Report on Preliminary Geotechnical and Environmental Investigation
Proposed Residential Development
Lot 2 McGregor Street, Port Hedland

1. Introduction

This report presents the results of a preliminary geotechnical and environmental investigation undertaken for a proposed residential development at Lot 2 McGregor Street and Lot 5474 Thompson Street, Port Hedland, which is commonly referred to as the "Telstra Site". The investigation was commissioned in an email dated 31 March 2011 by Mr John Beck of Blaxland Property Pty Ltd on behalf of Watson Properties 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;
- 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 potential contaminants.

The investigation included the excavation of 17 test pits, the performance of seven cone penetration tests and laboratory testing of selected samples. Details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site is known as Lot 2 McGregor Street and Lot 5474 Thompson Street in Port Hedland but is commonly referred to as the "Telstra Site". The site is bound by McGregor Street to the south, by Clark Street to the west, by existing residential housing to the north and by existing housing and Thompson Street to the east. The site is roughly rectangular in shape and covers an area of approximately 8.20 ha and has maximum dimensions of about 420 m in an east west direction and 180 m in a north south direction.

At the time of investigation the site was covered in grass with a Telstra building located at the centre of the site. There was a paved roadway leading from McGregor Street to the Telstra building and numerous buried services running across the site. A lake was located across the south-western corner of the site. Lot 5474 appeared to have been raised in level by approximately 2 m through the placement of sand filling.

The topography of the site slopes down towards the south from a maximum elevation on the northern boundary of RL 11.9 m AHD to a minimum level at the lake in the south-western corner of the site of RL 2.1 m AHD.

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. Field Work Methods

Field work was carried out on 13 to 16 April 2011 and included the performance of seven cone penetrometer tests (CPT) and the excavation of 17 test pits. Dynamic Cone Penetrometer testing (DCP) or Perth Sand Penetrometer (PSP) were performed alongside each test pit. Cable location clearance was done prior to each CPT and test pit being undertaken. A further visit was undertaken on 7 June for the purpose of taking additional environmental samples.

The CPTs (CPT18 to CPT24) 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 TP17) 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, TP5, TP7, TP8, TP12 and TP16 at 0.5 m intervals to depths of between 2.5 m and 3.0 m. Samples were placed immediately into labelled snap lock bags and 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 near surface soils immediately adjacent to test locations TP1, TP3, TP5, TP7, TP12, TP13, CPT18 and CPT 23 at depths of between 0.2 m and 0.45 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. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and cone penetration testing are presented in Appendix C, together with notes defining descriptive terms and classification methods. The ground conditions are presented in the cross sections in Appendix B and a summary of the ground conditions are given below:

Sand – orange, orange-brown and light brown, medium grained sand with a trace of silt for the full depth of excavation (2.6 – 3.1 m) in TP1 to TP10 and TP17.

Clayey Sand/Sandy Clay – dense to hard, light brown, medium grained, low plasticity, clayey sand/sandy clay was observed in TP11 to TP16 within the 3 m depth. The clay was mostly stiff to hard with the exception of TP14 where it is described as soft.

The results of the Cone Penetration Tests are summarised in Table 1 below whilst the results of the Test Pits are described in Table 2.

Table 1: Summary of Cone Penetration Test Results

Strata Description	Test	Depth of Interface (m) & Reduced Level (m AHD)						
		CPT18	CPT19	CPT20	CPT21	CPT22	CPT23	CPT24
	SL	10.1	8.0	8.5	4.4	4.3	3.7	3.9
SAND		md	md	md	md - vd	md - vd	d - vd	d - vd
Depth		7.4	4.5	5.6	1.3	1.6	1.0	1.0
RL		2.7	3.5	2.9	3.1	2.7	2.7	2.9
CLAY & SANDY CLAY		st - h	NE	st - v st	s - st	s - v st	s	s
Depth		8.8	4.5	6.3	5.3	3.4	4.2	4.5
RL		1.3	3.5	2.2	-0.9	0.9	-0.5	-0.6
SILTY SAND/ CLAYEY SAND		d - vd	md - d	md	v l	l - md	NE	NE
Depth		10.1	8.8	6.7	6.0	5.0	4.2	4.5
RL		0.0	-0.8	1.8	-1.6	-0.7	-0.5	-0.6
SANDY CLAY		st	NE	f - st	NE	NE	NE	NE
Depth		11.0	8.8	9.4	6.0	5.0	4.2	4.5
RL		-0.9	-0.8	-0.9	-1.6	-0.7	-0.5	-0.6
SAND		vd	md	md	md	v l	md	v l
Refusal Depth		11.2	9.0	9.5	6.0	6.8	4.5	5.1
RL		-1.1	-1.0	-1.0	-1.6	-2.5	-0.8	-1.2

NE = Not Encountered
SL = Surface Level

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

Table 2: Summary of Test Pit Results

Strata Description	Test	Depth of Interface (m) & Reduced Level (m AHD)								
		TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9
	SL	10.0	9.5	9.0	10.0	9.5	6.0	6.4	5.5	5.7
SAND		d	md - d	md - d	md - d	md - d	md - d	md	md	md
Depth		2.6	2.6	2.6	2.6	3.0	3.0	3.0	3.0	3.1
RL		7.4	6.9	6.4	7.4	6.5	3.0	3.4	2.5	2.6
CLAY & SANDY CLAY										
Depth										
RL										
SILTY SAND/ CLAYEY SAND										
Depth										
RL										
SANDY CLAY/ CLAY										
Target Depth										
RL										

Strata Description		Depth of Interface (m) & Reduced Level (m AHD								
	Test	TP10	TP11	TP12	TP13	TP14	TP15	TP16	TP17	
	SL	6.0	4.0	3.5	2.5	4.0	4.4	4.5	6.2	
SAND		d	md	l	l	md - d	md	md	md	
Depth		3.0	0.7	0.2	0.2	1.7	2.0	2.3	3.0	
RL		3.0	3.3	3.3	2.3	2.3	2.4	2.2	3.2	
CLAY & SANDY CLAY			NE	v st - h	st	s	v st	h		
Depth			0.7	1.3	2.8	2.7	2.8	3.0		
RL			3.3	2.2	-0.3	1.3	1.6	1.5		
SILTY SAND/ CLAYEY SAND			d	NE						
Depth			1.4	1.3						
RL			2.6	2.2						
SANDY CLAY/ CLAY			v st	st						
Target Depth			3.1	3.0						
RL			0.9	0.5						

NE = Not Encountered
SL = Surface Level

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The results show that there are some poor ground conditions in the vicinity of TP14 at shallow depth (i.e. around 2.0 m) and beyond depths of 2.7 m in CPT21 to CPT24. These conditions will influence the type of foundations used for the proposed development and the settlement under filling and building loads.

4.2 Groundwater

Groundwater was observed in test pits TP12-TP15 and measured in CPT21, CPT23 and CPT24. These observations indicated that the groundwater level was between RL 0.4 m AHD and RL 1.9 m AHD on 13 and 14 April 2011.

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 one sample; and
- the California bearing ratio and maximum modified dry density on two samples.

Results of the testing are summarised in Tables 3 and 4 and test certificates are presented in Appendix D.

Table 3: 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	1.2	Sand	5	0.15	0.37	-	-	-	-	-
TP5	1.2	Sand	4	0.16	0.37	-	-	-	-	-
TP11	1.1	Clayey Sand	27	<0.0135	0.32	-	-	-	-	-
TP11	1.5	Clay	-	-	-	-	-	-	-	4.8
TP15	1.4	Slightly Clayey Sand	13	<0.0135	0.23	-	-	-	-	-
TP15	2.4	Clay	-	-	-	76	26	50	17	-
TP16	2.8	Clay	-	-	-	69	25	44	9.5	-
TP17	0.9	Sand	9	0.08	0.29	-	-	-	-	-

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 4: Results of Laboratory Testing for Pavement Design Parameters

Test Location	Depth (m)	Soil Description	OMC (%)	MMDD (t/m^3)	CBR (%)
TP3	0.3	Sand	12.4	1.752	25
TP9	0.3	Sand	12.4	1.800	30

Where:
- 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 on selected soil samples by the ALS Group 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 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 Laboratory Group 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 (<0.5 m) considered to be the most likely soil horizon that may be impacted by contamination resulting from past site activities. A total of eight 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 pesticides (OCP); 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.

