of the site in accordance with the requirements of AS 2870-2011.
- Provide recommendations on site preparation.
- Provide parameters for pavement design, including a suitable California bearing ratio (CBR) for the subgrade encountered at the site and provide comments on road construction.
- Assess the permeability of the shallow soils and provide comments on site drainage.
- Measure the groundwater level beneath the site at the time of the field work, if encountered.

The investigation included the excavation of 40 test pits, the drilling of three geotechnical boreholes, the installation of three groundwater monitoring wells, permeability testing at four locations and laboratory testing of selected samples. The details of the field work and laboratory testing are presented in this report, together with preliminary comments and recommendations on the issues listed above.

2. Site Description

The site comprises an irregular shaped area of approximately 25 hectares and lies immediately to the north of the existing South Hedland development in Western Australia. It is bounded by Hamilton Road to the west, North Circular Road to the south and has bushland to the east and north (Refer to Drawing 1, Appendix A).

At the time of the field work, the site was covered in medium length grasses, small bushes and some isolated small trees. The site is transected by two large open drains. Surficial soils, where exposed, comprise brown and red-brown sand. The ground surface level across the site is generally flat, although dipping slightly to the north, with levels of approximately RL 10.0 m (AHD) in the south falling to RL 9.0 m in the north.

The Port Hedland 1:50 000 Urban Geology Map Sheet indicates that the site is underlain by sand and silt from alluvial and aeolian origin (locally termed Pindan Sand).

Pindan Sands are known to possibly exhibit collapsing potential. Collapsing soil is a weakly cemented material that is subject to large settlement upon wetting under load, and this could possibly have an impact on the proposed houses.

3. Field Work Methods

Field work was carried out between 4 and 8 August 2011 and comprised:

- The excavation of 40 test pits (TP1 to TP40).
- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- The drilling of three geotechnical boreholes (MB42, BH43 and BH44).
- The construction of three groundwater monitoring wells (MB41, MB42 and MB45).
- Four in situ permeability tests.

The test pits were excavated to a maximum depth of 3.25 m using a 5 tonne Kubota excavator equipped with a 450 mm wide, toothed bucket. PSP tests were carried out adjacent to the test pit locations in accordance with AS1289.6.3.3 to assess the in-situ density of the shallow soils.

The boreholes were drilled to depths of between 7.3 m and 10.2 m, by Edge Drilling using an Explorer 50 drilling rig. The boreholes were advanced using hollow stem auger drilling techniques. Boreholes (MB42, BH43 and BH44) were drilled within the vicinity of three possible locations for the proposed Waste Water Pumping Station for the development. Standard penetration testing (SPT) was carried out at regular depth intervals of 1.5 m within these boreholes. Groundwater monitoring wells were installed at locations MB41, MB42 and MB45, for sampling by others.

Each test location was logged in general accordance with AS 1726–1993 by a suitably experienced representative from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

Permeability testing was carried out at a depth of 0.5 m adjacent to test locations TP1, TP16, TP23 and TP30 using the falling head method.

Test locations were determined using a GPS and are marked on Drawing 1. Surface elevations at each test location were interpolated from a survey plan produced by McMullen Nolan and provided by the client. Levels are quoted relative to the Australian Height Datum (AHD) on the test pit and borehole logs in Appendix A.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix A, together with notes defining descriptive terms and classification methods. A summary of the ground conditions encountered is:

- **Sand** – medium dense, brown and red-brown, slightly silty sand extending from surface to depths of between 1.8 m and termination depth in the test pits and to depths of between 3.0 m and 4.0 m in the boreholes. Rootlets were generally encountered to depths of between 0.2 m and 0.3 m within the test pits.
- **Clayey Sand** – medium dense, red-brown, clayey sand underlying the sand to termination depth in the test pits, and to depths of between 5.5 m and 6.8 m within the boreholes.
- **Clayey Gravelly Sand** – medium dense, red brown mottled brown and grey, clayey gravelly sand from 2.3 m to termination depth at TP5.
- **Sandy Clay** – stiff, red-brown, low to medium plasticity sandy clay within the boreholes from depths of 5.5 m and 6.8 m to termination depths of up to 10.2 m depth.

Weakly cemented soils with collapsing potential were not identified at the site during the field investigation.

4.2 Groundwater

No free groundwater was observed within any of the test pits excavated on 4, 5 and 8 August 2011 to depths of up to 3.25 m below surface level (RL 5.75 m at TP18, lowest test pit level). The test pits were immediately backfilled following the investigation, which precluded longer-term monitoring of groundwater levels. Groundwater levels encountered at each of the boreholes is displayed in Table 1.

Table 1: Summary of Groundwater Levels

Test Location	Date of Drilling	Interpolated Surface Level* [1] (m AHD)	Groundwater Depth (m)	Date of Groundwater Measurement	Groundwater Level [2]* (m AHD)
MB41	06/08/2011	10.0	3.135	07/08/2011	6.9
MB42	06/08/2011	9.2	3.155	07/08/2011	6.0
BH43	06/08/2011	9.3	3.080	07/08/2011	6.2
BH43	07/08//2011	9.2	2.820	08/08/2011	6.4
MB45	07/08/2011	9.3	3.130	08/08/2011	6.2

Notes for Table 1 - [1]: Surface level interpolated from survey plan provided by the client.
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.
* : At time of reporting, the levels of the wells were being surveyed by the project surveyor. Detailed surface level and groundwater levels will be provided once available.

4.3 In Situ Permeability Testing

Four in situ permeability tests using the falling head method were carried out at a depth of 0.5 m at selected locations across the site. A field permeability value was estimated using the Horslev method (1951). Results of the permeability analysis are summarised in Table 2.

Table 2: Summary of the In-Situ Permeability Testing and Derived Values

Test Location	Depth (m)	Measured Permeability (m/s)	Material
TP1	0.5	7.0×10^{-6}	Slightly Silty Sand
TP16	0.5	5.1×10^{-6}	Slightly Silty Sand
TP23	0.5	1.2×10^{-5}	Slightly Silty Sand
TP30	0.5	2.6×10^{-6}	Slightly Silty Sand

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- The particle size distribution of 16 samples.
- Atterberg limits and linear shrinkage of ten samples.
- California bearing ratio (CBR) and modified maximum dry density (MMDD) of four samples.

Detailed test report sheets are given in Appendix B and the results are summarised in Table 3 (following page).

Table 3: Results of Laboratory Testing

Pit	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI	LS (%)	OMC (%)	MMDD (t/m^3)	CBR (%)	Material
TP1	0.5	17	0.0135	0.4	-	-	-	-	-	-	-	Slightly Silty Sand
TP2	0.25	14	0.029	0.41	NP	NP	NP	NP	7.5	1.981	45	Slightly Silty Sand
TP2	1.9	34	<0.0135	0.32	39	14	25	9.5	-	-	-	Clayey Sand, some silt and trace gravel
TP2	2.5	32	<0.0135	0.31	32	13	19	5.0	-	-	-	Clayey Sand, some silt and trace gravel
TP12	0.3	17	0.014	0.4	-	-	-	-	7.3	2.034	60	Slightly Silty Sand
TP16	0.5	15	0.02	0.43	-	-	-	-	-	-	-	Slightly Silty Sand
TP21	0.6	20	<0.0135	0.39	18	14	4	1.0	-	-	-	Slightly Silty Sand, trace clay
TP21	2.5	32	<0.0135	0.37	36	13	23	7.0	-	-	-	Clayey sand, some silt
TP23	0.5	13	0.029	0.49	-	-	-	-	-	-	-	Slightly Silty Sand
TP28	0.4	18	<0.0135	0.39	17	15	2	1.0	7.9	2.050	70	Slightly Silty Sand
TP30	0.5	15	0.026	0.425	-	-	-	-	-	-	-	Slightly Silty Sand
TP33	0.3	11	0.05	0.49	-	-	-	-	9.6	1.965	50	Sand, some silt
TP33	2.1	29	<0.0135	0.39	28	13	15	7.0	-	-	-	Slightly Clayey, some silt
MB42	6-6.45	39	<0.0135	0.23	35	15	20	7.0	-	-	-	Clayey Sand, some silt
BH43	4.5-4.95	38	<0.0135	0.31	39	13	26	10.5	-	-	-	Clayey Sand, some silt
BH44	6-6.45	29	<0.0135	0.32	33	13	20	7.5	-	-	-	Clayey Sand, some silt

Notes on Table 3:

- The % fines is the amount of particles smaller than 75 µm
- A d_{10} of 0.17 mm means that 10% of the sample particles are finer than 0.17 mm
- A d_{60} of 0.23 mm means that 60% of the sample particles are finer than 0.23 mm
- LL: liquid limit
- PL: plastic limit
- PI: plasticity Index
- LS: linear shrinkage
- MMDD: modified maximum dry density
- CBR: California bearing ratio
- OMC: optimum moisture content.
- NP: non plastic fines
- '-' means 'Not Tested'

6. Proposed Development

It is understood that the proposed development includes the construction of a residential development with associated roads and public open space. The site is likely to be raised with imported filling to mitigate inundation by flooding.

A waste water pumping station with a wet well with depth of approximately 6 m below existing surface level will also be constructed. The proposed construction method of the wet well is not known at time of writing.

7. Comments

7.1 Ground Conditions and Collapsing Soils

The results of the investigation indicate that there is little lateral variation in the shallow ground conditions across the site, which generally consist of slightly silty sand, overlying clayey sand in turn overlying sandy clay. This soil profile is typical of Pindan Sand, a geological soil unit found throughout the north-west of Western Australia and known to have a collapse potential.

Undisturbed samples were collected with the view to testing their collapse potential, although, no soils were discovered on site that exhibited signs of having collapse potential. Even so, it is considered prudent to undertake suitable site preparation measures, as indicated in Section 7.3, to minimise any potential impacts of collapsing soils, should they exist at locations other than those investigated at the site.

7.2 Site Classification

The shallow ground conditions beneath the site generally comprise slightly silty sand overlying slightly reactive low plasticity clayey sand and sandy clay. Current classification of the site in accordance with AS 2870-2011 was determined using the results of the field work and subsequent laboratory testing. The method presented in Kay (1990) was used to calculate the characteristic free surface movement (ys) for the site, based on procedures outlined in AS 2870-2011, the typical soil profiles revealed in the test pits, the results of laboratory testing and on a design depth of suction change of 4 m, as proposed by McManus et al (2004) for semi arid flood prone sites.

Based on the results of the assessment, the site should be classified as ‘Class S’ in accordance with AS 2870-2011.

7.3 Site Preparation

It is recommended that site preparation is supervised by a suitably experienced geotechnical engineer. Prior to excavation of foundations and/or placement of fill, all deleterious material including topsoil and vegetation should be stripped from building envelopes and pavement areas and removed from site or reused for landscaping purposes, if applicable. Rootlets occurred within the upper soil profile to a depth of 0.3 m. It is considered that the top 0.1 m of this profile should be stripped from the site prior to any filling.

Tree roots remaining from any clearing operations within the proposed building envelopes and pavement areas, should be completely removed.

Following removal of unsuitable material and prior to any filling, to minimise the risk of damage to structures and roads due to possible soil collapse, it is recommended that the following preparation is undertaken across each building envelope and pavement area:

- Flood the site with water and allow to drain; then
- Compact the site using several overlapping passes of a heavy vibrating roller (minimum 18 tonne).

Following the site preparation suggested above, filling should be placed within 2% of its optimum moisture content, in layers not exceeding 200 mm thickness and each layer compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. Care should be taken not to operate heavy plant adjacent to existing structures or services.

With the exception of the top 0.1 m layer of surfical soil containing rootlets, the natural materials across the site are generally suitable for re-use as filling material for support of structures. This material should be placed as detailed above.

The base of all footing excavations should be compacted prior to placement of reinforcement and casting of concrete. The use of a vertical rammer is considered to be suitable equipment for this task.

Compaction control of sand could be carried out using a Perth sand penetrometer in accordance with test method AS 1289.6.3.3. It is recommended that all areas within building and pavement envelopes be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration when tested in accordance with the above test method. Compaction control of clayey materials should be carried out using a nuclear surface moisture-density gauge, in accordance with test method AS 1289.5.8.1.

7.4 Earth Retaining Structures

Design of temporary and permanent retaining structures can be based on a bulk unit weight for the retained material of 20 kN/m^2 and an active earth pressure coefficient Ka of 0.33 in sand assuming level backfill and adequate drainage. In addition to the soil pressure, wall design should also allow for external loads such as buildings and live loads.

7.5 Foundation Design

7.5.1 Residential Structures

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support residential structures. Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of the appropriate site classification detailed in Section 7.2.

AS 2870-2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. For buildings not covered by AS 2870-2011, a presumptive allowable bearing pressure of 150 kPa is suggested for foundation design of strip and pad footings founded at a minimum depth of 0.5 m following suitable preparation detailed above. This should ensure that total settlements are less than about 20 mm.

7.5.2 WWPS Wet Well

Detailed information for the proposed wet well to be constructed at the WWPS is not available at time of writing, however it is understood that the footing at the base of the well is likely to be approximately 6 m below existing surface level. Boreholes MB42, BH43 and BH44 were drilled in the vicinity of potential locations for the WWPS, as nominated by Pritchard Francis. The material encountered at the proposed base of the wet well at each of these locations consists of medium dense clayey sand underlain by stiff sandy clay. A preliminary allowable bearing capacity of 250 kPa is suggested for the design of the wet well footing in the material encountered at the foundation depth at these locations.

The wet well should also be designed to resist hydrostatic pressure (uplift). To calculate the shaft resistance to uplift, the following parameters are provided in Table 4.

Table 4: Soil Parameters for Shaft Resistance to Uplift at Proposed WWPS Locations

Soil Unit Weight Above Water **γ** **(kN/m^3)**	**Drained Angle of Friction for Sand** **Φ'** **(Degrees)**	**Friction Angle between Sand and Pre-cast Concrete** **δ** **(Degrees)**	**Coefficient of Earth Pressure – at Rest** **K_0**
18	32	17 - 22	0.5

7.6 Pavement Design Parameters and Road Construction

As noted in Section 4.1 the shallow soils across the site comprise slightly silty sand. This material may constitute the subgrade for the proposed pavements across the site.

Laboratory testing results detailed in Section 5 indicate CBR values between 45% and 60% for 4-day soaked samples compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and tested under a confining surcharge of 4.5 kg for silty sand subgrade. Based on observations made in the field and a review of the available laboratory testing results, a subgrade CBR design value of 10% is suggested for the design of pavement on the silty sand material, provided the subgrade is prepared in accordance with Section 7.3, compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and suitably drained.

7.7 Site Drainage

Results of the permeability analysis are summarised in Table 2 and indicate a permeability values in the order of between 1 x 10 $^{-5}$ and 3 x 10 $^{-6}$ m/s for the slightly silty sand encountered beneath the site.

Given the high fines content of the soils at the site, which is generally increasing with depth, it is considered that stormwater disposal via soakwells is unsuitable. An alternative method of stormwater disposal, such as directing water to retention basins or similar should be considered. The implementation of a suitable drainage strategy is suggested to control water collecting on the site surface during the large rain events which seasonally occur in the Pilbara region.

The typical approach for ensuring amenity of sites such as this in regional areas includes grading of the lots to allow surface water to flow into roadside drains, and on towards a subsequent suitable outflow.

8. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings

9. Limitations

Douglas Partners (DP) has prepared this report for a residential development at the Hamilton Precinct in South Hedland, WA in accordance with DP's proposal dated 18 July 2011 and acceptance received from Cory Johnson of Pritchard Francis Pty Ltd on 26 July 2011. This report is provided for the exclusive use of Pritchard Francis for this project only and for the purposes described in the report. It should not be used by or relied upon for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About this Report
Drawings
Results of Field Work

About this Report

Introduction

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

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

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Sampling Methods

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
$\underline{\triangledown}$	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

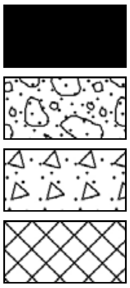
fg	fragmented
bnd	band
qtz	quartz

July 2010

Symbols & Abbreviations

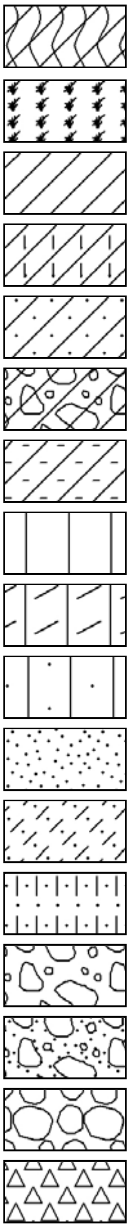
Graphic Symbols for Soil and Rock

General



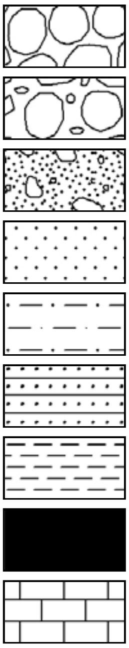
- Asphalt
- Road base
- Concrete
- Filling

Soils



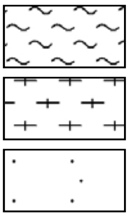
- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks



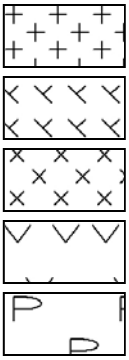
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks



- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks



- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

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CLIENT: Pritchard Francis Pty Ltd		TITLE:	**Location of Tests** **Hamilton Precinct** **South Hedland, WA**
OFFICE: Perth	DRAWN BY: B. Divilly		
SCALE: As shown	DATE: 10 Aug 2011		

MGA

PROJECT No.: 76250
DRAWING No.: 1
REVISION: A

PINPOINT CARTOGRAPHICS (08) 9562 7136

76250-d01.dgn

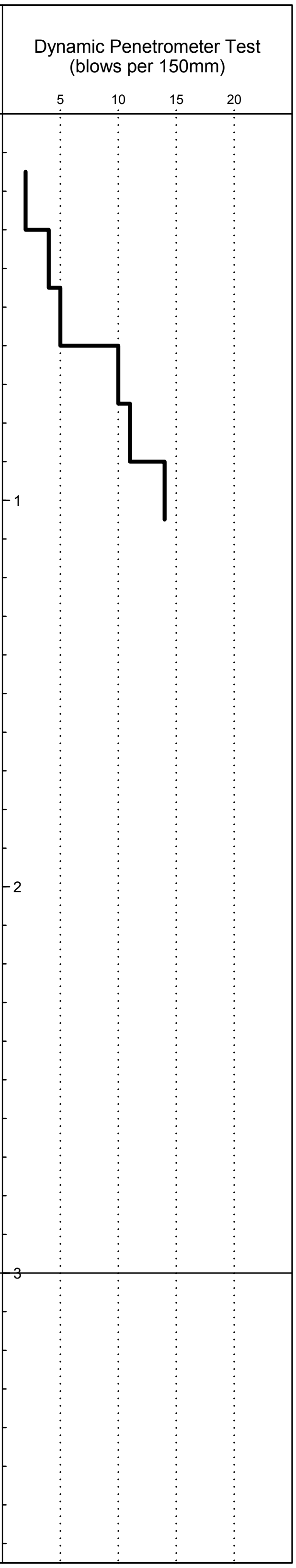
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666133
NORTHING: 7744009
DIP/AZIMUTH: 90°/--

PIT No: TP 1
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.						
9								
		- with a trace of rootlets to 0.3 m.						
		- becoming red-brown from 0.35 m.						
		- becoming dry to moist from 0.4 m.		D	0.5			
		- becoming slightly silty sand from 0.5 m.						
		- becoming dense from 0.6 m.						
	1							
8								
		- with some clay from 1.4 m.						
		- becoming moist and mottled light brown from 1.5 m.						
		- clay content increasing with depth.						
		- becoming slightly clayey sand with some fine to medium sized gravel from 1.8 m.						
		- becoming light brown mottled red-brown and black from 1.9 m.						
	2							
7								
				D	2.3			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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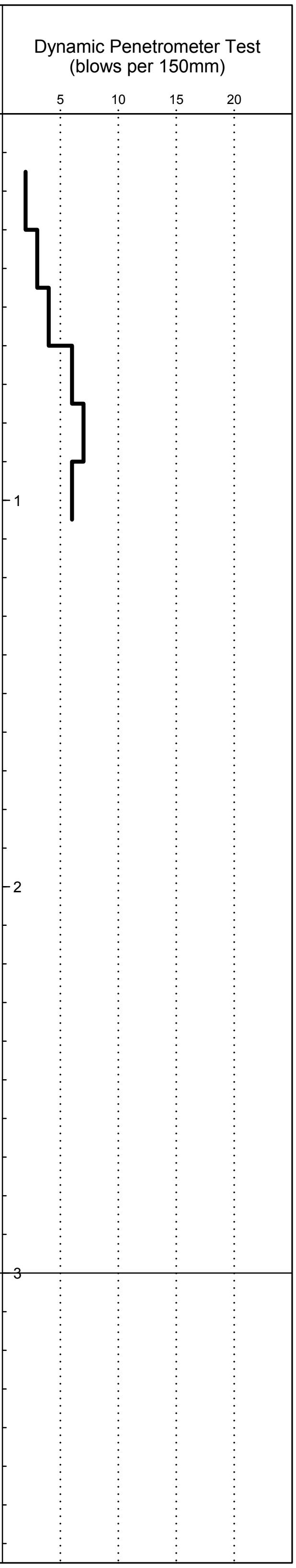
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666185
NORTHING: 7743949
DIP/AZIMUTH: 90°/--

PIT No: TP 2
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with some rootlets to 0.2 m. - becoming red-brown from 0.2 m.		B	0.25			
		- becoming dry to moist from 0.8 m.						
		- with a trace of clay from 0.9 m.						
	1	- clay content increasing with depth.						
8								
				D	1.4			
		- with some clay and mottled light brown from 1.5 m.						
	1.8	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with some silt and a trace of fine sized gravel, moist.		D	1.9			
	2							
7								
				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

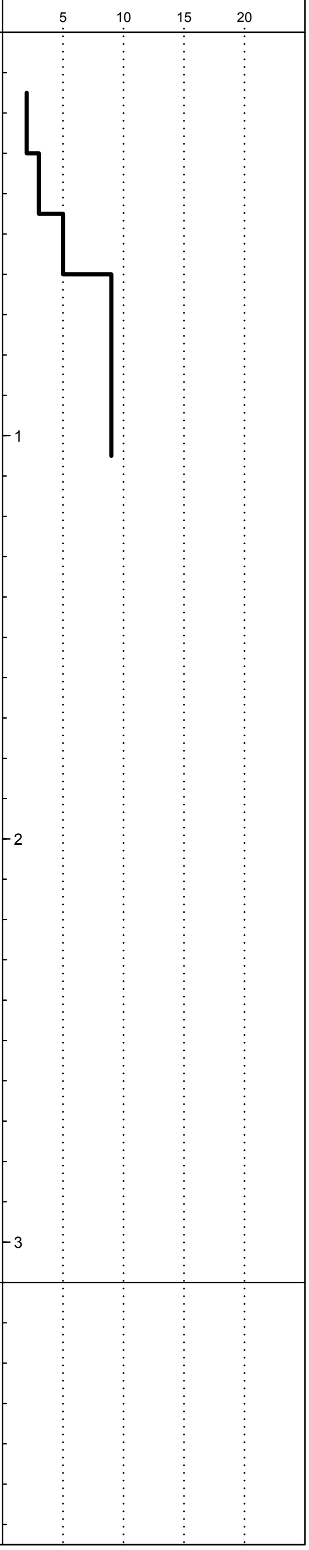
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666237
NORTHING: 7743887
DIP/AZIMUTH: 90°/--

PIT No: TP 3
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- becoming red-brown from 0.3 m.						
9								
		- becoming dense from 0.6 m.						
				D	0.7			
		- becoming dry to moist from 0.9 m.						
	1	- becoming light brown from 1.0 m.						
8								
		- becoming light brown mottled red-brown and black, slightly clayey sand with some silt and fine sized gravel, moist from 1.5 m.		U_{150}	1.5 1.7			
	2							
7				U_{150}	2.4			
		- becoming red-brown mottled light grey 2.5 m.						
				D	2.6			
	3							
	3.1	Pit discontinued at 3.1m (Target)						
6								

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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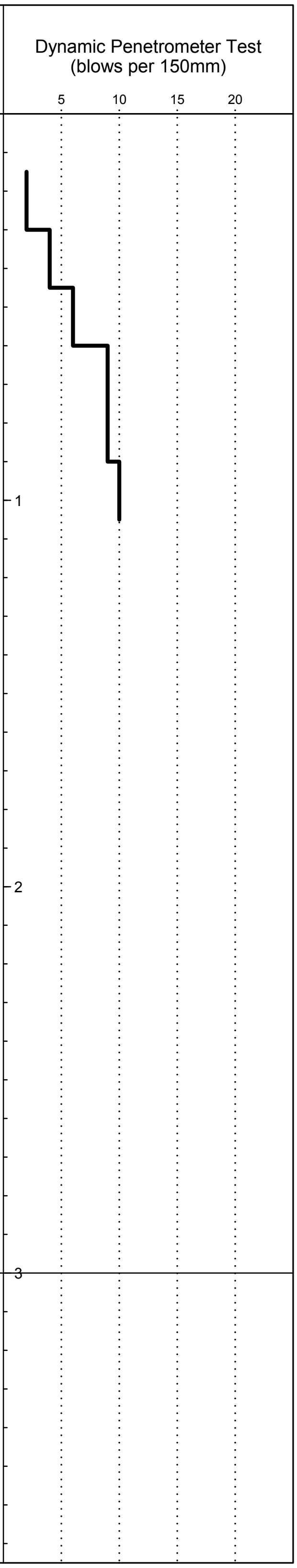
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666294
NORTHING: 7743831
DIP/AZIMUTH: 90°/--

PIT No: TP 4
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with trace of rootlets to 0.3 m.						
		- becoming red-brown from 0.3 m.						
9		- becoming dry to moist from 0.6 m.						
		- becoming dense from 0.6 m.		D	0.7			
	1							
		- with a trace of clay from 1.2 m.						
		- clay content increasing with depth.						
8		- becoming light brown mottled red-brown with a trace of fine sized gravel from 1.5 m.						
		- with some clay from 1.6 m.						
	2	- becoming mottled black, slightly clayey sand with some silt from 1.9 m.						
		- weakly cemented in pockets from 2.2 m.						
				D	2.3			
7		- gravel size increasing to fine to medium sized from 2.6 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

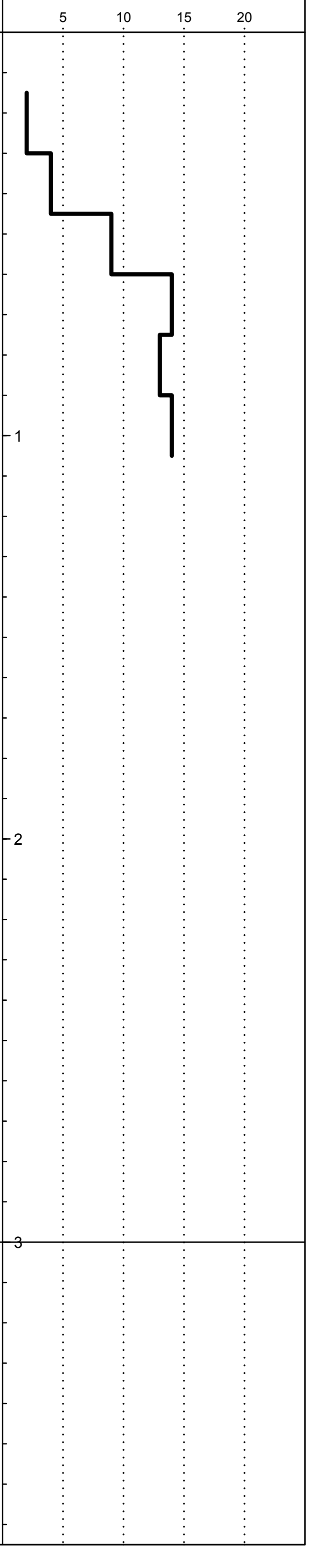
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666347
NORTHING: 7743882
DIP/AZIMUTH: 90°/--

PIT No: TP 5
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.15 m. - becoming red-brown from 0.2 m. - becoming dry to moist from 0.35 m. - becoming dense from 0.45 m. - with a trace of clay from 0.5 m.					
9		- clay content increasing with depth.					
			D	0.9			
	1	- with some clay from 1.1 m.					
		- becoming light brown mottled red-brown from 1.4 m.					
8							
	2	- becoming slightly clayey sand with some silt from 1.9 m.	D	2.0			
	2.3	CLAYEY GRAVELLY SAND - medium dense, red-brown mottled brown and grey, fine to medium grained clayey gravelly sand. Gravel is fine to medium sized. Moist.	D	2.4			
7							
	3 3.0	Pit discontinued at 3.0m (Target)					
6							

