Appendix A (i)

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

ASS Assessment (Coffey 2011a)

coffey environments
SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

PRELIMINARY (NON-INTRUSIVE) ACID SULFATE SOIL INVESTIGATION PROPOSED NWI MULTI USER IRON ORE EXPORT FACILITY

Prepared for:

North West Infrastructure
PO Box 423
WEST PERTH WA 6872

Report Date: 13 June 2011
Project Ref:ENAUPERT02319AA
Report Ref: EP2010/239, V2

Written/Submitted by:

Barbara Langford
Environmental Scientist

Reviewed/Approved by:

Justin Lumsden
Associate
Team Leader Contaminated Sites

coffey environments
SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

13 June 2011

North West Infrastructure
PO Box 423
WEST PERTH WA 6872

Attention: Tony Considine

Dear Tony

RE: PRELIMINARY (NON-INTRUSIVE) ASS INVESTIGATION, PROPOSED NWI MULTI USER IRON ORE EXPORT FACILITY

Coffey Environments are pleased to provide this report documenting our desktop investigation into the potential presence of acid sulfate soils (ASS) within the proposed Multi-user Iron Ore Export Facility project area. If you have any questions about the attached report, feel free to contact me on 9355 7100.

For and on behalf of Coffey Environments Australia Pty Ltd.

Barbara Langford
Environmental Scientist

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2	ENAUPERT02319AA-Reporting_001_bl_V1	V1	18 February 2011	Coffey Environments Pty Ltd	BL
1	ENAUPERT02319AA_ASSI_Reporting_001_bl_V2	V2	13 June 2011	NWI	BL
1	ENAUPERT02319AA_ASSI_Reporting_001_bl_V2	V2	13 June 2011	Coffey Environments Pty Ltd	BL

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ABBREVIATIONS

AASS	Actual Acid Sulfate Soils
AHD	Australian Height Datum
ASS	Acid Sulfate Soils
ASSMP	ASS Management Plan
BHPBIO	BHP Billiton Iron Ore
CD	Chart Datum
Coffey	Coffey Environments
DEC	Department of Environment and Conservation
DoW	Department of Water
DSE	Department of Sustainability and Environment
EPA	Environmental Protection Authority
GIS	Geographic Information System
GL	Gigalitres
ha	hectares
HBI	Hot Briquetted Iron
km	kilometre(s)
m	metre(s)
M	Million
m^3	Cubic metre(s)
mAHD	Meter(s) Australian Height Datum
mbgl	meter(s) below ground level
mCD	meter(s) Chart Datum
mg/L	milligrams per litre

ABBREVIATIONS

No.	Number
NWI	North West Infrastructure
NWIOA	North West Iron Ore Alliance
OEPA	Office of Environmental Protection Authority
PASS	Potential Acid Sulfate Soils
PDWSA	Public Drinking Water Source Protection Area
PHPA	Port Hedland Port Authority
RL	Reduced Level
SAP	Sampling and Analysis Plan
SKM	Sinclair Knight Merz
TDS	Total Dissolved Solids

EXECUTIVE SUMMARY

Coffey Environments (Coffey) were commissioned by the North West Infrastructure (NWI) to undertake a preliminary investigation into the potential presence of acid sulfate soils (ASS) that may be encountered as part of the proposed Multi-user Iron Ore Export Facility Project (the project), located approximately 3km south-east of Port Hedland and 1,700km north of the city of Perth. The preliminary investigation entailed a desktop assessment together with a site inspection and is designed to satisfy 'Step 1: Desktop Assessment and Site Inspection' of Department of Environment and Conservation (DEC 2009a) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*. No intrusive investigations were performed.

This report has been produced to inform the scoping of a detailed intrusive ASS investigation by taking into account where Potential Acid Sulfate Soils (PASS) is likely to be encountered in the project area and how the proposed development may interact with the presence of PASS. This report has been produced in support of the clients' project assessment under the *Environmental Protection Act 1986.*

The conclusions of the preliminary ASS investigation are as follows:

- The preliminary ASS investigation has confirmed that the northern portion of the project area is highly likely to contain PASS. This conclusion is based on geomorphology and vegetation indicators noted during the site walkover together with published ASS risk mapping and environmental studies completed nearby. No evidence of PASS was identified in the southern two thirds of the project area however it is considered possible that PASS could be present along low-lying land such as dry creek beds that are present. Where PASS is present in the local area, it is likely that its presence is strongly lithologically dependent, with previous intrusive studies nearby indicating a strong correlation between mangrove mud horizons and the presence of PASS.
- The relationship between PASS and the proposed Multi-user Iron Ore Export Facility has been assessed and it is apparent that the majority of infrastructure will fall within the northern portion of the project area and therefore likely to interact with PASS. The construction of a proposed car dumping facility, stockyard area and wharf area will require ground disturbance with in excess of 1,000,000m^3 of material to be excavated over an area of more than 100ha. These bulk earthwork estimates do not necessarily equate to PASS disturbance since PASS may only be present within certain horizons or locations even within the higher risk northern portion of the project area.
- Groundwater within the northern portion of the project area is likely to be relatively shallow within the footprint of the proposed car dumping facility and therefore it is anticipated that groundwater dewatering will be necessary during construction. Although an intrusive groundwater investigation did not form part of this preliminary assessment, it is possible that groundwater within the northern portion of the site may inherently contain high acid buffering capacity where there is a hydraulic connection with the nearby estuarine environment.
- The proposed development has the potential to result in the generation of ASS which could be detrimental to the nearby estuarine environment, vegetation, and proposed infrastructure. Depending on any inherent acid buffering capacity within groundwater, disturbance of ASS may also acidify groundwater resulting in unnaturally high metal concentrations such as arsenic and aluminium. Where the disturbance of ASS results in a risk to the environment or human health, such areas may be classified by the Department of Environment and Conservation (DEC) as contaminated under provisions of the *Contaminated Sites Act (2003)*.

EXECUTIVE SUMMARY

In order to ensure that potential ASS risks are adequately assessed the following recommendations should be implemented:

- A risk-based intrusive ASS investigation should be undertaken within the project area and should be designed to satisfactorily characterise the various geological/geomorphological units. Investigations should be tailored towards areas where PASS is mostly likely to exist and/or areas where ground disturbance is greatest such as the northern portion of the project and in particular the proposed car dumping facility, stockyard area and wharf area. Some ASS investigation within the southern two thirds of the project is considered prudent to ensure good spatial coverage and geological/geomorphological characterisation.
- Intrusive groundwater assessment should form part of the detailed investigation works. As a minimum, groundwater bores should be positioned in the surrounds of the proposed car dumping facility, where deep excavation and groundwater dewatering is proposed, to assess baseline groundwater quality and the vulnerability of groundwater to acidification. The scope of groundwater assessment should also include the collection of site-specific hydrogeological parameters to assist in accurate modelling of dewatering cone of depression and, in turn, predicting any associated impacts.

The above risk-based intrusive investigations should be designed in line with the intent of the DEC ASS Guideline Series. It is recommended that a Sampling and Analysis Plan (SAP) is developed to formalise the proposed investigation works and that agreement is sought from the DEC where specific sampling and analysis frequency deviations from DEC ASS Guideline Series are proposed.

1 INTRODUCTION

1.1 Background

Coffey Environments (Coffey) were commissioned by North West Infrastructure (NWI) to undertake a preliminary investigation into the potential presence of acid sulfate soils (ASS) that may be encountered as part of the proposed Multi-user Iron Ore Export Facility Project (the project). The project area is located approximately 3km south-east of Port Hedland and 1,700km north of the city of Perth. It is understood that the project comprises the construction of a port facility and rail corridor which runs north to south and is approximately 30km long and 1km wide. The regional location and project area are shown in Figure 1 and Figure 2, respectively. This report has been produced in support of the clients' project assessment under the *Environmental Protection Act 1986 (EPA)* and is a preliminary desktop study only.

This report has been produced to inform the scoping for a detailed intrusive ASS investigation. Through consideration of the project scope and ASS risk profile of the project area, the preliminary ASS investigation will assess whether a risk-based approach may be appropriate in investigating and managing potential ASS (PASS) that may exist. The preliminary ASS investigation is designed to satisfy 'Step 1: Desktop Assessment and Site Inspection' of the Department of Environment and Conservation (DEC) (2009a) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*.

1.2 NWI Background

The North West Iron Ore Alliance (NWIOA) was formed in 2007 by a number of emerging iron ore companies with assets in the Pilbara region of Western Australia, which led to the incorporation of NWIOA Ops. Pty Ltd in June 2009. The business name North West Infrastructure was registered in February 2011. The key objective of NWI is to promote the development of a successful, economically viable and dynamic junior iron ore industry in the Pilbara region through corporation and collaboration on key project development frontiers, including infrastructure access and development, statutory approval and government and community relations. The current shareholders of NWI are Atlas Iron Limited, Brockman Resources Limites and FerrAus Limited. Atlas Iron Limited is currently the only company actively mining iron ore and via a short term limited arrangement is exporting through existing facilities in the Port of Port Hedland.

