Appendix E

Environmental Referral, North West infrastructure Multi User Iron Ore Export (Landside) Facility

Hydro-geological Assessment

REPORT

Hydrogeological Assessment, Proposed Port Development, Port Hedland, Western Australia

8 JUNE 2011

Prepared for

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Abbreviations

Abbreviation	Description
ARI	Average Reoccurrence Interval
BHPBIO	BHP Billiton Iron Ore Pty Ltd
BHPBIO HBI	BHP Billiton Iron Ore Hot Briquetted Iron Plant
BOM	Bureau of Meteorology
Coffey	Coffey Environments Pty Ltd
DFS	Definitive Feasibility Study
DoW	Department of Water
EIA	Environmental Impact Assessment
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
FMG	Fortescue Metals Group
Hancock	Hancock Prospecting
K	hydraulic conductivity
km	kilometre
m	metre
m^2	metre squared
m/a	meter per annum
m/d	metre per day
m^3/d	cubic metre per day
mAHD	metres relative to Australian Height Datum
mbgl	metre below ground level
mg/L	milligram per litre
ML/d	megalitre per day
mm	millimetre
NWI	North West Infrastructure
PHPA	Port Hedland Port Authority
RHIO	Roy Hill Iron Ore Pty Ltd
SKM	Sinclair Knight Merz
SP1-4	Stanley Point 1 - 4
SWL	standing water level
URS	URS Australia Pty Ltd

Executive Summary

North West Infrastructure (NWI) proposes to construct and operate a Multi- Use Export Iron Ore Facility in Port Hedland, Western Australia.

URS Australia Pty Ltd (URS) has been engaged by Coffey Environments Pty Ltd (Coffey) on behalf of their client - NWI - to undertake a groundwater study of one aspect of this facility, referred to as the Landside Project, to support the environmental impact assessment process.

The groundwater study was at a desktop level only. Based on the review of the available hydrogeological data and assessment of the Landside Project infrastructure on the baseline groundwater environment, the following conclusions have been made;

- The local hydrogeological environment is characterised by a shallow water table (2-5 mbgl) within alluvial deposits of low hydraulic conductivity. Groundwater is expected to be recharged by the Turner River, with groundwater flow influenced by topography and is expected to discharge to the ocean;
- The key potential impactors to groundwater include stockpiled material, dewatering of groundwater during the car dumper construction and spills and leaks of contaminates to sensitive marine and terrestrial receptors;
- Migration of salinised water from the stockpiling area to the adjacent mangroves is considered to be a risk, however it is considered to be low; and
- Based on the modelling of the potential cone of depression resulting from car dumper dewatering, the radius of the cone of depression has been determined to be 500m (at the 5th percentile of likliehood). Therefore, the potential impacts to surrounding receptors have been assessed as being low to medium. However, this should be reassessed following collection of site specific geotechnical and hydraulic data.

Based on the data reviewed, the following data gaps have been identified. These include;

- Understanding of potential waterlogging of soils around the stockpile operations is unknown due to the absence of geotechnical data;
- Understanding of impacts to mangroves by stockpiling operations cannot be accurately determined in the absence of site specific groundwater quality and hydraulic data;
- Confirmation of accuracy of the impacts to groundwater from the construction works in the absence of site specific aquifer parameter data.

Based on the conclusions and identified data gaps, the following further works are recommended;

- Collection of site specific geotechnical data to assist with design of surface-drainage system in stockpile area;
- Establishment of a small network of shallow groundwater monitoring bores adjacent to the northern and western boundaries of the rail loop and undertake groundwater gauging and monitoring for salinity to monitor potential salinity impacts to adjacent mangroves;
- Undertake a mangrove health risk assessment to provide baseline data on mangrove health for future reference, and if required prepare a groundwater mitigation action plan, with trigger levels;
- Installation of a production bore in the car dumper area and undertake a pumping test to determine site specific aquifer parameters to confirm the construction dewatering effects; and
- Ensure any on-site storage and handling of hydrocarbons conforms to relevant Australian Standards. Further, a Job Safety Analysis should be prepared for any future excavation/ groundwater abstraction works which may result in human exposure to impacted groundwater (if any).

URS

Introduction

1.1 Background

North West Infrastructure (NWI) proposes to construct and operate a Multi- Use Iron Ore Export Facility in Port Hedland, Western Australia.

The facility has been divided into three separate project areas, including;

- South West Creek Dredging and Reclamation (Port) Project, which for which Port Hedland Port Authority (PHPA) is the proponent;
- Landside Project, for which NWI is the proponent and is the subject of this assessment (*the site*); and
- Rail Project, for which NWI is the proponent.

Each of these projects has or will be referred to the Environmental Protection Authority (EPA) under Section 38(1) of the Environmental Protection Act.

A number of preliminary reports have been prepared for the proposed Landside facility. The Environmental Prefeasibility Study (Coffey, 2009) identified that a number of specialist studies, including a groundwater assessment, were required to be undertaken as part of the assessment of the development.

URS Australia Pty Ltd (URS) has been engaged by Coffey Environments Pty Ltd (Coffey) on behalf of their client - NWI - to undertake a groundwater study of the Landside Project to support the environmental impact assessment process.

Due to delays with obtaining land access approvals, at the request of Coffey, this groundwater study is at a desktop level only. It is understood that intrusive groundwater investigations may be progressed following the outcomes of the desktop study and granting of site access.

1.2 Objectives

The overall objectives for the groundwater study at the Landside Project include:

- Assess the hydrogeology of the existing environment;
- Interpret available data to develop a conceptual hydrogeological model, baseline groundwater conditions and dewatering models;
- Identify and assess potential project impacts to groundwater and sensitive receptors; and cumulative impacts caused of nearby developments; and
- Identify measures to avoid, minimise or mitigate adverse impacts to groundwater.

1.3 Scope of Work

In order to achieve the project objectives, the following scope of work was undertaken for the desktop groundwater study;

1. Conduct desktop review of available data;
2. Based on available data, assess the groundwater environment including physiography, climate, geology, hydrogeology, hydrology and sensitive receptors;
3. Based on available data, characterise the baseline groundwater environment and assess the interface between the terrestrial and marine environment (if data is available);
4. Discuss study assumptions and limitations;
5. Assess potential measures to avoid and mitigate impacts to groundwater;

6. Assess project related impacts and risks to groundwater, after implementation of identified management and mitigation measures; and
7. Provide recommendations for any monitoring or further investigations required to inform characterisation and management of groundwater.

1.4 Relevant Legislation and Guidelines

The groundwater assessment has been undertaken with consideration to the following legislation and guidance documents;

- *Environmental Protection Act 1986*;
- *Rights in Water and Irrigation Act 1914;*
- *Rights in Water and Irrigation Regulations 2000;*
- Department of Environment (2006), *Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives;*
- Department of Environment and Conservation (2003) Contaminated Site Guideline Series;
- Department of Environment and Conservation (2009), *Draft Treatment and Management of Soils and Waters in Acid Sulfate Soil Landscapes*- Acid Sulfate Soil Guideline Series;
- Department of Mines and Petroleum (2006) *Mining Environmental Management Guidelines: Mining Proposal in WA*;
- Department of Planning and Infrastructure (2006), *Coastal Protection Policy for Western Australia*;
- Department of Planning and Infrastructure (2006), *Draft Coastal Zone Management Policy for Western Australia*.
- Environmental Protection Authority (2006) *Guidance Statement No 6 Rehabilitation of Terrestrial Ecosystems;*
- Environmental Protection Authority (2001) *Final Guidance Statement No 1: Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline*; and
- Environmental Protection Authority (2004) *Final Guidance Statement No 29: Benthic Producer Habitat Protection for Western Australia's Marine Environment*.

Project Description

2.1 Project Area

The proposed facility is situated in Port Hedland, located in the Pilbara region of Western Australia, approximately 1,665 km north of Perth (**Figure 1 - Appendix A**), and comprises three functional units:

- South West Creek Dredging and Reclamation (Port) Project, which for which Port Hedland Port Authority (PHPA) is the proponent;
- Landside Project, for which NWI is the proponent and is the subject of this assessment (*the site*); and
- Rail Project, for which NWI is the proponent.

The proposed Landside leased and licensed area for the Landside development covers approximately 380 hectares and includes all elements to be located with land currently or proposed to be vested within the PHPA. A rail spur (Rail project) extending from the PHPA controlled lands to a connection with potential rail providers may extend up to 26.4km to the south of Port Hedland, the specifications of which are dependant on the rail solution chosen.

Lands to the east and north (including Finucane Island and Nelson Point) of the proposed NWI facility, is operated by a number of other mining entities, including BHP Billiton Iron Ore (BHPBIO), Fortescue Metals Group (FMG) and Hancock Prospecting (RHIO) who have developed their own iron ore haulage and port infrastructure.

This report focuses on the Landside Project only (see **Figure 1**).

2.1.1 Proposed Landside Project Infrastructure

The key features to be developed within the Landside Project include, inloading, stockyard and outloading components. URS have summarised those features which are relevant to the groundwater assessment below.

Inloading

The inloading components of the Landside project include:

- A rail connection from the southern extent of PHPA land proposed to be vested;
- Rail loop of approximately 10km in length which accommodates a twin-cell rotary rail car dumper;
- Twin cell rotary rail car dumper will allow for emptying of the ore from the rail cars and stacking within the stockpile area;

Based on the Definitive Feasibility Study (DFS) construction plan for the car dumper (plan number DM-DG-0040, SKM, 2011), the topographic level of the car dumper area is 5.5 meters Australian Height Datum (mAHD). The construction plan indicates the car dumper will be excavated to approximately 18 meters below ground level (mbgl), with the base of the concrete slab of the car dumper structure to be at approximately -13.2 mAHD. The conveyor will extend from basement level of the car dumper to ground surface (SKM, 2010). It is estimated that a total volume of 340,000m^3 of soil will be excavated in the construction (SKM, 2010).

As groundwater is anticipated to be around 3 mbgl, dewatering will be required during the construction phase of the car dumper and around the conveyor belt for a horizontal distance of around 100 meters from the car dumper. Construction is anticipated to extend over a nine-month period (Coffey, 2009).

2 Project Description

These structures will be permanently below the groundwater table therefore both structures will be constructed as a cofferdam, upon completion.

Stockyard

A stockyard is proposed for open storage of iron ore prior to ship loading and will be located within the rail loop. The stockyard will provide a total storage capacity of eight 220,000-tonne live stockpiles and two 2,000,000-tonne dead stockpile rows, and at design capacity will be serviced by two stackers and one reclaimer. The area will built up with material excavated from the car dumper to allow for adequate surface drainage around the stockpiles.

Outloading

The outloading infrastructure will comprise a 5.8-km overland conveyor corridor between the stockyard and wharf, with an elevated conveyor over the Finucane Island Causeway and adjacent floodways. The corridor will include an access and service corridor between the stockyard and wharf for water, power etc.

A two-berth wharf located at the south-western end of South West Creek in the Port Hedland inner harbour. NWI's berths have been designated by the PHPA as Stanley Point 3 (SP3) and Stanley Point 4 (SP4) and are located south of RHIO's Stanley Point 1 (SP1) and Stanley Point 2 (SP2) berths.

Dredging is also proposed, however the assessment of any impacts of dredging have been previously considered by PHPA (PHPA, 2010) and therefore have not been addressed in this report.

Other Infrastructure/ Considerations

It is understood that there is a general philosophy not to construct facilities for activities which can be outsourced to nearby towns and industrial areas. Ancillary infrastructure such as administration buildings, control rooms, laboratories, crib rooms, ablution facilities, stores, workshops; and laydown areas, will be constructed where necessary. No bulk fuel storage is anticipated as part of this project.

Environmental Setting

3.1 Climate

The Pilbara region is defines as sub-topical, with the Port Hedland area prone to storm events and cyclones. In December to February, the mean temperature ranges between 25°C- 36°C and in the winter months, the mean temperature range is 17°C- 32°C (BOM, 2010).

Pilbara average rainfall ranges between 250-400mm annually, with the majority of the rain falling during the summer months, when thunderstorms and tropical cyclones are prevalent (Coffey, 2009). Port Hedland is considered to be within a cyclone prone area, with the main cyclone season between November to April.

3.2 Hydrology

The site is located within the Port Hedland Coast Basin, which covers an area of 35,353km^2 (ANRA, 2009).

Several creeks converge at the Port Hedland Harbour, including Stingray Creek, South Creek, South East Creek, South West Creek and West Creek, with South West Creek and South Creek the main drainage lines into Port Hedland Harbour. The creeks within the Port Hedland area are generally ephemeral, however after heavy rainfall, significant runoff occurs and inundates the coastal plain (Coffey, 2009).

The main river within proximity to the project site is the Turner River, located 10km west of the site, with the river catchment covering an area approximately 4,700 km^2. The Turner River divides into two main branches as it approaches the coast and fans out into a system of wide and braided flow paths before discharging to Oyster Passage and the Indian Ocean. Most of the drainage of the catchment is along the east and west branches of the river.

