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6.0 EXISTING ENVIRONMENT

6.1 Location and General Site Characteristics

The site nominated by Pacific Reef Fisheries lies approximately 40 km north west of Bowen and is 3 km north of the township of Guthalungra. The proposed development site is east of the lower reaches and mouth of the Elliot River. The property mostly consists of cleared eucalypt scrub and has been used for many years for cattle grazing

6.1.1 Topography

The site topography can be characterised as relatively flat coastal plan, grading from approximately 8.0 m AHD in the south east to 2.0 m along the salt pan areas on the northern boundary at the property (typically a gradient of approximately 4%). A full topographic survey of the site has been undertaken, and surface contours are shown Figure 6-1.

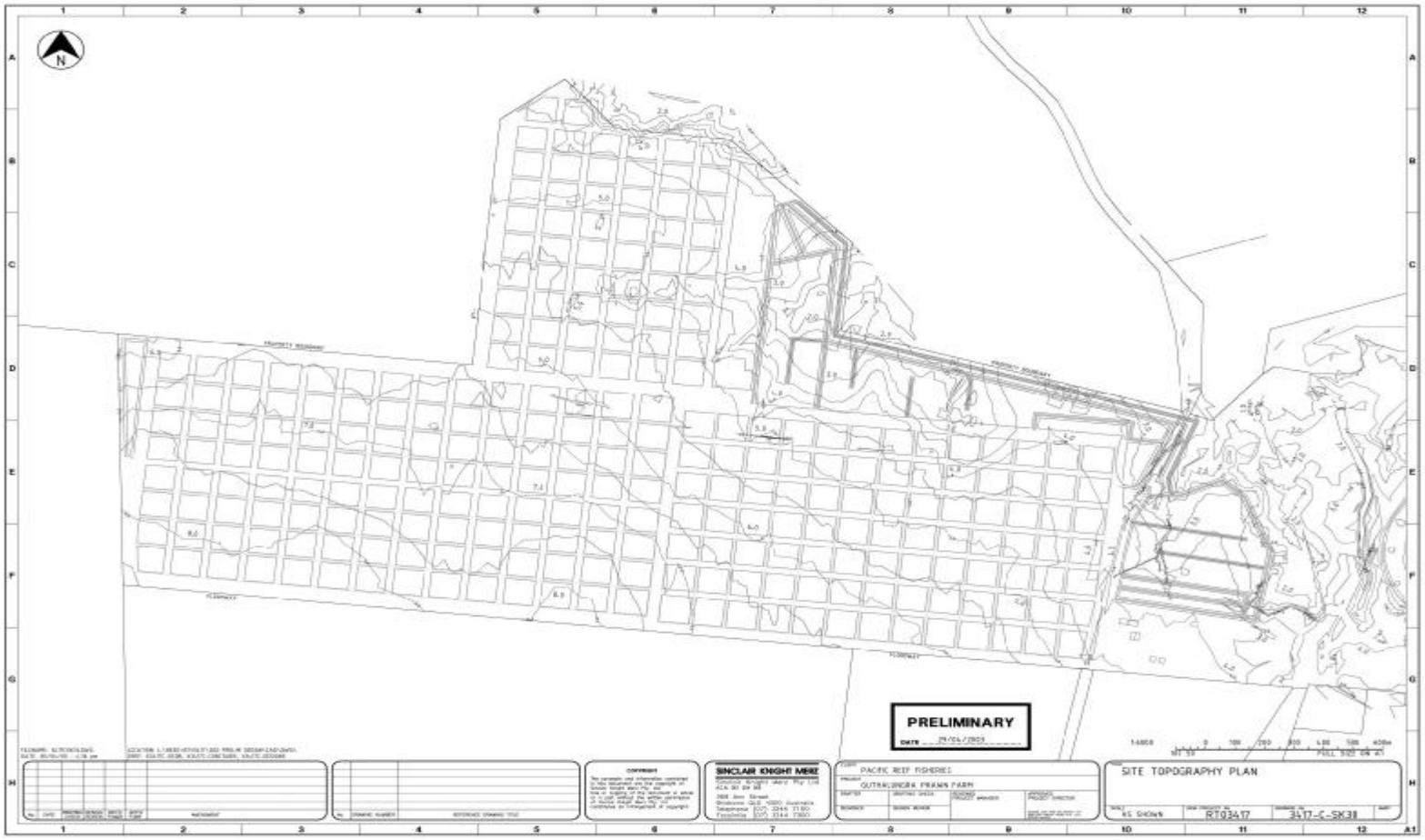

Figure 6-1
Surface Topography

Figure 6-2
Erosion Areas Near Salt Pan

Several shallow depression systems run from south to north across the site. Near the salt pan considerable erosion of these drainage lines has occurred and erosion gullies have formed. This has probably been a result of loss of vegetation over many years, possibly due to grazing. Figure 6-2 shows the nature of the topography in this area.

As a consequence, the transition from coastal plain to salt pan is quite abrupt along erosion gullies, with a 1.0 m to 1.5 m escarpment defining the transition. These areas of erosion appear to be active.

West of Coventry Road, a relatively flat area of alluvial plain is bordered on the east by a more extensive drainage line and erosion area.

The pipeline route traverses several different terrain types (refer Appendix B longitudinal sections). Immediately north of the main farm area it crosses a salt pan area with surface levels around 1.0 m AHD. Approximately 600 m north of the site the pipeline turns to follow Coventry Road, which typically has natural surface levels of 4.5 m to 5.5 m AHD.

From Coventry Road to the coast, the pipeline quote crosses a freshwater wetland area with levels down to 1.0 m AHD. Close to the coast primary and secondary coastal dunes rise to 3.4 m and 5.6 m AHD respectively.

6.2 Climate

The site, situated in the dry tropics, experiences relatively low rainfall which mainly falls in the summer months with a high degree of variability in amount and intensity. The nearest Bureau of Meteorology registered rainfall station is located at Bowen, some 40km south east of the site. It is believed this station is representative of the rainfall patterns at the site.

Bowen has an average annual rainfall of 1020 mm. Table 6-1 displays average monthly rainfall as recorded by the Bureau of Meteorology for Bowen. A large proportion of total annual rainfall is from December through to March. Evaporation rates are also high and generally exceed rainfall for nearly all months.

The area experiences warm to hot summers and mild winters, typical of North Queensland. Average monthly maximum temperatures range between 25.0 and 30.6°C, with minimum temperatures above 15°C (Refer Table 6-1).

Table 6-1
Climatic Data for Bowen

Month	Temperature				Predominant Winds @ 9am		Predominant Winds @ 3 pm	
	Min (C)	Max (C)	Rainfall (mm)	Evaporation (mm /day)	Speed (km/h)	Direction	Speed (km/h)	Direction
Jan	25.0	30.6	250	8.4	11- 20	SE	21-30	NE
Feb	24.0	30.0	247	6.5	11- 20	SE	21-30	E
March	24.0	30.0	157	7.7	11- 20	SE	21-30	E
April	21.2	26.8	60	6.9	11- 20	SE	21-30	SE
May	17.5	26.2	66	5.8	11- 20	SE	21-30	SE
June	16.2	25.0	26	5.1	11- 20	SE	21-30	SE
July	15.0	26.2	24	4.3	11- 20	SE	21-30	SE
August	16.8	26.8	15	5.6	11- 20	SE	21-30	SE
September	17.4	28.0	15	6.7	11- 20	SE	21-30	NE
October	20.6	30.5	22	7.8	11- 20	SE	21-30	NE
November	23.0	30.5	35	8.4	11- 20	SE	21-30	NE
December	23.6	30.6	103	7.4	11- 20	SE	21-30	NE

Source: Bureau of Meteorology

The winds at Bowen are typically south-easterly at 9 am. These change to north-easterly in the afternoon for the warmer months of November, December and January. These changes suggest a strong afternoon sea breeze is common during these months.

Queensland is subject to cyclonic activity during the summer months. Though a number of cyclones form out in the ocean, on average only 1-2 of these cyclones will "'landfall" on the Queensland coast (Australian Bureau of Meteorology, Tropical Cyclone Warning Centre, 7th November, 2000 and SW Pacific and Australian (Queensland) Landfalling Tropical Cyclones in 2000/01, Benfield Greig Hazard Research Centre, University College, London, UK). The last major cyclone on the Queensland east coast was in April, 1989 at Ayr/Home Hill, some 13 years ago (Australian Bureau of Meteorology, Tropical Cyclone Warning Centre, 7th November, 2000).

There is likelihood of cyclonic activity in the Bowen region however it is difficult to predict the frequency of such events.

6.3 Geology and Soils

6.3.1 Acid Sulphate Soils

The State Planning Policy 2/02 Planning and Managing Development Involving Acid Sulphate Soils (SPP) applies to all land, soil and sediment at or below the 5 m AHD. The project will trigger the SPP 2/02 through excavation and filling of soil and sediment. Under the State Planning Policy 2/02 Guideline Acid Sulphate Soils (SPP Guideline) an assessment of Acid Sulphate Soils (ASS) is required along with an Acid Sulphate Soils Management Plan (ASSMP) if ASS are to be disturbed.

An ASS investigation program has been completed to assess the risks posed by acid sulphate soils. An ASSMP has been developed, based on results of the investigation program.

Field investigations were undertaken by geotechnical consultants Douglas Partners. A description of the methodology and results of this investigation are included as Appendix H. The general field approach and sampling program were developed following consultation with the Queensland Department of Natural Resources acid sulphate soils group (QASSIT).

The general approach involved:

- A geological appraisal (field inspection) of the site by an experienced geotechnical engineer to assess the overall acid sulphate soil potential, and to identify priority areas for sampling;
- Discussions with QASSIT regarding the intended approach;
- An initial field sampling and analysis program, concentrating firstly on the main growout pond and settlement ponds;
- Discussions with QASSIT regarding initial findings, and the need to undertake any additional testing to confirm findings;
- Investigation of the pipeline route, plus any additional testing identified on the main production pond and settlement pond areas; and
- Compilation of conclusions from earlier results and development of an ASSMP.

Given the large area of the site, initial discussions with QASSIT focussed on the feasibility of undertaking an investigation program that was not in strict accordance with QASSIT guidelines (in terms of sampling intensity) to limit costs. As a consequence the staged approach outlined above was agreed.

Sampling of the main production area was undertaken in conjunction with the geotechnical investigation, with samples collected from test pits that were excavated by backhoe. Test pits were approximately 3.0 m deep. Of the 58 pits excavated, 28 were sampled, concentrating on areas closest to the tidal flats. Locations of pits sampled are shown in Figure 6-3.

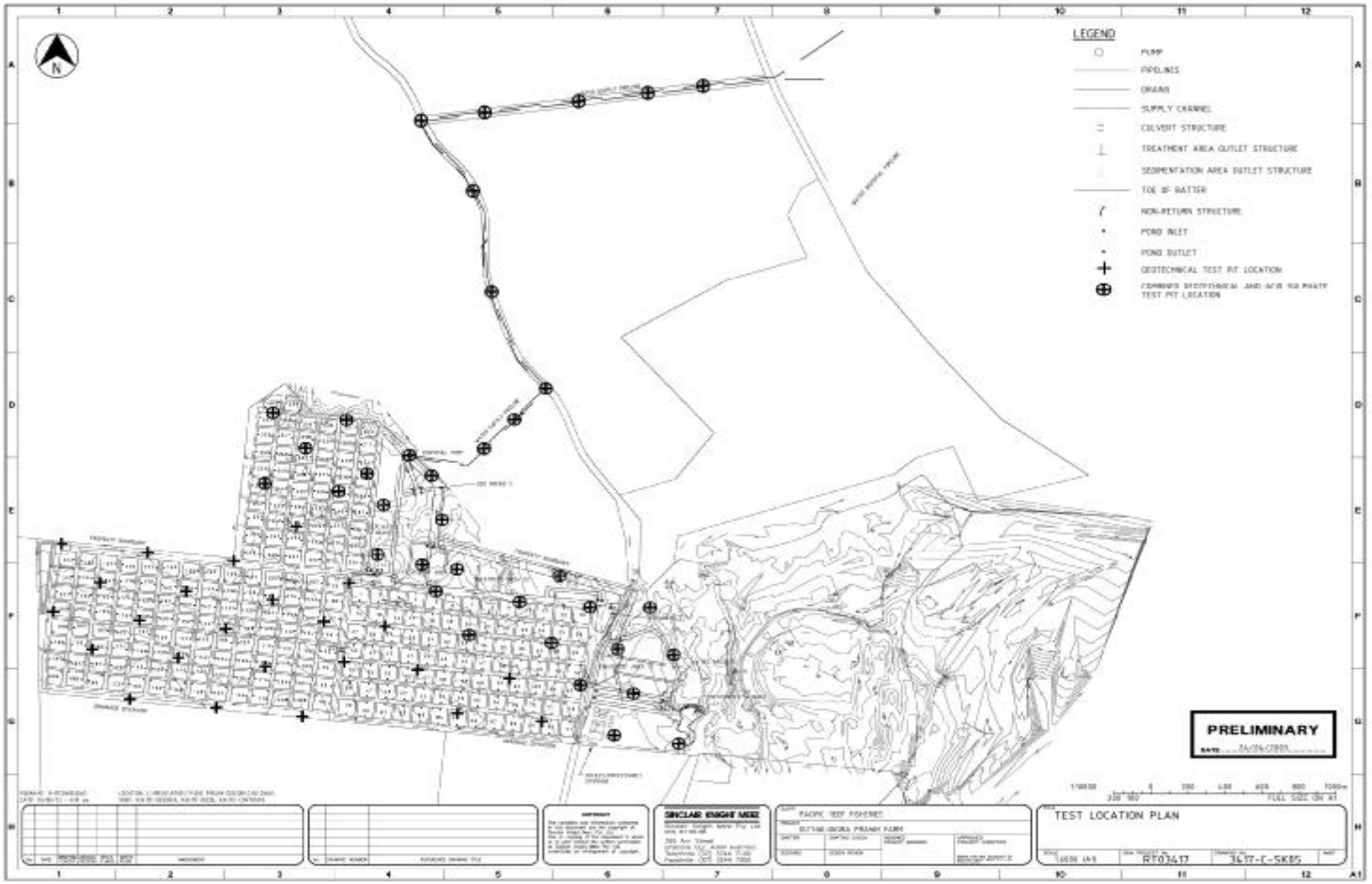

Figure 6-3
Acid Sulphate Soils and Geotechnical Test Pit Locations

On-site screening of samples was undertaken (pHF and pHFOX), with results interpreted in accordance with QASSIT Guidelines. A total of 168 on-site pH tests were conducted. Potentially acidic samples were selected for POCAS testing in the laboratory. Where no acid potential was identified from on-site testing, the most acidic sample from each pit was selected for POCAS testing. A total of 25 POCAS tests were undertaken and a number of Chromium Reducible Sulphur (Scr) tests were also carried out to distinguish the effects of any organic material in the samples.

Results indicated that the site is largely free of PASS. PASS was encountered at only one location (Pit 39) at depths below 2.0 m. This pit is outside the footprint area of the proposed development. Marginally elevated results at shallow depths in Pit 15 and Pit 17 were also found, however additional Scr testing indicated that this was probably linked to sulphur present in organic matter.

As a result subsequent discussions with QASSIT regarding the need for further testing on the main site area, no further investigations were undertaken on the main production area after the initial testing program.

Investigation of the pipeline route was carried out subsequent to the investigation on the main site. Initial field assessment suggested that much of the route could be underlain by PASS. A sampling and testing regime was subsequently developed recognizing this likelihood. The sampling and analysis protocols were identical to those described for the earlier investigation, as described above.

A total of 12 locations were sampled, either via excavated test pits or by hand-augering according to site conditions. Samples were taken to 2.0 – 3.0 m depths for all locations except Bore 102, where stiff clays limited penetration, and Pit 112 were sandy conditions hindered pit excavation. A total of 12 POCAS and 3 Scr tests were conducted.

The results confirmed the initial field assessment, indicating that PASS is present across lower lying areas of the salt pan and wetland areas that exist along parts of the pipeline route. No PASS was found along the section adjacent to Coventry Road, where a sand ridge exists.

On the basis of the above findings an ASSMP has been prepared to enable appropriate management of PASS during construction (refer Appendix F).

6.3.2 Geotechnical and Soil Chemistry Characteristics

The geology of the site is characterised by alluvial and deltaic sedimentary deposits, of varying particle size (sand through clay with gravel), and semi-consolidated in places. Close to and beyond the northern boundary of the site coastal mudflats (littoral flats and salt pans) and superficial coastal dunes are found (Douglas Partners, 2002). East of Coventry Road a significant part of the site consists of an oxbow loop of the Elliot River. Visual assessment suggests a greater proportion of lighter textured alluvial soil deposits are present in this area.

Hopley (1970) provided a description of the geomorphology of the area, as shown in Figure 6-4.

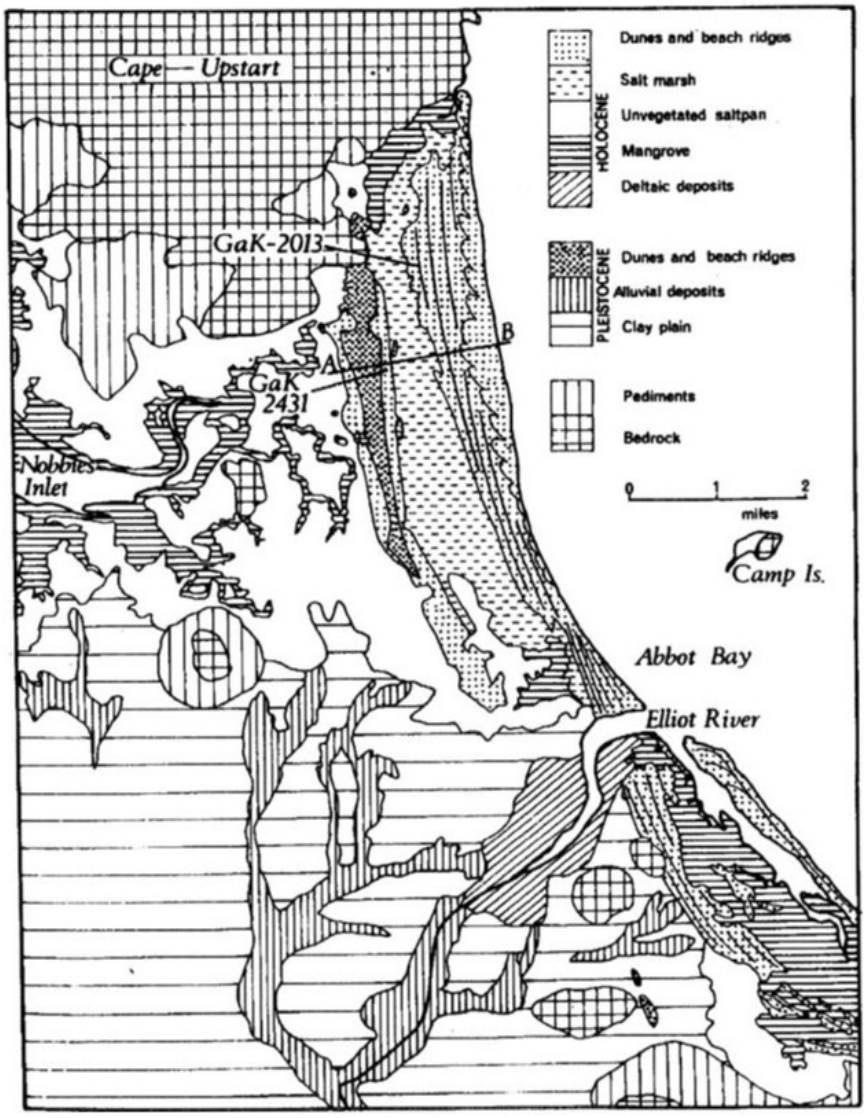

Figure 6-4
Geomorphology of the Elliot River Floodplain

An assessment of the soil characteristics of the site has been undertaken, concentrating on the suitability of the soils for prawn farm construction. The investigation was undertaken by geotechnical engineers Douglas Partners, and is fully described in Appendix G.

The investigation included:

- A walkover appraisal by an experienced geo-environmental engineer;
- Excavation of 54 backhoe test pits across the area planned for development, typically to a depth of approximately 3.0 m. These pits were on an approximate grid of 200 m to 500 m, with additional pits excavated where appropriate. The locations of the pits is shown in Figure 6-3;

- Visual assessment and description of soil stratigraphy from test pits, and preparation of test pit logs for each excavation; and
- Analysis of selected soil samples for Plasticity Index, dispersivity (Emerson Class), permeability (remoulded laboratory analysis), and shrinkage.

This field program was undertaken in addition to an earlier investigation completed by Sinclair Knight Merz in 2000 that included excavation of 13 test pits. Analysis of samples from those pits was undertaken at the time by Douglas Partners and are included in Appendix G.

In addition to testing for engineering and acid sulphate characteristics, the earlier investigation also included analysis of elements and metals. This was undertaken to determine whether elevated levels of metals or specific elements were present that could effect aquaculture production.

a) Soil Profiles

The investigations have shown that the site can be characterised by two profile types.

Shallow Profile 1 – Dark Grey Silty Clays
These soils covered approximately 50% of the site (Figure 6-5), and are described as very stiff dark grey silty clay to depths up to 1.4 m. Underlying this upper clay was a transition layer of hard sandy/silty clays, usually grey/brown. This layer extends to 1.7 – 3.2 m depths.

Shallow Profile 2 – Brown Grey Sandy/Silty Clay
The reminder of the site is typically very stiff to hard sandy silty clay to depth 0.3 m to 3.1 m. This layer was typically underlain by a transitional layer of sandy silty clay, grading to clayey sands in places.

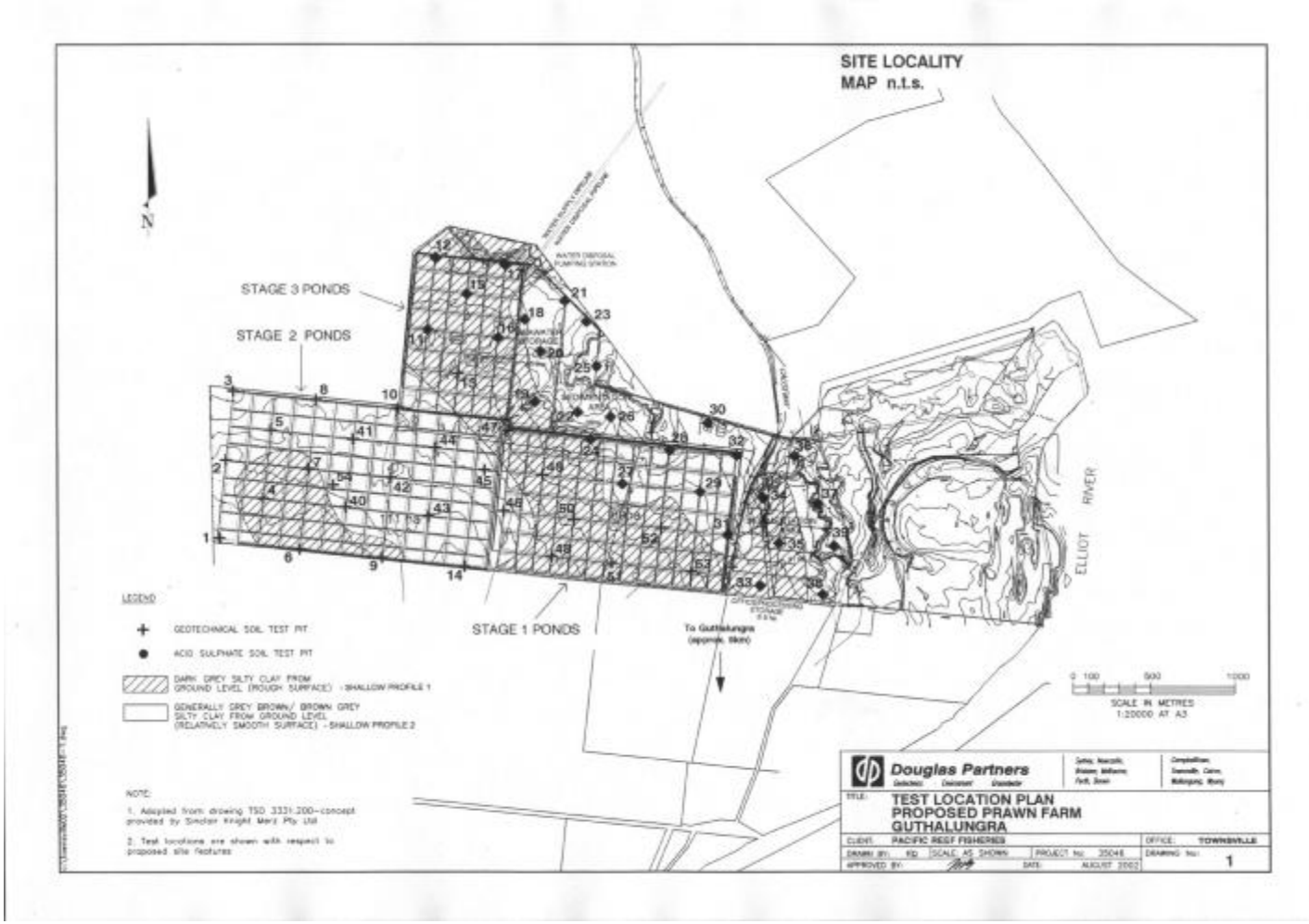

Figure 6-5
Site Soil Map

Below these profiles, many of the test pits encountered clayey sand, generally below depths 0.8 m to 2.8 m.

The investigation indicated that an area of lighter textured sub grade material is likely to exist along a depression system running north-south in Stage 26 construction area. Other localised shallow sand strata could also be encountered elsewhere, reflecting the alluvial nature of the site. The presence of these sand layers was also indicated by the geo-hydrological survey of the site.

b) Groundwater

Groundwater was encountered in 7 pits, varying in depth, from 2.3 m to 3.1 m. All of these pits were located along the lower lying northern part of the site. The water level in several pits increased following pit excavation, suggesting confined aquifer conditions.

c) Plasticity

Soil plasticity reflects the ability to handle and compact soils in a manner which ensures the required densities and strengths are achieved. The upper and lower limits of the range of water content over which soil exhibits plastic behaviour are defined as the liquid limit and the Plastic Limit, expressed as percentage moisture content. The water content range itself is expressed as the Plasticity Index, and should range from 8% to 23% for best compatibility. The Liquid Limit should also exceed approximately 10%.

A total of 18 samples were selected from both shallow profiles and transitional layers for plasticity testing, all of which satisfied the above criteria.

d) Shrinkage

Soils that shrink or swell excessively ("reactivity") can cause problems due to excessive cracking when dry and consequent lack of structural integrity. Plasticity Index can give an indication of the shrink/swell characteristics of soils, although specific shrinkage tests can also be carried out.

Field inspections suggested that "Shallow Profile 1" soils may be more reactive than "Shallow Profile 2" soils, although this was not borne out by the plasticity testing. Limited shrinkage testing on Profile 1 soils confirms the field assessment. It is noted that care will need to be taken to ensure compacted bank earthworks are re-topsoiled to minimise the risk of excessive cracking.

The above conclusions were not strongly supported by the earlier testing by Sinclair Knight Merz, where lower Plasticity Index values were recorded for 5 of the 8 tests. Most of these tests however, were located outside of the proposed development area.

e) Dispersivity

Excessively dispersive soils are prone to erosion and can cause problems such as poor runoff water quality, loss of soil from embankment batters that can reduce structural integrity, and in severe cases, piping failure through banks or around structures. A common measure of soil dispersivity is the Emerson Dispersion Test. Highly to dispersive soils have low Emerson Class No. from 1 to 3. More stable soils range from Emerson Class No. 4 to 7. All of the 18 samples analysed showed Emerson Class No.'s from 4 to 7, indicating relatively stable soils. These were supported by the earlier Sinclair Knight Merz results, of which 6 of the 8 samples were greater than Class 4.

f) Hydraulic Conductivity

Permeability tests were undertaken in the laboratory using 6 remoulded samples selected to be representative of the soils on the site. The results have been reproduced in Table 6-2 below.

Table 6-2
Summary of Permeability Test Results for Remoulded Soil Samples

Pit No.	Depth (m)	Description	Remoulded Density Ratio (%)	Relative Moisture Content* (%)	Permeability (m/sec)
20	1.0	Sandy silty clay	98.0 STD	0.1 WET	1×10^{-9}
28	1.0	Silty clay	97.5 STD	0.3 WET	3×10^{-11}
33	0.5	Silty clay	98.0 STD	3.0 WET	3×10^{-11}
42	0.5	Silty clay	98.0 STD	1.5 WET	5×10^{-11}
46	1.0	Sandy silty clay	98.0 STD	0.1 WET	2×10^{-10}
47	0.5	Silty clay	98.0 STD	4.9 WET	5×10^{-11}

The above results indicate that the soils present on the site have very low permeability when adequately compacted. As such they are well suited for use in pond construction and clay lining.

g) Metal and Elements Analysis

Samples were taken from all 13 of the original Sinclair Knight Merz test pits and analysed for a range of 23 metals and elements. This investigation is detailed in Appendix G.

All samples contained metal and element concentrations with the range of "background" or "natural" levels and many were below detection limits. However, in four tests, manganese exceeded the investigation levels set by ANZECC (1992), although they were well within background ranges typical of Australian soils.

6.4 Hydrology & Water Quality

6.4.1 Hydrology

An assessment of the natural flooding of the site has been undertaken, and is described in Appendix H. The investigation included assessment of the hydrological characteristics of the site in terms of:

- Storm surge;
- Local catchment flows;
- Elliot River flooding.

a) Storm Surge

The most detailed storm surge information available for the Bowen region was documented in a report produced by consultants, Blain, Brenner & Williams for the Beach Protection Authority in 1985. This report was one of a series covering various parts of the Queensland Coast. The results quoted in the report suggest the 1 in 500 year storm surge level at Elliot River would be 2.5 m AHD. The 1 in 100 year level would be less than Highest Astronomical Tide for the site (quoted as 2.2 m AHD). These levels are relatively low compared to natural surface levels at the site, and based on these estimates storm surge flooding would be confined mainly to low lying coastal salt pan and wetland systems.

Notwithstanding the above estimates, storm surge cannot be discounted as a significant factor in any coastal development in north Queensland. Allowance has been made for storm surge risk in terms of the siting of the works on the land available, and in the design of the intake pump station, as discussed in Section 7.5.

b) Local Catchment Runoff

Runoff from grazing land south of the site passes through the area to be developed at a number of locations. A hydrological assessment has been completed to determine the extent of the catchment areas and likely runoff rates for storm events of various recurrence intervals.

Upstream of the main production pond area, three relatively small catchment areas were identified, ranging from 72 ha to 308 ha, as shown in Figure 6-6.

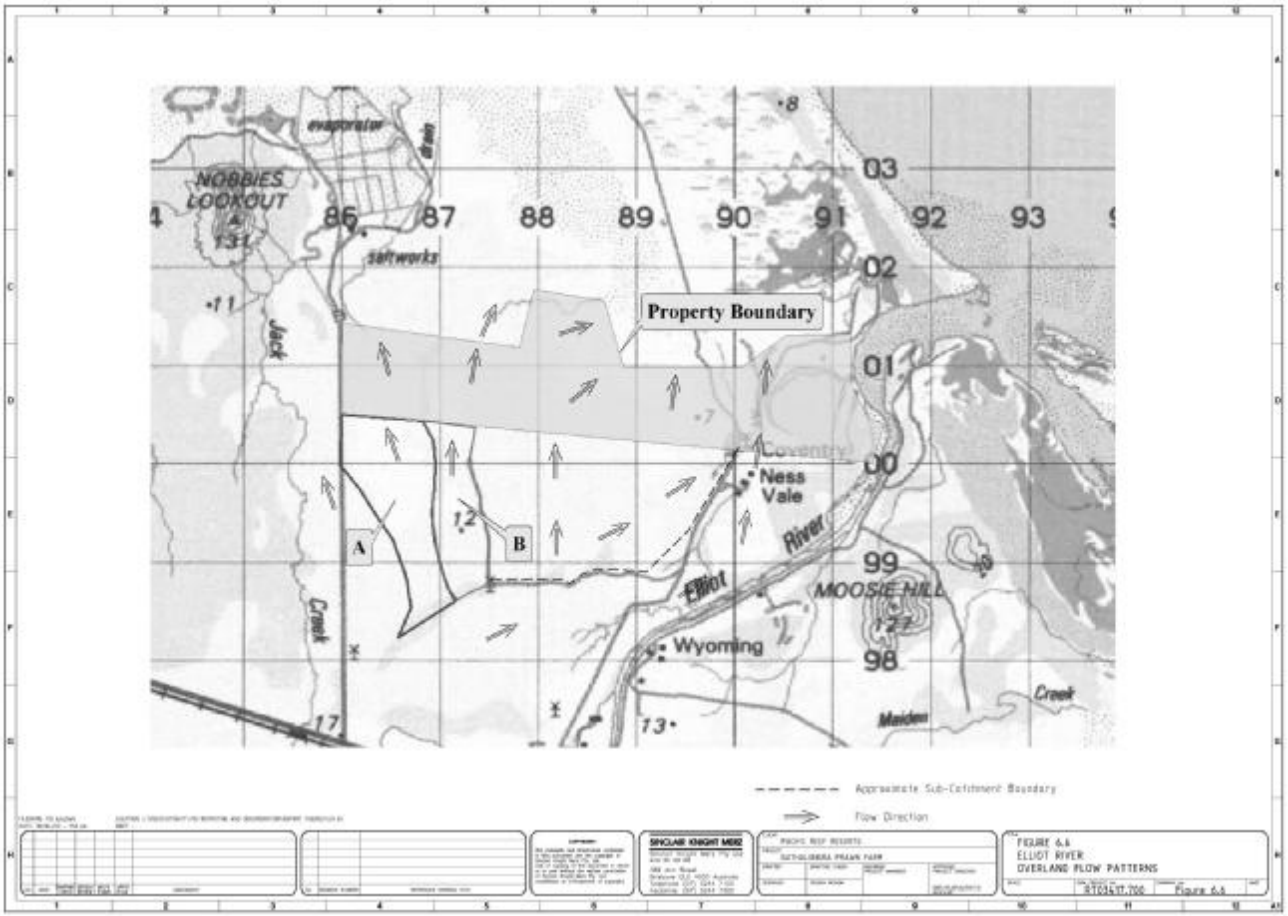

Figure 6-6
Local Catchment Area Boundaries and Overland Flow Patterns

Runoff from catchment areas passes through the property east of Coventry Road however these will not be materially affected by the proposed development. Drainage pathways through the production pond area are generally poorly defined. Much of the runoff occurs as overland sheet flow, discharging to the salt pan to the north of the site at numerous locations. Main drainage pathways were identified from topographical survey and aerial photography, and are shown in Figure 6-6.

