11. RECEIVING MARINE ENVIRONMENT: OFFSHORE PIPELINE

11.1 Introduction

This chapter summarises the existing physical and biological marine environment (Sections 11.2 and 11.3 respectively) and resource utilisation conditions of Segments 18 to 23 of the proposed pipeline route (Section 11.4) described in Chapter 6, Pipeline and Facilities Location Context. These segments comprise the 360-km-long marine route across the Gulf of Papua from the mouth of the Omati River to the outer edge of Caution Bay (see Figure 6.13). The environment at the western end of the offshore pipeline route (Segment 17, i.e., the Omati River Landfall) is described in Chapter 10, Receiving Onshore Environment: Upstream Facilities and Onshore Pipelines, and the environment at the eastern end of the offshore pipeline route (Segment 24, i.e., Caution Bay) is described in Chapter 13, Receiving Marine Environment: Marine Facilities.

This chapter is based on Appendix 11, Offshore Impact Assessment, which uses the following sources of information:

- Review of recent scientific literature on the oceanography and sediment transport in the Gulf of Papua (e.g., Wolanski et al., 1995).
- Results from a survey of the marine pipeline route undertaken in March and April 2008, which included underwater video photography, benthic grab sampling and geotechnical work.
- Meetings with the National Fisheries Authority (NFA) (e.g., Mobiha, pers. com., 2008 and NFA, pers. com., 2005).
- Discussions with PNG Ports Corporation (Kabilu, pers. com., 2007).

Further discussion with stakeholders will take place prior to construction, details of which are provided in Chapter 9, Stakeholder Engagement.

Information on subsistence fishing was summarised from a survey of the Omati-Kikori delta, which is provided as Appendix 3, Resource Use Survey of the Omati–Kikori Delta.

11.2 Physical Environment

11.2.1 Proposed Route

This section of the proposed offshore pipeline route begins at the mouth of the Omati River adjacent to Goare Village on Goaribari Island (see Figure 6.12) and runs southeast to avoid the existing crude oil export facilities (i.e., the Kumul Marine Terminal, loading tanker anchoring zone and associated marine section of the existing crude oil export pipeline from shore) (see Figure 6.13).

Once south of the Kumul Marine Terminal, the proposed route runs eastward for approximately 110 km. From there, it runs southeast, parallel with the coastline, avoiding the steep gradients of the continental shelf (Figure 11.1), and terminating at the outer edge of Caution Bay approximately 4 km offshore of Redscar Head (see Figure 6.14).

A detailed description of the route is provided in Chapter 6, Pipeline and Facilities Location Context.

11.2.2 Physiography

The Gulf of Papua covers an area of approximately 50,000 km^2 bordering the southern coast of Papua New Guinea. The gulf shoreline is a low-lying swamp comprising the delta complexes of large rivers draining the mountainous highlands of central Papua New Guinea. The Fly, Kikori and Purari rivers discharge huge volumes of fresh water (combined rate of 15,000 m^3/s) and sediment (combined load of 350 Mtpa) into the Gulf of Papua with little seasonal variation (Wolanski et al., 1995; Wolanski et al., 1984, cited in Harris et al., 1996).

The Purari River is the third largest river in Papua New Guinea and contributes a mean flow of 2,360 m^3/s into the gulf; while the Kikori River contributes about 1,500 m^3/s into the gulf (Petr, 1983). Comparative discharge volumes of the Omati River are not known; however, it is a similarly large and turbid river, over 1.5 km wide at the pipeline landfall.

Segments 18 to 23 (see Section 6.4.5.2, Segments 18 to 23: Omati River Mouth to Caution Bay) of the proposed offshore pipeline route through the Gulf of Papua traverse two geomorphic zones:

- A prodelta associated with sediment accumulation and coastal progradation. Localised short-term erosion and accretion is substantial, and the prodelta delivers large amounts of terrestrial organic material ranging in size from small fragments of vegetation to semi-submerged trees, all in various stages of decomposition, into the estuarine channels and out into the gulf.
- The edge of a continental shelf, which becomes less affected by the sediment influxes from the prodelta as it continues eastward.

