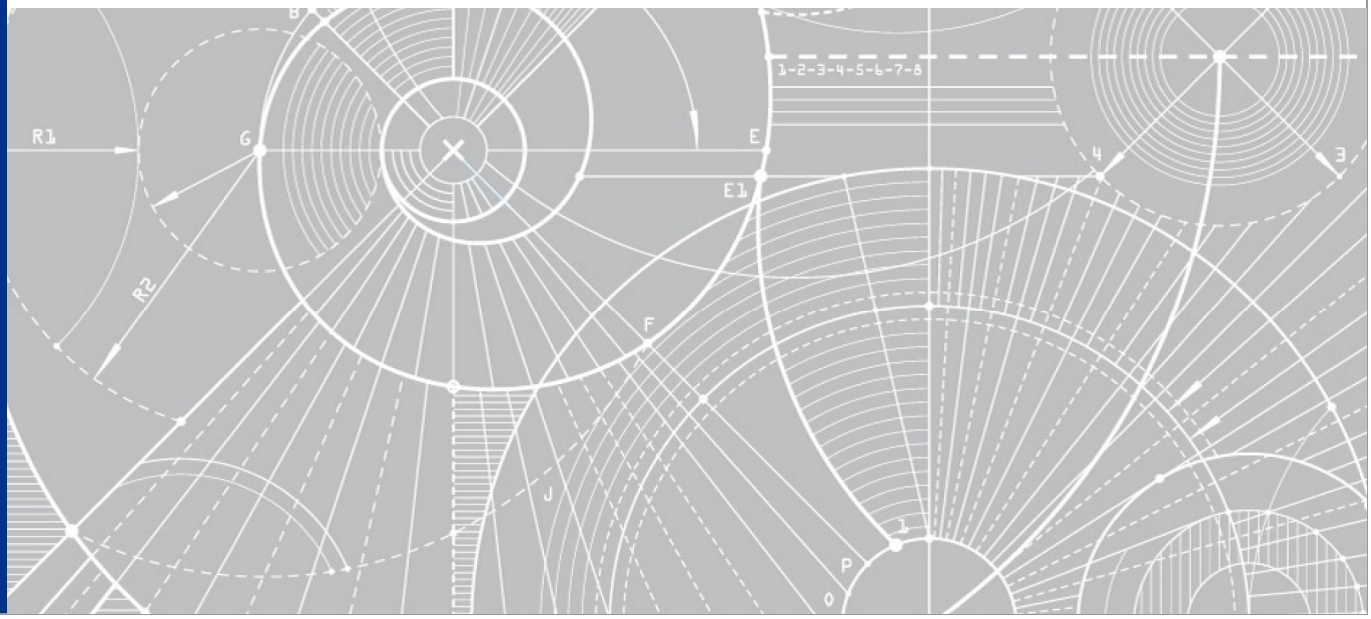
Project Fitzroy

SKIRON OPCO PTY LTD

Western Australian Environmental Protection Act Referral

WV04564-0241 | Revision 0

May 2014



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Document history and status

Revision	Date	Description	By	Review	Approved
A	01.12.2013	Draft for Technical Review	L. Elvidge		
B	04.12.2013	Draft for Practice Review	L. Elvidge	A.de Vos	
C	06.12.2013	Draft for Client Review	A.de Vos	B. Brown	A.de Vos
D	20.02.2014	Draft for Practice Review	L. Elvidge	A de Vos	A.de Vos
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0	20.05.2014	Final	A. de Vos	G. Neylan	A. de Vos

Contents

Executive summary

SKIRON OPCO Pty Ltd (the 'Proponent') is proposing to construct and operate an offshore submarine fibre optic cable network between Port Hedland (Western Australia) and Darwin (Northern Territory) (henceforth referred to as the 'Proposal').

This document provides supporting information to assist the Western Australian Environmental Protection Authority (EPA) in assessing the section 38 referral of the Proposal under the *Environment Protection Act 1986* (WA).

The Proposal involves the installation of approximately 2000 km of fibre optic cable from Port Hedland to Darwin. The Proposal is divided into two stages:

- Stage 1 - Marine route survey to obtain a detailed account of the seabed
- Stage 2 - Installation of the fibre optic cable.

Within WA State territory, the Proposal involves:

- A geophysical & geotechnical survey
- Construction of a landing station onshore at Port Hedland
- A cable beach crossing via Horizontal Directional Drilling (HDD) at Cemetery Beach
- Cable lay

The Key Environmental Factor identified for the Proposal within State waters is Marine Fauna.

Other relevant factors identified for the Proposal include:

- Benthic Habitat
- Water Quality
- Social (Commercial and Recreational Fishing)
- Maritime Archaeology

Potential impacts to turtle nesting from the Horizontal Direction Drilling (HDD) works at Cemetery Beach have been identified as the key risk / uncertainty. The Proponent has mitigated this risk by committing to avoiding HDD work at Cemetery beach during the peak turtle nesting period (January-February). As such impacts to marine fauna are expected to be minimal and with the proposed management measures in place, the EPA management objective for Marine Fauna is expected to be achieved.

The EPA management objectives for all Relevant Environmental Factors are expected to be met via standard management measures.

Important note about this report

The sole purpose of this report and the associated services performed by Jacobs SKM is to undertake and document an environmental imapct assessment in accordance with the scope of services set out in the contract between Jacobs SKM and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs SKM derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

Jacobs SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs SKM for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs SKM's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs SKM and the Client.

Jacobs SKM accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Proposal Overview

SKIRON OPCO Pty Ltd (the 'Proponent') is proposing to construct and operate an offshore submarine fibre optic cable network between Port Hedland (Western Australia) and Darwin (Northern Territory) (henceforth referred to as the 'Proposal'). The proposed route is shown in Figure 1-1.

The proposed cable system will fulfil connectivity requirements for the current and emerging offshore resource industry in Western Australia and the Northern Territory. The cable will initially connect to a number of confirmed offshore oil and gas customers with provision made for future connections as additional customers are confirmed. The cable will connect with the Proponents existing cable network which includes over 20,000 km of terrestrial cable and the Australia Singapore Submarine Cable project.

This document provides supporting information to assist the Western Australian Environmental Protection Authority (EPA) in assessing the section 38 referral of the Proposal under the Environment Protection Act 1986 (WA) (EP Act).

1.2 Proponent

The Proponent for the proposed development is SKIRON OPCO Pty Ltd, is a related company to a licenced carrier (Nextgen Networks Pty Ltd) under the *Telecommunications Act 1997* (Cth). The contact person for the proposal is:

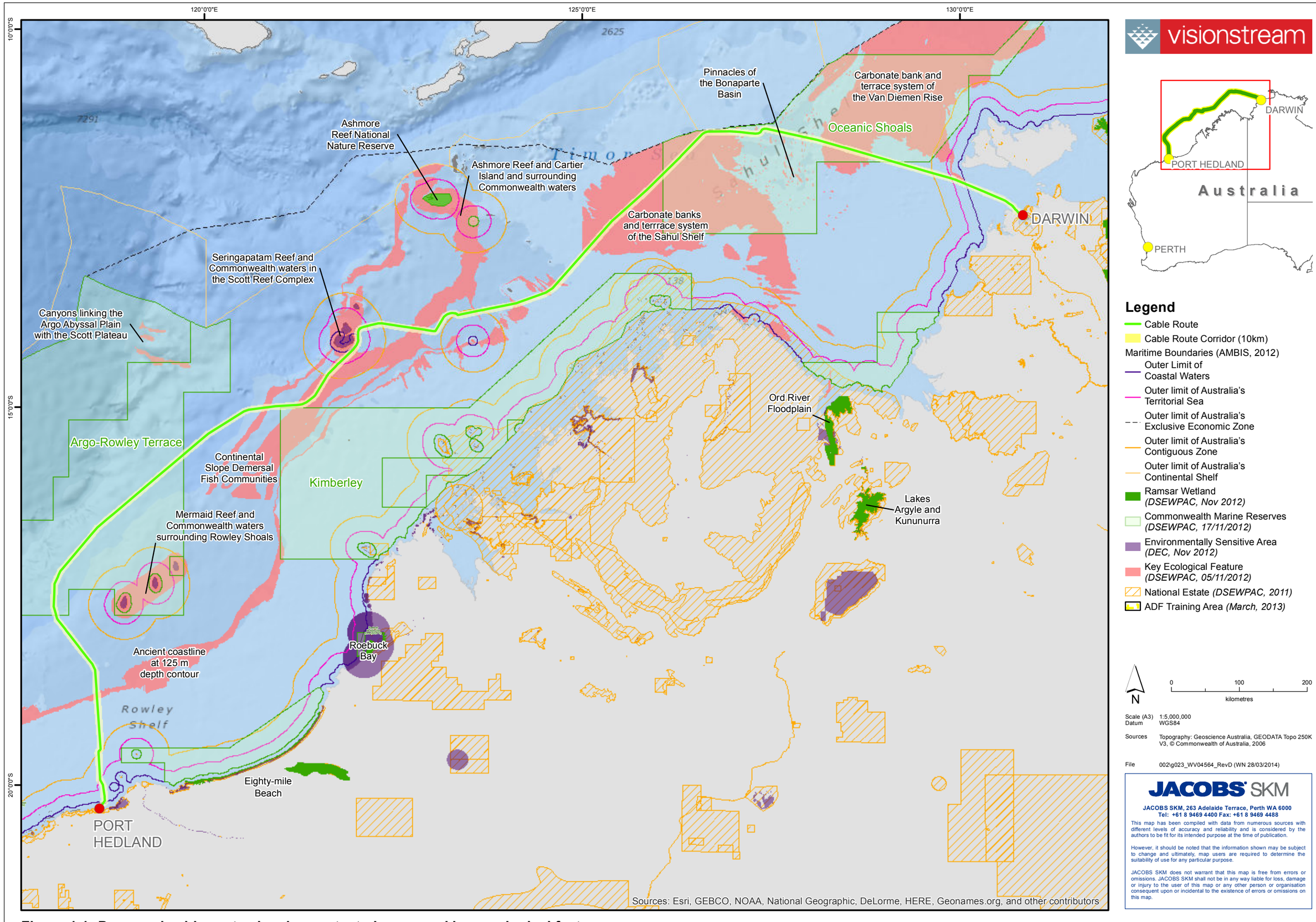
Proponent:	SKIRON OPCO Pty Ltd
Contact Name:	c/o Greg Neylan - Land Access and Regulatory Manager
Address:	236 East Boundary Road, Bentleigh East Vic 3165
Phone:	+61 428 925 193
Email:	greg.neylan@visionstream.com.au

1.3 Scope and Purpose of this Document

This document which provides supporting information, has been prepared as part of the referral of the Proposal under the WA EP Act. Its purpose is to present an environmental impact assessment of the Proposal.

The scope of the referred Proposal is limited to construction and operation of the Fitzroy Cable in WA territory including the undertaking of the geophysical survey. Where construction activities within Commonwealth waters may potentially affect environmental factors within WA waters, these activities have been considered within this document.

It should be noted that certain components of the Proposal are regulated under the *Telecommunication* Act 1997 (Commonwealth). This act allows licenses carriers to undertake certain low impact activities without the need for further approvals. Notwithstanding this, all aspects of the Proposal that may have an environmental impact within Western Australia territory have been considered within the environmental impact assessment presented within this document.



visionstream

Legend

- Cable Route
- Cable Route Corridor (10km)

Maritime Boundaries (AMBIS, 2012)

- Outer Limit of Coastal Waters
- Outer limit of Australia's Territorial Sea
- Outer limit of Australia's Exclusive Economic Zone
- Outer limit of Australia's Contiguous Zone
- Outer limit of Australia's Continental Shelf
- Ramsar Wetland *(DSEWPAC, Nov 2012)*
- Commonwealth Marine Reserves *(DSEWPAC, 17/11/2012)*
- Environmentally Sensitive Area *(DEC, Nov 2012)*
- Key Ecological Feature *(DSEWPAC, 05/11/2012)*
- National Estate *(DSEWPAC, 2011)*
- ADF Training Area *(March, 2013)*

N

0 100 200
kilometres

Scale (A3) 1:5,000,000
Datum WGS84

Sources Topography: Geoscience Australia, GEODATA Topo 250K V3, © Commonwealth of Australia, 2006

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Figure 1.1: Proposed cable route showing protected areas and key ecological features.

1.4 Associated Proposals

Relevant activities associated with the Fitzroy Cable will be referred to the Commonwealth Department of the Environment (DoE) and the Northern Territory Environmental Protection Agency (NTEPA)

1.5 Legislation and Regulation

Relevant WA legislation applicable to the Proposal is listed in Table 1-1. It should be noted that certain aspects of the Proposal are regulated under the *Telecommunication* Act 1997 (Commonwealth).

Table 1-1 : Legislation relevant to the Proposal

Legislation	Description
Western Australia	
The Aboriginal Heritage Act 1972	This Act provides protection to all Aboriginal cultural heritages within Western Australia.
Fish Resources Management Act 1994	This Act provides protection and management of fish resources, including the establishment of fish habitat protection areas and regulation of aquaculture licenses.
Port Authorities Act 1999	This Act grants power to the Port Hedland Port Authority to manage and operate the Port of Port Hedland.
WA Environmental Protection Act 1986	This Act provides regulatory powers to the WA EPA and requires projects likely to have a significant environmental impact to undergo environmental impact assessment.

2. Description of Proposal

2.1 Overview

Project Fitzroy involves the installation of approximately 2000 km of fibre optic cable from Port Hedland to Darwin (Figure 1-1). The project is divided into two stages:

- Stage 1 - Marine route survey to obtain a detailed account of the seabed
- Stage 2 - Installation of the fibre optic cable.

Within WA State territory, the Proposal involves:

- Geophysical and geotechnical survey
- Construction a landing station onshore at Port Hedland
- A cable beach crossing via Horizontal Directional Drilling (HDD) at Cemetery Beach
- Cable lay

The development corridor (refer Section 2.2) within WA state waters and the Port Hedland cable landing point are shown in Figure 2-1. The proposed route has been designed to avoid all known sensitive receptors where practicable. Please refer to Section 4 for a description of the route selection process.

2.2 Development Corridor

To facilitate the identification of an optimum route alignment post geophysical survey, the Proponent is seeking approval for a development corridor in which the final route will be located. The proposed development corridor is 10 km wide at its widest point, and becomes narrower as it enters shallower water and approaches the cable landing point at Port Hedland. The route passes the eastern side of Scott reef but does not enter WA state waters around the reef location. The development corridor approach allows for flexibility in the final route selection and in turn, selection of the most appropriate route from an engineering and environmental perspective. The Proposed development corridor within Western Australian state waters is shown in Figure 2-1.

660000
670000
680000
7770000
7760000
7750000
INDIAN OCEAN
J
I
One
H
West Australian Coastal Water Limit
Cemetery Beach
PORT HEDLAND
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

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DARWIN
PORT HEDLAND
Map Extent
NT
WA
SA

Legend

- HDD Exit Point
- Cable Route
- Outer Limit of Coastal Waters
- Road
- Track
- Railway
- Spoil Ground (PHPA, 2013)
- Existing Shipping Channel
- Cable Route Corridor
- Anchorage
- National Estate *(DSEWPAC, 2011)*

N

0 1 2
kilometres

Scale (A3)	1:100,000
Datum	Geocentric Datum of Australia 1994
Projection	Map Grid Australia, Zone 50
Sources	Topography: Geoscience Australia, GEODATA Topo 250K V3, © Commonwealth of Australia, 2006 Roads/Rail : Geodata, GA 2006 Anchorage/Shipping Channel : Seafer's Chart, 2007
File	001\g0031_WV04564_RevA (WN 15/04/2014) (WN 28/03/2014)

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Figure 2.1: Development corridor within Western Australian State Waters.

2.3 Infrastructure Details

2.3.1 Submarine Cable

The proposed cable type is from the Alcatel-Lucent OALC5 14 mm cable family. The diameter of the cable will vary along the cable length with diameters ranging from 14.0 mm to 35 mm. The cable width is determined by the level of armouring that is applied, which in turn is determined by the depth of water, risks to cable and seabed type where the cable section is being laid. The cable will carry an electrical charge of up to 5000 volts (DC), at both cable landing areas, which is a requirement for the operation of the cable and associated equipment along its length. **Table 2-1** shows the features of the relevant cable types, as well as which seabed types are suitable for installation of each cable type. **Table 2-2** shows which cable is likely to be used at the various depth ranges along the cable route and the likely installation method. In water depths up to 700 m below sea level the cable will primarily be buried to provide extra protection and stabilisation. Beyond these depths the cable will be laid directly on the seabed. Figure 2-2 shows an example of the various cable types.

Table 2-1 : Range of cable types, applications and features

Cable Type	Application	Features
Lightweight	• Benign, sandy bottom • Depths to 8,000 m	• Core cable
Lightweight Protected	• Somewhat rocky bottom • Risk of moderate abrasion and/or attack by marine life • Depths up to 7,000 m	• Metallic tape and polyethylene outer jacket applied over core • Additional abrasion protection
Single Armoured	• Rocky terrain • Risk of trawler damage • Depth to 1,500 m	• Armour wire layer applied to core cable
Double Armoured	• Rocky terrain • Risk of trawler damage • Moderate abrasion risk • Depth to 500 m	• Two armour wire layers applied to core cable

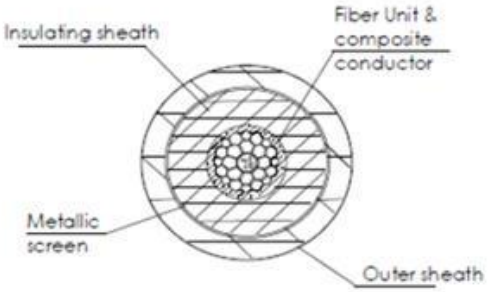
Table 2-2 : Proposed cable types and methods of installation

Approximate Depth Range (m)	Cable Type	Method of Installation
MLWM to 5	Single Armour	Installed in HDD Conduit
5 to 15	Double Armoured	Diver Burial
15 to 700	Single Armour	Plough Burial
700 to 2,000	Light Weight Protected	Surface Lay

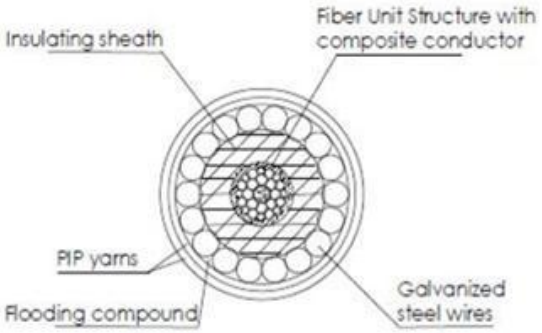
The proposed cable is surrounded by conductive material (cable screen for the terrestrial part, or cable screen/steel armor and /or conductive sea water for submerged part) and does not generate any electric field external to the cable. Whatever the cable voltage, there is no gradient of potential outside the insulating material, and consequently the electric field is zero. A DC current is maintained constant along the cable (the system is fed in “series”) and is of low magnitude (typically 1 Ampère). There is a magnetic field, constant along the cable length, proportional to the current, rapidly decreasing with the distance – it is not strictly zero however is far below any sensitive effect.[1]

[1] Studies carried out in the well-established industry of electrical High Voltage DC power submarine cables (“HVDC systems” of several thousand of Megawatt) have demonstrated no environmental effect for 1000 Ampère DC current (Worzyk 2009). The magnetic field generated by a fibre optics cable of 1 Ampère DC is about 1000 times lower, and then far below any sensitive effect

The cross section to the right shows a lightweight protected cable that will be utilised in water depths greater than 700 m for surface lay activities. The lightweight cable includes a metallic screen and polyethylene outer jacket applied over the core cable for basic protection from moderate abrasion and/or attack by marine life (Alcatel Lucent, 2013a). This method of protection is applied when there are no known risks to the cable from human factors (Worley Parsons, 2011). The external insulating sheath consists of High Density Polyethylene (HDPE) dielectric and the metallic sheath restricts the cable's electromagnetic emissions (ICPC, 2011).



The cross section to the right shows a single armour cable that will be utilised within the HDD and in water depths up to 700m. The single armour cable includes a light armour wire layer (galvanised steel) applied to the core cable, with additional abrasion protection consisting of PIP yarns (Alcatel Lucent, 2013a). This level of protection also includes a 'flooding compound' that consists of a bituminous based material blended with synthetic polymers for bonding and corrosion protection between the armouring wires and plastic sheath (ICPC, 2011 and H&R ChemPharm Ltd, 2006). This type of protection is applied in areas with a moderate to high risk of trawler damage (Worley Parsons, 2011).



The cross section to the right shows a double armour cable that will be utilised during shallow water lay operations (less than 500 m deep). It consists of the same protective measures applied to the cable core as the previous cable cross section however; it also includes a second armour wire layer. This type of protection is required in areas with a high risk from trawler damage as it substantially reduces the potential for a cable being snagged (Alcatel Lucent, 2013a). It also protects the cable in areas exposed to harsh wave conditions as with the coastline.

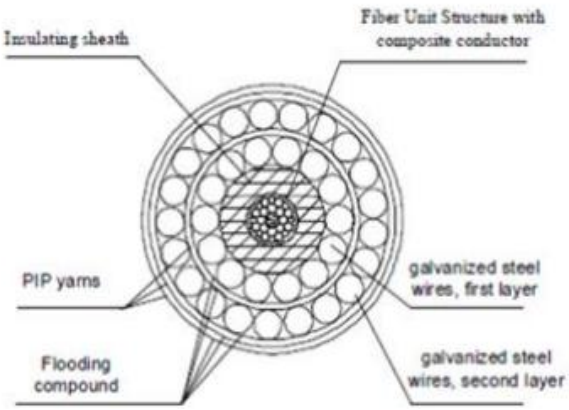


Figure 2-2 : Example of cables that may be used on Project

2.3.2 Beach Manhole

The cable will transverse the beach and dune areas underground, emerging at the Port Hedland landing point via a beach manhole, approximately 3 m x 2 m x 2 m in size (underground). The beach manhole is required to facilitate the initial shore end landing, cable haul and cable maintenance.

2.3.3 Landing Station / Equipment Shelter

A cable landing station / equipment shelter will be required onshore at Port Hedland. The shelter will consist of a transportable building with cosmetic treatment and will be approximately 3.2 m high (excluding the height of the foundations). The shelter will be constructed on a minimum lot size and will be fully fenced. The shelter will contain the required electronic equipment to maintain the operation of the cable and will also contain a generator. The shelter will be unmanned during operation. Figure 2-3 shows an indicative landing station design. Figure 2-4 shows the location of the proposed landing station including street views.

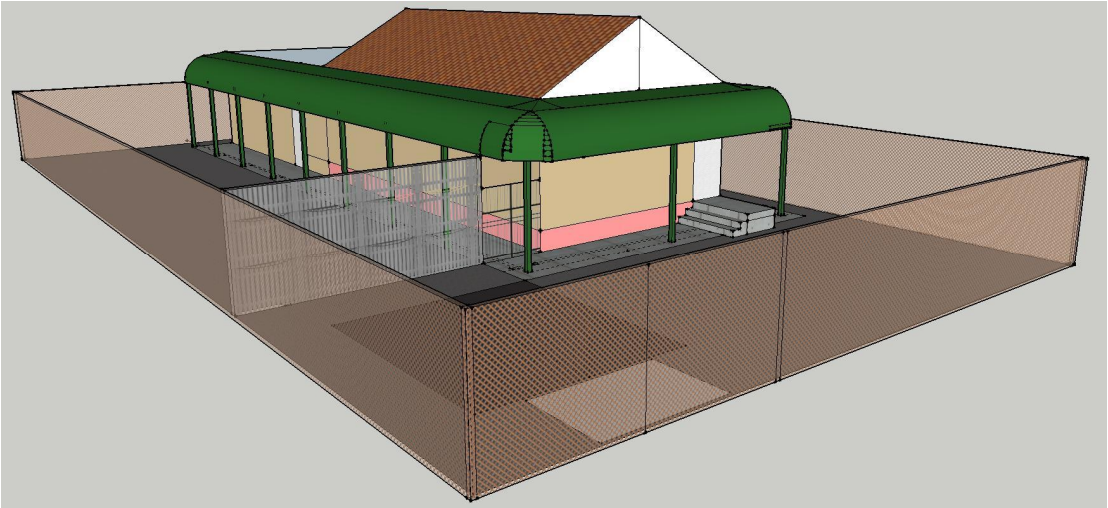


Figure 2-3 : Proposed cable landing station design

Figure 2-4 : Proposed onshore landing site at Port Hedland

2.4 Construction Method

2.4.1 Stage 1 – Marine Route Survey

A marine route survey, otherwise known as a geophysical and geotechnical survey will be undertaken along the proposed cable route and will incorporate technical methods and procedures similar to other geophysical surveys conducted in Australian waters. No unique or unusual equipment or operations are proposed. This survey is of low intensity and relatively high frequency and does not involve the use of air gun arrays or boomer style acoustic equipment associated with offshore exploration seismic survey (see Appendix E).

The aim of the survey is to acquire detailed bathymetry together with details of seabed type and thickness. In waters greater than 700 m in depth, thickness is not required as the cable will be laid directly on to the seabed.

The exact vessel that will be used for the survey has not yet been confirmed. Examples of the types of vessel that could potentially be used for the survey are provided Appendix A. Vessels will likely come from International waters, however this is yet to be confirmed. All State and Commonwealth biosecurity requirements will be complied with to prevent Introduced Marine Species.

In deep waters, information will be acquired via a single pass. In shallower waters, multiple passes may be required to achieve the required coverage. The vessel will operate at between 4 – 7 knots depending on water depth.

In very shallow waters (typically <20 m) it may not be safe to operate the main survey vessel. In this case a small local vessel may be mobilized with portable survey equipment to complete the survey.

The acoustic equipment that will be used to obtain the required data will include a Multi-beam Echo sounder (MBES), a Side Scan Sonar (SSS) and a Sub-bottom Profiler (SBP). A summary of the typical survey equipment proposed for the marine route survey has been included in Appendix B and is also described below.