8. Proposed Development

It is understood that the proposed development comprises a mix of single unit dwellings, town houses and multistorey apartment blocks (up to seven floors) together with public open space, recreation facilities and internal access roads. At this stage, no information has been provided on the overall extent of earthworks anticipated for the development or the level of the individual building blocks. Consequently, the comments provided below are of a generic nature and will need to be reviewed as part of the concept design development to ensure that the overall project concept is consistent with the restraints imposed by the ground conditions. Essentially, the report provides an outline of the

geotechnical restraints and options for optimising the master plan to suit the restraints imposed by the current ground conditions.

In providing the advice below it is anticipated that there may be a desire on the behalf of the developer to amend the overall masterplan to limit the extent of ground improvement works required before building construction commences. For this reason and the fact that additional investigation will be required 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 northern part of the site and that filling depths towards the southern part of the site would be restricted to allow for uniform drainage across the site and to eliminate the current low spots in which surface water flow is ponding;
- Foundation loads will amount to 10 kPa per floor to enable estimates of building settlements;
- There are no restrictions on the type of foundations which can be utilised for the proposed buildings 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.

9. Comments

9.1 Ground Conditions

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

- The northern part of the site and along the eastern and western boundaries where conditions are predominantly sand to depths of about 3 m overlying a soil sequence comprising either stiff to hard clay or dense to very dense sand layers;
- A triangular shaped area based along McGregor Street at the southern end of the site where the surficial sand layers overly some soft clay layers which will impose some restraints on foundation design and could cause unacceptably high settlement if substantial thicknesses of filling are used to raise site levels. In addition to the poor ground conditions encountered on part of the site, groundwater levels have been recorded at shallow depths at the southern portion of the site and will therefore impose restraints upon earthworks and the installation of underground services. The triangular area is roughly defined by CPT21, CPT22 and CPT23 and CPT24 but the boundaries will require further investigations.

9.2 Geotechnical Restraints

The major geotechnical restraints imposed by the soil conditions are:

- Ground settlement as a result of compression of soft clay layers by loads imposed by additional filling to raise site levels and foundations;

- Groundwater depths. It would appear that the presence of surface water runoff in ponds at the southern side of the site has resulted in softening of the near surface soils which will make excavations for underground services more difficult than normal depending upon the extent of filling and foundation types chosen;
- The shrink / swell potential of the clay materials on site. This is relatively high but in most instances the clays are at depths in excess of 2 m below the site and should therefore not have a significant impact on the development unless deep excavations are proposed.

The site can be divided into two areas as indicated on Drawing 1 in Appendix B. Zone A consists of areas where the foundation conditions are relatively straightforward and will impose little or no restraint on building development. Zone B is underlain by some soft clay deposits which could lead to settlement under building loads if shallow foundations are utilised or under the loads imposed by site filling. These settlements will need to be taken into consideration in final design. Section 7.5 below provides preliminary estimates of potential settlements in Zone B based upon assumed building and filling loads and the variable conditions encountered in the cone penetration tests.

9.3 Site Suitability

The investigations so far indicate that the site is underlain by a variable soil profile comprising medium dense or dense sand to depths of up to 3 m overlying clay which in most instances is stiff or very stiff. There are, however, locations where the sand depth is less than 2 m and overlies soft clay. Whilst these conditions do impose some geotechnical restraints on the proposed development, such soil conditions are routinely encountered in many large infrastructure projects and are 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 particularly those in Zone B where there is shallow groundwater and soft clay. 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 limited to filling the existing depression near the southern boundary of the site to provide uniform gradient across the site for drainage of surface water flow. 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 is provided below.

9.4.1 Zone A

In Zone A, the existing conditions comprise sand to approximately 2 – 3 m overlying stiff to hard clay. Site preparation in these areas for the proposed buildings (which are mainly low rise structures up to two storeys) should comprise the following:

- 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 could be undertaken using a Perth Sand Penetrometer with a minimum resistance of 5 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.

9.4.2 Zone B

In Zone B where poor soil conditions are prevalent beneath the surficial sandy soil layers the following site preparation techniques are suggested:

- Drain the existing ponds to the southwest of the existing Telstra building and excavate any soft sediments that will prevent compaction of fill layers;
- If necessary, place a bridging layer including geofabrics over the existing natural soils. The bridging layer will need to be approximately 0.5 m thick as a minimum to enable compaction of the material placed immediately above;
- Strip the vegetation and the topsoil from all other areas. These materials could be stockpiled for use in landscaping mounds or alternatively, removed from the site;
- Proof roll all areas to be occupied by buildings and pavements with a roller of at least 10 tonne static weight. A smooth drum roller would probably be best for this process as the near surface soils predominantly comprise sandy materials;
- Carry out a close inspection of the proof rolling by an experienced geotechnical engineer who would advise on the necessity to either excavate soils causing excessive deflection or other procedures to ensure that the base of the filling is adequately compacted to enable placement and compaction of fill embankments;
- Place and compact granular filling to achieve a minimum density ratio of 95% of the modified maximum dry density or 85% density index.

As for the treatments suggested for Zone A measures should be taken to prevent erosion of the near surface sandy soils after the filling has been completed. Testing could be undertaken using a nuclear density meter or a Perth Sand Penetrometer as indicated 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 (CPT23 and CPT24) and at two

typical locations in Zone A. CPT23 and 24 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 60 kPa building load which has been adopted for a six level of suspended floors for the multistorey buildings.

The results are presented in Appendix E and are summarised in Table 5 below.

Table 5: Settlement Estimates (in mm)

CPT	2 m of Filling			2 m of Filling + 60 kPa Building		
	At 1 Year	20 Years	Difference	1 Year	20 Years	Difference
23	65	86	21	162	183	21
24	51	73	22	127	150	23
19	24	24	0	60	60	0
20	21	21	0	53	35	0

Zone A

The results of the settlement analysis for Zone A shows that settlement under 2 m of new filling (i.e. 40 kPa) would be completed in about 6 months with residual settlement of close to zero. An additional 36 mm occurs with a 60 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 just feasible to utilise a soft slab to support 6 storey buildings.

Zone B

The results indicate that for the poorest conditions encountered near the southern boundary of the site, settlements of 50 – 65 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 60 kPa building load is applied coincidentally with the 2 m of filling the settlements increase substantially to 130 – 160 mm after one year then increasing to 150 – 180 mm at the end of a 20 year period. This analysis indicates that founding buildings on a shallow raft slab in the poorer southern areas of site is not feasible. 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 be only 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 large buildings in Zone A so that

the impacts of settlement are much less due to the more favourable soils conditions in the northern 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;
- 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 bored 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 drive 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 six storey buildings.

9.7 Pavement Design Parameters

The investigation indicates that the site is underlain principally by sandy soils to depths of approximately 2 m over most of the site. For these soils it is considered that a design CBR of 10% would be appropriate. Laboratory testing of two near surface sands for California Bearing Ratio returned CBR values of 25% and 30%. However, there are indications of variable compaction and silt content in the near surface sands and for this reason the measured values have been downgraded for pavement design.

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 at least 2 m of well compacted sand which has a low shrink / swell capacity. However, the material directly beneath the sand is of medium to high plasticity with a high potential for shrinking and swelling under fluctuating moisture conditions. In addition, a shrink / swell index of 4.8% was measured for a sample of brown clay taken from a depth of 1.5 m in Test Pit 11. Accordingly, it is suggested that for planning purposes the entire site be classified as Class M. When final site levels are known it may be possible to reduce this classification particularly along the northern boundary where single dwellings will be constructed and where it is unlikely that any excavation will be necessary to form the level areas for building construction.