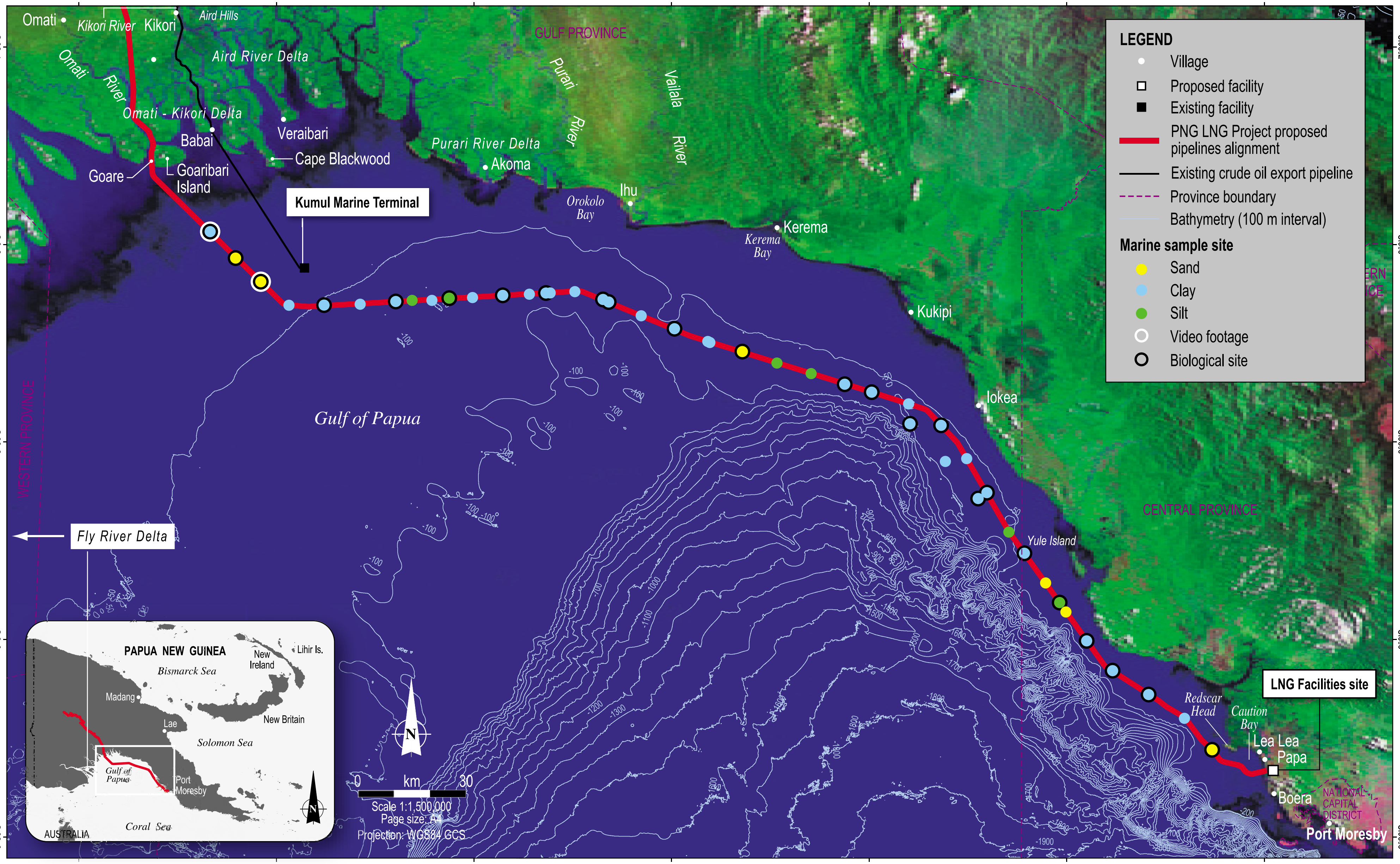
11.2.3 Climate

11.2.3.1 Winds

Wind patterns in the Gulf of Papua are seasonal (NSR, 1990; Williams, 1994; Woolfe et al., 1997). The two wind regimes that influence climate within and along the coast of the Gulf of Papua are:

- The northwest monsoon (November to April) winds, which are predominantly from the northwest or west and generally less than 31 km/h (17 knots), with wind speeds exceeding this only 15% of the time.
- The southeast trade winds (May to October), which exceed 31 km/h (17 knots) for 30% of the time in the Gulf of Papua (NSR, 1990).

Between the two main seasons are transitional periods of calm weather (doldrums).



Note:
Pipelines approximate the proposed alignment based on engineering data provided up to 1 October 2008.

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Offshore pipeline route, bathymetry and marine pipeline survey sampling locations

Figure No: 11.1

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Short-lived squalls of about 1 hour's duration, with wind speeds of 55 to 65 km/hr (30 to 35 knots) – known as *gubas* – occur during the northwest monsoon in the Gulf of Papua. They can sometimes be associated with thunder, lightning and heavy precipitation and are a common feature of equatorial weather. Port Moresby experiences *gubas* about five times a year (McAlpine et al., 1983).

11.2.3.2 Cyclones

The Gulf of Papua is an area of low to moderate cyclone risk. Most occur further to the south but generate storm-force winds and long-period waves in the Gulf of Papua. These conditions can cause substantial seafloor scouring and sediment movement in shallow waters. Cyclones occur mainly during the period from February to April; however, Tropical Cyclone Guba – which caused flooding and evacuations in Oro and Milne Bay provinces – occurred in mid-November 2007.

Tropical Cyclone Guba formed in the Coral Sea and skirted the south coast of mainland Papua New Guinea, including the Gulf of Papua. During this time peak winds reached 140 km/h.

11.2.3.3 Temperature and Rainfall

Meteorological stations located at Port Moresby (on the eastern side of the Gulf of Papua) and Daru (on the western side of the Gulf of Papua) are the closest long-term sources of meteorological data for the Gulf of Papua.

Temperature does not vary greatly in Port Moresby. December and January are the hottest months, with the average daily temperature minimum and maximum being 24°C and 32°C. The average daily temperature minimum and maximum in the coolest months (July and August) are 23°C and 28°C (BBC Weather, 2006).

Temperatures at Daru are similar to those at Port Moresby. The hottest month is January when the average daily temperature minimum and maximum are 27°C and 31°C respectively. The average daily temperature minimum and maximum are 24°C and 28°C respectively and occur during July (MSN Weather, 2008).

Rainfall in Papua New Guinea varies greatly from place to place due to the range of altitudes and exposure to the seasonal wind patterns. Annual rainfall across most areas of Papua New Guinea ranges from about 2,000 to 3,000 mm per annum, although higher rainfall (i.e., 5,000 mm per annum) occurs at high altitudes. Port Moresby is one of the driest areas in Papua New Guinea and receives an average annual rainfall of 1,125 mm (BBC Weather, undated). The wet season, when most rainfall occurs, is from December to April.

11.2.4 Oceanography

11.2.4.1 Tides

Tides in the Gulf of Papua are semi-diurnal to mixed. A maximum spring tidal range of 4 m and mean spring tidal ranges of 2.5 to 3 m occur in the western gulf (Wolanski & Eagle, 1991, cited in Woolfe et al., 1997). Tidal ranges in the eastern extent of the gulf and eastwards to Port Moresby tend to be smaller, with a mean spring tidal range of less than 3 m.

11.2.4.2 Currents

Oceanic circulation within the Gulf of Papua is dominated by a clockwise gyre, generated as the northwards-flowing Coral Sea Coastal Current enters the gulf along the eastern edge of the Torres Strait and exits to the northeast (Woolfe et al., 1997) (Figure 11.2). As a result, most of the freshwater (and sediment) delivered to the gulf by the large Papuan rivers travels eastwards. During the southeast trade wind season, short-term periods of strong winds can drive nearshore surface waters to the west for a number of days (King, pers. com., 2008).

11.2.4.3 Waves

The Gulf of Papua is exposed to the local surface waves generated by winds during the southeast trade wind season. These waves propagate in the general southeast direction of the winds along the coastline of the gulf but refract across shallow waters toward the shoreline. During the southeast trades, the seasonally-averaged significant wave height[1] reaches 1.5 m relatively close to the coast (Hemer et al., 2004). During the northwest monsoon, the offshore winds result in little or no wind-driven swell.

