WOOD & GRIEVE ENGINEERS

Anketell Strategic Industrial Area

Engineering Services and Infrastructure Plan Report

Prepared for:

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Revision

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1	28 November 2013	Draft Submission	**Justin Zelones**
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3	1 July 2015	Updated to reflect new project reports	**Justin Zelones**
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The Anketell Port Project was initiated by the Western Australian Government in 2010 in response to ongoing demand to export iron ore and other commodities from the Pilbara region, and the lack of independent port capacity and infrastructure provision within the region.

The Strategic Industrial Area (SIA) has been planned to enable industry to be established for the support of the proposed Anketell Port and future surrounding mining operations. The SIA will comprise a number of areas and include both heavy industry areas and a general industry area. The SIA will be connected to the future port, key regional infrastructure and local resources such as gas and iron ore.

This Engineering Services and Infrastructure Plan Report has been prepared to support the ongoing preparation of RPS's Improvement Scheme Report and Guide Plan for the Anketell SIA.

While water supply services are provided to the surrounding towns, there is no existing water supply infrastructure in the vicinity of the SIA. The Industrial Ecology Strategy prepared by GHD in July 2013 provides an Indicative Industry Input / Output Assessment, which divides water usage in the SIA into three categories, Potable Water, High Quality Industry Feed Water and Low Quality Industry Feed Water. The various areas within the SIA are forecast to require significant quantities of water, as detailed in Table 1 below (GHD 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis by WGE, May 2016):

Area	Potable Water Usage Per Annum	High Quality Industry Feed Water Usage Per Annum	Low Quality Industry Feed Water Usage Per Annum
HIA1 and HIA2	90 ML	8,257 ML	16,817 ML
GIA	16 ML	460 ML	486 ML
TOTAL	**106 ML**	**8,717 ML**	**17,303 ML**

Table 1 – SIA Water Demand

The Water Corporation has advised that there is no water supply planning covering the SIA. The Department of Water have advised that availability of groundwater in the area is quite limited, and it is therefore unlikely that the existing aquifer(s) will yield a reliable supply for a large scale and long term project of this nature. Given that neither scheme water nor sufficient groundwater is available for use in the SIA, privately owned facilities will be required to meet the forecast water demands. The majority of feedwater for the facilities must be sourced from a combination of seawater and industrial effluents. A potential alternative water supply is groundwater extraction from more distant aquifers, the West Canning Basin, located approximately 100km east of Port Hedland.

The Water Corporation has also advised that there are no existing wastewater treatment plants or reticulation in the vicinity of the SIA. Excluding output from a potential industry feedwater facility located within the Anketell SIA, the SIA is expected to discharge an estimated 21.84 GL of water per annum (GHD 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis by WGE, May 2016). Wastewater treatment options include wastewater treatment plants and aerobic treatment units (ATUs).

Power in the vicinity of the SIA is distributed by Horizon Power and is generated at multiple power stations. The Industrial Ecology Strategy analyses the predicted power demand and generation of potential ancillary services and industry which may be housed in the SIA. The estimated power demand for the SIA is shown in Table 4 (GHD 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis by WGE, May 2016).

Potential Industry	Power Demand
HIA 1 and HIA2	373 MW
GIA	19 MW
TOTAL	**392 MW**

Table 4 – SIA Power Demand

It is likely that a gas fired power station will be required to meet this demand. To minimise the infrastructure costs, it is efficient to install the proposed power station in the proximity of load centres. It may be possible to service the early stages of the development using the existing power generation facilities in the region, including the new facility located in Boodarie.

There is existing Telstra infrastructure within North West Coastal Highway to the south of SIA. Although no information is available to quantify the communications infrastructure requirements for SIA, future operations within SIA will require a reliable communication infrastructure to connect with the outside world.

Privately operated gas supply mains exist in the vicinity of the SIA being Cape Lambert Lateral Pipeline, which runs immediately west of the Proposed Central Infrastructure Corridor, and Pilbara Energy Pipeline, which runs roughly parallel with North West Coastal Highway.

The estimated gas demand for the SIA is shown in Table 5 (GHD 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis by WGE, May 2016).

Potential Industry	Gas Demand TJ/day	Gas Demand TJ/annum
HIA1 and HIA2	739.9 TJ/d	270,081 TJ/a
GIA	2.6 TJ/d	956 TJ/a
TOTAL	**742.5 TJ/d**	**271,037 TJ/a**

Table 5 – SIA Gas Demand

Generally, gas is provided via extension or upgrading of ATCO Gas's distribution network, which is connected to privately owned and operated main natural gas pipelines such as the DBNGP or the PEPL, via meter stations (installed by the private gas carrier) and pressure reducing stations (installed by ATCO Gas). However, for industries with very high gas demands such as smelters, refineries and power stations, gas supply is generally negotiated with a private gas carrier and taken directly from a main pipeline via a dedicated lateral pipeline, thus bypassing ATCO Gas's distribution network.

Main Roads Western Australia (MRWA) maintains and operates North West Coastal Highway (NWCH), which lies to the south of SIA and provides links to Geraldton in the south and Port Hedland to the north. NWCH is a sealed single carriageway road, and is primarily utilised for access between Karratha and Port Hedland. Cleaverville Road is to the west of SIA, severing both the Proposed Central and Western Service Corridor, is an unsealed access track linking NWCH to the coast at Cleaverville (west of the planned Anketell Port site). There are also numerous informal tracks throughout the SIA region.

Executive Summary

Jacobs Group (Australia) Pty Ltd's has completed traffic modelling for the Anketell Port and SIA and has provided advice on the following infrastructure treatments and upgrades:

- A proposed single lane two way road servicing the SIA from NWCH within the Western Corridor will have sufficient capacity for projected traffic volumes.
- The proposed right turn onto NWCH from the Western Corridor is predicted to operate at a level of service C, which is acceptable, whilst other movements are predicted to operate at a level of service A or B.
- A link road from the Proposed Central Infrastructure Corridor to NWCH is therefore not required in terms of capacity.
- Single lane two way roads will connect to the Western Corridor road to provide access to each of the SIA land parcels.
- A section of the proposed Central Infrastructure Corridor will be constructed to provide an access link between HIA1 and the Port. Alternatively this Central Infrastructure Link Road could be located within the SIA boundary to form a central spine road.
- A secondary road, which could be unsealed, is recommended as an emergency access/egress route between the Central Infrastructure Link Road and NWCH utilising the Central Infrastructure Corridor and the southern section of Cleaverville Road or, if the MCC mine proceeds, the MCC access road within the Central Infrastructure Corridor.
- Cleaverville Road is to remain open until the Western Corridor Port Access Road is operational, then it is recommended that the existing central section of Cleaverville Road be closed.
- At the northern end of the SIA at the interface with the Port, it is recommended that sufficient land be retained for potential future road infrastructure linking the causeway to the SIA to accommodate general traffic, high wide loads (HWLs) and a heavy haul road.
- It is not anticipated that there will be sufficient demand, if any, that necessitates the Eastern Corridor route between Wickham and the Port and the SIA. The existing Pannawonica rail line to Cape Lambert is a constraint that would need to be addressed if such a demand was to eventuate.
- Projected traffic volumes generated by the Port and SIA do not trigger a need to upgrade NWCH to a dual carriageway between Karratha and Wickham.

Rio Tinto operates the Pannawonica railway line to the east of the SIA. This rail is independent of the SIA and port development. No other rail infrastructure exists in the vicinity of the SIA.

Rail lines will be used primarily for the transport of bulk freight, such as raw materials and minerals and products to and from the Anketell Port from the surrounding mine sites. The Western Corridor will provide the primary rail access to the SIA and Port area. While the majority of future rail requirements in the Western Corridor will be at the discretion of mining proponents, allowance for rail to serve the proposed iron ore processing precinct is considered necessary. It is anticipated that one rail line with a turnaround facility will be required for the SIA, and allowance should be made for a potential second line within the SIA (GHD, 2013).

Jacobs' advice on recommended rail infrastructure treatments and provisions is summarised below:

- MRWA has advised that a grade separated railway crossing is required where the proposed railway crosses the North West Coastal Highway.
- Once the Western Corridor Port Access Road is operational, it is recommended that Cleaverville Road be closed south of the Port Access Road.
- A railway crossing will be required on the access road constructed from the Western Corridor Port Access Road to heavy industry area HIA1.

The area surrounding SIA is subject to intense rainfall associated with severe cyclonic activity, typically occurring from November through to April each year. This combined with the high soil clay content in the area results in extreme stormwater runoff flow rates, and makes SIA susceptible to storm surge and flooding. The proposed stormwater drainage strategy as outlined in the RPS Environmental's DWMS is summarised below:

- Open drains and swales will be used as the principle stormwater conveyance mechanism.

- Lots will be required to retain the first 15mm of rainfall (as a minimum) through appropriate landscaping, to improve the quality of stormwater discharging from lots.
- Lots will be required to implement stormwater management systems to provide a suitable level of stormwater quality control depending on the specific industrial land use, processes and materials present on the site.
- Road pavements will be flush kerbed, discharging flows to open drains located within road reserves.
- Road pavements will be designed significantly lower than surrounding lots to provide flood protection to properties.
- Open drainage channels will be sized so that the 5 year ARI event top water level (TWL) is 300mm below the level of the road shoulder, and designed to maintain low flow velocities to minimise erosion and sediment transportation.
- Road reserve drains will be used in conjunction with arterial drainage corridors throughout the development to convey stormwater flows from lots to downstream drainage reserves or discharge points.
- Open drains will be designed to contain 100 year ARI event flows.
- Arterial drainage corridors will utilise the existing surface topography and natural drainage features as much as possible to retain the pre-development hydrological regime and minimise earthworks requirements.
- Erosion and sediment transport will be minimised by reducing flow velocities through the use of detention basins, drop structures, pitching and vegetation of drainage channels.

An assessment of hydrological characteristics and hydraulic modelling of the 1 in 5-year ARI and 1 in 100-year ARI events was carried out for each of the three development areas within the SIA. Potential for inundation of the sites caused by a 1 in 500-year ARI storm surge event, including allowance for a 0.9m sea level rise (State Planning Policy 2.6), was also investigated.

Coffey Geotechnics desktop geotechnical assessment undertaken in April 2013 states that SIA is likely to be underlain by variable geology. Marine mud is expected in areas close to the coast, and silt/sand/gravel deposits are indicated along and adjacent to drainage features, which lie between more elevated areas underlain by shallow volcanic rock (Coffey Geotechnics, 2013).

Significant fill is expected to be required in low lying areas to achieve adequate clearance to the floodplain. Elevated areas that would typically be used as a source of fill are likely to be underlain by shallow rock. Cost dictates that deep cut and other excavation in rock should be avoided wherever possible. The likely presence of rock may therefore limit the quantity of suitable fill available.

Areas with a 'low probability' of ASS are anticipated to be locally present within the numerous creeks and gullies that traverse the site. Similarly, areas with a 'high probability' of ASS are anticipated in numerous coastal areas, particularly within the Western Corridor. Given that ASS is likely to occur primarily in low lying areas, it is likely that the extent of excavation within suspected ASS areas will be relatively minimal due to fill required in these areas to provide clearance to the floodplain.

An assessment of the opportunities, constraints and constraint removal measures for each service and SIA land parcel are detailed below.

Water

Opportunities

- Water supply for the SIA should be considered in conjunction with requirements of both MCC's mining operation and the Anketell Port area. Economies of scale may exist if shared water supplies are developed.
- While significant groundwater is not expected to be encountered during port or SIA development, MCC will likely require dewatering in the mine pit. This water may potentially be treated and reused in SIA (Preston, 2011).
- Significant requirement for low quality process water will reduce cost of both construction and ongoing operation of treatment facilities. A third-pipe, and possibly a fourth-pipe recycled water network may be established to supply low-quality and high-quality industry feedwater. By creating separate reticulation networks for low and high quality industry feedwater, treatment costs may be minimised.
- There is potential for shared desalination facilities.

- It may be possible to supply water from the West Canning Basin or similar aquifers.
- A private, third-party supplier may see a commercial opportunity to establish a water supply to service SIA.

Constraints
- Water supply likely to be privately sourced.
- Little available groundwater within SIA and surrounding areas.
- High cost of construction and ongoing operation of desalination and wastewater recycling facilities.
- Environmental considerations regarding waste from desalination and wastewater recycling.
- Large quantities of water required, including large quantities of high quality industrial feedwater.
- Large site area will result in high transmission costs.

Constraint Removal
- High volumes of industrial effluent may potentially be reused may reduce the required volume of seawater to be desalinated.
- While the large site area will result in high transmission costs, these costs may be minimised by the proposed colocation of similar industries.

Wastewater

Opportunities
- Potential reuse of wastewater within the development via treatment and a third and fourth-pipe water network for low-quality and high-quality industry feedwater.

Constraints
- No outlet to Water Corporation wastewater treatment facilities.
- High transmission and treatment costs of wastewater.
- Presence of rock will increase the cost of a gravity fed reticulation network.

Constraint Removal
- Establishment of private wastewater treatment facilities as required.
- Proposed colocation of similar industries will allow wastewater treatment facilities to be constructed in the vicinity of high-discharge users.
- Sewer depths should be minimised to avoid excavation in rock wherever possible. Pump stations will be located strategically around the SIA to convey pressurised wastewater at shallower depths.

Power

Opportunities
- Locate proposed power station in the vicinity of load centres.
- Utilise existing Karratha power plant for short term supply once the Pilbara power station is commissioned.
- Potential expansion of Pilbara power station for short time supply.
- Consider power requirements in conjunction with the requirements of MCC's mining operations and the port area.

Constraints
- Cost of development of the proposed power station.
- Distance between load centres will lead to high transmission costs.

Constraint Removal
- Serve initial stages of development from existing transmission lines in the vicinity of the SIA, reducing the initial outlay for earlier stages of development.
- There is potential to supply power to the various load centres at transmission voltage, possibly providing a more reliable supply.

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Communications

Opportunities
- Extension available from existing communications in North West Coastal Highway.
- Need for communications at Port.

Constraints
- High costs to extend communications cables.

Constraint Removal
- Minimise costs through co-ordination with the Port's communications demands.
- Approach NBN Co. to supply communications through their satellite service removing the need for cable.

Gas

Opportunities
- Gas is already present within the SIA.
- Demand for gas likely to make supply feasible for gas suppliers.

Constraints
- Significant upgrades to existing infrastructure required to supply predicted demand.

Constraint Removal
- Locating high gas users near each other to reduce transmission costs.
- Users with small requirements to be services early by existing infrastructure.

Stormwater / Drainage Management

Constraints mapping provided by RPS Environmental within the District Water Management Strategy identifies areas within the SIA that are generally constrained by stormwater and earthworks issues.

Opportunities
- Results of the recommended Coastal Vulnerability Study will enable refinement of the Design Plan.
- Liaison with industry proponents will assist in identification of 'high priority' and 'low priority' areas, enabling flood clearance requirements to be tailored to suit and potentially reducing the overall fill quantity.

Constraints
- Intensity of storm events leads to relatively high floodplain levels. Significant fill will be required to low lying areas and those within flood corridors.
- Existing flood corridors are relatively wide and meandering. This will act to either limit the developable area or increase fill requirements.
- Cyclonic activity between December and April means construction periods and types will constrain construction.
- Shallow groundwater may impact building foundations.

Constraint Removal
- Refinement of design plan to limit development to more elevated areas wherever possible.
- Filling of lower lying areas to provide clearance to flood plains. This may potentially be achieved by sourcing material from elevated areas within the estate.
- Existing flood corridors to be narrowed, straightened and formalised wherever possible to reduce the impact on developable area.
- Construction activities to take place between May and November to avoidance delay and disruption by cyclones.
- Avoid areas of shallow groundwater or consider building methods less affected by shallow groundwater.

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Geotechnical / Earthworks

Opportunities

- Results of the recommended Coastal Vulnerability Study will enable refinement of the Design Plan.
- Liaison with industry proponents will assist in identification of 'high priority' and 'low priority' areas, enabling flood clearance requirements to be tailored to suit and potentially reducing the overall fill quantity.
- Construct early stages in high ground areas to minimise fill import/cut to fill operations.

Constraints

- Intensity of storm events leads to relatively high floodplain levels. Significant fill will be required to low lying areas and those within flood corridors.
- Existing flood corridors are relatively wide and meandering. This will act to either limit the developable area or increase fill requirements.
- The presence of shallow rock will limit the availability of fill on site.
- Sources of fill in the region are scarce and therefore expensive.
- Cyclonic activity between December and April means construction periods and types will constrain construction.
- Steep grades will limit suitable areas for construction if high earthwork costs are to be avoided.
- Presence of Acid Sulfate Soils within drainage lines.
- Environmental constraints exist in the form of protected flora and fauna.

Constraint Removal

- Refinement of design plan to limit development to more elevated areas wherever possible.
- A detailed geotechnical investigation will similarly enable refinement of the design plan, and will also enable earthworks design to target areas where fill is present and minimise excavation in rock.
- Filling of lower lying areas to provide clearance to flood plains. This may potentially be achieved by sourcing material from elevated areas within the estate.
- Existing flood corridors to be narrowed, straightened and formalised wherever possible to reduce the impact on developable area.
- Reuse of dredged material as clean fill, pending investigation regarding suitability.
- Potential ability to source fill material from undeveloped areas within the site. Pending environmental approvals, among others.
- Potential availability of fill from MCC mining operations.
- Avoidance of deep excavation wherever possible.
- Construction activities to take place between May and November to avoidance delay and disruption by cyclones.
- Consideration given to maximum allowable grades within lots with earthworks limited to building envelopes.
- Site development to avoid high risk ASS areas or design to minimize cutting operations.
- Avoidance of areas identified as containing protected flora and fauna.

Heavy Industrial Area 1

Opportunities

- Relatively central within the combined SIA and port area. HIA1 will likely be close to centralised servicing facilities, which benefits the early development of the precinct.
- Eastern portion of the precinct is relatively high and unlikely to be prone to flooding.
- Fill may be sourced from higher ground levels within the precinct to fill lower portions of the precinct, or other lower lying areas in the SIA.

Constraints

- Lack of existing infrastructure in the vicinity of the SIA will result in high establishment costs being incurred in the initial stages of development.
- Major creek line runs through western portion of site. Potential for flooding and need for large quantities of fill.
- Tidal flats contain soils that will give poor stability without major earthworking.

- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Priority Flora species.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- Initial construction of centralised facilities may be limited to provide capacity to serve only the early development stages. Such facilities should be constructed with the capability of future upgrade.
- As aforementioned, initial stages of development can possibly source power from existing overhead transmission lines in the vicinity of the SIA.
- Early construction to utilise eastern portion of site to avoid need for fill to avoid flooding.
- Utilise portion of site that does not contain poor strength soils or look at building solutions which allow for construction in these areas.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Priority Flora species areas to be avoided.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

Heavy Industrial Area 2

Opportunities

- Due to likely development timeframe, the majority of infrastructure will be existing at the time of development.
- Located in a relatively elevated area. While fill will likely be required to flood corridors, the relative quantity of fill required will likely be less than other areas.
- Western and eastern areas of the precinct are relatively high and unlikely to be prone to flooding.
- There may be an opportunity to source fill from within HIA2 for use in other areas.

Constraints

- Providing that access is not available via the Proposed Central Infrastructure Corridor, access to HIA2 must be through HIA1. In addition to providing a less direct link to HIA2, this access requires crossing of the existing Rio Tinto gas main and power lines.
- Timing of development is unknown due to MCC mining operations.
- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- The development layout should be designed such that a clear link to HIA2 is provided through HIA1.
- Liaison should be undertaken with MCC to determine more accurate development timeframes.
- Crossing points to be established where road is safely constructed over/under existing Rio Tinto gas main and power lines.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

Executive Summary

General Industrial Area

Opportunities

- Located proximately to Western Corridor.

Constraints

- Likely distance of the GIA from centralised water & wastewater servicing facilities will result in high transmission costs.
- Located in a low lying area that will likely require significant quantities of fill.
- Higher areas within the precinct appear to be quite steep and would require significant earthworks to produce a usable lot.
- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Priority Flora species.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- Potentially source fill from aforementioned locations, or other precincts within the SIA.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Priority Flora species areas to be avoided.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

Estimated costs provided in the below table are based on the information referenced in this report. Due to the preliminary nature of the available information, the costs are notional and should to be used as an order of magnitude guide only. All costs are subject to ongoing review pending refinement of the Guide Plan.

ITEM	COST (EXC GST)	NOTES
Water Supply		**Water Supply Cost from West Canning Basin**
Reticulation	$150m	$150m (reticulation) + $650m (transmission) + $375m (treatment)
Desalination	$650m	
Wastewater		
Reticulation	$95m	
Pump Stations	$65m	
Treatment & Recycling	$280m	
Power		
Reticulation	$55m	
Zone Substations & Associated Infrastructure	$250m	

Gas Fired Power Station	$525m	Additional $525m (min) for carbon capture and storage (CCS).
Communications	$45m	
Gas		
Connection to Supply Support Industry Area	$10m	
Meter Station & Associated Infrastructure	$250m	Pending further advice from APA
Road	$90m	
Rail	$120m	
Earthworks	$910m	
Stormwater Drainage	$50m	
TOTAL	**$3,545m**	

Further detailed investigations, together with discussions and negotiations with the relevant authorities are required to progress infrastructure planning for the development and to better define estimates of development costs. The below actions and their timing are considered appropriate to progress servicing of the SIA.

Can be undertaken now:

Item	Responsibility	Comment
Detailed Geotechnical Investigation of SIA land parcels.	Proponents	Costs could be saved by combining investigations with multiple proponents.
Engagement with Anketell Port, proposed industry and authorities to co-ordinate service demands, strategic positioning, planning and timing.	Proponents/LandCorp	LandCorp undertaking servicing investigation.
Engage with private water suppliers.	Proponents	For feasibility it is likely that one private supplier will need to provide to multiple proponents.
Preliminary earthworks modelling.	Proponents	

Can be undertaken prior to application to WAPC for development approval:

Item	Responsibility	Comment
Feature and topographic survey	Proponents	Costs could be saved by combining surveying with multiple proponents.
Precalculation plan	Proponents	

To be undertaken in conjunction with detailed design:

Item	Responsibility	Comment
Water Management Plan	Proponents	

1. Introduction

The Anketell Port Project was initiated by the Western Australian Government in 2010 in response to ongoing demand to export iron ore and other commodities from the Pilbara region, and the lack of independent port capacity and infrastructure provision within the region.

The Anketell Port Project will create a new multi-user, multi-commodity port and associated industrial areas for strategic and downstream processing industries in the Pilbara. The Anketell Port is proposed to be developed as the next major deepwater port for the Pilbara coast, including an iron ore export facility and provision for heavy industry exports, general cargo trade and fuel imports.

The Anketell Port Project comprises the Port Precinct, Infrastructure Corridor and Strategic Industrial Area (SIA) as shown in Appendix 1.

The Port Precinct is intended mainly for export of iron ore from Pilbara mines with an ultimate capacity of not less than 350 million tons per annum (Mtpa), accommodating the iron ore supply chain infrastructure such as stockpiles, rail loops, car dumpers and conveyors. The Pilbara Port Authority and a number of private sector companies are currently considering feasibility options to develop the multi user port facility.

The Infrastructure Corridor will be a multi-user area critical to the development and utility/operability of the port and industrial areas. It will contain rail lines and associated marshalling yards, port access roads and other infrastructure services, and connect the Port Precinct with the North West Coastal Highway.

The Strategic Industrial Area has been planned to enable industry to be established for the support of the proposed Anketell Port and future surrounding mining operations. The SIA will comprise a number of areas and include both heavy industry areas and a general industry area. The SIA will be connected to the future port, key regional infrastructure and local resources such as gas and iron ore.

The Anketell Port Master Plan was produced in June 2014 following extensive consultation with government and industry stakeholders. This plan contains an Ultimate Development Concept which describes the expected ultimate layout and infrastructure configuration of the Anketell Port, the Infrastructure Corridor and the SIA, with an ultimate annual iron ore export capacity of not less than 350Mtpa. The Ultimate Development Concept has been planned to allow design and construction of all major components to be staged, while allowing existing operations to continue with minimal disruption.

The Department of State Development (DSD) is the lead agency for the project, responsible for the coordinating the land acquisition, land use planning framework, infrastructure provision, tenure and other approval processes to create the port and SIA at Anketell.

The Anketell SIA will be owned freehold and managed by LandCorp on behalf of the State, and sites within the SIA will be leased to future proponents of heavy and general industrial development.

1.1 Statutory Planning Framework

The characteristics and specific requirements of the Anketell SIA create the need for an appropriate statutory planning framework to manage the allocation and future development of land within the Anketell SIA boundary. An Improvement Plan has been gazetted and an Improvement Scheme is being established.

LandCorp, as the manager of the Anketell SIA on behalf of the State (Department of State Development), commissioned RPS Australia East Pty Ltd to prepare an Improvement Plan and Improvement Scheme for the Anketell SIA. The Improvement Plan and Improvement Scheme do not apply to the Port Precinct and Infrastructure Corridor.

The Improvement Plan was gazette on 8 May 2015 providing the head of power for an Improvement Scheme to be prepared.

Introduction

The Improvement Scheme will be the principal statutory tool for implementing the strategic objectives of the SIA. The Improvement Scheme zones land within the SIA for the purposes defined in the Scheme and therefore controls and guides land use and development. The Improvement Scheme Report provides and outline of the planning arrangements as they apply to the area, the strategic intensions for the industrial area and an overview of the statutory provision of the Improvement Scheme. The Guide Plan, which is part of the Improvement Scheme, provides a spatial guide for the preparation, assessment and determination of applications for subdivision, leasehold and planning approval of site-specific developments.

Wood & Grieve Engineers (WGE) has been commissioned by LandCorp to provide engineering services and infrastructure advice based on the draft Guide Plan for the SIA, to assist in delivery of Phase 1 Services for the proposed Anketell SIA.

Phase 1 Services represents the due diligence phase of the project, with WGE's commission including review of existing plans, data and other information, reporting on existing infrastructure and services through and around the SIA area and providing advice and an order of magnitude cost estimate for future infrastructure and services required to support the development of the SIA.

This Engineering Services and Infrastructure Plan Report has been prepared to support the ongoing preparation of the Improvement Scheme and Guide Plan for the Anketell SIA.

Initial planning for the Anketell SIA identified two heavy industry areas HIA1 and HIA2 (HIA1 is intended to be developed first and HIA2 in the future as demand requires) and two general industry areas GIA1 and GIA2. Current amendments to planning for the SIA have resulted in GIA1 being incorporated into HIA1 to maximize priority land for its highest and best use. GIA2 is now the only GIA and is hence now referred to as the GIA. This Engineering Services and Infrastructure Plan Report reflects the current planning.

1.2 Locality

The locality of Anketell is situated on the West Pilbara Coast, 1,250km northeast of Perth and approximately 25km east of Karratha and 10km west of Cape Lambert, within the Shire of Roebourne. The proposed port facility will be located at Anketell Point, approximately 40km east of Port Dampier and 10km west of Rio Tinto's Port Walcott.

Access to the port will be via road and rail located within the Infrastructure Corridor, which comprises two proposed routes. The major corridor, or Western Corridor, intersects with the North West Coastal Highway at a point approximated 15km east of Karratha Road, running north-northwest towards the coast, then east between Cleaverville and Mount Anketell to the Port Precinct. A potential secondary corridor, the Proposed Central Infrastructure Corridor, is proposed from the North West Coastal Highway approximately 2km east of the Western Corridor intersection, running northeast to the Port Precinct, passing to the south-eastern side of Mount Anketell.

The Anketell SIA consists of several industrial precincts located adjacent to the infrastructure corridors, and is intended to service the proposed Anketell Port and surrounding mining operations with both heavy (core) and support/general industry.

RPS's Improvement Scheme Report and Guide Plan sets out the strategic objectives of the components (zones) of the SIA. The location of the zones within the SIA are shown in Appendix 1 and summarised below.

Strategic Industrial Zone

The aim of this zone is to provide for establishment of multiple resource processing industries including downstream processing industries and other uses as set out in RPS's Improvement Scheme Report and Guide Plan. The scheme comprises two stages of core industry subdivision and development, Heavy Industrial Area 1 (HIA1) and Heavy Industrial Area 2 (HIA2) as further described below.

Introduction

The zone is surrounded by a protection area, ensuring the primacy of the resource processing industry, enabling process operations to meet ultimate capacity and operating efficiency. Activities within the zone are intended to operate in conjunction with port export facilities and common user-infrastructure.

Heavy Industrial Area 1 (HIA1)

HIA1 has an area of 667 ha and is located is in the vicinity of Mount Anketell between the two infrastructure corridors and is intended to be developed immediately, pending required land acquisitions and approvals.

Primary points of access assume road connections through the Western Corridor, the Proposed Central Infrastructure Corridor and the Port Precinct. A key consideration for road design is the alignment of an existing pipeline on the eastern boundary of the area. The design seeks to achieve a balance between situating the road on the eastern side of the pipeline whilst minimising vehicle crossing points. The internal road network is designed to provide loops, offering alternative ingress, egress and staging options.

Surface water management maintains pre-development flow paths as much as possible. Two surface water movement corridors of approximately 100 metres in width are provided within the western portion of HIA1, linking through to an existing creek. Flow paths originating from elevated land immediately west of the area will require overland corridors through proposed lots adjacent the western boundary. The eastern portion of the development area straddles a natural surface water movement depression flowing northward. Depending on ultimate lot configuration, the flow-path in this area may be re-engineered to provide a more central alignment at the rear boundary of properties, or alternatively, water management areas incorporated within the context of larger lots.

Heavy Industrial Area 2 (HIA2)

HIA2 is approximately 420ha in area and located to the south of HIA1 and the Proposed Central Infrastructure Corridor and lies within the Metallurgical Corporation of China's (MCC) proposed mine site. HIA2 will likely not be available for development until the suitable completion of MCC operations in approximately 30 years.

Industry Zone

The aim of the Industry Zone is to provide for industrial activity that has a direct relationship to, or supports the operations of the port or activities within the Strategic Industry Zone. Provision of land for support activity is to ensure optimal utilisation of the Strategic Industry Zone for resource processing.

The General Industrial Area is intended to provide low emission, lighter industries to support development of the port, transport operations, and proposed mining operations, as further described below.

General Industrial Area (GIA)

The GIA is 173ha in area and is located to the west of the Western Corridor within the proximity of the North West Coastal Highway. Timing for the GIA will be dependent upon demand.

The GIA relies on primary access being achieved via the Western Corridor. Either single or dual access can be achieved if required for emergency/risk management requirements.

Two water catchments are within the GIA with indicative surface water corridors providing movement southward, and north/north-west respectively.

Industry Protection Zone

The aim of this zone is to protect industrial activity from encroachment by uses that are not compatible with resources processing and related activities, and to ensure sensitive land uses are not impacted upon. The Industry Protection Zone as depicted in Figure 4 in Appendix 1 has been established with regard to the planning and environmental criteria for noise, risk (at a level of one in a million per year or less) and air quality.

Introduction

Development within the Anketell SIA, as with other SIA's, is expected to occur over a long term timeframe dependent on demand for strategic and heavy industry sites within Heavy Industrial Areas. Due to the uncertain nature of demand for such sites within the SIA, the subdivision and development of the Heavy Industrial Areas is intended to occur when required by future proponents or industry operators.

1.3 Scope

The intent of this report is to provide engineering advice regarding servicing of the proposed SIA, including:

- Review of existing plans, data and other information, familiarisation with site characteristics and the existing infrastructure and services facilities through and around the study area;
- Provide overview of existing infrastructure assets in proximity to the land;
- Provide advice on the infrastructure requirements that will be needed to support the proposed industrial development areas;
- Provide comment on the potential of future services availability for the SIA;
- Identify opportunities and constraints in regard to the provision of future services for the developments areas, taking into account site characteristics and any geotechnical issues;
- Provide an Order of Magnitude Cost Estimate to provide the required services to the SIA; and
- Prepare an Engineering Services & Infrastructure Plan Report incorporating the above.

Infrastructure and services include, but are not limited to, existing and future supply options for the following:

- Earthworks;
- Potable water;
- Process water;
- Power supply;
- Gas;
- Communications;
- Roads;
- Rail;
- Wastewater management; and
- Stormwater drainage management.

The study area for this report includes the following:

- Heavy Industrial Area 1 (HIA1);
- Heavy Industrial Area 2 (HIA2);
- General Industrial Area (GIA); and
- Proposed Central Infrastructure Corridor.

The Port Precinct, Industry Protection Zone, Western Corridor, Proposed Central Infrastructure Corridor and the potential Eastern Corridor are beyond the scope of this report.

The Port Precinct, Western Corridor and Proposed Central Infrastructure Corridor are not subject to the provisions of the Improvement Scheme. Reference should be made to the Pilbara Ports Authority for details.

While the scope of this report is confined to the SIA, we recommend including consideration of the future port areas servicing requirements into the SIA to minimise total costs.

The report is divided into three sections –Engineering Services, Opportunities & Constraints, and an Order of Magnitude Estimate.

Introduction

This Engineering Services and Infrastructure Plan Report has been produced utilising information provided by various sources listed below, and WGE's experience in the region:

- Anketell Port and Strategic Industrial Area, Design Plan Report, prepared by Preston Consulting Pty Ltd, dated February 2011;
- Karratha Coastal Vulnerability Study, prepared by JDA Consultant Hydrologists dated August 2012;
- Desktop Assessment – Anketell Strategic Industrial Area Project, prepared by Coffey Geotechnics (Ref GEOTPERT09901AA-AB), dated 30 April 2013;
- Anketell Strategic Industrial Area, Industrial Ecology Strategy, prepared by GHD, dated July 2013 *(herein referenced as the GHD report)*;
- Anketell SIA Transport – Transport and Traffic Planning Report; prepared by Jacobs (Ref IW051600-RP-0001, Draft 5), dated 22 April 2016 *(herein referred to as Jacob's Transport and Traffic Planning Report)*;
- Anketell Port Master Plan, prepared by Department of State Development, dated April 2014;
- Flood Study Report – Anketell Strategic Industrial Area; prepared by RPS Environmental (Ref L1305904, Rev 1), dated June 2015 *(herein referred to as RPS Environmental's Flood Study Report)*;
- Improvement Scheme Report – Anketell Strategic Industrial Area, prepared by RPS Australia East Pty Ltd (Ref PR116865-1, Final Draft), dated April 2016 *(herein referred to as RPS's Improvement Scheme Report and Guide Plan)*;
- District Water Management Strategy – Anketell Strategic Industrial Area, prepared by RPS Environmental (Ref L1305907, Rev 2), dated April 2016 *(herein referred to as RPS Environmental's DWMS)*.

Due to the preliminary nature of some of the information provided, we recommend ongoing review and revision of this document to ensure that details accurately reflect the latest available information.

2. Site Conditions

Site conditions for the SIA development area are described in Coffey Geotechnics' Desktop Assessment – Anketell Strategic Industrial Area Project, dated 30 April 2013 and RPS Environmental's District Water Management Strategy report, dated April 2016. A summary of this information is included below.

2.1 Topography

The topography of each industrial site is described below:

General – Surface elevations within the proposed development areas range between approximately 3m AHD in the northern, coastal fringing portion of HIA1 to as high as approximately 40m in some portions of the site which are flanked by ranges (RPS Environmental, 2016).

Heavy Industrial Area 1 (HIA1) – A high point near the eastern arm of HIA1 divides the site two sub-areas. The central to western portion of the site is characterised by creek lines traversing the site, with Rocky Creek flowing south to north (10m to 3m AHD) near the site's western boundary and a further tributary flowing into Rocky Creek in an east to west direction. The western boundary rises steeply against the north-south creek line. The eastern portion of the site slopes down from the high point to the north east and is flanked by ranges to the east and west. A creek line appears to follow the fall of this portion of the site. In general the topography of HIA1 ranges between 10m and 25m AHD, however the site reaches higher elevation along the northern boundary adjacent to the ranges directly north. The site is further spotted by outcrops.

Heavy Industrial Area 2 (HIA2) – The site slopes from approximately 40m AHD at the eastern and western boundaries down to approximately 15m AHD along Rocky Creek that dissects the site in a south to north direction. The central to eastern portion of the site is reasonably flat as opposed to its south western and eastern boundaries which are significantly steeper.

General Industrial Area (GIA) – The topography is elevated with moderate relief in the southern and western areas (up to 35m AHD), and relatively flat over most of the eastern and northern areas where a saddle point appears between two creek lines (around 10m AHD).