3.3 Geological Setting

The Port Hedland area is located within the Pilbara Craton, which is described as a metamorphosed basement of granitoid rocks and gneiss. The Pilbara Craton is overlain by the Hemersley Basin, which is a Late Archaen volcanic sedimentary sequence characterised as basal basic lavas overlain with clastic sedimentary sequences and banded iron formations (Coffey, 2009).

The Hamersley Basin sediments are overlain by various Quaternary units, including silt and mud deposits within the intertidal zones, coastal sand deposits and alluvial deposits, including sand, silt, clay and gravel adjacent to main drainage channels.

It is expected that soils encountered at the site will comprise calcareous sandy/ silty clays, underlain by thin silt layers, mildly to strongly cemented calcareous sandstone and conglomerate (SKM, 2010).

3.4 Regional Hydrogeology

The exploratory drilling undertaken during the development of the Turner River borefield identified that water sampled from the bores installed within the weathered bedrock and alluvial aquifer are chemically similar, indicating a hydraulic connection between the aquifers (Farbridge, 1967).

Surficial Sediments

Near coastal unconfined saline resource with salinity >35,000 mg/L TDS, which interacts with estuarine/ocean waters. Saline groundwater is likely overlain by thin fresh or brackish groundwater through stratification due to salinity differences.

The main alluvial aquifers are developed along the Yule, Turner and De Grey Rivers. These are major aquifers which currently supply Port Hedland with potable water. The alluvium occupies the area close to the current river channels and is recharged directly from the rivers when they flow. The alluvium is up to about 60 metres thick in the De Grey valley.

The salinity tends to be low along the river and increases outwards. The area of the alluvium aquifer also includes thinner and less permeable flood plain deposits on the coastal plain, and these are used principally for pastoral purposes. Bore yields are highest in the coarse alluvium along the river beds, but decrease with distance from the river. There is potential for further development along the Yule and De Grey Rivers[1]. Salinity variation is generally between 1,000-3,000 mg/L.

Granitoid

The Pilbara fractured rock aquifer consists of Precambrian granite-greenstone terrain overlain by surficial sediments in the river valleys. The water table is generally within 5 to 10 metres of the surface in the granitic areas, but may be quite deep below the greenstone hills. The major aquifers within these rocks are quartz veins, and chert layers. Groundwater is mainly fresh, ranging up to brackish towards the coast. Bore yields vary depending on intersection of fractures. Marble Bar town water supply is drawn from bores in acid volcanic rocks. Nullagine's town water supply is drawn from both shallow alluvium (less than 12 m deep) and fractured sandstones. Water has also been produced by dewatering from the iron ore mines in the Goldsworthy-Shay Gap-Yarrie area. There are not considered to be any major regional groundwater resources in the Pilbara fractured rock. Development will be on a local basis principally for mining and town water supply. Pastoral bores intercept both the fractured rock and the overlying weathered zone[2]. Salinity generally ranges between 1,000-3,000 mg/L.

3.4.1 Registered Groundwater Bores

A data request search for the Water Information Network (WIN) was undertaken for installed groundwater bores within 10km of the approximate centroid of the project site. A summary of bores which have standing water level (SWL) data is presented in **Appendix B.**

3.5 Tidal Influence and Storm Surges

Tides in the Port Hedland region are predominately semidiurnal, with two high waters and two low waters each tidal day (Coffey, 2010).

Storm surge is a complex function of cyclone intensity and motion, extent of maximum winds, bathymetry and coastline shapes. The worst-case storm surge occurs when a severe cyclone passes near the coast concurrent with a high tide. The associated sea level ('the storm tide') is a combination of the storm surge and tidal variation.

[1] References: De Grey -Davidson (1973), WRC Hydrogeology Report 34 by M.Martin; Yule - Whincup (1967) and Forth (1972); Turner - Farbridge (1967); Davidson (1975); Forrest and Coleman (1996).
[2] Reference: Forrest and Coleman (1996); WRC Hydrogeology Report 61 by A. Wright (1997)

SKM (2010) has undertaken a preliminary tide, storm surge and flood modelling for the project site. The modelling indicates that part of the Landside project area will be inundated during the highest astronomical tide of 4.0 mAHD and almost all the Landside project area will be inundated during a 1 in a 100 average reoccurrence interval (ARI) storm surge of 7.4 mAHD. A detailed hydrological assessment is currently being undertaken by SKM.

3.6 Environmental Receptors

Port Hedland hosts the transition zones from the terrestrial to marine environments.

For groundwater, the transition zone occurs within the tidal embayments and foreshore areas, including mangroves, salt marshes (e.g. samphire), bioturbated high tide mud flats and algal mat covered high tide flats. Upstream of the tidal range is a suite of terrestrial environments.

The main environmental receptors of Port Hedland are potential Groundwater Potential Ecosystems (GDEs), such as;

- Mangroves and marine interface that hosts samphire, algal mats and salt flats; and
- Terrestrial vegetation.

The EPA (EPA, 2001) have defined regionally significant areas of mangrove communities in the area. The closest regionally significant area is the Oyster Passage Barrier Mangrove Management Area (Area 21, EPA 2011), of which the western rail loop of the Landside Project encroaches on 5.3ha of this area (Coffey, 2010). However, it is noted that in the portion of the management area which overlap the proposed construction footprint, no mangroves are present and will not be affected (Coffey, 2010).

The location of the Oyster Passage Barrier Mangrove Management Area is presented on **Figure 2.**

The proximity of the mangroves within the Oyster Passage Barrier to the car-dumper has been considered in this assessment (refer to Section 6.1.2).

Interpreted Baseline Groundwater Environment

4.1 Hydrostratigraphy

Specific data on site hydrogeological characteristics is scarce. The interpreted hydrostratigraphy of the site is based on the local lithological profiles described in the Department of Water (DoW) WIN database and Port Hedland hydrogeological literature. The WIN database contains lithological logs determined during drilling of local monitoring bores. These logs are broad and lack detail, however when viewed in conjunction with the literature (to provide context) the logs give a reasonable indication of site hydrogeological characteristics. It should be noted that the hydrostratigraphy described is highly interpretive.

Two cross-sections have been prepared, with the locations of the cross-section shown on **Figure 2**. An interpreted conceptual hydrogeological model for the general site is displayed in **Figure 3**, in a north south orientation adjacent to the Landside and rail projects. An interpreted conceptual hydrogeolocial model for the proposed car dumper area in presented as **Figure 4**.

The conceptual models shows the site to contain three main hydrostratigraphic units, which include alluvial deposits overlying a calcareous unit which in turn overlies weathered and fresh Archaen bedrock.

The alluvial deposits contain the unconfined superficial aquifer (water table) and are largely associated with the Turner River and minor drainages in the area. The deposits are generally fine grained, with clays, silts, sands and gravels dominating the profile. Clay content appears to increase toward the north. The unit ranges in thickness from approximately 7 m to 20 m, increases toward the north where topographic relief decreases. The unit is interpreted to be partially saturated to the north, with saturated thicknesses ranging from 2 to 5 m. The unit is unsaturated in the upper slopes to the south.

The calcareous unit underlies the alluvial deposits and also thickens to the north, with thicknesses ranging from 1 to 15 m. This unit is described as a calcrete or saprolitic calcrete in the WIN database logs, however the exact composition is not fully understood. The unit lies below the water table in the northern coastal region, but is unsaturated in the up-hydraulic gradient direction of the southern portion of the area.

The Archaen bedrock sequence features a discontinuous clay unit overlying weathered granite and fresh migmatitic granite. The unit dips relatively sharply to north and ranges in depth from approximately 10 metres below ground level (mbgl) in the south to >30 mbgl in the down gradient northern area. The unit hosts the water table in the far southern up-gradient areas.

Groundwater occurrences are typically related to the sands and gravels of the alluvial deposits.

4.2 Groundwater Levels and Flow

Groundwater levels have been sourced from the WIN database and compared with literature to provide context and determine accuracy. The database is incomplete and provides only a ‘snapshot’ of groundwater levels due to the lack of ongoing monitoring. In many cases, readings were taken years or even decades ago, however are thought to provide an indication of current water levels due to absence of impacting factors such as groundwater abstraction.

Groundwater levels range from 2.4 to 18.4 mbgl, with shallower depths located to the north close to the coast. Levels range from 3.5 to 38.1mAHD, with levels decreasing toward the coast. Higher levels are associated with higher topography and also a north-south ridge system to the southeast of the area and the Turner River to the southwest.

4 Interpreted Baseline Groundwater Environment

In the far northern area in the vicinity of the Landside project, groundwater levels are interpreted to flatten out to between approximately 1 and 3 mAHD, with depth to groundwater of approximately 2 to 5 mbgl. This equates with groundwater monitoring at BHP Billiton Iron Ore's nearby Hot Briquetted Iron Ore Plant (Coffey, 2009) which shows the depth to groundwater is approximately 3.5 m. This monitoring also showed seasonal variability of up to 2 m, with groundwater elevations peaking in April. Whilst no long term trends are available for the project area, a similar seasonal variability is assumed.

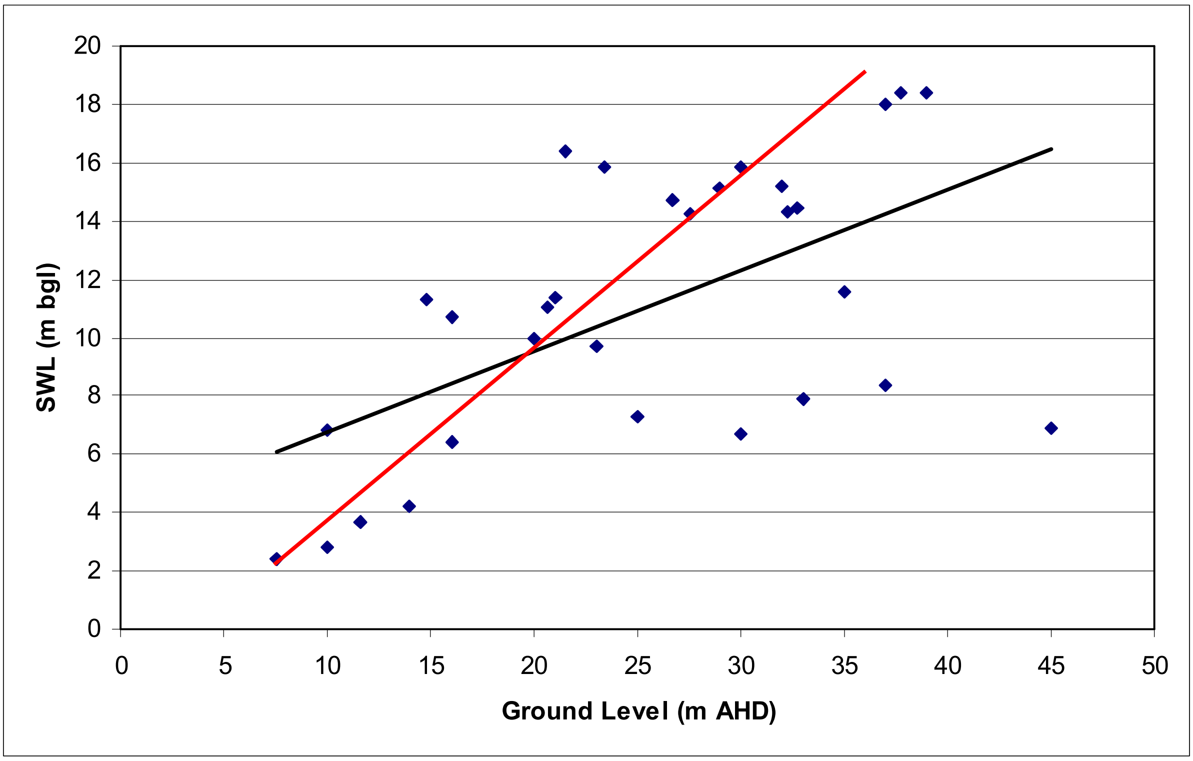
Figure 5 shows an inferred groundwater table contour map and groundwater elevations in the area.

4.2.1 Groundwater Levels and Relationship to Topography

An assessment of the relationship between topography and measured shallow groundwater levels is displayed below and demonstrates reasonable topographic control on the water table elevation. The relationship is skewed by water levels surrounding the Turner River, where shallower water tables correspond with higher ground level elevations in comparison to the rest of the site. The red line represents the relationship excluding the data surrounding the Turner River, whilst the black line shows the relationship across the site.

The relationship between topography and shallow groundwater levels was assessed by displaying bore locations on a topographic contour map to determine bore datum level. The method was relatively inaccurate, due to the spacing of contours which varied between 0.5 and 5 m, however was deemed the most appropriate method due to lacking or suspect datum levels listed on the WIN database.

