7 The adverse and beneficial impacts of the project

7.1 *Environmental values*

This section directly addresses concerns raised by one respondent.

Environmental values determined through consultation with the community were described in Section 7.2.6, GAPFR, 2003.

The beneficial uses to be managed are:

1. The protection of aquatic ecosystems and in particular seagrass meadows, which are important grazing grounds for dugongs and turtles, and coral reefs;
2. Maintenance of recreational values; and
3. Maintenance of aesthetic values.

Additional environmental values relate to the presence of the World Heritage Area of the Great Barrier Reef. These are discussed in more depth in Section 7.14 World Heritage Values. However, the water quality objectives for protecting these environmental values are encompassed by water quality objectives for the values listed above.

7.2 *Water quality*

This section directly addresses concerns raised in two comments. A number of responses relating to water quality are contained in following sections.

7.2.1 Water quality objectives

Parameter	Aquatic Ecosystem	Recreation/ Aesthetic values	Default WQO QWQG, 2005	Current median values in Abbot Bay	Water Quality Objectives PRF Guthalungra
Total N	0.2 $mg.L^{-1}$	None applicable	0.20 $mg.L^{-1}$	0.21 $mg.L^{-1}$	0.21 $mg.L^{-1}$ (no change)
Total P	0.02 $mg.L^{-1}$	None applicable	0.02 $mg.L^{-1}$	0.014 $mg.L^{-1}$	0.014 $mg.L^{-1}$ (no change)
Total Suspended Solids	15 $mg.L^{-1}$	None applicable	15 $mg.L^{-1}$	3.25 $mg.L^{-1}$	10 $mg.L^{-1}$
Chlorophyll a	2.0 $\mu g.L^{-1}$	None applicable	2.0 $\mu g.L^{-1}$	0.8 $\mu g.L^{-1}$	1.2 $\mu g.L^{-1}$
Dissolved Oxygen	90 - 100% saturation	None applicable	90 - 100% saturation	76 – 97% saturation	76 – 97% saturation (no change)
pH	8.0 – 8.4	None applicable	8.0 – 8.4	7.69 – 8.35	7.69 – 8.35 (no change)

Table 7.1. Derived water quality objectives for Abbot Bay after the development of Pacific Reef Fisheries Guthalungra Prawn Farm.

The water discharged from the prawn farm will contain dissolved nutrients and suspended solids and may cause phytoplankton blooms in the receiving waters. Default water quality objectives were determined from the Draft Queensland Water Quality Guidelines 2005 for enclosed coastal waters on the Central Coast and derived values for Abbot Bay after the development of the prawn farm account for either the default values or the current status of water quality in the Bay. These water quality objectives are shown in Table 7.1.

The water quality objectives derived for Abbot Bay after the Pacific Reef Fisheries Guthalungra Prawn Farm development have been derived on the basis of:

- Maintaining the Environmental Values of Abbot Bay described above.
- Providing an opportunity for future discharges into Abbot Bay in those cases where current water quality provides such an opportunity bearing in mind the QWQG, 2005.
- Providing for no change where current water quality indicates no additional capacity relative to QWQG, 2005.
- The generally accepted objective applicable to slightly to moderately disturbed ecosystems of not exceeding trigger values.

7.3 Discharge Water Quality Objectives - current

This section directly addresses concerns raised in seven comments by respondents.

The following discharge water quality objectives have been derived to achieve the water quality objectives shown in Section 7.2.1 Water quality objectives and are believed by the proponent to be achievable.

7.3.1 Objectives for concentration of nutrients

- Annual maximum total suspended solids at end of discharge pipe < 30 $mg.L^{-1}$
- Annual mean total suspended solids at end of discharge pipe < 20 $mg.L^{-1}$
- Annual maximum total nitrogen at end of discharge pipe < 2 $mg.L^{-1}$
- Annual mean total nitrogen at end of discharge pipe < 1.5 $mg.L^{-1}$
- Annual maximum total phosphorus at end of discharge pipe < 0.3 $mg.L^{-1}$
- Annual mean total phosphorus at end of discharge pipe < 0.15 $mg.L^{-1}$
- pH range at end of discharge pipe between 6.0 and 9.0.
- Dissolved oxygen at end of discharge pipe > 70% of ambient (background) value.

7.3.2 Objectives for dilution of nutrients

- Dilution of total suspended solids to <10 $mg.L^{-1}$ within 500 m of discharge
- Dilution of total nitrogen to background +10% within 500 m of discharge
- Dilution of total phosphorus to background +10% within 500 m of discharge

7.3.3 Objectives for total load

- An annual load for total suspended solids of 466 $T.annum^{-1}$ (6.59 $kg.Ha^{-1}.day^{-1}$).
- An annual load for total nitrogen of 34.9 T (0.49 $kg.Ha^{-1}.day^{-1}$).
- An annual load for total phosphorus of 3.50 T (0.05 $kg.Ha^{-1}.day^{-1}$).

Calculation of daily loads is shown in the spreadsheet contained in Appendix 2.

7.3.4 Comparison with industry standards

The target load for TSS is 55% of the current industry standard of 12 $kg.Ha^{-1}.day^{-1}$, the target load for Total Nitrogen is 62% of the current industry standard of 0.8 $kg.Ha^{-1}.day^{-1}$, and the target load for Total Phosphorus is 33% of the current industry standard of 0.15 $kg.Ha^{-1}.day^{-1}$ reflecting the objective of the proponents to be of a high standard and achieving best practice environmental management.

7.3.5 Other Parameters that may be considered

Water Quality Objectives for chlorophyll *a* and Secchi Depth have not been derived since:

- although objectives for chlorophyll *a* are listed in the Great Barrier Reef Water Quality Action Plan (2001), chlorophyll *a* does not reflect any significant environmental impact of aquaculture discharge not measured by total suspended solids or other nutrients,
- there is a significant correlation in prawn discharge effluent between TSS and chlorophyll *a* and we seek to avoid duplication of effort (Table 5.3), and
- Secchi depth is an unreliable and rudimentary measure of turbidity that varies between operator and again does not reflect any significant environmental impact not measured by total suspended solids.

7.3.6 Economic implications of the current water quality objectives

Achievement of the current water quality objectives has both an economic cost to the company and an economic benefit to the region.

The water quality objectives will be achieved through incorporation of advanced technologies such as sand filtration into the processing of prawn farm effluent. This technology will be incorporated at a cost of an estimated $2 million or 5% of the total construction cost.

Changing the land use for approximately 769 Ha of land from its current cattle grazing to prawn farming will result in significant economic benefit. Sustainable cattle grazing in the coastal strip of Queensland can be undertaken at 4 Ha/beast provided that the pasture has been supplemented with legumes, or 8 Ha/beast for native pasture (QDPI, 2005). Supplemented pasture allows production of approximately 175 $kg.head^{-1}.year^{-1}$ (QDPI, 2005) at a market value of $3.19.$kg^{-1}$ (MLA, 2005). This results in potential production of $140.$Ha^{-1}.year^{-1}$ for cattle or $107,660 annual production from 769 Ha. By comparison, the same area devoted to prawn farming and mitigation as described below provides $37,711.$Ha^{-1}.year^{-1}$ or approximately $29 million of annual production from 769 Ha. In environmental terms, the changed land use increases the economic return from the environmental impact:

- from $239.Tonne of $sediment^{-1}$ to $62,231.Tonne of $sediment^{-1}$,
- from $149,526.Tonne $nitrogen^{-1}$ to $830,000.Tonne $nitrogen^{-1}$ and

- from \$0.67 million.Tonne phosphorus^{-1} to \$0.85 million.Tonne phosphorus^{-1}.

7.3.7 Modelling of water quality impacts – Predicted outcomes of the proposed discharge

7.3.7.1 Fundamental Principle

The fundamental principle adopted in the modelling described in the Appendix Q, GAPDE, 2003, was to demonstrate worst-case scenarios. Based on feed-back from regulatory agencies, this is apparently not the usual practice in development proposals. The modelling was intended to demonstrate worst-case scenarios as clearly stated in Section 7, GAPDE, 2003. However, a number of respondents suggested that using ANZECC guideline values for determining the impact of discharge water on Abbot Bay was inappropriate as water quality as measured in Abbot Bay (Section 5.1 Water quality and Section 6.4.1, GAPDE, 2003) was poorer than expected from ANZECC guideline values. Despite this, in view of the proponents commitment to excellent environmental management, it was decided not to remodel the impact area on the basis of new data for a number of reasons. The impact of the values used in the previous models as compared with actual values is reviewed below.

7.3.7.2 Time period of modelling

The periods originally chosen for the models were 1990 and 1998 as a worst-case and a average example respectively. February is the period of maximum discharge.

7.3.7.3 Background water quality values

Changing the background values used for modelling impacts from ANZECC 2000 guideline values to 80th percentile measured Total Nitrogen and Total Phosphorus values, which are approximately 300% greater (Table 5.1), would result in significant reduction of the modelled impact area. Therefore, any data generated using ANZECC 2000 values as background for nitrogen and phosphorus is clearly a worst-case scenario.