2.2 Existing Ground Conditions

Geographical mapping of Dampier and Roebourne indicates variable geology underlying the SIA, comprising:

- Marine mud in areas close to the coast in supratidal and intertidal flats;
- Silt, sand and gravel deposits along and adjacent to drainage features; and
- Shallow bedrock, dominated by volcanic formations in more elevated areas, including volcanic dolerite outcrops.

In coastal areas, significant depths of soft, loose and organic material may be encountered that is unsuitable to directly support foundations. In these areas the use of ground improvement and/or piled foundation solutions may be necessary.

2.3 Hydrology

The SIA site is relatively close to the coast and there are a number of creeks and gullies crossing the site, with the dominant drainage line being Rocky Creek which dissects development areas HIA1 and HIA2.

The site is comprised of three distinct surface water catchments, the Rocky Creek catchment located within HIA1 and HIA2 and two relatively small catchments located within the eastern portion of HIA1 and the GIA respectively. The

Site Conditions

Rocky Creek catchment flows northwards through intertidal mudflats and mangroves to discharge into the ocean near Dixon Island.

HIA1 – The central and western portion of the site is situated within the Rocky Creek catchment, and may be subject to seasonal flooding. The north western portion of HIA1 is situated on low-lying coastal flats which may be subject to inundation from storm surge during extreme events. The eastern area of HIA1 is situated within a relatively small catchment immediately east of Rocky Creek catchment. This area of HIA1 is located in the upstream portion of the catchment and receives run-off from a steep but very small upstream catchment area. Consequently, there is only a very minor, shallow drainage channel within this area of HIA1 which flows north-east to an expansive low-lying area of intertidal flats and mangroves, which may be subject to seasonal flooding.

HIA2 – Falls mostly within the Rocky Creek catchment, and may be subject to seasonal flooding. A minor southern portion of the development site is situated within an upstream area of an adjacent drainage catchment, in an elevated area not subject to flooding.

GIA –Does not receive runoff from any external catchment areas or contain any significant water sources, rather just a series of semi-defined stormwater flow paths. The southern portion of the GIA drains in a westerly direction to an unnamed tributary of the Nickol River, which discharges to coastal mudflats adjacent to the GIA. The northern portion of the GIA comprises minor localised drainage channels discharging to coastal mudflats to the north and west.

RPS Environmental have undertaken a flood study to investigate the hydrological processes and risk of flooding at the SIA, including flood management advice for the 1 in 100-year Average Recurrence Interval (ARI) event and potential for inundation due to a 1 in 500-year ARI storm surge event.

Refer to Section 4.8 of this report and RPS Environmental's Flood Study Report, dated June 2015 for further details.

2.4 Groundwater

The SIA falls within the proclaimed "Pilbara Groundwater Area". Due to a lack of information on groundwater resources for the area, no allocation limit from groundwater licensing has been identified by the DoW, with groundwater allocations managed on a case-by case basis.

Groundwater flow is generally in a northerly direction across the site towards the coastline. Depth to groundwater varies across the site from <2m below ground level (mbgl) to the north in tidal flat zones adjacent to the coast and along the Rocky Creek water course, to >100mbgl along ridge lines.

Refer to RPS Environmental's DWMS, dated April 2016, for further details.

We note dewatering will be required in service trenches affected by the presence of groundwater.

2.5 Acid Sulfate Soils (ASS)

ASS risk mapping indicates the majority of the SIA development site has 'no known occurrence' of ASS being present in surface soils.

Isolated areas of 'moderate to low' risk of ASS within 3m of natural soil surface occur across the site associated with a number of creeks and gullies, including within HIA1 and HIA2 in proximity to Rocky Creek. Approximately 25% of GIA2 is mapped as 'moderate to low' risk of ASS within 3m of natural soil surface.

A 'high probability' of ASS is indicated for a number of the near coastal areas, particularly in the Western Corridor, which is coincident with the likely distribution of Marine Mud.

Site Conditions

Given that ASS is likely to occur primarily in low lying areas, it is likely that the extent of excavation within suspected ASS areas will be relatively minimal due to fill required in these areas to provide clearance to the floodplain.

It is recommended that prior to further development proceeding, additional detailed investigation be carried out to better assess the location, extent and severity of potential ASS across the site. If the site is found to contain ASS which may be disturbed by the development, an Acid Sulfate Soils and Dewatering Management Plan will be required to address specific management and treatment of potential ASS and resultant dewatered effluent during the construction phase of the project.

3. Engineering Services

3.1 Water

3.1.1 Existing Infrastructure

Bulk potable water in the vicinity of the SIA is supplied by the Water Corporation, which operates the West Pilbara Water Supply Scheme. The scheme is reliant upon surface supply in the Harding River Dam, and groundwater extraction from the Millstream Aquifer. Both of these sources of water have significant constraints. The Harding Dam relies on rainfall associated with tropical cyclones for refill, which by nature are irregular in occurrence. The Millstream aquifer has pumping limits in order to preserve the environmental integrity of its location. Water is piped from these locations to service towns surrounding the proposed SIA, namely Karratha, Wickham and Roebourne.

While service is provided to the surrounding towns, there is no existing water supply infrastructure in the vicinity of the SIA.

3.1.2 Development Demand

The Industrial Ecology Strategy prepared by GHD in July 2013 provides an Indicative Industry Input / Output Assessment, which divides water usage in the SIA into three categories, described below. The assessment is included as Appendix 2 to this report; however we recommend review of the information in conjunction with the remainder of GHD's Industrial Ecology Strategy report. It is important to note that the legacy data from the GHD report is based on the superseded planning layout comprising two Heavy Industrial Areas HIA1 and HIA2 and two General Industrial Areas GIA1 and GIA2. General Industry Area GIA1 has now been incorporated into Heavy Industry Area HIA1 and therefore the indicative input and output requirements for HIA1 are expected to be higher than shown in the GHD legacy data

- **Potable Water** – Standard quality water typically used for human consumption.
- **High Quality Industry Feed Water** – High quality water for use in boilers and processing, among other industrial applications.
- **Low Quality Industry Feed (Process) Water** – Low quality water for purposes such as dust suppression and industrial cooling.

The various areas within the SIA are forecast to require significant quantities of water, as detailed in Table 1 below (GHD 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis by WGE, May 2016):

Area	Potable Water Usage Per Annum	High Quality Industry Feed Water Usage Per Annum	Low Quality Industry Feed Water Usage Per Annum
HIA1 and HIA2	90 ML	7,638 ML	15,557 ML
GIA	16 ML	460 ML	486 ML
TOTAL	**106 ML**	**8,717 ML**	**17,303 ML**

Table 1 – SIA Water Demand

To give some context to these figures, the total sum of potable and process water required for the SIA (26.13 GL/annum) is in excess of the total current production of the Water Corporation's West Pilbara Water Supply Scheme.

3.1.3 Supply

The Water Corporation has advised that there is no water supply planning covering the SIA. They have also advised that previous discussions held with the Department of State Development several years ago concluded that industry proponents would pursue private water sources.

The Department of Water have advised that availability of groundwater in the area is quite limited, and it is therefore unlikely that the existing aquifer(s) will yield a reliable supply for a large scale and long term project of this nature.

Given that neither scheme water nor sufficient groundwater is available for use in the SIA, privately owned facilities will be required to meet the forecast water demands. It is proposed that centralised facilities be established within the SIA to produce fit-for-purpose industry feedwater (GHD, 2013). This statement should be extended to include the comparatively minimal supply of potable water. Given that the vast majority of water demand arises from HIA1 & HIA2, it is preferable to locate the feedwater facility in the vicinity of these areas.

Given the lack of available groundwater in the vicinity of the SIA, the majority of feedwater for the facilities must be sourced from a combination of seawater and industrial effluents. Water Corporation advised that depending on the required specifications, it may be possible to source some portion of both low and high quality industry feedwater via wastewater recycling, however the remaining portion of feedwater and all potable water must be sourced from desalination. We note that Water Corporation currently has wastewater recycling facilities in Kwinana that produce industry feedwater suitable for the specific industries in the area.

A potential alternative water supply is groundwater extraction from more distant aquifers. The West Canning Basin, for example, is located approximately 100km east of Port Hedland. The Department of Water has set a total extraction limit of 41GL/yr from the Broome Sandstone and Wallal aquifers in the Pilbara section of the West Canning Basin, with 10GL/yr being reserved for public water supply (Department of Water, 2012). There is potential for the remaining water to be utilised in the SIA, however due to the distance of the basin from the SIA, transmission costs would be high and treatment would still be required prior to industry use.

We recommend further investigation be undertaken into the potential use of the West Canning Basin or similar aquifers in the vicinity of the SIA should significant barriers to desalination of seawater be encountered, however we note that the above would potentially involve amendment of the Water Corporation's West Pilbara and Port Hedland Regional Water Supply Schemes.

3.2 Wastewater

3.2.1 Existing Infrastructure

Treatment and disposal of wastewater in the Pilbara region is typically undertaken by the Water Corporation on a catchment basis within each townsite.

The prevailing weather conditions allow for relatively inexpensive treatment by means of evaporation and oxidation ponds, which are currently being used in the region. This treatment produces effluent of low quality that is currently being reused for municipal purposes only, under strict operating conditions.

Water Corporation has advised that wastewater treatment facilities in Karratha are currently being upgraded to produce recycled water that is fit for use as low quality industry feedwater.

Water Corporation has also advised that there are no existing wastewater treatment plants or reticulation in the vicinity of the SIA. The nearest, small townsite treatment plants are located at Wickham and Roebourne.

3.2.2 Development Output

Excluding output from a potential industry feedwater facility located within the Anketell SIA, the SIA is expected to discharge 21.84 GL of water per annum (GHD 2013, amended to incorporate revised HIA1 area on a pro-rata area basis by WGE, May 2016).

It is envisaged that a percentage of this water will be recycled for re-use by industries within the SIA, thereby reducing the quantity of water to be sourced via groundwater abstraction and/or desalination. The amount of water requiring treatment prior to re-use is dependent upon industry requirements, however some portion of this water may potentially be suitable for re-use without treatment.

Wastewater treatment options including wastewater treatment plants and aerobic treatment units (ATUs) are discussed below. It is recommended that a specialist consultant be engaged to further investigate options for industrial wastewater management so that preliminary infrastructure planning and cost estimates can be progressed.

3.2.3 Treatment via Wastewater Treatment Plants

Water Corporation has advised that there are currently no plans or capital to construct a wastewater treatment plant or reticulation network in the vicinity of the SIA. Providing Water Corporation's stance does not change in the future, wastewater treatment must therefore be arranged independent of the Water Corporation.

Despite treated effluent in the region currently being used for municipal purposes only by the Water Corporation, and upgrades being undertaken to produce low quality industrial feedwater in Karratha, opportunity exists for more extensive reuse in the SIA, similar to the aforementioned wastewater recycling in Kwinana's Industrial Area. If a higher quality of treatment was to occur, in accordance with the Australian Government Department of Health's guidelines, it is possible that high-quality industrial feedwater could be produced. Due to significant volumes of high-quality industrial feedwater required by SIA, we expect more extensive reuse will be required, including development of a third, and possible fourth-pipe reticulation network for recycled water constituting both low-quality and high-quality industrial feedwater. We note the potential to produce high-quality industry feedwater from recycled wastewater is dependent upon individual industries' required specifications for such water. Liaison is required with industry proponents and wastewater treatment specialists to determine the scope of treatment required to potentially achieve such an outcome.

Due to the undulating nature of the existing landform, prevalence of rock, and the size of the development area, it is likely that several gravity-fed reticulation catchments will be necessary throughout the SIA, feeding into pump stations to convey wastewater to centralised treatment facilities, in lieu of an entirely gravity-fed network. As the majority of wastewater is expected to be generated by HIA1 and HIA2, it is preferable for wastewater treatment facilities to be located in the vicinity of these areas, while taking into consideration required buffers.

GHD's Industrial Ecology Strategy recommends that a centralised wastewater treatment facility be established and located in proximity of heavy users; however individual industrial proponents may alternatively treat wastewater onsite should there be significant barriers to centralised treatment.

3.2.4 Treatment via Aerobic Treatment Units

It is common practice for local authorities to approve installation of onsite sewer treatment systems, including traditional septic tanks and leach drains and Aerobic Treatment Units (ATUs), in areas where properties cannot be reasonably connected to a reticulated sewer system with centralised treatment facilities. These systems are generally used for the treatment of domestic wastewater. ATUs have the added advantage of being able to use the chlorinated effluent to surface-irrigate garden areas.

Indicative costs from similar situations for supply and installation of ATUs to suit small to medium sized offices (BioMAX, 2015) are shown in Table 2. Costs are exclusive of internal plumbing within lots, GST, fees and charges. More

detailed information on expected land usage will be required in order to determine wastewater flows and ATU capacity requirements so that costs may be more accurately defined.

No of People (in Office Environment)	Capacity Litres/day	Cost $
24	1,800	26,000
72	5,400	60,000
120	9,000	100,000

Table 2 – Indicative costs for individual ATUs

An alternative to individual ATU's, is the construction of a number of central Aerobic Treatment Units suitably located to service sub-catchments within the core and support industry areas. Sub-catchments would require piped gravity sewer systems to the central ATU facilities.

Indicative costs for supply and installation of commercial ATU systems (BioMAX, 2015) are shown in Table 3. Internal plumbing, gravity sewers, pump station and pressure main costs, GST, fees and charges are not included. As also noted above, more detailed information on expected land usage will be required in order to determine wastewater flows and ATU capacity requirements so that costs for central ATU systems may be more accurately defined.

Capacity Litres/day	Plan Area of ATU (m x m)	No of People (in Office Environment)	Cost $M
200,000	30 x 45	2,700	$2.3
300,000	30 x 45	4,000	$3.2
500,000	30 x 60	6,700	$3.8

Table 3 – Indicative costs for commercial ATU systems

3.3 Power

3.3.1 Existing Infrastructure

Power in the vicinity of the SIA is distributed by Horizon Power and is generated at multiple power stations. Nearby existing and future power stations of relevance are listed below:

- Existing 80MW Karratha power station located south of Karratha City.
- Existing 100 MW capacity Hedland Precinct power station, located at new power precinct, Boodarie Industrial Estate, commissioned in early 2015.
- New 150MW Pilbara power station, currently being built, owned and operated by TransAlta Energy (Australia) Pty Ltd at Boodarie Industrial Estate.
- Potential 130 MW Rio Tinto-owned power station, which may be located adjacent to the Horizon Power Cape Lambert zone substation.

The Hedland Precinct power station, currently providing 60MW to the Pilbara network, is a temporary installation comprising four mobile natural gas turbines which will remain in place until at least 2017 when the new Pilbara power station is fully operational. The Pilbara power station, commissioned to meet growing energy demand due to growth in the Pilbara, will power Fortescue Metals Group's port operations and supply 110MW of electricity to Horizon Power, and can be expanded to supply power to other commercial users from 2017 onwards.

The Hedland Precinct and Pilbara power stations are intended to relieve dependency on the Karratha power station. It is uncertain whether the Karratha power station will continue to operate after the Pilbara power station is commissioned.

Power is distributed between the power stations and zone substations at transmission voltage. There is an existing 132 kV line between Karratha and the Cape Lambert zone substation, along with a 220 kV line which runs between Port Hedland and Cape Lambert. These lines run to the east of the SIA, as shown in Appendix 3.

The Horizon Power owned Cape Lambert zone substation is located approximately 6 km north east of the site and is the most proximate zone substation to the development. The substation steps the transmission voltage power down to 11 kV (high voltage) and serves to distribute power to Point Samson, Wickham and Roebourne. It is understood that the transformers which step the power down to high voltage are operating at close to capacity.

3.3.2 Development Demand

The Industrial Ecology Strategy analyses the predicted power demand and generation of potential ancillary services and industry which may be housed in the SIA. The estimated power demand for the SIA is shown in Table 4 (GHD 2013, amended to incorporate revised HIA1 area on a pro-rata area basis by WGE, May 2016).

Potential Industry	Power Demand
HIA 1 and HIA2	373 MW
GIA	19 MW
TOTAL	**392 MW**

Table 4 – SIA Power Demand

The timing of the growth of the industry and the corresponding power demand is uncertain at this time.

The power demands of the Anketell Port are beyond the scope of this report, however the port must be considered as part of the overall servicing strategy for the region.

3.3.3 Supply

The magnitude of the ultimate load – if fully realised – will necessitate additional generation of power in the area with a capacity in the order of approximately 500 MW. This would allow for the full load as estimated by GHD, significant spare capacity which will be utilised by the port itself, and redundancy. It is likely that a gas fired power station will be required to meet this demand. To minimise the infrastructure costs, it is efficient to install the proposed power station in the proximity of load centres.

Due to the high loads and the separation distances of the zones (for example, the distance between the GIA & HIA1 is approximately 6 kilometres), underground high voltage transmission (11 kV, 22 kV, or 33 kV) may not be exclusively suitable for delivering power of a reliable quality. If this is the case, it is anticipated that power will be reticulated at transmission voltage on overhead lines to multiple zone substations around the development. Power transformers in the substations will step the voltage down to high voltage, which will subsequently be reticulated around the SIA precinct in buried cables, and further transformed to low voltage for use on individual lots as required.

It may be possible to service the early stages of the development using the existing power generation facilities in the region. Providing that the Karratha power station is kept in service, it may be useful for this purpose. Expansion of the new Pilbara power station may be another potential option for short term supply. It is anticipated that power would be routed to the SIA via the existing transmission line between Karratha and Cape Lambert. If the transmission line is heavily utilised for this purpose it is anticipated that the 132 kV line will require an upgrade to 220 kV. These transmission lines would be extended on overhead cables into the SIA and terminated into a zone substation within the development.

A more detailed understanding of the growth in the region and input from Horizon Power is required to develop the servicing strategy and infrastructure requirements during high level planning of the development.

3.4 Communications

3.4.1 Existing Infrastructure

There is existing Telstra infrastructure within North West Coastal Highway to the south of SIA and in both Wickham and Karratha townsites. Dial Before You Dig information does not show any communications infrastructure currently running through the SIA. Existing Telstra infrastructure within the vicinity of the SIA is shown in Appendix 3.