Multi-beam Echo Sounder (MBES)

The MBES will be used to measure the depth of the water. It will operate at 12 kHz in deep water and 300 kHz in shallow water (Alcatel Lucent, 2013). The MBES works by measuring the time interval between emissions and return of a broad acoustic fan shaped pulse emitted from a specially designed transducer across the full swath across track (Fugro, 2001).

Side Scan Sonar (SSS)

The SSS will be used to determine the composition of the seafloor in water depths from 0-700 m. SSS works by ensonifying a strip of seabed and measuring the intensity of the returning sound waves (Fugro, 2001).

Sub-bottom Profile (SBP)

The SBP will be used for determining the structure of the upper few metres of seabed. It operates in the 1-10 kHz range (Alcatel Lucent, 2013).

Other Survey Equipment

A range of other equipment (non-acoustic) will be used for ground truthing the measurements of the acoustic equipment including, grab samplers and gravity corers, magnetometers and possibly Cone Penetrometer Testing (CPT) (Alcatel Lucent, 2013).

Port Hedland Landing Site

A limited low energy geophysical survey and drilling of borehole(s) are expected to be undertaken onshore to confirm the geotechnical conditions around the HDD landing site.

2.4.2 Stage 2 – Cable Installation

Cable installation will consist of onshore HDD and various cable lay methods in the nearshore and offshore areas. Examples of the types of vessel that could potentially be used for the cable lay are provided in Appendix A. The various techniques for cable installation are described in detail below (Alcatel Lucent, 2013).

Onshore Horizontal Directional Drilling

The beach crossing will be drilled via HDD with an internal diameter of 100 mm. The process involves drilling a horizontal hole (pilot hole) at the onshore entry point (Figure 2-1). The drill bit will then be steered over a predetermined pathway underneath the shoreline to the exit point offshore, where divers will recover the drilling assembly once all equipment has been removed from the seabed. Typically, fluids are released to the seabed once the drill bit is removed. Analysis was undertaken to quantify the volume of drilling fluids that may potentially be released to the surrounding environment and was estimated to be between: 20 – 30 m^3. To combat this, the positioning of the drill head will be monitored constantly and additional water will be added if fluids are anticipated to be lost. The addition of water will alleviate the loss of bentonite and polymers to the water column (Worley Parsons, 2011).

Drilling muds will be used to stabilize the hole and remove cuttings out of the borehole back to the surface (Worley Parsons, 2011). Prior to drilling operations commencing, mud mixing will take place. After consultation

and viewing the Geotechnical Investigation a drilling fluid will be prepared specific to the local conditions to be encountered. Using a fresh water supply, a rapid yielding high solids bentonite will be prepared in the makeup tank of the Solids Control Unit. The fluid will be prepared with the assistance of a qualified Mud Technician. Additives may be necessary depending on the water quality and the varying cross section of materials encountered during the drilling process. The final fluid selection will depend on various factors such as the ability to form filter cake within the more porous material, most likely on the subsea exit approach. In addition to these important factors the drilling fluid also helps to suspend solids and carry them to the surface with the assistance of constant fluid velocity. The drilling fluid also helps lubricate the drill pipe and maintain hole stability. All materials to be used on site will have approvals and copies of their Materials Safety Data Sheets readily available (Coe Drilling Pty Ltd, 2013).

Pre-cable lay Activities

Before the cable is laid, a clearance process will be undertaken to specifically remove debris along the route. A Pre-Lay Grapnel Run (PLGR), which involves towing a grapnel device along the seafloor, will also be undertaken immediately prior to cable installation to remove common marine debris from within the area. A PLGR will not be used in any planned surface lay areas and will only be conducted within areas planned for burial (Alcatel Lucent, 2013). This method involves towing a grapnel array through the area and is therefore not designed for deep penetration into the seabed (Alcatel Lucent, 2013).

The method will be to launch the grapnel and pay out a towing line scope appropriate to the depth of water. The towing line is passed over a sensitive dynamometer which is monitored continuously. Changes in recorded tension may indicate that debris has been encountered. The grapnel is recovered and any debris cleared and retained on board. The grapnel array is then redeployed. Even if no tension increases are noted, the grapnel is recovered to the surface at regular intervals, to allow visual checking of the condition of the grapnel. Each time the grapnel is re-deployed, the launch position is adjusted so there is an overlap between each grapnel drive. The lengths of the individual drives will be nominally around 30 km each, although may be shortened if excessive debris is being recovered, and may be extended if very little or no debris is being recovered over the earlier drives. Towing speeds will be approximately 1.5 km/hr.

Cable Lay

When landing the cable to shore, the maximum length that can be handled is about 3 km. The main cable lay vessel is typically limited to water depths of 15 m or more. As the 15 m contour is greater than 3 km from the beach (approximately 43 km offshore), a separate shallow draft barge will be mobilized for the Port Hedland portion of the cable installation and the cable will be pre-laid (for vessel technical specifications see Appendix A). The remainder of the cable lay in Commonwealth waters will be undertaken by a specialised cable lay vessel with a powerful Dynamic Positioning capability (Alcatel Lucent, 2013a).

Cable payout from the main lay cable ship will be by a Linear Cable Engine. During shallow water lay operations (usually in Double Armour, typically in water depths less than 100 m depth), the cable payout will be in bottom tension mode, where the LCE speed is automatically varied to maintain outboard cable tension at a set value (usually between 2 – 5 knots). In water depths <700 m, the cable will be buried. Burial will be achieved via a combination of ploughing, trenching and post lay burial via jetting, dependant on location.

Plough burial can be undertaken simultaneously to the laying of the cable and will be used where sufficient suitable sediment exists in waters up to 700 m water depth. As the plough is lowered to the seafloor and pulled along by the cable ship, the cable is simultaneously threaded through the plough. The plough creates a narrow trench approximately 200 mm wide into which it places the cable before burying it. The machine proposed to be used for ploughing will be a Soil Machine Dynamics Ltd long-beam type plough with a maximum penetration into the seafloor in ideal conditions of 2.4 m. An example of the plough system is shown in Figure 2-6. Target cable depth for deployment by plough for this project is 1 m.

Where sufficient suitable sediment does not exist, the cable may be surface laid.

In other areas where ploughing is not possible, such as the planned Branching Unit locations, and at the planned pipeline crossing, a Remotely Operated Submersible Vehicle using jetting techniques will be used as an alternative method to bury the cable.

Surface lay of the cable will also be used where it is not feasible to bury the cable or where there is no threat to the cable if it is laid on the surface.

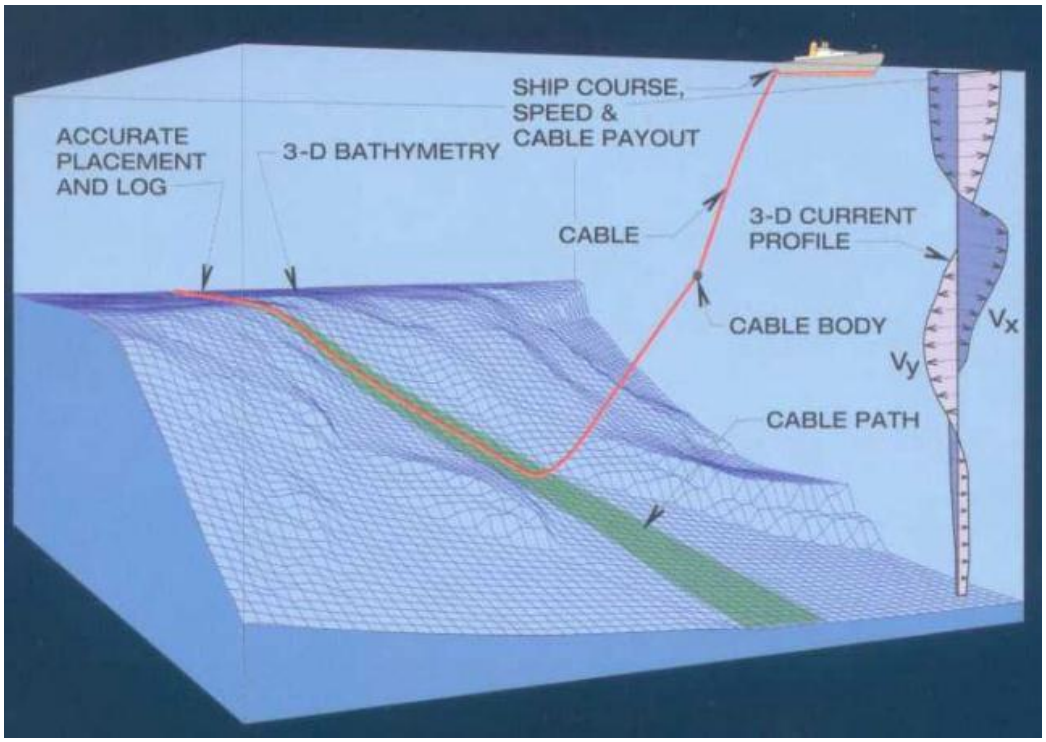


Figure 2-5 : Illustration of cable lay technique (Source - www.makai.com).

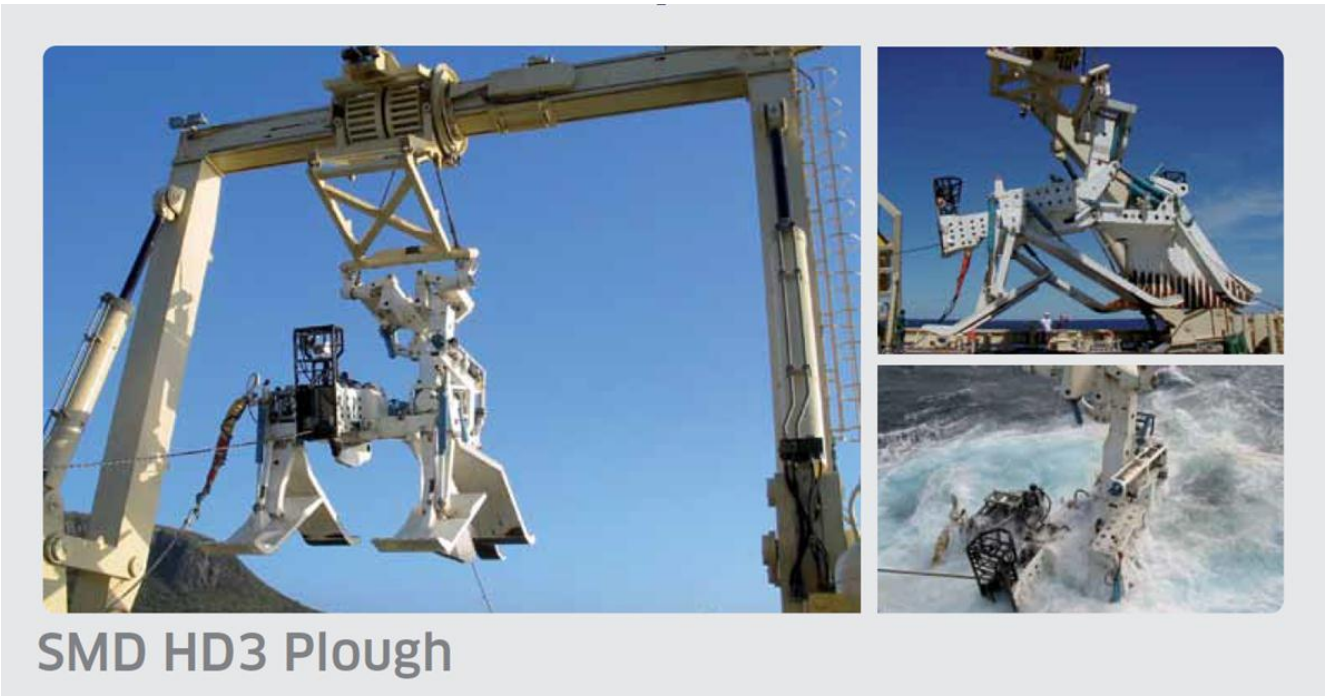


Figure 2-6 : Example of plough system

2.4.3 Schedule

The Proposal will be undertaken in three distinct phases.

Marine Route Survey

The proposed time frame for the geophysical and geotechnical survey is Q3-Q4 2014 (Aug-Oct). It is expected that survey activities for the entire project may take up to 12 weeks to complete.

Horizontal Direction Drilling

HDD is planned to occur between Q2 and Q3 2015. No HDD will occur at Port Hedland during January and February so as to avoid key turtle nesting season.

Directional drilling will take approximately 4-5 weeks at each landing point:

- Mobilisation and drilling set up – 1 week
- Drilling (conduits) – 3 weeks
- Clean-up and demobilisation – 1 week.

Cable Installation

Estimated time frame of Installation Port Hedland Shore End is Q3 2015 and Main lay is scheduled for Q1-Q2 2016 (Jan-Apr).

Landing Station

Construction of the cable landing station (CLS) at the proposed Port Hedland will be undertaken in sequence beginning in Q1 2015 and finishing in Q4 2015.

Commissioning

Commissioning of the Proposal including final network testing is expected to take 1-2 months, completion in Q2 2016.

2.5 Connection to Customers

The scope of this referral does not include customer connections. Regulatory requirement with respect to future customer connection will be managed separately either by the Proponent or the Customers themselves.

2.6 Operations

Operation of the cable will be managed remotely via the Proponents existing operations centre in Melbourne. Maintenance and corrective actions will be undertaken at the Port Hedland equipment shelter on an as needs basis.

It is not envisaged that maintenance activities will be undertaken on the cable unless unforeseen corrective action is required.

2.7 Maintenance

Once installed, it is not expected that the cable network will require any routine maintenance activity. In the unlikely event of damage or failure of the cable, relevant authorities and stakeholders will be consulted. In this case, it is likely that repairs will involve hauling the cable to the surface for repair. Sufficient slack will be included in the cable to allow for this eventuality.

2.8 Decommissioning

The life of the cable is a minimum of 25 years and removal of the decommissioned cable is not considered feasible as:

- The potential environmental impacts of the retrieval and disposal of 2000 km of buried cable are likely to significantly outweigh the impacts of leaving an inert cable in place.
- The commercial cost of retrieval and disposal of 2000 km of buried cable are likely to significantly affect the commercial viability of the Proposal.
- Developing technology may extend the life of the cable or may lead to recommissioning of the cable being a viable option in the future.

3. Impact Assessment Approach

3.1 Lessons Learnt from Previous Similar Projects.

The Proponent has undertaken a review of previous similar projects, such as the Australian Singapore Cable (ASC) Project. The lessons learnt from the reviewed projects have been applied to this Proposal.

The key lesson that is being applied to this Proposal is the application of a development corridor in which the final cable route will lie. The development corridor is being applied to provide flexibility in the final route selection and to allow for the selection of the most appropriate route from an engineering and environmental perspective without the requirement to re-refer the Proposal or apply for changes to the relevant approvals. This approach will allow for the final route to be designed to avoid:

- Seabed features
- Identified potential heritage sites
- Identified potential key habitat areas

This approach was discussed with the EPA during consultation on 01 November 2013. Any further lessons learnt from the ASC project during the build phase will also be applied to this Proposal as appropriate.

3.2 Environmental Risk Assessment and Environmental Assessment Guidelines

Environmental Assessment Guideline 9 (EAG9) provides guidance for the application of a significance framework in the environmental impact assessment process using a risk based approach. It focuses on the key environmental factors of the project and relates to the extent to which a proposal meets the EPA's environmental objectives, and how the framework is applied through the entire EIA process.

The EPA has identified 15 environmental factors as being relevant and practical for the EIA process. A factor is characterised as a key environmental factor, if the EPA considers that there is currently a lack of confidence that the proposal is likely to meet the environmental objective for that factor (EPA, 2013).

An environmental risk assessment was undertaken early in the assessment process to identify the key and relevant factors in relation to this Proposal. The risk assessment was undertaken via a detailed workshop and attended by various marine and EIA specialists as well as Proponent engineers and project staff. The approach used was to identify all potential environmental risks and then assess the significance of the risk and potential impacts with standard management measures applied. Risk areas which were identified as significant or where uncertainty with respect to the significance was present were identified for further investigation with respect to the potential impacts and suitable management and mitigation measures.

Table 3-1 details the EPA identified environmental factors and their relevance to this project. It should be noted that social (commercial and recreational fishing) has been included as a relevant factor for the Proposal although it is not identified in the EPA guidance.

The key and relevant factors are discussed further in Section 6, Table 6-1 and Table 6-2.

Table 3-1 : EPA Relevant Environmental Factors

Zone	Relevant Environmental Factors	Relevance to this Proposal
Sea	Benthic communities and habitat	**Relevant – potential impacts that can be managed with standard measures**
	Coastal processes	Not Relevant – negligible likelihood of impacts
	Marine environmental quality	**Relevant – potential impacts**
	Marine fauna	**Key – potential impacts requiring active management as described in Table 6-1**
Land	Flora and vegetation	Not Relevant – negligible likelihood of impacts
	Landforms	Not Relevant – negligible likelihood of impacts
	Subterranean fauna	Not Relevant – negligible likelihood of impacts
	Terrestrial environmental quality	Not Relevant – negligible likelihood of impacts
	Terrestrial fauna	Not Relevant – negligible likelihood of impacts
Water	Hydrological processes	Not Relevant – negligible likelihood of impacts
	Inland waters environmental quality	Not Relevant – negligible likelihood of impacts
Air	Air quality	Not Relevant – negligible likelihood of impacts
People	Amenity	Not Relevant – negligible likelihood of impacts
	Heritage	**Relevant – potential impacts that can be managed with standard measures**
	Human health	Not Relevant – negligible likelihood of impacts
	Social (not identified in EAG 8)	**Relevant – potential impacts that can be managed with standard measures**

3.3 Principles of Environmental Impact Assessment

The Environmental Impact Assessment Administrative Procedures 2012 define the Principles of Environmental Impact Assessment for Proponents. How these principles are addressed for this Proposal is described in Table 3-2.

Table 3-2 : Principles of Environmental Impact Assessment

Principle		How to address in project
1	Consult with all stakeholders, including the EPA, DMAs, other relevant government agencies and the local community as early as possible in the planning of their proposal, during the environmental review and assessment of their proposal, and where necessary during the life of the project	Stakeholder consultation undertaken for this proposal is detailed in Section 4.
2	Ensure the public is provided with sufficient information relevant to the EIA of a proposal to be able to make informed comment, prior to the EPA completing the assessment report	Detailed information relating to the Proposal, existing environment and potential impacts that may occur are provided in Sections 2 and 6.
3	Use best practicable measures and genuine evaluation of options or alternatives in locating, planning and designing their proposal to mitigate detrimental environmental impacts and to facilitate positive environmental outcomes and a continuous improvement approach to environmental management.	Best practical measures such as a route selection analysis and applying lessons learnt from similar projects, have been implemented throughout this Proposal and will continue to be implemented throughout project execution. Section 4 describes the assessment of alternatives for the proposal. The management measures that will be applied are detailed in Section 6.
4	Identify the environmental factors likely to be impacted and the aspects likely to cause impacts in the early stages of planning for their proposal. The onus is on the proponent through the EIA process to demonstrate that the unavoidable impacts will meet the EPA objectives for environmental factors and therefore their proposal is environmentally acceptable.	The key environmental factors and aspects of the proposal were identified during the risk assessment stage and discussed with the EPA on 01 November 2013. Section 6 details how the EPA objectives for the key environmental factors will be achieved.
5	Consider the following, during project planning and discussions with the EPA, regarding the form, content and timing of their environmental review: a) the activities, investigations (and consequent authorisations) required to undertake the environmental review; b) the efficiency of the investigations to produce sound scientific baseline data about the receiving environment; c) the documentation and reporting of investigations; and d) the likely timeframes in which to complete the environmental review; and use best endeavours to meet assessment timelines	The scope and contents of the environmental assessment of the Proposal was discussed with the EPA on 1st November 2013. The results of these discussions have been incorporated into the EP Act referral form and this supporting document. Timeframes for delivery of the referral and supporting documentation were also discussed with the EPA and the Proponent will make every effort to meet these timeframes.
6	Identify in their environmental review, subject to the EPA's guidance: a) best practicable measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment; and b) responsible corporate environmental policies, strategies and management practices, which demonstrate how the proposal can be implemented to meet the EPA's environmental objectives for environmental factors.	Best practical measures to avoid, alleviate and manage environmental impacts on the Proposal are described in Section 6.

3.4 Principles of Environmental Protection

The objective of the EP Act is to protect the environment of the State, having regard to five principles. These principles have been considered in the project and are provided below in Table 3-3.

Table 3-3 : Principles of Environmental Protection

Principle	Consideration given in proposal
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by : (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk-weighted consequences of various options.	The Proponent has applied the precautionary principle during the route selection phase of the phase of the Proposal and during execution planning. Key examples of the application of the precautionary principle includes: • The iterative route selection process focussed on avoiding all key ecological features as far as possible. • To mitigate the uncertainty surrounding potential impact to nesting turtles at Cemetery beach, the Proponent has committed to not undertaken HDD at Cemetery beach during the months of January and February.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The Proponents route selection process and decisions concerning construction methodology have considered intergenerational equity in that they have been based on the approach of avoiding potential impacts wherever possible rather than managing or offsetting impacts.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Conservation of biological diversity and ecological integrity has been a key consideration of the route selection process. For example, the route has been designed run a significant distance from Rowley Shoals despite the additional project cost, thus avoiding any potential impacts to that key ecological feature.
4. Principles relating to improved valuation, pricing and incentive mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principle — those who generate pollution and waste should bear the cost of containment, avoidance or abatement. (3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	The Proponent appreciates the need for industry to improve valuation, pricing and incentive mechanisms and endeavours to pursue these principles when and wherever possible. The Proponent notes however that the application of this Principle on this Proposal is a difficult due to the nature of the services that will be provided to the Customers. Examples of how the Proponent has attempted to implement this principle include: • environmental factors have played a major role in determining the cable route • environmental performance plays a critical part in contractor selection.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Waste discharge to the environment will be minimised by ensuring all regulations (e.g. MARPOL) are complied with and that all recoverable waste including drill cuttings and drilling fluid are disposed of at a licensed facility.

4. Project Justification and Route Selection

4.1 Project Justification

The Fitzroy fibre optic cable is being constructed to provide connectivity to offshore oil and gas facilities for the provision of telecommunications services. The cable will service a growing demand for high speed data transfer and will enable the current reliance on satellite connectivity to be reduced. The Proposal provides the most cost effective means of data transfer within current technology constraints. This project is an opportunity for the town of Port Hedland to receive wholesale broadband opportunities and subsequent public benefits through the Proponents private investment and interworking with retail broadband providers. As a wholesale provider of services, the Proponent works seamlessly with many retail telecommunications companies in Australia to provide public network services. The alternative is to not proceed with the Proposal which will result in increased cost, no pro-competitive benefits, lower capacity for customers and lost commercial opportunities for the Proponent.

4.2 Route Selection Process

The route selection was an iterative process and based on the following requirements:

- Place cable within 20 km of potential future customers.
- Engineering feasibility – requirement to avoid seabed features such as shoals and canyons and to install the cable in the best engineering areas such as ridge lines when crossing the continental shelf to maximise protection of the cable.
- Access to deep water (> 1000 m) in the shortest distance possible to reduce installation costs and maintain project commercial viability.
- Environmental impact minimisation – place the cable away from key ecological features.

Constraints mapping was undertaken to identify and avoid sensitive areas while still maintaining cost and engineering feasibility. The route avoids Scott Reef and instead runs to the east; avoiding State waters around the reef location and avoiding fishing and other ecological constraints in the immediate vicinity of the area. Scott Reef is an isolated coral reef system in Western Australia's north-west marine region and is listed as a Commonwealth Heritage Place (Gilmour *et al*, 2013).

The area in the lagoon at south Scott Reef includes a diverse community of hard corals and soft corals, sponges, algae, sea urchins and other organisms (Gilmour *et al*, 2013). Scott Reef is known to support diverse pelagic and benthic marine species and waters surrounding the reef are nutrient deficient with tides that are generally diurnal and reach a peak of 4.5 m during the spring tide (DEWHA, 2008; Woodside, 2011).

Examples of how the route selection has been applied to achieve a better environmental outcome include:

- An early concept route ran across the north-west corner of the Kimberley Commonwealth Marine Reserve. This route was reverted to the north of the Kimberley Commonwealth Marine Reserve to avoid any potential disturbance to the area, which is known as a key migratory pathway for Humpback whales.
- An early concept route was located in close proximity to Rowley Shoals which provided an acceptable engineering and commercial solution, but presented an environment risk to the Shoals. The route selection process resulted in a revised route that provides a solution that meets environmental, engineering and commercial requirements.

5. Stakeholder Consultation

A wide range of stakeholders has been identified and consulted for the Proposal. Consultation undertaken with the relevant Western Australian Stakeholders to date, and the Proponent's response to issues raised, are detailed in Table 5-1.

Consultation has also been undertaken with various other Stakeholders that may have an interest in some part the project (Table 5-2).

Table 5-1 : Summary of WA Stakeholder Consultation

Date	Topics/Issues Raised	Proponent Responses
Recfishwest		
30/10/13	Recfishwest raised the following concerns: • Exclusion zones for geophysical survey and cable lay activity. • Timing of activity and notice to locals.	Proponent's Response: • Exclusion Zones for both the Survey and Installation Vessels (Table 6.2) • At this stage there will be no permanent exclusion zone around the cable • The Survey Vessel can move at speeds of up to approximately 6-7 knots (Section 2.4.1). • The Installation Vessel can operate at approximately 1-2 knots (Section 2.4.2). Also as discussed throughout the meeting the Proponent will endeavour to notify Recfishwest for inclusion in the monthly notification to fisherman of the intended survey and installation dates so as to communicate activities and potential interruptions to recreational fishing can be minimised.
Department of Transport		
30/10/13	No environmental issues were raised.	The Proponent will endeavour to establish mapping to ensure that the proposed cable alignment will not be within the Department of Transport's jurisdiction and as such, further consultation will not be required. The Proponent has undertaken consultation with the Port Hedland Harbour Master and confirmed that the Department of Transport - Marine Safety will not require further consultation.
Department of Fisheries WA		
31/10/13	The Department of Fisheries raised the following concerns: • Exclusion zones for geophysical survey and cable lay activity. • Biosecurity and what management measures will be taken to prevent IMS.	Proponent's Response: • Exclusion Zones for both the survey and installation vessels are 1 nautical mile where practical outside port limits. When inside port waters, exclusion zones will be negotiated at the time with the Harbour Master. • Currently no permanent exclusion zone around the cable is planned • The survey vessel can move at speeds of up to approximately 6-7 knots (Section 2.4.1). • The installation vessel can operate at approximately 1-2 knots (Section 2.4.2). • Biosecurity measures will be implemented as per guidance provided by DoF.

