6. Existing Environment

6.1 Timor Sea Climate

The climate of the Timor Sea area comprises two distinct seasons, a dry 'winter' from April to September and a 'summer' from October to March, during which most rain falls.

The winter is characterised by steady easterly winds of 5 to 12 m/s originating from over the Australian mainland and travelling over the Timor Sea (the South East Trade Winds). The summer is characterised by the North-West Monsoon, a steady, moist west-south-west to north-west wind reaching speeds of 5 m/s for periods of 5 to 10 days.

The September/October transition season is characterised by the development of low pressure systems over central Australia. Surface winds in the vicinity of the Sunrise Gas Field are likely to possess a westerly component and at other times the synoptic easterlies may persist (WNI, 2001). The winds will be light and frequently less than 5 m/s.

In the March/April transition season, the North-West Monsoon retreats northward resulting in south-easterly winds (WNI, 2001). By the end of April the dry easterly airflow of the winter period is usually well established.

Monthly wind roses typical of the Sunrise area are presented in **Figure 6-1.**

Tropical cyclones form in the area generally south of the equator in the eastern Indian Ocean area, and the Timor and Arafura seas. In the Timor Sea area most of the storms are tropical lows or developing storms passing well to the south of the Sunrise Gas Field; however, the storms can be fully developed at this latitude. Examples of this are tropical cyclone Tracy that devastated Darwin and the much more intense cyclone Thelma that remained offshore until it reached the Kimberley area of Western Australia. The most active months for tropical cyclones in the Timor Sea region are January to March. However, the most severe cyclones likely to affect the region will most often occur in the months of December to April (WNI, 2001). Records of cyclonic activity in the region over the past 30 years indicates only storms with wind speeds less than gale force in the Sunrise area (**Figure 6-2).**

The mean annual rainfall on the south coast of Timor ranges from 1,500 to 3,000 mm (SKM, 1993) with mean annual rainfall for the Sunrise Gas Field expected to be in the order of 1,700 mm with the bulk of the rainfall occurring between November and March. The mean summer and winter air temperatures measured for the Jabiru field for 1984 were 28.4°C and 26.9°C respectively. Jabiru is about 420 km south-west of the Sunrise Gas Field.

6.2 Geology and Soils

6.2.1 Regional Geology and Soils

The development area is situated on the outer shelf and upper slope of the Sahul Platform off the northern margin of Australia in the Timor Sea. The lithospheric plate boundary between Australia and East Timor lies to the north of the area with the bottom of the oceanic trench (Timor Trough) lying about 55 km north at 3,000 m water depth. The Australian tectonic plate is moving northwards and slowly being subducted under the Indonesian Plate. The subducted plate is associated with numerous earthquakes in the region north of Timor, although some deep-seated earthquakes extend south of Timor. A distinct shelf break defining the change between the shelf and upper slope exists at around about the 130 m water depth contour. During the last sea level low stand (approximately 14,000 to 20,000 years ago) the water level would have coincided with this depth contour.

The Melita Valley lies south of the Sahul Platform within the middle shelf zone and a channel system derived f.rom this valley crosses the outer shelf. Seismic lines show the shelf edge to be made up of a series of prograding (outward growing) sediment wedges, each in the order of 100 m thick and presumably generated as deltas. Bedding within these wedges is frequently complex, though downslope from them the strata are more uniformly layered. The steep slopes beyond the shelf edge are caused by the most recent delta fronts. The channel mentioned above appears to have fed the most recent prograding wedge.

Prograding sediment wedges are common features on continental margins forming as deltas off river mouths and are frequently developed during low stands of sea level. They are generally produced by very high sediment accumulation rates. These features are often dormant during high sea level stands such as during the last 14,000 to 20,000 years (approximately). Results of seismic surveys indicate a number of faults that affect the deeper sediments. Some of these faults extend relatively close to the seabed in the vicinity of the proposed development.

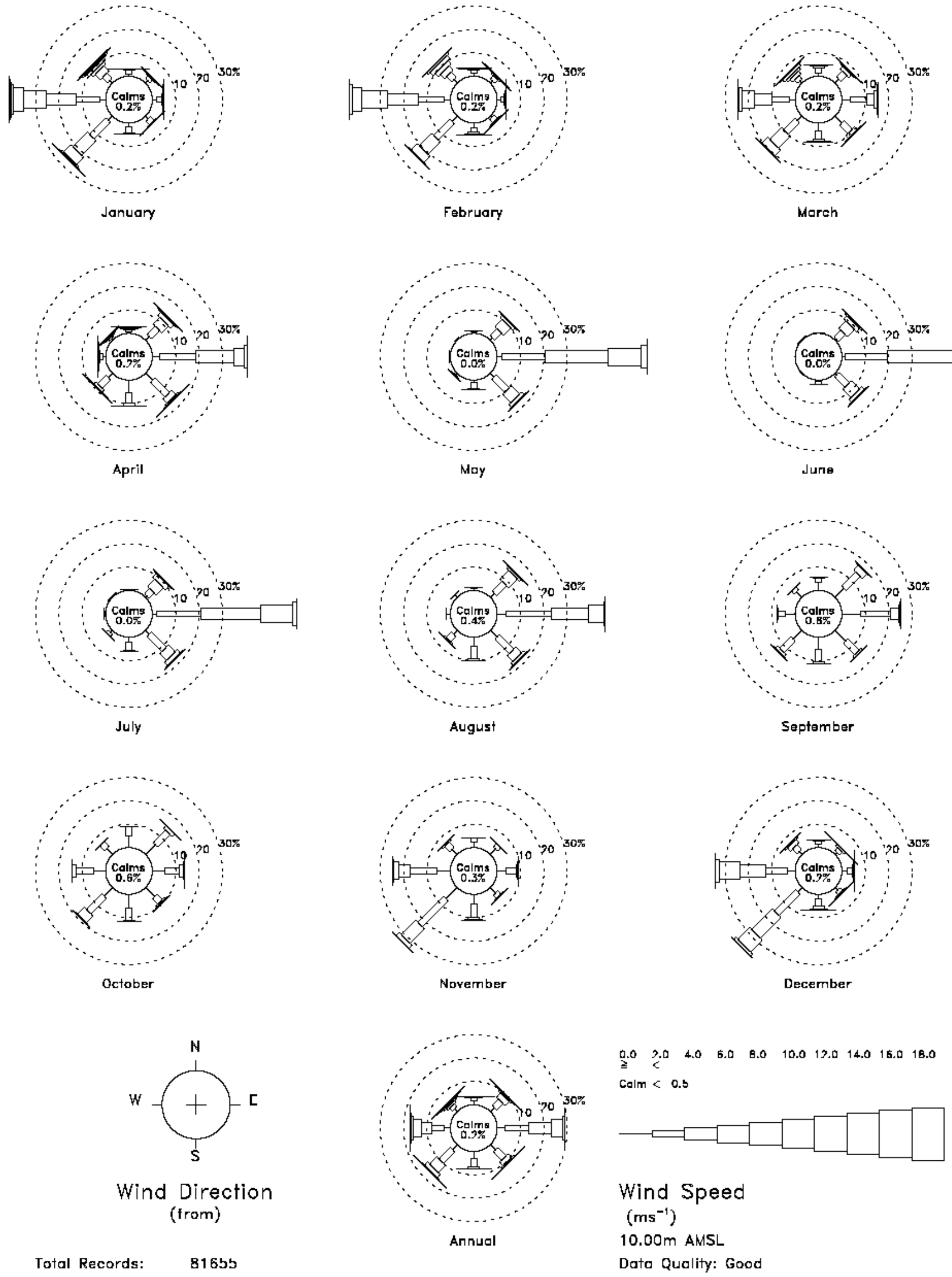
The structural formation of the Sahul Platform is described (Barnes 1998 in Woodside 2001) as an essentially prograding carbonate wedge formed during Miocene times, developed following an early Tertiary phase of faulting. The collision of the Australian plate with the Timor plate produced uplift and the development of a localised mid-Miocene unconformity. As an Australian plate started to subduct, subsidence of the shelf occurred during the Pleistocene, thereby forming space for the accumulation of the Pleistocene sequence. Carbonate sediments have dominated this accumulation near the shelf edge.

The Pleistocene carbonates are characterised by Reef and Shoal facies near the shelf edge. Reef facies are interpreted as carbonate accumulations dominated by reef growth and developed during lower sea levels. The uncemented sediments that exist in places on the surface of the cemented sequence are probably an accumulation of Holocene fine sediments from suspension. The shoal facies are interpreted as carbonate accumulations, sub-aerially exposed and subject to erosion when the Reef facies were being deposited. These were later submerged, and carbonate shoals (mounds) were formed as the sea level rose. In the last 10,000 years, continued subsidence coupled with rapidly rising sea levels have resulted in these mounds not being able to keep up with rising sea levels. Current thinking is that growth of the mounds has also been assisted by the continual cycle of halimed growth and debris generation, which is high in carbonate content. However, storm activity in the area erodes the build up of debris, thereby further stunting the growth of these mounds. The water depths on top of the mounds are rarely shallower than about 40 m.

6.2.2 Subsea Pipeline

The pipeline route is 218 km in length to the Wye location of the proposed section. Water depth ranges from 72 m to 140 m along the Sunrise to Wye section. The route crosses various valleys and gulleys and reaches a depth of approximately 151 m at the centre of Melita Valley at a KP of 130 km from the platform.

The pipeline route travels approximately 3 km before reaching the shelf break (approximately 135 m depth). From KP 3 km to KP 95 km the pipeline traverses the Sahul Platform, where the water depth reduces gradually to approximately 70 m. However, localised gullies are crossed at KP 50 km and KP 60 km. The Melita Valley, which is a Graben feature, is crossed in its broad upper reach area, between about KP 95 km and KP 190 km. Water depths over this region can reach as much as approximately 150 m. Beyond 190 km to the location of the Wye (KP 218 km approximately), the pipeline traverses the edge of Bathurst Terrace where water depths are in the vicinity of about 70 m.