11.2.5 Water Quality

The Gulf of Papua has very high suspended sediment loads that originate from:

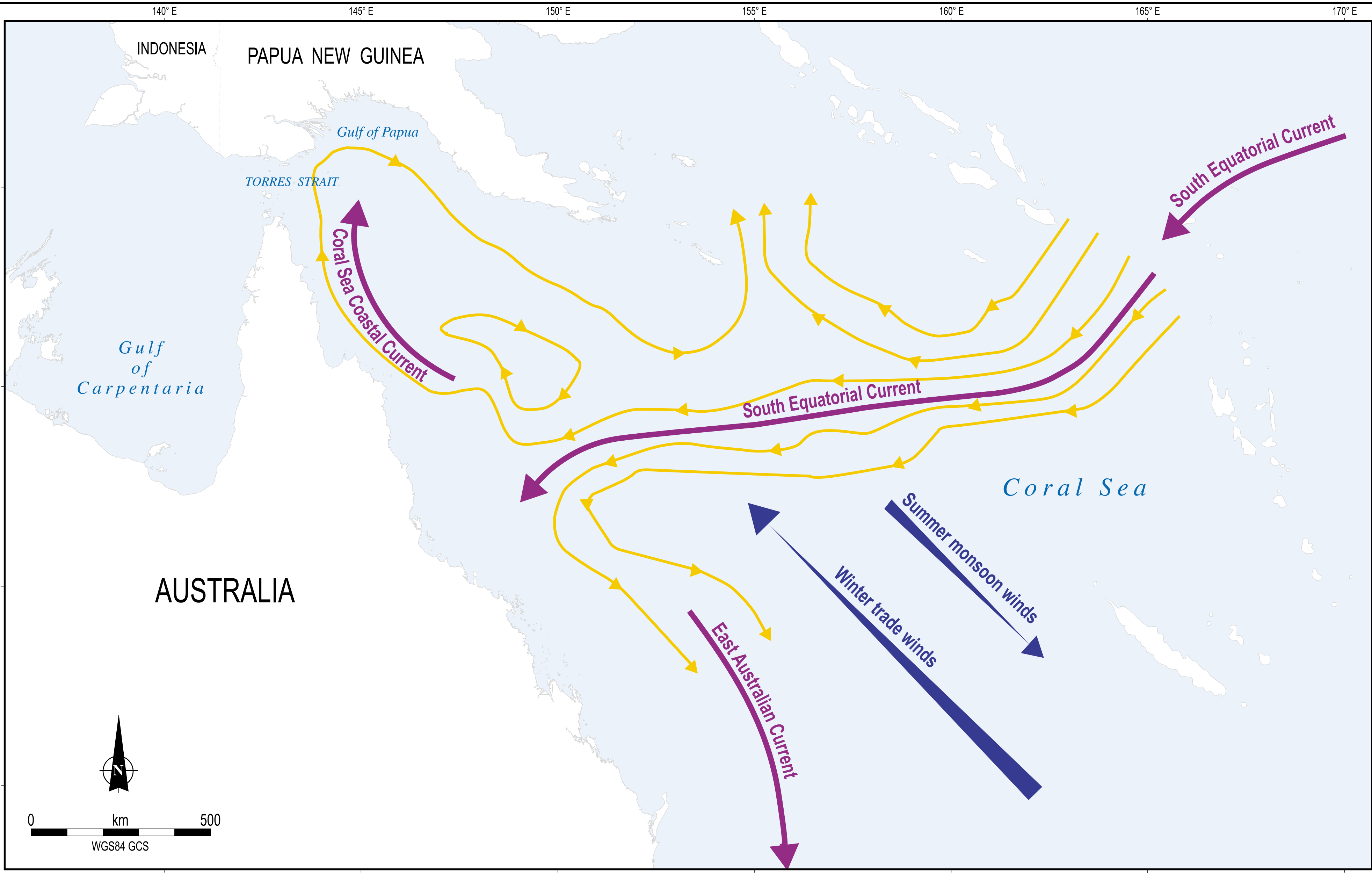
- High suspended sediment loads discharged from the Fly, Omati, Kikori and Purari rivers (in particular) into the Gulf of Papua.
- Reworking of sediments by strong tidal currents and wave action.
- Fluid-mud bodies (which are known to occur in the Fly River delta) that flow along the deepest parts of subsea channels as dense, mobile, near-seafloor suspensions, typically around 1 m in thickness (Dalrymple et al., 2003).

Concentrations of fine-grained suspended sediment rarely fall below 500 mg/L within the river mouths and the Fly River delta but can range from 10,000 mg/L to a maximum of 40,000 mg/L in fluid-mud bodies, which take around 35 hours to travel across the 20-km-wide, low-gradient delta front (see Harris et al., 2004; Dalrymple et al., 2003).

Turbid brackish surface plumes are often present and can extend as far as 50 km offshore (Plates 11.1 and 11.2). Forest debris transported by the rivers is also present in varying amounts in these plumes (see Plate 11.2). Waters are generally clear towards the eastern side of the gulf, away from the influence of large rivers.

Water quality in the Omati River and Caution Bay are discussed in Sections 10.2.8.2, General Riverine Water Quality, and 13.2.4.1, Water Quality, respectively.

[1] The average height (trough to crest) of the one-third of largest waves.



Source:
Burrage et al. (1993) as cited in Woolfe et al. (1997)

Job No: 1284	Esso Highlands Limited	Oceanic circulation in the Gulf of Papua	Figure No: 11.2
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Plate 11.1
Turbid outflow from the Omati-Kikori delta

Plate 11.2
Forest debris in the Gulf of Papua near the Omati-Kikori delta

Plate 11.3
Video footage showing high levels of suspended sediment near the Omati River mouth

11.2.6 Underwater Noise

Noise is naturally present in oceans and occurs through physical and biological processes. These are described in Appendix 11, Offshore Impact Assessment, and summarised below.

Physical sources of underwater noise are from air ocean interaction, wind, waves, rainfall and other oceanic processes. The dominant source of naturally-occurring noise across the band frequencies from 1 to 100 Hz is associated with ocean surface waves generated by wind, from which ambient noise levels can be up to 98 dB re 1 µPa, 20 to 1,000 Hz (Richardson et al., 1990).

Biological sources of noise include the sounds made by whales, dolphins and fish; invertebrates are also a source of underwater sound, sometimes at high levels. Cetacean echo-location vocalisations have been reported as high as 228 dB re 1 µPa at 1 m distance from false killer whales (Thomas & Turl, 1990, as cited in NRC, 2003) and bottlenose dolphins (echo-locating in the presence of other noise) (Au, 1993, as cited in NRC, 2003). The highest levels are calculated at 232 dB re 1 µPa at 1 m distance from adult male sperm whales (Møhl et al., 2000, as cited in NRC, 2003).

Noise from man-made sources includes shipping, from which noise levels measured for the larger class vessels (e.g., supertankers), can be up to 180 dB re 1 µPa, (at the lower frequency band of 20 Hz) (Richardson et al., 1995).