Chart 4-1 Relationship Between Topography and Shallow Groundwater Levels



4.2.2 Groundwater Flow

Figure 5 displays groundwater level contours and flow directions for the superficial aquifer. Flow directions are also represented in the conceptual cross sections in **Figures 3** and **4**. The figures indicate regional groundwater flow to the north, with discharge to the ocean or possibly the mangrove environment. Radial flow from the Turner River also appears evident. At the southern area of the site this flow runs east from the river and converges with westward flow emanating from the ridge system, before flowing north to the discharge point. The hydraulic gradient at the ridge system is steeper than the regional flow system, with gradients of approximately 0.005 in comparison to 0.001, indicating low permeability zones at the ridge.

The Turner River is interpreted to be the main mechanism for recharge to the water table in the area, particularly during flood events. Direct rainfall recharge is also likely to occur but considered to be low due to the fine grained nature of the superficial formation. Local discharge is interpreted to occur in minor north-south drainages in the central region of the site following flood events or seasonally high groundwater elevations. Dune systems (as shown on **Figure 5**), which run longitudinally north-south through the area, are interpreted to form local recharge zones during periods of high rainfall.

Groundwater flow in the calcareous unit and the deeper weathered bedrock is difficult to determine due to the lack of bore data from these units. It is likely that groundwater flow in these units is also related to topography, however, vertical flow gradients and connection between aquifers cannot be accurately determined.

4.2.3 Tidal Influence

Groundwater levels may respond to tidal fluctuations. A rise in sea level may be accompanied by a rise in groundwater levels. The ratio of concurrent change between tidal amplitude and groundwater level fluctuations is termed the tidal efficiency of an aquifer. Usually, highly confined aquifers have low tidal efficiency (not impacted by tidal actions), whereas unconfined water table aquifers may have a tidal efficiency approaching 1.0 (dimensionless).

The tidal efficiency is not understood for the area due to a lack of monitoring data. In order to determine accurate tidal efficiency, a programme of groundwater bore monitoring using data loggers would need to be undertaken, with results compared against collated tidal data for the same period.

4.3 Interpreted Aquifer Parameters

In the absence of site specific hydraulic data it is difficult to determine accurate aquifer parameters. A field programme, involving drilling and testing of groundwater monitoring bores would need to undertaken to accurately quantify these parameters.

The alluvial deposits and carbonaceous unit are likely to be of low hydraulic conductivity, due to its relatively fine grained nature. Hydraulic conductivity is likely to decrease away from the Turner River, where comparatively high permeability sands decrease in thickness. Haig (2009) reported hydraulic conductivity in the alluvial aquifers at Turner River at 4 m/d with storativity of around 0.02. It is likely the hydraulic conductivity in the vicinity of the Landside project is significantly less due to the finer grained nature of the sediments.

Due to the a lack of site specific hydraulic data for the aquifer material on-site, aquifer parameters have been developed using the Monte Carlo, probabilistic technique. The Monte Carlo technique is a method of determining an outcome, not as a single number, but as a range of possible answers at differing levels of confidence. The method can be applied to any numerical equation that includes one or more input values where some uncertainty or variability exists. For those input parameters where uncertainty or variability exists, a range of possible input values are used. The range is assigned a statistical probability distribution (e.g. normal, log-normal, uniform), with input values nominated at key percentiles (usually 50th percentile, i.e. median, and the 95th percentile).

Details and results of the Monte Carlo analysis and adopted aquifer parameters are described in Section 6.

4.4 Groundwater Quality

Limited data exists on groundwater quality in the area. Groundwater quality at BHP Billiton Iron Ore's nearby Hot Briquetted Iron Ore Plant (Coffey, 2009) which indicates that pH from groundwater across the site ranges from 6.7 to 8.4, and salinity levels range from 940 mg/L to 61,000 mg/L. It is likely that the superficial aquifer hosts saline groundwater due to the proximity to the ocean and low recharge rates. Salinity levels are likely to increase with distance from the Turner River.

In order to accurately determine groundwater quality across the site, groundwater sampling and laboratory analysis would need to be undertaken on existing site bores, with new bores also required to be installed and sampled.

Site Conceptual Hydrogeological Model

The site is located in a coastal environment characterised by flat topography and low vegetation. The geology is underlain by a sequence of fine grained, unconsolidated sediments, interlayered with thin, semi-consolidated calcrete (calcium carbonate).

In a regional setting (in the context of **Figure 5**), the topography declines from south to north. Archean, granitic bedrock is overlain by an increasing thickness of weathered bedrock (clay) and unconsolidated sediments as the topography fall toward the coast.

Groundwater flow is influenced by topography, with major flow toward the north where discharge to the sea is likely to occur. A relatively shallow water table varies from approximately 2 (north) to 18 mbgl up hydraulic gradient to the south. Seasonal fluctuations in groundwater levels are thought to be in the order of 2 m, with peak levels in April. Localised discharge to minor drainages is possible following peak seasonal groundwater highs. Groundwater recharge rates are interpreted to be low, with the Turner River the major source of recharge. Hydraulic gradients range from approximately 0.001 to 0.005 with higher gradients associated with an elevated ridge system in the southeast of the area. Higher permeability zones appear associated with the central portion of the site region and the Turner River.

Depth to the watertable below the site is expected to be in the order of 3.0 – 4.0 mbgl and is hosted in alluvial deposits of low hydraulic conductivity that range in thickness from 7 to 20 m, overlying a fine grained calcareous unit of again, a low hydraulic conductivity, and deeper weathered bedrock. The sequence of fine grained sediments above fresh granite bedrock is expected to be of low to very low hydraulic conductivity (< 1 m/d). In the area of the site, the depth to fresh bedrock is unknown but is likely to be in excess of 40 mbgl.

At an hydraulic gradient of 0.001 and a representative hydraulic conductivity for the fine grained sediments above the bedrock, of 0.5 m/d, the average linear velocity of groundwater movement though the saturated sediments would be expected to be low (< 0.5 m/a) therefore the rate of groundwater discharging along the coast (per linear metre) would also be expected to be very low (<0.05 m^3/d per metre).

Groundwater Impacts Assessment

6.1 Potential Impacts to Groundwater

Based on URS' understanding of the proposed infrastructure and site activities and site conceptual model, the Landside Project may have the potential to impact on groundwater via the following;

- Large masses of stockpiled material impacting the local groundwater in proximity to a sensitive tidal environment;
- Construction of the rail car dumper to a depth of around -13.2mAHD and the dumper conveyor belt will necessitate dewatering and likely cause a cone of depression; and
- Spills and leaks of contaminates, such as hydrocarbons, may also impact sensitive marine and terrestrial receptors.

Based on the reviewed available hydrogeological data, the assumed low hydraulic conductivity of the aquifer, in which the car dumper is to be constructed, the ingress of groundwater is considered to be low, and can likely be managed by either a drainage sump, or as detailed in the Definitive Feasibility Study (SKM, 2011), via treatment of concrete and steel to prevent water ingress into the final car dumper facility. Therefore, ongoing dewatering should not be required and therefore the impact of ongoing dewatering to the baseline groundwater environment has not been considered further.

6.2 Potential Groundwater Impactors

6.2.1 Stockpiled Material

There is scant site-specific data into the geotechnical and hydraulic properties of the alluvial soil/aquifer material within the rail loop/stockpile site or the quality of the groundwater in the shallow alluvial aquifers at the site. What data is available concerning groundwater quality, those data suggest the shallow groundwater is likely to be both shallow (< 5m bgl) and brackish (>500 – 30,000 mg/L). In the near coastal groundwater discharge zone (i.e. within 500 metres of the tidal zone), evaporative concentration of shallow groundwater can potentially result in saline soil and groundwater (> 30,000 mg/L) extending in zone parallel to the tidal line.

The placement of potentially up to 5.7 million tonnes of ore stockpiles over an unconsolidated, shallow aquifer containing brine quality water, could result in compression of the near-surface, saturated soil structure, increasing both the saturated pore pressure and reducing porosity in the underlying aquifer material. This scenario can lead to the vertical and lateral migration of the shallow groundwater and the potential for waterlogging within the stockpile area. The consequences can also lead to the rapid lateral migration of a 'slug', or series of slugs, of highly saline water into the nearby tidal zone. The result, should the salinity be highly saline (i.e. >50,000 mg/L), could be a decline in vitality of mangroves that may be growing within in the discharge area of the slug(s).

The distance from the proposed ore stockpile area within the rail loop, to the nearest stands of mangroves, is in the order of one kilometre. At this distance and greater (as much of the stockpile area would be), the risk of a saline slug migrating to those mangroves would be expected to be low. Furthermore, should shallow groundwater salinity within the area of the proposed stockpiles be at or less than adjacent seawater (around 25,000 mg/L), the threat to mangrove health from a potential release of shallow groundwater from the site, would be expected to be minimal.

Table 6-1 Threat/Mitigation Matrix – Ore Stockpiling

Potential Threats	Likelihood	Mitigation Measures
Waterlogging of stockpiling operations	***Medium***	Collect site specific geotechnical and groundwater data - undertake waterlogging assessment study; design appropriate surface drainage system and corrosion protection for on-site infrastructure (if required).
Reduction in local mangrove vitality	***Low***	Gather site-specific aquifer quality and hydraulic data. If groundwater salinity is > 50,000 mg/L, establish a small network of shallow groundwater monitoring bores adjacent to the northern and western boundaries of the rail loop site and develop and initiated a groundwater gauging and salinity monitoring program. Undertake a mangrove health risk assessment and if required, develop a groundwater mitigation action plan, with trigger levels.

6.2.2 Dewatering Works – Car Dumper and Car Dump Conveyor

The impact of dewatering associated with construction of the car dumper and underground conveyor (reference CD201 and CV201 in design drawings, SKM, 2011) has been assessed in terms of the extent of the potential cone of groundwater depression in the alluvial aquifer. The assessment has been made to consider if the cone of groundwater depression from construction dewatering has the likelihood to impact on groundwater receptors, in particular:

- Along potential groundwater /seawater interface zones north and west of the rail loop should a potential cone of dewatering give rise to seawater intrusion, especially in relating to impacts within Area 21 – Oyster Passage Barrier Area Regionally Significant Mangrove Area (EPA, 2001), and
- A reduction of flow in the Turner River through a reduction in groundwater baseflow.

Due to the a lack of site specific hydraulic data for the aquifer material on-site, a dewatering impact assessment has been undertaken using the Monte Carlo, probabilistic technique.

The Monte Carlo Technique

The Monte Carlo technique is a method of determining an outcome, not as a single number, but as a range of possible answers at differing levels of confidence.

The method can be applied to any numerical equation that includes one or more input values where some uncertainty or variability exists. For those input parameters where uncertainty or variability exists, a range of possible input values are used. The range is assigned a statistical probability distribution (e.g. normal, log-normal, uniform), with input values nominated at key percentiles (usually 50^{th} percentile, i.e. median, and the 95^{th} percentile). The selection of the most appropriate probability distribution and assignment of percentiles to be used can be made based on:

1. statistical analysis of real data (such as rainfall records or hydrographic levels);
2. expert knowledge/opinion/experience; or,
3. published literature.

The Monte Carlo simulation performs multiple (i.e. thousands) calculations of the same numerical equation(s). For every calculation run, one value is selected from each of the relevant and applicable input variable probability functions, and used in the calculation. The frequency values selected for calculation are dictated by the type and range of their probability function. So, values at or below the 10^{th} percentile will be selected at random, 1 out of 10 times – therefore of 1000 calculations, 100

6 Groundwater Impacts Assessment

would be selected from the lower 10^{th} percentile range of possible input values or another way of looking at it, 500 answers would result from input values selected from above the 50^{th} percentile input function and 500 from those selected below the 50^{th} percentile input function.

The resulting solution to a Monte Carlo simulation is therefore (in the case above), 1000 possible answers which, similar to any range of related numbers, can be presented as a probability function.

The current groundwater resource evaluations have been undertaken using Crystal Ball®, a Microsoft Excel spreadsheet add-on. All simulation outputs were based on 2000 Monte Carlo calculations. All input probability functions for the simulations have been assigned a log-normal probability distribution.

Site Conceptual Model Rationale

The limitation on the rail loop site, where car dumper and dumper conveyor construction dewatering is proposed, is that critical hydraulic properties of the shallow aquifer material; storativity and hydraulic conductivity, saturated thickness, required to estimate dewatering impacts, are unknown.

A conceptual site model for the car dumper site has therefore been developed based on available data, primarily Haig (2009) and his summary of studies into the Turner River borefield, located approximately 10 kilometres to the south-west of the rail loop site.

All available data suggests that the ‘aquifer’ material underlying the site is fine gained, partially calcareous with commensurately low hydraulic conductivities. Haig (2009) reported hydraulic conductivity in the alluvial aquifers at Turner River at 4 m/d with storativity of around 0.02.

As the Turner River bores were constructed in sand material targeted, as likely being the highest yielding aquifer material, those sediments, adjoining the Turner River bed alignment are most probably river deposits and of a coarser nature than sediments deposited at increasing distances from the river alignment. The reported Turner River aquifer material hydraulic conductivity, although low, is therefore considered likely to be higher than that which could be expected for typical saturated alluvial sediments on the rail loop site, around 10 kilometres to the north-west of the Turner River borefield.