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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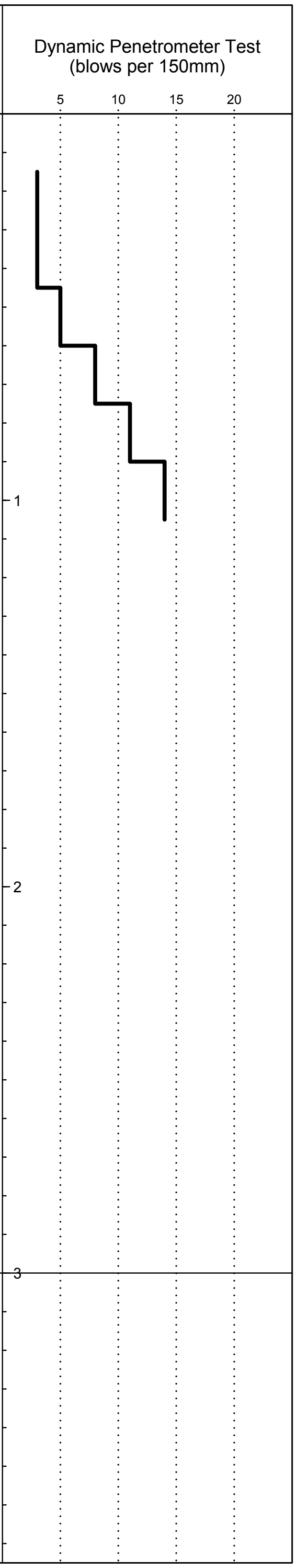
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666295
NORTHING: 7743945
DIP/AZIMUTH: 90°/--

PIT No: TP 6
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - trace of rootlets to 0.25 m. - becoming red-brown from 0.3 m. - becoming dry to moist from 0.4 m. - becoming dense from 0.6 m. - with a trace of clay from 0.9 m. - clay content increasing with depth. - becoming mottled light brown with some clay from 1.3 m. - becoming red brown mottled black and light brown and slightly clayey sand with some silt from 1.5 m. - with a trace of fine sized gravel from 1.6 m.		D D	1.0 1.7			
	3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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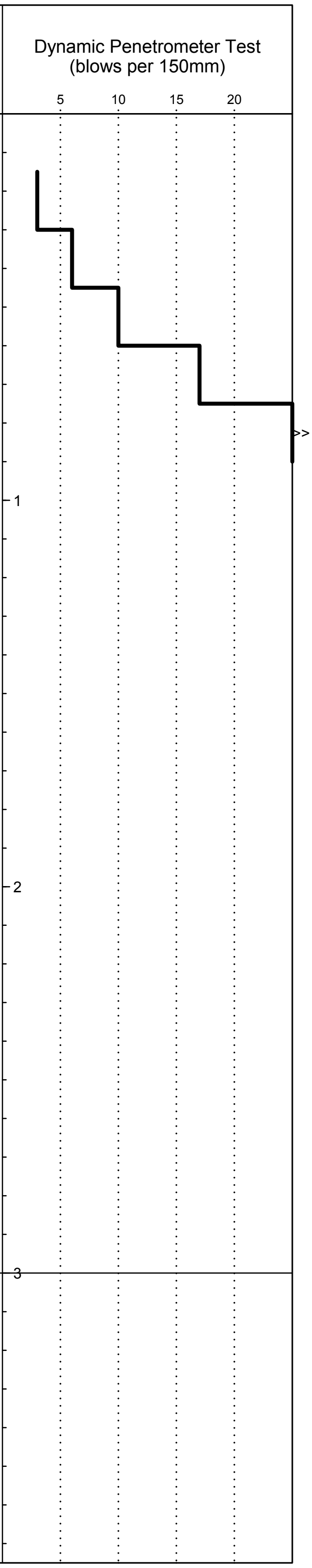
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666244
NORTHING: 7744006
DIP/AZIMUTH: 90°/--

PIT No: TP 7
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
		SAND - dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with some rootlets and a trace of roots to 0.25 m. - becoming light brown from 0.3 m.						
		- becoming dry to moist from 0.6 m. - weakly cemented in pockets from 0.6 m.						
	1			D	1.0			
8								
	2	- becoming red-brown mottled light brown with some clay from 1.9 m. - with some fine sized gravel from 2.0 m. - clay content increasing with depth.		D	2.1			
7								
		- becoming slightly clayey sand with some silt and moist from 2.3 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

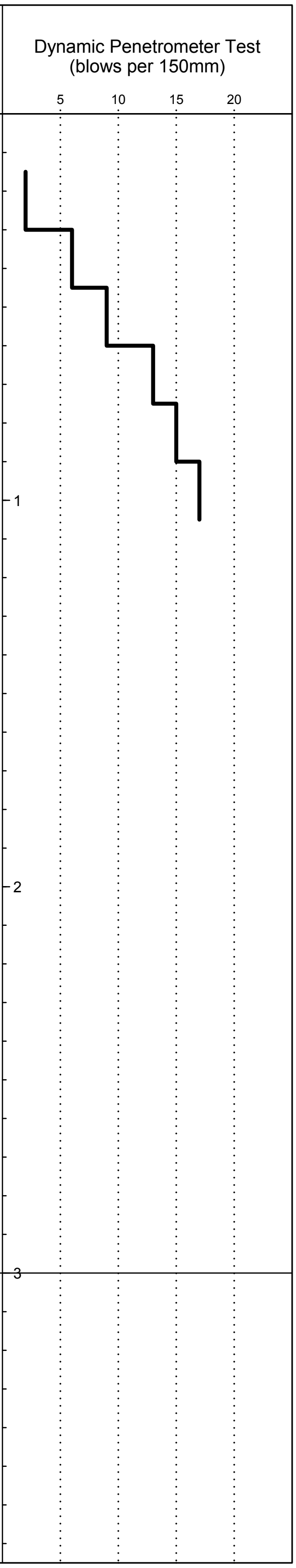
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666186
NORTHING: 7744061
DIP/AZIMUTH: 90°/--

PIT No: TP 8
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.25 m.						
		- becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.4 m.						
	1							
8				D	1.1			
		- with some clay from 1.5 m.						
		- clay content increasing with depth.						
		- becoming light brown mottled red-brown with trace of fine sized gravel from 1.7 m.						
	2	- becoming red-brown mottled light brown, slightly clayey sand with some silt and fine sized gravel from 1.9 m.		D	2.0			
7								
		- becoming mottled grey from 2.7 m.						
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

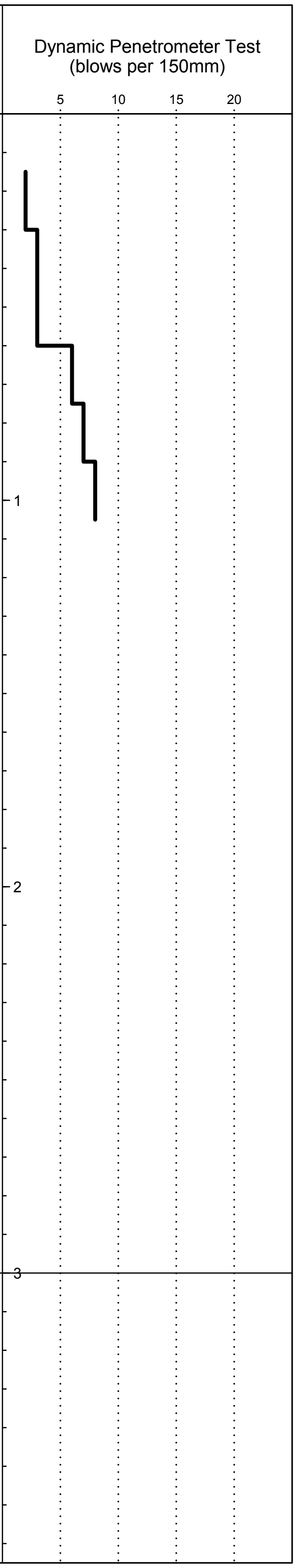
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666247
NORTHING: 7744115
DIP/AZIMUTH: 90°/--

PIT No: TP 9
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.25 m. - becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.5 m.						
8	1	- becoming light brown mottled red-brown with trace of clay from 1.0 m.						
				D	1.2			
		- with some clay and fine sized gravel from 1.5 m. - becoming moist from 1.5 m. - weakly cemented in pockets to 1.5 m.						
		- becoming mottled black, slightly clayey sand with some silt from 1.8 m.						
7	2							
				D	2.5			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

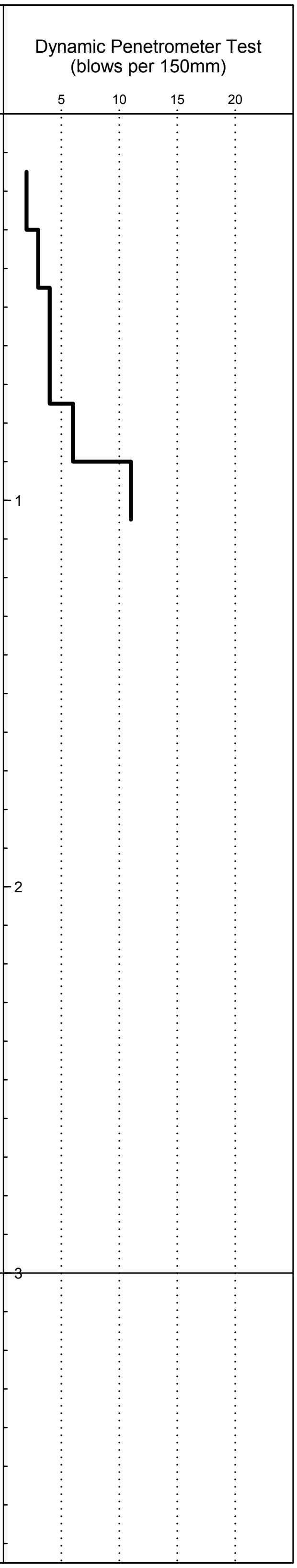
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666299
NORTHING: 7744059
DIP/AZIMUTH: 90°/--

PIT No: TP 10
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.4 m.		B	0.4			
	1							
8								
		- with some clay from 1.3 m.						
		- becoming mottled light brown, slightly clayey sand with some silt from 1.7 m.						
				D	1.9			
	2							
7								
				D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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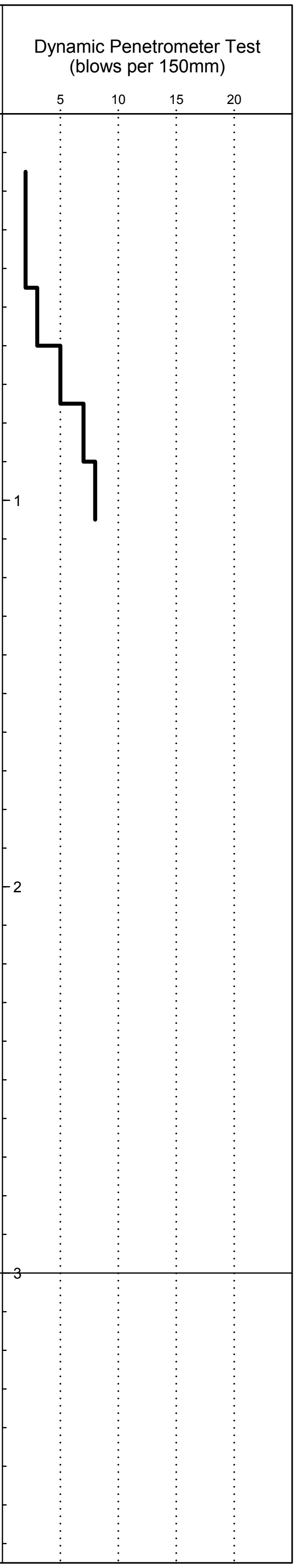
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666355
NORTHING: 7743996
DIP/AZIMUTH: 90°/--

PIT No: TP 11
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
9		- becoming red-brown from 0.3 m. - with a trace of roots and rootlets to 0.3 m.					
	1	- with a trace of clay from 0.9 m. - clay content increasing with depth.					
8							
		- becoming light brown mottled red-brown from 1.5 m.					
		- becoming slightly clayey sand with some silt, a trace of fine sized gravel and moist from 1.8 m.					
	2	- becoming mottled black from 2.0 m.					
7		- with some fine sized gravel from 2.3 m.					
			D	2.4			
	2.8	CLAYEY SAND - medium dense, red-brown mottled light brown and black, fine to medium grained clayey sand with some silt and fine to medium sized gravel, moist.	D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)					
6							



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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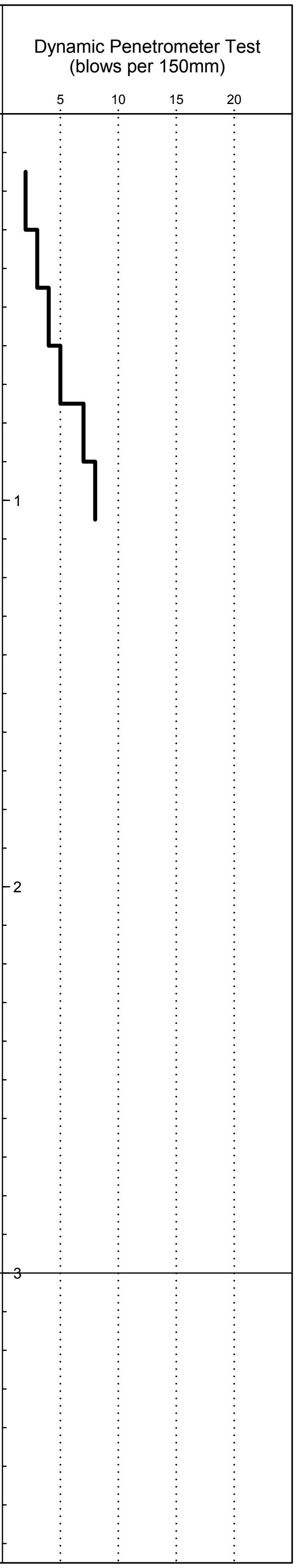
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666405
NORTHING: 7743938
DIP/AZIMUTH: 90°/--

PIT No: TP 12
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.25 m.		B	0.3			
9		- becoming dry to moist from 0.5 m.						
	1							
		- with some clay from 1.1 m.						
				D	1.2			
8		- becoming mottled light brown from 1.5 m.						
		- becoming mottled light brown and black, slightly clayey sand with some silt and trace fine sized gravel from 1.8 m.						
	2			D	2.0			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

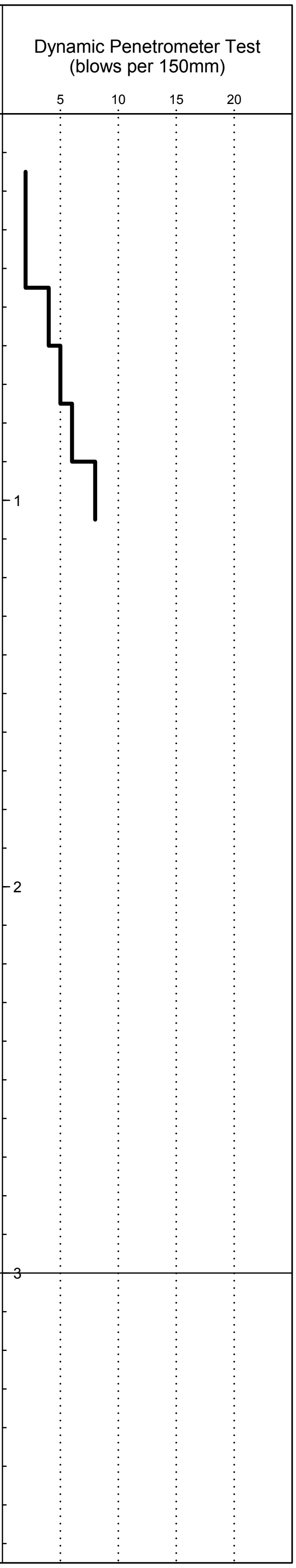
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666526
NORTHING: 7743931
DIP/AZIMUTH: 90°/--

PIT No: TP 13
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- becoming red-brown from 0.25 m.						
		- with a trace of rootlets to 0.35 m.						
9								
		- weakly cemented in pockets to 0.6 m.						
	1			D	1.0			
		- with some clay from 1.2 m.						
		- clay content increasing with depth.						
8								
		- becoming mottled light brown and slightly clayey sand with some silt from 1.8 m.						
	2							
		- with a trace of fine sized gravel from 2.2 m.						
				D	2.4			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

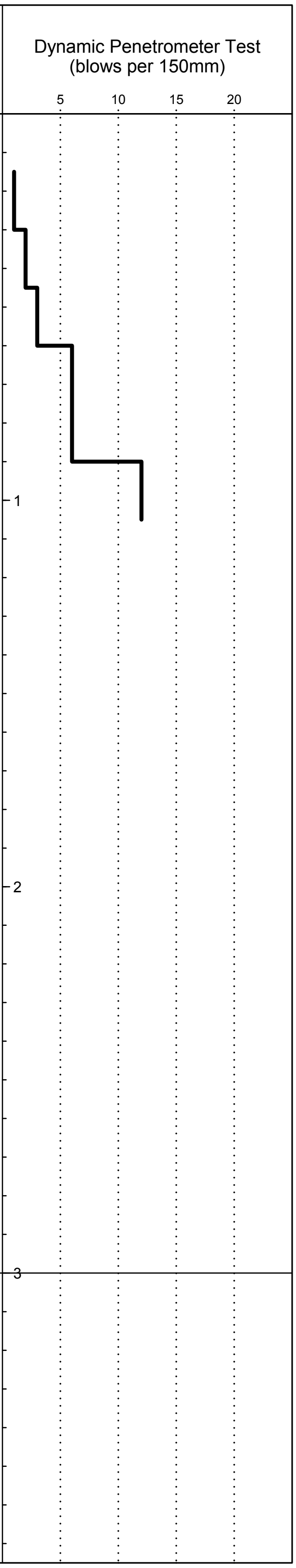
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666475
NORTHING: 7743996
DIP/AZIMUTH: 90°/--

PIT No: TP 14
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with some rootlets to 0.35 m. - becoming red-brown and dry to moist from 0.4 m. - with a trace of clay from 0.8 m. - becoming dense from 0.9 m. - clay content increasing with depth.		D	1.0			
		- becoming mottled light brown and moist from 1.7 m. - becoming slightly clayey sand with some silt from 2.0 m.		D	2.2			
		- becoming mottled black, with a trace of fine sized gravel from 2.6 m.						
	2.7	CLAYEY SAND - medium dense, red-brown mottled light brown and black, fine to medium grained clayey sand with trace of fine sized gravel, moist.		D	2.9			
	3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

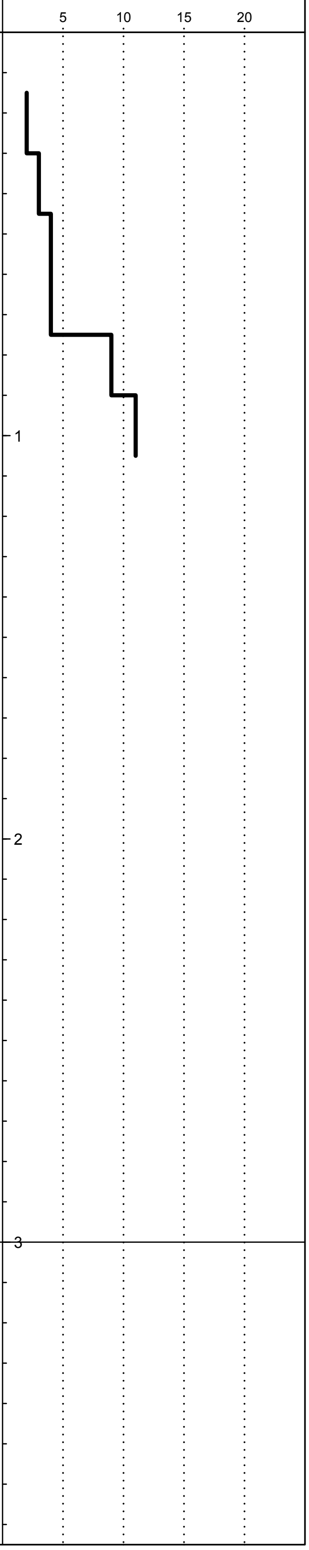
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666417
NORTHING: 7744052
DIP/AZIMUTH: 90°/--

PIT No: TP 15
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry.						
9		- with some rootlets and trace of roots to 0.3 m.						
		- becoming dry to moist from 0.5 m.						
				D	0.7			
		- becoming dense from 0.75 m.						
	1							
8								
		- with some clay from 1.4 m.						
				D	1.6			
		- becoming mottled light brown and moist from 1.7 m.						
	2	- becoming slightly clayey sand with some silt from 2.0 m.						
7								
				D	2.4			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

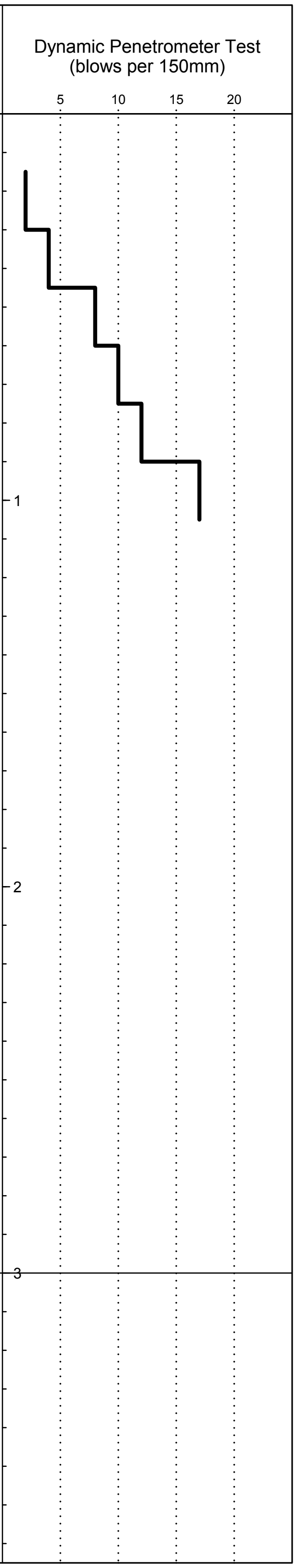
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666363
NORTHING: 7744112
DIP/AZIMUTH: 90°/--

PIT No: TP 16
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with some rootlets from 0.25 m. - becoming red-brown from 0.25 m. - becoming dense from 0.45 m. - becoming dry to moist from 0.5 m.		D	0.5			
8	1	- with some clay from 1.2 m.						
		- becoming red-brown mottled light brown slightly clayey sand with some silt, moist from 1.7 m.		D	1.8			
7	2	- with some fine sized gravel from 2.8 m.						
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

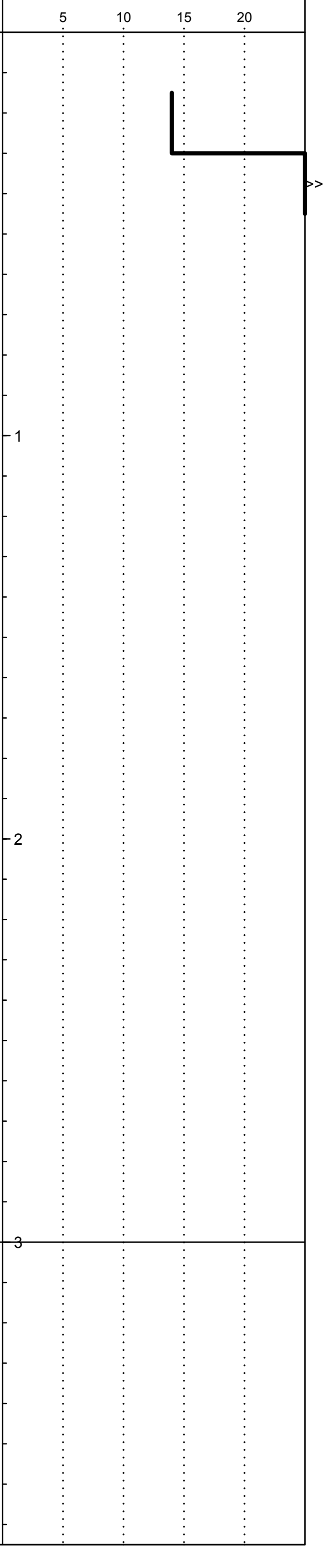
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.7 m AHD*
EASTING: 666314
NORTHING: 7744169
DIP/AZIMUTH: 90°/--

PIT No: TP 17
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - very dense, red-brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.2 m.						
		- becoming dry to moist from 0.5 m. - weakly cemented in pockets to 0.5 m.		D	0.6			
9								
	1							
		- with some clay from 1.2 m.						
		- clay content increasing with depth.		D	1.4			
		- becoming mottled light brown and moist from 1.5 m.						
8								
		- becoming slightly clayey sand with some silt from 1.8 m.						
	2							
				D	2.3			
	2.5	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand with some silt, moist.		D	2.6			
7								
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test
(blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

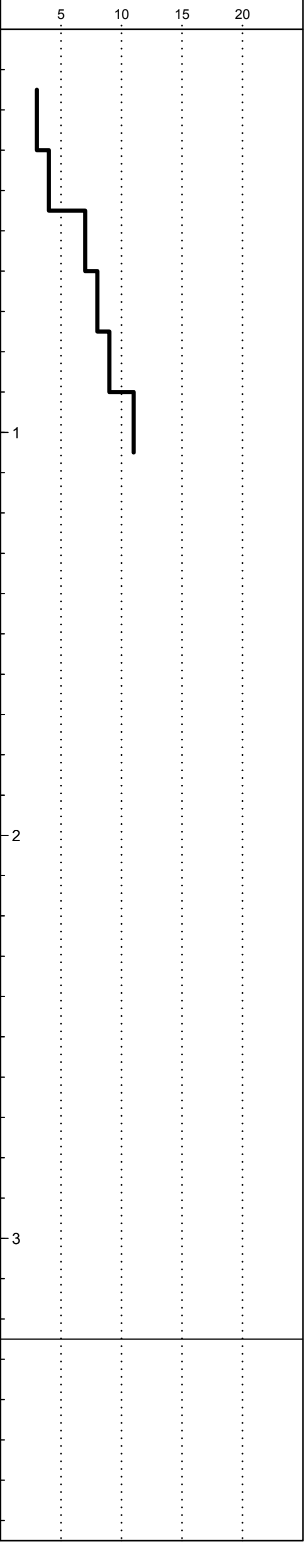
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666365
NORTHING: 7744225
DIP/AZIMUTH: 90°/--

PIT No: TP 18
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9	0	SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- trace of roots and rootlets to 0.2 m.					
		- becoming red-brown and dry to moist from 0.25 m.					
		- becoming dense from 0.45 m.					
8	1						
		- with a trace of clay from 1.2 m.					
		- clay content increasing with depth.					
		- with some clay from 1.5 m.	D	1.5			
		- becoming mottled light brown from 1.8 m.					
		- becoming slightly clayey sand with some silt from 1.9 m.	U_{150}	1.9 2.1			
7	2						
		- becoming moist from 2.1 m.					
			U_{150}	2.6 2.8			
6	3	- becoming moist to wet from 3.0 m.					
	3.1	CLAYEY SAND - medium dense, red-brown, fine to medium clayey sand, moist to wet.	D	3.2			
	3.25	Pit discontinued at 3.25m (Target)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

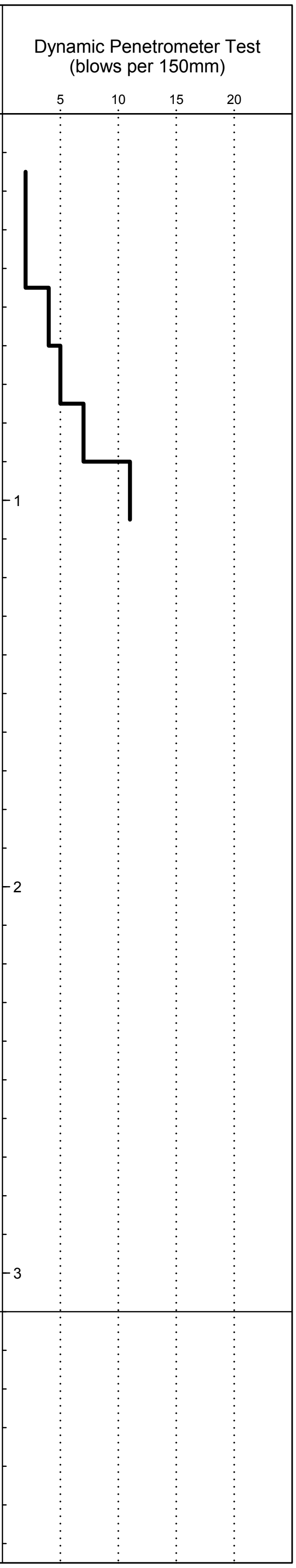
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.9 m AHD*
EASTING: 666430
NORTHING: 7744163
DIP/AZIMUTH: 90°/--

