1. INTRODUCTION

This traffic report has been prepared by Transcore, on behalf of Blaxland Pty Ltd with regard to the rezoning applications and the proposed development plan for the Tindale Street Site in Spinifex Hill, Port Hedland (hereafter referred to as subject site). The rezoning application entails a proposed change from existing zoning into residential/urban.

The original traffic report for the proposed subdivision was prepared in December 2010. The proponent has subsequently amended the development plans to introduce changes to the internal subdivision design, access system and housing stock. Total dwelling yield has since been reduced from 198 to 90 units. Accordingly, the proposed changes warranted a revision of the original traffic report.

Figure 1. Aerial photo of the subject site

The subject site is situated between the "Telstra Site" and the Water Corporation Effluent Water Ponds site (EWP) and bounded by McGregor Street to the north, Tindale Street to the west and south and Cooke Point Drive to the east. Tindale Street, abutting the subject site along western and southern perimeter is currently unmade; however, this rezoning application allows (land) for the construction of this road including the potential future upgrade of McGregor Street/Clark Street/Tindale Street intersection into a four-way roundabout. For the purpose of this assessment, it is assumed that Tindale Street will be constructed by the time the proposed subdivision is fully developed.

The subject area (approximately 2.6ha) is currently vacant. Refer **Figure 1** for details.

This report aims to assess the impact of the proposed change of zoning with respect to traffic generation upon the adjacent road network and to identify any road network and traffic management measures that may be required to accommodate the additional traffic. The traffic assessment will also consider the traffic from the proposed residential development on the neighbouring "Telstra Site". This development will share vehicular access off McGregor Street with the "Telstra Site" development via the proposed 4-way roundabout intersection.

2. PROPOSED SITUATION

According to the information provided by Blaxland Pty Ltd, the proposed rezoning application for the subject area includes redevelopment of the site into a 89-dwelling residential subdivision comprising a mix of 3- and 4-bedroom townhouses and 3-bedroom apartments.

The proposed internal subdivision road system takes access from the external road network via three access points located on McGregor Street (northern perimeter) and the future Tindale Street (western and southern perimeter). It should be noted however that Council may elect not to proceed with construction of the future Tindale Street but rather set aside subject road reserve for future residential development. The proponent has developed a robust development plan which accommodates both options (with and without Tindale Street). However, the focus of this report is the scenario which features Tindale Street.

Access on McGregor Street is proposed to be located approximately 250m east of McGregor Street/Clark Street intersection, while Tindale Street (west) access point is proposed approximately 65 south of McGregor Street/Tindale Street intersection and 65m west of the future Tindale Street/Cooke Point Drive intersection. Both Tindale Street accesses are proposed to operate as full-movement crossovers.

The entry into the development from McGregor Street access point is proposed through a 4-way roundabout intersection where McGregor Street forms the western and eastern legs and the southern leg represents the access road. The fourth (northern) leg of the intersection would be the access road into the future development north of McGregor Street ("Telstra Site"). The proposed roundabout will act to regulate the traffic at this intersection as well as control the speed of traffic along this section of McGregor Street.

Refer to the proposed concept plan (drawing number: 1211 SK146 issue 02) from July 2011prepared by KT Architects (**Appendix A**).

3. EXISTING SITUATION

The rezoning application is for the "Tindale Street Site" located in Spinifex Hill, approximately 4.5km east of the Port Hedland town centre. It is bounded by McGregor Street to the north, Tindale Street to the west and south and Cooke Point Drive to the east. The area surrounding the subject site to the west and east is vacant land with the Telstra Site to the north earmarked for future residential development. The area to the south east is the Water Corporation Effluent Water Ponds site (EWP), which is to be decommissioned in future. Refer **Figure 2** for details.

Figure 2. The subject site

McGregor Street and **Cooke Point Drive** are both undivided, two-lane two-way roads, with a pavement width of approximately 7m, road reserve of 20m (28m for Cooke Point Drive) and operating under speed limit of 60km/h and 80km/h, respectively. A concrete pedestrian footpath is in place along the northern verge of McGregor Street at this location. Cooke Point Drive does not entail any pedestrian facilities.

According to Main Roads WA *Functional Road Hierarchy* both roads are classified as Local Distributor roads with maximum desirable traffic volume of 6,000 vehicles per day (vpd).

Traffic count information provided by Main Roads WA states that McGregor Street (west of Crawford Street) carried approximately AWT 5,060vpd in May 2009. It is however estimated that the traffic volumes in the immediate vicinity of the subject site are somewhat lower and most likely at the level of 4,500vpd.

According to the same source Cooke Point Drive (south of McGregor Street) carried approximately AWT 3,550vpd in May 2009.

Presently, McGregor Street and Clark Street form a priority-controlled T-intersection with Clark Street terminating on its southbound approach. No crash records are available for this intersection.

McGregor Street forms a 3-way roundabout intersection with Cooke Point and Athol Street near the northeast corner of the subject site. According to the intersection crash report sourced from Main Roads WA for the 5-year period to December 2009, this intersection experienced a total of 5 crashes. It is ranked 3,023rd in the State Frequency Rank.

4. TRAFFIC ASSESSMENT

This section of the report provides an estimation of the traffic expected to be generated by the proposed rezoning and the subsequent residential subdivision and assesses the potential impact of this traffic on the immediate road network at the locality. An assessment of the internal subdivision road hierarchy and the road reservation requirements will also from part of this assessment.

4.1 Traffic Generation and Distribution

In order to assess the traffic impact from the proposed residential subdivision onto the abutting road network a traffic generation and distribution exercise was undertaken.

To estimate the future traffic that would be generated from the proposed development, the document *"Guide to Traffic Generating Developments, Roads and Traffic Authority NSW, 2002 (RTA-NSW)"* was sourced. This document proposes a variety of trip generation rates for different types of the residential dwellings which range from 3 to 9 trips per dwelling per day. Specifically, an average rate of 6 trips per day per dwelling is adopted for the subject residential subdivision.

Accordingly, the proposed residential development is estimated to generate approximately **535** total daily vehicular trips (inbound and outbound combined) for a typical weekday.

Based on the actual location of the subject site and the existing road network, the following assumptions were made for the distribution and assignment of the subdivision-generated traffic:

- Approximately 60% of the traffic generated from the subject site would travel to/from the west;
- Approximately 10% of the traffic generated from the subject site would travel to/from the east;
- Approximately 30% of the traffic generated from the subject site would travel to/from the south.

Accordingly the anticipated total daily traffic for the internal subdivision and external road network (existing plus subdivision traffic) are illustrated in **Figure 3**. It should be noted that traffic volumes on McGregor Street, Cooke Point Drive and Athol Street represent the combined traffic impact from both "Telstra Site" and "Tindale Street Site" developments.

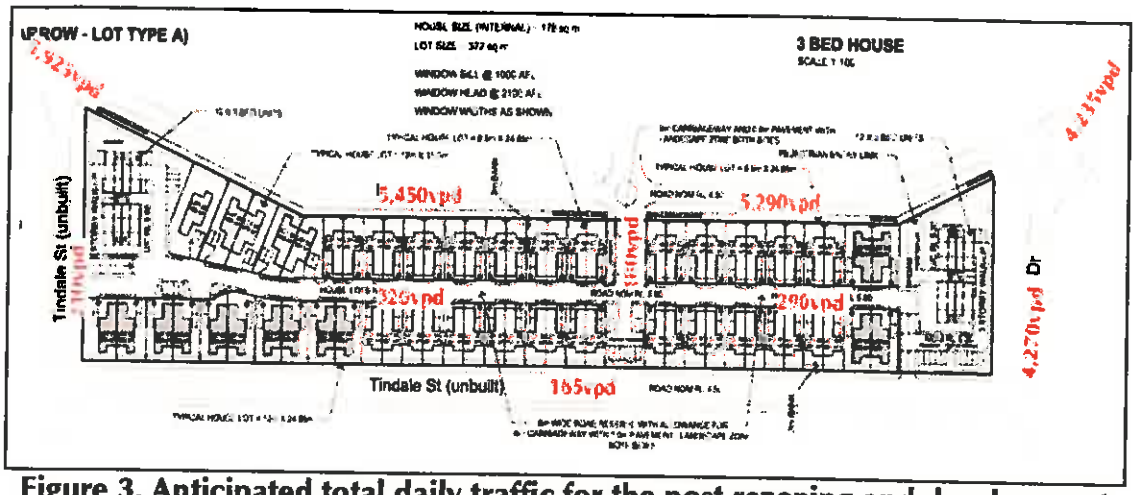


Figure 3. Anticipated total daily traffic for the post rezoning and development scenario

The analysis undertaken in this report demonstrates that the anticipated traffic from the proposed rezoning of the subject site would impact the immediate road network at this locality as following:

- The estimated ultimate daily traffic volume on McGregor Street will not exceed the desirable threshold for *Local Distributor* class of road;
- The projected traffic volumes on McGregor Street in the vicinity of the subject site do not warrant re-classification and upgrade of this road to *District Distributor* standard in the post-development stage (target traffic volume range for District Distributor is 6,000vpd to 8,000vpd). However, as other developments occur in the area and traffic volumes increase further, it is suggested that McGregor Street reclassification and upgrade be considered in the future;
- The traffic volumes on Tindale Street, Cooke Point Drive and Athol Street will reach 210vpd, 4,270vpd and 4,235vpd, respectively. These levels of traffic are well within the desirable thresholds for *Access Road* and *Local Distributor* road classes. Additional spare capacity for future growth would remain available for all three roads even in the post-development stage.

4.2 *Intersection Capacity Analysis*

At-grade, unsignalised intersections rely on gap selection for the entry of minor road traffic into or across the major road and for right-turn movements from the major road. As such, high conflicting movements directly impact on the overall performance of the intersection, resulting in increased delays, queuing and risk of crashes. It is therefore important to assess the capacity of relevant intersections to ensure the anticipated traffic volumes can be accommodated.

Reference to Table 2.4 from AUSTROADS *"Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings"* document illustrates the traffic volume thresholds above which a detailed intersection capacity assessment is required to

confirm that adequate capacity is in fact available (refer **Table 1**). However, it is considered that sufficient capacity is available if the anticipated traffic volumes through intersections are below the indicative thresholds in which case a detailed capacity assessment is not required.

Major Road type	Major Road Flow (vph[1])	Minor Road Flow (vph)
Two-lane	400	250
	500	200
	650	100
Four-lane	1,000	100
	1,500	50
	2,000	25

Table 1. Traffic volume threshold for detailed intersection analysis

Assuming that typical peak hour traffic represents approximately 10% of the total daily traffic volume, it is confirmed that uninterrupted traffic flow conditions can be expected at all key internal subdivision intersections and that detailed assessment or capacity analysis is not warranted (refer **Figure 3** for internal subdivision roads daily traffic projections). It is further confirmed that the internal subdivision road network layout ensures efficient traffic distribution throughout the development with no bottlenecks or traffic congestion.

Similarly, it is established that uninterrupted traffic flow conditions can be expected at both external subdivision intersections on Clark Street and McGregor Street. Furthermore, the proposed 4-way roundabout at McGregor Street/Subdivision Access Road is anticipated to operate satisfactorily and provide speed management along the McGregor Street and subdivision entry road.

4.3 Internal Subdivision Road Network

Due to the site constraints and in order to improve resident amenity the internal east-west subdivision road is proposed to be a 9m wide road reserve. As such, this road reserve does not formally conform to the WAPC *"Liveable Neighbourhoods"* standard for *Access Streets*; however, the proposed carriageway width of 6m is in line with the recommended carriageway width of an *Access Street D*. Accordingly, the proposed east-west road has the capacity to carry up to 1,000vpd, as recommended by the WAPC *"Liveable Neighbourhoods"* guidelines.

The forecast traffic volumes on the internal east-west road are significantly lower than the recommended 1,000vpd threshold for *Access Street D* (refer **Figure 3** for the anticipated traffic volumes within the subdivision). Therefore, as long as the verge width is sufficient to accommodate suitable pedestrian facilities and necessary services (drainage, sewage, water and gas mains, power and telephone lines) can also be accommodated, the proposed road reserve should be

[1] *vph – vehicles per hour, typically represent 10% of total daily traffic volume*

considered sufficient. Nonetheless, it is recommended that the project engineers liaise with service authorities and the ToPH officers during the detail design stages to develop a suitable cross-section to the satisfaction of the ToPH and ensure services can be accommodated.

The access road from McGregor Street (southern leg of the proposed McGregor Street 4-way roundabout) is proposed to be a 17.8m road reserve, with a 7.2m wide carriageway. The proposed road reserve conforms to the recommended typical road reserve for the Access Street B (WAPC *"Liveable Neighbourhoods"* guidelines) and as such is able to carry up to 3,000vpd. As the anticipated traffic volume for this road does not exceed 200vpd the proposed road reserve is considered sufficient for this purpose.

Visitor on-street parking for the subject subdivision is provided within the site through four designated parking areas conveniently distributed over the site.

4.4 Pedestrian Network

The pedestrian connectivity of the proposed subdivision is achieved through integration with existing external footpath system at this location. Accordingly, external connections to existing pedestrian facilities on McGregor Street are proposed. As part of the proposed pedestrian/cyclist system for the subdivision, it is proposed that the existing footpath on the northern verge of McGregor Street be upgraded to shared path standard and coupled with a new pedestrian footpath within the southern verge of McGregor Street (development frontage).

5. CONCLUSIONS

This Traffic Report has been prepared by Transcore on behalf of Watson Properties with respect to the proposed rezoning application and Masterplan for the Tindale Street Site in Spinifex Hill, Town of Port Hedland.

The proponent intends to develop the subject site into an 89-dwelling residential subdivision comprising a mix of townhouses and apartments.

Accordingly, the proposed residential subdivision is estimated to generate approximately **535** total **daily** vehicular trips (inbound and outbound combined) for a typical weekday.

The traffic assessment for the post-development stage of the development indicates that anticipated traffic volumes on the abutting roads are within the desirable thresholds for the relevant road classifications.

The proposed 4-way roundabout at McGregor Street/Subdivision Access Road is anticipated to operate satisfactory and provide speed management along the McGregor Street and at subdivision entry.

However, the following traffic management measure/road network upgrades are recommended to improve the traffic operation and safety at this location during the post-development stage:

- Upgrade the existing footpath along northern verge of McGregor Street to a shared path standard;
- Construction of a footpath along the southern verge of McGregor Street;
- Ensure subdivision design includes corner truncations at McGregor Street/Tindale Street intersection to provide for future upgrade of this intersection to a roundabout standard with the future Tindale Street as the southern intersection leg;
- Ensure that sufficient parking supply within the development is provided to satisfy anticipated demand so that all parking is catered for within the development and with no negative impact on the operations of the external road network;
- Sometime in the future and as a result of other major developments in the area, consideration should be given to re-classify McGregor Street to *District Distributor* standard with implementation of the necessary upgrades to accommodate the anticipated future traffic volumes.

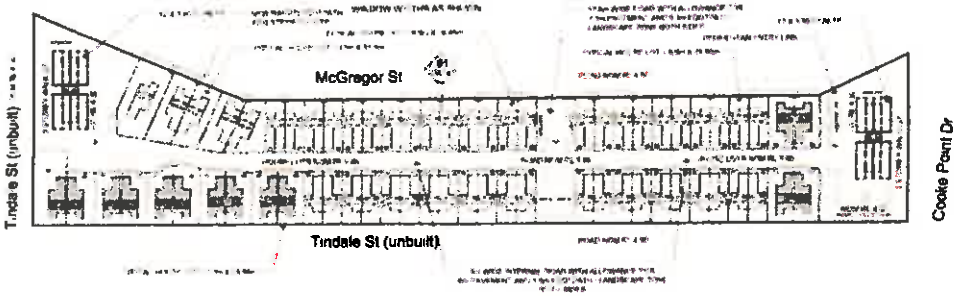
APPENDIX A

Concept Plan

4 BED HOUSE (NARROW - LOT TYPE A)

3 BED HOUSE

PARKING SCHEDULE



SCHEME YIELD :

3 BED HOUSES	= 46 = 52% APPROX
4 BED HOUSES	= 19 = 21% APPROX
3 BED 3-STOREY WALK-UP UNITS	= 24 = 27% APPROX

TOTAL DWELLINGS = 89

LEGEND

- 3 BED HOUSE
- 4 BED HOUSE - LOT TYPE A
- 4 BED HOUSE - LOT TYPE B

PORT HEDLAND MASTERPLAN

LOT 4 CLARK STREET
PLANNING APPLICATION SCHEME

blaxland

1211	SK146	04

A1

Appendix 5 – Traffic Technical Note 1

transcore pty ltd

Technical Note: No 1 **Date:** 28/07/2011
Project No: t11.098
Project: Telstra Site & Tindale Street Developments, Port Hedland

Subject: Port Hedland/Cooke Point Drive Intersection Assessment

INTRODUCTON

Transcore has been commissioned by Blaxland Pty Ltd to prepare Traffic Reports for the proposed Telstra Site and Tindale Street residential subdivisions as part of the rezoning application for the subject sites. Accordingly, Transcore prepared traffic reports for previous development options for these sites in November 2010. In their response to the rezoning application (letter from 05 May 2011, Ref: 06/3513-04) Main Roads WA requested that, as part of the traffic assessment for the proposed developments, a detailed capacity assessment of the Port Hedland/Cooke Point Drive intersection in Port Hedland be undertaken to assess the impact from the proposed developments on this intersection.

Hence the purpose of this technical note is to estimate the combined traffic impact from the residential developments resulting from the proposed rezoning on Port Hedland/Cooke Point Drive intersection and assess the capacity of this intersection to accommodate the additional traffic. Refer **Figure 1** for locality plan.

Figure 1. Aerial photo of the locality

transcore pty ltd

EXISTING SITUATION

The Port Hedland Road/Cooke Point Drive intersection is located approximately 5km southeast of the Port Hedland town centre (refer **Figure 1**).

Port Hedland Road is an important link in the local road network connecting Port Hedland and South Hedland town sites. It is also a major heavy haulage route providing access to Port Hedland port. This road is currently is a single carriageway with a pavement width of approximately 8m. There are wide gravel shoulders on both sides of this road. According to Main Roads WA *Functional Road Hierarchy* it is classified as a *Primary Distributor*. At this location, Port Hedland Road operates under 110km/h speed limit.

Cooke Point Drive provides a link between Port Hedland Road and residential areas at the east end of Port Hedland town site. This road is a single carriageway with a pavement width of approximately 7m. This road also entails wide gravel shoulders on both sides. According to Main Roads WA *Functional Road Hierarchy* it is classified as a *Local Distributor*. At this location, Cooke Point Drive operates under 80km/h speed limit.

The latest available traffic count data sourced from Main Roads WA and Town of Port Hedland for Port Hedland Road and Cooke Point Drive in the vicinity of the subject intersection is shown in **Table 1**.

Road Section	Date	AWT[1]	HV%	Source
Port Hedland Rd (E of Cooke Point Dr)	24/9/2007	12,921	13.6	MRWA
Port Hedland Rd (W of Cooke Point Dr)	24/9/2009	10,615	11.4	MRWA
Cooke Point Dr (N of Port Hedland Rd)	9/3/2011	4,002	6.3	ToPH

Table 1. Traffic count data for relevant roads

Port Hedland Road and Cooke Point Drive form a priority-controlled, partially channelised T-intersection with Cooke Point Drive terminating at its southern approach to the intersection. This intersection is designed as a Channelised Right Turn (CHR) Type rural intersection with a 150m right-turn pocket on Port Hedland Road (westbound direction). Cooke Point Drive flares on its approach to the intersection.

Due to the relatively flat terrain at this locality available sightlines on all approaches to the intersection are satisfactory with no impediments.

[1] AWT – Average Weekday Traffic (vehicles)

INTERSECTION ANALYSIS

In order to assess existing and future traffic conditions of Port Hedland Road/Cooke Point Drive intersection, existing morning and afternoon peak hour traffic volumes were derived from the relevant traffic count data sourced from Main Roads WA and Town of Port Hedland.

As available traffic count data reports only combined total daily traffic flows (no directional split), *Furness method* was applied to derive peak hour turn volumes from daily volumes. Additionally, further adjustments were made to reflect the typical peak directional traffic split. It should be noted that, morning and afternoon peak hours for the two roads do not coincide; however, in order to allow for a robust assessment it is assumed that peak periods for both roads fall within the same hour.

Furthermore, as traffic count data for Port Hedland Road dates back to 2007 and 2009, a default growth factor of 2% per annum was applied to estimate 2011 traffic volumes for this road. Accordingly, the estimated morning and afternoon peak hour volumes at the Port Hedland Rd/Cooke Point Dr intersection are shown in **Figure 2.**

The anticipated combined traffic impact of the proposed residential developments at Telstra Site and Tindale Street on the Port Hedland Road/Cooke Point Drive intersection is estimated to be in order of approximately 720 vehicles per day. Assuming a typical 10% factor for peak hour traffic, it is estimated that the proposed residential developments would generate approximately 72 vehicle trips through this intersection in the morning and afternoon peak hour periods respectively. **Figure 3** illustrates projected traffic volumes for the post-development period with inclusion of the additional traffic from the Telstra Site and Tindale Street developments.