In order to facilitate the export of iron ore by the NWI, suitable infrastructure is required to be constructed and operating agreements developed within Port Hedland. Therefore to meet the long-term needs of the NWI members, a Multi-user Iron Ore Facility was proposed within Port Hedland to commence exporting iron ore in 2014.

1.3 Objectives

With a view towards supporting the clients' project assessment under the *Environmental Protection Act 1986*, the objectives of the preliminary ASS investigation were as follows;

- develop a preliminary understanding of the potential existence of PASS within the project area;
- assess how the proposed development may interact with the presence of PASS and what risk this may pose to the environment and human health; and
- with consideration to the outcomes of the preliminary ASS investigation, provide recommendations for intrusive investigations to further investigate potential risks to the environment and human health.

1.4 Scope of Works

In order to meet the objectives outlined above the following activities were carried out;

- review of the DEC ASS Risk Map online database;
- review of the proposed development, in particular any ground or groundwater disturbance elements;
- use of Geographic Information Systems (GIS) to identify any inferred ASS areas within conceptual design coordinates;
- review of previous ASS assessments within the Port Hedland area;
- site inspection by qualified personnel;
- collation and assessment of this information in relation to potential ASS risk; and
- preparation of a report describing the above findings.

The desktop assessment and site inspection were undertaken in accordance with guidelines presented in DEC (2009a) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*. Potential ASS disturbance associated with any project dredging within the Port Hedland Inner Harbour is beyond the scope of this report. It is understood that dredging related ASS risks will be addressed separately through Port Hedland Port Authority-led approvals (Coffey, 2010a).

2 ACID SULFATE SOILS AND POTENTIAL ADVERSE EFFECTS FROM DISTURBANCE

ASS are soils that contain iron sulfides (pyrite). The formation of pyrite requires the presence of iron (naturally available from sediments), sulfur (usually from seawater or sediments of marine origin) and organic matter. ASS is thus formed under specific environmental conditions. When exposed to air due to drainage or disturbance, these soils produce sulfuric acid, potentially releasing quantities of iron, aluminium and heavy metals, which may have detrimental impacts on the natural environment and infrastructure

Pyritic soils of concern on low-lying and coastal lands have mostly formed in the Holocene period, (i.e. 10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils that formed prior to the Holocene period (i.e. >10,000 years ago) would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen. ASS are thus found predominantly in alluvial coastal landforms lying lower than Reduced Level (RL) 5m above Australian Height Datum (AHD), which is approximately the height of the seas during the Holocene period, and they are usually only present in unconsolidated sediments.

When ASS is exposed to air, (that is, no longer in a waterlogged anaerobic state), the iron sulfides in the soil react with oxygen and water to produce a variety of iron compounds and sulfuric acid. Consequently under the anaerobic reducing conditions maintained by permanent groundwater/surface water, the iron sulfides are stable and the surrounding soil pH is often weakly acid to weakly alkaline. Such soils, although potentially considered acidic do not pose a threat to the natural or manmade environment, provided the conditions remain constant.

Therefore ASS can broadly be divided into two broad categories namely actual ASS (AASS), which are soils in which the pyrite has already been oxidised and sulfuric acid is present in the soil, and PASS where the pyrite is present but has not been oxidised. Disturbance of both AASS and PASS have the potential to release acid by;

- the reburial of AASS below the water table; and
- the oxidation of PASS and in-situ PASS (change from an anaerobic to an aerobic environment such as by excavating/dredging the soils or lowering the water table).

The release of acid can cause the degradation of both the environment and infrastructure.

2.1 Environmental Impacts

The main environmental effects of ASS disturbance are changes to surface and groundwater quality, habitat degradation and poor plant productivity. The effects will depend on the natural buffering capacity of the receiving environment and vegetation type.

Water Quality

The release of acid into both the surface and ground waters can significantly reduce the natural buffering capacity of the water lowering pH and dissolve metals into toxic forms (generally pH <3.5).

Habitat degradation

In waterway habitats drainage from AASS and PASS (upon oxidation) has the potential to cause iron precipitation that smothers vegetation and microhabitat.

Poor plant productivity

Potential to cause reduced plant productivity and stunted growth at low soil pH because of the following;

- toxic effects of aluminium, iron and manganese (become more available at low pH);
- deficiency in plant base minerals such as calcium, magnesium and potassium;
- low availability of nutrients;
- increased attacks by plant pathogens due to stressed growing condition;
- decrease in soil microbes, particularly those responsible for nitrogen fixation; and
- stunting of roots producing water stress.

Under strongly acid conditions the activity of important soil micro-organisms is reduced, in particular fungi, bacteria and *actinomycetes*[1]. Nutrient availability is also reduced for the following, nitrogen, phosphorous, potassium, sulfur, calcium, magnesium, boron, copper and zinc and molybdenum. Nutrient availability of aluminium and iron could potentially be increased to potentially toxic levels.

In addition to the potential impacts, identified above, long-term impacts may result in the dying off of some species and colonisation by species more resistant to the acid conditions. For example, the tall swamp grass *Phragmites* is intolerant of highly acid conditions and may be replaced by other species. If surface water remains acidic over time, nutrient cycling will be reduced because of the reduced activity of soil micro-organisms which are normally concentrated in the topsoil.

2.2 Infrastructure Impacts

The potential impacts of any free acid on infrastructure may be severe. The uncontrolled release of acid from AASS and/or disturbed PASS can corrode infrastructure and building elements made of concrete and iron. Historically acidic conditions, associated with ASS have contributed to the failure of bridges, culverts and other structures.

[1] Anaerobic bacteria noted for a filamentous and branching growth pattern, found in soil profiles. It is often considered as an important pathogen contributing to ecosystem function particularly with respect to the decomposition of organic materials

3 SITE IDENTIFICATION

Project area identification details are summarised in Table A.

TABLE A
SITE IDENTIFICATION DETAILS

Site Name	Multi-user Iron Ore Export Facility (Project Area)	
Site Address	Project Area – Shown on Figure 2.	
Coordinates of Site Boundary (WGS84 and Zone 50)	The coordinates of the site boundary are shown on Figure 3. The points listed below are at the outermost point within the project area in each direction.	
	North	Northing 7751302 Easting 661653 (Point 2, Figure 3)
	West	Northing 7747166 Easting 654662 (Point 4, Figure 3)
	South-East	Northing 7722440 Easting 673173 (Point 12, Figure 3)
Lots / Plans	The study area encompasses the lots listed below on the following plans, as seen on Figure 2: • Lot 47 on Plan 241374; • Lot 65 on Plan 048920; • Lot 173 on Plan 186111; • Lot 202 on Plan 220389. • Lot 203 on Plan 220594; • Lot 265 on Plan 193736; • Lot 273 on Plan 219540; • Lot 279 on Plan 193734; • Lot 280 on Plan 193734; • Lot 311 on Plan 194620; • Lot 323 on Plan 220768; • Lot 324 on Plan 220768; • Lot 370 on Plan 035619; and • Lot 372 on Plan 035620.	
Size of Project Area	Approximately 6,855ha.	

TABLE A
SITE IDENTIFICATION DETAILS (CONT'D)

Project Area Occupiers	Primary occupiers (lease holders and mining entitlements) are listed below and shown in Figure 2: • Port Hedland Port Authority (PHPA); • various BHP Billiton entities; • Atlas Iron Ltd; • Boral Resources (WA) Ltd; • Croydon Gold Pty Ltd; • CSR Ltd; • Ferro Metals Australia Pty Ltd; • Fortescue Metals Group Ltd; • The Pilbara Infrastructure Pty Ltd; and • Young, Bradford John.

4 PROJECT DESCRIPTION

It is understood that the NWI are in the process of formalising its preferred design for the proposed Multi-user Iron Ore Export Facility including in-loading, stockyard, out-loading and other infrastructure. It is recognised the design information provided in the Draft Definitive Feasibility Study Report (SKM 2011) is not final and therefore the actual development layout may differ. In the context of this preliminary ASS investigation, major project components according to SKM 2011 are summarised below. Figure 4 depicts the proposed development within the northern portion of the project area, which is where all development will take place aside from a rail spur.

Rail Spur

- A 26km rail spur to a third party railway is proposed in the southern portion of the project area.
- Excavations are not proposed for the rail spur, instead the area will be built up with approximately 2.48Mm^3 of fill material (includes the rail loop).

Rail Loop Northern Area

- A 10km rail loop and adjacent access road will be constructed within the northern portion of the project area with an indicative disturbance area of 38 hectares (ha).
- Excavations are not proposed for the rail loop, instead the area will be built up to approximately 8mAHD.