3.4.2 Development Demand

Although no information is available to quantify the communications infrastructure requirements for SIA, future operations within SIA will require a reliable communication infrastructure to connect with the outside world.

3.4.3 Supply

NBN has been nominated as the telecommunications provider for towns surrounding the SIA, however the SIA itself falls outside of NBN's current planning. NBN has advised that planning may be updated in the future to include SIA, however this will be dependent on their new development criteria at the time.

It is more likely that SIA will be serviced by Telstra via existing infrastructure in North West Coastal Highway, including any required upgrades to the existing network.

Providing NBN's planning is not updated to include SIA, Telstra have advised they will provide telephony and wideband services to the development as part of their universal servicing obligations.

3.5 Gas

3.5.1 Existing Infrastructure

Despite being located in a region that provides a significant proportion of Australia's domestic gas supply, the Pilbara region is not provided with a reticulated gas supply network.

Privately operated gas supply mains exist in the vicinity of the SIA, as described below, and as shown in Appendix 3.

- **Cape Lambert Lateral Pipeline (CLLPL)** – an underground gas main originating at DBP's Dampier to Bunbury Natural Gas Pipeline (DBNGP) near Karratha and extending to Cape Lambert. The CLLPL traverses the SIA and is located immediately west of the Proposed Central Infrastructure Corridor. The CLLPL has a capacity of 95 TJ/day (34,675 TJ/annum) and is a dedicated main servicing Rio Tinto's Cape Lambert power station. Pipeline capacity may potentially be available for the provision of gas services for industries within the SIA, subject to there being spare capacity within the pipeline, and subject to negotiations with Rio Tinto.
- **Pilbara Energy Pipeline (PEPL)** – an 'uncovered' gas main originating at DBNGP mainline valve 7 (MLV7) some 20km south of Karratha and extending to Port Hedland, where it interconnects with the Telfer Gas Pipeline (TGPL). The PEPL passes to the south of the SIA, following a route roughly parallel to the North West Coastal Highway. The main has a capacity of 166TJ/d (60,590 TJ/annum) (Gas Bulletin Board, April 2016) and been owned and operated by the APA Group since they assumed ownership and control of Epic Energy in December 2012. The pipeline is currently a free-flow pipeline system, however its capacity can be increased through compression and/or looping to meet future increases in demand. The PEPL is part of a network of four pipelines owned by the APA Group for supply of natural gas to existing and future loads within the Pilbara region. Pipeline capacity may be available for the provision of gas services for industries within the SIA, subject to negotiations with APA Group.

ATCO Gas Australia has advised there are no current plans to provide reticulated gas to any area in the vicinity of SIA. ATCO Gas Australia is also not aware of any plans by other energy infrastructure companies to provide such a network.

3.5.2 Development Demand

The Industrial Ecology Strategy analyses the predicted gas demand of potential core industry and ancillary services and support industry which may be housed in the SIA. The estimated gas demand for the SIA is shown in Table 5 (GHD 2013, amended to incorporate revised HIA1 area on a pro-rata area basis by WGE, May 2016).

Potential Industry	Gas Demand TJ/day	Gas Demand TJ/annum
HIA1 and HIA2	739.9 TJ/d	270,081 TJ/a
GIA	2.6 TJ/d	956 TJ/a
TOTAL	**742.5 TJ/d**	**271,037 TJ/a**

Table 5 – SIA Gas Demand

The timing of the growth of the industry and the corresponding gas demand is uncertain at this time.

The gas demands of the Anketell Port are beyond the scope of this report, however the port must be considered as part of the overall servicing strategy for the region.

3.5.3 Supply

ATCO Gas has advised that typically heavy industry areas are not reticulated with gas mains, as any infrastructure that may be installed during development would not be fully utilised as some industries do not require gas and others may require more than can be provided by the installed reticulated mains. The common practice in heavy industry areas is for individual industries to arrange extension of gas mains to their site to suit their own specific requirements as and when required.

Generally, gas is provided via extension or upgrading of ATCO Gas's distribution network, which is connected to privately owned and operated main natural gas pipelines such as the DBNGP or the PEPL, via meter stations (installed by the private gas carrier) and pressure reducing stations (installed by ATCO Gas). However, for industries with very high gas demands such as smelters, refineries and power stations, gas supply is generally negotiated with a private gas carrier and taken directly from a main pipeline via a dedicated lateral pipeline, thus bypassing ATCO Gas's distribution network.

It is envisaged individual industries within the Anketell SIA will source private gas supplies via the DBNGP, PEPL or CLLPL as required, however ATCO Gas has advised they may negotiate gas supply with individual proponents if sufficient demand exists.

It may be viable to install a reticulated medium pressure PE gas network from say the PEPL or the CLLPL to suit commercial / light industrial development to the general/industry zone GIA only. This would be subject to the capacity of these pipelines, the presence/location of meter stations and negotiation with the private gas carriers. Under this scenario, industries within HIA1 and HIA2 would still be required to fund the extension of larger and/or higher pressure steel mains or lateral pipelines to their site to suit their specific needs.

3.6 Roads

Jacobs Group (Australia) Pty Ltd were commissioned by LandCorp to provide a Transport and Traffic Planning study for the SIA, based on the Anketell Port Master Plan (DSD, 2014), Industrial Ecology Strategy (GHD, 2013) and the Design Plan Report (Preston, 2011). A summary of Jacob's findings are included below.

3.6.1 Existing Roads

Main Roads Western Australia (MRWA) maintains and operates North West Coastal Highway, which lies to the south of SIA and provides links to Geraldton in the south and Port Hedland to the north. North West Coastal Highway is a sealed single carriageway road, and is primarily utilised for access between Karratha and Port Hedland.

Point Samson-Roebourne Road lies to the east of SIA, on the opposite side of Rio Tinto's rail infrastructure.

Cleaverville Road is to the west of SIA, severing both the Central and Western Service Corridor, is an unsealed access track linking North West Coastal Highway to the coast and existing boat ramp at Cleaverville (west of the planned Anketell Port site), providing access for recreational users.

There are also numerous informal tracks throughout the SIA region.

3.6.2 Development Demand

North West Coastal Highway (NWCH) is intended as the primary access to SIA via the Western Corridor. The Western Corridor will provide the only access to the SIA until the Proposed Central Infrastructure Corridor becomes available in the future. An ongoing review of availability of the Proposed Central Infrastructure Corridor should be undertaken to promote external access to the SIA and port area.

Jacobs Group (Australia) Pty Ltd's has completed traffic modelling for the Anketell Port and SIA and has provided advice on the following infrastructure treatments and upgrades:

- A proposed single lane two way road servicing the SIA from NWCH within the Western Corridor will have sufficient capacity for projected traffic volumes after full development;
- The right turn onto NWCH from the Western Corridor is predicted to operate at a level of service C, which is acceptable, whilst the other movements at the intersection are predicted to operate at a level of service A or B;A link road from the Proposed Central Infrastructure Corridor to NWCH is therefore not required in terms of capacity;
- Single lane two way roads will connect to the Western Corridor road to provide access to each of the SIA land parcels;
- It is proposed to construct a section of the proposed Central Infrastructure Corridor to provide access between HIA1 and the Port – the Central Infrastructure Corridor Link Road. This link road could be located within the SIA boundary area to form a central spine road, rather than follow the currently planned proposed Central Infrastructure Corridor alignment.
- It is recommended that a secondary route to the site for emergency access/egress is provided by constructing a section of road (which could be unsealed) between the proposed Central Infrastructure Corridor Link Road and NWCH via the existing southern section of Cleaverville Road.
- If the MCC mine development proceeds and the proposed Central Infrastructure Corridor is constructed to service their access requirements, this would provide an alternative access in and out of the SIA area for use in an emergency;
- It is recommended that Cleaverville Road remains open until the Western Corridor Port Access Road is operational. Following construction, access to the beach and boat ramp would be via the existing section of Cleaverville Road to the north of the new Western Corridor Port Access Road, and the existing central section of Cleaverville Road would be closed. If the MCC mine proceeds and the Central Infrastructure Corridor access road is constructed, the existing southern section of Cleaverville Road would also be closed.

- At the northern end of the SIA at the interface with the Port, it is recommended that sufficient land be retained for potential future road infrastructure linking the causeway to the SIA to accommodate general traffic, high wide loads (HWLs) and a heavy haul road;
- It is not anticipated that there will be sufficient demand, if any, that necessitates the Eastern Corridor route between Wickham and the Port and the SIA. The existing Pannawonica rail line to Cape Lambert is a constraint that would need to be addressed if such a demand was to eventuate;
- Ongoing consultation will be required with MRWA and the City of Karratha in regard to the potential need and timing around upgrading NWCH to a dual carriageway between Karratha and Wickham, and consideration of the conflicts between road trains and other road users;
- Provision of a coastal road joining on from the Dampier Highway was not considered, pending further information from MRWA as to its inclusion or otherwise.

For further details regarding future road requirements, refer to Jacobs's Transport and Traffic Planning Report for the SIA (April 2016).

3.7 Rail

Jacobs Group (Australia) Pty Ltd's Transport and Traffic Planning study for the SIA also includes commentary on rail requirements for the SIA. A summary of Jacob's findings are included below.

3.7.1 Existing Rail

Rio Tinto operates the Pannawonica railway line to the east of the SIA. The Pannawonica railway line runs from Rio Tinto's Mesa J mine to Cape Lambert, crossing NWCH via a bridge to the east of the SIA site. This rail line is independent of the proposed Anketell SIA and port development. No other rail infrastructure exists in the vicinity of the SIA.

3.7.2 Development Demand

Rail lines will be used primarily for the transport of bulk freight, such as raw materials and minerals and products to and from the Anketell Port from the surrounding mine sites. The Western Corridor will provide the primary rail access to the SIA and Port area. If required, the Proposed Central Infrastructure Corridor could also accommodate a rail route.

Based on GHD's Indicative Industry Input / Output Assessment and Infrastructure Requirements by Precinct assessment, only heavy industrial areas within SIA will require access to rail. The indicative assessment has been included as Appendix 4 however we recommend review of the information in conjunction with the remainder of GHD's report.

While the majority of future rail requirements in the Western Corridor will be at the discretion of mining proponents, allowance for rail to serve the proposed iron ore processing precinct is considered necessary. It is anticipated that one rail line with a turnaround facility will be required for the SIA, and allowance should be made for a potential second line within the SIA (GHD, 2013).

It is assumed that the SIA will make use of the rail loop to be located within the port area. It is also assumed that marshalling yards, shunting, servicing and maintenance of rolling stock is not required within the SIA, but will be a shared facility with the port. Accordingly, a separate rail loop, marshalling yards, etc. are not required for the SIA. (GHD, 2013).

We recommend liaison with industry proponents to more accurately determine future rail requirements over and above those provided by Preston Consulting, the Pilbara Port Authority and GHD. It is noted that the width of the Western Corridor has provision to accommodate up to four rail lines.

Jacobs' advice on recommended rail infrastructure treatments and provisions is summarised below:

North West Coastal Highway

MRWA has advised that a grade separated railway crossing is required where the proposed railway crosses the North West Coastal Highway (east of the Western Corridor Port Access Road), regardless of the number of rail lines that will be constructed.

Western Corridor

Once the Western Corridor Port Access Road is operational, it is recommended that Cleaverville Road be closed south of the Port Access Road. A railway crossing will therefore not be required at the Cleaverville Road/Port Access Road intersection.

A railway crossing will be required on the access road constructed from the Western Corridor Port Access Road to heavy industry area HIA1, as detailed below:

- A level rail crossing across the proposed rail line/s is recommended for up to two rail lines.
- Stop signs are recommended as a first stage where only one rail line is constructed.
- Installation of flashing lights at the crossing is recommended when a second rail line is constructed, or when traffic volumes dictate (whichever is earliest).
- A grade separated crossing is likely to be required if/when three or four rail lines are constructed.
- If in future the Western Corridor Port Access Road is closed and an alternate access is provided solely from the Proposed Central Infrastructure Corridor Link Road, the railway crossing on the Western Corridor Port Access Road would also be closed. In this scenario, a grade separated crossing would not be required. Ability for vehicles to cross the rail lines in the event of an emergency via a barrier or gate may still be possible.
- The land area where the crossing is required is heavily inundated with tributaries and it is possible that a grade separated crossing may be required to mitigate water inundation, regardless of the number of rail lines constructed.

Proposed Central Infrastructure Corridor

There is sufficient room to provide a 30m to 40m rail reserve within the Proposed Central Infrastructure Corridor, however, GHD's Industry Ecology Strategy states that rail is not usually viable for short haul distances.

It is recommended that a potential route is nominated and sufficient land be retained that can be made available for potential future rail and/or conveyor use.

For further details regarding future rail requirements, refer to Jacobs's Transport and Traffic Planning Report for the SIA (April 2016).

3.8 Stormwater / Drainage Management

RPS Environmental were commissioned by LandCorp to provide a District Water Management Strategy for the SIA, based on the Anketell Port Master Plan (DSD, 2014), Industrial Ecology Strategy (GHD, 2013) and the Design Plan Report (Preston, 2011). A summary of RPS Environmental's recommendations for stormwater management and flood management are included below.

3.8.1 Stormwater Management

The area surrounding SIA is subject to intense rainfall associated with severe cyclonic activity, typically occurring from November through to April each year. This combined with the high soil clay content in the area results in extreme stormwater runoff flow rates, and makes SIA susceptible to storm surge and flooding.

To accommodate the high stormwater flow rates, SIA must utilise open drains located strategically throughout the site. These drains will discharge either to larger open drains in the road network, or directly to existing drainage corridors.

To minimise the extent of earthworks, pre and post-development flow and drainage corridors will be matched wherever possible. To minimise impacts of this on developable area, existing corridors may be narrowed and formalised in certain areas, depending on the final Guide Plan. Due to the expected size of lots within the SIA, grading of the design surface level will be required in lieu of flat lots, to direct runoff to desired locations and to minimise earthworks costs.

Similarly, open drains will likely be required within lots to control stormwater runoff. The presence of open drains within lots may necessitate creation of easements to avoid blockage of downstream reaches of drains.

Due to the intensity of storms, pit and pipe drainage networks are not typically used within the Shire of Roebourne. This is due to the large pipe sizes required for the intense storm events experienced and high maintenance costs associated with such systems.

The proposed stormwater drainage strategy as outlined in RPS Environmental's DWMS is summarised below:

- Open drains and swales will be used as the principle stormwater conveyance mechanism with pipes systems only being considered for use in localised or landlocked low points as required. Water sensitive urban design (WSUD) principles will be incorporated where suitable.
- Lots will be required to retain the first 15mm of rainfall (as a minimum) through appropriate landscaping, to improve the quality of stormwater discharging from lots.
- Lots will be required to implement stormwater management systems to provide a suitable level of stormwater quality control depending on the specific industrial land use, processes and materials present on the site. Requirements will be identified at the WMP stage.
- Road pavements will be flush kerbed, discharging flows to open drains located within road reserves.
- Road pavements will be designed significantly lower than surrounding lots to provide flood protection to properties.
- Open drainage channels will be sized so that the 5 year ARI event top water level (TWL) is 300mm below the level of the road shoulder, and designed to maintain low flow velocities to minimise erosion and sediment transportation.
- Road reserve drains will be used in conjunction with arterial drainage corridors throughout the development to convey stormwater flows from lots to downstream drainage reserves or discharge points.
- Open drains will be designed to contain 100 year ARI event flows.
- Arterial drainage corridors will utilise the existing surface topography and natural drainage features as much as possible to retain the pre-development hydrological regime and minimise earthworks requirements.
- Erosion and sediment transport will be minimised by reducing flow velocities through the use of detention basins, drop structures, pitching and vegetation of drainage channels.

3.8.2 Flood Clearance

RPS Environmental was commissioned by LandCorp to complete a flood study to investigate hydrological processes and risk of flooding at the SIA in order to inform future planning and design decisions for the SIA. An assessment of hydrological characteristics and hydraulic modelling of the 1 in 5-year ARI and 1 in 100-year ARI events was carried out for each of the three development areas within the SIA. Potential for inundation of the sites caused by a 1 in 500-year ARI storm surge event, including allowance for a 0.9m sea level rise (State Planning Policy 2.6), was also investigated.

Engineering Services

RPS Environmental's completed Flood Study Report and Addendum to Flood Study Report (containing more detailed modelling of the Rocky Creek area), both dated June 2015, are contained within appendices to RPS Environmental's DWMS. A summary of RPS Environmental's findings is included below:

Heavy Industry Areas HIA1 and HIA2

- The primary source of flooding at the SIA is from Rocky Creek, which flows through heavy industrial sites HIA1 and HIA2. Modelling indicates that Rocky Creek is likely to overtop its bank during a 1 in 100-year ARI event.
- Development levels adjacent to Rocky Creek will need to be designed to ensure floor levels of habitable structures are provided with a minimum 0.5m clearance to 1 in 100-year ARI peak water levels, in accordance with DoW flood protection policy.
- Maintaining flow capacity within Rocky Creek by restricting development or the filling of land within the flood plain in significant flow areas will also need to be considered, together with appropriate design and sizing of infrastructure such as bridges and culverts.
- Detailed modelling of Rocky Creek revealed extensive filling within the flood plain to restrict flow width and maximise developable areas results in significant increases in peak velocities, leading to higher potential scour and erosion issues and more costly engineering solutions for flood control.
- Areas along the northern boundary of HIA1 adjacent to the Western Corridor will experience significant depths of flooding and relatively high velocities from flows initiating in steeper areas of the catchment. Drainage design will require appropriate stormwater management measures, including use of diversion drains or levees, to manage high velocity flows through or divert flows around these areas.
- The potential for flooding impacts within the north-western arm of HIA1 is generally limited to a small unnamed creek that runs through the middle of this portion of the site.
- Development levels adjacent to this creek will need to be designed to ensure floor levels of habitable structures are provided with a minimum 0.5m clearance to 1 in 100-year ARI peak water levels, in accordance with DoW flood protection policy.
- Upstream areas on the boundary of this creek experience significant flows and consideration to flow control measures will be required in these locations.

General Industry Area GIA

- The GIA is not flood prone and is not impacted by backwater affects or inundation from storm surge.
- Development within the GIA is therefore not affected by flooding.
- Designn measures will include providing adequate grade and sizing of drainage infrastructure to manage overland stormwater flow paths and safely convey flows through the site.