Source: WNI Science & Engineering (2001)

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Wind Roses for the Sunrise Gas Field

Figure 6-1
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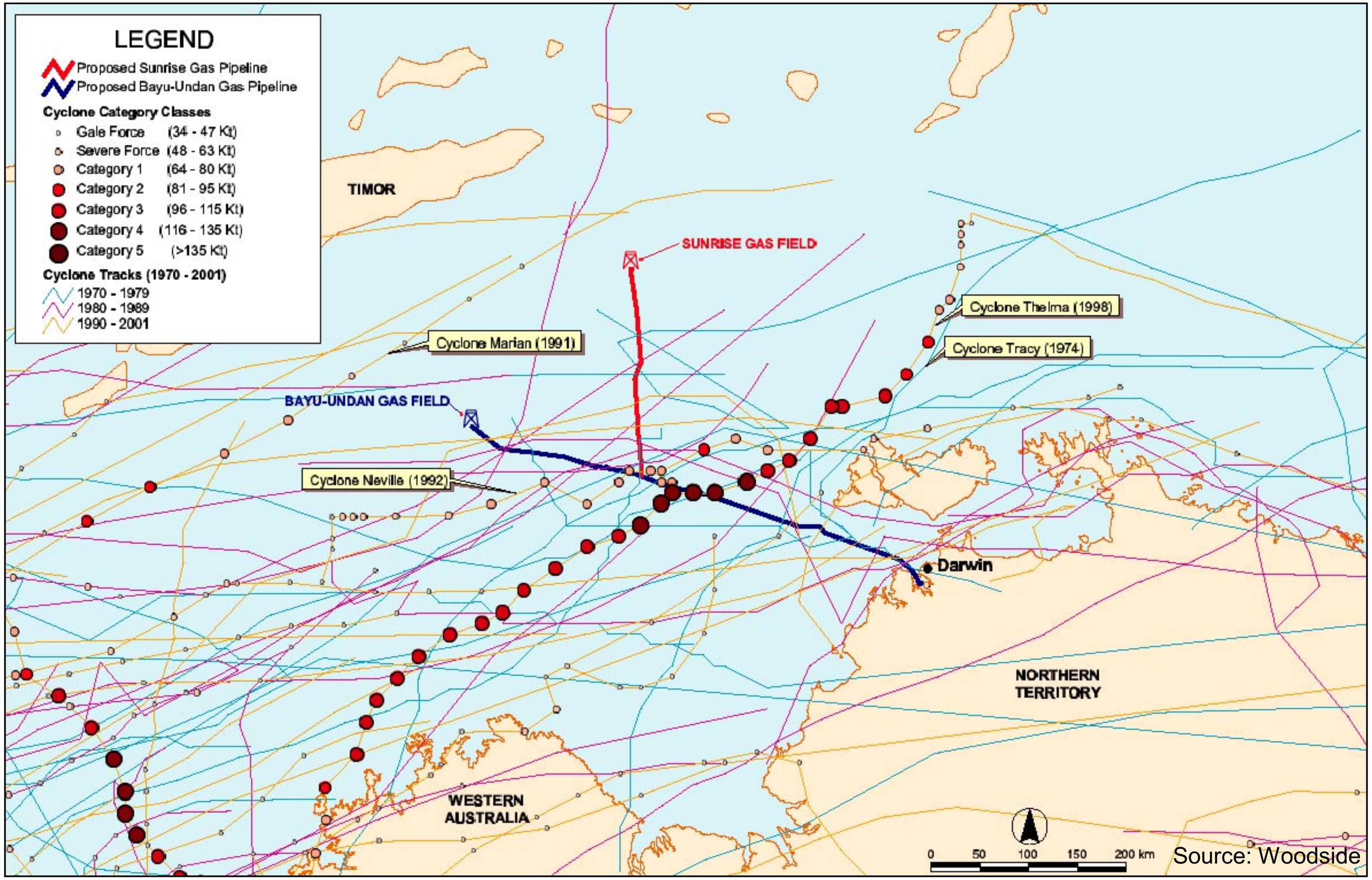
Date Prepared: 16/10/01



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Cyclonic Activity in the Timor Sea Region (1970 – 2001)

Figure 6-2

Project No.: DE2090.100
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Initially a reconnaissance geophysical investigation to gather preliminary geotechnical information to finalise the pipeline route was undertaken during May/June 2001. Subsequently, a reconnaissance geotechnical investigation was undertaken along the proposed pipeline route between Sunrise and the Wye from June to July 2001. This included fieldwork and testing of soil samples recovered. As part of this programme, piston core samples commenced at the Wye and proceeded to the platform location. Following this Piezocone Penetration Test (PCPT) testing was undertaken. Based on the geotechnical investigation results the route can be divided into five zones of similar surficial sediments summarised as follows and illustrated in **Figure 6-3:**

- *Zone 1*: KP 0 to KP 21 km – the materials in this zone are characteristic of the surficial soils within the area of the prograding sediment wedge, found to be an old delta front. Samples are described as carbonate sandy silt below a depth of approximately 0.7 m with the layer above being of a marginally coarser grading.
- *Zone 2*: KP 21 to KP 71 km – in this zone, a surficial layer, generally classified as carbonate silty exists to depths of between approximately 0.5 m and 0.7 m.
- *Zone 3*: KP 71 to KP 115 km – similar characteristics to Zone 2 except that the surficial layer has a higher clay size particle content and is classified as a carbonate clayey sand.
- *Zone 4*: KP 115 to KP 179 km – the surficial soil over this area is remarkably similar to a depth of 2.5 m below seabed and is classified from samples as a carbonate clay.
- *Zone 5*: KP 179 km to Wye – the surficial layer in this zone varies from carbonate clay to clayey sand with gravel.

6.3 Seismicity

The Timor Trench lies immediately north of the Sunrise Gas Field and to the south of the island of Timor. Subduction earthquakes, caused by one edge of one crustal plate being forced below the edge of another, associated with the Timor Trench dominate the earthquakes of the Sunrise Gas Project area.

It should be noted that detailed seismograph coverage for the area was limited until 1964 when there was a significant improvement in world wide coverage, including the Timor Sea area. For the period prior to 1964, data compiled from various historical catalogues for major events between 1900 and the 1963 was used for the study.

The Sunrise Gas Field is located at the southern boundary of the Timor Trench, on the Australian Plate, which is subducting to the north under Timor. The subduction zone is steeply dipping with the rate of activity along the subduction zone appearing to be greatest to the east (towards the Banda Sea) than to the west (towards Sumbawa). There appears to be an absence of seismicity to the north-west of the Sunrise Gas Field under East Timor, although this may not be a long-term feature of the seismicity of the area.

Although it is not possible to use the distribution of earthquakes to delineate active faults in the immediate area of the Sunrise Gas Field because of the proximity to the Timor Trench, it is reasonable to expect that shallow earthquakes will occur in the area. Earthquake activity is dominated by the subduction events to the north and it can be assumed that these will continue in the pattern of the past 100 years. Earthquake activity is not dominated by the earthquakes in any particular location or time period.

At the Timor Trench, the subduction zone earthquakes are shallow at the offshore trench and are deepest to the north with most subduction earthquakes occurring at depths down to approximately 200km. Few events lie between 300 and 500 km although some events do occur at depths exceeding 600km. Events deeper than 300 km are too deep to create damage at the surface for major engineered structures.

Figure 6-4 identifies the earthquakes that occurred in the Sunrise Gas Field area since 1900. However, it should be noted that the locations of events recorded prior to 1964 are highly uncertain with those occurring after 1964 increasingly accurate with an uncertainty of 10 to 20 km. **Table 6-1** (extracted from Seismology Research Centre, WEL 2001b) identifies the strongest earthquakes in the region since 1900, within 600 km of Sunrise. However, of the 131 earthquakes listed in the original table (Seismology Centre, 2001) only five of these reach an intensity of 5. Note that **Figure 6-4** identifies earthquakes by both depth and magnitude. A formula is then used to calculate intensity. Magnitude is defined as a number indicating the "size" of an earthquake. It is closely related to the amount of energy released during the rupture, or to the rate at which energy is released. There are a number of magnitude scales in use, each measured in a different way. If the word magnitude is used without qualification, in the past it usually referred to the Richter magnitude ML, but is now usually the moment magnitude MW. The ML, MS and MW scales give similar numerical values

In summary, Woodside has undertaken extensive research into the issue of seismicity for the Sunrise Gas Development. Subduction earthquakes associated with the Timor Trench, located north of the Sunrise field and south of Timor, dominate the Sunrise area. Subduction earthquakes are the result of the Australian tectonic plate being deflected (subducted) under the Indonesian tectonic plate. Being located on the subducting plate, the seismicity of the area is less onerous than the area north of the subduction zone. However, detailed probabilistic and deterministic analyses have been undertaken to determine the seismic design criteria relevant to this development. Deterministic hazard studies consider the effect of specific large earthquakes rather than the cumulative effect of all possible earthquakes as considered in a probabilistic study. Detailed results of this study are presented in Seismology Research Centre (2001). These criteria will be used to ensure that the development is designed to safely withstand the maximum credible seismic event defined for this area.

