2. DESCRIPTION OF PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The proposed Blackmore River (East) Aquaculture lease occupies an area of approximately 796 ha on Middle Arm, Darwin Harbour, approximately 25 km south-east of Darwin. The site is bound to the west by the woodland/mangrove margin of the Blackmore River and to the north by the existing road to the Middle Arm boat ramp. The eastern boundary is matched to the shape of the proposed freshwater dam and is the vicinity of Finn Road, which runs south to Berry Springs. The lease area is predominantly woodland. The land immediately surrounding the Blackmore River Aquaculture site consists of undeveloped Crown Land, within the Litchfield Shire.

The location of the proposed aquaculture development site is presented in **Figure 1**. The proposed development, overlaid onto an aerial photograph of the area, is presented as **Figure 2**.

2.2 SITE SELECTION

An assessment of the fundamental attributes of a suitable site was made with the following factors considered to be of highest importance:

- Tropical climate for optimum water temperatures for best growth of selected species.
- Access to seawater with sufficient channel depth to draw off on all tides with minimum interference to mangrove populations.
- Close proximity to a large population centre for staffing, supplies and access to a major airport for chilled, frozen and live exports.
- Suitable soil types and topography for pond, dam and road construction.
- Suitable site and catchment area to construct a freshwater dam to hold sufficient supply for salinity adjustments in the production ponds to an eventual scale of 115 ha of production pond area.
- Viable access to the Power and Water Authority (PAWA) electricity grid.
- Viable access to PAWA reticulated water, or alternatively potable groundwater.
- Site area to enable effective layout of up to 115 ha of production ponds and 80 ha of exchange water treatment ponds.

Initially, a site on the Howard River (Northern Territory) was considered for the project. However, in co-operation with the Northern Territory Government, with consideration for issues raised by community interest groups, the Howard River site was abandoned in favour of this Blackmore River (East) site. The Blackmore River (East) site is considered by Phelps/Panizza to possess the following attributes:

- Tropical climate.

- Access to seawater with the Blackmore River running closely adjacent to the farm area, allowing saltwater supply with minimal impact to mangroves.
- Reasonable proximity to Darwin (with minor Wet Season access limitations).
- On site material that will be satisfactory for construction requirements. Suitable site for the construction of a freshwater dam.
- Suitable areas within the lease enabling construction of the project's required infrastructure.
- Reasonably accessible domestic electricity supply (approximately 4 km from the proposed pond area). Connection is planned home time after the initial development is operational.
- Identified potable groundwater reserves in the area.

2.3 PROJECT SCHEDULE

It is proposed that the aquaculture development be undertaken in two stages. Stage 1 will comprise the initial establishment of twenty-two production ponds (approximately 27 ha in total). It is proposed to commence the construction of Stage 1 in July 2001, for completion in early 2002. Phelps/Panizza propose to spend the first three years working with 22 ponds to establish appropriate economic and environmental management practices. During this period full analysis of many aspects of the aquaculture farm will be conducted, including:

- species for production;
- water and discharge water management, evaluating closed circuit systems;
- computer systems, remote sensing and controls;
- pond number/size and layout;
- aeration type, size and configuration;
- requirement for own hatchery;
- feed distribution; and
- potential markets.

Phelps/Panizza foresee sufficient production and revenue to operate profitably from Stage 1. This is based upon detailed cash flow projections on six monthly yields of 4 and 5 tonnes of prawns per hectare. If Stage 1 of the project is deemed economically and environmentally appropriate, expansion of the farm to reach full-scale (Stage 2) is expected to occur at a fairly constant rate over the following three years. Prior to any such expansion Phelps/Panizza undertake to complete additional environmental assessment in consultation with the Environment and Heritage Division of DLPE, Fisheries Division of the Department of Primary industries and Fisheries (DPI&F), and CSIRO Marine Research CRC.

When operating at full-scale, aquaculture production is expected to occur within a total of 93 production ponds, encompassing an area of approximately 115 ha.

2.4 PROJECT LAYOUT

The proposed layout of Stages 1 and 2 of the aquaculture project, overlaid onto an aerial photograph of the area, is provided in **Figure 2**.

In summary, the final development (Stages 1 and 2) will comprise a total of 93 production ponds (approximately 115 ha) and a saltwater supply, settling and storage channel. A freshwater dam (186 ha in area, with a holding capacity of approximately 5,500 ML), four exchange water treatment ponds (80 ha in total) and 26 ha of pasture area will also be incorporated in the project design. This infrastructure will be serviced by a network of saltwater supply channels, three saltwater intake pumps installed on a pump jetty in the Blackmore River, channeling and pipe work required for supply and drainage, three above ground fuel (diesel) storage tanks, power generators and supply lines. A packing/processing factory, hatchery, office building and managerial/staff housing will be built. Fencing, access and farm roads will also be constructed.

Construction activities required to complete Stage 1, and the additional development requirements of Stage 2, are listed below.

Stage 1 (Initial)**:**

- A 350 m above ground supply channel and pump jetty, installed with 2 x 600 mm pumps, on the Blackmore River;
- 5 ha saltwater settling channel and storage dam for salt water supply to farm;
- twenty-two production ponds, with each pond having an area of 1.24 ha (approximately 27 ha in total);
- on-site freshwater dam with a planned water area of 20 ha and holding capacity of approximately 460 ML, built to 15m Australian Height Datum (AHD), and lift pump(s);
- 1.6 km of on farm saltwater supply channels, equipped with a pumps re-lifting water from the settling channel;
- a 20 ha exchange water treatment pond;
- channeling and pipework for supply and drainage;
- three 55,000 L above ground fuel tanks;
- a 12 m x 24 m workshop and office;
- aquaculture shed, incorporating holding tanks and quarantine;
- a 12 m x 24 m packing factory;
- demountable style single-person's quarters and amenities, to accommodate two to four people;
- 5 km of access and farm roads;
- fencing; and

- power generators and power supply lines.

Stage 2 (Completed)**:** Additional works:

- the installation of a third 600 mm lift pump on the pump jetty;
- the construction of a further 71 production ponds (93 in total), each pond with an area of 1.24 ha (approximately 115 ha in total);
- the addition of a second larger freshwater dam, constructed to the 14m AHD covering a 186 ha area (holding capacity approximately 5,500 ML);
- 4.8 km of on farm saltwater supply channels and the addition of a third lift pump to re-lift water from the saltwater settling channel;
- three exchange water treatment ponds, with a further area of 60 ha;
- channeling and pipework for supply and drainage as required;
- 5 ha desalination bays for solid pond waste;
- pasture area of 26 ha;
- expansion of workshop, office and packing and storing facilities; manager's residence, 5-10 houses for married staff and 10-20 single staff quarters;
- additional power generators and/or supply lines, or connection to grid power; and
- further access and farm roads (approximately 2 km) to Stage 2 structures.

