

Section 7
Existing Marine Environment



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7. Existing Marine Environment

7.1 Studies and Surveys

The proposed Blacktip Project lies within the Joseph Bonaparte Gulf, in the Northern Territory, Australia. This section provides a background to the region and a description of the Joseph Bonaparte Gulf, focusing on the marine environment. Particular focus is given to the environmental conditions within the proposed offshore and nearshore project area. The existing terrestrial environment is discussed in **Section 8**.

Due to the remoteness and inaccessibility of the offshore and onshore locations there is a lack of historical information. Where this is the case, it has been acknowledged throughout the section. Environmental studies and surveys were undertaken as part of the EIA process to provide specific information on certain environmental aspects and to gain a better understanding of the potential environmental issues. Surveys and studies undertaken include:

- marine seabed survey;
- intertidal fauna and flora survey;
- sea turtle and dugong distribution and turtle nesting activity;
- hydrodynamic measurements and trajectory modelling.

The complete findings of the studies are presented in **Technical Appendices B–C & J–K Volume 2** of this Draft EIS. Results have been summarised in the relevant sections below.

7.2 Physical Environment

7.2.1 Regional Setting

The Blacktip Project is located in the Joseph Bonaparte Gulf. The climate is influenced by the shift in the monsoon between the dry and wet seasons. During the wet season (October to March) the north-west winds generate regular thunderstorm activity and high rainfall, particularly over coastal areas and during cyclones. Four major rivers empty into the bottom of the Gulf, affecting water quality and creating vast areas of high water turbidity. The large tidal range contributes to the high turbidity, even in the dry season. Sedimentation resulting from land run-off, along with strong tidal currents, also effect the bathymetry and sediment composition, particularly in the lower Gulf. These influences diminish with increasing distance offshore.

7.2.2 Climate

The purpose of this section is to describe the climatic conditions that are most pertinent to the marine environment. Other climatic conditions including rainfall, temperature and humidity are discussed in **Section 8**.

The regional climate of the project area is tropical monsoonal, consisting of two predominant seasons. The winter or ‘dry season’ months (April to September) are influenced by easterly winds generated over inland Australia, resulting in dry and warm conditions, with very little rainfall and

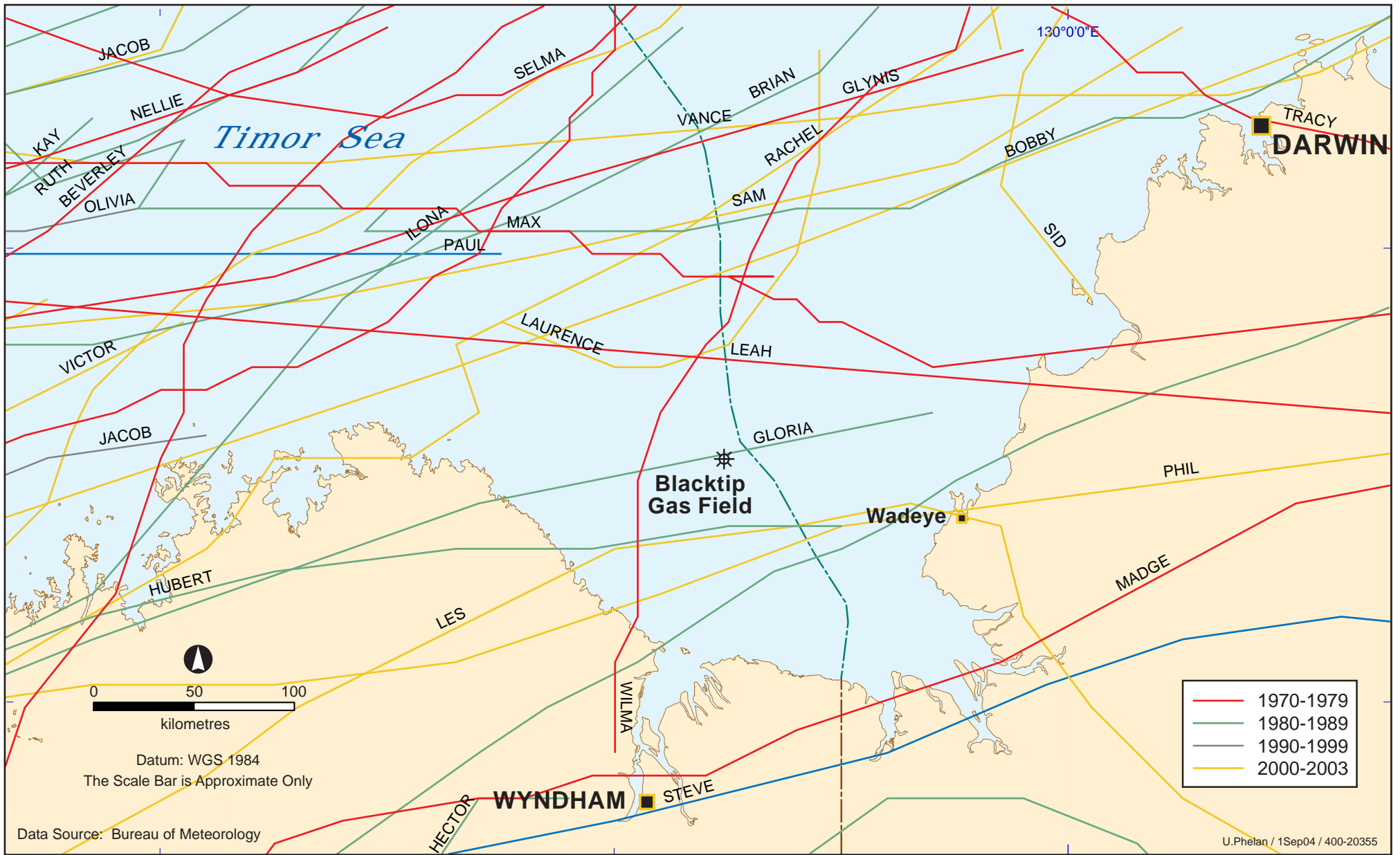
low relative humidity. A hot and often wet summer, known as the wet season, persists from October to March. The high humidity and thunderstorm activity of the wet season is caused by steady west to north-west winds, bringing moisture from the Timor Sea. Detailed meteorology data is presented in **Section 8.2.2**.

Cyclones: Cyclones may occur in the region between December and April, resulting in severe storms with gale force winds. Typically, cyclones form south of the equator in the Timor or Arafura Seas when sea temperatures are greater than 26.5°C. Cyclones may move in any direction; however, the majority of past cyclones have moved over the Timor Sea to the north of the project area (**Figure 7-1**). On average, the Joseph Bonaparte Gulf receives ten cyclones per decade (Bureau of Meteorology 2003) (**Figure 7-2**).

Severe cyclones can significantly disturb shallow water habitats and may influence water quality in deeper waters. WNI Oceanographers and Meteorologists have undertaken location specific modelling of ambient conditions, as well as winds, waves and currents during cyclonic events (WNI 2001; 2004). Results of the modelling which included estimates of wind speeds, wave heights and storm surge conditions, will be used to assist in determining design requirements for the Blacktip Project and provide information for operational planning.

Storm Surge: Storm surge is a raised mass of water, generally 2–5 m higher than normal tide levels, which result from strong onshore winds and reduced atmospheric pressure (Bureau of Meteorology 2003). Storm surge is often associated with cyclones and can cause flooding and damage through raised tides and waves. The height of storm surge is influenced by many factors, including the intensity and speed of an associated cyclone, the angle at which the cyclone crosses the coast and the topography of the affected area. There are no records of storm surges in the Joseph Bonaparte Gulf; however, it is expected that surges may occur in the region as a result of cyclones.

Modelling of cyclonic conditions in the Joseph Bonaparte Gulf by WNI suggests that the 10 year return period is 0.6 m and the 100 year return is 0.9 m for storm surge. This has been taken into account when investigating a site for the onshore plant and the preferred site has been located 2.5 km inland in an elevated position to avoid any potential impact from storm surge.



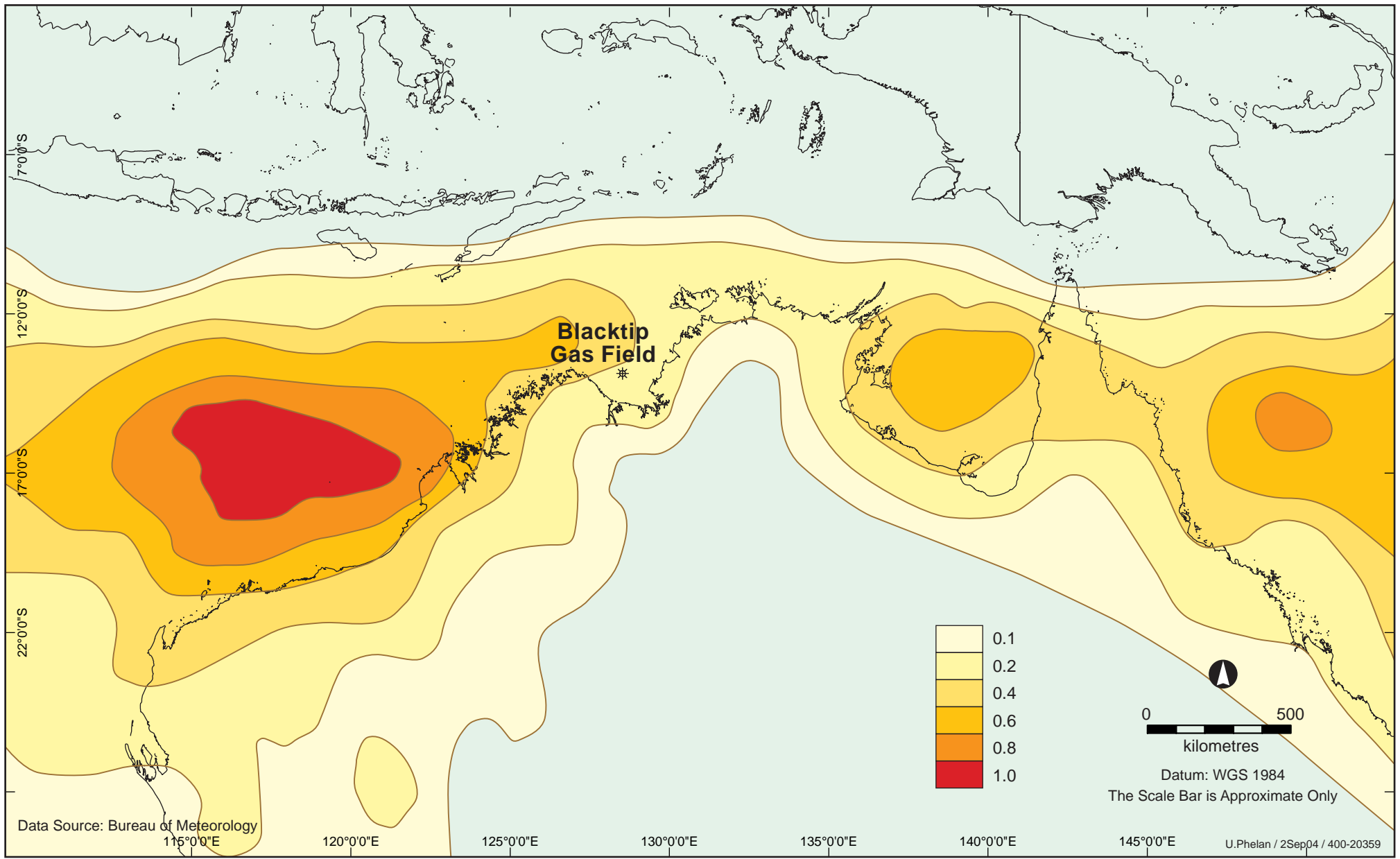
Blacktip Project

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TROPICAL CYCLONES

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7.2.3 Bathymetry and Seabed Features