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 6 below shows the measured groundwater levels in the cone penetration tests and the test pits. Of the 24 total tests performed groundwater was observed at only seven locations and of these four test pits noted seepage only. It is therefore possible that the tests did not penetrate into the permanent groundwater although the site is at a relatively low elevation where groundwater flows would be expected.

Table 6: Groundwater Depths and Levels

Test No.	Surface Level (m)	Groundwater Depth (m)	Groundwater Level (m AHD)	Comments
CPT 21	4.4	2.5	1.9	
CPT 23	3.7	2.1	2.6	
CPT 24	3.9	2.1	2.8	
TP 12	3.3	2.9	0.4	Seepage
TP 13	2.5	2.1	0.4	Seepage
TP 14	4.0	2.6	1.4	Seepage
TP 15	4.4	2.9	1.5	Seepage

In order to record groundwater levels and possible seasonal fluctuations it is suggested that monitoring wells be installed during the detailed investigation that will be required.

9.12 Stormwater Disposal

The site is underlain by up to 3 m of fine to medium grained sand which is normally satisfactory for stormwater disposal. It is noted, however, that the sand is underlain by low permeability clay and that the sand thickness decreases in a southerly direction across the site. Disposal of the stormwater into the sand on the higher portion of the site may therefore cause problems at the lower end of the site because of restricted flow. It is therefore recommended at this stage that stormwater be disposed of into subsurface drains rather than into soakage trenches on the site.

10. Further Geotechnical Investigation

The investigations so far have been restricted to cone penetration tests at eight locations and 17 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 7.

Table 7: 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.

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 below the adopted action criterion of 0.03% S for all samples submitted for analysis.

Based upon on the above information, it is considered that the risk of acid sulphate soils to a depth of 3.0 m is low and a specific ASS management plan would not be warranted for excavations of less than 3.0 m.

11.3 Conclusions

Based upon the laboratory testing, DP concludes that the risk of acid sulphate soils to a depth of 3.0 m below the existing surface level is low, which is consistent with the published risk mapping.

12. Soil Quality Assessment

12.1 Adopted Assessment Criteria

The adopted site assessment criteria (SAC) for soils are derived from Ecological Investigation Levels (EILs) and Health-based Investigation Levels (HILs) for residential use with accessible soils presented in Table 1 of the DEC publication *Assessment Levels for Soils Sediment and Water* r1 (2010).

Contaminant concentrations below the adopted EILs are generally accepted as indicating negligible potential phytotoxic impact. Contaminant concentrations above these EILs 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 HILs. 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 8.

Table 8: 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	-
Benzo(a)pyrene	1	1	-

Analyte	Ecological Investigation Levels[1]	Health -based Investigation Levels - Residential[2]	Background Ranges[3]
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 8 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 eight soil samples submitted.

12.3 Conclusions and Recommendations

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 should be noted that only a limited number of near surface soil samples were collected as part of the assessment which 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, however, provides a preliminary evaluation of the soil quality at the site.

It should also be noted that at the time of the investigation the surface of the site was heavily vegetated with grasses. In this regard, although considered unlikely based upon the observations made during the fieldwork, the potential for fly tipped material including possible asbestos containing materials (ACM) cannot be ruled out.

The investigation did not include an assessment of groundwater quality at the site. Given the shallow depth of groundwater reported in the investigation, potential impacts to groundwater quality resulting from surrounding landuses and/or historical site activities should also not be ruled out.

Limitations

Douglas Partners (DP) has prepared this report for a project at the "Telstra 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 behalf of Watson Properties Pty Ltd on 31 March 2011. The report is provided for the exclusive use of Watson Properties 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.

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 – Environmental Report

VDM CONSULTING

Environmental Review

Proposed Development of the Telstra Site

Port Hedland

Issue No. 2

July 2011

Document Control Record

VDM Environmental 310 Selby Street North Osborne Park WA 6017			
Telephone:	(+61) (08) 9241-1800	**File Reference:**	U:\2010\100818_Telstra_Site_Port_Hedland
Facsimile:	(+61) (08) 9241-1999	**Date of Issue:**	22 July 2011
email:	enquiries@vdmconsulting.com.au	**Project Leader:**	Ciaran Lavery

Title:	Environmental Review (Issue 2) Proposed Development of the Telstra Site 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 of the Telstra Site 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
1	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

VDM Consulting was requested to undertake an environmental review as part of the due diligence for the proposed development of the Telstra Site, Lot 20 McGregor Street, Port Hedland. The site is bound by existing residential development to the north and east, McGregor Street to the south and Clark Street to the west. To the south of McGregor Street is open land (Lot 4) and the Waste Water Treatment Plant and Disposal Ponds.

It is the intention to develop the site with a mixture of residential uses with roadways and open spaces. The existing Telstra infrastructure is to be retained within the development.

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 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	Contamination of surface soils is not evident. 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	 Existing infrastructure remains as part of development. 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 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.

Table of Contents

List of Figures

1. Introduction

VDM Environmental was requested to undertake an environmental review as part of a due diligence for the proposed development of Lot 20 (Telstra Site) Port Hedland. It is the intention to develop the site for residential development whilst the existing Telstra infrastructure will be retained.

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

Lot 20 (Telstra Site) McGregor Street Port Hedland is some 7.9ha in extent and is bound by existing residential development to the north and east, McGregor Street to the south and Clark Street to the west. To the south of McGregor Street is open land (Lot 4) and the Waste Water Treatment Plant and Disposal Ponds (Figures 1, 2 and 3).

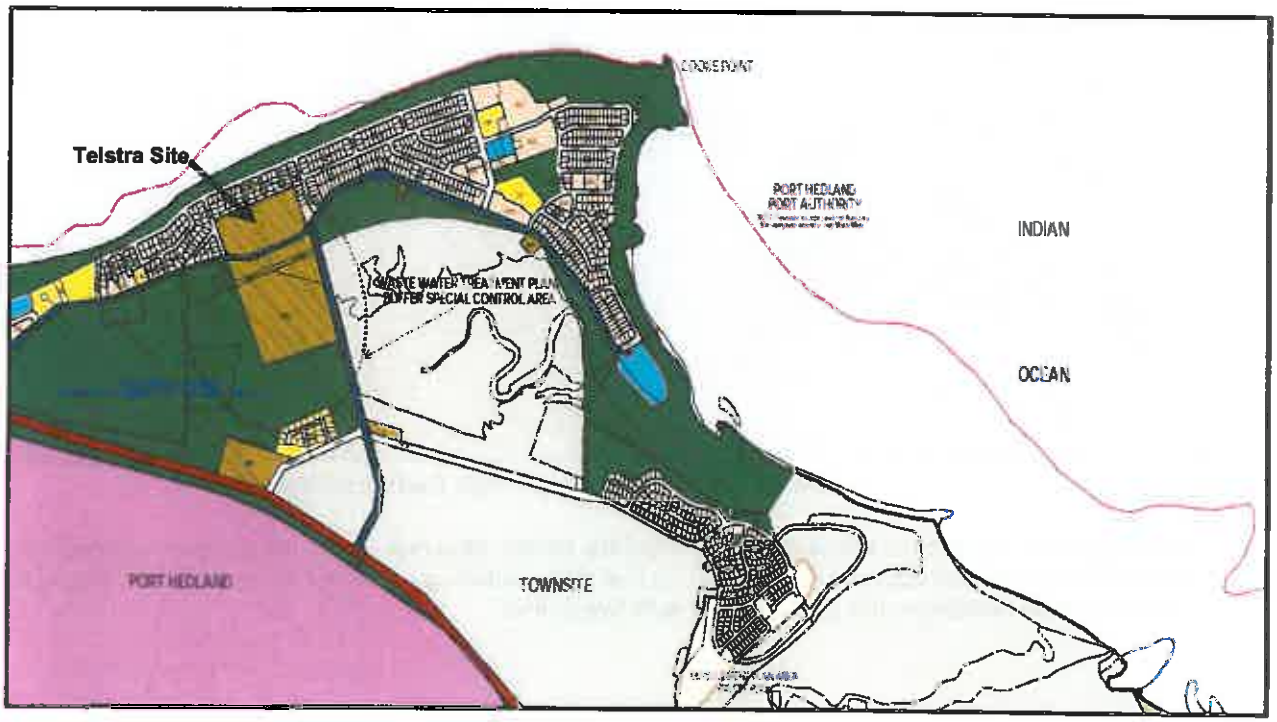


Figure 1: Location.