11.3 Biological Environment

11.3.1 Habitats and Seafloor Characteristics

This section is primarily based on a report prepared by EGS Survey Pty Ltd (EGS) (EGS, 2008) following the marine pipeline survey completed in March and April 2008 and observations made by Coffey Natural Systems during the same survey. During this survey, sediment was collected from 44 locations using a grab sampler and described by EGS[2]. Sediment types and locations along the route are shown on Figure 11.1 and detailed descriptions of the sediment are provided in Appendix 11, Offshore Impact Assessment. Coffey Natural Systems collected video footage of the seafloor along the proposed route from two sites[3] near the mouth of the Omati River (see Figure 11.1). Infauna was also collected along the route (see Section 11.3.1.1, Infauna, and Appendix 11, Offshore Impact Assessment).

At the mouth of the Omati River in the vicinity of Goaribari Island, water depth is approximately 6 m. The shoreline in the vicinity of the pipeline landfall is lined with vegetation, including nypa palms (*Nypa fruticans*) and reeds (*Phragmites* sp.) (see Plate 6.29), and the riverbed and seafloor in this area is comprised almost entirely of very soft clays and silts.

Water depths increase to approximately 30 m as the proposed pipeline route runs 50 km southeast to a point just south of the existing Kumul Marine Terminal. The substrate composition along this section of the pipeline route consists of very soft clays and silts, with some sand

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[2] Sediment description data was provided to Coffey Natural Systems.

[3] Mechanical problems with equipment prevented further coverage at this time.

megaripples.[4] Video footage collected in this area showed high levels of suspended sediment (Plate 11.3).

Once south of the Kumul Marine Terminal, the proposed route heads east along the continental shelf, where water depths along this 90-km-long pipeline section gradually increase to approximately 90 m. Seafloor sediment composition in this section varies from very soft clay to well-layered interbedded sand, silt and clay layers. Sandwaves, 1.5 to 2 m in height with wave lengths of approximately 150 to 180 m, are present in this section of the route, along with shallow seafloor depressions typically several tens of metres across and a few metres deep (EGS, 2008).

The next section of the proposed pipeline route runs to the east-southeast for approximately 110 km, where the depth gradually reduces from 90 to 60 m and the seafloor is composed of very soft, slightly silty clay layers 1 to 12 m thick. Rock outcrops occur along this section, surrounded by slightly clayey, slightly sandy gravel. Some parts of this section are characterised by shallow seafloor depressions.

The remaining section of the proposed pipeline route runs in a southeasterly direction parallel to the coastline and water depths decrease from 60 to 35 m where the proposed route meets the outer edge of Caution Bay. The seafloor is mostly composed of slightly silty clay substrate although rock outcrops also occur. The water depth at the edge of Caution Bay (i.e., at the end of segment 23) (see Section 6.4.5, Omati River Landfall to the LNG Facilities Site) is 36 m.

The marine pipeline survey undertaken in March and April 2008 did not identify any communities of seagrass or corals. Along the proposed route, seafloor depths shallow enough to support seagrass and corals are limited to areas near the Omati River and Caution Bay.

Near the Omati River end, high levels of suspended sediment (see Plate 11.3) prevent the establishment of seagrass habitats, which rely on sunlight for photosynthesis. Additionally, the seafloor here consists of very soft clays and silts that are unsuitable for the establishment of seagrass or coral communities.

While no seagrass or corals were identified along the proposed route outside of Caution Bay, both corals and seagrass do occur within Caution Bay (i.e., Segment 24 of the proposed route). These are described in Chapter 13, Receiving Marine Environment: Marine Facilities.

11.3.1.1 Infauna

Infauna[5] was sampled at 23 sites along the proposed pipeline route during the marine pipeline survey (see Figure 11.1). A total of 488 animals were collected from which 137 species were identified. The most common group of animals collected was polychaete worms, with 193 animals from 56 species identified. Other identified groups include other annelids (e.g., oligochaetes) crustaceans, molluscs, echinoderms, poriferans, cnidarians, bony fish and nemertean worms; as typically found in marine sedimentary habitats. Analyses of results showed no strong geographical patterns. Two sites shallower than 20 m depth were sampled, both of which are located between the mouth of the Omati River and the Kumul Marine Terminal (see Figure 11.1).

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[4] Undulations produced on the seafloor by fluid movement (waves and currents) over sediments, generally with wavelengths of 0.5 m to 25 m.

[5] Aquatic animals that live within the sediment on the seafloor, rather than on the seafloor surface.

Infauna present in these shallower waters along the proposed route included the same groups found in the deeper sites further along the pipeline route. This is not unexpected, as sediments collected along the route were similar (very fine, mostly comprising of silts and clays).

In summary, no differences in faunal composition were evident between the sampling sites, which suggests that there are no unusual habitats and that the substrate type is fairly uniform along the proposed pipeline route.

11.3.2 Marine Fauna

Marine fauna occurring in the Gulf of Papua is reasonably well known from observations of catches made from prawn trawlers that have operated in the area since the 1970s. Surveys of the prawn trawl grounds carried out by the PNG National Fisheries Authority in 2004 and 2005 to investigate the current status of prawn stocks (NFA, pers com., 2005; Koren, 2004a, 2005, 2006) included sample locations that were coincident with the proposed offshore pipeline route and provide information on typical species observed.

Plates 11.4 and 11.5 show typical catches taken by prawn trawlers operating in the Gulf of Papua, comprising prawns and by-catch of small fish, and occasionally, large rays or sharks. The commercial prawn fishery mainly targets banana prawns (*Penaues merguiensis)* and black tiger prawns (*Penaues monodon*).

Commercial grade prawns usually form about 10% of the catch. Most of the remaining fish and crustaceans are small, of low commercial value and are most often discarded. These include numerous species of fish, such as pony fish, hairtails, anchovies, clupeids, jewfish, goatfish and Bombay duck, and invertebrates, such as squid, crabs and mantis shrimps.

Six species of sea turtle occur within PNG waters, specifically the green turtle (*Chelonia mydas),* hawksbill turtle (*Eretmochelys imbricata),* leatherback turtle (*Dermochelys coriacea)*, olive ridley turtle *(Lepidochelys olivacea),* loggerhead turtle *(Caretta caretta)* and flatback turtle *(Natator depressus).*

All of the world's sea turtles are listed by the International Union for the Conservation of Nature's (IUCN) Red List of threatened species (IUCN, 2007). In the Gulf of Papua there are no known nesting beaches for any turtle species. Turtles are often caught in prawn trawl nets in the Gulf of Papua, including the olive ridley and green turtle (Plates 11.6 and 11.7). Other reptiles, such as of sea snakes (Plate 11.8), are also caught in these prawn trawl nets.