Simulation Parameters

The Theis modified non-equilibrium equation has been adopted to estimate drawdown, and therefore the extent of potential construction dewatering, in the alluvial aquifer at the rail loop site.

To avoid the use of complex modelling of a large number of closely spaced, low pump-rate dewatering bores on two dewatering benches within the proposed car dump and conveyor excavation, a lower number (i.e. 6) of conceptual, higher pumping volume dewatering bores have been simulated, spaced at a 50-75 metre grid with vertical and lateral coverage of the excavation alignment.

The parameters adopted for Monte Carlo dewatering impact simulations are summarised in Table 6-2 below.

Table 6-2 Monte Carlo Simulation: Drawdown Calculation Input Parameters

	Input Parameter	Units	Data Input Format	Data Input Value(s)		
Alluvial Aquifer	Pumping Rate (per Bore) (Q)	m^3/d	Probability Function (Log-Normal Distribution)	50%-ile	95%-ile	
				100	150	
	Storativity (S)	unitless	Probability Function (Triangular Distribution)	Min	Likely	Max
				0.01	0.05	0.1
	Pumping Duration (t)	days	Probability Function (Log-Normal Distribution)	50%-ile	95%-ile	
				240	300	
	Hydraulic Conductivity (K)	m/d	Probability Function (Log-Normal Distribution)	50%-ile	95%-ile	
				0.1	1	
	Saturated Thickness (b)	m	Probability Function (Log-Normal Distribution)	50%-ile	95%-ile	
				25	30	

Number of Simulations: 2,000 *Note: transmissivity = Kxb*

The hydraulic parameter which will have the greatest impact on the extent of the cone of groundwater depression as a result of construction dewatering operations at any given dewatering rate, is the specific storage or storativity of the aquifer. The transmissivity of the aquifer will have greatest bearing on the pumping rate and available drawdown in each dewatering borehole. Both of these key hydraulic parameters are not known with certainty for the rail-loop site, however the range of values adopted for the Monte Carlo simulations are considered to be representative of those that characterised by an unconfined, fine grained, clay, silt or calcarenite rich, shallow aquifer as conceptualised for the rail loop site.

The output from the 2,000 Monte Carlo simulations, using the input frequency function data above, suggest the radius of drawdown influence, extending from each dewatering borehole at the rail-loop car dump and conveyor excavations, could be:

Table 6-3 Monte Carlo Simulation: Extent of Dewatering Cones of Depression

Percentile	Radius of Cones of Groundwater Depression
5^{th}	500 metres
50^{th} (Median)	300 metres
95^{th}	220 metres

From Table 6-3, it can be seen that the expected cones influence from dewatering around each of the conceptual dewatering bores, across the range of output possibilities would be expected to be a relatively restrained area around the construction zone (i.e. 5% precent of simulation output calculations result in cones of depression of greater than 500 metres radius), even allowing for the superimposition of the cones of dewatering from the multiple bores.

6 Groundwater Impacts Assessment

Figure 6 illustrates the calculated extent of dewatering in the rail-loop area excavation and construction area from the above Monte Carlo output percentiles. The figure shows the 50th percentile cone of depression could be expected to extend to the south-eastern corner of the designated area of the Oyster Passage Barrier, significant mangrove area (Area 21) (EPA, 2001). At the 5th percentile, the extent of dewatering could be expected to lie within Area 21 by a couple of hundred meters. The area of potential impact within Area 21 is expected to be well to the south and south east (i.e. > 1,000 metres) of the areas were mangroves are present. Furthermore, the extents of potential dewatering, across all percentiles, fall well short of the tidal zone, suggesting that seawater intrusion as a result of dewatering, is negligible.

Figure 6 also shows that the Turner River is several kilometres beyond the likely western extent of the cone of dewatering, therefore, groundwater baseflow to the river is also unlikely to be affected by dewatering activities on the rail loop site.

The dewatering pumping rates simulated ranged up to 150 m^3/d for each conceptual dewatering bore (median rate of 100 m^3/d). The cumulative daily groundwater pumping volume from the 6 conceptual dewatering bores therefore totalled up to 800 m^3/d (95th percentile) or 0.8 ML/d. Since the quality of the groundwater in the shallow aquifers at the rail loop site are unknown, but likely to be saline, the disposal of groundwater from dewatering operations will require consideration.

As the quality of the groundwater is likely to be significantly different from the adjacent surface waters of the marine or river environments, the mixing of the dissimilar water types could result some dysfunction of dependant ecosystems within the mixing zone of those surface water environments.

Based on the referral document to the EPA (Coffey, 2010), disposal of the water extracted from the car dumper, is proposed to be pumped to the proposed PHPA South West Creek Dredging and Reclamation Project dredge management area, where it will be mixed with the large volume of dredge-derived seawater circulating through the dredge material management area, before being discharged to the inner harbour. Therefore, potential disposal options have not been further addressed in this report.

Table 6-4 Threat/Mitigation Matrix – Rail Loop Construction Dewatering

Potential Threats	**Risk**	**Mitigation Measures**
Salination impacts (short term) on adjacent coastal terrestrial vegetation through promotion of seawater intrusion.	***Very Low***	Gain site-specific aquifer parameters – reassess construction dewatering effect on basis of site data.
Reduction (short term) in Turner River groundwater baseflow.	***Very Low***	As above.
Environmental impacts to river or marine water dependant ecosystems as a result of disposal of groundwater from dewatering operations.	***Medium***	Gain site-specific groundwater quality data and assess surface disposal options which could include retention and disposal of groundwater in a temporary evaporation basin.

6.2.3 Spills/Leaks of Anthropogenic Compounds.

Most industrial operations involve the introduction of anthropogenic compounds to the operational environment. Threats to sensitive environmental or human receptors will be dependant on the nature of the compounds and the modes and concentration of exposure to those receptors.

Given the operation of the rail-loop and stockpiling site, anthropogenic compounds that can be expected on the site and that could impact groundwater, are limited. These will include hydrocarbon compounds (lubricating compounds and vehicle fuel) and nutrients (from crib-room toilet facilities).

Table 6-5 Threat/Mitigation Matrix – Spills/Leaks of Anthropogenic Compounds

Potential Threats	**Risk**	**Mitigation Measures**
Human health – exposure to anthropogenic compound contaminated groundwater.	***Low***	Include threat identification and personal protective equipment (PPE) on Job Hazard Assessments (or equivalent) for works involving trenching and potential exposure to groundwater.
Environmental health – exposure to anthropogenic compound contaminated groundwater.	***Low***	Ensure any on-site hydrocarbon product storage and handling conform to Australian standards. Recover and dispose hydrocarbon spill impacted soils once identified.

6.3 Cumulative Impacts

Based on URS assessment of potential impacts to groundwater, the cone of depression is small and is not expected to extend out beyond the Landside Project site boundary. Based on a review of works on neighbouring sites, including BHPBIO (BHPBIO, 2008) and Roy Hill (Roy Hill, 2010), their environmental referral documents do not indicate impacts to groundwater.

Any impact to groundwater in the site are expected to be both short term and not extending beyond the boundaries of the site therefore, cumulative impacts to groundwater from the Landside Project and neighbouring operations in the area are not expected.

Figure 7 shows the potential relative extents of car dumper construction dewatering in relation to neighbouring operations.

Conclusions and Recommendations

7.1 Conclusions

Based on the review of the available hydrogeological data and assessment of the Landside Project infrastructure on the baseline groundwater environment, the following conclusions have been made;

- The local hydrogeological environment is characterised by a shallow water table (2-5 mbgl) within alluvial deposits of low hydraulic conductivity. Groundwater is expected to be recharged by the Turner River, with groundwater flow influenced by topography and is expected to discharge to the ocean;
- The key potential impactors to groundwater include stockpiled material, dewatering of groundwater during the car dumper construction and spills and leaks of contaminates to sensitive marine and terrestrial receptors;
- Migration of salinised water from the stockpiling area to the adjacent mangroves is considered to be a risk, however it is considered to be low; and
- Based on the modelling of the potential cone of depression resulting from car dumper dewatering, the radius of the cone of depression has been determined to be 500m (at the 5^{th} percentile of likliehood). Therefore, the potential impacts to surrounding receptors have been assessed as being low to medium. However, this should be reassessed following collection of site specific geotechnical and hydraulic data.

7.2 Data Gaps

Based on the data reviewed, the following data gaps have been identified. These include;

- Understanding of potential waterlogging of soils around the stockpile operations is unknown due to the absence of geotechnical data;
- Understanding of impacts to mangroves by stockpiling operations cannot be accurately determined in the absence of site specific groundwater quality and hydraulic data;
- Confirmation of accuracy of the impacts to groundwater from the construction works in the absence of site specific aquifer parameter data.

7.3 Recommendations

Based on the conclusions and identified data gaps, the following further works are recommended;

- Collection of site specific geotechnical data to assist with design of surface-drainage system in stockpile area;
- Establishment of a small network of shallow groundwater monitoring bores adjacent to the northern and western boundaries of the rail loop and undertake groundwater gauging and monitoring for salinity to monitor potential salinity impacts to adjacent mangroves;
- Undertake a mangrove health risk assessment to provide baseline data on mangrove health for future reference, and if required prepare a groundwater mitigation action plan, with trigger levels;
- Installation of a production bore in the car dumper area and undertake a pumping test to determine site specific aquifer parameters to confirm the construction dewatering effects; and
- Ensure any on-site storage and handling of hydrocarbons conform to relevant Australian Stands. Further, a Job Safety Analysis should be prepared for any future excavation/ groundwater abstraction works which may result in human exposure to impacted groundwater (if any).

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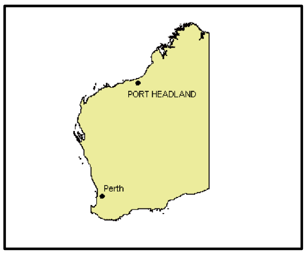
Limitations

This conclusion and all information in this Report is given strictly in accordance with and subject to the following limitations and recommendations:

a) The Phase One Environmental Site Assessment undertaken to form this conclusion is limited to the scope of work agreed between URS and **Coffey Environments Pty Ltd** as outlined in section **1.3** ("Scope of Works") of this Report.
b) This Report has been prepared for the sole benefit of **Coffey Environments** and neither the whole nor any part of this Report may be used or relied upon by any party other than those third parties authorised in writing.
c) The investigations carried out for the purposes of the Report have been undertaken, and the Report has been prepared, in accordance with normal prudent practice and by reference to applicable environmental regulatory authority and industry standards, guidelines and assessment criteria in existence at the date of this Report.
d) This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by URS for use of any part of this Report in any other context.
e) This Report was prepared between **January** and **June 2011** and is based on the conditions encountered on the site and information reviewed during the time of preparation. URS accepts no responsibility for any changes in site conditions or in the information reviewed that have occurred after this period of time.
f) Where this Report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information except as expressly stated in the Report.
g) Given the limited Scope of Works, URS has only assessed the potential for contamination resulting from past and current known uses of the site.
h) No inspections of the site have been made in preparation of this report.
i) No sampling or laboratory analysis has been undertaken by URS as part of this investigation. URS does not guarantee that contamination does not exist at the site.
j) Except as otherwise specifically stated in this Report, URS makes no warranty or representation as to the presence or otherwise of asbestos and/or asbestos containing materials (“ACM”) on the site. If fill has been imported on to the site at any time, or if any buildings constructed prior to 1970 have been demolished on the site or materials from such buildings disposed of on the site, the site may contain asbestos or ACM.
k) No investigations have been undertaken into any off-site conditions, or whether any adjoining sites may have been impacted by contamination or other conditions originating from this site.
l) The conclusion set out above is based solely on the information and findings contained in this Report.
m) Except as specifically stated above, URS makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.
n) Use, development or re-development of the site for any purpose may require planning and other approvals and, in some cases, environmental regulatory authority and accredited site auditor approvals. URS offers no opinion as to whether the current use has any or all approvals required, is operating in accordance with any approvals, the likelihood of obtaining any approvals, or the conditions and obligations which such approvals may impose, which may include the requirement for additional environmental works.
o) URS makes no determination or recommendation regarding a decision to provide or not to provide financing with respect to the site.
p) The ongoing use of the site and/or use of the site for any different purpose may require the owner/user to manage and/or remediate site conditions, such as contamination and other conditions, including but not limited to conditions referred to in this Report.