7.3.7.4 Discharge values

For two of the parameters modelled in Appendix Q, GAPDE, 2003, namely Total Nitrogen and chlorophyll *a*, maximum discharge values were used. For the third parameter, Total Phosphorus, the average discharge value was used. Use of maximum values that may be present in the discharge for a relatively short period of time serves to provide an indication of *possible* areas of impact of the discharge, whilst the use of average values gives a better idea of *likely* areas of impact of discharge. Thus, the models for Nitrogen and chlorophyll *a* show worst-case scenarios and those for Phosphorus show a more likely scenario.

7.3.7.5 Volume values

In the majority of the modelling previously undertaken (Appendix Q, GAPDE, 2003), two discharge values of 200 ML.day^{-1} and 100 ML.day^{-1} were used. The basis for this was that 100 ML.day^{-1} is approximately the average value of discharge from the prawn farm while 200 ML.day^{-1} is a "conservative" maximum. However, 200 ML.day^{-1} overstates significantly the nutrient load on the environment by 88% (Table 7.5, GAPDE, 2003). Again, whilst the original authors sought to demonstrate a worst case scenario, overstating the volume of the discharge by such a large amount has resulted in confusion. Therefore, the average volume of approximately 100 ML.day^{-1} is considered to provide a more appropriate basis for determining impact.

7.3.7.6 Determination of Threshold values

Consideration of the nature of the environment in Abbot Bay suggests that the interactions between water quality and seagrass biology, in particular, is not well encompassed in currently accepted critical values. For instance, the GBRMPA critical value for seagrass environments is 1.0 µg.L^{-1} for chlorophyll *a* (GAPDE, 2003) although the 80th percentile for chlorophyll *a* at the sample site in Abbot Bay adjacent to where seagrass is present is 1.3 µg.L^{-1}. Thus determining a critical value for chlorophyll *a* that is relevant to seagrass in this region is difficult. Similarly, Abbot Bay waters have 80th percentile values for Total N and Total P over 200% and nearly 300% respectively of the values cited by GBRMPA as critical for seagrass environments. This factor makes any *model* of impacts on seagrass (the likely major impact of discharge in the present study) a central point of debate rather than consideration about impacts in general. Accordingly, models determining impacts using threshold values used by GBRMPA and cited in GAPDE, 2003, are considered inappropriate for this situation.

7.3.7.7 Area of impact as determined by models

Having considered the above, the question remains as to what is the likely impact of the discharge water quality on the environment of Abbot Bay? The models already presented in GAPDE, 2003, provide adequate information to assess this.

7.3.7.8 With regard to maximum impacted areas:

- Figure 24a, Appendix Q, GAPDE, 2003, shows the outcome of modelling Total Nitrogen in February 1990 with Background = 0.1 mg.L^{-1}, Discharge = 2 mg.L^{-1}, Flow = 200 ML.day^{-1}. This model is generated using 30% of true background and above the maximum flow expected (Appendix C, GAPDE, 2003). Figure 24a, Appendix Q, GAPDE, 2003, shows an area of 15 Ha inside the 0.15 mg.L^{-1} contour, which is itself 50% of actual background. Similar parameters modelled in February 1998 gave an impact area of 8.28 Ha inside the 0.15 mg.L^{-1} contour (Figure 25a, Appendix Q, GAPDE, 2003).

- Figure 24b, Appendix Q, GAPDE, 2003, shows the outcome of modelling Total Phosphorus in February 1990 with Background = 0.015 mg.L^{-1}, Discharge = 0.15 mg.L^{-1}, Flow = 200 ML.day^{-1}. This model is generated using 30% of true background and above the maximum flow expected (Appendix C, GAPDE, 2003). Figure 24b, Appendix Q, GAPDE, 2003, shows an area too small to measure accurately (< 0.09 Ha) inside the 0.025 mg.L^{-1} contour, which is itself 56% of actual background. Similar parameters modelled in February 1998 gave an impact area of similar dimension (<0.09 Ha) inside the 0.025 mg.L^{-1} contour (Figure 25b, Appendix Q, GAPDE, 2003).

- Figure 24c, Appendix Q, GAPDE, 2003, shows the outcome of modelling Chlorophyll *a* in February 1990 with Background = 0.001 mg.L^{-1}, Discharge = 0.03 mg.L^{-1}, Flow = 200 ML.day^{-1}. This model is generated using 77% of true background and above the maximum flow expected (Appendix C, GAPDE, 2003). Figure 24c, Appendix Q, GAPDE, 2003, shows an area of 1.1 Ha inside the 0.003 mg.L^{-1} contour. Similar parameters modelled in February 1998 gave an impact area too small to measure (<0.09 Ha) inside the 0.003 mg.L^{-1} contour (Figure 25c, Appendix Q, GAPDE, 2003).

7.3.7.9 With regard to likely impacted areas:

- Figure 32a, Appendix Q, GAPDE, 2003, shows the outcome of modelling Total Nitrogen in 1990 with Background = 0.1 $mg.L^{-1}$, Discharge = 2 $mg.L^{-1}$, Flow = 100 $ML.day^{-1}$. This is 30% of true background and about the average flow expected (Appendix C, GAPDE, 2003). Figure 32a, Appendix Q, GAPDE, 2003, shows an area of 0.44 Ha inside the 0.15 $mg.L^{-1}$ contour, which is itself 50% of actual background. Similar parameters modelled in 1998 gave an area of 0.88 Ha inside the 0.15 $mg.L^{-1}$ contour (Figure 33a, Appendix Q, GAPDE, 2003).
- Figure 32b, Appendix Q, GAPDE, 2003, shows the outcome of modelling Total Phosphorus in 1990 with Background = 0.015 $mg.L^{-1}$, Discharge = 0.15 $mg.L^{-1}$, Flow = 100 $ML.day^{-1}$. This is 30% of true background and about the average flow expected (Appendix C, GAPDE, 2003). Figure 32b, Appendix Q, GAPDE, 2003, shows an area too small to measure accurately (< 0.09 Ha) inside the 0.025 $mg.L^{-1}$ contour, which is itself 56% of actual background. Similar parameters modelled in 1998 gave an area of similar dimension (<0.09 Ha) inside the 0.025 $mg.L^{-1}$ contour (Figure 33b, Appendix Q, GAPDE, 2003).
- Figure 32c, Appendix Q, GAPDE, 2003, shows the outcome of modelling Chlorophyll *a* in 1990 with Background = 0.001 $mg.L^{-1}$, Discharge = 0.0.03 $mg.L^{-1}$, Flow = 100 $ML.day^{-1}$. This is 77% of true background and about the average flow expected (Appendix C, GAPDE, 2003). Figure 32c, Appendix Q, GAPDE, 2003, shows an area too small to measure accurately (<0.09 Ha) inside the 0.003 $mg.L^{-1}$ contour. Similar parameters modelled in 1998 gave an area of similar dimension (<0.09 Ha) inside the 0.003 $mg.L^{-1}$ contour (Figure 33c, Appendix Q, GAPDE, 2003).

These models show:

- ♦ *the largest **likely** impacted area of 0.88 Ha (Total Nitrogen, 1998, Figure 33a, Appendix Q, GAPDE, 2003).*
- ♦ *the largest **possible** impacted area of 15 Ha ((Total Nitrogen, February 1990, Figure 24a, Appendix Q, GAPDE, 2003).*

7.3.7.10 Settling of particulate matter and biological activity

Settling of particulate matter is not included in the model as particulate matter is largely neutrally buoyant algae as shown by the correlation between TSS and chlorophyll *a* in aquaculture discharge (Table 5.3).

Biological activity is not included in the model as it is not possible to model it with any accuracy due to its complexity. Therefore, any model proposed would be speculative. This would also include the prediction of any phytoplankton growth as a result of increased nutrient availability. In practice, increased phytoplankton growth is considered unlikely to occur as the nutrients in the discharge are largely incorporated into organic matter. Growth of phytoplankton would therefore only occur as a consequence of nutrient turnover. Again, the complexity of the processes involve would inevitably lead to speculative conclusions at best.

7.3.7.11 Flow from the Elliot River

Flows from the Elliot River were not included in the modelling as they are:

- intermittent and infrequent with an average of one event per year over the last 30 years which may only occur for a period of one week in any single event (Qld DNRM data service).
- significantly higher in each of median Total Suspended Solids, Total Nitrogen and Total Phosphorus than usual Abbot Bay waters (Table 5.1) and so any impact of discharge by the Guthalungra Prawn farm is likely to be lessened when Elliot River flows are considered (Qld DNRM data service).

7.3.8 Nutrient sources into Abbot Bay

The discharge from GFB Fisheries Pty Ltd is the only other point source discharge into Abbot Bay. Additional input of nutrient comes from diffuse agricultural activities, cattle grazing and horticulture.

The proponent understands that GFB Fisheries increased its level of operation and discharge to the maximum current capability between the 2002/03 and the 2005 data collection periods described in Section 4. Comparison of the water quality data collected from Abbot Bay in the 2002/03 and 2004/05 periods shows no statistically significant differences between the two periods (Table 7.2). The treated discharge of GFB Fisheries enters Saltwater Creek and then travels over 5 km before entering the upper reaches of the Elliot River Estuary. Untreated discharge from a prawn farm subjected to the processes occurring in a mangrove lined creek was found to have no effect on samples taken off-shore of the mouth of the creek (Trott and Alongi, 2001). It is therefore considered likely that the impact of the treated discharge from GFB Fisheries will have similarly little effect on the water quality of Abbot Bay.