Car Dumping Facility

- The car dumping facility will be installed in the northern portion of the project area with an indicative disturbance area of 2ha.
- With an excavation depth of approximately 17m below ground level (mbgl) and bulk earthwork cut volume of 187,000m^3, the car dumper will be installed below the water table and will require dewatering over the estimated nine months of excavation and construction works. Dewatering is expected to be required at depths beyond 3mbgl.

Stockyard Area

- The stockyard area is located in the northern portion of the project area with an indicative disturbance area of 93ha.
- The stockyard area will be built up to approximately 8mAHD. However some excavation of this area, with an estimated bulk cut volume of 1,070,058m^3, is anticipated due the geotechnical qualities of the underlying soils.

Wharf Area

- The wharf area, located in the northern-most portion of the project area, will be cleared and dredged as part of the Port Hedland Port Authority-led approvals with an estimated dredge volume of 3,626,854m^3. Pile drivers will be used to drive steel piles into the ground after which a concrete and steel deck, conveyor ship loader and service access road will be constructed to form the wharf.
- The proposed invert of each pile is dependent on the depth to basement rock and total dredging depth at each location. Currently dredging in likely to occur to -19m chart datum (CD) while basement rock exists from approximately -50mCD.

Conveyor Corridor

- A 5.8km long and 40m wide conveyor corridor will be constructed between the stockyard and wharf comprising an indicative disturbance area of 26ha and bulk excavation cut volume of 1,274m^3. The conveyor will be constructed on an 8mAHD high earth causeway over tidal flats and minor creeks and on trestles over major tidal creeks, i.e. Salmon Creek.
- Culverts will be installed beneath the earth causeway to minimise tidal flow and flood drainage impacts. Proposed culvert invert levels are approximately 3mAHD.

At the time of reporting, no information was available in relation to the quality, rates or volume of groundwater effluent that may be generated through dewatering of the car dumping facility or to fulfil construction process water requirements (if applicable). It is understood that long-term project water supply requirements are likely to be in the order of 1.8GL per annum (Coffey, 2010a). It is understood the water supply source is currently being investigated and will be the subject of a separate referral to the Office of Environmental Protection Authority (OEPA).

5 ENVIRONMENTAL SETTING

5.1 Land Use and Vegetation

At its closest, the project is approximately 3km to the southwest of the town of Port Hedland, 8km to the west of the residential area of South Hedland and 8km to the west of the industrial area of Wedgefield. The project is in close proximity to BHP Billiton Iron Ore's Hot Briquetted Iron (HBI) plant and the Port Hedland Port Authority managed area for port-related purposes. A portion of the project is located on Boodarie Pastoral Station, which is owned by BHP Billiton Iron Ore.

The vegetation fringing Port Hedland Harbour is comprised of various mangrove communities. At higher elevations, the port area vegetation is comprised of mixed salt tolerant shrubs and grasses interspersed with areas of algal mats. Further inland, the vegetation changes to a scrubland/grassland mosaic (Biota, 2004). Further detail of the local vegetation communities is presented in Coffey (2010b).

5.2 Topography and Hydrology

The topography of the Port Hedland area is predominately influenced by the Abydos Plain which rises from the coastal lowlands to around 300m – 400m above the mean sea level adjacent to the Chichester Range (van Vreeswyk *et al*. 2004; BHPBIO 2008a).

On the Abydos Plain, the rail corridor crosses the Port Hedland Area Catchment and the Turner River Catchment. Part of the project intersects the Turner River proclaimed priority 1 public drinking water source area (PDWSA) (DoW, website accessed 20 April 2011). In common with most Pilbara catchments, these catchments contain ephemeral drainages, which only flow following rainfall events, with the exception of isolated springs and pools (Environ 2004). For the remainder of the year, these creeks are not water logged and become completely dry (BHPBIO 2008a), and therefore an unlikely source of PASS.

5.3 Geology

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 Hamersley Basin, a Late Archean volcanic sedimentary sequence characterised as basal basic lavas overlain with clastic sedimentary sequences and banded iron formations. Quaternary sedimentary units overlay the tertiary deposits of the Hamersley Basin. The Quaternary sediments of the Pleistocene epoch are generally identified as clastic rocks forming sedimented clayey sandstones and conglomerates (BHPBIO 2008a).

5.4 Hydrogeology

Located within the northern vicinity of the project area, groundwater levels are in close proximity to the surface and have a recorded salinity level ranging from 400mg/L to 8,000mg/L total dissolved solids (TDS) (Environ 2004).

Groundwater monitoring from the BHPBIO Boodarie HBI Ore Plant shows that depth to groundwater at that location is approximately 3.5m but varies seasonally by up to 2m, with groundwater elevations peaking in April. The pH of groundwater across this BHPBIO Dredged Material Management Area A site, located adjacent to the northern boundary of the project, ranged from approximately 6.7 to 8.4 (BHPBIO 2008a). Based on previous studies nearby (see Section 7) and the presence of the nearby

estuarine environment, groundwater beneath the northern portion of the project area where majority of development will take place is expected to have a neutral pH and high alkalinity.

Part of the project intersects the proposed PDWSA boundary expansion of the Turner River aquifer, which is currently being assessed by the Department of Water (DoW) for the Pilbara Groundwater Plan (DoW, website accessed 20 April 2011). Port Hedland and South Hedland are supplied with drinking water from the Yule River well-field that is located 45km to the east of Port Hedland (BHPBIO 2008a).

6 ASS RISK MAPPING

Based on the published mapping (DEC 2010) approximately 895ha of the project is described as having a potentially high to moderate risk of ASS, while approximately 45ha is considered moderate to low risk of ASS within 3m of the natural soil surface (Figure 5). The DEC risk map for the entire project area is presented in Figure 6, and indicates the remainder of the project has no known ASS risk (approximately 6855ha).

The risk mapping for ASS is considered consistent with the published geological mapping, as ASS is generally associated with areas where organic material has accumulated in a saturated, anoxic environment, allowing the formation of sulfide minerals which can subsequently release acidity when oxidised. Accordingly, it would be expected that the relatively small northern portion of the project area (<14% of the total project area) would be at a high to moderate risk of ASS occurring as it is within the low-lying, waterlogged Holocene deposits associated with mangrove environments of Port Hedland (Paling 2002; DSE 2010).

PASS are likely to occur within the surficial marine sediments (top 1 to 2m) of Port Hedland Harbour. Although identified, the presence of PASS within marine sediments of Port Hedland harbour, relative to dredging operations, is beyond the scope of this report.

7 PREVIOUS INVESTIGATIONS

There have been numerous baseline studies of the general environmental characteristics within the Port Hedland area. Table B provides a summary of known ASS investigations that have been undertaken within or near the project area. However, to date there have been no known intrusive ASS investigations within the project area.

TABLE B: SUMMARY OF NEARBY ACID SULFATE SOILS INVESTIGATIONS

Reference	Location	Focus of survey	Outcomes
BHPBIO (2009)	Nelson Point, Port Hedland	Determine the extent of PASS. Develop management measures and contingency plans to minimise impact.	The impact of PASS can be minimised; material will remain saturated during transport. Two dredge spoil areas were to be established. No AASS were identified in any of the samples analysed across the proposed dredge footprint.
Paling, E.I. 2002.	Borrow Area A, Port Hedland	Assessment of issues relating to ASS at Port Hedland, for Hope Downs Management Services Pty Ltd	Several areas of PASS impacts could have arisen. Tests show soil is not acid producing, and therefore the disturbance, removal and placement of material will not cause an impact in terms of acid soils. Suggests there was no requirement for ASSMP.
BHPBIO (2008b)	Harriet Point, Port Hedland	Dredging methods, handling of dredged materials and disposal options for PASS.	No AASS were detected in sediment samples. PASS was limited to the upper 2m of the seabed in 18m bore samples taken at the footprint of the dredge operations.
Coffey (2010b)	Finucane Island, Port Hedland	Excavation of ASS material in relation to the development of a car dumper facility on Finucane Island on behalf of BHP Billiton Iron Ore.	The ASS requiring management was determined to be soil beneath the Dune Sands unit, and above the Calcareous Clay/Gravel unit (i.e. largely the Mangrove Mud horizon and interbedded horizons). Management measures to be implemented were outlined.

8 SITE INSPECTION

'Step 1: Desktop Assessment and Site Inspection' of DEC (2009a) *Acid Sulfate Soils Guideline Series: Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes* suggests that in all cases, a site inspection should be undertaken to support the findings of the desktop assessment. The site inspection should include, as a minimum:

- Visual assessment of topography and geomorphology;
- Visual assessment of surface water and hydrology;
- Visual assessment of prevalent plant communities; and
- Examination of surface soils and the soil profile.