Date	Topics/Issues Raised	Proponent Responses
		As requested in the meeting, a shape file of the proposed cable alignment and the proposed RPL will be forwarded to WA DoF Alcatel Lucent (construction contractor) will be Responsible for Submitting VRASS and all other operational permitting requirements.
Department of Mines and Petroleum		
31/10/13	No environmental issues were raised.	As discussed in the meeting, the Proponent will continue to liaise with the relevant tenement holders regarding the installation of the Submarine Cable. The Proponent will also confirm Survey and Installation dates.
Environmental Protection Authority WA		
01/11/13	The Environmental Protection Authority western Australia raised the following issues of concern: • Discuss lessons learnt from previous projects. • Potential impacts on turtles during turtle nesting season are a key issue that could be mitigated by committing to avoid HDD drilling during peak nesting times. • Proponent should quantify emissions and discharge quantities wherever possible • Proponent should consult with Port Hedland Harbour Master and Department of Fisheries (DoF).	In response to the issues raised by the EPA, the Proponent will: • Discuss the application of previous lessons learnt on this Proposal (Section 3.1). • Commit to not undertaking HDD drilling at Cemetery beach during peak turtle nesting season (Table 6-1). • All expected emissions and discharges will be quantified where possible (Table 6-1). • Consult with the recommended parties (Table 5-1).
Port Hedland Port Authority (PHPA)		
19/11/13	No environmental issues were raised.	• The PHPA was provided with the Route Positioning List for the current cable installation alignment within the port limits, for use internally to assess the potential for possible interactions between PHPA operations and the Fitzroy Cable System. • The Proponent will update the PHPA on proposed Survey and Installation dates as these come to hand and provide a project overview for inclusion to their Notice to Mariners (Table 6-2)
WA Seafood		
19/11/13	No environmental issues were raised.	A copy of the project overview with the proposed cable alignment and detailed map of proposed proximity to Scott's Reef was sent to WA Seafood to assess whether there will be any interactions between their commercial operations and the cable installation.

Table 5-2 : Summary of other Stakeholder Consultation

Date	Topics/Issues Raised	Proponent Responses
Department of the Environment		
16/10/2013	The Department of Environment raised the following issues of concern: *Light Impacts* • Need to discuss impacts from light on turtles. • Need to explain how drill rig will be below horizon when viewed from beach. • Need to address light glow (not just direct line of sight). *Vibration Impacts on Cemetery Beach* • Need to justify assessment that no impacts will occur (or avoid nesting season). • Need to quantify expected vibrations etc. where possible. *Seismic Surveys* • Commit to previous management measures. • Need to quantify expected power levels and detail seismic survey equipment and method. *HDD exit point* • Need to quantify the expected drill fluids release amount. • Need to describe the drill fluid (type, toxicity etc. where possible). *Key Ecological Features* • Need to address these as a separate sensitive receptor. *Commonwealth Marine Reserves* • Need to address the 'values' of each of the marine reserves and how we are meeting the associated objectives. *Scott's Reef - Significant concerns around the proximity to Scott's reef* • Need to look at the Woodside work that has been done in the area. • Certain buffer zones will be in place and we need to abide by these. *General* • Need to quantify everything where possible (seismic power, plough width, drill fluids etc.)	The Proponent has established some responses to questions asked throughout the meeting and these are as follows: • The Proponent will quantify the widths of the plough that will be used for the cable installation (0). • The Proponent will quantify the concentration of the drilling fluid that may be released during Horizontal Directional Drilling. • The Proponent will research and then quantify the vibrational impacts of the Horizontal Directional Drilling on the Turtle Populations at Port Hedland. • The Proponent will take into account the species present and localised recreational and commercial activities when programming and permitting the works. • The Proponent will provide more detailed explanations of the power of the equipment used for the low power geophysical survey. • The Proponent will provide more information of the trenching installation methodology of the cable. • The Proponent will address the Key ecological features also in their submission.
Northern Territory Environmental Protection Authority		
17/10/2013	The Northern Territory Environmental Protection Authority raised the following issues of concern: • Heritage – low profile wrecks. • Quantify widths of plough used for cable installation. • Quantify concentrations of drilling fluid to be released.	Proponent's Response: • The Proponent will provide to EPA data on wreck and debris field locations identified during the survey. • All requested information will be included in the Notice of Intent submission. • The use of HDD will ensure that the Proposal does not adversely affect the Mindil Beach seagrass.

Date	Topics/Issues Raised	Proponent Responses
	• Seagrass at Mindle Beach • Revised NT approvals process	
Northern Territory Department of Primary Industry and Fisheries		
17/10/2013	No issues environmental were raised.	Proponent's Response: • Exclusion Zones for both the Survey and Installation Vessels are 1 nautical mile (where practical outside port limits). • At this stage there will be no permanent exclusion zone around the cable. • The survey vessel can move at speeds of up to approximately 6-7knots. • The installation vessel can operate at approximately 1-2knots. • As requested in the meeting the Proponent will forward the following to NT DoF when the information comes to hand: - A shape file of the proposed cable alignment and the proposed RPL. - Alcatel Lucent (Construction Contractor) will be responsible for submitting VRASS and all other operational permitting requirements.
Department of Lands, Planning and the Environment		
12/11/2-13	• The Department of Lands Planning and the Environment was primarily concerned about Heritage – low profile wrecks	Proponent's Response: The Proponent will provide to EPA data on wreck and debris field locations identified during Survey.
Darwin Port Corporation		
12/11/2-13	No environmental issues were raised.	Proponent's Response: • The operating exclusion zones inside the Darwin Port will be negotiated with the Port Corporation in accordance with the proposed activities at the time of Survey and Installation • The proposed route position list for inside the Port Corporation waters has been provided and consultation regarding the installation route will occur after survey. • At this stage there will be no permanent exclusion zone around the cable. • The survey vessel can move at speeds of up to approximately 6-7knots. The installation vessel can operate at approximately 1-2knots.
Department of Mines and Energy		
12/11/2-13	No environmental issues were raised.	It has been established that there will be little to no predicted interactions or interferences with the Department of Mines and Energy.
Northern Territory Seafood Council		
12/11/2013	No environmental issues were raised.	Operational logistics and notification to the Seafood Council will ensure that commercial viability of the local operators is not

Date	Topics/Issues Raised	Proponent Responses
		compromised.
Paspaley		
11/11/2013	No environmental issues were raised.	It has been established that there will be little to no predicted interactions or interferences with Paspaley pearling operations.
Northern Prawn Fishery Industry		
15/11/13	The Northern Prawn Fishery Industry recommended that the Proponent liaise with A Raptis & Sons and recommended a map with specific coordinates be forwarded.	The Proponent consulted with A Raptis & Sons (Refer to consultation outcomes below).
Department of Lands		
31/10/13	No environmental issues were raised	As discussed in the meeting the Proponent will continue to liaise with the Town of Port Hedland regarding the leasing of Crown Lands sites on Port Hedland for installation of the Cable Landing Station. Once the installation and EPA permitting process has further progressed the Proponent will once again be in contact to discuss the Crown License for the installation of the cable in State Waters.
Commonwealth Fisheries Authority		
24/10/13	No environmental issues were raised.	A brief overview of the project and an introductory letter was forwarded to the Commonwealth Fisheries Authority. The Proposal was then passed on to other contacts within the organisation who were instructed to contact the Proponent directly if they had any further queries.
Australian Fisheries Management Authority		
24/10/13	No environmental issues were raised.	Recommendation was made by AFMA for the Proponent to consult directly with the interested parties using the Petroleum Industry Consultation Guidelines. These consultations are in hand.
MG Kailis		
24/10/13	Concerned with commercial fishing operations and also recommended consultation with WAFIC.	The Proponent will be consulting with the relevant parties and also a notice to mariners will be issued in accordance with maritime requirements.
WAFIC		
Ongoing	No environmental issues were raised.	The Proponent has had trouble establishing consultation with WAFIC after numerous emails requesting meetings were sent. Since then, the Proponent has consulted all of the relevant other parties regarding the fisheries industry in WA and NT.
A Raptis & Sons		
19/11/13	Concern around proximity to Scott Reef.	A copy of the project overview with the proposed cable alignment and detailed map of proposed proximity to Scott's Reef was sent to A Raptis & Sons to assess whether there will be any interactions between their commercial operations and the cable installation. No specific response received.
Austral Fisheries		

Date	Topics/Issues Raised	Proponent Responses
19/11/13	Concern around proximity to Scott Reef.	A copy of the project overview with the proposed cable alignment and detailed map of proposed proximity to Scott's Reef was sent to Austral Fisheries, to assess whether there will be any interactions between their commercial operations and the cable installation. No specific response received.
Northern Prawn Fishery (Qld) Trawl Association Inc		
20/11/13	No environmental issues were raised.	The Proponent sent an email including the Project Overview to the Northern Prawn Fishery (Qld) Trawl Association Inc for comment. No specific response received.
National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)		
09/04/14	Advised that no NOPSEMA related requirements apply to Proposal.	Noted.

6. Environmental Impact Assessment

The following section provides an assessment of the predicted environmental impacts of the project, on the key (**Table 6-1**) and relevant factors (**Table 6-2**) identified along with proposed management measures that will be applied. A brief summary of the existing environment is also included in each table.

The Key Environmental Factor identified for the proposed project is:

- Marine Fauna

Other relevant factors identified for the project include:

- Benthic Habitat
- Water Quality
- Social (Commercial and Recreational Fishing)
- Maritime Archaeology
- Terrestrial Fauna.

Activities associated with the Proposal have been assessed to identify potential impacts on the key and relevant environmental factors, and the level of risk associated with that potential impact. The process was used to determine the type of management to be applied to the risk, to meet the EPA objective for that factor. Please refer to Section 3.2 for further details on the risk assessment process undertaken for this Proposal.

Table 6-1 : Summary of Key Environmental Factors

Factor	EPA Management Objective	Existing Environment	Impact Assessment	Avoidance, Mitigation and Management Measures	Predicted Environmental Outcomes
Marine Fauna	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.	**Marine Turtles** Green and flatback turtles use the Port Hedland area for foraging. Flatback turtles (*Natator depressus*) are endemic to Australia and are the most frequently found turtles nesting within the Port Hedland area predominantly at Cemetery Beach (Pendoley Environmental, 2009 as cited in BHP Billiton, 2010). They utilise Cemetery Beach for nesting with the peak nesting season being from December to February (DPAW, 2013a). **Marine Mammals** Humpback whales migrate through the north-west marine region to breed in warm waters off the Kimberly Coast. Peak migration periods are generally between June and July (Jenner et al, 2001). Spotted Bottlenose Dolphin and Dugong are also found in the Port Hedland area **Species of Conservation Significance** Thirteen species are listed under the EP Act as being of conservation significance. These are detailed in Appendix C and include: 1 x Priority 1 species 2 x Priority 2 species 9 x Schedule 1species 1 x Schedule 4 = species In addition, 19 species listed under the EPBC Act may be present in the development area. These species are detailed in Appendix C.	**Potential impacts** Potential impacts from the Proposal on marine fauna include: • Physiological and / or behavioral impacts to fauna from the emission's relating to the proposal (e.g. light, noise and vibrations). • Fauna injury or mortality from direct interaction with construction vessels and/or the cable. • Other indirect impacts resulting from changes to the environment as a result of the proposal (e.g. changes in water quality, habitat disturbance, introduced marine species) **Impact Assessment – Marine Fauna** <u>Physiological and / or behavioral impacts</u> *Vibrations from HDD Drilling* The scientific literature contains little information on the impact of terrestrial vibrations on nesting sea turtles. There is anecdotal evidence that vibrations may influence the nonsynchronous emergence of hatchlings, but this has not been tested. It should be noted though, that unlike rock and water, sand is a poor conductor of vibration (Guinea, 2007). Due to the lack of available literature on the potential impacts the Proponent has committed to not undertake HDD activities at Cemetery Beach during peak turtle nesting and hatching (See table 2 Appendix C). As such, potential impacts to turtles from HDD drilling vibrations are expected to be minimal. *Noise Impacts* The geophysical survey will produce underwater noise that could potentially lead to behavioral changes of marine fauna transiting the survey area i.e. mask sounds vital for cetacean navigation, identification of prey and predator locations etc. A low powered geophysical survey that does not include airguns is proposed. It is expected to generate noise levels between 110-130 dB, decreasing rapidly with distance from the source (refer to Appendix B). The radiated power generated from a seismic survey is significantly higher than what is generated from a geophysical survey; therefore the latter have much less of an impact on marine fauna. The intensity of the source level is also significantly greater in a seismic survey which uses airguns, than with a geophysical survey which uses echo sounders. For details on radiated power vs source level for geophysical and seismic surveys, see (refer to Appendix D). Survey activities in and around Western Australia State Waters are expected to be completed within a matter of days. Given the short nature and low power of the geophysical survey it is considered very unlikely that marine fauna will be significantly impacted by noise emissions from the geophysical survey. *Light Impacts* Light spill has been found to disrupt female turtles while they're nesting and cause	The following management measures will be applied to this Proposal to protect marine fauna from potential impacts: *Vibrations from HDD Drilling* • Procedures will be incorporated in the directional drilling contractor's Environmental Management Plan to minimise the impact of the loss of drilling fluid as the drill pipe exits through the seabed, such as by the introduction of additional quantities of water into the drilling fluid to dilute the concentration of additives when the breakthrough is imminent. *Noise Impacts* • Interaction between survey vessel and cetaceans within the survey area will comply with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.04 – Interacting with Cetaceans) which are as follows: • o Survey vessels will not travel at greater than 6 knots within 300 m of a cetacean (caution zone). o Survey vessels will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of animals bow riding); *Light Impacts* • Lighting will be maintained at minimum levels that allow safe operation of equipment i.e. no excess lighting *Habitat Disturbance* • Route selection processes to include 10 km (max width) development corridor. Final route to be within this corridor and take into account habitat identified during phase 1 – geophysical survey. *Introduced Marine Species (IMS)* • The Proponent will comply with State and Commonwealth biosecurity requirements to prevent IMS. *Water Quality Impacts* • Vessels will have appropriate waste management procedures and emergency fuel/ oil spill plans in place (i.e. MARPOL regulations). • Addition of water to the drill head as the drill head reaches the exit points to reduce the concentration bentonite and polymers lost to the water column.	Impacts to marine fauna are expected to be minimal and with the proposed management measures in place, the EPA management objective for Marine Fauna is expected to be achieved.

Factor	EPA Management Objective	Existing Environment	Impact Assessment	Avoidance, Mitigation and Management Measures	Predicted Environmental Outcomes
			disorientation to hatchlings. Light spill will occur for a shorty duration (approximately 5 weeks) from the HDD rig at Port Hedland in close proximity to Cemetery Beach. As previously noted the Proponent has committed to not undertaking HDD activities at Cemetery Beach during peak nesting season. As such, impacts to nesting turtles from lighting from the HDD rig are expected to be negligible. Light emissions will also occur as a result of the 24 hour operation of the survey and cable lay vessels. These emissions which will be similar to that of standard marine construction vessels are unavoidable due to safety and navigational requirements. Marine fauna including turtles and shorebirds, transiting through the area, may temporarily alter their normal behavior due to attraction to the light emissions from the vessel. This attraction may increase their vulnerability to predation (DSEWPaC, 2012). This is particularly the case for seabirds where interruption of their migratory path may potentially lead to incomplete migration. However, the short duration of the geophysical survey and cable lay activities and the limited extent of light spill, make it highly unlikely that any significant impacts will be caused to marine fauna as a result of light spill. <u>Injury or Mortality from Direct Interaction with Proposal</u> *Vessel Strike / Entanglement with Infrastructure* Given the short duration of the survey and cable lay activities and the low speed at which the vessels will be travelling (6-7 knots), it is considered highly unlikely that any significant impacts will occur to marine fauna as a result of vessel strike. <u>Indirect Impacts</u> *Habitat Disturbance* HDD will be used at the shore crossings at Port Hedland. As such there is not expected to be any habitat disturbance of the shoreline and no impacts associated with loss of foraging habitat. The burial of the cable in near shore waters (in water depths of up to 700 m) may temporally disturb the sub-tidal habitat. This disruption is expected to be minimal in extent (in the order of a few meters width) and temporary in nature. Existing information and the results of the geophysical survey will be used to avoid ecological features. As such, the impact of habitat disturbance on marine fauna as a result of cable lay activities is expected to be very minor and temporary and as such is not expected to be significant. *Introduced Marine Species (IMS)* IMS could potentially be introduced via vessel movements, ballast water discharge and bio fouling activities and have the potential to prey on and/or compete with native marine species. The management measures in place are expected to be sufficient to prevent the introduction of IMS and impacts to marine fauna are considered highly unlikely. *Water Quality Impacts - Discharges from HDD Drilling* A small volume (estimated at approximately 20-30 m^3) of drilling fluids are expected to be released near-shore, at the HDD exit point. The concentration of drilling fluid released will be minimised by the addition of water as the drill head approaches the exit point (thus diluting the drill fluid). The main component of this drilling fluid is bentonite which has a low toxicity, is biodegradable and it highly dispersive. Given the relatively low volume of drill fluid to be released and its low toxicity and		

Factor	EPA Management Objective	Existing Environment	Impact Assessment	Avoidance, Mitigation and Management Measures	Predicted Environmental Outcomes
			dispersive nature, there is not expected to be any resultant impact to water quality or marine fauna. The volume of drill cuttings that will be generated at the HDD site will be between 5-10 m^3. These drill cuttings will be taken onshore and disposed of in accordance with relevant regulations. *Water Quality Impacts – Turbidity* The cable lay activities are expected to cause minor, short term and localised elevated turbidity levels. Given the turbid nature of the waters around Port Hedland, these short term events (in the order of hours) are not expected to impact on marine fauna. *Water Quality Impacts - Accidental Waste, Hydrocarbon or Chemical Discharge* Waste, hydrocarbon and / or other chemicals accidentally discharged have the potential to be toxic to marine fauna that may be present in the area. The likelihood of an accidental waste, hydrocarbon or chemical discharge from the cable lay vessel is expected to be low, due to the management procedures that will be implemented and the short duration of the cable lay activities. As such it is considered unlikely that any significant impacts will occur.		

Table 6-2 : Summary of Relevant Environmental Factors

Factor	EPA Management Objective	Existing Environment	Impact Assessment	Avoidance, Mitigation and Management Measures	Predicted Environmental Outcomes
Benthic habitat and communities	To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales.	• Dense areas of arid zone mangroves occupy the intertidal areas along the coastline in Port Hedland however, mangroves are not found to exist directly at Cemetery Beach The majority of sub-tidal benthic habitat is characterised by un-vegetated substrate with sparse patches of turf algae • Topography along proposed route predominantly influenced by the Abydos Plain (SKM, 2010) • Coastal fringe of the mainland is generally 10 m AHD (Australian Height Datum) or less (SKM, 2010) • Port Hedland is located on sandy calcarenite and oolite and calcilutite sedimentary soils known as the Holocence, Bossut Formation (SKM, 2010) • Coastal areas composed of saline muds and marine sands (SKM, 2010).	**Potential Impacts** Potential impacts from the Proposal on marine benthic habitat include: • Changes to benthic habitat structure from IMS • Physical disturbance to benthic habitats and damage to and localised losses of benthic assemblages i.e. macroalgae, sponges, ascidians and corals as a result of cable lay activities • Toxic or sub-lethal impacts on sessile and less mobile benthic marine organisms as a result of HDD drilling activities. **Impact Assessment** *Disturbance of Benthic Habitat* Within WA state waters, the cable will be buried and as such direct disturbance to benthic habitat will occur along the cable route. This disruption is expected to be minimal in extent (in the order of a few meters width) and temporary in nature. The final route will be selected to avoid any identified significant habitat (e.g. seagrass). Significant habitat mapping in the Port Hedland area was undertaken by BHP Billiton Iron Ore who described the area as a sparse mixed mosaic habitat existing in a dynamic, frequently disturbed area (BHP, 2010). BHP Billiton Iron Ore found that disturbed habitat in the area would recover within five years as long as the substrate was not removed. Given the low size of the disturbance area, the sparse nature of the habitat, the high representation of similar habitat in the area and the high likelihood of rapid recovery post disturbance, the impact to benthic habitat in the area as a result of the proposal is considered to be very minor. *HDD Drilling Fluids* Escape of drilling fluids has the potential to cause toxic or sub-lethal impacts to benthic marine organisms. With the implementation of management procedures and the small volume of fluids that are estimated to be released the impacts to benthic habitats and communities from cable lay activities are expected to be minimal. *Introduced Marine Species* For impacts from IMS see marine fauna section (Table 6-1).	The following management measures will be applied for benthic habitats and communities: *Disturbance of Benthic Habitat* • Route selection processes to include 10 km route corridor. Final route to be within this corridor and take into account habitat identified during phase 1 – geophysical. *HDD Drilling Fluids* • For management procedures of drilling fluids see marine fauna section (Table 6-1). *Introduced Marine Species* • For management procedures of IMS see marine fauna section (Table 6-1).	As any potential disturbance to benthic habitat is expected to be minor and temporary, it is expected that the EPA objective will be met.
Key Ecological Features – Scott Reef	Key Ecological Features to not be adversely affected.	Scott Reef is an isolated coral reef system in Western Australia's north-west marine region and is listed as a Commonwealth Heritage Place (Gilmour *et al*, 2013). The area in the lagoon at south Scott Reef includes a diverse community of hard corals and soft corals, sponges, algae, sea urchins and other organisms (Gilmour *et al*, 2013). Scott Reef is known to support diverse pelagic and benthic marine species and waters surrounding the reef are nutrient deficient with tides that are generally diurnal and reach a peak of 4.5 m during the spring tide (DEWHA, 2008; Woodside, 2011).	**Potential Impacts** Potential impacts from the Proposal on Scott Reef include: • Disturbance to marine species, particularly threatened and migratory species as a result of the geophysical surveys and light spill. **Impact Assessment** While the cable route and associated survey runs in relatively close proximity to Scott Reef, the outer edge of the survey corridor is 17 km from the environmentally sensitive areas as defined by the DEC (2012). As can be seen in Appendix B, the proposed survey equipment is expected to only cause disturbance to marine fauna a maximum of 6 km from the source (and significantly less at most times). As such there is not expected to be any impact to marine fauna at Scott Reef from the Proposal. Given the distance from the vessels to Scott Reef (>17 km), there is not	As there are not expected to be any impacts to Scott Reef from the Proposal, no addition management measures are proposed.	There is no significant impact expected to Scott Reef from the proposed activities. The project can be implemented to meet the EPA objective.

Factor	EPA Management Objective	Existing Environment	Impact Assessment	Avoidance, Mitigation and Management Measures	Predicted Environmental Outcomes
			expected to be any impact to marine fauna at Scotts reef as a result of light emissions from the proposal.		
Marine Environmental Water Quality	To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.	Nearshore environments near Port Hedland are characterised by variable turbidity, high sedimentation and variable light and temperature conditions.	**Potential Impacts** Potential impacts from the Proposal on marine water quality include: • Reduction in water quality due to ploughing and/or jetting • Reduction in water quality due to the release of drilling fluids during HDD drilling **Impact Assessment** The cable lay activities are expected to cause minor, short term and localised elevated turbidity levels. Given the turbid nature of the waters around Port Hedland, these short term events (in the order of hours) are not expected to be significant. There is not expected to be any significant impact to water quality as a result of HDD (refer to Table 6-1)	The following management measures will be applied for marine water quality: • Addition of water to the drill head if fluids are anticipated to be lost. This will dilute the bentonite and polymers being released into the water column.	The project is unlikely to significantly impact marine environmental water quality as the control measures for managing the release of drilling fluids at the HDD exit point will prevent any impacts from occurring. The project can be implemented to meet the EPA objective.
Heritage and Maritime Archaeology	To ensure that historical and cultural associations are not adversely affected.	There are no National Heritage Places in close proximity to cable route. There are no known shipwrecks found within close proximity to the cable route in WA state waters.	**Potential Impacts** Potential impacts from the Proposal on heritage include: • Physical disturbance to unknown shipwrecks **Impact Assessment** There are no impacts expected to non-indigenous and natural heritage values. The unpublished Archaeological report prepared for Visionstream on behalf of the Proponent (Appendix E), indicates that there are no Aboriginal artefacts in the immediate vicinity of the proposed activity. Therefore, impacts are considered to be negligible.	The following management measures will be applied for heritage and maritime archaeology: • Route selection process to avoid known shipwrecks • If during the course of the cable laying operation a shipwreck is encountered, measures will be undertaken to lay the cable around the wreck. Survey data will be used to finalise the proposed installation route to avoid debris or shipwrecks. Any survey data that is gathered during the geophysical survey or the cable lay that indicates new debris or shipwrecks will be forwarded to the relevant authority.	The project is not expected to impact recognised non-indigenous and natural heritage site and will meet the EPA objective.
Social (Recreational and Commercial Fishing)	Social and Recreational fishing are not adversely affected.	Commercial fisheries operating offshore from Port Hedland include: • Nickol Bay Prawn Fishery • Mackerel Fishery • Pearl Oyster Fishery • Non-maxima Pearl Oyster Aquaculture Lease; and • Pilbara Demersal Finfish Fishery • Recreational fishing is common in Port Hedland	Potential impacts from the Proposal on recreational and commercial fisheries include interactions between construction vessels and fishing vessels. While exclusion zones will be applied during construction, These will only be in place temporarily (matter of weeks) and are unlikely to be in place around key fishing areas. There will be no long term exclusion zones around the cable.	The following management measures will be applied for recreation and commercial fisheries: • Fisherman will be made aware of dates of the cable route survey and cable laying activities so these items and areas can be avoided. • Notices for surveys and cable lay works will be placed on boat ramps, sailing clubs, fishing stores, Recfishwest website and VMR	The project is not expected to impact on commercial and recreational fisheries and as such the EPA objective will be met.