2.5 MAJOR COMPONENTS

2.5.1 Pump Jetty and Supply Channel

The Stage 1 development will commence with the construction 350 m long raised earthen road and raised channel through the mangroves to reach the Blackmore River, to enable the installation of a 30 m long pump jetty. This will permit the installation of 2 x 600 mm salt water supply pumps in a deep channel (around 8 m based on a mid tide). The water will be pumped into pipework for movement along the jetty structure to enter the supply channel.

The jetty will be constructed of steel and concrete.

The channel will be of earthen construction, with suitable clayey soils available for borrow out of the adjacent pond area. A concrete headwall will be installed at the head of the channel closest to the pumps.

An access road will be constructed to run either side of the supply channel and will be capped with approximately 150 mm of lateritic gravel material available from within the farm area. The road surface will be constructed to a level of 6.5 m AHD (2.5-3.0 m in height above existing mangrove mud surface) to ensure that there is sufficient free board from peak tide levels.

The seaward walls of the channel and roads will be lined with rock as required to prevent erosion from wave action and tidal surge. Suitable rock is available on site for this purpose.

To ensure conservative design estimates, Darwin Harbour peak combined sea level predictions were adopted for design calculations. The predicted 100-year peak combined sea level for Channel Island is 5.1m AHD (DLPE, 1994). However, the site is approximately 15 km upstream in the Blackmore River from Channel Island and is not expected to experience as high a storm surge as predicted for Channel Island. In addition, the mangrove fringe between the site and the Blackmore River is likely to retard the actual storm surge at the site.

2.5.2 Production Ponds

Production ponds associated with Stage 1 will be located towards the northern end of the site in the woodland area adjacent to the mangroves (**Figure 3a**). The Stage 1 development will include twenty-two ponds. Each rectangular pond will be 138 m in length and 90 m wide, covering an area of approximately 1.24 ha and having a capacity of approximately 18.5 ML. The ponds will be aligned in four rows of 5 or 6 ponds each and will utilise a network of supply channels (**Figure 3b**). The Stage 1 supply and drainage system, including construction details, are provided in **Figures 3c** and **3d**.

Stage 2 of the development will incorporate and eventual total of 93 production ponds that will cover an area of approximately 115 ha, extending to the south, east and north from the Stage 1 ponds (**Figure 4a**).

Pond walls will be constructed to a height of 1.5 m above the existing terrain. It is anticipated that each pond will be excavated into the soil to an average depth of approximately 0.5 m. The bottom surface of the pond will be sloped to allow drainage to one point. This slope, at approximately 0.7% is consistent to the existing average slope of the proposed pond site. Depth of water in the operational production ponds will be approximately 1.5 m, with 0.5 m freeboard between the water surface and the top of the pond walls. The Stage 2 supply and drainage system, including construction details, is provided as **Figure 4b**.

Once the lease area is sufficiently dry (following the end of the Wet Season), the pond walls will be constructed, primarily from clayey lateritic soils excavated during pond floor construction using dozers and self-elevating scrapers. Details of construction cut and fill quantities are detailed in **Section 2.6.2**. The excavated clays will be compacted to sufficient density to ensure stability. Between 0.l m and 0.2 m of lateritic gravel will be compacted on the crests and sides of the pond walls to enable vehicular access and to minimise erosion. The laterite material will be transported to location by dump truck and spread using a laser-controlled grader.

Each pond will be filled by a single 450 mm intake pipe drawing from the end supply channel running off the main supply channel at the head (southern end) of the ponds. Discharge will be through 500 mm pipes connected to concrete drainage structures ('monks'). The floor to the ponds will be gently sloped (0.7%) to the discharge point to facilitate drainage of the ponds during harvest. A cross section of the proposed pond supply and drainage channels is presented as **Figure 5**.

Each pond will have a concrete bay constructed at the base of the pond to be used for harvest of the prawns. The concrete bay will be of sufficient size to accommodate two harvest cages.

As an alternative to mud pond floors, the floors may be lined with a synthetic liner. The advantages of using a synthetic liner include reduced pond cleaning costs and reduced potential for the harbouring of disease pathogens in the soil of the pond floor. The viability of using synthetic pond floor liners will be investigated by establishing a trial pond with a synthetic liner during Stage 1 operations.

2.5.3 Saltwater Settling, Storage and Supply Channel

The raised channel from the Blackmore River will run to an in-ground channel constructed adjacent to the mangrove margin area, running approximately 2 km to the second stage saltwater lift pumps. This channel will be constructed to an average water width of 30 m allowing the incoming water to slow down and for suspended solids in the water to settle out in the water column, significantly improving the clarity of the water being supplied to the production ponds.

This channel structure will have a storage capacity of approximately 56 ML, which will assist in flexibility of farm management making available a buffer of water for supply to the ponds even on low tides. The settling channel will be of similar construction to the production ponds, with the height of the wall being approximately 2 m above the natural ground level of the 4 m AHD. The channel will follow the alignment of the natural contour, adjacent to the mangroves, to the second stage lift pumps, matching the level of the roads along the channel from the pump jetty.

The channel walls will be constructed using material from the channel floor and using both dozer and self-elevating scraper. The walls will be capped with laterite material transported to location by dump truck and spread using a grader. Maximum excavation depth within the channel may be as much as 1.5m to remove higher knobs of terrain to leave an evenly graded flat bottom to the channel, allowing complete drainage for future maintenance.

Pumps to provide a second lift from the settling channel to the production ponds will be installed at the eastern end of the settling channel to lift the salt water to the farm saltwater supply channel. These pumps will be selected to match the capacity of the first stage pumps installed on the pump jetty in the Blackmore River.

2.5.4 Freshwater Storage Dam

The Darwin region has a definite Dry Season each year, in which generally a period of six months will pass with little rainfall. During this period evaporation will cause steadily increasing salinity in the production ponds with associated slower growth rates. To maintain growth rates and stock health a supply of freshwater will be required. A freshwater dam will be constructed for this purpose.

During Stage 1 development a 20 ha freshwater dam (holding capacity 460 ML) will be constructed to the south-east of the production ponds, at the headwaters of the north arm of Middle Creek, in centre of the lease (**Figure 6a)**. The freshwater dam will have a catchment area of approximately 75 ha.

The dam wall (approximately 628 m in length) will be constructed to a height of approximately 15 m AHD (a maximum wall height of 7.5 m). The wall of the freshwater dam will be constructed of clay material from the dam floor and will be excavated using dozers and self-elevating scrapers (**Figure 6b**). Calculations of Stage 1 dam construction volumes are included in **Figure 6c**. A spillway will be located at the southern end of the dam wall.

Overflow design for the Stage 1 dam construction will include a 40 m long, low spillway at the southern end of the dam wall. The spillway will be capped with a layer of compacted gravel.