Appendix A Figures



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0 0.5 1 2 5 Kilometres

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COFFEY ENVIRONMENTS PTY LTD

GROUNDWATER STUDY
MULITI-USER IRON ORE EXPERT FACILITY

SITE LOCATION MAP

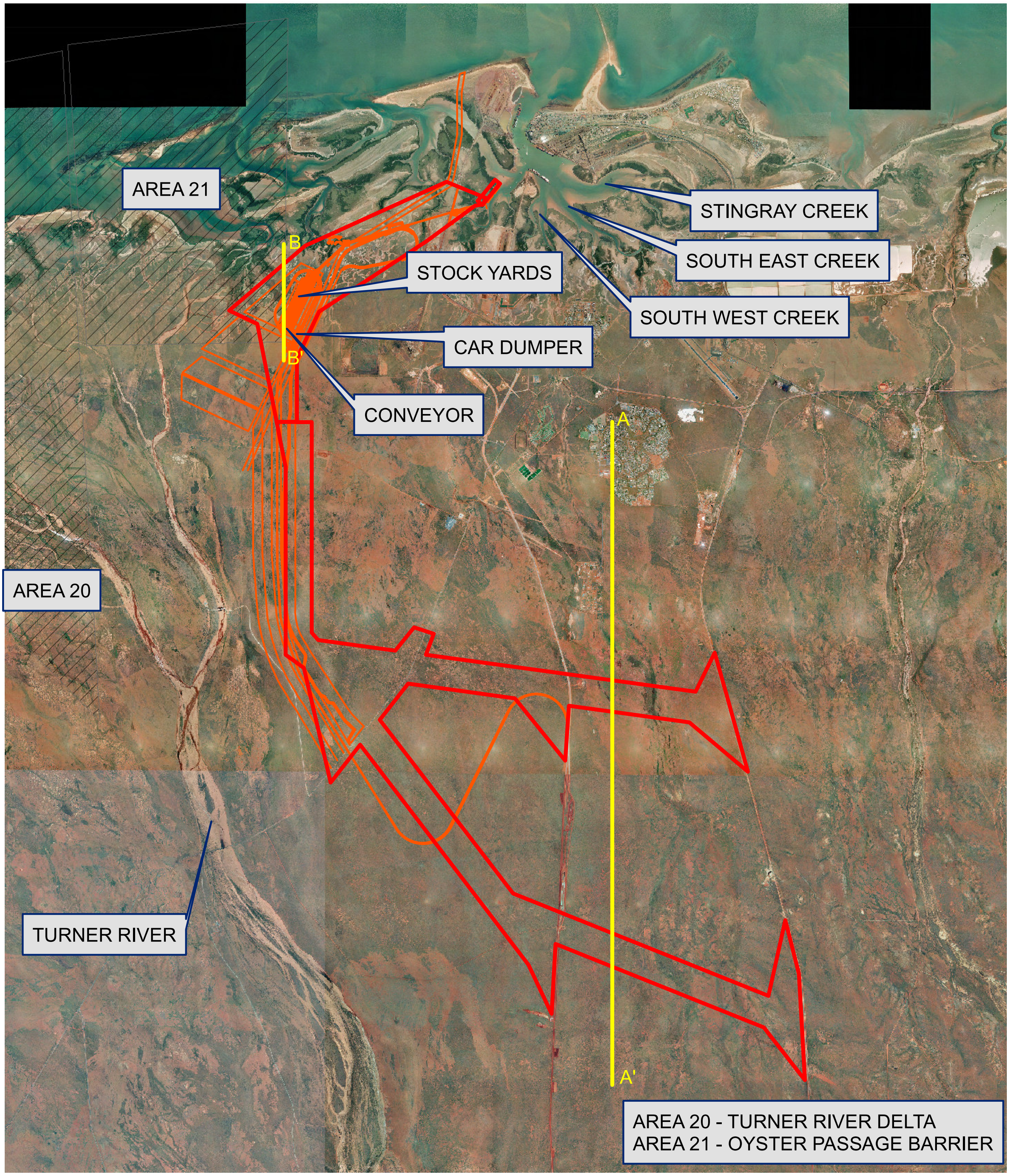
URS

NWI PORT HEADLAND - LANDSIDE PROJECT

Figure: **1**

File No: **Figure 1.mxd** Drawn: **JA** Approved: **AC** Date: **07.06.2011**

Rev. B A4



Legend

Areas of Mangroves Designated "Regionally Significant"

Project Site

Proposed Infrastructure

N

0 2.5 5 10 Kilometres

COFFEY ENVIRONMENTS PTY LTD

GROUNDWATER STUDY
MULIT-USER IRON ORE EXPORT FACILITY

SITE LOCALITY

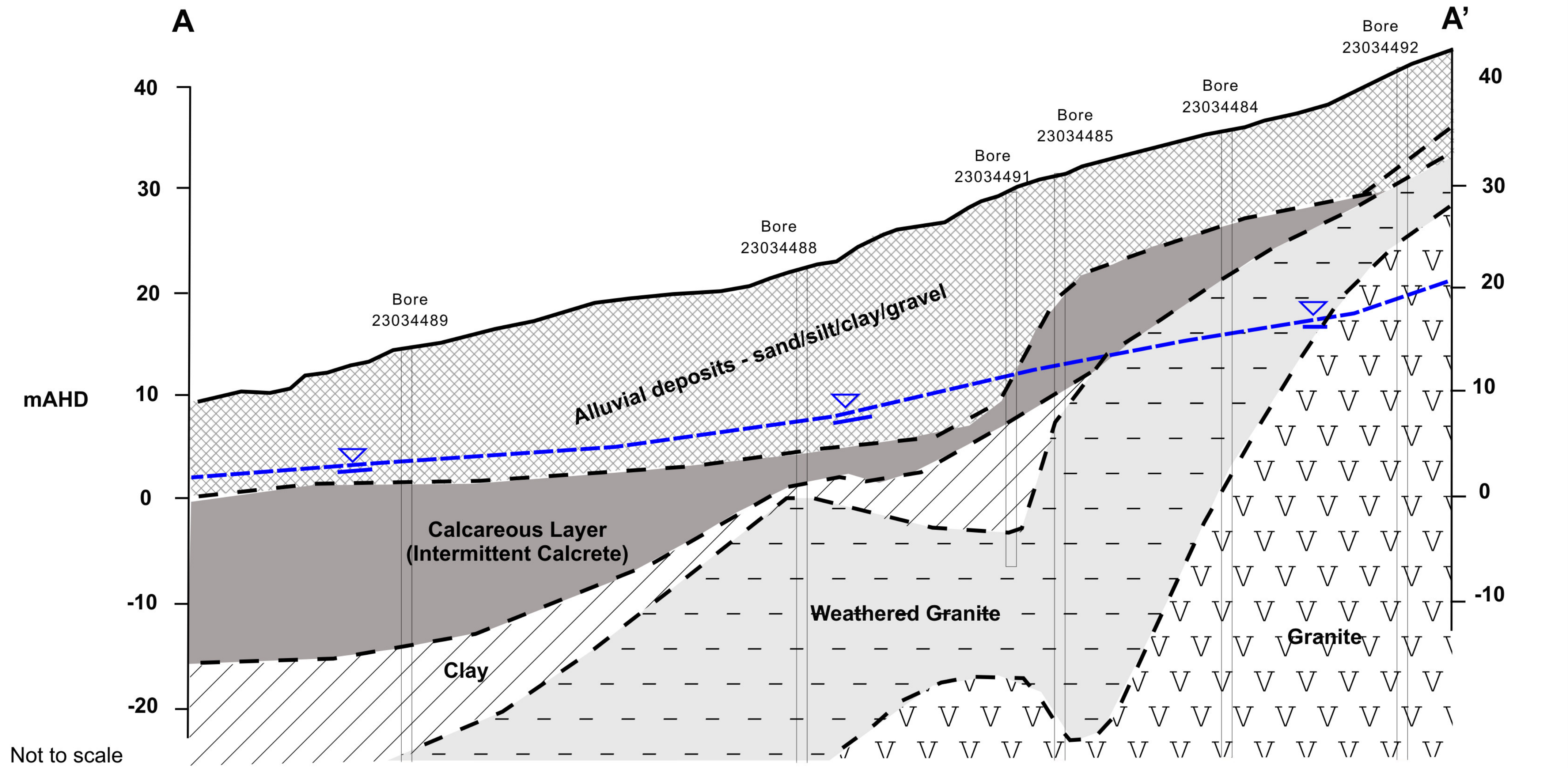
URS

NWI PORT HEADLAND - LANDSIDE PROJECT

Figure: **2**

File No: **Figure 2.mxd** Drawn: **JA** Approved: **AC** Date: **07.06.2011**

Rev. B A4



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GROUNDWATER STUDY - MULTI USE IRON ORE EXPORT FACILITY

CONCEPTUAL CROSS SECTION A

URS

NWI PORT HEDLAND - LANDSIDE PROJECT

Figure: **3**

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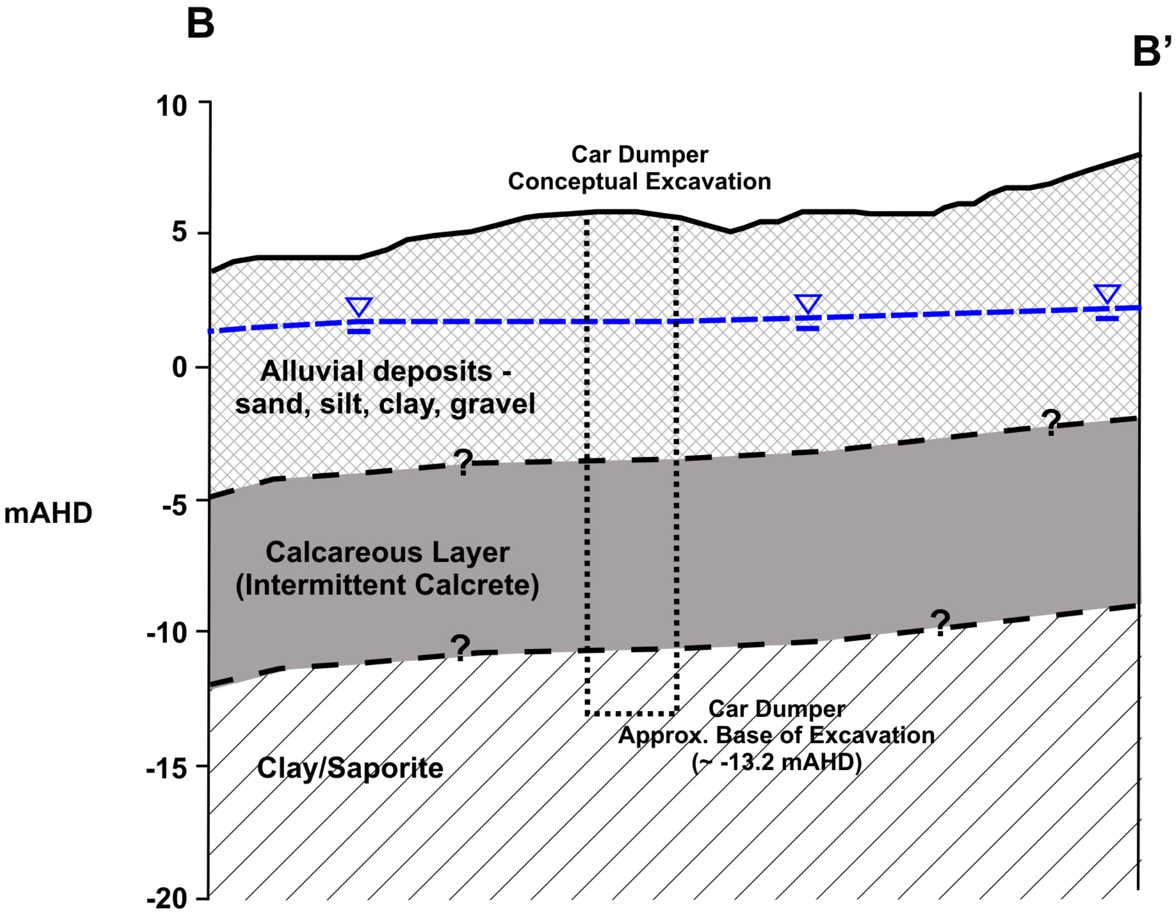