PIT No: TP 19
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.25 m.						
		- becoming red-brown from 0.25 m.						
		- becoming dry to moist from 0.5 m.						
		- becoming dense from 0.75 m.						
		- with a trace of clay from 0.8 m.						
8		- clay content increasing with depth.						
	1							
		- with some clay from 1.2 m.						
		- becoming slightly clayey sand with some silt, a trace of fine sized gravel and moist from 1.5 m.		D	1.6			
7								
	2							
				D	2.7			
		- becoming moist to wet from 2.8 m.						
6								
	3							
	3.1	Pit discontinued at 3.1m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

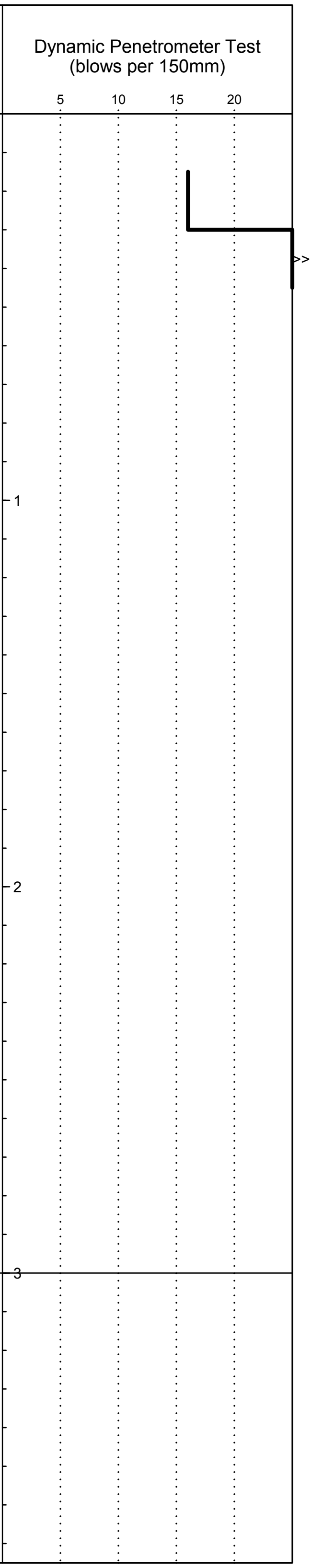
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.6 m AHD*
EASTING: 666473
NORTHING: 7744101
DIP/AZIMUTH: 90°/--

PIT No: TP 20
PROJECT No: 76250
DATE: 8/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - very dense, red-brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.25 m.						
				D	0.4			
9		- becoming dry to moist from 0.5 m.						
8		- with some clay from 1.6 m.						
		- becoming moist from 1.8 m.						
		- becoming mottled light brown with some fine to medium sized gravel from 2.1 m.		D	2.2			
		- becoming slightly clayey sand with some silt from 2.4 m.						
7				D	2.6			
	3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

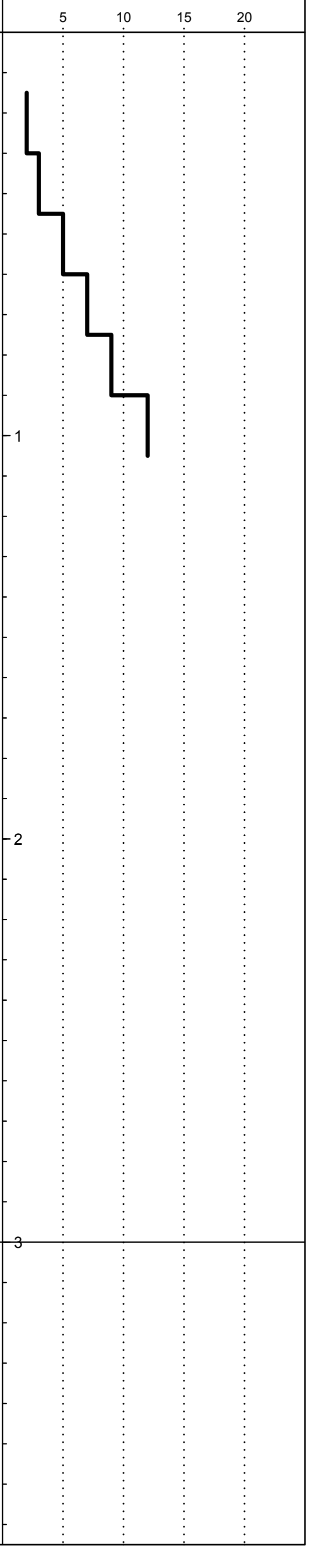
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666528
NORTHING: 7744046
DIP/AZIMUTH: 90°/--

PIT No: TP 21
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
9	1 2	SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - becoming red-brown from 0.3 m. - with a trace of rootlets to 0.3 m. - with a trace of clay and becoming moist from 0.5 m. - becoming dense from 0.6 m. - becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.		D	0.6				
8 7	2.4	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand with some silt, moist.		D	2.5				
6	3 3.0	Pit discontinued at 3.0m (Target)							

RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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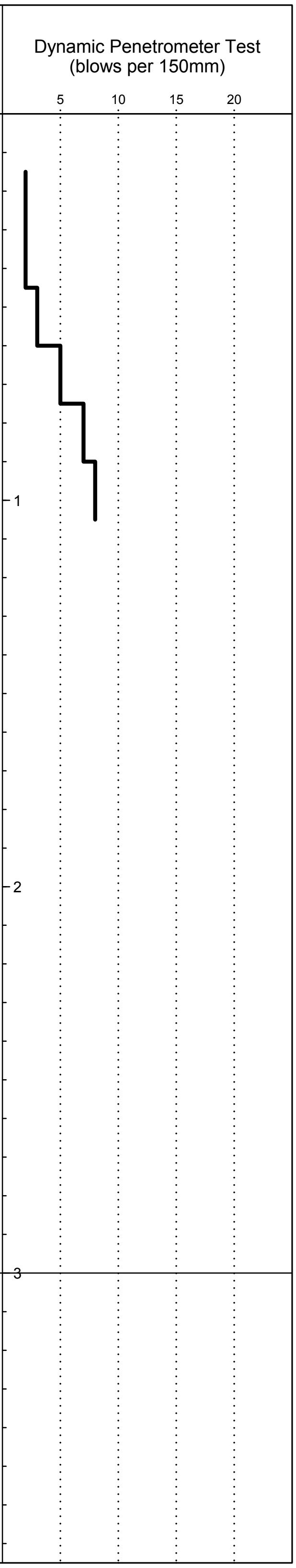
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666585
NORTHING: 7743984
DIP/AZIMUTH: 90°/--

PIT No: TP 22
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - becoming red-brown from 0.2 m. - with a trace of rootlets to 0.2 m.						
9								
	1	- with a trace of clay from 1.0 m. - clay content increasing with depth.						
8				D	1.6			
		- becoming mottled light brown and moist from 1.8 m.						
	2	- becoming slightly clayey sand with some silt from 1.9 m. - with a trace of fine sized gravel from 2.0 m.						
7								
	2.8	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand with a trace of silt, moist to wet.		D	2.9			
3	3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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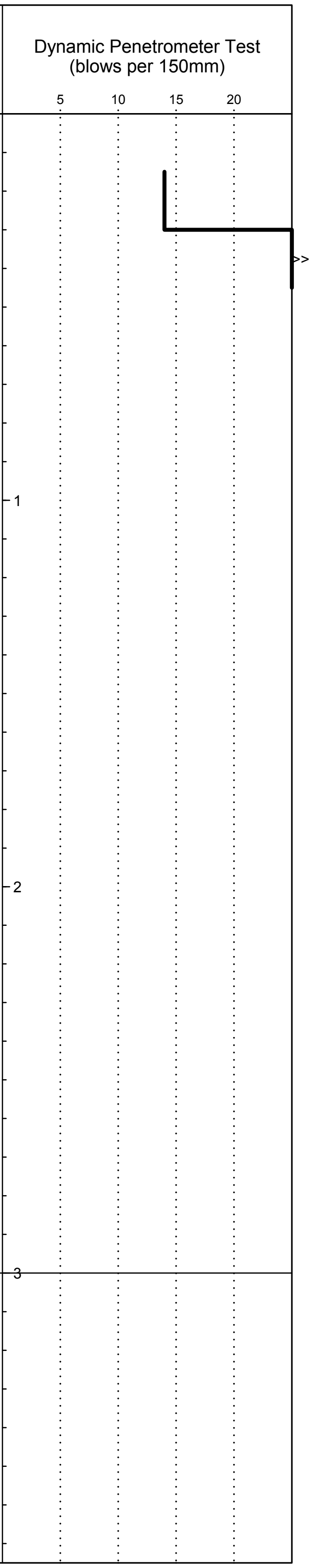
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 10.0 m AHD*
EASTING: 666697
NORTHING: 7743969
DIP/AZIMUTH: 90°/--

PIT No: TP 23
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
10		SAND - very dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.2 m.						
		- weakly cemented in pockets to 0.5 m.		D	0.5			
		- becoming dry to moist from 0.5 m.						
		- with a trace of clay from 0.7 m.						
				D	0.8			
		- clay content increasing with depth.						
9	1							
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.		D	1.9			
8	2							
7	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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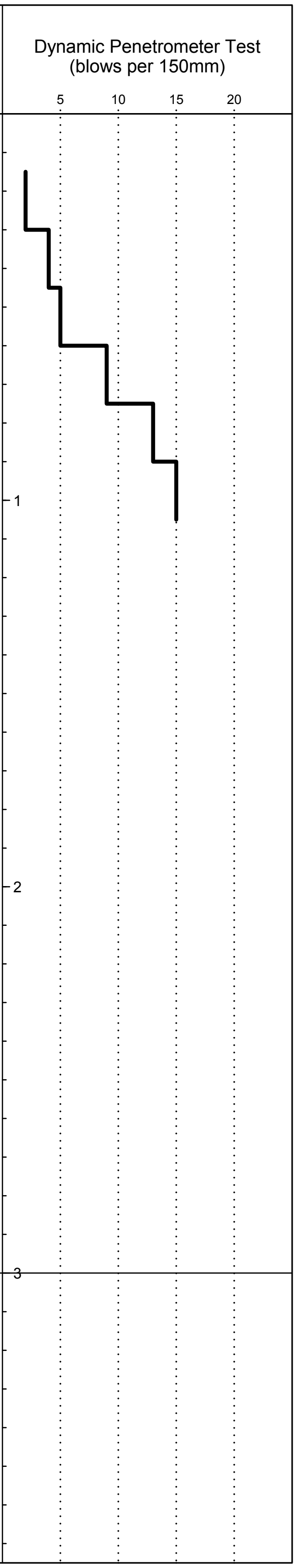
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666637
NORTHING: 7744044
DIP/AZIMUTH: 90°/--

PIT No: TP 24
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.15 m. - becoming red-brown, with a trace of clay and dry to moist from 0.2 m. - clay content increasing with depth. - weakly cemented in pockets.						
9								
		- becoming dense from 0.6 m.		D	0.6			
	1							
8								
				D	1.6			
		- becoming mottled light brown from 1.8 m.						
	2							
		- becoming slightly clayey sand with some silt from 2.2 m. - becoming moist from 2.3 m.						
7				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

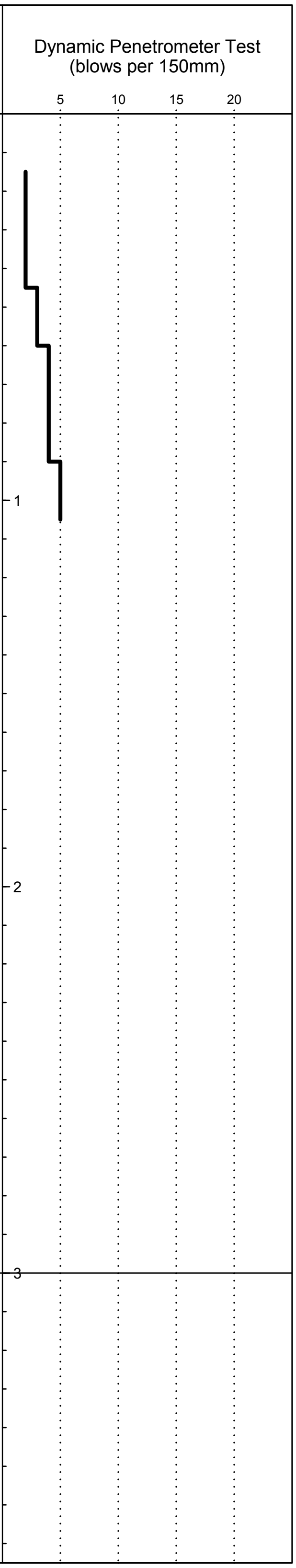
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666587
NORTHING: 7744098
DIP/AZIMUTH: 90°/--

PIT No: TP 25
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.25 m.						
		- becoming red-brown, with a trace of clay from 0.3 m.						
9		- clay content increasing with depth.		D	0.4			
	1			U_{150}	1.0 1.2			
8								
		- becoming mottled light brown and moist from 1.5 m.		D	1.6			
	2							
		- becoming slightly clayey sand with some silt from 2.2 m.		U_{150}	2.1 2.3			
7								
				D	2.7			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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TEST PIT LOG

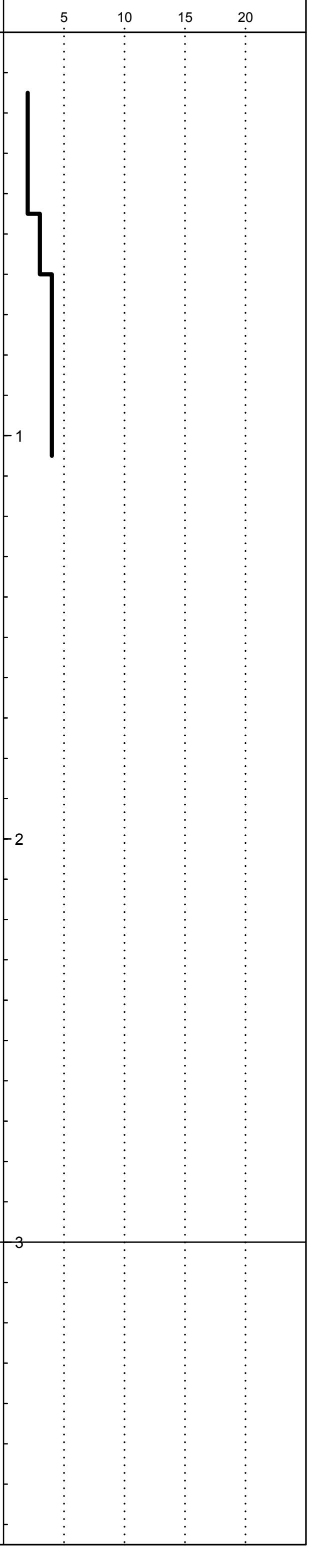
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666538
NORTHING: 7744157
DIP/AZIMUTH: 90°/--

PIT No: TP 26
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with a trace of rootlets to 0.25 m.						
		- becoming red-brown from 0.3 m.		D	0.4			
				D	0.8			
8	1	- becoming dry to moist from 1.5 m.						
		- becoming slightly clayey sand with some silt and moist from 1.5 m.						
				D	1.8			
7	2							
6	3 3.0	Pit discontinued at 3.0m (Target)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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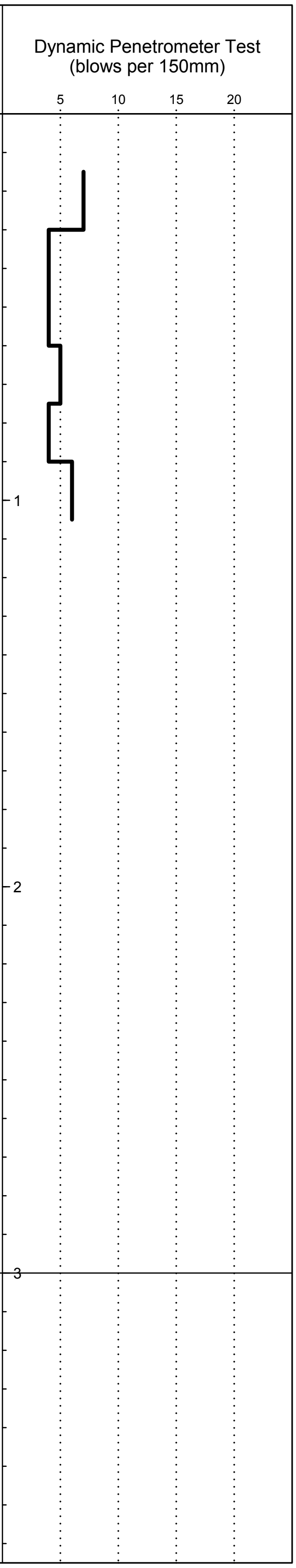
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.8 m AHD*
EASTING: 666484
NORTHING: 7744212
DIP/AZIMUTH: 90°/--

PIT No: TP 27
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - dense, brown, fine to medium grained sand with some silt, dry.						
		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.25 m.						
		- becoming medium dense from 0.45 m. - becoming dry to moist from 0.3 m. - with a trace of clay from 0.5 m.						
		- clay content increasing with depth.						
8				D	0.8			
	1							
		- with some clay and becoming moist from 1.2 m.						
		- becoming mottled light brown from 1.5 m.						
				D	1.6			
7								
	2							
		- becoming slightly clayey sand with some silt from 2.0 m.						
				D	2.2			
				D	2.7			
6								
	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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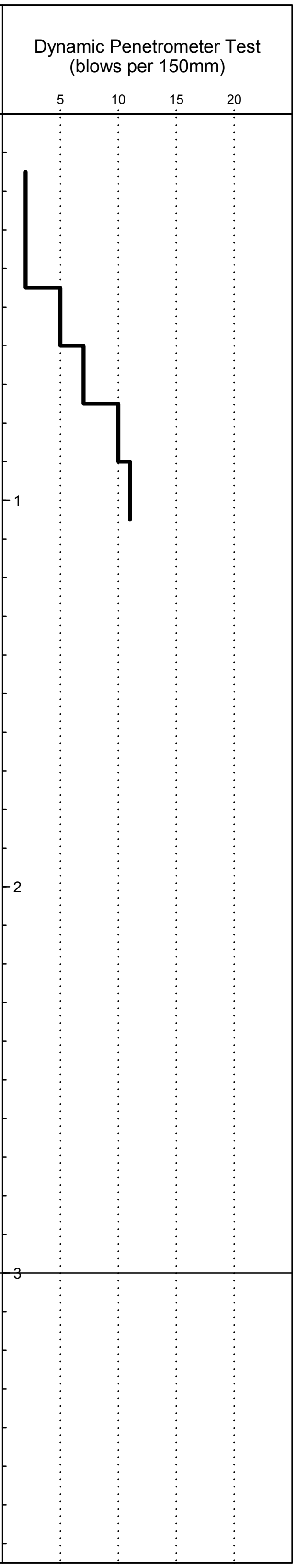
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666434
NORTHING: 7744282
DIP/AZIMUTH: 90°/--

PIT No: TP 28
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.2 m. - becoming red-brown from 0.2 m.						
				B	0.4			
		- becoming dense from 0.45 m.						
		- becoming dry to moist from 0.8 m. - with a trace of clay from 0.8 m.						
8	1	- clay content increasing with depth.						
		- with some clay from 1.2 m.						
				D	1.5			
		- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.8 m.						
7	2							
				D	2.2			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

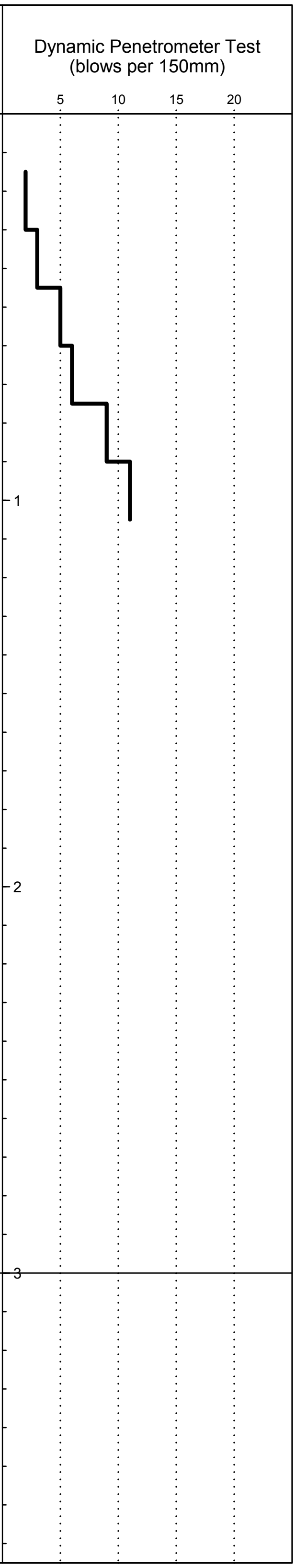
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666487
NORTHING: 7744328
DIP/AZIMUTH: 90°/--

PIT No: TP 29
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry. - with some rootlets to 0.25 m. - becoming red-brown from 0.3 m. - becoming dry to moist from 0.4 m. - becoming dense from 0.75 m. - with a trace of clay from 0.8 m.						
8	1	- clay content increasing with depth. - with some clay from 1.5 m.		D	1.5			
7	2	- becoming mottled light brown, slightly clayey sand with some silt, fine sized gravel and moist from 1.9 m.						
	2.6	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with a trace of fine sized gravel, moist.		D	2.7			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

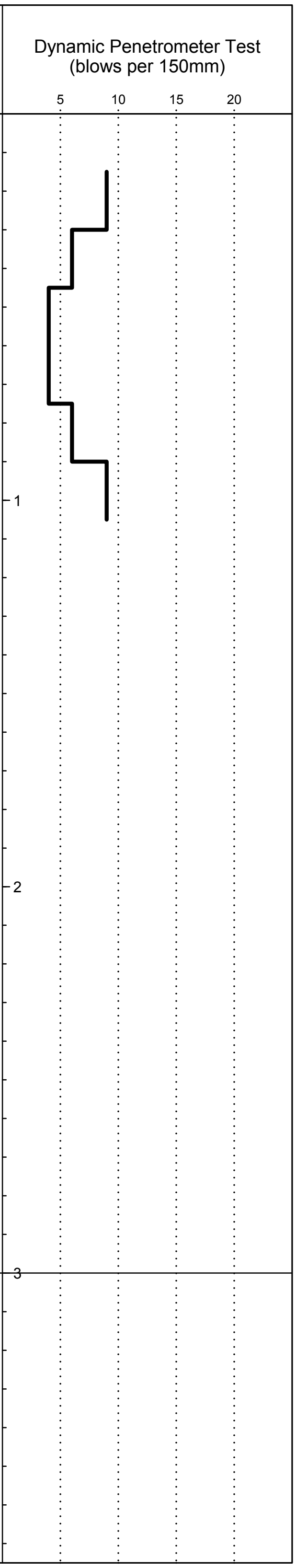
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666536
NORTHING: 7744274
DIP/AZIMUTH: 90°/--

PIT No: TP 30
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - dense, brown, fine to medium grained slightly silty sand, dry.						
		- becoming red-brown from 0.25 m.						
		- becoming medium dense from 0.45 m.		D	0.5			
		- becoming dry to moist from 0.6 m.						
		- with a trace of clay from 0.7 m.						
		- clay content increasing with depth.						
		- with some clay from 1.5 m.						
				D	1.7			
		- becoming mottled light brown and moist from 2.3 m.						
		- becoming slightly clayey sand with some silt from 2.4 m.		D	2.5			
	3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

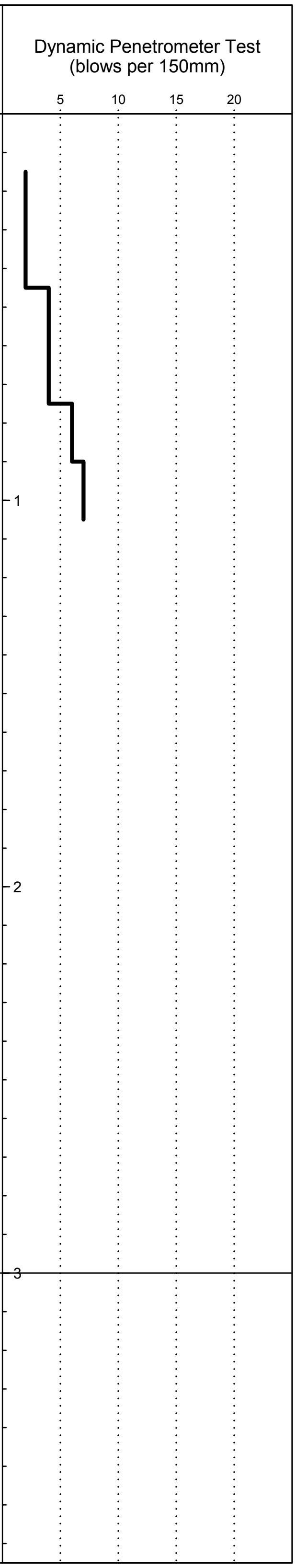
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666597
NORTHING: 7744213
DIP/AZIMUTH: 90°/--

PIT No: TP 31
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.15 m.						
		- becoming red-brown from 0.25 m.						
		- with a trace of clay from 0.3 m.						
		- clay content increasing with depth.						
				D	0.6			
		- becoming dry to moist from 0.8 m.						
	1							
8								
				D	1.4			
		- becoming mottled light brown from 1.5 m.						
		- with some clay from 1.6 m.						
	2							
		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.0 m.		D	2.1			
7								
		- becoming moist to wet from 2.8 m.						
				D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)

LOGGED: BD

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

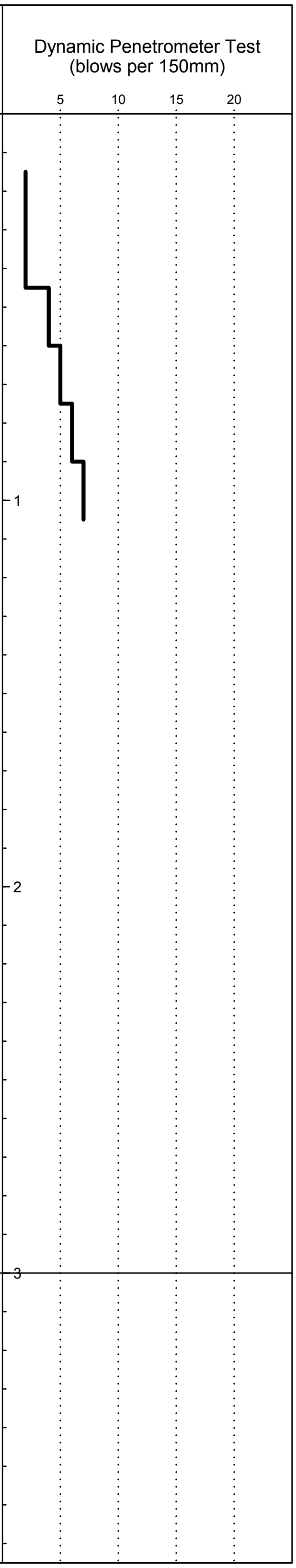
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666649
NORTHING: 7744150
DIP/AZIMUTH: 90°/--

PIT No: TP 32
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
9		- with a trace of rootlets to 0.2 m.						
		- becoming red-brown from 0.3 m.						
		- becoming dry to moist from 0.6 m.						
	1	- with a trace of clay from 1.0 m.						
8		- clay content increasing with depth.						
		- becoming mottled light brown, with some clay and moist from 1.4 m.						
	2	- with some fine sized gravel from 2.0 m.						
7		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.2 m.		D	2.3			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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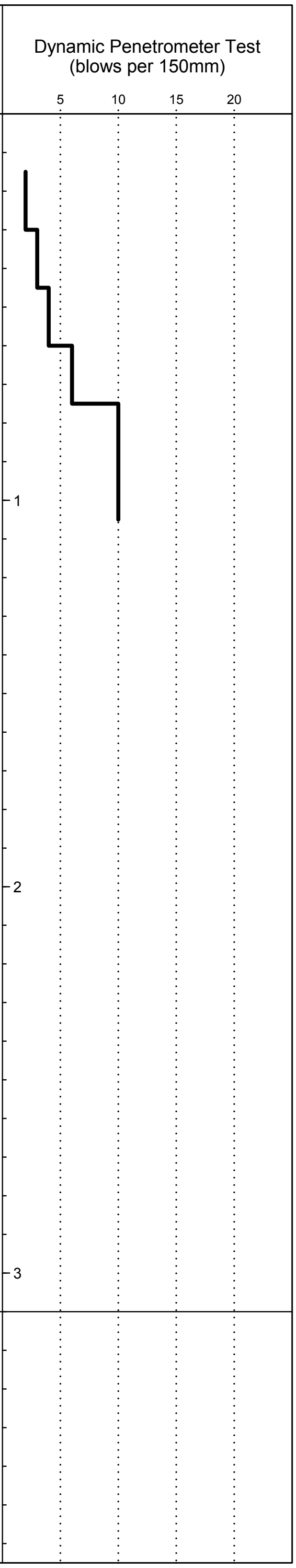
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666701
NORTHING: 7744095
DIP/AZIMUTH: 90°/--