A second freshwater dam will be constructed before expansion of the farm to full scale, possibly in Year 3 of development, at the headwaters of the south arm of Middle Creek. This dam will have a surface area of approximately 186 ha and a storage capacity of approximately 5,500 ML (**Figure 7a**). The catchment area for the Stage 2 freshwater dam will be approximately 1,170 ha.

Construction of the Stage 2 freshwater dam will incorporate the use of several material types laid down in zones. Preliminary dam design details are presented in **Figure 7b**. The dam wall will be constructed to a height of approximately 14m AHD (a maximum wall height of 13 m). The base of the fully constructed dam wall will be keyed into the underlying material to a depth that will be determined following appropriate geotechnical investigations of underlying material. The extent of excavation elsewhere on the dam floor (at 5.0 – 9.0 AHD) will depend on fill requirements, and will be taken in such way to ensure that the entire dam area is self-draining.

Overflow design for the fully constructed dam will include the construction of a spillway, at approximately 13m AHD, at the dam's southern end. The spillway will be excavated into shallow laterite (<lm depth below surface level) and will be designed to release overflow water in a manner that will minimise channeling and erosion. Appropriate erosion control measures will be adopted to minimise scouring from spillway runoff. The spillway design will be included as part of the Stage 2 freshwater dam design that will be finalised at a later date.

The Stage 2 freshwater dam will be constructed primarily by scrapers. Excavation of material for the clay core will be from the dam floor. Laterite material will be excavated from the spillway area and other construction material will be obtained from within the dam boundary. All excavation areas will self-drain back into the floor of the dam.

High Voltage Tower

One tower of the NT high voltage grid stands in the reaches of the Stage 2 freshwater dam. At the time this dam is constructed (year 3), measures will be taken to ensure that PAWA have uninterrupted access to this tower for inspection and/or repair. The dam water will flood the area around the tower to a depth of 1.5 m, typically, for the period from February to May each year.

In consultation with PAWA, the proponents will take the following steps, depicted in **Figure 7c**, to ensure that the tower is not damaged by increased rust and is permanently accessible whilst the dam is full:

1. Encase the currently exposed base section of the tower legs with concrete to a height of 1.7 m above the existing concrete footings giving the steel members protection from rust to a level 300 mm above the highest water level of the dam. The old concrete footing will be 'scabbled' so that the new concrete adheres and seals, preventing moisture reaching the steelwork.
2. Construct a compacted earthen road above the dam water line to and around the tower base,

enabling vehicular access at all times during the wet season. This road will be built up to 2.2 m around the tower, a level equivalent to 14 m AHD and 700 mm above the highest water level and will be continued back to the northern reaches of the dam. This road will be 6 m wide at the top and be aligned with the power line.

3. The area within the base of the tower will be filled with earth to a level equal to the height of the new concrete footings, 300 mm above the highest water level, to enable free movement of personnel around the base of the tower. This area will be permitted to drain back into the dam, to prevent pooling of water around the steelwork of the base.
4. The road and other earthen surface will be topped with suitable gravel material to minimise bogging and slipping for both vehicles and personnel.

5. The work will be carried out in consultation with PAWA management to ensure it is completed to the satisfaction of PAWA.

2.5.5 Finn Road Access through Stage 2 Freshwater Dam

Water in the southern reaches of Stage 2 freshwater dam will inundate a part of Finn Road. The Planning Division of the DLPE intend to realign this road in the near future such that new alignment will not conflict with the dam in its proposed form. However, if at the time this dam is constructed authorities require Finn Road to remain open, the following steps are proposed to ensure continuing use by the public:

- The existing culvert will be extended to accommodate building up of the roadway.

- A compacted earthen road, 8 m in width, will be constructed.

- Signage and guide rails will be installed as required.

The proposed earthworks for the Finn Road crossing are detailed in **Figure 7d**. All work will be done in consultation with Litchfield Shire Council.

2.5.6 Exchange Water Treatment Ponds

The production of marine species in semi-intensive aquaculture production ponds will produce discharge water with increased levels of nutrients and suspended solids. To minimise the amount of nutrients and suspended solids released from the farm, exchange water treatment ponds will be installed to provide "passive treatment" of the effluent. Stage 1 development will include a single 20 ha exchange water treatment pond and Stage 2 development will include four exchange water treatment ponds.

The discharge water ponds have been designed in accordance with the latest research in aquaculture discharge water treatment. The proposed discharge water treatment regime will have the highest ratio of treatment pond area to production pond area of any aquaculture development in Australia.

Details of the anticipated composition of the discharge water discharge from the production ponds and the effectiveness of exchange water treatment ponds are discussed in **Section 4.6.2**.

Construction of the exchange water treatment pond will commence once the lease area is sufficiently dry (following the end of the Wet Season). The Stage 1 exchange water treatment pond will be constructed alongside the western edge of the production ponds (**Figure 8**) with dimensions of the walls being similar to the production pond wall construction.

Since the treatment ponds are to be situated at a lower level than the production ponds discharge water from the Stage 1 production ponds will flow into the exchange water treatment pond. The treatment pond is designed so that discharge water will pass along a distance in excess of 2 km at a slow velocity, improving rehabilitation of the water through allowing solid material to settle out.

Discharge water outflow from the treatment pond will be controlled by a valve fitted to a 1200 mm diameter waste discharge pipe at the south-eastern corner of the treatment area. This will permit the released discharge water to flow into an existing natural channel in the mangroves (Figure 3). Erosion prevention measures will be adopted where the released discharge water enters the natural creek channel.

The number of exchange water treatment ponds associated with Stage 2 of the development will depend on the performance of the Stage 1 treatment pond. Current design for Stage 2 is based on a ratio of 80 ha of exchange water treatment ponds to 115 ha of production ponds, with the construction of three additional exchange water treatment ponds during Stage 2 (**Figure 9**). Additional treatment ponds, to be located on alignments between the 4m and 6m AHD, will be of similar principle and construction to the Stage 1 treatment pond.

Following construction of the additional Stage 2 treatment ponds, discharge water will be released to the north arm of Middle Creek. Discharge, at the southern side of the north arm of Middle Creek, will be controlled with piping and valves similar to the proposed Stage 1 outlet. To prevent scouring or erosion a discharge channel will be constructed to discharge into the creek.

2.5.7 Solids Desalination Bays and Pasture

The process within the production ponds results in the generation of a solid waste material, sludge, which needs to be removed from the pond, after harvest. This material will be removed for holding and desalination in a 5 ha area, referred to as the Solids Desalination Bays. This will be an area positioned around the 10 m AHD, adjacent to the small freshwater dam, which will be bunded with a low earthen wall and a release wall, to slow the run off of water from the impoundment.

Any run off water will be directed to the discharge treatment ponds for eventual release after treatment.