Figure 2: Aerial Photograph.

Figure 3: Aerial Photograph with Cadastral Map.

The proposed residential development comprises mixed densities with public open spaces whilst the existing Telstra infrastructure will remain. The five storey building is highlighted in yellow in Figure 4 below. This is the only building in the development with five stories.

Figure 4: Development Plan.

2.2 Land Use and Zoning

Lot 20 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:

- Residential: west north and east.
- Telecommunications, Waste Disposal and Treatment and Parks and Recreation: south-west, south and south-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 qui te 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.

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

The site is sparsely vegetated by open grassland and supra-tidal/saline mudflats. 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% (1577km^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) alterations have been made to the scope of works and layout of the site. There will be no six storey buildings on the site, with the highest now being five storeys. The site sections displayed below demonstrate the gradient from the top of the five storey buildings towards the beach.

The distance from the five storey building to the beach is approximately 220 m. It can be seen that the light from the five storey building will be obscured from the existing residential buildings between the site and the beach (Figure 6). It is highly unlikely that light from the proposed development will impact upon nesting activities for the flatback turtles.

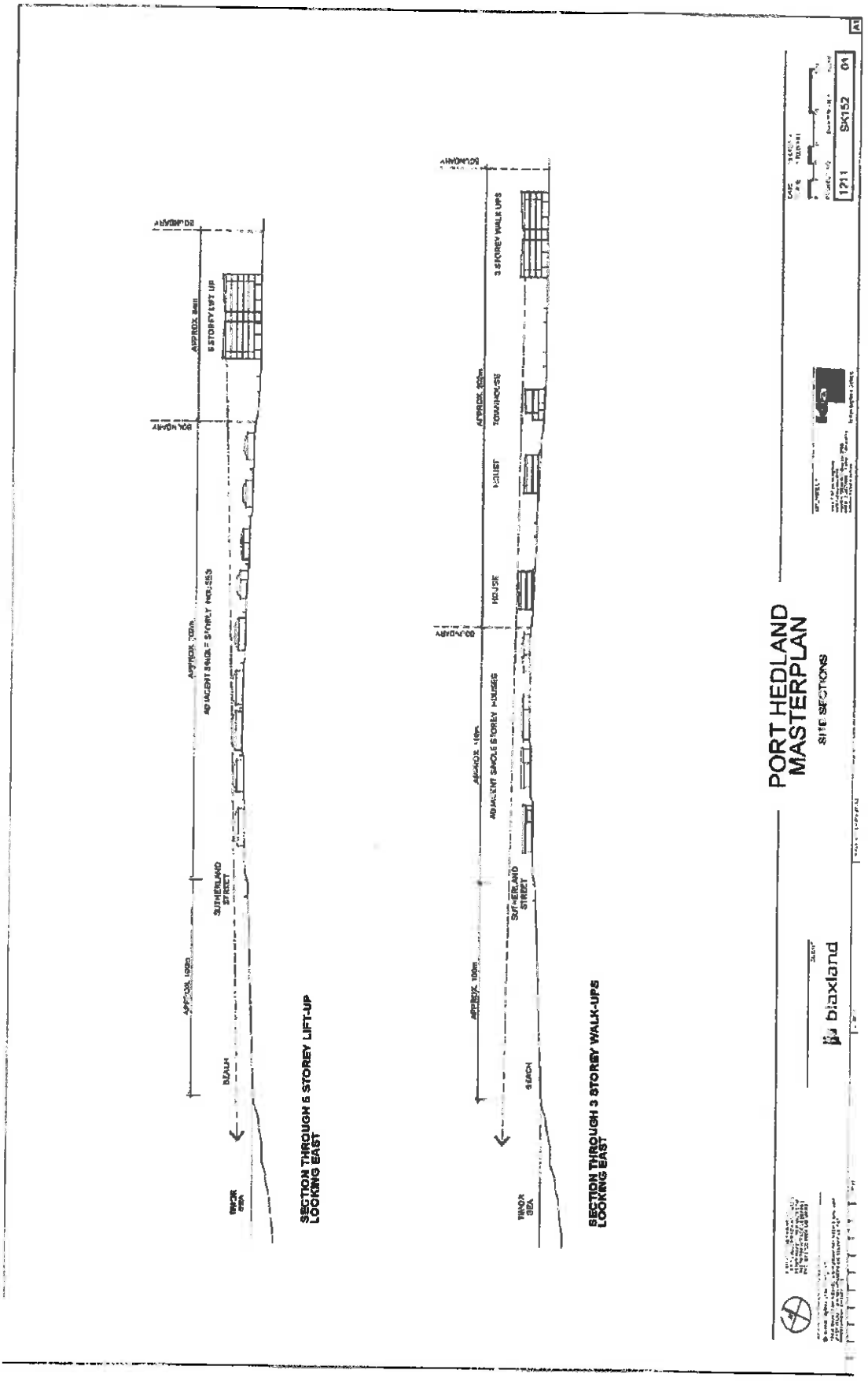


Figure 6 – Cross Section of Area

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 comprises landforms that include dunes (northern portion of site across higher elevations; Figure) and mangroves and mud flats (southern two thirds of site).

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).

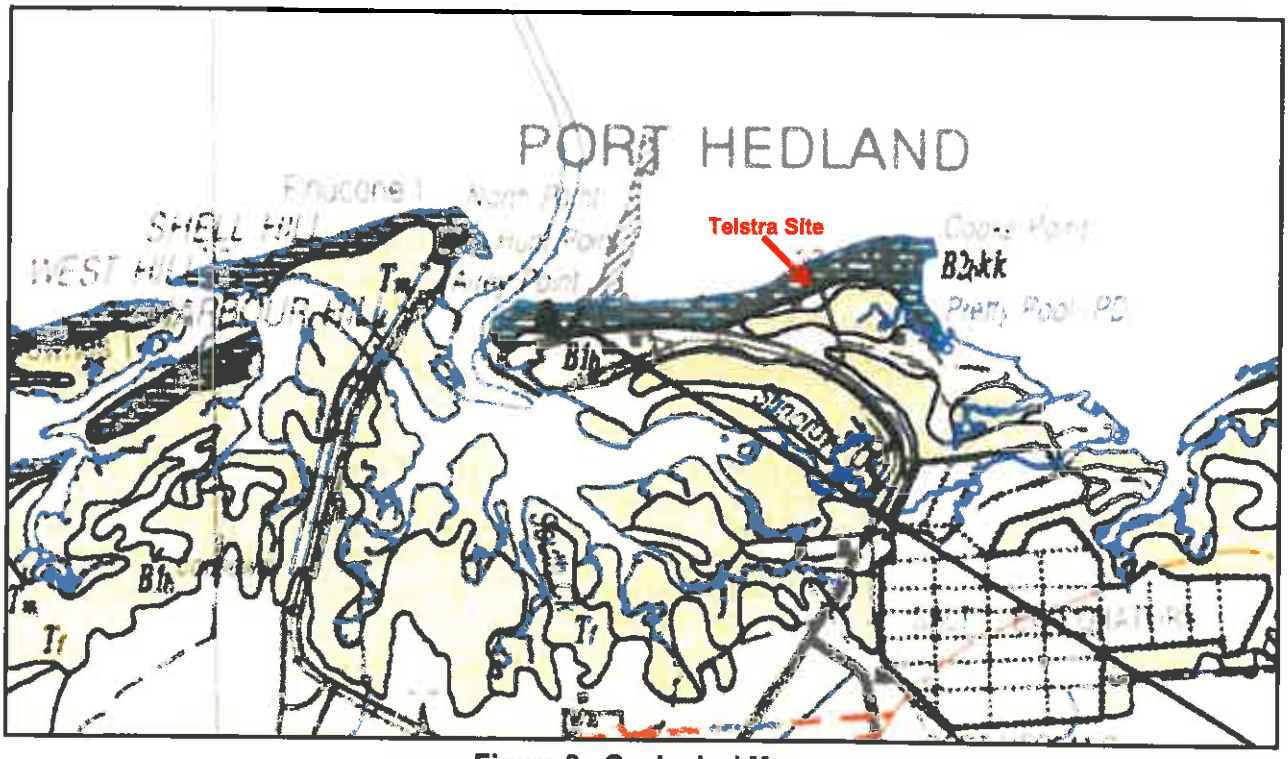


Figure 8: Geological Map.