The Joseph Bonaparte Gulf lies within the Bonaparte Basin, which adjoins the Kimberley Basin at the Cambridge Gulf. The bathymetry in parts of the southern of the Gulf is strongly influenced by the strong tidal movement and channels of the Ord, Keep, Victoria and Fitzmaurice Rivers as shown on **Figure 7-3**. A series of extensive sandbars, known as the King Shoals and Medusa Banks, have been generated in the south-west by the strong outflows of sediment-laden water from Cambridge Gulf. Similar sandbars can be found in the south-east of the Joseph Bonaparte Gulf; however, all these are well south of the Blacktip Project.

Further north, beyond these sandbars, water depths shelve gently offshore (SDA 1998). The seabed in the upper (outer) reaches of the Gulf, towards the Timor Sea, is generally flat and continues to slope gently downwards, becoming deeper with distance offshore.

The Blacktip reservoir is located in the upper (outer) reaches of the Gulf, in an area of relatively flat seabed. The majority of the proposed pipeline route is also generally flat, sloping gently upwards from approximately 52 m water depth at the proposed wellhead platform location to 31 m water depth approximately 47 km east of the wellhead platform. Results of the geotechnical survey undertaken along the pipeline route in 2004 confirm that the seabed is flat and featureless and contains very soft, grey green, gravelly sand clays (Fugro 2004). Furthest east, towards the pipeline landfall the seabed becomes more irregular and channelled, due to the main tidal channel for the Victoria River (**Figure 1-1**).

The seabed in the Victoria River channel is variable, probably due to strong currents that have deepened existing channels and created new ones. Depth varies from 20–50 m, with some deep pockets of up to 70 m depth; however, the pipeline does not traverse these deep pockets. A number of ridges occur in this area, comprised of firmer shelly gravel overlying stiff brown clays. The largest ridges protrude up to 4 m from the surrounding seabed. Therefore, the final pipeline route will need to be positioned to avoid these clay ridges as much as possible because of the limitation on unsupported pipeline spans during the installation process.

Further east beyond the Victoria River channel, approximately 70 to 90 km from the wellhead platform (approximately 28 to 18 km from the proposed pipeline shore crossing), the seabed flattens and is generally level, with water depths of 20–30 m. A few hummocks and shallow elongated shoals and depressions are present. The geotechnical survey (Fugro 2004) observed that this area of seabed alternates between flat and featureless seabed containing soft to firm silty clay and an area of hummocky seabed containing megaripples/sand waves. This area generally consists of unconsolidated coarse sand and fine gravel, and occasionally sediments that are consolidated/cemented and contain hard/soft coral and algae. The megaripples and sand waves are likely to be caused by the accumulation of mobile sediments over ridges of firm clay. Two small gorgonian corals (< 15 cm in height) were collected during the offshore environmental survey along the 107.5 km pipeline route and nearshore areas.

The bathymetry 90 to 105 km from the wellhead platform (approximately 18 to 3 km from the proposed pipeline shore crossing) displays a 5 m rise and then shoals very gently to a water depth of 15 m. The final 3 km of seabed to the coast consists of a steep climb from 15 m to 2 m.

7.2.4 Oceanography and Water Quality

The proposed development spans a variety of marine regions from the wellhead platform, along 90 km of pipeline where it crosses deep and shallow waters, the intertidal zone and finally the pipeline landfall at a sandy beach. Consequently, the oceanography and marine water quality are expected to vary over the length of the pipeline.

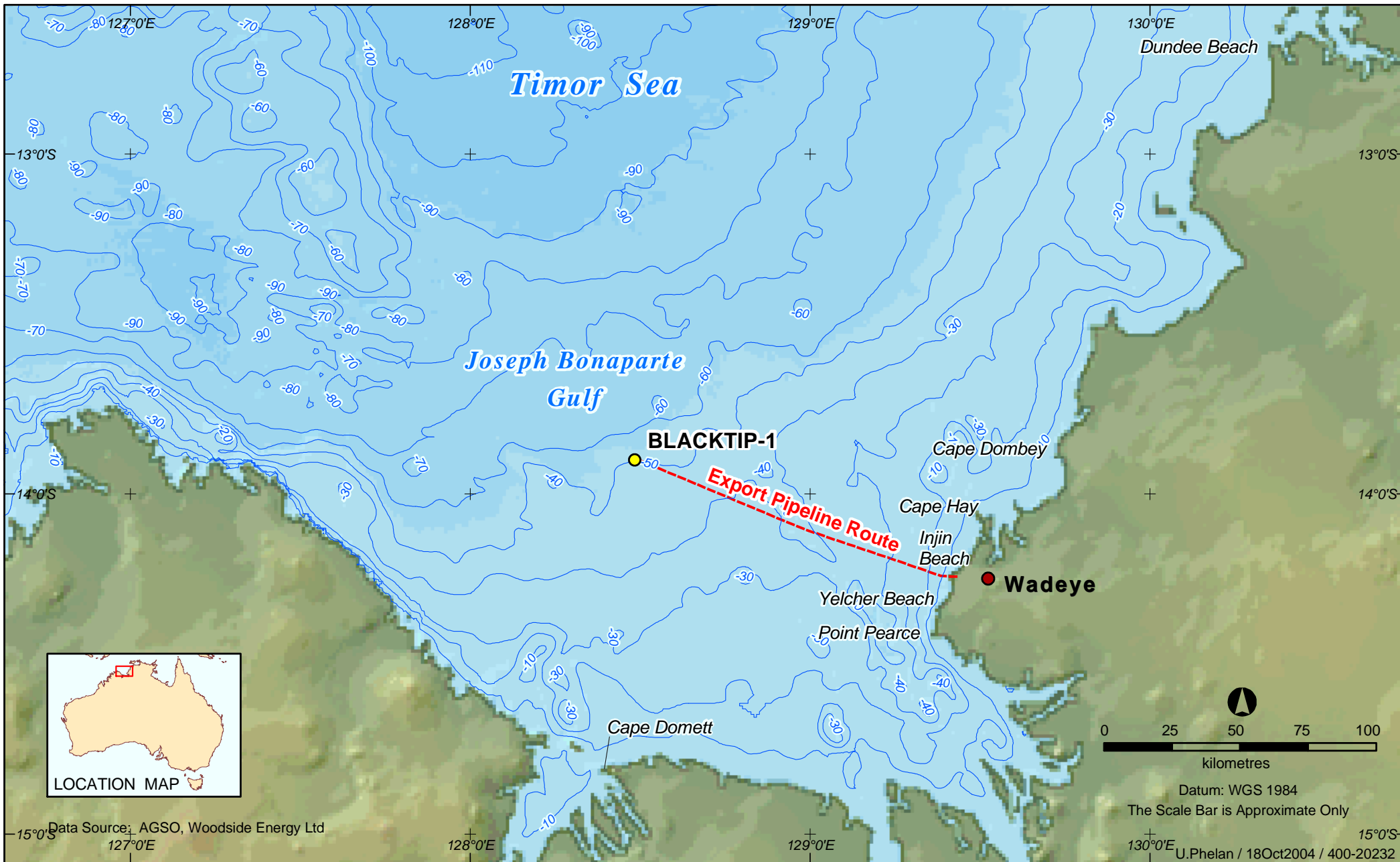
Oceanographic data for the field development were collected in May and July, 2004. A detailed interpretation of these data is presented in WNI (2004). The following presents a summary of the findings.

Water Temperature: Satellite images from the CSIRO Marine Research Remote Sensing facility show that summer temperatures during January 2004 were approximately 31–34°C in the Joseph Bonaparte Gulf and near the mouth of the Victoria River (CSIRO 2004). Temperatures near the wellhead platform location range from 29–31°C (CSIRO 2004). Direct measurements taken in May 2004 recorded water temperatures between 28 and 29°C across the project area, with virtually no variation in temperature with water depth (measured down to 25 m where possible), indicating that the water column was well mixed with no temperature stratification.

Waves: The Joseph Bonaparte Gulf is protected from swell generated in the Southern Ocean, therefore swells affecting the area are limited to those generated by cyclones or prolonged strong winds. Sea waves, which are usually short period (1–8 second) waves, are generated by local synoptic winds and reflect wind directionality. Persistent strong winds capable of generating significant seas are generally associated with the south-easterly trade winds which dominate during winter or dry season months. However, the small south-easterly fetch is expected to limit the development of large seas throughout the project area, particularly in the inshore areas. Larger seas typically occur during the winter, from June to August. The period of calmest seas occurs from April to May.

Tides and Currents: Tides in the Joseph Bonaparte Gulf are semi-diurnal with two high and two low tides per day. The tidal wave propagates in from the Timor Sea and circulates around an amphidromic point located offshore from Cape Londonderry. As a result, there is considerable variation in the tidal range along the north-west Kimberley coast and within the Gulf.

The spring tidal range at Wadeye, just north of the development site, is 8m whilst there is a slightly higher range of 8.2 m at Pelican Island, on the southern side of the Gulf. On the western side of the Gulf, ranges are lower varying from 4.2 m at Reveley Island to 5 m at Cape Whiskey. A 5.8 m tidal range has been measured at the Blacktip wellhead platform location. The neap tidal range is typically 2 to 3 m.