PIT No: TP 33
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Results & Comments	Water
	SAND - medium dense, brown, fine to medium grained sand with some silt, dry.				
	- becoming red-brown and dry to moist from 0.2 m.				
	- with a trace of rootlets to 0.25 m.	B	0.3		
	- weakly cemented in pockets.				
	- becoming slightly silty sand with a trace of clay from 0.5 m.				
	- becoming dense from 0.75 m.				
		D	1.2		
	- with some clay from 1.6 m.				
	- becoming mottled light brown from 1.9 m.				
	- becoming slightly clayey sand with some silt from 2.0 m.	D	2.1		
2.8	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, moist.	D	2.95		
3.1	Pit discontinued at 3.1m (Target)				



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	₮	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

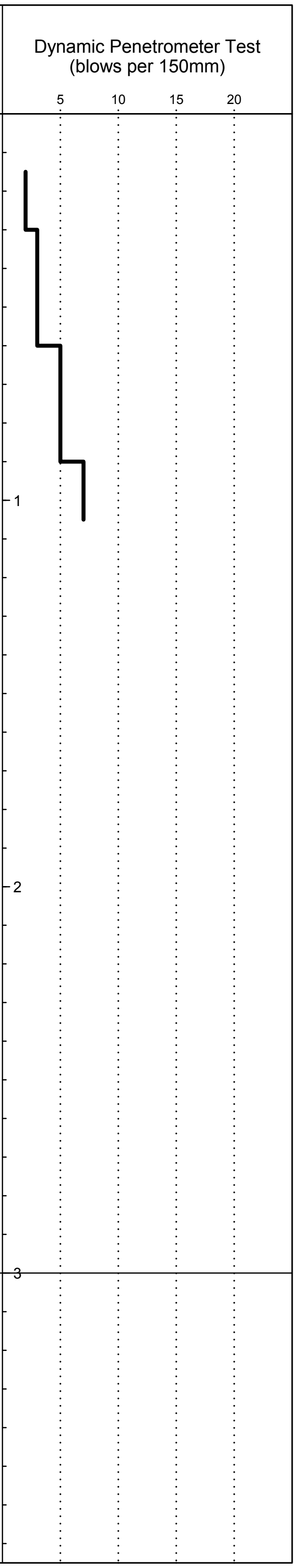
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.5 m AHD*
EASTING: 666755
NORTHING: 7744037
DIP/AZIMUTH: 90°/--

PIT No: TP 34
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- weakly cemented in pockets.						
		- becoming red-brown and dry to moist from 0.2 m.						
		- with a trace of rootlets to 0.25 m.						
		- with some clay from 0.4 m.		D	0.4			
9								
		- clay content increasing with depth.						
	1							
				D	1.2			
8		- becoming slightly clayey sand with some silt from 1.5 m.						
	2	- becoming mottled brown from 2.0 m.						
				D	2.4			
7								
	2.8	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, moist.		D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

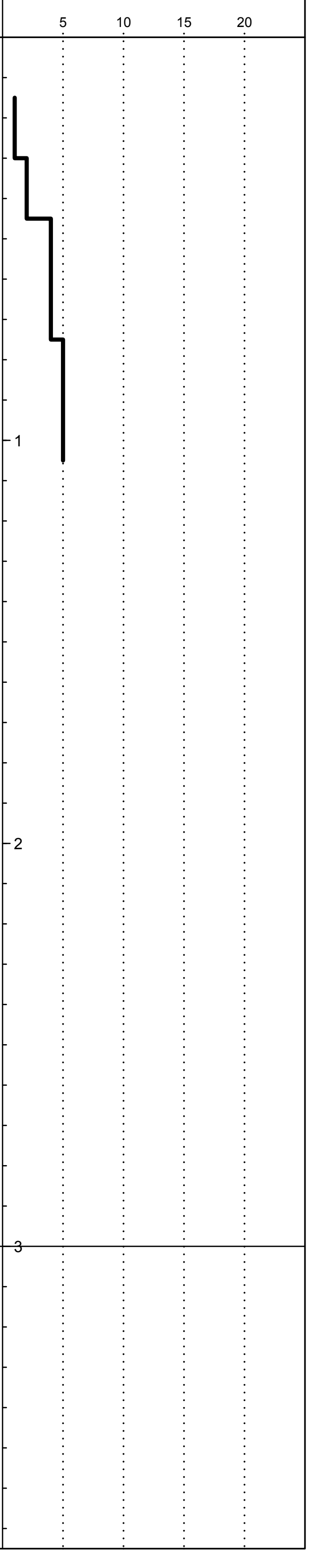
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.4 m AHD*
EASTING: 666817
NORTHING: 7744088
DIP/AZIMUTH: 90°/--

PIT No: TP 35
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.						
		- with some rootlets to 0.3 m.						
9		- becoming red-brown and slightly silty sand from 0.4 m.						
		- becoming dry to moist from 0.5 m.						
	1	- with a trace of clay from 1.0 m.						
		- clay content increasing with depth.						
8		- with some clay and becoming moist from 1.5 m.						
				D	1.8			
	2	- becoming mottled brown from 2.0 m.						
7		- becoming slightly clayey sand with some silt and a trace of fine sized gravel from 2.5 m.						
				D	2.7			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

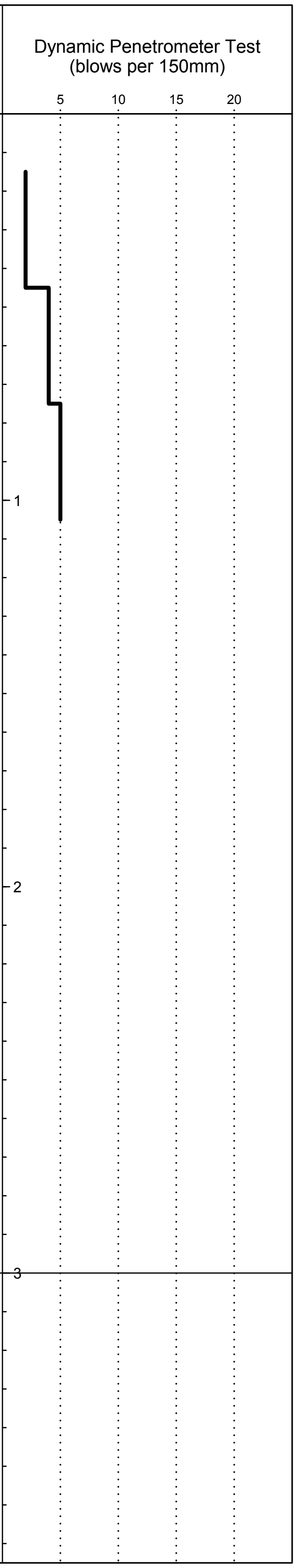
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666759
NORTHING: 7744147
DIP/AZIMUTH: 90°/--

PIT No: TP 36
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained sand with some silt, dry.					
		- with a trace of rootlets to 0.2 m. - with a trace of clay and becoming red-brown and dry to moist from 0.25 m.					
		- clay content increasing with depth.					
			D	0.7			
	1	- with some clay from 1.0 m.					
8							
		- becoming moist from 1.6 m.					
		- becoming mottled light brown from 1.8 m.					
	2	- becoming slightly clayey sand with some silt from 2.0 m.					
7							
			D	2.2			
	2.7	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, moist to wet.					
			D	2.9			
	3 3.0	Pit discontinued at 3.0m (Target)					
6							

Dynamic Penetrometer Test (blows per 150mm)



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

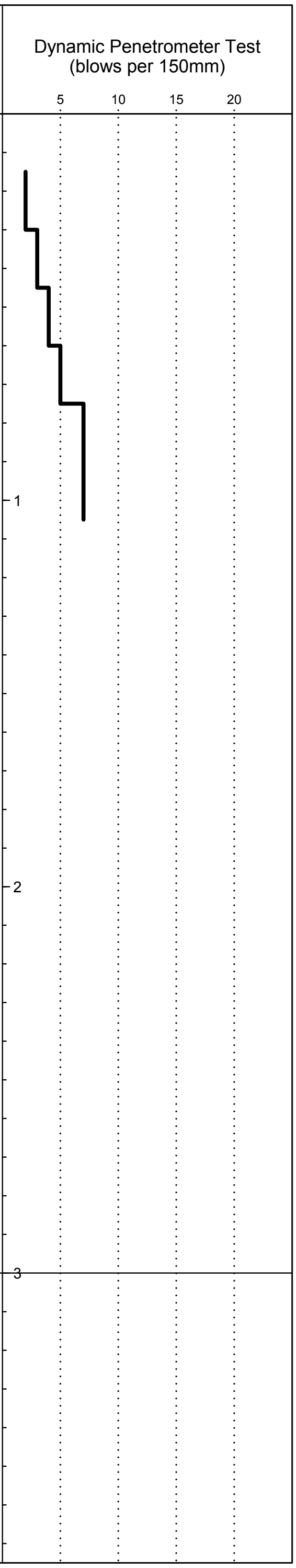
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.1 m AHD*
EASTING: 666711
NORTHING: 7744206
DIP/AZIMUTH: 90°/--

PIT No: TP 37
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.						
		- with some rootlets to 0.25 m. - with a trace of clay and becoming red-brown and dry to moist from 0.25 m. - clay content increasing with depth.						
				D	0.7			
	1							
8								
		- becoming moist from 1.4 m.		D	1.4			
		- becoming mottled light brown from 1.8 m.						
	2			D	2.0			
7								
		- becoming slightly clayey sand with some silt from 2.2 m.						
				D	2.5			
	3 3.0	Pit discontinued at 3.0m (Target)						
6								



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

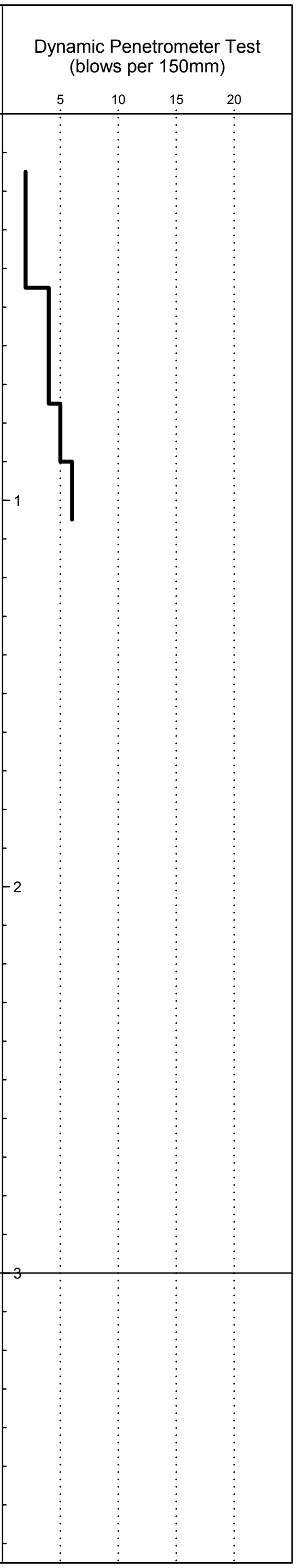
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.0 m AHD*
EASTING: 666654
NORTHING: 7744266
DIP/AZIMUTH: 90°/--

PIT No: TP 38
PROJECT No: 76250
DATE: 5/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- with some rootlets and a trace of roots to 0.3 m. - becoming red-brown from 0.35 m.					
		- becoming dry to moist from 0.5 m.					
8	1	- with a trace of clay from 1.0 m.					
		- becoming mottled light brown from 1.8 m.					
7	2	- becoming slightly clayey sand with some silt from 2.0 m.	D	2.1			
			D	2.8			
6	3 3.0	Pit discontinued at 3.0m (Target)					



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

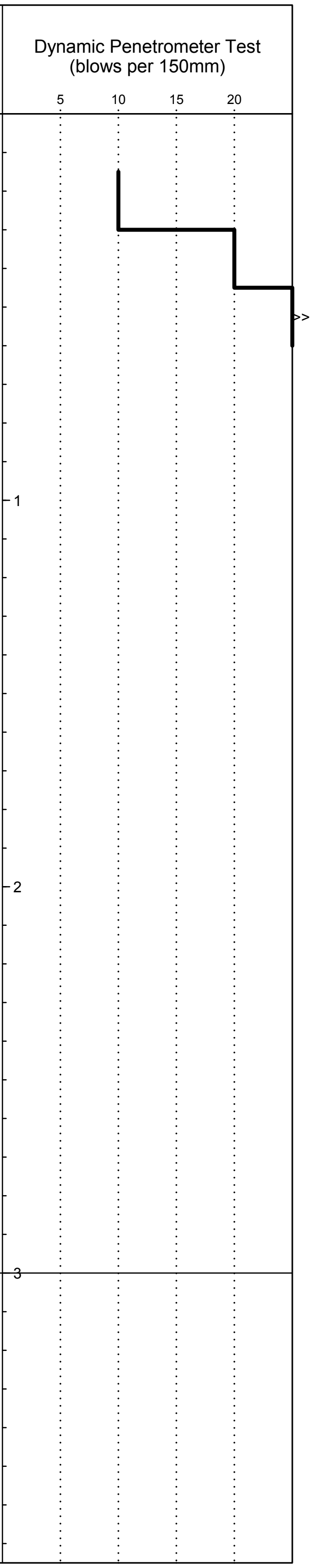
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666599
NORTHING: 7744320
DIP/AZIMUTH: 90°/--

PIT No: TP 39
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
9		SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry. - with a trace of rootlets to 0.1 m.						
		- weakly cemented in pockets to 0.5 m. - becoming dry to moist from 0.5 m.						
		- with a trace of clay from 0.8 m.		D	0.9			
8	1	- clay content increasing with depth.						
7	2	- becoming mottled light brown and black, slightly clayey sand with some silt and a trace of fine sized gravel from 2.0 m.		D	2.1			
6	3 3.0	Pit discontinued at 3.0m (Target)						



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

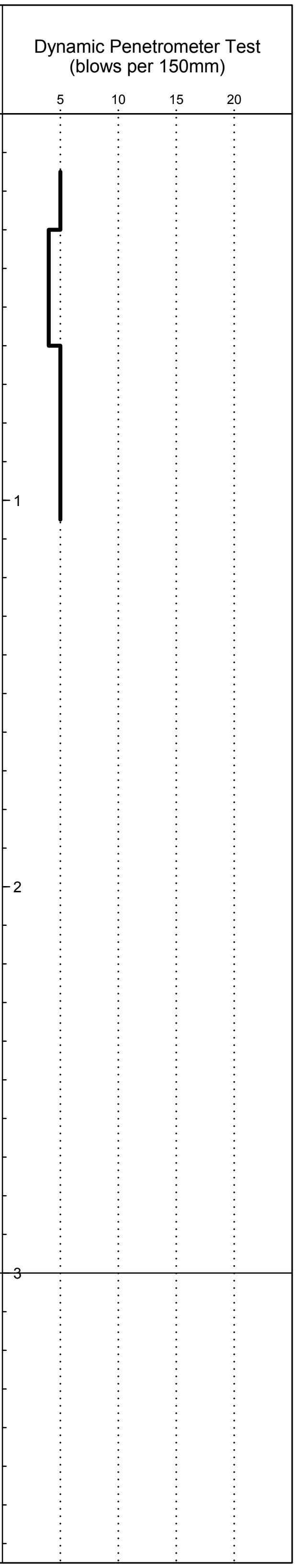
TEST PIT LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 8.9 m AHD*
EASTING: 666550
NORTHING: 7744378
DIP/AZIMUTH: 90°/--

PIT No: TP 40
PROJECT No: 76250
DATE: 4/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		SAND - medium dense, brown, fine to medium grained slightly silty sand, dry.					
		- with a trace of rootlets to 0.15 m.					
		- becoming red-brown from 0.25 m.					
		- becoming dry to moist from 0.4 m.	D	0.4			
		- with a trace of clay from 0.5 m.					
		- clay content increasing with depth.					
8							
	1						
		- becoming moist from 1.2 m.					
		- with some clay and a trace of fine sized gravel from 1.3 m.	D	1.4			
7							
	2	- becoming mottled light brown from 2.1 m.					
		- becoming slightly clayey sand with some silt from 2.2 m.					
			D	2.5			
		- becoming moist to wet from 2.8 m.					
6							
	3 3.0	Pit discontinued at 3.0m (Target)					



RIG: 5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Surface level interpolated from survey plan provided by the client

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

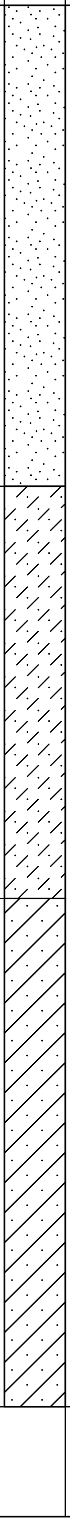
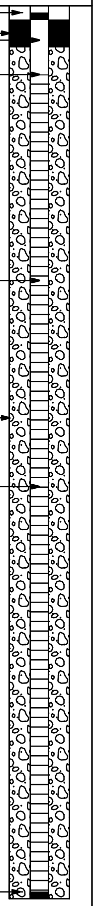
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 10 m AHD*
EASTING: 666701
NORTHING: 7743966
DIP/AZIMUTH: 90°/--

BORE No: MB 41
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
10	0	SAND - red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to moist from 0.5 m. - with some clay and becoming moist from 1.5 m. - becoming slightly clayey sand with some silt from 2.0 m.						▼ 07-08-11 (3.1)	 Top cap Bentonite Seal 50 mm Class 18 PVC Pipe 2 50 mm Class 18 Slotted PVC Pipe 3 Gravel Pack
	3.5	CLAYEY SAND - red-brown, fine to medium grained clayey sand, with some silt, moist. - with some medium sized white gravel at 0.55 m. - possible small lens of rock.							
	6.5	SANDY CLAY - red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist. - possible thin rock layer at 8.0 m.							End Cap
	10.2	Bore discontinued at 10.2m (Target)							

RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.135 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

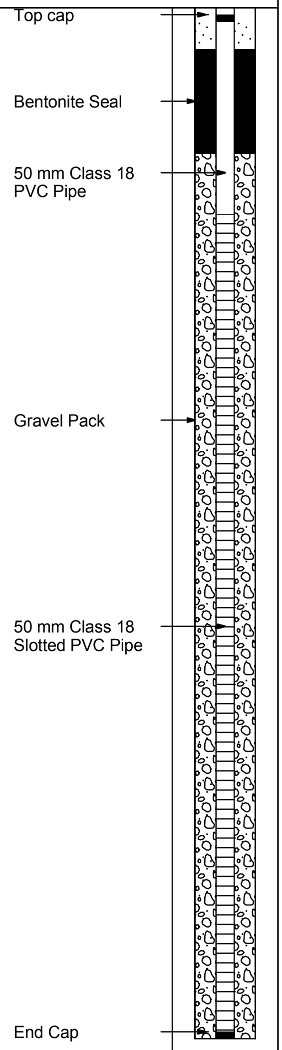
BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666116
NORTHING: 7744014
DIP/AZIMUTH: 90°/--

BORE No: MB 42
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	SAND - medium dense, red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to moist from 0.5 m. - becoming moist from 1.0 m. - becoming mottled light brown, slightly clayey sand with some silt from 1.5 m.	S	1.5 1.95		9,8,8 N = 16	
	- with some fine sized gravel from 3.5 m.	S	3.0 3.45		5,7,10 N = 17	▼ 07-08-11
4.0	CLAYEY SAND - medium dense, red-brown mottled light brown, fine to medium grained clayey sand, with some silt and a trace of fine sized gravel, dry to moist.	S	4.5 4.95		7,10,12 N = 22	
		S	6.0 6.45		7,10,9 N = 19	
6.8	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Dry to moist.	S	7.5 7.95		8,16,22 N = 38	
7.95	Bore discontinued at 7.95m (Target)					



RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.155 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666179
NORTHING: 7743903
DIP/AZIMUTH: 90°/--

BORE No: BH 43
PROJECT No: 76250
DATE: 6/8/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SAND - medium dense, red-brown, fine to medium grained slightly silty sand, dry. - becoming dry to moist from 0.4 m. - with some clay from 1.5 m. - becoming slightly clayey sand with some silt and moist from 1.8 m.		S	1.5 1.95		6,7,11 N = 18		
	3.0	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt and fine to medium sized gravel, moist.		S	3.0 3.45		4,6,8 N = 14	▼ 07-08-11	
				S	4.5 4.95		6,6,12 N = 18		
				S	6.0 6.45		7,12,14 N = 26		
	6.5	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist.		S	7.5 7.95		9,13,23 N = 36		
	7.95	Bore discontinued at 7.95m (Target)							

RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.080 m on 7/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.2 m AHD*
EASTING: 666389
NORTHING: 7744129
DIP/AZIMUTH: 90°/--

BORE No: BH 44
PROJECT No: 76250
DATE: 7/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	SAND - medium dense, red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to moist from 0.4 m. - with some clay from 0.8 m.						
	- becoming mottled light brown, slightly clayey sand with some silt and moist from 1.6 m.	S	1.5 1.95		3,5,8 N = 13		
		S	3.0 3.45		3,5,6 N = 11	▼ 08-08-11	
3.5	CLAYEY SAND - dense to medium dense, red-brown mottled light grey, fine to medium grained clayey sand, with some silt, moist.						
	- with a trace of fine sized gravel from 4.5 m.	S	4.5 4.95		10,16,23 N = 39		
		S	6.0 6.45		7,10,13 N = 23		
6.5	SANDY CLAY - hard, red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Dry to moist.	S	7.5 7.8		18,R refusal 34 blows for 145 mm penetation		
7.795	Bore discontinued at 7.8m (Target)						

RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 2.820 m on 8/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

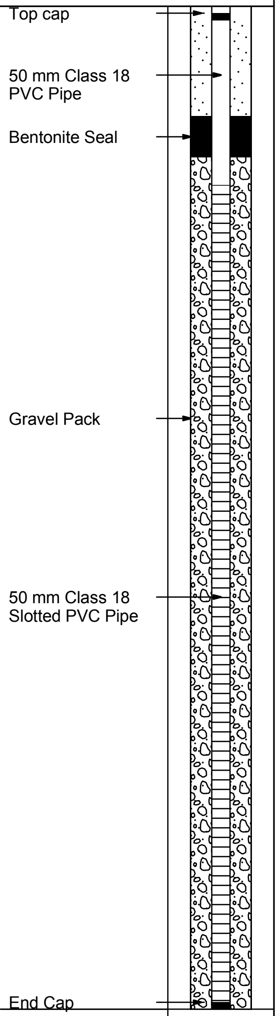
CLIENT: Pritchard Francis Pty Ltd
PROJECT: Hamilton Precinct
LOCATION: South Hedland, WA

SURFACE LEVEL: 9.3 m AHD*
EASTING: 666553
NORTHING: 7744284
DIP/AZIMUTH: 90°/--

BORE No: MB 45
PROJECT No: 76250
DATE: 7/8/2011
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.0	SAND - red-brown, fine to medium grained, slightly silty sand, dry. - becoming dry to most from 0.5 m. - with some clay from 1.2 m. - becoming slightly clayey sand with some silt from 2.2 m.					▼ 08-08-11
3.3	CLAYEY SAND - red-brown, fine to medium grained clayey sand, moist.					
5.5	SANDY CLAY - red-brown, low to medium plasticity sandy clay. Sand is fine to medium grained. Moist.					
7.3	Bore discontinued at 7.3m (Target)					

Well Construction Details



RIG: Explorer 50 **DRILLER:** Edge Drilling **LOGGED:** BD **SURVEY DATUM:** MGA94
TYPE OF BORING: Hollow stem auger **CASING:** None
WATER OBSERVATIONS: Groundwater measured at 3.130 m on 8/8/11
REMARKS: * Surface level interpolated from survey plan provided by the client

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix B

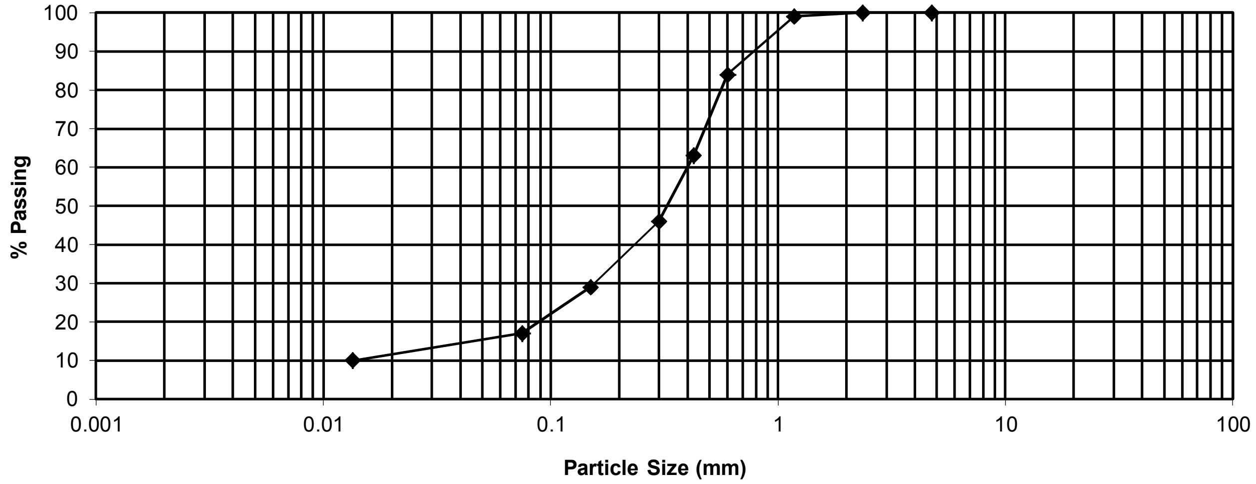
Geotechnical Laboratory Testing

Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: **60017**
Report No: **60017-P11/2663**
Sample No: **P11/2663**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **TP 1**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	84
0.425	63
0.300	46
0.150	29
0.075	17
0.0135	10

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Kevin M Jones

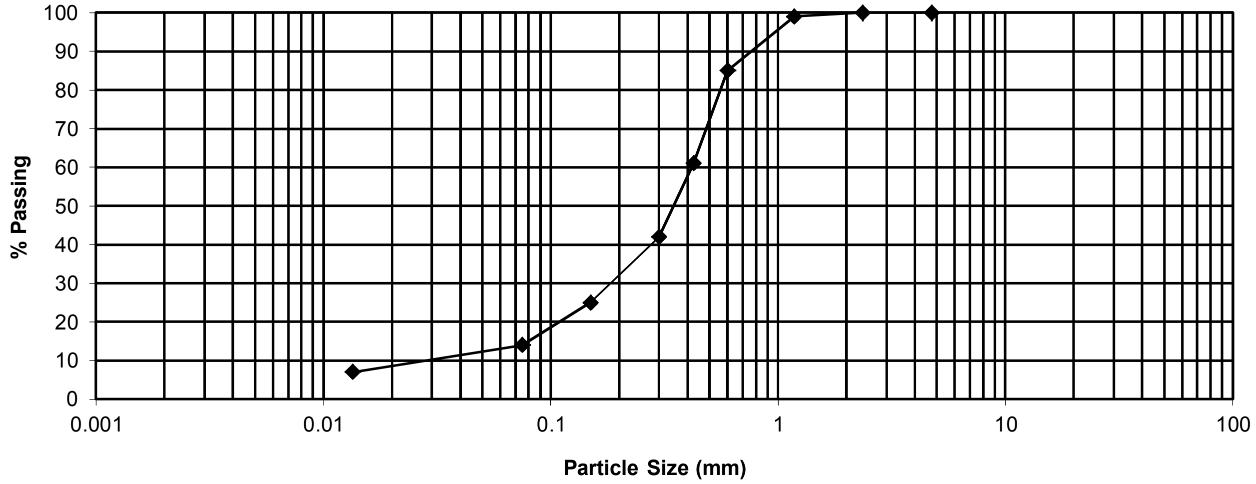
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: **60017**
Report No: **60017-P11/2664**
Sample No: **P11/2664**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 2**
Depth (m): **0.25**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	85
0.425	61
0.300	42
0.150	25
0.075	14
0.0135	7