Once the solid waste material has spent several seasons in the solids desalination bays, being turned over in each Dry season, it will be removed to a 26 ha pasture area where it will be spread over the land for any remaining nutrient value and to build the topsoil.

2.5.8 Buildings

All buildings will be positioned between the 16 m AHD and 30 m AHD contours (Figure 4a). Sufficient parking areas will be constructed adjacent to all buildings and dressed with suitable gravel material.

Buildings associated with Stage 1 development will include:

- a processing factory (12 m x 24 m);
- a farm workshop and office (12 m x 24 m);
- an aquaculture shed, incorporating holding tanks and quarantine; and
- accommodation for 2-4 single workers.

The processing factory and workshop will be built with a concrete base, steel frame and colourbond cladding.

The aquaculture shed will have a concrete base and floor, steel frame and cladding and will be fitted with tanks and water supply for the holding of juvenile stock.

Accommodation will consist of demountable buildings connected to power and sewerage. Permanent residences will be constructed once the project becomes operational and it is feasible to establish suitable conditions for the accommodation of a larger number of staff including families.

Buildings associated with Stage 2 development will include: packing and storage facilities, office and expanded workshop; a Manager's residence, 3 to 8 houses for married staff and 5 to 12 single staff quarters.

Lawns and garden beds will be established around the factory, office and residences.

2.5.9 Roads

Access to the proposed development will be via the existing Middle Arm Boat Ramp Road. The Middle Arm Boat Ramp Road is considered to be an acceptable access road for the types of traffic generated by the development. Middle Arm Boat Ramp Road and other gravel roads in the area have the following limitations:

- Flooding preventing passage after large rainfall events. Temporary closure of the road usually lasts for relatively short periods, with 4WD passage generally possible at all times.
- Reduced visibility from dust generation during the Dry Season when passing or overtaking other vehicles can result in dangerous driving conditions. All staff and families will be advised of these dangers.

Roads constructed as part of the Blackmore River (East) Aquaculture Development will provide:

- access from Middle Arm Boat Ramp Road to the property boundary;
- access from the property boundary to the housing/production area;
- access along the pond/bund walls; and
- general access within the farm area.

Roads constructed on the lease will comprise all-weather access gravel roads, lined with compacted laterite material applied at a thickness of 100-200 mm. Roads will be designed to minimise erosion through the provision of table drains installed across the natural slope where possible. All construction material will be sourced from a borrow pit located within the boundaries of the lease area.

2.6 EXTRACTIVE MATERIALS

2.6.1 Soil Suitability

Clayey soils (including clayey sand and clayey gravel) and gravel will be required for construction purposes at the Blackmore River (East) Aquaculture Development.

Soils with sufficient clay content to limit infiltration will be used to form the base of the production ponds, supply channel, exchange water treatment ponds and freshwater dams. Suitable soils may include sandy clay, silty clay, clayey sand and clayey gravel. Significant quantities of clayey sand and clayey gravel are anticipated to be available on-site, in the lateritic profile generally encountered in this area.

Lateritic gravel will be used for the following purposes:

- Prevention of erosion by lining of bund walls.
- Construction of roads along the surface of the pond walls, the bund walls, the channel walls and freshwater dams.
- Construction of access roads within the lease area.
- Miscellaneous construction, including car park surfacing and general fill.

The lateritic gravel will be obtained from on-site sources where available. The available quantities of material on the lease area and the location of potential borrow pits has not been investigated. Where necessary, suitable gravel will be imported from off-site sources.

A preliminary geotechnical investigation of the lease area conducted by Ullman & Nolan (1996), identified silty sands, clayey sand/clayey gravel and clays on the lease area. It is considered that the silty sands (identified in isolated areas) is suitable for use as general fill, however due to low fines content is not suitable for embankment construction. The clayey sand/clayey gravel (occurring across the majority of the lease area) may be suitable for embankment construction and sealing of the ponds while the clays may be suitable for lining water retaining structures. Clays are present in the vicinity of the proposed Stage 2 Freshwater Dam as surface sandy clay and deeper (>2m depth) silty clay derived from weathering of underlying siltstone bedrock.

There is potential that leakage may occur through gravel layers at the base of water holding structures (ponds, channels or freshwater dam). Should highly permeable gravel layers be encountered at the base of water holding structures the gravel will be removed to a minimum depth of 0.5m and replaced with compacted clay material.

The pump jetty and initial section of the saltwater supply channel will be constructed over mangrove clays present in the vicinity of the Blackmore River. These clays will not be excavated and will undergo some consolidation. While the depth and spatial extent of mangrove clays in this area has not been investigated, isolated rock outcrops observed indicate that the mangrove clays are likely to be relatively shallow reducing the potential for settlement.

The subsurface profile of the Blackmore River at the location of the proposed saltwater pump jetty will be investigated prior to final construction design.

2.6.2 Volumes

The fill required for both Stage 1 and Stage 2 development will be sourced from the borrow areas as listed in **Table 2**.

Table 2

Source of Fill

Requirement	Source of Fill
Freshwater dam wall	Freshwater dam floor
Main supply channel through mangroves	Main supply / settling channel floor
Main supply / settling channel wall	Main supply / settling channel floor
Supply and drainage channels to ponds	Floor of drainage channels & floor of exchange water treatment dam
Production pond walls	Production pond floors
Exchange water treatment pond walls	Exchange water treatment pond floor

Preliminary earthworks calculations indicate that there will be sufficient material available from proposed excavations (cut) to satisfy construction requirements (fill). However a shortfall in lateritic gravel for road and embankment wall surfacing and erosion control may occur. It is envisaged that this shortfall will be sourced from borrow areas located within the water-holding structures of the development (production ponds, freshwater dam, the exchange water treatment ponds and the supply and drainage channels) or from other on-site borrow areas. Excavation in these areas will be designed in such a way as to minimise the possibility stagnant water ponding.

Accurate cut/fill calculations are difficult to currently determine due to variations in occurrence of on-site materials and ground slope. While preliminary calculations indicate sufficient material is available on-site should a shortfall be encountered material will be imported from off-site.

2.7 PROPOSED OPERATIONS

2.7.1 Species

The development is based primarily on production of black tiger prawn *(Penaeus monodon).* This species is produced in existing aquaculture farms in the Northern Territory, Queensland and northern New South Wales. However, rotating production species has both financial and husbandry benefits associated. The feasibility and environmental acceptability of farming other species will be investigated in the future. The following species may be considered:

Prawn Species

- Banana prawns (*Penaeus merguiensis*, *P. indicus*)
- Brown tiger prawn (*Penaeus esculentus*)
- Kuruma prawn (*Penaeus japonicus*)

Fish Species

- Barramundi (*Lates calcarifer*)
- Golden snapper (*Lutjanus johnii*)
- Barramundi cod (*Cromileptes altivelis*)

2.7.2 Sources of Juvenile Prawns

Stage 1 of the development will be established as a "production-only" farm. In accordance with current standard industry practice in the Northern Territory the juvenile prawn stock ('post-larvae') will be purchased initially from selected Queensland hatcheries.