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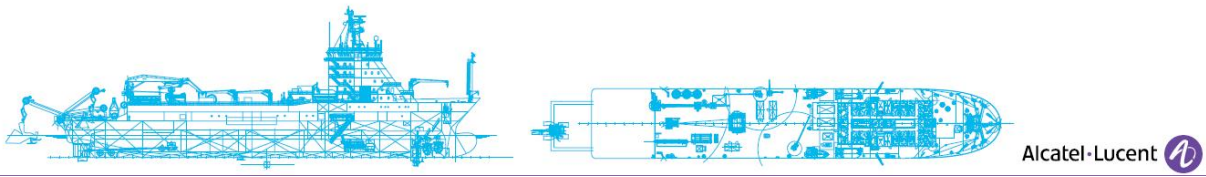
Appendix A. **Vessel Technical Specifications**

Ile de Brehat / Ile de Sein / Ile de Batz

Installation vessels

Technical Specifications

DESCRIPTION / POSITIONING	Three state-of-the-art vessels, highly powerful for long-haul cable installation and burying in the harshest conditions. Duplex DP and Integrated Control System
OWNER	ALDA MARINE
OPERATOR	ALDA MARINE S.A.S.
SHIP MANAGER	LOUIS DREYFUS ARMATEURS S.A.S.
FLAG	French
CONSTRUCTION YEAR	2002
LENGTH OVERALL	140.36 m
BREADTH	23.40 m
DRAFT	8.00 m (summer draft)
DEADWEIGHT	9820 mt
ACCOMMODATION	Single cabins: 60; double cabins: 5
CABLE TANK CAPACITY	Main cable tank: 2 x 2500 tonnes (max cap each tank: 3500 tonnes), 2 x 1500 m^3 Spare cable tank: 2 x 250 tonnes, 2 x 150 m^3
REPEATER STORAGE	2 x 100
CABLE MACHINERY	1 Linear Cable Engine – DOWTY 21 Wheel pairs, Drum Engine – DOWTY 6T DOHB / 28T Drum, 2 Transporter – DOWTY 2 Wheel Pairs, 1 Stern Hauler – DOWTY 2 Wheel Pairs
TYPE OF PLOUGH	1 SMD HD3 Plough – burial in all soils (including fractured rocks). Max burial: 3.00 m
CABLE LAYING SOFTWARE	MakaiLay
DYNAMIC POSITIONING	DP2 BV PDY MATAR ALSTOM
TRANSIT SPEED	15 knots
BOLLARD PULL	100 tonnes
POWER GENERATION	4 x 4320 kW MAK + 1 x 1360 kW MAK
THRUSTERS	2 x Lips 1500 kW Bow Thrusters, 1 x Lips 720 rpm - 1500 kW AZ Fore Thruster 2 x Lips 1500 kW Aft Thrusters
PROPULSION	2 electrically driven fixed pitch propellers. Output 4000 kW each. Propeller diameter: 3700 mm. Max propeller speed: 146 rpm



Alcatel·Lucent

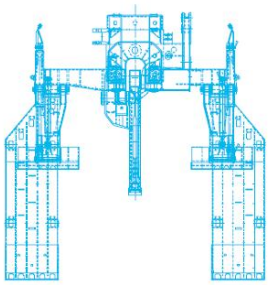
SMD Heavy Duty HD3 Plough

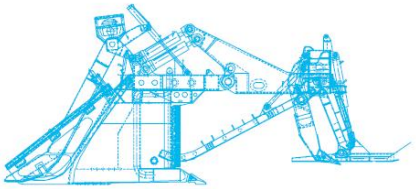
Ploughs

Technical Specifications

GENERAL SPECIFICATION AND OPERATION

DIMENSIONS	10.82 m long (skids down, plough hinged, depressor down) 4.80 m high (plough hinged) 5.96 m wide (over rear stabilisers)
SUBMERGED WEIGHT	25 tonnes (excluding ripper and jetting package)
OPERATION	Pulled by tow wire from surface vessel
CONTROL	Full remote control from shipboard control cabin or from remote control console whilst being towed
STEER ANGLE	+/- 16º
BURIAL DEPTH	2.30 m trench depth at zero share pitch (soil dependent) 3.00 m achievable in soft soils with plough pitched aft Optional interchangeable share 1.5 m available A forward mounted Rock Tooth can cut the trench in rock usually with a layer of soil above it
OPERATING DEPTH	1500 m maximum
REPEATER BURIAL	Repeater burial depth 50-90% of plough burial depth, dependent on soil conditions
SOIL TYPE	Any, within limits of pull force (130 tonnes)
SOFT MUD CAPACITY	5 kPa minimum
PLOUGHING SPEED	Recommended maximum 2 knots depending on seabed conditions
HYDRAULIC SYSTEM	RESERVOIR: Flexible pressure compensated, 100 litres working capacity SYSTEM HYDRAULIC OIL: Houghton Vaughan Hydrodrive HPE 22
CYLINDERS	Heavy duty marine type with welded swivel eyes
SURVEILLANCE EQUIPMENT	The surveillance equipment comprises CCTV cameras, associated lamps, pan and tilt units CAMERAS: 3 x SIT LAMPS: 5 x 150 W 24 V incandescent SONAR: Mesotech 1000 digital sonar head (range up to 100 m) HYDROPHONE: A hydrophone is provided with an integral pre-amplifier ACOUSTIC POSITIONING: Provision is made for responder/ transponder unit





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Appendix B. **Survey Equipment**

Survey Equipment	Frequency (kHz)	Source Level (dB re 1µPa-m)	Energy (dB re 1µPa^2-s)	Stand-Off Distance (km)	
				Disturbance	Harassment
Single Beam Echosounder					
Kongsberg EA400 Dual Frequency	38 / 200	180	82	0.01	0.001
Multi Beam Echosounder					
0 - 100m Depths: Reson Seabat 8125	455	216	118	0.11	0.03
0 - 250m Depths: Simrad EM 3002	300	207	111	0.1	0.035
0 - 700m Depths: Simrad EM 710	70	210	114	0.4	0.11
500 - 10,000m Depths: Simrad EM 122	12	211	117	6	1.0
Side-Scan Sonar					
GeoAcoustics Sidescan dual frequency	100 / 500	223	127	0.37	0.08
Klein 3000	100 / 500	223	127	0.37	0.08
Benthos Combined	100 / 400	225	129	0.40	0.10
High-Resolution Sub-Bottom Profilers					
Applied Acoustics AA201 & AA301	0.5 – 7	215	122	0.55	0.045
C-Boom	0.5 – 2.5	220	127	1.0	0.08
GeoAcoustics GeoChirp II	0.5 – 13.5	205	112	0.18	0.014
GeoAcoustics 4x4 Pinger	0.5 – 13.5	210	117	0.32	0.025
Kongsberg GeoPulse	2 – 12	214	121	0.5	0.04
Benthos Combined	3	207	114	0.22	0.08
Reflection & Refraction Sparkers					
Applied Acoustics Delta Sparker	0.2 – 5	226	136	2.0	0.16
EGS Seabed Refraction Sparker	0.1 – 3	220	130	1.0	0.08
USBL Positioning System					
Sonardyne USBL 8021	19 - 36	202	109	0.1	0.01
Sound Sources Used In Hydrocarbon Exploration					
Airgun	0.05 - 0.25	243	153	14	1.2
Airgun Array	0.05 - 0.25	255	165	56	4.5

Equipment not used in survey

Appendix C. **Protected Marine Fauna**

Table 7-1 : Protected Marine Fauna

Scientific Name	Common Name	EPBC Migratory Status	EPBC Threatened Status	Priority Codes for WA Fauna	Conservation Codes for WA Fauna
Birds					
Macronectes giganteus	Southern Giant-Petrel	Migratory	Endangered	P4	-
Rostratula australis	Australian Painted Snipe	-	Endangered	-	T
Apus pacificus	Fork-tailed Swift	Migratory	-	-	-
Fregata ariel	Lesser Frigatebird	Migratory	-	-	-
Mammals					
Balaenoptera musculus	Blue Whale	Migratory	Endangered	-	T
Megaptera novaeangliae	Humpback Whale	Migratory	Vulnerable	-	T
Balaenoptera edeni	Bryde's Whale	Migratory	-	-	-
Dugong dugong	Dugong	Migratory	-	-	S
Orcinus orca	Killer Whale	Migratory	-	-	-
Sousa chinensis	Indo-Pacific Humpback Dolphin	Migratory	-	P4	-
Tursiops aduncus	Spotted Bottlenose Dolphin (Arafura/Timor Sea Populations)	Migratory	-	-	-
Reptiles					
Aipusurus apraefrontalis	Short-nosed Seasnake	-	Critically Endangered	-	T
Caretta caretta	Loggerhead Turtle	Migratory	Endangered	-	T
Chelonia mydas	Green Turtle	Migratory	Vulnerable	-	T
Dermochelys coriacea	Leatherback Turtle	Migratory	Endangered	-	T
Eretmochelys imbricate	Hawksbill Turtle	Migratory	Vulnerable	-	T
Natator depressus	Flatback Turtle	Migratory	Vulnerable	-	T
Sharks					
Pristis clavata	Dwarf Sawfish	-	Vulnerable	P1	-
Rhincodon typus	Whale Shark	Migratory	Vulnerable	-	-

** P1: Priority one: Poorly-known species (on threatened lands) - Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.*

** P4: Priority four: Rare, Near Threatened and other species in need of monitoring - (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.*

**T: Schedule 1 under the Wildlife Conservation Act 1950; Threatened Fauna (Fauna that is rare or is likely to become extinct). Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.*

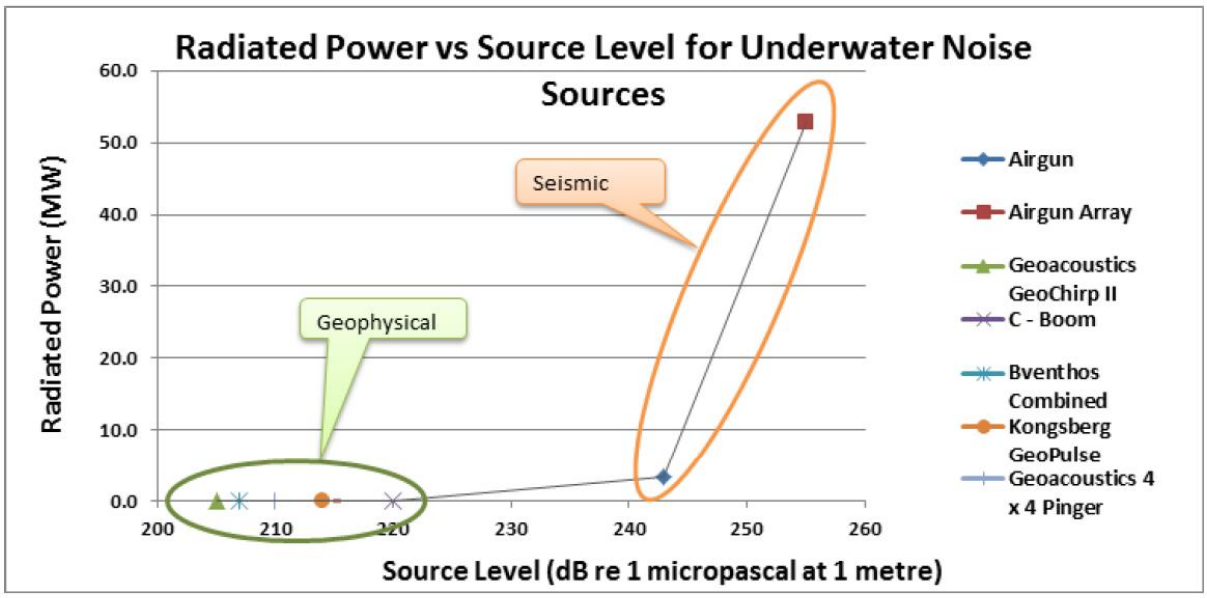
S: Schedule 4 under the Wildlife Conservation Act 1950; Other specially protected fauna. Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.

Table 7-2 : Movements patterns of key marine fauna

Marine Fauna	J	F	M	A	M	J	J	A	S	O	N	D
Near shore species												
Turtles - nesting *EPA, 2010*	X	X	X							X	X	X
Dugongs – calving *McCauley, 1994*							X	X	X			
Salt-water crocodile *DoE, 2013l*	X	X										X
Open ocean species												
Humpback whales -northern migration *McCauley, 1994*					X	X	X					
Humpback whales – southern migration *McCauley, 1994*								X	X	X		
Blue whales – northern migration *McCauley and Jenner 2010 in DSEWPaC, 2012b*				X	X	X	X	X				
Blue whale – southern migration *McCauley and Jenner 2010 in DSEWPaC, 2012b*										X	X	X
Whale sharks *DPAW 2013b*					X	X	X					

Peak nesting periods

Appendix D. **Radiated Power vs Source Level for Underwater Noise**



Source	Acoustic Power (Watts)
Geoacoustics GeoChirp II	528
Bventhos Combined	838
Geoacoustics 4 x 4 Pinger	1671
Kongsberg GeoPulse	4198
Applied Acoustics	5284
C - Boom	16711
Airgun	3334264
Airgun Array	52844525

The **decibel** (**dB**) is a logarithmic unit used to express the ratio between two values of a physical quantity (usually measured in units of power or intensity).

Appendix E. **Archaeological Survey Report**

REPORT ON CULTURAL HERITAGE SURVEYS OF PLACES AT ONSLOW AND PORT HEDLAND, W.A., WHERE A SUBMARINE FIBRE OPTIC CABLE MAY COME ASHORE

prepared for

Visionstream Pty Ltd, Melbourne, Victoria

by

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February 2014

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APPENDIX

Executive Summary

Surveys to identify and avoid any traces of Aboriginal cultural heritage were undertaken at Onslow and Port Hedland on 4-5 December 2012 at several places where a submarine fibre optic cable might come ashore, to determine which proposed development area (PDA) was the least destructive option.

Visionstream Pty Ltd (the 'Company') had been contracted by NextGen Networks Pty Ltd, a licenced telecommunications carrier within Australia, to provide the requisite engineering and regulatory services for this project, which will be carried out under the *Telecommunications (low impact facilities) Determination Act* (1997), and to act as the principal point of contact for all the permits required for the marine work and terrestrial landings

In the deep sea, the cable will simply rest on the seabed, but once the water depth off the Western Australian coast shallows to 1500 m, some 150 km offshore at Onslow and over 250 km offshore at Port Hedland, the cable will be ploughed into the seabed to a depth of approximately 1 m, depending on the hardness of the substrate.

The cable will come ashore, at either Onslow or Port Hedland, through a tunnel 150 mm in diameter and up to 1 km long that will be drilled at least 1.5 m below the beach and sea floor to connect the offshore cable to inspection manholes on land. Directional drilling disturbs the ground surface very little; while the likelihood of the areas to be drilled containing an *in situ* buried cultural component are vanishingly small. A cable will connect the manhole to a CEV site, a prefabricated building housing electronic equipment that requires a cleared area of 100 sq m for its construction.

The author was required to inspect carefully two possible positions for the beach manhole and CEV site at Onslow, Options 1 and 2, three at Port Hedland, Options A, B and C; and the routes connecting the offshore cable with the onshore facilities at both towns. Which site would finally be chosen would rest at least in part on the results of those inspections. Should conclusive evidence of past Aboriginal activity be identified near any of the PDAs, their locations would be changed.

At Onslow, the preferred site for the manhole (Option 1) was in an informal carpark near the beach, some metres north of the pre-existing deep water jetty. The CEV site was adjacent to the town's Sports Complex. The cable connecting the two would be laid in road reserve in a trench less than 0.5 m wide and at least 1 m deep. The maximum width of cleared ground required for the cabling machinery to manoeuvre easily is 5 m. The beach manhole for Option 2 was on the foreshore on the northeastern edge of town and the CEV site was on a vacant block in the town centre. A third possible CEV site location was rejected as already being full of Telstra equipment.

At Port Hedland, regardless of which site was preferred, the inspection manhole would be within the CEV compound. Option A was always the Company's preferred choice. It is located east of the Sports Complex opposite the Shire Offices. The cable would connect with the submarine cable through a directional bore deep beneath Clarke Street and the beach below Sutherland Street. Option B was located to the west of the Sports Complex and would connect to the submarine cable by a directional bore beneath the Shire Offices. Option C, perched on a high cliff at corner of Howe and Kingsmill Streets, was only inspected cursorily because the site is too constricted to be suitable for CEV construction. It had been suggested by the Port Hedland Town Council because other infrastructure is already installed there. The beach below Sutherland Street was also inspected because it is a turtle nesting ground.

No surface traces of Aboriginal cultural material could be found at any of the areas inspected, all of which have been comprehensively disturbed. Hence, the likelihood of there being a buried cultural component at any PDA was considered to be vanishingly small.

As a result of those inspections, and in light of subsequent discussions between the Company and Port Hedland Town Council, during which Option A, east of the Sports Complex, was definitively chosen as the CEV site, the author makes the following **recommendations**:

No additional surveys of Option A at Port Hedland will be required before cable installation begins, but it is **recommended** that the connecting cable from the CEV site to the submarine cable should be run through a directional bore deep beneath the beach below Sutherland Street, to avoid the possibility of disturbing turtle nests, since the animals come ashore there to breed.

Furthermore, the Company is reminded of its legal obligation to report the discovery of human remains to the Police, the Department of Aboriginal Affairs (tel: 08-6551-8000) and the relevant Aboriginal Corporation or instrumentality. Human remains must ***not*** be moved until they have been inspected by ***all*** these authorities. Ideally, human remains should be removed by a skilled forensic archaeologist.

The Company must also ensure that cable installation crews and contractors are made aware of their legal obligations under the *Aboriginal Heritage Act* (1972), that they adhere to the areas surveyed and remain vigilant at all times in case human bones, stone artefacts or shell midden deposits are found below the present ground surface. Should any such signs of past Aboriginal activity be noted, work ***must*** cease immediately and the Company ***must*** be notified.

The author was requested by the Company not to submit this report any sooner for reasons of client confidentiality.

Acknowledgements

The author thanks Greg Neylan, Land Access and Regulatory Manager at Visionstream, for the speed and efficiency with which he answered her initial questions about the project and for accompanying her in the field.

She also thanks the staff in the GIS section of the Company who supplied her with many of the maps and visual images included in this report.

Disclaimer

This report was prepared for Visionstream Pty Ltd on the basis of the ethnographic information available to the author at the time the surveys were undertaken. The author cannot be held responsible for omissions of or inconsistencies with any information about the country covered by this survey that may become available in the future. While every attempt has been made to ensure that the ethnographic information contained in this report is accurate and correctly reflects the views of the authors of the works cited, such information cannot in and of itself form the basis of any current or future native title claims.

Notes

All the MGA co-ordinates given in this report are based on the **GDA-94** datum.

1 Introduction

In November 2012, Visionstream Pty Ltd (hereinafter the 'Company') commissioned the author to undertake cultural heritage surveys at several places at Onslow and Port Hedland where a submarine fibre optic cable might come ashore and connect to facilities to be constructed onshore, to ensure that no traces of past Aboriginal activity were impacted by the proposed works.

NextGen Networks Pty Ltd, a licenced telecommunications carrier within Australia, has been engaged to manage this project, which will be carried out under the *Telecommunications (low impact facilities) Determination Act* (1997). The Company has been contracted by NextGen to provide the requisite engineering and regulatory services and to act as the principal point of contact for all the permits required for the marine work and terrestrial landings.

In the deep sea, the cable will simply rest on the seabed, but once the water depth off the Western Australian coast shallows to 1500 m, some 150 km offshore at Onslow and over 250 km offshore at Port Hedland, the cable will be ploughed into the seabed to a depth of approximately 1 m, depending on the hardness of the substrate.

If Onslow were selected, the cable would come ashore through a tunnel 150 mm in diameter and up to 1 km long that would be drilled at least 1.5 m below the beach surface and the sea floor to connect the offshore cable to an inspection manhole near the beach and thence to a CEV site, a prefabricated building housing electronic equipment that requires an area of 100 sq m devoid of traces of past Aboriginal activity for its construction. The onshore cable between each manhole and CEV site would be laid in road reserve in a trench 0.5 m wide and at least 1 m deep. The maximum width of cleared ground required for the cabling machinery to manoeuvre easily is 5 m.

There were two possible sites for both the beach manhole and the CEV site at Onslow. Option 1 for the beach manhole was located to the west of the town, some 100 m north of the deep water jetty built some years ago. The CEV site was in disturbed ground beside the sports oval. Option 2 was on the foreshore east of the town and the CEV site was in disturbed ground in the centre of town.

If Port Hedland were selected, the cable would also come ashore through a tunnel 150 mm in diameter drilled at least 1.5 m below the beach surface, but the inspection manhole would be sited within the CEV compound, for which there were three possible locations. Option A was sited immediately east of the tennis courts opposite the shire offices. Option B was sited in the informal carpark area east of the access road to the sports complex and race course. Option C was in an industrial complex at the corner of Howe and Kingsmill streets, west of the old hospital complex.

Having conducted heritage surveys for the Company in the past and watched boring take place (Webb 2002, 2010), the author can testify that directional drilling disturbs the ground only minimally. Trenching is more disruptive, but the ground along all the alignments to be trenched has already been disturbed by road construction and was inherently unlikely to include a buried *in situ* cultural component.

Nonetheless, to meet the Company's 'due diligence' approach to avoiding damaging or disturbing any place or object of cultural heritage significance, whether Aboriginal or European, the author was required to survey the places where the cable might come ashore in both towns, every possible CEV site and the ground between the onshore and offshore facilities. The surveys were undertaken in early December 2012. All the possible development areas were inspected, although only one will be selected for actual construction.

As well as conducting the field surveys, the author was required to compile a report which met the Department of Aboriginal Affairs' (DAA) criteria for cultural heritage survey reports. To achieve this, the

author was required to:

- undertake adequate background research to meet the requirements of Sections 15 and 17 of the Western Australian *Aboriginal Heritage Act* (1972, revised – hereinafter the *AHA*),
- identify any known or potential Aboriginal heritage issues that might affect cable installation,
- identify and record to the standards expected by DAA any Aboriginal sites found in or near the project development areas, or likely to be affected by cable installation,
- make recommendations regarding the management of both the known, and any previously unrecorded, Aboriginal sites identified during the surveys,
- submit a preliminary report to the Company in a timely fashion upon completion of the survey,
- submit the requisite number of hard copies of the final report, following any necessary editing, to the Company and DAA.

This report acquits those requirements.

2 Aim of the Survey

Archaeology is the study of the material culture of past human societies. In Australia, that material culture chiefly takes the form of flaked stone artefacts, because the organic artefacts Aboriginal people are known to have made rarely survive to form part of the archaeological record. Other types Aboriginal cultural evidence that may be found when conducting cultural heritage surveys include burials, caches of ritual objects, scarred trees, arranged stones, rock art and evidence of grinding activity; shell middens and fish traps may also be found, principally in the coastal zone.

Under Section 17 of the *AHA*, it is an offence to damage or disturb *any* evidence of past Aboriginal activity without prior consent *in writing* from the Minister of Aboriginal Affairs, in accordance with Section 18 of the *AHA*. Cultural heritage surveys are conducted in advance of any proposed development that will impact the present ground surface in order to ensure that such traces, ***sites***, are not damaged accidentally, and to record those traces in sufficient detail that, if disturbance is unavoidable, the landowner can successfully apply to DAA to disturb the site, under Section 18.

In Sections 5, 6 and 39 (2) of the *AHA*, Aboriginal sites are defined as places or objects that are/were important and/or significant to Aboriginal people. During surveys, such places or things are most efficiently identified by an archaeologist working in conjunction with Aboriginal people with personal knowledge of the country being surveyed.

The sections of the *AHA* that relate to cultural heritage surveys are cited in full in Appendix 1.

As practised in Australia, ethnography is the study of how Aboriginal societies functioned before British colonists arrived. As Hiscock (2008:182-186) noted, however, it is impossible now to determine whether the patterns of Aboriginal social and customary behaviour observed by the first British settlers to report such data can be extrapolated back into the archaeological past because, throughout Australia, the colonists' arrival began almost immediately to affect adversely Indigenous cultural behaviour not just in the areas colonised, but further afield. Hence, traditional Aboriginal social and customary behaviour collapsed within a generation of first contact. For example, King George Sound, now Albany, was settled in 1827, the Swan River Colony, now Perth, was founded in 1829; within a few years, Stirling (1835), was commenting to the Colonial Secretary in Westminster about the detrimental effect British arrival was having on the culture of the Noongar people of not just the Swan Valley, but the Southwest in general. Armstrong (1836), the fledgling colony's official Interpreter, made similar comments on the adverse effects of colonisation on Noongar culture and traditional life.

Despite the cultural dislocation that followed colonisation, and the disastrous effects of nineteenth and early twentieth century 'protectionist' policies on Aboriginal people (Haebich 1992, 2000), some older people in particular still relate to 'country' in ways that can be difficult for non-Aboriginal people to understand. Therefore, when conducting heritage surveys, it is important to involve Aboriginal people who 'know' the country to be surveyed, to ensure that no sites of ethnographic or socio-cultural significance are located in or near the project development area. Identifying the relevant people was comparatively easy in this case because the Native Title claim over Onslow has been determined. Buurabbalayji Thalanyji Aboriginal Corporation is a Registered Native Title Body Corporate that holds Native Title over Onslow. The Kariyarra Native Title claim has not yet been determined (WC99/3), but it covers Port Hedland. Neither group was consulted before the proposed development areas (PDAs) were surveyed on 4-5 December 2012, however, due mainly to the very short lead time between the project being approved and the field survey taking place, but also because the Company had carefully sited every PDA on ground that had already been comprehensively disturbed, probably for decades. Moreover, previous cultural heritage surveys at Onslow and Port Hedland had failed to identify any sites of cultural significance near any of the small parcels of land to be impacted by any of the PDAs.

Sections 15 and 17 of the *AHA* were scrupulously observed, however. Each PDA was carefully inspected by the author, a geoarchaeologist with over 20 years' experience of conducting field research and cultural heritage surveys in Australia.

