6 Project Description – design, construction and operational considerations

Section 6 discusses variations in the proposed design and operation of the development that have been introduced in an attempt to reduce potential impacts proposed by respondents. In general, the changed designs and operations ensure the project maintains best practice actions.

6.1 Revised Seawater Intake and Discharge Arrangements

This section directly addresses concerns raised in four comments.

Section 4.1.1 GAPDE, 2003 describes the initial design and further detail is provided in Sections 4.1.6, 4.2.4, 4.3.

Impacts on the sensitive environments of the beach and dunal system were identified as a result of the initial design. In order to limit these impacts, the proponent has identified alternative technology incorporating an offshore pump station.

In particular, the pump station construction and the heavy vehicle movement through the wetland and across the dunes required to construct the land based pumping station is no longer required. This will require final proving at the detail design stage but extensive risk analysis (see below) indicates that it is feasible and in fact offers some significant engineering benefits.

6.2 Location of Pipelines and Diffuser

This section directly addresses concerns raised in four comments.

The route of the discharge pipeline remains as was presented in GAPDE, 2003, with the start of the diffuser being approximately 450 m off-shore from the 0 m AHD line at a depth of –6.0 m AHD. Due to the low grade of the floor of Abbot Bay at this point, achieving a depth in line with sewage effluent guidelines being developed by GBRMPA and EPA (-6.5m AHD) would require a substantially longer pipe and associated increased impacts on the bed of the bay and costs of construction.

The route of the intake pipeline has been changed to follow the discharge pipeline with the off-shore pumping station located approximately 200 m off-shore from the 0 m AHD line at a depth of –4.8 m AHD. With the pump station protruding 1.5 m above the seabed, there will be approximately 1.7 m between the top of the pumping station and the sea surface at Lowest Astronomical Tide.

6.3 Design Concept

The design concept originally adopted for the supply of seawater to the farm involved a wet-well pumping station set back approximately 50 m from the front of the primary dune. This pump station was to be located below ground, with a diameter of approximately 8.5 m and extending to a depth of over 12 m. The pump station was to be supplied via twin 1,000 mm dia. HDPE pipes, extending approximately 360 m seaward from the pump station. The intake pipes would have supplied water to the pump station under gravity, and would have involved deep trench excavation across the upper parts of the beach and dune system.

A number of concerns were raised by referral authorities in relation to the environmental impacts of such a pumping arrangement, and the potential for the pump station to be exposed should beach erosion occur. With these concerns in mind, the proposed concepts for water supply to the farm have been revised. The proposed arrangements now include the location of the supply pumps at the seaward end of the intake pipelines, housed in a pump enclosure on the sea floor. The pumps would be powered via high voltage transmission line laid along the sea floor adjacent to the intake pipelines.

The general arrangements for the proposed pumping system are shown in Figures 6.1 to 6.6. The main attributes of the system are:

- A reinforced concrete pump enclosure located on the sea floor, approximately 3.5 m high and protruding 1.5 m above the sea floor to minimise sand intrusion. The enclosure would be approximately 8.9 m diameter, and would include a sand trap and fully enclosed pump chamber (Figure 6.1). The enclosure would be anchored via foundation anchors.
- The entrance would house three submersible centrifugal pumps, providing a total design capacity of 180 L/s. Pumps would be of a "quick release" type, facilitating easy removal for repair or maintenance. Pumps will be rated at 3.3 kV, with a power consumption of 400 kW each.
- Pumps would be powered via a buried high voltage power transmission line, laid parallel to and off-set from the rising main pipeline by 3 m. Pump control wiring would be co-located with this line.
- Permanent anchor pylons would be located each side of the pump enclosure to provide navigational warning and allow barge anchoring during maintenance. These pylons would be fitted with the requisite navigation lighting and identification.
- The pumps would discharge to a single 1,000 mm dia. HDPE rising main to the shore. This pipeline would be anchor weighted, and laid with minimal cover, as proposed for the previous gravity pipelines (Figure 6.6). To minimise the extent of marine disturbance during pipeline installation, the pipeline alignments have been revised to allow the discharge pipeline to be co-located with the intake pipeline (Figure 6.2).
- A small fenced enclosure would be located at the rear of the coastal dune system which would house a 15 kV to 3.3 k/240 V transformer, and a pump control cabinet. This enclosure would be approximately 5 m x 5 m and would be fully concreted and bunded.

This arrangement has significant advantages compared to a shore-based wet-well pumping system, including:

- avoidance of a wet-well facility within the coastal drive system, and the associated environmental and potential construction problems;
- because the rising main pipeline from the seabed pumping station will operate as a pressure pipeline there will be no need to lay the pipeline on a constant negative grade back to shore. This means the pipe can be laid at a much shallower depth (dictated only by potential exposure due to beach erosion), thereby greatly simplifying construction and reducing potential environmental risks;

- avoidance of locating the pump station on the shore will eliminate the need for heavy vehicle access to that area. Access will only be required for occasional inspection and maintenance of the transformer and control hardware.

The requirement for only one 1,000 mm dia. rising main pipeline (rather than two as previously proposed) will allow the discharge pipeline to be co-located with the intake pipeline. This will minimise the amount of disturbance to the marine environment during construction.

The pump station enclosure will be constructed using pre-fabricated concrete modules, placed and joined in-situ.

Pipeline and power transmission line installation will be undertaken using a combination of conventional excavation equipment and dredges, as described in detail below (Section 7.8 Ocean Intake and Discharge Pipelines Construction (Beach and Marine Sections)).

Insert Figure 6.1

Figure 6.1. Seawater pump station arrangement concept drawing

Insert Figure 6.2

Figure 6.2. Pipeline, pump station and pipeline locations

Insert Figure 6.3

Figure 6.3. Longitudinal section - Intake pipeline

Insert Figure 6.4

Figure 6.4. Longitudinal sections - Intake pipeline causeway typical cross-sections

Insert Figure 6.5

Figure 6.5. Longitudinal sections – Discharge pipeline

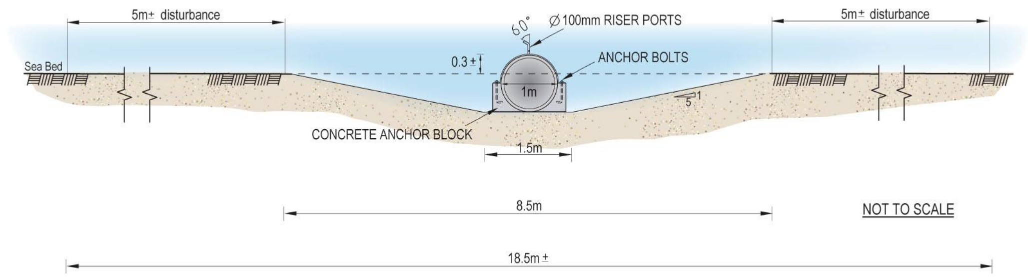

Figure 6.6. Generalised installation cross-section for the intake and discharge pipelines.

6.4 Construction Approach

This section directly addresses concerns raised in one comment.

The seabed pumping station concept presents a number of construction challenges. However, consultation with experienced marine construction contractors indicates that the proposed works do not present any insurmountable difficulties.