Quarantine facilities, set up for the arrival of post-larvae to the farm, will be positioned adjacent to the production area, with access to both saltwater and freshwater. The installation will consist of several large holding tanks housed within a steel frame shed. Using recirculated water these tanks will be designed to keep the new arrivals in favourable conditions for a period of five days whilst the technical staff check them for disease. The water supplied to these ponds will be moved first to a holding tank and not discharged to the farm drainage system until the new batch of post-larvae has been declared disease-free and has been placed in the production pond.

Consideration will be given to the establishment of a hatchery during the Stage 2 development.

2.7.3 Stocking Rates

Lower stocking rates will generally simplify pond management, reduce yield potential and reduce costs. Stocking rates in the Australian prawn farming industry vary widely, from 8 to 40 prawns/m^2. Stocking rates will depend on management techniques adopted and water quality issues.

The current proposal is based on an initial stocking rate of 28 post-larvae/m^2. This rate will be refined during operations. Based on a conservative survival rate of 80% to maturity and harvest, the estimated yields per crop per hectare are presented in **Table 3**.

Table 3

Estimated Crop Yields

Prawn size at harvest (g)	Prawns/ha	Yield/ha (kg)	Yield/1.24 ha pond (kg)
17.5	224,000	3,920	4,860
20.0	224,000	4,480	5,555
22.5	224,000	5,040	6,250
25.0	224,000	5,600	6,944
27.5	224,000	6,160	7,638
30.0	224,000	6,720	8,333

Note: Stocking rate at 28 prawns/m^2, assuming 80% survival to harvest.

2.7.4 Farming Techniques

The production ponds will be laid out in uniform lines as depicted in Figure 4. The supply of salt and freshwater will be gravity fed from an elevated supply channel, distributing to ponds through a 450 mm supply pipe. Discharge water from each pond will be released to the discharge water channels at the opposite ends of the ponds to the supply channel to flow into the exchange water treatment pond.

The production ponds will be aerated using a combination of paddlewheel and airjet style aeration. During the initial stages of the crop cycle four 1.5 kW units will be used per pond, increasing to twelve 1.5 kw units per pond during the final stages of the crop cycle. A schematic of the proposed aerator placement is presented as **Figure 10**.

Stock will be placed in the ponds as juveniles and feed will be provided in pellet form with the use of blower spreaders. Suitable feeds are manufactured in Australia, whilst some feeds are imported into Australia. Various brands of feed will be trialled to establish the best conversion and growth rates with the lowest waste, to gain cost efficiency and minimise nutrient build-up in the pond water.

There are several stages of growth in the life cycle of *P. monodon* that require different forms of pelletised feeds. Indicative feed requirements for *P. monodon* are presented in **Table 4**.

Table 4

Indicative Pelletised Feed Requirements for *P. monodon*

Feed stage	Feed type	Feed size (mm)	Composition (%)			
			Protein	Fat	Fibre	Moisture
PL 1	Mini pellets	0.2 x 0.4	37.0	3.0	3.0	11.0
PL 2	Mini pellets	1.0 x 1.5	37.0	3.0	3.0	11.0
Starter 1	Mini pellets	2.0 x 2.5	36.0	3.0	3.0	11.0
Starter 2	Pellets	2.3 x 3.5	36.0	3.0	3.0	11.0
Production	Pellets	2.3 x 6.5	35.0	3.0	3.5	11.0
Finisher	Pellets	2.3 x 8.0	35.0	3.0	3.5	11.0

Feeding rates will vary through the course of the production cycle. Feed trays set on predetermined positions of the pond floor will be lifted at intervals after feeding to establish the percentage of the feed used in the last feed. This will allow adjustment to the rate of the next feed to prevent wastage and nutrient build up, and to maximise growth rates. Estimated feeding rates for *P. monodon*, assuming optimum growth conditions and health, are presented in **Table 5**.

Table 5

Feeding Rates for *P. monodon*

Prawn Body Weight (g)	Feed Rate - % of body Weight per Day	Feeds per Day	Time after Feeding to Check Feed Usage (hrs)
PL - 0.1	20 – 40	4	2.5
0.1 - 0.5	15 – 20	4	2.5
0.5 - 2.0	8 – 15	4	2.5
2.0 - 3.0	7 – 8	4	2.5
3.0 - 5.0	5.5 – 7	4	2.5
5.0 - 10.0	4.5 – 5.5	5	2.0
10	4.5	5	1.5 - 2.0
15	3.9	5	1.5 - 2.0
20	3.2	5	1.5 - 2.0
25	3.1	6	1.0 - 1.5
30	2.7	6	1.0 - 1.5
35	2.4	6	1.0 - 1.5
40	2.2	6	1.0 - 1.5

At the beginning of a crop cycle, lime will be added to the newly prepared pond to adjust pH and to disinfect the pond. Through the crop cycle, lime may be added to maintain a stable pH.

Small amounts of fertilisers such as Dynamic Lifter and/or a combination of Urea and NPK (16:20:0) will be applied (at rates of approximately 6 kg/ha) to initially promote algal growth in the early stages of a crop cycle. Algal bloom is important to young prawns as algae:

- produces oxygen by photosynthesis;
- shades the pond bottom and impedes the growth of harmful benthic algae;
- provides a darker environment, which is less stressful to the young prawns;
- utilise nitrogen and phosphate wastes; and
- reduce rapid fluctuations in water temperature.

The pond walls having a freeboard of around 0.5 m prevent the escape of stock from the production ponds. This will prevent the passage of stock from one pond to another.

Each pond will be drained via a monk structure. This structure will be screened with suitable size mesh, matched to the size of the stock, to prevent any passage from the pond to the waste drain as part of water exchange or storm overflow.

A structure will be constructed at the discharge point to hold the discharge back at certain times of the day, depending on the tide. This structure will also be screened as a secondary measure for escape prevention. Should there be an accidental loss of large numbers of stock from the pond, the escapees will be collected at this second structure.

2.7.5 Harvest

Black Tiger prawns have an approximate 120 to 150 day crop cycle, at which time they will be harvested. Harvest of the prawns will take place adjacent to the waste drain at a concrete bay (able to accommodate two harvest cages) at the bottom of each pond. The pond water will be discharged via the outlet pipe through one of the harvest cages; the prawns will run with the flow of water and become trapped within the cage. The water flow will be alternated between the cages, with the full cage being lifted onto a waiting crane truck and immersed in water for transportation to the cooking and packing facility.