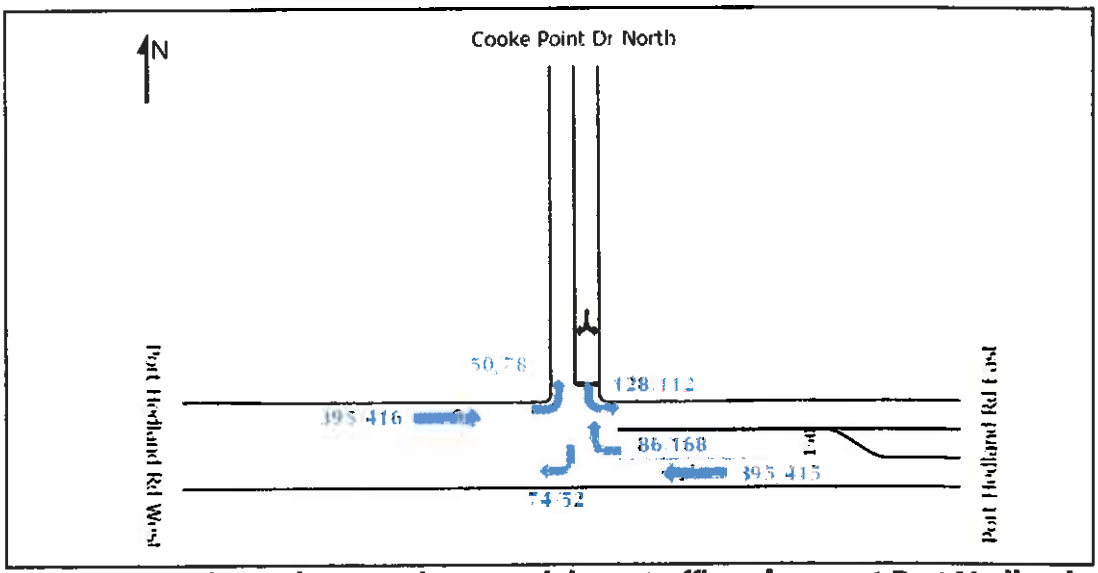


Figure 2. Estimated AM and PM peak hour traffic volumes at Port Hedland Road/Cooke Point Drive intersection - existing

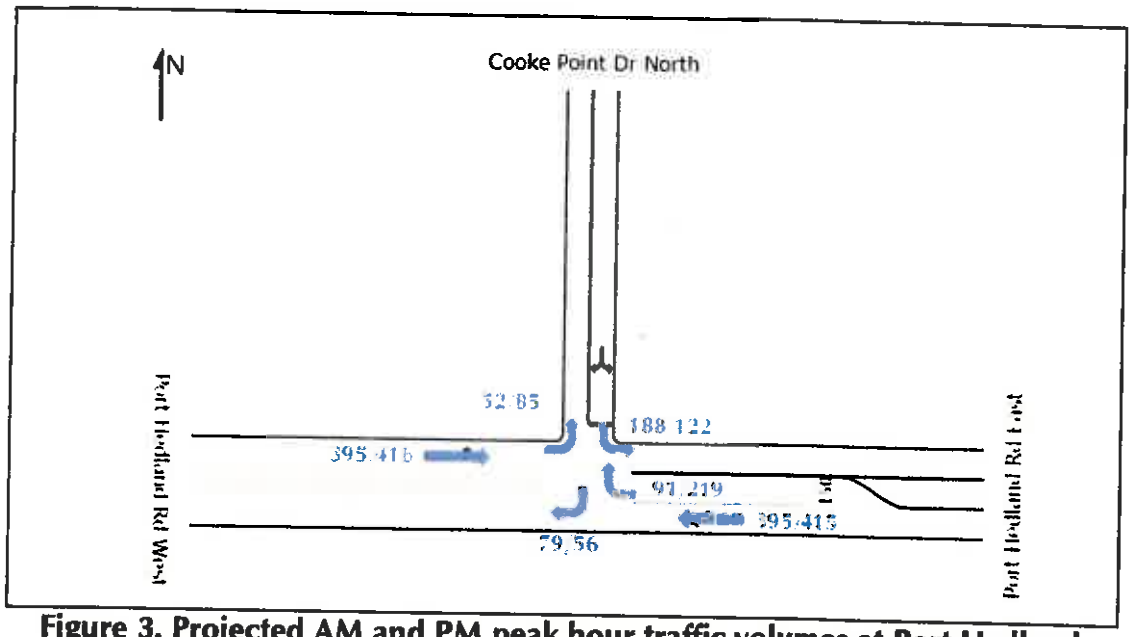


Figure 3. Projected AM and PM peak hour traffic volumes at Port Hedland Road/Cooke Point Drive intersection – post development

The capacity analysis of the Port Hedland Road/Cooke Point Drive intersection, during the peak weekday morning and afternoon peak period, was undertaken using the SIDRA intersection-modelling software. Heavy vehicle factor used in SIDRA analysis was derived from the Main Roads and ToPH traffic count data.

SIDRA is an intersection-modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.
- **Level of Service**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection.
- **95% Queue**: is the queue length below which 95% of all observed queue lengths fall.

The existing and post-development SIDRA results for the Port Hedland Road/Cooke Point Drive intersection are shown in **Tables 3** to **6**.

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: Port Hedland Rd East											
11	T	416	6.3	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	91	6.3	0.085	15.4	LOS C	0.4	2.7	0.51	0.79	63.9
Approach		506	6.3	0.222	2.7	NA	0.4	2.7	0.09	0.14	99.5
North: Cooke Point Dr North											
1	L	135	6.3	0.303	16.2	LOS C	1.3	9.8	0.59	0.86	60.1
3	R	78	6.3	0.303	16.0	LOS C	1.3	9.8	0.59	0.92	60.6
Approach		213	6.3	0.303	16.1	LOS C	1.3	9.8	0.59	0.89	60.3
West: Port Hedland Rd West											
4	L	53	6.3	0.259	13.5	LOS B	0.0	0.0	0.00	2.04	67.2
5	T	416	12.0	0.259	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		468	11.4	0.259	1.5	NA	0.0	0.0	0.00	0.23	104.0
All Vehicles		1187	8.3	0.303	4.7	NA	1.3	9.8	0.14	0.31	90.4

Table 3. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – AM peak existing

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: Port Hedland Rd East											
11	T	437	6.3	0.233	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	177	6.3	0.179	15.0	LOS C	0.8	5.7	0.56	0.84	63.0
Approach		614	6.3	0.233	4.8	NA	0.8	5.7	0.16	0.24	93.2
North: Cooke Point Dr North											
1	L	118	6.3	0.267	16.5	LOS C	1.1	8.0	0.60	0.87	59.8
3	R	55	6.3	0.267	16.3	LOS C	1.1	8.0	0.60	0.92	60.3
Approach		173	6.3	0.267	16.4	LOS C	1.1	8.0	0.60	0.88	59.9
West: Port Hedland Rd West											
4	L	52	6.3	0.288	13.5	LOS B	0.0	0.0	0.00	1.83	67.2
5	T	433	12.0	0.288	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		520	11.1	0.288	2.1	NA	0.0	0.0	0.00	0.29	101.6
All Vehicles		1306	8.2	0.288	5.2	NA	1.1	8.0	0.16	0.36	89.4

Table 4. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – PM peak existing

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: Port Hedland Rd East											
11	T	416	6.3	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	96	6.3	0.091	15.4	LOS C	0.4	2.8	0.51	0.79	63.8
Approach		512	6.3	0.222	2.9	NA	0.4	2.8	0.10	0.15	99.0
North: Cooke Point Dr North											
1	L	198	6.3	0.379	16.4	LOS C	1.9	14.2	0.60	0.91	59.9
3	R	83	6.3	0.379	16.2	LOS C	1.9	14.2	0.60	0.95	60.3
Approach		281	6.3	0.379	16.4	LOS C	1.9	14.2	0.60	0.92	60.0
West: Port Hedland Rd West											
4	L	55	6.3	0.261	13.5	LOS B	0.0	0.0	0.00	2.02	67.2
5	T	416	12.0	0.261	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		471	11.3	0.261	1.6	NA	0.0	0.0	0.00	0.23	103.8
All Vehicles		1263	8.2	0.379	5.4	NA	1.9	14.2	0.17	0.35	87.6

Table 5. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – AM peak post-development

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 Port Hedland Rd East											
11	T	437	6.3	0.233	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	231	6.3	0.235	16.1	LOS C	1.1	7.9	0.58	0.96	62.7
Approach		667	6.3	0.235	5.6	NA	1.1	7.9	0.20	0.36	90.0
North Cooke Point Dr North											
1	L	126	6.3	0.302	17.1	LOS C	1.3	9.5	0.61	0.89	59.0
3	R	59	6.3	0.302	16.9	LOS C	1.3	9.5	0.61	0.93	59.5
Approach		187	6.3	0.302	17.1	LOS C	1.3	9.5	0.61	0.91	59.2
West Port Hedland Rd West											
4	L	69	6.3	0.282	13.5	LOS B	0.9	6.6	0.00	1.78	67.2
5	T	438	12.0	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		507	11.0	0.282	2.3	NA	0.0	0.0	0.00	0.30	101.0
All Vehicles		1362	8.1	0.302	5.9	NA	1.3	9.5	0.19	0.38	87.3

Table 6. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – PM peak post-development

The results of the intersection capacity analysis indicate that Port Hedland Road/Cooke Point Drive intersection presently operate with a good overall Level of Service C (LoS C) during both morning and afternoon peak hour periods. Moderate queuing and delays are reported only for the right-turn movements from Cooke Point Drive.

With the addition of the development-generated traffic this intersection maintains the existing overall LoS C with expected increases in delays and queues for the relevant movements. The increase in delays and queues are expected and are moderate during both peak hours. Importantly, the spare capacity available for this intersection in the post-development stage remains above 62% suggesting that other future developments in this area and further general growth in traffic can be accommodated.

It is therefore concluded that the traffic from the proposed Telstra Site and Tindale Street developments will not have any adverse impacts on the future operation of Port Hedland Road/Cooke Point Drive intersection.

Appendix 6 – Geotechnical Report

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on Preliminary Geotechnical and Environmental Investigation

Proposed Residential Development
Lot 4 Tindale and McGregor Streets
Port Hedland, WA

Prepared for
Blaxland Property Pty Ltd

Project 76177
August 2011

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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

	Signature	Date
Author	James Lawrence	9 August 2011
Reviewer	pp. F. L_g A	9 August 2011

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Table of Contents

Report on Preliminary Geotechnical & Environmental Investigation
Proposed Residential Development
Lot 4 Tindale and McGregor Street, Port Hedland, WA

1. Introduction

This report presents the results of a preliminary geotechnical and environmental investigation undertaken for a proposed residential development at Lot 4 Tindale Street, Port Hedland, commonly referred to as the "Tindale Site". The investigation was commissioned in an email dated 31 March 2011 by Mr John Beck of Blaxland Property Pty Ltd and was undertaken in accordance with Douglas Partners' proposal dated 25 February 2011.

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

- provide a description of the sub-soil conditions;
- 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, including requirements to improve the site classification;
- assess the depth to competent layer and to bedrock, if encountered;
- provide the appropriate earthquake design factor for the site, in accordance with AS 1170.4;
- provide recommendations on site preparation, compaction and earthworks so as to allow the proposed development;
- suggest suitable foundation systems to support the proposed development;
- determine allowable bearing pressures and likely in-service settlements for the suggested foundation systems;
- provide parameters for pavement design, including California bearing ratio of likely subgrade;
- provide design parameters for retaining walls;
- assess the groundwater level beneath the site at the time of the field work, if encountered, and comment on likely seasonal fluctuations;
- assess the potential for on-site stormwater disposal based on field observations and laboratory testing;
- assess the risk of acid sulphate soils beneath the site based upon readily available desktop information and limited sampling and analysis; and
- undertake limited soil sampling for assessment of a broad range of commonly found contaminants.

The investigation included the excavation of six test pits, the performance of four cone penetration tests and laboratory testing of selected samples. Details of the fieldwork are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site is known as Lot 4 Tindale and McGregor Street and is commonly referred to as the "Tindale Site". The site is roughly rectangular, covers an area of approximately 2.62 ha and measures about 370 m in an east west direction (along McGregor Street) and 70 m in a north south direction. It is bound by McGregor Street to the north, by Cooke Point Road to the east, by a track known as Tindale Street to the south and by undeveloped land to the west. The Water Corporation maintains several effluent ponds on the southern side of Tindale Street.

At the time of investigation, the western half of the site consisted of an area of apparently natural ground with numerous soil stockpiles. The eastern half of the site had been raised through the placement of filling to a level approximately 1.2 m above the natural level. Five stockpiles of soil, approximately 2.5 m in height, occupied the middle of the eastern half of the site.

The surface levels of the natural surface on the western half of the site varies between RL 3.1 m and RL 3.6 m AHD with the stockpiles reaching RL 4.4 m to 5.0 m AHD. The surface levels on the eastern side of the site vary between RL 4.4 m and 5.0 m AHD with this level sloping down to the natural material on the eastern, southern and western edges of the filling.

The Port Hedland 1:50 000 Environmental Geology Sheet indicates that the site is generally underlain by dune shelly sand, possibly overlying mud and silt which can be soft in consistency.

Published acid sulphate soil risk mapping indicates that the site is located within areas of "moderate to low risk of acid sulphate soils occurring within 3 m of natural soil surface."

3. Fieldwork Methods

Fieldwork was carried out on 14 April 2011 and included the performance of four cone penetrometer tests and the excavation of six test pits. Dynamic penetrometer tests (DCP) or Perth Sand Penetrometer (PSP) tests were performed beside each test pit to assess the density and strength of the near surface soils.

The CPTs (CPT7 to CPT10) were carried out by using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 20 mm/sec into the soil by hydraulic thrust from a ballasted truck mounted rig. Strain gauges in the cone and sleeve measure resistance to penetration and this data allows the assessment of the type and condition of the materials penetrated. Upon withdrawing the CPT probe, each location was dipped in an attempt to measure the depth to groundwater.

The test pits (TP1 to TP6) were excavated to a maximum depth of 3.2 m, using a 5 tonne Komatsu excavator equipped with a 400 mm wide toothed bucket, and were logged in general accordance with test procedure AS 1726–1993 by a suitably experienced representative from Douglas Partners. Representative soil samples were recovered from selected locations for subsequent geotechnical laboratory testing.

Soil samples for assessment of acid sulphate soils were collected at test locations TP1, TP3, TP4 and TP6 at 0.5 m intervals to depths of approximately 3.0 m. Samples were placed immediately into labelled snap lock bags, hand pressed to exclude air and stored on ice in a chilled, insulated esky for subsequent freezing at DP's office.

Soil samples for the assessment of potential contaminants were collected from test locations TP1, TP3, TP5 and TP6 at depths of between 0.2 m and 0.5 m. Samples were placed immediately into laboratory prepared, labelled glass jars and stored on ice in a chilled insulated esky for transport to the laboratory.

The following sample handling and transport procedures were employed:

- laboratory prepared sample jars were labelled with individual and unique identification, including project number and sample number;
- samples were placed in insulated coolers until transported to the analytical laboratory;
- chain-of-custody documentation was maintained at all times and countersigned by the receiving laboratory on transfer of samples; and
- A NATA accredited laboratory was engaged to conduct the analysis.

DCP and PSP tests were carried in accordance with AS 1289.6.3.2 and AS 1289.6.3.3 to assess the relative density of the shallow soils.

Test locations were determined using existing site features and are shown on Drawing 1 in Appendix B. Surface elevations at each test location were interpolated from a survey plan provided by Survey North and are quoted in metres above Australian Height Datum (AHD).

4. Fieldwork Results

4.1 Ground Conditions

Detailed logs of the ground conditions and cone penetration testing are presented in Appendix C. A summary of the ground conditions encountered is given below:

Sand – yellow-brown to orange, fine to medium grained, sand with a trace of clay at TP1 and TP3 to depths of 0.05 m and 0.25 m respectively. A layer of light brown sand was also noted in TP5 between depths of 1.2 m and 1.7 m

Filling (Sand) – medium dense to dense, red-brown to yellow-brown sand and sand at TP4 to TP6 to depths of between 0.8 m and 1.6 m.

Sandy Clay / Clayey Sand – loose to medium dense / stiff to very stiff, fine to medium grained, medium plasticity, sandy clay / clayey sand was observed in all of the test pits. It was observed in TP1-TP3 between the surface and 1.7 m. In TP4 to TP6 it was observed below the filling between the depths of 0.8 m and 2.0 m although the bottom of this layer was not confirmed in TP5.

Silty Clay – brown to grey, high plasticity, silty clay was observed in all test pits except TP5. It was observed from a depth of 0.6 m and the bottom of the layer was not observed in any of the test pits. The CPT results indicate that this layer terminates at a depth of between 4.3 m and 5.8 m.

Table 1 shows a summary of the interfaces of the various strata encountered in the CPTs and test pits.

Table 1: Summary of Cone Penetration Test and Test Pit Results

Strata Description		Depth of Interface (m) & Reduced Level (m AHD)									
	Bore	CPT7	CPT8	CPT9	CPT10	TP1	TP2	TP3	TP4	TP5	TP6
	Surface Level	3.2	3.3	4.6	4.4	3.2	3.4	3.4	4.6	4.7	4.3
SANDY CLAY		st - v st	st - v st	SAND md	l	st	st - v st	st	SAND md	SAND md	SAND md
Depth		1.2	1.3	1.3	0.8	1.5	2.2	1.7	1.6	1.7	1.2
RL		2.0	2.0	3.3	3.6	1.7	1.2	1.7	3.0	3.0	3.1
CLAY & SILTY CLAY		s	f then s	s - st	st - h	s -f	f	s - f	v st	v st	st - v st
Depth		4.3	4.5	4.4	2.2	3.2	3.0	3.0	3.1	3.0	3.0
RL		-1.1	-1.2	0.2	2.2	0.0	0.4	0.4	1.5	1.7	1.3
SAND/ CLAYEY SAND		d - vd	l	l	md						
Depth		4.4	5.2	5.8	5.1						
RL		-1.2	-1.9	-1.2	-0.7						
ORGANIC CLAY					s						
Depth					5.4						
RL					-1.0						
SAND					l - md						
Depth					5.9						
RL					-1.5						

NE = Not Encountered

vl = very loose
l = loose
md = medium dense
d = dense
vd = very dense

s = soft
f = firm
st = stiff
v st = very stiff
h = hard

The results show that the lithology is variable and that the engineering parameters of the various strata is also variable. Whilst the above summaries are intended to give a general picture of the geotechnical conditions beneath the site, the conditions vary sufficiently to mean that the results of the individual tests must be inspected to enable an overall view of the soil conditions beneath the site.

The ground conditions indicate a surficial layer of stiff to very stiff clay or medium dense sand, overlying alluvial deposits which are mostly soft or loose to the full depth of testing. The better engineering properties of the near surface soil are possible due to desiccation of the natural clays or compaction of the sand filling. Given the proximity of the site to large effluent ponds along the southern side of Tindale Street, it is possible that seepage from the ponds is impacting on the moisture content of the soils beneath the subject site.

The soil conditions on the western half of the site comprise stiff to very stiff clay to 1.2 m to 2.2 m over soft to firm clay to about 4.5 m then loose to dense sand to 4.4 m to 5.2 m (RL -1.2 m to -1.9 m). On the eastern half of the site the soil profile consists of 0.8 m to 1.7 m of sand which is mostly medium dense overlying stiff to very stiff clay. It therefore appears that geotechnical conditions are more favourable to development on the eastern part of the site. Ground surface levels in the eastern area are also consistently higher than the western portion of the site, being about RL 4.5 m compared to RL 3 m to 3.5 m in the west.

4.2 Groundwater

Groundwater seepage was observed within all of the test pits and in CPT7 and CPT8 on 14 April 2011. The observed measurements were between RL 0.5 m AHD and 1.8 m AHD.

5. Geotechnical Laboratory Testing

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory. Testing included the determination of:

- the particle size distribution on five samples;
- the Atterberg limits and linear shrinkage on two samples;
- the shrink-swell index on two samples; and
- the California bearing ratio and maximum modified dry density on two samples.

Results of the testing are summarised in Tables 2 and 3 and test certificates are presented in Appendix B.