SIC = Slipped in cup
NP = Non Plastic
***Non standard test as liquid limit was not determined.**
Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	SIC	%
Plastic limit 3.2.1	NP	%
Plasticity index 3.3.1	NP	%
Linear shrinkage 3.4.1	0.0*	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Kevin M Jones

Mining &
Civil
Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) 9414 8022
Fax (08)9414 8011
Email kevin@mcgeotest.com.au

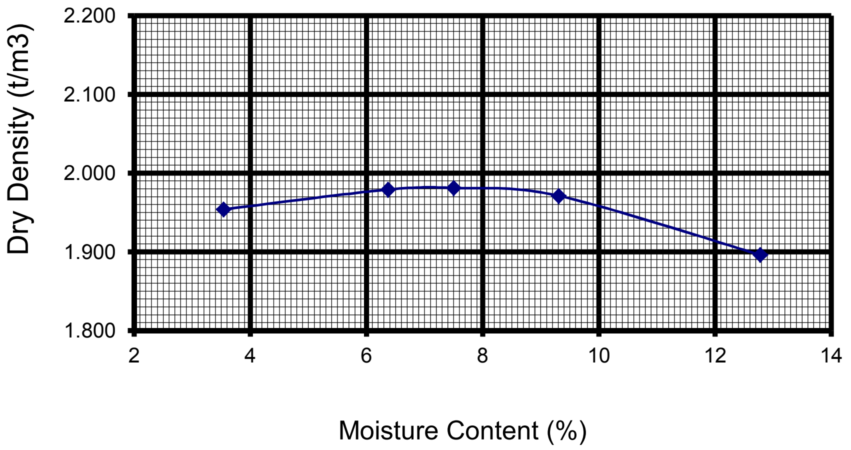
Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Sheet 2 of 2

Certificate No:	60017-P11/2664	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2664	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 2, 0.25m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.981	**Conditions at Test**	
Optimum Moisture Content %:	7.5	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	11.1
Mass of hammer kg	4.9	Entire Moisture Ratio %	148.1
Number of layers	5	Top 30mm Moisture Content %	10.6
Number of blows/layer	29	Top 30mm Moisture Ratio %	140.6
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.883	C.B.R. at 2.5 mm Penetration %	45
Moisture Content %	7.4	**Conditions after Soaking**	
Density Ratio %	95.1	Dry Density t/m^3	1.881
Moisture Ratio %	99.1	Moisture Content %	11.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	94.9
		Moisture Ratio %	151.9

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

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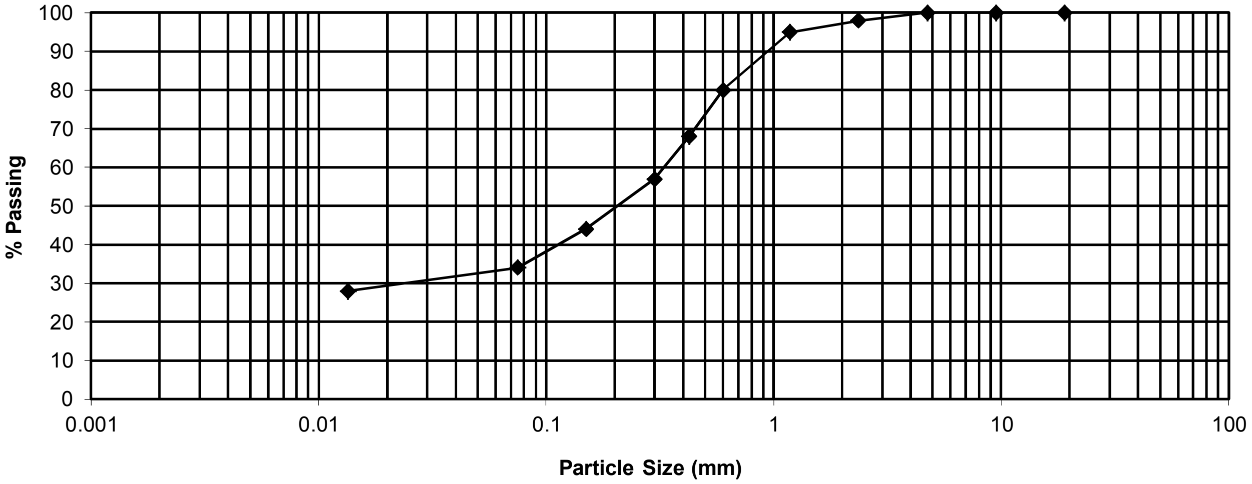
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2665
Sample No: P11/2665
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **TP 2**
Depth (m): **1.9**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	98
1.18	95
0.600	80
0.425	68
0.300	57
0.150	44
0.075	34
0.0135	28

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	39	%
Plastic limit 3.2.1	14	%
Plasticity index 3.3.1	25	%
Linear shrinkage 3.4.1	9.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Sheet No: 1 of 1

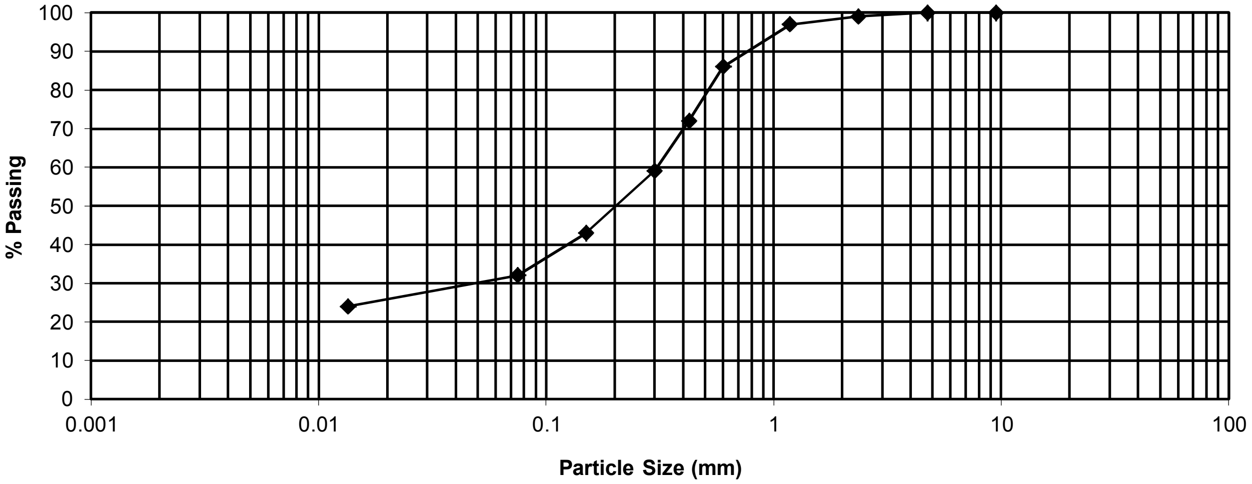
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P11/2666**
Sample No:	**P11/2666**
Issue Date:	**24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 2**
Depth (m): **2.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	97
0.600	86
0.425	72
0.300	59
0.150	43
0.075	32
0.0135	24

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	32	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	19	%
Linear shrinkage 3.4.1	5.0	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Kevin M Jones

WA PSD PI April 2009

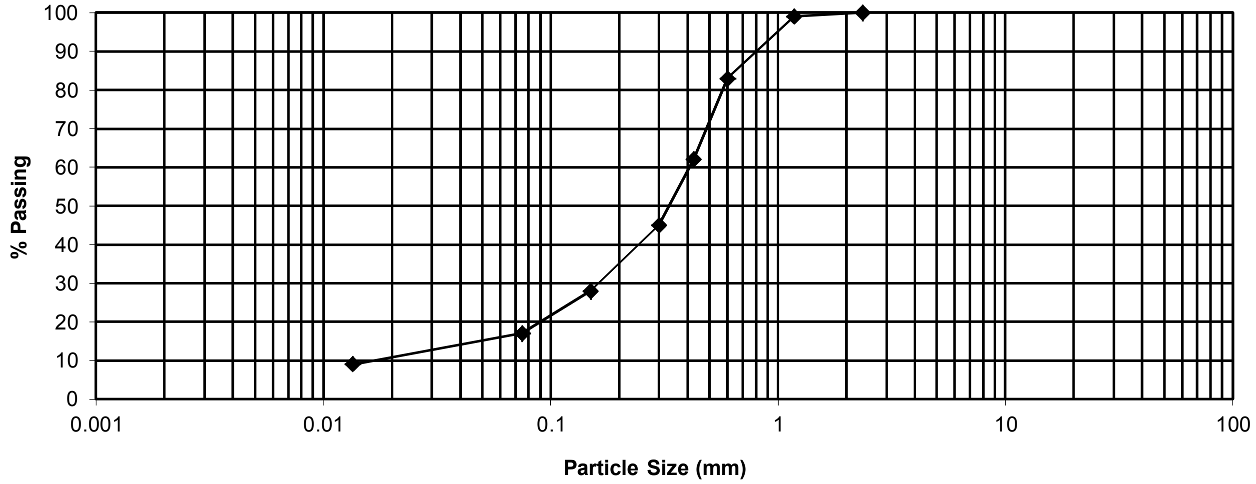
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No: **60017**
Report No: **60017-P11/2667**
Sample No: **P11/2667**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 12**
Depth (m): **0.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	99
0.600	83
0.425	62
0.300	45
0.150	28
0.075	17
0.0135	9

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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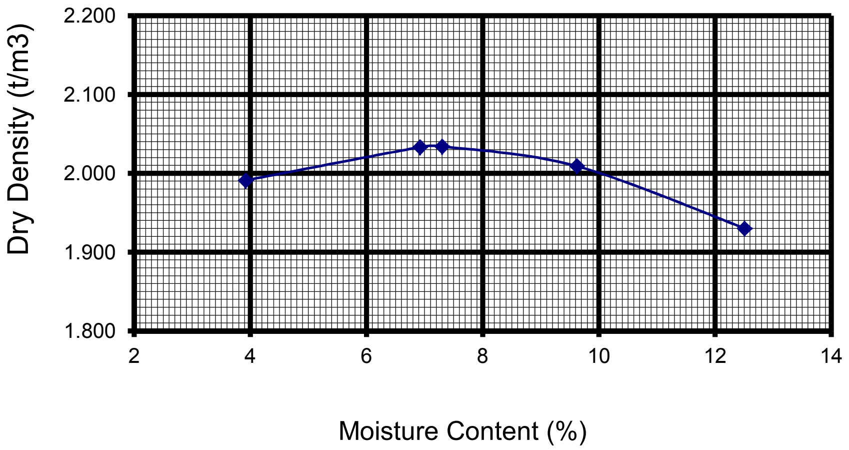
Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Sheet 2 of 2

Certificate No:	60017-P11/2667	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2667	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 12, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	2.034	**Conditions at Test**	
Optimum Moisture Content %:	7.3	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	9.8
Mass of hammer kg	4.9	Entire Moisture Ratio %	133.6
Number of layers	5	Top 30mm Moisture Content %	9.9
Number of blows/layer	30	Top 30mm Moisture Ratio %	135.9
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.937	C.B.R. at 2.5 mm Penetration %	60
Moisture Content %	7.2	**Conditions after Soaking**	
Density Ratio %	95.2	Dry Density t/m^3	1.936
Moisture Ratio %	98.8	Moisture Content %	10.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.2
		Moisture Ratio %	142.5

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

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Particle Size Distribution & Plasticity Index tests

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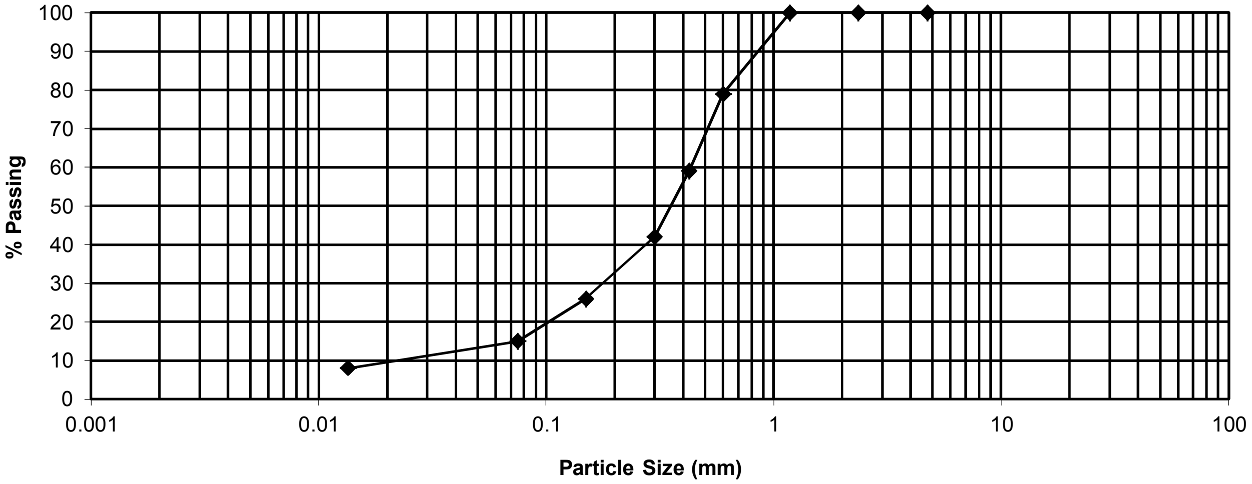
Job No:	**60017**
Report No:	**60017-P11/2668**
Sample No:	**P11/2668**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 16**
Project:	**Hamilton Precinct**	Depth (m):	**0.5**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	79
0.425	59
0.300	42
0.150	26
0.075	15
0.0135	8

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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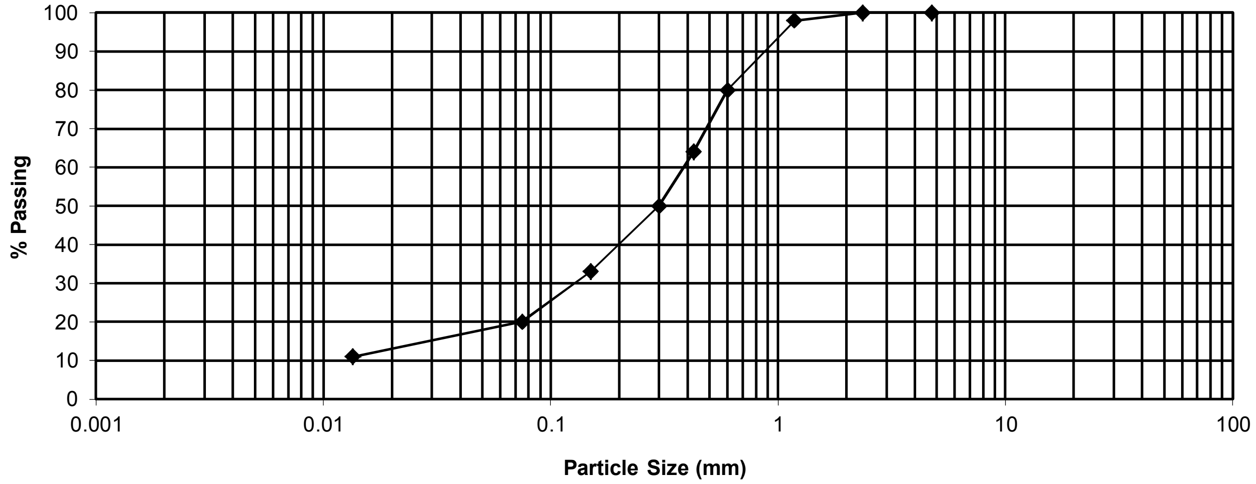
Job No:	**60017**
Report No:	**60017-P11/2669**
Sample No:	**P11/2669**
Issue Date:	**24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 21**
Depth (m): **0.6**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	98
0.600	80
0.425	64
0.300	50
0.150	33
0.075	20
0.0135	11

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	18	%
Plastic limit 3.2.1	14	%
Plasticity index 3.3.1	4	%
Linear shrinkage 3.4.1	1.0	%

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Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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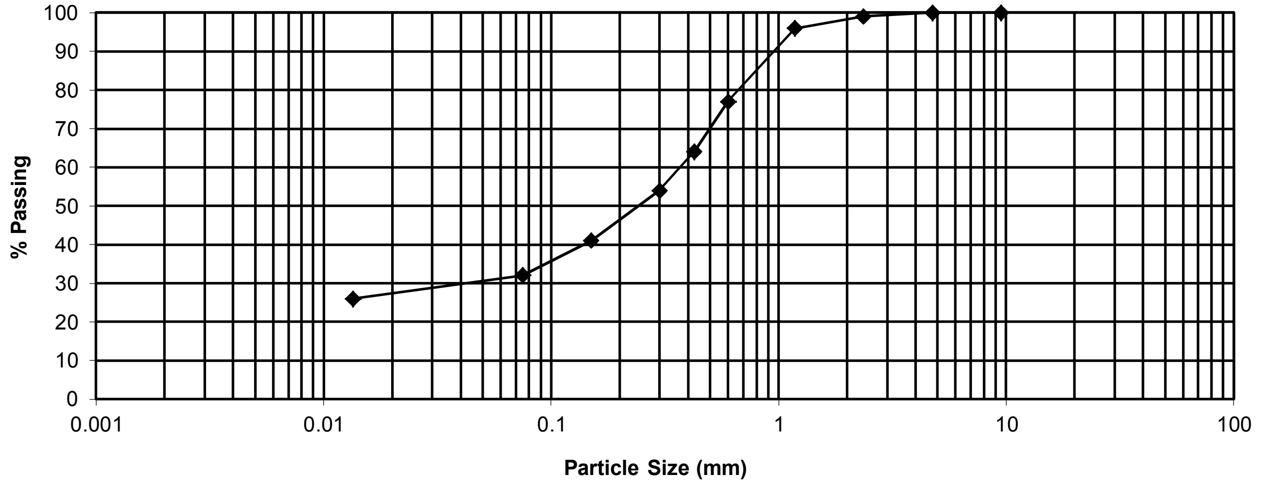
Job No:	**60017**
Report No:	**60017-P11/2670**
Sample No:	**P11/2670**
Issue Date:	**24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 21**
Depth (m): **2.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	96
0.600	77
0.425	64
0.300	54
0.150	41
0.075	32
0.0135	26

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	36	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	23	%
Linear shrinkage 3.4.1	7.0	%

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Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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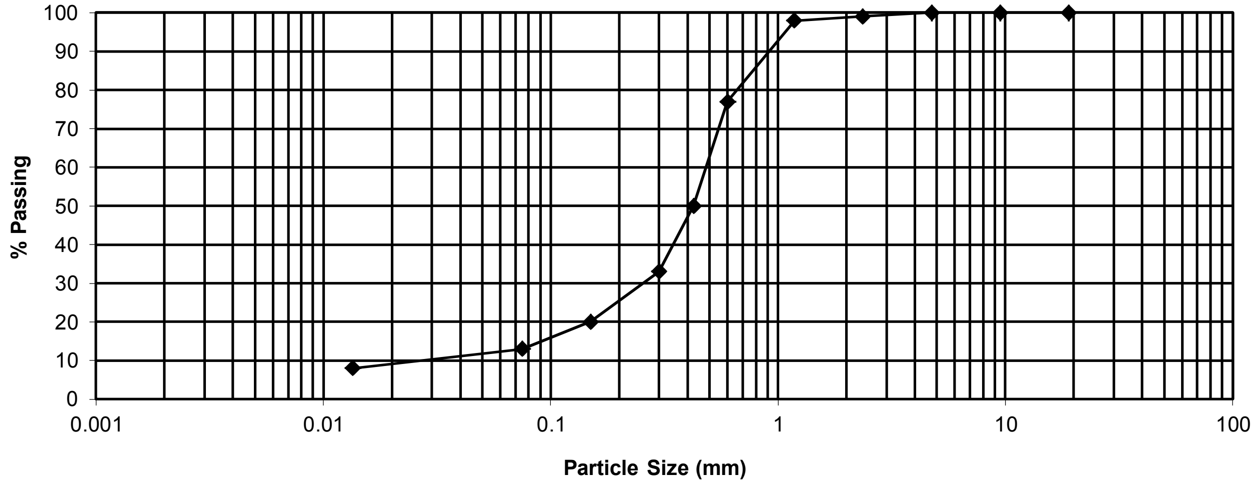
Job No: 60017
Report No: 60017-P11/2671
Sample No: P11/2671
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 23**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	99
1.18	98
0.600	77
0.425	50
0.300	33
0.150	20
0.075	13
0.0135	8

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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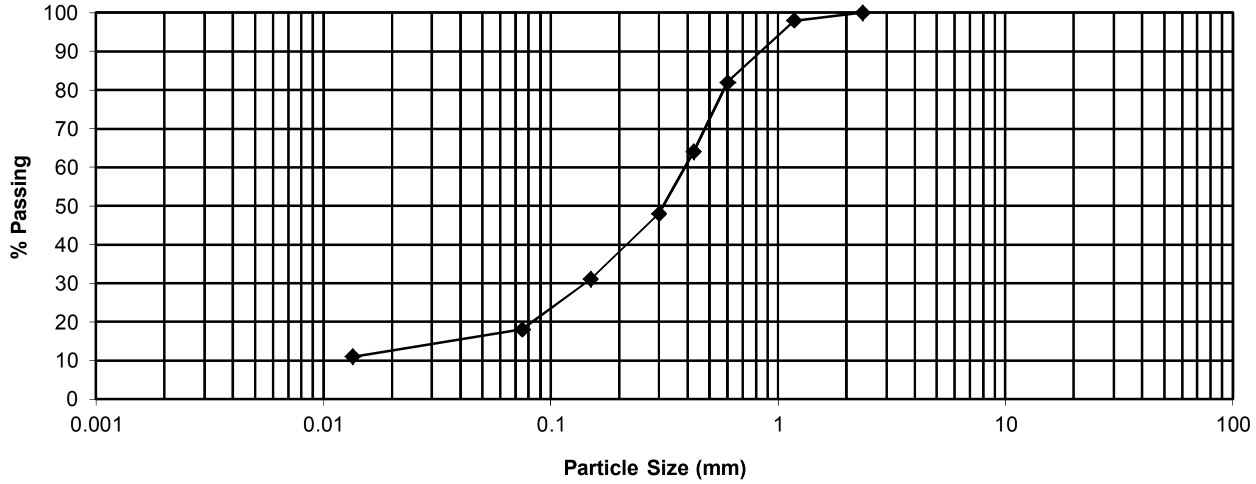
Job No: 60017
Report No: 60017-P11/2672
Sample No: P11/2672
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 28**
Depth (m): **0.4**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	82
0.425	64
0.300	48
0.150	31
0.075	18
0.0135	11

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	17	%
Plastic limit 3.2.1	15	%
Plasticity index 3.3.1	2	%
Linear shrinkage 3.4.1	1.0	%

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Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

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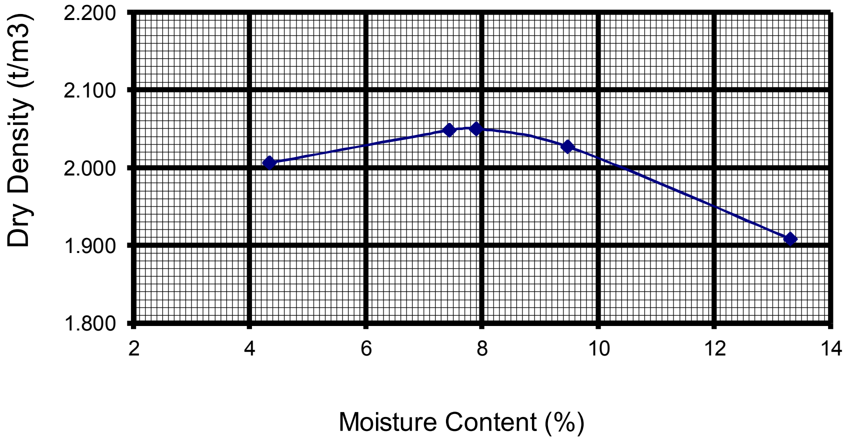
Sheet 2 of 2

Certificate No:	60017-P11/2672	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2672	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 28, 0.4m	**Job No:**	60017

Maximum Dry Density t/m^3:	2.050	**Conditions at Test**	
Optimum Moisture Content %:	7.9	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	9.0
Mass of hammer kg	4.9	Entire Moisture Ratio %	114.4
Number of layers	5	Top 30mm Moisture Content %	8.8
Number of blows/layer	25	Top 30mm Moisture Ratio %	111.7
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.951	C.B.R. at 5.0 mm Penetration %	70
Moisture Content %	7.8	**Conditions after Soaking**	
Density Ratio %	95.2	Dry Density t/m^3	1.950
Moisture Ratio %	98.4	Moisture Content %	10.3
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.1
		Moisture Ratio %	130.4

Comments:



Client address: 36 O'Malley St, Osborne Park

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Particle Size Distribution & Plasticity Index tests

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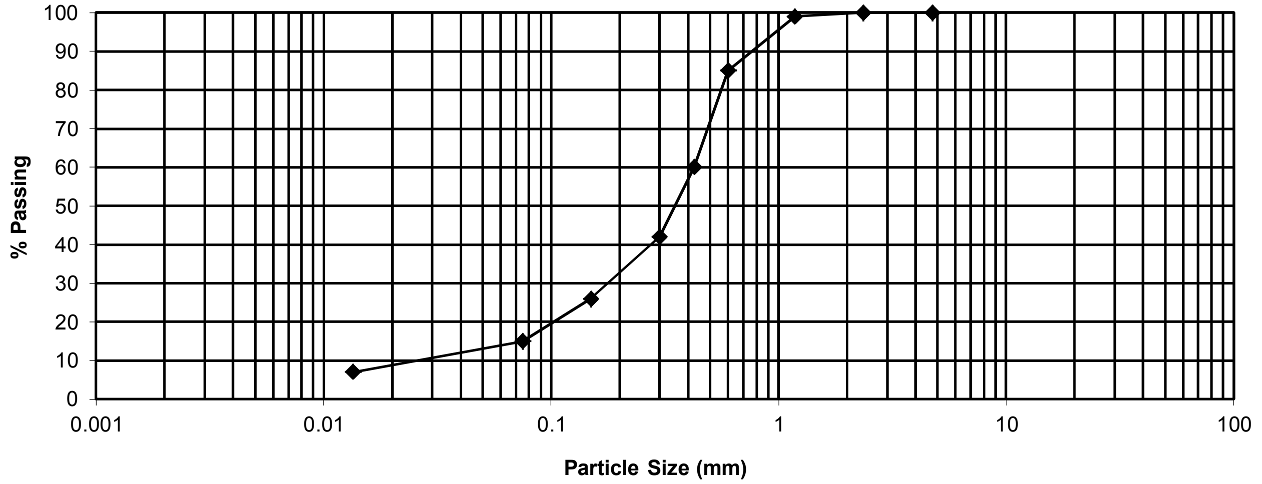
Job No: **60017**
Report No: **60017-P11/2673**
Sample No: **P11/2673**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **TP 30**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	85
0.425	60
0.300	42
0.150	26
0.075	15
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

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Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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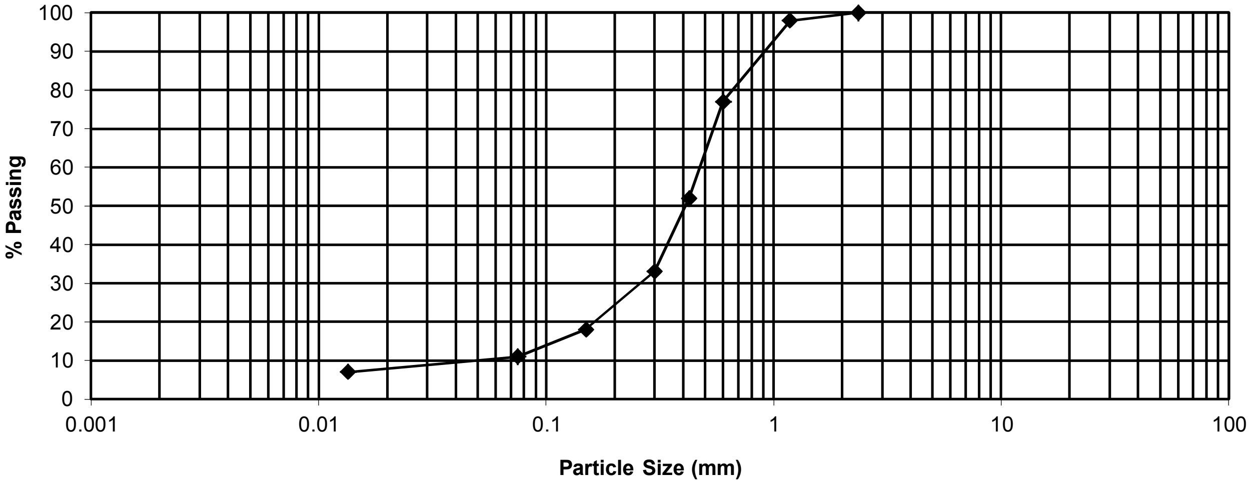
Job No: **60017**
Report No: **60017-P11/2674**
Sample No: **P11/2674**
Issue Date: **24 August 2011**