Peak discharge rate estimates for the three catchments are shown in Table 6-3.

Table 6-3
Peak Discharges for Local Catchment Runoff

Storm Event (ARI)	Peak Discharge Catchment A (m^3/s)	Peak Discharge Catchment B (m^3/s)	Total Discharge (A + B) (m^3/s)	Peak Discharge Catchment C (m^3/s)	Critical Duration
100	6.91	4.22	11.13	13.90	12 hrs*
50	5.62	3.37	8.99	11.09	12 hrs*
20	3.93	2.49	6.42	7.85	12 hrs
10	2.95	1.90	4.85	5.95	36 hrs
5	2.34	1.47	3.81	4.63	36 hrs
2	1.33	0.86	2.19	2.65	36 hrs

* 6 hours for Catchment C

Provision has been made in the design of the project to ensure local runoff is appropriately managed, as discussed in Section 7.1.

c) Regional Flooding

Hydrologic and hydraulic modelling of the lower Elliot River floodplain indicates that much of the land immediately adjacent to the river is prone to flooding, even under relatively small flood events. This conclusion is supported by anecdotal evidence from local residents.

Flood mapping for the 1:20 year and 1:100 year floods indicates that parts of the footprint area of the proposed development would be inundated during these events. Figure 16-7 shows the expected inundation of the site from a 1 in 100 year flood event in the Elliot River.

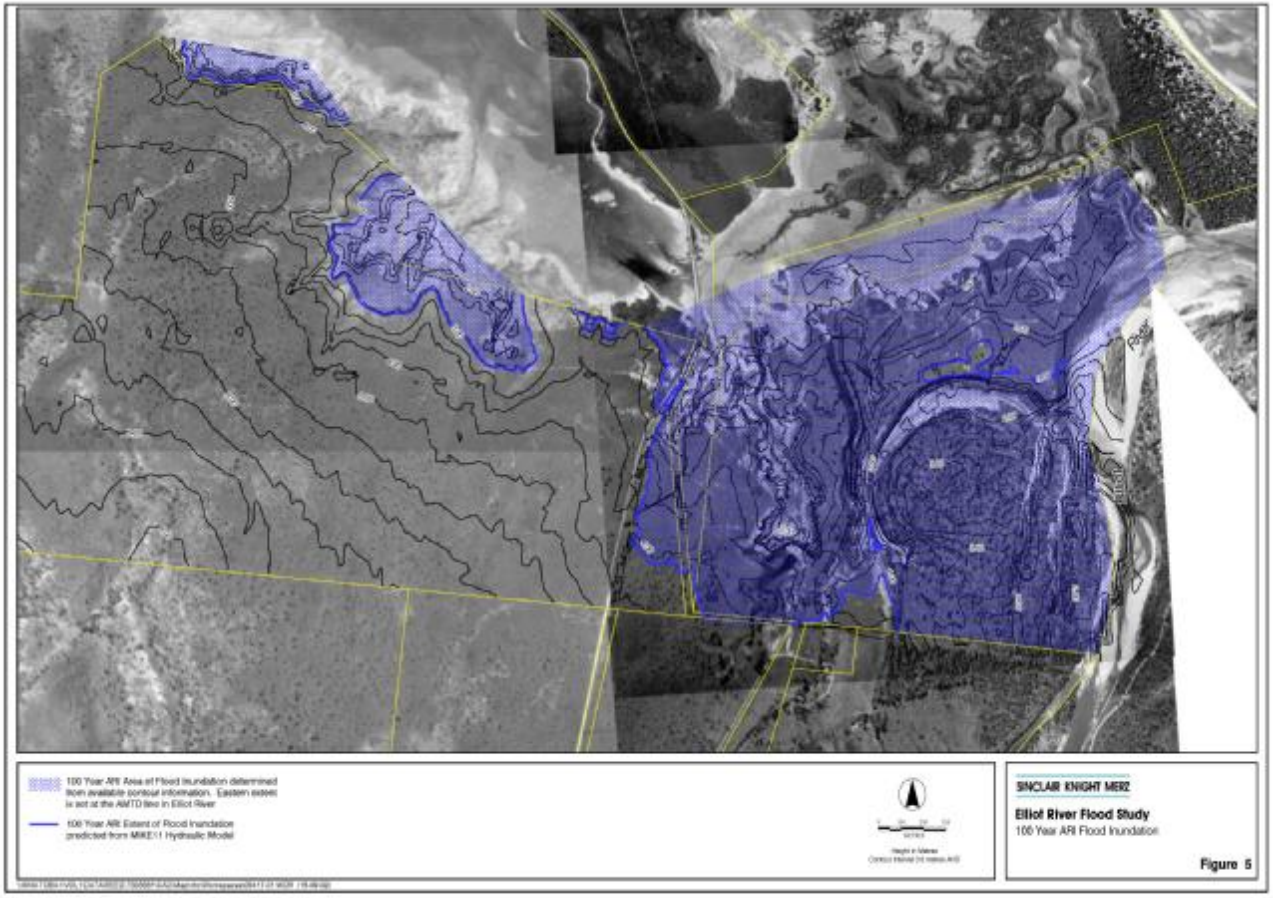

Figure 6-7
1:100 Year Elliot River Flood Inundation Map

The depths of inundation however, are typically not great, with a 1:20 year flood level just east of Coventry Road of approximately 3.4 m, and a level of 4.3 m for the 1 in 100 year event. Lower lying parts of the site west of Coventry Road immediately adjacent to the mud flats would also be inundated.

6.4.2 Tidal Hydrology Abbot Bay

The tidal hydrology in Abbot Bay was measured by Dr. Peter Ridd of James Cook University. This data was used to calibrate the CRC for Reef Research water quality model.

6.4.3 Licensing Requirements under Water Act 2000

The *Water Act 2000* has specific licensing requirements in relation to the extraction of surface water and groundwater, and associated works.

A review of the requirements of the Act indicates that no licences will be required for this project. Extraction of groundwater is not, in the first instance, being proposed, and in any event, a licence for this would not be required because the area is not within a declared groundwater protection zone.

The Act requires that extraction of surface water from waterways is licensed. Whilst use of the existing farm dam for potable water is proposed, the depression on which this dam is located could not be construed as being a watercourse, and therefore no licence will be required.

The upgrade works proposed for the dam embankment are aimed at improving the security of the structure. No change to the dam's storage capacity is proposed. Given the small size of the dam, and the minimal risk of its failure representing any significant risk to life or property, this dam would not be classified as a Referrable Dam under the Act, and hence, a failure impact assessment is not required.

6.4.4 Groundwater Quality and Levels

The assessment of the groundwater conditions at the site included the following elements:

- A site appraisal by an experienced hydrogeological engineer;
- Discussions with local landholders regarding groundwater characteristics and uses;
- Desk-top assessment of hydrogeological conditions;
- A geophysical survey of the area west of Coventry Road to characterise salinities in the top 5 to 10 m of the geological profile;
- Installation of 8 groundwater observation bores at the site, logging of geological profiles, and regular subsequent level monitoring of these bores; and
- "Slug" testing of the bores to determine basic aquifer characteristics.

A description of the groundwater investigations undertaken is given in Appendix O.

The geophysical survey consisted of a EM34 measurement and mapping of the area to be used for growout ponds, water storage and settlement ponds. As well as giving a good indication of the soil/water salinity status of the site, it provided guidance on where to best place observation bores. The survey indicated that conductivities ranged from 40 mS/m (400 EC) to 225 mS/m (2250 EC) although the results had been influenced by soil saturation from recent heavy rain. It highlighted several areas of prior stream activity, where lower conductivity readings were recorded due to the presence of localised sandy soils. The survey indicated other prior stream systems could exist at deeper depths.

Figure 6-8 shows the mapping completed using the EM34 results.

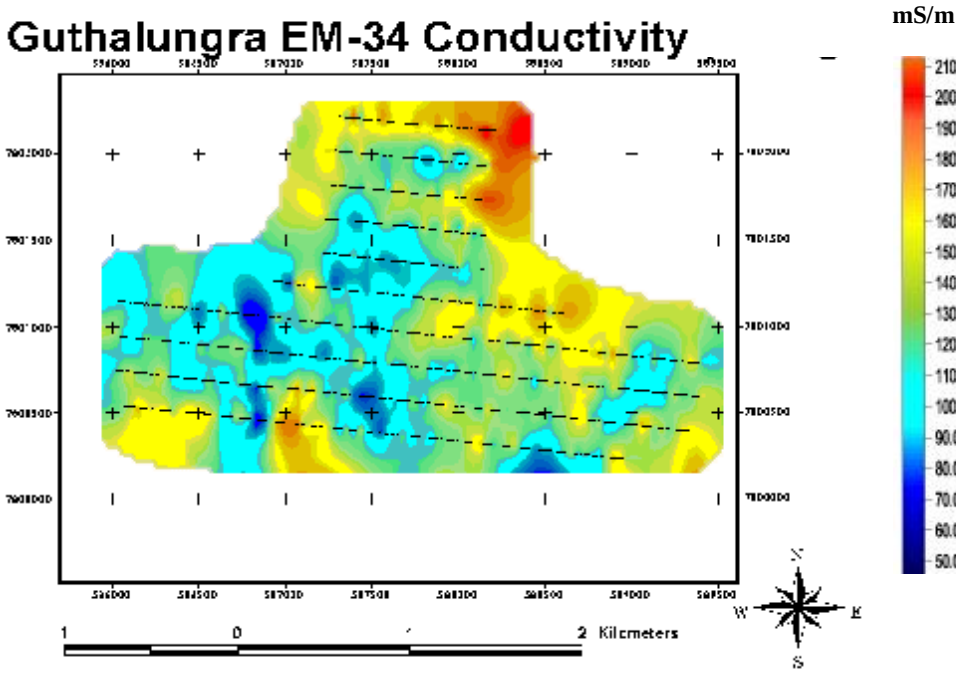

Figure 6-8
Geophysical (EM 34) Mapping

As a consequence of the geophysical investigation, 8 groundwater bores were installed as shown in Figure 6-9. Bores were located around the perimeter of the development to enable them to be preserved for ongoing use after completion of the project. They were also located where the likelihood of encountering groundwater was greatest. These bores ranged in depth from approximately 10.0 m to 13.0 m. An attempt was made to install a deeper bore to intersect any deep aquifers, however inadequate drilling equipment meant this was not possible.

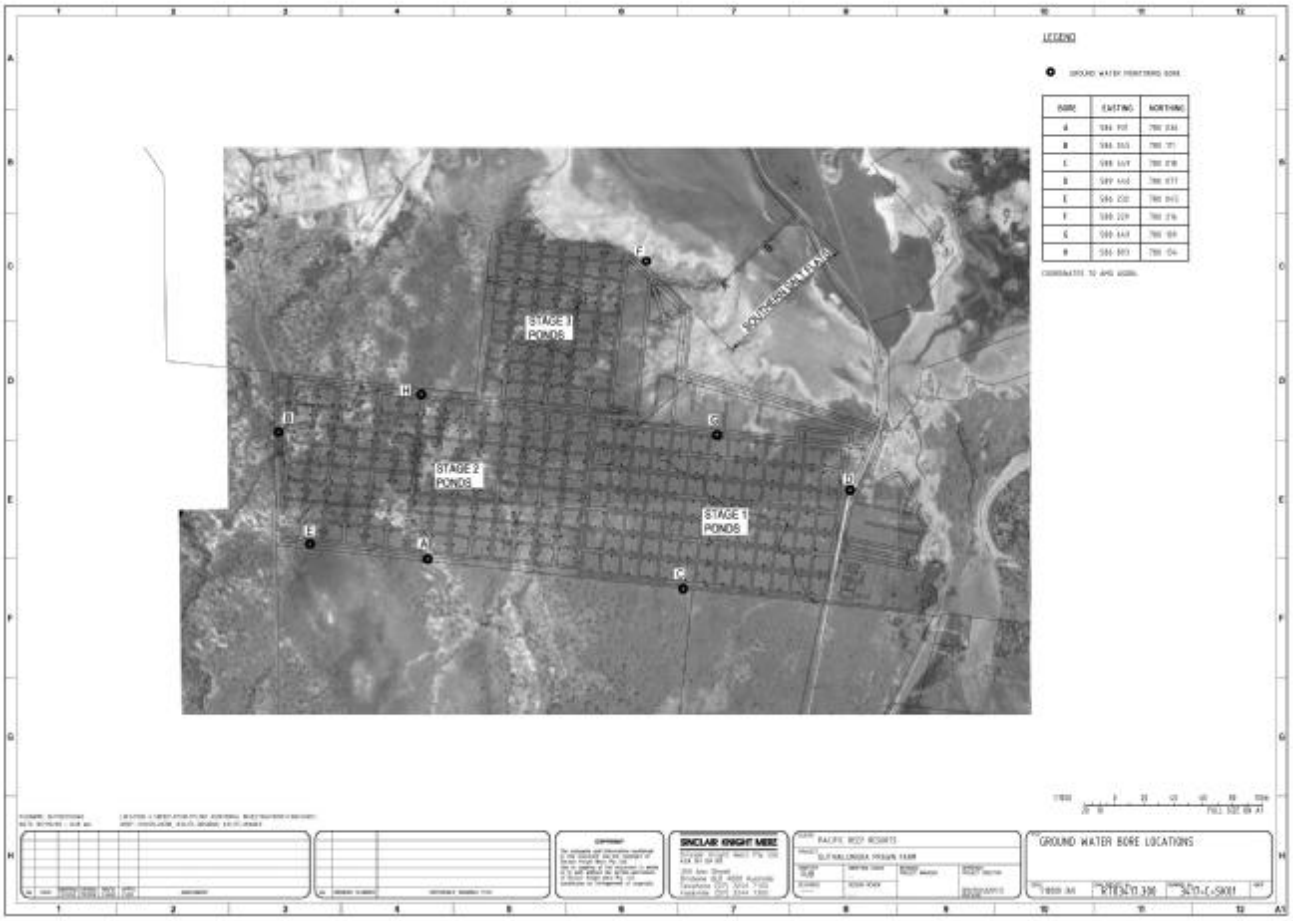

Figure 6-9
Groundwater Observation Bore Locations

Bore logs are shown in Appendix O. They show that the bores intersected sand layers at varying depths, reflecting the alluvial nature of deposits.

Depth to groundwater varied from 7.5 m at the higher southern boundary of the site (bore 1) to 1.0 m near the salt pan (Bore 6). Increases in watertable levels were noted in several bores after initial intersection of the aquifer, suggesting confined aquifer systems. Groundwater salinity was similar to that of seawater, with an average salinity across all bores of 32 500 mg/l. Subsequent levelling of the bores and analysis of regional groundwater information showed that groundwater levels at the time of sampling graded from east to west, and was approximately 2.0 m AHD at the south-west end of the site, reducing to 0.4 m near the salt pan at Coventry Road.

In addition to this, localised shallow freshwater perched aquifer systems are present in the area, as evidenced by several bores in the area, typically near the Elliot River. These bores draw from the shallow alluvial aquifers.

Slug testing of 4 of the observation bores indicated that the aquifer is of very low hydraulic conductivity, reflecting the predominance of clay soils.

6.4.4.1 Bore Locations

Refer Section 4.1

6.4.4.2 Pond Lining Material Characteristics

Refer Section 4.1.

6.4.4.3 Hydrodynamics of Watercourses Impacted

Refer Section 7.2

6.4.4.4 Hydrodynamics of Receiving Waters

Refer Section 7.2

6.4.5 Marine Bathymetry

Bathymetric survey of Abbot Bay in the vicinity of the proposed ocean pipelines was undertaken by depth soundings. A four kilometre grid with lines one kilometre apart was surveyed, plus additional transects near the proposed pipelines. Soundings were corrected for swell and reduced to AHD using gauge readings at the Elliot River mouth. A map of the Abbot Bay bathymetry produced by the survey is shown in Appendix J.

6.4.6 Coastal Geomorphology

An assessment of the coastal geomorphology has been undertaken by James Cook University to characterise the land and coastal forms in the vicinity of the site. This assessment has been used to determine coastal processes that could impact on the development, and to assess potential impacts of the development on the coastal geomorphology. This investigation is reported in Appendix K.

The coastal geomorphology investigation had two main objectives:

- Describe the natural historical changes that have taken place along the coastline from Cape Upstart to Mt Curlewis; and

- Describe the potential impact of the discharge and intake pipelines on natural sand movements in Abbot Bay, including patterns of longshore drift along the coastline.

Cape Upstart is a sub-circular granitic outcrop joined to the mainland by a tombolo (a narrow sand ridge) that consists of a double barrier complex, directly adjacent to the mouth of the Elliot River. The River has contributed large volumes of sand to the tombolo in the past (Hopley, 1970). The creation of the tombolo changed the hydrodynamic conditions in both Abbot and Upstart Bay. Hopley (1970) historical account describes how sand deposition from the Elliot River created the tombolo that linked Upstart Island to the mainland during the Pleistocene. Continued deposition has led to the progradation of the shoreline to its current position. This narrow sand ridge is the only feature connecting Cape Upstart to the mainland that is not subject to tidal inundation.

The investigation included aerial photograph analysis, surface sediment sampling, and wave refraction mapping techniques.

a) Aerial Photo Analysis

The coastline between Cape Upstart and Mt Curlewis was mapped from three sets of vertical aerial photos from 1942, 1974 and 1998. The position of coastline was accurately measured directly from the aerial photos. The movement of the coastline over time was plotted by measuring the change in the offset of the coast from fixed transect lines. The position of the transect lines was based on known fixed topographical features.

The photographic analysis indicates that the area around the mouth of the Elliot River is highly active. The left bank of the river mouth has eroded an average of 60 m since 1942. Sand has been added to the coastline directly adjacent to the river mouth from 1974–1998, which resulting in an advance of up to 84 m.

If current patterns of erosion and accretion continue, the mouth of the Elliot River may be blocked off completely from the sea, and a new mouth may be formed elsewhere along the coast.

Direct measurements of shoreline position around the proposed location of the pipelines indicate a complex pattern of erosion and progradation over the 56 years between 1942 1998.

The coastline directly adjacent to the proposed location of the pipeline (1500 m either side) is very dynamic and has prograded an average of 32 m or at a rate of 1 m/yr between 1942 and1974. This rapid advance was followed by a retreat along this whole 3 km stretch of coast in more recent years (1974 to 1998). Substantial erosion occurred along the proposed location of pipeline and along the 750 m section of coast north of the proposed location of the pipeline with an average retreat of 21.9 m from 1974 to 1998 or a rate of 0.9 m/yr. However the coastline 1,500 m to the south of the proposed location of the pipeline has been relatively stable from 197 to1998, for example there has been less than 4 m of erosion and 3.6 m of progradation, 250 m south of the proposed location of the pipeline. In contrast to the other sections of coast, the area 2,000 m north of the proposed location of the pipeline suffered erosion of 24 m from 1942 - 1974 and has since recovered, prograding 26.4 m during the subsequent 24 years to 1998.

The rest of the coast to the north of proposed location of the pipeline has steadily prograded from 1942 - 1998, advancing an average of 50 m (a rate of 0.9 m/yr), adding to the substantial Holocene barrier system which has accumulated over the last 5 000 years. The most substantial rates of shoreline advance occur from 3000 - 3500 m south of the proposed location of the pipeline, which is directly adjacent to the mouth of the Elliot River. This section of the coast prograded an average of 59 m from 1974-1998, an annual rate of 2.4 m between 1974 and 1998.

b) Sediment Analysis

Over one hundred sediment samples were collected from dune, beach, intertidal and offshore areas along the coastline between Cape Upstart and Mount Curlewis. The samples were graded using standard dry sieving techniques.

Overall there is a seaward fining of sediment from very coarse (grainsize of 1.2 mm) to fine sand (grainsize of 0.125 - 0.25 mm) with patches of silty fine sand further offshore. The very coarse – coarse sediments are concentrated in the river channel, however there is a small area of very coarse sediment about 500 m offshore just north of the proposed location of the pipeline.

Onshore sediment deposits become finer towards Cape Upstart, with very coarse-coarse sand deposits on the barrier spit and the spit directly adjacent to the river mouth fining to medium to fine sand towards the Cape. Despite a trend of a northward fining in the near-shore sediments (<500 m off the coast) further off the coast, coarse sediment is consistently found, fining just south of Cape Upstart. Well sorted sediments are found in the river mouth, while moderately well to poorly sorted sediments are found in both the near-shore and further off the coast up to the Cape. The area around the proposed pipeline is dominated by moderately well to moderately sorted sediments.

c) Wave Refraction

Wave refraction patterns can have a direct effect on coastal processes. Wave refraction maps were constructed for Abbot Bay using a standard technique that utilises a template derived from a graph illustrating the relationship between water depth, wave period and wave length.

Wave refraction maps were drawn for south easterly, easterly and north easterly winds. South easterly and easterly winds are dominant for most of the year (May to Nov.) while north easterly winds are common during summer (Dec to Apr.) and can be associated with cyclones. An analysis of historical wind data was also undertaken to determine whether any changes in wind patterns have occurred over time that may have affected wave refraction patterns and hence coastal processes.

Wave refraction around Camp Island will direct wave energy at the mainland coastline, with the area of concentration sensitively varying according to wind direction, i.e. moving south when winds are more northerly and moving north when winds are more southerly. This adds to the dynamic nature of this section of coast and is superimposed on the more general south to north movement of sediments along the beach.

During south easterly winds wave energy is concentrated along the coastline, which may bring sediment on to the shore. Easterly winds produce a sparse concentration of wave energy on the shore, however wave energy is still concentrated at the location of the proposed pipeline. North easterly winds tend to produce much more concentrated wave energy along the coastline and the wave refraction pattern suggests that this may produce the transfer of sand towards the Elliot River mouth. This may result in erosion along the coastline and accretion near the river mouth. If the trend shown in the 1969 to 1978 wind data of weaker winds is representative of the previous 25 years, we can surmise that the wind regime was weaker from 1942 to 1978, this may account for the widespread coastal progradation between 1942 to 1974. Subsequent erosion around the proposed location of the pipeline and continued progradation at the northern and southern ends of the coast from 1974 to 1998 may reflect the strengthening of winds during this period.

d) General Trends

The entire coastline between Cape Upstart and Mt Curlewis is dynamic, exhibiting rapid rates of coastal change since 1942. The coastline around the proposed location of the pipeline is particularly dynamic, with substantial amounts of progradation and erosion over this 56 year period. The dynamism of this section of coast is probably a result of wave refraction around Camp Island.

It seems likely that there may be a 30 year cycle of accretion and erosion. If this is occurring then we would see erosion continuing at the same pace 0.9 m/yr for the next few years and then perhaps a recovery of about 1.5 m/yr over the next few decades. This cyclic pattern is probably related to changes in the dominant wave pattern, in response to changes in the dominant wind direction.

6.4.7 Estuarine and Near-Shore Water Quality

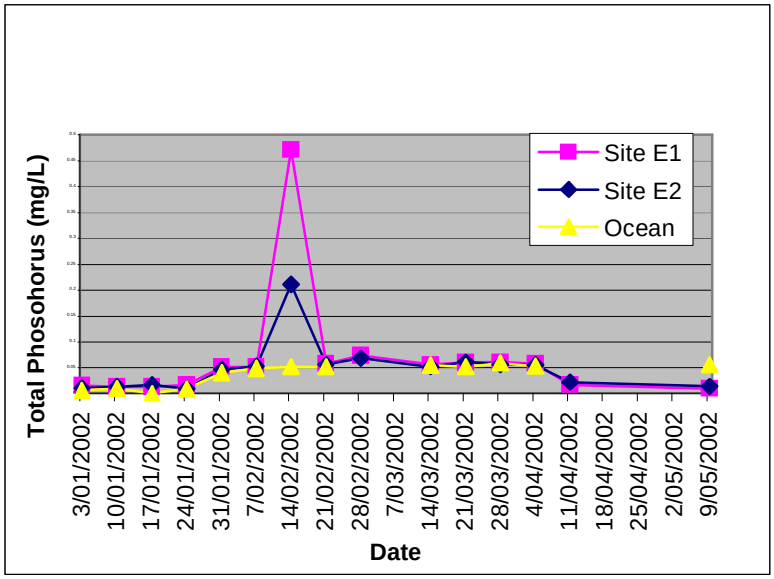

Figure 6-10
Guthalungra Intake Monitoring Total Phosphorus
January 2002 to May 2002

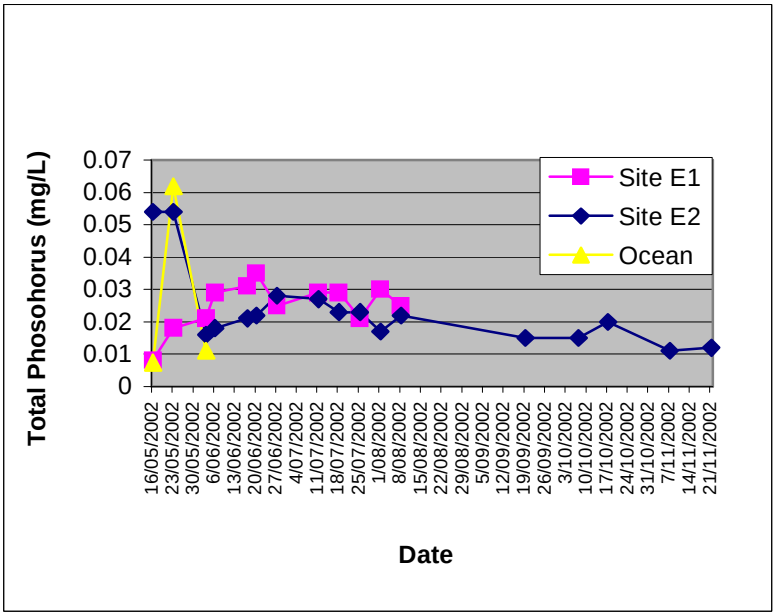

Figure 6-11
Guthalungra Intake Monitoring Total Phosphorus
May 2002 to November 2002