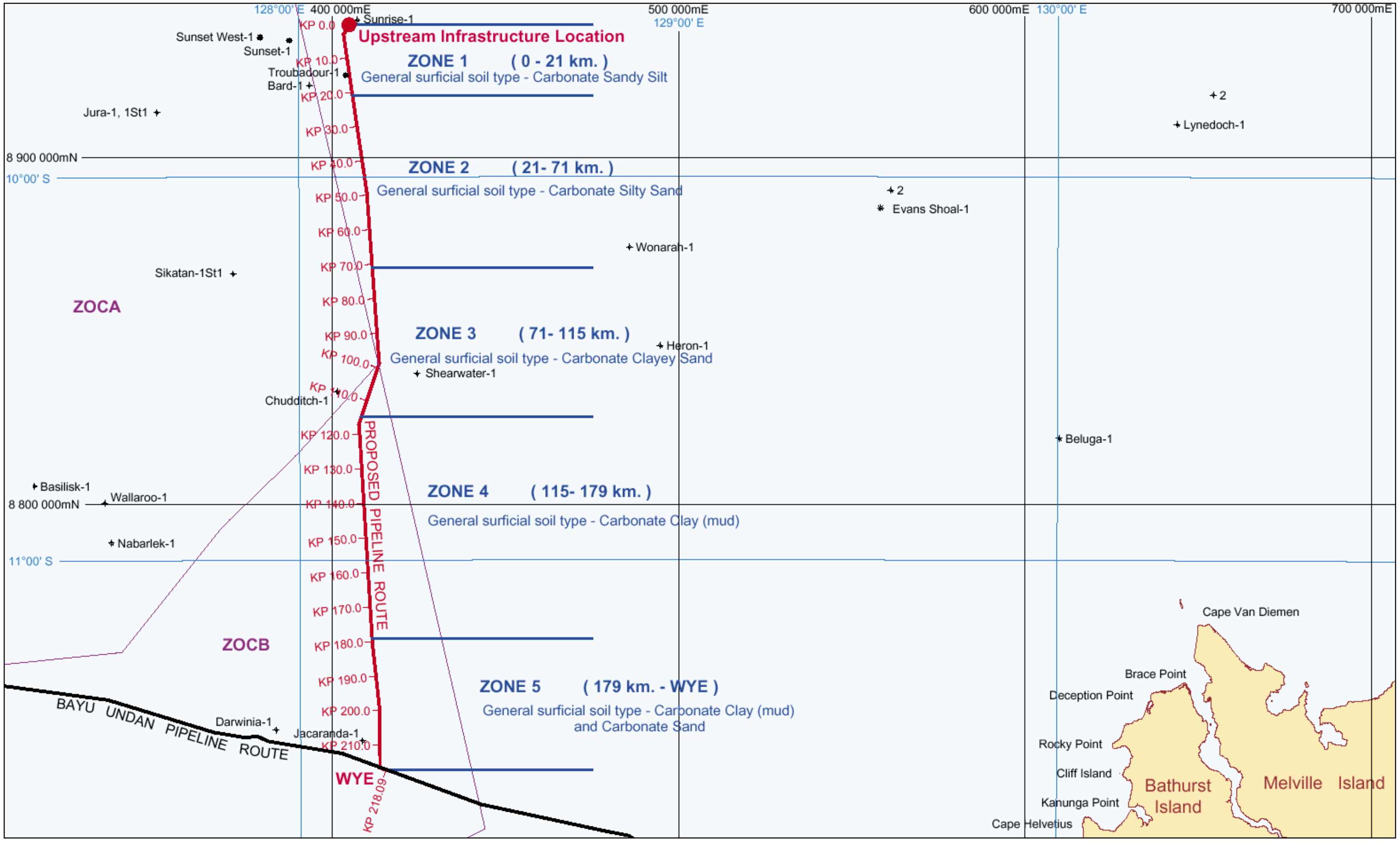
Further details on this research can be found in – Seismology Research Centre (2001). "Review of Seismicity, Sunrise". Prepared for Woodside Energy Limited, June 2001.

There are no computed intensities for the Sunrise Gas Field exceeding a Modified Mercalli (MM) Intensity of 5, either for large or distant earthquakes or smaller nearby events. Damage is not experienced for intensities less than about MM 6. Based on the Modified Mercalli Intensity scale, well-engineered structures should not experience damage for intensities less than about MM 8. Since 1900 the location of the nearest earthquake to Sunrise was located 138 km away in East Timor with an intensity of 3, a Peak Ground Acceleration (PGA) of 64.48 and magnitude 5.2.

Table 6-1 Strongest Earthquakes Experienced within 600 km of the Sunrise Gas Field since 1900

Year	Origin	Location		Magnitude[1]	Distance from Sunrise (km)	Intensity[2]	PGA[3] (mm/s^2)
		Latitude	Longitude				
1917	Banda Sea	7.50 °S	128.00 °E	Ms 7.8	231	5	161.20
1918	Banda Sea	8.00 °S	127.50 °E	Ms 7.8	190	5	141.63
1952	East Timor	8.00 °S	126.60 °E	Ms 7.2	245	5	102.88
1962	Banda Sea	7.44 °S	128.30 °E	Ms 7.2	237	5	104.13
1963	Banda Sea	6.94 °S	129.53 °E	Ms 8.2	328	5	118.00

1 Preferred magnitude, scale and value. Different scales give different values depending on many factors. The preferred magnitude is usually the average of magnitudes computed from several seismographs.
2 Intensity calculated at Sunrise using Esteva & Rosenblueth attenuation function.
3 PGA - Peak Ground Acceleration calculated at Sunrise in mm/s^2 using Esteva & Rosenblueth attenuation function.



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Site Investigation Zones

Figure 6-3

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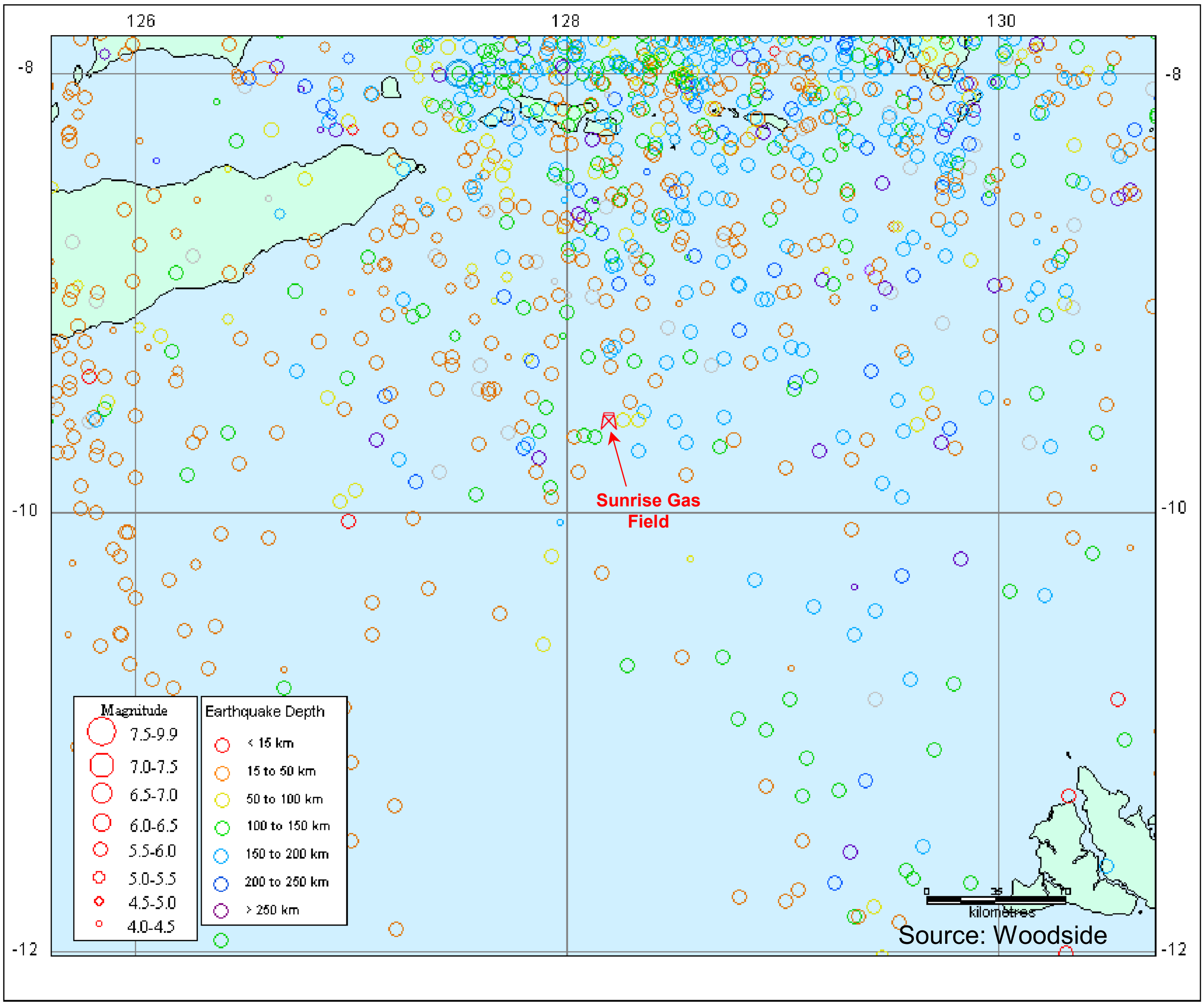
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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Earthquake History in the Sunrise Gas Field Area Since 1900

Figure 6-4

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

6.4 Bathymetry

6.4.1 Sunrise Gas Field

The seabed in the vicinity of the Sunrise Gas Field lies approximately 160 m below the water surface. The gas field lies at the top of the steep shelf break where the depth drops to about 300 m over a distance of 15 km. There are four shallow shoal features adjacent to the southern part of the Troubadour Gas Field, including the Sunrise Bank. These shoals are covered by minimum water depths of approximately 40 to 50 m. The bathymetry of the Sunrise Gas Field is illustrated in **Figure 6-5.**

6.4.2 Subsea Pipeline

Route 05 – Preferred Alignment: Refer to **Section 3.3.2.**

From the Wye to shore the pipeline covers the same corridor as the Phillips Bayu-Undan pipeline. The bathymetry between the Wye and shore is suitable for the construction and operation of a natural gas pipeline (Dames & Moore 1997). While the general alignment of the pipeline will be within the corridor roposed for the Bayu-Undan pipeline the final detailed alignment is yet to be determined.

6.5 Hydrodynamics and Oceanography

6.5.1 Sunrise Gas Field

Metocean data for ZOCA permit 91-03, located to the south-west of the Sunrise Gas Field, has previously been described in a report prepared for Woodside Petroleum Pty Ltd (Sinclair Knight Merz, 1993). Oceanographic data has also been collected by Woodside for the Laminaria Field, approximately 280 km from the Sunrise-2 Well location (Woodside, 1995). A metocean monitoring programme including meteorological, wave and current measurements across the shelf and around the Sunrise production platform area commenced in October 2000. Data from the programme, which is available from October 2000 to March 2001, has been used to revise previous estimates of environmental design criteria for the development (WNI, 2001). Information on the biological and physical characteristics of the seabed has been reported in environmental assessments for Ludmilla-1 well in AC/P16. The following summarises the metocean conditions expected for the Sunrise Gas Field.