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **TP 33**
Depth (m): **0.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	77
0.425	52
0.300	33
0.150	18
0.075	11
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

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Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

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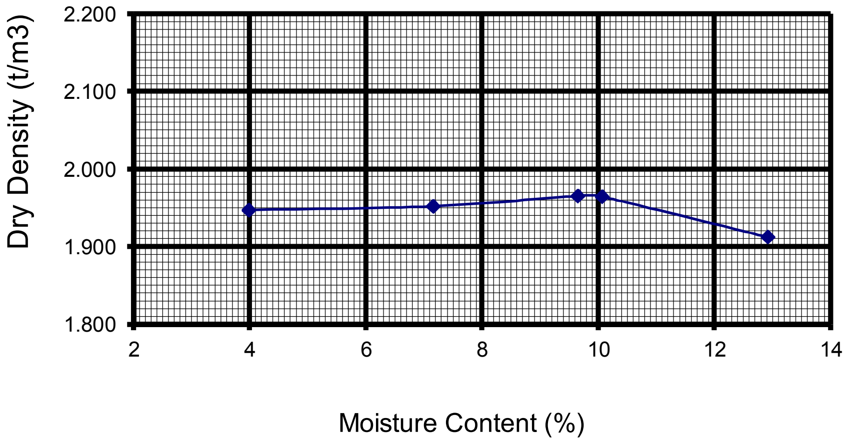
Sheet 2 of 2

Certificate No:	60017-P11/2674	**Client:**	Pritchard Francis Pty Ltd
Sample :	P11/2674	**Project:**	Hamilton Precinct
Location:	South Hedland, WA	**Date of issue:**	24 August 2011
	TP 33, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.965	**Conditions at Test**	
Optimum Moisture Content %:	9.6	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	10.8
Mass of hammer kg	4.9	Entire Moisture Ratio %	112.5
Number of layers	5	Top 30mm Moisture Content %	10.2
Number of blows/layer	26	Top 30mm Moisture Ratio %	105.7
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.864	C.B.R. at 5.0 mm Penetration %	50
Moisture Content %	9.3	**Conditions after Soaking**	
Density Ratio %	94.9	Dry Density t/m^3	1.863
Moisture Ratio %	96.7	Moisture Content %	11.7
Soaked / Unsoaked	Soaked	Dry Density Ratio %	94.8
		Moisture Ratio %	121.4

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

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Particle Size Distribution & Plasticity Index tests

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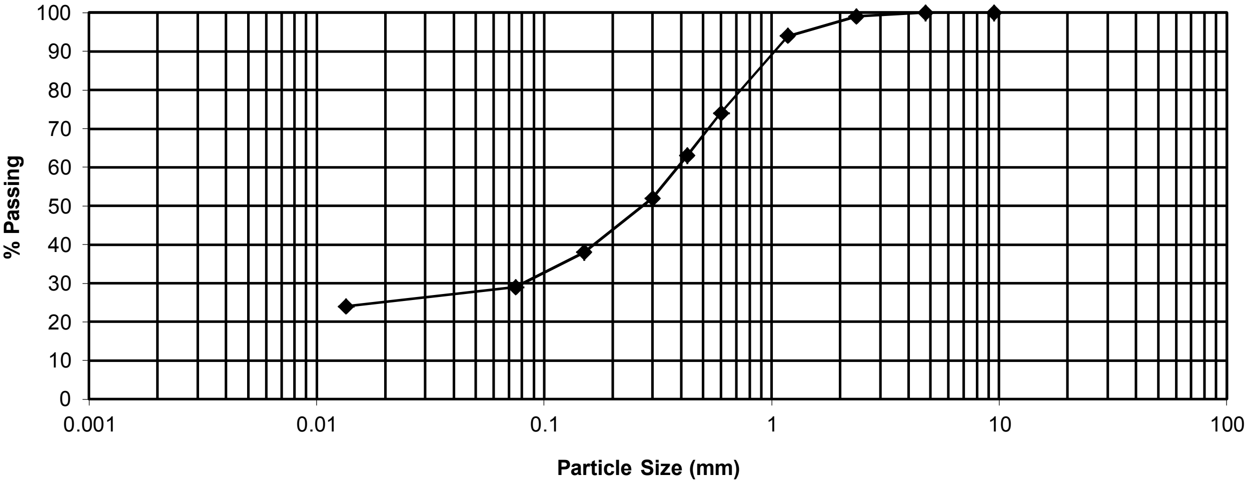
Job No:	**60017**
Report No:	**60017-P11/2675**
Sample No:	**P11/2675**
Issue Date:	**29 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**TP 33**
Project:	**Hamilton Precinct**	Depth (m):	**2.1**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	94
0.600	74
0.425	63
0.300	52
0.150	38
0.075	29
0.0135	24

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	28	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	15	%
Linear shrinkage 3.4.1	7.0	%
Cracked	☐	
Curled	☑	

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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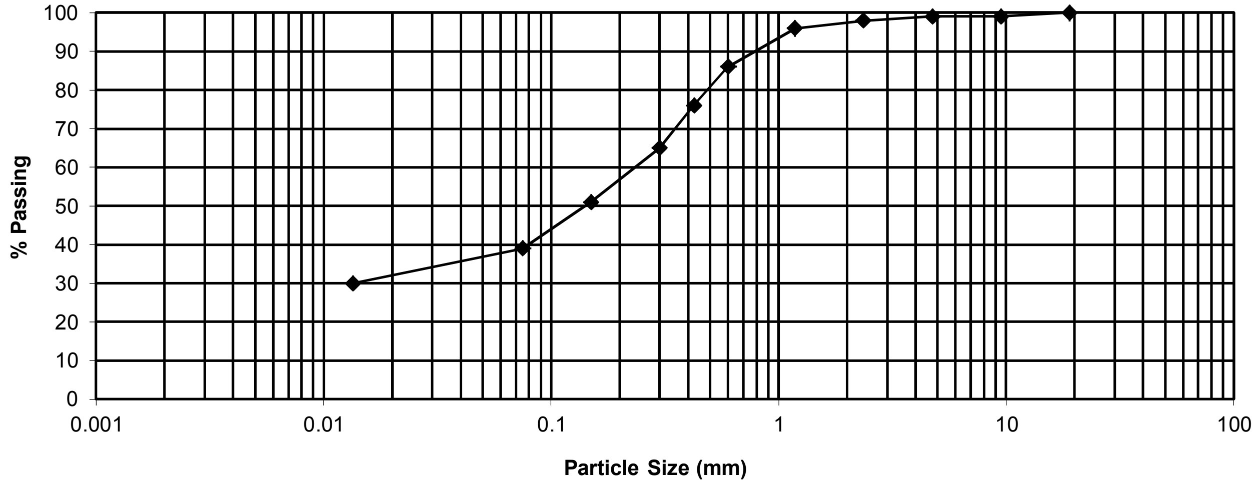
Job No: 60017
Report No: 60017-P11/2676
Sample No: P11/2676
Issue Date: 29 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**

Sample Location: **MB 42**
Depth (m): **6.00 - 6.45**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	98
1.18	96
0.600	86
0.425	76
0.300	65
0.150	51
0.075	39
0.0135	30

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	35	%
Plastic limit 3.2.1	15	%
Plasticity index 3.3.1	20	%
Linear shrinkage 3.4.1	7.0	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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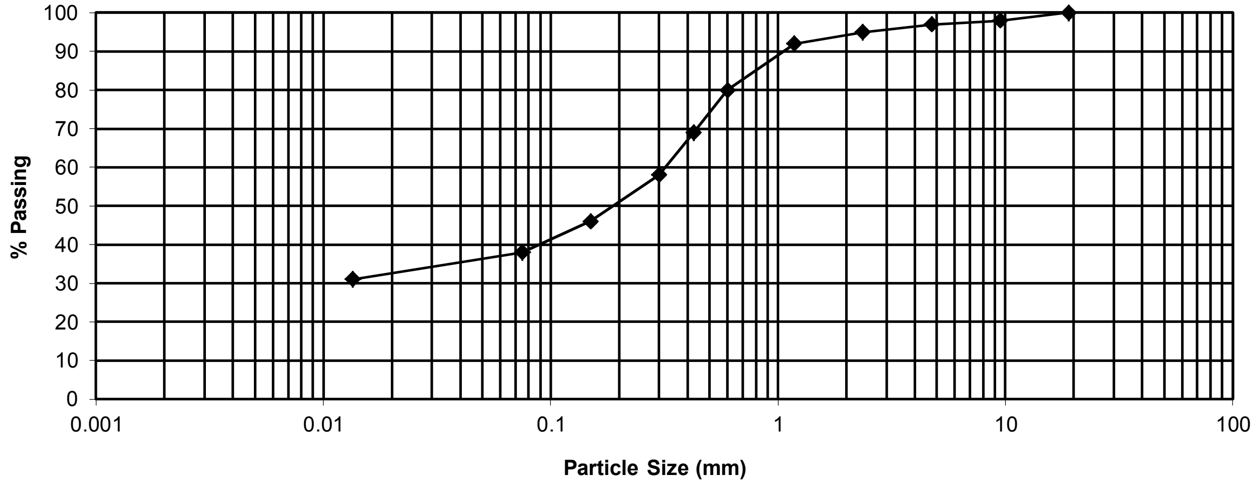
Email: kevin@mcgeotest.com.au

Job No: 60017
Report No: 60017-P11/2677
Sample No: P11/2677
Issue Date: 24 August 2011

Client: **Pritchard Francis Pty Ltd**
Project: **Hamilton Precinct**
Location: **South Hedland, WA**
Sample Location: **BH 43**
Depth (m): **4.50 - 4.95**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	97
2.36	95
1.18	92
0.600	80
0.425	69
0.300	58
0.150	46
0.075	38
0.0135	31

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	39	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	26	%
Linear shrinkage 3.4.1	10.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

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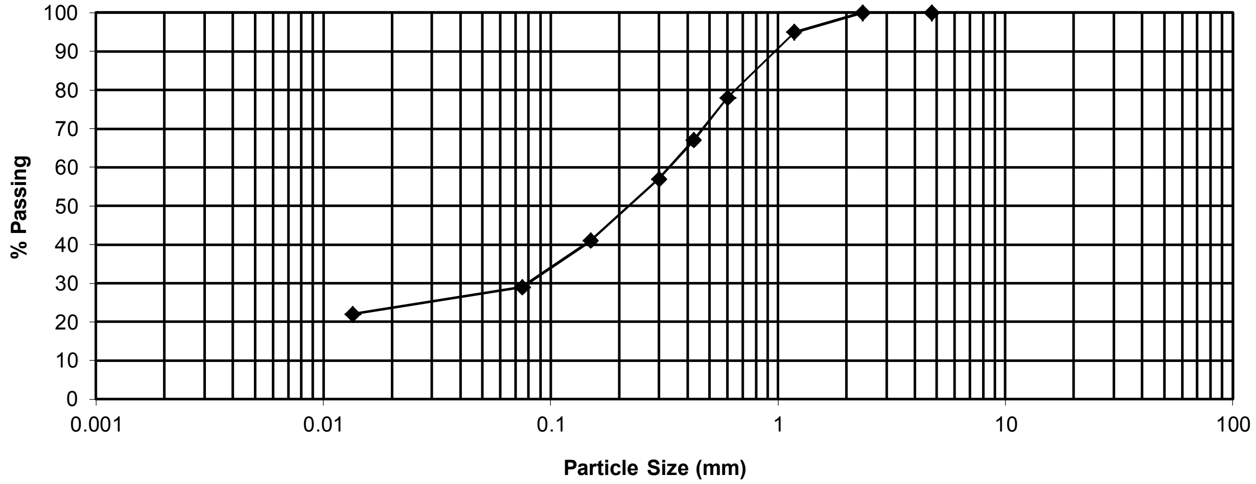
Job No:	**60017**
Report No:	**60017-P11/2678**
Sample No:	**P11/2678**
Issue Date:	**24 August 2011**

Client:	**Pritchard Francis Pty Ltd**	Sample Location:	**BH 44**
Project:	**Hamilton Precinct**	Depth (m):	**6.00 - 6.45**
Location:	**South Hedland, WA**		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	95
0.600	78
0.425	67
0.300	57
0.150	41
0.075	29
0.0135	22

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	33	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	20	%
Linear shrinkage 3.4.1	7.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

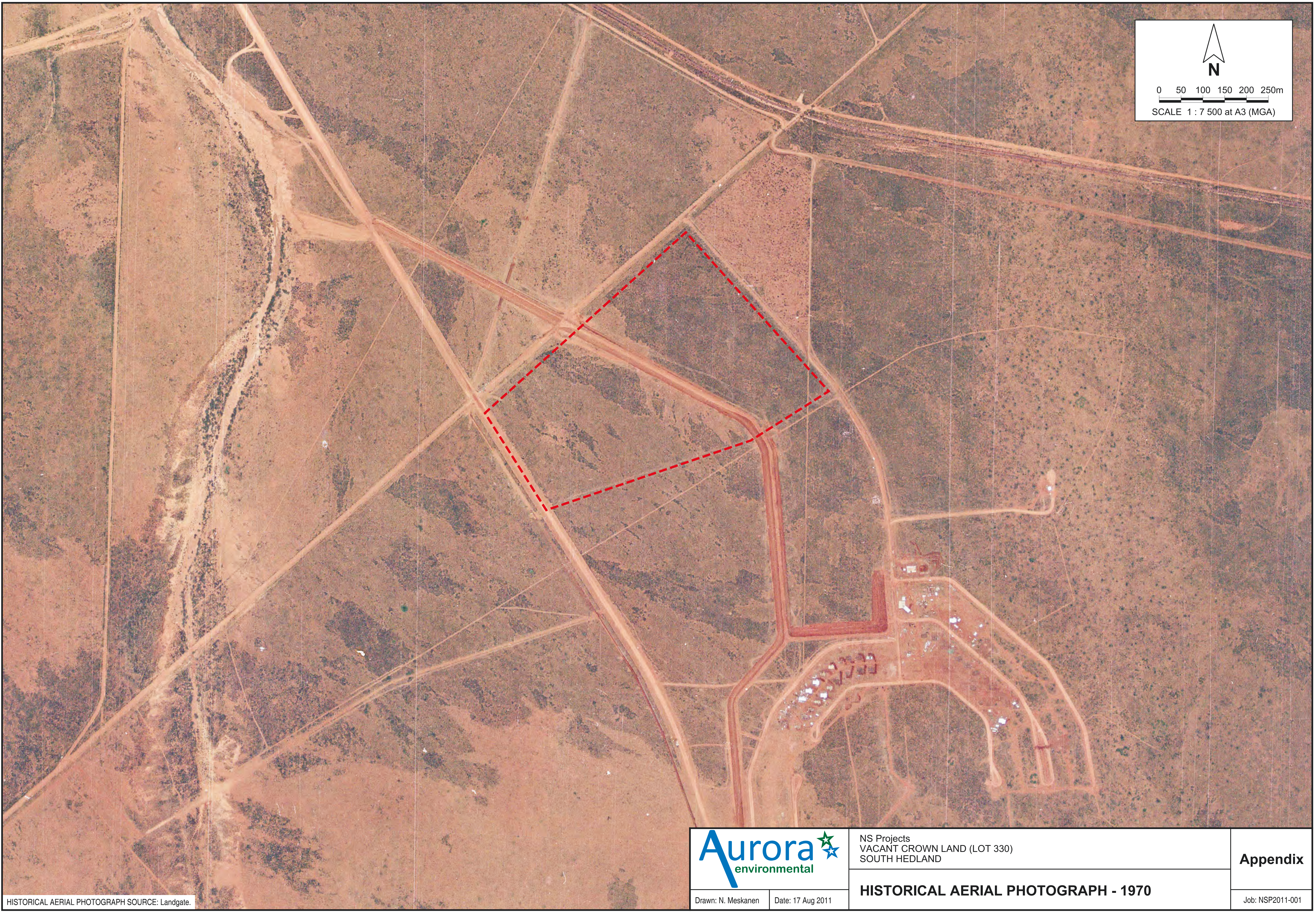
Sampling Procedure: Tested as received

Approved signature

Kevin M Jones

APPENDIX 2

Historical Aerial Photos



HISTORICAL AERIAL PHOTOGRAPH SOURCE: Landgate.

Aurora environmental

NS Projects
VACANT CROWN LAND (LOT 330)
SOUTH HEDLAND

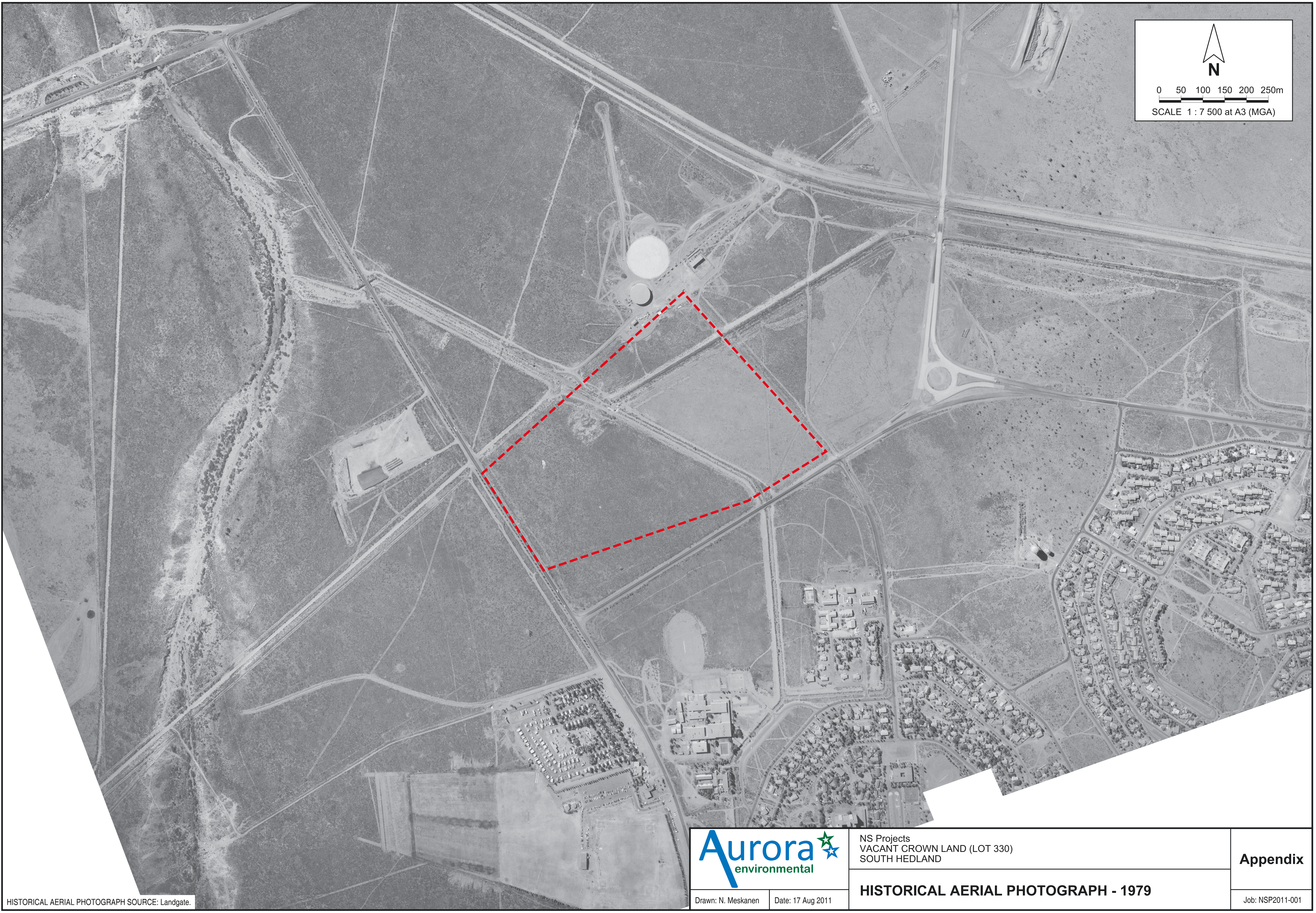
HISTORICAL AERIAL PHOTOGRAPH - 1970

Drawn: N. Meskanen | Date: 17 Aug 2011

Appendix

Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136 NSP2011-001-Reporting-001_pz-hap-1970.dgn



HISTORICAL AERIAL PHOTOGRAPH SOURCE: Landgate.

Aurora environmental

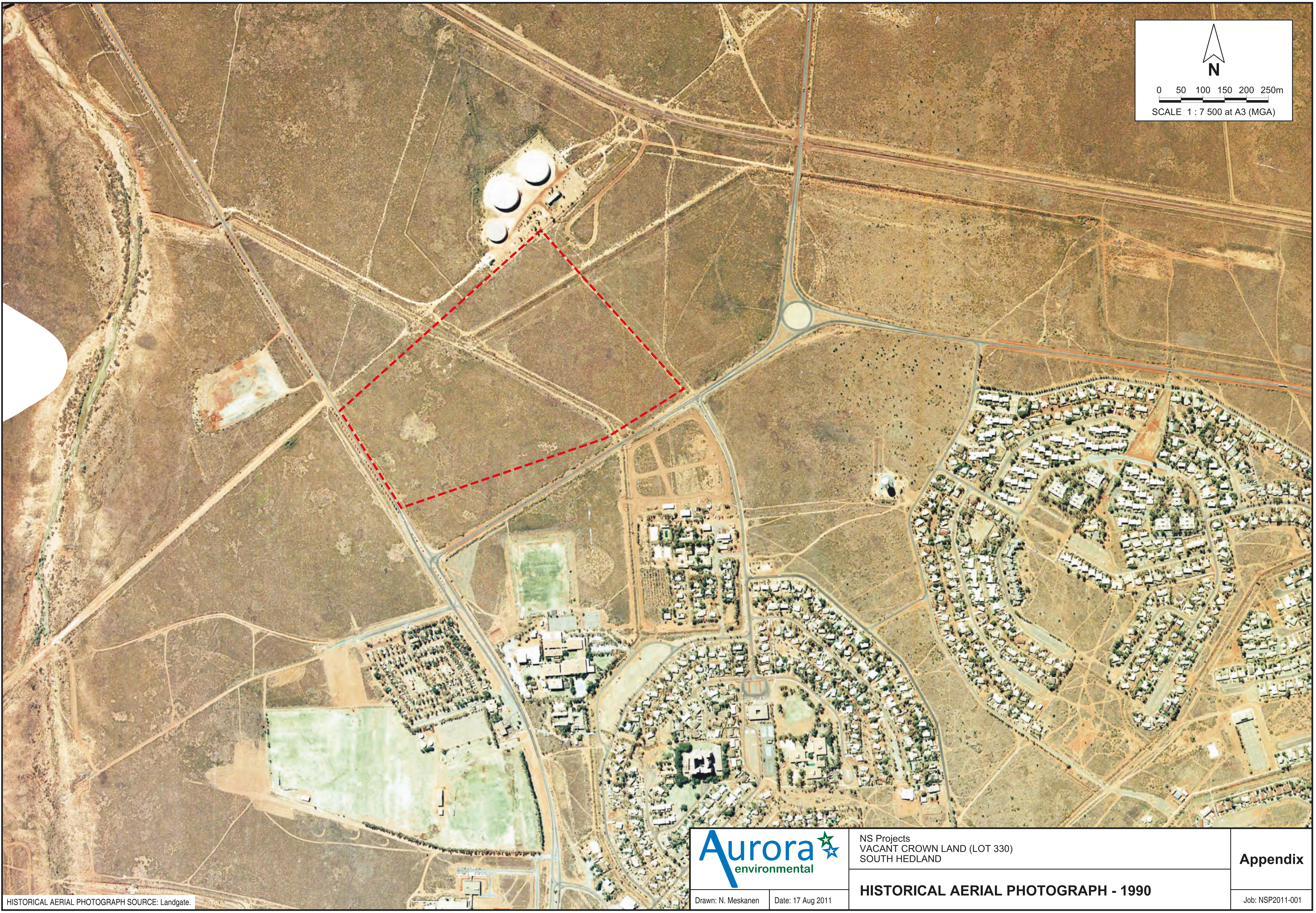
NS Projects
VACANT CROWN LAND (LOT 330)
SOUTH HEDLAND

Appendix

HISTORICAL AERIAL PHOTOGRAPH - 1979

Drawn: N. Meskanen
Date: 17 Aug 2011
Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136 NSP2011-001-Reporting-001_pz-hap-1979.dgn



HISTORICAL AERIAL PHOTOGRAPH SOURCE: Landgate.

Aurora environmental

NS Projects
VACANT CROWN LAND (LOT 330)
SOUTH HEDLAND

HISTORICAL AERIAL PHOTOGRAPH - 1990

Appendix

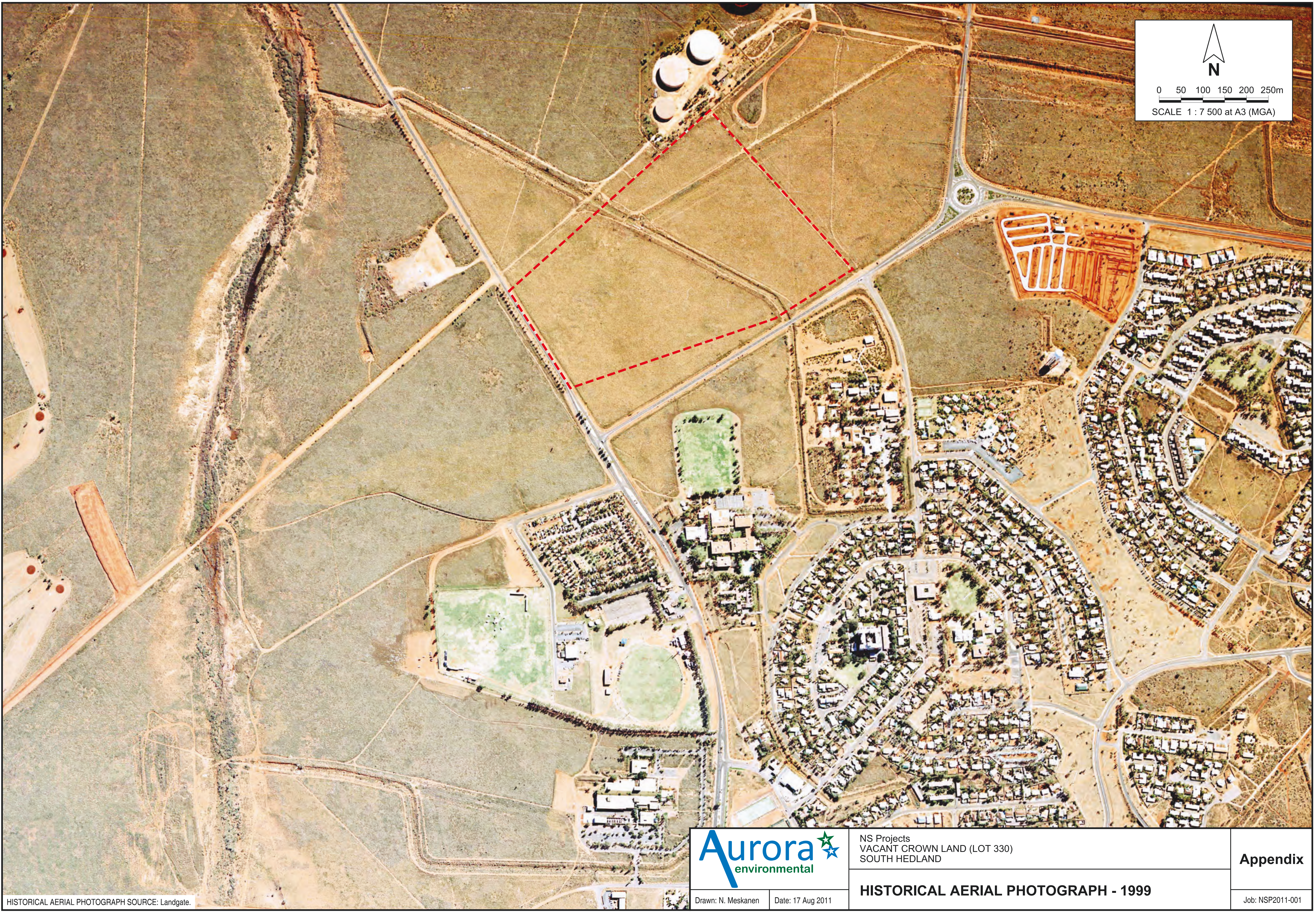
Drawn: N. Meskanen

Date: 17 Aug 2011

Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136

NSP2011-001-Reporting-001_pz-hap-1990.dgn



HISTORICAL AERIAL PHOTOGRAPH SOURCE: Landgate.