Climate Change

- Flood levels within the SIA site are not affected by the modelled 0.9m sea level rise, except for the very downstream portion of HIA1 where Rocky Creek discharges to the coast.

Storm Surge Modelling

- Storm surge modelling is not available for the site. The 1 in 500-year ARI storm surge level has been estimated from storm surge modelling that was undertaken as part of RPS Environmental's Karratha Coastal Vulnerability Study.
- The estimated 1 in 500-year ARI storm surge level is 7.1m AHD.
- Development levels will need to be designed to ensure the minimum floor level of habitable structures for all sites within the SIA is 7.1m AHD, subject to further refinement of storm surge modelling.
- A significant area in the central area of HIA1 adjacent to Rocky Creek will require fill to provide clearance to storm surge levels (refer RPS Environmental's DWMS Figure 9).
- Modelling suggests that two or three small areas along the northern and southern boundary of the GIA may be subject to storm surge. These lower-lying areas may require fill to provide clearance to storm surge levels.
- Plans showing existing topography in each of the industrial precincts are provided in Appendix 5 for reference.

Further modelling will be required at detailed design stage to determine the effect of drainage infrastructure, particularly road crossings, bridges and other structures within the flood plain, on the post-development flood levels.

3.9 Earthworks / Geotechnical

Coffey Geotechnics desktop geotechnical assessment undertaken in April 2013 states that SIA is likely to be underlain by variable geology. Marine mud is expected in areas close to the coast, and silt/sand/gravel deposits are indicated along and adjacent to drainage features, which lie between more elevated areas underlain by shallow volcanic rock (Coffey Geotechnics, 2013).

Based on expected existing geotechnical conditions, sensitivity of earthworks design to existing landform is of critical importance to the viability of SIA. Several conflicting issues exist that require consideration during the planning phase and detailed design.

Significant fill is expected to be required in low lying areas to achieve adequate clearance to the floodplain. Elevated areas that would typically be used as a source of fill are likely to be underlain by shallow rock. Cost dictates that deep cut and other excavation in rock should be avoided wherever possible. The likely presence of rock may therefore limit the quantity of suitable fill available.

It may be possible to source fill from the following offsite locations:

- Port dredging operations (GHD, 2013). This is dependent on suitability of dredged material as fill.
- Undeveloped areas in the vicinity of SIA, however such activities would require a Clearing Permit from the Department of Environment & Conservation, and would be subject to Aboriginal Heritage and Native Title considerations, among others.
- MCC mine may be able to supply large quantities of fill (Preston, 2010) however availability of fill will be dependent on timing of MCC operations, which are currently unknown.

It remains to be seen whether sufficient fill will be available in the vicinity of SIA to satisfy the total development requirements. Other sources of fill in the region that could potentially be imported to the site are scarce and therefore expensive.

While Coffey Geotechnics' desktop assessment has been reviewed during preparation of this report, we recommend commissioning a detailed geotechnical assessment of the site prior to finalisation of the concept plan to confirm existing conditions in the vicinity of SIA. Results of the detailed assessment may assist in refining the subdivision concept. A detailed geotechnical report will also likely be a Condition of Subdivision.

Coffey's geotechnical assessment also provides advice regarding Acid Sulphate Soils (ASS), refer also to Section 2.5 of this report. The assessment states the majority of the site is anticipated to show 'no known occurrence of ASS'. Areas with a 'low probability' of ASS are anticipated to be locally present within the numerous creeks and gullies that traverse the site. Similarly, areas with a 'high probability' of ASS are anticipated in numerous coastal areas, particularly within the Western Corridor. Given that ASS is likely to occur primarily in low lying areas, it is likely that the extent of excavation within suspected ASS areas will be relatively minimal due to fill required in these areas to provide clearance to the floodplain. Prior to subdivision and development of the SIA it is recommended that further ASS studies and management plans be provided as necessary.

4. Opportunities & Constraints

4.1 Engineering Services

4.1.1 Water

Opportunities

- Water supply for the SIA should be considered in conjunction with requirements of both MCC's mining operation and the Anketell Port area. Economies of scale may exist if shared water supplies are developed. Liaison with MCC is required in this regard.
- While significant groundwater is not expected to be encountered during port or SIA development, MCC will likely require dewatering in the mine pit. This water may potentially be treated and reused in SIA (Preston, 2011). Liaison with MCC is required in this regard.
- Significant requirement for low quality process water will reduce cost of both construction and ongoing operation of treatment facilities. A third-pipe, and possibly a fourth-pipe recycled water network may be established to supply low-quality and high-quality industry feedwater. By creating separate reticulation networks for low and high quality industry feedwater, treatment costs may be minimised.
- There is potential for shared desalination facilities.
- It may be possible to supply water from the West Canning Basin or similar aquifers.
- A private, third-party supplier may see a commercial opportunity to establish a water supply to service SIA. There are examples in Perth and in the eastern states where the state supply authority is unable or unwilling to provide an economically viable service and a private party has been utilised.

Constraints

- Water supply likely to be privately sourced.
- Little available groundwater within SIA and surrounding areas.
- High cost of construction and ongoing operation of desalination and wastewater recycling facilities.
- Environmental considerations regarding waste from desalination and wastewater recycling.
- Large quantities of water required, including large quantities of high quality industrial feedwater.
- Large site area will result in high transmission costs.

Constraint Removal

- While no scheme water is anticipated to become available, and there is little available groundwater in the immediate vicinity of SIA, the high volumes of industrial effluent that may potentially be reused may reduce the required volume of seawater to be desalinated.
- While the large site area will result in high transmission costs, these costs may be minimised by the proposed colocation of similar industries. There is potential to minimise transmission costs by locating water intensive industries within HIA1 and HIA2 in proximity of feedwater facilities.

4.1.2 Wastewater

Opportunities

- Potential reuse of wastewater within the development via treatment and a third and fourth-pipe water network for low-quality and high-quality industry feedwater.

Constraints

- No outlet to Water Corporation wastewater treatment facilities.
- High transmission and treatment costs of wastewater.
- Presence of rock will increase the cost of a gravity fed reticulation network.

Constraint Removal

- Establishment of private wastewater treatment facilities as required.
- Proposed colocation of similar industries will allow wastewater treatment facilities to be constructed in the vicinity of high-discharge users.
- Sewer depths should be minimised to avoid excavation in rock wherever possible. Pump stations will be located strategically around the SIA to convey pressurised wastewater at shallower depths.

4.1.3 Power

Opportunities

- Locate proposed power station in the vicinity of load centres.
- Utilise existing Karratha power plant for short term supply once the Pilbara power station is commissioned.
- Potential expansion of Pilbara power station for short term supply.
- Consider power requirements in conjunction with the requirements of MCC's mining operations and the port area.

Constraints

- Cost of development of the proposed power station.
- Distance between load centres will lead to high transmission costs.

Constraint Removal

- Serve initial stages of development from existing transmission lines in the vicinity of the SIA, reducing the initial outlay for earlier stages of development.
- There is potential to supply power to the various load centres at transmission voltage, possibly providing a more reliable supply.

4.1.4 Communications

Opportunities

- Extension available from existing communications in North West Coastal Highway.
- Need for communications at Port.

Constraints

- High costs to extend communications cables.

Constraint Removal

- Minimise costs through co-ordination with the Port's communications demands.
- Approach NBN Co. to supply communications through their satellite service removing the need for cable.

4.1.5 Gas

Opportunities

- Gas is already present within the SIA.
- Demand for gas likely to make supply feasible for gas suppliers.

Constraints

- Significant upgrades to existing infrastructure required to supply predicted demand.

Constraint Removal

- Locating high gas users near each other to reduce transmission costs.
- Users with small requirements to be services early by existing infrastructure.

4.1.6 Stormwater / Drainage Management

Constraints mapping provided by RPS Environmental's DWMS identifies areas within the SIA that are generally constrained by stormwater and earthworks issues. The Constraints mapping is provided in Appendix 6.

Opportunities

- Results of the recommended Coastal Vulnerability Study will enable refinement of the Design Plan.
- Liaison with industry proponents will assist in identification of 'high priority' and 'low priority' areas, enabling flood clearance requirements to be tailored to suit and potentially reducing the overall fill quantity.

Constraints

- Intensity of storm events leads to relatively high floodplain levels. Significant fill will be required to low lying areas and those within flood corridors.
- Existing flood corridors are relatively wide and meandering. This will act to either limit the developable area or increase fill requirements.
- Cyclonic activity between November and April means construction periods and types will constrain construction.
- Shallow groundwater may impact building foundations.

Constraint Removal

- Refinement of design plan to limit development to more elevated areas wherever possible.
- Filling of lower lying areas to provide clearance to flood plains. This may potentially be achieved by sourcing material from elevated areas within the estate.
- Existing flood corridors to be narrowed, straightened and formalised wherever possible to reduce the impact on developable area.
- Construction activities to take place between May and October to avoidance delay and disruption by cyclones.
- Avoid areas of shallow groundwater or consider building methods less affected by shallow groundwater.

4.1.7 Geotechnical / Earthworks

Opportunities

- Results of the recommended Coastal Vulnerability Study will enable refinement of the Design Plan.
- Liaison with industry proponents will assist in identification of 'high priority' and 'low priority' areas, enabling flood clearance requirements to be tailored to suit and potentially reducing the overall fill quantity.
- Construct early stages in high ground areas to minimise fill import/cut to fill operations.

Constraints

- Intensity of storm events leads to relatively high floodplain levels. Significant fill will be required to low lying areas and those within flood corridors.
- Existing flood corridors are relatively wide and meandering. This will act to either limit the developable area or increase fill requirements.
- The presence of shallow rock will limit the availability of fill on site.
- Sources of fill in the region are scarce and therefore expensive.

- Cyclonic activity between November and April means construction periods and types will constrain construction.
- Steep grades will limit suitable areas for construction if high earthwork costs are to be avoided.
- Presence of Acid Sulfate Soils within drainage lines.
- Environmental constraints exist in the form of protected flora and fauna.

Constraint Removal

- Refinement of design plan to limit development to more elevated areas wherever possible.
- A detailed geotechnical investigation will similarly enable refinement of the design plan, and will also enable earthworks design to target areas where fill is present and minimise excavation in rock.
- Filling of lower lying areas to provide clearance to flood plains. This may potentially be achieved by sourcing material from elevated areas within the estate.
- Existing flood corridors to be narrowed, straightened and formalised wherever possible to reduce the impact on developable area.
- Reuse of dredged material as clean fill, pending investigation regarding suitability.
- Potential ability to source fill material from undeveloped areas within the site. Pending environmental approvals, among others.
- Potential availability of fill from MCC mining operations.
- Avoidance of deep excavation wherever possible.
- Construction activities to take place between May and October to avoidance delay and disruption by cyclones.
- Consideration given to maximum allowable grades within lots with earthworks limited to building envelopes.
- Site development to avoid high risk ASS areas or design to minimize cutting operations.
- Avoidance of areas identified as containing protected flora and fauna.

4.2 Precinct Specific

4.2.1 Heavy Industrial Area 1

Opportunities

- Relatively central within the combined SIA and port area. HIA1 will likely be close to centralised servicing facilities, which benefits the early development of the precinct.
- Eastern portion of the precinct is relatively high and unlikely to be prone to flooding.
- Fill may be sourced from higher ground levels within the precinct to fill lower portions of the precinct, or other lower lying areas in the SIA.

Constraints

- Lack of existing infrastructure in the vicinity of the SIA will result in high establishment costs being incurred in the initial stages of development.
- Major creek line runs through western portion of site. Potential for flooding and need for large quantities of fill.
- Tidal flats contain soils that will give poor stability without major earthworking.
- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Priority Flora species.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- Initial construction of centralised facilities may be limited to provide capacity to serve only the early development stages. Such facilities should be constructed with the capability of future upgrade. While this method would likely increase the total establishment cost, significant cost would be deferred until the ultimate supply is required. Additionally, greater flexibility is afforded to future capacity of supply.
- As aforementioned, initial stages of development can possibly source power from existing overhead transmission lines in the vicinity of the SIA.
- Early construction to utilise eastern portion of site to avoid need for fill to avoid flooding.
- Utilise portion of site that does not contain poor strength soils or look at building solutions which allow for construction in these areas.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Priority Flora species areas to be avoided.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

4.2.2 Heavy Industrial Area 2

Opportunities

- Due to likely development timeframe, the majority of infrastructure will be existing at the time of development.
- Located in a relatively elevated area. While fill will likely be required to flood corridors, the relative quantity of fill required will likely be less than other areas.
- Western and eastern areas of the precinct are relatively high and unlikely to be prone to flooding
- There may be an opportunity to source fill from within HIA2 for use in other areas.

Constraints

- Providing that access is not available via the Proposed Central Infrastructure Corridor, access to HIA2 must be through HIA1. In addition to providing a less direct link to HIA2, this access requires crossing of the existing Rio Tinto gas main and power lines.
- Timing of development is unknown due to MCC mining operations.
- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- The development layout should be designed such that a clear link to HIA2 is provided through HIA1.
- Liaison should be undertaken with MCC to determine more accurate development timeframes.
- Crossing points to be established where road is safely constructed over/under existing Rio Tinto gas main and power lines.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

4.2.3 General Industrial Area

Opportunities

- Located proximately to Western Corridor.

Constraints

- Likely distance of the GIA from centralised water & wastewater servicing facilities will result in high transmission costs.
- Located in a low lying area that will likely require significant quantities of fill.
- Higher areas within the precinct appear to be quite steep and would require significant earthworks to produce a usable lot.
- Buffer zone requirements to other lots and surrounds dependent on proposed land use may render large areas of developable land unusable.
- Potential for Acid Sulfate Soils within existing drainage lines.
- Presence of Priority Flora species.
- Presence of Significant Fauna species.
- Presence of Registered Aboriginal Heritage Sites and Other Heritage Places.

Constraint Removal

- Potentially source of fill from aforementioned locations, or other precincts within the SIA.
- Planning measures to be implemented to ensure as little developable land as possible is lost to buffer zones.
- Initiate further investigation into the presence of Acid Sulfate Soils. If present area can be either avoided or filled.
- Priority Flora species areas to be avoided.
- Significant Fauna species to be relocated as required or habitat areas avoided.
- Development to avoid Registered Aboriginal Heritage Sites and Other Heritage Places.

5. Order of Magnitude Estimate

Estimated costs are based on the information referenced in this report. Due to the preliminary nature of the available information, the costs are notional and should be used as an order of magnitude guide only. All costs are subject to ongoing review pending refinement of the Guide Plan.

Due to the uncertainty regarding both timing and staging of the SIA, the costs referenced below do not include preliminary and overhead costs typically expected in civil construction contracts. Additionally, no allowance has been made for ongoing costs associated with the proposed infrastructure. Allowance has been made for establishment costs only.

Estimated costs are for servicing of the SIA only. Future consideration should be given to servicing of the Anketell Port area in conjunction with the SIA to minimise total costs.

5.1 Water

Allowance has been made for desalination and water reticulation in accordance with the Engineering Services section of this report.

The cost of establishment of a centralised desalination facility is particularly volatile. An allowance of $650m should be made for establishment of a desalination facility of adequate capacity, however liaison is required with desalination experts to validate this figure.

Allowance should be made for a third-pipe and fourth-pipe reticulation network for recycled wastewater / desalinated water at anticipated low quality and high quality industry feedwater standard. This is in excess of a standard potable water reticulation network. The total cost of water reticulation networks is estimated to be $150m.

As aforementioned, should there be prohibitive constraints to construction of a desalination facility with adequate capacity in the vicinity of the SIA, there is potential for water to be sourced from the West Canning Basin. Transmission and treatment costs of water from the basin are notionally estimated to be $650m and $375m respectively, in addition to the unchanged internal reticulation cost of $150m. The treatment cost of water from the West Canning Basin is estimated to be less than that of Anketell; it has been assumed that untreated water drawn from the Basin will be considered 'low quality industry feedwater', reducing the volume of water to be processed at the desalination facility. Liaison is required with industry proponents to determine the standard required for 'low quality industry feedwater', and further investigation is required to determine whether untreated water in the Basin will meet this standard.

5.2 Wastewater

Allowance has been made for wastewater treatment and reticulation in accordance with the Engineering Services section of this report.

Establishment of wastewater treatment and recycling facilities is also particularly volatile and is dependent on the nature of effluent to be treated. Consultation with industry proponents and wastewater treatment specialists in this regard is required, however it is estimated that these facilities will cost in the order of $280m.

An allowance should be made for several gravity fed reticulation networks, feeding into pump stations and conveyed thereon to the centralised wastewater treatment facility by pressurised sewer mains throughout the SIA. The cost of pump stations and the associated reticulation networks is estimated to be $65m and $95m respectively.

5.3 Power

As aforementioned, the initial works to bring transmission voltage power from existing generation facilities may necessitate the upgrade of existing transmissions lines, and the establishment of zone substations to convert the power to a voltage suitable for usage by industry proponents. These works are estimated to cost $250m. Actual cost incurred will be dependent on the load uptake, pole route, and requirements for network reinforcement.

The installation costs of the proposed gas fired power station will vary greatly depending on a number of factors, including the remote location of the development, however estimates exist for the cost of establishing power plants for various generation technologies. Worley-Parsons' 2012 report entitled 'Cost of Construction – New Generation Technology' indicates that a gas fired power plant without Carbon Capture and Storage (CCS) is in the order of $1,000/kW. This can be cross referenced to the updated U.S. Energy Information Administration's 2013 report entitled 'Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants', which estimates a similar cost per kilowatt. This leads to a capital cost in the order of $525m to establish a power plant suitable to supply the SIA. The capital costs for a plant with CCS technology may be in excess of double those for a plant without the technology, however this cost would need to be considered in conjunction with any greenhouse gas incentives (such as carbon pricing) and environmental regulations which are in effect.

Internal power reticulation within the SIA precincts is estimated to cost $55m based on similar industrial developments in the Pilbara region.

5.4 Communications

Provision of Telstra services within the SIA is estimated to be $45m, based on similar industrial developments in the Pilbara region.

5.5 Gas

Allowance has been made for provision of medium pressure gas mains to the general/support industry area only, in accordance with the Engineering Services section of this report.