Table 2: Results of Laboratory Testing for Soil Identification

Pit	Depth (m)	Soil Description	Fines (%)	D_{10} (mm)	D_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	I_{ss} (%)
TP1	0.5	Sandy Clay	66	-	0.03	-	-	-	-	-
TP1	1.3	Silty Clay	95	-	-	-	-	-	-	-
TP2	0.9	Silty Clay	-	-		-	-	-	-	3.6
TP2	1.2	Silty Clay	98	-	-	70	25	45	13	-
TP4	0.6	Slightly silty sand	14	0.02	0.38	-	-	-	-	-
TP5	1.8	Sandy Clay	-	-	-	46	17	29	9	-
TP6	1.1	Sand with some silt and clay	21	0.02	0.23	-	-	-	-	-

Pit	Depth (m)	Soil Description	Fines (%)	D_{10} (mm)	D_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	I_{ss} (%)
TP6	1.3	Sand with some silt and clay	-	-	-	-	-	-	-	2.3

Where:
- The % fines is the amount of particles smaller than 75 µm
- A d_{60} of 0.23 mm means that 60% of the sample particles are finer than 0.23 mm
- A d_{10} of 0.13 mm means that 10% of the sample particles are finer than 0.13 mm
- '-' means 'Not Tested'
- LL: liquid limit
- PL: plastic limit
- PI: plasticity index
- LS: linear shrinkage
- I_{ss} : shrink swell index

Table 3: Results of Laboratory Testing

Pit	Depth (m)	MMDD (t/m^3)	CBR (%)	OMC (%)	Material
TP2	0.3	1.77	2.0	13.1	Sandy clay
TP5	0.4	1.79	25	14.0	Sand

Notes:
-MMDD: modified maximum dry density;
-CBR: California bearing ratio;
-OMC: optimum moisture content.

6. Acid Sulphate Soil Laboratory Testing

Initial acid sulphate soil screening tests were undertaken by the ALS Laboratory Group (ALS) on selected soil samples in accordance with the method as described in Ahern CR, McElnea AE, Sullivan LA (2004), *Acid Sulphate Soils Laboratory Methods Guidelines*. The screening tests comprised the measurement of pH of the soil in water (pH_F) and the pH of the soil after oxidation with a 30% solution of hydrogen peroxide (pH_{FOX}).

Following the screening tests, selected soil samples were sent to ALS and, as required by the DEC, analysed for Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite of testing. Soil samples were submitted for laboratory analysis with due consideration of the following:

- Lowest reported pH_{FOX} within a soil strata at each test location.
- Reported reaction strength.
- Visual identification of the soils encountered.

The screening results and laboratory testing for the SPOCAS suite are presented in Table F-1 in Appendix F together with the detailed laboratory reports and associated chain-of-custody reports. The results are evaluated and discussed in Section 10.

7. Soil Quality Laboratory Testing

Soil samples for contamination testing were collected from the near surface (within 0.5 m depth) considered to be the most likely soil horizon that may be impacted by contamination resulting from past site activities. A total of four soil samples, collected from locations considered to give a broad representative coverage of the site were submitted to a NATA accredited laboratory for quantitative analysis for the following general suite of common contaminants:

- heavy metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- total petroleum hydrocarbons (TPH);
- polycyclic aromatic hydrocarbons (PAH);
- polychlorinated biphenyls (PCB);
- total phenols;
- organochlorine (OC) and organophosphorus (OP) pesticides; and
- asbestos (absence / presence).

The results of the testing are presented in Table F-2 in Appendix F, along with the laboratory reports and associated chain-of-custody reports. The results are evaluated and discussed in Section 11.

8. Proposed Development

It is understood that the proposed development comprises a mix of single unit dwellings, town houses and multistorey apartment buildings up to four storeys high, together with public open space and access roads. At this stage, no information has been provided on the likely extent of earthworks required for the proposed development or the level of individual building blocks. Consequently, comments provided below are of a generic nature only and will need to be reviewed during the concept design development to ensure that the type of buildings proposed and their location is consistent with the restraints imposed by the ground conditions. Essentially, the report provides an outline of the geotechnical restraints and options for developing the site. Further investigation will be needed to refine the geotechnical model before detailed design commences.

In providing the advice below, it is anticipated that the developer may wish to amend the masterplan to limit the extent of ground improvement works required before construction commences. For this reason, and the fact that further investigations will be required to enable detailed designs to be prepared for the individual building blocks, this report is preliminary in nature and will need to be updated as the overall concept for site development is refined.

In preparing this report it has been necessary to make a number of assumptions about the overall site development. These are:

- There will be minimal excavation on the higher (eastern) part of the site and the filling thickness on the eastern part of the site will be restricted to prevent significant settlement of the underlying soft clay;
- Foundation loads will be 10 kPa per floor to enable estimates of the building settlements;

- There are no restrictions on the type of foundations that can be utilised for the proposed development although this may need to be modified at a later date if local authority restraints dictate that certain pile types are unacceptable due to either noise or vibration;
- There are no restrictions imposed by the Water Corporation as a result of the adjoining effluent ponds and that these ponds are properly sealed to prevent the flow of groundwater onto the subject site.

9. Comments

9.1 Ground Conditions

The investigation indicates that the site can be essentially divided into two zones, namely:

- The western half where soil conditions basically comprise stiff to very stiff clay to depths of about 1 m to 2 m over soft to firm clay to about 4.5 m then loose to dense sand to 4 to 5 m where refusal occurred in the cone penetration test;
- The eastern part of the site where the soil conditions comprise about 1 m to 2 m of medium dense sand overlying stiff to very stiff clay.

The investigation indicates that the conditions on the western part of the site are much poorer than on the eastern area meaning that there will be a need to vary the design and site development to accommodate the poorer conditions in the west.

9.2 Geotechnical Restraints

The major geotechnical restraints imposed by the soil conditions are:

- Ground settlements as a result of consolidation of soft clay layers by loads imposed by additional filling to raise site levels and foundations;
- Groundwater depth. The site is relatively low lying adjacent to some effluent ponds and the investigation indicates that the groundwater seepage occurs at depths of 1 m to 2 m below existing surface level. The shallow groundwater may have resulted in softening of the near surface soils which will make excavation for underground services more difficult than normal;
- The shrink / swell potential of the clay materials on site. On the western portion of the site the near surface soils comprise stiff to very stiff clay and sandy clay overlying soft to firm clay. The near surface soils have a potential for shrinking and swelling which will need to be accommodated in foundation design. On the eastern side of the site, soil conditions comprise medium dense sand to depths of about 1 m to 2 m overlying stiff to very stiff clay. Whilst the potential for shrinking and swelling is lower on the eastern side of the site than on the western side, the type of foundations adopted will depend on the extent of site filling proposed for both areas and the type of material to be imported to the site.

The notional divide between the two areas is shown on Drawing 1 in Appendix B. Zone A (on the eastern side) consists of areas where the foundation conditions are relatively straight forward and will

impose little or no restraints on building development. Zone B is underlain by clay which appears to be desiccated near the surface and soft to firm from depths of about 1 – 2 m below existing surface level. The soft clay deposits could lead to settlement under building loads if shallow foundations are utilised or under the loads imposed by site filling if the levels are to be raised. These settlements will need to be taken into consideration in final design. Section 7.5 provides preliminary estimates of potential settlements in both zones based upon assumed building and filling loads and the variable conditions encountered in the cone penetration tests.

9.3 Site Suitability

The investigation indicates that the site is underlain by a variable soil profile as described in Section 7.1 above. The conditions in Zone B do impose some geotechnical constraints on the proposed development but the soil conditions are no worse than those routinely encountered in many large infrastructure projects and can be dealt with using standard construction techniques. Therefore, the site is suitable for the proposed development providing the variable soil conditions are taken into consideration, in particular, those in Zone B where there is relatively shallow groundwater and some soft to firm clays. The methods for handling these soil conditions are outlined in the subsequent subsections of the report.

9.4 Site Preparation

At this stage it is assumed that the site preparation will be limited to filling on the western part of the site to raise the levels to approximately those that exist in Zone A on the eastern part of the site. In addition, it is assumed that there will be no significant excavations apart from those required to level individual building areas for foundation construction. The site preparation for each of the two Zones will be essentially the same with the only difference being the probable importation of filling to raise the levels in Zone B. Site preparation should therefore comprise the following procedures:

- Remove all vegetation and topsoil to expose the natural soils. These materials could be reused in landscaping mounds or disposed off site;
- Proof roll the entire area to be occupied by buildings and pavements with a smooth drum roller of at least 10 tonne static weight. The proof rolling should be observed by an experienced geotechnical engineer and should continue until there is no further movement in the surface soils. Alternatively, any materials that cause significant deformation under rolling should be removed and replaced with granular filling;
- Compact the surface soils to at least 85% density index or 95% of the modified maximum dry density. Alternatively, testing of the compaction of sand could be undertaken using a Perth Sand Penetrometer with a minimum resistance of 8 blows per 150 mm recommended for inclusion in the project specification;
- Immediately cover pavement areas with a sub-base layer compacted to 96% modified density to prevent erosion of the near surface sandy soils by wind or stormwater runoff. It may also be prudent to seal exposed surfaces where buildings will eventually be constructed to also prevent disturbance of the near surface soils by erosion;

- Imported filling should preferably comprise granular material which is placed in layers not exceeding 300 mm thickness and compacted to the same density standards as indicated in point 3 above.

9.5 Settlement

As part of the site evaluation, analysis has been undertaken to determine the likely settlement under a number of different scenarios at two critical CPT locations in Zone B (CPT7 and CPT8) and at two locations in Zone A. CPT7 and 8 represent the poorest conditions encountered on site. The analysis was conducted for two scenarios as follows:

- Settlement under 2 m of filling with no applied building loads;
- Settlement under 2 m of filling with a 30 kPa building load which has been adopted for three levels of suspended floors for the multistorey buildings.

The results are presented in Appendix E and are summarised in Table 4 below.

Table 4: Settlement Estimates (mm)

CPT	2 m of Filling			2 m of Filling + 30 kPa Building		
	At 1 Year	20 Years	Difference	1 Year	20 Years	Difference
7	54	74	20	94	114	20
8	52	69	17	92	108	16
9	25	32	7	43	50	7
10	15	16	1	25	27	2

Zone A
The results of the settlement analysis for Zone A shows that settlement of about 15 mm to 25 mm are expected under 2 m of new filling (i.e. 40 kPa) but that these settlements would be completed in about 6 months with residual settlement of less than 10 mm. An additional 10 to 20 mm occurs with a 30 kPa building load but this also occurs rapidly (i.e. in about 6 months) so post construction settlement would be minimal. It is necessary to undertake further modelling to confirm these results, particularly taking into consideration the stiffness of any ground floor slabs but it appears feasible to utilise a raft slab to support 3 storey buildings.

Zone B
The results indicate that for the poorest conditions encountered on the western side of the site, settlements of 50 mm to 60 mm will occur under 2 m of filling during an assumed construction period of one year. Post construction settlements are expected to be of the order of 20 mm.

When a 30 kPa building load is applied coincidentally with the 2 m of filling the settlements increase substantially to about 90 mm after one year then increasing to approximately 115 mm at the end of a 20 year period. This analysis indicates that founding buildings on a shallow raft slab in the poorer western areas of site is probably not feasible because of the complex detailing needed to accommodate differential settlement between underground services and the building. It is, however, feasible to fill the site for a period of 12 months and then to carry out construction by supporting the

buildings on pile foundations as settlements of the order of 20 mm for the areas surrounding the buildings are probably acceptable.

It is possible to reduce the settlements by undertaking preloading of the soils in Zone B to reduce the post construction settlement or to preload the area with an additional surcharge to further reduce settlement. However, the impacts of preloading and surcharging will only be significant for the consolidation settlement which occurs during the time that excess moisture is expelled from the soil by the load imposed upon the clay materials. It will have little impact upon creep settlement which continues under constant load for many decades. Further advice can be provided on settlement when consideration is given to the impacts of the site soils on the masterplan layout. One method of avoiding excessive settlement due to building loads is to locate the larger buildings in Zone A so that the impacts of settlement are much less due to the more favourable soils conditions in the eastern part of the site.

9.6 Foundation Options

With the soils conditions encountered on this site it is considered that there are two options namely:

- Shallow foundations for single and two storey dwellings constructed in Zone A. It may be necessary to use piles for four storey structures depending on the results of further testing and analysis;
- Deep foundations for all buildings in Zone B.

9.6.1 Shallow Footings

Shallow foundations for the one and two storey structures in Zone A could comprise either shallow strip or pad footings or raft slabs. Strip or pad footings could be designed for allowable bearing pressure of 150 kPa whereas raft slabs which are traditionally designed using a modulus of subgrade reaction (K value) could be designed using a K value of 5 kPa/mm.

9.6.2 Pile Foundations

For the conditions encountered on this site, it is considered that either driven precast piles or continuous flight auger piles would be suitable. These should be taken to at least the depth of cone penetrometer refusal which occurs at approximately RL -2 m over most of the site. At this stage, the investigation has not confirmed the presence of bedrock at this level so further investigation is required to ascertain whether the cone penetration tests refused on gravel layers or on bedrock. Further testing would include test bores to either core the bedrock material or to prove the total depths of gravels if refusal has occurred within gravels, cobbles or boulders.

It is possible to design driven or bored piles in gravels but further testing is needed to ensure that the founding layer is of sufficient thickness to support the proposed design loads without unacceptable settlements. In some instances, in alluvial deposits, gravel layers occur over soft and compressible clays and silts which then undergo substantial settlements when subjected to loads from a large number of piles supporting multiple buildings. The design parameters and likely load capacities for individual piles can only be determined when the further investigation is completed. However, at this

stage, it appears possible that piles to about RL -2 m will be feasible to carry the load imposed by four storey buildings.

9.7 Pavement Design Parameters

The investigation indicates that the eastern part of the site is underlain principally by medium dense sandy soils to depths of approximately 0.8 m to 1.7 m. For these soils it is considered that a design CBR of 6% would be appropriate. On the western part of the site the near surface soils are sandy clay for which a design CBR of 3% is recommended.

9.8 Retaining Wall Design

At this stage there is no indication of the need for retaining walls but if they are required due to terracing of the site it is suggested that they be designed using a unit weight of retained material of 20 kN/m^3 and an active earth pressure coefficient of 0.35 for retained sand and clay.

9.9 Site Classification

The majority of the site is underlain by clay, even though there is a limited covering of sand at the eastern end. Testing indicates that the clays are of medium to high plasticity with a high potential for shrinking and swelling under fluctuating moisture conditions. Shrink / swell indices of 3.6% was measured for a sample of silty clay taken from a depth of 0.9 m in TP2 and 2.3% for a sample from TP6. Accordingly, it is suggested that for planning purposes the entire site be classified as Class M.

9.10 Earthquake Design

Australian Standard AS1170.4 Earthquake Actions in Australia indicates that a Hazard Factor (Z) of 0.12 should be adopted for Port Hedland. Additionally, the soil conditions encountered during the investigation are consistent with a Class C_e site classification.

9.11 Groundwater

Table 5 below shows the measured groundwater levels in the cone penetration tests and the test pits. Groundwater was observed at all ten locations where tests were performed. It is possible that the tests did not penetrate into the permanent groundwater but the site is at a relatively low elevation where groundwater flows would be expected. Consequently, it is expected that groundwater will pose a limitation on design.

Table 5: Groundwater Depths and Levels

Test No.	Surface Level (m)	Groundwater Depth (m)	Groundwater Level (m AHD)	Comments
CPT7	3.2	1.7	1.5	
CPT8	3.3	1.5	1.8	
CPT9	4.6	3.1	1.5	
CPT10	4.4	2.9	1.5	
TP01	3.2	2.1	1.5	Seepage
TP02	3.4	2.4	1.0	Seepage
TP03	3.4	2.9	0.5	Seepage
TP04	4.6	2.9	1.7	Seepage
TP05	4.7	3.0	1.7	Seepage
TP06	4.3	2.9	1.4	Seepage

It is noted that groundwater levels fluctuate with the seasons and often rise to near ground level in periods of heavy, prolonged rainfall. In order to record groundwater levels and possible seasonal fluctuations it is suggested that monitoring wells are installed during the detailed investigation that will be required.

9.12 Stormwater Disposal

The site is underlain by up to 1 m to 2 m of fine to medium grained sand on the eastern side only and clay on the remainder. It is therefore recommended that stormwater be disposed of into subsurface drains rather than into soakage trenches on the site.

10. Further Investigation

The investigations so far have been restricted to cone penetration tests at four locations and six test pits. Before final design commences, it will be necessary to undertake investigations for each large building and testing to determine the hydrogeological characteristics of the site. The extent of testing will depend somewhat upon the final scope of the development and would realistically be done in stages as each building is being designed. However, it would be prudent to undertake the hydrogeological investigation before any development commences so that background monitoring of groundwater levels is possible over a significant period of time to determine the likely seasonal fluctuations in groundwater and the impact that these may have on buildings and inground facilities.

In addition to the hydrogeological investigation, it would be necessary to undertake drilling to determine bedrock levels or alternatively, founding levels for pile foundations if refusal has in fact occurred on gravel layers immediately beneath the clay. At the same time, undisturbed samples need to be taken so that they can be tested to determine the deformation properties of the soft clay soils.

11. Acid Sulphate Soil Assessment

11.1 Adopted Assessment Criteria

The screening test results were assessed for the possible presence of actual acid sulphate soil (AASS) or potential acid sulphate soil (PASS) on the basis of the following guidance indicators specified in the Department of Environment (2009), ASS Guideline namely:

- $pH_F \leq 4$ strongly indicates oxidation has occurred in the past and that AASS are likely to be present.
- $pH_{FOX} < 3$, plus a pH_{FOX} reading at least one pH unit below the corresponding pH_F, plus a strong reaction with peroxide, strongly indicates the presence of PASS.

The Department of Environment Acid Sulphate Soil Guideline Series *Identification and Investigation of Acid Sulphate Soils, Perth, Western Australia*, May 2009 specifies texture-based action criteria to initiate management of acid sulphate soils. These are summarised in Table 6.

Table 6: Texture-Based Action Criteria

Type of Material		Net Acidity Action Criteria	
		< 1,000 tonnes of material is disturbed	> 1,000 tonnes of material is disturbed
Texture range McDonald et al (1990)	Approx. Clay content (%)	Equivalent sulphur (%S)	Equivalent sulphur (%S)
Coarse texture sands to loamy sands	< 5	0.03	0.03
Medium texture sandy loams to light clays	5 – 40	0.06	0.03
Fine texture medium to heavy clays and silty clays	> 40	0.1	0.03

Notes: Table adopted from DEC's Identification and Investigation of Acid Sulphate Soils, Perth, Western Australia.

If the net acidity, calculated from the results of the titratable actual acidity (TAA) and the peroxide oxidisable sulphur (S_{POS}) is greater than the action criterion, it is considered that acid sulphate soils are present and excavations/dewatering within this material would require specific management. Net acidity using the SPOCAS suite of analysis is calculated as follows:

Net Acidity ($\%_{sulphur}$) = S_{POS} + TAA + S_{RT} – ANCe/FF
where:

- TAA - titratable actual acidity.
- S_{POS} – peroxide oxidisable sulphur.
- S_{RT} - retained acidity (reported for $pH_{kCl} < 4.5$).
- ANC_E – excess acid neutralising capacity (reported for $pH_{kCl} > 6.5$).
- FF – fineness factor (assumed by the laboratory to be 1.5).

For the purposes of assessing the laboratory results and in the absence of detailed information on proposed excavations, it is assumed that more than 1,000 tonnes of material would be disturbed during site development. Therefore, an action criterion of 0.03% has been adopted for the assessment.

11.2 Assessment of Analytical Results

Screening Test Results
The screening test results presented in Table F-1, Appendix F indicate the following:

- The results for pH_F are not strongly indicative of actual acid sulphate soils conditions.
- The results for pH_{FOX} are not strongly indicative of potential acid sulphate soil conditions.

It should be noted that the screening tests undertaken by ALS are indicative only and inferences made from these results should be confirmed by laboratory testing. This is particularly true in relation to the strong effervescence experienced with many samples which may be as a result of carbonate material in the sample.

Laboratory Results
The results of laboratory testing on selected soil samples are summarised in Table F-1, Appendix F. The results indicate that the calculated net acidity using S_{POS} (excluding ANC) are above the adopted action criterion of 0.03% S for two of the four samples submitted for analysis. The exceedances were reported at test locations TP1 and TP3 at a depth of 0.5 m and 2.95 m respectively to a maximum net acidity of 0.09% S.

Laboratory analysis using the SPOCAS suite can overestimate the net acidity in particular ground conditions, i.e. when organic materials are present. Therefore, in order to assess the sensitivity of the SPOCAS testing, chromium reducible sulphur testing was also requested on all samples which exceeded the criterion using SPOCAS suite. The net acidities using the chromium reducible sulphur are <0.02% S and 0.059% S at test locations TP1 and TP3 respectively. With due consideration of the texture based criteria summarised in Table 6, provided excavation of the silty clay is less than 1,000 tonnes, a higher action criterion of 0.1% S would be adopted. Based upon an action criterion of 0.1% S, the net acidity of 0.09 % S reported at TP3 is below the action criterion. Therefore, for excavation within the silty clay of less than 1,000 tonnes, management of acid sulphate soil would not be required.

It should also be noted that the results report a significant amount of neutralising capacity, ranging from 0.95% S to 4.77% S. This is well above the corresponding net acidities of between 0.04% S and 0.09% S. The results for pH_{FOX} and pH_{OX} also indicate that, following chemical oxidation, pH does not decrease below 6.0.

11.3 Acid Sulphate Soil Conclusions

Based upon the results of laboratory testing, DP concludes that acid sulphate soils above the adopted action criterion were reported at a depth 2.95 m within material described as dark brown silty clay.