Table 7.2. F values for the comparison of 2002/03 and 2004/05 water quality data from Abbot Bay.

Parameter	F	p<
TN	0.42	Not significant
TP	1.6×10^{-6}	Not significant
TSS	0.87	Not significant
Chla	1.00	Not significant

The major likely source of nutrients into Abbot Bay is from agricultural activities. These activities are unlikely to increase. In fact, the GRBWQAP (2001) seeks to reduce loads from agriculture.

Other developers may contemplate other point source loads at some time in the future. Whilst there remains some capacity for additional nutrient loadings for Total Suspended Solids and Total Phosphorus, on the basis of the trigger values proposed in QWQG (2005), there is little capacity for additional Total Nitrogen. the guideline trigger values are based on general principles and the true value will depend upon various nutrient fluxes, interactions and transport into and out of a water body. Consequently, these values must be seen as a guideline. The additional load of Total Nitrogen provided by the proposed Prawn Farm is 4.47% of total loads in the Don River catchment. Assuming even distribution and no other net changes in transport or fluxes of nitrogen, this will increase the ambient concentration of Total N in the Bay from 2.10 $mg.L^{-1}$ to 2.2 $mg.L^{-1}$, a change within any confidence interval that could reasonably be applied to these values. Note however, that the water quality objective for Abbot Bay is no net change in Total N.

7.3.9 Risk of cross-contamination

It is not clear what is meant by " risk of contamination between sites". Another farm (GFB Fisheries) discharging into Abbott Bay is a finfish farm (different species) that has been operating for 3 years at the time of writing. The background water quality described in Section 5.1 Water quality, includes periods prior to and after the operation of GFB Fisheries and shows no effect of that farm on water quality at the proposed discharge point. The modelling of impacts described earlier in this section shows that background levels of water quality will be achieved within 100 m of the discharge point. Thus, the data indicate that there will be no additive effect of having two farms on Abbot Bay and any risk of cross contamination between the aquaculture enterprises discharging into Abbot Bay is alleviated by the culture of different species. GFB Developments has sought a decision on whether enlarging their activities to farm prawns as bioremediation is a referred action under the EPBC Act. The proponent does not consider that this corresponds to a decision by GFB Developments to invest in or to undertake such an action and cannot therefore be a consideration in any application by the proponent.

7.4 Water Quality Objectives – Future

This section directly addresses concerns raised in three comments.

7.4.1 Comparison of Don River and Elliot River Catchments

The Great Barrier Reef Water Quality Action Plan (2001) (GBRWQAP) proposes water quality targets for 2011 for sediment, nitrogen and phosphorus inputs into the Great Barrier Reef lagoon. GBRWQAP provides data for the Don River Catchment, but not for the Elliot River Catchment, which is described as one of a series of:

"small water courses that have a high priority in terms of the risk to water quality of the Reef but have not been included in the primary prioritisation of river catchments. These systems represent approximately 7% of the total pollutant loading and are significant on a local level."

Although locally important and incorporated into the Don River Catchment, water quality in flows from the Elliot and Don Rivers are very similar (Qld DNRM Data service, Elliot and Don River Data). In addition, the Elliot river comprises 7.4% of the total Don River Catchment. The nature of the catchment for the Elliot River is similar to the rest of the Don River Catchment in that it is characterized by a large proportion of land clearing and with the dominant land uses being cattle grazing and horticulture.

Consequently the issues for the Elliot River Catchment are the same as those that apply to the Don River Catchment namely:

- Soil erosion on the river delta and flats is significant and is caused predominantly by growing horticultural crops.
- Intensive agriculture and extensive use of chemicals have potential to cause contamination of soils and water.
- Intensive groundwater use *(where available)*.
- Grazing lands have isolated severe gully erosion in cleared areas.
- Major stream modifications have occurred in the catchment.

- *The majority* of the catchment has been cleared.
- Only *(insignificant)*% of the catchment is within protected areas.
- Proximity to seagrass beds and dugong protection areas
- Commercial and recreational fishery.
- Recreational marine use.
- *(Proximity to a)* Commercial port.

On this basis, it is considered that the nutrient load and flow data for whole of the Don River Catchment is relevant to assessing the impacts of the present proposal.

7.4.2 Current vs Future Status of the Don River Catchment and the contribution of the proposed farm discharge

The Great Barrier Reef Water Quality Action Plan (2001) identified an estimated 509.5 kT of sediment, 812 T of nitrogen and 178 T of phosphorus entering the GBR lagoon from the Don River catchment each year. Of this, 450 T of sediment, 0.72 T of nitrogen and 0.16 T of phosphorus are estimated to be coming from the area of the proposed prawn farm.

Table 7.3 Discharge of sediment, nitrogen and phosphorus from the proposed prawn farm in comparison with the current and target loads in the Don River Catchment.

Current ($T.year^{-1}$)	Total Suspended Solids	Total Nitrogen	Total Phosphorus
Total Don River Catchment (GBR Action Plan)[1]	509,528	812	178
Current amount of nutrient in runoff from the proposed Pacific Reef Farm Area[2]	1,062	1.69	0.37
EPA Policy on Current Prawn Farm Effluent[3]	870	56.6	10.6
Proposed Discharge Loads[4]	484	36.3	3.6
Proportion of total catchment discharge loads	0.09%	4.47%	2.04%
Load ($kg.Ha^{-1}.day^{-1}$)	6.84	0.51	0.05
Target 2015 ($T.year^{-1}$)			
Total Don River Catchment[1] (2011 target)	341,384	544	89
Target amount of nutrient in runoff from the proposed Pacific Reef Farm Area[2]	711	1.13	0.19
Proposed Discharge Target 2015[3]	324	24.3	1.8
Proportion of total catchment discharge loads	0.09%	4.47%	2.04%
Load ($kg.Ha^{-1}.day^{-1}$)	4.59	0.34	0.026

[1] Great Barrier Reef Water Quality Action Plan (2001), Don River Catchment Data
[2] Assuming a development area of 729 Ha (including area for mitigation) and a total Don River Catchment of 3695 km^2 as cited in the GBRWAP (2001).
[3] Values based on Discharge Requirements cited in the Policy multiplied by the total $discharge.annum^{-1}$ (22,638

ML.annum-1) cited in Appendix D, GAPDE (2003).
[4] Values calculated using mean nutrient concentration objectives listed in Section 7.3 Discharge Water Quality Objectives - current and discharge volumes provided in Appendix D, GAPDE, 2003.

The operational practices and design principles proposed in GAPDE, 2003, are better than those of the general industry. The objectives cited above (Section 7.3 Discharge Water Quality Objectives - current) result in sediment, nitrogen and phosphorus loadings that are 55%, 62% and 33% respectively of that considered acceptable for currently licensed prawn farms (EPA, 2003).

In comparison to the current activities in the Don River Catchment, the proposed prawn farm will result in effectively no increase in the estimated loading of sediment coming from the farm area. The nitrogen load from the farm area will increase by approximately 49 times and the phosphorus from the farm area by about 22 times. These values should be considered in the light of an increase in economic output of the area by over 400 times.

The contribution of the loadings coming from the proposed prawn farm as a proportion of the total load coming from the whole catchment will be 4.47% for nitrogen and 2.04% for phosphorus.

7.4.3 Future Objectives for total load

GBRWQAP identifies reduction of loads from the Don River Catchment in sediment and nitrogen by 33% and phosphorus by 50% by 2011. Application of these values toward reducing loading of the GBR lagoon gives the Target values shown in Table 7.3 for both the Don River Catchment and the proposed prawn farm.

Significant advances in technology will be required in order to achieve this reduction in the nutrient content of the prawn farm discharge, some of which have been previously described in Section 6.6.2.3 Future Development. However, in view of the proponent's commitment to development of best practices in the industry, it considers that non-obligatory targets for nutrient load are appropriate to encourage such development. Thus, the propoenent proposes to work toward achieving the target loads for sediment and nutrients as identified in Table 7.3, namely:

- An annual load for total suspended solids of 312 T.
- An annual load for total nitrogen of 23.4 T.
- An annual load for total phosphorus of 1.7 T.

These targets compare favourably with those of the GBRWAP (2001).

7.5 Seagrasses

This section directly addresses concerns raised in five comments by respondents.

Seagrass distribution in Abbot Bay and the immediate project area were discussed in Section 6.5.1 (c) and Appendix L of GAPDE 2003. Although a value was presented in GAPDE, 2003 of 4465 Ha of seagrass, this was incorrect. Plotted areas of seagrass comprise 3500 Ha in Abbot Bay. Characteristics of the seagrass beds were the presence of *Halophile ovale*, *Halophile spinulosa and Halodule uninervis*. These species are known to have rapid turnover, which is in the order of 28 days and are considered unlikely to be impacted by the discharge and are considered to be likely to recover quickly from any short-term impact. A risk assessment and discussion of likely impacts on seagrass are presented in Sections 7.2.8.2 - 7.2.12 in GAPDE 2003.