2.7.6 Processing and Packaging

A grading, cooking and packing factory will be constructed on-site. The factory will conform to all relevant health regulations. Refrigeration facilities will be established on-site for product storage and ice making.

When harvested, the prawns will be taken immediately to the cooking and packing facility. The prawns in the harvest cage will be emptied into a hopper feeding to a grading machine. Prior to entering the grading machine, the prawns will pass over a manual sorting table where four to six workers will remove foreign material (other species or inert objects) from the incoming prawns. The grading machine will sort the prawns into as many as five sizes and drop them into separate bins. The produce in these bins will be manually moved to the cooker, where cooking will be effected by immersion in boiling brine for a period of just under three minutes. The bins of cooked produce will be dropped temporarily into sub-zero brine for chilling, then removed and packed into heavy-duty plastic bags, then placed into styrofoam boxes with ice, marked for size and sealed. The styrofoam boxes will hold approximately 17.5 kg of produce and 1.5 kg of ice. A conveyor will move these boxes to a stacking area where the sizes will be sorted onto pallets for storage in the cool room(s). A schematic of the packing shed operation is presented as **Figure 11**.

The grading machine will have a capacity of 1 tonne per hour and processing from harvesting to packing is expected to take a maximum of three hours, with an expected daily throughput of 10 tonnes.

2.7.7 Water Supply

2.7.7.1 Water input to production ponds

Water input to the production ponds will include the following:

- saltwater from the Blackmore River via the saltwater supply channels;
- freshwater from freshwater storage dam(s); and

- freshwater from direct precipitation.

Whilst the species of prawns to be cultured can live in good health in a range of salinities from <7,000 ppm to about 40,000 ppm, optimum growth rates are achieved at salinity levels between 15,000 ppm and 25,000 ppm. Depending on the time of year, management objectives will be, first to keep salinity to a safe level, and next to adjust to mid-range to promote faster growth rates. In the Dry Season, targets will be to keep the salinity at 25,000 ppm or below and in the Wet Season, the target will be set at 15,000 ppm or above. However, in practice it is expected the range will extend between 10,000 and 35,000 ppm with the extremes reached in the peak of the Wet Season and at the end of the Dry Season.

Saltwater Supply

The saltwater supply for the Stage 1 production ponds will be pumped from the Blackmore River via the supply channels being fed individually through the 450 mm supply pipe at the head of each pond. It is estimated that saltwater pumping will be possible from the Blackmore River at almost any tide level but will be undertaken mainly above the 4.5 m tide level permitting approximately two five-hour periods of pumping per day (average tides are approximately 4 m AHD).

Saltwater supply for Stage 2 will be obtained also from the Blackmore River, with the addition of extra pumps at the pump jetty. The channel system will be designed and constructed to accommodate the full volume required for the completed farm.

During the Wet Season the water in the Blackmore River will vary markedly in salinity levels, with a large freshwater influence from overland runoff into the river. In the area adjacent to the pump jetty the river has been observed to form salinity strata in the water column with predominantly freshwater (eg: 5,000 ppm) flowing across the river surface, with higher salinity water moving 4 to 5 m lower in the water column. The phenomenon is referred to as "saltwater wedging". To ensure that the water with the most favourable salinity available is pumped from the river, the jetty is positioned to place the pumps in a deep channel. The pumps will be fitted with an intake pipe, which can be adjusted to draw water from different levels of the water column (**Figure 12**).

Freshwater Inflow from Dam

Freshwater inflow requirements to the production ponds will be sourced from direct rainfall or gravity fed/pumped from the freshwater dam. Volumes of freshwater required would depend on the maintenance of salinity in the production ponds. A monthly summary of the predicted water management techniques is presented in **Section 2.7.7.4**. Freshwater requirements are calculated as follows:

- **Stage 1**

In Stage 1, the aim of management will be primarily to replace evaporation, to keep the salinity at a safe level. With the benefit of freshwater available from periodic rainfall events and lower salinity water from the Blackmore River through the late Wet to early Dry Seasons, management will hold salinity of ponds to approximately 30,000 ppm until 1st July.

The Stage 1 freshwater dam will be used to replace evaporation lost from the Stage 1 production ponds during the July to October period. Assuming a maximum average daily evaporation rate of 8.5 mm, a maximum of approximately 277 ML (2.3 ML/day) of freshwater will be required to replace

evaporation from the 27 ha of production ponds during July to October of the Dry Season.

The capacity of the freshwater dam is approximately 460 ML. Evaporation from the Stage 1 dam is dependent on the surface area of the dam as the reservoir depletes during the Dry Season. The actual annual evaporation is difficult to determine, as the dam surface area is dependent upon topography, progressive water demand, annual rainfall, wind effects and monthly rainfall. In the absence of sophisticated modeling a conservative approximation of 170 ML evaporation has been derived from an estimated reduction in the surface area of the reservoir through the July to October period.

Assuming the Stage 1 freshwater dam fills annually with evaporation of approximately 170 ML from the 460 ML freshwater dam, a total of approximately 290 ML will be available to replace the 277 ML evaporation predicted from the production ponds.

Should freshwater supply periodically be insufficient for demand, management will consider allowing the salinity level of production ponds to increase, utilising water from Blackmore River, increasing catchment of the dam through the construction of catchment drains and/or reducing the number of active production ponds.

- **Stage 2:**

The Stage 2 freshwater dam (186 ha) will be used to replace evaporation lost from production ponds during the Dry Season. Assuming a maximum evaporation rate of 8.5 mm/day from the 115 ha of Stage 2 production ponds through July to October, approximately 1,175 ML (9.78 ML/day) of freshwater will be required to replace evaporation from the production ponds.

The large freshwater dam has a catchment area of approximately 1,170 ha. Modeling by PAWA (1996), using the Boughton (AWBM) rainfall runoff model, indicates that the Stage 2 freshwater dam will provide sufficient freshwater to replace evaporation from the production ponds between 80% and 90% of the time. Should freshwater demand exceed supply, either the salinity level in the production pond will be allowed to increase, or the number of active production ponds decreased. The results of the PAWA Boughton model are presented in **Appendix D**.

When the large dam is completed and the project is at full scale, surplus water will be used to reduce salinity in the production ponds, to achieve higher growth rates. Aiming to lower operating salinity to 27,000 ppm, closer to best growth optimum, the seasonal freshwater requirement would be in the order of 3,575 ML.

Precipitation

Volumes of direct precipitation of rainwater onto the production ponds will vary considerably between the Wet Season and the Dry Season. The mean annual precipitation for the Darwin region is 1,702 mm (Bureau of Meteorology, 1999). The mean annual volume of direct precipitation expected to fall onto the Stage 1 production ponds is 464 ML and the mean annual volume of direct precipitation onto the Stage 2 production ponds is 1,976 ML.