Due to the conceptual nature of the proposed development and large project area, examination of the sub-surface soil profile did not form part of the site inspection. The site inspection field notes can be found in Appendix A and the site walkover locations are shown in Figure 7. Site observations relevant to ASS are summarised as follows:

- Vegetation in the project area generally ranges from grasses and shrubland across the southern two thirds of the project (see Plate 1 and Plate 2) to salt and/or waterlogging tolerant vegetation such as mangroves and salt marsh (see Plate 3 and Plate 4) in the northern third of the site.
- With the exception of vegetation that had been recently burnt, vegetation appeared to be healthy and did not show any signs of stress. The absence of vegetation in some bare low-lying areas (see Plate 5) is attributed to excessive salinity rather than evidence of AASS.
- An inspection of creeks found in the northern portion of the project area found the creeks to be muddy brown and typical of the local estuarine environment (Plate 3). No evidence of PASS or AASS such as extensive iron staining, unusually clear or milky blue-green water, oily looking iron bacteria scum, was noted.
- Soils in the northern portion of the site that are nearby to the estuarine system were found to low lying, waterlogged, dark-brown in colour (see Plate 6) and geologically recent (i.e. inter tidal sediments). No evidence of AASS was noted such as sulfurous odours, corroded shell, jarosite deposits, or iron oxide mottling in surface encrustations.

In summary, the site inspection indicated the northern portion of the site, where the majority of infrastructure under the proposed development (Section 4) will be constructed, is highly likely to contain PASS. This conclusion is consistent with DEC ASS risk mapping for the area.

9 DISCUSSION

The preliminary ASS investigation has confirmed that the northern portion of the project area is highly likely to contain PASS. This conclusion is based on geomorphology and vegetation indicators noted during the site walkover together with published ASS risk mapping and environmental studies completed nearby. No evidence of PASS was identified in the southern two thirds of the project area however it is considered possible, albeit unlikely, that PASS could be present along low lying land such as dry creek beds that exist in this area. Where PASS is present it is likely that its presence is strongly lithologically dependent, with previous intrusive studies nearby (Coffey, 2010b) indicating a strong correlation between mangrove mud horizons and the presence of PASS.

The relationship between PASS and the proposed Multi-user Iron Ore Export Facility has been assessed and it is apparent that the majority of infrastructure will be positioned within the northern portion of the project area and therefore likely to interact with PASS. For the most part, the proposed development entails filling and above ground construction, such as the proposed 26km rail spur, the 10km rail loop and the 5.8km coveyor corridor, and design elements do appear to be sensitive to minimising environmental impact (i.e. culverts along drainage channels and trestles for larger creeks). However, the SKM (2011) Definitive Feasibility Study estimates that volumes of soil that will be excavated (in excess of 1,000,000m^3) and the area of land that will be disturbed (excess of 100ha) will be significant to enable construction of the proposed car dumping facility, stockyard area and wharf area. These bulk earthwork estimates do not necessarily translate to equivalent PASS disturbance volumes since PASS may only be present within certain horizons or locations even within the higher risk northern portion of the project area.

Groundwater within the northern portion of the project area is likely to be relatively shallow and in the order of 3mbgl within the footprint of the proposed car dumping facility (Coffey, 2010a). Since construction of the car dumping facility will necessitate groundwater dewatering to at least 12mbgl and soils are likely to unconsolidated, the proposed development has the potential to create a significant of cone of depression in this area. Although an intrusive groundwater investigation did not form part of this preliminary assessment, it is possible that groundwater within the northern portion of the site may inherently contain high acid buffering capacity where there is a hydraulic connection with the nearby estuarine environment.

In summary, bulk earthworks and groundwater dewatering associated with the proposed development within the northern portion of the project area has the potential to result in the generation of ASS which could be detrimental to the nearby estuarine environment, vegetation, and proposed infrastructure. The proposed development is not considered a sensitive landuse (i.e. residential) and therefore potential risks to human health within the project area as a result of PASS disturbance are considered low. Human health risks could hypothetically arise however through indirect exposure, such as via recreational activities in nearby surface waters that become acidified and contaminated. Depending on any inherent acid buffering capacity within groundwater, disturbance of ASS may also acidify groundwater resulting in unnaturally high metal concentrations such as iron, aluminium and arsenic. Where the disturbance of ASS results in a risk to the environment or human health, such areas may be classified by the DEC as contaminated under provisions of the *Contaminated Sites Act (2003)*.

Based on the above findings, in particular the low risk of PASS together with the low level of disturbance across the southern two thirds of the project area, it is considered appropriate to develop a risk-based approach in designing the scope of intrusive investigations for the project. A risk-based

approach is commonly adopted when characterising large sites (i.e. >20ha) and, in accordance with DEC (2009a), such an approach may be acceptable providing the investigation program is designed to satisfactorily characterise the various geological/geomorphological units that exist within the project area.

10 CONCLUSIONS AND RECOMMEDATIONS

10.1 Conclusions

Coffey were commissioned by NWI to undertake a preliminary investigation into the potential presence of ASS that may be encountered as part of the proposed Multi-user Iron Ore Export Facility Project (the project), located approximately 3km south-east of Port Hedland and 1,700km north of the city of Perth. The preliminary investigation entailed a desktop assessment together with a site inspection and is designed to satisfy 'Step 1: Desktop Assessment and Site Inspection' of DEC (2009a) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*. No intrusive investigations were performed.

This report has been produced to inform the scoping of a detailed intrusive ASS investigation by taking into account where PASS is likely to be encountered in the project area and how the proposed development may interact with the presence of PASS. This report has been produced in support of the clients' project assessment under the *Environmental Protection Act 1986.*

The findings of the preliminary ASS investigation are as follows:

- The preliminary ASS investigation has confirmed that the northern portion of the project area is highly likely to contain PASS. This conclusion is based on geomorphology and vegetation indicators noted during the site walkover together with published ASS risk mapping and environmental studies completed nearby. No evidence of PASS was identified in the southern two thirds of the project area however it is considered possible that PASS could be present along low-lying land such as dry creek beds that are present. Where PASS is present in the local area, it is likely that its presence is strongly lithologically dependent, with previous intrusive studies nearby indicating a strong correlation between mangrove mud horizons and the presence of PASS.
- The relationship between PASS and the proposed Multi-user Iron Ore Export Facility has been assessed and it is apparent that the majority of infrastructure will fall within the northern portion of the project area and therefore likely to interact with PASS. The construction of a proposed car dumping facility, stockyard area and wharf area will require ground disturbance with in excess of 1,000,000m^3 of material to be excavated over an area of more than 100ha. These bulk earthwork estimates do not necessarily equate to PASS disturbance since PASS may only be present within certain horizons or locations even within the higher risk northern portion of the project area.
- Groundwater within the northern portion of the project area is likely to be relatively shallow within the footprint of the proposed car dumping facility and therefore it is anticipated that groundwater dewatering will be necessary during construction. Although an intrusive groundwater investigation did not form part of this preliminary assessment, it is possible that groundwater within the northern portion of the site may inherently contain high acid buffering capacity where there is a hydraulic connection with the nearby estuarine environment.
- The proposed development has the potential to result in the generation of ASS which could be detrimental to the nearby estuarine environment, vegetation, and proposed infrastructure. Depending on any inherent acid buffering capacity within groundwater, disturbance of ASS may also acidify groundwater resulting in unnaturally high metal concentrations such as arsenic and aluminium. Where the disturbance of ASS results in a risk to the environment or human health, such areas may be classified by the DEC as contaminated under provisions of the *Contaminated Sites Act (2003)*.

10.2 Recommendations

In order to ensure that potential ASS risks are adequately assessed the following recommendations should be implemented:

- A risk-based intrusive ASS investigation should be undertaken within the project area and should be designed to satisfactorily characterise the various geological/geomorphological units. Investigations should be tailored towards areas where PASS is mostly likely to exist and/or areas where ground disturbance is greatest such as the northern portion of the project and in particular the proposed car dumping facility, stockyard area and wharf area. Some ASS investigation within the southern two thirds of the project is considered prudent to ensure good spatial coverage and geological/geomorphological characterisation.
- Intrusive groundwater assessment should form part of the detailed investigation works. As a minimum, groundwater bores should be positioned in the surrounds of the proposed car dumping facility, where deep excavation and groundwater dewatering is proposed, to assess baseline groundwater quality and the vulnerability of groundwater to acidification. The scope of groundwater assessment should also include the collection of site-specific hydrogeological parameters to assist in accurate modelling of dewatering cone of depression and, in turn, predicting any associated impacts.

The above risk-based intrusive investigations should be designed in line with the intent of the DEC ASS Guideline Series. It is recommended that a Sampling and Analysis Plan (SAP) is developed to formalise the proposed investigation works and that agreement is sought from the DEC where specific sampling and analysis frequency deviations from DEC ASS Guideline Series are proposed.