Notwithstanding this, the proponent sought independent advice from Dr Rob Coles, an internationally recognised expert in seagrass biology employed by Qld DPI&F, Northern Fisheries Centre. The response from Qld DPI to our enquiries is contained in Section 11.7 Appendix 7. Response from Qld Department of Primary Industries Regarding enquiries in respect to impacts of the project on seagrass.

Qld DPI&F recommended no further studies of seagrass distribution in Abbot Bay, finding "seagrass distribution, speciation and productivity will vary significantly throughout the year and between years due to natural and anthropogenic influences on the Bay".

7.5.1 Impact of light reduction be algae and particulate matter on seagrass

The seagrasses present in the area are tolerant of light levels 10-30% of surface levels. The water quality objectives at the discharge (Section 7.3.1 Objectives for concentration of nutrients) identify maximum Total Chlorophyll *a* of 0.03 $mg.L^{-1}$. Dubinsky and Berman (1981) found that this level of chlorophyll would result in attenuation of light by less than 40% and there would need to be 100 – 200 $mg.L^{-1}$ chlorophyll to reduce the light to 20% of the surface values. As discussed by Qld DPI&F, additional nutrients may result in increased chlorophyll by stimulating algal growth, but it is highly unlikely that this would occur within the modelled impact area as most nutrients are already incorporated into organic matter and there would be a high rate of dispersion of nutrients by wind and current. Modelling of nutrients shows that at a greater than maximum flow of effluent of 200 $ML.day^{-1}$, chlorophyll *a* greater than 0.003 $mg.L^{-1}$ for more than 2.4 hours a day would extend for only 250 m from the outfall. The nearest mapped seagrass is 180 m to the northwest or 225 m to the southeast (Figure 3.1; Figure 2c, Appendix Q, GAPDE, 2003). It is highly unlikely that the discharge from the proposed project will impact on seagrass by attenuating light.

Gallegos (2001) modelled the circumstance where Total Suspended Solids and Chlorophyll *a* were both considered in effects on incident light for seagrasses. However, since it is apparent that TSS in the discharge of prawn farm effluent is correlated with chlorophyll *a* (Table 5.3), there is unlikely to be additive effects not due to TSS other than algae in the presnt circumstance.

In view of

- the light tolerance of seagrasses present in Abbot Bay,
- the absence of likely attenuation effects of TSS and chlorophyll *a* discussed above,
- the fact that discharge will only occur for a maximum of 270 days per year and
- the known rapid turnover rate of the seagrasses present in Abbot Bay,

It is not considered likely that there will be a significant sub-lethal effect on seagrasses as a result of the discharge of water from the proposed prawn farm.

7.5.2 Impacts on the periphery of seagrass distribution in Abbot Bay

There is a possibility of effects of reduced light at the periphery of the distribution of seagrasses in the immediate area of the discharge point. Light incident on submerged aquatic fauna is reduced by the scattering effect of particulate matter such as algae and inorganic sediments and by physical absorption of light energy by the water. One of the factors controlling the distribution depth of submerged aquatic vegetation is therefore depth. Whilst there may be significant areas of seagrass outside of the study areas investigated by the consultant employed by the proponent, the shallow incline of the Bay suggests that any effect of light limitation on seagrass distribution would begin somewhat off-shore from the proposed discharge point, where there would be no impact of nutrients from the plume of the discharge.

7.6 Marine animals

This section directly addresses concerns raised in three comments by respondents.

7.6.1 Errata to tables

Table 7.16 (EIS page 7.61) omitted the following species and potential impact:

Scientific Name	Common Name	Status	Potential Impact
Caretta caretta	Loggerhead Turtle	Endangered	Degradation of habitat as a result of prawn farm discharge. An increase in nutrients and algal flocs may have a minor effect on seagrass distribution and abundance in Abbot Bay. It is predicted that less than 5% of the seagrass may be impacted. Therefore some minor changes to Loggerhead Turtle feeding regimes in Abott Bay may occur.

7.6.2 Impact on fishery

There is no evidence to suggest that aquaculture discharge will occasion loss in the wild fishery. Wild fisheries co-exist with commercial aquaculture developments around Australia and in many parts of the world, with no detrimental effect. Some local fishermen see aquaculture as a potential threat. This concern is misplaced as:

- Underwater structures such as the discharge structure are well recognised as Fish Attracting Devices (FADs) of benefit to local fishermen. Such FADs (eg artificial reefs) are popular and successful means of improving recreational fishing in a very localised region.
- Recreational fishing species such as barramundi are anecdotally described as being attracted to discharge areas because there is an abundance of baitfish.

Notwithstanding these beneficial influences, the impact is restricted to the area where the discharge occurs, in the present case and area of approximately 0.88 Ha in diameter.

7.7 Birds and other wildlife

This section directly addresses concerns raised in three comments by respondents.

7.7.1 Errata to Tables

Table 7.16 (EIS page 7.61) omitted the following species and potential impact:

Scientific Name	Common Name	Status	Potential Impact

Saccolaimus saccolaimus	Bare-rumped sheath-tail bat	Critically Endangered	Degradation of *Eucalyptus platyphylla* habitat as a result of prawn pond construction. This species utilises old growth trees with hollows in well-timbered areas or caves for roosting (Strahan, 1983). The area on which the ponds will be constructed has sparse and regenerated *E. platyphylla* unlikely to provide habitat for this species. The impact is likely to be nil or extremely low as *S. saccolaimus* has never been recorded south of Ayr and only once south of Townsville (Compton and Johnson, 1983). Further, *E. platyphylla* is widely present on the surrounding woodland, providing plenty of alternative habitat if *S. saccolaimus* is present.

7.7.2 Re-evaluation of likelihood of presence of certain species

We have been advised by Qld EPA that records for the following species are found in the Wildnet Database. (NB. Wildnet has extremely restricted access not including the proponent or their consultants, which explains the absence of these records in the original survey.) Accordingly, the likelihood of the occurrence of these species has been reconsidered. The liklihood of impacts on these species is not considered to be changed, however, for the reasons discussed in section Section 7.7.3 Methodology of study.

Species	Common name	EPBC	Record	Key resources	Habitat	Likelihood of occurrence			Appendix M ref.
						Main site	Pipeline	Adjacent areas	
Delma labialis	striped tail delma,	V	EPA	poorly known	poorly known but present in dunal area	Low: habitat not present	High: suitable habitats present	Present: suitable habitats present	Table 6.2
Merops ornatus	rainbow bee-eater	m	EPA	availability of habitat	open sand ridges	Low: habitat not present	High: suitable habitats present	Present: suitable habitats present	Table 6.3
Plegadus falcinellis	glossy ibis	m	EPA	availability of habitat	freshwater wetlands and pasture	High: suitable habitats present	High: suitable habitats present	Present: suitable habitats present	Table 6.3

7.7.3 Methodology of study

A field study was undertaken but targeted searches were not conducted, as the likelihood of finding the listed species is extremely low. The cost of conducting targeted searches is prohibitive in those cases where likelihood of finding species is low since they involve having operatives in the field for long periods of time and during various times of the year. Therefore, the likelihood of impacting on a species was assessed based upon habitat types observed in the field and known habitats for listed species as described in the literature.

As stated on Page 7-57 section b) Rare or Threatened Fauna, GAPDE, 2003, none of the rare or threatened species known or likely to occur in the project area are anticipated to be significantly affected by the proposal since:

- For the majority of species, potential habitat immediately adjacent to the main development area and proposed pipeline will not be affected; and
- In instances where potential habitat will be disturbed, only relatively small areas are affected and extensive areas of similar habitat occur locally and regionally.

This approach adopts risk management principles. In these cases, the risk of the species being present is low and the effect on the animals is low based on the presence of alternative habitat nearby. Therefore, the risk is not considered to warrant extensive targeted searches.

7.8 Ocean Intake and Discharge Pipelines Construction (Beach and Marine Sections)

This section directly addresses concerns raised in four comments by respondents.

7.8.1 Trench Excavation

The installation of the ocean intake and discharge pipelines requires a trench with an approximate bed width of 3m for the co-located twin 1000 mm dia. intake and discharge pipes, and 1.5m for the single discharge pipe section. The installation method for these pipelines is by hydraulic excavator on land and for as far seaward as possible. The use of the hydraulic excavator will continue mounted on a barge into the ocean. The final section of pipeline to be installed in the ocean bed will be installed using a cutter-suction dredge.

Cutter-suction dredges operate by pumping a substrate and water slurry (20% solids; Cameron Hall, Hall Construction, personal communication, 2005) to a shore based settlement area. Correct use of appropriate sized dredging equipment and careful dredging techniques allow minimising turbidity from dredging activities (eg Ellicott, 2005). Further, as identified in the EMP “Intake and Discharge Pipeline Construction” in Section 9.1.3 of GAPDE, 2003, a works schedule based on the predicted tidal regime to optimise tidal flow and hence dispersion of any sediment plume will be used. The dredge is held in place using side anchors and spuds – poles extending to the sea floor.

However, the lack of cohesive strength in the trench materials will mean that trench batters will be relatively flat. This is expected to be more evident for under water sections of the route, when current and wave action will exacerbate trench instability. As a consequence the width of excavation will be determined by a combination of the required trench depth, trench bed width, and the location (whether on the beach or in the water).