4.6.1 Soil Contamination

Whilst there are indications that site soils have been disturbed (clay pit and in the south-west portion of the site with firebreaks along perimeters of the site; 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.

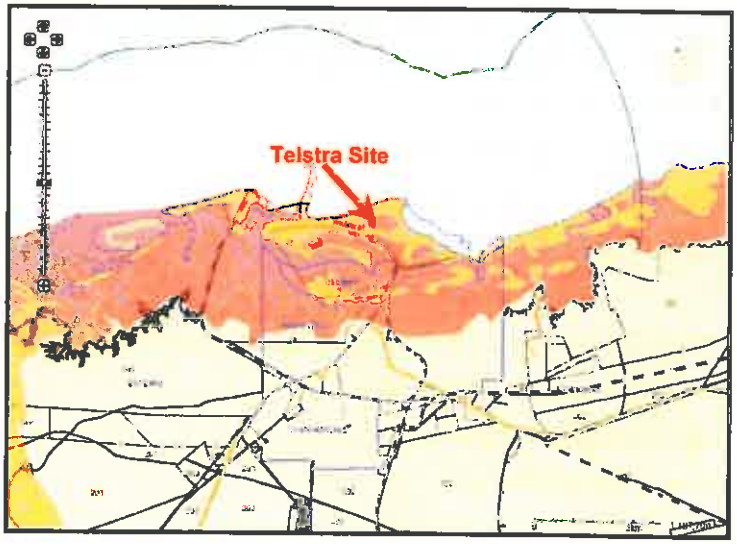
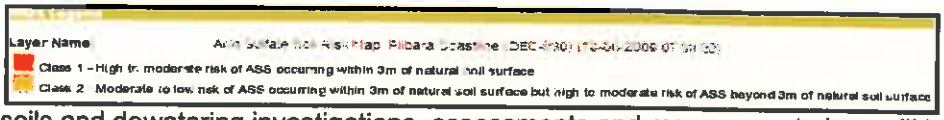


Figure 9: Acid Sulfate Soils.



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 floodprone 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 a portion of 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
- 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

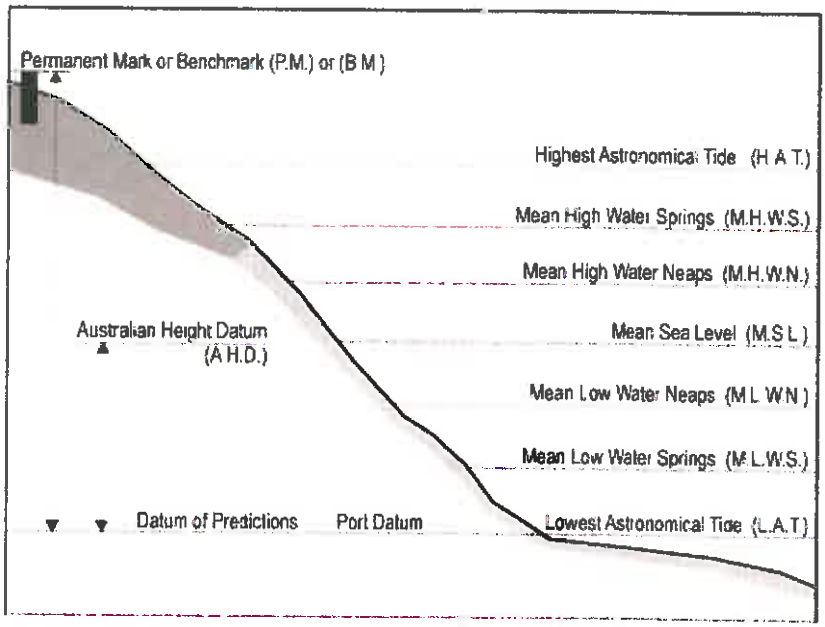


Figure 11: Key to Tidal Data (BoM, 2010).

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 south-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 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 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	 Existing infrastructure remains as part of development. 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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Town of Port Hedland: Town Planning Scheme No. 5.

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.

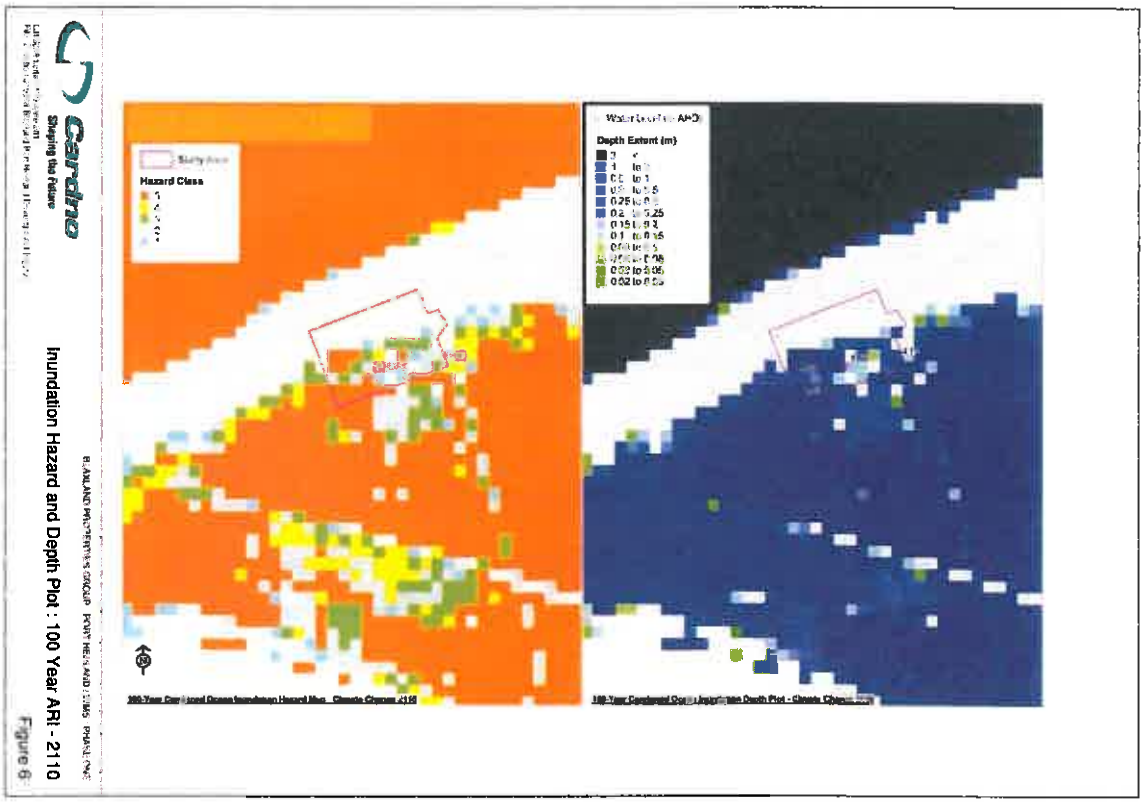


FIGURE 3.1 EXTRACT FROM CARDNO STORM SURGE PROJECTIONS

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:

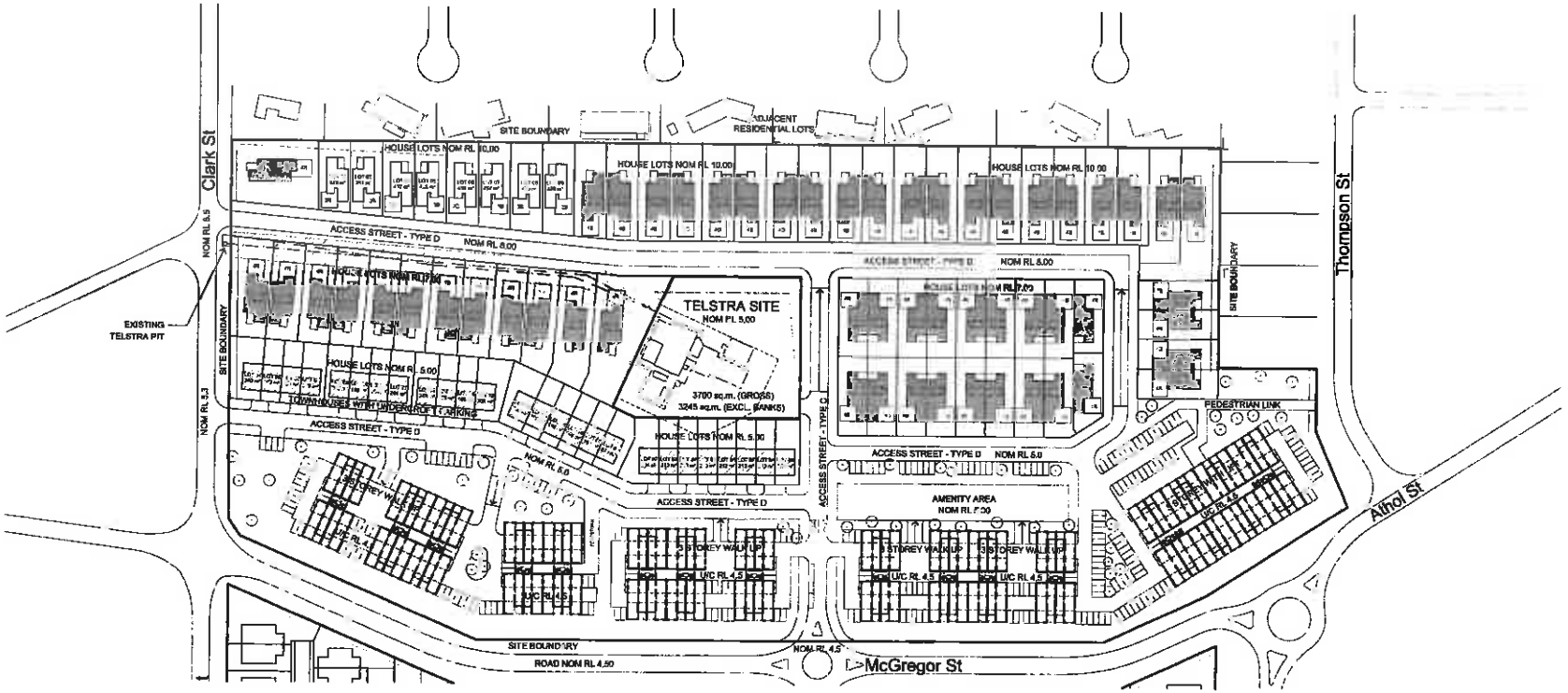
Appendix 1

Appendix 2

Appendix 3

Appendix 4

Appendix 9 – Indicative Architectural Masterplan



ACCESS STREET TYPES:

TYPE C - 15.4m WIDE - 7.2m CARRIAGE WAY WITH 4.1m WIDE LANDSCAPE / PAVEMENT EITHER SIDES (ALLOWS FREQUENT ON-STREET PARKING)
TYPE D - 14.2M WIDE - 6.0m CARRIAGE WAY WITH 4.1m WIDE LANDSCAPE / PAVEMENT EITHER SIDES

RESIDENT CAR PARKING SPACES		
	REQUIRED	PROVIDED
HOUSES	178	178
3 STOREY WALK-UPS	288	288
5 STOREY LIFT-UP	160	144

VISITOR CAR PARKING SPACES		
	REQUIRED	PROVIDED
HOUSES	18	ON-STREET
3 STOREY WALK-UPS	29	25
5 STOREY LIFT-UP	16	12

LEGEND:

- EASEMENT ZONE
- 4 BED DETACHED HOUSE
- 4 BED SEMI-DETACHED HOUSE
- 3 BED DETACHED HOUSE
- 4 BED TOWNHOUSE

SCHEME YIELD:

4 BED DETACHED HOUSES	= 33	≈ 10% APPROX.
4 BED SEMI-DETACHED HOUSES	= 22	≈ 07% APPROX.
3 BED DETACHED HOUSES	= 08	≈ 03% APPROX.
4 BED TOWNHOUSES	= 26	≈ 08% APPROX.
3 STOREY WALK-UPS	= 144	≈ 46% APPROX.
5 STOREY LIFT-UP	= 80	≈ 26% APPROX.
TOTAL DWELLINGS	= 313	

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

CLIENT
blaxland

PORT HEDLAND MASTERPLAN

DEVELOPMENT PLAN SCHEME

ARCHITECT
buffalo taylor architects

DATE 08.09.2011
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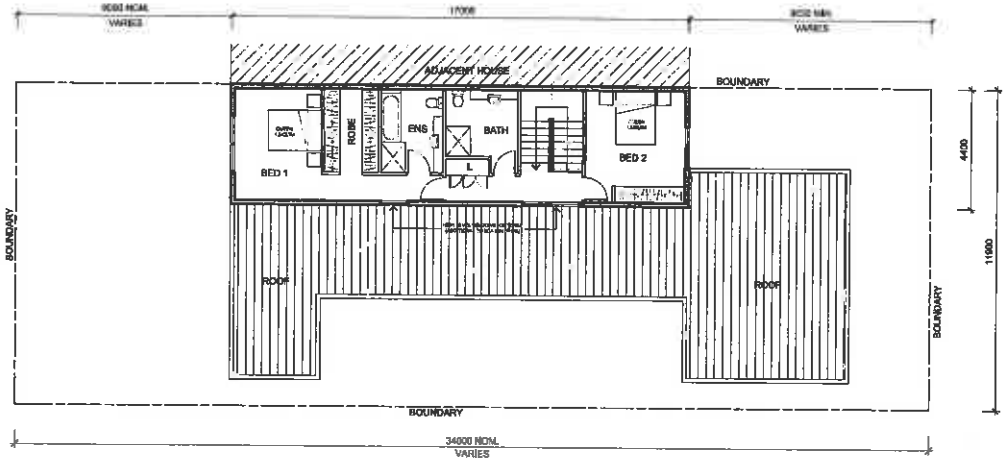
PROJECT NO.	DRAWING NO.	ISSUE
1211	SK165	02