Two species of crocodile, the estuarine or saltwater crocodile (*Crocodilus porosus)* and the freshwater crocodile (*Crocodilus novaeguineae*), occur in the estuaries of Papua New Guinea (Pernetta & Burgin, 1983; Genolagani & Wilmot, 1988), but are unlikely to be found more than several kilometres offshore.

Plate 11.4
Shark in prawn trawl catch

Plate 11.5
Ray in prawn trawl catch

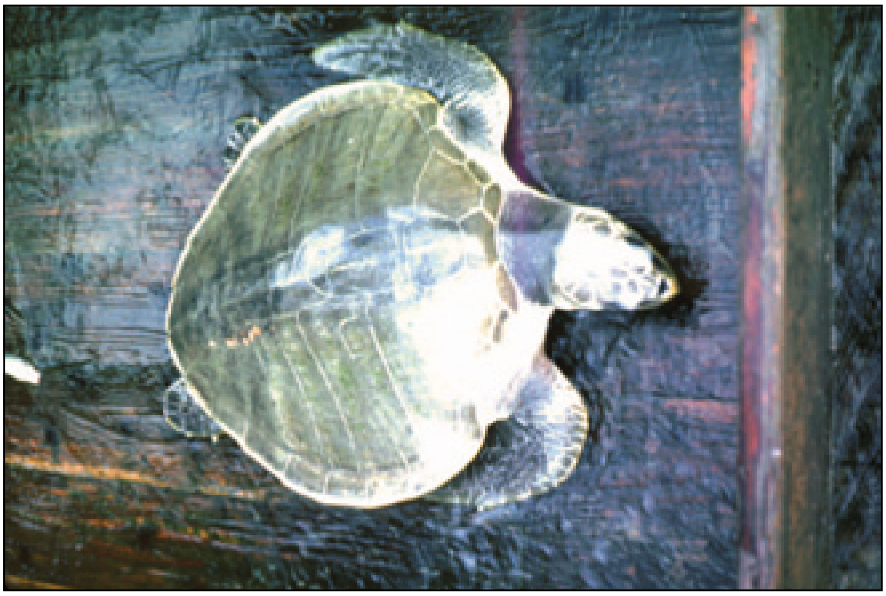


Plate 11.6
Olive ridley turtle in prawn trawl catch

Plate 11.7
Green turtle in prawn trawl catch

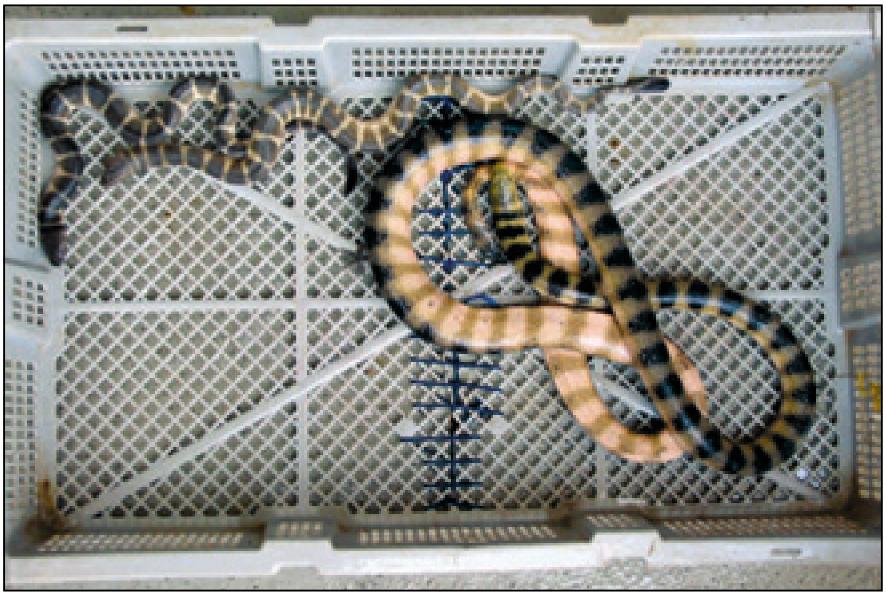


Plate 11.8
Sea snakes in prawn trawl catch

Plate 11.9
Dolphins observed during the marine pipeline survey

Adult tropical rock lobsters (*Panulirus ornatus*) annually migrate from reefs in northern Queensland in Australia and Torres Strait across the Gulf of Papua to the reefs of Yule Island and further east along the PNG coast (Figure 11.3). The migration is related to spawning and occurs from August to December each year. The migration path through the Gulf of Papua is coincident with the deeper part of the prawn trawl grounds, mostly between 40 m and 80 m depth. There is no evidence of a return migration by adults (Moore & MacFarlane, 1984).

An approximate 100 km section of the proposed pipeline route off Yule Island runs through the tropical lobster breeding ground (see Figure 11.3).

Marine mammals in the Gulf of Papua include the dugong (*Dugong dugon*), which occurs along coastal areas of Papua New Guinea, mainly to the west of the Fly River delta coincident with areas of seagrass, their primary habitat. The dugong is listed as vulnerable to extinction in the IUCN's Red List of threatened species (IUCN, 2000). It is also a protected species under the PNG *Fauna (Protection and Control) Act 1976.*

Whales are not often seen in the Gulf of Papua but species that may occasionally be present in the area include the Bryde's whale (*Balaeonoptera edeni*), sperm whale (*Physeter catodon*), minke whale (*Balaenoptera acutorostrata*) and humpback whale (*Megaptera novaeangliae*). The sperm whale and humpback whale are both listed as threatened and the minke whale is listed as lower risk near threatened by the IUCN (Cetacean Specialist Group, 1996a, 1996b, 1996c).