Aurora environmental

NS Projects
VACANT CROWN LAND (LOT 330)
SOUTH HEDLAND

Appendix

HISTORICAL AERIAL PHOTOGRAPH - 1999

Drawn: N. Meskanen

Date: 17 Aug 2011

Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136 NSP2011-001-Reporting-001_pz-hap-1999.dgn

HISTORICAL AERIAL PHOTOGRAPH SOURCE: Landgate.

Aurora environmental

NS Projects
VACANT CROWN LAND (LOT 330)
SOUTH HEDLAND

Appendix

Drawn: N. Meskanen

Date: 17 Aug 2011

HISTORICAL AERIAL PHOTOGRAPH - 2009

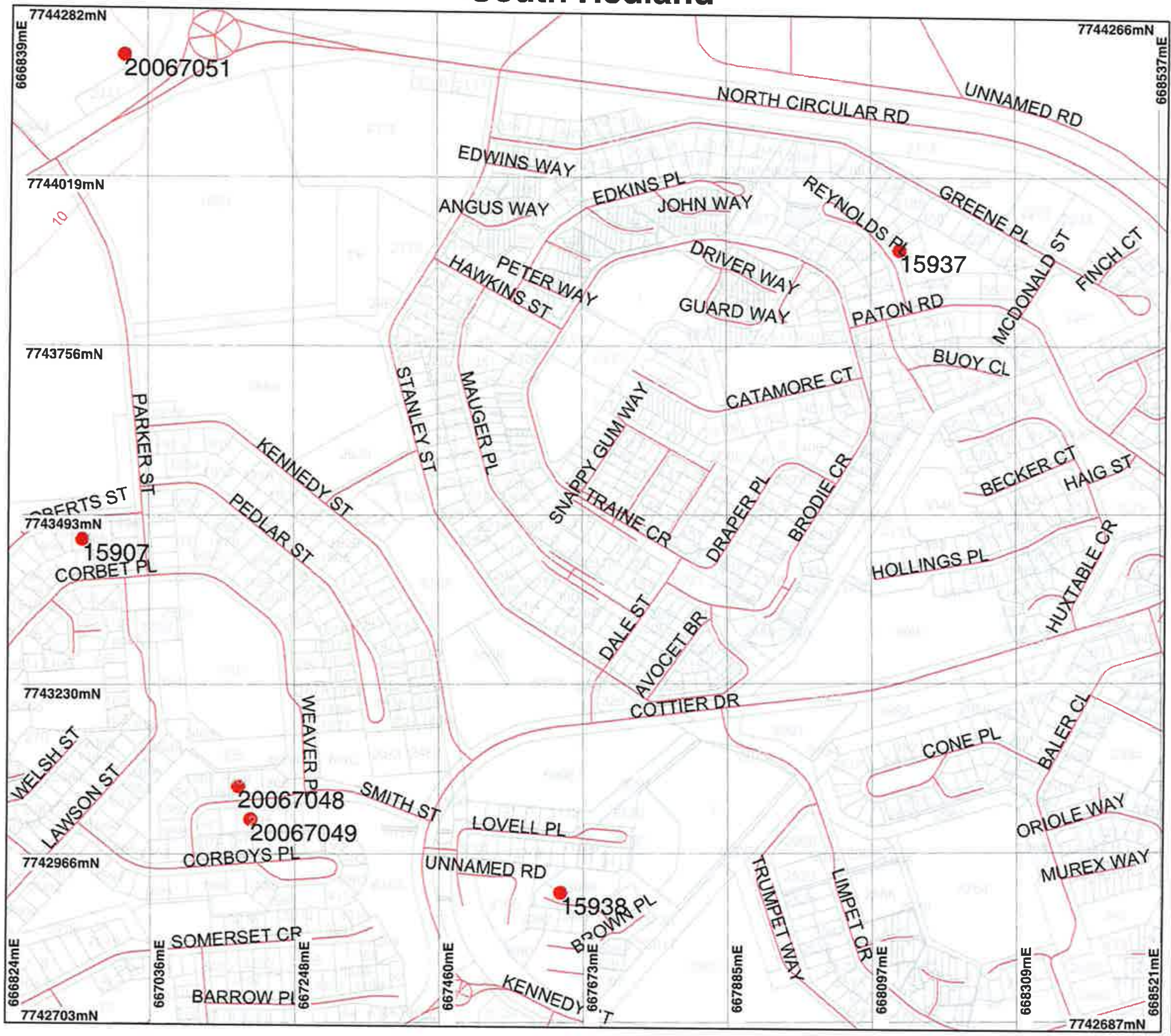
Job: NSP2011-001

PINPOINT CARTOGRAPHICS (08) 9562 7136 NSP2011-001-Reporting-001_pz-hap-2009.dgn

APPENDIX 3

WIN Database Information

South Hedland



LEGEND

Topographic Contours, Statewide - Landgate

Cadastre for labelling - DLI

Road Centrelines - Landgate

Hydrography, linear (medium scale, 250k GA)

● WIN Groundwater Sites, Other - DoW

● WIN Groundwater Sites, Monitoring - DoW

WA Coastline - DoE

N

0 ~250 m

Scale 1:8379

(Approximate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

Prepared by: lerchr
Prepared for:
Date: 28/07/2011 9:20:26 AM

Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.

Government of **Western Australia**
Department of Water

<Type here to customize title>

Date: 2011-07-11

WIN Site Id	Depth From	Depth To	Stratigraphy
20067048	0.000	3.050	LOAM AND SAND
20067048	3.050	5.180	RIVER SAND WITH SHINGLE
20067048	5.180	7.620	DAMP RIVER SAND WITH SHINGLE
20067048	7.620	8.530	SOLID CLAY
20067048	8.530	10.060	RIVER SAND WITH TRACES OF CLAY - SHINGLE SIZE 1/8 - 1/4"
20067048	10.060	13.560	RIVER SAND WITH SHINGLE
20067051	0.000	3.000	CLAY
20067051	3.000	21.000	OLD RIVER SANDS AND PEBBLES. WATER, TOO SALTY TO CONTINUE DRILLING

<Type here to customize title>

Date: 2011-07-11

WIN Site Id	Drilled Depth	Drill Method	Pump How Test	Event Comment	Construction Category	Construction Element	Construction Material	Distance To Top (m)	Distance To Bottom (m)	Element Comment
20067048	13.560	(none)			Inlet	Inlet unknown	Unknown	8.990	13.560	
20067048	13.560	(none)			Lining	Line unknown	Unknown			0 - 44FT6" X 5"
20067049		(none)			Lining	Line unknown	Unknown			NOT CASED
20067050		(none)			Lining	Line unknown	Unknown			20FT (6.09M)
20067051	21.000	Rotary drill	SALINITY TEST ONLY		Inlet	Slotted	Unknown	6 000	21.000	
20067051	21.000	Rotary drill	SALINITY TEST ONLY		Lining	Line unknown	Unknown			PVC

WIN Site Id	Site Default Site Name	Collect Date	Sample Id	Group Code	Project Code	Sample Number	Borehole water supply (m3/day)	TDSolids (in situ) (mg/L)	TDSolids (in situ) (no units)
20067044	MULLUMBRIDGIE WELL	01/01/1000	20080625	WIN SAMP CUSTODIANS	<1996AQWADATA	Field		2586	
20067048	BORE	01/01/1000	20080633	WIN SAMP CUSTODIANS	UNKNOWN	Field	27.2765		(none)
20067049	BORE	30/06/1980	20080634	WIN SAMP CUSTODIANS	<1996AQWADATA	Field	196	3950	

APPENDIX 4

Concept Landscape Master Plan

LEGEND
1 central public open space
2 footbridge
3 resting points with seating and shelter
4 casual crossing points with stepping stones
5 streetscape planting and footpath
6 linear drainage parkway
7 on street parallel parking
8 private access
9 share use path
10 circuit path (share use)
11 trafficable paving

Hamilton Development_South Hedland

REV 4_Preliminary 31.10.2011

1:1000 @ A1

HASSELL

LEGEND

1 casual kick about field

2 bridge crossing

3 resting points with seating and shelter

4 casual crossing points with concrete stepping stones

5 opportunity for future kiosk with shade and seating

6 shade shelter with seating and bbq facilities

7 base of drainage channel

8 rock boulders locally sourced

9 native planting to channel bank

10 opportunity for future water play area

11 teenage play area

12 junior play area

13 native planting bed

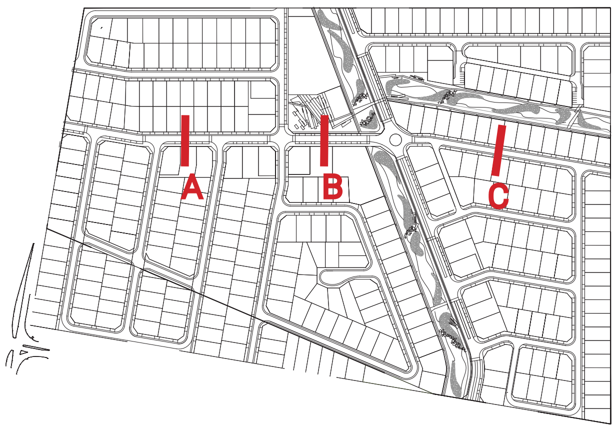
14 trafficable paving

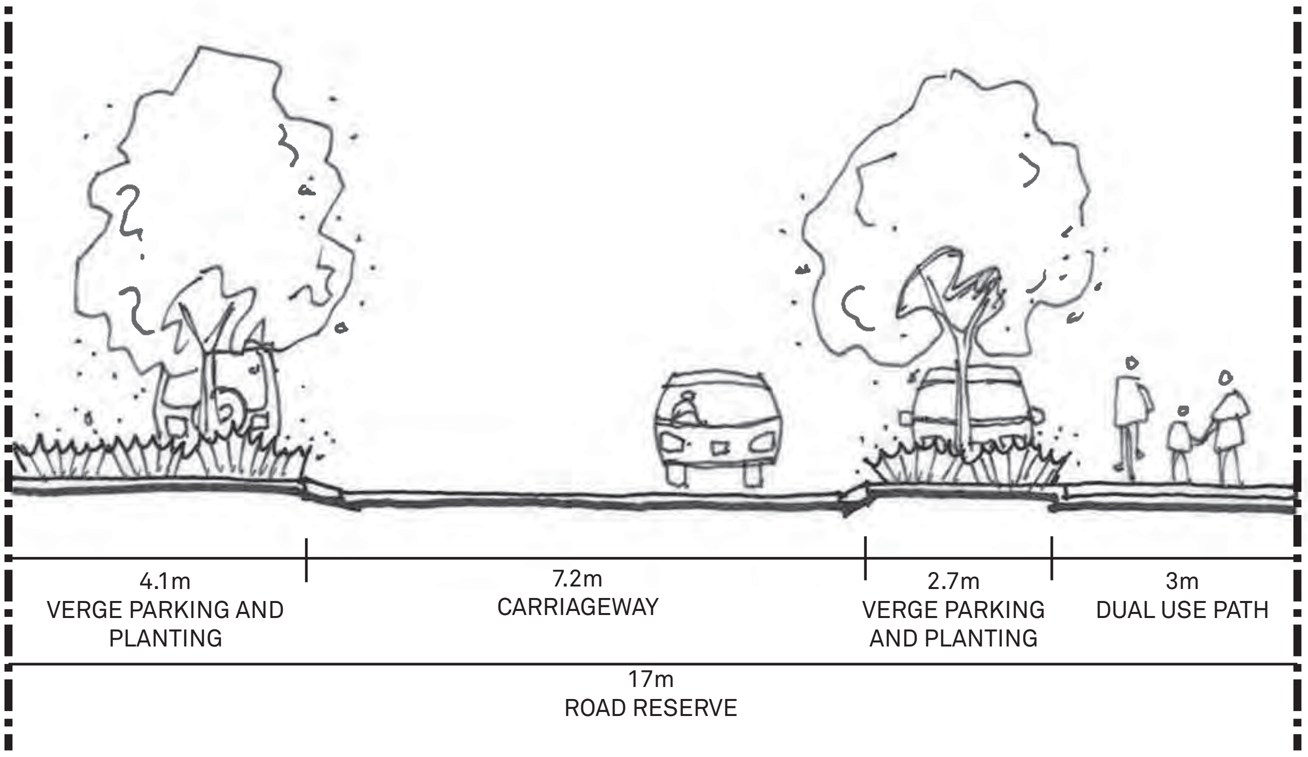
HAMILTON DEVELOPMENT_SOUTH HEDLAND

Detail Plan_rev 4_Preliminary 31.10.2011

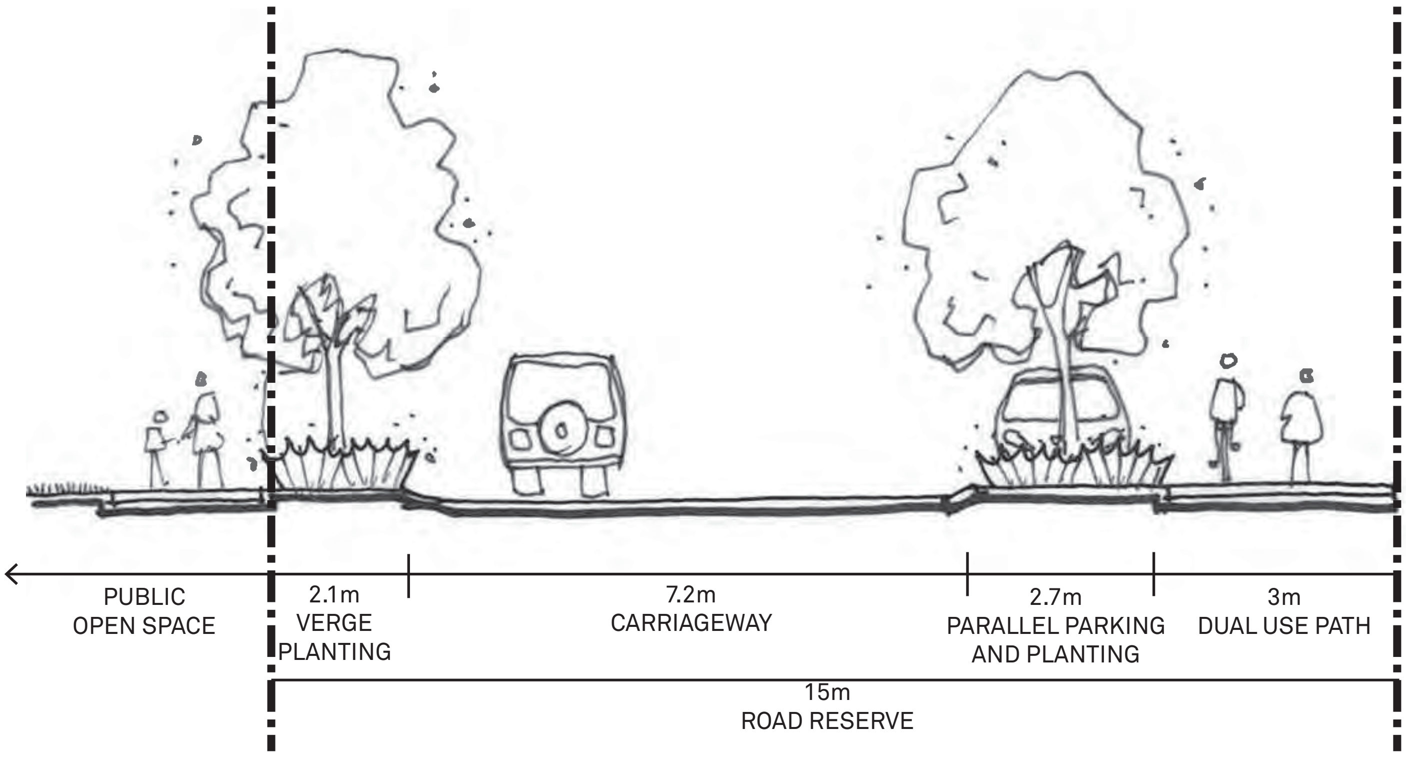
1:400 @ A3

HASSELL

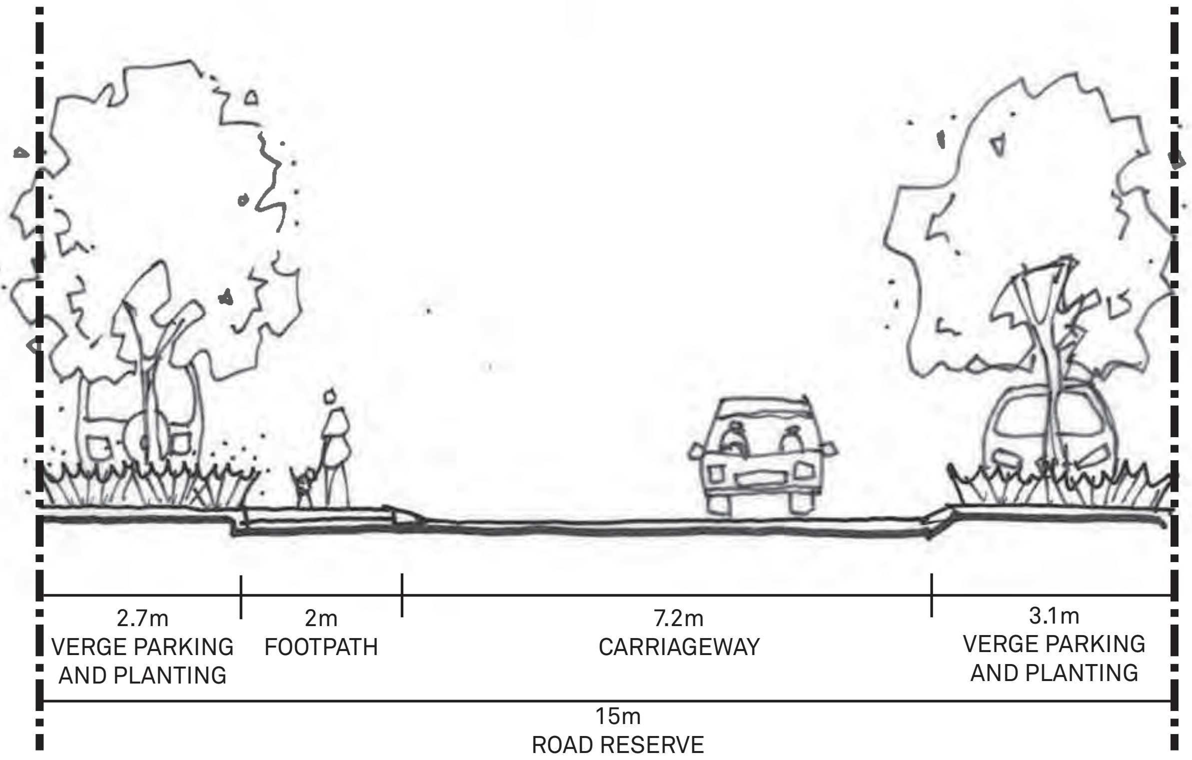




ROAD 4_SECTION A



ROAD 4_SECTION B



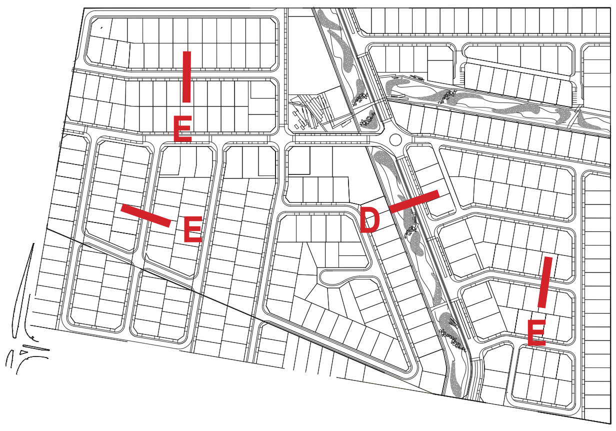
ROAD 4_SECTION C

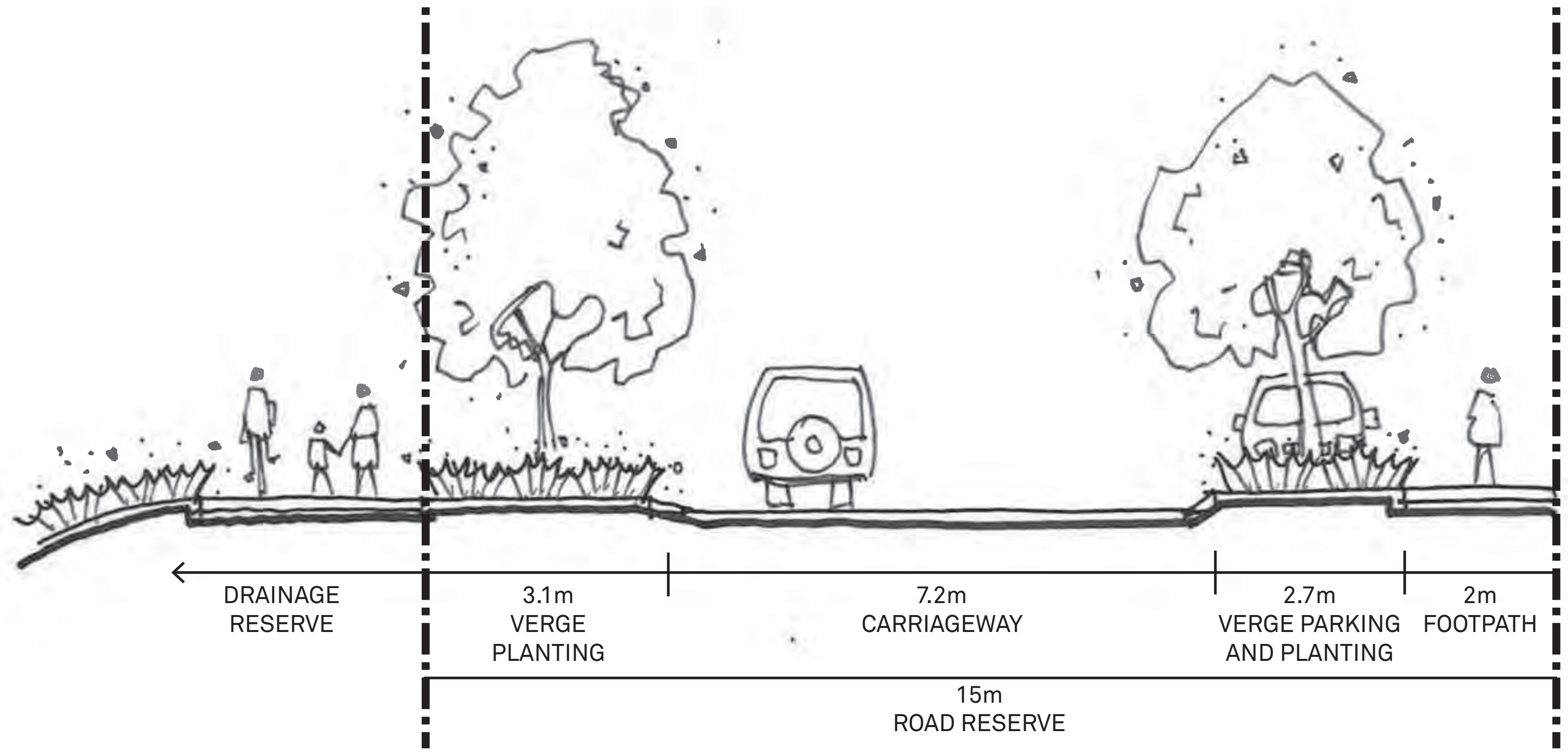
STREETSCAPE AND FOOTPATH STRATEGY_ ROAD SECTIONS

0 .5 2 4m

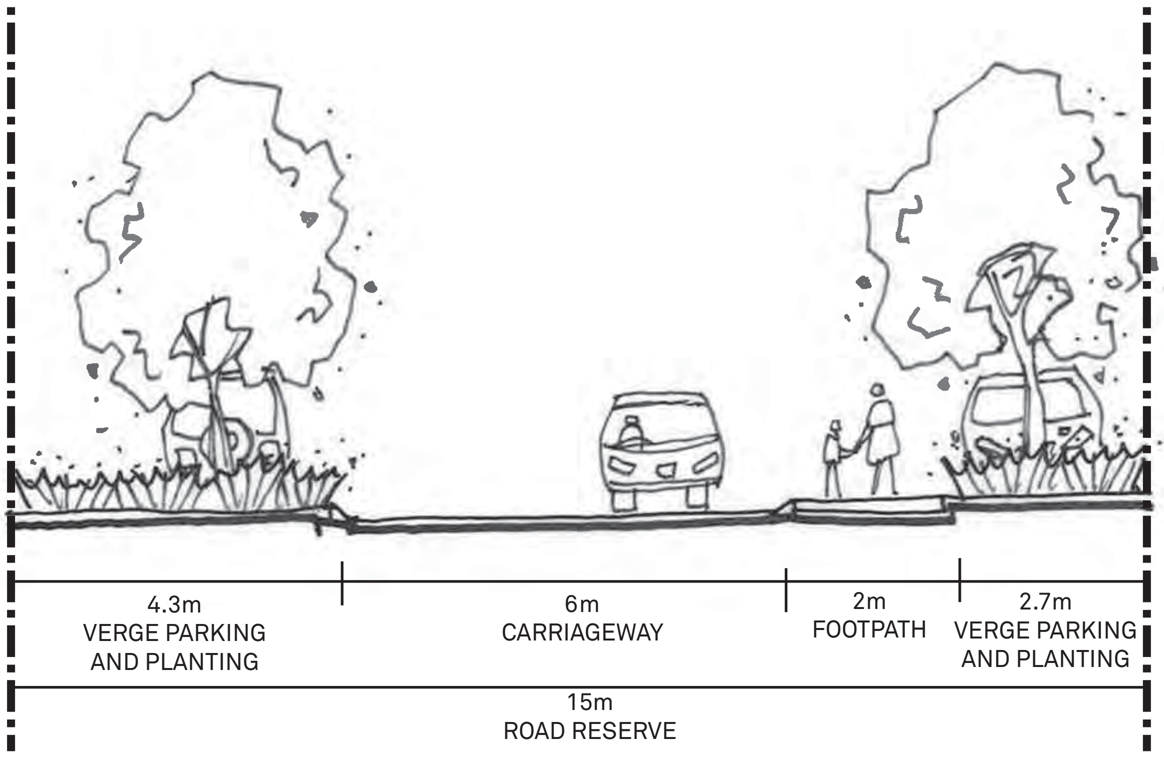
Revision	Date	Scale	Client	Project Name	Drawing
C, Preliminary	1-November2011	1:100@A3 1:50@A1	BHP Billiton	Hamilton Development South Hedland	SK02 Road Sections