Based on a pipe depth of 3m across the beach (pipe invert depth), the width of excavation for the co-located pipes will be approximately 33 m, allowing for 5H:1V batter slope.

Within the marine environment the depth of the pipelines will be progressively reduced so that the depth to invert will be approximately 1m for much of their length. The width of excavation will therefore reduce to about 15m for the co-located pipes, and 13m for the section of single discharge pipe.

It can be expected that disturbance of bed material during the excavation process will result in an area of disturbance extending up to 5m each side of the edge of excavation, resulting in a total impact width of approximately 25m and 18m for the co-located and the single pipelines respectively.

The footprint area of excavation under water is therefore anticipated to be approximately 0.58 ha, with a total potential impact area of 1.0 ha.

Using the above information, there would be 200 m of double pipe, 242 m of single pipe (using a Control line value of 5175 as the initial point of seaward dredging) and average dredge depth of 1 m. Including the pump station, approximately 8500 m^3 of spoil will be removed by the dredging.

In order to minimise impact on the beach zone, slurry from the dredging will be pumped to the main site, dewatered and either used in pond construction or treated according to the PASS EMP if it contains ASS.

As described in Section 4.3.2 (a), backfilling of the trench will occur as a result of natural sediment movement in Abbot Bay in the underwater section and with beach sand across the beach.

Note that the path of the pipeline does not pass through a seagrass bed previously identified (Figure 3.1). In view of the width of the disturbance and the absence of seagrasses along the pipeline path, there will be no direct impact on seagrass by the construction of the pipeline.

7.8.2 Directional Drilling

Directional drilling was considered as an alternative pipeline installation method, mainly as a means of facilitating easy construction and to minimise environmental impacts. Directional drilling is an emerging technology that has the potential to reduce environmental impacts by minimise surface disturbance when installing pipelines in sensitive areas. It would involve the establishment of a launch pit somewhere near the beach zone, from which a drilling head would be used to drill a tunnel through which a pipeline would be subsequently pulled. To ensure tunnel stability, the drilled tunnel is usually located at a greater depth than would have the case for the current project.

The primary reasons why directional drilling was not considered to be the most appropriate method of installation for the pipelines were:

- The feasibility of installation of the ocean intake and discharge pipelines by directional drilling is likely to be limited due to the diameter of the pipes. Directional drilling has been proven as a technology on smaller pipe diameters. However, there have only been a very small number of projects that directional drilling has been used on pipes on comparable size to the intake and discharge pipelines.
- The need to install multiple pipelines would mean multiple drilling operations would be required.
- Directional drilling to install pipelines in sand is likely to have increased risks. Sand is a relatively unstable medium and the installation of the pipeline by directional drilling may cause increase risk of trench instability, which is likely to result in cave-

ins. This would require the digging out of the drilling equipment, which would cause surface disturbance. This would also mean further disturbance by commencing the pipeline installation again.

- The installation of the pipeline by directional drilling will require an area to treat ASS and PASS encountered in the pipeline installation. This area would include a pond to remove water from the drill slurry, waste management processes to ensure water is pH neutral prior to discharge and an area to treat ASS and PASS. It is estimated that this area would be required to be in the order of 1.5 hectares. An additional area of disturbance for the drilling operations would also be required.
- The cost of directional drilling is higher than traditional installation. Quotations obtained for directional drilling were significantly higher than those obtained for traditional pipeline installation. The direction drilling quotations did not include contingency costs for the any problems encountered in the installation. Therefore installation of the pipeline by directional drilling, in light of the risks outlined above, is considered to be cost prohibitive.

7.9 Dune system

This section directly addresses concerns raised in four comments by respondents.

7.9.1 NHT study: Priorities for remnant vegetation protection – Dryland Component

The dune ridge vegetation is in an area of regional conservation significance identified in Perry *et al*. (2002).

The area to be impacted contains an area "of concern" remnant vegetation communities in the dunal systems. The remnant vegetation community comprises

- a small patch of *Ipomoea pes-caprae* and *Spinifex sericeus* grassland ± *Casuarina esquitifolia* (RE 11.2.2) at the seaward end of the pipeline. The impacted area previously identified as 0.1 Ha and or <0.5% of the pre-cleared area (Appendix M, GAPDE, 2003). However, modification of the structure of the intake and discharge pipelines is likely to reduce this impacted area over that previously identified.

The impact of the current project on the area of this Regional Ecosystem is insignificant by any reasonable measure. This is even more apparent when revegetation of the impacted area is considered.

7.9.2 Disturbance to the dune system.

7.9.2.1 <u>Construction</u>

The construction of the pipeline through the dune system has been described in GAPDE 2003, Sections 4.3.2 and 7.3.2. The proposed changed location of the pumping station to an off-shore site described above in Section 6.1 Revised Seawater Intake and Discharge Arrangements will result in the construction of a small (5 m x 5 m) bunded and fenced control station within the dunes. The service road will extend only to the pumping control station and will be located adjacent to the pipeline route and constructed as shown in Figure 6.4. The project requires revegetation of the dunes as described in Section 4.3.2 of GAPDE 2003 and the EMP in Section 9.1.3 of GAPDE 2003. It has been stated in a response to GAPDE 2003 that:

"This area has experienced clearing of coastal fore dunes during previous ecotourism developments that have not progressed. The areas that were cleared have not revegetated after ten years."

Revegetation is not a passive process but requires intervention. Active exclusion of grazers, prevention of wind disturbance and a temporary unnatural supply of water may be required to ensure revegetation. Revegetation of dunal areas is relatively well understood and can be seen in many areas adjacent to population centres in North Queensland and similar processes will be adopted to revegetate the proposed pipeline route.

Previous clearing associated with developments that have not progressed have not engaged in such active management of the revegetation and the failure of these areas to revegetate is therefore unsurprising.

As described in Section 4.3.2 (a), the trench will be backfilled with dune sand.

7.9.2.2 Operation

As it is now intended that pumping of intake water will be undertaken using a submersible pump located in a pump station off shore, noise disturbance and major (initial) disturbance to dunes resulting from locating the pump station in the secondary dune will not now eventuate.

7.10 Wetland

This section directly addresses concerns raised in six comments by respondents.

7.10.1 Wetlands present or affected by the project

The pipeline passes through the South Cape Upstart Wetland aggregation and the Great Barrier Reef Marine Park. Impacts on the GBRMP are discussed separately under the Water Quality and Seagrass sections of this report. The following information is relevant to the South Cape Upstart Wetland aggregation.

7.10.2 NHT study: Priorities for remnant vegetation protection - Wetland Component

The wetland through which the pipeline passes is in an area of regional conservation significance identified in Blackman *et al*. (2002). This wetland comprises an 11,089 Ha wetland aggregation, largely based around Nobbies Inlet on the southwest of Cape Upstart (Blackman *et al*., 2002). The component of the wetland impacted by this project is an area of "seasonally inundated grassland and sedgeland, bare ground and shallow lagoons associated with old channels and drainage lines. The freshwater wetlands appear to have been created due to disruption of of the natural saline or brackish hydrology resulting from the construction of a powerline access track servicing the Camp Island supply line".

The impacted area is expected to be 1.25 Ha which comprises 0.01% of the total wetland area.

7.10.3 Wetland hydrology

The structure of the Southern Upstart Bay wetland has been described in GAPDE 2003, Section 6.6.3. This wetland comprises a series of depressions filled by drainage from the surrounding area. Water in this wetland is artificially retained as a result of bunding on the southern end as a result of the construction of a power line access track servicing the Camp Island supply line and as a result, flow within the wetland is likely to be minimal. The natural surface of the wetland at the site of the road reserve is between 0.75 m AHD and 1.0 m AHD. The height of the bunding on the southern end is approximately 4.8 m AHD. The proposed track will be constructed to a surface of 2.225 m AHD and will have two 750 mm diameter pipes under it at the lowest point (Figure 6.4). The under-track pipes will prevent interruption to the hydrology of the wetland under low flow conditions. As the track surface is below the level of the bunding, it will not result in any impediment to flows under conditions of flooding when the bunding is over-topped.

As the track will no longer have to carry heavy machinery other than a backhoe for trenching, the construction of the road across the wetland will be successfully achieved by stripping of 150 mm of surface material particularly to allow for rehabilitation on completion of construction followed by laying geofabric, rock and gravel as previously described in Section 4.1.1 (j) in GAPDE 2003. Such a construction method has been designed such that it will not impact on groundwater hydrology of wetland.

Concern was expressed over interception of impermeable soils in a wetland area in the dune swales resulting in damage to this wetland. Prior to construction, the soil profile of the entire pipeline path will be determined and thus allow the risk of interception of such layers to be determined. construction methods will be used to ensure that integrity of impermeable layers that provide for maintenance of the wetland.

7.10.4 Backfill of pipe trench

As shown in Figure 6.4, the backfill over the pipes across the wetland will consist of gravel as part of the track construction.

7.10.5 Compliance with Coastal Management Plan – Queensland's Coastal Policy

The Coastal Management Plan – Queensland's Coastal Policy Coastal Wetlands Policy (2.8.2) requires:
Loss or degradation of coastal wetlands is avoided and impacts on coastal wetlands prevented, minimized or mitigated (in order of preference).
Buffers of sufficient width are to be provided to safeguard the functions of the wetland and allow for natural fluctuations of location.