Features of the construction process will include:

- The excavation required to found the pump enclosure will be undertaken using a cutter suction dredge. Whilst no geotechnical investigation of the site has been undertaken, it is expected that rock will not be encountered within the excavation depths required.
- Pump enclosure anchors will be installed by the installation of screw anchors into the underlying sediments. If rock is encountered, rock anchors will be used.
- The rising main supply pipeline will be co-located with the discharge pipeline, and will be anchor-weighted using concrete collars as previously proposed for the twin intake pipelines. The pipelines will only be partially buried to minimise the depth of trench excavation and consequent impact on the marine environment during construction but will be buried below –3 m LAT in the offshore section as shown in Figures 6.3 and 6.5.
- Across the beach and frontal dune, the pipelines will be located at a depth of 2 m. This will provide a reasonable degree of protection from the risk of pipeline exposure due to beach erosion, whilst minimising impacts during construction. The longitudinal profile of the pipelines is shown in Figures 6.3 to 6.5. Section 6.4.7 GAPDE, 2003, discussed the Coastal Geomorphology of the area and concluded that a short period of retreat is likely to be followed by decades of advancement of the beach front suggesting that the most probable outcome is the burial of the pipe rather than its exposure. In the unlikely event of some exposure of the pipeline, the anchors shown in Figure 6.6 will ensure that the pipeline will remain undamaged.

6.5 System Maintenance

Operation and maintenance issues have been a key consideration in the development of the proposed pumping arrangement.

Specific considerations and design provisions are discussed below.

6.5.1 Inspection of Pumps and Fittings

Regular inspections will be undertaken of the pump station, both during the farm growing season, and as part of the annual off-season maintenance program. These inspections will be undertaken by divers and will include assessment of marine bio-accumulation, sand build-up or ingress, and damage to or interference with the facility.

The enclosure will be designed with quick release lockable access hatches for diver entry.

6.5.2 Regular Maintenance

Annual maintenance will be undertaken during the off-season (June – September) using divers and a maintenance barge. This will include:

- removal of sand accumulation within the enclosure;
- removal of bio-accumulation from external surfaces on pumps and fittings. If necessary, these will be raised to the barge for cleaning;
- removal of weed accumulation from the entry screens.

The pumps will be removed and inspected initially on an annual basis to check for wear or deterioration. Pump removal will be facilitated via quick release couplings and guide rails (Figure 6.1)

Subject to the rates of wear identified in initial years, it is expected that it will only be necessary to remove and inspect pumps every 3 or 4 years in the long term. This will be done on a rotation basis, with one pump being removed each year.

6.5.3 Pipeline Pigging

Rates of bio-accumulation within both the intake and discharge pipelines are not expected to be great. Experience with ocean intakes elsewhere in north Queensland (Anderson, personal communication) indicates that the use of HDPE pipe material inhibits marine growth. Notwithstanding this, provision will be made for reverse pigging from the shore to the pump station. This will involve the removal of the discharge manifold to allow the pig to escape at the pump station end. Pig launching will occur at the prawn farm, as described previously (Section 4.5.15, GAFR, 2003).

6.5.4 Operational Risks and Mitigation Measures

Careful consideration has been given to the operational risks posed by a seabed pumping station. These risks and proposed mitigation measures are discussed below.

6.5.4.1 Pump Mechanical Failure

Pump failure during the growing season would reduce the supply of water to the farm, with possible consequent affects on productivity. Should failure occur during inclement weather, there is a risk of access to the pumping station could be delayed. A number of mitigation measures are proposed to address this risk:

It is intended that only high quality submersible pumps will be installed. A number of commercially available submersible pumps exist that are specifically designed for marine applications (for example, ITT Flygt pumps). There are numerous examples world-wide where these types of pumps have operated successfully in marine environments for many years.

A 3-pump system will be installed to provide the full-development supply rate of 180 ML/d. In the first year of farm development, two pumps would be installed, providing 100% redundancy. In the second year, the third pump will be installed to ensure 50% redundant capacity and all three pumps will be in operation by the third year. This staged approach will provide flexibility to allow the pumps to be closely monitored during early operation, and retrieved for inspection if required during this period, even during the growing season.

The use of a 3-pump installation minimises the impact of failure of any single pump. It is expected that other mitigation measures will enable the farm to operate for some time in the event of single or multiple pump failure (See Section 6.5.4.4 Other Mitigation Measures).

A fourth standby pump will be held ready for immediate deployment should pump failure occur.

Regular inspections and preventative maintenance will be undertaken to ensure pumps are maintained in good condition.

The pumps will be continuously monitored in real time for a range of operating conditions, including bearing and stator temperatures, vibration, water / oil ingress to motor housings, and power consumption. This data will be logged and transmitted via a SCADA system to the control centre at the farm. On-going analysis of this information will allow preventative action to be taken to avoid pump failure.

6.5.4.2 Sand Ingress and Bio-fouling

The risks of sand ingress or bio-fouling of the intake are similar for both a seabed pump station and a shore-based wet-well system.

A number of measures have been incorporated to minimise sand ingress to the seabed pump station:

The pump enclosure will incorporate a grit chamber to minimise ingress of sand into the pumping chamber. This chamber will be cleaned regularly and if necessary can be cleaned from the surface.

The entry aperture will be elevated 1.5m from the sea floor, thereby reducing the likelihood of sand entering the enclosure.

The pump enclosure will be circular in plan, which will reduce the potential for sand accumulation against the outside of the structure.

Pump components will be selected to minimise the impact of sand on impeller and housing wear rates.

It will be possible to modify the intake configuration in the future by fitting sand deflectors or preferentially directing the intake aperture. This may be considered if it is found that sand movement is consistently from the same direction.

Bio-fouling will be managed by regular inspection and maintenance. Notwithstanding this, there will remain a risk of blockage of the intake by large scale movement of seaweed, for example following a storm. In such cases, the pump station may need to be shut down whilst the facility is cleaned.

6.5.4.3 Other Causes of Loss of Pumping Capacity

There are a number of other mechanisms by which the pumping seawater capacity could be affected. These are discussed below.

Incidental Damage: There is a risk that the pump station could be damaged by marine craft. The positioning of marker / anchor pylons each side of the enclosure should minimise this risk. Robust construction of the enclosure should also ensure that incidental damage from anchors, etc. will be minimal.

Human Interference: The pump station will be located in a remote area, and will be largely unattended. There is a risk that the facility could be interfered with, however, design of a robust enclosure with lockable access should minimise this risk.

6.5.4.4 Other Mitigation Measures

The design and operation of the farm will incorporate additional features that provide protection from the loss of intake pumping capacity, including:

- the project will include a raw water storage with a capacity of 340 ML. This will provide up to a week's supply under full development, with restricted exchange arrangements in place;
- the project incorporates the capability to internally recycle water within the farm. The duration for which this is possible will be limited only by salinity, water quality and disease concerns, but could extend for several weeks.

These provisions mean that should complete loss of pumping capacity during the peak growing period at full development (i.e. worst case scenario), the farm could continue to operate without serious impacts on productivity for up to 14 days. This will provide ample time to address any of the potential failure mechanisms described above.

6.6 Settlement ponds and discharge water quality

This section directly addresses concerns raised in six comments.