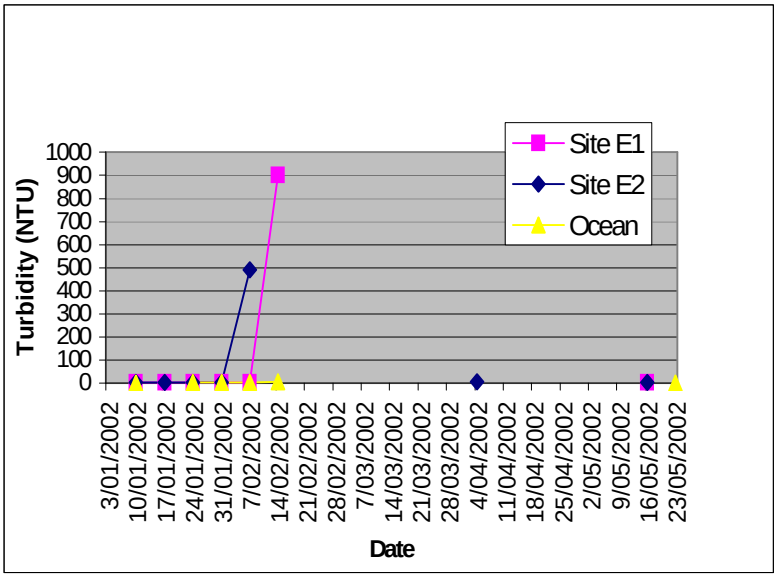

Figure 6-12
Guthalungra Intake Monitoring Turbidity
January 2002 to May 2002

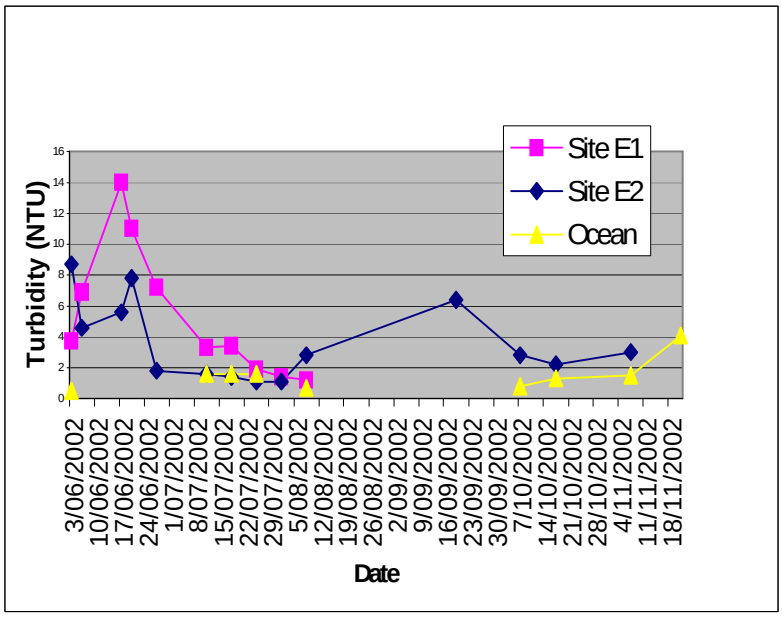

Figure 6-13
Guthalungra Intake Monitoring Turbidity
June 2002 to November 2002

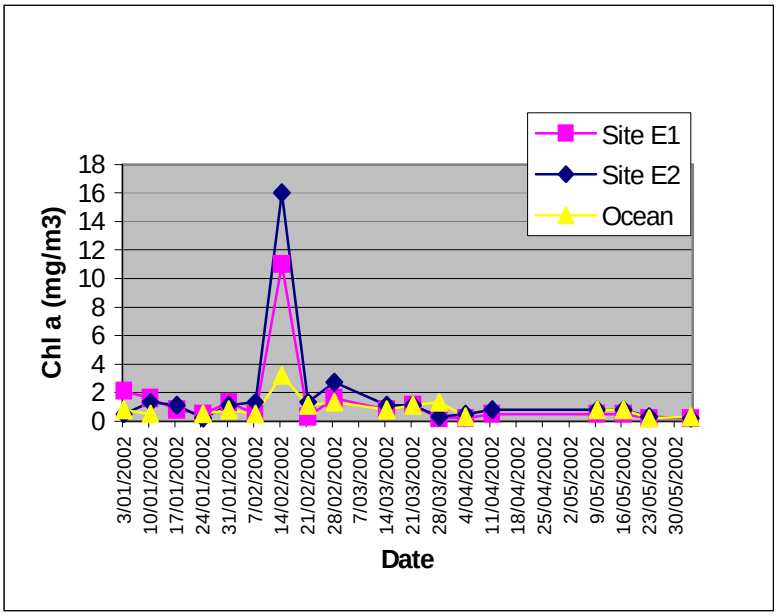

Figure 6-14
Guthalungra Intake Monitoring Chl a
January 2002 to May 2002

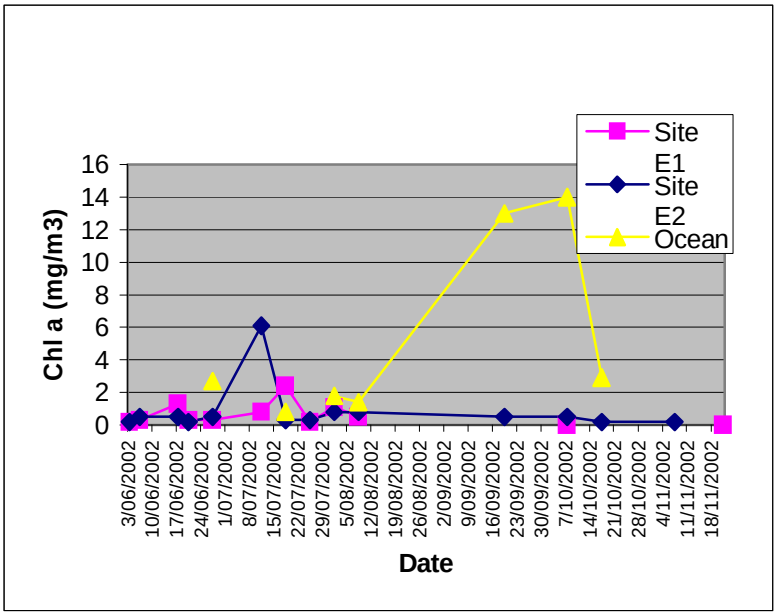

Figure 6-15
Guthalungra Intake Monitoring Chl a
June 2002 to November 2002

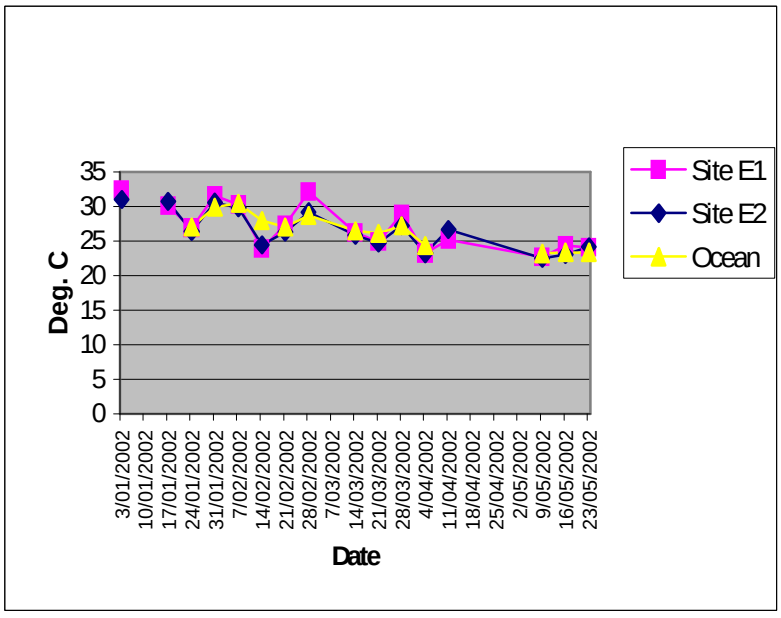

Figure 6-16
Guthalungra Intake Monitoring Temperature
January 2002 to May 2002

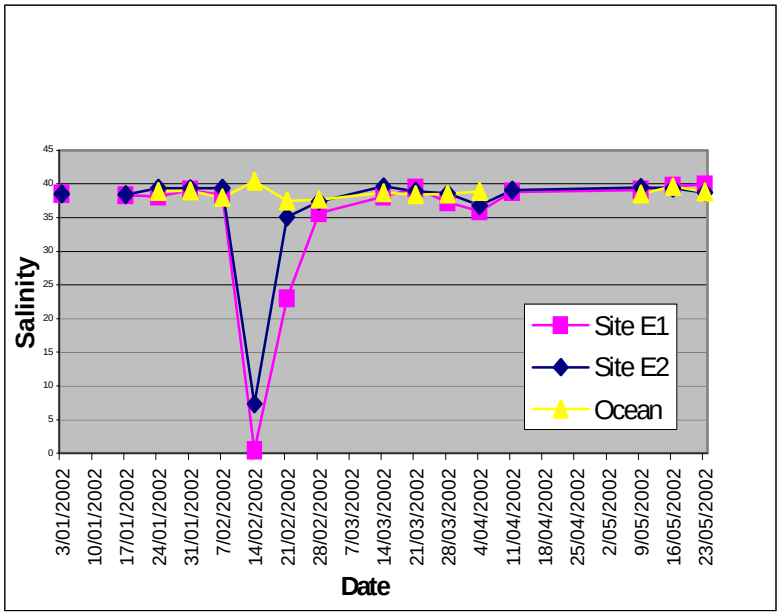

Figure 6-17
Guthalungra Intake Monitoring Salinity
January 2002 to May 2002

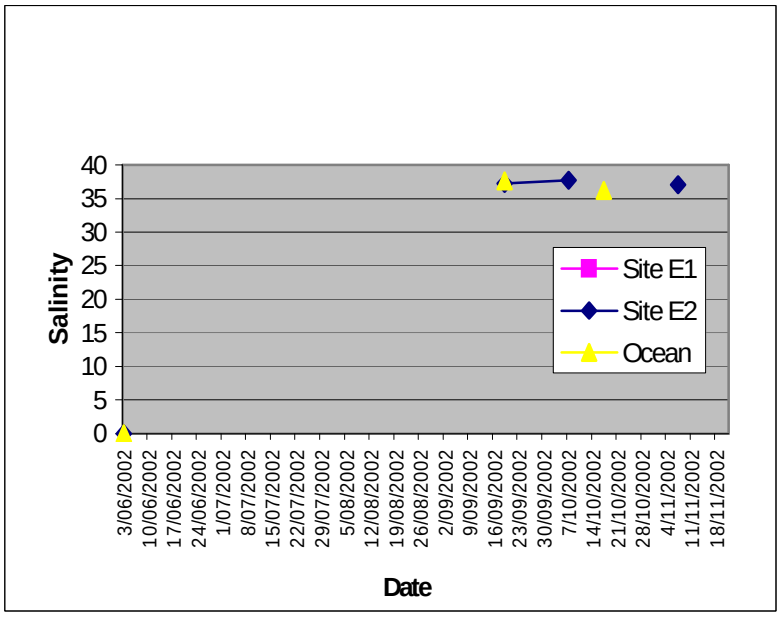

Figure 6-18
Guthalungra Intake Monitoring Salinity
June 2002 to November 2002

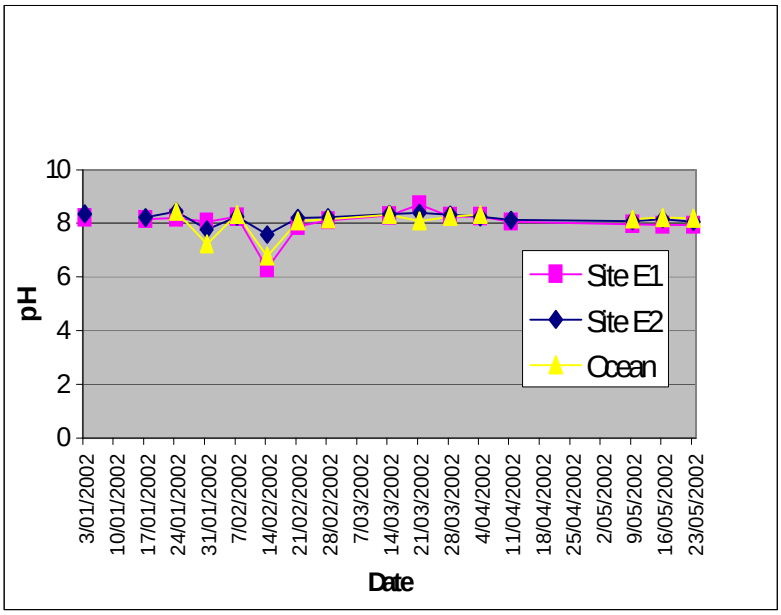

Figure 6-19
Guthalungra Intake Monitoring pH
January 2002 to May 2002

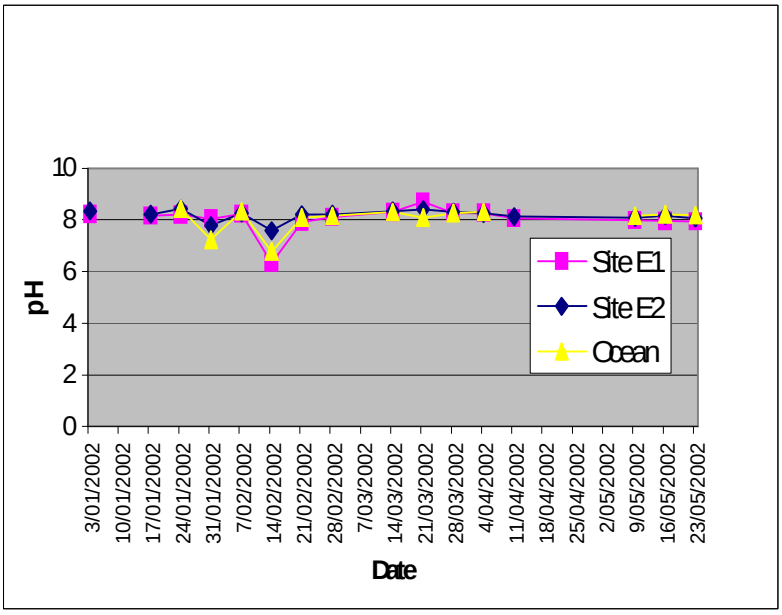

Figure 6-20
Guthalungra Intake Monitoring pH
June 2002 to November 2002

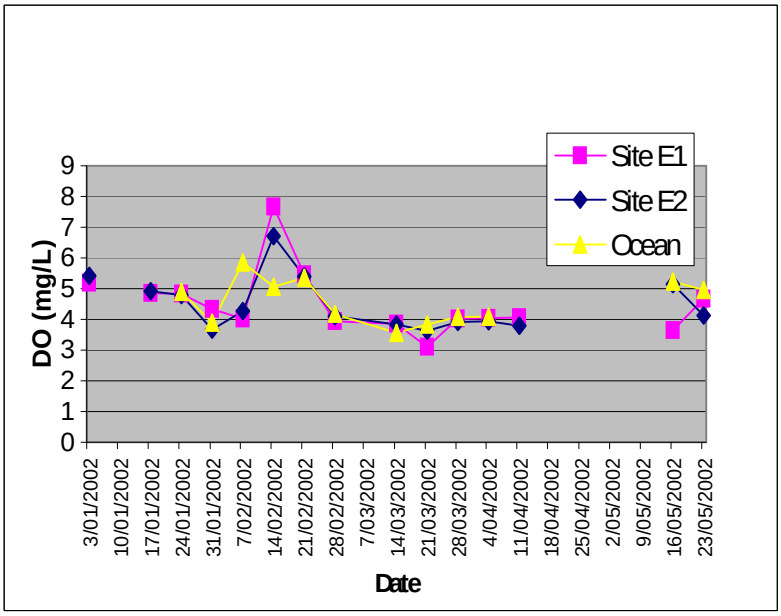

Figure 6-21
Guthalungra Intake Monitoring Dissolved Oxygen
January 2002 to May 2002

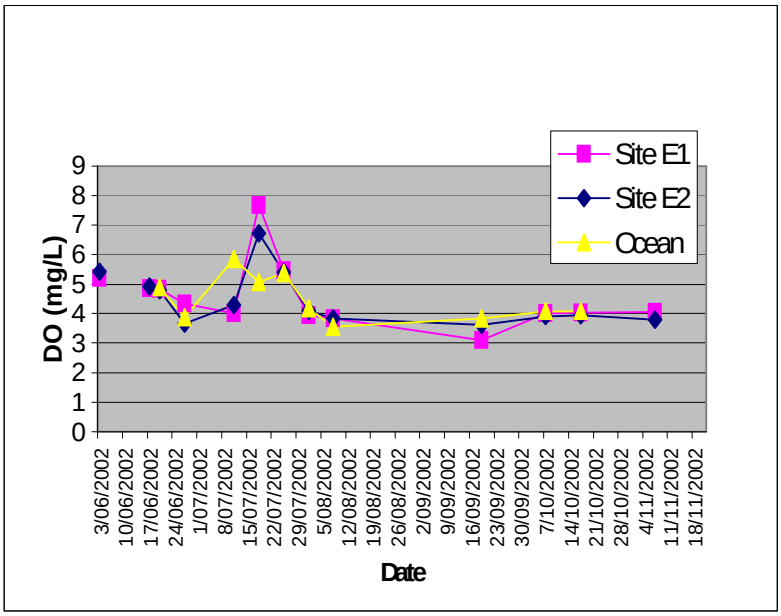

Figure 6-22
Guthalungra Intake Monitoring Dissolved Oxygen
June 2002 to November 2002

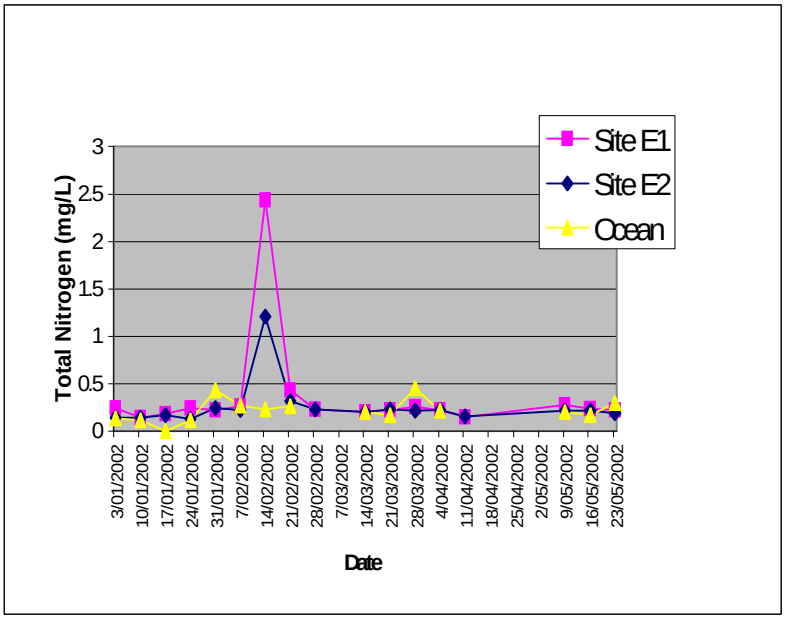

Figure 6-23
Guthalungra Intake Monitoring Total Nitrogen
January 2002 to May 2002

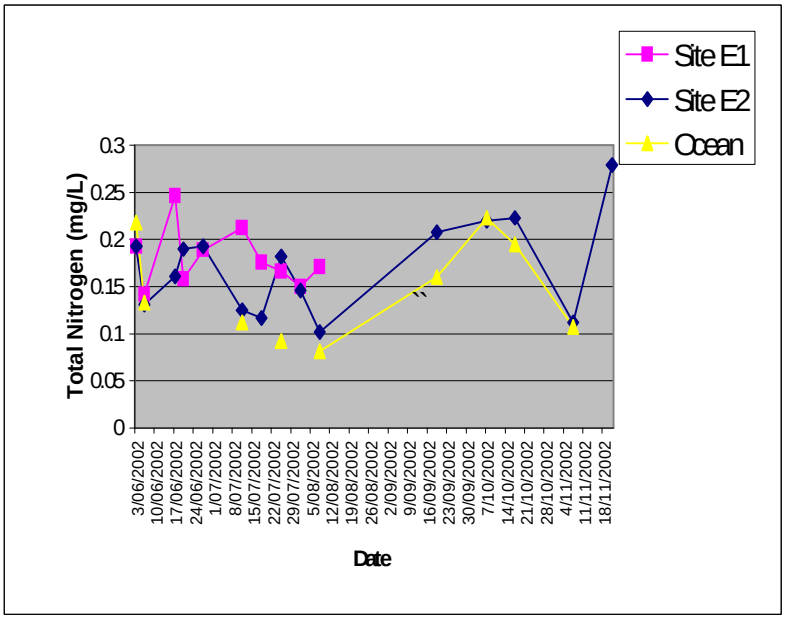

Figure 6-24
Guthalungra Intake Monitoring Total Nitrogen
June 2002 to November 2002

Total suspended solid concentrations were generally between 1 and 10 mg/L from water samples collected from Abbot Bay. These concentration values generally matched those found at the mouth of the Elliot River and upstream of Nobbies Creek in the Elliot River. Most TSS concentrations (over 80 % of values) were less than 5 mg/L.

Total nitrogen concentrations were generally less than or equal to 250 µg/L in water samples collected from Abbot Bay. These concentrations again generally matched those found at the mouth of the Elliot River and upstream of Nobbies Creek in the Elliot River. The trigger ANZECC level for near shore tropical marine systems is 100 µg/L for Total Nitrogen. Many of the concentrations found in Abbot Bay were slightly above the trigger level (~ 120 µg/L) with several values between 200 and 250 µg/L.

Total phosphorus concentrations were generally less than or equal to 50 µg/L in water samples collected from Abbot Bay. These concentrations generally matched those found at the mouth of the Elliot River and upstream of Nobbies Creek in the Elliot River. The trigger ANZECC Level for near shore tropical marine systems is 15 µg/L of Total Phosphorus. Many of the concentrations found in Abbot Bay were of this order with several values as high as 50 µg/L.

Turbidity levels recorded in Abbot Bay reflect the low total suspended solid concentrations found in Bay. Most turbidity values were between 1 and 5 NTU's.

Chlorophyll a concentrations were generally less than or equal to 1 µg/L in water samples collected from Abbot Bay. These concentrations again generally matched those found at the mouth of the Elliot River and upstream of Nobbies Creek in the Elliot River. The trigger ANZECC Level for near shore tropical marine systems is 0.5 µg/L. Many of the concentrations found in Abbot Bay were slightly above the trigger level ~ 0.8 to 1.0 µg/L.

Salinity concentrations were generally between 38 to 39 ppt.

Generally the water quality in Abbot Bay was good with values ranging in concentrations three or four fold triggering the ANZECC trigger ANZECC level for near shore tropical marine systems.

These concentrations are in general less than nutrient concentrations found in estuarine rivers and creeks of Queensland (Dennison and Abal, 1999).

6.5 Terrestrial & Marine Communities

6.5.1 Abbot Bay Marine Ecology

a) Marine Park Bioregions

The Great Barrier Reef Marine Park Authority, through the classification phase of the Representative Areas Program, has mapped the biological and physical diversity of the GBR World Heritage Area (GBRMPA, 2001).

Bioregions (based on animal and plant assemblages and landform features) have been identified within the GBRWHA to identify and protect representative examples of all habitats and communities (GBRMPA, 2001).

As such, the development site is adjacent to one non-reef bioregion and one reef bioregion:

- Non-reef bioregion NA3: Abbot Bay is representative of the High Nutrients Coastal Strip (NA3) bioregion (terrigenous mud and high levels of nutrients from the adjoining land. Seagrass in sheltered sites only. Good turtle and dugong feeding habitat. Wet tropical influence for much of the coast);
- Reef bioregion RF2: Camp Island is representative of the Central Open Lagoon Reef (RF2) bioregion (region dominated by episodic Burdekin flood plumes. Sea floor deeper and lagoon significantly wider, with more tidal movement than RF1. Few reefs and islands).

b) Fish Habitat Areas

Refer to Section 6.6.4 (Conservation and Heritage Values) for discussion on Fish Habitat Areas.

c) Marine Plant Communities

Mangrove Communities

Narrow bands of Grey Mangrove (*Avicennia marina*) and Club Mangrove (*Aegialitis annulata*) communities exist along the seaward margin of the site. One small patch occurs in the Elliot River adjacent to Lot 370, with a more extensive occurrence along the tributary to the north of Lot 370 (Thomas, 2002).

Salt Couch Communities

Salt couch (*Sporobolus virginicus*) grassland occurs in a narrow band between the terrestrial grassland community and saltflats in the north east of the main study area (Thomas, 2002).

Samphire Communities

Extensive areas of hypersaline flats with isolated individuals or patches of samphire (*Halosarcia halocnemoides*) and salt couch occur on the northern portion of the site and halfway along the proposed pipeline route (Thomas, 2002).

Refer to the Ecotone Environmental Services report (Thomas, 2002) in Appendix J for a more detailed discussion of the marine vegetation communities within and adjacent to the main development area and proposed pipeline route.

Abbot Bay Seagrass Distribution

Broadscale seagrass surveys in 1987 by the Queensland Department of Primary Industries (Queensland Fisheries Service - Northern Fisheries Centre) identified seagrass meadows in Abbot Bay as marked in Figure 6-1. This study identified 35.4 km^2 or 3500 ha of seagrass meadows in Abbot Bay, comprising seven species (Lee Long *et al.*, 1993). As tropical seagrass meadows are subject to natural temporal changes, varying seasonally and between years (Mellors *et al.*, 1993), the seagrass meadows shown in Figure 6-25 may have changed in the fifteen years since the QDPI survey.

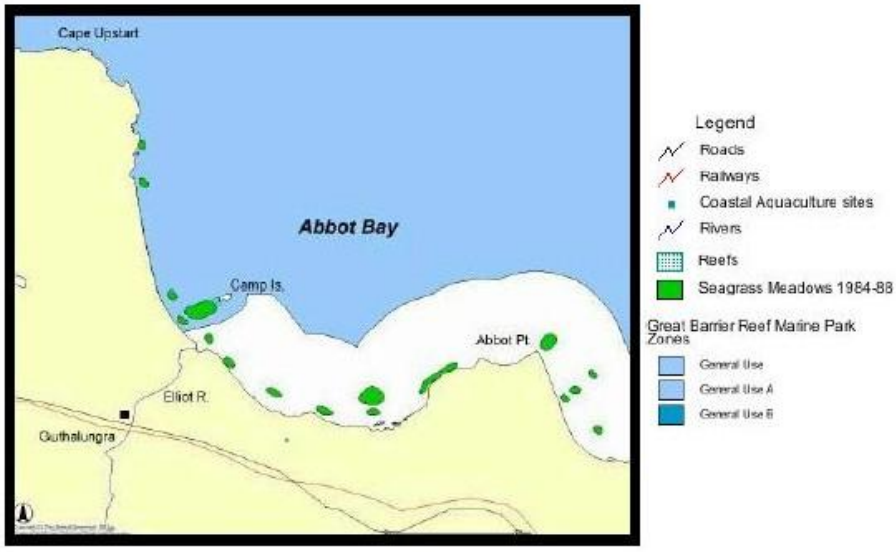

Figure 6-25
Seagrass Habitat in Abbot Bay (Coles *et al.*, 1992)

A follow-up survey of seagrass in Upstart Bay (the adjacent northerly bay to Abbot Bay) was undertaken 10 years later by the DPI Northern Fisheries Research Centre (Coles, pers. comm.). This study determined the seagrass density and location was similar to their previous survey and there had been little change over this time period.

Abbot Bay seagrass has a more dynamic environment and changes may have occurred to these areas over the resulting time since the original survey. However, it appears that seagrass beds ebb and flow in size depending upon seasonal conditions and it is likely that a similar area of seagrass to that reported occurs in Abbot Bay when measured over these ebb and flow periods.

Scientific Marine Ltd undertook a marine resources survey of Abbot Bay in December 2002. They surveyed an area of approximately 15km^2 and found approximately 1000 ha of seagrass in their survey (refer to Figure 6-2). Approximately 100 ha of this seagrass were surveyed previously by Coles *et al.* (1992). Three species of seagrass (*Halophila ovalis, Halophila spinulosa* and *Halodule uninervis*) were recorded. *Halodule uninervis* could further be described as either thin or wide leaved. *Halophila ovalis* and *Halophila spinulosa* were the most common species, being found in 59% and 54% of samples, respectively. Dugong feeding trails were noted at two sites.

Figure 6-26
Seagrass Habitat in the northern section of Abbot Bay (Scientific Marine, 2002)

Overall, the density of the seagrass meadows were low with moderate to high densities recorded in the area approximately 1 km due north of the mouth of the Elliot River (refer to Figure 6-26).

Zone 1 had significantly lower mean densities of *Halophila spinulosa* and *Halodule uninervis* (wide) than all other sites and a significantly higher density of *Halodule uninervis* (thin). Zone 2 had a significantly higher density of *Halophila ovalis* and a significantly lower density of *Halodule uninervis* (thin) than all other sites.

The highest densities recorded were for sites 25 – 31 in the area due north of the mouth of the Elliot River and east of the intake pipe. No seagrasses were recorded in the area adjacent to the river mouth (Sites 32, 33, 34, 36) (refer to Figure 6-26).

Halophila ovalis was uniformly distributed throughout the depth range surveyed. Significant increases in shoot densities for *Halophila spinulosa* and *Halodule uninervis* (wide) were noted with increasing depth. *Halodule uninervis* (thin) was present at only one of the deeper sites.

The density of *Halodule uninervis* (wide) was significantly lower at the outfall pipe site compared to all sites surveyed.

Refer to the Abbot Bay Marine Habitat Survey report (Scientific Marine, 2002) in Appendix L for a more detailed discussion of the seagrass communities within and adjacent to the proposed intake and discharge points of the proposed pipeline.

d) Fringing Reef Communities

During the Scientific Marine survey in December 2002 divers identified fringing reefs around Camp Island with an extensive area of back reef (see Appendix L). Coral Bleaching events in 1998 and 2001, and Crown-of-thorn starfish outbreaks in 2001 were reported by the caretaker of Camp Island (Dennis Turner, *pers. com.*). The effects of these events were evident to the divers, by the areas of recently dead coral, covered in algae. Sites F3 and B3 (see Appendix L) were particularly affected, as evidenced by the large areas of dead staghorn thickets.

The mean percent live hard coral cover for all sites (see Appendix L) was 11.5% (+/- 2.6 SE). Cover ranged from 6.6% (+/- 2.7 SE) at site B2 on the southern side, through to 24.2% (+/- 6.2 SE) at the north-eastern point of the island. Acroporid corals were the most common hard corals found, making up more than 50% of hard coral cover at all sites except B3.

Soft corals and sponges accounted for less than 5% cover. The total mean % algae cover was 43.4% (+/- 4.1 SE), with *Sargassum sp.* and *Padina sp.* being most common.

No significant differences in mean per cent live cover of hard coral, soft coral, algae or sponges was noted between the three sites along the south-east front (F1, F2, F3) and the three sites on the lee side (B1, B2, B3) of the island (see Appendix L).

Site F1, on the north-eastern point of Camp Island recorded the highest hard coral cover, with a low score for number of species (Table 6-4). Acroporid corals were the dominant species at this site. Site B3 on the south western side of the island recorded the greatest diversity of hard corals, with 21 species groups detected from 11 families. Site F2, on the eastern most point of the island, was the next most diverse site with 15 species groups from 7 families (Table 6-4).

e) Significant Marine Species

The likely presence of, and habitat suitable for, marine species that have local, state, national or international significance in waterways adjacent to the proposed site is discussed in this section. These include species listed under the (Commonwealth) *Environmental Protection and Biodiversity Conservation Act 1999* and the (Queensland) *Nature Conservation (Wildlife) Regulation 1994* as Rare, Vulnerable or Endangered, including cetaceans (dolphins and whales) and species listed by Pogonoski *et al.* (2002).

Table 6-1 lists the threatened fauna species scheduled under Commonwealth and Queensland legislation that are known to occur within the general study area. The table also lists those species covered by Migratory provisions of the EPBC Act. This list is based upon species identified in the database searches.

The table includes a brief description of the known occurrences or preferred habitat for each species and, based on an assessment of the availability of these habitat features within Abbot Bay, makes an assessment as to whether each species is likely to occur in the study area (either: High, Moderate or Low).

Table 6-4
Threatened species known to occur or potentially occurring in the study area

Order	Scientific Name	Common Name	EPBC	NCWR	Habitat	Likelihood of occurrence
Chondrichthyes	*Carcharodon carcharias*	Great White Shark	V		An inhabitant of continental and insular shelf waters. Often occurs close inshore near the surf-line, and may penetrate shallow bays in continental coastal waters; it also occurs around continental islands. This species can be found from the surface down to the bottom in epicontinental waters, but occasionally ranges down the continental slope, where it has been caught on a bottom set longline at 1,280m (Compagno, 1984). It is normally found in inshore waters in the vicinity of islands, and often near seal colonies. Nursery areas are located in inshore coastal waters (Smith and Pollard, 1997).	Low
Chondrichthyes	*Rhinocodon typus*	Whale Shark	V m		Whale Sharks follow migratory patterns that may be related to the presence of their prey. They are seen by divers near coral reefs, but they also occur well offshore (Australian Museum, 2002).	Low
Mammalia	*Balaenoptera musculus*	Blue Whale	E m		The blue whale is oceanic. Extensive migrations occur between warm water (low latitude) breeding and cold water (high latitude) feeding grounds; in southern hemisphere. The species is recorded from all Australian states. Migration paths are widespread, but do not follow coastlines or oceanographic features. The species is known to almost exclusively feed on Antarctic Krill (*Euphausia superba)* in colder, Antarctic waters. (Bannister *et al*., 1996)	Low
Mammalia	*Dugong dugon*	Dugong	m	V	Important sites in the southern GBRWHA include Hinchinbrook Island, Cleveland Bay, Upstart Bay and Shoalwater Bay. Seagrasses are the staple food of dugongs (Lanyon *et al*., 1989) and most sightings of dugongs have been in the vicinity of seagrass beds (Marsh and Corkeron, 1997). Dugongs occur all along the coast of the GBRWHA and have been sighted more than 50km off shore associated with deepwater and reefal seagrass beds in the Far Northern Section (Marsh and Corkeron, 1997).	High

Order	Scientific Name	Common Name	EPBC	NCWR	Habitat	Likelihood of occurrence
Mammalia	*Megaptera novaeangliae*	Humpback Whale	V m	V	The GBRWHA is a breeding area and northern terminus for humpback whales traveling along the eastern Australian coastline each year during their breeding migrations from the Antarctic to tropical waters (Simmons and Marsh, 1986).	Low
Reptilia	*Caretta caretta*	Loggerhead Turtle	E m	E	Approximately 70% of the Australian population nests at Mon Repos, Wreck Island, Tyron Island, Erskine Island and the Wreck Rock beaches (Limpus and Reimer, 1994). Following their emergence the hatchlings undergo a pelagic dispersal phase, and return after 15-20 years to within 2000-2500 km of their hatching location, and then drop out onto the shallow continental shelf feeding upon benthic fauna, primarily molluscs and crabs. The GBRWHA, with its broad continental shelf provides one of the largest areas of suitable feeding habitat for mature loggerhead turtles. (Limpus, 1997)	Low
Reptilia	*Chelonia mydas*	Green Turtle	V m	V	Two breeding grounds for the green turtle are within the GBRWHA. Raine Island and Moulter Cay in the north, and the Capricorn-Bunker group in the south (Limpus, 1997). Following a pelagic dispersal phase of young hatchlings, the turtles return to within 2,500 km of their nesting place (Limpus, 1997). The green turtle is a herbivore feeding upon seagrasses and algae. The shallow and recently discovered deeper seagrass meadows and algae with the GBRWHA provide the essential resources for the southern GBR populations (Limpus, 1997).	Moderate

Order	Scientific Name	Common Name	EPBC	NCWR	Habitat	Likelihood of occurrence
Reptilia	*Crocodylus porosus*	Estuarine Crocodile	m	V	Breeding populations of estuarine crocodiles are found in a number of coastal river systems north of the Tropic of Capricorn. They utilise a variety of habitats from river mouths through to freshwater swamps well inland. Freshwater swamps, ephemeral swamps, and the tidal reaches of rivers often provide good nesting habitat. Large numbers of crocodiles do not occur in the GBRWHA (Miller and Bell, 1995). They have been recorded from inner-, mid- and outer- shelf locations (Miller and Bell, 1995). Following a major rain, crocodiles have been known to move out of rivers and along the coast (Miller, 1997). Some of these may also move further out to the islands of the GBRWHA (Miller, 1997).	Moderate
Reptilia	*Dermochelys coriacea*	Leatherback Turtle	V m	E	The leatherback turtle has a very limited occurrence in the GBRWHA with most records coming from the Wreck Rock to Battle Creek area at the southern extremity of the GBRWHA (Limpus, 1997). The leatherback turtle is an oceanic turtle, feeding primarily upon jellyfish on the ocean side of the outer reefs (Limpus, 1997).	Low
Reptilia	*Eretmochelys imbricata*	Hawksbill Turtle	V m	V	Significant nesting locations in the GBRWHA include Millman Island, Boydong Island and Hannibal Island (Limpus, 1997). Hawksbill turtles feed almost exclusively on sponges and can be found on almost all reefs in the GBRWHA (Limpus, 1997).	Low

Order	Scientific Name	Common Name	EPBC	NCWR	Habitat	Likelihood of occurrence
Reptilia	*Natator depressus*	Flatback Turtle	V m	V	Flatback turtles are endemic to the continental shelf of Australia. Although they forage around Papua New Guinea and Indonesia as well as within the Marine Park, they have only been found nesting in Australia (Parmenter, 1994). Breeding is centered in the southern GBR around Peak, Wild Duck, Avoid, Curtis and Facing Islands (Limpus, 1997). However, low density nesting by flatback turtles occurs on many mainland beaches and offshore islands north of Gladstone. The largest known nesting site in Queensland (Crab Island) lies outside the World Heritage Area. The flatback turtle avoids hard substrates such as coral reefs and rocky shores, spending most time in soft bottom areas of the GBRWHA. It feeds primarily on soft bodied invertebrates (Limpus, 1997).	High

Key to Status:

E Endangered
V Vulnerable
m Listed under migratory provisions of the EPBC Act

Table 6-5 lists those species covered by Marine provisions of the EPBC Act which may occur in the study region. The preferred habitat of the following species is likely to exist adjacent to the proposed site (e.g. shallow coastal waters and estuaries with sandy/rocky substrates occurring amongst algae and seagrass), if awarded a “moderate” likelihood of occurrence.

For example, species such as sea snakes were awarded a “moderate” likelihood of occurring in proximity to the proposed site if the species is known from soft bottomed communities such as estuaries and inshore waters. Whereas sea snakes known mostly from reef communities or deeper waters were awarded a “low” likelihood of occurring near the site.

Species listed in the marine provisions of the EPBC Act 1999 from the database search which have not been listed as occurring in the GBR WHA in Pogonoski *et al.,* 2002 were awarded a “low” likelihood of occurring near the proposed site.