Not to scale

COFFEY ENVIRONMENTS PTY LTD

GROUNDWATER STUDY - MULTI USE IRON ORE EXPORT FACILITY

CONCEPTUAL CROSS SECTION B

URS

NWI PORT HEDLAND - LANDSIDE PROJECT

Figure: **4**

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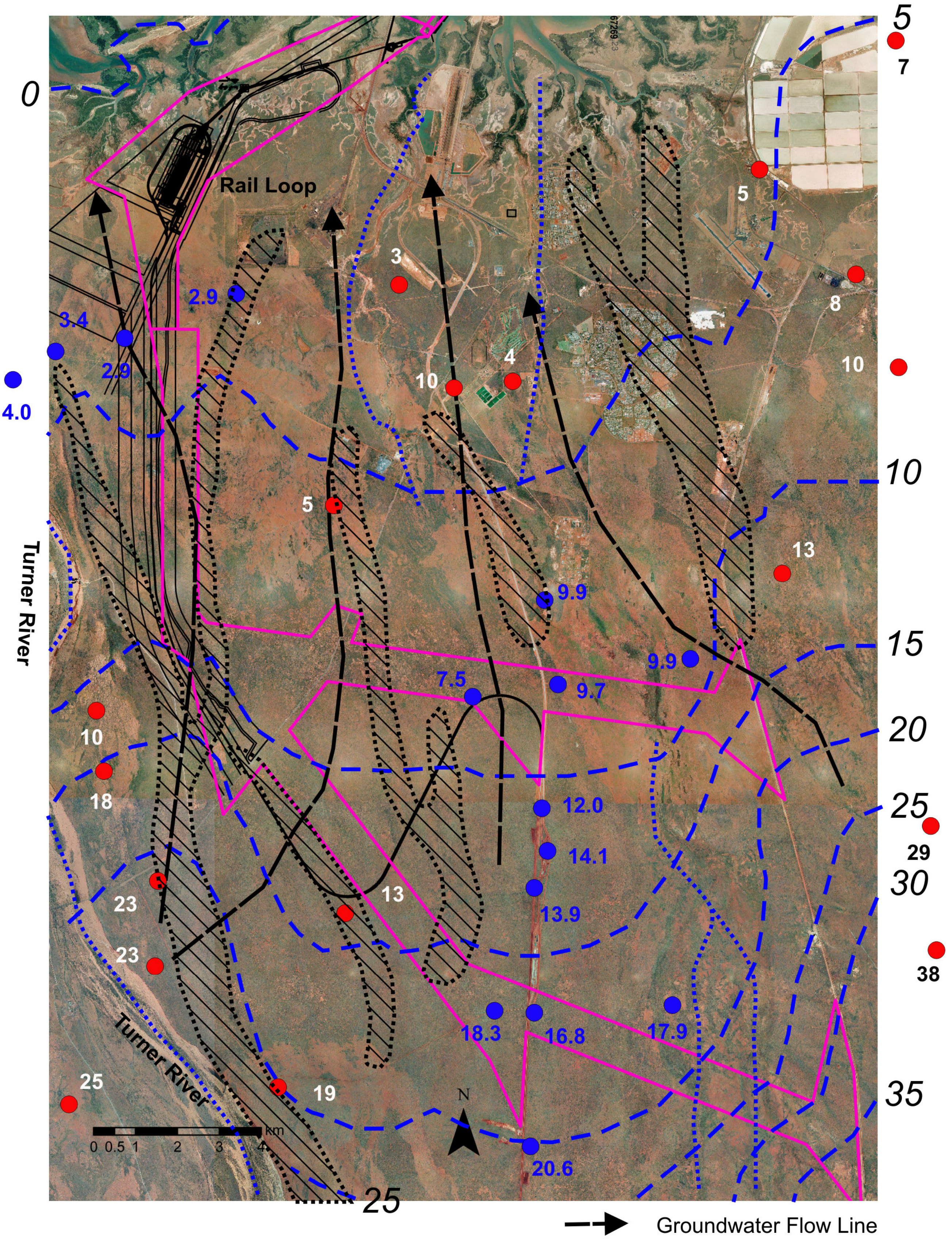

Groundwater Flow Line

Surface Drainage Line

38 Groundwater RL (+/- 5 mAHD)

4.0 Groundwater RL (+/- 0.5 mAHD)

Inferred Dune

30 Groundwater Contour (mAHD)

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GROUNDWATER STUDY - MULTI USER IRON ORE EXPORT FACILITY

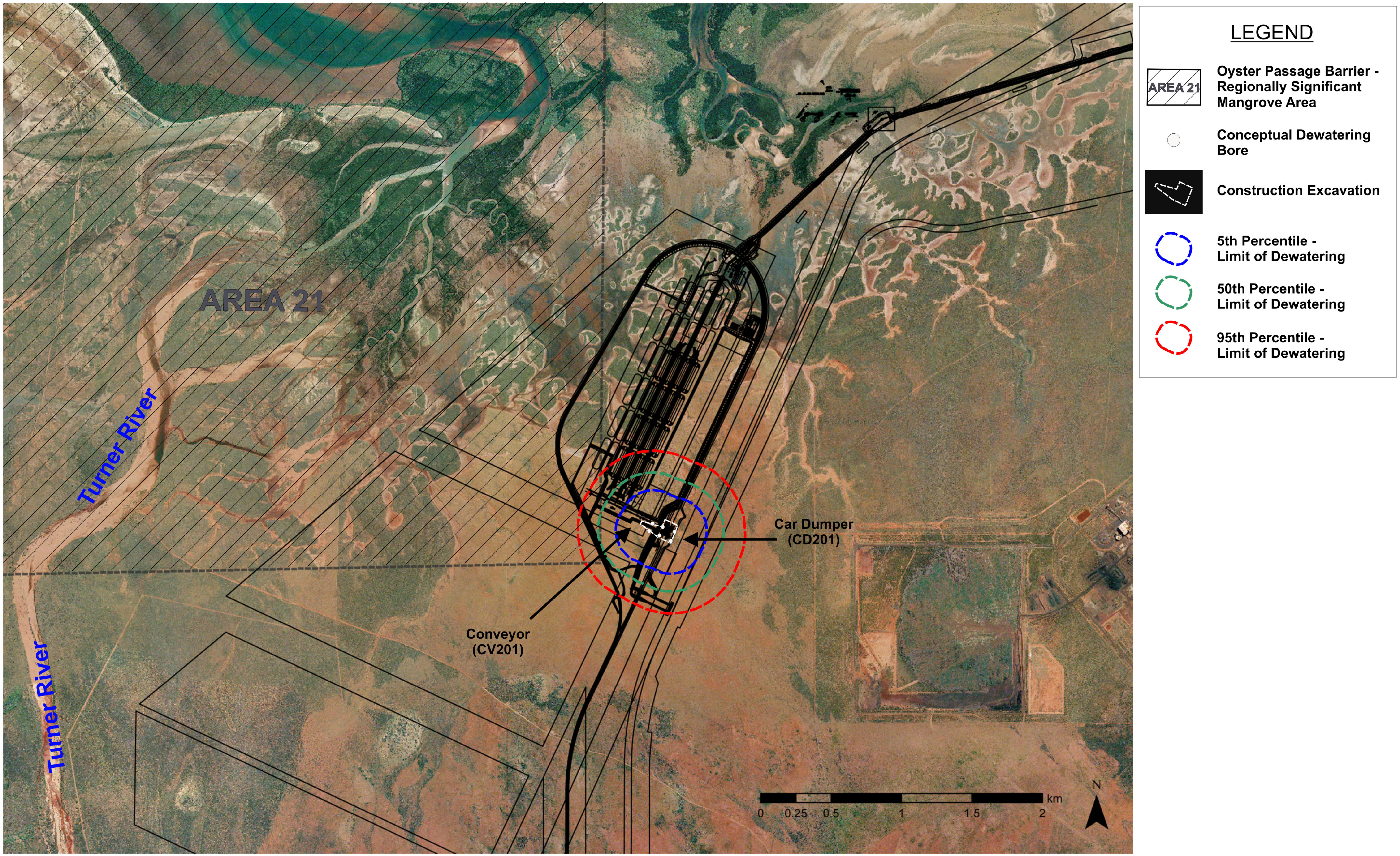
INFERRED GROUNDWATER CONTOURS (mAHD) AND FLOW DIRECTION

URS

NWI PORT HEDLAND - LANDSIDE PROJECT

Figure: 5

File No: 43326023-Fig005.crd Drawn: DPF Approved: IB Date: 08-06-2011 Rev.B A4



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GROUNDWATER STUDY - MULTI USE IRON ORE EXPORT FACILITIES

CONES OF GROUNDWATER DEWATERING - CAR DUMPER CONSTRUCTION

URS

NWI PORT HEADLAND - LANDSIDE PROJECT

File No: **43326023-Fig006.crd** Drawn: **DPF** Approved: **IB** Date: **08-06-2011**

Figure: **6**

Rev. **B** A3

COFFEY ENVIRONMENTS PTY LTD

GROUNDWATER STUDY
MULTI-USER IRON ORE EXPORT FACILITY

N

0 0.5 1 2 3 4 5 km

DEWATERING IMPACTS RELATIVE TO NEIGHBOURING OPERATIONS

URS

NWI PORT HEADLAND - LANDSIDE PROJECT

Figure: **7**

File No: **Figure 7.mxd** Drawn: **JA** Approved: **AC** Date: **07.06.2011** Rev. **A** A4