6.5.2 Waves

The ambient wave climate for the Sunrise Gas Field and associated pipeline is composed of both sea and swell waves.

Sea waves are locally generated wind waves and as such the sea wave climate at Sunrise Gas Field is closely allied to the prevailing wind regimes **(Figure 6-6),** with westerly and southwesterly seas prevailing from December to March, shifting to predominantly easterly seas from April to October. Sea waves in the area may have periods ranging from 2 or 3 seconds to as long as 6 or 7 seconds.

Swell waves are surface wind waves that have propagated to a site following generation by remote storms (i.e. 200 – 7000 km away). Swell reaching the Sunrise area results predominantly from storms in the Southern Ocean or the southern portion of the Indian Ocean. As such, the predominant swell direction at Sunrise Gas Field is from southwest to west, with a period usually greater than 10 seconds, commonly ranging up to 18 seconds and occasionally 20 seconds. Shorter period swell (6 to 10 seconds) may result from tropical cyclones and from winter easterlies over the Arafura Sea and eastern portions of the Timor Sea (WNI, 2001).

In summer the one and ten year return period significant wave heights are 2.4 and 3.9 m, respectively. Whilst for winter the expected relevant significant wave heights are 2.8 m and 3.5 m, respectively. During cyclones the hundred year return significant wave height is in the order of 7.0 m.

6.5.3 Tides

The tides of the Kimberley Shelf region are unusual as they retain a substantial amplitude at a relatively large distance from the coastline (WNI, 2001). The tides are semidiurnal (two highs and two lows per day) with a small diurnal inequality (difference in heights of successive highs and successive lows). The tidal range is typically 4 metres during spring tide and 1.8 m during neap tide (Australian National Tide Tables). Tides are expected to flow east-north-east and ebb west-south-west in the upper 100 m of the water column, whilst flooding south-east and ebbing west-north-west in the lower portion of the water column. Tidal current speeds in the order of 0.6 m/s (springs) and 0.2 m/s (neaps) are anticipated (Woodside, 1995). The tide levels for the Sunrise Gas Field are presented in **Table 6-2** (WNI, 2001).

Table 6-2 Estimated Tide Levels for Sunrise

Tide	Level (m)
Highest Astronomical Tide (HAT)	3.1
Mean High Water Spring (MHWS)	2.8
Mean High Water Neap (MHWN)	1.9
Mean Sea Level (MSL)	1.7
Mean Low Water Neap (MLWN)	1.7
Mean Low Water Spring (MLWS)	0.4
Lowest Astronomical Tide (LAT)	0.0

Source: WNI (2001) *Preliminary Metocean Conditions Sunrise Pipeline Timor Sea, R1032.*

6.5.4 Currents

Surface currents for the Sunrise Gas Field are strongly influenced by the semidiurnal tide and to a lesser extent by the wind-driven and drift current contributions.

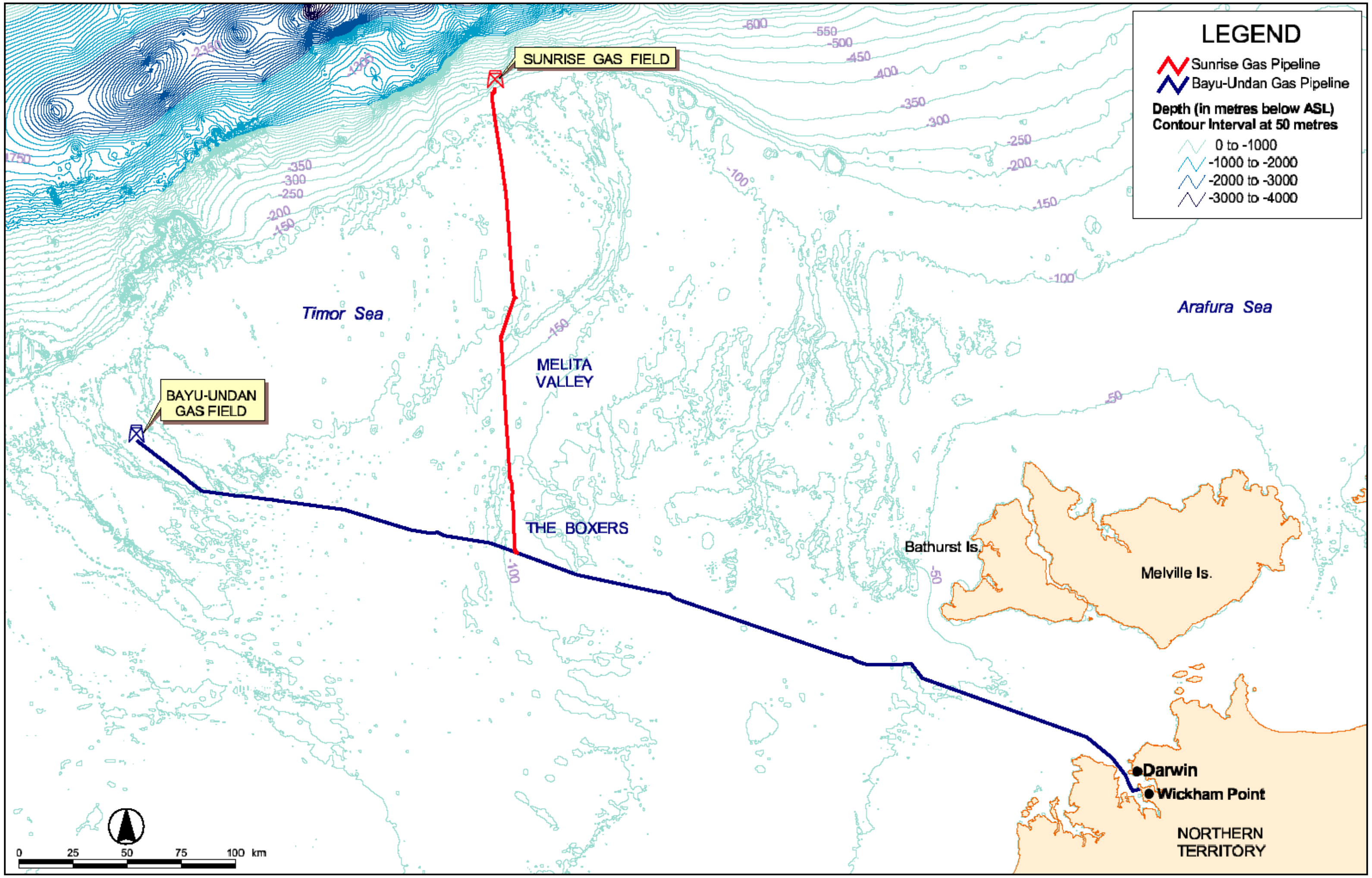
Tidal currents are directed across the local bathymetry, flooding to the south-southwest and ebbing to the north-northwest. Tidal current speeds will range up to 0.4 m/s, during spring tides and reduce to 0.2 – 0.3 m/s during neaps.

Surface currents are expected to reflect seasonal wind regimes, with summer easterly to north-easterly currents, and winter westerly to south-westerly currents. Local wind-driven surface currents are likely to attain maximum speeds of 0.7 m/s during extreme monsoonal or Trade Wind surges. More typical speeds would be in the range of 0.2 to 0.4 m/s (WNI, 2001).

Non-tidal currents drift to the west-northwest with speeds approaching 0.1 m/s and a maximum of 0.6 m/s. Current roses illustrated in **Figure 6-7** through **Figure 6-9** show the direction and speed of currents in the vicinity of the Sunrise Gas Field at a depth of 20 m below the sea surface, at 100 m below the sea surface and at 260 m below the sea surface respectively. Generally, the current speeds do not significantly vary from month to month and summer to winter at all depths.

6.5.5 Water Temperatures

The mean monthly surface water temperatures in the vicinity of the Sunrise Gas Field are expected to vary between about 26°C and 30°C. Waters are expected to be stratified all year round with the thermocline nearer the surface in summer (50 m) than in winter (100 m).



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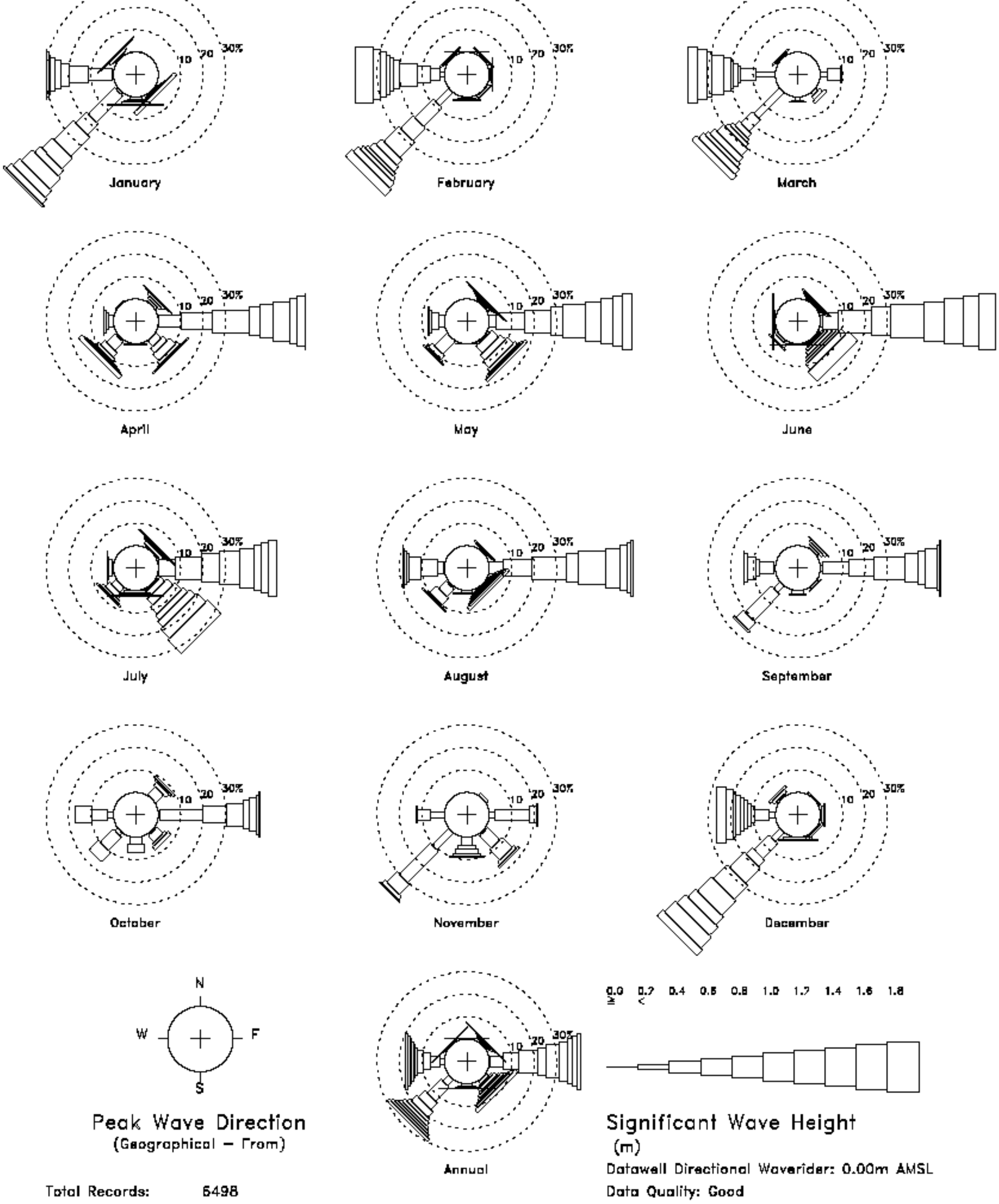
Bathymetry of the Sunrise Gas Field and Pipeline Route