Table 6-5
Species covered by Marine provisions of the EPBC Act 1999

Order	Scientific Name	Common Name	Likelihood of Occurrence
Mammalia	*Dugong dugon*	Dugong	High
Osteichthyes	*Acentronura tentaculata*	Hairy Pygmy Pipehorse	Low
Osteichthyes	*Campichthys tryoni*	Tryon's Pipefish	Low
Osteichthyes	*Choeroichthys brachysoma*	Pacific Short-bodied Pipefish, Short-bodied Pipefish	Low
Osteichthyes	*Choeroichthys suillus*	Pig-snouted Pipefish	Low
Osteichthyes	*Corythoichthys amplexus*	Fijian Banded Pipefish, Brown-banded Pipefish	Low
Osteichthyes	*Corythoichthys flavofasciatus*	Yellow-banded Pipefish, Network Pipefish	Low
Osteichthyes	*Corythoichthys intestinalis*	Australian Messmate Pipefish, Banded Pipefish	Low
Osteichthyes	*Corythoichthys ocellatus*	Orange-spotted Pipefish, Ocellated Pipefish	Low
Osteichthyes	*Corythoichthys paxtoni*	Paxton's Pipefish	Low
Osteichthyes	*Corythoichthys schultzi*	Schultz's Pipefish	Low
Osteichthyes	*Cosmocampus darrosanus*	D'Arros Pipefish	Low
Osteichthyes	*Doryrhamphus excisus*	Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Low
Osteichthyes	*Festucalex cinctus*	Girdled Pipefish	Low
Osteichthyes	*Halicampus dunckeri*	Red-hair Pipefish, Duncker's Pipefish	Low
Osteichthyes	*Halicampus grayi*	Mud Pipefish, Gray's Pipefish	Low
Osteichthyes	*Halicampus nitidus*	Glittering Pipefish	Low
Osteichthyes	*Halicampus spinirostris*	Spiny-snout Pipefish	Low
Osteichthyes	*Hippichthys cyanospilos*	Blue-speckled Pipefish, Blue-spotted Pipefish	Low
Osteichthyes	*Hippichthys heptagonus*	Madura Pipefish, Reticulated Freshwater Pipefish	Low
Osteichthyes	*Hippichthys penicillus*	Beady Pipefish, Steep-nosed Pipefish	Low

Order	Scientific Name	Common Name	Likelihood of Occurrence
Osteichthyes	*Hippocampus bargibanti*	Gorgonian Seahorse	Low
Osteichthyes	*Hippocampus kuda*	Spotted Seahorse, Yellow Seahorse	Low
Osteichthyes	*Hippocampus planifrons*	Flat-face Seahorse	Low
Osteichthyes	*Hippocampus zebra*	Zebra Seahorse	Low
Osteichthyes	*Micrognathus andersonii*	Anderson's Pipefish, Shortnose Pipefish	Low
Osteichthyes	*Micrognathus brevirostris*	Thorn-tailed Pipefish	Low
Osteichthyes	*Nannocampus pictus*	Painted Pipefish, Reef Pipefish	Low
Osteichthyes	*Solegnathus hardwickii*	Pipehorse	Low
Osteichthyes	*Solenostomus cyanopterus*	Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Low
Osteichthyes	*Solenostomus paradoxus*	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	Low
Osteichthyes	*Syngnathoides biaculeatus*	Double-ended Pipehorse, Alligator Pipefish	Low
Osteichthyes	*Trachyrhamphus bicoarctatus*	Bend Stick Pipefish, Short-tailed Pipefish	Low
Osteichthyes	*Trachyrhamphus longirostris*	Long-nosed Pipefish, Straight Stick Pipefish	Low
Reptilia	*Acalyptophis peronii*	Horned Seasnake	Low
Reptilia	*Aipysurus duboisii*	Dubois' Seasnake	Low
Reptilia	*Aipysurus eydouxii*	Spine-tailed Seasnake	High
Reptilia	*Aipysurus laevis*	Olive Seasnake	Low
Reptilia	*Astrotia stokesii*	Stokes' Seasnake	High
Reptilia	*Caretta caretta*	Loggerhead Turtle	Low
Reptilia	*Chelonia mydas*	Green Turtle	Low
Reptilia	*Crocodylus porosus*	Estuarine or Salt-Water Crocodile	Moderate
Reptilia	*Dermochelys coriacea*	Leathery Turtle	Low
Reptilia	*Disteira kingii*	Spectacled Seasnake	Low
Reptilia	*Disteira major*	Olive-headed Seasnake	Low
Reptilia	*Enhydrina schistosa*	Beaked Seasnake	High
Reptilia	*Eretmochelys imbricata*	Hawksbill Turtle	Low
Reptilia	*Hydrophis elegans*	Elegant Seasnake	High
Reptilia	*Hydrophis mcdowelli*	A seasnake	High
Reptilia	*Hydrophis ornatus*	A seasnake	High
Reptilia	*Lapemis hardwickii*	Spine-bellied Seasnake	High
Reptilia	*Laticauda colubrina*	A sea krait	Low
Reptilia	*Laticauda laticaudata*	A sea krait	Low
Reptilia	*Natator depressus*	Flatback Turtle	High
Reptilia	*Pelamis platurus*	Yellow-bellied Seasnake	Low

Table 6-6 lists those species described in Pogonoski *et al.* (2002) that are likely to occur adjacent to the proposed site (but which were not listed in provisions of the EPBC Act 1999) based on habitat suitability, e.g. presence of shallow coastal waters and estuaries with sandy/rocky substrates occurring amongst algae and seagrass.

Table 6-6
Species listed in Pogonoski *et al.* (2002) that are likely to occur adjacent to the proposed site based on habitat suitability

Scientific Name	Common Name	IUCN	Likelihood of Occurrence
Brachaelurus colchoughi	Colclough's shark	VU	High
Carcharhinus limbatus	Common blacktip shark	DD	High
Carcharhinus obscurus	Dusky shark	LR (nt)	High
Carcharhinus plumbeus	Sandbar shark	LR (nt)	High
Epinephelus coioides	Estuary rockcod	LR (lc)	High
Epinephelus fuscoguttatus	Flowery cod	LR (lc)	High
Epinephelus lanceolatus	Queensland grouper	LR (cd)	High
Epinephelus malabaricus	Malabar grouper	LR (lc)	High
Himantura chaophraya	Freshwater whipray	VU	High
Hippocampus dahli	Low-crown seahorse	LR (nt)	High
Hippocampus hendriki	Eastern spiny seahorse	DD	High
Hippocampus taeniopterus	Common seahorse	DD	High
Pristis clavata	Dwarf sawfish	EN	High
Pristis miscrodon	Freshwater sawfish	CR	High
Pristis zijsron	Green sawfish	EN	High
Syngnathoides biaculeatus	Alligator pipefish	DD	High
Urogymnus asperrimus	Porcupine ray	LR (nt)	High

Key to Status (in order of importance):

CR Critically Endangered
EN Endangered
VU Vulnerable
LR (cd) Lower Risk (conservation dependent)
LR (nt) Lower Risk (near threatened)
DD Data Deficient
LR (lc) Lower Risk (least concern)

Table 6-7 lists those species described in Pogonoski *et al.* (2002) that also occur in the Great Barrier Reef however habitat suitability has not been assessed. Therefore the likelihood of their presence in waters adjacent to the proposed site has not been assessed.

Table 6-7
Species with no synopses in Pogonoski *et al*. (2002) but which are found in the Great Barrier Reef (Stokes *et al*., 2001)

Scientific Name	Common Name	IUCN
Aetobatus narinari	Spotted eagle ray	LR (lc)
Carcharhinus amblyrhynchos	Grey reef shark	LR (lc)
Carcharhinus brevipinna	Spinner shark	LR (lc)
Carcharhinus falciformis	Silky shark	LR (lc)
Carcharhinus leucas	Bull shark	LR (lc)
Galeocerdo cuvier	Tiger shark	LR (lc)
Hypogaleus hyugaensis	Blacktip topeshark	LR (lc)
Manta birostris	Manta ray	LR (lc)
Pseudocarcharias kamoharai	Crocodile shark	LR (lc)
Rhynchobatus djiddensis	Whitespot giant guitarfish	LR (lc)
Sphyrna lewini	Scalloped hammerhead	LR (lc)
Sphyrna mokarran	Great hammerhead	LR (lc)
Taeniura lymma	Bluespotted ribbontail ray	LR (lc)
Triaenodon obesus	Whitetip reef shark	LR (lc)

Where IUCN status LR (lc) = Lower Risk (least concern).

6.5.2 Terrestrial Ecology

The majority of information in this section was derived from the Ecotone Environmental Services flora and fauna report (Thomas, 2002) in Appendix M.

a) Significant Flora Species

Table 6-8 lists the rare or threatened flora species scheduled under Commonwealth and Queensland legislation that are known to occur within the proposed site and adjacent area.

The table includes a brief description of the known occurrences or preferred habitat for each species and, based on an assessment of the availability of these habitat features, makes an assessment as to whether each species is likely to occur in the proposed site or adjacent area.

Table 6-8
Threatened flora known from the region and assessment of likely occurrence within the proposed site and adjacent area (Thomas, 2002)

Species	EPBC Status	Qld Status	Record	Growth Form	Habitat	Likelihood of occurrence		
						Main Site	*Pipeline*	*Adjacent Areas*
Babingtonia papillosa [Myrtaceae]		E	QH		Woodland/forest	*Low;* no suitable habitat present	*Low; no suitable habitat present*	*Low; no suitable habitat present*
Aponogeton queenslandicus [Aponogetonaceae]		V	QH	waterplant	ephemeral freshwater pools with clay bottoms	*Moderate,* shallow ephemeral wetland habitats present on clay substrate; specimen known from Guthalungra area	*Moderate,* shallow ephemeral wetland habitats present on clay substrate; specimen known from Guthalungra area	*Moderate,* shallow ephemeral wetland habitats present on clay substrate; specimen known from Guthalungra area
Cassia sp. (Paluma Range G.Sankowsky+450) [Caesalpiniaceae]		R	QH	shrub	Rainforest	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Croton magneticus [Euphorbiaceae]	V	V	EPBC	shrub	vine thicket in boulder strewn coastal areas	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Actephila sessilifolia [Euphorbiaceae]		R	QH		rainforest, vine forest, dry scrub	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Bonamia dietrichiana [Convolvulaceae]		R	QH	vine	rainforest, vine forest, dry scrub	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Hydrocharis dubia [Hydrocharitaceae]	V	V	QH, EPBC	waterplant	shallow freshwater wetlands and streams	*Moderate,* suitable wetland habitat present; known from Ayr	*Moderate,* suitable wetland habitat present; known from Ayr	*Moderate,* suitable wetland habitat present; known from Ayr
Marsdenia brevifolia [Asclepiadaceae]	V	V	EPBC	Vine	in North Qld. occurs on acid granite derived soils	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Tylophora williamsi [Asclepiadaceae]	V	V	EPBC	Vine	deciduous vine thickets, dry rainforest	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Corchorus hygrophilus [Tiliaceae]		R	QH	shrub	rainforest, fringing rainforest	*Low*; no suitable habitat present	*Low*; no suitable habitat present	*Low*; no suitable habitat present
Grewia graniticola [Tiliaceae]		R	LA	shrub	woodland on hill slopes or coastal dunes	*Low*, no suitable habitat present	*Moderate*, small area of dunal woodland traversed	*Moderate*, dunal woodland present adjacent to pipeline

Species	EPBC Status	Qld Status	Record	Growth Form	Habitat	Likelihood of occurrence		
						Main Site	*Pipeline*	*Adjacent Areas*
Livistona drudei [Arecaceae]		V	QH	palmtree	moist coastal habitats	*Low*; specimens from study region may be misidentified *L. decipiens*; generally regarded to occur north of Townsville	*Low*; specimens from study region may be misidentified *L. decipiens*; generally regarded to occur north of Townsville	*Low*; specimens from study region may be misidentified *L. decipiens*; generally regarded to occur north of Townsville
Eucalyptus raveretiana [Myrtaceae]	V	V	QH, EPBC	Tree	riparian and fringing woodland/forest	*Low*, suitable habitat present but a distinctive species that was not observed during the EES traverses of the site	*Low,* suitable habitat present but a distinctive species that was not observed during the EES traverses of the site	*Low,* suitable habitat present but a distinctive species that was not observed during the EES traverses of the site
Ozothamnus eriocephalus [Asteraceae]	V	V	EPBC	shrub	Rocky ridges, rocky soils, most records from Eungella area	*Low*; no suitable habitat present, no local records	*Low*; no suitable habitat present, no local records	*Low*; no suitable habitat present, no local records

Key to Records:

QH Records of specimens held by the Queensland Herbarium for the study region
EPBC EPBC database search records for the study region
LA Occurrence in the study region cited by Lokkers and Anderson (2001)

Key to Status:

E Endangered
V Vulnerable
R Rare

b) Significant Fauna Species

Table 6-9 lists the rare or threatened fauna species scheduled under Commonwealth and Queensland legislation that are known to occur or potentially occur within the proposed site and adjacent area.

The table includes a brief description of the known preferred habitat and key resources for each species and, based on an assessment of the availability of these habitat features, makes an assessment as to whether each species is likely to occur in the proposed site or adjacent area.

Table 6-9
Rare or threatened fauna known from the region and assessment of likely occurrence within the proposed site and adjacent area. (Thomas, 2002)
NB: species are listed according to their highest conservation status

Species	Common Name	EPBC Status	Qld Status	Record	Key Resources	Habitat	Likelihood of occurrence		
							Main Site	*Pipeline*	*Adjacent Areas*
Endangered									
Birds									
Erythrotriorchis radiatus	Red goshawk	V	E	EPBC	trees > 20m for nesting within 1km of a watercourse or wetland abundance of passerine prey	coastal and sub-coastal forests and riparian forests	*Low*, lack of suitable foraging and nesting habitat	*Low*, lack of suitable foraging and nesting habitat	*Low*, lack of suitable foraging and nesting habitat
Neochmia ruficauda ruficauda	Starfinch	V	E	EPBC	rank grassland and reedbeds near freshwater	grassy woodland and rank grassland near permanent freshwater	*Low*, limited areas of suitable habitat; very few records in NQ in recent years	*Low*, limited areas of suitable habitat; very few records in NQ in recent years	*Low*, limited areas of suitable habitat; very few records in NQ in recent years
Sterna albifrons (Australian breeding individuals)	Little tern		E	B	undisturbed unvegetated sites near estuaries and lakes and on coral quays	feeds in inshore waters	*Low*; only small artificial wetlands for foraging present, no breeding habitat	*Moderate*; wetlands for foraging present, but no breeding habitat	*Moderate*; wetlands for foraging present, but no breeding habitat

Species	Common Name	EPBC Status	Qld Status	Record	Key Resources	Habitat	Likelihood of occurrence		
							Main Site	*Pipeline*	*Adjacent Areas*
Vulnerable									
Birds									
Esacus neglectus	Beach Stone-curlew		V	EES	nesting areas at the back of the beach free from feral predators	beaches of all types, particularly near estuaries and mangroves	*Low*; suitable habitat not present	*High*; suitable beach habitat present	*Present* along the Elliot River sandflats and mangrove channel adjacent to the north-east periphery of the main site
Geophaps scripta scripta	Squatter pigeon	V	V	EPBC, ACTFR	grassland near fresh water	eucalypt woodland with a grassy understorey in close proximity to fresh water	*Moderate*; grazing over the majority of the site maintains a low grass cover and there are few water sources within woodland areas, but the eastern portion of Lot 370 may provide suitable habitat conditions. The Burdekin Valley is a stronghold for the species.	*Low*; suitable grassland habitats are not present	*Moderate*; grazing maintains a low grass cover within the adjacent woodland areas so sub-optimal habitat present.
Poephila cincta cincta	Black-throated finch	V	V	EPBC, ACTFR	access to seeding grasses and fresh water	grassy woodland dominated by eucalypts, Melaleucas or acacias	*Moderate*; grazing over the majority of the site maintains a low grass cover, but the eastern portion of Lot 370 may provide suitable habitat conditions.	*Low*; grassy woodland areas are absent	*Moderate*; grazing maintains a low grass cover within the adjacent woodland areas so sub-optimal habitat present.

Species	Common Name	EPBC Status	Qld Status	Record	Key Resources	Habitat	Likelihood of occurrence		
							Main Site	*Pipeline*	*Adjacent Areas*
Mammals									
Dasyurus maculatus maculatus	Spotted tailed quoll	V	V	EPBC, B	caves, rock outcrops, logs, tree hollows	rainforest, wet and dry sclerophyll forest, woodland	*Low*; key habitat resources not present; likely to be a paucity of prey given the adverse effects of grazing on ground habitats	*Low*; key habitat resources and preferred habitat types not present	*Low*; key habitat resources not present; likely to be a paucity of prey given the adverse effects of grazing on ground habitats
Xeromys myoides	False water rat	V	V	EPBC	inter-tidal areas with abundant crustaceans and other prey items	coastal wetlands and mangrove areas particularly within the inter-tidal zone	*Low*; only small mangrove areas present with short (relatively steep) inter-tidal zones	*Low*; no mangroves or inter-tidal wetlands present	*Low*; only small mangrove areas present with short (relatively steep) inter-tidal zones
Reptiles									
Crocodylus porosus	Estuarine crocodile		V	EPBC	in estuarine areas, availability of tidal flats for basking	coastal wetlands, inland reaches of major rivers, and estuaries	*Low*; suitable habitats do not occur within the boundary of the main site	*Low*; only shallow wetlands present with limited vegetation	*High*; estuarine habitats of the Elliot River and small mangrove lined tributary adjacent to Lot 370 provide suitable foraging habitat but breeding unlikely
Delma labialis	Striped-tailed Delma	V	V	LA	poorly known	poorly known but may be present in dune vine thickets	*Low*; suitable habitat not present	*Low*; suitable habitat not present	*Low*; suitable habitat not present
Rare									
Birds									
Accipiter novaehollandiae	Grey goshawk		R	B	dense forest types	wet forests and riverine forest among woodland	*Low*; suitable forest habitats not present	*Low*; suitable forest habitats not present	*Low*; suitable forest habitats not present

Species	Common Name	EPBC Status	Qld Status	Record	Key Resources	Habitat	Likelihood of occurrence		
							Main Site	*Pipeline*	*Adjacent Areas*
Ephippiorhynchus asiaticus	Black-necked stork		R	EES, ACTFR, B	aquatic habitats	river pools, wetlands, tidal flats	*High*; likely to utilise artificial and seasonal wetlands on Lot 370	*High*; suitable wetland habitats present	*Present*; observed feeding on Elliot River tidal flats
Melithreptus gularis	Black-chinned honeyeater		R	ACTFR, B	flowering trees and shrubs	woodlands, riparian forests and woodlands	*High*; suitable woodland habitat present	*Moderate*; small area of woodland habitat present along the eastern section of the route	*High*; suitable woodland habitat present
Nettapus coromandelianus	Cotton pygmy-goose		R	QM, EPBC, ACTFR, B	deep water with vegetation	deep lagoons, wetlands and dams with floating marcophytes	*Moderate*; dam adjacent to the main track in Lot 370 provides limited suitable habitat	*Moderate*; shallow wetlands with little floating macrophytes present	*Moderate*; farm dams on adjacent properties provide limited suitable habitat
Numenius madagascariensis	Eastern curlew		R	EES,B	inter-tidal areas for feeding	estuaries, mudflats, mangroves, sandspits	*Low*; inter-tidal areas not present	*Low*; inter-tidal areas not present	*Present* along the Elliot River sandflats and mangrove channel adjacent to the north-east periphery of the main site
Rallus pectoralis	Lewin's Rail		R	LA	availability of habitats	saltmarsh areas with thick vegetation	*Low*; suitable marsh habitat not present	*Moderate,* suitable marsh habitat present	*Moderate,* suitable marsh habitat present adjacent to pipeline
Rostratula benghalensis	Painted snipe	w m	R	EPBC	marsh habitat	marshes with moderate vegetation cover	*Low*; suitable marsh habitat not present	*Moderate*; limited marsh areas with vegetation cover present	*Low*; suitable marsh habitat not present
Tadorna rajah	Radjah shelduck	w	R	QM, EPBC ACTFR	aquatic habitats	coastal wetlands and rivers, mudflats, saltmarsh, mangroves, paperbark swamps	*Low*; limited wetland areas present and few records for the Ayr-Bowen area	*Low*; wetland areas present but few records for the Ayr-Bowen area	*Low*; wetland areas present but few records for the Ayr-Bowen area

Species	Common Name	EPBC Status	Qld Status	Record	Key Resources	Habitat	Likelihood of occurrence		
							Main Site	*Pipeline*	*Adjacent Areas*
Mammals									
Saccolaimus saccolaimus	Bare-rumped sheathtail bat		R	QM	small hollow branches, especially in poplar gum	tropical woodland and tall open forest especially woodland dominated by poplar gum (*Eucalyptus platyphylla*)	*High*; poplar gum woodland containing potential roost hollows present	*Low*; only small area of woodland present without poplar gum	*High*; poplar gum woodland containing potential roost hollows present
Reptiles									
Varanus semiremex	Rusty monitor		R	LA	availability of habitats	mangrove forests and adjoining vine thicket	*Low*; suitable mangrove habitats not present	*Low*; suitable mangrove habitats not present	*Low*; only small areas of mangrove habitats present

Key to Records:
EES Observed during the March 2002 EES survey of the study area
QM Records of specimens held by the Queensland Museum for the study region
EPBC EPBC database search records for the study region
LA Occurrence in the study region cited by Lokkers and Anderson (2001)
ACTFR Recorded during the 1991/1993 Burdekin River Irrigation Area Flora and Fauna Survey (Thomas and Pearson 1994)
B Records of surveys undertaken 1969-1973 in the Lower Burdekin Area including a site at Inkerman approx. 25km to the northwest of the study area (Lavery and Johnson, 1974; Lavery and Seton, 1974)

Key to Status:
E Endangered
V Vulnerable
R Rare
w Listed under wetland provisions of EPBC Act comprising species listed under CAMBA and/or JAMBA
m Listed under migratory provisions of EPBC Act

c) Migratory Bird Species

Table 6-10 lists the migratory bird species scheduled under the EPBC Act, the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA) that are known to occur or potentially occur within the region.

The table includes a brief description of the known preferred habitat and key resources for each species and, based on an assessment of the availability of these habitat features, makes an assessment as to whether each species is likely to occur in the proposed site or adjacent area.

Table 6-10
Migratory and wetland fauna known to occur or potentially occurring in the proposed site and adjacent area (Thomas, 2002)

Species	Common Name	EPBC Status	JAMBA CAMBA	Record	Key resources	Habitat	Likelihood of occurrence		
							Main site	Pipeline	Adjacent areas
Actitis hypoleucos	Common sandpiper	m	J, C	B, LA		banks, rocks, sandy beaches near water	*Low*; suitable habitats not present	*Low*; suitable mangrove habitats not present	*High*; suitable habitats present along the Elliot River and to the north of the main site
Ardea alba	Great egret	m	J, C	LA	availability of habitats	floodwaters, rivers, wetlands, inter-tidal habitats	*High*, suitable natural and artificial wetland habitats present	*High*; suitable wetland habitats present	*High*; suitable natural and artificial wetland habitats present
Ardea ibis	Cattle egret	m	J, C	LA	availability of habitats	pasture especially among cattle, occasionally wetlands	*High*; suitable pasture and wetland habitats present	*Low*; pasture habitats absent	*High*; suitable pasture and wetland habitats present
Calidris acuminata	Sharp-tailed sandpiper	m	J, C	EES, LA		coastal and interior wetlands	*Low*; only limited wetlands of low suitability present	*Present* along the eastern section	*High*; estuarine, and freshwater shores occur to the north and east of the main site
Calidris ferruginea	Curlew sandpiper	m	J, C	LA		coastal and inland shores	*Low*; suitable habitats not present	*Moderate*; wetland and saltflat habitats present along much of the pipeline	*Moderate*; estuarine, mudflat and saltflat habitats occur to the north and east of the main site

Species	Common Name	EPBC Status	JAMBA CAMBA	Record	Key resources	Habitat	Likelihood of occurrence		
							Main site	Pipeline	Adjacent areas
Calidris ruficollis	Red-necked stint	m	J, C	B, LA		coastal and inland shores	*Low*; suitable habitats not present	*High*; wetland and saltflat habitats present along much of the pipeline	*High*; estuarine, mudflat and saltflat habitats occur to the north and east of the main site
Calidris melanotus	Pectoral sandpiper	m	J	LA		grassy coastal and inland swamps	*Low*; suitable habitats not present	*Moderate*; grassy wetlands present along eastern section	*Low*; suitable habitats not present
Charadrius mongolus	Lesser sand plover	w	J, C	EPBC, B	availability of habitats	coastal wetland, estuarine, mudflats and saltflat habitats	*Moderate*; some saltflat habitat occurs along the northern periphery of the main site	*High*; wetland and saltflat habitats present along much of the pipeline	*High*; estuarine, mudflat and saltflat habitats occur to the north and east of the main site
Charadrius veredus	Oriental plover	m	-	LA		dry plains, occasionally coastal	*Low*; suitable habitats not present	*Moderate*; may utilise wetland habitats	*Moderate*; may utilise wetland habitats associated with the Elliot River
Chlidonias hybridus	Whiskered tern	m	-	ACTFR, B, LA		lakes, swamps, saltmarsh, estuaries	*Moderate*; likely to utilise dam on Lot 370	*High*; freshwater wetlands along eastern section	*High*; estuarine habitats of the Elliot River
Chlidonias leucopterus	White-winged black tern		J, C	B, LA		lakes, estuaries, coastal seas	*Moderate*; likely to utilise dam on Lot 370	*High*; freshwater wetlands along eastern section	*High*; estuarine habitats of the Elliot River
Gallinago hardwickii	Latham's snipe	w m	C	EPBC, ACTFR B	availability of habitats	wetland grasses, open, wooded swamps, ephemerally inundated grasslands	*Moderate*; ephemerally inundated grasslands likely during wet season	*High*; grassy wetland habitats present along the eastern section	*Moderate*; ephemerally inundated grasslands likely during wet season

Species	Common Name	EPBC Status	JAMBA CAMBA	Record	Key resources	Habitat	Likelihood of occurrence		
							Main site	Pipeline	Adjacent areas
Glareola maldivarum	Oriental pratincole	m	J, C	B, LA		open plains, bare ground around swamps, claypans	*Moderate*; suitable habitat available	*Moderate*; suitable habitat available	*Moderate*; suitable habitat available
Grus antigone	Sarus crane	w	C	EPBC	availability of habitats	wetland habitats, grassy open woodland	*Low*; outside main distribution in North Qld, no local records	*Low*; outside main distribution in North Qld, no local records	*Low*; outside main distribution in North Qld, no local records
Haliaeetus leucogaster	White-bellied sea eagle	t m	C	EPBC, ACTFR, B	availability of prey and nesting sites	large rivers, fresh and saline lakes, coastal seas and shoreline, islands	*High*; likely to utilise perches adjacent to the Elliot River and mangrove tributary, but no nests observed	*High*; likely to utilise wetland, dune woodland and beach habitats, but no nests observed	*High*; likely to forage along the Elliot River and tributaries
Hirundapus caudacutus	White-throated needletail	t m	C	EPBC, B	availability of high-flying insect swarms	aerial over coastal habitats and mountain ranges	*Moderate*; may occasionally utilise airspace above site	*Moderate*; may occasionally utilise airspace above pipeline	*Moderate*; may occasionally utilise airspace above adjacent areas
Hirundo rustica	Barn swallow	t m	J	EPBC	availability of habitat	open country, cultivated lands, urban areas	*Moderate*; may occasionally utilise available habitats	*Moderate*; may occasionally utilise available habitats	*Moderate*; may occasionally utilise available habitats
Limosa limosa	Black-tailed godwit	w	J, C	EPBC	tidal flats with adequate prey populations	tidal flats, inland wetlands	*Low*; suitable habitats not present	*Moderate*; wetland habitat present	*Moderate*; likely to utilise tidal flat areas of the Elliot River
Limosa lapponica	Bar-tailed godwit	m	J, C	LA		tidal flats	*Low*; suitable habitats not present	*Low*; suitable habitats not present	*Moderate*; likely to utilise tidal flat areas of the Elliot River

Species	Common Name	EPBC Status	JAMBA CAMBA	Record	Key resources	Habitat	Likelihood of occurrence		
							Main site	Pipeline	Adjacent areas
Monarcha melanopsis	Black-faced monarch	t m	-	EPBC, ACTFR, B	availability of forest habitat	forest habitats including riparian forest	*Moderate*; may utilise the woodland areas on the eastern section of Lot 370	*Moderate*; may utilise the small area of dunal woodland traversed by the pipeline	*Moderate*; may utilise riparian woodland/forest along the Elliot River
Monarcha trivirgatus	Spectacled monarch	m	-	EPBC, ACTFR, B	availability of forest habitat	rainforest, riparian forest, mangroves	*High*; likely to utilise the woodland areas on the eastern section of Lot 370	*Moderate*; may utilise the small area of dunal woodland traversed by the pipeline	*Moderate*; may utilise riparian woodland/forest along the Elliot River
Myiagra cyanoleuca	Satin flycatcher	t m	-	EPBC, ACTFR	availability of habitat	forests, riparian forest, woodland	*High*; likely to utilise the woodland areas on the eastern section of Lot 370	*Moderate*; may utilise the small area of dunal woodland traversed by the pipeline	*Moderate*; may utilise riparian woodland/forest along the Elliot River
Numenius minutus	Little curlew	w m	C	EPBC, EES, B	inter-tidal areas for feeding	open plains, grassland, parkland, mudflats	*Moderate*; grassy plains present but with high grazing pressure	*Moderate*; saltflats, grassy ephemeral wetlands and freshwater wetlands likely to be utilised	*High*; Inter-tidal areas of the Elliot River and saltmarsh areas to the north of the main site (i.e. within the NP) provide suitable habitat
Numenius phaeopus	Whimbrel	m	J, C	LA	inter-tidal areas for feeding	estuaries, mudflats, mangroves, sandspits	*Low*; inter-tidal areas not present	*Low*; inter-tidal areas not present	*Present* along the Elliot River sandflats and mangrove channel adjacent to the north-east periphery of the main site

Species	Common Name	EPBC Status	JAMBA CAMBA	Record	Key resources	Habitat	Likelihood of occurrence		
							Main site	Pipeline	Adjacent areas
Plegadus falcinellus	Glossy ibis	m	C	LA	availability of habitat	freshwater wetlands and pasture	*Moderate*; suitable habitats present	*Moderate*; suitable habitats present	*Moderate*; suitable habitats present
Pluvialis fulva	Pacific golden plover	m	-	EES, B, LA		beaches, mudflats, shallow wetlands	*Low*; suitable habitats not present	*Present* along the eastern section	*High*; likely to utilise estuarine, and freshwater habitats to the north and east of the main site
Sterna caspia	Caspian tern	m	C	EES, ACTFR , LA		coastal and inland watercourses and lakes	*Moderate*; likely to utilise dam on Lot 370	*Present* over freshwater wetlands along eastern section	*Present* over the estuarine habitats of the Elliot River
Tringa nebularia	Common greenshank	m	J	EES, B, LA	wetland habitat	coastal and inland lakes and wetlands	*Moderate*; limited wetland areas present but likely to utilise large dam on Lot 370	*High*; suitable freshwater and saline wetlands available along eastern section	*Present* along Elliot River, also likely to the north of the main site
Tringa stagnatilis	Marsh sandpiper	w m	C	EPBC, B	availability of suitable wetland habitat	fresh or saltwater wetland habitats	*Moderate*; small areas of freshwater wetland available on Lot 370	*High*; suitable freshwater wetlands available along eastern section	*High*; suitable habitat along the Elliot River and tributaries adjacent to the north-east periphery of the main site

Key to Records:

EES Observed during the March 2002 EES survey of the study area
QM Records of specimens held by the Queensland Museum for the study region
EPBC EPBC database search records for the study region
LA Occurrence in the study region cited by Lokkers and Anderson (2001)
ACTFR Recorded during the 1991/1993 Burdekin River Irrigation Area Flora and Fauna Survey (Thomas and Pearson, 1994)
B Records of surveys undertaken 1969-1973 in the Lower Burdekin Area including a site at Inkerman approx. 25km to the northwest of the study area (Lavery and Johnson, 1974; Lavery and Seton, 1974)

Key to Status:

w	Listed under wetland provisions of EPBC comprising species listed under CAMBA and/or JAMBA
m	Listed under migratory provisions of EPBC
t	Listed under terrestrial provisions of EPBC
J	JAMBA
C	CAMBA

d) 'Problem' Species

Very few native wildlife or vegetation occurring onsite could become 'problem' species within the context of this proposed aquaculture enterprise. Native birds such as terns, cormorants, pelicans, black-necked storks, herons, egrets, and ibis could prey on the prawn stock. A number of these bird species are primarily fish feeders and will be likely to feed in the pond discharge channels where they capture fish. Cormorants in particular will dive into the ponds for the prawns.

Fish could also prey on the prawn stock and rodents could feed on the stock feed. However appropriate management protocols will be utilised to minimise this effect. Refer to Section 9 for mitigation measures.

Mosquitos are unlikely to breed within the growout ponds as the water movement is not conducive to mosquito larval development. Although unlikely, mosquito larval development may occur in the settlement ponds. However local fish species will naturally inhabit the ponds and will consequently minimise mosquito numbers.

e) Vegetation Communities: Main Development Area

The vegetation within the main development area is predominantly remnant eucalypt open woodland with large areas of cleared or modified vegetation also occurring. Clearing of original vegetation was apparently undertaken to facilitate cattle grazing which has been the main land use for many years. A number of tree stumps are evident throughout the area however, these are most likely to have resulted from post cutting rather than timber getting, as the mature trees on the property do not attain large girth sizes.

The open nature of the eucalypt communities is most likely similar to the natural density of the vegetation and reflects the difficult growing conditions of the site, particularly the heavy textured alluvium that occurs across most of the site, and pronounced seasonal fluctuation in rainfall and soil moisture. Overlaid on these natural conditions are the effects of sustained grazing pressure over many years, including suppression of recruitment of juvenile trees through trampling and grazing, and compaction and erosion of the ground surface leading to mortality of mature trees from root damage.

The ground cover vegetation is indicative of significant disturbance in terms of both structural and species composition. The two introduced grasses *Bothriochloa pertusa* (Indian bluegrass) and *Digitaria ciliaris* (summer grass) dominate the ground cover across the majority of the main development area with a small number of native grasses also present.

The woody weeds *Acacia nilotica* (prickly acacia) and *Zizyphus mauritianus* (chinese apple) are widespread in the otherwise treeless areas and within the eucalypt community occurring on lighter textured alluvium in the eastern part of the area.

f) Vegetation Communities: Proposed Pipeline Route

The proposed pipeline route traverses inter-tidal and coastal areas supporting a wide range of vegetation types. Sparsely vegetated hypersaline flats are crossed to the north of the main development area before the route joins the weedy vegetation adjacent to Cape Upstart Road and then turns eastward towards the coastline of Abbot Bay. A large expanse of freshwater/brackish wetlands is traversed between this point and the beach dunes. The natural vegetation of this area is most likely salt couch and samphire flats subject to occasional tidal inundation.

The vegetation of the coastal dunes is dominated by the typical sequence of eucalypt and *Melaleuca* woodlands associated with the ridge/swale sequence. A grassy ephemeral wetland is traversed before the foredune vegetation is reached. The vegetation of the dunes and beach is regarded as remnant and there has been little anthropogenic or grazing related disturbance of the ground surface or natural vegetation, although there are significant infestations of ground cover and woody weeds becoming established.

A map of the vegetation types occurring on and immediately adjacent to the main development area and proposed pipeline route is provided in Figure 6-27. Refer to Table 6-11 for description of vegetation map unit codes.