Blacktip Project

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BATHYMETRY OF JOSEPH BONAPARTE GULF

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Modelling shows that the currents and tides in the Joseph Bonaparte Gulf propagate in from the Timor Sea and circulate around an Amphidromic Point located offshore from Cape Londonderry in the north-west. Currents and tidal ranges increase shorewards with maximum tidal ranges exceeding 8 m along the shoreline between Wyndham and Darwin. Currents and tidal ranges reduce offshore towards the proposed Blacktip platform.

The proposed subsea pipeline route crosses the main tidal channel from the Victoria River where currents are modelled to be stronger than at the offshore location of the wells and wellhead platform. Wind generated currents are expected to be of minor importance, except during the irregular passage of cyclones. Currents in 18 m of water at the proposed pipeline are expected to be as high as 2.5 kn (1.4 ms^{-1}) in severe cyclonic conditions (WNI 2004).

Ambient current conditions are considered an important aspect in design considerations for the project, as they influence the size and orientation of subsea pipelines. Furthermore, currents in cyclonic or storm conditions have an influence in that condensate export will be postponed until more favourable conditions prevail.

Although the geotechnical survey confirmed the presence of sand waves between the Victoria River channel and the coastline, there is no evidence of large amplitude sand waves. Sand waves are wave-like sand structures on the seabed, probably generated by the interaction between currents, waves and seabed topography. Sand waves can migrate at a rate of several metres per year depending on their location and surrounding environmental conditions. Sand waves are important in terms of the subsea pipeline design, as large-scale movement of sand waves could result in pipeline exposure and free spanning. These factors are taken into consideration in the design of pipelines and selection of pipelaying technique.

Marine Water Quality: Joseph Bonaparte Gulf is a broad and relatively shallow embayment with a coastline dominated by sand and mud flats, tidal creeks and estuaries of major river systems. Major inputs of fine silt sediments from the Ord, Victoria and Keep River systems occur during the wet season creating vast areas of high turbidity, particularly in the southern part of the Gulf. The sediments are deposited to form sand bars and mud flats which are themselves the source of high turbidity throughout the year as sediments are resuspended by tidal movements.

Consequently, high turbidity levels occur in the lower region of the Gulf throughout the wet season and during phases of high tidal variation (spring tides) during both the wet and dry seasons. When measurements were taken in May 2004, turbidity ranged from around 2 NTU offshore from about the 30 km mark, peaked near 40 NTU at 3 km from the coast but were high (> 10 NTU) from 2 to 15 km from the coast at the proposed pipeline crossing. Satellite images clearly show the high sediment load in shallow areas of the lower part of the Gulf and clearer waters further offshore.

Only limited marine and nearshore water quality data is available for the Blacktip Project area; however, as there are no major developments or population centres near the proposed locations of the Blacktip offshore facilities, the potential for existing pollution is limited. Water temperature, turbidity, salinity, dissolved oxygen and pH profiles were measured along the pipeline route and

around the nearshore facilities during May 2004. Dissolved oxygen and pH values were within the ANZECC guidelines. Salinity increased minimally from around 33 ppt nearshore to nearly 35 ppt offshore; however, it is expected that the range would be much greater during the wet season.

There are also records of algal blooms occurring in the region, particularly during the calmer months of September and October which can affect water quality. These blooms are probably caused by the blue-green algae (Cyanobacteria) *Trichodesmium* (formerly known as *Oscillatoria*) and can result in fish kills, often during the first river flush of the wet season as a result of increased water acidity.

7.2.5 Geology and Sediment Type

The following substrate descriptions are based on published geological maps and the hydrographic and geotechnical surveys undertaken by Woodside for the project.

Offshore: The top layer of sediment from approximately 3 to 35 km offshore is expected to be greater than 1 m in depth and consists of sands and gravels with variable proportions of clay. This material is primarily alluvium, derived from sedimentary sandstones and basal conglomerate. Sonar images indicate some minor palaeochannels in this area containing megaripple or sand waves. These sediments are generally unconsolidated coarse sand, fine gravel interspersed with areas of flat and featureless seabed containing very soft to firm gravelly clays.

The main drainage channels for the Victoria River System occur from approximately 35 to 58 km offshore. This area is dynamic as currents and tidal influence are constantly changing the seabed features in the area. Due to the dynamic nature of the channels, the thickness of the top layer of sediment is expected to be variable. A top layer greater than one metre in depth and consisting of sands and gravels with variable proportions of clay is expected from 59 km to 65 km offshore, with some minor palaeochannels occurring. The influence of alluvial inputs diminishes from around 60 km offshore to the proposed platform location. This top layer increases to greater than two metres in depth from 66 km offshore and the sediments range from loose silty/clayey sands from 66 km to 75 km and very soft clayey silt and silty clay from 75 km offshore to the proposed platform location. Again, the seabed alternates between flat and featureless seabed containing very soft to firm silty clay and an area of hummocky seabed containing megaripple or sand waves, though the seabed is generally flat from about 66 km offshore to the proposed platform location.

Nearshore: Large tidal variation and cyclonic storm events have a major influence on the nearshore substrate. A rocky ridge occurs from about 1–1.5 km from the shore crossing, with depths of 3–4 m LAT. Offshore of this rocky ridge, the seabed comprises poorly sorted, thin loose sands, gravels and muds overlain by large boulder sized particles or very coarse sandy gravels. It appears that finer sediments are swept away by the strong currents that predominate in the area. Inshore of the rocky ridge, sediments consist of sandy muds. The distribution of nearshore sediments correlates strongly with predicted nearshore currents (**Section 11.18 & 11.19**). Close to the proposed pipeline landfall, the hydrodynamic model set up for the Blacktip Project predicted a

recirculating gyre (circular ocean current). Beyond this gyre, currents are at their strongest and diminish slowly with increasing distance offshore.

7.3 Ecological Environment

7.3.1 Regional Setting

The lower part of Joseph Bonaparte Gulf, to the south of the project area, is relatively shallow with a coastline dominated by sand banks, extensive mudflats, mangrove systems, tidal creeks and the estuaries of the Victoria River system and Cambridge Gulf. Waters are extremely turbid in this part of the Gulf due to the large tides and periodic flow of sediment-laden water from the Victoria River system and Cambridge Gulf. The dominant offshore features in the lower Gulf are the elongated parallel sand shoals extending out from the Victoria River and the extensive sand shoals on either side of the entrances to the Cambridge Gulf, known as the King Shoals and Medusa Banks (**Figure 1-1**).

Depth increases gradually out to the continental margin; however, the continental shelf is dissected by numerous paleo-channels. Shallow shoals, small seamounts and occasionally a few islands and tidally exposed reefs occur along the edge of the continental shelf.

The western coastline of the Joseph Bonaparte Gulf extends into Western Australia's Kimberley region and the predominant coastline features are limestone cliffs with shallow sand and/or mud bays and pockets of mangroves. By contrast, the coastline to the east between Cape Hay and Pearce Point is predominantly sand flats and long sandy beaches, separated by rocky headlands and rocky platforms and a few mangrove-lined inlets (LDM 1994).

Regional Habitats: There is limited information regarding the habitats of the Joseph Bonaparte Gulf, and the region is very poorly documented in terms of marine biological community composition and distribution.

The sedimentary processes in the area and the existence of a prawn fishery in the Gulf suggest that soft substrates dominate the offshore areas. This was confirmed by the geotechnical and environmental surveys undertaken for the Blacktip Project in 2004. The islands and reefs scattered throughout the Gulf may support scattered corals, macroalgae and seagrasses, although high turbidity and river flows appear to limit epibenthic development (**Technical Appendix B, Volume 2**).

Coastal habitats in the Gulf include beaches, rocky coastlines and mangroves. The broad scale distribution of mangroves in the Northern Territory is described in LDM (1994); Wightman (1989); and DIPE (2002). The Joseph Bonaparte Gulf is not considered to be a significant mangrove area, although mangroves occur throughout the Gulf and there are locally important groups, mainly on the southern coast of the Gulf (LDM 1994). **Figure 7-4** shows the extent of mangroves in the Joseph Bonaparte Gulf and surrounding area. The illustration is a false colour representation of a satellite image. Areas of dense vegetation are shown as dark red areas. The figure highlights mangroves along the coast and inlets and an area of coastal rainforest.

There are 48 species of mangroves recorded in northern Australia, of which 38 species have been recorded at Darwin, 39 on the Gove Peninsula and only 20 at the Joseph Bonaparte Gulf (LDM 1994). A total of 18 mangrove species are known to exist from the 1° by 1° grid cell of latitude and longitude (between 14 ° and 15 ° South and 129 ° and 130 ° East) including Port Keats (Wightman 1989). However, only eight species were recorded from the intertidal survey (May 2004) of habitats in the vicinity of the proposed pipeline crossing (**Section 7.3.3**). The Joseph Bonaparte Gulf appears to be one of the least diverse regions in terms of mangrove species richness, and densities are up to 20 times lower in the Joseph Bonaparte Gulf than at Gove or Darwin (LDM 1994).

Local Setting: The proposed Blacktip Project is located in the north-eastern part of the Joseph Bonaparte Gulf. The nearest offshore features from the proposed shore crossing are two areas of rocky reef or shoals namely, Howland Shoals and the Emu Reefs (**Figure 1–1**). These are located approximately 20 to 30 km north of the project site and extend offshore in a north-westerly direction from Wadeye for some 15 to 30 km.