Under DEC guidelines, an exceedance of the action criterion would trigger a requirement to manage acid sulphate soils under an appropriate management plan.

However, as discussed in Section 10.2, management of acid sulphate soils would not be required under the following scenario:

- excavations for construction are less than 3.0 m depth below existing surface level;
- excavation of the silty clay is less than 1,000 tonnes; and
- dewatering is not undertaken.

In light of the above, it is recommended that the requirement to undertake further investigation and management of acid sulphate soils be assessed following completion of detailed design, when specific excavation requirements for construction are known.

12. Soil Quality Assessment

12.1 Adopted Assessment Criteria

The adopted site assessment criteria (SAC) for soils are derived from Ecological Investigation Levels (EIL) and Health based Investigation Levels (HIL) presented in Table 1 of the DEC publication *Assessment Levels for Soils Sediment and Water* r1 (2010).

Contaminant concentrations below the adopted EIL are generally accepted as indicating negligible potential phytotoxic impact. Contaminant concentrations above these EIL does not necessarily mean that a substance will cause ecological harm, but indicates the requirement for an additional risk-based assessment to determine whether there is likely to be a significant impact on shallow rooted plants. With respect to the assessment of human health risk, contaminant concentrations are compared with the HIL. For this site the residential landuse exposure setting has been selected for comparison purposes [HIL column A (HIL A) Table 1]. These guidelines are also broadly consistent with the NEPM, 1999 Schedule B(1) Health-Based Investigation Levels. Background ranges for heavy metals in Australian soils are also provided for reference purposes.

The adopted assessment criteria for soils are presented in Table 7.

Table 7: Site Assessment Criteria for Soil (mg/kg)

Analyte	Ecological Investigation Levels[1]	Health -based Investigation Levels - Residential[2]	Background Ranges[3]
Arsenic	20	100	1-50
Cadmium	3	20	1
Chromium (Cr III)	400	120 000	5-1000
Chromium (Cr VI)	1	100	
Copper	100	1000	2-100
Lead	600	300	2-200
Mercury (inorganic)	1	15	0.03
Nickel	60	600	5-500
Zinc	200	7000	10-300
Benzene	1	1.1	-
Toluene	3	520	-
Ethyl Benzene	5	230	-
Xylenes	5	600	-
C_{6-9}	100	-	-
C_{10-14}	500	-	-
C_{15-28}	1000	-	-
C_{29-36}	-	-	-
Individual OCP	0.5	-	-
Total OCP	1	-	-
dieldrin	0.2	-	-
Aldrin + dieldrin	-	10	-
chlordane	0.5	50	-
DDT + DDD + DDE	1	200	-
heptachlor	0.5	10	-
Individual non-chlorinated pesticides	1	-	-
Anthracene	10	17000	-
Fluoranthene	10	2300	-
Pyrene	10	1700	-

Analyte	Ecological Investigation Levels[1]	Health -based Investigation Levels - Residential[2]	Background Ranges[3]
Benzo(a)pyrene	1	1	-
Total PAH	-	20	-
Total PCB	1	10	-
Phenol	-	8500	-
Total Phenols	1	-	-

Notes:
1. DEC (2010) *Assessment Levels for Soil, Sediment and Water* (Version 4, revision 1) – Ecological Investigation Levels,
2. DEC (2010) *Assessment Levels for Soil, Sediment and Water* (Version 4, revision 1) – Level 'A' applicable to standard residential with garden/accessible soil (home grown produce contributing less than 10% of vegetable and fruit intake; no poultry,
3. NEPC (1999) Background Ranges

- Not Specified

12.2 Assessment of Analytical Results

The laboratory results presented in Table F-2, Appendix F, in comparison to the adopted assessment criteria summarised in Table 6 indicate the following:

- reported concentrations of potential contaminants are below the adopted ecological investigation levels (EIL);
- reported concentrations of potential contaminants are below the adopted health investigation "A" levels (HIL-A); and
- no asbestos detected in four soil samples submitted.

12.3 Soil Quality Testing Conclusions

Based upon the results of limited soil sampling and analysis, the risk of broad scale soil contamination on the site appears to be low.

It is strongly emphasized, that only a limited number of near surface soil samples were collected as part of the assessment and assessment of historical site activities was not undertaken. We point out, therefore, that the assessment does not constitute a Preliminary Site Investigation (PSI) or Detailed Site Investigation (DSI) in accordance with Department of Environment and Conservation's (DEC) guidelines. The assessment does, however, provide a preliminary evaluation of the soil quality at the site which should identify significant widespread contamination, if present.

It should also be noted that at the time of the investigation the surface of the site was heavily vegetated with grasses and a number of stockpiles of filling were noted. In this regard, the potential for fly tipped material including possible asbestos containing materials (ACM) cannot be ruled out.

Assessment of groundwater quality was not part of the scope for this investigation. Adverse impacts to groundwater quality beneath the site as a result of adjacent land uses cannot be ruled out.

13. Limitations

Douglas Partners (DP) has prepared this report for a project at Tindale Site, Port Hedland, WA in accordance with DP's proposal dated 25 February 2011 and acceptance received from Mr John Beck of Blaxland Property Pty Ltd on 31 March 2011. The report is provided for the exclusive use of Blaxland Property Pty Ltd for this project only and for the purpose(s) described in the report. It should not be used 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

Geotechnical Report - Appendices

PLEASE NOTE: Several of the below appendices are duplicated in this Development Plan report. Full copies of the Geotechnical and Environmental Investigation (and all of its appendices) will be forwarded to Council under separate cover. These appendices include:

Appendix A	About this Report
Appendix B	Site Plans and Cross Section
Appendix C	Results of Cone Penetration Tests and Test Pits
Appendix D	Results of Geotechnical Laboratory Testing
Appendix E	Settlement Analysis
Appendix F	Table F-1: Summary of Screening and SPOCAS Suite of Testing
	Table F-2: Summary of Soil Quality Laboratory Testing
	Laboratory Reports and Chain of Custody Forms

Appendix 7 – Environment Report

VDM CONSULTING

Environmental Review

Proposed Development at 4 Clark Street

Port Hedland

Issue No. 2

July 2011

Document Control Record

VDM Consulting (Environmental Discipline) 310 Selby Street North Osborne Park WA 6017			
Telephone:	(+61) (08) 9241-1800	**File Reference:**	u:\OP100818 (Civil OP100058)\4 Clark Street\Enviromental Review 4 Clarke Street.doc
Facsimile:	(+61) (08) 9241-1999	**Date of Issue:**	22 July 2011
email:	enquiries@vdmconsulting.com.au	**Project Leader:**	Ciaran Lavery

Title:	Environmental Review Proposed Development at 4 Clark Street Port Hedland
Author(s):	Ciaran Lavery
Status:	Issue 2
Synopsis:	This document details an environmental review undertaken as part of a due diligence for the proposed development at 4 Clark Street at Port Hedland, including opportunities and constraints with recommendations to mitigate and/or manage environmental constraints during future planning and approval.

Issue No	Issued by:	Approved by	Distributed to	Number of Copies
2	CL	CL	Blaxland Property	1 Electronic

Disclaimer and Limitations

The information contained within this report is provided in good faith in the belief that no information, opinions or recommendations made are misleading.

All comments and opinions given in this report are based on a limited survey of the study site or on information supplied by the client, his agents and third parties.

Environmental assessments of the site and the extent and nature of impacts of and to this study site are limited within the terms of reference stated within this report, and by the limited timeframe of study. Therefore, the results presented herein cannot be considered absolute or conclusive without additional long-term follow-up studies and investigations.

VDM Environmental, its agents and employees, expressly disclaim any and all liability for representations, expressed or implied, contained in, or omissions from, this report or any of the written or oral communications transmitted to the client or any third party.

Acceptance of this document denotes acceptance of these terms.

Executive Summary

VDM Consulting (Environmental Discipline) was requested by Watson Properties to undertake an environmental review as part of the due diligence for the proposed residential development at 4 Clark Street, Port Hedland, WA. The site is some 2.6 ha in extent and is bound by McGregor Street on the north, Clark Street on the west, Cooke Point Drive on the east and Tindale Street on the south between the site and Water Corporation's Waste Water Disposal Ponds.

Potential impacts, their significance and suggested management and mitigation strategies are tabulated below:

Potential Impact	Significance of Impact	Management/Mitigation Strategy and Frequency
Flora and Fauna	None	Landscape in accordance with the requirements of the Town of Port Hedland.
Conservation	None	None required.
Socio-Economic	Positive	Extend existing and proposed (Telstra Site to the north) development and provide additional land with the opportunity for residential and business development and local employment.
Visual Amenity	Positive	Incorporate the Town of Port Hedland Town Planning Scheme No 5.
Stakeholders	None	Undertake development in accordance with planning and approvals processes.
Soils/Geology	Surface Soils: likely, local Acid Sulfate Soils: present, local	Implement a Construction Environmental Management Plan to control sediment and dust during construction. Investigate, prepare and obtain approvals for Acid Sulfate Soils and Dewatering Management including Dewatering and Disposal Licenses.
Surface Water	Regional flooding and inundation	Implement an Urban Water Management Strategy incorporating Water Sensitive Urban Design. Undertake Hydraulic Impact Assessment to facilitate detailed design. Design and construct to incorporate requirements of existing water supply and sewage infrastructure.
Ground Water	Local	Undertake ground water investigation and monitoring to support the detailed planning and design of urban water management measures. Implement a Dewatering Management Plan during construction.
Air Quality Noise and Vibration	Local	Site is located within the Waste Water Treatment Plant Buffer Special Control Area. Blaxland Pty Ltd indicated that the existing Waste Water Treatment Plant is currently being relocated. Once the plant and disposal ponds be decommissioned in accordance with acceptable environmental practice, odour assessments and management may not be required. Implement Demolition/Construction Environmental Management Plan to control dust, noise and vibration.
Rehabilitation	None	None required.
Other: Hazardous Materials Site Contamination	None Local	Limited soil and ground water sampling to be included in Acid Sulfate Soils Investigation.

The environmental requirements to further planning and approval of the development are:

- Undertake Odour Impact Assessments if and when required. Blaxland Pty Ltd indicated the existing Waste Water Treatment Plant. Once the plant and disposal ponds be decommissioned in accordance with acceptable environmental practice, odour assessments and management may not be required.

- Undertake acid sulfate soils and ground water investigations, coupled with limited soil and water sampling to ascertain the contamination status of the site, and assessments and devise appropriate management strategies and plans. Obtain approvals from the Department Environment Conservation (Acid Sulfate Soil Management Plan) and the Department of Water (Dewatering Strategy and Licence to Take and Dispose of Ground Water).
- Undertake a Hydraulic Impact Assessment to ascertain extent of flooding and inundation.
- Develop and implement an Urban Water Management Strategy incorporating Water Sensitive Urban Design.
- Undertake ground water monitoring in accordance with the requirements of the Department of Water for Local Water Management Strategies and Urban Water Management Plans.
- Prepare and implement a Construction Environmental Management Plan.

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List of Figures

1. Introduction

VDM Consulting (Environmental Discipline) was requested by Blaxland Pty Ltd to undertake an environmental review as part of a due diligence for the proposed development of 4 Clark Street Port Hedland. It is the intention to develop the site for residential development (90 dwellings).

1.1 Aims and Objectives

This document has been complied in accordance with the Environmental Protection Act of 1986 and the guideline *Environmental Guidance for Planning and Development* (2005) published by the EPA. The aims and objectives of this review are therefore to investigate and assess potential environmental impacts on the local and surrounding physical environment including soils and the hydrological and hydrogeological regimes and propose mitigation and/or management measures and investigation and assessment and monitoring programs to address the impacts, if any, of the proposed development on local environmental factors:

Environmental Factors	Environmental/EPA Objective
Principles of Environmental Protection	To address the precautionary, inter-generation equality, conservation of biological diversity and ecological integrity, waste minimization principles and those relating to improved valuation, pricing and incentive mechanisms.
Biophysical	
Flora and Fauna	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
Wetlands (wetlands and rivers)	To maintain the integrity, ecological functions and environmental values of wetlands.
Water (surface and ground)	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
Land (terrestrial and marine)	To maintain the integrity, ecological functions and environmental values of soils, landforms, the seabed and the coast.
Conservation	To protect the environmental values of areas having significant environmental attributes.
Pollution management	
Air, Water (surface, ground and marine) and Soil Quality	To ensure that the development, emissions and/or discharges do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards compatible with the intended land use and consistent with appropriate criteria.
Noise	To protect the amenity of nearby amenities from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.
Hazard	To ensure that hazardous materials are removed and disposed of adequately in accordance with the guidelines of the Department of Health, the Code of Practice for the Safe Removal of Asbestos 2nd Edition [NOHSC: 2002(2005)] and the Code of Practice for the Management and Control of Asbestos in Workplaces [NOHSC: 2018(2005)].
Radiation	To ensure that radiological impacts, if any, to the public and the environment are kept as low as reasonably achievable and comply with acceptable standards.

Aspects that will require specific attention are:

- The requirements of local and state government, relevant planning schemes/codes/development criteria and planning and development approvals.
- Review and inspection of the proposed development to identify and ascertain any potential environmental concerns particularly contaminating land uses and activities, hazardous materials, soils, water quality, drainage, flooding and inundation and management issues.
- Local environmental conditions.

- Identify flooding, inundation and urban water management requirements.
- Identify opportunities and constraints.

1.2 Scope of Work

The environmental review included:

- Search of relevant databases.
- Desk top assessment of all relevant data.
- Compilation of an environmental review that will guide subsequent investigations and assessments and submissions to planning and approval authorities.

2. Background

2.1 Location

4 Clark Street Port Hedland is some 2.6ha in extent and is bound by McGregor Street on the north, Clark Street on the west, Cooke Point Drive on the east and Tindale Street on the south between the site and Water Corporation's Waste Water Disposal Ponds (Figures 1, 2 and 3).

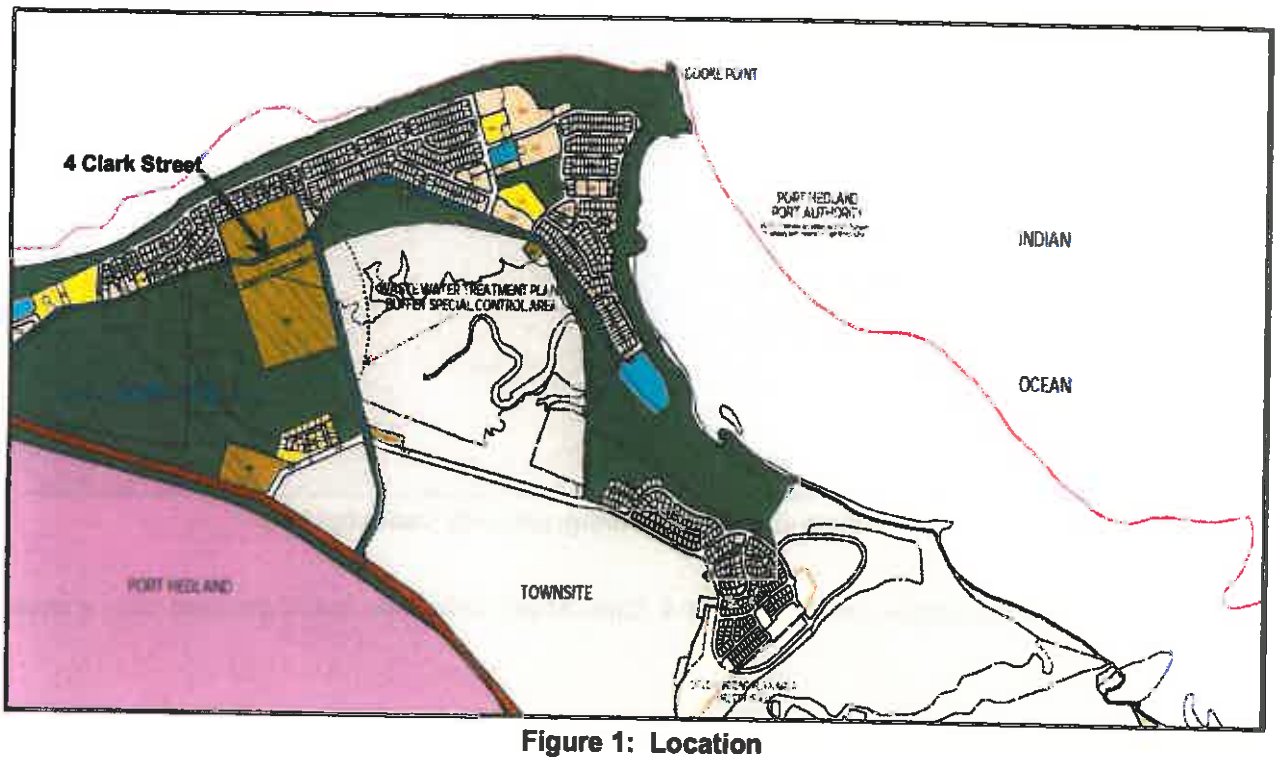


Figure 1: Location

Figure 2: Aerial Photograph

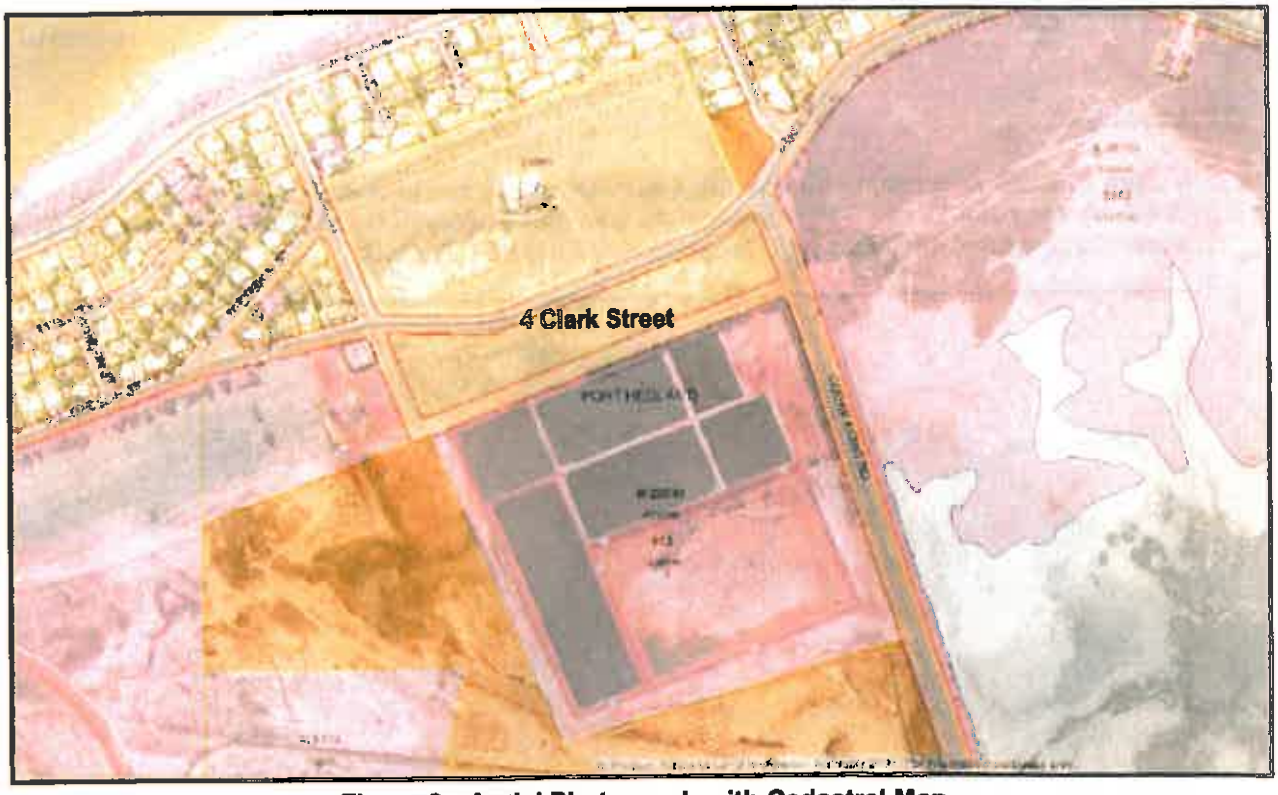


Figure 3: Aerial Photograph with Cadastral Map

The proposed residential development at 4 Clark Street comprises mixed densities with a public open space:

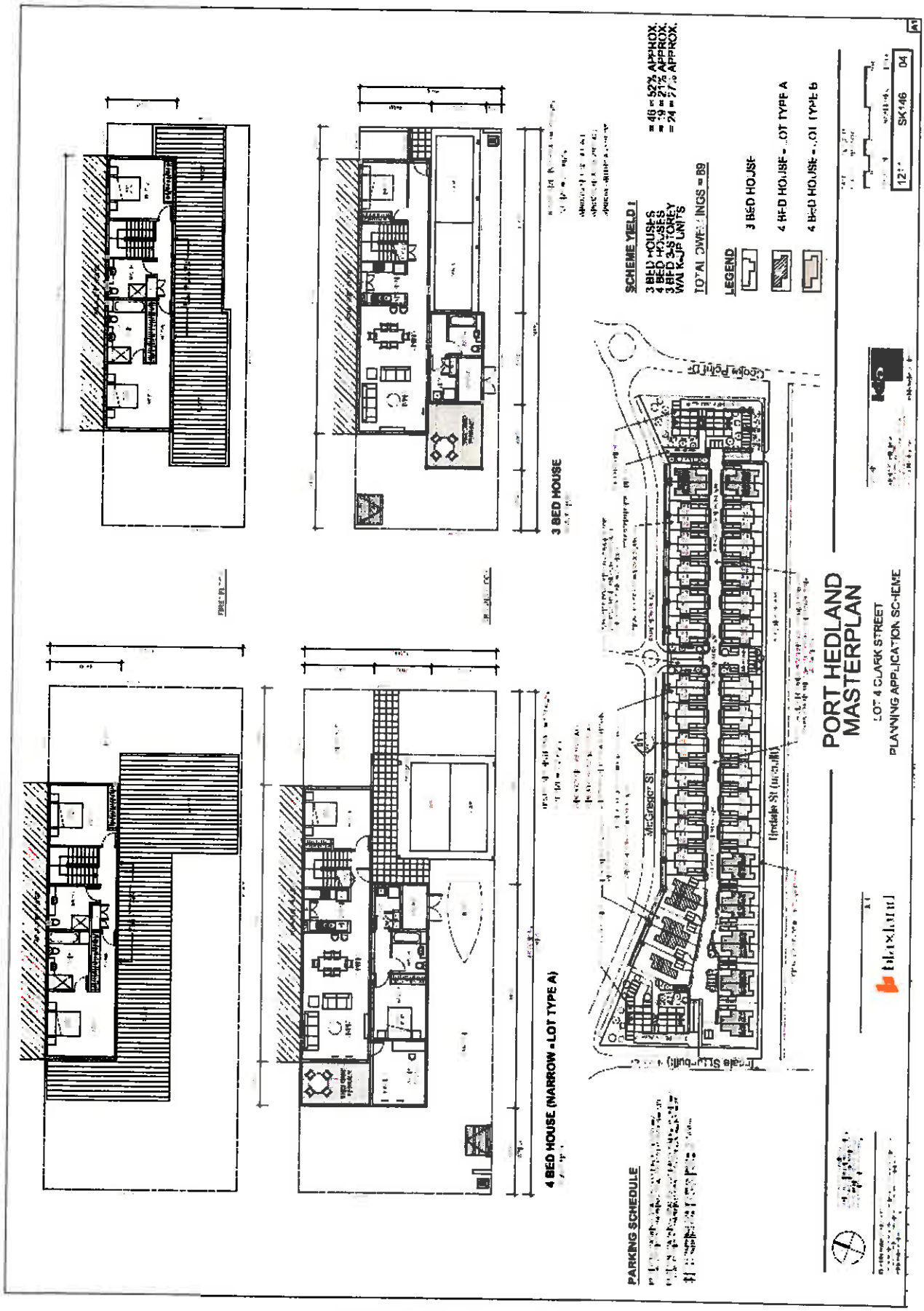


Figure 4: Development Plan

2.2 Land Use and Zoning

4 Clark Street is currently zoned *Telecommunications* in the Town of Port Hedland Town Planning Scheme No. 5 (District Scheme) and lies entirely within the *Waste Water Treatment Plant Buffer Special Control Area* (Figure 5).

It is noted that Council shall have regard to, when considering applications:

- Compatibility of the development with the operations of the treatment plant.
- Impact of the proposal on the operations of the treatment plant.
- Council may approve, with or without conditions, or refuse a proposal for reasons relevant to the operations of the treatment plant.

Figure 5: Land Use and Zoning.

Surrounding land uses and zone include:

- Telecommunications (north), Waste Disposal and Treatment (south) and Parks and Recreation: west and east.

2.3 Climate

Port Hedland is a port on the Pilbara coast having an arid-tropical climate. Rainfall (Station 004032 Port Hedland Airport; Latitude 20.37°S and Longitude 118 .63 °E and Elevation: 6m) is low throughout and quite variable averaging 310mm (1942 to 2010) and typical of the south where tropical cyclone effects are less frequent. Most of the summer rain peaks in February each year averaging 93mm.

The coast from Port Hedland to Exmouth Gulf is the most cyclone prone area in Australia. Port Hedland has been severely impacted by several severe tropical cyclones in the last thirty years. One of the most damaging was Cyclone Joan in December 1975 causing damage estimated at $20 million. Maximum wind speeds in Port Hedland reached 208km/h with the centre of the cyclone crossing some 50km west of the town.

The region contains some of Australia's consistently hottest places. Only along the coast is there some relief to the summer heat provided by sea breezes. Inland maximum temperatures in summer range between 37°C and 42°C whilst the coast is 2°C to 3°C cooler but usually more humid. Several days with 45°C maximum temperatures occur each year. Winter maximum temperatures are mild/warm between 23°C and 27°C. Winter is short, 6 weeks to 8 weeks, and retreats quickly by late August. Frost does not normally affect the coastal areas. Prevailing winds are from the south and east with sea breezes from the north.

2.4 Earlier Work

A data survey in the publications section and environmental health database of the Town of Port Hedland indicates that environmental investigations have not been undertaken within the project area.

3. Methods

3.1 General

Methods of investigation and assessment included:

- Database searches and requests for information: Department of Environment Conservation: Contaminated Sites Register, Department of Consumer and Employment Protection: Dangerous Goods Licences, Department of Water Ground/Surface Water Data Bases and Flooding, National Pollution Inventory, Department of Indigenous Affairs: Aboriginal Heritage, Town of Port Hedland, Water Corporation, Telstra, Landgate, Nearmap, Geological Survey of Western Australia, Western Australian Planning Commission, Bureau of Meteorology: Rainfall and Tidal Data, Department of Planning) and liaison with Telstra, Water Corporation and the Department of Water.
- Professional judgement.

4. Environmental Assessment

4.1 Flora and Fauna

Site soils have been disturbed by various earthworks and are covered by open grassland and supra-tidal/saline mudflats with scattered small shrubs and trees. The most recent land system mapping of the Pilbara bio-region was completed by van Vreeswyk *et al.* (2004). The mapping divides the Pilbara region into 102 land systems. The site includes one land system i.e. *Littoral (Lit)*: bare coastal mudflats with mangroves and coastal dunes which forms 0.9% (1,577km^2) of the Pilbara bio-region.

Correspondence from the DEC (dated 07 June 2011) highlighted concern of the proposed development towards the flatback turtles. The site is located approximately two streets back from the Cemetery Beach, which is a known nesting beach for flatback turtles. DEC has raised concerns that the construction of multiple storey dwellings at the site may results in a significant increase in the visibility of artificial light for turtles nesting at both Cemetery Beach and Pretty Pool Beaches in terms of direct light and light glow.

Since the original submission of the Environmental Review (Issue 1 dated November 2010) minor alterations have been made to the scope of works and layout of the site. However, the highest build is still three storeys. The site sections displayed below demonstrate the gradient from the top of the three storey buildings towards the beach.

The light from the three storey buildings is obscured from buildings within the proposed development along with building within the existing residential. It is highly unlikely that light from the proposed development will impact upon nesting activities for the flatback turtles.

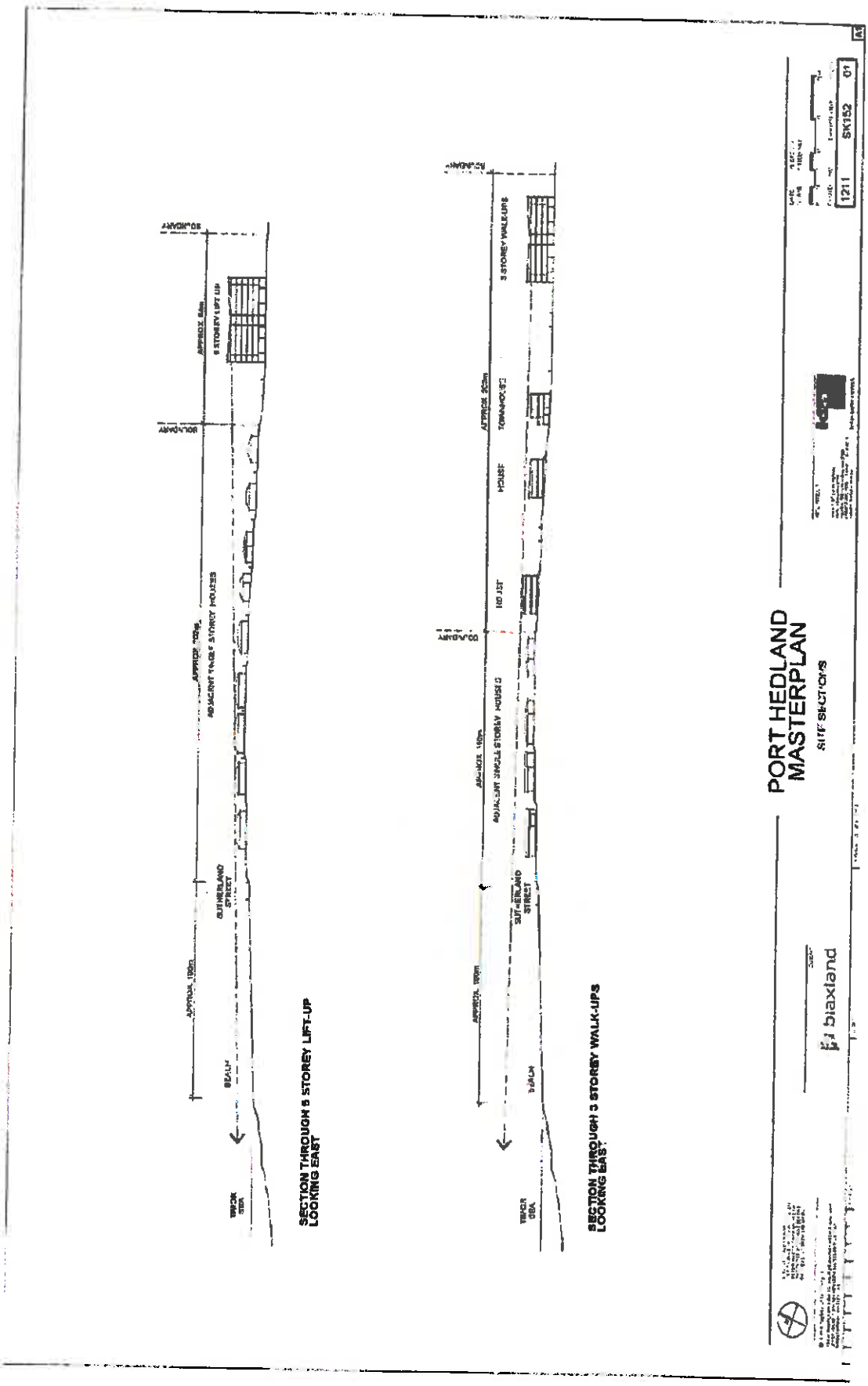


Figure 6 – Cross Section of Area

4.2 Areas of Conservation Significance and Heritage

There are no areas of conservation significance (Search 689447).

4.3 Socio-Economic Assessment

There is little doubt that the proposed development will positively impact on the local residential and business market by providing opportunities for local development and employment growth.

4.4 Visual Amenity

Visual amenity is unlikely to be impacted upon provided the proposed development take due cognisance of the Town of Port Hedland Town Planning Scheme No. 5 (District Scheme).

4.5 Public and Stakeholder Consultation

The proposed development will be undertaken in accordance with the planning process which includes consultation with authorities and relevant stakeholders. The Town of Port Hedland is the elected representative of the public in this process.

4.6 Soils, Geology and Landforms

The site, albeit disturbed, is relatively flat lying at 4.0mAHD.

Figure 7: Contour Elevations

The local and regional geology is depicted in Figure 7 (1:250,000 Geological Series: Sheet SF 50-04 Port Hedland-Bout Island, part of Sheet SE 50-16, Geological Survey of Western Australia) and comprises carbonate cemented ($B2_bkk$) coastal dunes ($B1_b$), and coastal (tide dominated) mud and silt on mangrove flats (T_m).

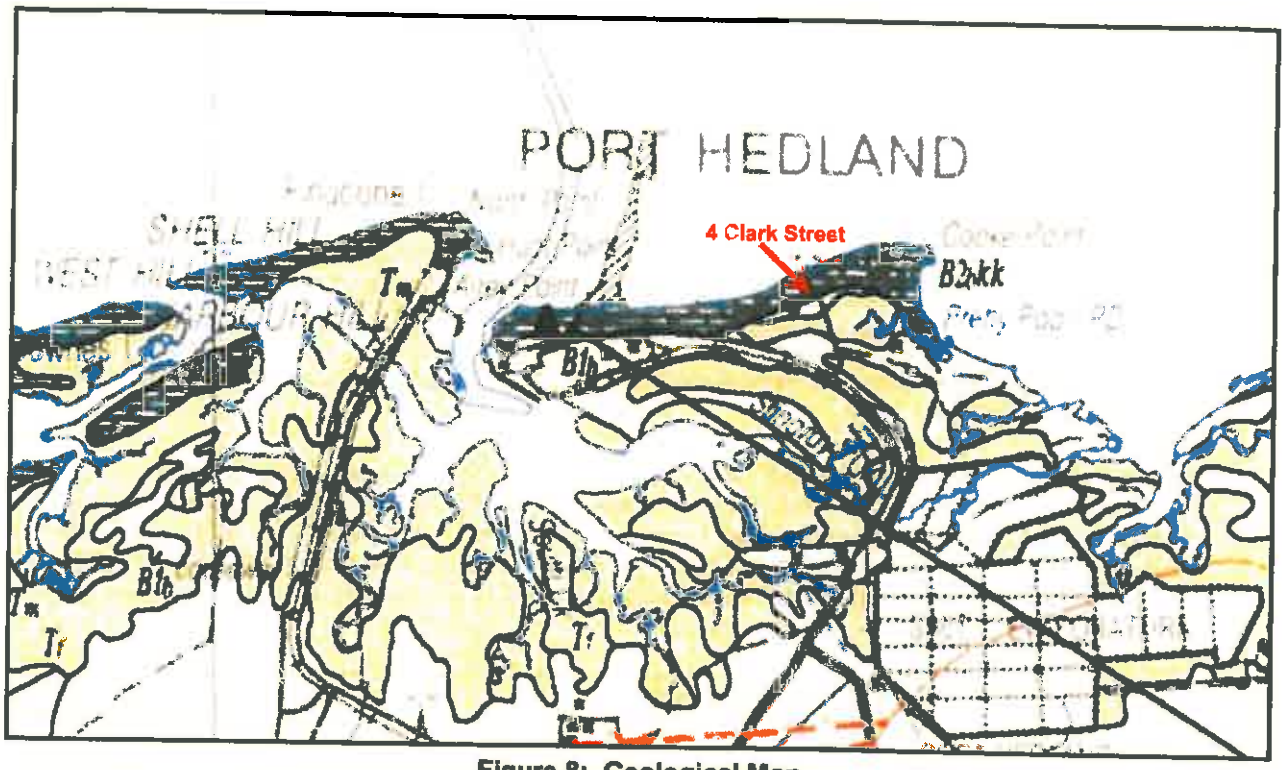


Figure 8: Geological Map

4.6.1 Soil Contamination

Whilst site soils have been disturbed (Figures 2 and 6), there is no indication and/or records that the site soils have been subjected to a contaminated land use.

4.6.2 Acid Sulfate Soils

The site is located within a zone classified as Class 1: high to moderate risk of acid sulfate soils.

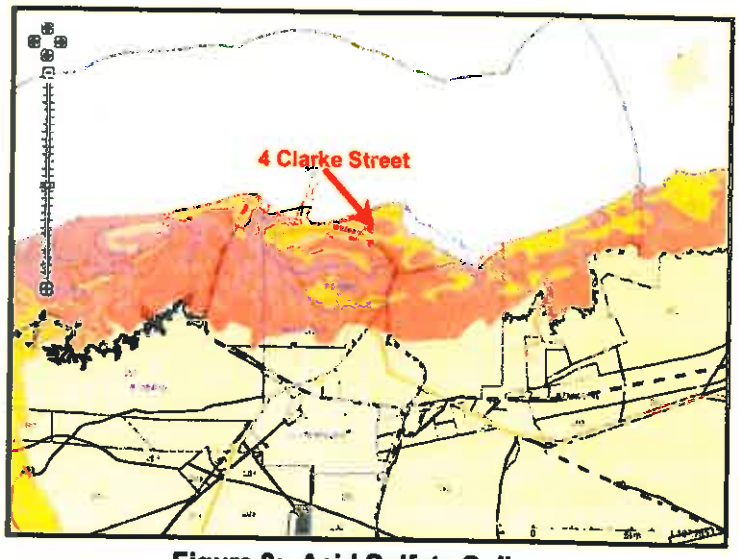
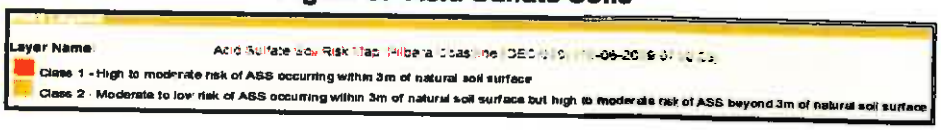


Figure 9: Acid Sulfate Soils



Acid sulfate soils and dewatering investigations, assessments and management plans will be required to facilitate filling of the land and for construction of services.

4.7 Surface Water (Hydrology)

Reviews of aerial photography indicated that there are no major surface water drainage systems within the perimeters of the site.

A request for information elicited that the Department of Water (DoW) *in carrying out its role in floodplain management, provides advice and recommends guidelines for development on floodplains with the object of minimising flood risk and damage.* The DoW *uses the following guidelines to ensure proposed development in flood prone areas is acceptable with regard to major flooding:*

(1) The development has adequate flood protection from a 100 year ARI flood.

(2) The development does not detrimentally impact on the existing 100 year ARI flooding regime of the general area.

Whilst the DoW does not have any floodplain mapping for Port Hedland, they provided a copy of a map (Figure 9) of a Storm Surge/Flood Study, prepared by GEMS for the Department of Planning in October 2000. The GEMS modeling shows that the site is affected by major flooding (refer attachment). However, DoW indicated that they consider the GEMS flood modeling to provide an indicative regional perspective on flooding (both storm surge and river/creek flooding) for the area. Further information on the study has been requested from the Department of Planning.

Figure 10: 100-yr Flood Zone.
(Map 4: combined effects of Storm Surge and Runoff)

The Coastal Management group at the Department of Transport (Fremantle) provided the following information on expected tidal/storm surge flooding in Port Hedland:

- Mean Sea Level for 2010: 3.95m (slightly below the 4.0mAHD elevation of the site)
- Highest recorded level: 8.20m in 1956
- Lowest recorded level: -0.40m in 1959

These values are referenced to LAT which is 9.523m below tidal benchmark PA 26. AHD is 3.90m on this scale.

The Bureau of Meteorology provided the following general tidal data (Figure 10):

- Highest Astronomical Tide (HAT): 7.56
- Mean High Water Springs (MHWS): 6.69
- Mean High Water Neaps (MHWN): 4.62
- Mean Sea Level (MSL): 3.95
- Mean Low Water Neaps (MLWN): 3.28
- Mean Low Water Springs (MLWS): 1.21
- Lowest Astronomical Tide (LAT): 0.02

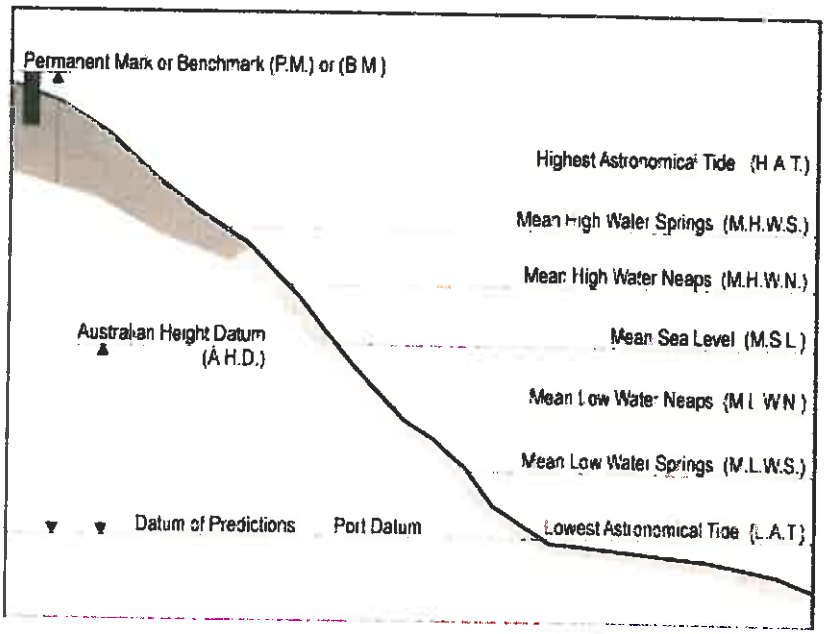


Figure 11: Key to Tidal Data (BoM, 2010)

The Town of Port Hedland generally advises the following on coastal development: *The developer to take note that the area of this application may be subject to rising sea levels, tidal storm surges and flooding. Council has been informed by the State Emergency Services that the one hundred (100) year cycle of flooding could affect any property below the ten (10) metre level AHD. Developers shall obtain their own competent advice to ensure that measures adopted to avoid that risk will be adequate. The issuing of a Planning Consent and/or Building Licence is not intended as, and must not be understood as, confirmation that the development or buildings as proposed will not be subject to damage from tidal storm surges and flooding.*

4.8 Ground Water (Hydrogeology)

The site lies within 1km from the coast and is therefore subject to seawater intrusion. Ground water is also likely to have been affected by any seepage that may occur from the up-gradient Waste Water Treatment Ponds.