11 REFERENCES

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12 STATEMENT OF LIMITATIONS

(please refer over the page)

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SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

Important information about Coffey Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change Interpretation of factual data

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

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Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Plates

Preliminary ASS Investigation
NWI Multi User Iron Ore Export Facility

Preliminary (Non-Intrusive) ASS Investigation
NWI - Plates

Plate 1: Looking west from FMG rail line at low-lying shrubland in southern inland portion of project area (photo 217)

Plate 2: Looking west off Boodarie Station Access Road at open grassland with evidence of fire in background (photo 43)

Preliminary (Non-Intrusive) ASS Investigation
NWI - Plates

Plate 3: Creek with fringing mangrove communities within northern portion of project area (photo 129)

Plate 4: Salt marsh vegetation within northern portion of project area (photo 96)

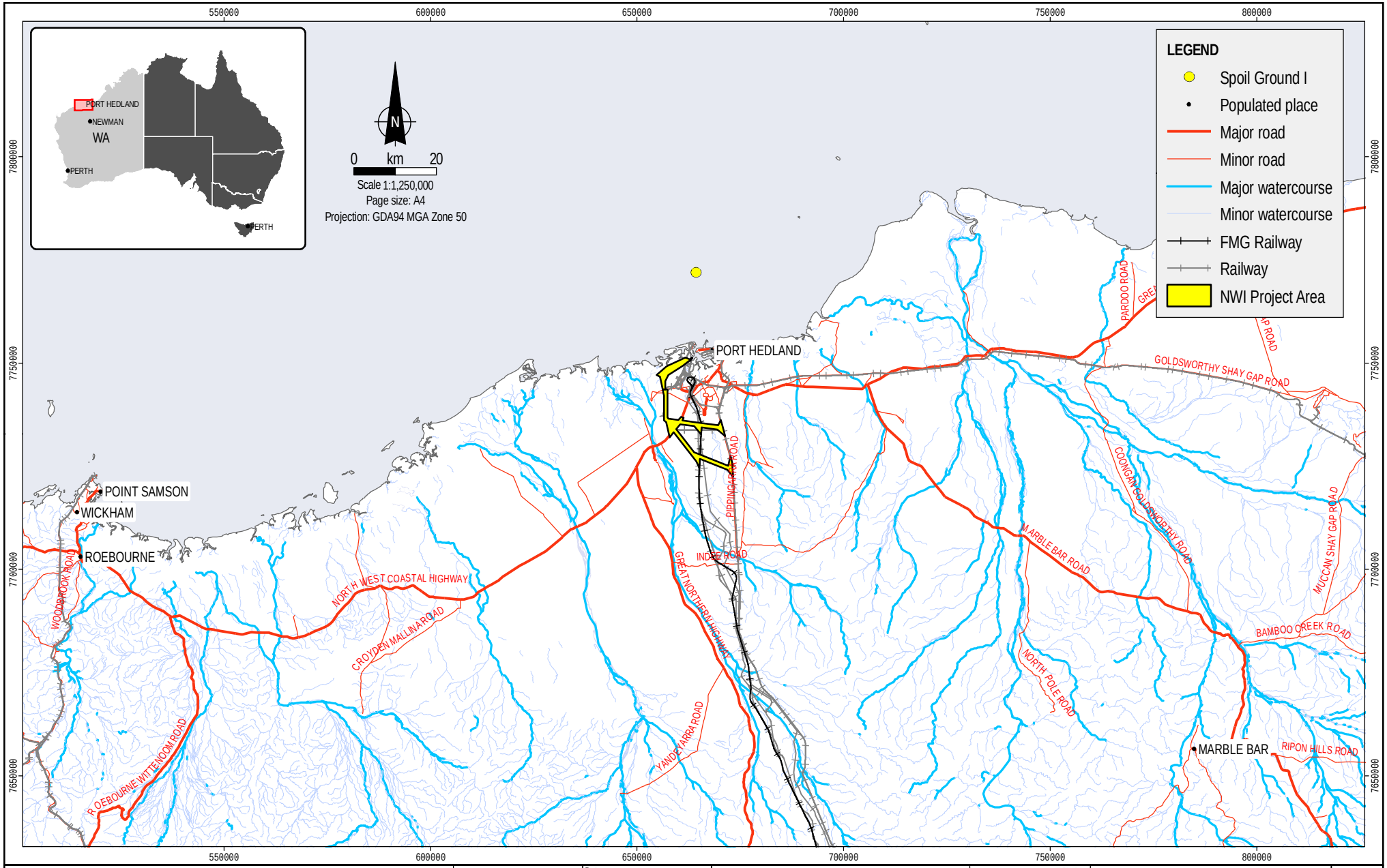
Preliminary (Non-Intrusive) ASS Investigation
NWI - Plates

Plate 5: Looking west at flood and salt plains that exist over the landscape of the project area (photo 92)

Plate 6: Looking east at mining infrastructure surrounding the project area in the north of the project area with fringing mangrove communities (photo 241)

Figures

Preliminary ASS Investigation
NWI Multi User Iron Ore Export Facility



Source:
Roads, rivers, rail and populated places from GEODATA TOPO 250K (optimum scale 1:250,000)
NWI study area (updated by Coffey 07.01.2011) and railways from SKM

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Date: 01.03.2011
MXD: 2319AA_EP2010239_GIS003_v0_4
File Name: 2319AA_EP2010239_F001_GIS