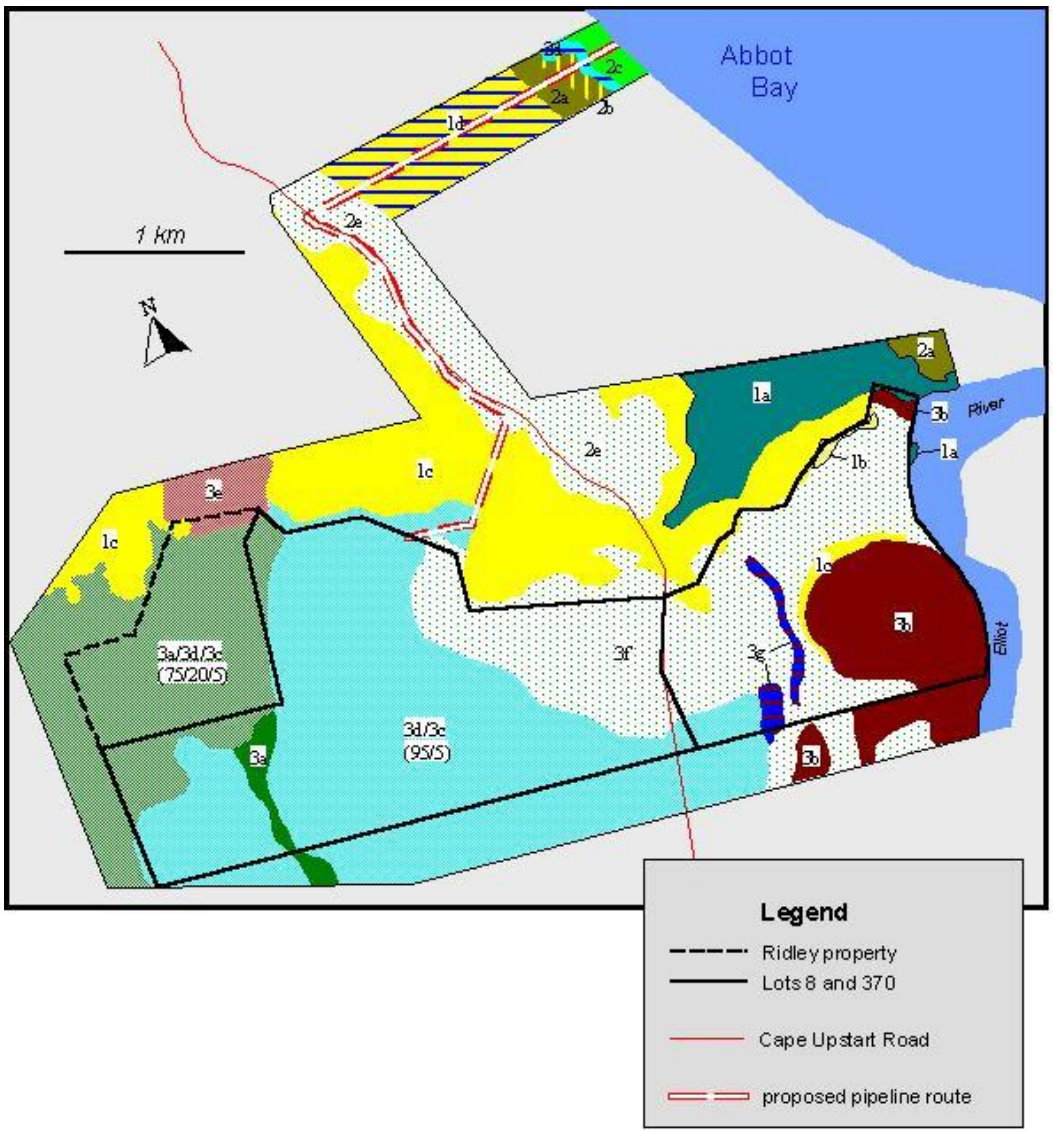

Figure 6-27
Vegetation within and adjacent to the main development area and proposed pipeline route (Thomas, 2002).

g) Regional Ecosystems and Biodiversity Status

A summary of the vegetation map units and their relationship to regional ecosystems is provided in Table 6-11.

In the table, VMA Status is the conservation status of the regional ecosystem under the (Queensland) *Vegetation Management Act 1999*. This is the legal instrument for managing and protecting vegetation in Queensland. Under the VMA, conservation status is determined primarily according to the proportion of a regional ecosystem remaining compared to its original pre-clearing extent.

There are three status categories under the VMA:

- *Endangered* - less than 10% of the pre-clearing extent remains;
- *Of concern* - less than 30% but more than 10% of the pre-clearing extent remains; and
- *Not of concern* - more than 30% of the pre-clearing extent remains.

Biodiversity Status is the conservation status recognised by the Environmental Protection Agency. This status may differ from the VMA status as it incorporates additional parameters into the determination of status such as the existence and severity of on-going threatening processes. Biodiversity status is not a legally binding status.

Table 6-11
Vegetation map units delineated for the main development area and pipeline route (Thomas, 2002).

	Vegetation Map Unit	Regional Ecosystem	VMA Status	Biodiversity Status	Main Development Area	Pipeline Route	Adjacent Areas
	Land Zone 1- quaternary marine deposits						
1a	Mangrove forest	11.1.4	not of concern	not of concern			√
1b	*Sporobolus virginicus* grassland	11.1.1	not of concern	not of concern	√		√
1c	sparsely vegetated hypersaline flats	11.1.2	not of concern	not of concern	√	√	√
1d	freshwater wetlands on modified tidal flats	Modified	nil status	nil status		√	√
	Land Zone 2- quaternary coastal dunes and beaches						
2a	*Corymbia tessellaris* shrubby woodland on ridges	11.2.5	not of concern	not of concern		√	√
2b	*Melaleuca dealbata* woodland in swales	11.2.5	not of concern	not of concern		√	√
2c	*Casuarina equisetifolia/Spinifex sericeum* foredune vegetation	11.2.2	of concern	of concern		√	√
2d	grassy ephemeral wetland in swales	11.2.5	not of concern	not of concern		√	√
2e	weedy grassland/forbland with scattered shrubs	Modified	nil status	nil status		√	√
	Land Zone 3- cainozoic alluvial plains						
3a	*Eucalyptus crebra* and/or *Corymbia dallachiana* open woodland/woodland	11.3.30	not of concern	not of concern^	√		√
3b	*Corymbia tessellaris* shrubby open woodland	11.3.7	not of concern	of concern*	√		√
3c	*Grevillea striata* open woodland	11.3.13	of concern	endangered#	√		√
3d	Grassland with isolated *Eucalyptus platyphylla* and *Corymbia tessellaris*	11.3.35	not of concern	not of concern	√		√
3e	*Acacia tephrina* woodland	11.3.34	not of concern	of concern^	√		√
3f	weedy grassland/forbland with scattered shrubs	Modified	nil status	nil status	√		√
3g	artificial freshwater lagoons	Modified	nil status	nil status	√		√

^ Under review
* Of concern because of threatening processes in addition to clearing (under review)
# Endangered because of threatening processes in addition to clearing (under review)

The EPA regional ecosystem map for the study area is presented in Figure 6-28. The modified regional ecosystem map for the study area based upon ground truthing the area is presented in Figure 6-29.

No *endangered* Regional Ecosystems have been mapped for the study area or adjacent areas, and none were encountered during the EES survey. Two *of concern* Regional Ecosystems occur within the study area:

- RE 11.3.13 [*Grevillea striata* open woodland] is mapped for the main development area and adjacent areas, and the EES survey confirmed the presence of this RE although it is not as widely distributed as suggested by the EPA RE mapping; and
- RE 11.2.2 [*Ipomoea pes-caprae* and *Spinifex sericeus* grassland ± *Casuarina equisetifolia*] occurs at the seaward extent of the proposed pipeline route where the pipeline enters Abbot Bay.

Another *of concern* Regional Ecosystem, 11.2.3 [low microphyll rainforest] is mapped by the EPA for the pipeline route; however, the EES survey suggests that this vegetation has been incorrectly mapped and is more closely attributable to RE 11.2.5 [*Corymbia tessellaris* on beach ridges]. This Regional Ecosystem is *not of concern*.

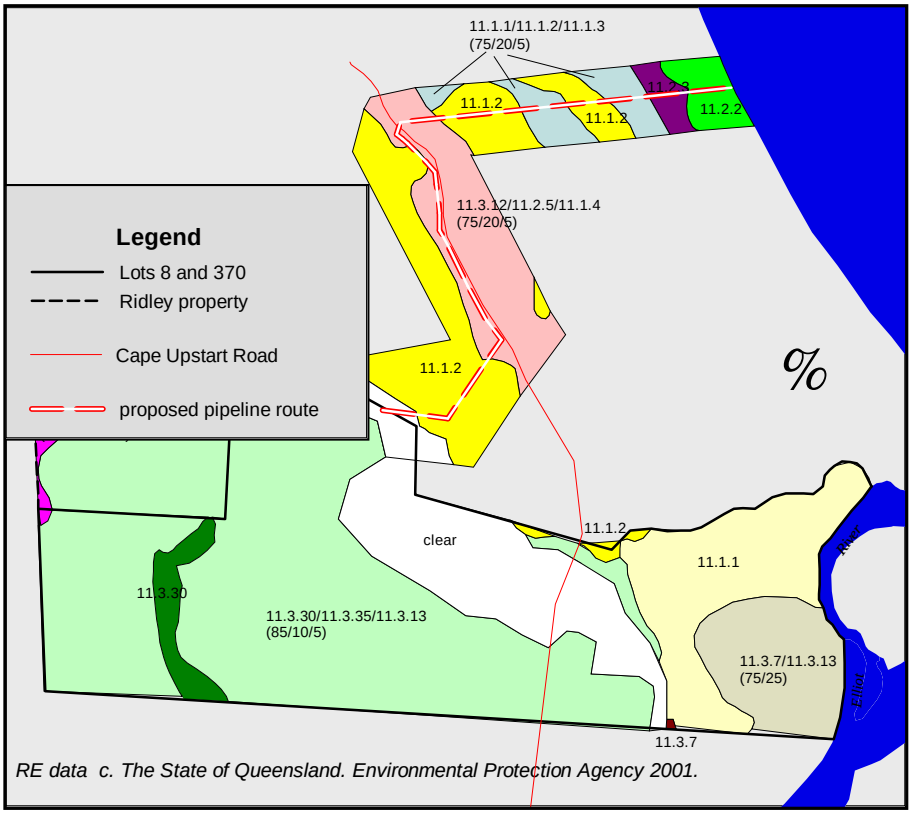

Figure 6-28
Regional Ecosystems within the main development area and along the proposed pipeline as mapped by the EPA (Thomas, 2002)

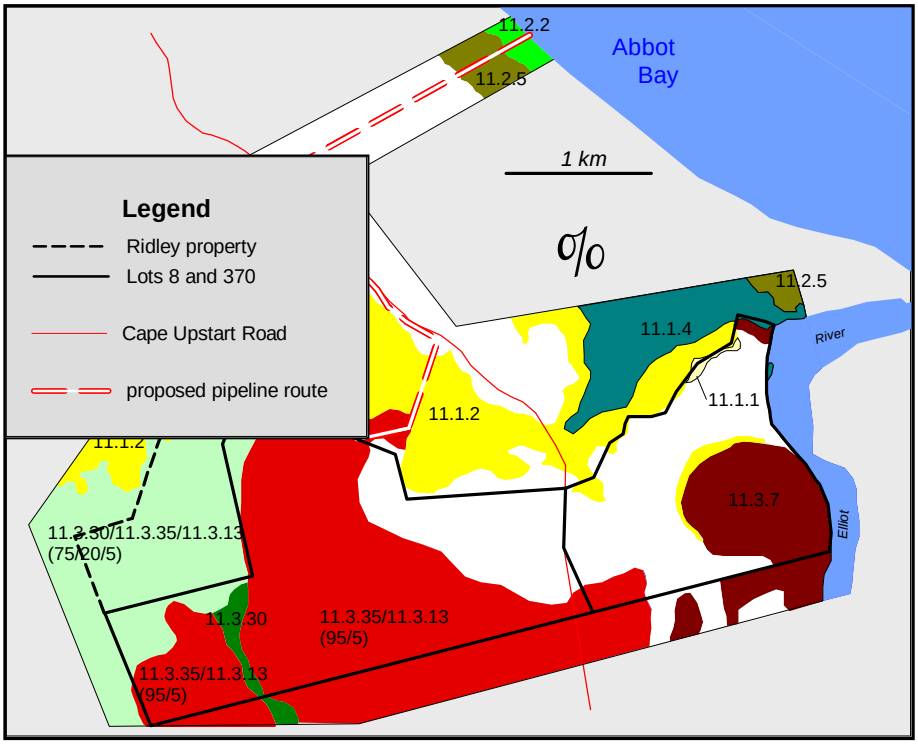

Figure 6-29
Modified map of Regional Ecosystems within the main development area and along the proposed pipeline (Thomas, 2002)

h) Wetland Areas

The intake and discharge pipeline route will traverse the Southern Upstart Bay wetland (identified as QLD009) listed on the *Directory of Important Wetlands in Australia* (Environment Australia, 2001). The wetland classification system used in the Directory identifies 40 different wetland types in three categories:

a) Marine and Coastal Zone wetlands;
b) Inland wetlands; and
c) Human-made wetlands.

Using the wetland classification system, Blackman *et al*. (2002) indicated that this wetland contains the following wetland types:

A2 Subtidal aquatic beds; includes kelp beds, seagrasses, tropical marine meadows;
A5 Sand, shingle or pebble beaches; includes sand bars, spits, sandy islets;
A6 Estuarine waters; permanent waters of estuaries and estuarine systems of deltas;
A7 Intertidal mud, sand or salt flats;
A8 Intertidal marshes; includes saltmarshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater marshes;
A9 Intertidal forested wetlands; includes mangrove swamps, nipa swamps, tidal freshwater swamp forests;

A10 Brackish to saline lagoons and marshes with one or more relatively narrow connections with the sea;
A11 Freshwater lagoons and marshes in the coastal zone; and
C1 Water storage areas; reservoirs, barrages, hydro-electric dams, impoundments (generally > 8 ha).

Figure 6-30 maps the distribution of wetland habitats in the study area using the classification scheme of Blackman *et al.* (1992). Descriptions of most of these wetlands can be found under the appropriate vegetation mapping unit in the preceding section. Wetlands from three ecological systems are present; namely, marine, estuarine and palustrine. A small area of lacustrine habitat also occurs within a farm dam on Lot 370, but is mapped as a mosaic with more extensive palustrine habitats.

Only a small area of wetland habitat occurs within the main development area comprising artificial wetland created by dams and hypersaline flats.

Wetlands are the predominant habitat along the proposed pipeline route, including natural and modified types. Hypersaline flats are the most common wetland type with a large palustrine wetland situated to the east of the Cape Upstart Road. This apparently freshwater wetland area has formed on previously hyper-saline flats due to alteration to the natural drainage patterns following the construction of a bund to the south. The far eastern portion of the pipeline route traverse dunal and beach wetlands typical of the region.

The estuarine habitats of the Elliot River and the marine habitats of Abbot Bay, dominate the habitat landscape to the east and north of the main development area. Farm dam wetlands occur on adjoining pastoral properties to the west and south of the main development area.

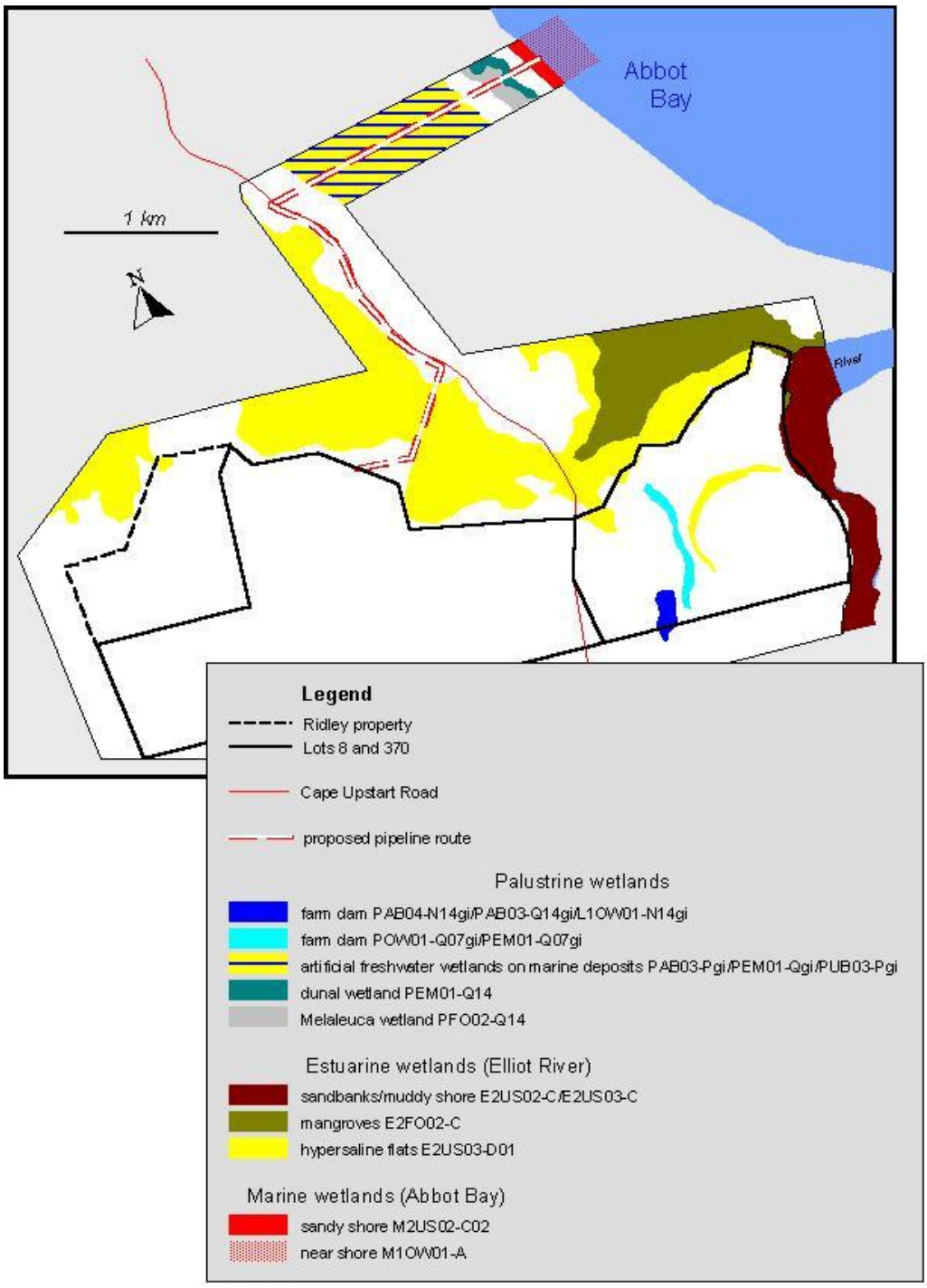

Figure 6-30
Wetland habitats occurring within the study area, identified according to the coded classification of Blackman *et al*. (1992)

i) Areas of Special Ecological Significance and Important Ecological Interactions

Main Development Area

None of the habitat areas occurring within the main development area are of particular ecological significance given their disturbed condition and abundance elsewhere in the study region. The wetlands occurring within the main development area (farm dams, hypersaline flats) are of limited spatial extent and are not expected to be of particular ecological significance, particularly given their abundance elsewhere in the study region.

An active nest of the osprey (*Pandion haliaetus*) was located in the north-eastern corner of Lot 370 in a dead eucalypt adjacent to the Elliot River. Although not a significant species under legislation, the osprey is restricted to seashore habitats and may be susceptible to disturbance of nesting habitat. Nests are re-used each breeding season. The osprey nest is regarded as a significant ecological feature. This section of Lot 370 will not be modified during construction or operation of the prawn farm.

Proposed Pipeline Route

Two ecologically significant areas occur along the eastern section of the pipeline route:

- The band of habitat types occurring on the dune complex fringing Abbot Bay; and
- The freshwater wetlands established on marine deposits.

The band of habitat types occurring on the dune complex fringing Abbot Bay provide a diversity of habitat opportunities for fauna including shrubby woodland, *Melaleuca* wetland, grassy ephemeral wetland, and foredune vegetation. While these vegetation types are not uncommon in the study region, the tract traversed by the pipeline route extends for a considerable distance northwards to Cape Upstart with little disturbance, and is of considerable extent. This corridor of dunal habitats also links the terrestrial habitats of Cape Upstart with the riparian vegetation of the Elliot River, and the small National Park patch located to the north of Lot 370. These habitats are of local significance.

The freshwater wetlands established on marine deposits (vegetation map unit 1d in Figure 6-31) are not remnant habitat features but provide extensive foraging habitat for migratory waders. Migratory shorebirds/waders such as godwits, sandpipers, plovers, snipes and egrets utilise the saltmarsh and wetland areas the proposed pipeline route will traverse. This wetland is identified as Southern Upstart Bay wetland (QLD009) listed on the directory of important wetlands in Australia (Environment Australia, 2002a).

These birds arrive in the north of Australia in September-October and return to their Siberian breeding grounds in April-May to breed. Refer to Section (c) above for the species list and JAMBA/CAMBA designations of these migratory bird species.

These wetlands extend for some 7km to the north where they merge with tidal wetlands adjacent to the Cape Upstart National Park, and also link up with the mangrove habitats of the Elliot River 2.5 km to the south.

Adjacent Areas

The main estuarine reach of the Elliot River is situated adjacent to, and downstream of the eastern boundary of the main development area and is regarded as a significant area supporting interactions with wading and fishing birds including migratory and rare species. The estuary is likely to provide significant feeding resources for these types of fauna, as evidenced by the presence of the Osprey nest on Lot 370.

6.6 Conservation and Heritage Values

6.6.1 World Heritage Values and Attributes

The development site is located adjacent to, and will discharge into, the Great Barrier Reef World Heritage Area (GBRWHA). The Great Barrier Reef World Heritage Area is the largest World Heritage Area in the world and one of just a few that meet all four natural World Heritage criteria:

Criterion (i)	An example of a major stage in the earth's evolutionary history
Criterion (ii)	An outstanding example of geological processes, biological evolution and people's interaction with their natural environment.
Criterion (iii)	A place with unique, rare and superlative natural phenomena.
Criterion (iv)	A place that provides habitats for rare and endangered species of plants and animals.

Within the Great Barrier Reef World Heritage Area (GBRWHA) particular emphasis is placed on the conservation of threatened species such as dugong, marine turtles, dolphins and whales. About 98% of the World Heritage Property is within the Great Barrier Reef Marine Park, the remainder being Queensland waters and islands. The Great Barrier Reef Marine Park was declared in 1975 with the purpose of preserving the area's outstanding biodiversity whilst providing for its reasonable use.

The prawn farm site and the adjacent area meets Criterion (ii), (iii), and (iv) as identified in Table 6-12 below.

Table 6-12
World Heritage values of the proposed site

Criterion	World Heritage Values
Criterion (ii)	The diversity of fauna and flora including: Marine reptiles; Marine mammals; Terrestrial vertebrate fauna; and Feeding grounds for international migratory seabirds and sea turtles.
Criterion (iii)	Superlative natural phenomena including: Migrating whales, dolphins, dugong, whales sharks, sea turtles, seabirds and concentrations of large fish.
Criterion (iv)	Habitats for species of conservation significance including: Seagrass beds; Mangroves; and Species of plants and animals of conservation significance.

Even though Abbot Bay meets these criteria and contains high conservation value, other areas in the Great Barrier Reef World Heritage Area (eg. Upstart Bay), have greater significance in relation to the World Heritage criteria. In particular, Upstart Bay has significant populations of Dugong and extensive seagrass meadows as it is protected from major climatic events by Cape Upstart, whereas Abbot Bay is coastal and highly dynamic and provides less protection for seagrass habitat.

6.6.2 Great Barrier Reef Marine Park Values

Marine Park Zoning

The Great Barrier Reef Marine Park is declared a (Commonwealth) Marine Protected Area, managed by Environment Australia, proclaimed under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999.*

The proposed pipeline intake and discharge site is located within the General Use 'A' zone of the Great Barrier Reef Marine Park. However the marine park boundary within Abbot Bay ceases immediately south of Camp Island at the mouth of the Elliot River (Figure 6-31). The marine park General Use zone is the least restrictive of the zones, and provides for all reasonable uses including shipping and trawling. Within General Use 'A' zone, prohibited activities include mining, oil drilling, commercial spear fishing and spear fishing with underwater breathing apparatus.

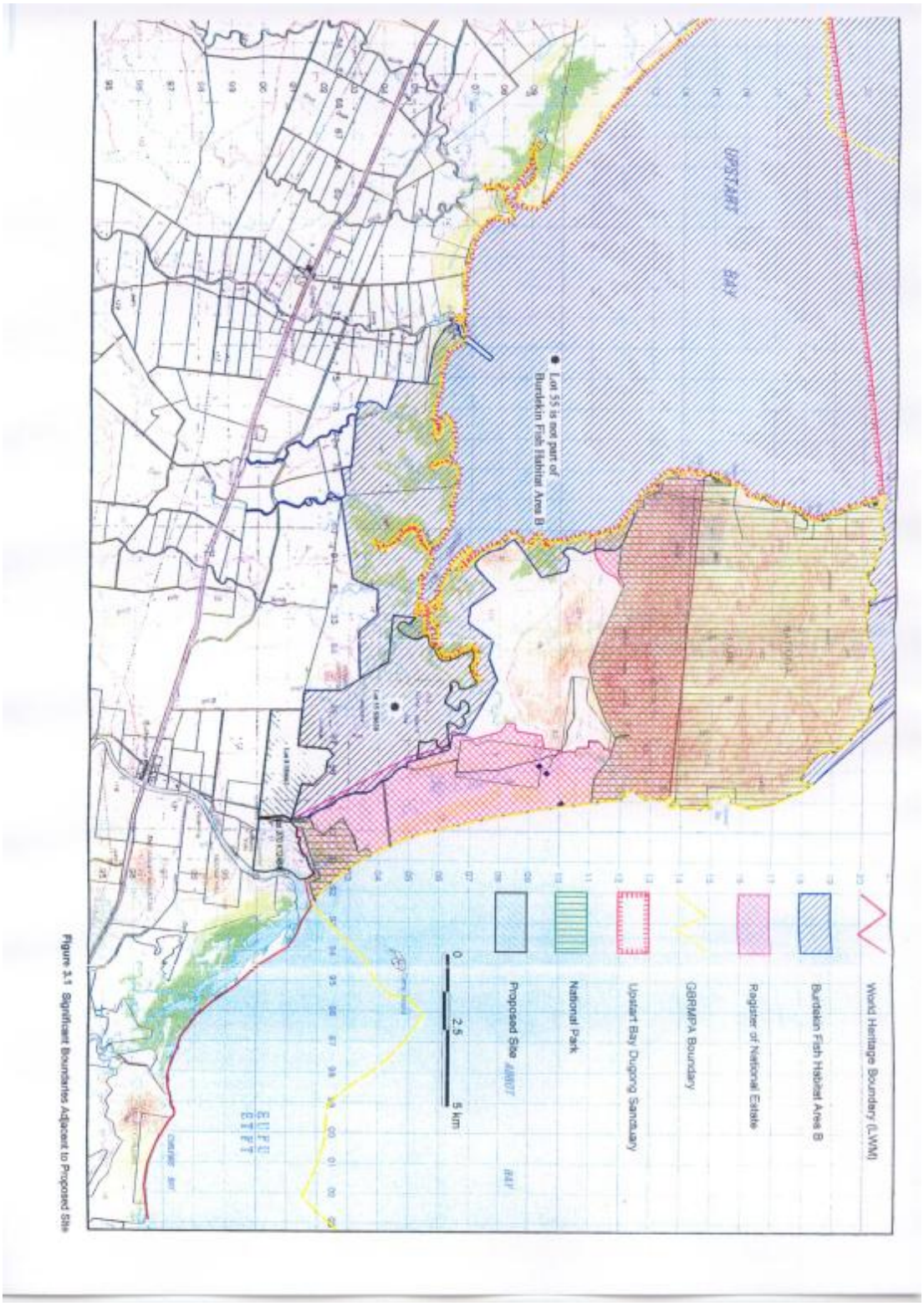

Figure 6-31
Abbot Bay and Upstart Bay marine park zoning, and the Burdekin Fish Habitat Area (Upstart Bay)

Seagrass Communities

Seagrass habitat is found throughout the Great Barrier Reef World Heritage Area: in estuaries, shallow coastal bays and inlets, coral reef platforms and in areas of more than 60 metres depth between reefs (Wachenfeld *et al.,* 1999). Fourteen (14) seagrass species occur between Cape York and Hervey Bay and most are typical of the northern Australian and Indo-West Pacific region (Lee Long *et al.,* 1993), but at least two may be endemic to north-eastern Australia (Wachenfeld *et al.,* 1999).

In the Great Barrier Reef region, the large majority of seagrasses grow no deeper than 10 metres, however high species richness occurs at depths of less than 6 metres (Lee Long *et al*., 1993). Seagrasses tend to die in some areas and colonise others fairly quickly as part of a natural cycle (Wachenfeld *et al.,* 1999). Therefore the distribution of seagrass habitat changes over time.

Seagrasses are of great ecological importance as food sources for threatened species such as dugongs and green turtles, and nursery areas for juvenile prawns and fishes (Wachenfeld *et al.,* 1999), consequently supporting local and offshore fisheries (Danaher, 1995).

Seagrass communities are also of major importance to coastal waters as they contribute large quantities of fixed carbon to coastal ecosystems (Larkum *et al.,* 1989) and play an important part in the cycling of nutrients (Kirkman, 1997). Many beaches, channels and sandy bottoms are stabilised by the spread of seagrass rhizomes through the prevention of underlying sediment movement (Kirkman, 1997).

The seagrass communities of Abbot Bay are not as extensive as other areas in the vicinity such as Upstart Bay to the north and Edgecumbe Bay to the south. Both of these areas have been classified as Fish Habitat Areas and Dugong Protection Areas. Therefore, in relation to these areas, Abbot Bay has a low to moderate overall conservation value for seagrass habitat. Refer to Section 6.5 – Abbot Bay Marine Ecology for discussion on Abbot Bay seagrass distribution.

Dugongs

The Dugong (*Dugong dugon*) is listed in the IUCN Red List of Threatened Animals (IUCN 1996) and on the (Queensland) *Nature Conservation (Wildlife) Regulation 1994* as being vulnerable to extinction.

Dugongs have a wide geographical distribution in shallow tropical and subtropical waters of the Indo-Pacific region. Their range includes waters of forty-three (43) different countries, and extends from eastern Africa to Vanuatu and between 27° north and 27° south of the equator (GBRMPA, 1994). However, many dugong populations are relict or extinct (GBRMPA, 1994).

Most of the world's dugongs are found in Australian waters between Shark Bay in Western Australia and across the north to Moreton Bay in Queensland. Of the 80,000 or so dugongs in Australia, about 12,000 occur in the Great Barrier Reef World Heritage Area (GBMPA, 1994).

Dugongs feed predominantly on seagrasses and show a preference for species of the genera *Halophila* and *Halodule* (Oliver and Berkelmans, 1999). These species are considered pioneer species and are low in fibre, high in available nitrogen and very digestible.

Insufficient information exists to adequately determine the relationship between dugong feeding behaviour and seagrass food sources. However the species of seagrass, its location and the tidal range of the area, the depth of the seagrass and the seasonality of the seagrass growth rate are all important factors (Oliver and Berkelmans, 1999). For example, a seagrass bed at 10 metres may be a food source for an adult dugong but not suitable for a neonatal calf (Oliver and Berkelmans, 1999). Therefore a relatively small but suitable area of seasonal *Halophila* may be far more important in the dugong life cycle than anticipated by aerial surveys of animal distribution (Oliver and Berkelmans, 1999).

Dugongs are present in Abbot Bay however the seagrass communities of the Bay are not as extensive as other areas in the vicinity such as Upstart Bay to the north and Edgecumbe Bay to the south. Marsh and Penrose (2001) confirm that dugong sightings in Abbot Bay are far less than those in Upstart Bay and Edgecumbe Bay suggesting that these two bays have a far greater importance in dugong conservation than Abbot Bay.

Therefore, in relation to these areas, Abbot Bay has a moderate overall conservation value for dugong habitat. Refer to Section 6.5 for discussion on Abbot Bay seagrass distribution.

Marine Turtles

Six (6) species of marine turtle live in the waters around Australia, and all are found within the Great Barrier Reef World Heritage Area (Limpus, 1997). The Green, Loggerhead, Hawksbill and Flatback Turtle are seen frequently in the Great Barrier Reef Marine Park, while the Olive Ridley and Leatherback Turtle, are known to occur in the park but are seldom seen (Dobbs, 2001).

Marine turtles are recognised internationally as species of conservation concern, and all species occurring in the Marine Park are listed on the EPBC Act, NCWR 1994 and in the 1996 IUCN (World Conservation Union) Red List of Threatened Animals (Dobbs, 2001). The migratory nature of turtles, as they travel across state and international boundaries, makes them a nationally and internationally shared resource (GBRMPA, 1994).

All of these species may potentially occur in the waters adjacent to the prawn farm site, however, only moderate levels of Flatback turtle nesting has been recorded for Abbot Bay (Limpus, 2002). As the seagrass meadows of Abbot Bay are not as extensive as other areas in the vicinity, the importance of the bay to Green Turtles would be low to moderate.

Therefore Abbot Bay would possess a moderate conservation value for turtle habitat.

Cetaceans

Over thirty (30) species of whale and dolphin visit the Great Barrier Reef World Heritage Area, of which four (4) species are listed as endangered or vulnerable under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (GBRMPA, 2000). Cetaceans are recognised among the World Heritage values of the Marine Park and are also protected under the (Commonwealth) *World Heritage Properties Conservation Act 1983*.