Figure 6-5
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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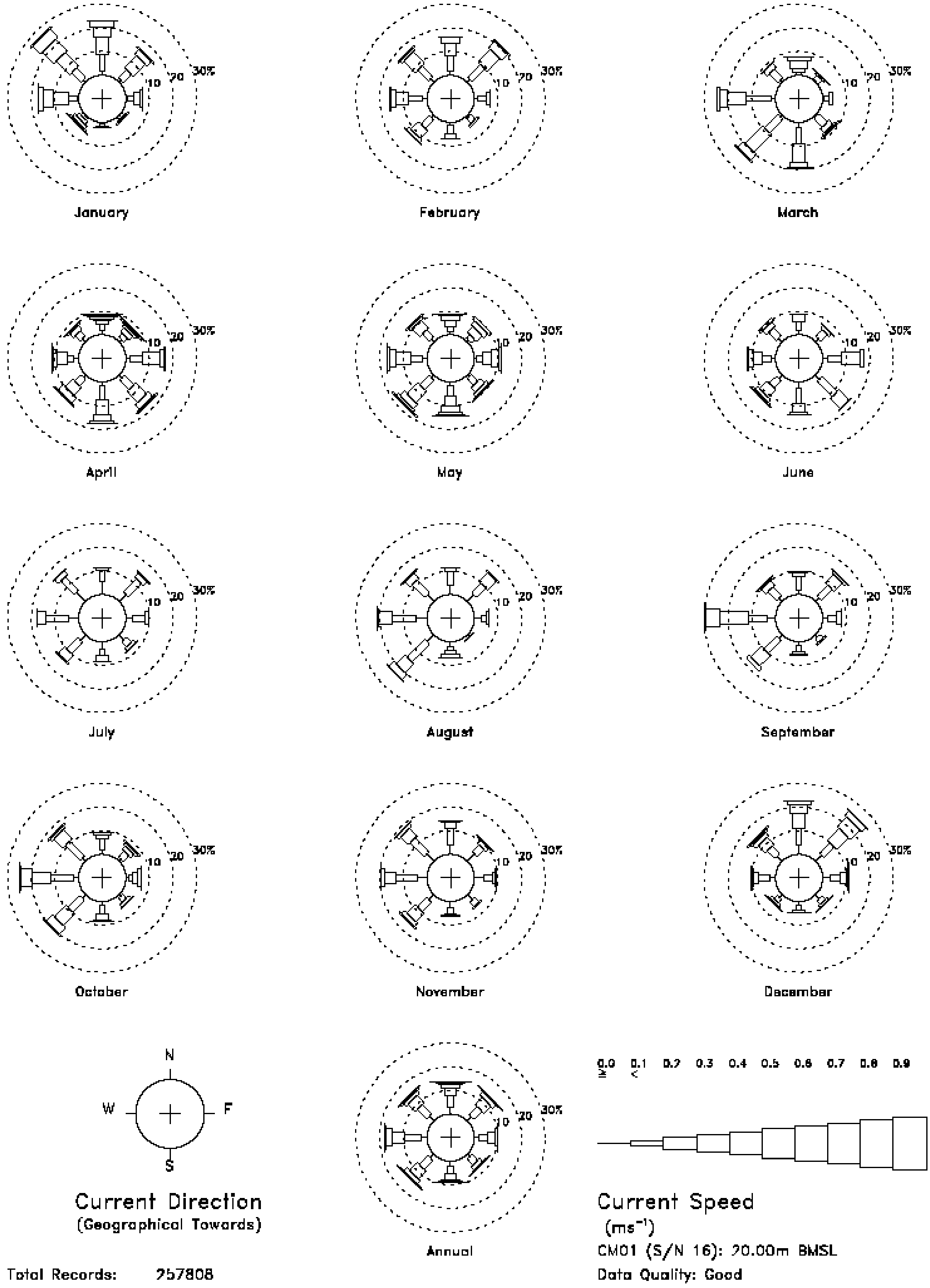
Wave Heights in the Vicinity of the Sunrise Gas Field

Figure 6-6

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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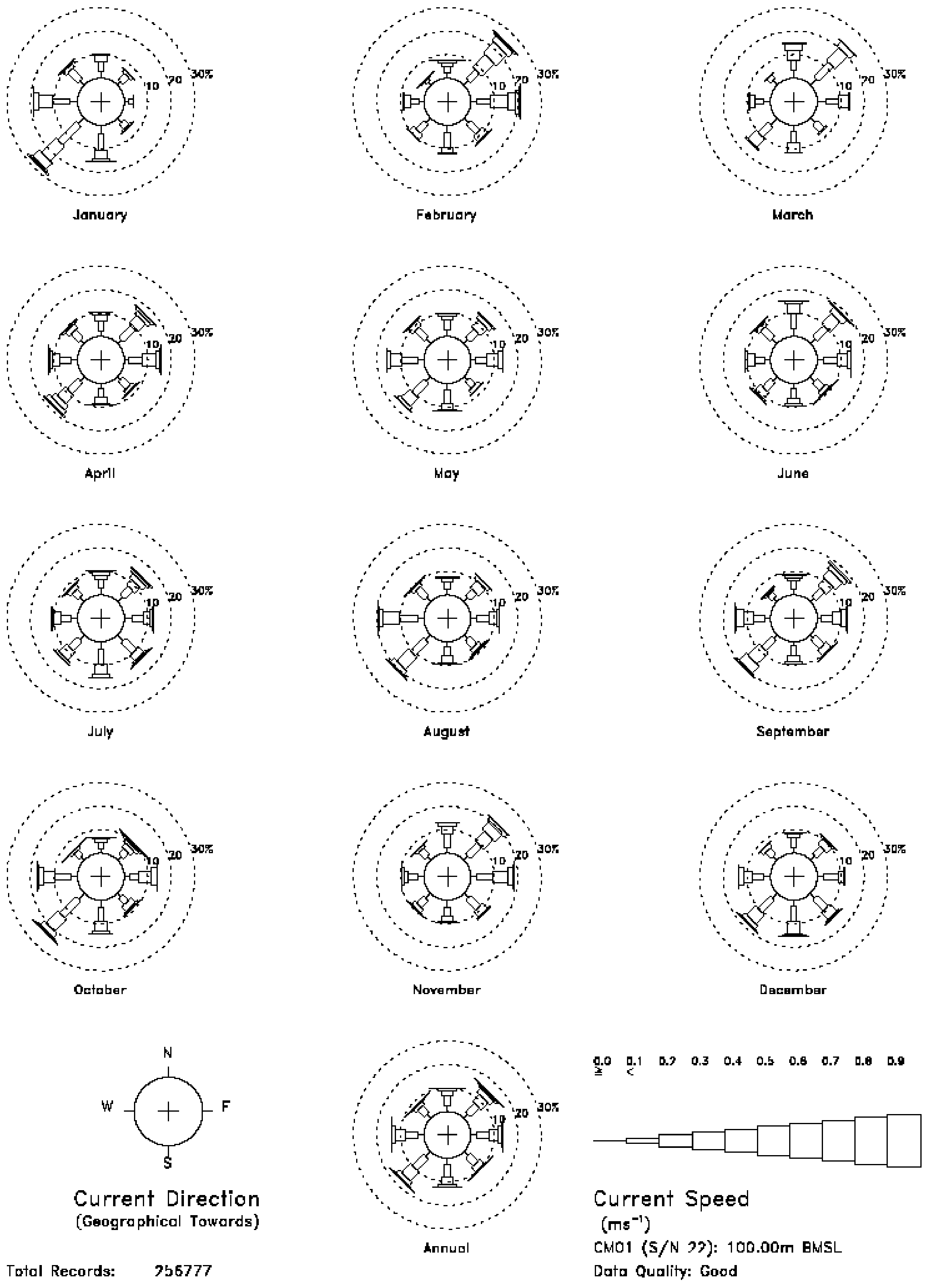
Current Rose for the Sunrise Gas Field at 20 m Below the Sea Surface Level

Figure 6-7
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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Current Rose for the Sunrise Gas Field at 100 m Below the Sea Surface