1) Approximately 1.25 Ha (0.011%) of wetland will be lost as a result of this project and it is inappropriate to construct a buffer as that would exacerbate the loss.
    - The portion of the wetland impacted by this project is artificially bunded and unlikely to move as a result of other coastal processes.
    - The project will not result in any additional nutrient loading of the wetland.
    - Mitigation will be achieved by returning portions of Lot 370 to the natural state.

Natural characteristics of wetlands, including topography, ground water hydrology, water quality, and plant and animal species are to be maintained.
Values and functionality of saltflats are to be retained. Habitat for rare, threatened and migratory species are to be maintained. The potential adverse impacts from the introduction of non-native plant or animal species is minimised. Adverse impacts on the sustainability of critical inshore fisheries habitat are minimised.

2) Wetland functions, in particular flow rates and timing (e.g. water supply is important for breeding and reproductive cycles) will be maintained at natural levels and stormwater is adequately treated prior to flowing into natural wetland.
    - See Section 7.10.3 Wetland hydrology
    - The impact on the salt flat is reversible (see Section 7.11 Salt pan)
    - The habitat for rare, threatened and migratory species are to be maintained. (see Sections 7.6 Birds and other wildlife and 7.7 Marine animals)

- Control of infestation from invasive species will follow the Weed and Pest Management Plan in Section 8.2 Weed and pest management plan.
- Impact on the in-shore fishery is minimal (see Section 7.6.2 Impact on fishery)

Adverse impacts to coastal wetland values from proposed access are to be minimised.

3) Where access is necessary, pathways and walkways are located away from sensitive areas. Public access points are located away from wetland areas of sensitive conservation value. Where potential impacts from access to conservation values are significant, access is avoided.
    - Public access will be prevented by placing a locked gate across the access track constructed to service the pipeline and pump control.

The role of wetlands in providing protection from coastal hazards, including changes in sea level rise is maintained.

4) Where a wetland has been identified as providing protection from coastal hazard or potential impacts from sea level rise, the wetland is to form part of the measures to reduce the risk from coastal hazards to the development. The location of the proposed development is to make provision for any changes in location, structure or habitat values of wetlands that may occur as a consequence of sea level rise or storm tide inundation (e.g. lateral migration of wetland). Such provisions may include greater set-back distances and maintaining hydrological links to other areas of conservation value.
    - This wetland has not been identified as providing protection.

7.11 Salt pan

This section directly addresses concerns raised in one comment by respondents.

An easement or other similar access will be negotiated with Cheetham Salt, lessees of the adjacent salt pan for the construction a pipeline across the saltpan. This construction will be undertaken to ensure no impact of PASS (see Section 6.9 Acid Sulphate Soils and 8.1 Acid Sulphate management plan).

Salt pan land will not be used for production ponds.

7.11.1 Trench Excavation

The construction of the pipeline through the saltpan was described in Section 7.3.2 in GAPDE, 2003. As described above for the Beach and Marine sections, the installation of the ocean intake and discharge pipelines requires a trench with an approximate bed width of 3m for the co-located twin 1000 mm dia. intake and discharge pipes. The installation method for these pipelines is by hydraulic excavator.

As described in described in Section 7.3.2 in GAPDE, 2003, the pipes will be laid at a depth of 1300 mm with a cover of 300 mm comprised of natural saltpan surface soil. The cohesive strength expected of the soil in the trench materials in the saltpan area will mean that trench batters are likely to be steep. Access for the excavator will be via either wooden matting as used in the construction of the Magnetic Island water supply pipeline by NQ Water (Glen Stevens, Maunsell Engineers, Townsville) or by a path comprised of Geofabric overlaid by a thin layer of soil (Ralph Burch, SKM, Brisbane). The final decision regarding the method will depend upon final analysis of site conditions including moisture content of the soil and will depend upon the ease with which the pathway can be removed to the original surface. As a result, the width of the impact area in the saltpan is expected to be restricted to the width of the excavation, the width of the spoil pile and the width of the wooden mats which is expected to be approximately 15 m. The length of the pipe through the saltpan is approximately 500 m giving a total footprint of the impacted area of 7500 m^2.

Since revegetation is expected to occur following construction of the pipelines as a result of natural inundation by tidal water, it is expected that the saltpan will return to its natural state.

7.12 Main Site

This section directly addresses concerns raised in two comments by respondents.

7.12.1 NHT study: Priorities for remnant vegetation protection – Dryland Component

The area to be impacted also contains an "of concern" remnant vegetation communities on the main site. The remnant vegetation communities comprises

- small patches of *Grevillea striata* open woodland (RE 11.3.13) on Lot 8 and Lot 370 (the main site). The impacted area comprises 0.9% of the pre-cleared area of this RE (Appendix M, GAPDE, 2003).

Whilst these impacts are acknowledged, the project will provide the financial resources to remove cattle grazing from the area and to control the infestation of prickly acacia and chinee apple present on Lot 370. These actions will permit the revegetation of these areas with natural vegetation over of a large proportion of Lot 370.

7.13 Marine Parks

This section directly addresses concerns raised in one comments by respondents.

The Great Barrier Reef Marine Park is a Commonwealth Marine Protected Area, proclaimed under the Great Barrier Reef Marine Park Act 1975 and managed by GBRMPA. The portion of Abbot Bay in which the construction of the pipelines and pumping station is proposed, has recently been rezoned under the Representative Areas Program as Habitat Protection Zone (HPZ). This zoning is principally designed to protect seagrass and coral communities in the area. This zoning will not prevent the construction or operation of a land based aquaculture outfall if "sensitive habitats" are protected. Any aquaculture facility would need to avoid harm to these habitats. A detailed discussion of the impacts of the proposed project on the seagrass habitats is presented in Section 7.5 Seagrasses.

The pipeline will pass under the natural surface of the saltpan which is about 0 m AHD and is therefore below Mean High Water Springs (High water). As a result, this section of the pipeline will also require approval under the Marine Parks Act and Marine Parks Reg.

7.14 World Heritage Values

This section directly addresses concerns raised by two respondents.

7.14.1 World Heritage Values and Attributes

Section 6.1, GAPDE, 2003, discuses in depth the presence of World Heritage Values at the site. 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 of GAPDE, 2003, and reproduced below.

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 relatively open coast and highly dynamic and provides less protection for seagrass habitat.

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.

Table 7.4 World Heritage values of the proposed site

7.14.2 Great Barrier Reef Marine Park Values

7.14.2.1 <u>Marine Park Zoning</u>

The Great Barrier Reef Marine Park is a Commonwealth Marine Protected Area, proclaimed under the Great Barrier Reef Marine Park Act 1975 and managed by GBRMPA. The portion of Abbot Bay in which the construction of the pipelines and pumping station is proposed, has recently been rezoned under the Representative Areas Program as Habitat Protection Zone (HPZ). This zoning is principally designed to protect seagrass and coral communities in the area.

The proposed pipeline intake and discharge site is located within Habitat Protection Zone of the Great Barrier Reef Marine Park as a result of the recent rezoning of the GBRMP. Habitat Protection Zone provides for land-based aquaculture.

7.14.3 Criterion iv, Habitats for species of conservation significance

7.14.3.1 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. 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).

Three species of seagrass were found in the area impacted by the discharge water with one of the species having two morphological variants. The area of seagrass directly impacted by the present project is largely “low” density seagrass (Appendix L, GAPDE, 2003) with only one area close by, but out of the impact zone (as determined by the water quality modelling), being of “moderate to high” density.

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. Notably, both of these areas have been classified as Fish Habitat Areas and Dugong Protection Areas but Abbot Bay has not. Therefore, in relation to these areas, Abbot Bay has a low to moderate overall conservation value for seagrass habitat.

The impact on seagrass is discussed in detail in Section 7.5 Seagrasses and Appendix 7. Response from Qld Department of Primary Industries Regarding enquiries in respect to impacts of the project on seagrass. In summary, Abbot Bay has relatively small and low density seagrasses present which are characterised by rapid turnover.

It is considered that the impact on seagrass of the present project is of low consequence.

7.14.3.2 Mangroves

While mangroves are present in the adjacent region, it is not expected that there will be any impact on those areas.

Hence, the impact on this part of the World Heritage value is of low consequence.

7.14.3.3 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.

The total impact on this area is described in Section 7.10 Wetland.

Although the total area of impact is small and will occur in the bunded area of the wetland's most southern part, on the basis of the relative area of wetland impacted, the impact has been assessed as of moderate consequence.

7.14.3.4 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 occurs at some distance from the prawn farm site therefore the impact on its conservation value will be of low consequence.

7.14.3.5 Regional Ecosystem 11.2.2 [Ipomoea pes-scaprae and Spinifex sericeus ± Casuarina esquisetifolia]

An area of RE 11.2.2 ocurs on the dunes through which the pipeline is proposed to pass. A discussion of the nature of this ecosystem is presented in Appendix M of GAPDE, 2003. The extent of the impact on this area is described in Section 7.9 Dune system.