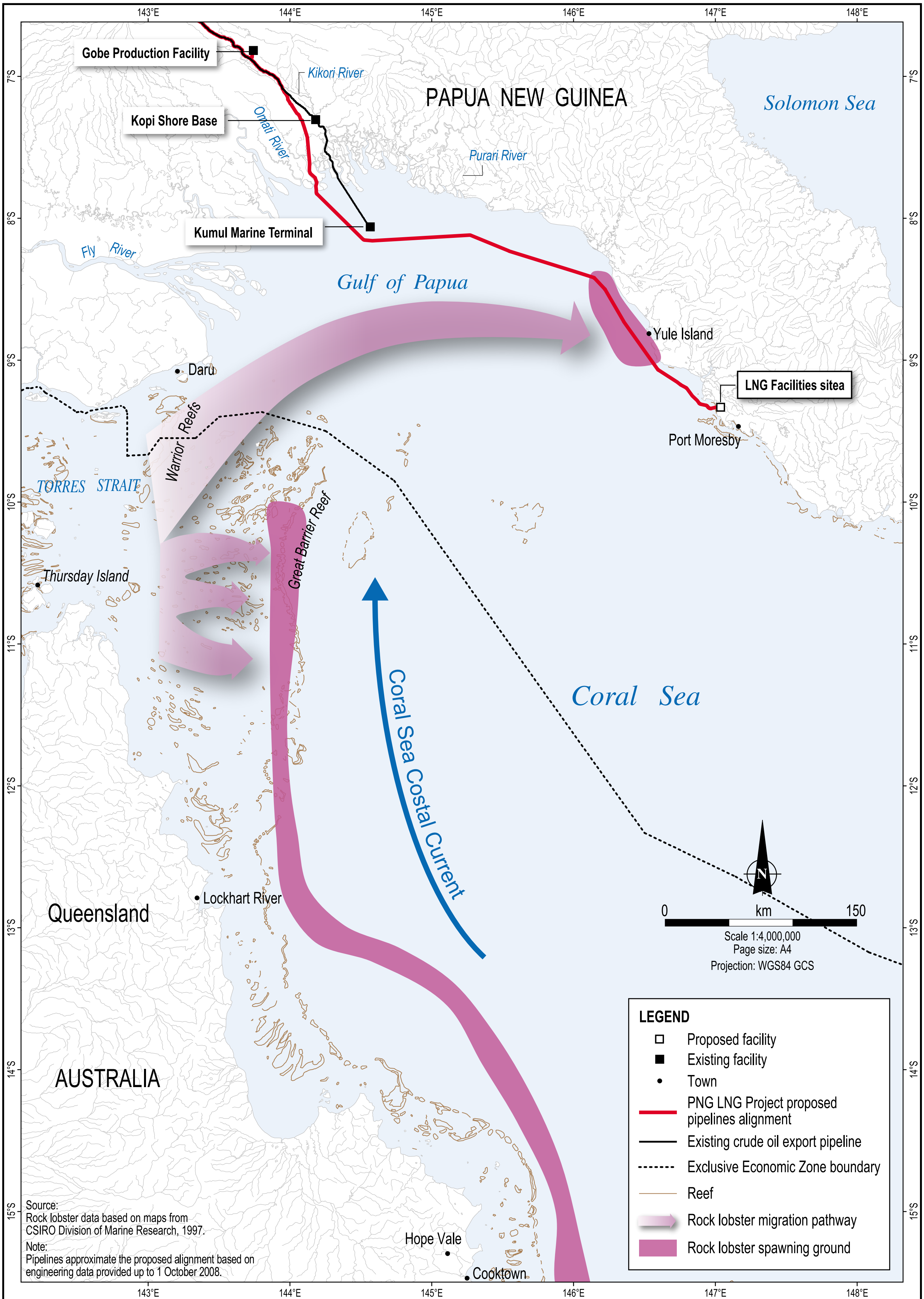
Several species of dolphins are present in the gulf, including the bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), the Indo-Pacific humpback dolphin (*Sousa chinensis*), and the Irrawaddy dolphin (*Orcaella brevirostris*). Many of the species of dolphins are frequently observed in inshore waters of the gulf near prawn trawlers, attracted to fish by-catch discarded overboard. During the marine pipeline survey, several dolphins, including a pod of 12, were observed from the vessel (Plate 11.9).

The Irrawaddy dolphin (*Orcaella brevirostris*) is a rare and poorly known species but surveys conducted in 1999 have reported sightings of individuals in the Kikori River (Namo, 2003). They inhabit turbid waters and travel up large river systems but generally stay within 5 km of the coast. The newly-recognised snubfin dolphin, *Ocraella heinsohni*, is also found in the southern parts of Papua New Guinea (Beasely et al., 2005).

11.4 Resource and Shipping Use

11.4.1 Commercial Fisheries

The development and management of the marine biological resources of Papua New Guinea falls under the jurisdiction of the National Fisheries Authority (NFA), a non-commercial statutory body that was established in 1995. The NFA works under the *Fisheries Management Act 1998* and related fisheries regulations.



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Date: 12.01.2009	Esso Highlands Limited	Tropical rock lobster migration paths through the Gulf of Papua	Figure No: 11.3
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The main commercial fishery in the Gulf of Papua is the Gulf of Papua Prawn Fishery. The main grounds follow an arc at least three nautical miles offshore and following the 30 to 60 m depth contours. The fishery extends from the Fly River delta in the west to the village of Iokea in the east, close to the border between Gulf Province and Central Province. The proposed offshore pipeline route traverses the trawl grounds, more-or-less perpendicular to the west of Cape Blackwood, and for the remainder of the route lies offshore of the trawling grounds.

11.4.1.1 Gulf of Papua Prawn Fishery

The Gulf of Papua Prawn Fishery is one of the most valuable fisheries in Papua New Guinea. Current catches of between 400 and 650 t of banana prawns and 160 t of black tiger prawns are harvested per year, bringing an annual economic return of approximately K15 million (ACIAR, 2006).

Recently, steep rises in fuel costs and declines in prawn prices have significantly impacted the economic viability of the prawn industry (ACIAR, 2006). Consequently, there has been an approximate 40% reduction in fishing effort, with the number of vessels operating in the Gulf of Papua Prawn Fishery falling from 15 to approximately 9 (Mobiha, pers. com., 2008).

Trawlers are typically around 30 m overall length (and up to 150 gross t) and operate twin- or quad-rigged trawl gear (Plate 11.10). All processing and freezing is performed onboard after each haul. As there are no harbour facilities adjacent to the fishing grounds, vessels operate from Port Moresby, about 24 hours' steam away, and remain at sea for periods of 4 to 5 weeks. Fishing takes place on a 24-hour basis and each trawl shot is, on average, about 4 hours, towed at speeds of around 3 knots.