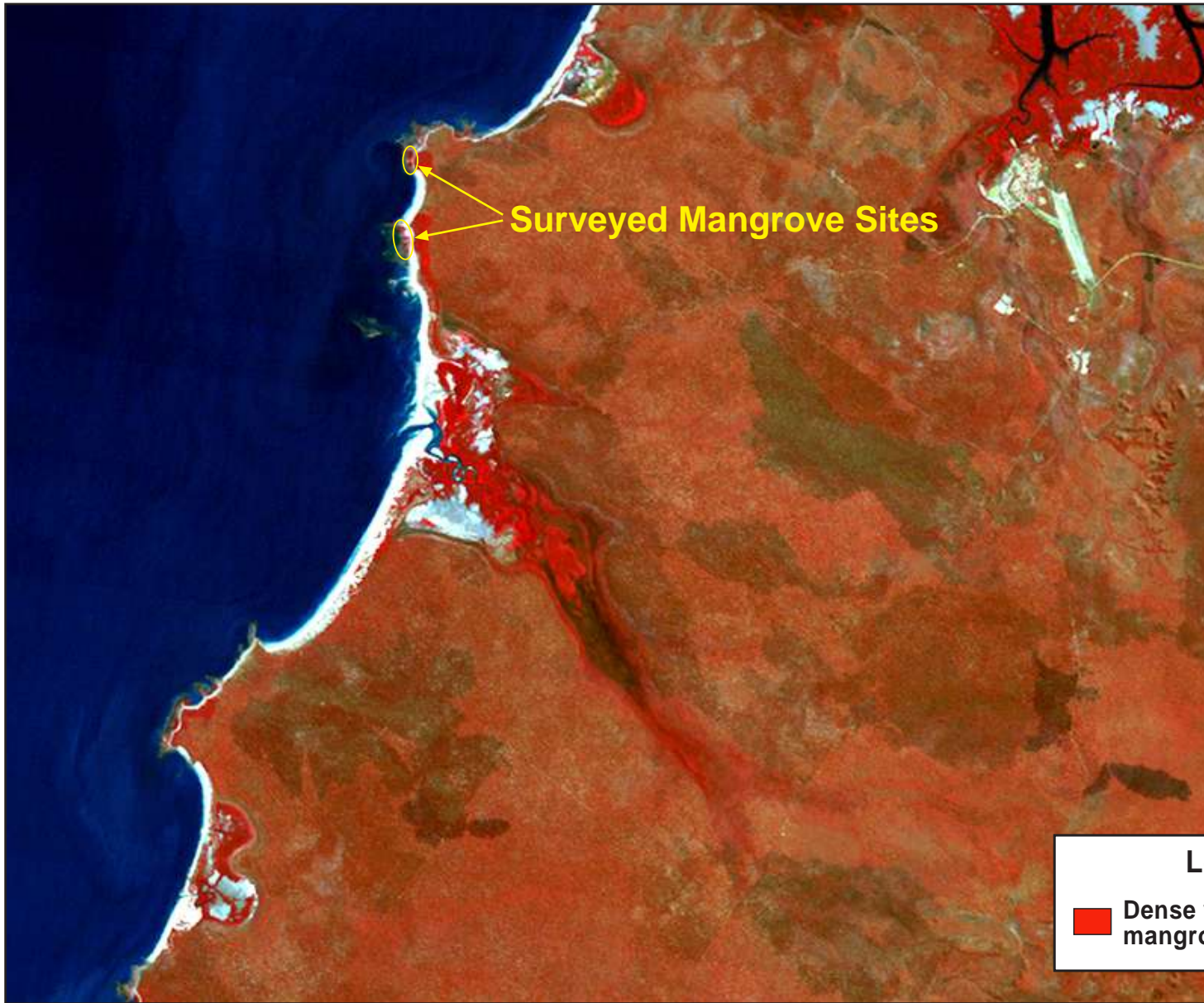
The predominant coastline features in the vicinity of the proposed pipeline shore crossing are sand/mud beaches with occasional rocky headlands, small pockets of mangroves and occasional tidal creeks. At Wadeye, approximately 12 km to the north-east of the shore crossing, is found the only large tidal inlet system nearby. Intertidal habitats in the vicinity of the proposed pipeline shore crossing are discussed further in **Section 7.3.3**.

7.3.2 Seabed Habitats and Communities

Algae: Macroalgae generally require adequate light and a hard substrate, and therefore largely occur in intertidal and shallow waters less than 5 m deep in turbid waters. Common macroalgal genera in northern Australia include *Sargassum*, *Padina*, *Dictyota*, *Hypnea*, *Gracilaria*, *Caulerpa* and *Cladophora* (Walker *et al.*, 1996).

There has been no comprehensive mapping of marine macroalgae distribution in the vicinity of the shore crossing or pipeline route. While it may be expected that, wherever suitable shallow hard substrate and sufficient light is available, some assemblages may occur, the intertidal and subtidal surveys failed to observe any macroalgae suggesting that conditions are not suitable for macroalgal growth. Further afield, suitable areas for macroalgae growth include Pelican and Reveley Islands, rocky platforms around Cape Domett, over 100 km from the proposed shore crossing (LDM 1994) and possibly on Howland shoals and Emu Reefs some 20 to 30 km to the north of the site.

Blue-green algal mats can occur in the upper tidal zone on sheltered salt/mud flats, inshore of fringing mangrove. Such salt/mud flats occur at a small tidal inlet behind mangroves, approximately 4 km to the south of the project site and also to the north at Wadeye. Algal blooms are discussed in **Section 7.2.4**.



MANGROVE DISTRIBUTION IN THE PROJECT REGION

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Seagrasses: Seagrasses predominantly occur in sheltered, shallow coastal waters, forming dense beds in some areas of Australia, though seagrass beds can occur in deeper waters at 30–40 m (seagrass has been recorded as deep as 60 m in the Great Barrier Reef Marine Park). Seagrasses are an important food source for dugong, turtles and commercial prawn species, as well as providing food or habitat for invertebrates and fish (LDM 1994). For these reasons seagrasses are regarded as being of high conservation value.

Eleven species of seagrass are known to occur in tropical north-western Australia (Poiner *et al.*, 1989). Although the Joseph Bonaparte Gulf has not been surveyed for seagrasses, any species present are likely to include similar species to those recorded elsewhere in tropical Australian waters.

The inner Joseph Bonaparte Gulf is not expected to support significant seagrass areas due to unsuitable environmental conditions, which include highly turbid water conditions and the mobile nature of the sediments (LDM 1994). A survey of intertidal seagrasses carried out by the WA Museum did not record any seagrasses in the Joseph Bonaparte Gulf, and no evidence of drift material was found at any of the sites surveyed (Walker *et al.*, 1996). LDM (1994) states that patches of seagrass occurs along the coast from Cape Hay to Pearce Point, with high densities recorded around Cape Hay.

However, discussions with Wadeye Aboriginals also indicated that during the lowest tides of the year, seagrass is exposed at the proposed pipeline crossing beach (Northern Yelcher Beach) and the southern end of the beach immediately to the north (Injin Beach). The seagrass is probably *Enhalus acoroides* and the Wadeye Aboriginals reported dugong-feeding trails amongst the seagrass (Guinea, M., *pers. comm.*, 2004). However, the environmental surveys conducted in May 2004 failed to detect any signs of seagrass indicating that the distribution of seagrass is, at best, patchy and limited. The offshore survey collected approximately 40 grabs along the proposed pipeline route, of which 24 grabs were collected within 4 km of the coast. No seagrass was observed in any of the grab samples.

Corals: The extensive coral reefs of the Timor Sea, including the Ashmore-Cartier group, Evans Shoals and Echo Shoals, lie over 300 km to the north of the Blacktip reservoir. A survey by Walker *et al.*, (1996) recorded isolated corals along the western coast of the Gulf at Reveley Island, 150 km from the proposed pipeline shore crossing, near the seaward edge of an intertidal rocky platform. Similar scattered corals may occur near other islands in the Joseph Bonaparte Gulf, although information is very limited due to the lack of surveys in the area. Isolated corals (probably *Goniastrea*) were observed on the seaward margins of the Yulow Point rocky platform at the south end of Northern Yelcher Beach.

The nearest large reefs or shoals that might support corals, Howland Shoals and the Emu Reefs (**Figure 1–1**), are located approximately 20 to 30 km north of the proposed landfall. Anecdotal evidence from local Aboriginal residents suggests that a small reef is located at the north end of Injin beach which supports coral growth (LDM 1994), approximately 7 km north of the proposed pipeline shore crossing.

7.3.3 Intertidal Habitats and Communities

The location of the pipeline shore crossing is a sandy beach with sand flats at low tide (Northern Yelcher Beach). Low rocky shoals extend out from rocky headlands on the northern and southern ends of the beach, which are flanked by mangroves. Therefore, the predominant intertidal habitats in the vicinity of the shore crossing are:

- sandy beaches with mud and/or sand flats in the low tidal zone;
- low rocky headlands on the shore;
- occasional mangrove lined tidal creeks.

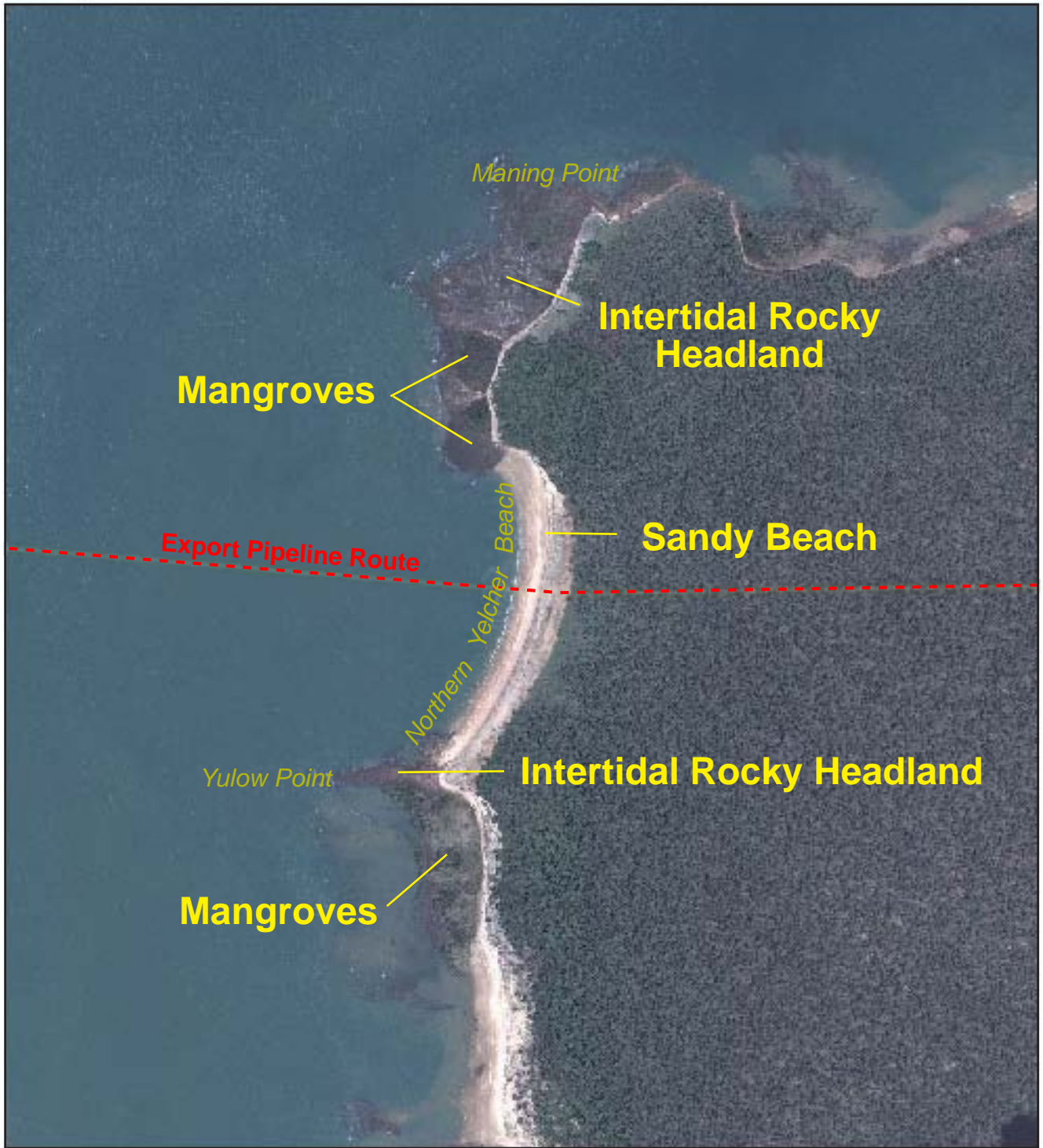
Figure 7-5 shows the intertidal habitat near the pipeline shore crossing, with various components outlined, such as the rocky platforms and mangroves.