Inflow water will be supplied from either the main freshwater supply channel or the main saltwater supply channel into the pond supply channel using a 700 mm supply pipe. Depending upon water requirements, salt or freshwater will be fed into the pond supply channel and then into the ponds using a 450 mm supply pipe. The layout of the ponds including the location of the main freshwater channel, the main saltwater channel, the pond supply channel and the waste drainage channel are presented in Figure

4a.

2.7.7.2 Water output from production ponds

Water output from the production ponds will include the following:

- daily water exchange;
- harvest release;
- evaporation; and
- stormwater overflow.

The daily water exchange is a production process conducted to reduce nutrient load from the ponds and maintain dissolved oxygen (DO) and salinity levels. A maximum daily water exchange for the farm of approximately 5% is anticipated with an overall average daily water exchange of between 3% and 5%. Accordingly, the Stage 1 development will involve a maximum daily water exchange of approximately 20.4 ML, and Stage 2 a maximum daily water exchange of approximately 86 ML.

During harvest, all water from the pond(s) being harvested is moved to the exchange water treatment pond. Each production pond has a capacity of approximately 18.5 ML. Assuming two harvests per year, Stage 1 will generate an annual harvest release of approximately 815 ML, and Stage 2 will generate an annual harvest release of approximately 3,441 ML. The production ponds will be harvested on a rotational basis throughout the year.

The mean daily evaporation rate for the Blackmore River region is 7.3 mm (Bureau of Meteorology, 1999). Accordingly, the average annual evaporation from Stage 1 and Stage 2 production ponds will be approximately 720 ML and approximately 3,065 ML, respectively.

The discharge from the production ponds will be gravity fed into the exchange water treatment ponds and after moving through the treatment system, over an average period of 16 days, will then be released to Middle Creek at the designated discharge point. Alternatively, the treated water will be gravity fed from the exchange water treatment ponds into the supply/settling channel and then pumped for return to the production ponds and recycled as saltwater supply.

The discharge water from the treatment area will be piped under the supply settling channel to a discharge point, which will be located on the adjacent estuarine creek, flowing to the Blackmore River. The discharge point will be the same in Stage 1 and Stage 2, as shown in Figure 4.

A flowchart summarising water movement through the aquaculture production system is presented as **Figure 13.**

2.7.7.3 Estimated production water requirements

The estimated production water requirements for the Stage 1 development is presented in **Table 6**.

Table 6

Stage 1: Estimated Production Water Requirements

Saltwater Supply	
Maximum daily saltwater requirement	60 ML *(pumps at full capacity filling saltwater supply/settling channel)*
Annual saltwater requirement	5,304 ML *(two refills plus average 3% daily exchange)*
Average daily saltwater requirement	14.5 ML
Freshwater Supply	
Maximum daily freshwater requirement	6 ML
Annual freshwater requirement	277 ML *(replacement of evaporation only)*
Average daily freshwater (120 days Dry Season)	2.3 ML *(replacement for evaporation only)*

The estimated production water requirements for the Stage 2 development (115 ha of production ponds) is provided in **Table 7**.

Table 7

Stage 2: Estimated Production Water Requirements

Saltwater Supply	
Maximum daily saltwater requirement	75 ML *(pumps at full capacity pumping to saltwater supply /settling channel)*
Annual saltwater requirement	22,590 ML *(two refills plus average 3% daily exchange)*
Average daily saltwater requirement	62 ML
Freshwater Supply	
Maximum daily freshwater requirement	25 ML
Annual freshwater requirement	3,575 ML *(target salinity 27,000 ppm)* 1,175 ML *(replace evaporation only)*
Average daily freshwater (120 days Dry Season)	29.8 ML *(target salinity 27,000 ppm)* 9.8 ML *(replace evaporation only)*

2.7.7.4 Water management

The predicted monthly account of water management during farm operation is outlined in **Table 8**.

Table 8

Predicted Monthly Water Management

Month(s)	Conditions	Action
November	Sporadic rain may fall. Estuary will have normal salinity. High water exchange requirement.	Use freshwater & Blackmore River for exchange. Aim to have ponds at maximum operational salinity (35,000 ppm) in preparation for Wet Season rainfall events.
December	Rain will be increasing. Estuary will have lower salinity. Rain will decrease need for water exchange.	Use Blackmore River saltwater for exchange. Lower the intake of the pumps to take in higher salinity water. Pond salinity will start to fall.
January – February	Peak Wet Season. Estuary will run fully fresh for many days. Low water exchange requirement.	Use Blackmore River saltwater for exchange. Pump highest possible salinity water in estuary for water exchange
March – April	Wet Season finishing. Estuary will have run-off keeping salinity down. Water exchange requirement will increase.	Use Blackmore River saltwater storage for exchange. Aim to have ponds at minimum operational salinity (12,000 ppm) in preparation for Dry Season.
May – June	Dry Season. Still small amounts of runoff into estuary. Water exchange requirement high.	Use Blackmore River saltwater for exchange. Increase salinity in production ponds.
July – October	Dry Season. High salinity in estuary. Water exchange requirement high.	Use Blackmore River and freshwater for exchange.

2.7.8 Sludge

When the production ponds are drained during prawn harvesting, a volume of solid waste sediment (referred to as sludge) is left as a deposit on the pond floor. Studies on Australian prawn farms (Smith, 1996) have indicated:

- the sediment is black, glutinous and superficially similar to some soils found in mangrove habitats;
- the sediment accumulates at between 20 x 10^3 kg ha^{-1} to 180 x 10^3 kg ha^{-1};
- the main source of the sludge is soil eroded from the production pond walls and base;
- the sludge additionally contains prawn feed, faeces and decaying plankton with organic content ranging from 13.9 mg g^{-1} to 22.8 mg g^{-1}; and
- fresh and dried sediment has a neutral pH.

Past and current practice within the Australian aquaculture industry for handling this sludge is to remove it from the pond floors and spread it around the outside of pond walls and other parts of the farm. Because of the scale of the proposed project it is considered that the volume of sludge created would render this approach impractical and problematic.

The proposed practice for dealing with this material at Blackmore River (East) Aquaculture Development is as follows:

1. Once a pond is drained, allow a period of drying time.

2. Stockpile material adjacent to the pond wall (and road) with a swamp dozer.

3. Load the sludge onto a dump truck using an excavator.

4. Transport sludge to the solids desalination bays, an on-farm holding area.

5. Allow Wet Season rainfall to desalinate the sludge, turning it over in the Dry Season for several seasons.

6. As the holding area fills, move the desalinated material to the pasture area (Stage 2).

2.7.9 General Wastes

General wastes generated within the lease area will include:

- sewage and domestic effluent.
- washdown water from the vehicle cleaning area, which may be saline and contain suspended solids and petroleum hydrocarbons;
- washdown water from the grading, cooking and packing factory, which will contain disinfectants and detergents;
- used cooking brine from the factory;
- diseased prawns;
- used parts, sump oils etc from farm machinery;
- miscellaneous items such as bags from feed and fertiliser supplies; and
- domestic garbage and food waste.