The estimate includes for provision of an ATCO Gas medium pressure gas mains to service the general/support industry area, GIA, via a DN150PE MP gas pipeline located within the Western Corridor Internal reticulation within the GIA has not been included as it is assumed that individual proponents will undertake reticulation extensions to suit their individual requirements. The estimate assumes that supply will come from the PEPL, via a pressure reducing valve at an existing meter station located on the PEPL within 20km of the intersection of the Western Corridor and the North West Coastal Highway. A nominal allowance has been made for meter station upgrade works, should this be required. These works are estimated to cost $10m.

Actual cost incurred will be dependent on capacity of the PEPL, location of existing meter station, extent of meter station upgrade works, size and length of pipeline, the pipeline route and ground conditions encountered. Should there be no meter station within the vicinity of the SIA, a new meter station may need to be constructed. Estimated cost of a new meter station may be in the order of $250m. Funding of the meter station would be subject to negotiation between the gas carrier and the developer.

No allowance has been made for the provision of gas to heavy industrial areas HIA1 or HIA2.

5.6 Roadworks

Construction of roads within the SIA and Infrastructure Corridor to a standard consistent with other industrial areas in the region is estimated to cost $90m.

5.7 Footpaths

No allowance has been made for the provision of footpaths, similar to the treatment to other industrial areas in the vicinity of the SIA.

5.8 Rail

The construction of two rail lines and a turnaround facility in the HIA1 and HIA2 area is estimated to cost $120m based on the cost of construction of the Fortescue Rail in the Pilbara region in 2008.

No allowance has been made to install rail infrastructure in the Western Corridor. It is assumed that this infrastructure will be constructed by other port users.

No allowance has been made to install rail infrastructure in the Proposed Central Infrastructure Corridor, should this be a requirement.

5.9 Earthworks and Retaining Walls

We have made a notional allowance for earthworks to create gently graded lots throughout the SIA. No allowance has been made for retaining walls, or to create level lots.

Please note that due to large lot sizes, and the comparatively small expected building sizes in the SIA, no allowance has been made to achieve a particular lot classification. It is envisaged that the building envelopes for each lot will be earthworked by industry proponents as necessary during the building phase.

The geotechnical report indicates that there is shallow rock at various locations across the SIA. We confirm that a notional allowance has been made for rock excavation in the estimate.

The estimated volume of imported fill required is 15 million compacted cubic metres, however caution should be exercised in utilising this value. Detailed earthworks design is yet to be undertaken and the volume of fill required is therefore volatile, particularly given the aforementioned uncertainty regarding flood clearances, the subdivision layout and the availability of suitable fill material on site and off site. Due to the uncertainty of potential supply, no allowance has been made for fill to be sourced from port dredging operations, undeveloped areas within the SIA, or MCC's proposed magnetite mine. It is assumed that any required excess fill will be supplied by outside sources. To minimise the required quantity of imported fill, it is recommended that lots falling towards the rear or side are designed in some locations. As aforementioned, the consequence of this is that drainage easements may be required along the rear and/or side boundaries of some lots. Additionally, some lots may not have a uniform fall to further minimise earthworks costs. This may adversely affect the sales price of the land, which should be considered in your feasibility.

The unit cost of import fill varies quite significantly in the Karratha region. We have utilised a rate of $45 per m^3 for the importing, placing and compacting of fill material to suit recent prices in the area. Due the expected development timeframes, ongoing review of all estimated construction rates should be undertaken, however particular attention should be paid to the import fill rate due to the expected volatility.

Due to uncertainty of excavation depths and the location of potential Acid Sulphate soils, no allowance for ASS treatment has been made in the estimate.

We estimate that cost of bulk earthworks for the SIA will be in the order of $910m.

5.10 Stormwater Drainage

Allowance has been made for stormwater treatment in accordance with the Engineering Services section of this report.

Open drainage swales and culverts as necessary at road crossings are expected to cost $50m. This does not include an allowance for culverts at driveway crossings to individual lots due to uncertainty regarding lot layouts.

As aforementioned, swales will likely be required within lots. These swales will likely require easements to avoid downstream lots filling the swales and blocking upstream flow. An allowance should be made by LandCorp for the effect of these easements on the sale price of lots. Allowance should also be made for the additional land required for open drains within road reserves.

Due to the likely in-situ ground conditions, no allowance has been made for sub-soil drainage adjacent to road pavements.

5.11 Staging

Unless otherwise noted, consideration has not been given to staging of infrastructure construction due the uncertainty regarding the timing of demand.

No allowance has been made for the time value of money, or for cost escalation due to uncertainty in both of these items.

5.12 GST

All cost referenced are exclusive of goods and services tax.

5.13 Summary of Infrastructure Costs

ITEM	COST (EXC GST)	NOTES
Water Supply		**Water Supply Cost from West Canning Basin**
Reticulation	$150m	$150m (reticulation) + $650m (transmission) + $375m (treatment)
Desalination	$650m	
Wastewater		
Reticulation	$95m	
Pump Stations	$65m	
Treatment & Recycling	$280m	
Power		
Reticulation	$55m	
Zone Substations & Associated Infrastructure	$250m	
Gas Fired Power Station	$525m	Additional $525m (min) for carbon capture and storage (CCS).
Communications	$45m	
Gas		
Connection to Supply Support Industry Area	$10m	
Meter Station & Associated Infrastructure	$250m	Pending further advice from APA
Road	$90m	
Rail	$120m	
Earthworks	$910m	
Stormwater Drainage	$50m	
TOTAL	**$3,545m**	

6. Conclusion

Wood & Grieve Engineers have been commissioned by LandCorp to undertake an assessment of the engineering works and civil infrastructure upgrades required to facilitate the future industrial development of Anketell Strategic Industrial Area, based on RPS's Improvement Scheme Report and Guide Plan, Final Draft dated April 2016.

A number of servicing options for the proposed development have been investigated, incorporating advice provided by respective sub-consultants and the relevant service authorities. Services and infrastructure considered in this report are summarised below:

- **Water**

  There is currently no potable water supply infrastructure in the vicinity of the SIA and that industry proponents will need to pursue private water sources. There is little information on groundwater availability within the area, however supply is expected to be limited.

  Forecast water demands for the SIA are 106 ML/annum for potable water, and 8,717 ML/annum and 17,303 ML/annum respectively for high quality and low quality industry feed water. Privately owned facilities will be required to meet the forecast water demands. Options for water supply include seawater desalination (potable and feedwater), recycling of industrial effluent (feedwater) and groundwater abstraction from more distant aquifers such as the West Canning Basin (potable depending on quality).

  Establishment of a centralised treatment facility for water supply will provide opportunity to improve efficiencies and minimise costs. Supply in conjunction with the port will also produce economies of scale to help reduce costs.

- **Wastewater**

  There are currently no wastewater treatment facilities within the vicinity of the SIA.

  Potential industry feedwater from treated wastewater from the SIA is forecasted to be 21.84 GL/annum with a percentage of this water being suitable for re-use by the proposed industry. A centralised wastewater facility established near heavy users would improve efficiencies and minimise costs. Light users could take advantage of ATU's.

- **Power**

  Power in the vicinity of the SIA is distributed by Horizon Power and is generated at multiple power stations, including the existing 80MW Karratha power station and two new installations at new power precinct, Boodarie Industrial Estate – the temporary 100MW capacity Hedland Precinct power station (commissioned in early 2015) and the new 150MW Pilbara power station currently being built, owned and operated by TransAlta Energy (Australia) Pty Ltd.

  The Pilbara power station, commissioned to meet growing energy demand due to growth in the Pilbara, will power Fortescue Metals Group's port operations and supply 110MW of electricity to Horizon Power, and can be expanded to supply power to other commercial users from 2017 onwards. The construction of these two power stations may result in decommissioning of the Karratha power station.

  The closest zone substation to the SIA is at Cape Lambert, servicing Point Samson, Wickham and Roebourne. Transformers within the facility are close to capacity. There is an existing 132kV transmission line between Karratha power station and the Cape Lambert zone substation, located to the east of the SIA and a 220kV line between Port Hedland and Cape Lambert.

  No power infrastructure currently exists within the SIA.

Conclusion

The estimated power demand for the SIA is 392 MW (GHD, 2013, amended to incorporate revised HIA1 area estimated on a pro-rata area basis, WGE, May 2016). Existing and planned future Horizon Power infrastructure is unlikely to have capacity to meet this demand. However, with the necessary infrastructure upgrades, it may be possible to utilise existing power generation facilities in the region to service the early stages of the development. A 500MW gas-fired power station strategically located within the SIA near the larger consumers will likely be required to generate sufficient power for the ultimate combined demand of the SIA and the port precinct. It is anticipated that power will be distributed via overhead transmission lines to multiple zone substations around the development, with reticulation to lots via buried cables.

- **Communications**

  There is existing Telstra infrastructure within North West Coastal Highway to the south of SIA and in both Wickham and Karratha townsites. No communications infrastructure currently exists within the SIA. No information is available to quantify the communications infrastructure requirements for SIA, however future operations within SIA will require a reliable communication infrastructure. The SIA will likely be serviced by Telstra, including telephony and wideband services, via existing infrastructure in North West Coastal Highway, including any required upgrades to their existing network.

  An opportunity exists through the use of NBN satellites that service the region, thereby providing a cost effective option to installing further cable in the ground.

- **Gas**

  Two existing gas mains are located in the vicinity of the SIA, the Cape Lambert Lateral Pipeline (CLLPL) which traverses the site, and the Pilbara Energy Pipeline (PEPL) located near the North West Coastal Highway. The CLLPL is a dedicated supply for Rio Tinto's Cape Lambert power station, but may potentially have some capacity to service the SIA. The PEPL is owned by ACO Group and may have capacity to service the SIA. Gas to the SIA development would potentially be supplied from the CLLPL and/or the PEPL (subject to capacity) via an existing or new Meter Station/s, new Pressure Reducing Station/s and reticulated gas mains designed and installed by ATCO Gas and funded by the developer or individual industries, depending on demand. In the case of high gas users, gas may be taken directly from the CLLPL or PEPL via individual lateral pipelines.

  Where a meter station is required, location near heavy gas users would provide an opportunity to minimise transmission costs.

- **Roads**

  Existing roads within the vicinity of the SIA are North West Coastal Highway (sealed road controlled by MRWA) to the south and Cleaverville Road (unsealed local authority road), which runs between the GIA and the HIA1 and HIA 2 sites. Jacobs has advised that North West Coastal Highway is suitable in its current state and that Cleaverville Road can remain as an unsealed road for use as emergency egress from SIA.

  Jacobs has identified that the SIA development will require a single lane two way road within the Western Corridor to service the SIA and port sites. Single lane two way spur roads would then be required to access each of the SIA land parcels.

- **Rail**

  Rio Tinto operates the Pannawonica railway line to the east of the SIA. No other railway lines are present within the SIA.

  The Western Corridor has capacity for four railways lines to serve the SIA and port. One of these railway lines is expected to serve the HIA, though allowance should be made for a second line.

  In establishing rail within the SIA, Jacobs has recommended that it be grade separated from North West Coastal Highway. Within the SIA grade separated crossings would only be required once a third railway line is constructed.

  Jacobs has made recommendation that Cleaverville Road be closed south of the Port Access Road once rail is established in the Western Corridor to avoid the need for a rail crossing.

Conclusion

A rail line could be constructed within the Proposed Central Infrastructure Corridor to service HIA 1 and HIA 2, however this will be dependent upon MCC's plans for the area.

- **Stormwater / Drainage Management**

Stormwater management throughout the SIA is expected to be via open drains strategically located throughout the site discharging to existing drainage corridors. Due to the intensity of storms, pit and pipe drainage networks are not typically used within the region.

The proposed stormwater drainage strategy as outlined in RPS Environmental's DWMS is summarised below:

- Open drains and swales will be used as the principle stormwater conveyance mechanism with pipes systems only being considered for use in localised or landlocked low points as required. Water sensitive urban design (WSUD) principles will be incorporated where suitable.
- Lots will be required to retain the first 15mm of rainfall (as a minimum) through appropriate landscaping, to improve the quality of stormwater discharging from lots.
- Lots will be required to implement stormwater management systems to provide a suitable level of stormwater quality control depending on the specific industrial land use, processes and materials present on the site. Requirements will be identified at the WMP stage.
- Road pavements will be flush kerbed, discharging flows to open drains located within road reserves.
- Road pavements will be designed significantly lower than surrounding lots to provide flood protection to properties.
- Open drainage channels will be sized so that the 5 year ARI event top water level (TWL) is 300mm below the level of the road shoulder, and designed to maintain low flow velocities to minimise erosion and sediment transportation.
- Road reserve drains will be used in conjunction with arterial drainage corridors throughout the development to convey stormwater flows from lots to downstream drainage reserves or discharge points.
- Open drains will be designed to contain 100 year ARI event flows.
- Arterial drainage corridors will utilise the existing surface topography and natural drainage features as much as possible to retain the pre-development hydrological regime and minimise earthworks requirements.
- Erosion and sediment transport will be minimised by reducing flow velocities through the use of detention basins, drop structures, pitching and vegetation of drainage channels.

Potential for flooding within each of the SIA development cells is summarised as follows:

- HIA 1 and HIA 2 are at risk of being flooded by Rocky Creek which is likely to overtop its bank in the 1 in 100 year ARI event. Development levels adjacent Rocky Creek will need to be set to 500mm above the 1 in 100 year ARI event in accordance with DoW flood protection policy.
- For the eastern arm of HIA 1, flooding impact is limited to a small creek that runs through the middle of this portion of the site. Development levels adjacent the small creek will need to be set to 500mm above the 1 in 100 year ARI event in accordance with DoW flood protection policy.
- The GIA is not flood prone.

Further modelling, including storm surge modelling, will need to be considered at Local Water Management Strategy and Urban Water Management Plan stages.

- **Earthworks / Geotechnical investigations**

Coffey Geotechnics desktop geotechnical assessment undertaken in April 2013 states that SIA is likely to be underlain by variable geology. Marine mud is expected in areas close to the coast, and silt/sand/gravel deposits are indicated along and adjacent to drainage features, which lie between more elevated areas underlain by shallow volcanic rock (Coffey Geotechnics, 2013).

Based on expected existing geotechnical conditions, sensitivity of earthworks design to existing landform is of critical importance to the viability of SIA. Significant fill is expected to be required in low lying areas to achieve adequate clearance to the floodplain. Elevated areas that would typically be used as a source of fill are likely to

be underlain by shallow rock. The likely presence of rock may therefore limit the quantity of suitable fill available.

It remains to be seen whether sufficient fill will be available in the vicinity of SIA to satisfy the total development requirements. Other sources of fill in the region that could potentially be imported to the site are scarce and therefore expensive.

Areas with a 'low probability' of ASS are anticipated to be locally present within the numerous creeks and gullies that traverse the site. Similarly, areas with a 'high probability' of ASS are anticipated in numerous coastal areas. Given that ASS is likely to occur primarily in low lying areas, it is likely that the extent of excavation within suspected ASS areas will be relatively minimal due to fill required in these areas to provide clearance to the floodplain.

Further detailed investigations, together with discussions and negotiations with the relevant authorities are required to progress infrastructure planning for the development and to better define estimates of development costs. The below actions and their timing are considered appropriate to progress servicing of the SIA.

Can be undertaken now:

Item	Responsibility	Comment
Detailed Geotechnical Investigation of SIA land parcels.	Proponents	Costs could be saved by combining investigations with multiple proponents.
Engagement with Anketell Port, proposed industry and authorities to co-ordinate service demands, strategic positioning, planning and timing.	Proponents/LandCorp	LandCorp undertaking servicing investigation.
Engage with private water suppliers.	Proponents	For feasibility it is likely that one private supplier will need to provide to multiple proponents.
Preliminary earthworks modelling.	Proponents	

Can be undertaken prior to application to WAPC for development approval:

Item	Responsibility	Comment
Feature and topographic survey	Proponents	Costs could be saved by combining surveying with multiple proponents.
Precalculation plan	Proponents	

To be undertaken in conjunction with detailed design:

Item	Responsibility	Comment
Water Management Plan	Proponents	

7. References

Anketell Port Master Plan 2011-2041- Executive Summary, Dampier Port Authority, 2011.

Anketell Port Master Plan, Department of State Development, April 2014.

Anketell – Port and Strategic Industrial Area Report – Revision D, Preston Consulting, February 2011.

Anketell Strategic Industrial Area – Industrial Ecology Strategy, GHD, July 2013.

Anketell SIA Transport – Transport and Traffic Planning Report, Jacobs, 22 April 2016

Cost of Construction – New Generation Technology, Worley Parsons, 10 July 2012.

Desktop Assessment – Anketell Strategic Industrial Area Project, Coffey Geotechnics, 30 April 2013.

District Water Management Strategy – Anketell Strategic Industrial Area, RPS Environmental, Rev2, April 2016

Draft Environmental Assessment Report – Anketell Strategic Industrial Area Improvement Scheme, RPS Environmental, Draft C, June 2015.

Flood Study Report – Anketell Strategic Industrial Area, RPS Environmental, Rev 1, June 2015

Improvement Scheme Report – Anketell Strategic Industrial Area, RPS Australia East Pty Ltd, Final Draft, April 2016

Karratha Coastal Vulnerability Study, JDA Consultant Hydrologists, August 2012.