Again, the total area of impact is small and is expected to recover following construction, on the basis of the relative area of RE 11.2.2 impacted, the impact has been assessed as of moderate consequence.

7.14.3.6 Regional Ecosystem 11.3.13 [*Grevillea striata* open woodland]

7.14.4 An area of RE 11.3.13 occurs in the main site. This Ecosystem occurs as small patches. The total impacted area is discussed in Section 7.11.1 Trench Excavation

The construction of the pipeline through the saltpan was described in Section 7.3.2 in GAPDE, 2003. As described above for the Beach and Marine sections, the installation of the ocean intake and discharge pipelines requires a trench with an approximate bed width of 3m for the co-located twin 1000 mm dia. intake and discharge pipes. The installation method for these pipelines is by hydraulic excavator.

As described in described in Section 7.3.2 in GAPDE, 2003, the pipes will be laid at a depth of 1300 mm with a cover of 300 mm comprised of natural saltpan surface soil. The cohesive strength expected of the soil in the trench materials in the saltpan area will mean that trench batters are likely to be steep. Access for the excavator will be via either wooden matting as used in the construction of the Magnetic Island water supply pipeline by NQ Water (Glen Stevens, Maunsell Engineers, Townsville) or by a path comprised of Geofabric overlaid by a thin layer of soil (Ralph Burch, SKM, Brisbane). The final decision regarding the method will depend upon final analysis of site conditions including moisture content of the soil and will depend upon the ease with which the pathway can be removed to the original surface. As a result, the width of the impact area in the saltpan is expected to be restricted to the width of the excavation, the width of the spoil pile and the width of the wooden mats which is expected to be approximately 15 m. The length of the pipe through the saltpan is approximately 500 m giving a total footprint of the impacted area of 7500 m^2.

Since revegetation is expected to occur following construction of the pipelines as a result of natural inundation by tidal water, it is expected that the saltpan will return to its natural state.

Main Site.

The total area of impact is small, on the basis of the relative area of RE 11.3.13 impacted, the impact has been assessed as of moderate consequence.

7.14.5 Criterion iii, Superlative natural phenomenon

7.14.5.1 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 (GBRMPA, 1994).

Dugongs feed predominantly on seagrasses and show a preference for species of the genera *Halophila* and *Halodule* (Oliver and Berkelmans, 1999).

While dugongs are present in Abbot Bay, relatively low standing populations of seagrass in Abbot Bay make it a less attractive site for dugong than Upstart and Edgecombe Bays to the north and south respectively Marsh and Penrose (2001).

The relative importance of Abbot Bay is demonstrated by the fact that it is not a designated Dugong Protected Area while Upstart and Edgecombe Bays are so designated.

Further, the project will not result in long term degradation of large areas of seagrass (see Section 7.5 Seagrasses) and the impact of the present project on dugong populations is assessed as low consequence.

7.14.5.2 Cetaceans and Whale Sharks

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).

Whale sharks are know to occur near coral reefs, but are more likely to occur well off-shore.

The shallow nature of Abbot Bay means that it is likely that larger whales or whale sharks would migrate further out to sea. Dolphins would occur in Abbot Bay however it is not a known significant site for them.

Therefore the impact on the conservation value of Abbot Bay to dolphins, whales and whale sharks is assessed as of low consequence.

7.14.5.3 Saltwater crocodiles, *Crocodylus porosus*

Saltwater crocodiles are known to inhabit estuarine and freshwater areas adjacent to the coast. The wetland, through which it is proposed that the pipelines pass, may provide suitable nesting habitat for this species. Crocodiles are known to enter prawn farms and provide a potential Occupational Health and Safety Risk for the staff. Impacts on this species are therefore likely to occur as a result of the impact on the wetland and the need to remove crocodiles from the immediate vicinity of the farm should they present a hazard to staff. The likelihood of the latter impact occurring is low with anecdotal reports of six animals per year affecting the whole of the Queensland prawn industry and there has never been such a need at the Alva Beach Farm of Pacific Reef Fisheries.

In view of the small area of wetland likely to be affected as a portion of the total habitat available to saltwater crocodiles, the impact on this species is assessed as low.

7.14.5.4 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, cited in GAPDE, 2003). The impact of the project on the availability of nesting sites and on the beach front is of low consequence during the construction and operation.

As the seagrass meadows of Abbot Bay are not as extensive as other areas in the vicinity as discussed above in relation to dugong, the importance of the bay to Green Turtles is of low to moderate consequence.

Therefore, the impact of the project on the turtle populations is assessed as of low to moderate consequence.

7.14.5.5 Fisheries

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, is the nearest FHA to the development site. The impact of the project on fisheries is discussed further in Section 7.6.2 Impact on fishery.

The impact on fisheries resources is assessed as of low consequence.

7.14.6 Criterion ii, The diversity of Flora and Fauna

The significant fauna are discussed in Sections 7.6 Marine animals and 7.7 Birds and other wildlife above and in Section 7.3.5 GAPDE, 2003. Whilst Abbot Bay can be expected to have similar diversity of fauna as other parts of the GBRMP, in view of;

- the relatively low density of seagrass,
- the absence of characteristics which would cause the Bay to be designated a Dugong Protection Area,
- the absence of characteristics which would cause the Bay to be designated a declared FHA,
- the relative shallowness of the Bay that probably causes the majority of megafauna to bypass the Bay,
- it cannot be considered exemplary in diversity.

Consequently the impact on the diversity of the World Heritage Area is assessed as of low consequence

7.15 Cultural Heritage

This section directly addresses concerns raised in two comments by respondents.

7.15.1 Cultural Heritage Protection

In Section 9.1 Environmental Management Plans (GAPDE, 2003, pp 9-20 & 9-59), the company clearly acknowledges its commitment to develop a Cultural Heritage Management Plan for the construction of both the pipeline and the prawn farm.

Within the framework of this policy a cultural heritage field officer, being an indigenous person and approved by the Gudjuda group will be employed on the construction and will monitor and provide guidance on cultural heritage matters in the course of construction.

The cultural heritage officer will provide training, information and guidance on all matters of cultural heritage significance.

7.15.2 Dispute Resolution

As the last paragraph of EIS 7-117 states, "The Gudjuda Reference Group endorses the results and recommendations of the cultural heritage assessment report." and conflict is not envisaged with the Traditional Owners or the native title claimants as the traditional owners have formally signed off on the Cultural Heritage assessment.

However, should a dispute arise in connection with a cultural heritage matter, we would immediately engage the chairperson of the Gudjuda Reference Group along with a senior Qld EPA officer involved in environmental planning, (currently John Richter) to mediate the matter. Any decisions made or solutions developed would certainly take into account the nature of the problem in cultural heritage terms and how development may be adjusted to take that into account along with any major technical or cost implications to the project.

7.15.3 Employment

In the course of the cultural heritage assessment, formal discussions were held with the leaders and elders in the Gudjuda group relating to the employment of indigenous workers on this project. The end result of these discussions was loosely summarized in the Cultural Heritage Report (11.4-2) "Traditional owners wish to enter into discussions with Pacific Reef regarding future training and employment" etc. In fact PacReef and the traditional owners have an in principal arrangement to set up a reference committee consisting of say two elders from the Gudjuda group and two senior executives from PacReef to prepare a format for employing and training young indigenous people on an on–going basis. This will be put in place when the project is nearer to commencement. It is not possible to give a commitment to a percentage of aboriginal people to be employed as this will be dependent on a number of factors including the number, quality and commitment of the applicants, as it is with all our employees. The traditional owners expressed their appreciation to the company for the attitude we are taking toward the employment and training of a number of their people.

In view of the fact that this project will substantially increase employment in the area and that indigenous people will be employed by the project, this project will provide significant benefit to the economic development of local indigenous people.

7.16 Other Social Impacts

This section directly addresses concerns raised in one comment by respondents.

7.16.1 Housing

7.16.1.1 <u>Source of staff</u>

Section 7.10.1.3 GAPDE 2003 discusses the areas from which staff will be sourced. Although apparently contradictory, it is expected that 50-75% of staff will be sourced locally. The proportion to be sourced from outside the region will vary according to the success of Pacific Reef Fisheries' ability to train skilled staff in sufficient numbers at the Alva Beach Farm and the ability to attract management and other skilled staff from other local aquaculture businesses of which there are now a number.

7.16.1.2 <u>Construction</u>

As stated in section 3.3.1, construction will be staged over four years. Contractors will be engaged to carry out all major construction works and accordingly will bring their work force with them. Certain, if not many of these contractors will come from Bowen, Burdekin and adjacent areas. It is difficult to determine the size of the construction work force. Based on current experience of developing an additional 30 Ha of ponds at our Alva Beach farm, the majority of construction workers are local residents, while those that are not stay in tourist accommodation and it is reasonable to assume that a similar arrangement will apply to construction workers at Guthalungra.

7.16.1.3 Effects on the private housing market

It is considered that the vast majority of our new employees will already be residing in the Bowen area. Bowen, having lost their meat works and rail-head have a large unemployment problem (see Section 3.3.3, GAPDE 2003). This is one of the reasons Bowen Shire Council explicitly supports this project. Therefore, we do not envisage any major pressure on the private housing market.