Appendix B WIN Groundwater Bore Data

WIN SITE ID	AWRC REF	REFERENCE	CONTEXT NAME	NAME	ZONE	EASTING	NORTHING	Distance from site (km)	COLLECTED DATE	Static Water Level (mbgl)	Relative Standing Water Level (mAHD)	TDS_COND
20064118	70910572	70910572	709 - PORT HEDLAND COAST	PWD BORE T.R. 2	50	655012	7734581	2	1000-01-01 00:00:00.000	12.190	-	
20064118	70910572	70910572	709 - PORT HEDLAND COAST	PWD BORE T.R. 2	50	655012	7734581	2	00:00:00 15/05/1966	11.070	-	
20064119	70910573	70910573	709 - PORT HEDLAND COAST	PWD NO 6A - 8 INCH BORE	50	655012	7734581	2	1000-01-01 00:00:00.000	9.800	-	TDSolids (in situ) 245.000 mg/L on 01-01-1000
20064120	70910574	70910574	709 - PORT HEDLAND COAST	PWD NO 7A 8 INCH BORE	50	655012	7734581	2	1000-01-01 00:00:00.000	10.670	-	TDSolids (in situ) 349.000 mg/L on 01-01-1000
20064121	70910575	70910575	709 - PORT HEDLAND COAST	PWD TR NO 8A	50	655012	7734581	2	00:00:00 30/07/1965	10.060	-	TDSolids (in situ) 840.000 mg/L on 30-07-1965
20064077	70910534	70910534	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO 3 WELL	50	654168	7735231	2	00:00:00 15/05/1966	8.000	-	
20064078	70910535	70910535	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO 1 BORE 8 INCH	50	654168	7735231	2	1000-01-01 00:00:00.000	9.140	15.590	TDSolids (in situ) 328.000 mg/L on 01-01-1000
20064078	70910535	70910535	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO 1 BORE 8 INCH	50	654168	7735231	2	1000-01-02 00:00:00.000	7.620	17.110	TDSolids (in situ) 328.000 mg/L on 01-01-1000
20064079	70910536	70910536	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO. 2 BORE 8 INCH	50	654168	7735231	2	1000-01-01 00:00:00.000	24.380	-1.970	TDSolids (in situ) 214.000 mg/L on 02-01-1000
20064079	70910536	70910536	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO. 2 BORE 8 INCH	50	654168	7735231	2	1000-01-02 00:00:00.000	7.160	15.250	TDSolids (in situ) 214.000 mg/L on 02-01-1000
20064080	70910537	70910537	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO. 3 BORE 8 INCH	50	654168	7735231	2	1000-01-01 00:00:00.000	9.140	13.780	TDSolids (in situ) 300.000 mg/L on 02-01-1000
20064080	70910537	70910537	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO. 3 BORE 8 INCH	50	654168	7735231	2	1000-01-02 00:00:00.000	6.860	16.060	TDSolids (in situ) 300.000 mg/L on 02-01-1000
20064081	70910538	70910538	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO 4 BORE	50	654168	7735231	2	1000-01-01 00:00:00.000	9.140	12.270	TDSolids (in situ) 300.000 mg/L on 01-01-1000
20064081	70910538	70910538	709 - PORT HEDLAND COAST	PWD TURNER RIVER NO 4 BORE	50	654168	7735231	2	1000-01-02 00:00:00.000	7.190	14.220	TDSolids (in situ) 300.000 mg/L on 01-01-1000
20064082	70910539	70910539	709 - PORT HEDLAND COAST	TURNER RIVER NO 5 BORE	50	654168	7735231	2	1000-01-01 00:00:00.000	9.140	13.740	
20064082	70910539	70910539	709 - PORT HEDLAND COAST	TURNER RIVER NO 5 BORE	50	654168	7735231	2	1000-01-02 00:00:00.000	7.920	14.960	
20064075	70910532	70910532	709 - PORT HEDLAND COAST	TURNER RIVER NO 1 WELL	50	654168	7735224	2	1000-01-01 00:00:00.000	9.140	12.430	
20067041	70910761	70910761	709 - PORT HEDLAND COAST	7 MILE WELL	50	657867	7733739	3	1000-01-01 00:00:00.000	16.360	-	Cond uncomp (lab) 1251.000 µS/cm on 08-11-1996
20067041	70910761	70910761	709 - PORT HEDLAND COAST	7 MILE WELL	50	657867	7733739	3	00:00:00 08/11/1996	14.500	-	Cond uncomp (lab) 1251.000 µS/cm on 08-11-1996
20064072	70910529	70910529	709 - PORT HEDLAND COAST	MOUMERGUBBINA WELL	50	655147	7739043	3	1000-01-01 00:00:00.000	8.840	-	TDSolids (in situ) 774.000 mg/L on 31-05-1969
20064074	70910531	70910531	FORTESCUE PORT PROJECT	CLAYPAN BORE	50	655067	7733189	3	1000-01-01 00:00:00.000	7.320	-	Cond uncomp (lab) 1039.000 µS/cm on 08-11-1996
20064074	70910531	70910531	FORTESCUE PORT PROJECT	CLAYPAN BORE	50	655067	7733189	3	00:00:00 08/11/1996	7.600	-	Cond uncomp (lab) 1039.000 µS/cm on 08-11-1996
20064100	70910554	70910554	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 6	50	653772	7733814	4	00:00:00 30/07/1965	8.990	8.850	TDSolids (in situ) 4470.000 mg/L on 30-07-1965
20064100	70910554	70910554	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 6	50	653772	7733814	4	00:00:00 15/05/1966	9.120	8.720	TDSolids (in situ) 4470.000 mg/L on 30-07-1965
20064101	70910555	70910555	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 7	50	653772	7733814	4	00:00:00 09/09/1965	7.800	6.250	TDSolids (evap @180°C) 390.000 mg/L on 14-11-1965
20064101	70910555	70910555	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 7	50	653772	7733814	4	00:00:00 15/05/1966	5.980	8.070	TDSolids (evap @180°C) 390.000 mg/L on 14-11-1965
20064102	70910556	70910556	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 8	50	653772	7733814	4	00:00:00 21/05/1965	7.520	7.360	TDSolids (cond) 390.000 mg/L on 14-04-1966
20064102	70910556	70910556	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 8	50	653772	7733814	4	00:00:00 15/05/1966	5.430	9.450	TDSolids (cond) 390.000 mg/L on 14-04-1966
20064103	70910557	70910557	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 9	50	653772	7733814	4	00:00:00 15/05/1965	10.310	-	TDSolids (in situ) 600.000 mg/L on 15-05-1966
20064103	70910557	70910557	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 9	50	653772	7733814	4	00:00:00 15/05/1966	10.000	-	TDSolids (in situ) 600.000 mg/L on 15-05-1966
20064104	70910558	70910558	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 10	50	653772	7733814	4	00:00:00 06/06/1965	9.650	7.470	TDSolids (in situ) 3130.000 mg/L on 06-06-1965
20064104	70910558	70910558	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 10	50	653772	7733814	4	00:00:00 15/05/1966	9.480	7.640	TDSolids (in situ) 3130.000 mg/L on 06-06-1965
20064105	70910559	70910559	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 11	50	653772	7733814	4	00:00:00 07/07/1965	9.630	15.060	TDSolids (evap @180°C) 980.000 mg/L on 08-07-1965
20064105	70910559	70910559	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 11	50	653772	7733814	4	00:00:00 15/05/1966	9.550	15.140	TDSolids (evap @180°C) 980.000 mg/L on 08-07-1965
20064106	70910560	70910560	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 12	50	653772	7733814	4	00:00:00 19/07/1965	15.440	17.940	TDSolids (in situ) 610.000 mg/L on 19-07-1965
20064106	70910560	70910560	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 12	50	653772	7733814	4	00:00:00 15/05/1966	15.610	17.770	TDSolids (in situ) 610.000 mg/L on 19-07-1965
20064107	70910561	70910561	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 13	50	653772	7733814	4	00:00:00 04/09/1965	10.790	19.260	TDSolids (evap @180°C) 830.000 mg/L on 04-10-1965
20064109	70910563	70910563	709 - PORT HEDLAND COAST	6 INCH GS TURNER RIVER BORE 15	50	653772	7733814	4	00:00:00 04/11/1965	9.270	6.210	TDSolids (cond) 360.000 mg/L on 19-11-1965
20064109	70910563	70910563	709 - PORT HEDLAND COAST	6 INCH GS TURNER RIVER BORE 15	50	653772	7733814	4	00:00:00 15/05/1966	8.760	6.720	TDSolids (cond) 360.000 mg/L on 19-11-1965
20064110	70910564	70910564	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 16	50	653772	7733814	4	1000-01-02 00:00:00.000	10.980	-	TDSolids (cond) 320.000 mg/L on 16-11-1965
20064110	70910564	70910564	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 16	50	653772	7733814	4	00:00:00 04/09/1965	11.000	5.040	TDSolids (cond) 320.000 mg/L on 16-11-1965
20064111	70910565	70910565	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 17	50	653772	7733814	4	00:00:00 09/11/1965	6.380	5.670	TDSolids (calc @180°C)-HCO3 910.000 mg/L on 13-11-1965
20064111	70910565	70910565	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 17	50	653772	7733814	4	00:00:00 15/05/1966	5.200	6.850	TDSolids (calc @180°C)-HCO3 910.000 mg/L on 13-11-1965
20064112	70910566	70910566	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 18	50	653772	7733814	4	00:00:00 06/08/1965	14.610	6.430	TDSolids (cond) 710.000 mg/L on 21-08-1965
20064112	70910566	70910566	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 18	50	653772	7733814	4	00:00:00 15/05/1966	14.990	6.050	TDSolids (cond) 710.000 mg/L on 21-08-1965
20064113	70910567	70910567	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 19	50	653772	7733814	4	00:00:00 25/11/1965	8.840	6.370	TDSolids (evap @180°C) 590.000 mg/L on 26-11-1965
20064113	70910567	70910567	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 19	50	653772	7733814	4	00:00:00 15/05/1966	7.470	7.740	TDSolids (evap @180°C) 590.000 mg/L on 26-11-1965
20064114	70910568	70910568	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 20	50	653772	7733814	4	00:00:00 19/11/1965	8.990	9.270	TDSolids (evap @180°C) 760.000 mg/L on 20-11-1965
20064114	70910568	70910568	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 20	50	653772	7733814	4	00:00:00 15/05/1966	8.520	9.740	TDSolids (evap @180°C) 760.000 mg/L on 20-11-1965
20064115	70910569	70910569	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 23	50	653772	7733814	4	00:00:00 31/07/1965	12.240	15.710	TDSolids (in situ) 1680.000 mg/L on 31-07-1965
20064115	70910569	70910569	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 23	50	653772	7733814	4	00:00:00 15/05/1966	12.690	15.260	TDSolids (in situ) 1680.000 mg/L on 31-07-1965
20064116	70910570	70910570	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 26	50	653778	7733795	4	00:00:00 15/11/1965	14.780	5.090	TDSolids (in situ) 930.000 mg/L on 15-11-1965
20064116	70910570	70910570	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 26	50	653778	7733795	4	00:00:00 15/05/1966	14.770	5.100	TDSolids (in situ) 930.000 mg/L on 15-11-1965
20064095	70910549	70910549	709 - PORT HEDLAND COAST	GS TURNER RIVER NO 1	50	653772	7733801	4	00:00:00 16/09/1965	10.460	12.700	TDSolids (evap @180°C) 360.000 mg/L on 22-09-1965
20064095	70910549	70910549	709 - PORT HEDLAND COAST	GS TURNER RIVER NO 1	50	653772	7733801	4	00:00:00 15/05/1966	11.170	11.990	TDSolids (evap @180°C) 360.000 mg/L on 22-09-1965
20064096	70910550	70910550	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 2	50	653772	7733801	4	00:00:00 19/07/1965	18.140	8.960	TDSolids (in situ) 580.000 mg/L on 19-07-1965
20064096	70910550	70910550	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 2	50	653772	7733801	4	00:00:00 15/05/1966	18.690	8.410	TDSolids (in situ) 580.000 mg/L on 19-07-1965
20064098	70910552	70910552	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 4	50	653772	7733801	4	00:00:00 03/07/1965	12.120	9.730	TDSolids (evap @180°C) 520.000 mg/L on 09-07-1965
20064098	70910552	70910552	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 4	50	653772	7733801	4	00:00:00 15/05/1966	9.580	12.270	TDSolids (evap @180°C) 520.000 mg/L on 09-07-1965
20064099	70910553	70910553	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 5	50	653772	7733801	4	00:00:00 01/08/1965	9.070	10.960	TDSolids (in situ) 1490.000 mg/L on 01-08-1965
20064099	70910553	70910553	709 - PORT HEDLAND COAST	GS TURNER RIVER BORE 5	50	653772	7733801	4	00:00:00 15/05/1966	8.850	11.180	TDSolids (in situ) 1490.000 mg/L on 01-08-1965
20064092	70910546	70910546	709 - PORT HEDLAND COAST	PWD TURNER RIVER 5-67	50	652904	7735099	4	00:00:00 30/06/1967	6.630	-	
20064093	70910547	70910547	709 - PORT HEDLAND COAST	PWD TURNER RIVER 6-67	50	652904	7735099	4	00:00:00 30/06/1967	8.230	-	TDSolids (in situ) 410.000 mg/L on 30-06-1967
20064094	70910548	70910548	709 - PORT HEDLAND COAST	PWD TURNER RIVER 7-67	50	652904	7735099	4	00:00:00 30/06/1967	8.920	-	TDSolids (in situ) 280.000 mg/L on 30-06-1967
20064088	70910542	70910542	709 - PORT HEDLAND COAST	PWD TURNER RIVER 1-67	50	652904	7735093	4	00:00:00 30/06/1967	5.640	-	
20064089	70910543	70910543	709 - PORT HEDLAND COAST	PWD TURNER RIVER 2-67	50	652904	7735093	4	00:00:00 30/06/1967	6.380	-	
20064090	70910544	70910544	709 - PORT HEDLAND COAST	PWD TURNER RIVER 3-67	50	652904	7735093	4	00:00:00 30/06/1967	7.320	-	TDSolids (in situ) 260.000 mg/L on 30-06-1967
20064091	70910545	70910545	709 - PORT HEDLAND COAST	PWD TURNER RIVER 4-67	50	652904	7735093	4	00:00:00 30/06/1967	6.550	-	