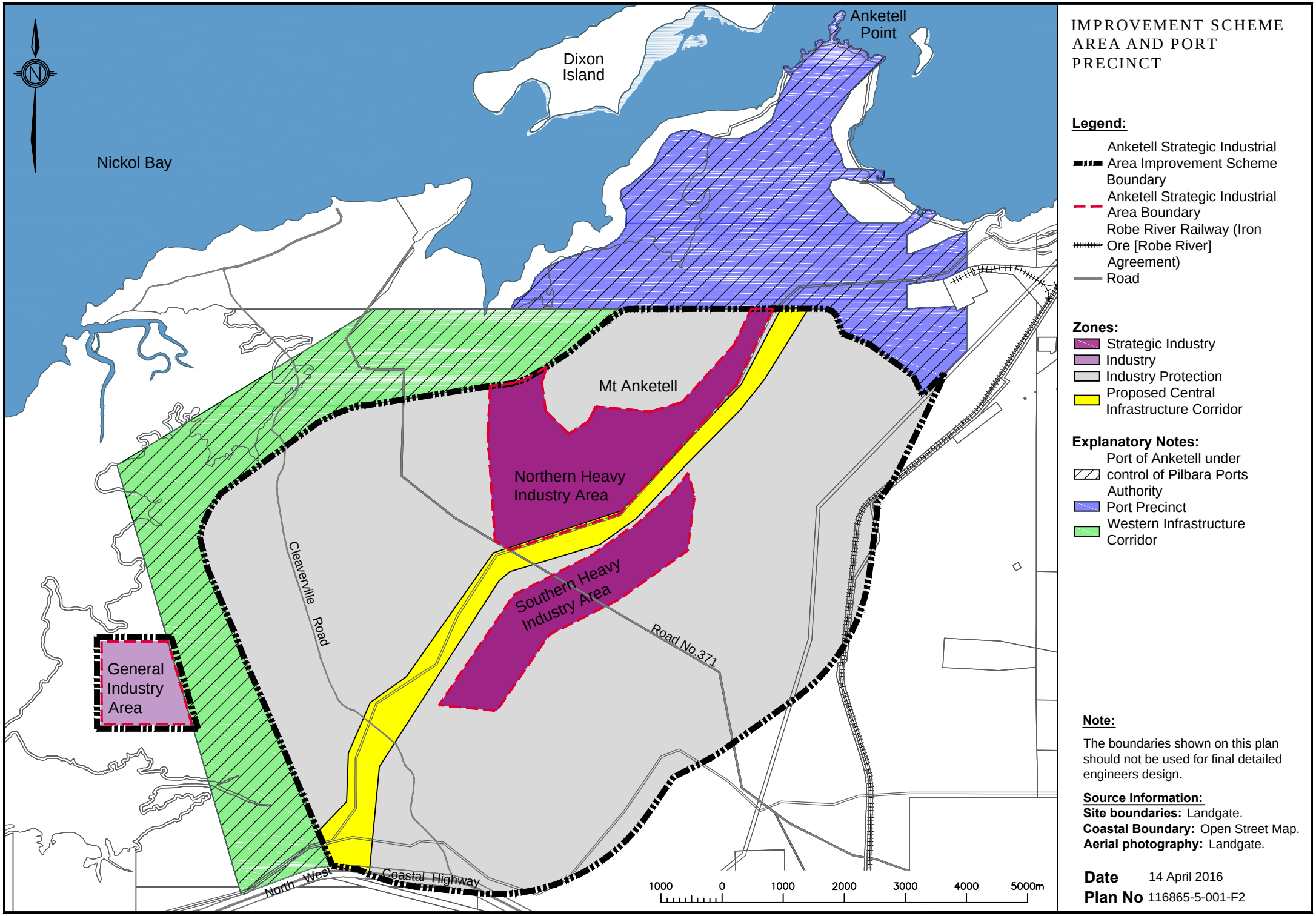
Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants, U.S. Energy Information Administration, April 2013.

West Canning Basin Groundwater Allocation Limit Report, Department of Water, October 2012.

Appendix 1

Location Plans

(RPS Environmental, 2016)



IMPROVEMENT SCHEME AREA AND PORT PRECINCT

Legend:

- Anketell Strategic Industrial Area Improvement Scheme Boundary
- Anketell Strategic Industrial Area Boundary
- Robe River Railway (Iron Ore [Robe River] Agreement)
- Road

Zones:

- Strategic Industry
- Industry
- Industry Protection
- Proposed Central Infrastructure Corridor

Explanatory Notes:

- Port of Anketell under control of Pilbara Ports Authority
- Port Precinct
- Western Infrastructure Corridor

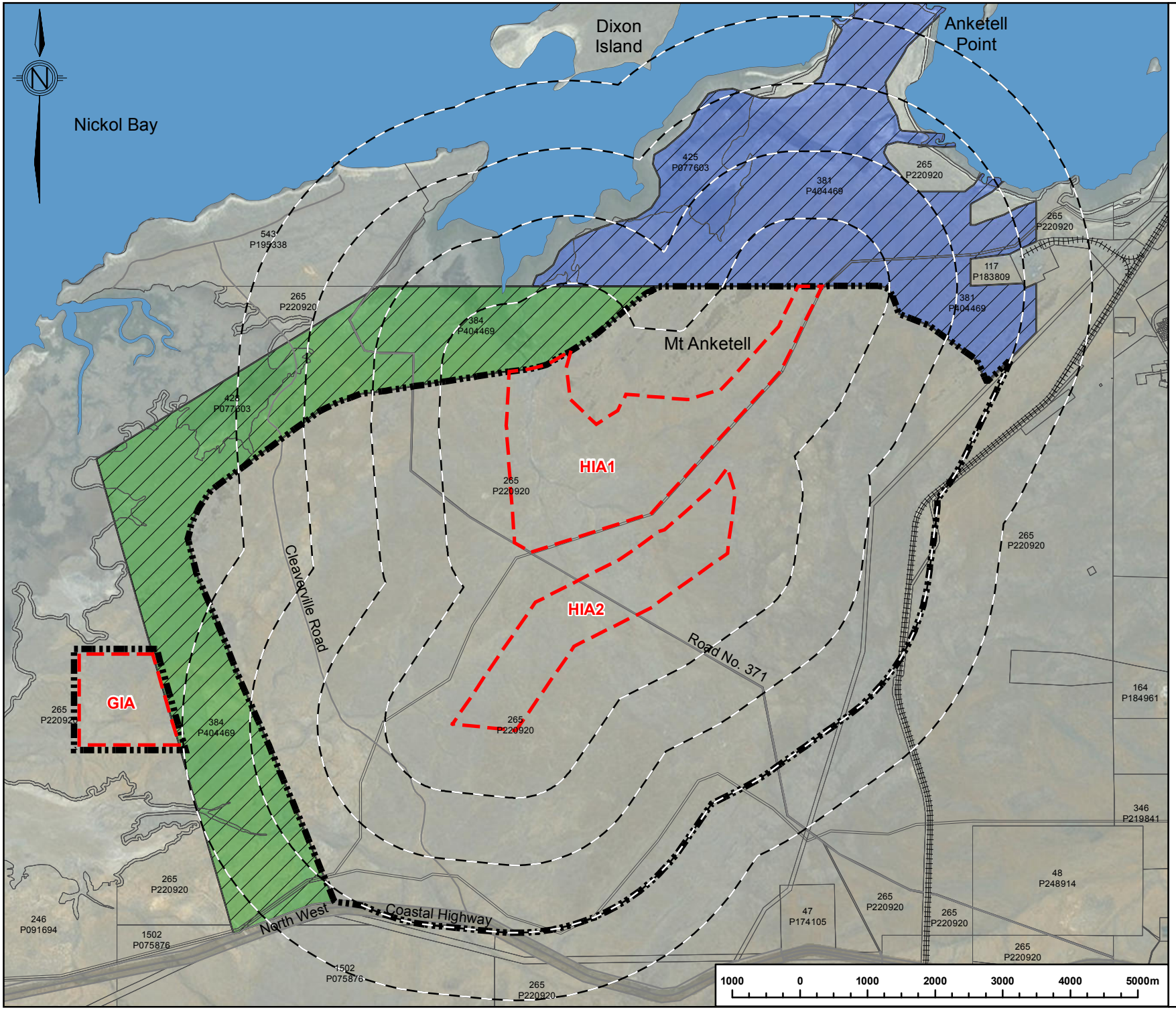
Note:

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:

Site boundaries: Landgate.
Coastal Boundary: Open Street Map.
Aerial photography: Landgate.

Date 14 April 2016
Plan No 116865-5-001-F2



BUFFER PLAN

Legend:

- Anketell Strategic Industrial Area Improvement Scheme Boundary
- Anketell Strategic Industrial Area Boundary
- Anketell Strategic Industrial Area Buffer
- Robe River Railway (Iron Ore (Robe River) Agreement)
- Road

Explanatory Notes:

- Port of Anketell under control of Pilbara Ports Authority
- Port Precinct
- Western Infrastructure Corridor

Note:

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:

Site Boundaries: Landgate
Coastal Boundary: Open Street Map
Aerial photography: Landgate

Date: 18 April 2016
Plan No 116865-5-001-F4

Appendix 2

Indicative Industry Inputs / Output Assessment

(GHD, 2013)

Note – This legacy data from the GHD report is based on a superseded planning layout. General Industry Area GIA1 has now been incorporated into Heavy Industry Area HIA1 and therefore the indicative input and output requirements for HIA1 are expected to be higher than shown in the GHD legacy data.

Table 2 Summary of selected industry mix and indicative industry input / output assessment

POTENTIAL INDUSTRIES		POTENTIAL AREA AND EMPLOYMENT				POTENTIAL KEY INPUTS						POTENTIAL KEY OUTPUTS		
#	Potential industry types	Total area	Potential direct employment			Power	Gas	Domestic use of potable water	High quality industry feed water	Process & cooling water (lower quality)	Raw / source materials	Water discharge	Products	By-products / wastes
			Total	'White collar'	'Blue Collar'									
		ha	persons	persons	persons	MW	TJ/a	ML/a (ktpa)	ML/a (ktpa)	ML/a (ktpa)	ktpa	ML/a (ktpa)	ktpa	ktpa
DOWNSTREAM PROCESSING OF IRON ORE														
1	Iron ore pelletising plant	75	400	120	280	10	2,000	11	1,050	1,950	5,250	2,408	5,000	250
1	Direct reduction / alternative smelting iron plant	85	400	120	280	60	50,000	11	2,100	3,900	5,250	4,815	2,000	726
1	Medium scale iron ore processing plant	50	200	60	140	20	5,000	5	175	325	788	401	750	38
Subtotal		**210**	**1,000**	**300**	**700**	**90**	**57,000**	**27**	**3,325**	**6,175**	**11,288**	**7,624**	**7,750**	**1,014**
DOWNSTREAM PROCESSING OF OTHER ORES														
1	Magnesium production plant	30	400	120	280	8	10,000	11	700	1,300	262	1,605	100	16
1	Titanium production plant	30	300	90	210	145	1,000	8	1,400	2,600	112	3,210	50	11
1	Medium scale resource processing plant	50	200	60	140	20	5,000	5	175	325	79	401	75	4
Subtotal		**110**	**900**	**270**	**630**	**173**	**16,000**	**25**	**2,275**	**4,225**	**454**	**5,216**	**225**	**31**
DOWNSTREAM PROCESSING OF GAS AND PETROCHEMICALS														
1	Methanol plant	40	100	30	70	1	28,000	3	875	1,625	595	2,006	800	125
1	Ammonia / urea plant	70	250	75	175	2	22,400	7	500	2,500	448	2,325	650	477
1	Ethane extraction	20	150	45	105	30	100,000	4	88	163	2,000	201	2,650	100
1	Ethane cracker	50	250	75	175	10	8,750	7	51	94	175	116	145	20
1	Medium scale gas processing plant	45	200	60	140	20	5,000	5	175	325	788	401	750	38
Subtotal		**225**	**950**	**285**	**665**	**63**	**164,150**	**26**	**1,688**	**4,707**	**4,006**	**5,049**	**4,995**	**759**
UTILITIES AND RESOURCE RECOVERY														
1	Gas fired power station (250 MW)	50	75	23	53	0	10,000	2	200	0	0	180	0	0
1	Waste-to-energy and material recovery facility	10	25	8	18	0	2,500	1	100	0	252	90	Double counting	32
1	Biofuels production plant	15	50	15	35	2	195	1	50	450	275	383	200	75
1	Industry feedwater facility	40	15	5	11	17	0	0.4	0	0	40,000	10,000	30,000	1
1	Energy facility (electricity, steam, heat, chill)	40	25	8	18	0	Double counting	1	Double counting	Double counting	0	Double counting	Double counting	0
Subtotal		**155**	**190**	**57**	**133**	**19**	**12,695**	**5**	**350**	**450**	**40,527**	**10,653**	**30,200**	**107**
GENERAL INDUSTRY AREA 1 - PORT RELATED														
4	General industries	12	60	18	42	2	156	2	80	80	105	132	100	5
2	Logistic industries	6	40	12	28	1	7	1	0	3	53	3	50	3
3	Stockpiling and lay-down areas	15	60	18	42	2	17	1	0	8	0	7	0	0
3	Metal scrap export and storage facilities	9	30	9	21	1	10	1	0	5	303	4	300	3
4	Offshore fabrication or assembly facilities	12	200	60	140	2	14	4	0	6	0	9	Unknown	0
Subtotal		**54**	**390**	**117**	**273**	**9**	**204**	**9**	**80**	**101**	**461**	**154**	**450**	**11**
GENERAL INDUSTRY AREA 2														
23	General industries	69	345	104	242	11	897	9	460	460	604	759	575	29
8	Logistic industries	24	160	48	112	4	27	4	0	12	210	12	200	10
2	Stockpiling and lay-down areas	10	40	12	28	2	11	1	0	5	0	5	0	0
3	Fuel storage facilities	9	30	9	21	1	10	1	0	5	96	4	96	0
3	Supply base and construction support industries	9	60	18	42	1	10	1	0	5	0	5	0	0
Subtotal		**121**	**545**	**164**	**382**	**19**	**956**	**16**	**460**	**486**	**910**	**784**	**871**	**39**
Total		**875**	**3,975**	**1,193**	**2,783**	**373**	**251,005**	**108**	**8,178**	**16,144**	**57,644**	**29,481**	**44,491**	**1,960**

Total industry feedwater demand	Excluding water from feedwater facilty		
24,322 ML/yr	17,644	19,481	14,491
	ktpa	ML/a (ktpa)	ktpa

Appendix 3

Combined Existing Services Plan

PORT PRECINCT

WESTERN CORRIDOR

HEAVY INDUSTRIAL AREA 1
(HIA1)

ROAD RESERVE

CLEAVERVILLE ROAD

PROPOSED CENTRAL CORRIDOR

HEAVY INDUSTRIAL AREA 2
(HIA2)

ROAD RESERVE

GENERAL
INDUSTRIAL AREA
(GIA)

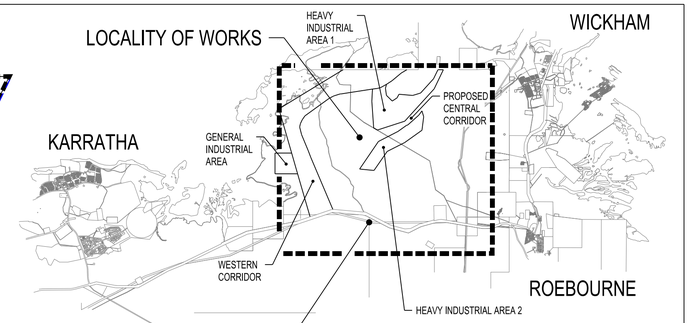
LATERAL PIPELINE EASEMENT

CAPE LAMBERT

NORTH WEST COASTAL HIGHWAY

PILBARRA ENERGY PIPELINE EASEMENT

PLAN
SCALE 1:20000



LOCALITY PLAN
SCALE N.T.S

LEGEND:

- EXISTING APA GROUP GAS
- EXISTING RIO TINTO GAS
- EXISTING TELSTRA
- EXISTING HORIZON POWER 132KV TRANSMISSION LINE, KARRATHA TO CAPE LAMBERT
- EXISTING HORIZON POWER 220KV TRANSMISSION LINE, PORT HEDLAND TO CAPE LAMBERT

REV.	DESCRIPTION	DRAWN	VER	APPROVED
B	GIA1 AMALGAMATED WITH HIA1	NJHE		
A	ORIGINAL ISSUE	NJHE	JCZ	JCZ 20/08/15

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PERTH
MELBOURNE
SYDNEY
BRISBANE
GOLD COAST
ALBANY
BUSSELTON
SHENZHEN
DARWIN

CLIENT:
LANDCORP

PROJECT:
ANKETELL STRATEGIC INDUSTRIAL AREA

TITLE:
COMBINED EXISTING SERVICES PLAN

DRAFT ISSUE

SECTION: CIVIL SERVICES	VERIFIED : J. ZELONES 20/08/2015	SCALE : A1
DESIGNED : M. CRAIN	APPROVED FOR TENDER:	DATUM : A.H.D.
DRAWN : N. HERNANDEZ	APPROVED FOR CONSTRUCTION :	WAPC : -

PROJECT No.	DRAWING No.	REVISION
25707-PER-C	G1	B

P:\25707\Civil Drawings\c plan combined services.dgn

Appendix 4

Indicative Industry Inputs and Outputs and Infrastructure Requirements by Precinct

(GHD, 2013)

Note – This legacy data from the GHD report is based on a superseded planning layout. General Industry Area GIA1 has now been incorporated into Heavy Industry Area HIA1 and therefore the indicative input and output requirements for HIA1 are expected to be higher than shown in the GHD legacy data.