Some species of cetacean are frequently seen in the Marine Park, such as Humpback Whales, Dwarf Minke Whales and Bottlenose Dolphins, while others such as Killer Whales or Common Dolphins are rarely seen but are known to occur in the Park (GBRMPA, 2000).

While protected in the waters of the GBRWHA, globally, the 1996 IUCN Red List ranks the Humpback as Vulnerable. Humpbacks come into the waters of the World Heritage Area in winter to calve before returning to summer feeding grounds in Antarctica.

Large-scale whaling in the 1940's, 1950's and early 1960's were thought to have reduced the population of Humpback Whales from 10,000 animals down to between 200-500 individuals. Since the 1970's whales have been protected in Australian waters and their numbers are on the increase with a 1996 survey putting the figures at 3,185 animals (GBRMPA, 2000).

Abbot Bay is not a known significant area for whales as the bay is reasonably shallow and it is likely that larger whales would migrate further out to sea. Dolphins would occur in Abbot Bay however it is not a known significant site for them. Therefore the conservation value of Abbot Bay to dolphins and whales would be low.

6.6.3 Wetlands of International or National Importance

The development site is located immediately to the south of the Southern Upstart Bay wetland (QLD009) and approximately ten (10) kilometres northwest of the Abbot Point - Caley Valley wetland (QLD001), (see Figure 6-32). Both wetlands are listed on the directory of important wetlands in Australia (Environment Australia, 2002a).

Southern Upstart Bay Wetland

Southern Upstart Bay wetland is an extensive low lying coastal plain area containing a complex of marine, estuarine and fresh or brackish water areas with interspersed sand ridges of siliceous sands. It is drained by the Elliot River, Station Creek and other smaller streams, all of which are strongly seasonal and dry out in the fresh water parts by mid year. Upstart Bay is considered to be an estuary of high fisheries value. Bunds constructed at the southern end of the swales that occur south of The Cape homestead increase the areas of freshwater available and isolate the lower lying areas from saltwater incursion. Extensive stands of semi deciduous notophyll vine forest occur between the swamp and the beach on sand ridges.

The proposed site for the intake and discharge pipeline traverses through this wetland area. This wetland contains a high conservation value as it is relatively undisturbed and provides habitat for migratory waders.

Abbot Point - Caley Valley Wetland

Abbot Point - Caley Valley wetland comprises a complex continuous wetland aggregation (Blackman *et al.,* 1992) of subtidal and intertidal marine and estuarine wetlands, with a large fresh and brackish water wetland within an artificial impoundment. The catchment for the area is a portion of the Salisbury Plain and the slopes of Mount Roundback and Mount Little immediately to the south. Spring, Table Top, Main and Mount Stuart creeks drain into Curlewis Bay to the northeast, while Six Mile, Goodbye and Saltwater creeks drain into the impounded area.

This wetland does not occur within or adjacent to the prawn farm site therefore its conservation value to the area has not been assessed.

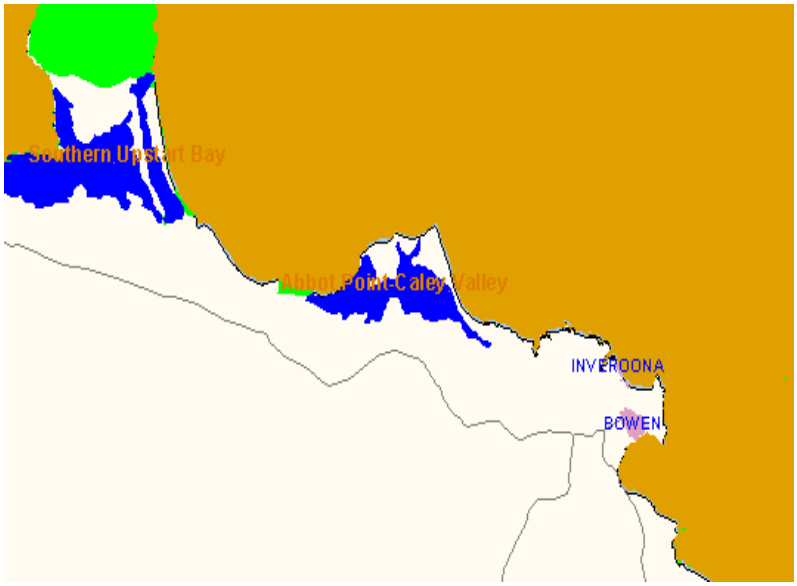

Figure 6-32
Southern Upstart Bay and Abbot Point-Caley Valley Wetlands

6.6.4 Fish Habitat Areas

Fish Habitat Areas in Queensland, both tidal and freshwater, are declared and managed by the Department of Primary Industries under the (Queensland) *Fisheries Act 1994* and the *Fisheries Regulation 1995*. These habitats include sand bars, shallow water areas, undercut banks, snags, rocky outcrops, pools, riffles, seagrass beds, mangrove stands, yabby banks etc.

The development site and the proposed pipeline intake and discharge site are not located within a declared Fish Habitat Area (FHA). The Burdekin Fish Habitat Area (FHA005), located in Upstart Bay (Figure 6-31), is the nearest FHA to the development site. The management designation of FHA005 is type 'B'.

Management provides for community use and enjoyment of the area, such as commercial and recreational fishing and boating, while restricting activities such as dredging, reclamation, discharging and drainage which may negatively affect the fisheries and habitat values of the area.

This Fish Habitat Area contains a very high conservation value for the area as it provides habitat for dugong, green turtles and acts as a nursery ground for fish.

6.6.5 Dugong Protection Areas

The development site and the proposed pipeline intake and discharge site are not located within a Dugong Protection Area (DPA) declared under the (Queensland) *Nature Conservation Act 1992*.

The nearest Dugong Protection Area is the Upstart Bay Dugong Sanctuary, classified Zone ‘A’ protection area (see Figure 6-33).

Zone 'A' protection areas include significant dugong habitats in the southern Great Barrier Reef. In these areas, the use of offshore set, foreshore set and drift nets are prohibited, except in Hervey Bay and Great Sandy Strait sanctuaries where specialized fish netting practices are allowed to continue with modifications. The use of river set nets are allowed with modifications in zone 'A' DPAs, except in two key areas where river set nets are prohibited (Hinchinbrook and Shoalwater Bay DPAs). Other netting practices such as ring, seine, tunnel and set pocket netting which are not considered to pose a serious threat to dugong are unaffected.

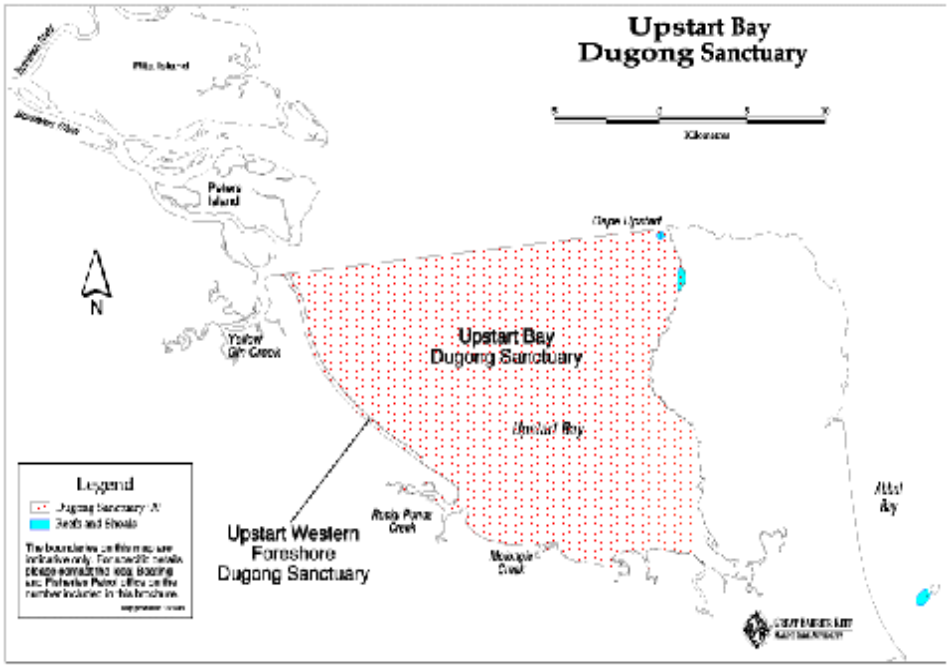

Figure 6-33
Upstart Bay Dugong Sanctuary

6.6.6 National Parks

The development site is located immediately south of Abbot Bay Resources Reserve (151 hectares), and approximately 10 kilometres to the south of Cape Upstart National Park (NP135), (8,480 hectares), (see Figure 6-31).

Both national parks possess a high conservation value as they contain threatened regional ecosystems. Cape Upstart National Park would also contain scenic values.

6.6.7 Places listed on the Register of the National Estate

The site is adjacent to two registered National Estate sites in the vicinity of Guthalungra township. These include Cape Upstart Lowlands National Estate, and Cape Upstart National Park. Both National Estate sites are listed within the “natural” class.

Cape Upstart Lowlands National Estate

Cape Upstart Lowlands National Estate (approximately 5,000 hectares), is located six (6) kilometres north of Guthalungra. The Australian Heritage Commission (2002) has determined that this place has Indigenous values of National Estate significance. Therefore this site contains a high conservation value.

The southern boundary of the Cape Upstart Lowlands National Estate adjoins the north-eastern section of the development site (Lot 370 K124848). The proposed site for the intake and discharge pipeline traverses through this National Estate site.

Cape Upstart National Park

Cape Upstart National Park, is located eighteen (18) kilometres north of Guthalungra, and comprises the northern portion of the peninsula, excluding Guthalungra township and Recreation Reserves and a small area at Coconut Bay. It is possible that Indigenous cultural values of National Estate significance may exist in this place (AHC, 2002). Therefore this site contains high conservation value.

Other Places listed on the Cultural Heritage Register

According to the Environmental Protection Agency there are no other places listed on the cultural heritage register as maintained by this Government Department.

6.7 Social & Economic Environment

6.7.1 Profile of Impacted Communities

Existing Socio-Economic Environment

In response to local council and state government economic development initiatives, a number of reports have been produced to map the strategic future of development in Bowen and in particular the aquaculture industry. Additionally, the State Government has identified the growth opportunities of aquaculture in rural Queensland and as a result has undertaken a number of studies and commissioned several reports.

The following studies are of relevance to this socio economic study:

- Identification of Prawn Farm Opportunities in the Bowen Region, Department of State Development & Bowen Collinsville Enterprise Group Inc., May 2002;
- Regional Community Report, The Bowen Region September 2002, Office of Economic and Statistical Research, Queensland Treasury;
- Queensland Regional Profiles Northern Statistical Division June 2001, Office of Economic and Statistical Research, Queensland Treasury;
- The Economic Impact of Aquaculture on the South Australian State and Regional economies, 200/01, EconSearch Pty Ltd for Primary Industries and Resources South Australia September 2002;
- The Economic Impact of Aquaculture on the Queensland Economy, Queensland Department of State Development February 2001;
- Bowen Shire Economic Profile 2002 Bowen Collinsville Enterprise Group Inc., 2002;
- Bowen Aquaculture Development Project - Project Outline Bowen Collinsville Enterprise Group Inc;

- Draft Bowen Aquaculture Industry development Project Plans, Bowen Collinsville Enterprise Group Inc., 2002;
- Economic Development Strategy for Bowen Shire, Gibson Associates 1998;
- The Bowen Shire Recreation and Sport Plan, Bowen Shire Council & Sport & Recreation Queensland Final Report, EDAW, September 2000;
- Bowen Shire Tourism Development Action Plan, Bowen Collinsville Enterprise Group Inc., Rob Tonge & Associates September 2001;
- Whitsunday Hinterland and Mackay WHAM 2015 Draft Regional Plan Queensland Department of Local Government and Planning, May 2002;
- Bowen Shire Council Planning Scheme, Gutteridge Haskins & Davey, 1998;
- Basic Community Profile – Bowen (s) 340100950, Australian Bureau of Statistics (ABS) Census 2001, 2002;
- Basic Community Profile – Guthalungra (s) 3050408, Australian Bureau of Statistics (ABS) Census 2001, 2002;
- Basic Community Profile – Queensland (s), Australian Bureau of Statistics (ABS) Census 2001, 2002;

Local Government Area

The study area for the purpose of the social impact assessment is defined as the local government area of Bowen.

The benefits associated with construction and operation of the Guthalungra prawn farm are likely to centre on Bowen Shire with some impact on the adjacent Burdekin and Whitsunday Shires.

The Bowen Shire

Bowen Shire is a rural shire of some 21 000 km^2 halfway between Mackay and Townsville, running from the coast to the inland highway. The principal towns of the shire are Bowen on the coast and Collinsville some 85 km inland. The shire has a population of around 12700 of which around 8,500 reside in Bowen, 1,800 in the Collinsville region and the remainder in the rural areas of the shire.

Historical Context

The following has been taken from the Economic Development Strategy for Bowen Shire 1998:

Since the 1860's the potential of Bowen Shire for development has been widely recognised. Apart from its large well protected harbour and its climate and coal resources, it has substantial areas suitable for agricultural and horticultural development and access to water resources. In spite of these natural attributes, the Shire has never fulfilled its promise.

Whilst agriculture has remained a major employer, the combination of limited rainfall and poor commodity growth have restricted the industry's opportunity for growth. An already difficult position was exacerbated by the recent closure (1998) of the meat works at Merinda, with the resultant lay-off of some 400 people.

The towns' tourism industry remains relatively static and is substantially confined to a fairly narrow, low cost and declining market.

The restructuring of the Collinsville coal mine has led to the operation stabilising with a reduced workforce and becoming established as one of the leading operations in Queensland in terms of profit and productivity.

Influences on the culture of the area include the early establishment of pastoral stations that initially grazed sheep then cattle. Development in Bowen did not match the early growth in other areas of Northern Queensland because of the unreliability of access to water caused by flooding of the Burdekin and other waterways.

As a result there was little major infrastructure investment. In recent times a coal loading facility has been constructed to service the production from the Collinsville coalmine. The mine production has reduced and is currently at 15 million tonnes per annum.

Industry within the Bowen shire was historically dominated by coal mining, power generation meat processing horticulture, fishing and railways. Over time the economic significance of these industries has changed dramatically.

Whilst still significant industries to Queensland, the coal mining power generation and railway support industries no longer employ significant quantities of people which has reduced their economic importance to Bowen shire.

6.7.1.1 Guthalungra Profile

Guthalungra is located 40 km north of Bowen in the central part of the Shire. Guthalungra itself comprises a roadhouse and a collection of grazing properties. A property near to the proposed prawn site adjacent to the roadhouse produces rock melons on around 500 hectares of land. The Cheetham saltworks is located adjacent to the Pacific Reef property however it is no longer operational. There are a number of temporary residential huts located on the south bank at the mouth of the Elliot River.

The Gumlu horticulture region is located around 15 km north of Guthalungra (see below). Fruit and vegetable production has expanded quite rapidly in the Bowen Shire in recent years. Both an expansion of area farmed and an intensification of production have enabled increases in production. However production from Guthalungra remains very low.

6.7.1.2 Industry Profiles

The following highlights the status of the existing industries operating in the Bowen Shire.

Table 6-13 illustrates the dependence on agriculture and fishing. Currently the horticulture industry is the largest employer in the Bowen shire, which together with the other agriculture sectors and the fishing industry employed 1,609 people at the 2001 census.

Table 6-13
Numbers employed in Bowen Shire by Industry

Industry	1986	1991	1996	2001
Agriculture, Forestry & Fishing	1131	1308	1621	1609
Mining	651	563	279	264
Manufacturing	561	563	552	250
Electricity, Gas & water supply	187	42	44	67
Construction	247	281	248	268
Wholesale & Retail Trade	777	892	1011	1016
Accommodation, Cafes & Restaurants	219		256	258
Transport & Storage	647	434	345	336
Communication services	64	33	29	72
Finance Insurance Property & Business Services	223	234	295	205
Government Administration & Defence	189	184	163	174
Education Health & Community Services	273	629	666	714
Cultural & Recreational Services	26		46	39
Personal & other services	77	331	111	120
Non-classifiable economic units	25	21	91	13
Not Stated	146	387	136	108
Total	5643	5902	5893	5,513

Source: ABS 2001 Census
Regional Community Report The Bowen (S) Region September 2002
Bowen Shire Economic Development Strategy, 1998

Horticulture

Bowen is well known for its production of tomatoes and is the largest tomato-producing region in Queensland. In 1998/99 tomatoes with a value of $59.5m followed by capsicum at 30.5m were produced. This had grown to $104m and $48m respectively by 2000.

The fruit and vegetable crops grown in the Bowen Shire bring in many millions of dollars to the shire. Through increasing the area under cultivation, and the yields and thus the volume, the value of these crops grew from $85 million to $125 million in the three years to 1995. Despite predictions that the trend to increasing area yield and volume would be reversed for Bowen Shire in 1998, output has continued to grow to around $230 million in 2000 (Bowen Shire Economic Profile, 2002).

Most of the crop production is concentrated around Bowen itself although a significant concentration of production is located around Gumlu. In 1992/93 Bowen had 4,397 ha of various crops under cultivation whilst Gumlu had 476 ha and a smaller range of crops. In 1996 both Bowen and Gumlu had increased the area under cultivation to 6,125 and 1,327 ha respectively giving 7,452 ha in total. By 2000 the total area under cultivation had not substantially increased at 7,683 ha indicating that intensification and improved irrigation techniques had assisted the growth.

Farming and processing of crops at the current level of production provides employment for around 1,500 skilled and unskilled workers on a largely seasonal basis. Itinerant labour is used extensively to satisfy the seasonal nature of employment in the Bowen Shire horticulture sector.

The crops grown in the Shire are shown in Table 6-14. The largest cropped area is for tomatoes followed by capsicums and chillies. Mangos, rock melons and honeydew also are important crops. Table 6-14 also provides information on the products grown and returns to the sector.

It would appear that the expansion of horticulture in the Bowen region is now limited to the area currently under cultivation due to limited water supplies. The current growers are concerned at the increasing salinity of water supplies.

Table 6-14
Bowen Shire Horticulture Production 2000

Crop	Area Grown (ha)	Estimated Tonnes/ha	Tot Production Tonnes	Return per Tonne ($)	Gross Return ($)
Beans	1860	5	8370	2281	19092000
Capsicums	1598	20	31960	1502	48002000
Chillies	33	40	1320	4292	5665000
Cucumber	67	35	2345	1143	2680335
Egg Plant	62	50	3100	1420	4402000
Honey Dew	155	40	6200	886	5493200
Okra	15	35	525	4996	2622900
Pumpkin	367	24	8808	436	3840288
Rockmelon	340	30	10200	820	8364000
Sweet corn	831	12	9972	1073	10699956
Squash	10	35	350	2571	899850
Tomatoes	1900	40	76000	1377	104652000
Watermelons	365	50	18250	485	8851250
Zucchini	80	35	1800	1396	3908800
Total	7683		180200		229175800

Source: Bowen Shire Economic Profile, 2002

Agriculture

Bowen produced around $160m worth of agricultural product in 1998/99 or almost 25% of the regions total output. Bowen livestock production was worth $30.5 million or 19.3% of the regions total agricultural output in 1998/99. It is interesting to note that around 95% of the land area of Bowen Shire is Zoned Rural Grazing. As the value of production from the grazing sector has remained static at around $30 million in the intervening years, its value relative to the rest of the agriculture sector has dropped to around 11%.

Mines

Two mines are located in Bowen. The mines are located at Collinsville and Newlands and supplying high quality coking and thermal coals to both domestic and export clients.

In 2000/01 an estimated 15 million tonnes of coal will be produced in the shire, with 10.8 million tonnes being shipped to export clients via the Port of Abbott Point.

Bowen also has a coking plant that produces coke for MIM smelter operations in Mount Isa and other areas.

Power Station

The Queensland State Government shut down the Collinsville Power Station in 1988. It was then sold in the mid 1990's. The refurbishment by the new owners was completed in 1998 and a contract with the Collinsville coal mine will see it supplied with coal for the next 14 years. The refurbishment has meant that the station is largely automated and requires a staff of around 32 to operate.

Seafood

According to local fishermen and processors the port of Bowen is the centre of a $10m fishing industry (pers comm. QSIA, 2002). The Bowen Shire Economic Profile (Bowen Collinsville Enterprise, 2002) indicated that over 300 tonnes of live reef fish is exported from the port each year from a total catch of 3000 tonnes.

Switala and Taylor-Moore (1999) reported that in 1996-97 the Gross Value of Production (GVP) for the port of Bowen was estimated at approximately $5.7million and 62 boats were registered. Line fishing was cited as the main fishery at Bowen with 31 Licence Packages (50%) relying on line fishing for most of their GVP. Trawling was the next largest activity with 19 Licence Packages (31%), followed by netting with 9 (15%) and crabbing with 3 (5%). Overall, 48 Licence Packages at Bowen (77%) fished locally.

Despite recent reductions in the Queensland trawl fishery and the restrictions on the reef line fishery, there are three processing facilities in operation in Bowen. A range of products are landed in Bowen from vessels that may not have been fishing in the vicinity of the Port. Catches include a variety of fish and shellfish as detailed in Section 6.7.

6.7.1.3 Demography

Population

On Census night, 7 August, 2001, there were 13698 people (7163 males and 6535 females) counted in Bowen (ABS Census Data, 2001). This represents a decrease of 713 people (4.9%) since the 1996 census, and a decrease of 463 people (3.3%) since the 1991 Census.

At 30 June 2001 the estimated resident population of the Bowen region was 12,648 persons, representing 0.3% of the state's population. The annual average rate of change in population in the Bowen (S) region between 30 June 1996 and 30 June 2001 was -0.8 %, compared with 1.7 percent for the state.

Table 6-15
Estimated resident population, Bowen Shire region 30 June 1996, 1999, 2000, 2001

	Region	Queensland	Region as a % of Qld
	Number		%
Area (km2)	21,177	1734190	1.2
1996	13,142	3,338,690	0.4
1999	12,803	3,512,356	0.4
2000	12,679	3,566,357	0.4
2001(preliminary)	12,648	3,627,816	0.3
Annual ave change %	-0.8	1.7	
	-0.2	1.7	

Source: OESR Regional Community Report - Bowen Region September 2002
ABS 2001 Census

Future Population Trends

Population projections published by the Department of Local Government and Planning in 2001 indicate that the population of the Bowen (S) region will decline from 12,585 in 2001 to 11,471 in 2021.

The annual average growth rate between 2001 and 2021 in the Bowen region is projected to be –0.5 %. This compares with an annual average growth rate of 1.6 % for the state. As a result, the regions share of Queensland's population is projected to be 0.2 % in 2021 compared with 0.3% in 2001.

Table 6-16
Population projections, medium series, Bowen region and Queensland 2001 to 2021

	Region	Queensland	Region as a % of Qld
	Number		%
2001	12,585	3,628,081	0.3
2006	12,143	3,962,034	0.3
2011	11,812	4,297,745	0.3
2016	11,584	4,632,195	0.3
2021	11,471	4,964,404	0.2
Annual average growth rate 2001-2021 (%)	-0.5	1.6	

Source: OESR Regional Community Report - Bowen Region September 2002

Age and Gender Structure

The median age of people in Bowen Shire in 2001 was 40 years. In 1996 it was 36 while in 1991 it was 33. In 1991, 24.3% of persons were aged 0 to 14 years and 65.5% were aged 15 to 64. By 2001 the proportion of persons in these age groups was 21.5% and 64.7 % respectively. In the Bowen region, older persons (those aged 65 years and over) represented 10.2% of the estimated resident population in 1991 compared with 13.8% in 2001. More up to date data for 2001 is provided in Table 6-17 and Table 6-18.

Table 6-17
Census Counts by Sex

	2001	1991	% Change 1991 – 2001
Male	7,163	7,435	-3.7
Female	6,535	6,726	-2.8
Total	13,698	14,161	-3.3

Overseas visitors are included in these counts
Source: ABS 2001 Census

The census figures highlight the trend towards an aging population in Bowen Shire. The shire is expected to maintain higher proportions of older people than the state average. It is also expected that the ratio of male to female in the population will decrease as the population ages. Table 6-18 supports this expectation; it is consistent with the gender profiles of older populations where women tend to live longer than men.

Table 6-18
Age by Sex

	0-14 years	15 - 24	25 – 44	45 - 64	65 & over	Total
Male	1,406	803	1,853	1,888	1,079	7,029
Female	1,219	687	1,707	1,689	1,103	6,405
Total	2,625	1,490	3,560	3,577	2,182	13,434
Percent	20	11	26	27	16	100

Note Overseas visitors are excluded from these counts
Source: ABS 2001 Census

People of Aboriginal and Torres Straight Origin

There were 748 people (5.6%) (387 males and 361 females) in Bowen Shire who were identified as being of indigenous origin in 2000. This represents an increase of 53 people (7.6%) (22 males and 31 females) since 1996 and an increase of 234 people (46%) (128 males and 106 females) since 1991.

In 1996 there were 695 people (4.9%) (365 males and 330 females) who identified as being of Indigenous origin, and 514 people (3.7%) (259 males and 255 females) in 1991 (ABS Census, 2001).

Ethnic Origin

For the 2001 Census, 10894 people (81%) stated they were Australian-born. This compares to 11,798 people (93%) in 1996 and 12312 (88%) in 1991. The number of people born overseas was 1,680 (13%) compared with 1,699 (12%) in 1996 and 1,437 (10%) in 1991.

Of those born overseas, the three main countries of birth were:

- United Kingdom 471 (3.5%);
- New Zealand 400 (3.0%); and
- Philippines 81 (0.60%).

(Source: 2001 Census)

Household Structure

Household structure in the region does not show a marked variation from the State as a whole. There is a lower number of couple families than the Queensland average, 43% in Bowen compared with the State average of 45% and a higher proportion of couple families without children, 42 % in Bowen compared with 37% in Queensland. Also, the percentage of lone person household is higher in Bowen (9.6%) compared with the Queensland Average (8.7%).

The figures possibly reflect a higher representation of older families whose children have left home, or where one member of the family is deceased.

Education Levels

The Bowen region educational levels were lower than Queensland as a whole with one exception; there were a greater proportion of resident individuals with a skilled vocational qualification than the State average.

Of persons aged 15 years and over with a qualification in the Bowen region at the time of the 1996 census, 12.9% had a bachelor degree and 39 % had vocational qualifications. The equivalent census figures for Queensland as a whole were 22% of persons with a qualification had a bachelor degree or higher and 35 % of persons with a qualification had vocational qualifications.

Gibson and Associates (1998) indicated that the greatest number of skilled vocational qualifications is in the engineering fields; this continues to be the case in 2001 (ABS Census, 2001). Bowen Shire Council (Bowen Collinsville Enterprise, 2002b) suggest that there is evidence of significant underemployment in the Bowen Shire, with many qualified people employed in seasonal industries. The 2001 Census figures suggest that the Shire has a good base of workers with trade qualifications.

Job opportunities in regional centres do not tend to be in areas where higher-level degrees are a prerequisite. It is noticeable that in the 2001 Census the greatest concentration of qualified workers are those with a skilled vocational qualification in the engineering field (931 people).

Table 6-19
Highest post school Educational Qualifications Bowen Region and Queensland

Qualification	Region		Queensland
	Number	%	%
Higher degree	27	0.9	2.5
Postgraduate diploma	60	1.9	2.6
Bachelor degree	319	10.1	16.9
Undergraduate diploma	153	4.9	7.9
Associate diploma	139	4.4	5.8
Skilled vocational	101	33.0	29
Basic vocational	186	5.9	6
Inadequately described	62	2	2.1
Not stated	1163	36.9	27.1
	3150	100	100

Source: OESR Regional Community Report - Bowen Region September 2002

Labour Force

The total number of employed people in Bowen shire at the 2001 Census was 5,535 (3,144 males and 2,391 females) representing 92.6% of the labour force.

Table: 6-20
Labour force status: Employed 2001

	Employed, working			Total
	Full-time (a)	Part-time	Not stated (b)	Employed
Male	2,444	578	122	3,144
Female	1,262	1,040	89	2,391
Total	3,706	1,618	211	5,535

Source: ABS 2001 Census

The overall unemployment rate in the Bowen at the 2001 Census was 444 representing 7.4% of the labour force. This compares with 8.2% for the State.

Table 6-21
Labour force status: Unemployed and not in the labour force

	Unemployed looking for					
	Full-time work	Part-time work	Total Unemployed	Total Labour force	Not in the Labour Force	Not stated (b)
Male	256	38	294	3,438	1,897	293
Female	99	51	150	2,541	2,403	244
Total	355	89	444	5979	4,300	537

Source: ABS 2001 Census

Employment by Sector

At the time of the 1996 Census, "labourers and related workers" was the occupation with the largest number of employed persons in the Bowen region on a usual residence basis (1406 persons or 26.1% of employed persons). Other occupations with relatively large numbers of employed persons included intermediate production and transport workers (737 persons or 13.7%), tradespersons and related workers (627 persons or 11.6 %) and intermediate clerical, sales and service workers (547 persons or 10.2%).

The highest degree of specialisation in the region occurred in the labourers and related workers and intermediate production and transport workers occupations. Of persons employed in the Bowen region 26.1% were employed in the labourers and related workers occupation compared with 9.8 % for Queensland as a whole. The proportion of persons employed in the intermediate production and transport occupation was 13% while the proportion for Queensland was 9.1%.

Table 6-22
Employment by Sector

Occupation	Region		Queensland	Specialisation
	Number	%	%	Ratio (b)
Managers & administrators	537	10	8.7	1.1
Professionals	409	7.6	15	0.5
Associate professionals	441	8.2	11.5	0.7
Tradespersons & related workers	627	11.6	13.7	0.8
Advanced clerical & service workers	130	2.4	4	0.6
Intermediate clerical, sales and service workers	547	10.2	16.3	0.6
Intermediate production and transport workers	737	13.7	9.1	1.5
Elementary clerical, sales and service workers	398	7.4	9.5	0.8
Labourers and related workers	1406	26.1	9.8	2.7

Occupation	Region		Queensland	Specialisation
Inadequately described	39	.7	.8	0.9
Not stated	114	2.1	1.6	1.3
Total	5385	100		1

Source; OESR Regional Community Report - Bowen Region September 2002
Specialisation ratio – Ratio of the percentage employed in the Bowen (S) region to the percentage employed in Queensland

6.7.1.4 Regional Economic Activities

Coal mining power generation, meat processing, horticulture, fishing, and railways historically have dominated industry in the Bowen Shire. Over time the economic significance of these industries has changed dramatically.

Whilst still significant industries to Queensland, the coal mining, power generation, and railway industries no longer employ significant numbers of people, this has reduced their importance to the Shire.

Agricultural Production

The total gross value of agricultural production in the Bowen Shire for the 1998/99 financial year was $159.1 million, representing 2.5% of the Queensland total. Crops comprised 78.2% of the regional total, while livestock disposals comprised 20.9% of the total and livestock products comprised 0.9%.

Table 6-23
Gross value of agricultural products Bowen region and Queensland 1998/99

	Region	Queensland	Region as a % of Queensland
	$m		%
Crops	124.4	3,542.8	3.5
Livestock disposals	33.2	2,274.2	1.5
Livestock Products	1.5	567.3	0.3
Total	159.1	6,384.3	2.5

Source: OESR Regional Community Report - Bowen Region September 2002

The traditional primary industries of cattle production, horticulture and fishing remain important to Bowen shire. Other significant industries are the manufacturing and retail industries. The industries that employ least people are the services such as communication service culture, and recreational services, and electricity gas and water supply.

Over time it can be seen that, whilst agriculture and fishing has remained fairly constant as a source of employment, the importance of mining, electricity, gas and water, transport and storage, and government administration and defence has decreased.

A category that has grown in importance, as a source of employment is the wholesale and retail trade. Other categories that have also grown to employ more people include services such as financial, insurance, property, and business services, education, health and community services, cultural and recreational services, and other services.

Regional Values

Like rural communities elsewhere in Queensland it is likely that the values of the inhabitants of Bowen are largely determined by the primary industries that have maintained the basis for the majority of employment and economy in the region over many years. The social structure, values, and aspirations of the region will be driven by this agronomic dominance.

Additionally the changing profitability of the primary sector and in particular commodity production of products such as sugar and beef, which is subject to the volatility and competition in the global market, has had an impact on individual confidence and personal attitudes in the region (Refer to Section 10 – Consultation).

6.7.1.5 Community Services and Infrastructure

Community infrastructure in the Shire is centred on Bowen and the surrounding rural communities rely on Bowen for the provision of some higher order services. The Regional centres of Mackay and Townsville provide the services of district offices of government departments. In particular social services to the region are provided through Mackay and Medical and health services through Townsville.

Community Services Projects/Initiatives

Community Services projects specifically targeting Bowen include those initiatives managed by Bowen Community Council including:

- The Bowen Neighbourhood Centre;
- Family Support Centre;
- Youth Centre; and
- Emergency Relieve Program.

Other initiatives include the Healthier Bowen Shire Partnership through which a number of community development programs are being trialed in conjunction with the University of Queensland.

6.7.1.6 Accommodation and Housing

The incidence of home ownership in Bowen Shire is lower than the state average; this is unusual for a rural community. Rural communities often have a greater proportion of people owning and living in family owned houses including farmhouses. The proportion of people renting housing is similar to the state average however the incidence of dwellings such as cabins and caravans is significantly higher.

Table 6-24
Accommodation in Bowen Shire

	% Of Dwellings Fully owned or being purchased	% Of Dwellings Rented	% Of Separate houses	% Of apartments	% Of other Dwellings (Caravans, cabins etc)
2001	59	30	72	8.5	15
1996	57	32	70	8.2	18
1991	56	34	74	4.1	15
Queensland 2001	62	30	77	12	3.8

Source ABS 2001 Census

Significant temporary accommodation is available in the Bowen Shire; most is centred on Bowen with 11 hotel/motels; 10 caravan parks and 8 holiday units/cottages and 3 resorts. Collinsville has 3 hotels/motels.