A1

100mm 200mm 300mm ON ORIGINAL



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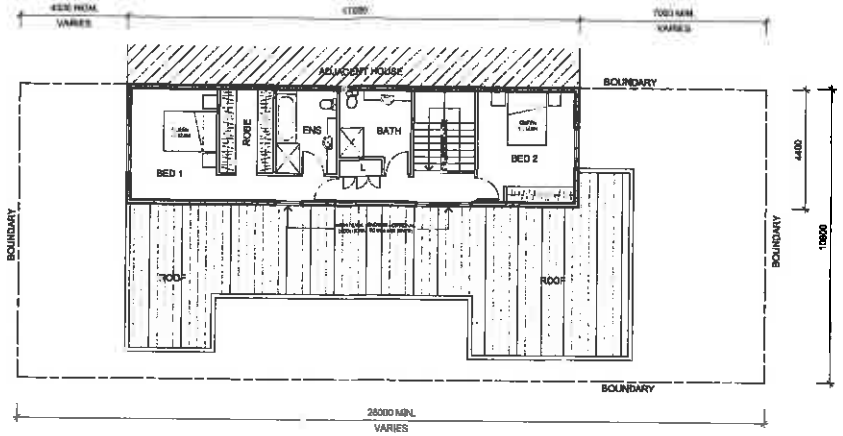
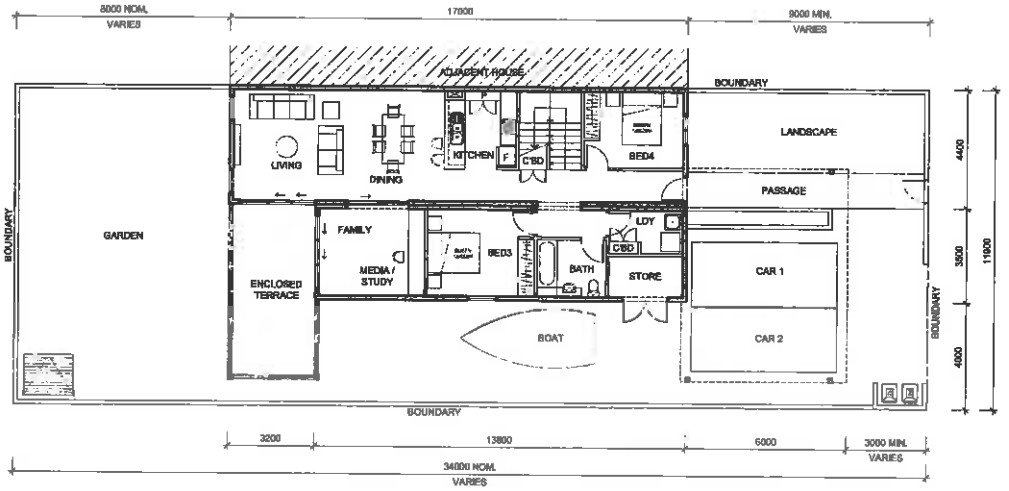
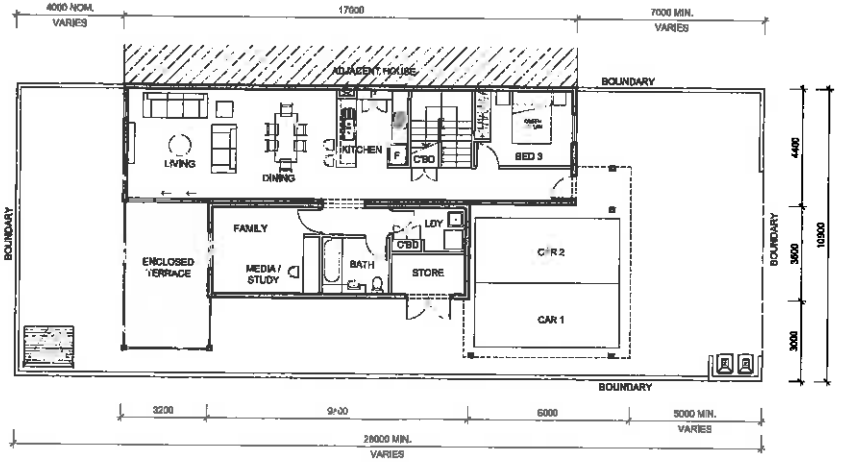




GROUND FLOOR



4 BED HOUSE
SCALE 1:100

HOUSE SIZE (INTERNAL) = 178 sq.m.
LOT SIZE = 405 sq.m.

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

3 BED HOUSE
SCALE 1:100

HOUSE SIZE (INTERNAL) = 163 sq.m.
LOT SIZE = 305 sq.m.

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

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

LOTS 2 & 5474 McGREGOR STREET
HOUSE PLANS

ARCHITECT
Ivrilde taylor architects

DATE 29.07.2011
SCALE 1:100@A1
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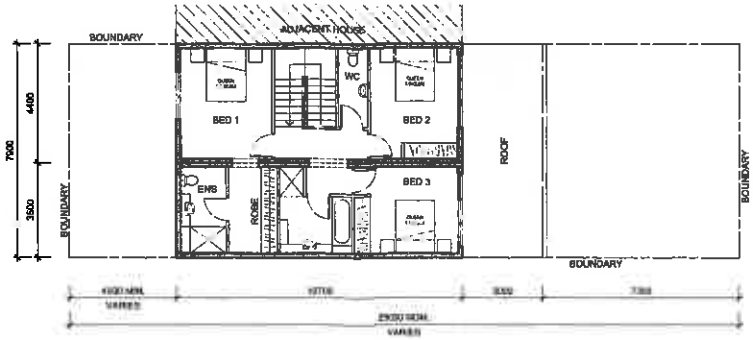
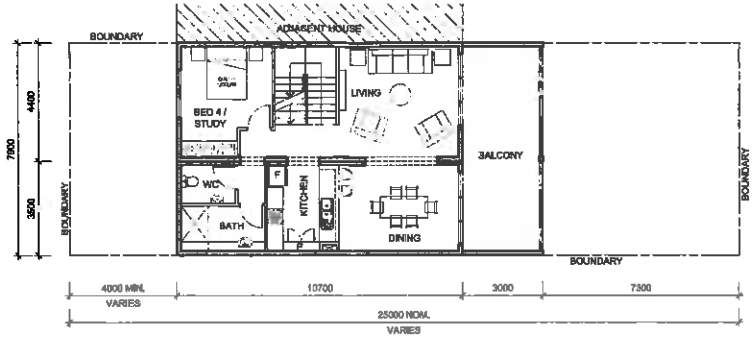
PROJECT NO.	DRAWING NO.	ISSUE
1211	SK160	01

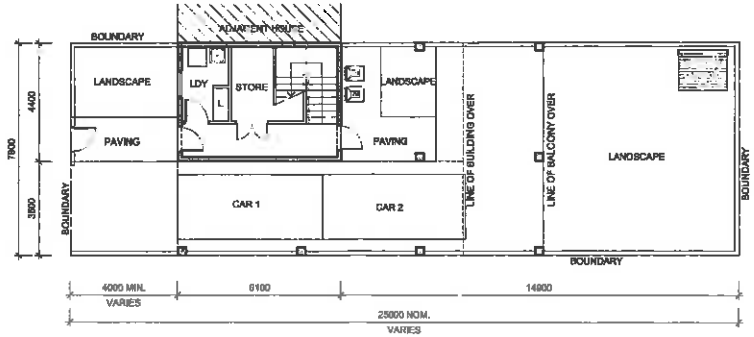
A1



LEVEL 2 PLAN



LEVEL 1 PLAN



UNDERCROFT LEVEL PLAN

4 BED TOWN HOUSE
SCALE 1:100

HOUSE SIZE (INTERNAL) = 189 sq.m.
LOT SIZE = 198 sq.m.

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

DO NOT SCALE DRAWINGS.
VERIFY ALL DIMENSIONS ON SITE.
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CLIENT
blaxland

PORT HEDLAND MASTERPLAN

LOTS 2 & 5474 McGREGOR STREET
HOUSE PLANS

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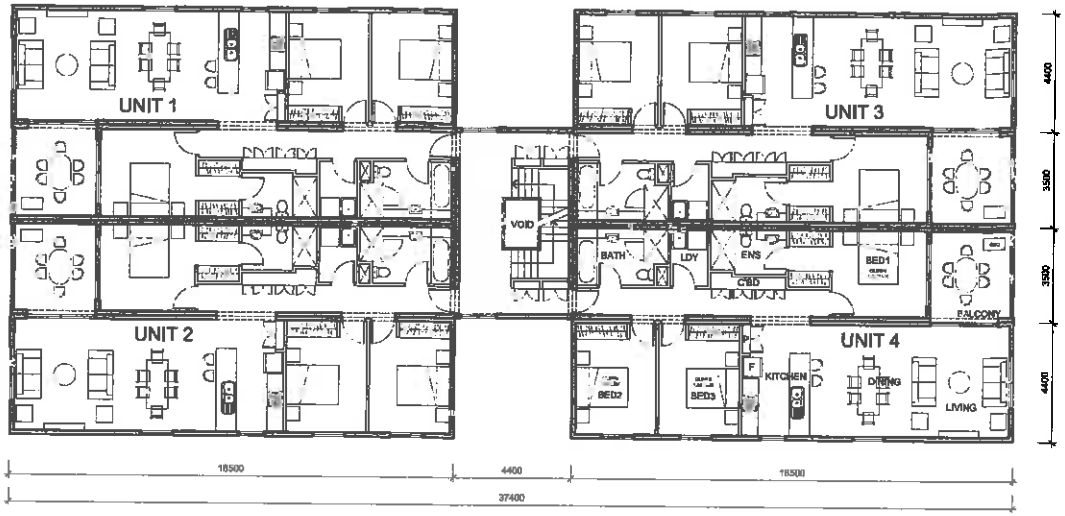
w www.ivrillataylor.com.au