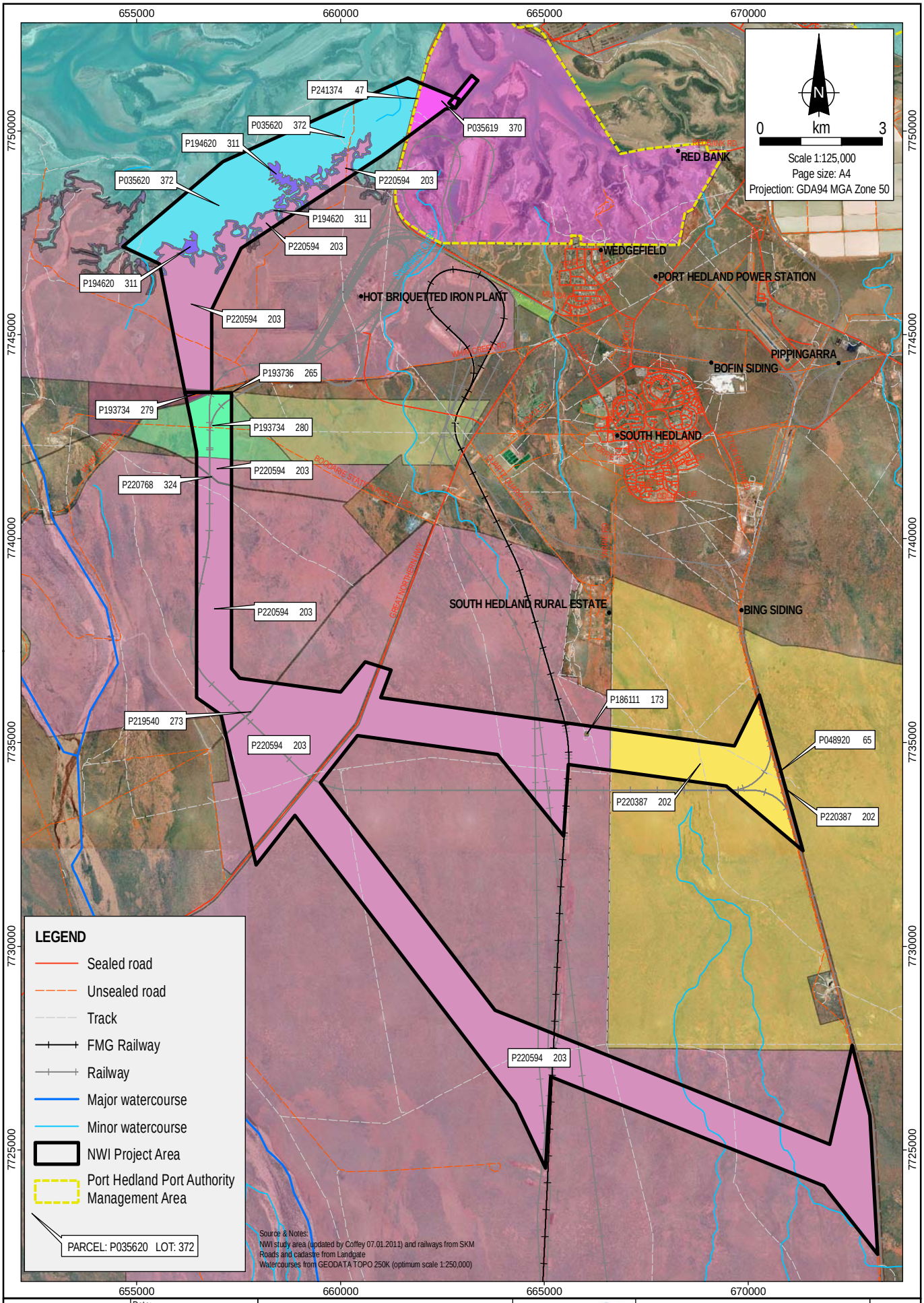
North West Infrastructure

Acid Sulfate Soils Investigation

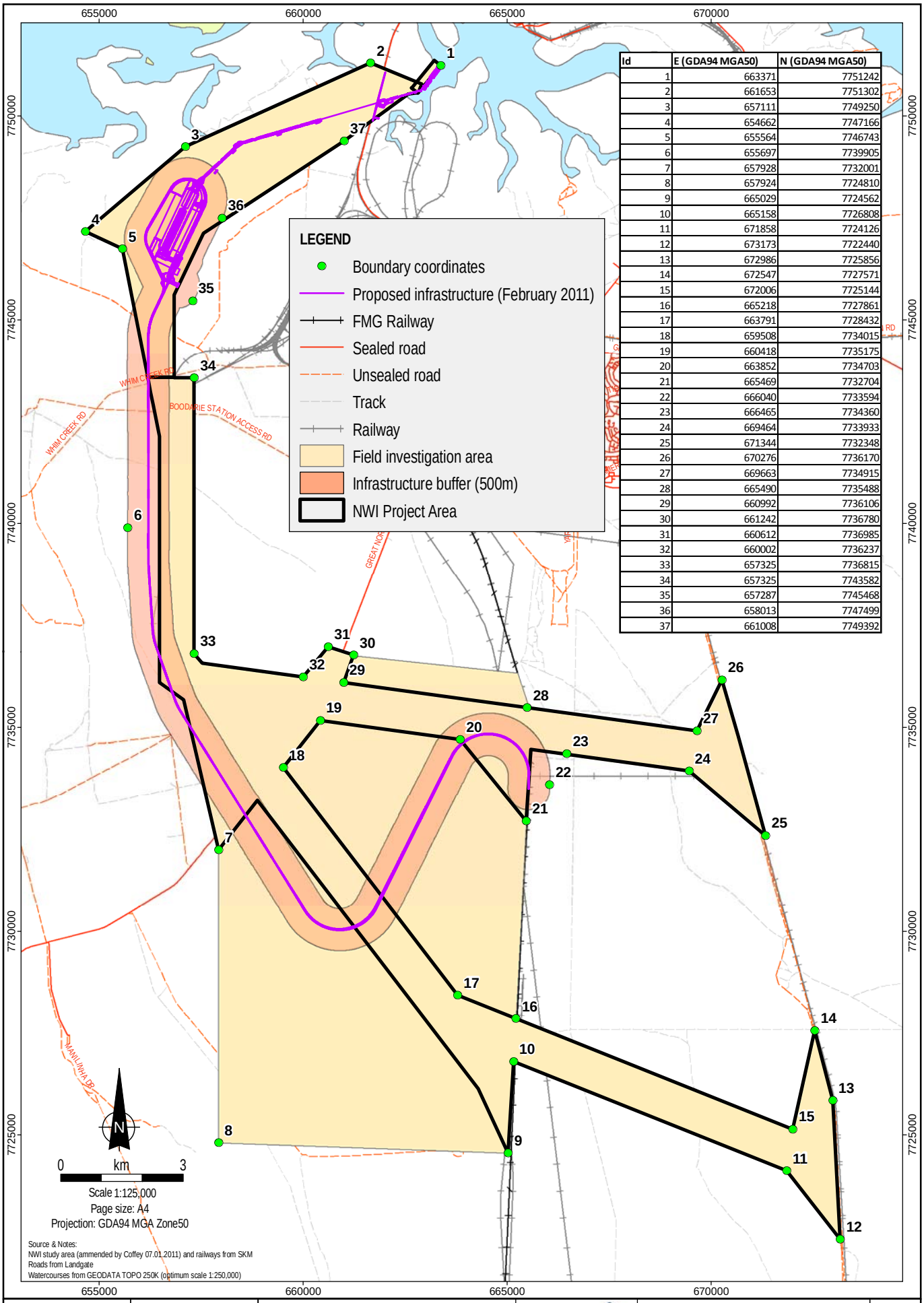
North West Infrastructure

Regional Location

Figure No: 1



coffey environments	Date: 01.03.2011 MXD: 2319AA_EP2010239_GIS001_v0_2 File Name: 2319AA_EP2010239_F002_GIS	North West Infrastructure Acid Sulfate Soils Investigation	North West Infrastructure	Project Area Layout	Figure No: 2



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2	661653	7751302
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4	654662	7747166
5	655564	7746743
6	655697	7739905
7	657928	7732001
8	657924	7724810
9	665029	7724562
10	665158	7726808
11	671858	7724126
12	673173	7722440
13	672986	7725856
14	672547	7727571
15	672006	7725144
16	665218	7727861
17	663791	7728432
18	659508	7734015
19	660418	7735175
20	663852	7734703
21	665469	7732704
22	666040	7733594
23	666465	7734360
24	669464	7733933
25	671344	7732348
26	670276	7736170
27	669663	7734915
28	665490	7735488
29	660992	7736106
30	661242	7736780
31	660612	7736985
32	660002	7736237
33	657325	7736815
34	657325	7743582
35	657287	7745468
36	658013	7747499
37	661008	7749392

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Date: 01.03.2011
MXD: 2319AA_EP2010239_GIS005_v0_3
File Name: 2319AA_EP2010239_F003_GIS