6.6.1 Pond Release Water Treatment System proposed for Guthalungra.

The proposed treatment system is based primarily on sedimentation processes but also incorporates a sandfilter previously tested and demonstrated to be effective in reducing nutrient loads in discharge. The design approach seeks to optimise the performance of the system by providing operational flexibility and the capacity to adapt the system configuration to include new technologies as they become proven. Adaptability of the system is demonstrated by the capacity to incorporate sandfilters into the process with minimal effort and structural change. Such a modification has already been conducted within the settlement system at the Alva Beach Farm. Features of the system are summarised below.

The extent of the processing system and incorporation of innovative sand filtration sets it apart from waste water processing systems elsewhere in the prawn industry. For this reason, the proponents are confident that the water quality objectives detailed in Section 7.3 Discharge Water Quality Objectives - current will be achievable.

6.6.1.1 Multiple Independent Treatment Systems

Three independently operated settlement / sedimentation pond systems, each servicing a specific area of grow out ponds (Production Areas). This approach provides flexibility to manage the treatment system according to the wastewater generation characteristics of each production area. These characteristics (Total suspended solids, chlorophyll a, nitrogen and phosphorus) will vary throughout the season. At any point in time, this will be different for each Production Area as each area will hold prawns at different stages of growth.

Multiple Independent Treatment Systems will also allow separate recirculation to occur, thereby preventing the mixture of water from one production area to another in the event that recirculation becomes possible. This is the most prudent disease management protocol.

6.6.1.2 Primary Sedimentation Areas

Each treatment area will consist of a twin-cell sedimentation area, discharging through to a large settlement pond. These sedimentation areas will allow remaining heavier sediments in the grow out pond release water to gravitate out of the water column. The multi-cellular design of the sedimentation area will allow for one cell to be dried during the growing season, so that accumulated sediment can be removed. The sedimentation areas will provide a hydraulic retention time of 8 hours under peak operating conditions, with the capacity to increase the storage level by increasing the height of the bund walls to provide 10.7 hours retention time if required. Based on results reported by Jones et. al. (2001), this sedimentation alone will result in reductions of Total Suspended Solids (TSS) of approximately 55%, Total Nitrogen 28% and Total Phosphorous 30%.

6.6.1.3 Sand Filter

Slow sand filtration is a traditional method of water supply treatment for urban schemes. It has potential for the treatment of prawn pond release water because it has the ability to treat large quantities of water, which contain low levels of pollutants, whilst being a relatively robust and easily managed treatment system.

Initial drum trial testing of this technology by Pacific Reef Fisheries in 2003 / 2004 indicated that removal efficiencies for suspended solids could be as high as 90%, up to 35% for total phosphorus and total nitrogen and up to 85% for chlorophyll *a*.

On the strength of these promising results, Pacific Reef Fisheries has undertaken a full-scale trial of sand filtration during the 2004 / 2005 growing season. This involved the construction and operation of a 0.2 ha sand filter to treat pond release water from 10 Ha on its Alva Beach Farm. Between 80-90% of all suspended solids and chlorophyl *a* were removed by the sandfilter, achieving extremely low TSS values of around 2.4 mg/L average. Around 25% of total nitrogen and total phosphorus was removed indicating that water quality objectives are likely to be easily met using the water treatment system proposed. Importantly the sand filter has also transformed a high percentage of the nitrogen into nitrate, a bio-available soluble form, which has good potential for further treatment and potential secondary crops. Further work is being undertaken on secondary processes to be incorporated into a polishing pond.

Although not commercially proven, this technology represents a significant advancement in the treatment of prawn farm wastewater and will be adopted for the Guthalungra project. A dual cell sand filter per section will allow drying, cleaning and maintenance during the production cycle. The sand filter will be used in conjunction with the primary Sedimentation Areas and tertiary treatment ponds. It is estimated that a total sand filtration area of about 5 ha would be required to treat the peak release flow rate from the proposed farm.

Construction cost for this area of sand-filter based on construction of the sandfilter at Alva Beach and allowing for some economies of scale is estimated to be $1.25 million or approximately 3% of the total cost of construction of the project.

Note that the sandfilter has not been incorporated into the concept drawings of the site but will occupy a portion of each of the areas designated Settlement Ponds in Drawing 3417-C-SK05.1 Appendix B, GAPDE, 2003.

6.6.1.4 Settlement Ponds/Polishing Pond

Each treatment system will incorporate a large settlement pond area, ranging in size from 12.4 ha to 15.0 ha. These ponds will allow for further sedimentation, and have been designed to enable the configuration and operation of the settlement areas to be modified if appropriate in the future to incorporate new treatment technologies or approaches.

Under peak operating conditions, the settlement ponds will provide a hydraulic retention time ranging from approximately 57.6 hours to 74 hours (depending on the pond). There will be capacity to increase this to 113 - 86 hours if required to meet short-term demands. These hydraulic retention times will exceed current industry practice for this type of treatment method for prawn pond release water. In particular, the capability to absorb short-term increases in load by preserving spare pond capacity will overcome the common problem of an inability to handle short-term increases in release volumes whilst operating at peak capacity.

A key attribute of the design of the settlement ponds is the flexibility available to modify the design and operation of the system to incorporate new treatment approaches as they become available in the future. The layout of the ponds and internal flow training banks will allow sectioning of the flow so that new technologies may be readily tested, and incorporated where appropriate. This may include such technologies as pond aeration, bio-remediation, and filtration. Pacific Reef Fisheries will continue to undertake trials of new technologies such as sad filter and polishing pond design using the flexibility afforded by the settlement pond design.

6.6.1.5 Water Recycling

The system has been designed to allow recycling of water from the settlement ponds back into each Production Area. The layout ensures that the independence of operation each Production Area / Treatment System combination is maintained. Recycling of water will depend on quality of water in the settlement ponds, and the grow out pond requirements. It must be noted however, that a major current constraint on recycling water relates to the present inability to reduce salinity and hence deal with evaporation. Incorporation of recycling has, as an absolute pre-requisite, the provision of a substantial freshwater supply to the site.

6.6.1.6 Summary of Treatment System Features

The benefits of the proposed system can be summarised as:

1. Dedicated treatment systems for each of the three Production Areas improves treatment efficiency through greater operational flexibility.

2. Multi-cell Sedimentation Areas allow removal of sediments from the treatment system, thereby significantly reducing TN, TP and TSS loads on settlement ponds.

3. Settlement ponds providing prolonged hydraulic retention times to maximise water treatment, well in excess of current industry practice.

4. Capability to increase storage within both Sedimentation Areas and Settlement Ponds to absorb short-term “shock” loads and hence maintain treatment standards.

5. Design of the Settlement Pond layouts to readily allow testing of new treatment technologies, and provide for easy incorporation of those technologies where found to be beneficial.

6. Facility to recycle water back to grow out ponds, thereby reducing discharge volumes.

6.6.2 Alternative Treatment Options

A number of approaches to the management of prawn pond release water have been put forward over recent years. Several of these have been tested via field trials, whilst others remain as concepts only. Treatment options include both “in-pond” approaches, and “end-of-pipe” treatment technologies, as discussed below.

6.6.2.1 In-Pond Prawn Pond Water Management

It has long been recognised that a key part of improving prawn farm discharge quality is the management of water quality within the growout pond. A number of strategies previously investigated are outlined below.

Feed Management

Tighter management of prawn feeding regimes has been shown to reduce the amount of excess organic matter that accumulates on pond floors during the growing season. This in turn reduces the generation of ammonia that occurs through the decomposition of the sediment organic material.