HASSELL



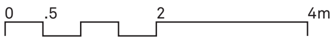


ROAD 10_SECTION D



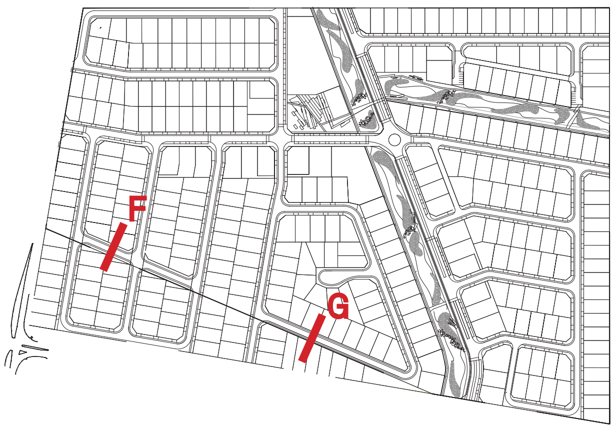
TYPICAL 15m ROAD_SECTION E

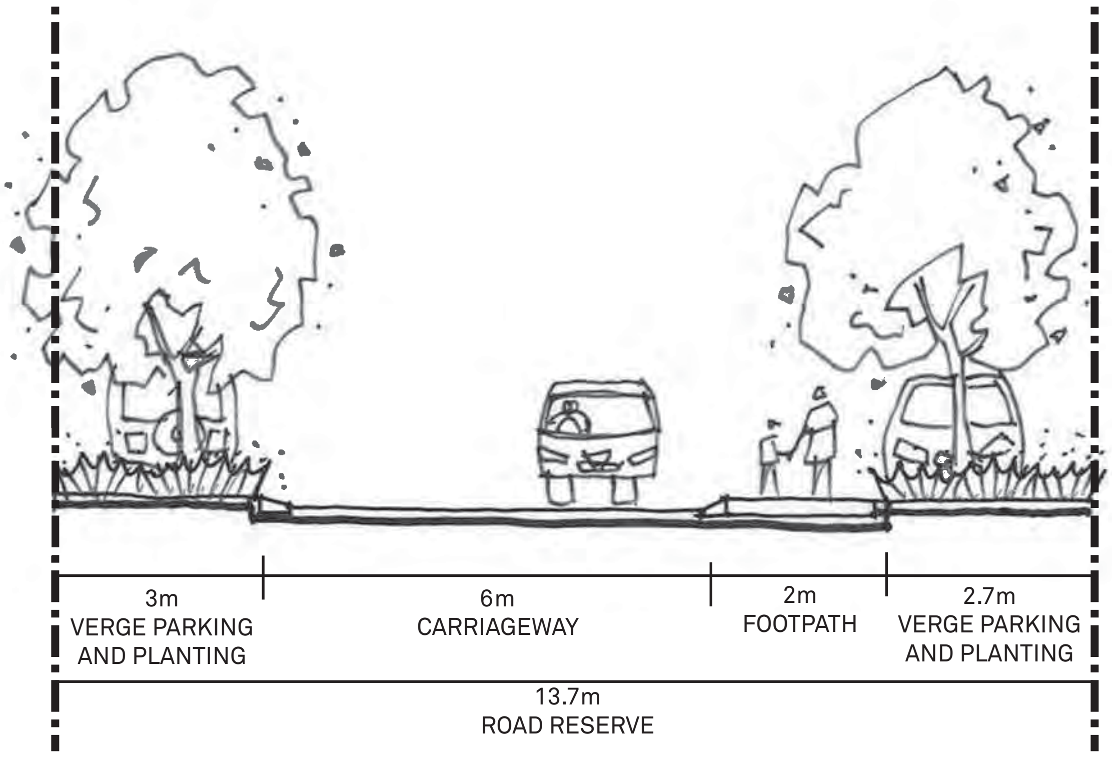
STREETSCAPE AND FOOTPATH STRATEGY_ ROAD SECTIONS



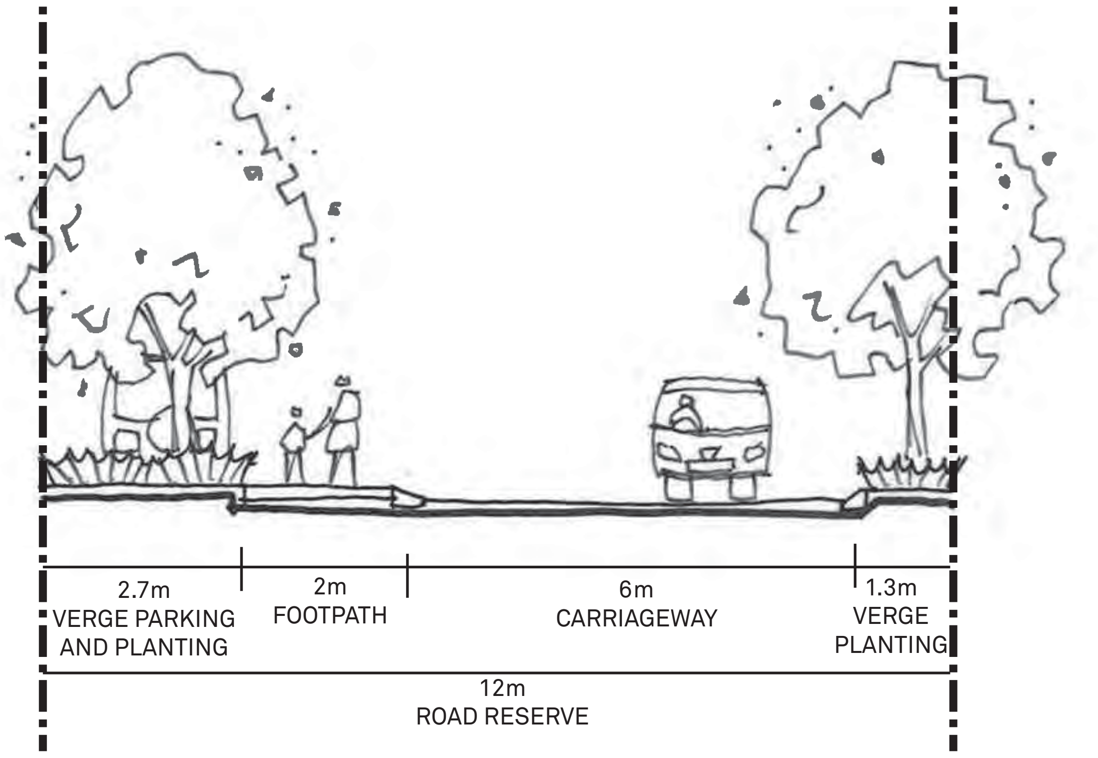
Revision	Date	Scale	Client	Project Name	Drawing
C, Preliminary	1-November2011	1:100@A3 1:50@A1	BHP Billiton	Hamilton Development South Hedland	SK03 Road Sections

HASSELL





TYPICAL 13.7m ROAD_SECTION F



TYPICAL 12m ROAD_SECTION G

STREETSCAPE AND FOOTPATH STRATEGY_ ROAD SECTIONS

0 .5 2 4m

Revision	Date	Scale	Client	Project Name	Drawing
C, Preliminary	1-November2011	1:100@A3 1:50@A1	BHP Billiton	Hamilton Development South Hedland	SK04 Road Sections

HASSELL

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Architecture Interior Design Landscape Architecture Planning Urban Design
Australia China Hong Kong SAR Singapore Thailand United Kingdom

HASSELL Limited
ABN 24 007 711 435

Communication

Project Hamilton Precinct South Hedland
Project number 003960
Subject Development Plan Landscape Strategy

To	David Read	TPG	david.read@tpgwa.com.au
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From	Nick Walker	HASSELL	nwalker@hassellstudio.com.au

Date 14/10/2011
Number of pages 4
Delivery ☒Email ☐Facsimile ☐Post ☐Courier ☐Hand

David
Please find the Landscape strategy herewith for inclusion in the Development Plan report.

Landscape and Open Space Strategy
The Hamilton Precinct landscape strategy is aimed at the creation of safe, attractive and comfortable settings for future residents, suitable for the social and recreational demands of the precinct and responsive to the local climate and environment. The existing regional drainage function will be maintained within the public open space and regenerated through a series of landscape and engineering improvements.

Central Public Open Space
The central public open space (approximately 3,500m2) is an appropriately sized neighbourhood park, including a large open grassed ‘kickabout’ area, an all ages playground, water play area, barbeque shelters, and a seasonal kiosk platform.

The park will provide a mix of partly shaded-open active recreation spaces and heavily shaded social and play areas, through tree planting and permanent shade structures.

The park will be shaped and planted in a manner reminiscent in character and materiality of the Pilbara’s natural environment, with pockets of lusher semi-tropical garden interspersed throughout dry land planting. Species selection and irrigation will be arranged on the principles of hydrozoning to maximise water efficiency.

Robust materials and structures will be selected and designed to withstand the rigours of the local climate. Lighting will be provided throughout the park to encourage outdoor use in the cooler nights.

Linear Parkways
The existing drainage channels are proposed to be reshaped and planted with more gradual slopes where possible, incorporated as integral components of the landscape public open space network.

Footpaths running along the top level will be linked across the channel by foot bridges to complete a pedestrian circulation loops within the precinct, and increase visual permeability and safety generally.

The footpaths provide links to the surrounding street and open space network, including the provision for a wider share use path catering for cyclists. Pedestrian pole top lighting will be provided along key pathways to encourage safe night time use.

Paved platforms and stone pitching will descend into the drainage channel at key locations to provide informal crossing opportunities, inviting exploration of the natural vegetation along stepping stones akin to a dry creek bed crossing. Retaining and pitching around the bridges will feature local stone in and draw a natural likeliness to the local Pilbara environments eg Karijini (Hamersely Range) National Park.

Streetscapes

Streetscapes through the residential areas will be defined and shaded through street tree planting, which will comprise local species assigned to different road types to assist orientation within the development. Footpaths are proposed to be provided on all road edges abutting future residential lots to increase pedestrian connectivity and amenity.

Informal visitor parking will be provided adjacent each single residential lot through simple gravel mulch treatments. Formalised on street parking is proposed only where directly adjoining the parks and high density residential lots.

Proposed Planting List

Planting and tree species will be selected from the following list, subject to availability and further discussion with Town of Port Hedland.

Streetscape

Trees

Acacia stenophylla	Shoestring Acacia
Corymbia flavescens (E. flavescens)	White Gum
Delonix regia	Poinciana
Eucalyptus victrix	Smooth-Barked coolabah
Tipuana tipu	Rosewood
Ulmus parvifolia	Chinese Elm

Understorey

Convolulus cneorum	Silver bush
Dianella 'Breeze'	Flax Lily
Dianella revoluta	Black Anther Flax Lily
Eremophila glabra 'Kalbarri Carpet'	Emu Bush
Gomphrena canescens	Pink Billy buttons
Grevillea 'Gin Gin Gem'	Grevillea
Hardenbergia comptoniana	Native wisteria
Lomandra Tanika	Matt rush
Myoporum parvifolium	Creeping Boobiala
Poa labillardierii 'Eskdale'	Bluegrass
Scaevola crassifolia	Thick leaf fan flower
Scaevola parvifolia	Camel weed
Westringia Mundii	Native rosemary

POS

Trees

Acacia aneura	Mulga
Acacia stenophylla	Shoestring Acacia
Brachychiton acuminatus	Burrup Kurrajong
Casuarina equisetifolia	Coastal sheoak
Corymbia aspera (E. aspera)	Brittle Bloodwood
Corymbia flavescens (E. flavescens)	White Gum
Eremophila glabra	Emu bush
Eucalyptus camaldulensis	River Red Gum
Eucalyptus victrix	Smooth-Barked coolabah
Ficus hillii	Hill's Fig
Hibiscus tileaceous rubra	Cottonwood
Melaleuca leucadendra	Weeping paperbark
Pulmeria obtusa	Frangipani
Mangifera indica	Mango Tree

Understorey

Acacia gregorii	Gregory's Wattle
Acalypha species	
Alyogyne hakeifolia	Native Hibiscus
Bougainvillea	
Convolulus cneorum	Silver bush
Carrisa grandiflora	Natal Plum
Dianella 'Breeze'	Flax Lily
Dianella revoluta	Black Anther Flax Lily
Eremophila glabra 'Kalbarri Carpet'	Emu Bush
Eremophila maculata	Native fuchsia
Ficinia nodosa	Noddy Clubrush
Gomphrena canescens	Pink Billy buttons
Ixora coccinea	
Lomandra Nyalla	Matt rush
Lomandra Tanika	Matt rush
Murraya paniculata	Orange Jessamine
Poa labillardierii 'Eskdale'	Bluegrass
Ptilotus exaltatus	Pink mulla mulla
Russelia equisetifomis	Firecracker Plant
Scaevola crassifolia	Thick leaf fan flower
Trioda wiseana	Lime spinifex
Westringia Mundii	Native rosemary
Olearia 'Little Smokie'	Daisy Bush

Drain Revegetation

Trees

Acacia aneura Mulga	Mulga
Acacia coriacea	Wiry Wattle
Corymbia aspera (E. aspera)	Burrup Kurrajong
Corymbia flavescens (E. flavescens)	White Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus victrix	Smooth-Barked coolabah
Casuarina equisetifolia	Coastal sheoak

Understorey

Eremophila longifolia	Native fuchsia
Eremophila maculata	Native fuchsia
Ptilotus exaltatus	Pink mulla mulla
Scaevola parvifolia	Camel weed
Spinifex longiflorus	Beach spinifex
Trioda pungens	Soft Spinifex
Triodia epactia	Spinifex
Triodia schinzii	Spinifex
Lomandra longifolia	Matt Rush
Juncus krausii	Sea Rush
Juncus pallidus	Pale Rush
Lepidosperma gladiatum	Coast Sword Sedge

Regards

Nick Walker
Associate
Email nwalker@hassellstudio.com

APPENDIX 5

5 Star Plus Stage 1 Building Requirements

Department of Housing and Works
Government of Western Australia

5 Star Plus

Energy Use in Houses Code
Water Use in Houses Code

Playing our part in building better communities for Western Australia

Introduction

In May 2006, Western Australia adopted the minimum 5 Star energy efficiency provisions of the Building Code of Australia for all new homes. Now the Government has gone further and introduced 5 Star Plus – that builds on the energy efficiencies from 5 Star with the added benefits of water reduction measures for all homes right across the State.

5 Star Plus is based around two new Codes:

The Energy Use in Houses Code - confirms the existing 5 Star provisions for house design and construction and adds requirements for energy efficient water heating.

The Water Use in Houses Code - aims to reduce the consumption of water in residential homes by requiring water efficient fittings, minimising the wastage of water and facilitating the appropriate use of alternative sources of water such as grey water and rain water.

5 Star Plus will be applicable to new homes approved for construction after 1 September 2007, however, existing home owners can also use these Codes to improve energy and water efficiency in their homes. During 2008, the Government will investigate measures to apply the 5 Star Plus provisions to existing homes.

The Energy Use in Houses Code and Water Use in Houses Code are written to supplement the Building Code of Australia (BCA) and adopt BCA definitions and format for consistency. The Codes are published together for the convenience of builders, plumbers and certifiers who may need a convenient reference on site.

The Codes are available online at **www.5starplus.wa.gov.au**

Energy Use in Houses Code

Application

This Code applies to all new buildings classified as Class 1 and 10 buildings by the Building Code of Australia.

Interpretation

"The Building Code of Australia" means the latest edition of the Building Code of Australia published from time to time by, or on behalf of, the Australian Building Codes Board, but not including explanatory information published with that Code.

Objective

The objective of this Code is to reduce greenhouse gas emissions.

Functional Statement

In order to reduce greenhouse gas emissions, a building, including its services, is to be capable of efficiently using appropriate sources of energy.

Compliance With This Code

A building will comply with this Code if its construction satisfies all the Performance Requirements. Compliance with the Performance Requirements can be shown by:

(a) Complying with the Deemed-to-Satisfy provisions as listed in the Acceptable Construction Practice; or

(b) Formulating an alternative solution that is shown to be equivalent to the Deemed-to-Satisfy provisions; or

(c) Formulating an alternative solution that is verified using an acceptable verification method; or

(d) Formulating an alternative solution that is based on expert judgement or supported by suitable evidence in accordance with clause 1.2.2 of the Building Code of Australia; or

(e) Any combination of the above.

Energy Use in Houses Code

Performance Requirements

PR1 – Building

A building must comply with the Building Code of Australia Performance Requirement P2.6.1.

PR2 – Services

A building's domestic services including any associated distribution system and components must have features that comply with the Building Code of Australia, Performance Requirement P2.6.2.

PR3 – Hot Water Systems

A building's hot water systems including any associated components must have features that produce low levels of greenhouse gases when heating water.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS1 satisfy the Performance Requirement PR1 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS2 satisfy the Performance Requirement PR2 for a building.
(c) Compliance with all of the Deemed-to-Satisfy provisions of DTS3 satisfy the Performance Requirement PR3 for a building.

Deemed to Satisfy Provisions

DTS 1 – Thermal Comfort

The building must comply with the provisions of Part 3.12 of the Building Code of Australia for Building Fabric, External Glazing, Building Sealing and Air Movement.

DTS 2 – Services

The building must comply with the provisions of Part 3.12 of the Building Code of Australia for Services.

DTS 3 – Hot Water Systems

A hot water system must be either:

(i) a solar hot water system, complying with AS 2712-2002, that has been tested in accordance with AS 4234-1994, and achieves a minimum energy saving of 60% for a hot water demand level of 38MJ per day for climate zone 3; or
(ii) a gas hot water system, complying with AS 4552-2005 that achieves a minimum energy rating of "5 stars"; or
(iii) a heat pump hot water system, complying with AS 2712-2002 that has been tested in accordance with AS 4234-1994, and achieves a minimum energy saving of 60% for a hot water demand level of 38MJ per day for climate zone 3.

Explanatory Notes:

1. **BCA Performance Requirement P2.6.1**

   A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

   (a) the function and use of the building; and
   (b) the internal environment; and
   (c) the geographic location of the building; and
   (d) the effects of nearby permanent features such as topography, structures and buildings; and
   (e) solar radiation being—
      (i) utilised for heating; and
      (ii) controlled to minimise energy for cooling; and
   (f) the sealing of the building envelope against air leakage; and
   (g) the utilisation of air movement to assist cooling.

2. **BCA Performance Requirement P2.6.2 – Services**

   A building's domestic services including any associated distribution system and components must have features that, to the degree necessary, facilitate the efficient use of energy appropriate to –

   (a) the domestic services and its usage; and
   (b) the geographic location of the building; and
   (c) the location of the domestic services; and
   (d) the energy source.

3. **AS 2712-2002** details the design and construction of solar and heat pump water heaters.
4. **AS 4234-1994** sets out the method of testing and calculation of energy consumption for domestic solar water heaters and heat pumps.
5. **AS 4552-2005** details the design of gas forced water heaters for hot water supply and/or central heating.

Water Use in Houses Code

Application

This Code applies to all new buildings classified as Class 1 and 10 buildings by the Building Code of Australia.

Interpretation

"The Building Code of Australia" means the latest edition of the Building Code of Australia published from time to time by, or on behalf of, the Australian Building Codes Board, but not including explanatory information published with that Code.

"Alternative Internal Water Supply" refers to a water supply such as collection of rainwater on site, external third pipe non-potable water source, on-site bores or the like, other than potable water supplied by a licensed water service provider, and approved for use inside a dwelling.

"Alternative External Water Supply" refers to a water supply such as collection of rainwater on site, external third pipe non-potable water source, re-cycled grey water, on-site bores or the like, other than potable water supplied by a licensed water service provider, and approved for use outside a dwelling.

"Potable Water" refers to water intended for human consumption supplied by a licensed water service provider.

Objective

The objective of this Code is to reduce water demand by efficiently using water, and minimising the wasting of water, and facilitating the appropriate use of alternative sources of water.

Functional Statement

To reduce potable water demand a building must:

(a) enable the efficient use of potable water; and
(b) prevent excessive loss of potable water; and
(c) have the capacity to connect to alternative sources of water supply; and
(d) use alternative sources in situations of high water demand or restricted availability of potable water.

Compliance With This Code

A building will comply with this Code if its construction satisfies all the Performance Requirements. Compliance with the Performance Requirements can be shown by:

(a) complying with the Deemed-to-Satisfy provisions as listed in the Acceptable Construction Practice; or
(b) formulating an alternative solution that is shown to be equivalent to the Deemed-to-Satisfy provisions; or
(c) formulating an alternative solution that is verified using an acceptable verification method; or
(d) formulating an alternative solution that is based on expert judgement or supported by suitable evidence in accordance with clause 1.2.2 of the Building Code of Australia; or
(e) any combination of the above.

Explanatory Notes:

Stage 1 of the Code will be prescribed in the Building Regulations to apply from 1 September 2007.

Stage 2 of the Code will be prescribed in the Building Regulations to apply from date to be determined.

Implementation of Stage 2 of the Code is dependent on further consultation and research to determine areas of application and on amendments to plumbing regulations and processes as well as ensuring compliance with health regulations and policies.

Water Use in Houses Code

Stage 1 - To apply from 1 September 2007

Performance Requirements

PR1 – Water Use Efficiency

A building must have features that, to the degree necessary, facilitate the efficient use of potable water appropriate to:

- (a) the geographic location of the building; and
- (b) the available potable water supply for the building; and
- (c) the function and use of the building.

PR2 – Water Loss Prevention

A building, including any water holding structures, must have features that, to the degree necessary, prevent the excessive loss of potable water appropriate to:

- (a) the geographic location of the building; and
- (b) the available potable water supply for the building; and
- (c) the function and use of the building; and
- (d) the effects of permanent features such as topography, structures and buildings.

PR3 – Hot Water Use Efficiency

A building must have features that, to the degree necessary, facilitate the efficient use of hot water appropriate to:

- (a) the geographic location of the building; and
- (b) the available hot water supply for the building; and
- (c) the function and use of the building.

Acceptable Construction Practice

- (a) Compliance with all of the Deemed-to-Satisfy provisions of DTS1 satisfies the Performance Requirement PR1 for a building.
- (b) Compliance with all of the Deemed-to-Satisfy provisions of DTS2 satisfies the Performance Requirement PR2 for a building.
- (c) Compliance with all of the Deemed-to-Satisfy provisions of DTS3 satisfies the Performance Requirement PR3 for a building.

Deemed to Satisfy Provisions

DTS 1 – Water Use Efficiency

- (a) all tap fittings other than bath outlets and garden taps must be minimum 4 stars WELS rated.
- (b) all showerheads must be minimum 3 stars WELS rated.
- (c) all sanitary flushing systems must be a minimum 4 stars WELS rated dual flush.

DTS 2 – Swimming Pool Covers and Blankets

An outdoor private swimming pool or spa associated with a Class 1 building must be supplied with a cover, blanket or the like that:

- (a) is designed to reduce water evaporation; and
- (b) is listed on the Smart Approved Watermark Scheme.

DTS 3 – Hot Water Use Efficiency

All internal hot water outlets (taps, showers, washing machine water supplies) must be connected to a hot water system or a recirculating hot water system with pipes installed and insulated in accordance with AS/NZS 3500:2003. Plumbing and Drainage, Part 4 Heated Water Services. The pipe from the hot water system or recirculating hot water system to the furthest hot water outlet must not exceed 20 metres in length or 2 litres of internal volume.

Explanatory Notes:

The Smart Approved Watermark Scheme is implemented through the National Water Commission as a simple identification label about water efficient products. Further information can be obtained from www.nwc.gov.au

Stage 2 - To apply from (date to be determined)

Performance Requirements

PR4 – Alternative Water Supply Use Capacity

A building, including any associated plumbing, must have features that, to the degree necessary, facilitate the future use of alternative water supplies appropriate to:

(a) the geographic location of the building; and
(b) the function and use of the building; and
(c) the soil type and ground condition; and
(d) the available alternative sources of water; and
(e) the size and type of external landscaping.

PR5 – Grey Water Use Capacity

A building including any associated plumbing, located on a lot of a size and in a location suitable for recycling of grey water, must have features that, to the degree necessary, facilitate the future use of grey water recycling appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for landscaping; and
(c) the function and use of the building; and
(d) the soil type and ground condition; and
(e) the available alternative sources of water; and
(f) the size and type of external landscaping.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS4 satisfies the Performance Requirement PR4 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS5 satisfies the Performance Requirement PR5 for a building.

Deemed to Satisfy Provisions

DTS 4 – Alternative Water Supply Use Capacity

All sanitary flushing systems and washing machines must be able to be connected at a later date, to an appropriate alternative water supply without the need to break, or cut into the fabric of the building to run new pipes.

DTS 5 – Grey Water Use Capacity

All shower, bath, laundry trough and washing machine drains must be able to be connected at a later date to an appropriate grey water diversion system without the need to break, or cut into the fabric of the building to run new pipes.

Explanatory Notes:

1. Health regulations apply to the use of alternative water supplies and will, amongst other things, limit the alternative water sources suitable for various uses.
2. The DTS 4 provisions do not require rainwater tanks. They require buildings to be able to be connected to such alternative water supplies relatively easily at a later date (i.e. the buildings are to be alternative supply ‘ready’). Subject to health regulations and policies, alternative water supplies could also include bore water, third pipes, and the like.
3. All plumbing work associated with these requirements must be carried out by licensed plumbers and in accordance with all relevant plumbing regulations.

Water Use in Houses Code

Performance Requirements

PR6 – Alternative Internal Water Supply

A building with more than two showers or two WC facilities must use alternative internal water supplies for internal uses appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building; and
(d) the available alternative sources of water.

PR7 – Alternative External Water Supply

A building located on a lot of a size and in a location likely to use significant potable water for landscaping use must use alternative internal or external water supplies appropriate to:

(a) the geographic location of the building; and
(b) the available potable water supply for the building; and
(c) the function and use of the building; and
(d) the soil type and ground condition; and
(e) the available alternative sources of water; and
(f) the size and type of external landscaping.

Acceptable Construction Practice

(a) Compliance with all of the Deemed-to-Satisfy provisions of DTS6 satisfies the Performance Requirement PR6 for a building.
(b) Compliance with all of the Deemed-to-Satisfy provisions of DTS6 or DTS7 satisfies the Performance Requirement PR7 for a building.

Deemed to Satisfy Provisions

DTS 6 – Alternative Internal Water Supply

All sanitary flushing systems and clothes washing facilities must be connected to an alternative internal cold water supply.

DTS 7 – Alternative External Water Supply

(a) All external garden taps and irrigation systems must be connected to an alternative external water supply; or
(b) all shower, bath, laundry trough and washing machine drains must be connected to an approved grey water diversion and recycling system.

Explanatory Notes:

1. Houses required to be "grey water ready" under PR5 are those on large enough lots to allow drains carrying appropriate water to be run outside the house before connection to other waste pipes, and where there is likely to be enough landscaped area to adequately dilute the grey water.
2. Lots where houses are required to comply with PR7 will be identified through regulations. Further research is needed with relevant stakeholders to resolve which lots will be subject to this requirement.
3. Health regulations apply to the use of alternative water supplies and will, amongst other things, limit the alternative water sources suitable for internal or external use in different localities. For example most private bore water, whilst it may be suitable for garden use, may be inappropriate for use internally.
4. Alternative water supplies can include but is not limited to, rainwater tanks, bore water, third pipes, and the like.
5. Subject to health regulations an acceptable alternative internal water supply is an appropriately sized rainwater tank harvesting the rainwater runoff from the roof.
6. Subject to health regulations an acceptable alternative external water supply is a domestic bore.
7. All plumbing work associated with alternative water supplies must be carried out by licensed plumbers and in accordance with all relevant plumbing regulations.
8. The Water Use in Houses Code is implemented in two stages to allow amendment of plumbing regulations and training of licensed plumbers to ensure alternative water supplies are appropriate and safe, and that there is no risk of cross contamination with potable water supplies.

Further information

May 2007 - First Edition

These Codes are intended to supplement the Building Code of Australia and will be called up by the Building Regulations 1989

For further information about 5 Star Plus please visit our website at www.5starplus.wa.gov.au

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East Perth WA 6004

APPENDIX 6

Drainage Swale Locations and Flood Routes

DRAFT

- - - DRAINAGE CATCHMENT

→ FLOW DIRECTION

▨ 1:5 YEAR ARI DRAINAGE SWALE.

PRELIMINARY DRAINAGE CATCHMENTS - HAMILTON

21:10:2011

HAMILTON YIELDS

Group housing / Apartment sites	
Number of Lots	2 lots
No. of Dwellings	69 (15.6%)
Average Lot Size	3528m²
Minimum Lot Size	2761m²
Maximum Lot Size	4296m²

3 x 2 Lots	
Number of Lots	126 lots
No. of Dwellings	126 (28.4%)
Average Lot Size	481m²
Minimum Lot Size	456m²
Maximum Lot Size	499m²

4 x 2 Lots	
Number of Lots	131 lots
No. of Dwellings	131 (29.6%)
Average Lot Size	523m²
Minimum Lot Size	500m²
Maximum Lot Size	592m²

5 x 2 Lots	
Number of Lots	13 lots
No. of Dwellings	13 (2.9%)
Average Lot Size	638m²
Minimum Lot Size	603m²
Maximum Lot Size	745m²

4 Pack Lots	
Number of Lots	26 lots
No. of Dwellings	104 (23.5%)
Average Lot Size	718m²
Minimum Lot Size	570m²
Maximum Lot Size	1031m²

Lot and Dwelling Totals	
Total Lots	298 lots
Total Dwellings	443 Dwellings
* Note potential for 45 lots in Circular Road reserve (45 dwellings)	

LEGEND

▭	Subject Site		Power Pole
▭	Proposed Lot	―	Road Kerb
▭	Drainage		Light Pole
▭	Contours		Power Pole
▭	POS		Over head Power

LOT TYPOLOGY LEGEND

		■	Group Housing
■	4 bed x 2 bath Lots	■	3 bed x 2 bath lots
■	5 bed x 2 bath Lots	■	3 bed x 2 bath lots

Hamilton - Concept Subdivision
Indicative Yields

Date: 6th October 2011 Designer: DR
Scale: 1:1000 @ A1 Drawn: PR
Drawing No. 711-340 CP7R 061011.dwg

tpg

0 25 m 50 m