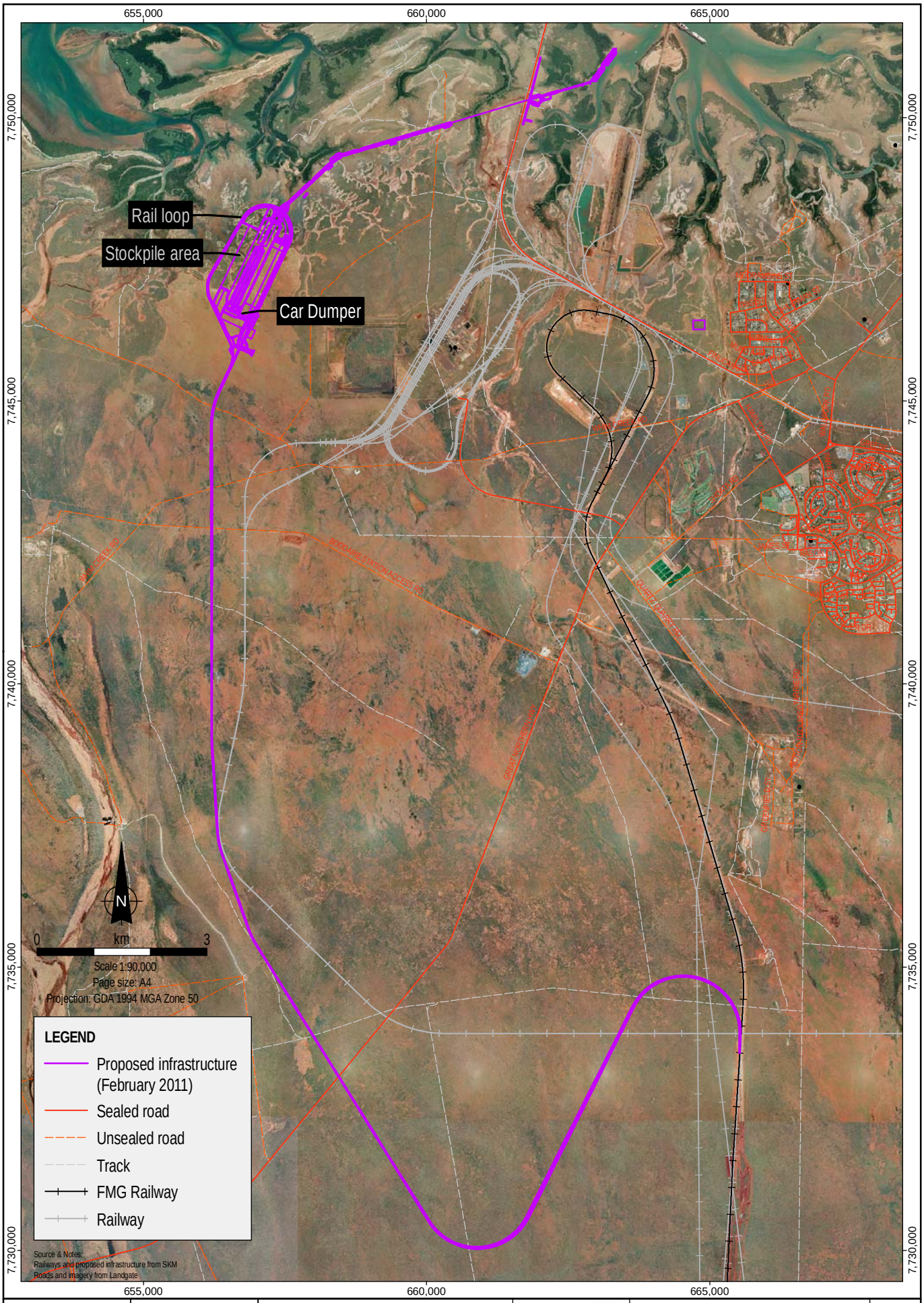
North West Infrastructure

Acid Sulfate Soils Investigation

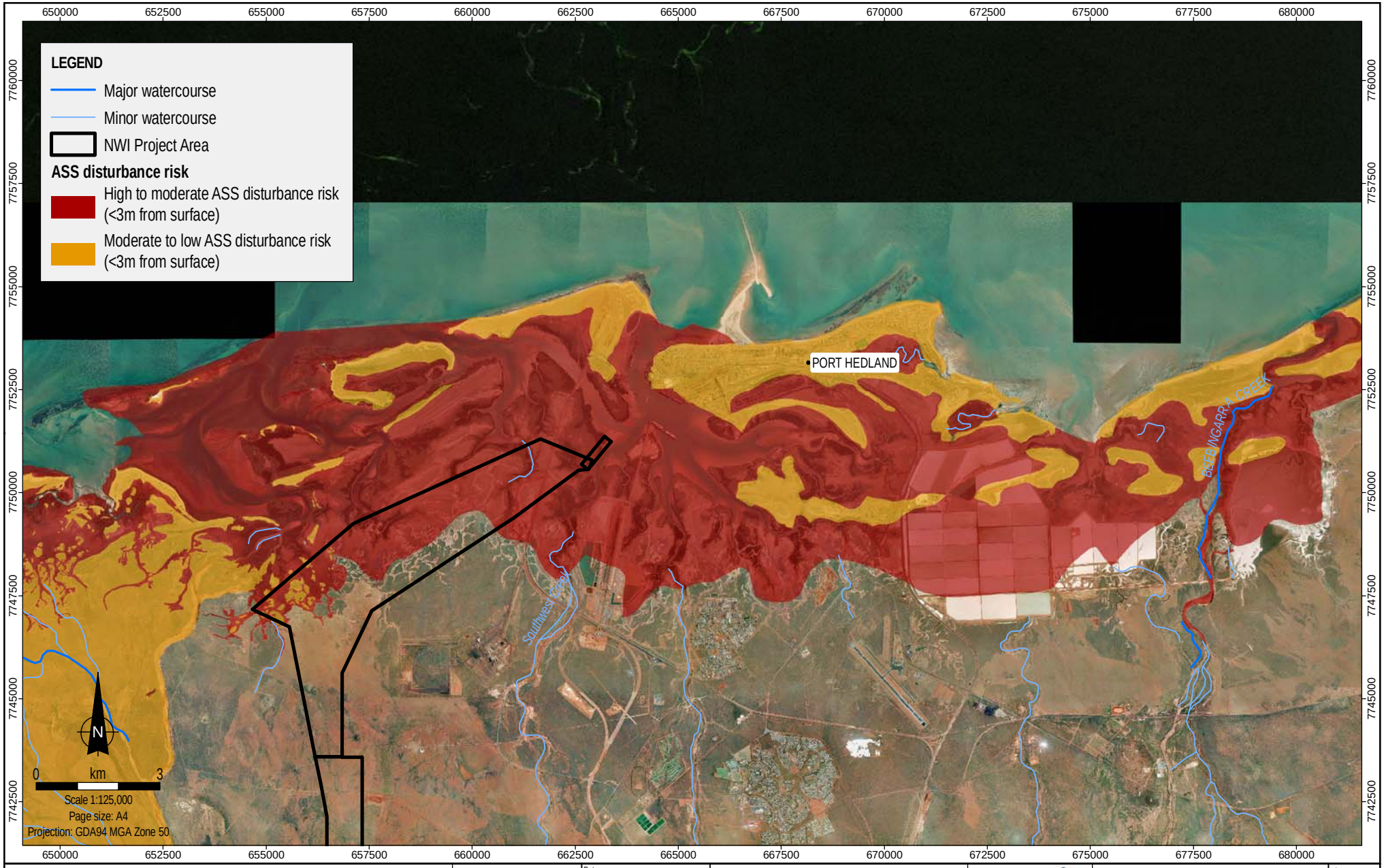
North West Infrastructure

Project Coordinates (Eastings and Northings)

Figure No: 3



coffey environments	Date: 21.04.2011 MXD: 2319AA_EP2010239_GIS009_v0_1 File Name: 2319AA_EP2010239_F004_GIS	North West Infrastructure Acid Sulfate Soils Investigation	North West Infrastructure	Proposed Development Layout	Figure No: 4



Source:
Roads and imagery from Landgate
Railways and NWI study area (updated by Coffey 07.01.2011) from SKM
Watercourses from GEODATA TOPO 250K (optimum scale 1:250,000)
Acid Sulfate Soil data from DEC

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Date: 01.03.2011
MXD: 2319AA_EP2010239_GIS002_v0_6
File Name: 2319AA_EP2010239_F005_GIS