Feeding management strategies have been successfully trialled at Pacific Reef Fisheries Alva Beach farm in recent years, and are now an integral part of that operation. Work is also on-going in relation to the use of improved feeds in collaboration with feed companies. Improved food management practices will be adopted for Guthalungra, wherever possible.

Pond Lining

Erosion of the bed and banks of prawn ponds has been identified as a major contributor to suspended solids loads in prawn pond release water.

Lining of ponds using High Density Polyethylene (HDPE) sheeting is a means of avoiding erosion. This approach is not uncommon overseas , where species of prawns other than Penaeaus monodon are grown. Farming of *Penaeus monodon* in fully lined ponds is not common, however, as it has been found that the benthic feeding characteristics of monodon favours the presence of earthen pond floor material. Full pond lining is also prohibitively expensive ($70,000 per pond), and is not trafficable using conventional maintenance equipment. HDPE lined ponds therefore typically require hand cleaning. This approach is not feasible for large ponds.

Rock protection of the banks (as has been undertaken at the Alva Beach Prawn Farm) is proven means of reducing erosion. For Guthalungra, it is proposed that the inner batters of all pond banks (including sedimentation and settlement ponds) will be lined with rock. Rock protection of the banks is preferable to other forms of lining as it improves prawn management, where weaker prawns are able to hold at the edge and be easily observed, and it reduces occupational health and safety risks that occur when the banks are comprised of a slippery wet surface.

No-release Partial Harvesting

Partial harvesting of prawns near the end of the growing cycle is commonly undertaken to improve crop yields. This has traditionally involved the release of pond water as part of the harvesting operation, which is in addition to normal daily water exchanges. Up to 20% of the total pond volume can be released during a partial harvest.

As the partial harvest releases occur late in the growing season when the grow out ponds are approaching maturity and nutrient levels are highest, these releases can impose significant loads on the treatment system.

Recent trials of no-release partial harvesting using nets have been successfully undertaken by Pacific Reef Fisheries at its Alva Beach Prawn farm and are now incorporated into the routine management of the farm. This technique will be used at Guthalungra and will help improve the performance system by eliminating additional loading late in the growing season.

Utilisation of in-pond microbial and phytoplankton processes

Zero-exchange high intensity systems have been described for growing *Penaeus vannamei* (Burford *et al*, 2003). High nutrient loadings were considered to be important to the successful operation of such systems. While *P. vannamei* are capable of surviving and growing at such high nutrient concentrations, *P. monodon* are not, thereby precluding this particular management option. Denitrification in *P. monodon* ponds as a result of sediment processes has previously been shown to be an ineffective method for removing nitrogen from the system (Burford and Longmore, 2001).

Sediment Collection Systems

Previous research has identified the accumulation of organic material on the floor of growout ponds as a significant contributor to dissolved inorganic nitrogen in release water. A number of systems have been proposed to collect and treat accumulated sediment throughout the growing season. These typically involve some means of collecting or concentrating sediment towards a central removal pit, from where the sediment is regularly removed via a suction pipe system beneath the pond floor. Sediment is then conveyed to a centralised treatment system.

These types of systems are typically proposed for lined ponds, to ensure reasonable collection efficiency. It is understood that they have been successfully used internationally for very high density farming of *Penaeus vannamei*.

The adoption of this approach to the farming of *Penaeus monodon* in Australian conditions is limited by three key factors:

1. *Scale*

These systems are best suited to smaller areas where sediment can be effectively collected and concentrated. The habitat requirements of *Penaeus monodon* means that larger, less intensive pond systems are required, making effective collection very difficult.

2. *Pond Floor Lining*

As discussed above, *Penaeus monodon* do not grow well in fully lined ponds. As a consequence, central collection systems, which rely on at least partial floor lining for effective sediment collection are not well suited to this species.

3. *Cost*

The lining of ponds, installation of in-pond collection systems and pipe systems for the reticulation of collected sediment would add approximately $95,000 to each pond.

As a consequence of these limitations, pond sediment removal systems are not proposed for Guthalungra.

6.6.2.2 "End-of-Pipe" Treatment Technologies

The treatment of pond release water using technologies other than proposed for Guthalungra (including that proposed by Ken Hartley in GAPDE, 2003) is constrained by a number of key factors.

1. High Volumes / Low concentrations: Prawn pond release water is typically high in volume but low in pollutant concentrations. This contrasts with domestic and industrial wastewater, for which most of the currently available treatment technology has been developed . As a consequence, the existing wastewater treatment technology is generally not well suited to prawn farms. There is however, more potential for the application of urban water (supply) treatment technologies (see below).

2. Nature of the pollutants: A significant proportion of nitrogen and suspended solids in prawn pond release water is dissolved nitrogen or bound up in microalgae. These pollutants can be difficult to remove. Microalgae is neutrally buoyant and so standard sedimentation systems often fail to remove it. This includes such systems as hydroclones and centrifuges.

These characteristics have meant that traditionally in Australia, prawn pond release water has been treated using relatively simple sedimentation processes. These are generally successful in removing only 30-35% of nitrogen and phosphorous, and about 50% of suspended solids.

One potential option is to utilise sand-filtration. This option has been adopted for this proposed project (Section 6.6.1.3 Sand Filter).

Bioremediation is the other commonly proposed "End-of-pipe" Technology.

Bio-remediation

The use of other biological organisms (fish, molluscs, aquatic vegetation, biofilters) to reduce nutrient levels, particularly nitrogen and chlorophyll *a*, has been tested with mixed success both in Australia and overseas. The strategy has benefits in terms of environmental compatibility and possible economic returns, however, there remain significant problems with the practical implementation and the robustness of these approaches on a large scale. As a consequence, bio-remediation as a wastewater treatment strategy is not widespread.

6.6.2.3 Future Development

The design of the Guthalungra development allows for on-going trialling of bio-remediation technologies, and the ready implementation of those technologies if they prove successful.

One of the characteristics of the sandfilter is that over 80% of TSS is removed but only 25% of total N and total P. It is thought that developments are possible in design of the polishing pond that will improve this outcome for total N and P and it is intended to pursue this issue at the Guthalungra site if not previously resolved at Alva Beach.

Other modifications that may be made to the design and operation of the Guthalungra Prawn Farm that may impact on nutrient loads are:

- Modification of water use regimes.
- Further modification of feed composition and delivery systems.
- Incorporation of polishing pond technologies into treatment of effluent discharged from the sandfilter.

6.6.3 Conclusions in Relation to Wastewater Quality Management Options

There are a number of alternative strategies for the management of pond release water quality and research is on-going both in Australia and overseas to assess their suitability. A number of options have been successfully tested by Pacific Reef Fisheries, and work on other new strategies is underway.

The Guthalungra proposal will incorporate a number of strategies for the improvement of release water quality and treatment over and above standard Australian prawn farm operating procedures, including:

- tightly controlled feed management;
- no-release partial harvesting;
- large-scale sand filtration.

Other approaches will be incorporated into the Guthalungra project as they are proven suitable for commercial development. The Guthalungra treatment system has been specifically designed to allow for this.

Pacific Reef Fisheries has demonstrated its commitment to continual improvement in the area of wastewater management in recent years, through the testing and adoption of new approaches and technologies. Again, the Guthalungra system has been specifically designed to allow this to continue.