The depth to ground water and ground water quality has not been ascertained and is to be determined during future drilling and testing programs for the investigation of acid sulfate soils.

4.9 Air Quality

The site is located within the odour buffer (large red circle) of the Waste Water Treatment Plant whilst the westernmost portion lies within the chlorine exclusion zone (smaller red circle).

Figure 12: Air Quality Buffer Zones.

Construction activities are likely to cause dust/gaseous emissions. To comply with locally and nationally recognised ambient air quality criteria during construction processes, management of dust/gaseous emissions from construction equipment/vehicles are to be included in the Construction Environment Management Plan for the proposed development.

4.10 Noise and Vibration

Noise and vibration are likely to be generated by construction activities and are to be managed in accordance with a Construction Environment Management Plan for the proposed development.

4.11 Rehabilitation

No rehabilitation and/or re-vegetation measures will be required.

5. Conclusions and Recommendations

Potential impacts, their significance and suggested management and mitigation strategies are tabulated below:

Potential Impact	Significance of Impact	Management/Mitigation Strategy and Frequency
Flora and Fauna	None	Landscape in accordance with the requirements of the Town of Port Hedland.
Conservation	None	None required.
Socio-Economic	Positive	Extend existing and proposed (Telstra Site to the north) development and provide additional land with the opportunity for residential and business development and local employment.
Visual Amenity	Positive	Incorporate the Town of Port Hedland Town Planning Scheme No 5.
Stakeholders	None	Undertake development in accordance with planning and approvals processes.
Soils/Geology	Surface Soils: likely, local Acid Sulfate Soils: present, local	Implement a Construction Environmental Management Plan to control sediment and dust during construction. Investigate, prepare and obtain approvals for Acid Sulfate Soils and Dewatering Management including Dewatering and Disposal Licenses.
Surface Water	Regional flooding and inundation	Implement an Urban Water Management Strategy incorporating Water Sensitive Urban Design. Undertake Hydraulic Impact Assessment to facilitate detailed design. Design and construct to incorporate requirements of existing water supply and sewage infrastructure.
Ground Water	Local	Undertake ground water investigation and monitoring to support the detailed planning and design of urban water management measures. Implement a Dewatering Management Plan during construction.
Air Quality Noise and Vibration	Local	Site is located within the Waste Water Treatment Plant Buffer Special Control Area. Blaxland Pty Ltd indicated that the existing Waste Water Treatment Plant is currently being relocated. Once the plant and disposal ponds be decommissioned in accordance with acceptable environmental practice, odour assessments and management may not be required. Implement Demolition/Construction Environmental Management Plan to control dust, noise and vibration.
Rehabilitation	None	None required.
Other: Hazardous Materials Site Contamination	 None Local	Limited soil and ground water sampling to be included in Acid Sulfate Soils Investigation.

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Google, 2010: Google Earth Aerial Photographs.

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van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., & Hennig, P. (2004). An Inventory and Condition Survey of the Pilbara Region of Western Australia: Technical Bulletin #92. Department of Agriculture and Food; Government of Western Australia.

Western Australian Planning Commission.

Appendix 8 – Infrastructure Report

Contents

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
Draft A	26/07/2011	BRK	JHG	BRK
Rev 0	1/08/2011	BRK	JHG	BRK
Rev 1 (amended for planning submission)	3/08/2011	BRK	JHG	BRK

1.0 Executive Summary

This report has been prepared by JDSi to assist Blaxland Property with identifying the implications of the servicing requirements for Lots 2 & Lot 4 Clarke Street, and Lot 5474 Thompson Street, Port Hedland residential subdivisional development.

The key issues and findings highlighted in this report are:

- Earthworks are a key issue. Both for geotechnical stability and filling required to meet minimum storm surge levels.
- The site requires a large volume of filling and this has become the major development issue as the extent of filling to achieve storm surge protection affects all services.
- Existing infrastructure is in varying states of improvement and thus timing for development is crucial.
- Advice on the provision for sewer and the decommissioning of the Waste Water Treatment Plant is that these matters are organized within Water Corporation.
- Advice on water supply is that development of the supply is planned, and should be completed when the buffer restriction is lifted.
- Advice on electric power is that there is sufficient power at source for the development. The upgrade of a feeder line to the site may be required and is dependent upon future Horizon Power advice.
- Stormwater drainage has authority requirements that need to be resolved through technical discussion.
- The existing Telstra facility will impose constraints to earthworks.
- The development will need to be submitted to NBN Co for consideration and communication infrastructure requirements.
- It is concluded that the existing surrounding infrastructure incorporating the upgrades described in this report is of sufficient capacity to serve the proposed development. This includes water, sewer and power.

2.0 Introduction

The site is within the Town of Port Hedland in the water front precinct and comprises the land known locally as the Telstra Site.

JDSi has been commissioned by Blaxland Properties to act as the Project Civil Engineers to undertake an infrastructure due diligence on the proposed residential development on the land.

This assessment provides an overview of existing and future servicing requirements to support the planned development. The site has a large number of constraints to development which are addressed. A considerable number of prior studies have been prepared for this site by other professional consultants. This report has been based on JDSi's review of previous studies, observations, assumptions and advice from our other partners in the Project Team and discussions with the various infrastructure stakeholders.

FIGURE 2.1 STUDY AREA

3.0 The Study Area

3.1 General assessment

The development Study Area is bounded by Clarke Street, Tindale Street (unmade) Cooke Point Drive, Thompson Street and the existing residential development on the northern side within the Town of Port Hedland.

The Study Area comprises two existing land uses. The first surrounds the existing Telstra facility which is largely undisturbed low coastal vegetation which is quite sparse. The second is the areas where earthworks have been carried out for a variety of purposes and these require remedial earthworks.

Lot 2 includes an existing Telstra facility which is to remain with amended service alignments. These service alignments will coincide with proposed access roads. The Telstra facility will be a constraint on earthworks within its vicinity.

Douglas Partners have undertaken a geotechnical assessment of the Study Area. Based on this report it is considered that the Study Area is suitable for residential land development.

3.2 Impacts of Storm Surge on Site Levels

The site is on the lee side of the original coastal dune and is open to storm flows around Point Cooke which are projected to cause inundation of the area under combinations of high tide and storm influence. The likely storm events have been studied for the Town of Port Hedland by marine consultants Cardno with the study outcomes yet to be released.

The Town of Port Hedland has verbally advised that they do not have set criteria for setting minimum lot levels to maintain residences above storm surge levels. They have also advised that the report prepared by Cardno, Port Hedland Coastal Vulnerability Study, is the report which the Town will use to determine lot levels in developments. This report is still in draft and undergoing review by various agencies.

Cardno prepared a letter dated 3 June 2011 for Blaxland Properties which addressed storm surge issues and included data from the draft report to define lot levels for this site. This letter is attached as Appendix 2.

The Cardno recommendation is" As a result, Cardno believe that Blaxland should be at this stage adopting a 100 year ARI, 2011 flood level of 5.9m AHD." The letter continues to recommend a minimum residential floor level 0.5m above the storm surge level.

These recommendations are thus for a minimum habitable lot level of RL 6.4m AHD.

The above advice has been considered for the Bulk Earthwork Concept.

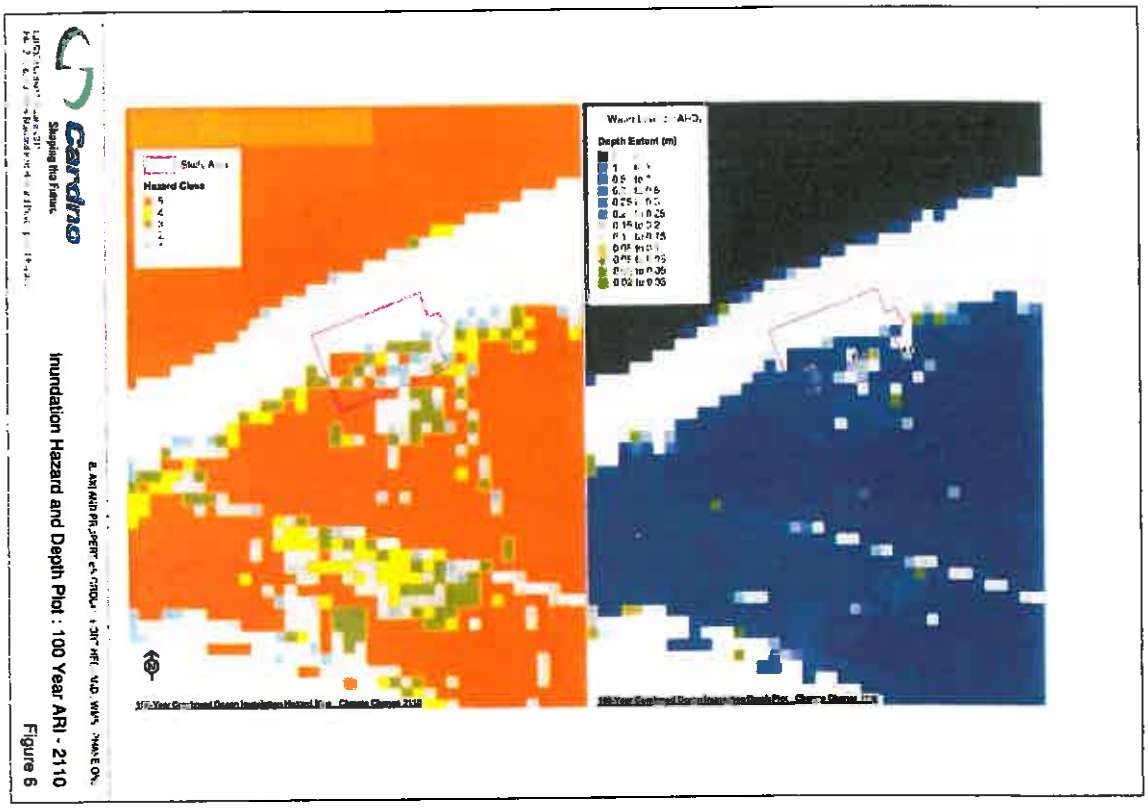


FIGURE 3.1 EXTRACT FROM CARDNO STORM SURGE PROJECTIONS

This figure is part of the Cardno Report "Port Hedland Coastal Vulnerability Study", April 2011, and should be read in conjunction with the extracts from the report provided in letter of 3 June, 2011.

3.3 Environmental considerations

There have been limited assessments on the site to assess the presence of contaminating materials. The Douglas Partners report for Lot 2 and Lot 4 with a limited assessment of test holes for the geotechnical review formed an opinion that Acid Sulphate Soils were unlikely to be present and that they observed no signs of other contamination.

Limited assessment did not indicate any evidence of contamination and it remains possible that some site contamination may be uncovered during the works. Without detailed study any materials found would need to be managed during the works by removal to an approved disposal site and replacement with imported material.

3.4 Geotechnical considerations

The supplied Douglas Partners report for Lot 2 included in Appendix 3, highlights an area of the site which overlies soft clays. Their report suggests placing filling over these areas would not achieve a suitable level of stability. The report recommends piled foundations for large buildings in the area described as Zone B in their report.

The supplied Douglas partners report for Lot 4 included in Appendix 3, highlights that this lot comprises some sand filling over a soft clay layer, similarly to Zone B in the Lot 2 report. The report suspects some infiltration from the adjacent settling ponds may be affecting the clay stability. The report recommends care in this lot due to high differential settlements and that filling may acerbate the settlements.

A method to stabilize soft soil is to preload the area by placing additional filling in a controlled manner. This filling layer pre consolidates the soft layer reducing differential settlements. Following an appropriate period the additional filling is removed. The time for access to the site which is governed by the WWTP buffer provides a window of some 18 months to carry out a preloading placement.

JDSi recommend this approach and that Douglas Partners be commissioned to prepare a detailed procedure for pre loading and end certification.

3.5 Filling at existing Telstra cables

The only reference to the Telstra requirements for limiting filling and development over existing cabling is in VDM's letter of 18 June 2010. This includes a statement attributed to Telstra that no filling shall be over existing cabling. While this is a fairly standard Telstra approach it has a substantial impact on the design of the site.

JDSi recommend that a meeting be held with Blaxland and Telstra to confirm the latest requirements. If cable relocations become necessary there is a timing issue that needs to be incorporated into the project plan.

4.0 Earthworks and Demolition

4.1 Derivation of Site Levels

The Study Area comprises Lots 2 and Lot 4 Clark Street which are separated by the McGregor Street reserve and pavement.

The landform for Lot 2 consists of general falls across three zones from the north to the southern boundary. The northern boundary is the south side of the coastal dune with top elevations ranging from RL 11.0 to RL 12.0, and this boundary abuts existing residences. The ground then falls sharply to a central east-west zone averaging RL 5.5 and the Telstra facility exists on this platform. The land continues to fall to the southern boundary at McGregor Street averaging RL 3.5 at the boundary. This part of the site has been previously quarried for materials and a large part of this area is in the RL 2.0 to RL 2.5 m height range.

The landform for Lot 4 is generally disturbed by previous excavation and filling works. The eastern portion, approximately 60% of the lot, has been filled to RL 4.0 to RL 4.7. The western portion is the excavation area averaging RL 3.3. The geotechnical report provides information in regard to the filling and the quality of the placing and compaction process in this lot.

There will be a requirement for bulk earthworks, to fill the excavations and to ensure levels are suitable for the intended purpose of the lots, setting building levels above the predicted storm surge.

Refer to Appendix 1 for the Earthworks Design Concept Plans.

All earthworks will be carried out in accordance with the provisions of Australian Standard AS3978-1996 "Earthworks for Residential and Commercial Development" and in accordance with the geotechnical advice. Site classifications will be governed by the available filling material and we understand that reasonable granular fill is in short supply in Port Hedland. However it is anticipated a minimum 'S' Classification would be achieved in accordance with AS 2870-2011 Residential Slabs and Footings.

4.2 Availability of filling material

The preliminary earthworks concept design included in this report requires the importation of approximately 70,000 cubic metres of filling for Lot 2 and lot 5474, and 40,000 cubic metres of filling for Lot 4. This volume will vary with the final design and bulking factors. Preliminary enquiries have been made with a local supplier (B J Young) who have advised that this quantity of material is available from their pits at South Hedland or Boodarie. The material is amended Pindan sand which typically has a low wet compressive strength and can be affected by moisture. Under roads it is essential that its placed status is maintained as dry through effective drainage.

This filling material does not have a high permeability and thus provides limited soakage for areas requiring subsoil drainage. In our opinion the extent of soakage required needs careful consideration during detail design.

4.3 Emergency Access during Storms

An essential part of the earthworks design is to achieve the residential floor levels above the predicted Design Storm Surge with the minimum of imported filling material. The concept design assumes that certain areas will be inundated during the design storm surge with the residential buildings being above the level by filling or construction of a ground floor as parking without habitable rooms.

For emergency access such as ambulance or fire services every residence must be accessible by vehicle and emergency personnel during the period of storm events. The earthworks concept provides that some roads will be at or above the still water level of RL 5.9. Other roads will be subject to inundation during storm surge periods, as will some surrounding roads and use of a water craft may be required.

To maintain habitability of residences, services connecting residences will require special arrangements so that the potential points of water ingress are above storm surge levels, particularly sewers, so that other systems are not disrupted by becoming inundated. It should be noted that electricity requirements are for major transformers and switchgear to be at least 1.0 metre above the projected 1 in 100 ARI water level. We would interpret the storm surge level for this occurrence as the Still Water level of RL 5.9.

5.0 Sewer

Water Corporation has advised in its response of 30 May, 2011 to the land rezoning application that there is a Government initiative to decommission the Waste Water Treatment Plant (WWTP) to de-constrain land for urban development. Design studies have commenced to re route sewage to the South Hedland WWTP and the timing of these works was unknown at the time of their response.

On 10 July, 2011 JDSi met with the area planning officer for Water Corporation who verbally advised;

1. The WWTP will be decommissioned and the works are programmed to be completed by July 2014

2. The decommissioning of the WWTP will require a Waste Water Pump Station to be constructed near the corner of Cooke Point Drive and McGregor Street. This station will be the collection point for the surrounding gravity sewer network including Lots 2 & 4, and new gravity connections will need to be constructed.

3. The new Waste Water Pump Station will need to be in operation.

4. The development of Lot 2& 4 can commence within the buffer zone and prior to the WWTP being decommissioned but occupancy can only be achieved once the Waste Water Pump Station has been commissioned; or alternatively a Water Corporation approved temporary pumping solution is implemented.

5. The Chlorine re injection facility will be relocated adjacent to the new Pump Station and will have a smaller buffer. This buffer should not impact Lots 2 & 4.

The Water Corporation has advised that there is an existing sewer at the intersection of McGregor and Clark streets. This sewer is on the south western side and is a gravity sewer connected to an existing Waste Water Pumping Station. The Water Corporation has advised that this pumping station is at capacity and as part of the WWTP decommissioning works will need to be upgraded.

With the filling of the site as described, in Section 4 Earthworks, finished lot levels will be achieved which will permit a gravity sewer connection to the existing sewer at the corner of Clarke and McGregor Streets as an interim connection. This could provide service to a portion of Lot 4. Any such temporary connection would be fully at the developers cost.

As the site will be divided into strata title sites all strata site internal sewers will be in accordance with the AS 3500 Part 2 Plumbing and Drainage Code and all lot services and external sewers will be in accordance with the Water Corporations requirements for normal green title lot development.

6.0 Water Supply

Water Corporation has advised, in its response of 30 May, 2011 to the land use rezoning application, that the East Pilbara Water Scheme is under substantial demand pressures and is at present unable to service any development in this locality.

Water Corporation has recently indicated that planning studies and the business case to augment the water conveyance systems will be completed in 2011. This could result in augmentation of headwork's and conveyance reticulation. In our opinion this means that source upgrades would be funded through headwork's contributions and be completed to provide sufficient water by the June 2014 decommissioning of the WWTP and lifting of its buffer. Any local connecting reticulation works to connect to the site would be a developer cost.

A 450DN and 300DN distribution main exists in McGregor Street and any change to road levels may warrant relaying of this main to suit the new road reserve levels.

7.0 Power Supply

7.1 Existing Distribution Power Network

The proposed development sites are located in an area that is currently supplied by underground power via two 22kV High Voltage (HV) feeders AST508.0 Anderson and AST 505.0 McKay feeders (please refer to Appendix 1 - Figure 1). These two existing feeders emanate from Anderson Zone Substation, which is approximately 4.5km west of the proposed development sites. There is no distribution overhead network in the vicinity of the proposed development sites. The existing Telstra Site on Lot 2 McGregor Street is currently supplied by Low Voltage (LV) underground cable that originates from a 500kVA transformer located at the corner of Thompson Street and Athol Street.

7.2 Existing Transmission Power Network

There are currently no transmission overhead lines or underground cables within or in the vicinity of the proposed development sites.

7.3 Likely Load

Based on the current master plan for the proposed development sites, it is assumed that the proposed development sites will be subdivided into the following:

Lots 2 and 5474 McGregor Street

- 54 green title lots
- 216 strata title lots (36 town houses within 6 green title lots and 180 walk-up units within 4 green title lots)

Lot 4 Clark Street

- 82 strata title lots (58 house lots and 24 walk-up units)

For strata development that consists of more than 10 units in Port Hedland, Horizon Power requires a minimum After Diversity Maximum Demand (ADMD) of 4kVA to be assigned to each strata unit. An ADMD of 6.2kVA per lot is required for all green title subdivision in Port Hedland. Therefore, based on the proposed lot yield information given and Horizon Power's minimum power requirements for all new strata and green title developments, it is estimated that the power demand of the proposed development at the abovementioned sites will be approximately 1.5MVA The table below provides a breakdown of the proposed lot yield and estimated load for the proposed development.

Location	Type of Load	Lot Yield	ADMD	Estimated Load (MVA)
Lots 2 & 5474	Green title	54	4.7kVA per lot	0.33
McGregor Street	Strata title	216	3.1kVA per lot	0.86
Lot 4 Clark Street	Strata title	82	3.1kVA per lot	0.33
Total				1.52

Please note that the actual power requirements of the proposed development may vary depending on the ultimate lot yield and the type of subdivision within the proposed sites as commercial and retail lots may significantly increase the total design load of the proposed development.