6.7.1.7 Educational and Childcare Facilities

There are 10 schools in the Bowen Shire, including two high schools. The shire also has a campus of the Barrier Reef Institute of TAFE known as the Bowen Campus.

The TAFE College offers full or part time certificate courses in a range of vocational areas including Office Administration and Engineering/Construction. The courses are intended to complement the current skill requirements of the shire.

There is an extensive bus service to transport the school children to school.

A range of childcare options is available. The introduction of the Commonwealth Childcare benefits Scheme on 1 July 2000 was intended to ensure that childcare is made available to a wider range of families. Childcare facilities in Bowen tend to be busy but capacity is in place to take further children.

The childcare centres are located in Bowen and Collinsville.

There are several preschool facilities including three kindergartens in Bowen and one in Collinsville and various Playgroup Associations. There is a junior school at Gumlu, 15 km north of Guthalungra. Existing high school age students from Guthalungra attend school in Ayr by bus.

6.7.1.8 Health and Social Services

The following community and welfare services are established in the Bowen Shire:

- Community health centres;
- Community help lines;
- Community support services;
- Blue nursing services;
- Aged Care/day respite;
- Services for Aboriginal people;

- Alcohol and drug rehabilitation;
- Services for people with disabilities;
- Unemployment services;
- Salvation Army & St Vincent de Paul; and
- Community neighbourhood centre.

Family Services Programs (and cultural and arts programs) are administered from Mackay, and Health from Townsville.

The usual difficulties associated with health care in regional areas such as access to higher order specialist services, difficulties attracting and retaining health professionals and pressure on emergency care, apply to the study area.

Medical Services in the Study Area

The Bowen Health Service District encompasses the shire of Bowen and Burdekin. The Bowen and Collinsville hospitals are located within the Bowen Shire. There are a number of doctors and medical centres available.

Table 6-25
A profile of facilities available for the health district

Facilities	Health District
Hospitals (available beds at 30/6/00)	Ayr (55), Bowen (27) Collinsville (15) Home Hill (14)
Outpatient clinics	-
	Ayr Community Medicine, Bowen community Medicine, Ayr Child Health, Bowen Child Health, Bowen Home and Community Care, Ayr Aboriginal Health.
Dental services	Ayr Dental, Bowen Dental; Schools – Bowen East
Private Health Facilities in District	Private hospitals/day centres 0 Private nursing homes (profit) 1 Private nursing homes (non profit) 1 Private hostels (non profit) 1

Source: Queensland Health – Health Service District Profile January 2002

6.7.1.9 Leisure and Recreation

Open space and recreation facilities and tourist attractions are listed below:

- Sport
  - Council/community: Aero club, athletics track, basketball complex, cricket complex, bowls clubs (3), mini golf complex, netball complex, pony clubs (2), rugby league complex, rugby union complex, sailing cubs (2), shooting ranges (2), soccer complex, polo cross facility, rodeo ground, showground, surf life saving club, swimming pool, tennis courts;
  - Private/commercial: Golf course, racecourse, fitness centre (2), indoor cricket centre, 2 squash courts, swimming pool; and
  - Additionally: school facilities and an extensive assortment of sporting facilities available at Collinsville.

- Recreation
  - Council Community: Outdoor bicycle training facility, BMX track, boat ramps (3), parks (8), lookouts (3), roller skating rink, skate bowl, swimming pool, foreshore walking paths;
  - Indoor: lapidary club, RSL club, community centre, guide hut, scout hut, halls (6), youth centre; and
  - Private: Cinema (2 screens), Ten pin bowling.

(Source: Bowen Shire recreation and Sport Plan 2000)

Tourism

Bowen is now considered part of the Whitsundays Region in terms of tourism and therefore comes under the influence of Tourism Whitsundays. Shire Council officers see the alignment of Bowen with the Whitsundays as a positive move.

The Bowen Shire Tourism Development Action Plan (2001) was commissioned by the Bowen Collinsville Enterprise. The report provides some data and analysis of tourist numbers to the region and their profile.

The estimated annual tourist visitation rate to Bowen (2000) is 60,000 with an estimated 20,000 overnight stays. The vast majority (85%) are domestic visitors and approximately 15% are international visitors. The drive market represents a significant proportion of the regions visitation.

The main source markets are:

- Regional (within 600km) 30%;
- Intra/interstate 55%;
- Overseas Visitors 15%.

The major existing markets for Bowen are cited as the “grey market” and Backpackers, and to a lesser degree residential markets in adjoining regions. Backpackers visit the area to obtain seasonal work and visit the tourist centre of the Whitsundays and more northerly parts of Queensland.

Grey Market

Grey market couples are older visitors travelling north in the colder months from southern states to spend time in the northern winter. They undertake extremely long visits (average 128 days away from home), often travel with a caravan, tend to be frugal in their spending patterns, and the majority originate from Melbourne.

Accommodation Standard

Analysis of the standard of accommodation based on RACQ ratings shows that 85% of accommodation is rated in the 1.5/3.5 range with over 59% of the accommodation rated 3/3.5 star standard.

Currently, much of the existing accommodation is in need of refurbishment however operators have highlighted the difficulty in justifying this upgrading investment because of the large seasonal fluctuations in visitor numbers to the area.

Seasonal Workforce

There appears to be a growing resistance by some caravan parks to accept seasonal workers because of noise, in some cases unruly behaviour, and the pets (dogs) they bring. Consequently it appears possible that the availability of accommodation for seasonal workers will be steadily but substantially reduced in future years (Bowen Shire Tourism Development Action Plan, 2001).

Seasonal workers are essential for the fruit and vegetable industry.

6.7.2 Cultural Heritage Values at the Site or Adjacent Areas

The potential for cultural heritage items, and/or places and cultural heritage values at the site or adjacent areas is detailed in the Cultural heritage Assessment Report (confidential document).

6.7.3 Past and Existing Adjacent Land Use

The previous and existing land use in the development area has included prolonged beef cattle grazing. The Guthalungra property was purchased from a direct neighbour for the purposes of constructing a prawn farm, the vendor was fully aware of the intention of the purchaser. Land immediately adjacent to the development area to the south and east are currently used fro cattle grazing. Other neighbours in the vicinity are graziers that have been farming in the area for many years. The current Bowen Shire Council Planning Scheme (1998) has zoned the vicinity as rural grazing.

In the past salt has been produced on the property directly adjacent (Special Lease SB638) to the development site to the north. The lease is held by Ridley Corporation for the purpose of salt production however the operation has been inactive for a number of years. There are no short term plans to resurrect the salt works by Ridley (Pers. Comm. Ridley Management, 2002).

Lot 370 of the development property includes a section of the northern bank of the Elliott River. On the opposite bank there is a collection of shacks or huts located on freehold and Crown land. There are around 50 structures. Some of the huts are permanently inhabited most serve as weekenders or holiday residences. Grazing properties are located elsewhere on the south bank of the Elliot River.

North of the salt works is further freehold land previously used for cattle grazing. Around 4 km south of the property a portion of a property is used for rock melon production.

There are several areas in the near vicinity of the development site having significant natural and environmental value; Lot 370 is located directly adjacent to an annexe of the Cape Upstart National Park, the bulk of the park is located 10km north.

Several nearby areas are listed with the Australian Heritage Commission under the Register of National Estate. These areas are Upstart Bay, Cape Upstart National Park, the Great Barrier Reef and the Cape Upstart Lowlands.

The Cape Upstart Lowlands includes the area to the north of the development site on the north bank of the Elliot River and the coastal strip north of the Elliot River. This area is listed on the Register of the National Estate for its natural and indigenous values. The National Estate database listing notes “the Australian Heritage Commission has determined that this place has indigenous values of National Estate significance. The

Commission is currently consulting with relevant indigenous communities about the amount of information to be placed on public record" (Australian Heritage Commission, Register of the National Estate Database, accessed via the AHC website). Further information regarding the traditional use made of the area by the traditional owners can be found in the Cultural Heritage Report (confidential document).

At the mouth of the Elliot River where it enters Abbott Bay, the Great Barrier Reef Marine Park, General Use 'A' zone commences.

Upstart Bay to the northwest is in the Great Barrier Reef Marine Park General Use 'B' zone.

The World Heritage Area commences at the mouth of the Elliott River.

6.7.4 Recreational, Commercial & Cultural Uses of Waterways and Receiving Environments

6.7.4.1 Recreational Use

The mouth of the Elliot River is a popular recreational boating and fishing location. A busy shack/hut community is located at the mouth of the river on its southern bank. Day visitors and residents of the huts make use of the area throughout the year; visitors are mostly from the local area including Bowen and Ayr.

Abbot Bay is a popular recreational fishing location particularly around Camp Island and over the coral outcrops (bommies) to the east of Camp Island.

Saltworks Road runs adjacent to the western boundary of the development property and provides access to Nobbies Inlet at the eastern corner of Upstart Bay. This is a popular access route for day visitors, particularly recreational fishers to eastern Upstart Bay.

6.7.4.2 Commercial Use

Commercial use of the waterways and the receiving environments is limited to fishing activity in the vicinity of Abbot Bay and Upstart Bay. See Section 6.7.

6.7.4.3 Cultural Uses

The cultural importance of the region is detailed in the Cultural Heritage Assessment Report (confidential document).

6.7.5 Ambient Noise

6.7.5.1 Nearest Sensitive Receivers and Local Setting

The proposed Guthalungra Prawn Farm is situated on the coastal fringe, near the northern banks of the Elliot River, Guthalungra. The site is bordered to the north and east by coastal dunes, heathland, salt pans and mud flats, adjacent to the Pacific Ocean. The land to the west and south is predominantly coastal vegetation, with some farming and scattered residential dwellings.

The land surrounding the proposed development site is gently undulating, with generally low relief and no significant topographical features.

The nearest sensitive residential community to the proposed site are located within the Guthalungra beach community (refer to Appendix N). This community, consisting primarily of holiday beach shacks adjacent to the mouth of the Elliot River, is located over 2 km east of the proposed storage ponds and processing area. An isolated residential dwelling is located approximately 450 m south-east of the proposed processing area.

The direct line of site from the Guthalungra beach community is partially restricted due to the presence of a small vegetated mound immediately to the west of the Elliot River (approximately 3 m RL).

The location of the proposed prawn farm and site and surrounds is shown in Figure 1-2 and 4-1.

6.7.5.2 Ambient Noise Levels and Noise Sources

The existing noise environment within the area adjacent to the proposed site is considered typical of a coastal rural community. The main noise contributions would typically include:

- Insects, birds, wind rustling leaves;
- Domestic sources;
- Wave noise from the nearby ocean; and
- Vehicle traffic using the local road network.

Given the remote location and the lack of industrial or transport related contributions to the existing noise environment, no ambient noise monitoring has been undertaken as part of this project. Instead, reference has been made to average noise levels listed in AS-1055 (Description and measurement of environmental noise) for areas with negligible transportation density and experience gained from previous projects.

The existing background (LA90) noise levels likely to be experienced at the Guthalungra beach community and at the isolated dwelling south-east of the site, under calm conditions have been assumed to be:

- 40 dB(A) during the daytime (6 am – 6 pm);
- 35 dB(A) during the evening (6 pm – 10 pm); and
- 30 dB(A) during the night-time hours (10 pm – 6 am).

The varying presence of wave noise, wind causing tree leaves to rustle, birds and insects and human influences, noise levels recorded at the site may be slightly higher or slightly lower than those stated above. However, for the purposes of this assessment, a conservative assumption of 35 dB(A) during the daytime and evening, and 30 dB(A) during the night-time hours has been made.

6.7.6 Existing Use of Groundwater

A number of bores have been drilled on the property by the previous owner and on neighbouring properties. Most of these bores have encountered brackish or saline waters not of use for domestic, stock water or irrigation purposes. The nearest existing bores that are currently in use are located to the south of the property. One bore located about 1500 m from the property is used to pump about 1.5 L/s for stock water. Two bore located about 4 km south of the property each produce about 4 L/s for pasture irrigation and limited fruit production.

The scarcity in good quality groundwater is reflected in the fact that the location is not included in a specific groundwater protection or groundwater management area. Accordingly there are no existing controls or constraints on ground water extraction in the area.

Ground and surface water use is described in detail in Section 6.4 - Hydrology and Water Quality, impacts of the proposal on Ground water in Section 7.1 – Effects on Groundwater through and seepage and in the Geohydrology Study (Appendix O).

6.7.7 Existing Industry

A description of existing industry in the region is provided in Section 6.7– Profile of Impacted Communities. Section 6.7 provides more information on commercial activities directly adjacent to the proposal. The following provides more information on the local fishing industry.

6.7.7.1 Commercial Fisheries

Information on fishing catch and effort in the area offshore from the development, and in the vicinity of the offshore discharge and intake sites, is contained in the Queensland Department of Primary Industries' Coastal Habitat Resources Information System (CHRIS). The data is presented for grids with 30-minute resolution. The relevant grid covering Abbot Bay and Upstart Bay is L22. Refer to Figure 6-34 below.

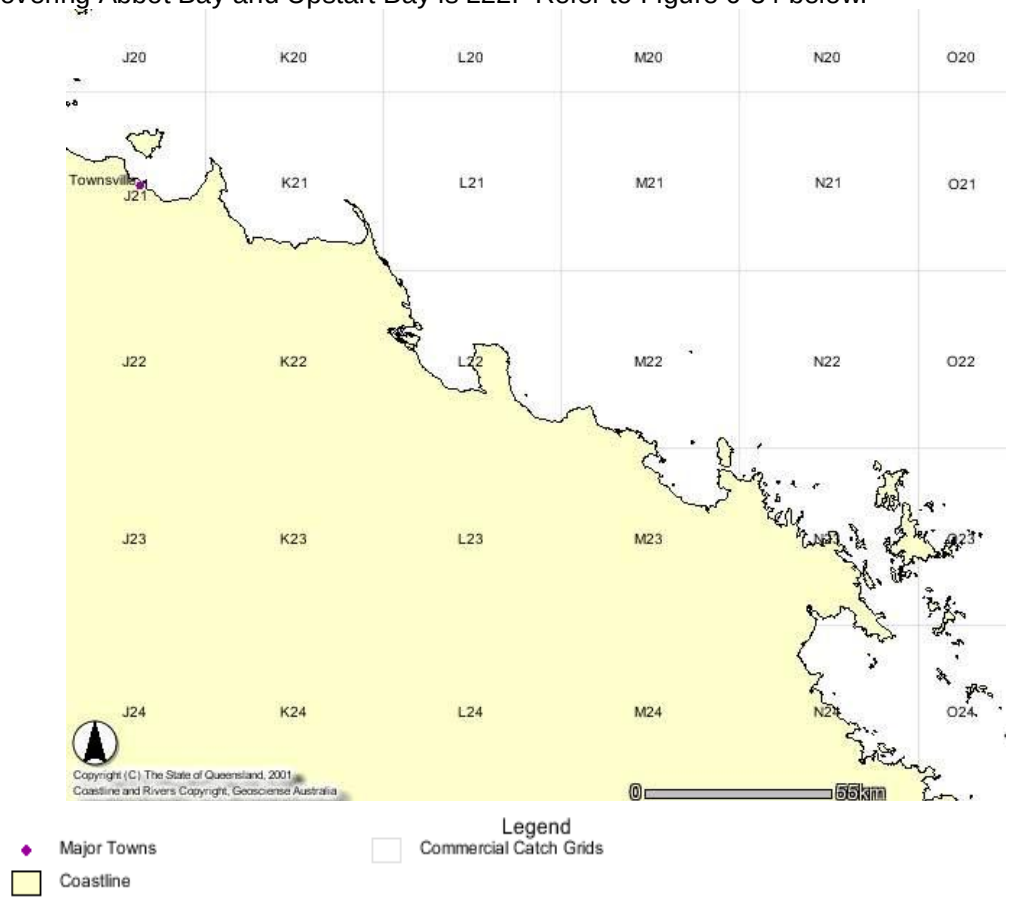

Figure 6-34
Northern Region – Commercial Catch Grids

Fishing boats based at Bowen may fish in the vicinity of western Abbot Bay however boats based at other ports also fish here. Fish caught in Abbot Bay can be landed at other ports, not necessarily Bowen. Table 6-26 provides the catch volumes for grid L22 (including Abbot Bay) for three separate years: 1990, 1995, and 2000. This provides an indication of the type of species caught in the area. As well as the seasonal variation in the species profile of the catch, there are also significant annual variations in the quantities of the various fish caught in the grid.

Table 6-26
Species/Catch Profile for CHRIS Grid L22 on three separate years: 1990, 1995, and 2000

1990		1995		2000	
	Kg		**Kg**		**Kg**
Crab - Mud	29043	Crab - Mud	15706	Crab - Mud	47331
Barramundi	6716	Barramundi	3750.4	Barramundi	12655
Bream - unspecified	249.3	Mullet - unspecified	933.6	Fish - unspecified	805
Fish - unspecified	898.7	Shark - unspecified	522.83	Flathead - unspecified	401
Flathead - unspecified	998.4	Threadfin - Blue	2704.7	Mullet - unspecified	2302
Grunter - unspecified	1193.1	Bugs - Whole	39644.8	Shark - unspecified	54123
Mullet - unspecified	1629.7	Crab - unspecified	2745	Threadfin - Blue	2967
Queen fish	579.3	Prawns - Banana	13253	Threadfin - King	359
Threadfin - Blue	1895.1	Prawns - Bay	219	Bugs - Whole	7765
Threadfin - King	809	Prawns - Coral	210	Prawns - Banana	15735
Triple Tail	338	Prawns - Endeavour	12826	Prawns - Coral	1518
Bugs - Whole	7612	Prawns - King	27289	Prawns - Endeavour	2116
Prawns - Banana	44524	Prawns - Tiger	115218	Prawns - King	5966
Prawns - Endeavour	11355	Scallops - Mud (Kg Meat)	20804	Prawns - Tiger	21248
Prawns - King	6277	Scallops - Saucer (Kg Meat)	1212.5	Shark - unspecified	110
Prawns - Tiger	51706	Squid - unspecified	606	Squid - unspecified	85
Scallops - Saucer (Kg Meat)	3224.5				
Total	**169048.1**	**Total**	**257644.8**	**Total**	**175486**

Source: QDPI CHRIS data

The variability in catch is further highlighted in Figure 6-35, which shows the annual gross value of production from the Grid over 12 years from 1988 to 2000.

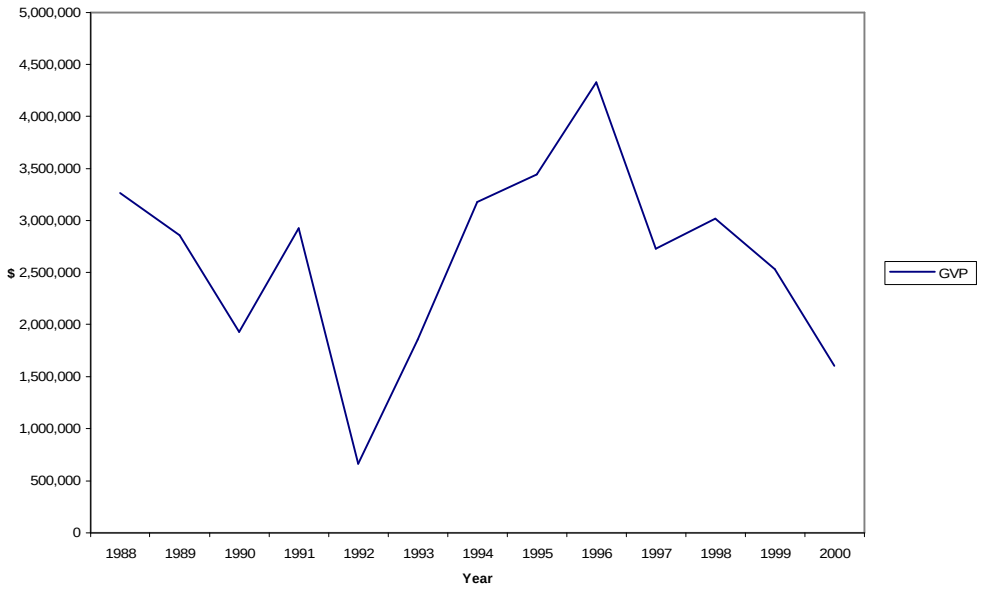

Figure 6-35
Catch GVP CHRIS Grid L22

The annual variability in catch rates and species profile is a function of the natural variability of the fisheries stocks, the management regime in place at the time and the market value of the species. In particular prawn catches are highly variable (as shown in Figure 6-36) and natural fluctuation in recruitment are extreme.

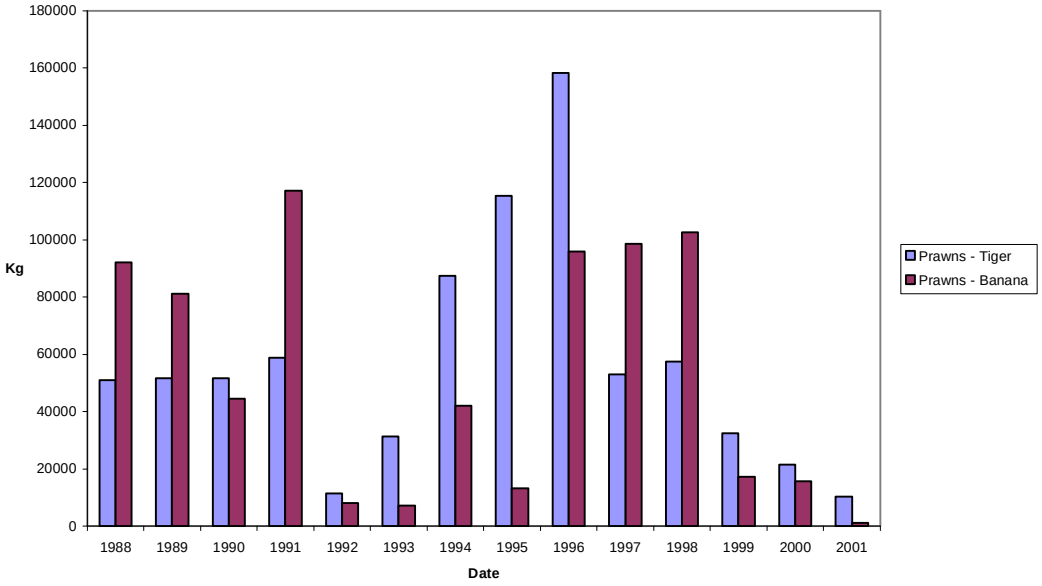

Figure 6-36
CHRIS Grid L22 Banana and Tiger Prawn Catches 1988 - 2001

Figure 6-37 below shows the catch rates from grid M23 for banana prawns plotted alongside the banana catches for L22. There has been some criticism that a prawn farm discharging into the waters of grid M23 has had a detrimental impact on catches of banana prawns in the area since it became operational in 1998. This criticism would appear unfounded as a major decline in catches was experienced in grid L22 at the same time as that recorded in M23. Currently there are no prawn farms operational in L22. Therefore the reduction in catch in grid M23 could be more appropriately attributed an overall natural decline rather than the impact of the prawn farm.

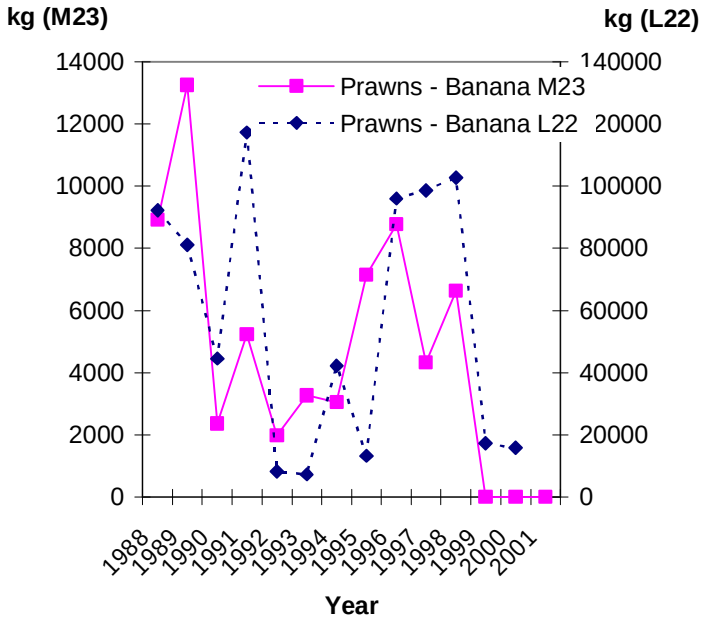

Figure 6-37
CHRIS Grid L22 & M23 Banana Prawn Catches 1988 – 2001

6.7.8 Emergency Services

The *State Counter Disaster Organisation Act, 1975* requires local governments to develop and maintain counter disaster arrangements within their shires using the resources of that shire. These Counter Disaster Plans include the provision for identifying threats to the communities, determining the level of risks from those threats, then developing mitigation strategies for risk reduction. Bowen Shire has a Counter Disaster Plan in place.

Each year Bowen emergency services co-jointly conduct an exercise based on a major incident scenario.

Emergency services such as Police, Fire and Ambulance are adequately provided for in Bowen. The following contacts are provided for organisations and services involved in the Counter Disaster Plan for Bowen Shire (Table 6-27 below):

Table 6-27
Emergency Services

Title	Name	Address	Town
Director of Nursing	Bowen Old Peoples Home Society	PO Box 966	Bowen
Officer in Charge	Bowen Police	28 William Street	Bowen
Officer in Charge	Bowen Ambulance service	PO Box 204	Bowen
The Secretary	Bowen Air Sea Rescue	PO Box 130	Bowen
Director of Nursing	Bowen Hospital	PO Box 808	Bowen
District Coordinator	State Emergency Services	PO Box 5845 MC	Townsville
Officer in Charge	Queensland Fire Service	PO Box 1133	Bowen
The Manager	Ergon Energy	PO Box 217	Bowen
Resident Officer	Salvation Army	42 Gregory Street	Bowen
Stock Inspector	Department of Primary Industries	PO Box 538	Bowen
Local Controller State Emergency Services	Bowen Shire Council	PO Box 306	Bowen
The Manager	Telstra	Herbert Street	Bowen
The Station Master	Pring Railway Station	9 Banksia Street	Bowen

Emergency services for Guthalungra are located at Bowen, with Police, Fire and Ambulance located there. Due to the distance from the site, the project is beyond the ten minute response capability of the stations and the proponents must ensure that suitable first aid treatment is available on site.

In order to plan any necessary emergency response for the project, the proponents have committed to undertake an al hazard risk management assessment in accordance with AS/NZS 4360:1999, in consultation with the local emergency services coordinator. This would allow for an appropriate disaster mitigation plan to be developed.

6.8 Planning Issues

The following section highlights the relevant statutory and non-statutory planning issues that have been considered in the preparation of this EIS.

6.8.1 Statutory and Non-Statutory Planning Frameworks

6.8.1.1 Bowen Shire Planning Scheme

The proposed development site is located within the Bowen Shire. The current zoning of the prawn development area is Rural Grazing. Agricultural land in the vicinity of the site is designated Rural Grazing. This zone applies to land, which is not classified as valuable agricultural land pursuant to the intent of State Planning Policy 1/92, and which is outside the Shire's towns, villages and low-density residential areas.

The Rural Grazing Zone is intended to provide for:

- Viable primary production on land suitable for primary industry; and
- Other land which may be suitable for development for other purposes the extent and timing of which would be subject to further detailed investigation.

Notably, Rural Grazing does not allow for the construction of more than one dwelling per Lot.

Guthalungra is the nearest township to the prawn farm development site.

Pacific Reef Fisheries will be making an application for the material change of use of the land on which the prawn farm will be built. The land will be rezoned Aquaculture to enable the prawn farm and processing facility to be established and allow the construction of 3 residences.

The Guthalungra prawn farm proposal is being prepared taking account of the existing Bowen Shire Planning Scheme. The Guthalungra proposal is consistent with the Councils vision for the future, the Strategic Development Principals and the Strategic Objectives of the Bowen Shire Planning Scheme. Where appropriate, specific sections of the EIS have been cited to illustrate consistency with the Bowen Shire Planning Scheme:

Council's Vision for the Future

The proposal directly supports the following components of Council Vision:

- Economic Development
  - Support for a thriving agricultural industry including expansion of food processing activities (refer to Section 7.10).
- Environmental Sustainability
  - Management of the environment such that the use of natural resources is ecologically sustainable and adverse environmental impacts of development are effectively addressed (Refer to Section 7.1, 7.2 and 7.3);
  - Conservation of places having significant ecological, cultural and heritage value. (Refer to Sections 7.1, 7.2 and 7.3); and
  - Support for development which has overall community benefit (refer to Section 7.10).

Strategic Development Principals

- Environment Management and Open Space
  - Significant areas of vegetation and landforms of high scenic and/or ecological quality are critical and sensitive features and should be protected accordingly and taken into account in planning decisions. (Refer to Section 6.6 and Section 7.8 ;
  - Development whether individually or in conjunction with other activities should not negatively impact on the water quality and ecological values of surface and groundwater resources, mangroves and estuarine areas of the Great Barrier Reef Marine Park. (Refer to Section 6.2);
  - Responsibility for environmental management rests with the whole community.

Objectives and Implementation Criteria Agriculture Protection

- To promote viable areas of good quality agricultural land from fragmentation and non agricultural use. (Refer to Section 6.8);
- To encourage and maintain the viability of primary industries within the Shire. (Refer to Section 6.8).

Rural Landscape

- To allow for development in rural areas other than for horticultural, pastoral or other agricultural purposes which is compatible with rural activity and can be appropriately located.;
- To ensure that aquaculture operations do not detrimentally impact upon riverine and coastal areas. (Refer to Section 7.1, 7.2 and 7.3);
- To identify and protect environmentally sensitive areas within the Shire.

- *Coastline*

- To ensure that coastal areas are maintained in their natural state or where there has been degradation to promote rehabilitation and use for open space and recreation purposes.

Transport Infrastructure

- To ensure adequate provision for access parking and vehicle movement for each development. (Refer to Section 4.4).

6.8.1.2 Good Quality Agricultural Land (GQAL)

The Bowen Planning Scheme has zoned the Lot 8 and 340 at Guthalungra for Rural Grazing. This zone applies to land which is not classified as valuable agricultural land pursuant to the intent of State Planning Policy 1/92 and which is outside the Shires towns, villages and low density residential areas.

Despite the Council zoning on the property, the objectives of the State planning Policy 1/92 have been met by the Guthalungra prawn farm proposal as the following details:

The State planning Policy 1/92: development and the Conservation of Agricultural Land (SPP 1/92) and associated guidelines state:

- Good quality agricultural land has a special importance and should not be built on unless there is an overriding need for the development in terms of public benefit and no other site is suitable for the particular purpose (Section 3 in the policy); and
- The alienation of some productive agricultural land will inevitably occur as a consequence of development, but the Government will not support such alienation when equally viable alternatives exist, particularly where developments that do not have very specific location requirements are involved (Section 4 in the policy).

The Policy recognises that cases will arise where non-agricultural development is proposed on GQAL. In these cases, the proponent is required to demonstrate an “overriding need” in terms of benefit to the community at that particular location.

Giving Effect to SPP 1/92

The SPP 1/92 guidelines (developed to support SPP 1/92) provide guidance on determining "overriding need". Section 4.1.3 states that "determining an overriding need in terms of public benefit depends upon the circumstances of the particular proposal". Aquaculture (or any other non-agricultural) proposals are and will be dealt with on a case-by-case basis.

Justification by the applicant, of the alienation of land classified as GQAL, to enable aquaculture or any other non-agricultural development must be demonstrated as follows:

- The land is demonstrated through an appropriately detailed independent land capability assessment report, not to be GQAL; or
- Only a minor portion of the site is classified as GQAL; or
- There are significant additional direct and indirect employment benefits; or
- There are significant local, enterprise or regional economic benefits in terms of the growth of an existing industry or the introduction of a new industry; or
- There are significant State economic benefits in terms of the growth of a new industry or export potential.

GQAL should not be alienated in any of the following circumstances:

- Where alienation will, or is likely to threaten, the ongoing viability of an existing rural industry in the district/region; or
- Adversely affect or constrain any potential new or ongoing operations of an adjoining or nearby rural industry located on GQAL; or
- Adversely affect the existing use and ongoing operation of the rural enterprise on the property; or
- Where an alternative and suitable site, that would not involve the alienation of GQAL, can be identified.

Guthalungra Prawn Farm Proposal and GQAL

Of the two lots under consideration i.e. Lot 8 and 340, only Lot 8 will be substantially developed and will result in the alienation of the area to agricultural production for the duration of the aquaculture operation.

The State Panning Policy 1/92 and the Resource Planning Guideline No.E72 allow for aquaculture development on land identified as Good Quality agricultural Land provided that:

- There are significant additional direct and indirect employment benefits; or
- There are significant local, enterprise or regional economic benefits in terms of the growth of an existing industry or the introduction of a new industry; or
- There are significant State economic benefits in terms of the growth of a new industry or export potential.

In response, the Guthalungra prawn farm will generate 70 full time and 20 part time production jobs and in excess of 20 part time jobs in processing (88 FTEs). The employment details are provided in Section 4.4 - Number and Source of Workforce and in more detail in the Pacific Reef Fisheries Guthalungra Prawn Farm Business Plan (Confidential Report). This compares favourably with the existing use of the land. Local sources indicate that around 4000 acres is required to sustain a family sized grazing operation in the vicinity.

The annual gross value of production from the operation will be in excess of $29 million by 2008. Employment and services will be sourced locally and where competitive, supplies will be sourced from local vendors. The economic and social value to the shire is provided in Section 7.10.

The establishment of a prawn operation at Guthalungra is likely to stimulate further investment in aquaculture in the region as local expertise in the industry grows. Section 7.10 discusses the potential for the establishment of a number of aquaculture ventures in the Bowen Shire.

Pacific Reef production will predominantly target domestic markets in the short to medium term however there are long term plans to export, particularly value added products.