Table 3 Indicative industry inputs and outputs and infrastructure requirements by precinct

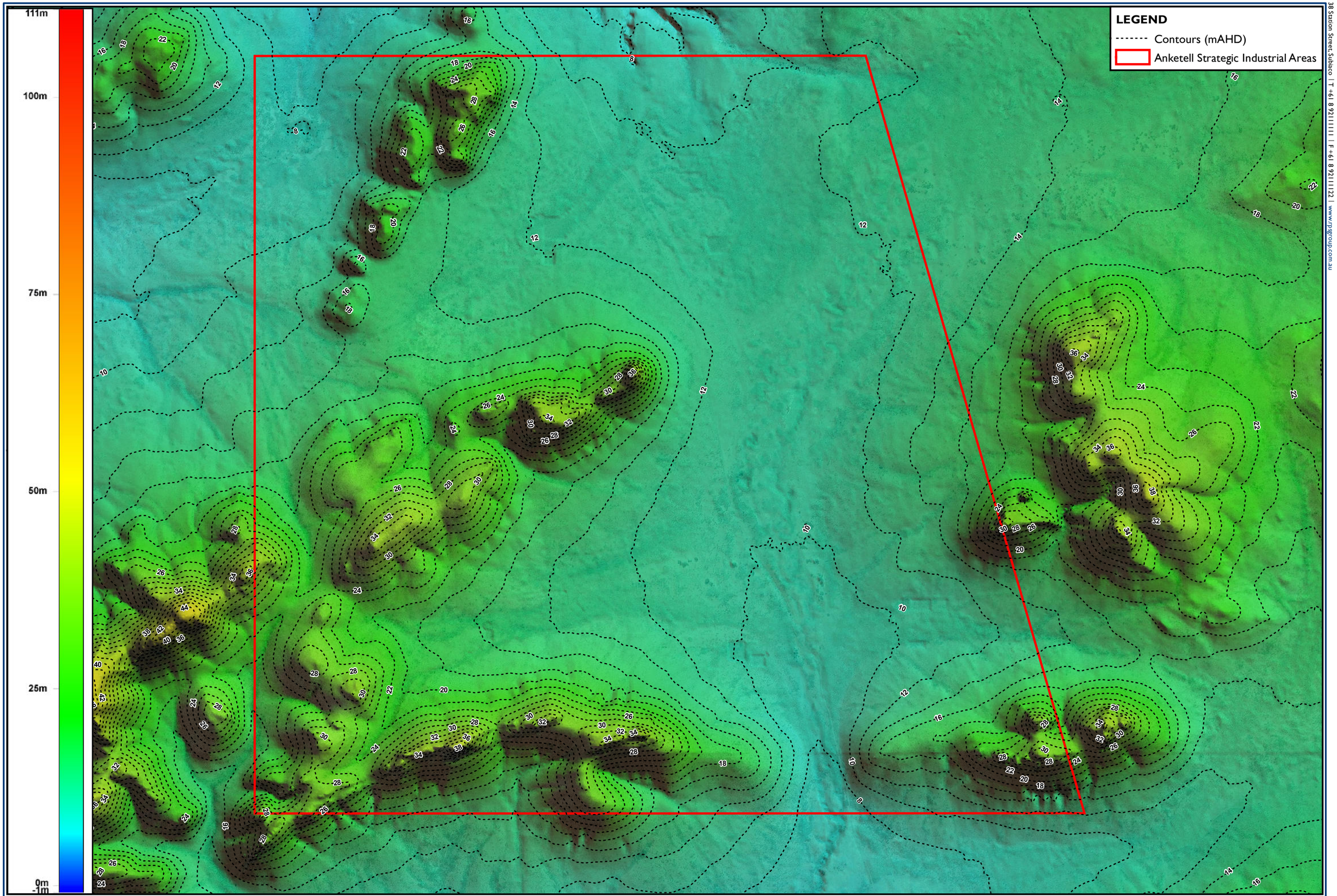
Excluding (alternative) industry feedwater systems and fuel/gas systems for energy consumption

POTENTIAL KEY INPUTS					POTENTIAL INFRASTRUCTURE REQUIREMENTS											
Power	Gas	Domestic use of potable water	High quality industry feed water	Process & cooling water (lower quality)	Potential road requirements		Potential rail requirements		Potential PAM requirements	Potential pipeline requirements			Potential conveyor requirements		
MW	TJ/a	ML/a (ktpa)	ML/a (ktpa)	ML/a (ktpa)	Resource type	ktpa	Resource type	ktpa		Resource type	ktpa	number	Resource type	ktpa	number
DOWNSTREAM PROCESSING OF IRON ORE															
90	57,000	27	3,325	6,175	Raw materials	850	Raw materials	7,188	Unlikely, unless steel plants are producing very large steel products (e.g. rolls, sheets)	Raw materials	800	2	Raw materials	2,450	2
					Products	2,375	Products	375		Products	0	0	Products	5,000	0
					By-products/waste	314				By-products/waste	0	0	By-products/waste	700	1
					Subtotal	**3,539**	**Subtotal**	**7,563**		**Subtotal**	**800**	**2**	**Subtotal**	**8,150**	**3**
DOWNSTREAM PROCESSING OF OTHER ORES															
173	16,000	25	2,275	4,225	Raw materials	146	Raw materials	303	Unlikely	Raw materials	5	1	Raw materials	0	1
					Products	160	Products	65		Products	0	0	Products	0	0
					By-products/waste	31				By-products/waste	0		By-products/waste	0	0
					Subtotal	**336**	**Subtotal**	**368**		**Subtotal**	**5**	**1**	**Subtotal**	**0**	**1**
DOWNSTREAM PROCESSING OF GAS AND PETROCHEMICALS															
63	164,150	26	1,688	4,707	Raw materials	100	Raw materials	0	Unlikely	Raw materials	3,906	5	Raw materials	0	0
					Products	828	Products	1,028		Products	3,123	13	Products	0	0
					By-products/waste	184				By-products/waste	575	2	By-products/waste	0	0
					Subtotal	**1,112**	**Subtotal**	**1,028**		**Subtotal**	**7,604**	**20**	**Subtotal**	**0**	**0**
UTILITIES AND RESOURCE RECOVERY															
19	12,695	5	350	450	Raw materials	527	Raw materials	0	Unlikely	Raw materials	40,000	2	Raw materials	0	0
					Products	150	Products	0		Products	30,050	3	Products	0	0
					By-products/waste	107				By-products/waste	0	0	By-products/waste	0	0
					Subtotal	**784**	**Subtotal**	**0**		**Subtotal**	**70,050**	**5**	**Subtotal**	**0**	**0**
GENERAL INDUSTRY AREA 1 - PORT RELATED															
9	204	9	80	101	Raw materials	459	Raw materials	0	Potentially, subject to specific industry types (e.g. assembly facilities)	Raw materials	0	0	Raw materials	0	0
					Products	449	Products	0		Products	0	0	Products	0	0
					By-products/waste	11				By-products/waste	0	0	By-products/waste	0	0
					Subtotal	**919**	**Subtotal**	**0**		**Subtotal**	**0**	**0**	**Subtotal**	**0**	**0**
GENERAL INDUSTRY AREA 2															
19	956	16	460	486	Raw materials	813	Raw materials	0	Unlikely	Raw materials	96	2	Raw materials	0	0
					Products	801	Products	0		Products	64	2	Products	0	0
					By-products/waste	39				By-products/waste	0	0	By-products/waste	0	0
					Subtotal	**1,653**	**Subtotal**	**0**		**Subtotal**	**160**	**4**	**Subtotal**	**0**	**0**
373	**251,005**	**108**	**8,178**	**16,144**	**Total**	**8,344**	**Total**	**8,958**		**Total**	**78,619**	**32**	**Total**	**8,150**	**4**

Appendix 5

Existing Topography Plans

(RPS Environmental, 2016)



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RPS

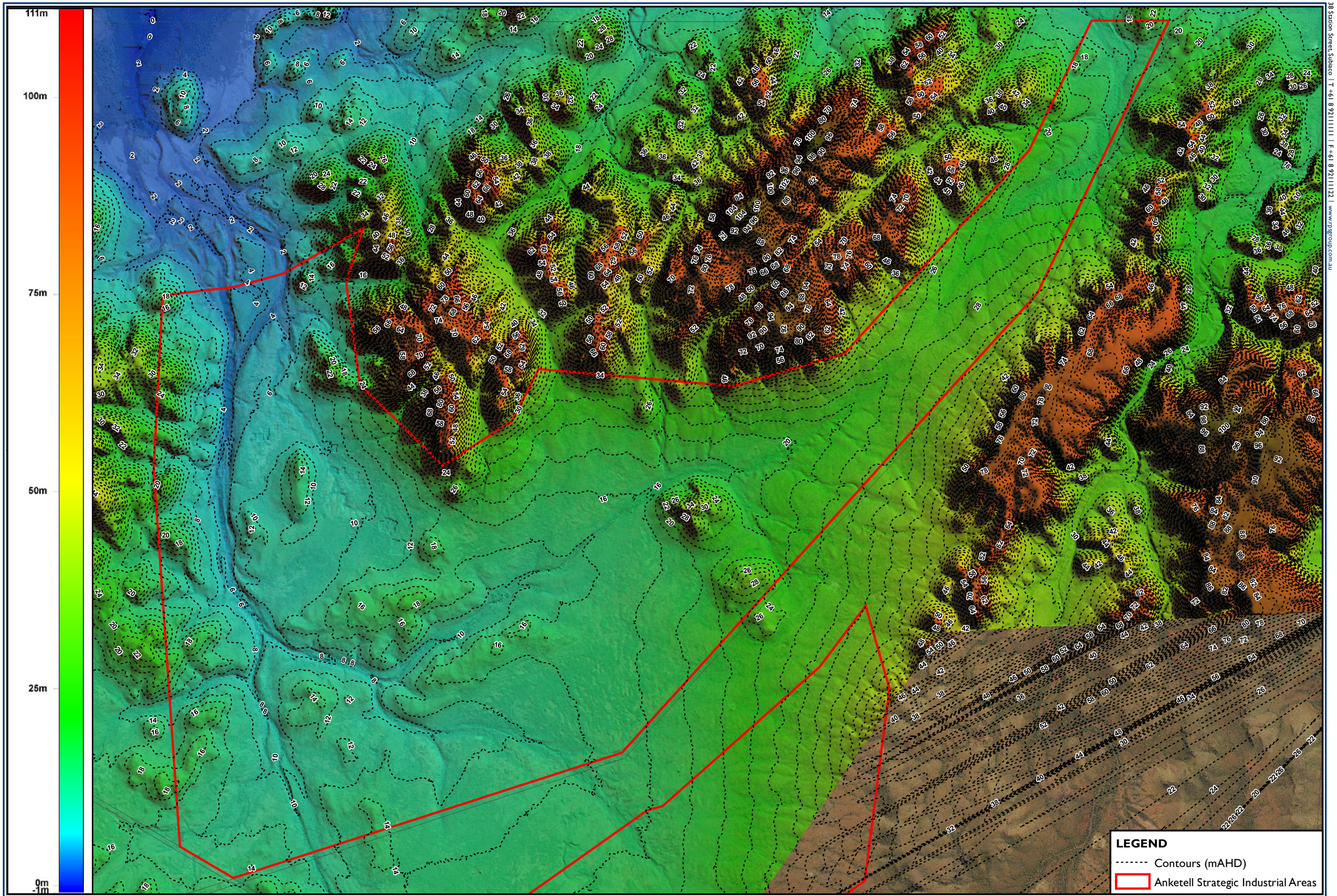
Job Number: L1305907
Doc Number: 003a
Date: 16.04.16
Scale: 1:6,000 @ A3
Created by: MA
Source: RPS 2016

GDA 1994 MGA Zone 50

0 25 50 100 150 200 m

Figure 3a

Topography - GIA



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RPS

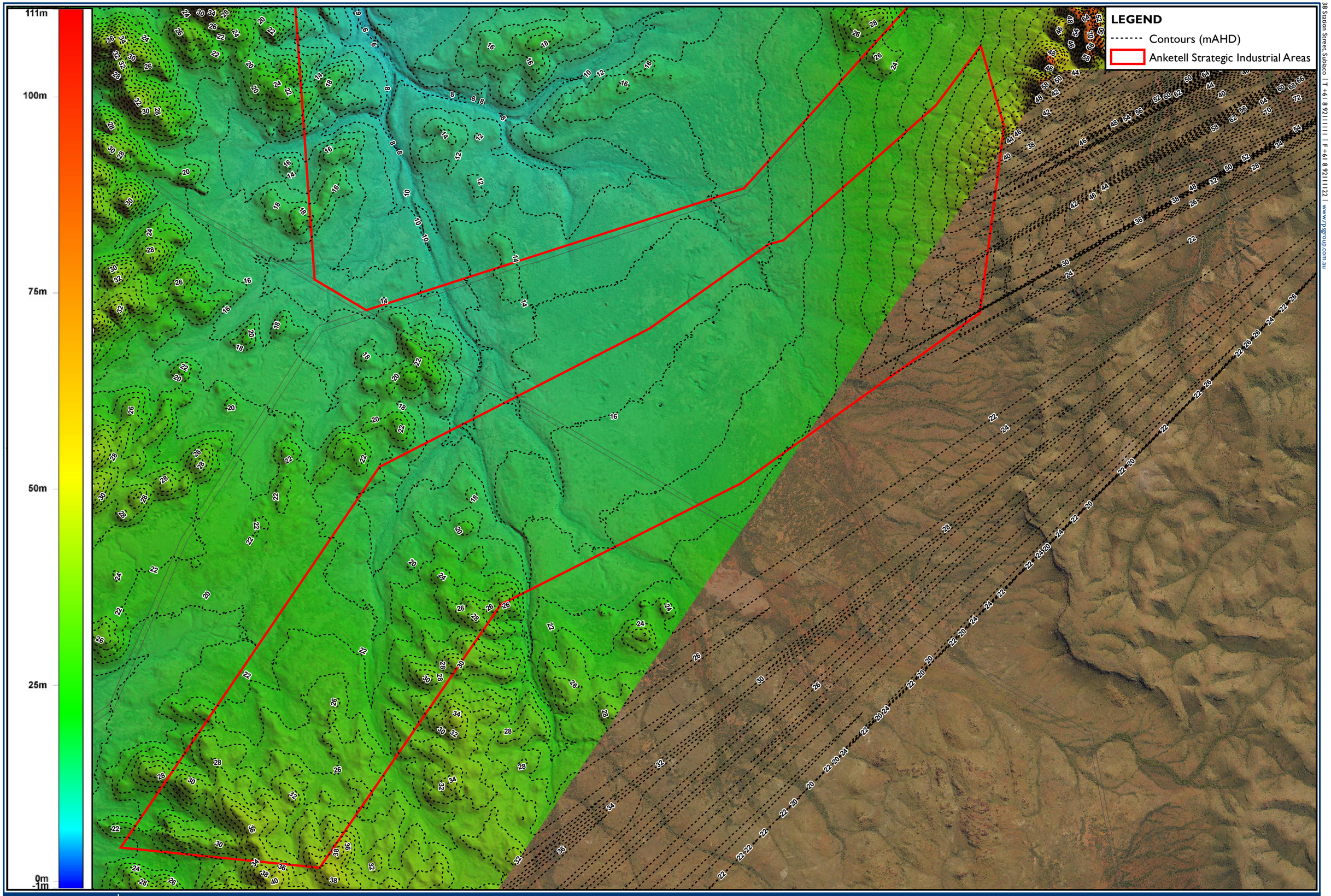
Job Number: L1305907
Doc Number: 003b
Date: 16.04.16
Scale: 1:15,500 @ A3
Created by: MA
Source: RPS 2016

GDA 1994 MGA Zone 50

0 65 130 260 390 520 m

Figure 3b

Topography - HIA1



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RPS

Job Number: L1305907
Doc Number: 03c
Date: 16.04.16
Scale: 1:15,867 @ A3
Created by: MA
Source: RPS, 2016

GDA 1994 MGA Zone 50

0 62.5 125 250 375 500 m

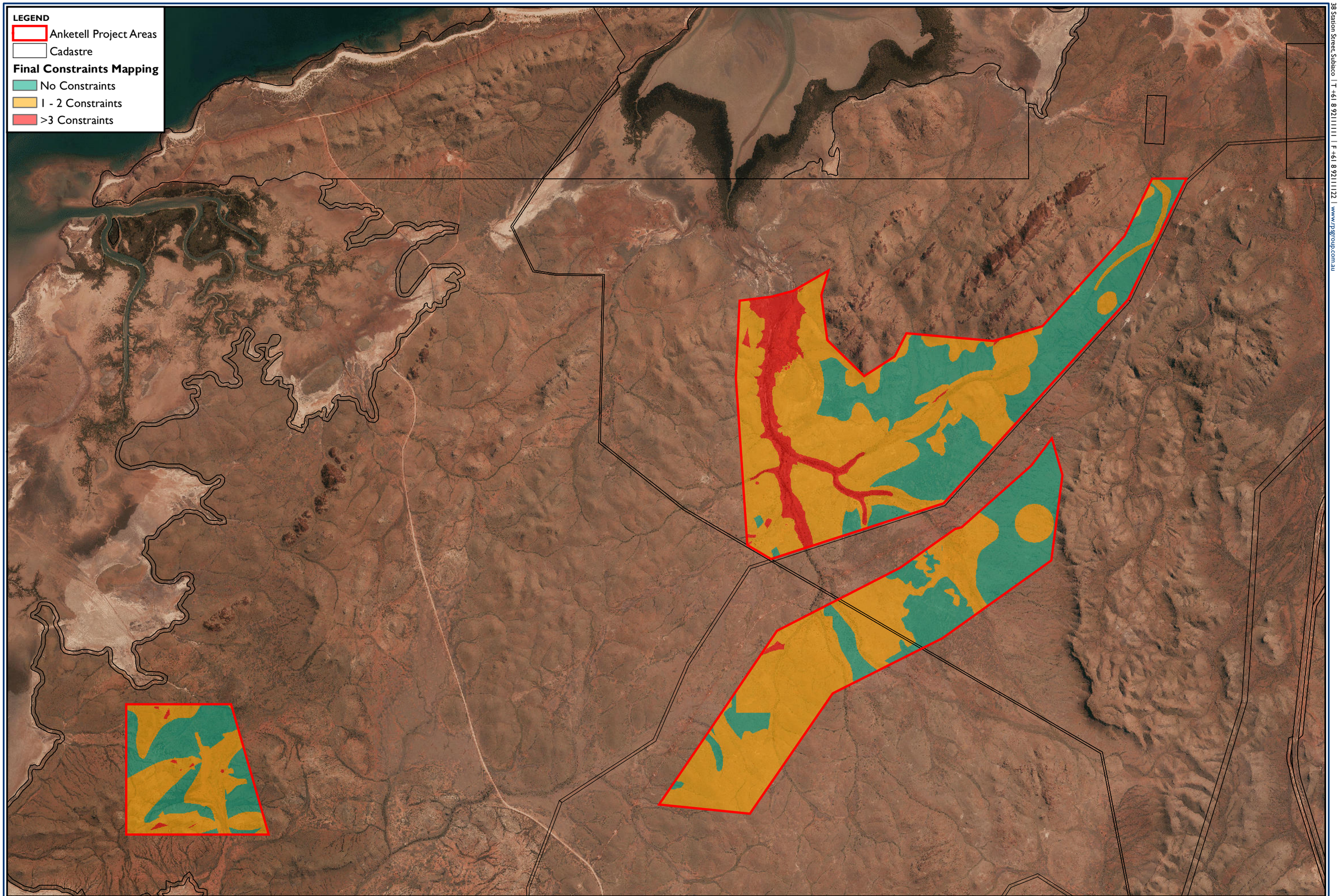
Figure 3c

Topography - HIA2

Appendix 6

Constraints Mapping

(RPS Environmental, 2016)



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RPS

Job Number: L1305907
Doc Number: 026
Date: 16.04.16
Scale: 1:35,000 @ A3
Created by: MA
Source: Orthophoto - Landgate, 2014

GDA 1994 MGA Zone 50

0 0.25 0.5 1 1.5 2 km

Figure 26

Final Constraints Mapping