7.4 Power Supply Scenario

It is assumed that the proposed development will be a multi-stage project that will occur over a period of approximately 1-5 years starting in 2013. There are currently no 22kV underground cables within or adjacent to the proposed development sites. The 22kV feeders AST508.0 and AST505.0 are currently supplying the areas

surrounding the proposed development sites. Therefore, it is anticipated that HV supply will need to be extended to the development sites from either or both of these feeders.

The total power demand of the proposed development at Lots 2 & 5474 McGregor Street and Lot 4 Clark Street are estimated to be approximately 1.19MVA and 0.33MVA respectively. There is no power supply to Lot 4 Clark Street and the existing Telstra site on Lot 2 McGregor Street is currently supplied via an underground LV supply. Based on the current lot layout plan for the development, it is expected that four 630kVA transformers will need to be installed within the development sites in order to provide adequate power supply to the residential lots, i.e. three 630kVA transformers within Lot 2 and 5474 and a 630kVA transformer within Lot 4 (refer to Appendix 1 - Figure 5 for HV Concept Plan).

If both of the 22kV HV feeders are heavily loaded and do not have adequate capacity to cater for the proposed development, it is expected that Horizon Power will require a new 22kV HV feeder to be brought out from Anderson Zone Substation.

The final power connection requirements will be confirmed when a Design Information Package or Preliminary Assessment request is submitted to Horizon Power.

7.5 Street Lighting

The number of street lights required depends on the following main factors:

1. Type of luminaire
2. Street light pole height
3. Width of road reserve
4. AS/NZS 1158 Lighting category

The new roads within the proposed development sites will most likely be lit up to the Australian Standards AS/NZS1158 P4 lighting category. This lighting category is commonly applied to most residential subdivisions. Horizon Power has recently installed 42W CFL street lights in the Pilbara area. For the proposed development, it is assumed that 42W Compact Fluorescent Light (CFL) luminaire and 6.5m street light pole will be used. Given that the road widths are not known at this stage, the number of street lights required for the entire developments was estimated based on the master plan given.

There are existing street lights outside the proposed development sites along Clark Street, McGregor Street and Cooker Point Drive (refer appendix 1 - Figure 4). It is estimated that approximately 23 and 11 street lights will need to be installed on the road reserves within Lots 2 & 5474 and Lot 4 respectively.

Please note that the estimate above does not include the number of street lights required within any of the strata developments.

8.0 Gas Supply

WA Gas Networks has advised there are no assets in the area, and thus a domestic supply to each residence will not be available.

9.0 Telecommunications

As a result of the Australian Government's decision to roll out a National Broadband Network (NBN) the ownership issues for delivering the wholesale fibre to the home system have been transferred to the Government with end connections to properties being provided by a number of retail service providers.

Developers of new residential estates apply to the NBN Co for service and they decide which areas will be served. Their usual requirement is for developments of 100 lots or more to be included in their system, with smaller developments being left to the other service providers. Under either system a reasonable level of service will be provided.

In either case the developer will be responsible for the installation of all pit and pipe infrastructure which will be required to accommodate a future communication networks.

Due to the possible NBN Co delays in rollout programming initial services with Telstra may be required. As Telstra are no longer the constructor of main systems, alternative communications options may be provided i.e. customers to receive an interim mobile service; access to the internet is only available through wireless broadband services.

Telstra has existing infrastructure surrounding and within the site. The current design practice for public road reserves, pavement and verge provisions will make adequate allowance for communication services including broadband in accordance with the agreed Utilities Service Providers handbook. There will be some local land requirements for equipment sites, similar to current provisions which will be accommodated at detailed subdivision stage.

10.0 Roads and Verges

10.1 Pavement standards

The subdivision roads within the development area will need to be constructed in accordance with the Town of Port Hedland sub divisional guidelines and standards, and IPWEA Subdivision Guidelines. The Town standards are included in Appendix 4.

The Design Concept Plans for Roads has been based on the existing master planning concepts included in Appendix 1. The Concept plan shows the roads which will be public subdivision roads and those roads which are within Strata Lots. The roads within the strata lots will be constructed to similar pavement standards and modified widths.

As detailed in the concept plan, intersection treatments such as brick paving will be incorporated into the design for traffic calming, to provide indication of priority, and to provide improved visual amenity.

Douglas Partners geotechnical investigation has recommended a pavement design CBR value of 10%. Based on this value and a design life of 40 years, the calculated minimum basecourse thickness for a flexible pavement is 250mm. This is also the Town's minimum pavement thickness under their standards. Roads will be kerbed and drained.

The Town has advised dual use paths are to be on all roads as part of the liveable neighborhoods standards and to increase connectivity. Internally in strata lots the paths will have a width of 2.0 metres.

10.2 External existing roads

McGregor Street exists as a constructed road. The existing pavement will be affected by the central intersection and any final decision to upgrade the road to reduce the need for retaining walls on the abutting land.

Tindale Street is currently unconstructed and as there is no proposed access to the site this road will be constructed by others. Council may elect not to proceed with construction of the future Tindale Street but instead move it further south to allow future development i.e. back to back lots. The proponent has developed a robust development plan which accommodates both options with or without the construction of Tindale Road.

11.0 Drainage

11.1 Design principles

The subdivision drainage within the Study Area will be constructed in accordance with the IPWEA Subdivision Guidelines and with the Town of Port Hedland's subdivisional guidelines and standards. These standards are included as Appendix 4.

The key requirements is for residential lots to manage their stormwater within the lot by soakage pits and recognizes the poor infiltration rate of the Pindan soils by requiring special pervious soils under soakwells. All lots are to be flood routed to road reserves.

The Key requirement for roads is a 1in 5 ARI capacity piped system discharging to drainage reserves, tidal areas or constructed systems. Roads to be designed to carry the 1 in 100 ARI events without flow into the adjoining land.

The Cardno report of 29 June, 2011 reports a communication with the Department of Water where the response was the usual retention of early flows and this requirement is intended to achieve maximum recharge to the groundwater or reuse of water. This appears achievable within the lots. The Cardno report also outlined a proposal for retention structures within road reserves. JDSi recommend that the practicality, efficiency, maintenance and soakage impact on the soil conditions be fully considered and discussed with the Town of Port Hedland before this proposal is adopted.

11.1 Existing Conditions

Within the site there is no formal stormwater system, and the stormwater runoff currently infiltrates through the ground, or runs off, being channeled through the road reserves and via overland flow towards the adjoining coastal inlet.

11.2 Drainage Concept Plan

A catchment plan has been prepared based on the bulk earthworks concept and pavement preliminary design levels. The proposed piped drainage system and the stormwater overland flow routes are shown on the plan included as Appendix 1.

The concept plan proposes road pavements that are crowned with kerbs on both sides and stormwater collected in inlet pits along the road. Based on this layout a pit and pipe network is proposed for all the road areas with discharge to adjoining existing systems and to the coastal inlet.

Pit and pipe design must be designed to accommodate the 5 year Average Recurrence Interval, with a minimum conduit diameter of 300mm.

The roads are proposed to be generally below the lot levels so that storm flood routes are contained within the road reserves and naturally fall towards the coastal inlet to minimise the risk of flooding to residential properties.

Lot drainage will be ultimately directed to road reserves to outlet into existing drainage systems.

11.3 Stormwater Detention

The proposed stormwater concept has been designed in accordance with the Town of Port Hedland's requirements. Detention is proposed for stormwater within the lots only.

12.0 Disclaimer

JDSi have undertaken this assessment based on limited information and subsequently assumptions have been made which, if incorrect, have potential to change costs. Major cost implications exist through factors which cannot be assured at this time including upgrading and provision of utility services, WAPC conditions of development, Local Authority Scheme Requirements, ground conditions, timing of adjacent developments, etc.

While JDSi has taken all care in the preparation of the likely development requirements and has noted key assumptions, JDSi responsibility for the accuracy of this report is limited to reports of a similar nature prepared in accordance with current market practice and provides it only as an indicative summary of engineering requirements.

If any further information is required or should you wish to clarify any issue, please contact our office.

Infrastructure Report - Appendices

PLEASE NOTE: Several of the below appendices are duplicated in this Development Plan report. Full copies of the Infrastructure Report (and all of its appendices) will be forwarded to Council under separate cover. These appendices include:

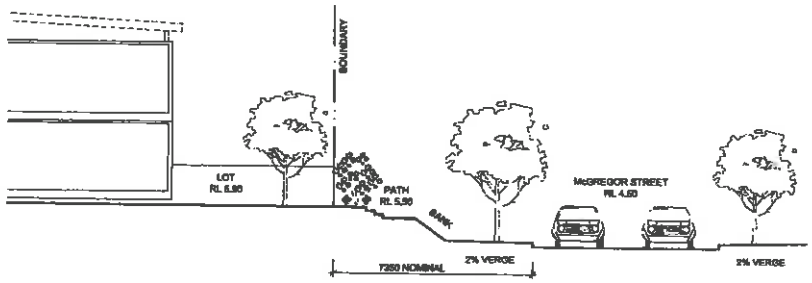
Appendix 1

Appendix 2

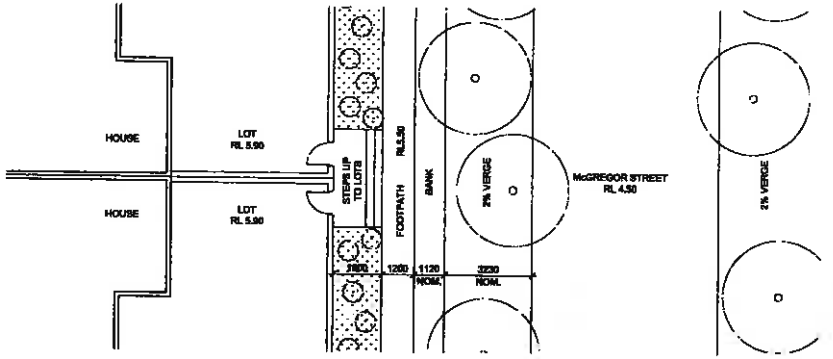
Appendix 3

Appendix 4

Appendix 9 – Indicative Architectural Masterplan

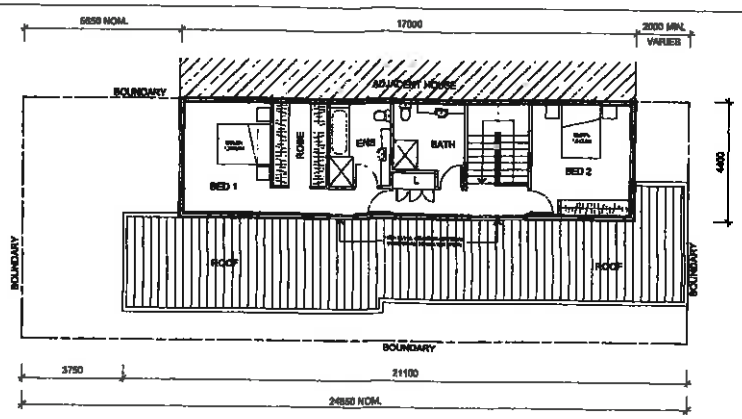


SECTION THROUGH RAISED PATH ADJACENT TO McGREGOR ST
SCALE 1:100

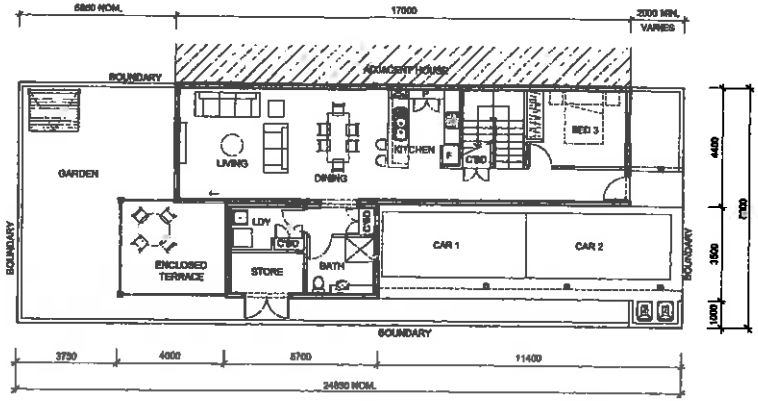


PART PLAN OF RAISED PATH ADJACENT TO McGREGOR ST
SCALE 1:100

FIRST FLOOR



GROUND FLOOR



3 BED HOUSE
SCALE 1:100

HOUSE SIZE (INTERNAL) = 149 sq.m.
LOT SIZE = 221 sq.m.

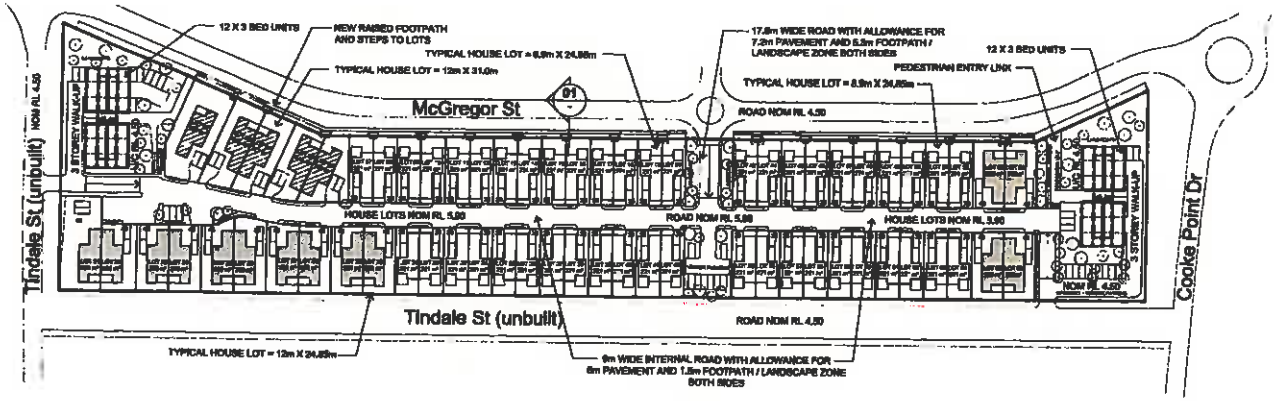
WINDOW SILL @ 1000 AFL
WINDOW HEAD @ 2100 AFL
WINDOW WIDTHS AS SHOWN

PARKING SCHEDULE

RESIDENT PARKING SPACES FOR EACH HOUSE = 2
TOTAL RESIDENT PARKING SPACES FOR HOUSES = 130

RESIDENT PARKING SPACES FOR EACH WALK-UP UNIT = 2
TOTAL RESIDENT PARKING SPACES FOR WALK-UPS = 48

VISITOR PARKING SPACES REQUIRED = 18 (T.B.C.)
VISITOR PARKING SPACES PROVIDED = 25



SCHEME YIELD :

3 BED HOUSES	= 46 ≈ 52% APPROX.
4 BED HOUSES	= 19 ≈ 21% APPROX.
3 BED 3-STOREY WALK-UP UNITS	= 24 ≈ 27% APPROX.

TOTAL DWELLINGS = 89

LEGEND

- 3 BED HOUSE
- 4 BED HOUSE - LOT TYPE A
- 4 BED HOUSE - LOT TYPE B

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS ON SITE. REPORT ANY DISCREPANCIES TO THE SUPERINTENDENT BEFORE PROCEEDING WITH THE WORK.

CLIENT
blaxland

PORT HEDLAND MASTERPLAN

LOT 4 CLARK STREET
DEVELOPMENT PLAN SCHEME

ARCHITECT
Ashton Raggatt McDougall

DATE 29.07.2011
SCALE 1:1000@A1
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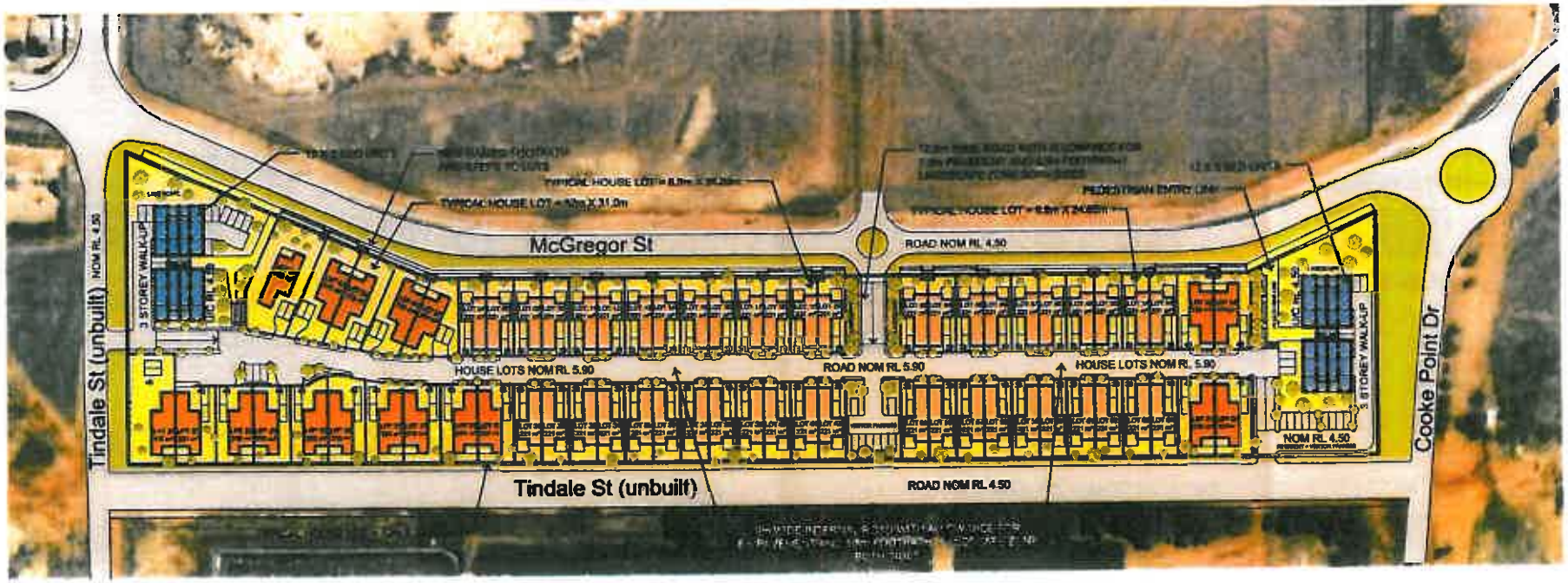
PROJECT NO.	DRAWING NO.	ISSUE
1211	SK146	06



SCHEME YIELD :

3 BED HOUSES	= 46 ≈ 51% APPROX.
4 BED HOUSES	= 20 ≈ 22% APPROX.
3 BED 3-STOREY WALK-UP UNITS	= 24 ≈ 27% APPROX.

TOTAL DWELLINGS = 90

LEGEND

- 3 BED HOUSE
- 4 BED HOUSE - LOT TYPE A
- 4 BED HOUSE - LOT TYPE B

DEVELOPMENT MASTERPLAN
LOT 4 CLARK ST PORT HEDLAND

DEVELOPMENT PLAN SCHEME

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS ON SITE. REFER ANY DISCREPANCIES TO THE SUPERINTENDENT BEFORE PROCEEDING WITH THE WORK.