3 Areas to be assessed

The areas assessed at Onslow are shown in Figure 1.

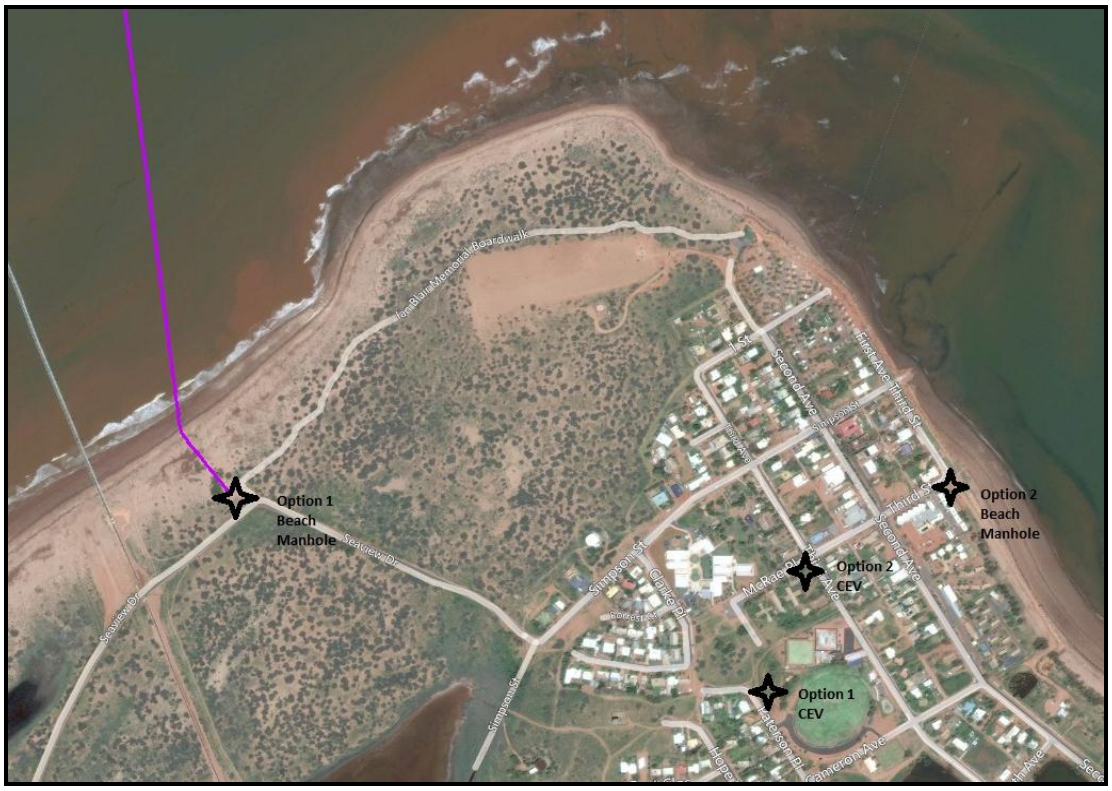

Figure 1: The proposed project development areas at Onslow. All four sites were inspected (image supplied by the Company).

Option 1 was the Company's preferred location here for the beach manhole. It is in a pre-existing informal carpark on the seaward side of the junction of Back Beach Road and Seaview Drive beside a formal picnic area, where an access track leads to the beach (Plates 1-3). The land is Unallocated Crown Land, responsibility for which is vested in the Shire of Ashburton. The cable (purple line in Figure 1) would come ashore through a tunnel 150 mm in diameter bored at least 1.5 m beneath the beach (Plate 4), as described above, some 100-200 m north of the large deep water jetty built some years ago to service offshore oil and gas exploration vessels (grey line in Figure 1). The preferred CEV site for Option 1 is beside the Sports Oval, on ground that has also already been completely disturbed (Plates 5-6). The cable connecting the CEV site to the beach manhole would be laid in a trench in the road reserve beside Back Beach Road (Plate 7) and Clarke Place.

Option 2 for the beach manhole at Onslow was located in a pre-existing recreation area on the eastern edge of town (Plate 8). The preferred CEV site for this option was behind the Onslow Community Garden, in an area of disturbed ground (Plates 9-10). A suggestion that the CEV building might be constructed in an compound already filled with Telstra equipment (Plate 11), was rejected by the Company. The compound is to crowded to accommodate a CEV building adequately.

Three PDAs were inspected at Port Hedland (Figures 2-4).

Figure 2: The preferred site for the onshore cabling facilities at Port Hedland (image supplied by the Company).

Options A and B are located south of McGregor Street within the Sports Complex, opposite the Town Offices. The Company's preferred site (Option A, Figure 2) for both the CEV building and the beach manhole is a low-lying area east of the tennis courts (Plates 13-14), which clearly becomes waterlogged when it rains. Option B is located to the west of the tennis courts in an area where people using the sports facilities park their cars (Figure 3). Option C is located on the corner of Howe and Kingsmill Streets (Figure 4), west of the abandoned Port Hedland Hospital. It is perched on a bluff

overlooking the Indian Ocean. All these areas, and the beach below Clarke and Sutherland Streets, were inspected. The land is all freehold, owned by the Town of Port Hedland. Native Title is, of course, extinguished over private property. At each option, the offshore cable would be connected to the CEV site through a tunnel 150 mm in diameter bored at least 1.5 m beneath the beach and pre-existing roads.

Figure 3: Option B for the site of the onshore cabling facilities at Port Hedland (image supplied by the Company).

Figure 4: Option C for the site of the onshore cabling facilities at Port Hedland (image supplied by the Company).

Option C is the Company's least preferred location for the CEV site because the free space available is too constricted. It was suggested by Port Hedland Town Council because other infrastructure has already been installed there.

4 Background

4.1 Geology

Geology and climate determine vegetation, fauna and water availability, which together determine how gatherer-hunters such as the Aboriginal occupants of the Pilbara coast would have used the land-scapes in which they lived around Onslow and Port Hedland; towns sited on very different bedrock.

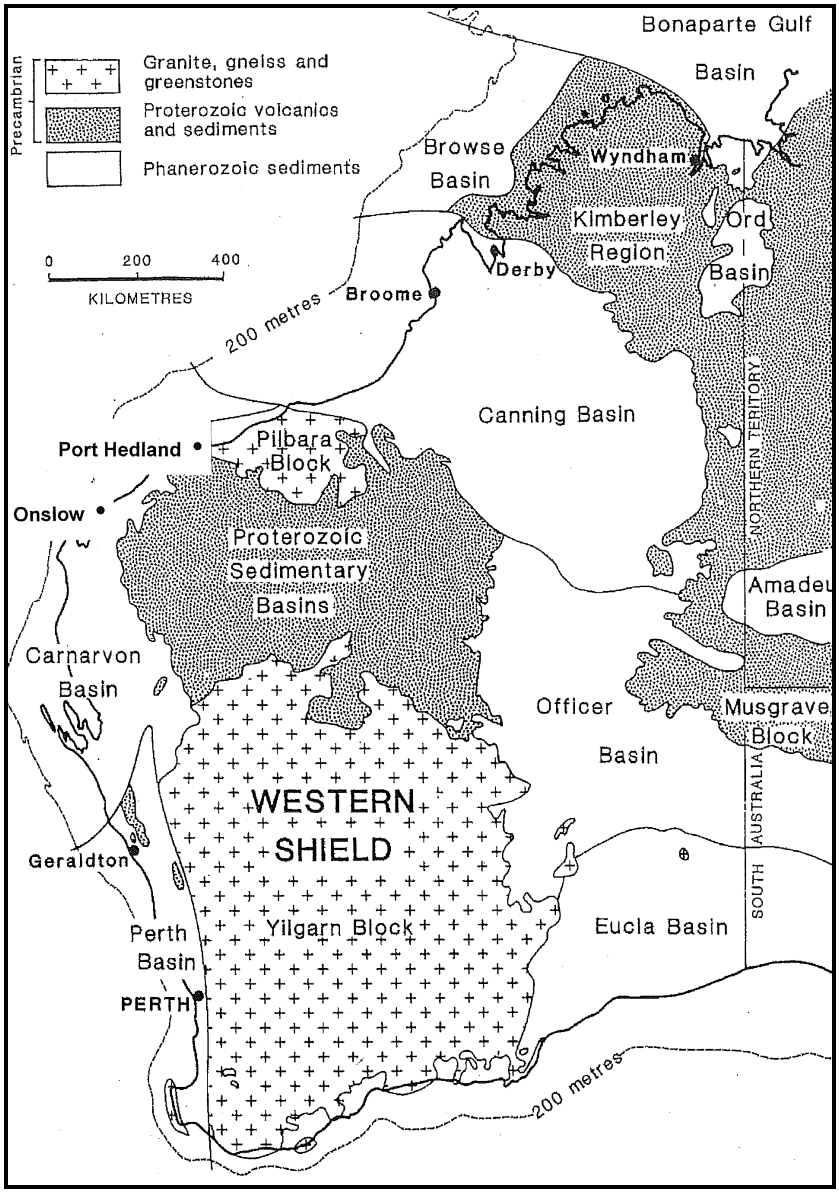

Figure 5: The geology underlying the proposed project development areas at Onslow and Port Hedland (Beard 1990:41).

Onslow is located at the northern end of the Carnarvon Basin (Figure 5) which is primarily

composed of uplifted coarse sediments originally deposited on the sea floor before Australia broke away from Gondwana in the Late Cretaceous, about 65 Ma (million years ago). These sedimentary rocks are porous and comparatively soft; forming a landscape of low relief where potable freshwater is rarely available on the present ground surface.

Port Hedland is located on the western edge of the Pilbara Block, a craton of Archaean shield rocks that is considerably older, albeit much smaller, than the Yilgarn Craton, which underlies much of the southern half of Western Australia (Figure 5). The beach below Sutherland Street is composed of Quaternary limestones that are approximately 20 m thick (Qhy in Figure 6). They formed during the Last Interglacial (van Kranendonk and Johnston 2009), Marine Isotope Stage (MIS) 5e, that climaxed approximately 120,000 years ago (BP). Sea levels were then 5-8 m higher than they are now (Chappell 2001). The Pilbara Craton formed over 300 Ma (Blockley 1975). Its greenstones include the very hard iron-rich rocks of the Banded Iron Formation (BIF) that have been the focus of mining activity ever since their potential was first realised in the late nineteenth century. Port Hedland was founded to service the mining industry. Iron ore from the inland Pilbara is brought to the port by rail to be shipped overseas for processing.

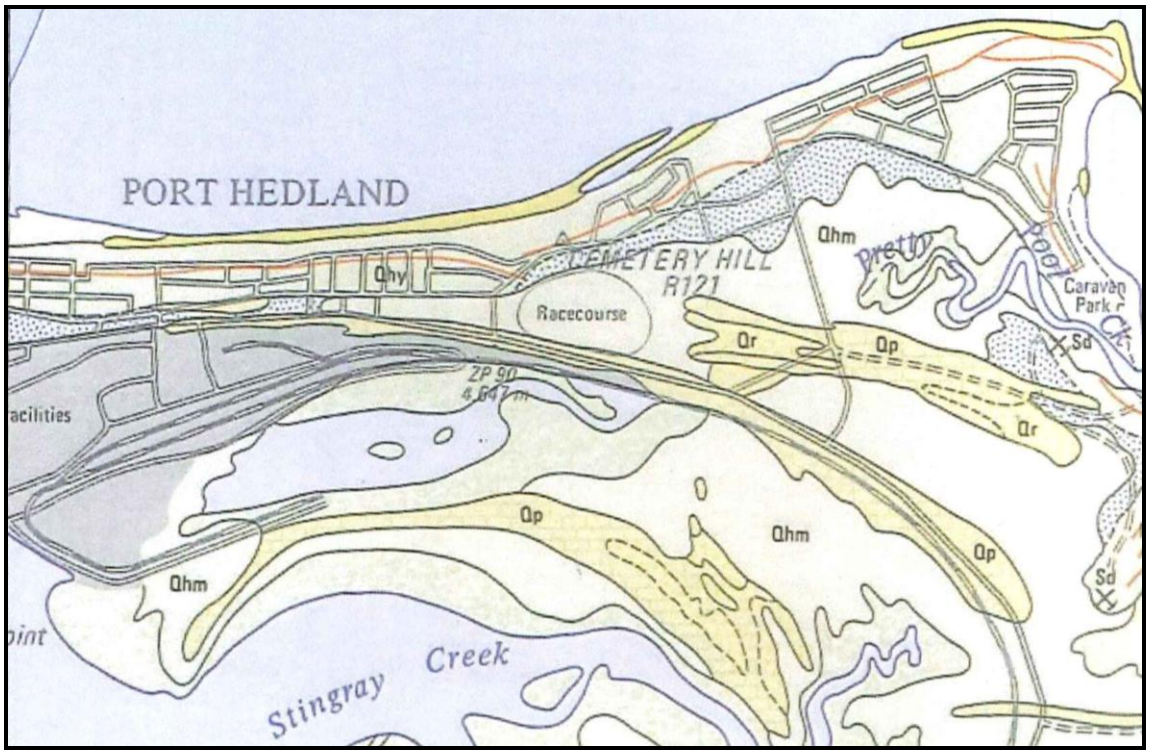

Figure 6: Detail of the geology underlying the proposed project development areas at Port Hedland, showing that it is all Quaternary in age (© Geological Survey of Western Australia).

4.2 Climate

Beard (1990:39) classified Onslow's climate as Desert with Summer Rain. Bureau of Meteorology data show that the town now receives 250-300 mm of rain a year, mostly in February, March, May and June (Figure 7). It rarely rains between September and December. Summer temperatures can reach 50 °C, while winter temperatures can drop below 5 °C; but the range is, on average, 20-35 °C.

Being located further north than Onslow, Port Hedland's climate is slightly warmer and (Figure 7). Beard (1990:39) classified it as Semi-Desert Tropical. The town receives more rain, about 310 mm a year,

than Onslow, but it falls more seasonally. One third falls in February during cyclone season. It rarely rains between August and November. The temperature range is similar to that at Onslow: 5-50 °C; but the average is slightly more extreme: 12-37 °C.

Evaporation, of course, exceeds precipitation at both towns by an order magnitude (Wyrwoll 1993: 40); meaning they both have negative water budgets.

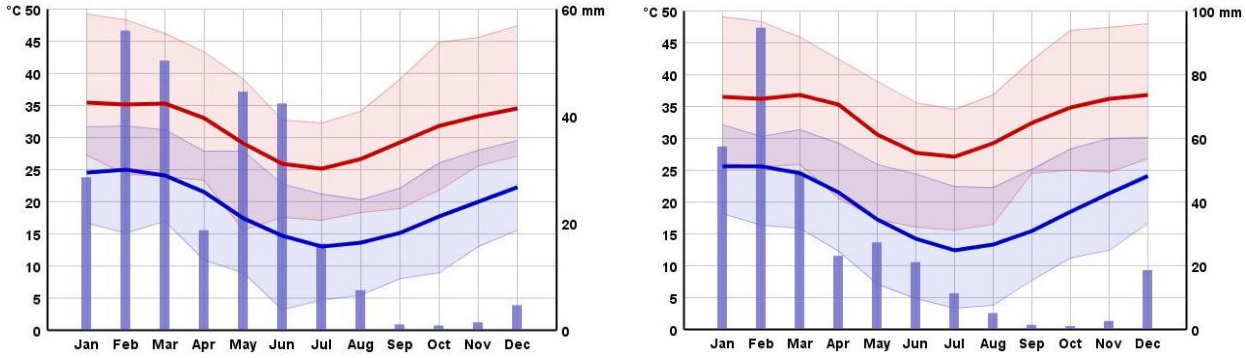

Figure 7: Bureau of Meteorology climatic data for Onslow (left) and Port Hedland (right).

It is well-known that global climate has changed radically over the past 50,000 or so years that people have lived in Australia (Hays *et al*. 1976). How those changes affected the Pilbara is more difficult to determine due to a lack of palaeo-environmental data (Kershaw 1995:658). The only site from which pollen data have been published is Dragon Tree Soak (Pedersen 1983; Wyrwoll *et al.* 1986) located 600 km inland from Port Hedland on the northern edge of the Great Sandy Desert. Carpenter's Gap I, an archaeological site in the inland Kimberley, 300 km northeast of Dragon Tree Soak, has yielded a 40,000-year-long palaeobotanic record (McConnell and O'Connor 1999; Wallis 2001; Hiscock and Wallis 2005; Frawley and O'Connor 2010), but the environmental picture it paints cannot be applied to either Port Hedland or Onslow because Carpenter's Gap is located in a different ecological zone.

All that can be said safely about the climate history of either Onslow or Port Hedland is that rainfall would have been considerably reduced and temperatures several degrees cooler during the Last Glacial Maximum (LGM = MIS 2), 25,000-15,000 BP, than they are at present (Pickett *et al*. 2004; McGowan *et al.* 2012). Sea level in the Indian Ocean would then have been about 130 m lower than at present (Chappell 2001), meaning that the coastline would have been about 70 km offshore at Onslow and nearly 200 km offshore at Port Hedland. Exposure of the continental shelf would have affected wind patterns and rainfall.

The climate of the Pilbara is principally driven by the Northwest Monsoon, which responds to orbital forcing and El Niño Southern Oscillation (ENSO) effects (Fitzsimmons *et al*. 2012; McGowan *et al*. 2012; Wyrwoll *et al*. 2012). ENSO creates shorter wetter summer monsoon seasons (Beaufort *et al*. 2010). The southward extent of the monsoon is inhibited by the Pilbara 'heat low' (Wyrwoll 1993). Wyrwoll and Miller (2001) argued that the monsoon intensified after 14,000 BP, but stabilised about 6500 BP (Wyrwoll *et al*. 1992, 1993); about the time when the Indian Ocean was also stabilising at its present level (Backhouse 1993).

More recently, McGowan *et* al. (2012) showed that changes to ENSO caused the Northwest Monsoon to fail between 6300 and 1300 BP. They argued that the resultant 'mega-drought' was so severe that it caused significant cultural change in Aboriginal societies in the Kimberley; although that scenario is controversial (Veth pers. comm. 2013). Whether it can be applied to the Pilbara is also unclear.

4.3 Flora and Fauna

Vegetation determines what animals can live in a given region. Onslow is located at the northern tip of the Carnarvon Botanical District (Beard 1990:202-213); Port Hedland in the Fortescue Botanical District (Beard 1990:240-252). Both districts are part of the Eremaean Province where drought-tolerant or xeric plants predominate.

Beard (1975:48-49) described the seaward edge of the Onslow Coastal Plain as salt flats, tidal swamps and sand dunes with saline loamy or shelly sandy soils. He mapped the native vegetation immediately around Onslow as spinifex (*Triodia* spp.) plains devoid of trees or shrubs (coloured pink in Figure 8), with saltbush *(Atriplex* spp.) and bluebush (*Kochia* spp.) scrub on sandy rises (purple in Figure 8) and unvegetated mudflats or claypans (white in Figure 8). Few traces of this natural cover survive at any of the PDAs surveyed because the land is 'managed' (Plates 1-3, 5-12); while the foreshore is sparsely vegetated with salt-tolerant grasses (Plate 4).

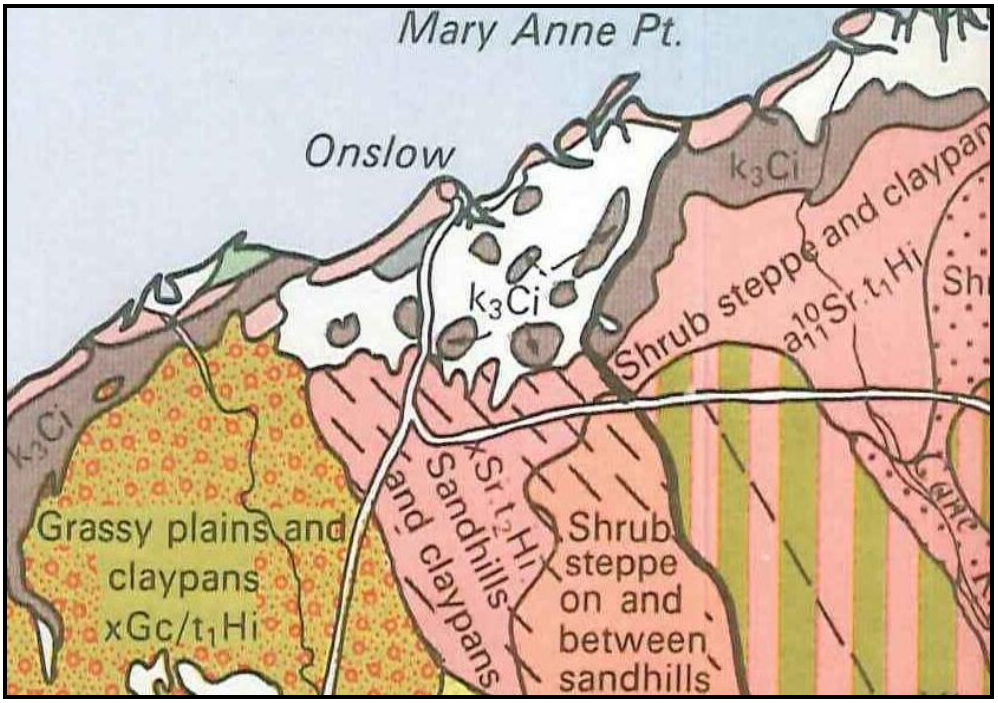

Figure 8: The natural vegetation around Onslow (Beard 1975).

The native vegetation at Port Hedland is similar (Beard 1975:50-56): spinifex (*Triodia* spp.) plains devoid of trees or shrubs (coloured pink in Figure 9), tidal mud flats supporting mangroves (*Barringtonia acutangula* or *Rhizophora mucronarta*, white and pale green in Figure 9) and dwarf shrubs and spinifex (pink+white), with grassy savannah with spinifex (green+red) on the high ground south of the railway line and roads. Few traces of this natural vegetation survive in the PDAs inspected because the land has been 'managed' for decades (Plates 13-14).

These coastal floras do not include many plants useful to humans (Wright 1970; Craig 1983), but the endemic herbivores would have eaten them happily.

No native animals were sighted during the surveys reported on below, due partly to the wholesale removal of the native vegetation over the areas surveyed. The surveys were also conducted in daylight, but most of the endemic fauna is nocturnal. Before colonisation, however, the country would have supported many birds and the terrestrial reptiles and mammals that Aboriginal people depended on for

food, while frogs, freshwater fish and shellfish could have been obtained from the Ashburton River near Onslow and the Turner River and Beebingarra Creek near Port Hedland; turtles, marine fish and shellfish can still be found in the Indian Ocean.

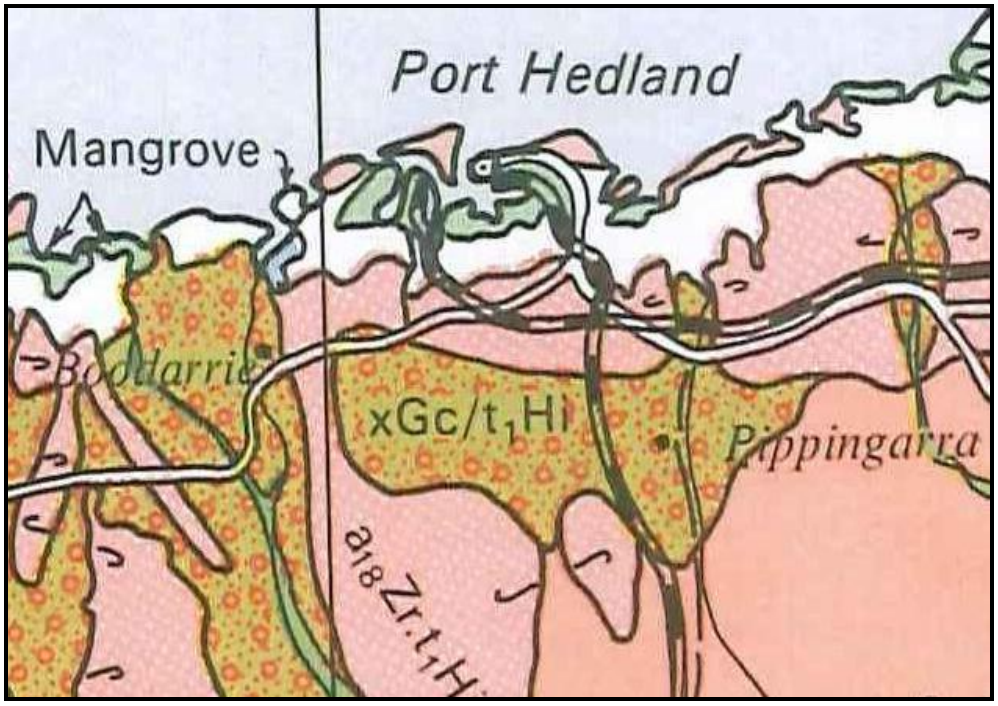

Figure 9: The natural vegetation around Port Hedland (Beard 1975).

The factor limiting human occupation of the areas surveyed would not have been food, but the availability of potable water, since the rivers only flow after rain. Some sources of free-standing freshwater are known near Onslow, but the precise location of these culturally significant *thalu* sites is known only to the Thalanyji, who have not yet been consulted about the project reported on here. *Thalu* were sometimes the focus of increase ceremonies, particularly for rain, and are still very important to Aboriginal people (Daniel 1995; Reynolds 1995). They should not be disturbed. Fortunately, these *thalu* appear to lie well southwest of the preferred PDA.

Tindale (1974:256) reported that the Talandji's water supply of last resort was a series of offshore springs at *'Pi:ltan*, which is located within the modern town of Onslow. The precise whereabouts of these springs is unclear. They do not appear on the DAA database; they are not the *thalu* sites. They may well have dried up as Onslow's water usage has grown since Tindale's time.

Three reliable freshwater soaks also used to exist Port Hedland (Hardie 1981), but like the springs at Onslow they do not appear on the DAA database and have probably dried up as Port Hedland's water usage has grown. They would have been known to the Kariara in the past, however. Pockets that will hold rainwater often develop in BIF and/or the duricrust that caps the Pilbara Craton in places. The Kariara would have known where they were and when they were likely to be full, but they would not have sustained many people for any length of time, even if covered.