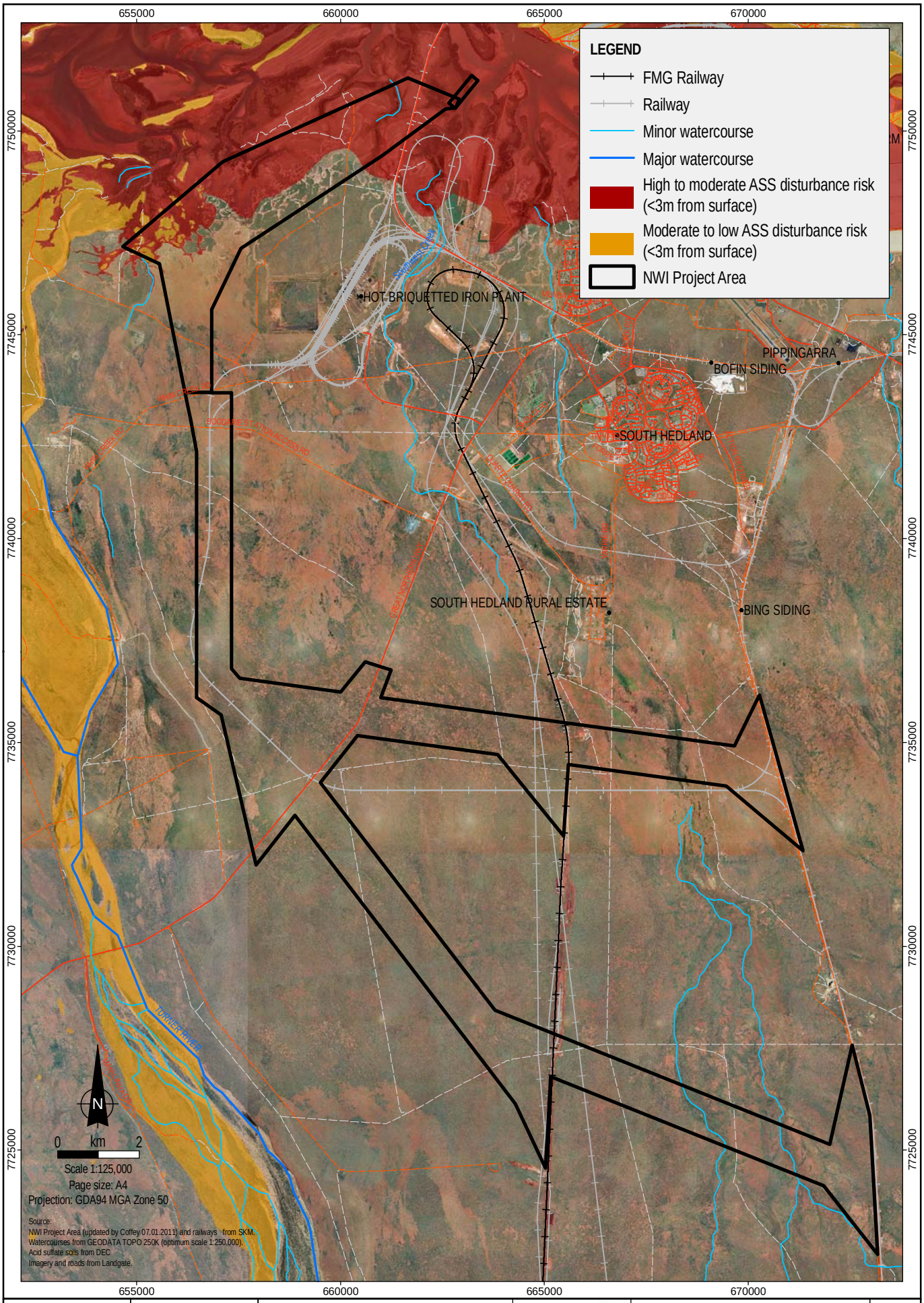
North West Infrastructure

Acid Sulfate Soils Investigation

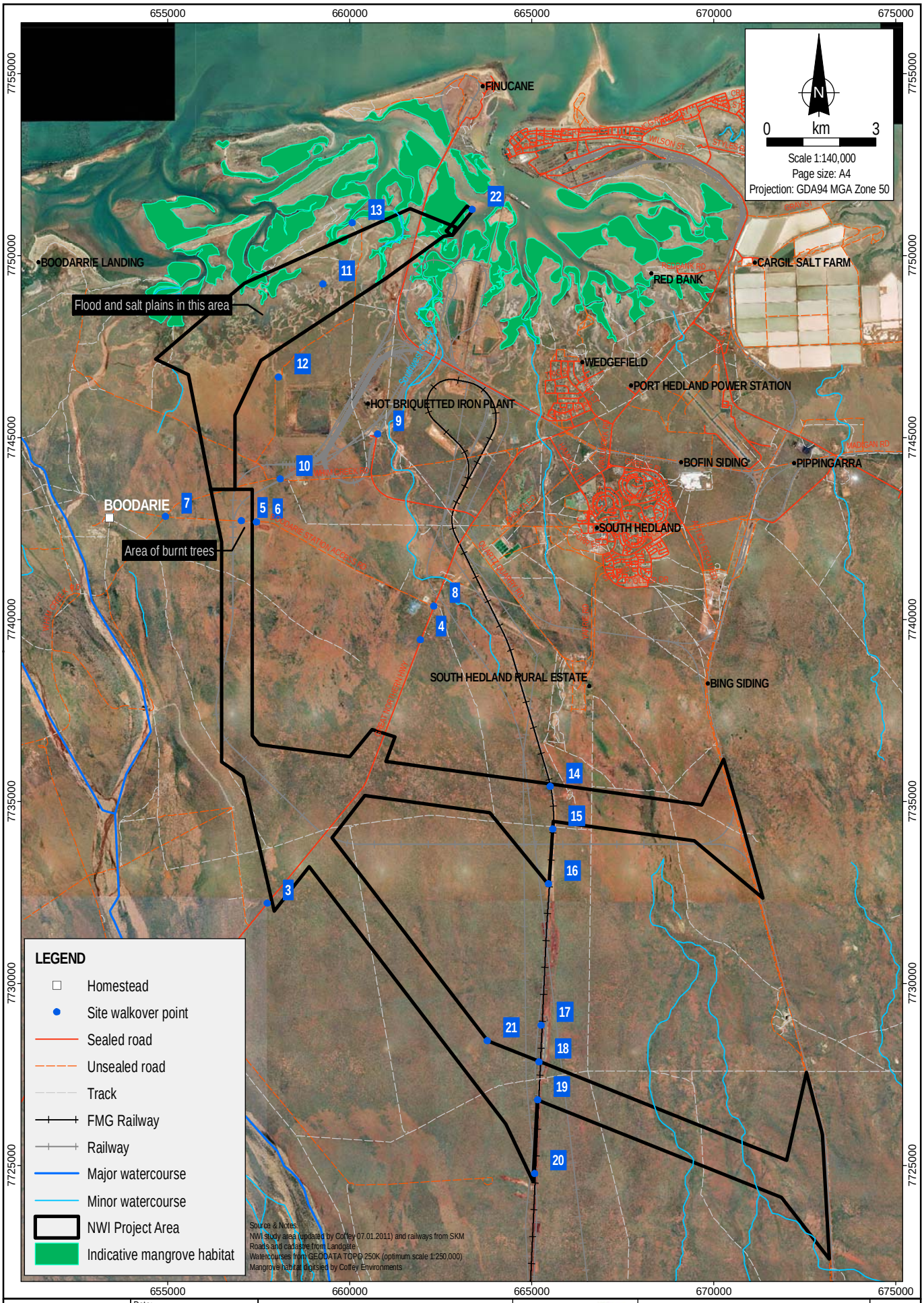
North West Infrastructure

Acid Sulfate Soils Risk Map DEC (Northern Portion of Project Area)

Figure No: 5



coffey environments	Date: 21.04.2011 MXT: 2139AA_EP2010239_GIS004_v0_2 File Name: 2139AA_EP2010239_F006_GIS	North West Infrastructure Acid Sulfate Soils Investigation	North West Infrastructure	Acid Sulfate Soils Risk Map DEC (Balance of Project Area)	Figure No: 6



coffey environments

Date: 21.04.2011
MXD: 2319AA_EP2010239_GIS008_v0_2
File Name: 2319AA_EP2010239_F007_GIS

North West Infrastructure

Acid Sulfate Soils Investigation

North West Infrastructure

Site Inspection Locations

Figure No: 7

Appendix A
Site Inspection Field Notes and Photo Register (CD)

Preliminary ASS Investigation
NWI Multi User Iron Ore Export Facility

Site Walkover Field notes – Proposed Multi-User Iron Ore Export Facility

Project No.: ENAUPERT02319AA ***Date: 16/01/2011***

1 – E: 0651224 N: 7727231 – Near NW20 or 18

- 8kms south of point 7
- Vegetation – low shrubs, taller trees closer to the road – 2m high.
- Conducting road works
- No contamination or contaminating activities (c/ca) noted.

2 - Turner River

- Dry, small, sparse shrubs growing.

3 - E: 0657730 N: 7732210 – Near NW10

- 200m west of point 7
- Stockyards, trucks going in and out
- Low shrubs, dense, healthy, not a lot of sand/space in between vegetation.

4 - E: 0661936 N: 7739456 – Near NW19

- 2km north east point 31/30
- In truck stop area
- Vegetation as above
- No c/ca noted

5 – E: 0657023 N: 7742718 – NW12

- Near 34 on Boodarie Station Road
- Burnt trees indicated recent fire (photo 43)
- Vegetation low space grass clumps (green), not dense, lots of sand in between.

6 – E: 0657440 N: 7742688 Sand Mine (Boodarie Sand Pit)

- Trucks coming in and out moving natural red sand
- No c/ca noted

7 – Drove to the intersection of Whim Creek Rd & Boodarie Rd. gate locked – no acces.

- Vegetation as per 3, dense in parts further from the track.
- No c/ca noted
- Windmill noted (farmland)

8 – Intersection of Boodarie RD & Great Northern Hwy

- Some sort of factory/industry works
- Truck stop
- Blue metal to stop spills?
- Vegetation dense, green, grass clumps/shrubs

9 – HBI Factory close up surrounded by low shrubs in what appears to be in good condition as per 3.

10 – E: 0658091 N: 7743870 Boodarie Station Coastal RD – Near MW11, near point 34.

- Vegetation same as 3, very dense
- Flood plain

11 – E: 0659266 N: 7749225 Salt plains. Large areas where no vegetation is located, patches of white (salt).

- NW2 – Photos – 92 and 96.
- To the east of 36, where the railway loop will be located.
- Surrounded by shrubbery, not dense, patches of sand/salt in between.

12 – Along track between point 35 and 2, as per figure/map.

Changing landscapes:

- Rocks
- Salt/scrub/marsh
- Mangroves
- Muddy areas
- Sandy areas

13 – E: 0660070 N: 7750906 End of track – Aboriginal Heritage Area

- Shells and rocks cover ground
- Waterway, river, flowing through surrounded by dense, tall, green vegetation (mangroves) near the river.
- No swampy smell, water without oily film, no iron staining, no other evidence of AASS or PASS.
- Photo – 129
- NW14

14 – E: 0665508 N: 7735416 Beginning of NW10A Project Area near FMG Railway p. 28.

- Water in what appears to be a river bed - sign says area prone to flooding.

15 – E: 0665575 N: 7734248 Dry river next to railway – photos 180- 184 NW4.

- Pipes installed under railway to prevent flooding
- Vegetation – prevent around water's edge green, low, sparse and then dense again approximately 5m from river, appears healthy.

16 – p. 21

- Muddy area
- Dry river bed
- Low, dense shrubbery
- FMG trains sitting on tracks

17 – E: 0665255 N: 7728861 – 1km north of p16 – site offices workshops etc.

- Vegetation – sparse near train tracks gets denser the further away they are, green, low lying, few taller "trees" in between.

18– E: 0665205 N: 7727250

- p. 16
- Vegetation – sparse shrubs dense approximately 30m from tracks, some treelike vegetation, mostly bushy.

19-- p.10

- Photo – 217
- Vegetation – same as above (18)
- General low lying shrub area.

20 – E: 0665076 N:7724781

- p. 9
- End if study area near FMG railway line
- Hills, rock feature
- Dense shrubs, some tress
- FMG area (site office?)

21 – Area near p. 17 (off track)

- Photo 217
- Taller bushes - 3m high
- Dense near track

22 – Wharf area p. 1

- Photos 241
- (From Finucane Island access road looking across)
- It was noted that about 15-20 vessels were waiting offshore – probably to come in and be loaded in the harbor.
- No swampy smell noted, no evidence of AASS or PASS.