An intertidal environmental survey was conducted at the landfall in May 2004. The findings of this survey are contained in **Appendix B, Volume 2** and are summarised below.

Sandy Beaches with Sandflats: The beach where the pipeline comes ashore is approximately 700 m wide. The high tide mark has been observed within a few metres of a low sand dune system at the back of the beach (Woodside 2003d). Landward of the dune is a broad sandy grassland area that merges with upland monsoon vine-forest and woodland. Only scattered trees including the Tamarind (*Tamarindus indica*) and White Bush Apple (*Syzygium eucalyptoides* spp. *eucalyptoides*) occur within the grassland. The dominant species in the grassland area behind the beach is Annual Sorghum (*Sorghum timorense*) with Beach Spinifex (*Spinifex longifolius*) and the vines *Ipomoea pes-caprae* and *Carnavalia rosea*.

Below the beach dune but above the high tide level (at approximately 8 m Port Keats Hydrogeographic Service tidal datum) the beach is gently sloping and composed of very coarse sand. Timber, mangrove leaves and other flotsam and jetsam are abundant in this habitat and this material provides shelter for high densities of the terrestrial hermit crab (*Coenobita variabilis*).

The upper intertidal zone slopes relatively steeply to the flatter mid tidal zone. The sand in the upper intertidal zone is typically coarse and comprises mainly shell grit with abundant quartz pebbles. The invertebrate infauna was abundant, though species richness was low and dominated by molluscs. In contrast, the mid-tidal zone at Yelcher Beach to the south is more variable, both in terms of topography and invertebrate fauna. Northern Yelcher Beach has a relatively steep gradient and the width of the intertidal zone is not particularly broad. The intertidal zone at Yelcher Beach is much wider and this beach has a more complex topography with rocky areas and intertidal sand spits. Large numbers of Soldier Crabs (*Mictyris* sp.) were common in sections of Yelcher Beach but uncommon on Northern Yelcher Beach.



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Rocky Headlands: Rocky shoals are located on the northern and southern ends of the pipeline shore crossing beach and extend offshore. The northern rocky point (Maninh Point) was not surveyed as it is of significance to the traditional Aboriginal owners due to the presence of the Cheesefruit Tree (*Morinda citrifolia*). The Yulow Point rocky platform at the south of Yelcher Beach comprises a flat lateritic point that extends approximately 400 m from the beach. It is relatively steep sided and flanked with an extensive area of lateritic boulders, up to 100 m wide to the north, standing water and mangroves to the south. The distribution of the biota was highly variable reflecting micro-topography. However, visual observations indicate that the more seaward section of the rocky platform supports a higher diversity and abundance of invertebrate fauna, including isolated corals, anemones, chitons and larger crustaceans than the nearshore sections.

Mangroves: The survey of intertidal habitats near the proposed pipeline crossing recorded eight species of mangroves. The mangroves at the southern end of the beach pipeline crossing (Yulow Point) form a strip less than 700 m long and between 100 to 300 m wide. The mangrove habitat is extremely sandy with muds only occurring in the most seaward margins with well-spaced trees and a relatively open canopy. By contrast, the mangroves at the northern end of the proposed pipeline crossing beach (Maninh Point) have a mud substrate and support a taller and more dense mangrove forest. The dominant species at both locations is *Rhizophora stylosa*.

Approximately 5 km to the south of the shore crossing lies the entrance to a small tidal creek lined with mangroves (**Figure 7-4**). The entrance to Wadeye, approximately 15 km to the north, is the largest mangrove-lined tidal inlet system in the vicinity of the project. The nearest significant mangrove conservation area, the Ord River Floodplain, is located inside the Cambridge Gulf approximately 100 km south-west of the project site.

7.3.4 Invertebrates

Infauna of the Offshore Region: Studies conducted on the infauna within the Blacktip Permit area WA-279-P found infauna to be diverse and abundant, with two major phyla, Arthropoda (crustaceans) and Annelida (polychaete worms) contributing over 80% of the total number of individuals (BBG 2000). Arthropoda species recorded include tanaids (shrimps), brachyurans (crabs) and grammarid amphipods. The Annelida were diverse comprising of 36 families, with the most abundant families being Terebellidae, Spionidae, Onphidae, Maldanidae and Ampharetidae. Members of these families are mainly tube-dwelling worms that feed on detrital material on the surface or in the surface sediments. Other abundant infauna were the Cnidaria (hydroids, soft corals), Mollusca (mainly bivalves) and Echinodermata (brittle stars, sea urchins).

The BBG (2000) study found that infauna species richness and abundance in the Joseph Bonaparte Gulf was related to sediment particle size. Richness and species abundance increased with distance from the mouth of the Victoria River, which coincided with an increasing proportion of fine particles in the sediment (BBG 2000). Sites near the Victoria River mouth generally had coarser sediments and lower species richness and abundance. The Blacktip permit sites supported a richer assemblage than sites closer to the Victoria River mouth (BBG 2000).

The recent Blacktip Marine Survey, conducted in May 2004 at the proposed wellhead platform, along the pipeline route and around the proposed nearshore facilities also documented a species rich fauna, with 135 nominal species identified. However, faunal abundance was low with only 528 individuals recorded and only 14 species recording more than 10 individuals across all the offshore samples. The composition of the infaunal community was somewhat unusual. Continental shelf infauna are generally dominated by polychaete worms. However, nearly three times as many crustaceans were collected as polychaetes. Bryozoans and hydroids were the next most abundant group after the crustaceans; and, nearly as many molluscs and echinoderms were collected as polychaetes. The most abundant species were a porcelain crab followed by a brittle star.

The BBG (2000) study also observed that sites near the Victoria River mouth, which generally had coarser sediments, had a greater proportional abundance of crustaceans and cnidarians (hydroids and soft corals) compared to sites further offshore, which supported a predominantly deposit feeding infauna.

Infauna of the Nearshore Region: Limited background information is available regarding invertebrates in the Joseph Bonaparte Gulf. Studies undertaken by Halse *et al.*, (1996) found that species-rich orders of invertebrates on the Victoria-Bonaparte mudflat, west of Keep River, were Cladocera, Ploimida, Coleoptera, Copepoda and Ostracoda. Many of the species found were undescribed, and many insect larvae could not be identified as their taxonomy is poorly known (Halse *et al.*, 1996). The recent intertidal surveys (May 2004) documented the fauna of the beach pipeline crossing, nearby mangroves and rocky platforms. The fauna on the beach was species poor and dominated by the bivalve *Donax faba*. Not surprisingly, the rocky platform and particularly the mangroves supported a more diverse fauna. The Littorinid *Littoraria ianthostoma* was observed in the mangroves and is endemic to the Joseph Bonaparte Gulf with a limited distribution range of several hundred kilometres. It is epiphytic on the trunks of mangrove trees in the seaward zone.

Crustaceans: Intertidal sites along the western Joseph Bonaparte Gulf coastline were found to have high species diversity, with up to 25 different species of crustaceans (Walker *et al.*, 1996). The study by Walker (1996) concentrated mainly on decapod crustaceans, in particular shrimp fauna, and most collections were made from intertidal environments. Mud crabs (*Scylla serrata*) are also important components of the mangrove ecosystem and were found during the recent intertidal survey (May 2004).

The dominant prawn species of the Joseph Bonaparte Gulf are the Penaeid species, namely tiger prawn (*Penaeus esculentus*), banana prawn (*P. merguensis*) and red-legged banana prawn (*P. indicus*). These species occur in coastal waters to depths of approximately 200 m, and are widely distributed through subtropical and tropical waters from Western Australia to New South Wales (Jones & Morgan 1994). Shallower inshore waters act as nursery grounds for juveniles, such as the river and tidal creek systems of the Joseph Bonaparte Gulf. Small numbers of prawns can also be found in mangrove habitats. More is known about the distribution and abundance of prawns in the

Joseph Bonaparte Gulf compared to other crustaceans because a number of species are commercially harvested.

As discussed in detail in **Section 9.7**, prawns are commercially caught in areas of the Joseph Bonaparte Gulf, mainly in the west of the gulf and in Fog Bay (Northern Territory) to the north of the proposed Blacktip Project. The juvenile prawns that migrate offshore to the fishery come from mangrove nursery habitats from the Victoria River in the east of the Gulf, to the Ord River and Cambridge Gulf in the west, forming a very extensive migration throughout the lower region of the Joseph Bonaparte Gulf. Although there is no data on the exact timing of the migration, it is likely to be from February to April and October to December (Loneragan, N., *pers. comm.*, 2004). Migration of the juveniles is thought to be triggered by rainfall and river discharge (**Section 9.7**).

Molluscs: The Joseph Bonaparte Gulf has relatively low mollusc species diversity, with less than 100 species recorded in the region (Walker *et al.*, 1996). Recreational fishing of the rock oyster, *Saccostrea cucullata* occurs; however, this is restricted to easily accessible, rocky areas of the Gulf. Squid are a large bycatch of the Northern Prawn Fishery, and may occur periodically in large numbers in the area, although very little is known regarding the distribution of squid in the area. Many different types of molluscs are found in the mangroves including clams such as *Gelona coaxans* and *Batissa violacea*.