Figure 6-8

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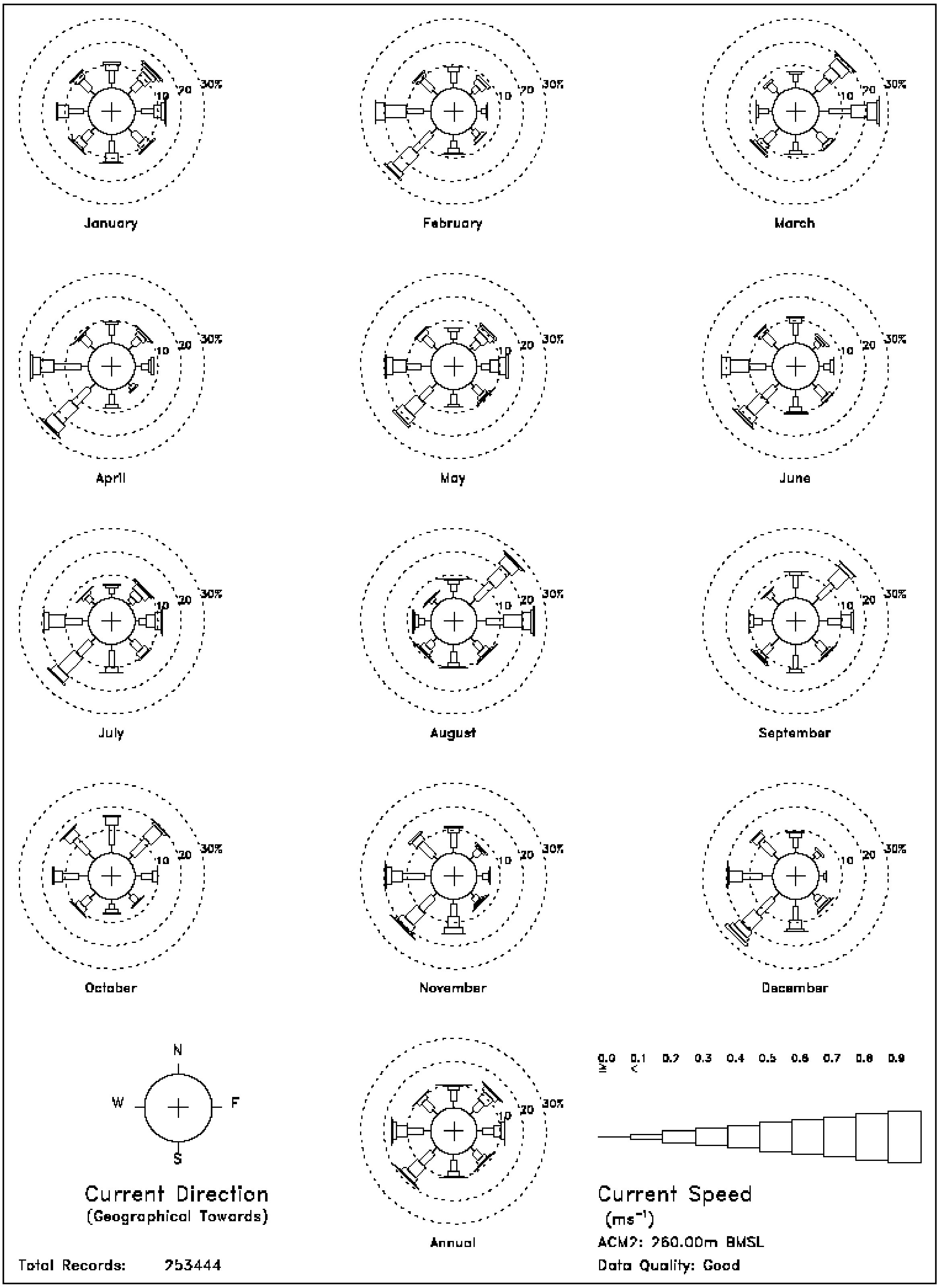
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering

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Current Rose for the Sunrise Gas Field at 260 m Below the Sea Surface

Figure 6-9
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

6.6 Major Offshore Habitats, Communities and Species

6.6.1 Sunrise Gas Field

A Jack-Up is the platform type to be used for offshore processing and does not require a permanent installation. The foundation on the seabed will be by means of bucket foundation, which will sink into the seabed. Environmental surveys of the Sunrise Gas Field were undertaken by Bowman Bishaw Gorham (2000, 2001) for potential platform locations. The biological survey of the area investigated the following locations as shown on **Figures 6-10** through **6-12.**

- Sunrise Bank;
- Sunrise South Bank;
- Sunrise West Bank; and
- Proposed Platform and FSO deep-water location and surrounding areas.

The crests of the three banks range in depth from approximately 40–50 m below Mean Sea Level. Each of the three banks support extensive areas of benthic communities considered as being both diverse and abundant. Sunrise and Sunrise West Banks support communities comprising a mixture of scleractinian corals and octocorals with varying amounts of the calcifying algae *Halimeda*. The coral-dominated communities comprise mainly deep-water species of horizontal morphologies adapted to low light regimes. These communities extend over almost the entire apex of each bank. Benthic communities are most well developed on the eastern margins and across the eastern part of the shallows on both banks.

In contrast, the distribution, diversity and abundance of communities on the Sunrise South Bank are much more limited. The diverse benthic communities on the Sunrise South Bank are confined to the northern half and the western side of the bank. Within these areas, the epibenthic community is very abundant, diverse and extensive. Beyond this zone, the sediments are virtually bare of attaching organisms. The bare area extends from approximately the middle of the bank to its southern limit and over the entire width of this area.

The southern half of the Sunrise South Bank differs to other shallow areas that were investigated by Bowman Bishaw Gorham (2000). The seafloor substrate comprises soft sediments with very little *Halimeda* gravel and notable lack of coral rubble. The biotic community is very sparse and comprises mainly of motile organisms such as holothurians and sea stars. The lack of hard substrate in the southern half of the Sunrise South Bank suggests that the area has not supported a high density of epibenthic communities in the near past nor is it expected to support them in the near future.

In comparison, the abundance and diversity of organisms of coral communities typical of the Sunrise and Sunrise West Banks, together with the distribution of these communities on the banks, supports the conclusion that these banks are of higher environmental significance.

The proposed platform (deep-water) location is generally characterised by a relatively level substrate comprised of sand and shell fragments which were not heavily bioturbated. The area supported sparse epifauna comprised of hydroids, seapens, sea whips and solitary hard corals. To the north of the proposed platform location is an east-west oriented ridge with a steep drop-off to the north. Reefal habitat was observed in water depth of 126 to 150 m and supported a diverse epibenthic community of gorgonians, sponges, soft corals, crinoids and black corals (*Antipathes* and *Cirripathes*).

Infauna

Benthic grab sampling by Bowman Bishaw Gorham (2001) of the proposed platform location documented 451 animals comprising 170 species belonging to 9 phyla. There were no strong apparent spatial patterns in the faunal distribution. The results are summarised in **Table 6-3** and briefly described as follows:

- *Annelida* (segmented worms) and *Arthropoda* (subphylum *Crustacea*) were the dominant phyla, together contributing over 80% of the individuals and 75% of the species;
- The *Annelida* assemblage was the most species-rich and abundant comprising of 32 families of polychaete worms; only three families: *Glyceridae, Lumbrinereidae*, and *Syllinae*, were represented by more than 20 individuals;
- The *Arthropoda* assemblage comprised 46 species of crustaceans which was dominated by gammarid amphipods; and
- *Echinodermata* (*echinoderms* – sea cucumbers, brittle stars), *Mollusca* (molluscs – bivalves) and *Cnidaria* (also known as *coelenterates* – includes jellyfish, corals, hydra, anemones) contributed more than 13% of the individual animals and more than 17% of the number of species.

Table 6-3 Infaunal Abundance in the Vicinity of the Sunrise Gas Field

Phylum	Common Name	Total Abundance	Percent Abundance	Species Richness	Percent Species Richness
Annelida	Bristle worms	262	58.1	82	48.2
Crustacea	Amphipods, crabs, shrimps, copepods, isopods	115	25.5	46	27.1
Echinodermata	Sea cucumbers, brittle stars	43	9.5	18	10.6
Cnidaria	Seapens, zooanthids, corals, hydroids, jellyfish	7	1.6	6	3.5
Mollusca	Bivalves	10	2.2	6	3.5
Porifera	Sponges	4	0.9	4	2.4
Sipuncula	Peanut worms	6	1.3	4	2.4
Nemertea	Ribbon worms	3	0.7	3	1.8
Bryozoa	Lace corals	1	0.2	1	0.6
Total		**451**		**170**	

Source: Bowman Bishaw Gorham (2001) *Sunrise Gas Project Pipelines Routes and Facilities Location Survey Report*