Hence, occupation of the land around Onslow and Port Hedland was probably seasonal. Its timing and duration would have been dictated by water availability, i.e. rainfall. Bates (White 1985:238) described a rainmaking ceremony she observed at Roebourne, which she said was effective. The prevalence of such ceremonies, and *thalu* sites, underlines the importance of water for Pilbara people.

Given that rain in this area now mostly falls in summer, either from the monsoon or cyclones, occupation of both the Onslow and Port Hedland areas probably occurred then; although people might well have also come to the coast to fish and collect shellfish during the drier, cooler, winter months. They probably congregated more often and in greater numbers in areas where food plants and water were more readily available (Wright 1970), however, such as at the deep pools found inland on the major rivers; places like Millstream, 60 km south of Roebourne, and the deep gorges in the Hamersley Plateau.

4.4 Archaeology

When conducting cultural heritage surveys, it is important to be able to assess the significance of any traces of past Aboriginal activity found in the PDA by comparing any sites identified with what is known of the archaeological record of the specific area studied in its wider Australian context. Hence, a brief summary of the archaeological record of the Pilbara coast will now be placed in its continental context.

Most archaeologists have accepted for at least the last decade that Aboriginal people first reached Australia about 60-50,000 BP (Mulvaney and Kamminga 1999:130-133). There is some evidence that the Hamersley Plateau, located between Paraburdoo and Newman in the inland Pilbara, was occupied fairly soon thereafter, by 35,000 BP at Juukan I (Slack *et al*. 2009) and Djidjiling (Law *et al*. 2010), for example, despite the climate probably having been arid at that time with very hot summers, unreliable rainfall and only a few small rock holes where rainwater could collect. Because the plateau is largely composed of BIF that is aggressively mined for iron ore, it has been a focus of cultural heritage surveys for 40 years, ever since the *AHA* became law. Consequently, hundreds of Aboriginal sites have been recorded on the plateau including many petroglyphs (engraved rock art motifs), occupation sites, burials and stone arrangements (Mulvaney and Kamminga 1999:204, 394-398). Human numbers were probably low and groups thinly spread through the landscape, however; most groups probably focused their activities around water sources that were visited seasonally.

As well as Juukan I and Djidjiling, several other rockshelters that have formed in the duricrust that caps the Hamersley Plateau have been test excavated, usually as part of cultural heritage consultancies. Only some of that research has been published, however (Maynard 1980; Brown 1987; Marwick 2002, 2009; Edwards and Murphy 2003; Veitch *et al*. 2005; Slack *et al.* 2009; Law *et al.* 2010; Hughes *et al*. 2011). Recently, the radiocarbon (^{14}C) dates from most of these sites were collated by Morse (2009:3-5). Of the 45 sites she listed, 10 appear to have been occupied at the height of the LGM (22,000-20,000 BP), which is interesting since the climate of that period was hyper-arid. Those Pleistocene-age sites were then abandoned for millennia and not re-occupied until the Holocene, now formally defined, in the GRIP ice core, as beginning at 11,653 BP (Walker *et al.* 2009). Actually, 29 of these 45 shelters (65%) were first occupied after 4000 BP (Morse 2009), by when present climatic conditions were probably well-established throughout the Pilbara.

The only evidence for Pleistocene occupation of the mainland coast is in the scarp face on the western side on North West Cape. Morse (1993) excavated three rockshelters on the west side of NW Cape: Mandu Mandu Creek, Pilgonaman Creek and Yardie Well; all probably formed by wave action. The ^{14}C dates she obtained from Mandu Mandu suggested two periods of use: 35,000-20,000 BP, in MIS3, and 6000-300 BP, after sea level stabilised. The dates she obtained from Pilgonaman are so stratigraphically confused that the shelter's occupation history cannot be interpreted. Yardie Well was only occupied infrequently between 10,500 and 5500 BP. Subsequently, Przywolnik (2005) investigated three more rockshelters on the tip of the Cape's west coast. She found a similar pattern of occupation to that at Mandu Mandu at two of her sites. C-99 was first occupied 35,000-21,000 BP and re-occupied 8000-1000 BP. Jansz was first occupied 35,000-30,000 BP and re-occupied 11,000-1000 BP.

The west side of NW Cape plunges straight into deep water; there is virtually no continental shelf. Hence at the height of the LGM, when sea level would have been at its lowest, the coast would only have been accessible by scrambling down the face of the scarp. Unsurprisingly, Morse's and Przywolnik's data suggest that people moved away from the Cape during the hyper-arid phase of the LGM because they could not easily access either marine or terrestrial foods. Where they went is unknown, but some might have moved offshore. Noala 2, a rockshelter on the Montebello Islands, which would then have been hills on the exposed continental shelf, began to be occupied about 27,000 BP (Veth 1993); while Lorblanchet and Jones (1979) obtained a date of 18,500 BP 'associated' with petroglyphs in Gum Tree Valley on *Marujuga*, the Burrup Peninsula.

The archaeological record of the Abydos Coastal Plain, which stretches from the Ashburton River south of Onslow to the de Grey River north of Port Hedland, and on *Marujuga*, is quite different from that of the Hamersley Plateau, partly because the bedrock is not conducive to the formation of rock-shelters, where archaeological deposits of Pleistocene age might be preserved. Also, the present coastline would have been far inland during the LGM when lower sea levels would have made the climate even more arid than it is now (Wyrwoll 1993). If the Pleistocene coast of the Abydos Plain was occupied, those sites are now under water. The dominant archaeological signature on this coast comprises shell middens of varying size and density that are often composed almost exclusively of *Anadara granosa*, an edible bivalve eaten by Aboriginal people wherever it is found, although the oldest middens lack *A. granosa*. They comrpise primarily the gastropod *Terebralia* spp, but all these middens formed after the Indian Ocean stabilized at its present level, after 6500 BP.

Bates (White 1985:250-259) noted that shellfish were a staple food for people living on or near the Pilbara coast in the early 1900s. Fish were caught using traps, weirs or poison, by clubbing or spearing; even after dark, using torches. People would wade out to offshore islands at neap tides to collect birds' eggs and shellfish. They also constructed flimsy rafts from mangrove trunks, but did not venture far offshore; although Bates said everyone could swim and remain submerged for a long time.

Bourke (2003) argued that the shift from *Terebralia* to *A. granosa* was environmentally, rather than culturally, driven. *A. granosa* lives on muddy, tide-dominated shorelines, where mangroves flourish. It only began to be collected after 4000 BP, when sea level had stabilised and near shore conditions favoured its proliferation. This focus on *A. granosa* did not last long. The shell beds were exhausted by about 500 BP and new, more diverse, economies had to be developed (Hiscock 2008:174-179).

Clune (2002) and Clune and Harrison (2009) argued that the largest *A. granosa* middens on the Pilbara coast formed quite recently, about the same time as the second phase of rockshelter occupation on the Hamersley Plateau, when large groups of Aboriginal people collected together for ceremonies in late summer, when other resources were also abundant. Harrison (2009:90) obtained 23 ^{14}C dates from seven middens he investigated at Anderson Point, immediately southwest of Port Hedland. All comprised primarily *A. granosa*, with some *Terebralia* and baler (*Melo* spp.). Apart from his site 14, which began to form 5000 BP, all these sites began to form after 4000 BP, supporting Bourke's (2003) suggestion that Aboriginal focus on *A. granosa* was environmentally-driven. Harrison (2009:94-95) also listed 78 ^{14}C dates from other middens on the Pilbara coast; only nine began to form before 6000 BP. Older shell middens will have been out on the continental shelf and are now not just under water, but almost certainly destroyed by wave action. The proliferation of middens after 4000 BP may also reflect the 'population packing' noted throughout Australia during the later Holocene, which may also have been climatically driven (Hiscock 2008: 219-267).

This pattern of rare evidence for early occupation and prolific evidence for much more recent occupation of the Pilbara coast reflects not only natural population increase but the taphonomy of site survival and destruction. Globally, younger archaeological sites are more common than older sites, but

this temporal pattern of site preservation is especially common in Australia due to its predominantly arid climates and fragile, highly erodible, soils which militate against the preservation of organic artefacts on sites in the open air, which was where most Aboriginal people lived in the past. Really old open air sites are easily disturbed, or become buried or destroyed over time (Rossi and Webb n.d.); whereas younger sites, simply because they formed much more recently, survive and are easier to find.

This brief review of Pilbara archaeology has been based on articles published in scientific journals and research theses rather than consultancy reports because the former are peer-reviewed, the latter are not. Unfortunately, apart from two doctoral studies on the archaeology of NW Cape (Morse 1993; Przywolnik 2005) and Clune's (2002) analysis of Abydos shell middens, the Pilbara coast has never been the subject of systematic research, hence our understanding of its archaeological record is very patchy. Also, too much of the relevant data is buried in consultancy reports that are not held by DAA, but retained by the developers/mining companies who funded the surveys; hence they are unavailable to independent researchers and consultants not involved in those surveys; a practice that must change.

In conclusion, coastal sand dunes were often preferred sites for inhumations; although no burials have actually been reported near Onslow or Port Hedland. Bates (White 1985:308-309) said that on the Ashburton and Fortescue Rivers, and in the Pilbara in general, dead bodies were folded compactly and buried in the smallest possible space. Hence, the contractors tasked with installing the cable that prompted these surveys should be made aware of the possibility of finding human bones. If bone is found, it ***must*** be left undisturbed while the Police, DAA and Aboriginal people with traditional ties to the place are informed. The latter will decide what should happen to such human remains, once forensic analysis has shown them to be Aboriginal, not evidence of a recent crime.

4.5 History

The first Europeans to sight the Pilbara coast between Onslow and Port Hedland were probably the unfortunate British on board the *Trial* which sailed up the coast of North West Cape only to wreck near the Montebello Islands in 1622 (Jarvis 1986). The next visitor was the Dutchman Abel Tasman in the *Limmen* and *Zeemeuw*. His route across the Indian Ocean brought him to NW Cape in 1644. Thence he followed the coast northeastward all the way to Cape York and New Guinea; navigating around one third of the Australian mainland (Spencer 2006:20). William Dampier (1729) visited in 1688 aboard the *Cygnet*, a privateer. He returned officially in 1699 in the *Roebuck* and made landfall on what is now the Dampier Peninsula. Europeans took no further interest in the Great South Land until 1801-1803 when Nicholas Baudin in the *Géographe* and *Naturaliste* and Louis de Freycinet in the *Casuarina* explored the entire Western Australian coastline; prompting Westminster to send Philip King, first in the *Mermaid*, then in the *Bathurst*, to claim the continent for Britain in 1818-1822 (Jarvis 1986). Earlier, Matthew Flinders (1814) explored the south coast as far west as Cape Leeuwin, in the *Investigator*. He published remarkably accurate maps of the entire continent (Sheehan 2008:24).

The first terrestrial explorer to reach the Pilbara coast, at Dampier, was Francis Gregory in 1861 (Favenc 1908:253-63). He explored as far north as Poissonier Point, 70 km northwest of Port Hedland. Between 25 May and 18 October, he also ventured into the Hamersley Ranges and explored from the Ashburton River to the Oakover and de Grey Rivers, on the southern edge of the Great Sandy Desert, which Favenc (1908:263) aptly described as 'the most hostile and repellent desert in Australia'.

Roebourne was gazetted as a town in 1866. In that year, Edward Hooley drove 2000 sheep from Perth to the Pilbara; partly to prove it could be done, partly because if he got the flock there safely he could take up a large pastoral lease on the Ashburton River (Sharp 1985). By the following year, 2.4 million ha of the Pilbara had been leased to pastoralists (Beard 1975:2). By using camels, Colonel Peter

Warburton (1875) managed to trek from Alice Springs to Roebourne in 1873-1874; while John Forrest, the first locally-born explorer, investigated the coast between Roebourne and Broome in 1879. Gregory's and Hooley's positive reports on the country opened the Northwest up for pastoralists and pearlers, both of whom ruthlessly exploited the Aboriginal people they forced to work for them (Green 1981:99). Pastoral leases began to be taken up around Onslow and Port Hedland soon after 1870 and the ill-treatment of Aboriginal labour that ensued (Hunt 1978), 'blackbirding' was effectively enforced slavery, finally prompted widespread indignation, particularly in Britain, and led to the Roth Royal Commission of 1905 which condemned existing pastoral and pearling practices (Haebich 1992:76-79).

Onslow was founded in 1883, at the mouth of the Ashburton River, as a port whence wool from the pastoral properties of the inland Pilbara was exported (Webb and Webb 1983). Wool was the major export until after World War II, despite lengthy droughts and floods caused by cyclones repeatedly damaging the large jetty built to accommodate the wool ships. In 1925, the present town was established 20 km farther north, in a more sheltered area. The 1935-1941 drought severely affected the wool industry, which failed to recover after WWII, and the town's raison d'être disappeared. In the late 1960s, Onslow reinvented itself as the major town of the 'Coral Coast' and a focus for tourism. Now, it is swamped with fly-in fly-out employees working offshore for the oil and gas industries.

Peter Hedland explored the Pilbara coast in 1863 looking for a good harbour. The modern port is named after him, although the Kariyarra and Nyamal people know the town as *Marapikurrinya*, which may refer to the three soaks mentioned above, or to the hand-like formation of the tidal creeks off the modern harbour; originally called Mangrove Harbour. A huge blind water snake, a Dreamtime Being called *Jalkawarrinya*, used to live in the large landlocked pool that is now the turning basin for ships entering the port. Their arrival drove the snake away (Hardie 1981).

Hedland reported the potential of Mangrove Harbour. The embayment was well-protected and freshwater was available, but he did not mention that its narrow entrance was sealed by a huge sandbar; so the harbour could only be entered at high tide. It was also difficult to navigate the sandbar in bad weather. In 1866, Mangrove Harbour was considered, but rejected, as an alternative town site to Roebourne, 160 km to the west of Port Hedland. In 1891, Mangrove Harbour was reassessed and two landing places were identified. Finally, a jetty was built in 1895. Now, Port Hedland processes more tonnage per annum than any other port in Australia. Iron mining began in the inland Pilbara in 1960s. The ore is brought to Port Hedland by rail to be shipped overseas for processing. A new channel was dredged in 1986 for the very large bulk carriers that now serve the iron ore industry.

Despite the changes to Mangrove Harbour since 1866, there is still a Flatback Sea Turtle rookery on the main beach below Port Hedland and Bottlenose, Hump-backed and Snubfin dolphins can be viewed. Red-necked Stints, Sharp-tailed Sandpipers and Dusky Gerygones regularly visit the Saltworks Bird Reserve, 20 km east of the port (www.birdlife.org). Australian Bustards, Bush Stone-curlews, Western Bowerbirds, Painted Finches and Canary White-eyes can also be seen, but Broad-billed Sandpipers, Asian Dowitchers, Curlew Sandpipers, Red-necked Avocets, Banded Stilts, Oriental Plovers, Oriental Pratincoles and White-winged Black Terns have declined in number as the port has grown (www.birdlife.org); Pretty Pool still supports mangroves, fish and waterbirds, however, as is a favoured picnic spot with locals.

4.6 Ethnography

According to Bates (White 1985:56-57, 90-94), the Aboriginal people living near the coast between the Ashburton River, south of Onslow, and the Sherlock River, midway between Roebourne and Port Hedland, did not circumcise their young men and were divided socially into four classes: *Boorong*,

Banaka, *Kaimera* and *Paljeri*. *Boorong* and *Banaka* were the fathers and mothers of *Kaimera* and *Paljeri*. Grandchildren were the same class as their grandparents of the same gender. Bates said that the *Tallainji* lived on the coast between the Ashburton and Lyndon Rivers. The *Nuala* people lived to their north, between the Ashburton and Fortescue Rivers and the *Ngalluma* lived further north, also on the coast. Bates said they were the northern-most of the uncircumcised groups in the Northwest. Their class-pairing system distinguished them from their neighbours; particularly those to their east, who circumcised.

Tindale (1974:144, 256) described the territory of the *Talandji* as centred on the Ashburton River, extending from the coast inland to Nanutarra (Figure 10). He thought the *Talandji*, who neither circumcised nor subincised, had expanded their territory to the coast of Exmouth Gulf in the early twentieth century in response to the migrations that so often followed colonisation, and the resultant dispossession throughout Australia of groups living in the areas where the British chose to settle.

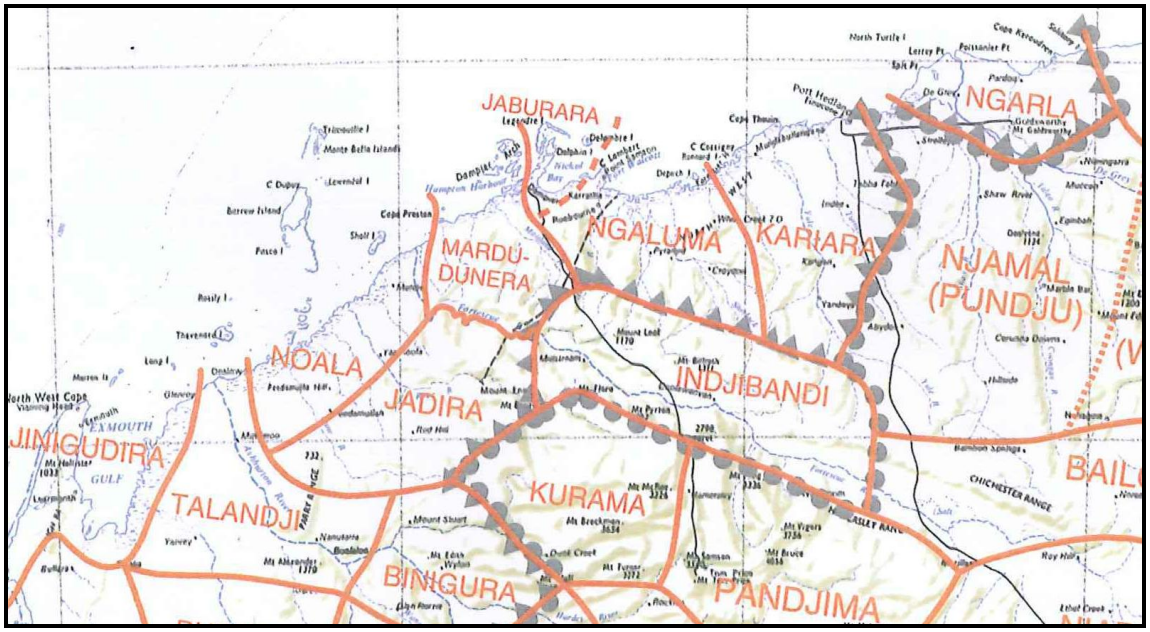

Figure 10: Aboriginal language groups between Port Hedland and Onslow (Tindale 1974).

Tindale (1974:58-59) reported that the Abydos Plain was the home of the *Ngaluma* and the *Kariara* (Kariyarra) whose territory lay southwest of Port Hedland (Figure 10). He noted that the latter feared the aggressive *Njamal* people who circumcised their young men. The *Kariara* did not; nor did they subincise. Tindale (1974:244) described the territory of the *Kariara* as extending inland from the coast to the foot of the Hamersley Plateau, north past Port Hedland to Petermarer Creek and south to the Peeawah River, but the *Kariara* seldom ventured east of the Turner River, for fear of the *Njamal*. He was told that the *Kariara* and *Indjibandi* were once one people, but were in conflict before the British arrived because the *Indjibandi* had adopted circumcision, the *Kariara* had not. He said the petroglyphs known in and around Port Hedland were made by the *Kariara*, not the *Indjibandi*, and that petroglyph production continued into modern times.

How far the social patterns and customary behaviours recorded by Bates (1913) or Tindale (1974) can be extrapolated back into or be used to interpret the archaeological record is moot, of course (Hiscock 2008:182-186). As Fink (1960:63) commented about the Yamaji of the Murchison Basin, '*it serves no purpose to speculate on the social organisation that formerly existed*' because 'the old ways' disappeared within decades of British arrival. She was told that there were no 'proper' old men left in the Murchison

by 1900 (Fink 1960:271-272), 40 years after the first pastoralists arrived there. Later researchers were told that no ceremonies had been held in that region since World War II (Gunn and Webb 2002:51-52). Similarly rapid cultural disintegration probably occurred around Onslow and Port Hedland.

The speed with which the British spread through Western Australia was too great for Aboriginal people to be able to adapt to the invasion, particularly since the invaders fenced off and defended by force land and water sources they now considered 'theirs', but which the Indigenous population had accessed for millennia. This dispossession soon gave rise to conflict because Aboriginal people did not understand 'ownership' in the same way as the British did. The former thought that resources could and should be shared, the latter did not; nor did Aboriginal people understand why they could not kill and eat the sheep that were driving out the animals they were used to hunting, making finding game increasingly difficult (Stirling 1835).

The history of black-white relations was bloody everywhere in Australia (Broome 1994:36-51; Harris 2003a), but possibly bloodier in the Northwest than in the Southwest (Green 1981); resistance to colonisation was certainly fierce in the Pilbara. According to the Rottnest Island (*Wadjemup*) Prison records (Green and Moon 1997), within a year of Hooley's historic trek, Aboriginal men began to be transported to *Wadjemup* from the Pilbara. In 1867, a year after Roebourne was founded, the first three local offenders were sentenced to three years' imprisonment for stealing sheep, although one was released early; another died on the island. It is unlikely that these men understood what they had done wrong; sheep were meat, they were hungry and there were few kangaroos. Their 'trial' would have been conducted in English, which they may not yet have spoken. Interestingly, in 1873 two Pilbara men were arrested for killing white men. One died of natural causes on *Wadjemup*, the other, although sentenced to death, was released in 1877, suggesting that the authorities may have had second thoughts about the case; although prisoners were also released to relieve overcrowding.

The colonists brought with them diseases such as whooping cough, chickenpox, measles, cholera and syphilis, even influenza, against which Aboriginal people had no defence. Eruptions of smallpox can probably be blamed on the Macassans, rather than the British, however. In 1858, smallpox spread down the Pilbara coast from the Kimberley and many people died (Curr 1886:219-221, 376-380). There were further smallpox outbreaks in 1865 and 1870 in which many more died, plus the uncounted deaths from 'blackbirding' and the 60-plus Aboriginal people killed during the *Flying Foam* Massacre of 1872 (Green 1981). Probably half the Aboriginal population of the Pilbara died in these disasters, as happened elsewhere (Cleland 1928; Green 1981; Dowling 1997; Campbell 2002; Harris 2003); mainly those most at risk in any society: the very old, the very young and pregnant or lactating women. Aboriginal societies were gerontocracies. If senior men died before they could pass on their cultural knowledge to the next generation, it could be irretrievably lost. Consequently, Green (1981) argued that wherever the British settled, Indigenous culture quickly became completely dysfunctional.

4.7 Aboriginal consultation

Data supplied to the author by the National Native Title Tribunal (NNTT) in November 2012 showed that the Buurabbalayji Thalanyji Aboriginal Corporation is a Registered Native Title Body Corporate and holds Native Title over Onslow; whereas the Kariyarra Native Title claim (WC99/3) has still not been determined, but it covers Port Hedland.

Neither group was consulted before the survey was undertaken on 4-5 December 2012, due to time constraints. Moreover, the DAA database search described below indicated that no sites of cultural significance were likely to be found in any of the areas to be surveyed, based on the maps of the PDAs supplied to the author by the Company.

Therefore, in consultation with the Company, it was decided that the Thalanyji and Kariyarra would be contacted if and only if the survey indicated that there could be a sub-surface archaeological component in any of the areas to be impacted that might be disturbed by cable installation. Then, they would be consulted about how the works should proceed.

5 Desktop research

Before survey began, the Company commissioned the author to search the DAA on-line database of registered Aboriginal sites to find out whether any sites were located near any of the PDAs, to view the files of information about the sites identified and to study the related cultural heritage survey reports and assess their relevance to the surveys reported on here.

In March 2013, DAA 'improved' its on-line database with photo-realistic base maps in pseudo-relief. At the same time, they decided to divide the database into two sections: ***Registered Sites*** and ***Other Heritage Places***. The latter comprise: '***stored data***' – that is sites that no longer exist because they have been destroyed with Section 18 approval, or that can no longer be found for a variety of reasons, or that have been assessed by the Aboriginal Cultural Materials Committee (ACMC) ***not*** to be '***sites***' within the meaning of Sections 5 and/or 39 of the *AHA*; sites about which '***insufficient information***' has been recorded to permit the ACMC to assess whether or not they meet the criteria of Sections 5 and/or 39 of the *AHA*; and recently recorded sites whose details have been '***lodged***' with DAA, but that are awaiting assessment by the ACMC. Site assessment is one of the ACMC's statutory functions under Section 39 of the *AHA*. Despite their 'second class' status, 'o***ther heritage places***' still need to be considered; although the value of much of '***stored data***' is debatable. Many of them have been judged by the ACMC ***not*** to be '***sites***'. This needs to be indicated on the database because non-sites are ***not*** protected.

The logic behind this subdivision of the Register is hard to understand when the preamble on the new printout from the DAA database states categorically that '*The AHA protects all Aboriginal sites in Western Australia* ***whether or not they are registered***' (emphasis added). Hence, this new division seems both pointless and likely to create confusion. Other consultants have already complained to this author that sites they have recorded are now listed as *other heritage places* and have effectively been deregistered, so they no longer have the protection of the *AHA*. This is clearly not the case and DAA needs to move swiftly to correct that misimpression. Because the database search described below was undertaken before the Register was subdivided, ***all*** the relevant sites have been listed in Tables 1 and 2, regardless of whether they are now registered sites or have been relegated to '*other heritage*' status.

This subdivision of the Register also means that database searches now take at least twice as long as they used to because *two* searches have to be done for any area. Actually, they take considerably longer because the ESRI base maps require a lot of computing memory and take a long time to load, although they are quite pretty. No doubt they will prove helpful to those, unlike this author, who never learned to interpret standard topographic maps.

An additional complication now is that the heritage reports linked to the surveys have also been subdivided, although surveys may well have reported both registered sites and places DAA has now relegated to 'o*ther heritage*' status. This means that great care has to be taken when requesting to view reports, to avoid unnecessary duplication of report requests.