6.7 Roll-in of current hatchery structures to new developments

This section directly addresses concerns raised in two comments by one respondent.

In 2004, Pacific Reef Fisheries obtained the necessary approvals and constructed a hatchery on the site at Guthalungra. This development incorporated construction of an evaporation pond, which will be incorporated into the settlement system described for the main project.

The brines remaining in the evaporation are likely to slowly dissolve over a period of time when the new settlement system is in operation. However, the peak volume of water being discharged from the site at Guthalungra is calculated to be 200 $ML.day^{-1}$. The operation of the hatchery has been designed to utilise recirculation technology for high volume components such as maturation and the discharge from the hatchery is calculated as approximately 18 ML/year which is 10% of one day of operation of the production ponds at peak period. Thus, the impact of hatchery discharge on the quality of the discharge water is likely to be insignificant. and, in any case, the discharge water will meet whatever criteria are incorporated into license agreements, independently of whether the contaminants originated from the hatchery or the production ponds.

A decision has yet to be taken regarding the continued operation of the hatchery subsequent to the development of the production ponds. The hatchery has been constructed according to the requirements of Qld DPI for quarantine facilities suitable for rearing stock imported from other States and the hatchery meets all reasonable standards regarding control of disease and escapees.

6.8 Pond construction and groundwater protection

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

6.8.1 Clay lining of ponded areas

As stated in Section 6.3.2 (d) and Appendix G of GAPDE 2003, approximately 50% of the site was covered by soils described as shallow profile 2 which contains clays suitable for pond lining and which are less reactive and not prone to cracking. It is intended to use this material for lining ponds. Douglas Partners calculated that there were 32 million m^3 of clay of this type, which allows for a lining of approximately 0.9 m across the whole site. This is more than adequate to construct ponds that are appropriately sealed and not prone to cracking. Thus, overlying with topsoil to prevent cracking is not necessary. Construction of clay liners of 0.5 m, properly laid and tested across the site as originally described in GAPDE, 2003, will result in substantial costs (approximately \$50,000.Ha^{-1}) and is excessive to providing properly sealed ponds. Accordingly, the proponents will engineer and construct the ponds as required under the Construction and Operation Guidelines for Coastal Land-Based Aquaculture Containment Structures currently being developed by an intergovernmental committee managed by the Department of Primary Industries. In view of the soil structure of the site, it is likely that there will be further significant layers of clay under the constructed clay liner.

Standard pond construction specifications include liner compaction testing and final result permeability testing.

6.8.2 Dispersion of clays

Dispersion of clays found on site was assessed using the Emerson Class dispersive test using distilled water and the outcomes are described in GAPDE, 2003, Section 6.3.2.

Concern over the potential for dispersion to occur within the clay lining of the water storage areas as a consequence of contact with saline water is somewhat confusing for two reasons:

i) It is generally accepted that for some clay soils (those high in exchangeable sodium), wetting with saline water ameliorates the dispersive effects on soil structure rather than causes dispersion. There is no evidence that exposure of clay soils to saline water will, by itself, cause soil dispersion.

ii) Any dispersion that may / may not occur in the clay liner will tend to <u>reduce</u> the hydraulic conductivity of the liner, rather than cause it to increase.

The potential impact of water electrolyte concentration on soil permeability has been widely investigated (Rose, 1966). For sodic soils (those high in exchangeable sodium), soil dispersion is lower when wetted with saline soils compared to fresh water.

By contrast, the wetting of non-sodic soils with saline water has little effect on soil structure (in terms of dispersivity) in the short term. For some soils, however, prolonged exposure to saline conditions can result in ion-replacement on the surface of the colloidal particles that make up the clay matrix. Upon subsequent exposure to water with lower ion concentrations, these soils can undergo declines in soil structure, as described in i) above.

It is important to note that the processes discussed above are generally applied to agricultural soils, where movement of water through soils is easier, and the physical processes of de-flocculation and flocculation can readily occur.

In terms of the importance of the above processes to the clay lining material for the proposed water storage ponds, the following comments are relevant:

- the soil test results show that the soils to be used for clay lining are relatively stable in distilled water. As discussed above, exposure to saline water will not diminish this stability;
- prolonged exposure to saline water may result in some increases in sodicity within the liner. The high compaction within the liner will limit the effect to the surface layer of the liner, and will limit the ability of the soil to physically respond to the chemical effects. Even so, dispersion would only subsequently occur when these soils are exposed to lower salinity water. In the normal course of operation, this is not anticipated to occur;
- even if dispersion should occur, this will tend to <u>decrease</u> rather than increase the hydraulic conductivity of the liner;
- in practice, the hydraulic conductivity of the liner is determined by a combination of the effectiveness of the clay lining, and the effects of biofilms and pore clogging by particulate materials settling within the ponds. These have been shown to significantly reduce seepage rates from water storage ponds, and are believed to be an important process in prawn ponds.

On the basis of the above discussion, it is believed that the proposed method of lining the ponds using compacted clay will be very effective, both in the short and long term.

6.8.3 Erosion control

Erosion control is required to minimise the risk of damage to the walls and consequent failure of the lining layer. The ponds will be constructed using Rip-rap (rocks) as erosion control rather than plastic lining of the pond banks. Rip-rap provides for improved management of prawns, providing for shelter for animals when they become sick and allowing earlier intervention. Plastic lining, being very slippery, does not provide as well for early detection of disease. Plastic liners also provide an occupational health and safety risk by preventing easy exit in the event that a person falls into the pond.

Further, there is no evidence that lining the pond banks with plastic is likely to reduce discharge nutrient levels. If anything, it is likely to increase the sediment in the pond discharge as there is would consequently be limited tertiary structure on the banks of the pond to facilitate retention sediment within the pond. Modelling of the use of plastic lining has not been conducted as it is considered the expense and time required would be wasted.

A buffer of 15 m between the toe of the bunds and the property boundary has been provided for. It is considered that this will be sufficient to prevent sediment from erosion of the bund entering onto neighbouring properties as the buffer will be well grassed in every case except adjacent to the saltpan. In order to ensure that there is no incursion of sediment onto the saltpan, the outside of the bunds adjacent to the saltpan will also be protected by rip-rap.

6.9 Acid Sulphate Soils

This section directly addresses concerns raised by three respondents.

Management of Acid Sulphate Soils (ASS) will be an important part of the construction process, particularly along the pipeline route where they are most likely to be encountered. Testing within the footprint area of the production ponds and water treatment areas indicates that ASS are unlikely to be encountered.

An Acid Sulphate Soils Management Plan (ASSMP) has been prepared (see Section 8.1 Acid Sulphate management plan) to manage Acid Sulphate Soils during construction. The ASSMP will accord with the Queensland Acid Sulphate Soil Technical Manual Soil Management Guidelines. The strategies which will be included in the ASSMP are:

- avoid disturbance of ASS;
- minimise disturbance;
- neutralise ASS;
- strategic reburial of PASS.

The avoidance of disturbance of ASS would be the first option considered to manage ASS. Where disturbance of ASS is unavoidable measures would be put in place to minimise the disturbance of ASS.