Plankton: The seas around northern Australia contain a relatively low biomass of zooplankton, which reach a maximum in an upwelling area between the north-west coast of Australia and Indonesia. The upwelling generally occurs during July and August and is related to the south-east monsoonal winds (Tranter 1962). Zooplankton feed on phytoplankton and provide an important feed source to larger animals such as whales, fish and crustaceans.

The Australian Institute of Marine Science has conducted a survey of plankton in areas of the Timor Sea; however, this work is yet to be published. With the exception of this work and that of Tranter in 1962, limited research has been conducted in this region and none in the Joseph Bonaparte Gulf.

7.3.5 Fish

There is limited information available on the fish of the Joseph Bonaparte Gulf, though it is expected that the species are similar to those found in comparable habitats in north-western Australia. The WA Museum survey of the eastern Kimberley coast found 43 species in the near coastal areas of the Gulf (Walker *et al.*, 1996). More extensive research has been undertaken in Darwin Harbour, over 200 km from the Joseph Bonaparte Gulf, with some 408 species being recorded, including 47 pelagic species, 72 species occurring in mangroves, mudflats and estuaries, and eight species in beach or sandflat habitats (LDM 1994). However, 44% of species in Darwin Harbour were associated with rocky or coral reefs, a habitat that is poorly represented in the Joseph Bonaparte Gulf.

Barramundi (*Lates calcarifer*) and threadfin salmon (*Eleutheronema tetradactylum*) are the most commercially important species in the Joseph Bonaparte Gulf. Both of these species generally occur in the estuaries of the Joseph Bonaparte Gulf (LDM 1994), and are targeted under the Kimberley Gillnet and Barramundi Fishery (**Section 9.7**). Sharks and catfish are common in both coastal estuaries and offshore locations. Sharks are caught commercially in the region, which forms part of the Northern Shark Fishery. The offshore zone is expected to support much less abundant fish and motile invertebrate fauna than the mangrove lined coastal areas and estuaries.

Many fish including barramundi, mangrove jack (*Lutjanus argentimaculatus*), bream (*Mulio berda*), javelin fish (*Pomadasys hasta*), four species of mullet and several species of catfish are commonly found in mangrove communities. Mudskippers are also found in mangrove environments during low tide.

In Australia, the freshwater sawfish *Pristis microdon*, which is listed as 'vulnerable' under the EPBC Act, appears to be confined to freshwater drainages and the upper reaches of estuaries in northern Australian waters including the Ord, Daly and Victoria Rivers (DEH 2004).

7.3.6 Dugongs

The dugong (*Dugong dugon*) is a migratory species listed as vulnerable under the International Union for the Conservation of Nature and Natural Resources, Red Data Book of Threatened Species (IUCN). Dugongs are patchily distributed throughout tropical and subtropical waters of the Indian and Pacific Oceans. Their distribution range in Australia extends from Shark Bay in Western Australia to Moreton Bay in Queensland.

Dugongs inhabit protected shallow coastal areas, such as wide shallow bays and mangrove channels. They feed on seagrass, and major concentrations of dugongs tend to coincide with sizeable seagrass beds. However, observations by Whiting (2002) revealed that dugongs also feed on macro algae on rocky reefs in tropical Australia, expanding the number of habitats utilised by dugongs.

Research undertaken in Northern Territory, including aerial surveys, has focused on dugong populations in the Gulf of Carpentaria and in the northern parts of the Territory such as the Tiwi Islands and Coburg Peninsula. No surveys have been undertaken in the Joseph Bonaparte Gulf therefore little is known about the distribution of dugongs in the Gulf (Southfield, K., *pers. comm.*, 2004). However, as high turbidity in the Joseph Bonaparte Gulf limits the development of seagrass beds, dugongs are not expected to be abundant.

Though not abundant in the Joseph Bonaparte Gulf, dugongs have been reported to occur along the coastline from Cape Hay to Point Pearce, with the main populations concentrated around Dorcherty Island (LDM 1994), 15–20 km to the north of the proposed pipeline crossing. This was confirmed by a survey undertaken in May 2004 by Mick Guinea (Charles Darwin University (CDU)). Dugongs were reported by the traditional Aboriginal owners to frequent the rock flats at Cape Hay on Dorcherty Island and the mouth of the Moyle River, to the north the proposed pipeline crossing, and the southern regions of Joseph Bonaparte Gulf, south of the proposed pipeline crossing. In the

region of the proposed pipeline crossing dugong activity is very limited. Discussions between local Aboriginals and Mick Guinea (May 2004) indicate that a single dugong was shot from a boat some years ago off the proposed pipeline crossing location.

7.3.7 Whales and Dolphins

A number of whale and dolphin species have broad distributions, which include the Joseph Bonaparte Gulf. However, this does not mean that these species are present in the Joseph Bonaparte Gulf or are regular visitors. For example, no cetaceans were observed during a series of environmental and geotechnical surveys conducted throughout most of May and June 2004 from the proposed wellhead platform location to the shore crossing along the proposed pipeline route. Several other surveys that have been undertaken in relation to the project over the last few years have recorded few, if any, dolphins and whales. A list of nationally significant whale and dolphin species as documented in the EPBC Act is provided as **Table 7-1**.

■ **Table 7-1 EPBC Listed Whale and Dolphin Species**

Species Name	Common Name	Schedule	Status
<i>Balaenoptera musculus</i>	Blue whale	Threatened Species Migratory Species Cetacean	Endangered (IUCN) Appendix I (CITES)
<i>Balaenoptera edeni</i>	Bryde's whale	Migratory Species Cetacean	Unknown (IUCN) Appendix I (CITES)
<i>Physeter macrocephalus</i>	Sperm whale	Migratory Species Cetacean	Insufficiently Known (IUCN) Appendix I (CITES)
<i>Tursiops aduncus</i>	Spotted bottlenose dolphin	Migratory Species Cetacean	Migratory (Arafura/ Timor Sea)
<i>Delphinus delphis</i>	Common dolphin	Cetacean	Insufficiently Known (IUCN) Appendix II (CITES)
<i>Grampus griseus</i>	Risso's dolphin	Cetacean	Insufficiently Known (IUCN) Appendix II (CITES)
<i>Orcaella brevirostris</i>	Irrawaddy dolphin	Cetacean	Insufficiently Known (IUCN) Appendix II (CITES)
<i>Sousa chinensis</i>	Indo-pacific humpback dolphin	Cetacean	Insufficiently Known (IUCN) Appendix I (CITES)
<i>Stenella attenuata</i>	Pantropical spotted dolphin	Cetacean	Insufficiently Known (IUCN) Appendix II (CITES)
<i>Tursiops truncatus s. str.</i>	Bottlenose dolphin	Cetacean	Insufficiently Known (IUCN) Appendix II (CITES)

Source: Department of Environment and Heritage 2004

Note: IUCN - International Union for the Conservation of Nature and Natural Resources, Red Data Book of Threatened Species

CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora

Whales: Whales are not expected to be common inhabitants of the Joseph Bonaparte Gulf. The whale species recorded to have a distribution that includes the Northern Territory are unlikely to be found in the shallow waters of the project area as they are usually restricted to deep waters (sperm

whale) or are very rare (blue whale). However, a sperm whale was apparently stranded on Injin Beach in 1990 and skeletal remains have been recorded (LDM 1994). Bryde's whale has not been recorded in the Northern Territory but is known to occur in south-west Indonesia, Western Australia and Queensland, therefore it could possibly travel through the Joseph Bonaparte Gulf.

The northern migration of the humpback whale terminates in Campden Sound over 400 km to the west of the proposed Blacktip Project and are not expected to occur in the Joseph Bonaparte Gulf.

Dolphins: Many of the species listed in **Table 7-1** have wide distributions, such as the common dolphin and bottlenose dolphin, which are found in all Australian States and Territories (Bannister *et al.*, 1996).

Irrawaddy dolphins inhabit tropical and sub tropical waters of northern Australasia, including Western Australia, Northern Territory and Queensland, and southern Asia. They prefer to live in shallow sheltered areas and turbid waters near the coast and in rivers.

The spotted bottlenose dolphin, Risso's dolphin, Indo-Pacific humpback dolphin and pantropical spotted dolphin also have northerly distributions, ranging throughout the north-west of Western Australia, through the Northern Territory to Queensland. Some of these species are also found further along the coast, such as the Indo-Pacific humpback dolphin, which ranges along the eastern coast to New South Wales. Dolphin species listed in **Table 7-1** are not restricted to Australian waters and are found in similar habitats throughout the world.

7.3.8 Birds

Prior to 1990, limited information was available regarding the location and status of waterbird and seabird breeding colonies along the northern coastline of the Northern Territory. Aerial and ground surveys were conducted from 1990 to 1999 throughout the Top End of the Northern Territory (north of latitude 16°35'S). It was revealed that the region has nationally and globally significant numbers of bird species in breeding colonies along the coastline and in major floodplains (Chatto 2000).

A variety of endemic and migratory bird species are dependent on the productive feeding grounds of the Northern Territory mangroves and intertidal flats. Some species are mangrove specialists, such as the mangrove robin (*Eopsaltria pulverulenta*), white-breasted whistler (*Pachycephala lanioides*), mangrove honeyeater (*Lichenostomus fasciogularis*) and mangrove kingfisher (*Ceyx pusillus*). Wading and waterbirds that make use of mangroves include jabiru (*Ephippiorhynchus asiaticus*) and various egret and heron species.

Colonial Waterbirds: Colonial waterbirds are those that breed in tightly packed breeding colonies along coastlines and include various species such as the Australian pelican (*Pelecanus conspicillatus*), the royal spoonbill (*Platalea regia*), cattle egrets (*Ardea ibis*), Australian white ibis (*Threskiornis molucca*), little pied cormorant (*Phalacrocorax melanoleucos*) and numerous others. Bird colonies in the region are typically distributed around most of the coastal and larger coastal flood plains but do not extend inland beyond approximately 40 km.

Waterbird habitat locations found in the region and in the vicinity of the shore crossing are illustrated on **Figure 7-6** and **Figure 7-7**.

Floodplains between the Moyle and Finnis River systems located north-east of the proposed landfall and plant site are also noted to be significant breeding grounds (Chatto 2000). The Moyle River and associated floodplains are located approximately 45 km northeast of the onshore developments.