WIN SITE ID	AWRC REF	REFERENCE	CONTEXT NAME	NAME	ZONE	EASTING	NORTHING	Distance from site (km)	COLLECTED DATE	Static Water Level (mbgl)	Relative Standing Water Level (mAHD)	TDS_COND
20064122	70910576	70910576	709 - PORT HEDLAND COAST	PWD 6 INCH BORE	50	652910	7735067	4	1000-01-01 00:00:00.000	1.830	-	TDSolids (in situ) 64.000 mg/L on 02-01-1000
20064123	70910577	70910577	709 - PORT HEDLAND COAST	PWD BORE	50	652910	7735067	4	1000-01-01 00:00:00.000	3.960	-	TDSolids (in situ) 85.000 mg/L on 02-01-1000
20064083	70910540	70910540	709 - PORT HEDLAND COAST	MOORAMBINE (MOORABIN WELL)	50	651495	7736391	5	1000-01-01 00:00:00.000	7.010	-	Cond uncomp (lab) 2220.000 µS/cm on 12-11-1996
20064083	70910540	70910540	709 - PORT HEDLAND COAST	MOORAMBINE (MOORABIN WELL)	50	651495	7736391	5	00:00:00 12/11/1996	8.500	-	Cond uncomp (lab) 2220.000 µS/cm on 12-11-1996
20067043	70911150	70911150	709 - PORT HEDLAND COAST	PIPININA WELL	50	660620	7739331	5	1000-01-01 00:00:00.000	10.720	-	TDSolids (in situ) 3073.000 mg/L on 01-01-1000
20064073	70910530	70910530	709 - PORT HEDLAND COAST	MAITLAND	50	651737	7733111	6	1000-01-01 00:00:00.000	7.620	-	TDSolids (in situ) 875.000 mg/L on 08-06-1969
20063828	70910438	70910438	709 - PORT HEDLAND COAST	BORE	50	656492	7730321	6	00:00:00 30/06/1971	6.710	-	
20064071	70910528	70910528	709 - PORT HEDLAND COAST	SAILOR WELL	50	651418	7739257	6	1000-01-01 00:00:00.000	5.790	-	Cond uncomp (lab) 1837.000 µS/cm on 08-11-1996
20064069	70910526	70910526	709 - PORT HEDLAND COAST	HOMESTEAD	50	654766	7742825	7	1000-01-01 00:00:00.000	9.450	-	TDSolids (in situ) 2300.000 mg/L on 28-05-1969
20064067	70910524	70910524	709 - PORT HEDLAND COAST	GARDEN WELL	50	652929	7742274	7	1000-01-01 00:00:00.000	9.450	-	Cond uncomp (lab) 891.000 µS/cm on 09-11-1996
20064067	70910524	70910524	709 - PORT HEDLAND COAST	GARDEN WELL	50	652929	7742274	7	00:00:00 09/11/1996	8.300	-	Cond uncomp (lab) 891.000 µS/cm on 09-11-1996
20064070	70910527	70910527	709 - PORT HEDLAND COAST	MOOKLEY WELL	50	655612	7743243	7	1000-01-01 00:00:00.000	6.100	-	TDSolids (in situ) 3095.000 mg/L on 31-05-1969
20064087	70910936	70910936	709 - PORT HEDLAND COAST	HOME BORE	50	653978	7742947	7	1000-01-01 00:00:00.000	6.630	-	TDSolids (in situ) 1376.000 mg/L on 01-01-1000
20064068	70910525	70910525	709 - PORT HEDLAND COAST	SHEARING SHED	50	653285	7742712	7	1000-01-01 00:00:00.000	7.010	-	TDSolids (in situ) 1460.000 mg/L on 31-05-1969
20067042	70910762	70910762	709 - PORT HEDLAND COAST	BUBBA CURRIE WELL	50	664010	7734761	8	1000-01-01 00:00:00.000	15.850	-	Cond uncomp (lab) 8490.000 µS/cm on 08-11-1996
20067042	70910762	70910762	709 - PORT HEDLAND COAST	BUBBA CURRIE WELL	50	664010	7734761	8	00:00:00 08/11/1996	12.500	-	Cond uncomp (lab) 8490.000 µS/cm on 08-11-1996
20063830	70910440	70910440	709 - PORT HEDLAND COAST	WANNA BUCKERY WELL	50	656361	7728433	8	00:00:00 09/11/1996	11.000	-	Cond uncomp (lab) 752.000 µS/cm on 09-11-1996
20063823	70910433	70910433	709 - PORT HEDLAND COAST	BORE	50	656406	7728377	8	1000-01-01 00:00:00.000	11.580	-	TDSolids (in situ) 324.000 mg/L on 31-05-1969
20063823	70910433	70910433	709 - PORT HEDLAND COAST	BORE	50	656406	7728377	8	00:00:00 31/05/1969	10.060	-	TDSolids (in situ) 324.000 mg/L on 31-05-1969
20066953	70911103	70911103	709 - PORT HEDLAND COAST	BUNGABAR WELL	50	660903	7729731	8	1000-01-01 00:00:00.000	14.250	-	TDSolids (in situ) 1060.000 mg/L on 01-01-1000
20067046	70910763	70910763	709 - PORT HEDLAND COAST	SAND HILL WELL	50	658267	7744278	8	1000-01-01 00:00:00.000	9.070	-	Cond uncomp (lab) 19750.000 µS/cm on 08-11-1996
20067046	70910763	70910763	709 - PORT HEDLAND COAST	SAND HILL WELL	50	658267	7744278	8	00:00:00 08/11/1996	9.900	-	Cond uncomp (lab) 19750.000 µS/cm on 08-11-1996
23034489	70912610	70912610	FORTESCUE PORT PROJECT	PWS6	50	663348	7742053	9	00:00:00 20/05/2006	4.220	-	TDSolids (in situ) 7100.000 mg/L on 01-05-2007
23034489	70912610	70912610	FORTESCUE PORT PROJECT	PWS6	50	663348	7742053	9	00:00:00 01/05/2007	4.220	-	TDSolids (in situ) 7100.000 mg/L on 01-05-2007
23034650	70912640	70912640	FMG RAIL CONSTRUCTION	WS1P3	50	665492	7736988	9	00:00:00 14/10/2006	10.000	-	Cond (unk) 2800.000 µS/cm on 14-10-2006
23034650	70912640	70912640	FMG RAIL CONSTRUCTION	WS1P3	50	665492	7736988	9	08:00:00 14/10/2006	10.000	-	Cond (unk) 2800.000 µS/cm on 14-10-2006
23034650	70912640	70912640	FMG RAIL CONSTRUCTION	WS1P3	50	665492	7736988	9	00:00:00 18/10/2006	10.000	-	Cond (unk) 2800.000 µS/cm on 14-10-2006
23034645	70912636	70912636	FMG RAIL CONSTRUCTION	WS1X4	50	665519	7737000	9	00:00:00 13/10/2006	11.040	-	
23034645	70912636	70912636	FMG RAIL CONSTRUCTION	WS1X4	50	665519	7737000	9	00:00:00 13/10/2006	11.040	-	
23034645	70912636	70912636	FMG RAIL CONSTRUCTION	WS1X4	50	665519	7737000	9	08:00:00 13/10/2006	11.040	-	
23034644	70912635	70912635	FMG RAIL CONSTRUCTION	WS1X3	50	665547	7737007	9	00:00:00 16/09/2006	9.400	-	Cond uncomp (in situ) 1510.000 µS/cm on 16-09-2006
23034644	70912635	70912635	FMG RAIL CONSTRUCTION	WS1X3	50	665547	7737007	9	00:00:00 16/09/2006	9.400	-	Cond uncomp (in situ) 1510.000 µS/cm on 16-09-2006
23034644	70912635	70912635	FMG RAIL CONSTRUCTION	WS1X3	50	665547	7737007	9	08:00:00 16/09/2006	9.400	-	Cond uncomp (in situ) 1510.000 µS/cm on 16-09-2006
23034487	70912608	70912608	FORTESCUE PORT PROJECT	PWS4	50	665578	7736815	9	1000-01-01 00:00:00.000	9.740	-	Cond uncomp (in situ) 5680.000 µS/cm on 27-09-2006
23034487	70912608	70912608	FORTESCUE PORT PROJECT	PWS4	50	665578	7736815	9	00:00:00 25/09/2006	9.700	-	Cond uncomp (in situ) 5680.000 µS/cm on 27-09-2006
23034487	70912608	70912608	FORTESCUE PORT PROJECT	PWS4	50	665578	7736815	9	00:00:00 01/10/2006	9.740	-	Cond uncomp (in situ) 5680.000 µS/cm on 27-09-2006
23034487	70912608	70912608	FORTESCUE PORT PROJECT	PWS4	50	665578	7736815	9	00:00:00 30/11/2007	12.230	-	Cond uncomp (in situ) 5680.000 µS/cm on 27-09-2006
23034649	70912639	70912639	FMG RAIL CONSTRUCTION	WS1P2	50	665612	7736618	9	00:00:00 03/10/2006	10.540	-	Cond uncomp (in situ) 6650.000 µS/cm on 08-10-2006
23034649	70912639	70912639	FMG RAIL CONSTRUCTION	WS1P2	50	665612	7736618	9	08:00:00 03/10/2006	10.540	-	Cond uncomp (in situ) 6650.000 µS/cm on 08-10-2006
23034649	70912639	70912639	FMG RAIL CONSTRUCTION	WS1P2	50	665612	7736618	9	00:00:00 10/10/2006	10.540	-	Cond uncomp (in situ) 6650.000 µS/cm on 08-10-2006
23034643	70912634	70912634	FMG RAIL CONSTRUCTION	WS1X2	50	665587	7737020	9	00:00:00 26/09/2006	9.600	-	Cond uncomp (in situ) 2630.000 µS/cm on 15-09-2006
23034643	70912634	70912634	FMG RAIL CONSTRUCTION	WS1X2	50	665587	7737020	9	00:00:00 26/09/2006	9.600	-	Cond uncomp (in situ) 2630.000 µS/cm on 15-09-2006
23034643	70912634	70912634	FMG RAIL CONSTRUCTION	WS1X2	50	665587	7737020	9	08:00:00 26/09/2006	9.600	-	Cond uncomp (in situ) 2630.000 µS/cm on 15-09-2006
23034642	70912633	70912633	FMG RAIL CONSTRUCTION	WS1X1	50	665623	7737019	9	00:00:00 16/09/2006	16.450	-	
23034642	70912633	70912633	FMG RAIL CONSTRUCTION	WS1X1	50	665623	7737019	9	00:00:00 16/09/2006	16.450	-	
23034642	70912633	70912633	FMG RAIL CONSTRUCTION	WS1X1	50	665623	7737019	9	08:00:00 16/09/2006	16.450	-	
23034646	70912637	70912637	FMG RAIL CONSTRUCTION	WS1X5	50	665640	7736826	9	00:00:00 27/09/2006	9.350	-	Cond uncomp (in situ) 2340.000 µS/cm on 24-09-2006
23034646	70912637	70912637	FMG RAIL CONSTRUCTION	WS1X5	50	665640	7736826	9	00:00:00 27/09/2006	9.350	-	Cond uncomp (in situ) 2340.000 µS/cm on 24-09-2006
23034646	70912637	70912637	FMG RAIL CONSTRUCTION	WS1X5	50	665640	7736826	9	08:00:00 27/09/2006	9.350	-	Cond uncomp (in situ) 2340.000 µS/cm on 24-09-2006
20064065	70910522	70910522	709 - PORT HEDLAND COAST	ARCHIE BORE	50	649453	7742190	9	00:00:00 12/11/1996	5.100	-	Cond uncomp (lab) 4900.000 µS/cm on 12-11-1996
20064066	70910523	70910523	709 - PORT HEDLAND COAST	COAST WELL	50	652373	7744455	9	1000-01-01 00:00:00.000	0.610	-	Cond uncomp (lab) 1415.000 µS/cm on 08-11-1996
20064066	70910523	70910523	709 - PORT HEDLAND COAST	COAST WELL	50	652373	7744455	9	00:00:00 08/11/1996	2.600	-	Cond uncomp (lab) 1415.000 µS/cm on 08-11-1996
20064085	70910541	70910541	709 - PORT HEDLAND COAST	RAM BORE	50	650987	7743878	9	1000-01-01 00:00:00.000	3.480	-	Cond uncomp (lab) 6220.000 µS/cm on 08-11-1996
23034488	70912609	70912609	FORTESCUE PORT PROJECT	PWS5	50	665918	7735074	10	1000-01-01 00:00:00.000	11.360	-	Cond uncomp (in situ) 4410.000 µS/cm on 12-11-2006
23034488	70912609	70912609	FORTESCUE PORT PROJECT	PWS5	50	665918	7735074	10	00:00:00 12/11/2006	11.300	-	Cond uncomp (in situ) 4410.000 µS/cm on 12-11-2006
23034488	70912609	70912609	FORTESCUE PORT PROJECT	PWS5	50	665918	7735074	10	00:00:00 20/11/2006	11.070	-	Cond uncomp (in situ) 4410.000 µS/cm on 12-11-2006
23034488	70912609	70912609	FORTESCUE PORT PROJECT	PWS5	50	665918	7735074	10	00:00:00 30/11/2007	10.300	-	Cond uncomp (in situ) 4410.000 µS/cm on 12-11-2006
20064124	70910937	70910937	709 - PORT HEDLAND COAST	NO. 3 WEST TURNER RIVER	50	646920	7736149	10	1000-01-01 00:00:00.000	8.530	-	
23034655	70912644	70912644	FMG RAIL CONSTRUCTION	WS1X12	50	666070	7735335	10	00:00:00 09/11/2006	11.250	-	Cond uncomp (in situ) 1420.000 µS/cm on 07-11-2006
23034655	70912644	70912644	FMG RAIL CONSTRUCTION	WS1X12	50	666070	7735335	10	00:00:00 09/11/2006	11.250	-	Cond uncomp (in situ) 1420.000 µS/cm on 07-11-2006
23034655	70912644	70912644	FMG RAIL CONSTRUCTION	WS1X12	50	666070	7735335	10	08:00:00 09/11/2006	11.250	-	Cond uncomp (in situ) 1420.000 µS/cm on 07-11-2006
23034486	70912607	70912607	FORTESCUE PORT PROJECT	PWS3	50	665473	7732177	10	00:00:00 02/05/2007	15.000	-	Cond (unk) 3500.000 µS/cm on 02-05-2007
23034486	70912607	70912607	FORTESCUE PORT PROJECT	PWS3	50	665473	7732177	10	00:00:00 02/05/2007	14.000	-	Cond (unk) 3500.000 µS/cm on 02-05-2007
23035033	70912809	70912809	FMG RAIL CONSTRUCTION	RWM7-I	50	665482	7732188	10	00:00:00 24/05/2007	14.700	-	
23035032	70912808	70912808	FMG RAIL CONSTRUCTION	RWM7-S	50	665479	7732163	10	00:00:00 20/05/2007	14.000	-	
20067047	70910764	70910764	709 - PORT HEDLAND COAST	SIX MILE WELL	50	662092	7744533	10	1000-01-01 00:00:00.000	6.810	-	Cond uncomp (lab) 19400.000 µS/cm on 08-11-1996
20067047	70910764	70910764	709 - PORT HEDLAND COAST	SIX MILE WELL	50	662092	7744533	10	00:00:00 08/11/1996	3.600	-	Cond uncomp (lab) 19400.000 µS/cm on 08-11-1996
20067044	70911151	70911151	709 - PORT HEDLAND COAST	MULLUMBRIDGIE WELL	50	664857	7742197	10	1000-01-01 00:00:00.000	11.300	-	TDSolids (in situ) 2586.000 mg/L on 01-01-1000

WIN SITE ID	AWRC REF	REFERENCE	CONTEXT NAME	NAME	ZONE	EASTING	NORTHING	Distance from site (km)	COLLECTED DATE	Static Water Level (mbgl)	Relative Standing Water Level (mAHD)	TDS_COND
23034491	70912611	70912611	FORTESCUE PORT PROJECT	PWS7	50	665600	7731210	10	00:00:00 01/05/2007	15.850	-	Cond (unk) 3260.000 µS/cm on 20-05-2007
23034491	70912611	70912611	FORTESCUE PORT PROJECT	PWS7	50	665600	7731210	10	00:00:00 20/05/2007	15.840	-	Cond (unk) 3260.000 µS/cm on 20-05-2007
20064064	70910521	70910521	709 - PORT HEDLAND COAST	MEERANDAGANNA WELL	50	647399	7741296	10	1000-01-01 00:00:00.000	4.570	-	TDSolids (in situ) 285.000 mg/L on 31-05-1969

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