Zooplankton

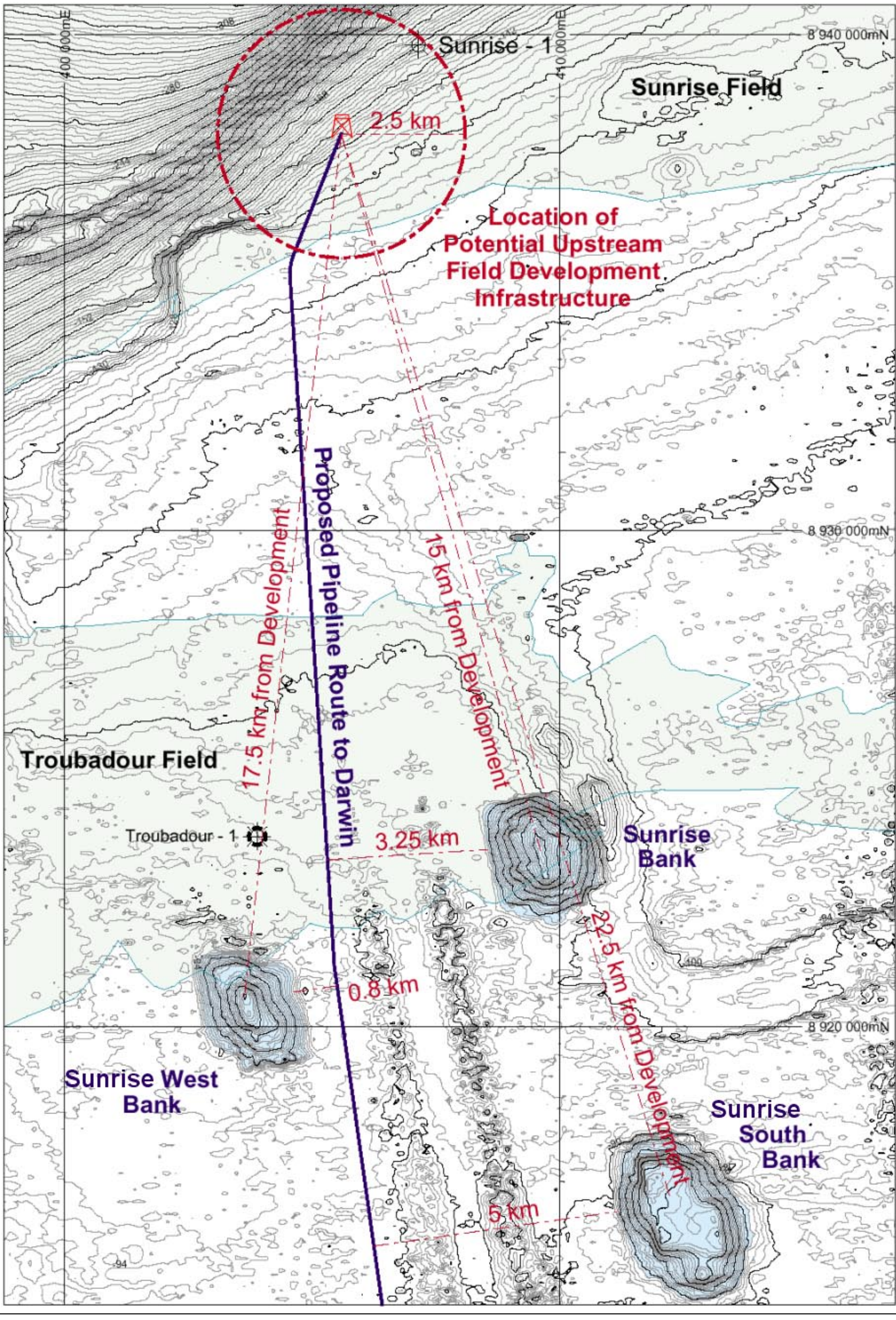
A total of 66 zooplankton taxa were identified indicating the presence of a relatively diverse zooplankton community. The zooplankton ranged from protists to vertebrates (**Table 6-4**). Most major phyla were represented including *Sarcomastigophora* (*foraminiferans* and *radiolarians*), *Annelida* (segmented worms – polychaetes), Chaetognatha (arrow worms), *Mollusca* (molluscs – gastropods, bivalves), *Arthropoda* (crustaceans – copepods, euphausids, ostracods) and *Chordata* (urochordates – appendicularian (Larvacean) tunicates*).*

Densities of zooplankters were highly variable ranging between 3,000 and 1,008,000 individuals/L. There were no apparent spatial trends in zooplankton density during the sampling period. *Copepods* were dominant accounting for at least 51% of the zooplankton community and were also the most diverse group with 40 taxa identified representing at least 9 families. The results of the survey indicate that densities of zooplankton vary widely and that the majority of assemblages are dominated by *calanoid*, *harpacticicoid* and *cyclopod copepods* on a numerical and gravimetrical basis.

Table 6-4 Zooplankton Abundance in the Vicinity of the Sunrise Gas Field

Phylum	Total Abundance	Percent Abundance	Species Richness	Percent Species Richness
Collected 11 May 2001				
Sarcomastigophora	29,494	13.0	10	15.9
Annelida	160	0.1	1	1.6
Chaetognatha	6,415	2.8	1	1.6
Mollusca	2,222	1.0	3	4.8
Arthropoda	155,918	68.9	40	63.5
Chordata	2,689	1.2	1	1.6
Unidentified	29,495	13.0	7	11.1
Collected 12 May 2001				
Sarcomastigophora	235	5.5	4	16.7
Mollusca	52	1.2	1	4.2
Arthropoda	3,549	83.8	17	70.8
Unidentified	399	9.4	2	8.3

Source: Bowman Bishaw Gorham (2001) *Sunrise Gas Project Pipelines Routes and Facilities Location Survey Report*



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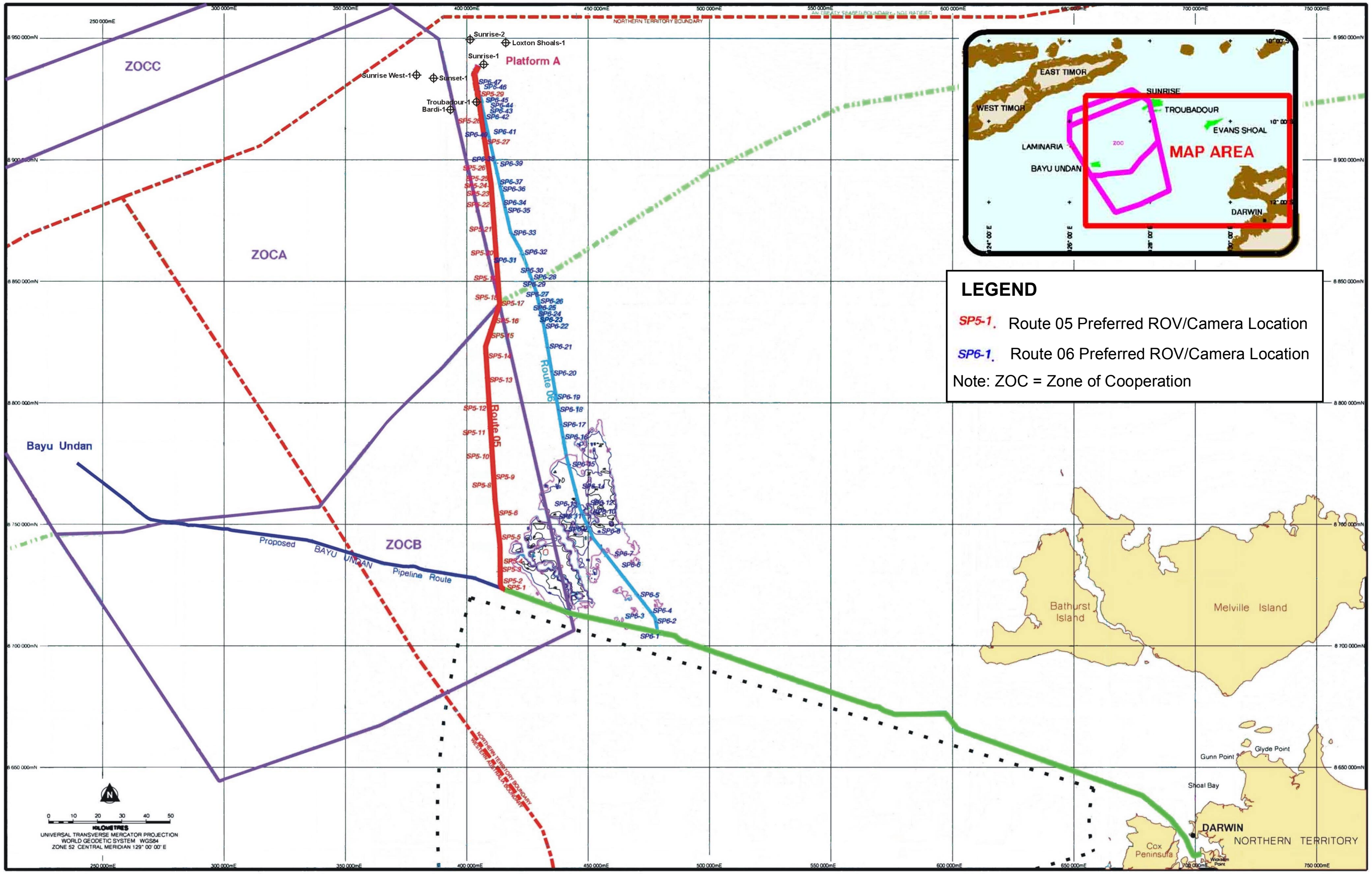
Sunrise Banks Location Map

Figure 6-10
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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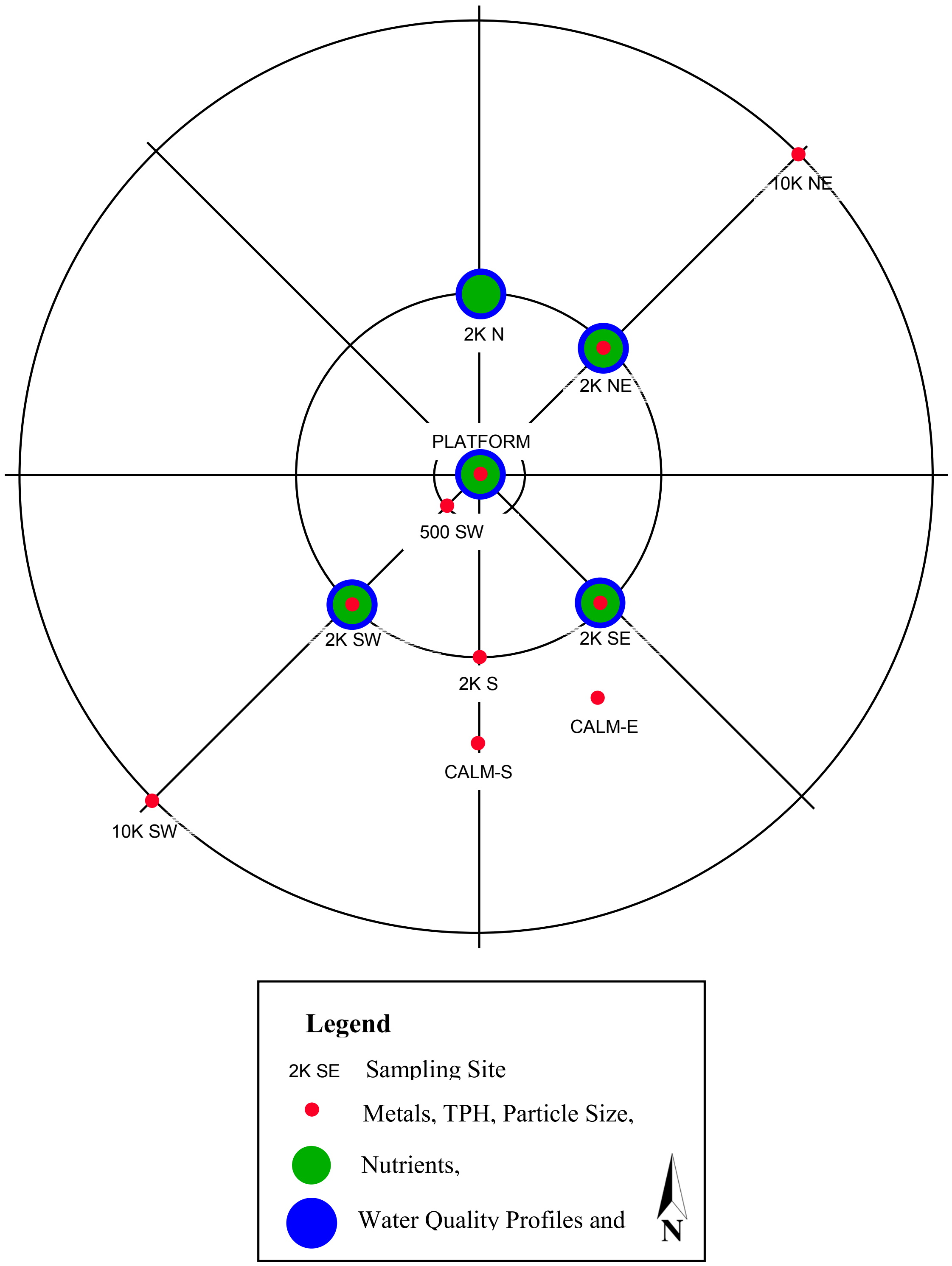
Pipeline Environmental Survey Sites