Shorebirds: Shorebirds inhabit coastal mudflats and adjacent areas, and include the great knot (*Calidris tenuirostris*), black-tailed godwit (*Limosa limosa*), lesser sand plover (*Charadrius mongolus*), bar-tailed godwit (*Limosa lapponica*), and grey-tailed tattler (*Heteroscelis brevipes*). Aerial and ground surveys undertaken by Chatto (2000) found that the shorebirds were most common in Anson and Fog Bays located over 100 km north-east of the project area (**Figure 7-7**).

Seabirds: Seabirds include various tern species, the silver gull (*Larus novaehollandiae*) and the common noddy (*Anous stolidus*). Colonial breeding seabirds are generally distributed around the northern and eastern coasts of the Northern Territory from the Tiwi Islands to the Queensland border. Breeding colonies are typically located on offshore islands, although colonies can occasionally be found on mainland beaches, and nesting generally occurs on or under the ground. Colonial seabird breeding occurs throughout most of the year, although most breeding occurs between May and November. The most important areas for seabird breeding include the Sir Edward Pellews Islands and the region extending from north-eastern Arnhem Land to Groote Eylandt (Chatto 2001). These locations are over 500 km from the project area.

There is no reported information concerning the populations of seabirds utilising the waters of the Blacktip Project area. However, the distributions of many common seabirds, including species of tern, booby and the lesser frigate bird (*Fregata ariel*) extend into the Joseph Bonaparte Gulf. No seabirds were observed during the offshore environmental survey conducted in May 2004 at the proposed wellhead platform, along the gas export pipeline and nearshore facilities.

Significant Bird Species: Many of the birds that occur in the Northern Territory migrate into the Northern Hemisphere and a number of these are protected under the *Japan Australia Migratory Bird Agreement* (JAMBA) and *China Australia Migratory Bird Agreement* (CAMBA). A list of nationally significant EPBC listed species, identified as likely to occur within the vicinity of the project area as defined by Department of Environment and Heritage, which incorporates JAMBA and CAMBA protected species, is provided as **Table 7-2**.

■ **Table 7-2 Nationally Significant Bird Species**

Species Name	Common Name	Schedule	Status
<i>Rostratula australis</i>	Australian painted snipe	Threatened species	Vulnerable
<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle	Migratory species Listed marine species	Migratory Listed
<i>Charadrius veredus</i>	Oriental plover, oriental dotterel	Migratory species Listed marine species	Migratory Listed - overfly marine area
<i>Glareola maldivarum</i>	Oriental pratincole	Migratory species Listed marine species	Migratory Listed - overfly marine area
<i>Numenius minutus</i>	Little curlew, little whimbrel	Migratory species Listed marine species	Migratory Listed – overfly marine area
<i>Rostratula benghalensis s. lat.</i>	Painted snipe	Migratory species Listed marine species	Migratory Listed
<i>Anseranas semipalmata</i>	Magpie goose	Listed marine species	Listed – overfly marine area
<i>Hirundo rustica</i>	Barn swallow	Listed marine species	Listed – overfly marine area

Source: Department of Environment and Heritage 2004

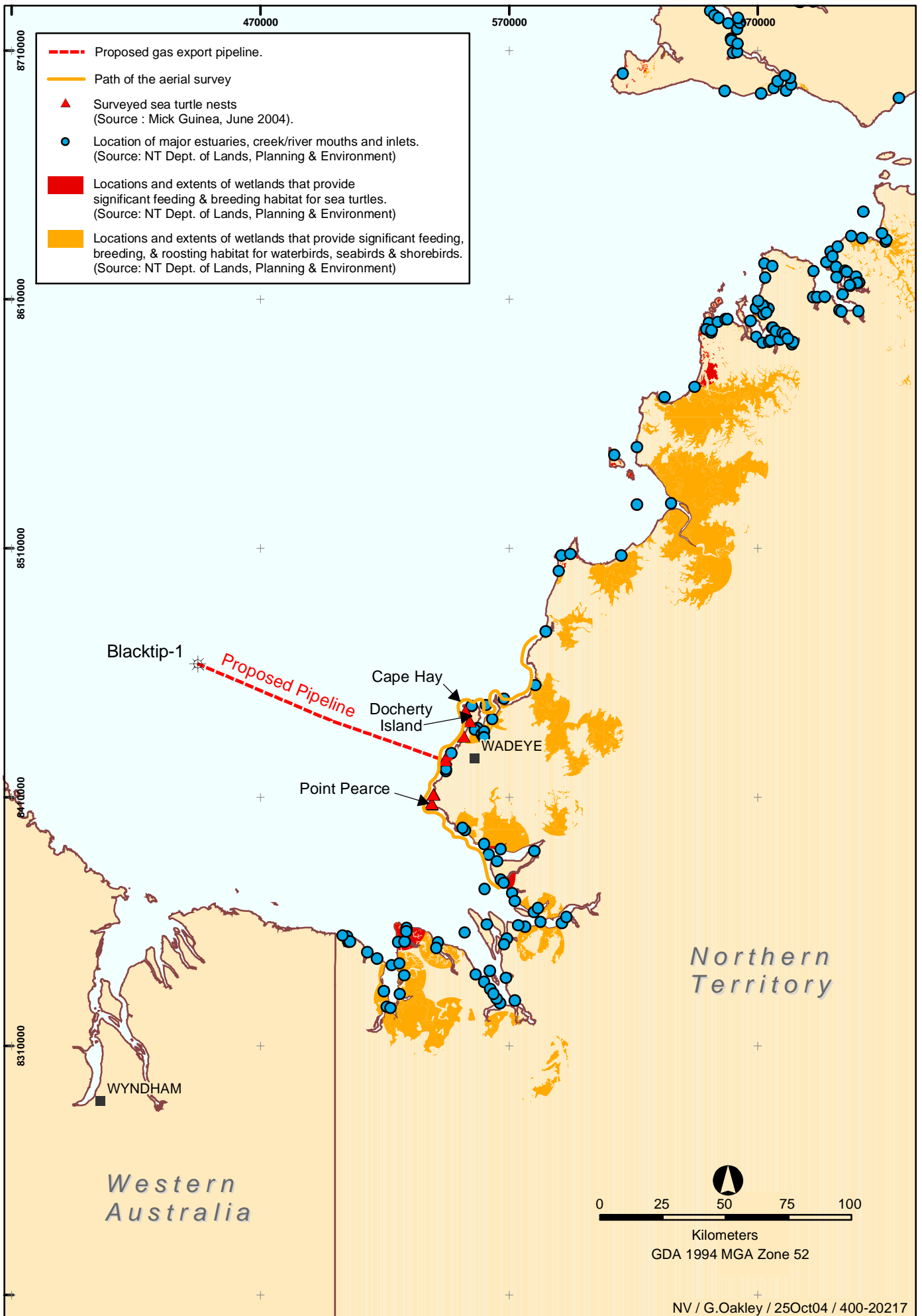
7.3.9 Sea Turtles

Six species of marine turtle are known to occur in northern Australian waters and presumably in the Joseph Bonaparte Gulf (**Table 7-3**). However, scarce data on turtle distribution and abundance in the lower Joseph Bonaparte Gulf has been collected and numbers are relatively unknown. The low incidence of reefs and the limited areas of seagrass and macroalgae habitat within the Joseph Bonaparte Gulf are believed to limit the numbers of green turtles (*Chelonia mydas*) (Woodside 2003h). Also, leatherback turtles (*Dermochelys coriacea*) are generally rare within their range and are probably only occasional visitors to the Joseph Bonaparte Gulf.

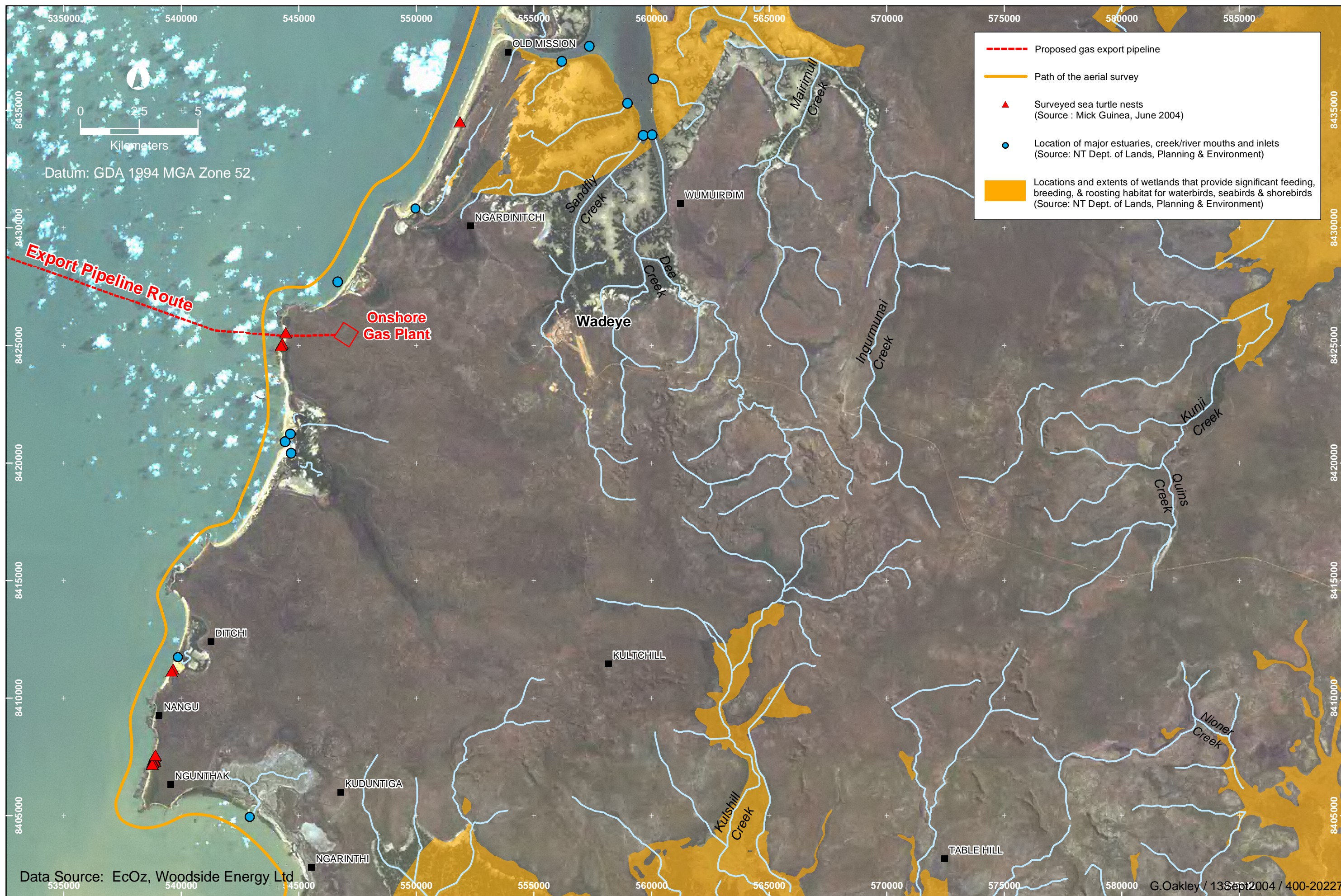
■ **Table 7-3 Nationally Significant Turtle Species**