DATE 29.07.2011
SCALE 1:100@A1
0 1 2 3 5 7.5M

PROJECT NO.	DRAWING NO.	ISSUE
1211	SK161	01

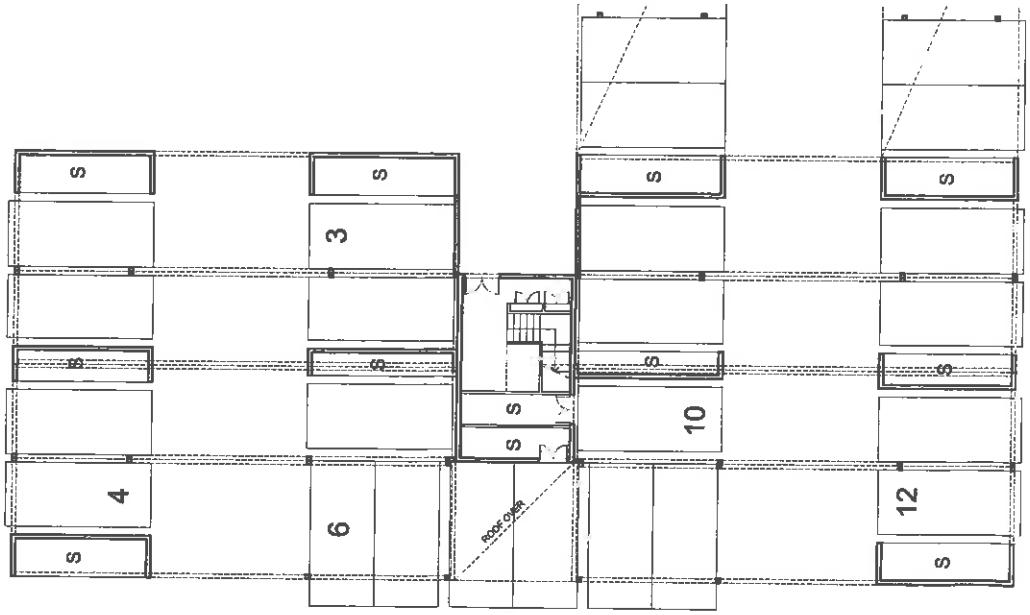
A1



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

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

3 STOREY - 3 BED WALKUPS

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w www.ivrkilistaylor.com.au

DATE 29.07.2011
SCALE 1:100@A1

0 1 2 3 5 7.5M

PROJECT NO.	DRAWING NO.	ISSUE
1211	SK126	02

A1

Appendix 10 – Indicative Landscape Concept Plan

INDICATIVE PLANTING

Street feature trees

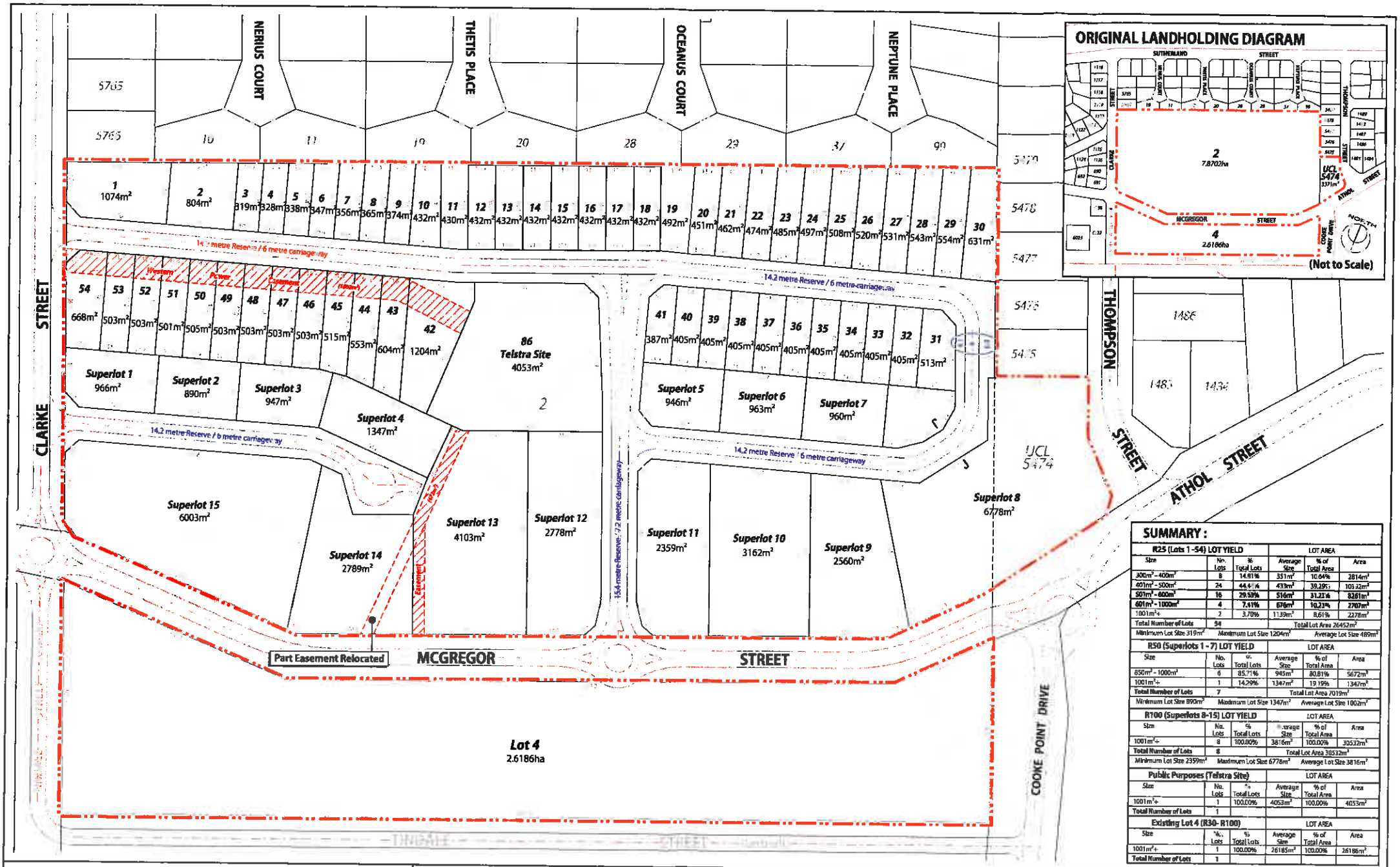
Native feature trees for POS and wide verge planting

Low - medium shrub planting

udla blaxland

01 4 CLARK STREET, PORT HEDLAND

Appendix 11 – Conceptual Subdivision



ORIGINAL LANDHOLDING DIAGRAM

SUMMARY :

R25 (Lots 1 -54) LOT YIELD			LOT AREA		
Size	No. Lots	% Total Lots	Average Size	% of Total Area	Area
300m² - 400m²	8	14.81%	351m²	10.64%	2814m²
401m² - 500m²	24	44.44%	433m²	39.39%	10322m²
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			LOT AREA		
Size	No. Lots	% Total Lots	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			LOT AREA		
Size	No. Lots	% Total Lots	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)			LOT AREA		
Size	No. Lots	% Total Lots	Average Size	% of Total Area	Area
1001m²+	1	100.00%	4053m²	100.00%	4053m²
Total Number of Lots	1				

Existing Lot 4 (R30- R100)			LOT AREA		
Size	No. Lots	% Total Lots	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
FILE ID:	M:\BLAPH\BLAPH001b.dgn		

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