GQAL should not be alienated in any of the following circumstances:

- Where alienation will, or is likely to threaten, the ongoing viability of an existing rural industry in the district/region; or
- Adversely affect or constrain any potential new or ongoing operations of an adjoining or nearby rural industry located on GQAL; or
- Adversely affect the existing use and ongoing operation of the rural enterprise on the property; or

The Guthalungra prawn farm proposal will not alienate or threaten the on going viability of rural industries in the region. There will be no negative impact on the economic viability of neighbouring operations. There will be no adverse affects on the quality or quantity of underground water in the region or on the quality of the soil on neighbouring properties (Refer to Section 7.1). The Geotechnical report is provided in Appendix G.

The operation will not adversely affect or constrain any potential new or ongoing operations of an adjoining or nearby rural industry. With one exception the neighbouring properties are grazing properties. Prawn farms do attract limited numbers of fish-eating birds such as shags and night herons. These birds will not impact on adjoining or nearby pastoral properties. Refer to Sections 7.2 and 7.10.

The prawn operation is a substantial development and although it is unforeseeable that the farm will close and revert back to grazing property, it is fully expected that rehabilitation of the site back to its current condition will be possible. Rehabilitation during construction is outlined in Section 7.3.

6.8.1.3 Draft State Planning Policy on the Planning and Management of Acid Sulphate Soils

The State Planning Policy 2/02 Planning and Managing Development Involving Acid Sulphate Soils (SPP) applies to all land, soil and sediment at or below the 5 m AHD. The project will trigger the SPP 2/02 through excavation and filling of soil and sediment. Under the State Planning Policy 2/02 Guideline Acid Sulphate Soils (SPP Guideline) an assessment of Acid Sulphate Soils (ASS) is required along with an Acid Sulphate Soils Management Plan (ASSMP) if ASS are to be disturbed.

6.8.1.4 Compliance with the Coastal Management Plan

The site is in the Dry Tropical Coast coastal region according to the *State Coastal Management Plan* (Queensland Government, 2001). The following information on this region was obtained from The State Coastal Management Plan – Queensland's Coastal Policy (pp: 71-73).

The Dry Tropical Coast extends from the northern boundary of Thuringowa City to the southern boundary of Bowen shire and incorporates all coastal islands and State waters in the region, as well as part of the Great Barrier Reef Marine Park. The region contains marine environments of international significance and forms part of the Great Barrier Reef Word Heritage Area. The region includes the City of Townsville as well as numerous low-density coastal settlements such as Saunders Beach, Bushland Beach and Congulla.

The name of this region adequately describes an area sometimes referred to as 'the dry tropics' as a result of the low rainfall encountered. It is a dynamic coast, subject to both long-term and short-term changes as a result of cyclones and normal wind and wave action. The coast is comprised of beaches, beach ridges, mangrove estuaries, saltpans and brackish coastal swamps.

Of particular note is the complex system of wetlands, including mangrove forests in estuarine areas, samphire communities associated with saltpans, and water lilies, sedges and grasses and paper bark forests associated with freshwater wetlands. In recognition of the region's important wetlands the Dry Tropical Coast boasts the Bowling Green Bay National Park, part of which is listed under the Ramsar Convention as a wetland of international importance. The southern section also contains regionally significant stands of 'beach scrub', equally important to the biodiversity of the region.

Coastal Resources

The Dry Tropical Coast has a range of significant conservation values including seagrass and mangrove communities, fringing reefs, marine turtle nesting areas, fish nurseries, and seabird, wader and raptor habitats. The intertidal and subtidal seagrass beds and mangrove-lined estuaries of Cleveland and Bowling Green Bays possess extensive baitfish species and other rare and threatened marine life, such as dugongs and marine turtles. The Bowling Green Bay wetlands seasonally support more that 20,000 waterfowl and almost half of the 244 bird species known to visit the area breed in these wetlands.

Vegetation characteristic of the region includes woodlands of ironbarks (*Eucalyptus melanophloia, E. crebra*), popular box and brown box (*E. populnea, E. brownii*) and brigalow (*Acacia harpophylla*), blackwood (*A. argyrodendron*) and gidgee (*A. cambagei*).

The Dry Tropical Coast possesses a range of significant Indigenous Traditional Owner cultural resources (refer to Policy 2.5.1 for examples) and other cultural heritage sites of significance. Important cultural heritage values are also associated with historical processes such as coastal exploration, coastal navigation, coastal shipping, maritime disasters, quarantine practices, provision of port facilities, the establishment of aboriginal reserves, fishing, mining, pastoralism, 19th century and World War II coastal defence, tourism and holiday resorts.

The Palm Island Group has many sites of heritage value, including a stone hut at Little Pioneer Bay, buildings and graves remaining from the leper colony on Frantome Island, and what remains of a shepherd's cottage and World War II installations at Yankees Jetty. A number of shipwrecks have been identified in the waters off Magnetic Island and the ruins of World War II coastal defence installations can be seen at the forts on the island. Other historic shipwrecks include the *Yongala*, located 11km off Cape Bowling Green. The South Bank area of Cleveland Bay contains Chinese market gardens, considered to be of major significance to north Queensland.

The Dry Tropical Coast supports a variety of land use including tourism, aquaculture, agriculture and industry. The region is also extremely important for commercial and recreational fishing, and other outdoor recreation and sporting activities. Townsville is a city of regional significance because of its service industries, industrial growth, defence establishments and port. Cities and towns associated with The Dry Coast also have strong links with the mining industry as logistical centres for mining operations and service centres.

Biogeographic description:

- Terrestrial bioregion – Brigalow Belt North (subhumid to semi-arid); and
- Marine bioregion – Lucinda-MacKay coast.

Existing management and administration

The local government areas of Townsville and Thuringowa have undergone a subregional planning process, resulting in the preparation of Townsville – Thuringowa strategy plan. This plan is being implemented through a range of mechanisms and processes, for example by informing the development of planning schemes and other natural resource management plans and strategies.

Additionally, there are three sub-regional catchment plans that have been developed as integrated catchment management initiatives. The completed plans are Townsville/Thuringowa Coastal Plains plan, and the Burdekin Rangelands and Burdekin-Bowen Integrated Floodplains Management strategies. The Burdekin Rangelands and Burdekin-Bowen Floodplains plans received interim endorsement from the Queensland Landcare and Catchment Management Council in late 2000, while the Townsville/Thuringowa Coastal Plains plan is awaiting final endorsement from the Council. A Burdekin Dry Tropics Regional Strategy is also being prepared for release in 2001 to coordinate the delivery of these strategies.

The Councils of Townsville City, Thuringowa City, Burdekin and Bowen have existing planning schemes and are required to prepare new planning schemes under the *Integrated planning* Act *1997* by 30 March 2003.

There are a number of Indigenous Traditional Owner groups in the region, including Bindal and Juru in the Townsville/Burdekin area, Munburra in the Palm Island area, Nywaigi in the Lucinda/Rollingstone area, and Ghia in the Bowen area. An Aboriginal council manages the Palm Island Deed of Grant Trust (DOGIT) area. Bwcolman are a group of Aboriginal peoples with historical associations to the Palm Island area.

Key coastal management issues

Important coastal management issues include:

- Future management of significant and extensive wetland systems, including the Bowling Green Bay Ramsar site;
- Siting of industrial land for future growth and expansion;
- Expansion to the Townsville Port and identifying sustainable and appropriately placed road and rail access to the port;
- Industrialisation of the region while ensuring that the necessary environmental protection measures are in place to protect the regions natural values, including breeding/nursery grounds;
- Management of aquaculture developments;
- Effective salinity and water management in intensive agricultural industries in the Burdekin;
- Urban development along the coast;
- Protection and conservation of rare and threatened species (dugongs, migratory wader birds, water fowl and various species of marine turtle);
- Protection of regionally appropriate sport and outdoor recreation resources;
- Ecologically and culturally sustainable tourism and outdoor recreation, including consideration of impacts and capacity to contribute to the economy and quality of life;
- Impacts of acid sulfate soils;
- Storm tide threat and cyclone impacts;
- Development of other agricultural industries such as horticulture;
- Ongoing resolution of native title (land and sea) issues;
- Recognition of Aboriginal Council jurisdictions;
- Recognition of community-based land and/or sea management organisations;
- Ongoing involvement of Indigenous Traditional Owner in management, planning and development, particularly during processes affecting land tenure designation, including coordination of mechanisms by relevant agencies for involving Indigenous Traditional Owners;
- Ongoing recognition of Indigenous Traditional Owners traditions and counting rights and interests in coastal management (e.g. management of fishing activities, coordination of and access to scientific and research information, repatriation of remains), including Indigenous Traditional Owner access to cultural resources (e.g. traditional food for ceremonial purposes);
- Recognising the importance to Indigenous Traditional Owners of maintaining management connectivity with upper reaches of catchments;
- Preservation of Indigenous Traditional Owner cultural from inappropriate access or use including appropriate management of Indigenous Traditional Owner knowledge and information;
- Maintenance of Indigenous Traditional Owner cultural resources (values, places and items);

- Aboriginal peoples and Torres Strait Islanders with historical associates within the region may have aspirations to be involved in the management of cultural resources;
- Identification and maintenance of cultural heritage resources (values, places and items);
- Coordination of management between relevant agencies, including Commonwealth, State, and local government agencies, and Aboriginal councils; and
- Impacts (health, safety and environmental) of defence-related activities (e.g. bombing exercise).

Compliance of the Project with the Principles of the State Coastal Management Plan

Compliance with the principles of the *State Coastal Management Plan* (Queensland Government, 2001) is discussed in this section, with reference to the following policies:

a) Aquaculture (Policy 2.1.14)

The project will comply with the following policies of the *State Coastal Management Plan* in relation to aquaculture developments:

- Maintain water quality (in accordance with policy 2.4.1). Procedures for evaluating discharges to coastal waters as listed in the *Environmental Protection (Water) Policy 1997* will be used to monitor waste prior to discharge. Section 4.5 and 7.2 describes mitigation measures proposed to minimize impacts of discharge of pond effluent on the marine environment;
- Maintain any wastewater discharge to meet relevant standards and requirements (in accordance with policy 2.4.2). Proposed procedures to minimize the impacts of discharge of pond effluent on the marine environment are detailed in Section 4.5 ;
- Maintain groundwater levels and quality (in accordance with policy 2.5.5). Procedures proposed to prevent changes to groundwater and flooding are detailed in Sections 4.1 and 6.4;
- Maintain coastal habitats, such as wetlands and shorebird roost sites, including their protection from potential significant adverse impacts from the disturbance of acid sulphate soil (in accordance with policy 2.4.6). Proposed procedures to identify, mitigate and manage acid sulphate soils are described in Section 9 of the report;
- Have no significant adverse impacts on fisheries (commercial, Indigenous Traditional Owner and recreational), fishing grounds, or spawning and nursery areas. Proposed methods to minimize any deleterious effects on fisheries resources are described in Section 6.7 of the report;
- Maintain natural coastal processes. Refer to Section 7.3 – Construction methods required for the intake and discharge structures, and measures proposed to manage the environmental impacts; and
- Be compatible with coastal landscape values and recreational amenity of the area. Impacts of the project on the amenity of the area during construction and operation and methods to minimize any deleterious effects on recreational resources and community activities are addressed in Section 7.3 of the report.

b) Erosion Prone Areas (Policy 2.2.2)

The project will comply with the policy of the *State Coastal Management Plan* in relation to erosion prone areas. The policy states, to the extent practicable, erosion prone areas are to remain undeveloped apart from acceptable temporary or recallable structures for safety and recreational purposes. Proposed procedures to manage the construction of the pump house buildings on the fore dune are detailed in Section7.3.

c) Future Need for Access (Policy 2.3.1)

The project will comply with the policy of the *State Coastal Management Plan* in relation to future need for access. The policy states that there is to be no net loss of public access to the foreshore or of public usability of coastal waters. This is to be maintained, protected and enhanced where the provision and operation of infrastructure of state economic significance and protection of coastal (natural and cultural) resources is not compromised.

Any new private structures proposed over state land on the coast or public waters that are not major private infrastructure of state economic importance, should not interfere with public access, usability or enjoyment of that land or water. Proposed measures to manage these issues are detailed in Section 7.3.

d) Design of Access (Policy 2.3.2)

The design of access to the coast or along the foreshore and any associated facilities is to meet the following criteria of the *State Coastal Management Plan*:

- Maintain the long-term stability of dunes or other types of landforms;
- Avoid alteration to tidal regimes and coastal processes;
- Minimize impacts on coastal resources, particularly disturbance to coastal wetlands, other coastal habitats, protected species and significant habitats including wildlife nesting and breeding areas (such as for turtles and shorebirds);
- Minimize damage to island substrate from anchor damage;
- Avoid routes that pass through or have an adverse impact on sites of cultural significance, except where such access is in keeping with the values of the site; and
- Provide appropriate signposting of access ways.

Proposed procedures to manage access of the pipeline route are discussed in Section 7.3.

e) Water Quality Management (Policy 2.4.1)

The *State Coastal Management Plan* states where environmental values and water quality objectives have been determined for coastal waters in accordance with the *Environmental Protection (Water) Policy 1997*, development and use of the coastal zone is planned and managed to protect the identified values and achieve the water quality objectives (in accordance with policy 2.4.1). The identification of environmental values and water quality objectives has been determined for these coastal waters and are discussed in Section 7.3.

The Plan also states that any wastewater discharge shall be maintained to meet relevant standards and requirements (in accordance with policy 2.4.2).

Proposed procedures to minimize the impacts of discharge of pond farm discharges on the marine environment are detailed in Section 7.2 of the report.

f) Wastewater Discharges to Coastal Waters (Policy 2.4.2)

In many developed coastal areas, sewage treatment plants and industries discharge to coastal waters. These discharges can have adverse impacts on coastal resources and their values. The *Great Barrier Reef Marine Park Act 1975* and regulations made under this Act control sewage discharges into Commonwealth areas.

The State Coastal Policy on Wastewater Discharges states that proposed discharges of industrial wastewater into coastal waters must be assessed using the waste management evaluation procedure for wastewater (as set out in the EPP (Water)) and will only be permitted where it is demonstrated that no other feasible alternatives exist.

Proposed procedures to minimize the impacts of discharge of pond effluent on the marine environment are detailed in Section 7.2 of the report.

g) Stormwater Management (Policy 2.4.4)

The project will comply with the stormwater management policy of the *State Coastal Management Plan* by ensuring best practice approaches are undertaken. Implementation of relevant industry codes of practice that include stormwater management measures and adherence to the *Environmental Protection (Water) Policy 1997* is achieved.

Proposed procedures for stormwater management are detailed in Section 9 of the report.

h) Involvement of Indigenous Traditional Owners in Managing their Cultural Resources (Policy 2.5.2)

The project will comply with the following policies of the *State Coastal Management Plan* in relation to the Involvement of Indigenous Traditional Owners Managing their Cultural Resources:

Indigenous Traditional Owner cultural resources are defined in policy 2.5.1. Policy 2.5.2 states that the planning for and management of Indigenous Traditional Owner cultural resources within their ancestral homeland estate is to be undertaken with the culturally appropriate involvement and acknowledgement of Indigenous Traditional Owners and their communities. Therefore, appropriate involvement mechanisms, meaningful partnerships, support and protocols have been established to facilitate their involvement in the planning for this Project.

i) Cultural Heritage (Policy 2.6.2)

The *State Coastal Management Plan* states that the development and use of the coast site is to be managed to conserve cultural heritage places and objects in accordance with relevant State and Government laws. The regional coastal plans will detail provisions to manage and conserve cultural heritage within each coastal region.

Proposed procedures to manage cultural heritage resources are described in Section 7.2 of the report.

j) Areas of State Significance (Natural Resources) (Policy 2.8.1)

The *State Coastal Management Plan* states that land identified to be developed in the future for rural land uses in regional plans and planning schemes is to be located outside of 'areas of state significance (natural resources)'.

If a use or activity that has an adverse effect is to occur within 'areas of state significance (natural resources)', it must have a demonstrated net benefit for the state as a whole. Land allocation for uses and activities adjacent to 'areas of state significance (natural resources)' is to be compatible with the maintenance of the area's values.

Proposed procedures to manage 'areas of state significance (natural areas)' are described in Sections 7.1, 7.2 and 7.3 of the report.

k) Coastal Wetlands (Policy 2.8.2)

The *State Coastal Management Plan* states that further loss or degradation of coastal wetlands is to be avoided and impacts on coastal wetlands prevented, minimized or mitigated.

The following matters are relevant to the conservation and management of Queensland's coastal wetlands, including within 100m of a coastal wetland (in order of preference):

- Maintenance of an area between the wetland and adjacent use or activity, of a width and with characteristics that will safeguard the functions of the wetland and allow for natural fluctuations of location;
- Minimizing any modification of the natural characteristics of the wetland included in the topography, groundwater hydrology, water quality and plant and animal species;
- Minimizing any adverse impact on coastal wetland values from proposed access;
- The wetland to retain the values and functionality of saltflats, to assist in the maintenance of estuarine system viability;
- The need to maintain the coastal wetland functions to provided habitat for rare, threatened an migratory species;
- The potential for a proposal to introduce plant or animal species non-native to the local area that may have or are likely to have adverse impacts on the coastal wetland ecosystem;
- Any long term maintenance and management implications particularly for government agencies.

l) The State Coastal Management Biodiversity (Policy 2.8.3)

Plan states that biodiversity on the coast is to be safeguarded through conserving and appropriately managing the diverse range of habitats including coral reefs, seagrass, soft bottom (benthic communities), dune systems, saltflats, coastal wetlands and riparian vegetation.

The following matters (as indicated in the Policy) are to be addressed to achieve the conservation and management of Queensland's coastal biodiversity:

- Ensuring viable populations of protected native species continue to exist throughout their range, by maintaining opportunities for long-term survival, genetic diversity and the potential for continuing evolutionary adaptation. This includes the protection of significant wildlife habitat, such as:

  - Protecting beaches protecting significant wildlife habitats (including roosting, nesting and breeding habitat for turtles, birds or crocodiles) through suitable management measures including buffers for these habitats;
  - Protecting the values and integrity of intertidal communities such as tidal flats, saltflats and rocky reefs, including natural fluctuations of location;
  - Retaining the current extent and quality of migratory and resident shorebird roosting and feeding habitat. If habitat is to be lost it should be replaced, where practicable, before loss, by an equivalent artificial habitat in a location that minimizes any alteration of distribution and abundance of shorebirds;
  - Maintaining the values and integrity of fish habitats and fish migratory pathways through suitable management measures including buffers for those habitats;
  - Protecting the values and integrity of soft bottom (benthic) communities; and
  - Retaining and protecting the existing extent, quality and functionality of seagrass beds, particularly in dugong protection areas or known areas of turtle habitat.

  - The retention of native vegetation where practicable;
  - The valuing of indigenous Traditional owners of managing biological diversity.

Proposed procedures to manage biodiversity are described in Section 7.2 and 7.3 of the report.

6.8.1.5 Whitsunday, Hinterland and Mackay (WHAM) Regional Plan

The following extracts have been sourced from the Whitsunday, Hinterland and Mackay (WHAM) Regional Plan. The application by Pacific Reef is consistent with the objectives of the regional plan. The Guthalungra prawn farm has been designed, and the EIS prepared, taking full account of the Whitsunday, Hinterland and Mackay (WHAM) Regional Plan. The regional plan is supportive of the development of an environmentally responsible aquaculture industry. The following sections of the plan are directly relevant to the aquaculture industry and aquaculture development in the region and have been taken into consideration in the preparation of this EIS:

Forward

The WHAM 2015 Regional has been prepared to provide a regional planning framework to assist local authorities in developing their own strategic plans. The plan will also assist State Government, business and community to better plan for future regional needs.

Executive Summary
Economy

For an emerging industry, aquaculture is highly regulated. There is a call for a review and rationalisation of the aquaculture project approval process that is required by the three levels of Government and the Great Barrier Reef Marine Park Authority (WHAM p IV).

Description of the Region Economy
Aquaculture

Aquaculture has emerged as a new industry in the region over the past decade. Substantial operations exist in the Bowen, Whitsunday and Broadsound areas. A recent Department of Primary Industries study has identified additional areas along the coast that could potentially provide for future aquaculture operations.

Aquaculture is very much a developing freshwater and marine industry, although its success is dependent on the development and/or access to necessary technologies and in achieving sustainable management practices. Influential factors will be marine management/regulation systems providing fair and secure access to aquaculture sites in an ecologically sustainable way, as well as research to support the industry (WHAM p 33).

Description of the Region
Urban Development and Non-Residential Development

A number of major infrastructure, tourist and commercial projects and developments are underway, or planned for the region. These projects will increase development pressure and have an impact on population and settlement in the region.

The main areas of development interest are:

- Mine expansions;
- Agriculture irrigation;
- Aquaculture;
- Tourism;
- Urban development along the coast;
- Social infrastructure services; and
- Agri-business (WHAM p 45)

Transport
Integrated Transport

Transport is a key component in the marketing of bulk commodities such as coal, sugar, sugar products, grains, livestock, horticultural products and aquaculture products. Road, rail and sea are the region's principle bulk commodity transport systems.

There is a growing need to facilitate coordination and integration of regional transport systems with other regional, State, National and International transport systems and to provide appropriate and strategically located transport interchanges to facilitate passenger and freight movements between different transport modes (WHAM p 56).

Regional Vision - Regional Outcomes
Economy

The region capitalises on its specialist knowledge, skills and research capability in the areas of sugar production, horticulture, broad acre cropping, organic farming, environmental services, grazing, mining service industries, coal mining, maritime services, fishing, aquaculture and areas relating to social capital (WHAM p 64).

Key Regional Issues

Environment and Natural Resources

Water Courses and Water Quality

Need to consider potential impacts of discharges from aquaculture operations. (WHAM p 81).

Economy

Existing Industries

The region has a number of competitive advantages that can assist in driving future economic activity, including emerging aquaculture and education and training industries (WHAM p 84).

Economic Diversity and New Industries

There may be opportunities to enhance the development of the region's aquaculture industry to take advantage of the high growth opportunities in this area.

For an emerging industry, aquaculture is highly regulated. There is a call for a review and rationalisation of the aquaculture project approval process that is required by the three levels of Government and the Great Barrier Reef Marine Park Authority (WHAM P 84).

Infrastructure
Water Supply

Growth in the region's aquaculture industry is likely to increase demand for high quality freshwater and seawater resources. Aquaculture demands need to be appropriately assessed and integrated into regional water infrastructure planning and water allocation processes (WHAM p 106).

Infrastructure
Transport

The rapid transportation of perishable products derived from fishing, aquaculture and horticultural activities, to markets outside the region is critical to the viability of these industries. The region has limited capacity for airfreight and relies on road transport to other export centres such as Cairns (WHAM p 112).

Regional Goals and Strategies
Economy

3.1: Economic Base

Goal 3.1: - To maintain and enhance the economic base of the region.

Regional Strategies

Maintain and strengthen the competitiveness and economic value of the region's existing industries:

- Mining;
- Sugar;
- Agriculture and Horticulture;
- Livestock;
- Fishing;
- Aquaculture;
- Tourism;
- Transport;
- Manufacturing; and
- Business, commercial, retail and warehouse (WHAM p 134).

3.2: Economic Diversification

Goal 3.2: - To broaden and deepen the economic base of the region.

Regional Strategies

Identify and support the development of new industries in the region, based on regional strengths and market opportunities (eg aquaculture, communication, knowledge and tradable services) (WHAM p 135).

3.2: Economic Diversification

Goal 3.2: - To broaden and deepen the economic base of the region.

Regional Strategies

Develop export opportunities for the region's research capabilities, innovations and knowledge of key industries such as coal mining, sugar production, aquaculture and renewable energy (WHAM P 136).

3.3: Sustainable Industries
Goal 3.3: - To develop "sustainable industries" which are capable of producing commercially viable goods or services without causing undue stress on the region's environment, natural resources and/or community values.

Regional Strategies

Develop a Regional Sustainable Industry Strategy, to assist industries to achieve long-term sustainability; with priority for the aquaculture, agriculture, fishing and tourism industries (WHAM p 136).

Ensure the long-term environmental sustainability of aquaculture activities, including the potential impacts on the Great Barrier Reef and its lagoon, are taken into account in assessing future development options for this industry (WHAM p 137).

Infrastructure and Transport

6.3: Water Supply

Goal 6.3: - To provide future water infrastructure in a cost efficient, timely, environmentally, culturally and socially acceptable manner, to meet the needs of the region's industries and communities.

Regional Strategies
Industry Water Supply

Undertake investigations, in consultation with infrastructure owners and industry, to quantify the resources and infrastructure capacity currently available to the agriculture, mining and aquaculture industries, including identification of areas of under or over servicing (WHAM p 165).

Complete regional assessment and mapping of lands suitable for, or likely to be developed for, irrigated agriculture, mining or aquaculture (WHAM p 166).

Alternative Water Supply Options

Work with the mining, agricultural and aquaculture industries to identify opportunities for the use of alternative water sources (WHAM p 168).

6.7: Sewerage

Goal 6.7: - To provide urban areas and small rural and coastal communities with access to appropriate, safe, effective and environmentally sustainable sewerage disposal.

Regional Strategies

Implement or maintain appropriate wastewater management practices for industry, particularly aquaculture, sugar mills and food processing industries (WHAM p 171).

Regional Structure Plan
Summary Overview

The Regional Structure Plan is intended to establish, in general terms, the preferred physical and spatial arrangements for the region over the next 15 to 20 years, in terms of its natural environment, urban settlement pattern, economic activities and key regional infrastructure.

Fisheries and Aquaculture

The region's commercial fishing industry operates out of Bowen, Sarina and Mackay. Recreational and tourist fishing are also important activities. Key fishery habitats include the Great Barrier Reef and its lagoon system, estuaries, wetlands, seagrasses, dams and streams. These resources will need to be managed to ensure a sustainable future for industry and biodiversity conservation.

The region is developing a strong aquaculture industry, with potential expanding markets. Sustainable development of aquaculture industries could assist in diversifying the region's economic base (WHAM p 184).

Water Resources and Water Infrastructure

The region has a number of major irrigation systems, utilising both surface and ground water resources. Mining, industry and urban areas also require efficient and reliable water supplies.

A number of potential opportunities have been identified to develop or expand water infrastructure for irrigation, mining, **aquaculture** and urban development. These opportunities need to be appropriately investigated and timely decisions made with respect to resource availability and future development strategies (WHAM p186).

Infrastructure Opportunities

Burdekin River Catchment
The Burdekin River Irrigation Scheme services extensive areas of agricultural land around Ayr and Home Hill immediately north of the WHAM region. The primary water source for this scheme is the Burdekin Falls Dam. This scheme has the capacity to provide for potential expansion along the coast between Ayr and Bowen and/or into the Collinsville area through the construction of additional water distribution infrastructure.

The provision of additional water into the Bowen area could provide for further agricultural, horticultural and aquaculture development as well as reduce the pressures on the Don River underground water resources and the inter-catchment transfers from the Proserpine River System (WHAM p 201).

Economic Development
Overview

The WHAM region has a strong and vibrant economy based around a number of core industries. These include mining, agriculture, horticulture, aquaculture, grazing, agri-business and tourism. The region also provides a wide range of service, retail, manufacturing, construction, transport and other activities to support these industries and the region's urban and rural communities (WHAM p 204).

Regional Economic Development Opportunities
Fishing and Aquaculture

The region's commercial fishing fleet operates out of Mackay, Bowen and Sarina. Key operational areas include the Great Barrier Reef and its coastal lagoon system. Products include commercial fish, live exports, prawns and aquarium fish. Prospects for further development are likely to lie in improved value adding and processing operations as well as the identification and development of new sustainable fishing areas.

Aquaculture has emerged as a new regional industry over the past decade. Current activities are located in the Bowen, Whitsunday, Sarina and Broadsound Shires along the coast. This industry has excellent potential for growth. Identification and provision of land and services to facilitate sustainable industry development is required. Future development options will need to consider environmental and sustainability issues, in particular, potential impacts on the Great Barrier Reef and marine waters (WHAM p 207).

Whitsunday and Bowen Districts
Overview

The Whitsunday and Bowen districts have a wealth of high quality natural resources that underpin their successful agriculture, tourism and mining industries.

The Whitsunday Island Group is one of Queensland's major coastal tourist destinations. The increasing social infrastructure services and employment opportunities available through Airlie Beach, Cannonvale and Shute Harbour, and the development of resorts such as Laguna Quays are also enhancing tourist opportunities on the mainland.

The Bowen and Proserpine districts are predominantly agricultural areas producing a range of crops, principally sugar (Proserpine) and horticulture (Bowen). The area also has a growing aquaculture industry (WHAM p 241).

Bowen

Opportunities for future development are likely to come from expansion of agricultural and horticultural areas under irrigation, increased value adding, aquaculture, sand and gravel extraction, agri-business industries and tourism (WHAM p 243).

Primary Industries

The Bowen and Whitsunday area has a very successful, nationally recognised primary industry based on sugar cane (Proserpine), horticulture (Bowen), aquaculture (Bowen-Proserpine), fishing (Bowen); and mining (Collinsville).

The district also has a range of value adding industries including sugar milling, fish processing, food processing, salt production and power generation. Options may exist for additional value adding industries, particularly in the horticulture and aquaculture industries.

Aquaculture

Aquaculture is becoming a prominent new industry in the Bowen and Whitsunday area. There are a number of existing establishments, with proposals for expansion of these and other developments over the next few years. Sustainable development of the aquaculture industry will assist in strengthening the districts' economy (WHAM p 244).

Regional Priorities

Priority Projects
Economy

Further diversify and expand the region's existing economic base to include value added industries and to capitalise on its competitive advantages such as; specialist knowledge of the sugar and mining service industries, research capabilities, maritime services, aquaculture sites, information and service industries and a high quality of life (WHAM p 260)

6.8.2 Existing and Proposed Aquaculture Operations

There is one proposed and one existing aquaculture facility within 20 km of the Guthalungra site.

There is one aquaculture operation located approximately 10 km east of the proposed prawn farm at Guthalungra. Good Fortune Bay Fisheries (formally Seafood Online) has been established near Mount Curlwis, adjacent to Saltwater Creek, at the western side of Salisbury Plain since 2000. Originally constructed as a reef fish hatchery and grow-out farm the operation was sold in 2002 without having produced any commercial quantities of fish. The new management are attempting to grow barramundi while continuing the research into reef fish production.

Currently Good Fortune Bay Fisheries is producing fingerlings from the hatchery however commercial grow-out at the farm has not begun, as discharge approvals are pending.

Secondly, an application for a prawn farming operation northwest of Guthalungra has been assessed and approvals for a portion of the operation have been given. This site is located on Rocky Ponds Creek, Upstart Bay, near Gumlu and approximately 30 km southeast of Home Hill. The total production area of the proposal is 100ha.

No impact on the Guthalungra proposal by the two other aquaculture facilities is envisaged. Conversely, the Guthalungra proposal will not impact on the operation or viability of the other sites.

6.8.3 Land Tenures and Native Title Claims

6.8.3.1 Land Tenure

Refer to Figure 1-2 to 1-7 in Section 1 for land tenure of the site and adjacent lands.

6.8.3.2 Native Title Claims

No native title claims have been lodged over the development site or over the seabed or adjacent properties through which the pipeline route is proposed.

A native title claim has been lodged over an area covering the Cape Upstart National Park. An annexe of the Cape Upstart National Park is located adjacent to the northern boundary of Lot 370, part of the development proposal. The claimant application number is QC97/19. The application details are outlined below and have been obtained form the National Native Title Tribunal.

NNTT File No and name: QC97/19 Birri Gubba
Federal Court No: QG6349/98
Date filed or lodged: 19/06/97
Date registered: 19/06/97

Body claim lodged with:

The application was lodged with the National Native Title Tribunal and, pursuant to schedule 5 part 3 item 6 was taken to have been filed in the federal court.

Address for service of the applicant:

C/- Central Queensland Land Council Aboriginal Corporation
31 Sydney Street
MACKAY QLD 4740

Description of the persons who it is claimed hold the native title:

Area of land or water covered by the Claim

State or Territory:
QLD

Description of the area:

- A map showing the external boundaries of the area covered by the claim see Figure 6-31.
- A technical description of the external boundary, being: Cape Upstart National park (Lot 135 on NPW 463).

Further details on the Native Title claim can be obtained from:

The National Native Title Tribunal
GPO Box 9973
Brisbane Qld 4001

6.8.4 Compliance with ESD

The term Ecologically Sustainable Development (ESD) was adopted in Australia to emphasize the importance of the environment to long-term survival and to ensure that there is a balanced approach in dealing with environmental, social and economic issues. The National Strategy on ESD (CoA, 1992) was agreed to by all Australian governments and includes three key objectives:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;

- To provide for equity within and between generations; and
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The project enhances the individual and community well being and welfare by following a path of economic development that safeguards the welfare of future generations

The Guthalungra prawn farm proposal will:

- Increase the total GVP of agriculture in the Shire by almost 15%;
- Employ equivalent to 10% of the Shire's agricultural labour force;
- Have an annual turnover equivalent to the value of the cattle grazing industry in the Shire;
- Increase personal household incomes in the Shire by up to $4.4 million per annum;
- Occupy an area equivalent to 0.04% of the area zoned for rural grazing in the Shire;
- Generate direct and flow-on business turnover in the region of $43 million per annum;
- Create 88 Full Time Equivalent positions directly on the farm and a further 20 elsewhere in the region; and
- Cost around $36 million to construct, many of the goods and services will be sourced locally;

To provide for equity within and between generations

The Guthalungra prawn farm proposal will:

- Provides employment and quality of life for this and future generations;
- Maintains the World Heritage Values of the Great Barrier Reef for this and future generations.

To protect biological diversity and maintain essential ecological processes and life-support systems.

The Guthalungra prawn farm proposal:

- Maintains the World Heritage Values of the Great Barrier Reef;
- Reduces the reliance on wild capture prawn fisheries and associated trawl damage;
- Protects the biological diversity of wetlands and migratory bird habitat;
- Protects the biodiversity of intertidal lands.