Figure 6-11
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: Bowman Bishaw Gorham (2001)

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Diagrammatic Representation of Sampling Sites– at Sunrise Platform Location

Figure 6-12
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Phytoplankton

The levels of phytoplankton in the surface waters, as indicated by chlorophyll concentrations, were extremely low (Bowman Bishaw Gorham 2001). The total range in concentrations was 0.07 to 0.14 µg/L. The concentration of phaeophytin, which is a breakdown of pigment, was also low and below detection. These data suggest a very low density of phytoplankton in the area typical of deepwater tropical regions, although on a local scale phytoplankton abundance is considerably lower than the 0.7 to 2.3 mg/L reported for the Gulf of Carpentaria and the Arafura Sea (Hallegraeff 1995).

6.6.2 Subsea Gas Pipeline Route

As part of the proposed development of the Sunrise Gas Field, Bowman Bishaw Gorham were commissioned to undertake a survey of habitats along the proposed pipeline route from the Sunrise Gas Field to the Bayu-Undan Wye.

The working corridor required for construction of the subsea pipeline will be 10 km in width. Should the pipeline have to deviate from the route surveyed by BBG in 2000/2001, for technical or engineering reasons, further marine surveys and assessments will be undertaken to identify any sensitive marine habitats, so that impacts on these habitats can be minimised.

The following descriptions of seafloor habitats have been extracted from the results of the survey.

Remotely Operated Vehicle (ROV) surveys along the pipeline route indicates that the seabed substrate comprises sediments ranging from soft muds to coarse sands containing large shell fragments and other rubble of biogenic origin. These sediments support epibiotic communities. Infauna populations are highly variable as indicated by the presence/absence of visible burrows.

Hard substrate comprising of low profile limestone pavements partially overlain by thin veneers of sand or silt are the most common occurring substrate along the length of the proposed pipeline route. Such substrate support moderate densities of filter feeding organisms, mainly sea whips, branching and fan gorgonians, sponges of various morphologies, soft corals of the genus *Dendronephthya* and black corals of the genus *Cirripathes*. Mobile fauna associated with these communities included crinoids, asteroids, urchins and some small fishes. Supporting a similar diversity of epibenthic organisms was also the reef community of approximately one metre in height.

6.7 Protected Fauna

At the commencement of the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) on 16 July 2000, the national list of threatened species, ecological communities and threatening processes consisted only of those previously listed under the *Endangered Species Protection Act 1992*.

Under the *EPBC Act* new categories have been added for listed threatened species and ecological communities. Critically endangered, conservation dependant and extinct in the wild have been added to the previous categories of endangered, vulnerable and extinct for threatened species and critically endangered and vulnerable have been added to the previous category of endangered for ecological communities.

New nominations for species and ecological communities will be assessed under the *EPBC Act* by the Threatened Species Scientific Committee (TSSC) according to the criteria for the new categories and listed accordingly. The TSSC will reconsider the status of the initial national list of threatened species and communities in line with the new refined EPBC categories as information is updated and made available for assessment.

A total of nine species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* could be expected to pass periodically through the Sunrise Project area. (**Table 6-5**).

Table 6-5 Threatened Species that May be Present in the Sunrise Gas Project Area

Category	Species Name	Common Name
Species that are Endangered	*Caretta caretta*	Loggerhead Turtle
	Lepidochelys olivacea	Pacific Ridley Turtle
	Balaenoptera musculus	Blue Whale
Species that are Vulnerable	*Chelonia mydas*	Green Turtle
	Eretmoochelys imbricata	Hawksbill Turtle
	Natator depressus	Flatback Turtle
	Dermochelys coriacea	Leatherback Turtle
	Balaenoptera borealis	Sei Whale
	Balaenoptera physalus	Fin Whale

There are no threatened ecological communities in the Sunrise Gas Project area.

A number of cetacean species may occur in the region including Sperm, Bryde's, Killer, Short-finned pilot and False killer whales, and Spinner, Bottlenose, Blue and White and Spotted dolphins. Whale encounters are expected to be unlikely, however dolphins are more likely to be encountered.

Shallow sections of shoals are potentially a feeding ground for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles (Sinclair Knight Merz, 1993). While a number of turtle species may be expected to transit the region, they are unlikely to be encountered in the survey area. The shallow shoal features to the south are unlikely to be utilised by turtles for feeding, given minimum water depths of between 30 and 40 m.

6.8 Ecological Considerations and Conservation Status

Timor Sea and Offshore Waters

The habitat in the vicinity of the Sunrise Gas Project, including the production facilities and subsea pipeline, has no defined conservation status; however, this does not mean that it is in any way less ecologically significant. The benthic habitat is not unique to the project area and is well represented in the Timor Sea on Australia's continental shelf. Epifauna such as soft corals, sponges, hydroids, infaunal assemblages and, to a certain degree, hard corals quickly recolonise disturbed seabeds because they are resilient organisms. The loss of a few hectares of benthos from what is likely to be thousands of square kilometres of similar habitat is not considered a significant impact.

The most ecologically important marine habitats in the Timor Sea region, in terms of biodiversity and productivity, are the various shallow intertidal coral reef and mangrove areas located about 150 km from Sunrise to East Timor and over 450 km to Darwin Harbour. The closest surveyed sub-surface coral reef habitat is Echo Shoals 140 km to the south-west. A number of other shoals occur in the region including Troubadour Shoals 50 km south-east of the Sunrise Gas Project, Bellona Bank 90 km to the south-west, and Martin Shoal 80 km to the east. However, none of these shoals have been adequately surveyed. Evans and Tassie shoals to the east-south-east of the Sunrise Gas Project have recently been surveyed as part of an offshore methanol plant development; however, the data is presently not available. The nearest mangroves lie much further away, 550 km on the south-west coast of Timor, 270 km on east Bathurst Island and 480 km on North Kimberley coastline.

The Sunrise Gas Field and subsea pipeline, does not occur within any marine parks, reserves or specially protected areas. The Beagle Gulf Marine Park (approximately 380 km from the Sunrise Gas Project) has been proposed as a means of coordinating marine and coastal resources. It extends along the marine and coastal area from Cape Ford to the eastern side of Cape Hotham and seaward to the extent of the Northern Territory jurisdiction; however, it does not infringe on the pipeline/gas field development.

6.9 International Obligations for the Protection of the Marine Environment

Relevant international obligations for the protection of the marine environment have been discussed in **Section 1.7**.

6.10 Heritage Conservation & Aboriginal Sacred Sites

Searches were undertaken of the following:

- The Northern Territory Heritage Register held by the Heritage Branch of the Department of Infrastructure, Planning and Environment, DLPE;
- The Sites Register, formerly held by the Museums and Art Galleries of the Northern Territory – MAGNT, now held by the NT DIPE;
- The Register of the National Estate, held by the Australian Heritage Commission;
- The sites database held by the NT branch of the National Trust of Australia; and
- The Northern Territory Wreck database compiled by the Maritime Archaeology and History section of MAGNT.

The results of these searches confirmed that all known sites have been avoided and no adverse impact is expected

6.11 National Parks & Conservation Reserves

Several existing/proposed marine protected or park areas lie in Indonesian waters within the region. The following summarises these protected areas listed by Hatcher (1988). The closest of these is 1,400 km away to the north-west:

- ***Northeast Roti*** – 1,000 ha Bakan Landu managed marine reserve;
- ***Southwest Timor*** – 1,000 ha Teluk Kupang/Pulau Kera marine recreation park;
- ***Komodo Island*** – 12,000 ha of marine waters of the Komodo Biosphere Reserve and National Park;
- ***Northwest Flores*** – the 5,000 ha Kepulauan Tujuhbelas Wildlife Reserve;
- ***Northwest Tanimbar*** – the 800ha Palau Angwamese marine nature reserve; and
- ***Northern Sumbawa*** – the 2,000 ha Pulau Rakit and 1,000 ha Pulau Satonda marine recreation parks.

The nearest Australian marine conservation zone and protected area is the Ashmore Reef National Nature Reserve, which lies approximately 240 km to the southwest of the Sunrise Gas Field. The reserve occupies an are of about 583 km^2 and is considered to be of high conservation significance. However it is too far from the Sunrise Gas Field to be impacted by the Project.