Finally, there is the fact that some sites, particularly in the Pilbara, have been re-recorded numerous times by different consultants/researchers and given new IDs by DAA. The most egregious example of duplicate IDs that this author has come across is site **715**, which was re-recorded as site **15018**, then as site **18009**, finally as sites **24641-24643**. This suggests not only that some consultants need to take more

care both when undertaking background research and when identifying known site in the field, but also that some way should be found to link duplicate site IDs on the database, and, if ***all*** the site information has been put into one (primary) file, then the duplicate numbers should be deleted from the database. It is very frustrating to ask for a site file only to find that it is empty. The information it contained has been added to another file, which was not identified when the database was searched. The usual reason for this is that the site's position has been corrected either by DAA's spatial analysts or by a consultant using a GPS correctly and it really lies outside the search polygon.

The area searched at Onslow was bounded by the following MGA Zone 50 co-ordinates: **7600000-7610000 mN** and **300000-310000 mE** (Figure 11). The area searched at Port Hedland was bounded by the following MGA Zone 50 co-ordinates: **7753000-7754000 mN** and **6680000-6690000 mE** (Figure 12). Both search areas were deliberately made much larger than necessary in order to gain a broader understanding of the range of site types that might be found near the PDAs.

Onslow

The 31 registered sites and 'other heritage places' known in and around Onslow are listed in Table 1. The sites whose files of information are '***open***' are described in Section 6, below. Open site files may be viewed by any legitimate enquirer.

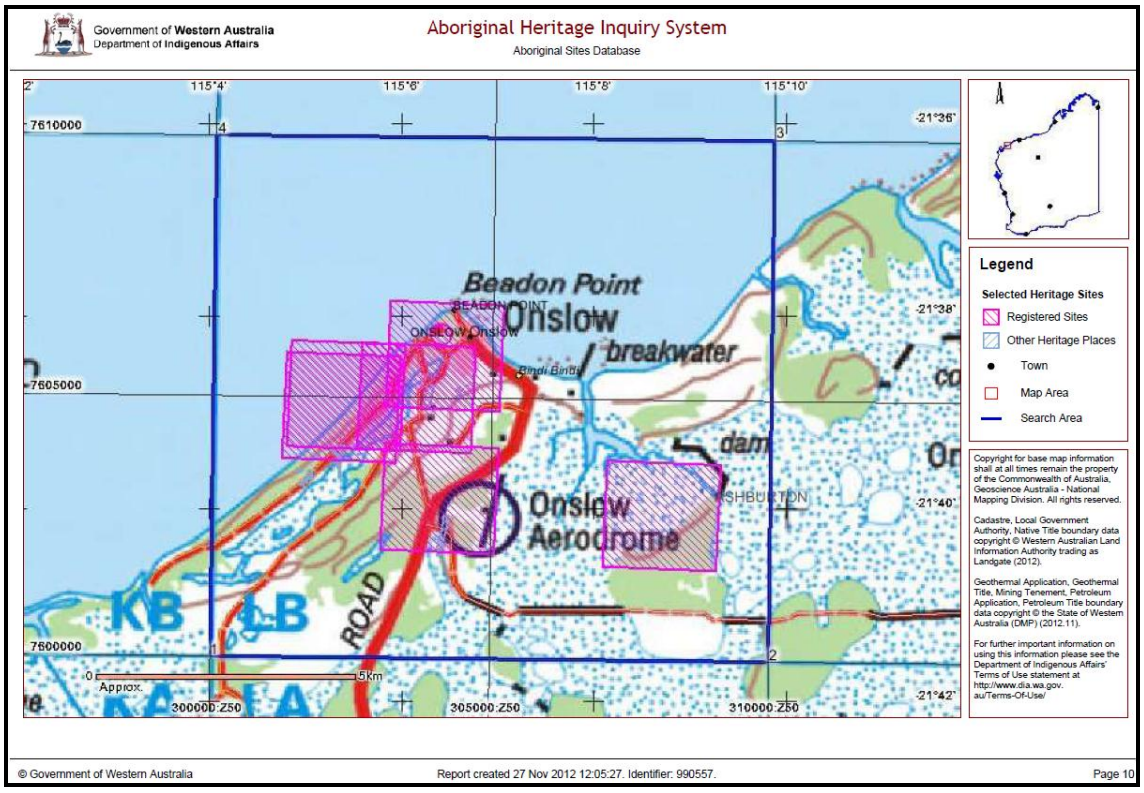

Figure 11: Aboriginal sites registered in and around Onslow.

The information in '***closed***' files can only be viewed with the written permission of the original Aboriginal informants, who are known to DAA; or their descendants. Permission was not sought to view the six closed files in Table 1 before survey began, due to time constraints. DAA no longer lists the co-ordinates for ***closed*** sites on its publicly-accessible database. Their locations are shown as large dithered squares on the maps generated by database searches. Each site lies somewhere within its designated area,

but without viewing its file a researcher has no idea exactly where. None of these **closed** sites appeared to lie close to any of the proposed PDAs, however.

Table 1 shows clearly that most of the evidence for past Aboriginal activity in the Onslow area is scatters of artefacts and mollusc shells, usually in/on the coastal sands. If these shell scatters are really 'middens', not cheniers (Sullivan and O'Connor 1993; O'Connor and Sullivan 1994), then they are the remains of meals people ate on the shore of the Indian Ocean. If any of the sites in Table 1 lies close to the preferred PDA (Option 1 in Figure 1) it must be re-found and avoided. None appeared to be located near Option 2.

Table 1: Aboriginal sites known near the project development area at Onslow.

site ID	site name	site type	MGA co-ordinates	status
6574	Beadon Creek	midden/artefacts	not available	**closed**, permanent
6575	Jinta 1 midden	midden/artefacts	not available	**closed**, permanent
6617	Burubarladji	mythological	not available	**closed**, permanent
6618	Dew *talu*	ceremonial/water	not available	**closed**, permanent
6619	Jinta 1	water source	not available	**closed**, permanent
6620	Jinta 2	water source	not available	**closed**, permanent
8920	Onslow 1	midden/artefacts	304068mE 7606217mN	open, permanent, reliable
24401	Os06-01	shell midden	303859mE 7605047mN	open, lodged, reliable
24768	Ows07-01	shell midden	301869mE 7603863mN	open, lodged, reliable
24769	Ows07-02	shell midden	301768mE 7603841mN	open, lodged, reliable
24770	Ows07-03	shell midden	302289mE 7604030mN	open, lodged, reliable
24771	Ows07-04	shell midden	302341mE 7604030mN	open, lodged, reliable
24772	Ows07-05	shell midden	302258mE 7603764mN	open, lodged, reliable
24773	Ows07-06	shell midden	302120mE 7604005mN	open, lodged, reliable
24774	Ows07-07	shell midden	302132mE 7604013mN	open, lodged, reliable
24775	Ows07-08	shell midden	301768mE 7603756mN	open, lodged, reliable
24776	Ows07-09	shell midden	301605mE 7603327mN	open, lodged, reliable
24777	Ows07-10	shell midden	301674mE 7603389mN	open, lodged, reliable
24778	Ows07-11	shell midden	301717mE 7603447mN	open, lodged, reliable
24779	Ows07-12	shell midden	301763mE 7603478mN	open, lodged, reliable
24780	Ows07-13	shell midden	301745mE 7603545mN	open, lodged, reliable
24781	Ows07-14	shell midden	301561mE 7603573mN	open, lodged, reliable
32402	Onslow Airport 1	shell midden	304137mE 7602378mN	open, lodged, reliable
32540	Lcor-1201	midden/artefacts	304545mE 7605239mN	open, lodged, reliable
32541	Lcor-1202	midden/artefacts	304464mE 7605167mN	open, lodged, reliable
32542	Lcor-1203	midden/artefacts	304459mE 7605142mN	open, lodged, reliable
32543	Lcor-1204	midden/artefacts	304420mE 7605124mN	open, lodged, reliable
32544	Lcor-1205	midden/artefacts	304407mE 7605039mN	open, lodged, reliable
32545	Lcor-1206	midden/artefacts	304392mE 7605188mN	open, lodged, reliable
32546	Lcor-1207	midden/artefacts	304367mE 7605154mN	open, lodged, reliable
32547	Lcor-1208	midden/artefacts	304354mE 7605178mN	open, lodged, reliable

Although the files of information on the three water sources were not studied, their presence is significant because easy access to sources of potable water is essential to human survival. Free-standing freshwater is not usually available in the coastal sands, despite Tindale's (1974:256) mention of offshore

springs.

Port Hedland

The five sites registered sites and 'other heritage places' known in Port Hedland are shown in Figure 12 and listed in Table 2. They are described in Section 6.

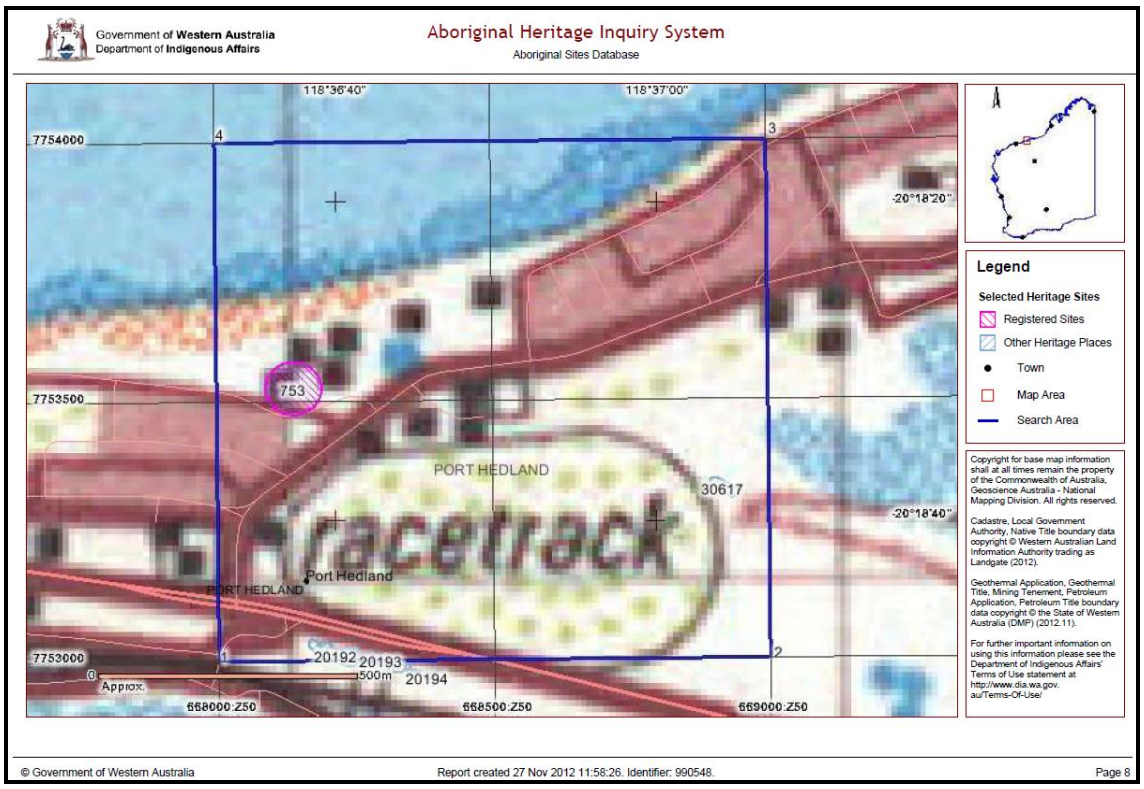

Figure 12: Aboriginal sites registered near all three project development areas at Port Hedland.

Table 2: Aboriginal sites known in and around Port Hedland.

site ID	site name	site type	MGA co-ordinates	status
753	Port Hedland Hotel	middens/ artefacts	668140mE 7753526mN	open , permanent, reliable
20912	Two Mile Ridge A	engraving	668210mE 7753015mN	open, lodged, reliable
20913	Two Mile Ridge B	engraving	668294mE 7752998mN	open, lodged, reliable
20914	Two Mile Ridge C	structure/midden	668357mE 7752981mN	open, lodged, reliable
30617	Three Mile limestone	midden/grinding/camp	668918mE 7753329mN	open, lodged, reliable

Table 2 shows that most of the evidence for past Aboriginal activity in the heart of Port Hedland is either shell middens, as at Onslow, or rock art. The latter sites in particular may have to be re-found to ensure that they will not be impacted by the proposed development.

Two-thirds of the sites in Tables 1 and 2 were recorded quite recently. Hence their details have merely been '***lodged***'. They are awaiting assessment by the ACMC. Lodged sites are protected by the *AHA*, however, even if they are subsequently relegated to '*other heritage*' status.

The other eight sites were first recorded long ago and are on the Permanent Register, meaning that they are recognised to be part of the cultural heritage of Western Australia. They are fully protected by

the *AHA*.

The database search undertaken on 27 November 2012 also generated a list of 31 survey reports; nine related to Onslow, 22 to Port Hedland. The reports relevant to the surveys undertaken in December 2012 are discussed in section 7.

6 Aboriginal sites

The information archived at DAA about the sites identified above will now be briefly reviewed to determine whether or not any site might be impacted by the developments proposed at Onslow and Port Hedland. First, the sites known near Onslow will be described, then those at Port Hedland. None of the ***closed*** sites in Table 1 seems to lie close to either of the PDAs at Onslow.

Onslow

Cue and Greenfeld (2012) stated that site **6617** is located north of Onslow Road, but did not say exactly where. They noted that the location of site **6620** needed to be identified by the Thalanyji so that work on the new airport did not impact on it; implying that it is nearby, although they did not say where. Their comments imply, however, that both sites are near the airport, which is several kilometres south of the PDAs that were the focus of this survey. Puletama *et al*. (2012) also noted that sites **6617** and **6618** *may* lie close to the area they surveyed immediately south of Onslow township, some distance away from Option 1 or Option 2. None of these sites will be impacted by the proposed development that prompted the survey reported on here.

A map in Quartermaine (1998) showed site **6575** lying 3 km southwest of Beadon Point, 2 km away from the preferred location for the CEV site (Option 1 in Figure 1); even further from Option 2. Hence, it will not be impacted by the proposed development that prompted the survey reported on here.

Site **8920** is located to the east of Back Beach Road on Unallocated Crown Land. In 1985, Turner described this site as a large, but low density, shell midden with some stone artefacts. *Anadara granosa* predominated (90%), but *Turbo* spp., *Terebralia* spp., mussels (*Brachidontes* spp.) and *Melo* spp. were also noted; suggesting that this midden formed over a considerable period. Chiton (*Acanthopleura* spp.) was rare. Some of the artefacts were made on bottle glass, suggesting that the site continued in use after the British arrived, but silcrete and chalcedony were also present; as were some igneous, probably dolerite or basalt, manuports. Turner commented that different shellfish species predominated in different areas of this large midden; suggesting that they represent separate harvesting events. The site was re-recorded by Quartermaine (1989). A DAA internal memorandum in the site file, noted that the site's dimensions were refined on 23 November 2012, so that its western boundary lies 500 m east of the preferred location for the CEV site (Option 1 in Figure 1). Hence, this site will not be affected by the proposed development that prompted the survey reported on here.

Site **24401**, a shell midden and artefact scatter, is located 1 km northeast of the Onslow Salt Administration building, 50 m east of the salt stockpile. This site lies 200 m east and over 1 km south of the preferred location for the CEV site (Option 1 in Figure 1); even further from Option 2. It will not be affected by the proposed development that prompted the survey reported on here.

Sites **24768-24781**, inclusive, are 14 shell scatters found on the shore southwest of Onslow. They are located between **301539-302349mE** and **7603310-7604050mN**. Hook (2007) described these scatters, which she called middens, as forming discrete clusters interspersed with areas where no shells were found, rather than a continuous 'site', but she noted no stone artefacts. She concluded that these sites were of ***low*** archaeological significance. Moreover, they lie 1.3-2.1 km west and 2.2-2.9 km south of the

preferred location for the CEV site (Option 1 in Figure 1), which is at **303670mE** and **7606150mN**. They will not be impacted by the proposed development that prompted the survey reported on here.

The information on file about site **32402** is a little confusing because the number on the recording form in the file is **32042**. This needs to checked and corrected. This site is located about 300 m west of Onslow Road, 340 m west of the primary runway and immediately south of the secondary runway at Onslow Airport. It comprises six concentrations of predominantly *Terebralia* spp. shells, with some *A. granosa* and *Melo* spp., in an area nearly 800 m long, but only 80 m wide. No artefacts were noted. Cue and Greenfeld (2012) considered this site of ***low*** archaeological significance. It lies about 4 km south of the preferred location for the beach manhole and CEV site (Option 1 in Figure 1). Hence, it will not be impacted by the proposed development that prompted the survey reported on here.

Sites **32540**-**32547**, inclusive, are eight shell scatters composed predominantly of *A. granosa* associated with stone artefacts in an area 200 m sq between Onslow Road and Macedon Road which the Shire of Ashburton proposes to develop into residential and industrial estates. Puletama *et al*. (2012) considered seven of these middens of ***low*** archaeological significance, but site **32544** was better preserved and of ***medium*** significance. These sites lie about 3 km south of the preferred location for the beach manhole and CEV site (Option 1 in Figure 1). They will not be impacted by the proposed development that prompted the survey reported on here.

Taken together, these sites suggested that the only type of archaeological evidence for past Aboriginal activity likely to be found in any of the proposed PDAs at Onslow would be a small scatter of mollusc shells on the present ground surface, with or without some stone artefacts.

Port Hedland

Site **753** is or was a scatter of *Anadara granosa* shells on the dune sands beneath the Port Hedland Hotel, on the north side of Lukis Street. The midden was densest beneath a transportable building on the south side of the hotel; earthworks to the east and south of this demountable subsequently exposed *A. granosa* shells to a depth of -0.4 m. An extension to the hotel built over this area in 1995 exposed further shells which extended eastwards for 15 m. This midden was clearly extensive; whether it still exists is moot, however. Moreover, all the possible locations for the CEV site at Port Hedland are on the outskirts of the town; whereas the hotel is at its heart. Hence, this site will not be impacted by the proposed development that prompted the survey reported on here.

Site **20912** is a petroglyph on Two Mile Ridge recorded by O'Connor (2003). He described it as a partly abraded, partly pecked, in-filled anthropomorphic figure on a boulder overlooking the junction of the Dampier Highway with Burrup Road. Two Mile Ridge is located south of the highway, which runs east-west south of the race course. Hence, site **20912** lies well away from all the possible locations for the CEV site at Port Hedland. It will not be impacted by the development that prompted the survey reported on here.

Quartermaine (2003) described site **20913** as four parallel incised lines covering 150 x 150 mm of a rock face on Two Mile Ridge. It was re-recorded by Parker (2003) and given the ID **20797** by DAA. O'Connor and O'Connor (2010:9) attributed this mistake to the fact that Parker used a different GPS datum from that used by Quartermaine, so thought he had found a new site. Lafrentz and Fordyce (2009) resurveyed the area and suggested that site **20913** was site **20797**. O'Connor and O'Connor (2010:9) concurred. An internal DAA memorandum in file **20913** agrees, stating that ID **20797** has primacy. Interestingly, site **20797** was not generated by the database search undertaken on 27 November 2012. It clearly lies well away from all the possible locations for the CEV site at Port Hedland; while the MGA co-ordinates given for site **20913** in Table 2 are presumably incorrect; although they were taken from the

DAA database. It appears that site **20797/20913** will not be impacted by the proposed development that prompted the survey reported on here.

Site **20914** cannot be discussed in detail because, although the DAA database showed this file as '***open***' in November 2012, in fact it is '***closed***'. O'Connor and O'Connor (2010:10) said that site **20798** is the same site as site **20914**, but site **20798** was not generated by the database search undertaken on 27 November 2012, suggesting that it lies outside the search area and/or the co-ordinates given for site **20914** in Table 2 are incorrect. Permission to access site file **20798** was not sought because, like sites **20912** and **20797/20913**, site **20798/20914** lies well away from all the possible locations for the CEV site at Port Hedland. It will not be impacted by the proposed development that prompted the survey reported on here.

Site **30617** comprises a campsite on a limestone ridge parallel to and approximately 0.5 km north-east of Two Mile Ridge, on the eastern edge of Port Hedland race track (Figure 12), where a scatter of *A. granosa* shells, a portable grindstone, two grinding grooves in which spear tips were probably sharpened and a waterhole were noted; suggesting that the area was a family campsite. Like sites **20912-20914**, site **30617** lies well away from all the possible locations for the CEV site at Port Hedland. It will not be impacted by the proposed development that prompted the survey reported on here.

Taken together, these sites suggested that there was little likelihood of finding any traces of past Aboriginal activity in any of the proposed PDAs at Port Hedland. The petroglyphs are located on Two Mile Ridge, which will be completely avoided; while the visual imagery supplied to the author by the Company before the survey took place showed that the land at all three possible locations for the CEV site had been so thoroughly disturbed that had shell middens been located at any of them they would have disappeared long ago.

7 Previous research and survey reports

The research that has been undertaken into the palaeo-environmental and archaeological record of the Pilbara coast was summarised in sections 4.2 and 4.4, above. That research focused on determining the position of the coastline since initial colonisation, how people responded to sea level changes and the significance of the apparent change over time from collecting *Terebralia* spp. to targeting *Anadara granosa*; was it a consequence of environmental or socio-cultural change?

Consultants cannot really examine such broad-scale research issues. Their projects tend to be quite localised and are often short-term. Once the survey has been completed and the report accepted by the proponent, the consultant moves on to the next project, never finding the time, inclination or energy to pull all their data for a specific area together into a discussion paper worthy of publication in a peer-reviewed scientific journal. Some consultants, of course, do not even submit copies of their reports to DAA, unless required to under Section 18 of the *AHA*, meaning that any data they may have collected is inaccessible to other consultants and/or researchers. The time has undoubtedly come to amend the *AHA* to make it a statutory requirement that a copy of every consultancy report be submitted to DAA, whether any new sites were found during the survey or not. As Morse (2009:2) remarked, the current situation is unprofessional, counterproductive, inhibits the growth and refining of archaeological knowledge and does a disservice to the preservation and protection of the cultural heritage.

The database search that identified the sites described in section 6 as lying near the proposed PDAs at Onslow and Port Hedland also generated a list of 31 cultural heritage survey reports that might be relevant to the survey reported on here. The conclusions of those that were relevant will now be summarised; first those for Onslow, then those for Port Hedland.

Onslow

Only five of the nine reports that related to Onslow were available for study in November 2012; although sections of some of the others, which were being assessed by DAA's heritage officers, were found in the relevant site files. The latter reports became available for study in July 2013; permitting completion of this report. Fortunately, the project that prompted the surveys reported on here was then 'on hold' for commercial reasons, so the enforced delay in completing this report was immaterial; not least because survey had shown that no Aboriginal sites were likely to be affected by the proposed development, when it finally went ahead.

Veitch *et al*. (1993) investigated two proposed pipeline routes for BHP Petroleum. One ran almost due east-west from the proposed gas processing plant at Tubridgi, across the Ashburton River to Onslow Road, some 13 km south of the town. The area surveyed was 23.6 km long and 20 m wide. The authors identified 18 small, diffuse shell scatters with or without stone artefacts along this alignment. They recommended that all but three of these sites could be disturbed because they were of ***low*** archaeological significance. They recommended that the other three sites be investigated and dated radiometrically, if possible. Whether this was done is unclear from their report, but Harrison (2009) does not list any dates from these sites. The other pipeline ran inland from the Indian Ocean across the coastal foredunes to Tubridgi Well 5. The area surveyed was 1.08 km long and 100 m wide and deviated from a route surveyed previously by 400 m at the coast (Veitch and Warren 1992). Veitch *et al*. (1993) identified five shell scatters and a burial in this area. Field Site 1 had already been investigated (site 8A/B = ID **15932**) and dated to 4200-3400 BP (Harrison 2009). The dates given by Veitch *et al*. (1993) were not the conventional ages, but were, quite improperly (Aitken 1990:95), only cited corrected for the marine reservoir effect. The burial had to be avoided. The middens were deemed to be of ***low*** archaeological significance and could be disturbed. Veitch *et al*. (1993) usefully summarised the results of previous surveys along the Pilbara coast. They noted that the change from *Terebralia* spp. to *A. granosa* occurred about 4000-3000 BP in shell middens on the Burrup Peninsula and at Shark Bay that had been dated radiometrically. It is also noteworthy that all 23 sites they found were closely associated with claypans, which only filled with water after rain. None of the PDAs inspected at Onslow in December 2012 is near a claypan.

Quartermaine (1998) investigated another proposed gas pipeline route between Onslow and Tubridgi that would run approximately 10 km inland from the coast. He noted that 14 archaeological sites, all shell middens, most with stone artefacts, had been registered near the route he surveyed. Judging by his maps, none of those sites lie close to the PDAs this author inspected.

Murphy and McDonald (2003) listed sites **6617-6620**, **6575** and **8920** as relevant to the area they surveyed, which ran southeast along the road from Onslow to the North West Coastal Highway, several kilometres from the PDAs this author inspected, but did not discuss any of them. More importantly, the Thalanyji involved in their survey did not report ***any*** significant sites in the area inspected, suggesting that none of the ***closed*** sites in Table 1 lies close to that alignment.

Murphy and McDonald (2003:Table 1) listed radiocarbon dates from many archaeological sites in the Pilbara. This table would have been quite useful had they included the sample type, laboratory identifier and sample number; and stated whether or not shell dates had been corrected for marine reservoir effect. Without those data the information is useless.

Hook (2007) reported on 14 scatters of mollusc shells (sites **24768-24781** inclusive) found in 2005 on the coast southwest of Onslow. She suggested a number of hypothetical research questions that might be answered by studying these shell scatters through test excavation and radiometric dating. In the light of research by Faulker (2010) and Sullivan *et al*. (2010), reported by RPS (2011) and discussed below, it is

legitimate to question whether these shell scatters formed culturally and merit further investigation or formed naturally and do not.