The principal technique which will be used to manage ASS when disturbed is neutralisation. When acid sulphate soil is identified it will be immediately carted to a designated treatment area within the footprint of the farm area. Alkaline material such as lime will be used to neutralise the ASS. This will include:

- calculation of the appropriate dosing rates;
- spreading of the ASS approximately 300 mm deep;
- watering and dosing the ASS with lime; and
- rotary hoeing the material.

Mixing of the lime and ASS will be carried out on a fully bunded treatment pad.

Mixed material would be selectively mixed at a ratio of 20:1 with bulk earthworks associated with the construction of the growout ponds and water treatment areas. This material will be selectively placed within the foundation earthworks of banks and linings.

The above processes will be undertaken as rapidly as possible to minimise the exposure of PASS to the atmosphere. It will be applied to ASS encountered during both the pipeline construction and the bulk earthworks associated with the farm production area. Where ASS is removed for treatment along the pipeline route, non-acidic material, which most closely resembles that removed from the pipeline trench, will be sourced from the main farm area and used as backfill. Where possible, non-ASS surface soils stripped from the pipeline alignment will be used to cover any material introduced for backfill.

As a precautionary measure, even in areas where ASS has not been encountered along the pipeline route, care will be taken during backfilling to ensure that material is backfilled in the same sequence as it was extracted.

6.10 Stormwater management and storm surge

This section directly addresses concerns raised in four comments.

6.10.1 Stormwater flooding and Bund Heights

Modelling indicates that the 1 in 20 year flood level (resulting from flooding from the Elliott River) is approximately 3.4 m AHD, and the 1:100 year flood level is approximately 4.3 m AHD (refer Section 6.4 and Appendix H of GAPDE, 2003).

The 1:100 year storm surge level for this area is much lower, around 2.5 m AHD (Beach Protection Authority Report, 1985). (See Section 6.10.2 Storm Surge).

Flooding of the site represents risks in terms of:

- damage to infrastructure through inundation;
- loss of access during flood times;
- hazard to human life; and
- inundation of ponds and treatment areas, causing escape of cultured animals and operational problems.

The design approach adopted to minimise these risks includes:

- the construction of all ponds, drains, channels, treatment areas with external heights not less than 5.0 m AHD; and
- the construction of all access roads, building foundations, etc. to a level not less than the 1:100 year flood level (4.5 m AHD).

The extent to which the consequent loss of floodplain storage may affect local flood levels is expected to be minimal (see Section 7.1.4 of GAPDE, 2003).

6.10.2 Storm Surge

Flooding of this site could occur via a number of mechanisms:

- flooding caused by local overland flow following storms;
- flooding caused by overland flows from Nobbies inlet;
- flooding caused by flood overflows from the Elliot River;
- flooding from the ocean caused by severe storms; and
- combinations of the above.

These mechanisms were assessed during the preparation of GAPDE, 2003, and the findings were detailed in Appendix H of that document.

Elliot River flooding risk was assessed using historic flow data for the Elliot River to determine flood discharge rates for the River that corresponded to particular likelihood of occurrence (Average Recurrence Intervals, ARI's). Hydraulic modelling and flood mapping was then undertaken for various ARI events to assess the extent and depth of flood inundation that would occur. This approach is widely used for flood risk assessment in Australia.

The use of historical data inherently means that likelihood of combined flood flows and storm surge events (i.e. Elliot River flooding occurring coincidentally with storm surge) is not accounted for.

This approach is considered reasonable for this site for a number of reasons:

i) The probability of coincident river flooding and storm surge is influenced by a range of factors including the size of the storm, the relative timing of rainfall compared to passage of the low pressure system across the coast, the direction of storm movement, and the location of the low pressure centre relative to the site. The probability of these factors combining to produce a "worst case" scenario is much lower than for individual modes of flooding, even allowing for the cyclonic nature of storm events in north Queensland.

iii) The location of the site close to the mouth of the Elliot River will mean that event in the event of coincident river and storm surge flooding, the storm surge would tend to be the primary factor influencing flood levels (i.e. Elliot River flooding would not greatly increase flood levels at the site above storm surge levels). This conclusion is supported by the hydraulic modelling undertaken for GAPDE, 2003 Appendix H, which concluded that the effects of elevated tail water levels dissipate quickly moving upstream from the mouth of the Elliot River.

The analysis of storm surge flood levels relied largely on the Blain, Bremner and Williams (1985) report for the Beach Protection Authority. This report suggested 1 in 500 year storm surge levels of around 2.5 m AHD. The more recent report referred to by DES (Harper, 2001) presents slightly modified estimates (Appendix 2), although these appear to have been drawn from the same report by Blain, Bremner and Williams (1985). The Harper report does, however, provide specific estimates for Elliot River, as shown in Table 6.1 below.

Table 6.1 Storm Tide Levels for Elliot River (Harper, 2001)

Storm Tide Level Relative to AHD					
50 Year	100 Year	500 Year	1000 Year	10000 Year	Extra Wave Set-up Allowance
2.0	2.2	2.6	2.8	3.5	0.5

HAT for the Elliot River site is 1.9 m AHD.

It is recognised that these results are based on limited historical data, and that hence the potential risk of storm surge flooding should not be treated lightly. Nevertheless, these estimates suggest that storm surge flooding would be limited to lower-lying areas along the near-coastal strip.

The majority of infrastructure proposed for the Guthalungra Prawn Farm development is well above the predicted storm surge levels predicted, even for very rare events. Also, the location of the site, several kilometres from the open water areas of Abbot Bay, will serve to protect it from the effects of wave run-up. The risks to farm infrastructure should therefore be minimal.

6.10.3 Stormwater management for capture and re-use

Section 7.1.4 (b), GAPDE, 2003, describes the process for managing local run-off. A potion of the run-off will be captured by the water storage described in Section 4.1.4 (c) thereby allowing it's reuse.

Fresh water waste water will be treated as described in Section 6.13 Wastewater treatment.

6.11 Operational matters

This section directly addresses concerns regarding a broad range of general operational matters raised in eleven comments.

6.11.1 Feed management

The relationship between the nutrient concentration in discharge and the nutrient level in the feed is complex. The best determination of this relationship is the nitrogen utilisation efficiency, which is approximated in practical studies by feed conversion ratio (FCR = amount of feed fed in Tonnes/growth in weight of prawns in Tonnes). This measures the efficiency of converting feed nutrient into prawn growth with the resultant waste settled out of the water column or discharged. Commercially, feed choice needs to take into consideration the growth rate and survival achieved with a particular feed and its cost. Each measure of performance is affected by the source of ingredients, the relative levels of nutrients and the manufacturing technology and methods. Also of great importance is the feeding method, which can reduce waste by careful management.

For example, Pacific Reef Fisheries compared in a commercial trial during 2004/05, two commercially available feeds for growth and FCR. These feeds are both sold with a specification of 40% crude protein. One of those feeds produced growth that was 5.95% slower and had a 3.85% poorer efficiency. In crude terms, this means that the poorer feed produced 4% greater nitrogen waste than the better feed, even though the protein level was the same in each feed. Thus, simple measures of protein levels in feed are not necessarily indicators of resultant nutrient loads on the environment.