Trawlers are fitted with vessel monitoring systems, whereby the Global Positioning System coordinates of the vessels are recorded each day by NFA. Figure 11.4 presents daily vessel positions for 2007 and clearly shows that the main fishing grounds are centred around Kerema Bay, with other concentrations of trawling effort:

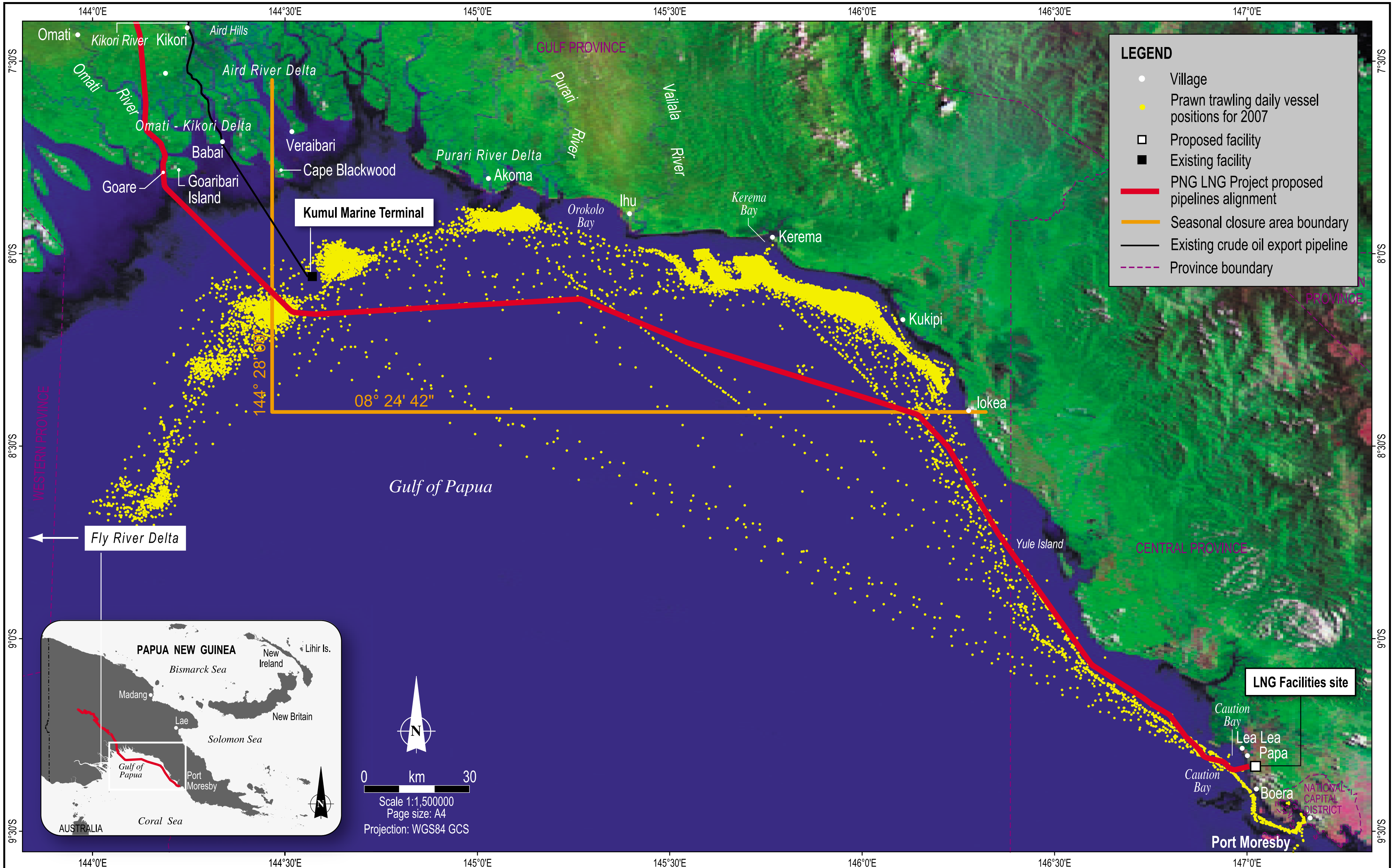
- At Orokolo Bay and south of the Purari River delta.
- To the south of Cape Blackwood and the Omati River mouth.
- In a small area east of the north arm of the Fly River delta.

The gap in the trawl grounds offshore of Cape Blackwood indicates the exclusion area around the Kumul Marine Terminal. A 15-km length of the proposed pipeline route south of the Kumul Marine Terminal is regularly trawled (see Figure 11.4). Routes used by fishing vessels transiting between trawling grounds and Port Moresby are shown in Figure 11.4 and show that the proposed pipeline route falls within parts of these transit routes.

The fishery is currently managed in accordance with the Gulf of Papua Prawn Fishery Management Plan, developed by NFA in 1998. Commercial vessels are prohibited from fishing within three nautical miles (nm) of the coast; however, many trawlers still operate in this area (ACIAR, 2006). A review of the management plan is being undertaken by NFA and the revised plan includes changing the 3-nm exclusion zone to a 2-nm exclusion zone, with any prawn trawling occurring within 2 to 3 nm from shore requiring prior consultation with traditional owners (Mobiha, pers. com., 2008).

Plate 11.10
Gulf of Papua Prawn Fishery trawler in Port Moresby

Plate 11.11
Canoes getting trash fish from a prawn trawler



Note:
Pipelines approximate the proposed alignment based on engineering data provided up to 1 October 2008.

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NFA has allocated up to 10 licences for a small-scale prawn fishery in the inshore waters, but these are not active. In part, this reflects the long-standing obstacles to localising the commercial prawn fishery posed by the lack of local harbour facilities and the long distance to markets.

Prawn nursery areas include the Aird River delta, and the Kikori, Purari and Vailala rivers (see Figure 11.4). New recruits migrate eastwards from these areas toward Kerema Bay (Frusher, 1983). This migration occurs within the 3-nm exclusion zone. Around March to April, the prawns move to deeper waters (approximately 12 m deep) where commercial fishing occurs (Koren, 2006). To protect nursery areas, the trawl grounds from Iokea to Cape Blackwood (see Figure 11.4) are subject to a seasonal closure from 1 December to 31 March each year.

11.4.1.2 Tropical Rock Lobster Fishery

Divers commercially fish tropical rock lobsters on the reefs in the Torres Strait as part of the Torres Strait and Western Province Tropical Rock Lobster Fishery. The main fishing ground in Papua New Guinea is the northern Warrior Reefs (NFA, 2002) (see Figure 11.3), which are well outside the project area. Lobsters were trawled in the Gulf of Papua, however, to preserve the breeding population, a ban was placed on trawling for lobsters in 1984. Over the last few years, however, some trawling has been done in the gulf (Ye et al., 2006) but there is no legal trawl fishery. An artisanal dive fishery is based on the seasonal breeding migration of rock lobsters, mainly on the coastal reefs of Yule Island. Further information about tropical rock lobsters, including migration and breeding, is discussed in Section 11.3.2, Marine Fauna.