Species Name	Common Name	Schedule	Status
<i>Caretta caretta</i>	Loggerhead turtle	Threatened Species Migratory Species Listed marine species	Endangered Migratory Listed
<i>Chelonia mydas</i>	Green turtle	Threatened Species Migratory Species Listed marine species	Vulnerable Migratory Listed
<i>Dermochelys coriacea</i>	Leatherback turtle	Threatened Species Migratory Species Listed Marine Species	Vulnerable Migratory Listed
<i>Eretmochelys imbricata</i>	Hawksbill turtle	Threatened Species Migratory Species	Vulnerable Migratory
<i>Lepidochelys olivacea</i>	Olive ridley turtle	Threatened Species Migratory Species Listed marine species	Endangered Migratory Listed
<i>Natator depressus</i>	Flatback turtle	Threatened Species Migratory Species Listed marine species	Vulnerable Migratory Listed

Source: Department of Environment and Heritage 2004



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Examination of the turtle habitat database developed and supplied by the Parks and Wildlife Commission of the Northern Territory (PWCNT) indicates that suitable coastal saline flats habitat for sea turtles exist at the bottom of the Joseph Bonaparte Gulf at Turtle Point, at the mouth of the Victoria River, the Whale Flat area, near the mouth of the Fitzmaurice River, and to the north of the project area around Anson Bay. Turtles nest on sandy beaches, particularly where those beaches are backed by high dunes. The coastline from Cape Hay to Pearce Point includes many suitable sandy beaches, and turtles have been reported to utilise all of these beaches for nesting (LDM 1994). Nesting has also been observed further north at Fog Bay (Woodside 2003h), suggesting that nesting also occurs along the coastline between Cape Hay and Fog Bay. Further south there is a significant nesting area for flatback turtles (*Natator depressus*) on the north side of Cape Domett, facing the open sea (CALM 1994), and lower levels of turtle nesting are reported from Pelican Island (Burbidge *et al.*, 1991). The main nesting period for flatback turtles in the Joseph Bonaparte Gulf is during the dry season, peaking in June, July and August (Woodside 2003h).

A recent survey was undertaken to address the lack of data on turtle activity between Cape Hay to Pearce Point. The complete findings of this study are contained in **Appendix C, Volume 2**. The results indicate that there are low levels of flatback turtle activity in the area of the proposed pipeline crossing (Northern Yelcher Beach) and Injin Beach to the north. Two flatback nests and a track of a flatback that came ashore but did not lay at the proposed pipeline crossing (Northern Yelcher Beach) were found during the survey. This suggests that there could be some tens of nests laid on this beach per year by possibly less than 20 individuals. Immediately south of the pipeline beach, on Yelcher Beach, there was no sign of sea turtle nesting. By comparison, from observations during the survey it is anticipated that some tens to hundreds of flatback turtles nest about 20 km to the north around Cape Hay, and near Point Pearce to the south. Turtle nesting locations found in the region and in the vicinity of the shore crossing are illustrated in **Figure 7-6** and **Figure 7-7**.

Hawksbill and Flatback Turtles: Hawksbill and flatback turtles are carnivorous, foraging for crustaceans, shellfish, molluscs and sponges. Hawksbill turtles typically feed in and around tidal and sub-tidal coral and rocky reefs and mangroves. Their distribution extends from tropical waters in northern Australia into warm temperate areas of northern New South Wales. They mainly feed on sponges, although they also eat seagrasses, algae, soft corals and shellfish. Although hawksbill turtles breed from the northern Great Barrier Reef to the eastern coast of the Northern Territory, and in the North West Shelf of Western Australia, there are no records of the species breeding in the Joseph Bonaparte Gulf.

Flatback turtles are common throughout northern Australian waters, although their feeding grounds extend into Indonesia and Papua New Guinea. Migratory movements occur from early spring to early autumn with the main nesting period for flatback turtles during the dry season, peaking in July and August. Flatbacks generally reside within 300 km of their nesting beach (Guinea 2004).

Green Turtle: Adult green turtles are herbivores, feeding on micro-algae and seagrass beds in shallow coastal waters. Green turtle distribution extends from the northern coast of Western Australia, through the Northern Territory to Queensland, and the Indonesian Archipelago. Four distinct nesting areas are known, these being the Great Barrier Reef in Queensland, the southeastern Gulf of Carpentaria in the Northern Territory, the south-west coast of the Gulf of Carpentaria adjacent to the Sir Edward Pellew Islands and the North West Shelf of Western Australia. The green turtle appears abundant in the Timor Sea region throughout the year; however, their presence in the Joseph Bonaparte Gulf is expected to be limited to migratory movement through the area, given the relative lack of suitable feeding habitat. No nests of the green turtle were observed during the recent survey (Guinea 2004).

Leatherback (Leathery) and Loggerhead Turtles: Leatherback turtles are oceanic pelagic feeders consuming jellyfish, comb jellies and other small invertebrates. Leatherback turtles are known to breed in Indonesia, Papua New Guinea and the Solomon Islands. Leatherback turtles feed off the coasts of Western Australia (south of Geraldton), south Queensland and New South Wales coasts, and are not particularly abundant in northern Australia. It is unlikely that leatherback turtles are present in number in the Joseph Bonaparte Gulf.

Loggerhead turtles inhabit coral reefs, bays and estuaries, and extend from New South Wales, through Queensland and the Northern Territory to Western Australia. The turtles are also found in Indonesia. Nesting areas are concentrated around the mid to southern parts of Queensland and the Muiron Islands in Western Australia. Loggerhead turtles are uncommon in northern waters and seldom recorded, therefore they are not expected within the vicinity of the Blacktip Project in any numbers.

Olive Ridley Turtles: Olive (or Pacific) ridley turtles may pass through the region during migrations. Relatively little is known about the habits of this turtle species although they have been recorded in Queensland and the Northern Territory. They are known to feed along the shores of Arnhem Land and scattered nesting sites are located from the Coburg Peninsula, Northern Territory to Crab Island, Queensland. No large olive ridley turtle rookeries have been recorded in Australia. Discussions with Wadeye traditional Aboriginal owners during the turtle nesting survey in May 2004 indicated that they recently collected eggs from an olive ridley nest on Injin Beach to the north of the proposed pipeline crossing (Guinea 2004).

7.3.10 Other Reptiles

A variety of reptiles can be found in amongst the mangroves, including the saltwater crocodile (*Crocodylus porosus*), the mangrove snake (*Fordonia leucobalia*) and the mangrove monitor (*Varanus indicus*).

Sea Snakes: Sea snakes are very common in subtropical and tropical Australian waters and occupy a wide range of habitats and water depths, extending offshore from the coast to the reefs and banks of the Sahul Shelf. Although there are no records of their specific occurrence in the Joseph

Bonaparte Gulf, sea snakes are expected to be very common, with as many as fifteen species known to occur in the Northern Territory (Storr *et al.*, 1986). These are listed in **Table 7-4**.

■ **Table 7-4 Nationally Significant Sea Snake Species**

Species Name	Common Name	Schedule	Status
<i>Acalyptophis peronii</i>	Horned seasnake	Listed marine species	Listed
<i>Aipysurus duboisii</i>	Dubois' seasnake	Listed marine species	Listed
<i>Aipysurus eydouxii</i>	Spine-tailed seasnake	Listed marine species	Listed
<i>Aipysurus laevis</i>	Olive seasnake	Listed marine species	Listed
<i>Astrotia stokesii</i>	Stokes' seasnake	Listed marine species	Listed
<i>Disteira kingii</i>	Spectacled seasnake	Listed marine species	Listed
<i>Disteira major</i>	Olive-headed seasnake	Listed marine species	Listed
<i>Emydocephalus annulatus</i>	Turtle-headed seasnake	Listed marine species	Listed
<i>Enhydrina schistosa</i>	Beaked seasnake	Listed marine species	Listed
<i>Hydrelaps darwiniensis</i>	Black-ringed seasnake	Listed marine species	Listed
<i>Hydrophis atriceps</i>	Black-headed seasnake	Listed marine species	Listed
<i>Hydrophis elegans</i>	Elegant seasnake	Listed marine species	Listed
<i>Hydrophis inornatus</i>	Plain seasnake	Listed marine species	Listed
<i>Hydrophis mcdowelli</i>	Small headed seasnake	Listed marine species	Listed
<i>Hydrophis ornatus</i>	Reef seasnake	Listed marine species	Listed
<i>Hydrophis pacificus</i>	Large-headed seasnake	Listed marine species	Listed
<i>Lapemis hardwickii</i>	Spine-bellied seasnake	Listed marine species	Listed
<i>Pelamis platurus</i>	Yellow-bellied seasnake	Listed marine species	Listed

Source: Storr *et al.*, 1986

Crocodiles: Two species of crocodiles can be found in Northern Australia, the freshwater crocodile (*Crocodylus johnstoni*), and the estuarine (saltwater) crocodile (*Crocodylus porosus*). The Northern Territory's saltwater crocodile population is the largest in Australia. The species is protected under section 43 of the *Territory Parks and Wildlife Conservation Act 2000*, although it is not listed as threatened under the Commonwealth EPBC Act. In Papua New Guinea, Indonesia and Australia, saltwater crocodiles are listed (in Appendix II) under the treaty known as the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

Generally high densities of crocodiles occur in tidal portions of mangrove-lined rivers, particularly those associated with extensive freshwater wetlands or floodplains. However, studies on crocodile populations in the Victoria and Fitzmaurice Rivers suggest that the project area is not significant for crocodile populations. Nesting sites are limited and recruitment rates are generally low. Crocodiles are however reported to be in the upper reaches of most rivers and creeks around the Wadeye area, and were spotted on recent surveys undertaken along the shore crossing beach.

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