Pacific Reef Fisheries is aware of no hard evidence coming from full-scale commercial trials to support the use of lower protein feed. A commercial trial, conducted by Qld DPI in the 1990s, used a locally manufactured low protein feed. The trial was abandoned when it was found growth slowed dramatically at 12-15 grams. A second trial was conducted by Ridley Aquafeeds, in conjunction with NSW Fisheries Port Stephens Fisheries Research Centre during 2003 comparing a 35% protein feed with a 40% protein feed. Although no differences in growth and feed conversion ratio were found, this experiment ceased when the prawns were 7 g and before they had doubled their weight (considered a minimum requirement for a valid growth trial). Further, transfer of such experimental data obtained in tanks to a commercial venture using ponds rarely provides similar results. Thus it is considered extremely risky to base commercial practice on such data and no legitimate operator in this business would risk the health of a commercial crop without clear and indisputable evidence that low protein feeds were effective in terms of both growth and prawn health in commercial environments.

Pacific Reef Fisheries has a record of innovation and research and development, including in feed development and use. The company will continue to undertake studies to improve feed efficiency and reduce nutrient loads under commercial conditions.

The source of protein in prawn feeds includes fish meal, other aquatic animal meals such as squid meal and plant meals. The presence of fish meal in prawn feed represents a relatively small use of global fish meal production - (30 % of total global fish meal production). The Guthalungra site will use 3200 tonnes of feed at peak production which will constitute usage of 1280 tonnes of processed fish meal. This is 0.017% of total global fish meal production.

Production of fish meal is a well managed global industry subject to quotas. In addition, the threat to aquaculture of restricted fish meal use has been well recognised and has been the subject of a substantial fish meal replacement program funded by the Fisheries Research and Development Corporation and contributed to by the Australian Prawn Farmers Association.

Although this project will be an insignificant user of global fish meal, the proponent through active participation in the industry association is contributing to minimising fish meal use.

6.11.2 Water management

6.11.2.1 Effect of salinity

Pacific Reef Fisheries has extensive experience in successfully farming *Penaeus monodon* in relatively high saline waters through its operations at its Alva Beach site, east of Ayr. While optimal salinities for farming *P. monodon* are lower than those found at Guthalungra, there are certain benefits in growing *P. monodon* prawns in more saline conditions, which includes better prawn health. Higher salinities do not mean higher water exchange rates, with exchange rates at Alva Beach being below usual industry practice.

6.11.2.2 Recirculation of water

Recirculation technology for prawn farming is used in a number of sites around the world with varying success. Critical factors in successful recirculation are maintenance of salinity and removal of nutrients. While removal of nutrients at Guthalungra will be done prior to discharge as a matter of course, evaporation will result in increases in salinity, which will prevent sustainable production of prawns. The bottom line is that recirculation will require supply of large amounts of freshwater and is not yet fully proven for full scale production or commercially viable for the Guthalungra site.

The design of the facility will allow for future development of recirculation technology as current developments prove it is viable in sites such as Guthalungra.

6.11.3 Source of seedstock

Seedstock will be obtained from hatcheries operated by Pacific Reef Fisheries or from other commercial hatcheries.

The source of broodstock for these hatcheries will either be from:

- Australian east coast wild caught
- The domestication strains currently being developed by Australian researchers in conjunction with the Australian Prawn Farmers Association
- The domestication project currently being undertaken by Pacific Reef Fisheries

The actual source will depend upon availability of stock, reliability of spawners and other commercial factors prevalent at the time. In all cases, Pacific Reef Fisheries will comply with legislative and regulatory requirements.

The actual number of seedstock required for production ponds at complete development cannot be delivered by currently available commercial supplies and additional hatchery production will be developed in the future by Pacific Reef Fisheries.

6.11.4 Disease Control

Section 7.3.11 GAPDE, 2003, refers to disease management and risks to wild stocks from aquaculture. From the responses to GAPDE, 2003, there appears to be a perceived risk of introducing disease to the environment as a result of farming prawns. Overseas a number of diseases have been introduced to the environment by prawn farming in the past. This has not occurred in Australia. Such introductions are characterised by poor countrywide quarantine protocols, poor environmental management and short-term commercial outlooks. Examples of these diseases are Taura Syndrome Virus and White Spot Virus, which have been widely dispersed throughout many other prawn farming countries. None of these exotic diseases currently exist in Australia.

The diseases that exist in Australian farmed and wild prawns are endemic, most notably Gill Associated Virus (GAV) and Mourilyan Virus (MOV). There is no evidence that farming has resulted in increased levels of these diseases in Australia. Further, Australian farmers in general and Pacific Reef Fisheries in particular, are in the process of developing disease free stocks of *Penaeus monodon*, thereby decreasing risks of disease transfer further.

The real and proven risk of transferring exotic diseases to our environment is through the importation of overseas product, an issue the Australian prawn farming industry has fought for years.

The truth is, support for local production will decrease this risk by replacing imported product from suspect overseas suppliers who do not have the stringent safeguards that we employ in Australia.

6.11.5 Bloom Management

Management of blooms of phytoplankton in prawn ponds is necessary early in the culture cycle as the phytoplankton provides food for the prawns and for zooplankton upon which the prawns also feed. The phytoplankton also shades the pond bottom to prevent the growth of benthic algae, which compromises the growth of the prawns.

In those cases where the bloom doesn't reach sufficient density to prevent growth of benthic algae, a blue vegetable dye with the commercial name of Aquatic Blue is added to the ponds. The dye in Aquatic Blue is a biodegradable compound which leaves no residue after one week and which is readily diluted by exchange water.

There is zero impact on the environment by the use of Aquatic Blue in prawn ponds.

6.11.6 Problem Species Management

Prawn farms generally suffer from impacts of predation by birds. Predatory birds can consume enormous quantities of prawns and compromise the commercial viability of the company if not controlled. On the other hand, wide-spread culling of birds is not acceptable to the broader community. In order to deal with this problem, Pacific Reef Fisheries has developed techniques of control that take account of the social and behavioural characteristics of the species creating the largest impacts.

Species that are observed fishing in ponds at Pacific Reef Fisheries Alva Beach farm are cormorants (*Phalacrocorax* sp.), Egrets (*Egretta* sp.), Pelicans (*Pelicanus conspiculatus*) and Jabiru or Black necked Stork (*Xenorhynchus asiaticus*). Of these, the surface feeding behaviour of pelicans, the edge feeding habits of egrets and the infrequency of visits from Jabiru mean they are little problem for prawn farms other than at harvest when they can be dissuaded by the presence of staff. Cormorants, however, are known to take large amounts of food (400 g/day/bird) (Lekuona et al, 2002), have been described as consuming 53% of the production of a fish farm in the Netherlands (Lekuona et al, 2002) and are known to cause significant economic loss to Australian fish farms.

Cormorants feed both singly and in flocks (Moerbeck et al, 1987; Lekuona et al, 1997) with those feeding singly being more resistant to predator deterrents than those feeding in flocks (Moerbeck et al, 1987). A comparison of deterrent methods including detonators, light flash cartridges, aircraft and helicopters and overhead lines by Moerbeck et al (1987) showed that cormorants were easily able to learn and avoid such deterrents.

Pacific Reef Fisheries has been utilising a product called Bird Fright Cartridges fired from a 12 gauge shotgun during the 2004/05 season and previously. The basis of the deterrent is to prevent the cormorants alighting on a pond and discovering the presence of food. The Bird Fright is fired into a flock or ahead of a cormorant as it flies over the farm where it explodes producing an loud report and a smoke cloud. In most cases this has the effect of scaring the flock and preventing them settling. Follow-up with a non-lethal shot from the shotgun encourages the birds to move on. We have supplemented this strategy with using hides distributed about the farm since cormorants are deterred by human activity close by, and are investigating attracting raptors to the farm by provision of nesting sites.