11.4.2 Subsistence Fisheries

The variety and abundance of fish, mud crab, prawn and lobster resources all along the Gulf of Papua coast support subsistence fishing and for occasional sale of excess catch to local markets and other outlets, such as logging camps. Subsistence fishing involves the use of a variety of pots, traps and gill nets. V-shaped scoop nets are commonly used along the beaches targeting fish and sub-adult prawns as they migrate from estuarine nursery areas to offshore grounds.

The main species fished for subsistence or sale is barramundi (*Lates calcarifer*). Seasonal gill net fishing takes advantage of the relatively predictable spawning movements along a 150-km-long narrow coastal strip on the south coast of Papua New Guinea and west of Daru, before the barramundi return to their inland river habitats (Kare, 1995). Other high-value species, such as threadfin (*Polynemidae*), jewfish (*Sciaenidae*) and catfish (*Ariidae*), are also targeted.

Subsistence fishing does not extend far offshore as resources are plentiful in rivers and along the coast. In calm conditions, dug-out canoes or banana boats will pull alongside prawn trawlers to exchange vegetables for by-catch fish (Plate 11.11). During the period of the southeast trade winds, conditions are seldom suitable for such offshore excursions.

Resource use in the Omati-Kikori delta is detailed in Section 10.5.2.2, Fisheries.

11.4.3 Shipping Routes

This section is based on interviews with representatives[6] from PNG Ports Corporation Ltd[7] (PNG Ports), a port authority wholly owned by the Independent State of Papua New Guinea and responsible for 21 declared ports throughout the country, including the Port of Port Moresby and the Port of Daru (Figure 11.5).

Shipping register records (PNG Ports, 2007) and the PNG Harbours 2004 Annual Report (PNG Harbours, 2004) contain data on the numbers and types of vessels berthing at the Port of Port Moresby and the Port of Daru. Records from these ports give an indication of the likely vessel types and frequency of occurrence along the proposed pipeline route and show that there are no defined shipping channels along the proposed offshore pipeline route.

11.4.3.1 Port of Port Moresby

The Port of Port Moresby is a medium-sized seaport located in Fairfax Harbour on the eastern side of the Gulf of Papua (see Figure 11.5), where over 1,400 overseas and coastal vessels berth annually. A summary of the number and types of vessels using the port facilities is provided in Table 11.1.

Table 11.1 Summary of vessels that berthed at the Port of Port Moresby during 2005 and 2006

	Type of Vessel	2005	2006
Overseas	Container	58	68
	General cargo	106	91
	Tanker	79	89
	Ro-Ro	14	13
	Cruise	5	10
	Log ship	94	77
	Other	155	138
Total		*511*	*486*
Coastal	General cargo	221	220
	Tanker	-	-
	Barge	105	132
	Passenger	25	57
	Other	557	519
Total		*908*	*928*
Overall Total		**1,419**	**1,414**

Source: Adapted from PNG Ports, 2007.

Overseas vessels entering the Port of Port Moresby are generally from Australia, China, Indonesia, Malaysia and Hawaii (PNG Ports, 2007).

[6] Mr Karme, Mr Kabilu and Mr Tavul.

[7] Formally PNG Harbours Limited.

Note:
Pipelines approximate the proposed alignment based on engineering data provided up to 1 October 2008.

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PNG LNG Project

Key ports within the Gulf of Papua

Figure No: 11.5

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Coastal vessels travel to and from the port from locations within the Gulf of Papua, including Daru, the Kumul Marine Terminal and Kiunga, and other areas in the country, such as Lihir, Lae, Kimbe and Rabaul.

Small bulk carriers transport Ok Tedi Mine copper concentrate from the Fly River to the Port of Port Moresby between May and September (Kabilu, pers. com., 2007). Log carriers deliver timber from the Paia Inlet (just east of the Omati River) to the Port of Port Moresby (Kabilu, pers. com., 2007). These shipping routes are likely to be traversed by the proposed offshore pipeline.

11.4.3.2 Gulf of Papua Ports

Ports within the Gulf of Papua include the Port of Daru, Napa Napa Oil Refinery and Kumul Marine Terminal (see Figure 11.5 and associated insert map that shows the Port of Daru). There are also small ports at Kikori (located on the Kikori River, approximately 15 km downstream of Kopi) and Baimuru (located on the Pie River, approximately 75 km east-northeast of the Omati River Landfall) serving coastal trading vessels. The Port of Daru is a small jetty port located on the western side of the Gulf of Papua and vessels using this port typically include logging transport ships and fishing vessels (PNG Harbours, 2004).

The port at the Napa Napa Oil Refinery, owned by InterOil, is located near the Port of Port Moresby (within Fairfax Harbour), and handles the export of oil and minerals, such as copper concentrate for the Ok Tedi mine (Kabilu, pers. com., 2007).

The Kumul Marine Terminal is situated near the Omati–Kikori Delta at the end of an oil pipeline and is used to export oil associated with Oil Search's Kutubu Petroleum Development Project. The terminal receives oil tankers and supply vessels. The proposed offshore pipeline has been routed to avoid the Kumul Marine Terminal and its associated anchoring zone.

11.4.4 Kumul Marine Terminal

The Kumul Marine Terminal of the Kutubu Petroleum Development Project is operated by Oil Search Limited and controls the loading of crude oil onto export tankers. The system comprises the submarine section of the Kutubu Crude Oil Export Pipeline, which runs 100 km from landfall in the Kikori River to a small, steel-jacket platform in 20 m of water 35 km off Cape Blackwood. Export tankers tie up at a single-point mooring and load crude oil under gravity flow from the storage tanks at the Kutubu Central Production Facility.

11.5 Implications for Offshore Facilities Planning, Design and Management

The offshore section of the LNG Project Gas Pipeline comprises two broad subsea environments: the muddy sediments of the Gulf of Papua prograding offshore from the deltas of the Kikori and Purari rivers; and the reefs and coral sand lagoons to the east and approaching landfall at the LNG Facilities site at Caution Bay.

Routing constraints are relatively straightforward: to avoid coral reefs, to avoid conflicts with existing oil export infrastructure; and to maintain a safe setback from unstable areas close to the continental shelf edge. Crossing prawn trawl grounds is unavoidable and will require procedures to avoid conflicts (by notification) and resolve issues of lost gear if there are sections of pipe that do not self-bury to the point where they might cause trawl gear to be lost. In addition, the ability of lobsters on migration from Torres Strait to Yule Island to negotiate exposed sections of pipeline requires assessment.