McDonald (2007) reported that no ethnographic sites were known in the area studied by Hook (2007), which included Seaview Drive, near where the cable that precipitated the survey reported here might come ashore (Option 1 in Figure 1). Nor did the Thalanyji he consulted identify any previously unrecorded culturally significant sites, either. He recommended, however, that any ground disturbance work be monitored to ensure that no cultural material was disturbed. Whether that was done is unclear.

Coldrick and McDonald (2010) conducted an ethnographic survey of the Macdeon terrestrial gas project which will be built to the southeast of Old Onslow. They discussed a previously unknown 'sacred site', first reported in 2009. This 'site' is similar to sites **6617**, **6619** and **6620**, but lies at least 15 km southwest of the proposed development reported on here.

Cue and Greenfeld (2012) surveyed the proposed extension to Onslow Airport. They identified site **32402**, an extensive shell scatter comprising six concentrations of predominantly *Terebralia* spp., suggesting that this midden accumulated before 6000 BP, although they made no attempt to date a site they considered of ***low*** archaeological significance.

Cue *et al*. (2012) reported on their detailed recording of site **32402**, which would be completely disturbed by the work to be carried at out Onslow Airport.

Puletama *et al*. (2012) surveyed an area immediately south of Onslow, where the Shire of Ashburton proposes to develop residential and industrial estates. They identified eight shell middens (sites **32540-32547** inclusive), all with some stone artefacts. The predominant species was *A. granosa*, suggesting that these sites formed after 4000 BP. They considered site **32544**, which was better preserved, to be of ***medium*** archaeological significance, the other sites were of ***low*** significance.

Taken together, these reports suggested that the only type of Aboriginal site that might be found in any of the areas this author surveyed at Onslow would be deposits of shells, with or without some stone artefacts; whether such shell deposits are 'middens' or natural accumulations would have to be assessed in the field as objectively as possible, based on the criteria described by Sullivan and O'Connor (1993), O'Connor and Sullivan (1994), Faulkner (2010) and Sullivan *et al*. (2010).

Port Hedland

Of the 22 reports generated by the database search undertaken in November 2012, Kalotas (1991) is ***closed***. Permission to access it was not sought. Several other reports proved to be irrelevant to the PDAs surveyed in December 2012. Green and Turner (1982) did not discuss any sites near Port Hedland. Sale (1994) relates to Walga Rock, near Cue. Quartermaine (2003) relates to the highway from Dampier to Karratha, which lies 220 km west of Port Hedland. Those reports are not discussed. DAA database searches often generate long lists of reports, some of which are irrelevant to the area being studied; that is the nature of keyword searches.

Clarke (1976), Sullivan (1984:17) and Atkins (1990) reported on efforts to conserve the petroglyphs on Two Mile Ridge. Randolph (1999) commented that this ridge was an extensive Aboriginal site with shell middens, evidence of pre- and post-colonial occupation, a well and possibly some ceremonial sites; as well as petroglyphs. The Company has taken care to avoid Two Mile Ridge completely.

Hook *et al*. (1993) noted that systematic collection of the archaeological record in and around Port Hedland ceased in the 1950s. They tried to clarify which of the known Aboriginal sites were or were not registered with DAA. They re-described a number of registered sites none of which are located near the PDAs that were the focus of the survey reported on here. As the earlier discussion of sites **20797/20913**

and **20798/20914** shows, the confusion in the Register has increased in the last 20 years as multiple surveys of the same areas are undertaken by competing cultural heritage consultancy firms with widely varying skill sets and different reporting standards.

Murphy *et al.* (1994) undertook a preliminary field investigation of parts of Port Hedland and desktop study of the relevant heritage reports. They concluded that the limited nature of previous studies precluded them from accurately assessing the town's cultural heritage. They recommended that the town should be the subject of detailed investigation, but that does not appear ever to have happened.

Warren (2001) listed site **753**, the shell midden beneath Port Hedland Hotel, but did not discuss it. He did note, however, that the occurrence of middens, petroglyphs and arranged stones on Two Mile Ridge is locally unique to that rocky outcrop. The land around the rest of Port Hedland is saline mudflats where mangroves predominate. His report includes very useful detailed maps showing the locations of the petroglyphs on Two Mile Ridge, but is otherwise irrelevant to the PDAs that prompted the survey reported on here.

Green *et al.* (2003) surveyed a proposed railway corridor between Hope Downs, 80 km north of Newman, and a new port to be constructed on Finucane Island, 5 km west of Port Hedland. They noted the well-known deficiencies of the DAA database and hypothesised that many previously unrecorded Aboriginal sites remain to be identified at Port Hedland, although not, in this author's opinion, in the areas she inspected in December 2012.

Harris (2003b) noted that many of the registered sites in the area she studied are not where DAA thinks they are. This is undoubtedly true because the method DAA used to convert the old Imperial map references to metric co-ordinates accidentally moved many sites a considerable distance from their original locations; while the accuracy with which sites were recorded before the use of hand-held GPS devices became common was critically dependent on the map-reading skills of the original reporter and/or their detailed description of the location; both were sometimes defective, as are some current consultants' GPS skills (Webb 2013:10-13). Harris (2003b) commented that every survey in and around Port Hedland reveals new Aboriginal sites, indicating how rich the cultural heritage of the area is. This is also undoubtedly true.

Green (2005), Mitchell and Green (2005) and Anthropos Australis (2009a, 2011) relate exclusively to St Cecilia's Catholic Primary School, which is built on the site of the Pioneer Cemetery, south of Sutherland Street and east of Stevens Street, and the Lock Hospital (site **680**) where Aboriginal people with 'syphilis' and/or 'leprosy' were incarcerated in the late nineteenth and early twentieth centuries (MacCallum 1995). Cleland (1928), a medical practitioner, stated that the 'syphilis' was actually granuloma of the pudenda, and the 'leprosy' was equally unusual; neither disease responded to treatments efficacious on Europeans. The Pioneer Cemetery no longer exists, but it appears to have been dug into extensive shell deposits. This area lies well away from and will not be impacted by the proposed development. In another discussion of the Pioneer Cemetery, RPS (2011) noted that Faulkner (2010) and Sullivan *et al*. (2010) argued that of 21 'middens' investigated in and around Port Hedland only three were definitely cultural in origin. Based on their radiometric dates, shell size, etc., the others were shown to be either natural accumulations of *A. granosa* on chenier ridges or the shells had been redeposited by wave action. These findings have important implications for the small 'middens' lacking stone artefacts recorded at Onslow by Hook (2007), Cue and Greenfeld (2012) and Puletama *et al*. (2012), which are also not necessarily cultural.

Anthropos Australis (2008) surveyed areas within the town of Port Hedland where the Water Corporation proposed installing sewage pipes below ground, including along Sutherland Street. None of the sites they said would be impacted by the proposed works was generated by the DAA database search

undertaken in November 2012. They presumably lie well away from the areas that were the focus of the survey reported on here. Anthropos Australis (2008:vi) specifically noted, however, that site **753** (Table 2) would **not** be impacted by the sewerage work.

Jackson *et al.* (2008) reported on an archaeological survey at Nelson Point and Finucane Island East. They identified 12 Aboriginal sites in the areas surveyed, all petroglyphs or shell scatters, that lie well away from the PDAs that were the focus of the survey reported on here and will not be disturbed.

Anthropos Australis (2009b) surveyed along McKay and Kingsmill Streets and identified site **11493**. This part of Port Hedland is close to the Company's least preferred location for the CEV site, Option C at the junction of Howe and Kingsmill Streets. Site **11943** was not generated by the database search undertaken in November 2012 (Figure 12). Hence, it presumably lies 'outside the box'. Moreover, it will not be impacted by the proposed development that prompted the survey reported on here because the CEV site will ***not*** be at Option C.

Taken together, these reports suggested that the only type of Aboriginal site that might be found in any of the PDAs surveyed at Port Hedland was a shell scatter; whether such scatters were 'middens' or natural accumulations would then have to be assessed as objectively as possible, based on the criteria described by Sullivan and O'Connor (1993), O'Connor and Sullivan (1994), Faulkner (2010) and Sullivan *et al*. (2010).

8 Field survey

Every PDA was surveyed in the same way. Accompanied by Greg Neylan, Land Access and Regulatory Manager for the Company, the author walked all over the parcels of land to be impacted and inspected the visible ground surface for signs of past Aboriginal usage. The original surface was nowhere visible because every area had been considerably disturbed by landscaping or other earth moving activity.

The Company's preferred option at Onslow comprises a beach manhole to be excavated into an informal carpark beside a formal picnic area on the seaward side of the junction of Back Beach Road and Seaview Drive (Option 1 in Figure 1), where an access track leads to the beach (Plates 1-4). The cable (purple line in Figure 1) would come ashore either in a trench less than 0.5 m wide and at least 1.5 m deep, or through a tunnel 150 mm in diameter bored 1.5 m beneath the beach and out to sea for up to 1 km. The CEV site for Option 1 would be constructed beside the existing Sports Oval, on ground that has also already been completely disturbed (Plates 5-6). The cable connecting the CEV site to the beach manhole would be laid in a trench less than 0.5 m wide and at least 1.5 m deep cut in the road reserve beside Back Beach Road (Plate 7) and Clarke Place.

Option 2 comprised a beach manhole to be excavated into the foreshore promenade and picnic area seen in Plate 8. The CEV site for this option is also near the Sports Oval (Plates 9-10). The option of placing the CEV site in the compound on the south corner of Third Street and Third Avenue was rejected because the site is restricted and in a residential area (Plate 11). The connecting cable for this option would be trenched into the road reserve beside Third Street (Plate 12). Neither the proposed manhole area nor the CEV site was inspected in detail because the original ground surface was nowhere visible. Nonetheless, the author considered the likelihood of finding any cultural material buried below the present ground surface in either area to be vanishingly small.

After the surveys were completed, the Company rejected Option 2 at Onslow in favour of Option 1. Late in 2013, however, with the full support of Port Hedland Town Council, which includes Aboriginal representatives, the Company decided to bring the cable ashore at Port Hedland Option A, not Onslow.

The Company's preferred option at Port Hedland was the low-lying area seen in Plates 13-14, opposite the junction of Clarke and McGregor Streets, east of the tennis courts at the Sports Complex (Option A, Figure 2). The area delineated would house both the inspection manhole and the CEV site, in a 100 sq m fenced compound. It was not inspected in detail because the ground surface was invisible, the vegetation was so dense, and the area had clearly been completely disturbed. It also obviously becomes waterlogged when it rains. The author considers the likelihood of finding any cultural material buried below the present ground surface in this area to be vanishingly small.

Option B at Port Hedland is located to the west of the tennis courts in an area where people using the sports facilities park their cars (Figure 3). It was not inspected in detail because the ground has clearly been completely disturbed (Plate 15) and the Company had already decided that Option A was a better location.

In the case of both Option A and Option B, the cable would be brought ashore through a tunnel 150 mm in diameter that began at the manhole and ran deep beneath Clarke Street (Plate 16) at such an angle that it would connect with the offshore cable, which would be laid in a trench at least 1.5 m deep.

Option C at Port Hedland is located on the corner of Howe and Kingsmill Streets on the outskirts of Port Hedland (Figure 4). This site is perched on a high bluff overlooking the Indian Ocean where there is a compound full of buildings. It was not inspected at all because the original ground surface was nowhere visible; has been completely disturbed and covered in concrete. It was the Company's least preferred option; the site is too constricted to house a CEV site adequately. The location was suggested by the Port Hedland Town Council because other infrastructure had already been installed there.

The beach below Sutherland Street was also inspected (Plate 17) to see whether the cable could be laid in a trench, rather than run through a directional bore that would begin in the Sports Complex and can be up to 1 km long. Trenching was rejected in favour of boring to avoid disturbing the turtles that nest in this area (Plate 18).

As noted above, in late 2013, with the full support of Port Hedland Town Council, the Company decided definitively to construct the CEV site at Option A. At least one side of the enclosure will be a wall decorated with motifs painted by local Aboriginal artists, greatly enhancing the streetscape.

9 Results

At Onslow, as expected, no traces of past Aboriginal land usage that would potentially be impacted by cable installation were noted at any of the PDAs inspected, because the ground had been thoroughly disturbed by recent landscaping or other activities (Plates 1-12).

The beach between the carpark at Option 1 and the waterline was also inspected, although this area would only be disturbed by a narrow trench or directional bore. Broken shells cover the entire beach, above the high water mark (Plate 4). There is no reason to suppose that any of this shelly material reflects past Aboriginal usage, however; or, if it does, it has been thoroughly disturbed by recent human activity and/or wave action. No stone artefacts were noted anywhere on the highly disturbed surface of the beach, where people clearly now come to walk dogs, jog, swim and generally disport themselves. Moreover, no Aboriginal sites were identified when the deep water jetty was built some 100 m away, some years ago.

It is possible, however, that cultural material or human remains *might* be found below the present ground surface when trenching occurs, particularly along Back Beach Road (Plate 7). Given that site **8920** lies to the east of the road, it would be advisable if the cable were laid along the west side of the road, to avoid any possibility of disturbing subsurface cultural material. It would also be advisable if that work

were monitored by an archaeologist with a proven ability to recognise Aboriginal stone artefacts and human bone, such as this author.

At Port Hedland, Option A was only inspected visually, given the density of the vegetation (Plates 13-14). No traces of past Aboriginal usage could be detected because the ground has been thoroughly disturbed by recent activity. Option B was inspected less carefully because the ground had even more obviously been thoroughly disturbed (Plate 15) and the Company preferred Option A. Option C was merely 'viewed' because the Company was unwilling to put their CEV site in that compound; the area available was too constricted.

The beach below Sutherland Street was also inspected (Plate 17). Many shell scatters were noted, but there is no reason to suppose that any of them reflect past Aboriginal activity, or, if they do, they have since been thoroughly disturbed by people and/or wave action. Few whole shells were noted, while the shell fragments formed lines parallel to the ocean, suggesting that they had been thrown up, or re-deposited, by the sea. No stone artefacts were observed in any of the scatters or on the highly disturbed surface of the beach, where turtles come ashore to lay their eggs. There is a turtle viewing platform on the cliff top at the end of Clarke Street (Plate 18), near steps leading down to the beach.

Bob Gozzard (WA Geological Survey, pers. comm. 2013) told the author that the underlying limestone is quite 'soft' and approximately 20 m thick (Figure 6). Once the (buried) capstone is pierced, he said the Company should have no difficulty drilling horizontally through the limestone. Hence, the author **recommends** that the Company runs the cable through a bore deep beneath the beach, rather than laying it in a trench; it will be less disturbing for the turtles which come ashore there to lay their eggs. A directional bore will run less risk of damaging turtle nests.

Having inspected all the possible manhole and CEV sites at Onslow and Port Hedland, the author has no hesitation in saying that there was not only no material evidence for past Aboriginal activity at any of the places inspected, but the possibility of disturbing subsurface cultural material was also vanishingly small at Port Hedland and very low at Onslow.

10 Recommendations

In light of the Company's decision in late 2013 to pursue only Option A at Port Hedland, the following **recommendations** are made:

No additional surveys of the PDA will be required before cable installation begins, unless the place where the cable comes onshore is changed; in which case the new PDA must be inspected by an archaeologist skilled at identifying Aboriginal stone artefacts and able to distinguish culturally important shell midden material from natural shell accumulations on cheniers.

It is **recommended** that the cable connecting the inspection manhole at Option A to the submarine cable should be run through a bore deep beneath Clarke Street and the beach below Sutherland Street to avoid the possibility of disturbing turtle nests, since the animals come ashore there to lay their eggs.

Given that trenching along Back Beach Road at Onslow *might* disturb human remains or cultural material, it is **recommended** that should ground disturbance take place in this area in future an archaeologist with a proven ability to recognise Aboriginal artefacts and human bones should monitor such work. Moreover, any such work should take place on the **west** side of Back Beach Road.

The Company is **reminded** of its legal obligation to report the discovery of human remains to the Police, the Department of Aboriginal Affairs (tel: 08-6551-8000) and the relevant Aboriginal people. Human remains must ***not*** be moved until they have been inspected by these authorities.

The Company must also **ensure** that all cable installation crews and contractors are made aware of their legal obligations under the *AHA* to adhere to the areas surveyed and, when trenching, to remain vigilant at all times in case cultural material of any kind is found below the present ground surface. Should any such material be noted, work must cease immediately and the Company must be notified.

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Plate 1: The informal carpark at the corner of Back Beach Road and Seaview Drive, Option 1 at Onslow. The beach manhole would be installed approximately where the car is parked.

Plate 2: The author inspecting the informal track from the carpark to the beach at Option 1, Onslow, with the deep water jetty in the background. The cable could be laid in a trench here, although directional drilling would be preferable.

Plate 3: The picnic area at Option 1, Onslow, showing that the ground is already 'managed'. The beach manhole would be just north of where the car is parked in Plate 1.

Plate 4: The beach at Option 1, Onslow. The continuous, highly-fragmented, nature of the dense scatter of shells on the foreshore indicates it is natural, ***not*** cultural; it can be trenched.

Plate 5: The preferred location for the Option 1 CEV site at Onslow, beside the sheds on the right. The area has already been extensively disturbed and is devoid of Aboriginal cultural material.

Plate 6: Another view of the preferred location for the Option 1 CEV site at Onslow.

Plate 7: Back Beach Road, Onslow. The cable should be laid in a trench to right of the road, as seen in this picture, because site **8920** lies to the left of the road.

Plate 8: The site for the Option 2 beach manhole at Onslow is in front of the parked car. The extent of the foreshore is clear, although the tide was beginning to come in when this photograph was taken. The limestone blocks are a protection against spring tides.

Plate 9: Alternative location (Option 2) for the CEV site at Onslow, in an area where the ground surface has clearly been disturbed and is devoid of Aboriginal cultural material.

Plate 10: Option 2 for the CEV site is located beside Onslow Community Garden.

Plate 11: This possible site for the CEV building at Onslow was rejected by the Company as being already too crowded with Telstra equipment.

Plate 12: Onslow streetscape. If Option 2 is selected, the cable connecting the CEV site to the beach manhole would be laid in a trench between the pavement and the fence around the Community Garden.

Plate 13: If Option A at Port Hedland is selected, the CEV site would be located to the left of the fence around the tennis courts, in ground that has clearly been disturbed and is devoid of Aboriginal cultural material.

Plate 14: The preferred location for the CEV site at Port Hedland viewed from the opposite direction to Plate 13.

Plate 15: If Option B at Port Hedland is selected, the CEV site would be located in an area used as an informal carpark within the Sports Complex, where the ground is disturbed and devoid of Aboriginal cultural material.

Plate 16: The junction of Sutherland and Clarke Streets, Port Hedland, the cable will be run through a tunnel bored deep beneath Clarke Street, facing the camera.

Plate 17: The beach below Sutherland Street, Port Hedland, showing the erosion that occurs during storm surges. The retaining embankment has been torn down by wave action.

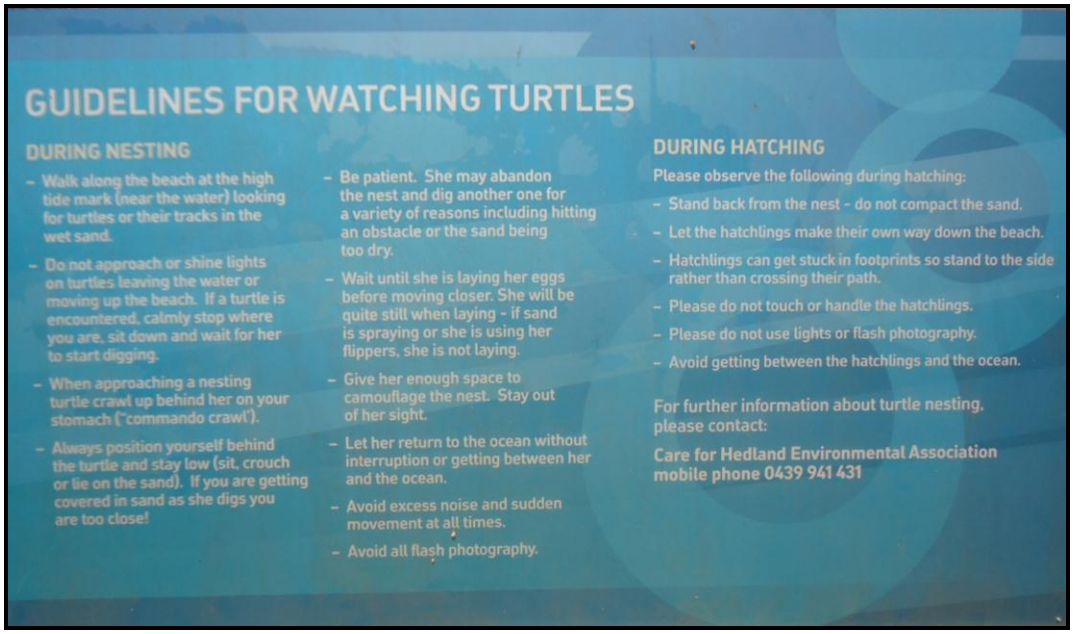

Plate 18: Notice beside the stairs down to the beach below the junction of Clarke and Sutherland Streets, Port Hedland, advising people of the correct protocols to follow when watching turtles. Because this beach is obviously used as a nesting site, it is **recommended** that the cable be run through a directional bore at least 1.5 m beneath its surface to avoid damaging any turtle nests. Ideally, this bore should ***not*** be drilled during nesting season, in case the animals are distressed; although boring really creates very little noise or ground disturbance.

Appendix

Obligations under the WA *Aboriginal Heritage Act* (1972, revised) relating to Aboriginal sites and surveys

Section 5: Application to places

This Act applies to:

(a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present,

(b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent,

(c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State,

(d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

Section 6: Application to objects

(1) Subject to subsection (2a), this Act applies to all objects, whether natural or artificial and irrespective of where found or situated in the State, which are or have been of sacred, ritual or ceremonial significance to persons of Aboriginal descent, or which are or were used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people past or present.

(2) Subject to subsection (2a), this Act applies to objects so nearly resembling an object of sacred significance to persons of Aboriginal descent as to be likely to deceive or be capable of being mistaken for such an object.

(2a) This Act does not apply to a collection, held by the Museum under section 9 of the *Museum Act (*1969), which is under the management and control of the Trustees under that Act.

(3) The provisions of Part VI of this Act do not apply to an object made for the purpose of sale and which:

(a) is not an object that is or has been of sacred significance to persons of Aboriginal descent, or an object so nearly resembling such an object as to be likely to deceive or be capable of being mistaken for the same, or

(b) is an object of the kind referred to in paragraph (a) that is disposed of or dealt with by or with the consent of the Minister.

Section 15: Report of findings

Any person who has knowledge of the existence of any thing in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual or ceremonial significance, cave or rock paintings or engravings, stone structures or arranged stones, carved trees, or of any other place or thing to which this Act applies

or to which this Act might reasonably be suspected to apply shall report its existence to the Registrar, or to a police officer, unless he has reasonable cause to believe the existence of the thing or place in question to be already known to the Registrar.

Section 17: Offences relating to Aboriginal sites

A person who:

(a) excavates, destroys, damages, conceals or in any way alters any Aboriginal site, or

(b) in any way alters, damages, removes, destroys, conceals, or who deals with in a manner not sanctioned by relevant custom, or assumes the possession, custody or control of, any object on or under an Aboriginal site, commits an offence unless he is acting with the authorisation of the Registrar under section 16 or the consent of the Minister under section 18.

Section 18: Consent to certain uses

(1) For the purposes of this section, the expression '*the owner of any land*' includes a lessee from the Crown, and the holder of any mining tenement or mining privilege, or of any right or privilege under the *Petroleum Act* (1967), in relation to the land.

(1a) A person is also included as an owner of land for the purposes of this section if (a) the person:

(i) is the holder of rights conferred under section 34 of the *Dampier to Bunbury Pipeline Act* (1997) in respect of the land or is the holder's nominee approved under section 34(3) of that Act, or

(ii) has authority under section 7 of the *Petroleum Pipelines Act* (1969) to enter upon the land, or

(b) the person is the holder of a distribution licence under Part 2A of the *Energy Coordination Act* (1994) as a result of which the person has rights or powers in respect of the land.

(2) Where the owner of any land gives to the Committee notice in writing that he requires to use the land for a purpose which, unless the Minister gives his consent under this section, would be likely to result in a breach of section 17 in respect of any Aboriginal site that might be on the land, the Committee shall, as soon as it is reasonably able, form an opinion as to whether there is any Aboriginal site on the land, evaluate the importance and significance of any such site, and submit the notice to the Minister together with its recommendation in writing as to whether or not the Minister should consent to the use of the land for that purpose, and, where applicable, the extent to which and the conditions upon which his consent should be given.

(3) Where the Committee submits a notice to the Minister under subsection (2) he shall consider its recommendation and having regard to the general interest of the community shall either:

(a) consent to the use of the land the subject of the notice, or a specified part of the land, for the purpose required, subject to such conditions, if any, as he may specify, or

(b) wholly decline to consent to the use of the land the subject of the notice for the purpose required,

and shall forthwith inform the owner in writing of his decision.

(4) Where the owner of any land has given to the Committee notice pursuant to subsection (2) and the Committee has not submitted it with its recommendation to the Minister in accordance with that subsection the Minister may require the Committee to do so within a specified time, or may require the Committee to take such other action as the Minister considers necessary in order to expedite the matter,

and the Committee shall comply with any such requirement.

(5) Where the owner of any land is aggrieved by a decision of the Minister made under subsection (3) he may apply to the State Administrative Tribunal for a review of the decision.

(7) Where the owner of any land gives notice to the Committee under subsection (2), the Committee may, if it is satisfied that it is practicable to do so, direct the removal of any object to which this Act applies from the land to a place of safe custody.

(8) Where consent has been given under this section to a person to use any land for a particular purpose nothing done by or on behalf of that person pursuant to, and in accordance with any conditions attached to, the consent constitutes an offence against this Act.

Section 39: Functions of the (Aboriginal Cultural Materials) Committee

(2) In evaluating the importance of places and objects the Committee shall have regard to:

(a) any existing use or significance attributed under relevant Aboriginal custom;

(b) any former or reputed use or significance which may be attributed upon the basis of tradition, historical association, or Aboriginal sentiment;

(c) any potential anthropological, archaeological or ethnographical interest;

(d) aesthetic values.