On occasions, either when a cormorant enters the farm unobserved or is not deterred by the Bird Fright, they may then be subsequently seen feeding on the ponds. Moerbeek et al. (1987) considered these birds to be “fish farm specialists”, a small part of the total population and more adept at avoiding other deterrents such as lines than the majority of the population. At Pacific Reef Fisheries, we have found that it is necessary to cull these particular birds, as no other action will deter them. In view of the relatively small portion of the population that they form, however, the impact on the total population is negligible.

The company is currently preparing a property management plan incorporating the strategy described above for control of cormorants at the Guthalungra Project. While this will necessarily involve application for a wildlife mitigation permit, our approach of training birds to avoid the farm means that the number of birds culled is very small by comparison with the total population. A draft PMP is contained in Section 11.6 Appendix 6. Property Management Plan for Managing Wildlife Impacts.

6.11.7 Pond Sediment Wastes

Pond sediment wastes constitute approximately 50 m^3 soil/Ha/year. This sediment is largely inorganic particulate matter (Burford and Longmore, 2001). Analysis of pond wastes from Alva Beach prawn ponds by a NATA registered laboratory revealed the composition shown in Table 6.2.

Table 6.2. Nutrient composition of pond wastes removed from a pond on completion of the production cycle at Pacific Reef Fisheries Alva Beach farm.

Parameter	Value
pH	7.9
Total Kjeldahl Nitrogen (mg/kg)	1600
Ammonia Nitrogen (mg/kg)	12

Total Oxidised Nitrogen (mg/kg)	9.3
Total Phosphorus (mg/kg)	1000
Colwell Phosphorus (mg/kg)	110
Total organic carbon (%w/w)	1.5
Total Carbon (% w/w)	1.6
Equivalent Organic Content (% w/w)	2.6
Total C: Total N Ratio	10

These data show that the pond waste has a “moderate” nitrogen content, “generally satisfactory” organic content and a C:N ratio normal for a cropped soil and is therefore not different in nutrient content to what would be considered a reasonable to good soil for cropping.

However, prudent prawn farm management allows for removal of the waste from the ponds each year, to avoid the transfer of disease from one season’s crop to the next. At Guthalungra, this waste will be removed and stockpiled in an adjacent bunded area for a period of greater than 2 years. This will allow further ageing of the organic material and killing of any disease organisms. In areas of high rainfall, such wastes are leached of salt and become useful in that they permit re-vegetation. In the dry tropics such as Alva Beach and Guthalungra, the rainfall is not sufficient to remove the salt and plant growth on the wastes is unusual. After the 2-year ageing period (determined by the nutrient analysis of the waste from the Alva Beach farm and thus precluding the requirement for modelling of nutrient breakdown), it is intended to utilise this sediment for earthworks repair in ponds and channels.

The total area required to stockpile the accumulated sediment from 270 Ha over 2 years stored in 2m high piles is a little over 1.2 Ha which will be accommodated on the land owned by the company immediately adjacent to the settlement ponds.

6.11.8 Pond bottom drying

In addition to removing pond bottom wastes, prudent management of prawn ponds requires the operator to ensure the bottom dries between each stocking. This is facilitated by scarifying (described as ripping in Section 4.2.2 of GAPDE 2003) to a depth of 50 mm. The soil disturbed by this process is readily recompacted by the water upon filling of the ponds. Since prudent design of ponds allows for at least 300 mm of clay liner (proposed as 500 mm in GAPDE 2003 in view of the excess clay available), scarifying the top 50 mm has no impact on permeability of the pond.

6.11.9 Trapping of wild fisheries resources

Fish and invertebrate eggs may be drawn in through the intake pump and pipe and may establish in the water storage system. Based on the experience at the company’s Alva Beach Farm, the number of such animals that are likely to establish in the storage system is likely to be very small. The practice of the company has been to allow these animals to remain in the water storages since it is contrary to the aquaculture license and environmental authority conditions to release any animal from the farm to the wild. We expect that this will also be the case for the proposed farm at Guthalungra.

However, it is possible that over a period of time, the number of fisheries resources will become substantial. In order to deal with this eventuality, a pipe to allow the seawater storage facility to be drained into the saltpan area will be located at the northern end of the storage (Figure 3.3).

6.12 Potable water supply

This section directly addresses concerns raised by one respondent.

Section 4.1.4 GAPDE 2003 refers to a supply of freshwater meaning non-saline water. Freshwater will have to be treated to ensure it is potable as described in 4.1.4 (d). Potable water will be used in processing, laboratory, hand washing and drinking water. As explained in Section 4.1.4 GAPDE 2003, the primary source of supply will come from the existing dam which holds 20000-25000 kL of water when full. As stated earlier in this document this dam will meet our annual needs of an estimated 12300 kL excluding garden watering. Standards applying to the supply of potable water and appropriate signage at water supply points will be met and a water management plan will be implemented for this site.

6.13 Wastewater treatment

This section directly addresses concerns raised in two comments.

Section 4.1.4 (e) of GAPDE 2003 describes the Wastewater treatment of two streams – Processing wastewater and Domestic wastewater.

6.13.1 Processing wastewater

Processing wastewater is water that has been used for processing prawns. This water will be collected, screened, disinfected and discharged into the settlement ponds. In view of the salinity of this water, which precludes irrigation, and the contemporary production of this water with normal prawn farm operations producing large volumes of discharge, it is considered that the settlement system is the most efficacious way of tertiary treating this wastewater. The resultant water quality for discharge from the settlement system will meet water quality standards prescribed for all seawater discharge. Assertions that this is not best practice are considered incorrect.

6.13.2 Domestic wastewater

Domestic wastewater is water that has been used for ablution, laboratory and household operations. As described in Section 4.1.4.(e) of GAPDE 2003, this water will be collected in a separate waste stream to the processing water and treated in a septic bio-processing facility as described in GAPDE 2003.

These systems will allow for irrigation of the treated water onto vegetated areas as described in GAPDE 2003. Accounting for the EPA recommendation of 250 $L.EP^{-1}.day^{-1}$, the maximum expected flows are 7.7 $kL.day^{-1}$or 2175 $kL.year^{-1}$. On the same basis as the calculations in GAPDE 2003 (distribution of 5 $ML.Ha^{-1}.year^{-1}$), an area of approximately 0.44 Ha will be required for irrigation.

The system incorporates primary treatment in septic tanks, which allow settlement and aerobic breakdown of organic and other particulate matter. Overflow will run into a storage tank from which water will be pumped through a slow sand-filter to a storage area prior to irrigation. The irrigation areas will be located in an area to be determined but so as to improve outlook and amenity of the entrance to the property while ensuring that it meets legislative requirements for distance from any waterways, production or discharge treatment areas. The septic tanks and sand filter will be placed underground, with lids to provide access for maintenance, preventing release of unpleasant odours. All vessels containing standing water will be covered to prevent mosquitoes utilising them as breeding areas. Detail design parameters of this system will, as usual, be provided by a qualified engineer to meet legislative requirements.