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ARCHITECT
kriklis taylor architects
a level 7 97 pacific highway north sydney new 2060
m po box 725 north sydney nsw 2059
p +61(0)2 9900 8000 f +61(0)2 9900 8001
w www.kriklistaylor.com.au

DATE 28.07.11
SCALE 1:1500 @ A3

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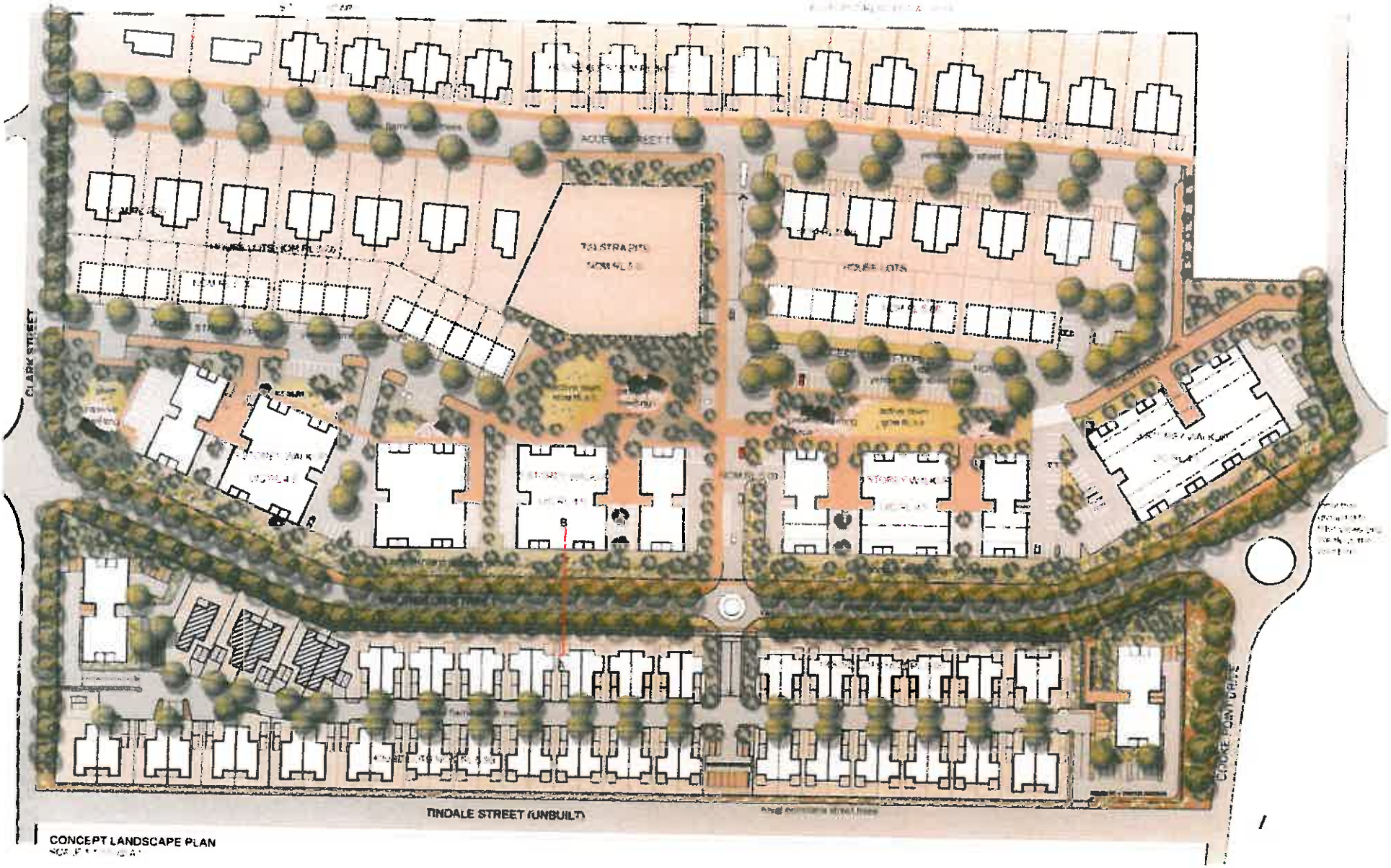
PROJECT NO.	DRAWING NO.	ISSUE
1211	SK 150	02

A3



CONCEPT LANDSCAPE PLAN

INDICATIVE PLANT LIST

Street Feature trees
Delonix regia
Tipuana tipu

Native feature trees for POS and wide verge planting
Eucalyptus vitrix
Eucalyptus bella
Eucalyptus herbertiana
Melaleuca viridiflora
Melaleuca argentia
Melaleuca leucadendra

Low - medium shrub planting
Acacia gregorii
Clianthus formosa
Thryptomene backeacea
Eremophila maculata var brevifolia
Trypomene backeana
Scaevola crassifolia 'Flat Fred'
Olearia axillaris 'Little Smoke'
Ptilotus exaltatus
Ptilotus nobilis
Senna artemisoides

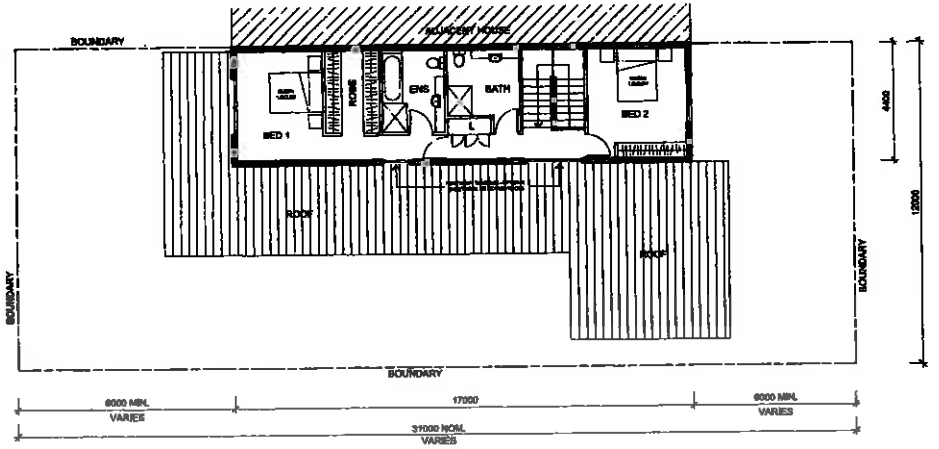
SECTION AB THROUGH McGREGOR STREET

udla blaxland

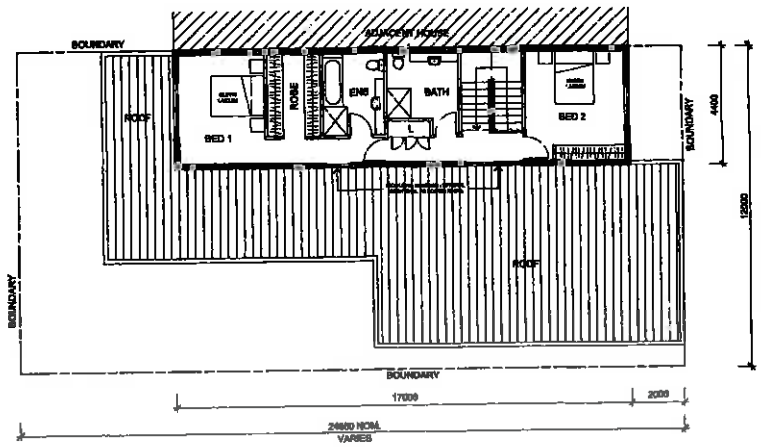
OT 4 CLARK STREET, PORT HEDLAND

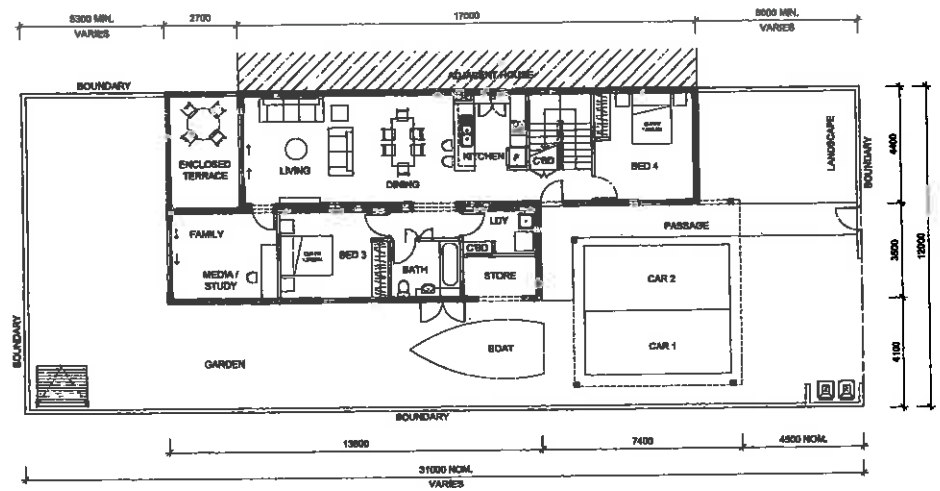
Appendix 11 – Conceptual Subdivision

Appendix 10 – Indicative Landscape Concept Plan

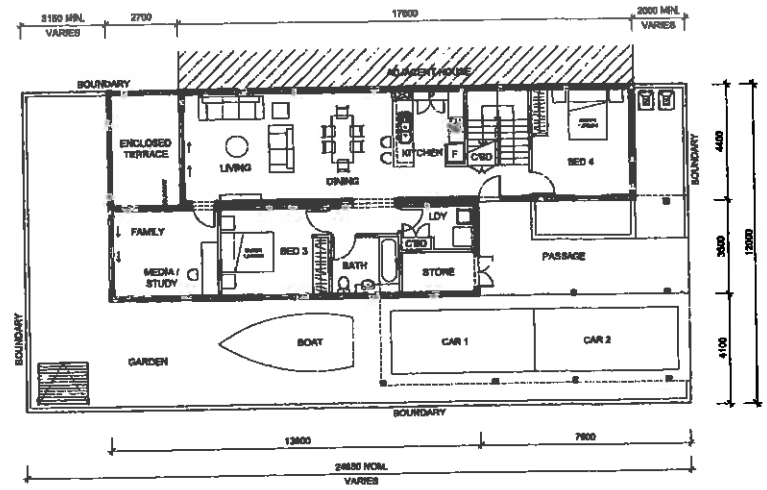


FIRST FLOOR





GROUND FLOOR



4 BED HOUSE - LOT TYPE A

SCALE 1:100

HOUSE SIZE (INTERNAL) = 176 sq.m.
LOT SIZE = 372 sq.m.

WINDOW SILL @ 1000 AFL
WINDOW HEAD @ 2100 AFL
WINDOW WIDTHS AS SHOWN

4 BED HOUSE - LOT TYPE B

SCALE 1:100

HOUSE SIZE (INTERNAL) = 176 sq.m.
LOT SIZE = 253 sq.m.

WINDOW SILL @ 1000 AFL
WINDOW HEAD @ 2100 AFL
WINDOW WIDTHS AS SHOWN

DO NOT SCALE DRAWINGS.
VERIFY ALL DIMENSIONS ON SITE.
REFER ANY DISCREPANCIES TO THE SUPERINTENDENT BEFORE PROCEEDING WITH THE WORK.

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PORT HEDLAND MASTERPLAN

LOT 4 CLARK STREET
DEVELOPMENT PLAN SCHEME

ARCHITECT
hillds taylor architects

DATE 29.07.2011
SCALE 1:100@A1

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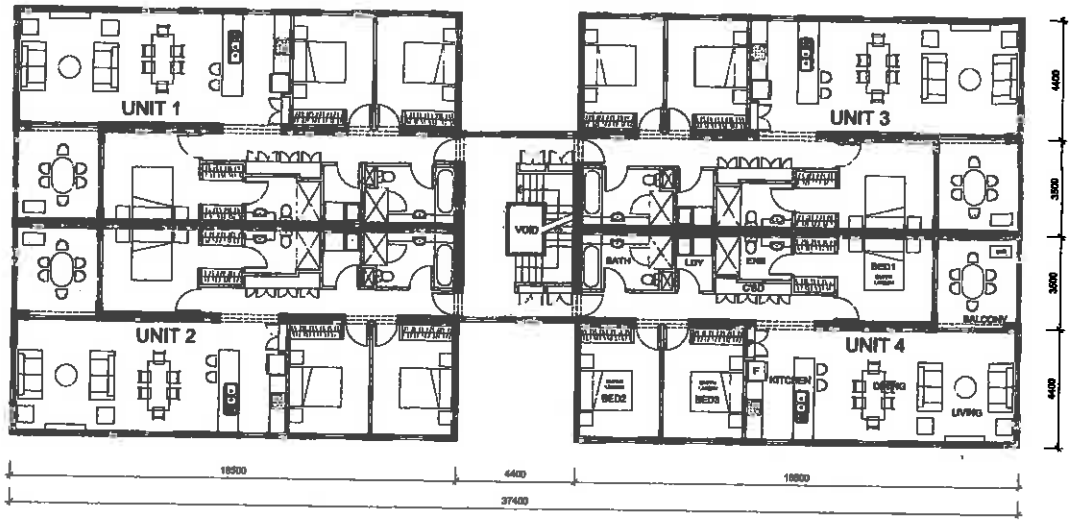
PROJECT NO. 1211
DRAWING NO. SK147
ISSUE 05

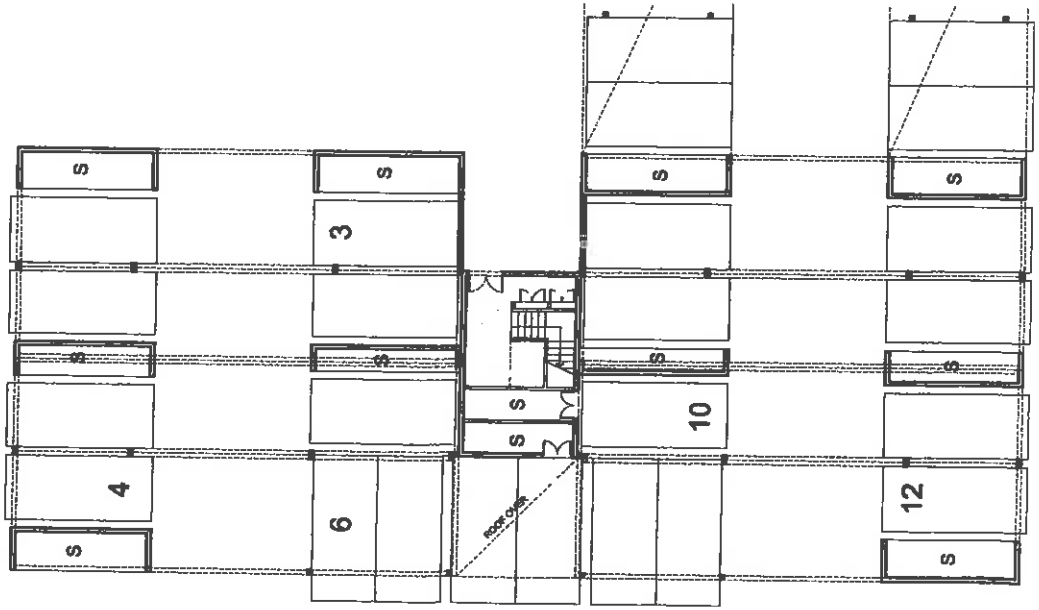
A1



TYPICAL FLOOR PLAN

UNIT SIZE (INTERNAL) = 112 sq.m.

WINDOW SILL @ 1000 AFL
WINDOW HEAD @ 2100 AFL
WINDOW WIDTHS AS SHOWN



UNDERCROFT LEVEL PLAN

CARPARK CAPACITY = 24 CARS

CLIENT
blaxland

PORT HEDLAND MASTERPLAN

3 STOREY - 3 BED WALKUPS

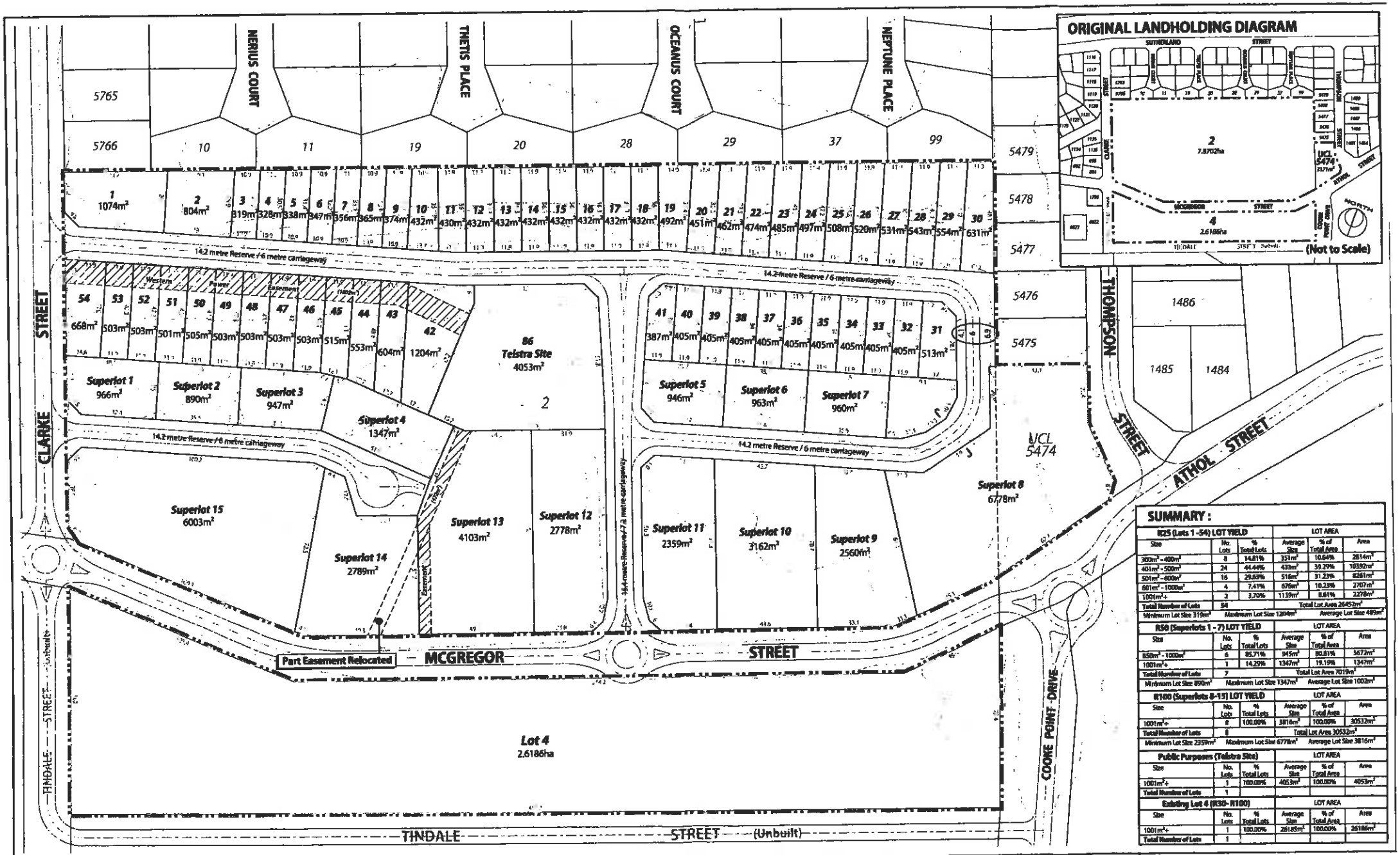
ARCHITECT
hillside taylor architects

DATE 28.07.2011
SCALE 1:100@A1

0 1 2 3 5 7.5M

PROJECT NO.	DRAWING NO.	ISSUE
1211	SK126	02

A4



ORIGINAL LANDHOLDING DIAGRAM

SUMMARY :

R25 (Lots 1 -54) LOT YIELD

Size	No. Lots	% Total Lots	LOT AREA Average Size	% of Total Area	Area
300m² - 400m²	8	14.81%	351m²	10.64%	2814m²
401m² - 500m²	24	44.44%	433m²	39.29%	10392m²
501m² - 600m²	16	29.63%	516m²	31.23%	8261m²
601m² - 1000m²	4	7.41%	676m²	10.23%	2707m²
1001m²+	2	3.70%	1139m²	8.61%	2278m²
Total Number of Lots	54		Total Lot Area 26452m²		
Minimum Lot Size 319m²	Maximum Lot Size 1204m²		Average Lot Size 489m²		

R50 (Superlots 1 - 7) LOT YIELD

Size	No. Lots	% Total Lots	LOT AREA Average Size	% of Total Area	Area
850m² - 1000m²	6	85.71%	945m²	80.81%	5672m²
1001m²+	1	14.29%	1347m²	19.19%	1347m²
Total Number of Lots	7		Total Lot Area 7019m²		
Minimum Lot Size 890m²	Maximum Lot Size 1347m²		Average Lot Size 1002m²		

R100 (Superlots 8-15) LOT YIELD

Size	No. Lots	% Total Lots	LOT AREA Average Size	% of Total Area	Area
1001m²+	8	100.00%	3816m²	100.00%	30532m²
Total Number of Lots	8		Total Lot Area 30532m²		
Minimum Lot Size 2359m²	Maximum Lot Size 6778m²		Average Lot Size 3816m²		

Public Purposes (Telstra Site)

Size	No. Lots	% Total Lots	LOT AREA Average Size	% of Total Area	Area
1001m²+	1	100.00%	4053m²	100.00%	4053m²
Total Number of Lots	1				

Existing Lot 4 (R30- R100)

Size	No. Lots	% Total Lots	LOT AREA Average Size	% of Total Area	Area
1001m²+	1	100.00%	26185m²	100.00%	26186m²
Total Number of Lots	1				

CONCEPTUAL SUBDIVISION

Lot 2 McGregor Street, Lot 5474 Thompson Street and Lot 4 Clarke Street
PORT HEDLAND
for: blaxland

ENDORSEMENT OF REGISTERED TOWN PLANNER

SIGNATURE: _____ DATE: _____

NOTES :

- AREA SUBJECT TO APPLICATION
- AREAS AND DIMENSIONS SUBJECT TO SURVEY
- CARRIAGEWAYS ARE DIAGRAMMATIC ONLY
- BASE DATA SUPPLIED BY LANDGATE

NORTH Scale 1: 1,500 @ A3
0 10 20 30 40 50 metres

COMPILED: DPS		DRAWN BY:	MDH
DATE:	20/07/2011	REVISED:	2/08/2011
GRID:	MGA 50	DATUM:	AHD
DRAWING NUMBER:	BLAPH001b	JOBCODE:	BLAPHLSP
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