With regard to travelling arrangements for seasonal workers, it will be the responsibility of the majority of workers to make their own arrangements. Our experience in the Burdekin region is that workers often make arrangements to car pool and this works very effectively. Workers in this region generally accept that they must travel some distance to find both full time and casual work. The area has a large vegetable growing industry, which is spread over a wide area. For example, Bowen to Gumlu supports a $230 million fruit and vegetable industry (Section 9.5.3, GAPDE 2003). There are large mango growing and packing sheds between Ayr and Townsville. These businesses draw their labour from the nearest towns often 30-50 kilometres away.

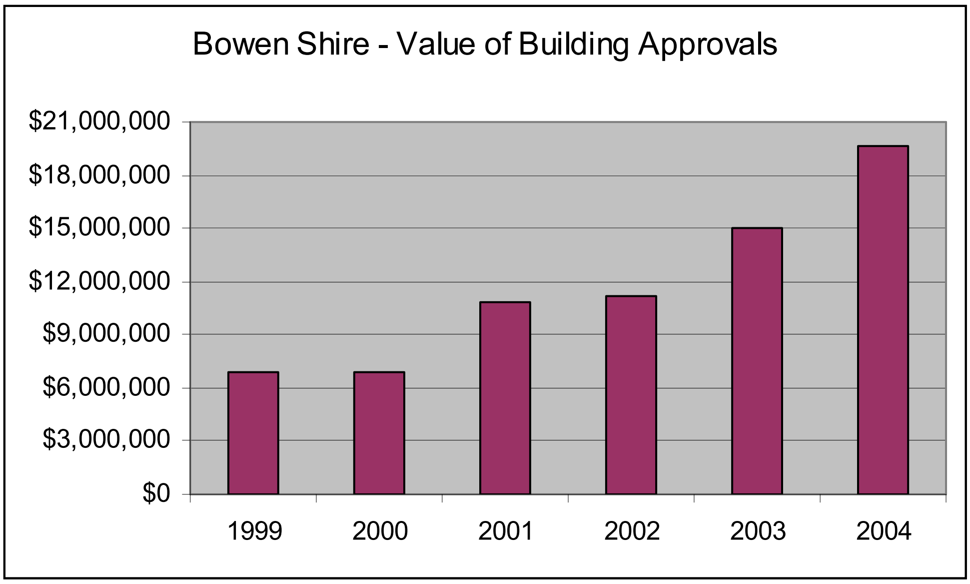

Figure 7.1. Value of building approvals in the Bowen Shire from 1999 to 2004. Source: Bowen Shire Council.

Substantial development of residential property is currently occurring in the Bowen Shire and the rate of house construction has been increasing over a number of years. In 2005/06 there is 303 units and 502 blocks scheduled for development and the value of building approvals in the Bowen Shire reached nearly $20 million in 2004 (Fig. 7.3). It is expected that developments in the Bowen Shire will allow for any increased demand for housing brought about by the current proposed project.

The mention of residential development in GAPDE 2003 relates essentially to infrastructure construction on the site. It will be necessary to provide two or three houses for managers and caretaker along with a dormitory style building with kitchen, toilet and shower facilities for shift workers who could be marooned on the site in the wet season. We do not envisage large-scale development in Guthalungra village at this time.

7.16.1.4 Casual rental market

In relation to the "cumulative social impacts of the project's demands for seasonal employment with seasonal employment in the agricultural and tourist industries", Section 3.3.3, GAPDE 2003 describes 2500 job losses in the area over the past 14 years. Even considering those that may have left the area, there remains a large pool of relatively skilled people available. Development at Guthalungra will have some other beneficial effects in terms of stability of the workforce. The prawn harvest season occurs at a different time of the year to cane harvesting and fruit picking and packing. Our experience at our Alva Beach farm indicates that this provides for staff to rotate through seasonal jobs in the cane, fruit and prawn industries and effectively achieve full-time employment. This has considerable benefit on the local community providing a greater standard of living for those people and a greater degree of stability in the population, since they no longer have to leave the region to find employment in the off-season. This will result in some people moving from the casual renting market to long-term rental or private housing.

7.17 Groundwater

This section directly addresses concerns raised in one comment.

Extensive groundwater investigations have been undertaken at the Guthalungra site and have been reported in the Draft EIS (GAPDE, 2003, Section 7.1.5) with additional information provided here (see Section 5.2 Groundwater).

The most intensively studied and best-known interaction between prawn ponds and groundwater is at Pacific Reef Fisheries' farm at Alva Beach. This study provides an excellent case study for determining the impacts of prawn farming on groundwater. However, some significant differences are present between the Alva Beach site and the Guthalungra site. Specifically, these are:

- The groundwater level at Alva Beach is much closer to the surface (1 - 3 m) than at Guthalungra (2 – 8 m).
- The ground water at Alva Beach has some areas of freshwater inland of the farm whereas that at Guthalungra is saline.
- The soil at Alva Beach comprises a high proportion of sand with clay lenses whereas the soil at Guthalungra is largely clay.
- The consequence of that is that movement of water through the soil at Alva Beach would be likely to be faster than at Guthalungra.

The nature of these differences, mean that it is likely that impacts on groundwater if they were to occur would be more likely at Alva Beach than at Guthalungra.

Appendix 8 shows a report provided by SKM regarding modelling of groundwater impacts of prawn ponds at Alva Beach. This document concludes that there will be little or no effect on groundwater on adjacent properties o f construction and operation of prawn ponds.

This conclusion is further supported by a report prepared by CSIRO and commissioned by the North Burdekin Water Board to investigate the impacts of the prawn ponds at Alva Beach on groundwater (CSIRO, 2006). That report found:

- That the prawn ponds caused mounding of about 1 m in the groundwater under the ponds when full.
- That the mounding was not present when the ponds were empty.
- That pumping of groundwater for irrigation also caused mounding of the groundwater of a similar magnitude.
- That the mound (an increase in the proposed base level of the water table by 100 mm) extended less than 300 m from the edge of the ponds.
- That heavy rainfall caused the groundwater to rise by at least 0.2 m.
- That there was no evidence of increased salinity in the groundwater as a result of the mounding under the prawn ponds.

It is concluded that, providing that construction of the ponds at Guthalungra is carried out such that a suitable clay lining is utilised in the ponds, there will be no leakage of salt or nutrients into the local groundwater that is likely to cause adverse impacts.

7.18 Mitigation

This section directly addresses concerns raised by one respondent.

A number of actions will impact on areas below HAT. Specifically, these are construction of the marine section of the pipelines, construction of the saltpan section of the pipelines and utilisation of approximately 1 Ha of saltpan for settlement area and potential impact on seagrasses by changed water conditions immediately adjacent to the discharge point.

The impacts on areas below HAT are essential activities, either because of the nature of the activity or the need to meet environmental guidelines in other areas such as discharge water quality.

Construction of the marine section of the pipelines and the pump station is necessary simply because water must be drawn from below HAT. Construction of the saltpan section of the pipeline is essential as there is no practical alternative path. Utilisation of the area below HAT for settlement area (approx.1 ha) is essential to provide sufficient area for final treatment of discharge water to achieve the expected water quality outcomes, thereby minimising the impact on other ecosystems below HAT.

The impacts of the pipeline construction are likely to be temporary with the affected species of seagrasses being noted for rapid turnover and ready recovery of saltpan vegetation known to occur.

However, the impact of utilisation of saltpan for settlement pond area will be permanent and the area of wetland utilised for the pipeline will also be permanent. In order to mitigate this impact, it is proposed that the current cattle will be excluded from the undeveloped area of Lot 370, which is severely degraded by over grazing. This area includes extensive saltpan and mangroves and includes the riparian areas of the Elliot River on the northern side and of an oxbow lake (Figure 3.1). The total area of exclusion is approximately 240 Ha of which approximately 59 Ha is wetland. This area of wetland comprises approximately 15 Ha of saltflats, 25 Ha of riparian zone and mangroves along the Elliot River, 8.5 Ha of oxbow lake, and 10.5 Ha of freshwater wetlands. The damage to the area as a result of cattle grazing is readily apparent and is shown in Figures 7.2 to 7.9. Such exclusion is well recognised to substantially reduce impacts on native vegetation which quickly recovers following such exclusions, thereby substantially improving the fisheries resources of adjacent waterways.

Additional weed management practices (see Section 8.2 Weed and pest management plan) on the remaining area of Lot 370 will further enhance the environmental values of the immediate region.

Figure 7.2. General degradation of the terrestrial environment by grazing of cattle

Figure 7.3. View of a freshwater marsh/farm dam (Figure 3.1) showing erosion and denuding of succulents by grazing

Figure 7.4. Cattle paths and eroded areas in the oxbow lake

Figure 7.5. Cattle paths and erosion at the edge of the salt marsh

Figure 7.6. Cattle paths and erosion at the upper edge of the inundation of the salt marsh

Figure 7.7. Grazed areas of the riparian zone of the Elliot River.

Figure 7.8. Comparison of grazed (left of fence) and ungrazed (right of fence) areas f mangrove and saltpan. Note the differences in vegetation on either side of the fence in the fore and middle ground.

Figure 7.9. Grazing and erosion of denuded ground in and around the farm dam.