Sewage and domestic effluent will be treated by septic tank systems designed in accordance with Territory Health guidelines. The residences will be equipped with a minimum of one toilet installation each and will be connected to an independent or combined septic system. The single staff quarters will have a minimum of one toilet installation per four persons. The office and workshop will be equipped with both male and female facilities and conform to workplace codes.

Other sources of domestic waste on the lease will be dealt with in the following manner:

- *Vehicle washdown*
  Potentially contaminated washdown water from vehicle and plant cleaning will be directed through a triple interceptor trap (TIT), located adjacent to the workshop. Discharge from the

TIT will be directed to either an absorption trench or lagoon system. The TIT will be installed by a licensed waste management contractor and regularly maintained.

- *Factory washdown*
  Washdown water from the factory area will pass to a grease trap prior to discharge to an absorption trench or lagoon system.

- *Used cooking brine*
  Spent cooking brine will be discharged to the discharge water channel.

- *Waste oil*
  Waste oil from vehicle maintenance will be collected and periodically disposed by a licensed waste management contractor.

- *General waste*
  General waste including hard rubbish and food scraps, will be temporarily stockpiled in an allocated area and either buried or disposed to municipal landfill in accordance with DLPE and Shire of Litchfield guidelines.

The proposed method for the disposal of diseased prawn stock is discussed in **Section 4.4**.

2.8 UTILITIES

Utility requirements of the project will include power and potable water.

An electricity supply will be required for pumps, aerators, processing and cool-rooms, the workshop, office and domestic consumption. Expected power consumption for Stage 1 development is detailed in **Table 9**.

Table 9

Stage 1: Expected Power Consumption

Item	Consumption		
	Average Daily (kw.hrs)	Average Monthly (kw.hrs)	Total Annual (kw.hrs)
Aerators	2,310	69,300	843,150
Pumps	1,125	33,750	410,625
Other	1,250	37,500	456,250
Total	**4,685**	**140,550**	**1,710,025**

During Stage 1 diesel powered generators will be installed for all power requirements. These will be situated between the workshop and the production ponds, with overhead wiring to all fixtures. Connection to the electricity grid is planned some time after Stage 1 is operational.

Expected power consumption for Stage 2 development is detailed in **Table 10**.

Table 10

Stage 2: Expected Power Consumption

Item	Consumption		
	Average Daily (kw.hrs)	Average Monthly (kw.hrs)	Total Annual (kw.hrs)
Aerators	9,840	295,200	3,591,600
Pumps	4,800	144,000	1,752,000
Other	5,325	159,750	1,943,625
Total	**19,965**	**598,950**	**7,287,225**

Diesel will be stored on-site in three 55,000 L above ground fuel tanks, which will be located within a concrete bunded area. The configuration of the storage tanks is presented in **Figure 14**.

Potable water will be required for domestic purposes, drinking, cooking and ice making. Potable water will be sourced from groundwater. Test bores will be drilled along the ridge adjacent to the access road within the leasehold area until a suitable supply is located. Detail of the potential groundwater supply is provided in **Section 3.6.2**.

2.9 STAFFING

The operation of the aquaculture farm will require both permanent and casual personnel. Stage 1 operations will require nine to twelve permanent personnel (including managerial and security staff) and 60-hours per week of casual labour. Additionally, approximately nine personnel will be required on harvest days for cooking and packing operations. The limitations of access via Middle Arm Boat Ramp Road (**Section 2.5.9**) will determine whether staff live on or off-site and will also determine the farm's ongoing organisation of supplies and services.

2.10 TRAFFIC

2.10.1 Construction Traffic

Traffic will primarily be limited to on-site movement of heavy machinery and other vehicles, most of which will remain within the lease area for the duration of the construction phase. As earth fill for construction will be sourced from within the lease area, there will be minimal construction traffic entering and leaving the lease area.

Traffic entering and leaving the lease area during the construction phase is largely expected to be limited to light vehicles for construction workers and site personnel. This traffic will access the lease area via Channel Island Road, left turn to Jenkins Road, right turn to Finn Road and right turn to Middle Arm Boat Ramp Road, to the lease area off this road. Alternate access, particularly after heavy rain is right turn off Cox Peninsula Road to Middle Arm Boat Ramp Road, to the lease area off this road. A limited volume of heavy vehicles will be required to transport construction machinery and materials to the development.

2.10.2 Operation Traffic

For Stage 1 development it is envisaged that approximately nine to twelve full time staff will be employed on the farm. Two staff will live permanently on the farm. Staff will access the lease area on an average of five days per week with an average occupancy rate of 1.5 persons per vehicle.

Casual employees will be required for cooking and packing at a rate of 1 person hour per 200 kg of production. The average duration of a casual shift is 5 hours, with an average occupancy rate of 2.5 persons per vehicle.

The farm produce (prawns) will be transported from the farm in lots of around 5 to 7 tonnes and an average of approximately one load per week will leave the farm. A light 4WD truck will be used for produce transport.

The main deliveries to the farm are prawn feed and diesel fuel. The requirement for diesel fuel will be reduced when the prawn farm is connected to the Northern Territory power grid. After connection to the power grid diesel use will be restricted to emergency electricity generation. Diesel will be stored on-site in three 55,000 L above ground fuel tanks. Sufficient diesel will be stored for up to 6 weeks of operation, reducing the requirement of fuel delivery during times when the access roads are difficult to negotiate following heavy rains.

Other deliveries will include small amounts of fertiliser, petrol and oils, packing boxes, machinery parts and miscellaneous farm supplies. These deliveries will often be conducted in conjunction with regular staff movement.

As the pond area is expanded (Stage 2) additional traffic will be generated for the farm's operation. Measures will be taken to reduce the amount of traffic over the Middle Arm Boat Ramp Road, including:

- Connection to Northern Territory power grid, reducing the amount of diesel deliveries.
- On-farm accommodation for staff.
- Use of mini buses to convey staff back and forward from town.
- Operation of school bus to Berry Springs/Palmerston for any children living on-site.
- Roster for shopping and supplies delivery to on-farm staff by off-farm staff.
- Possible transfer of cooking, packing and storing functions to a facility in Darwin.

Projected operation traffic movement on the Middle Arm Boat Ramp Road during Stage 1 and Stage 2 is detailed in **Table 11**.

Table 11

Estimated Operational Traffic, Middle Arm Boat Ramp Road

Road User	Vehicle Type	Comment	Round Trips per Month	
			Stage 1	**Stage 2**
Staff				
Permanent off-farm	Light passenger	Off–farm staff–transport to work.	90–130	380–550
Permanent on-farm	Light passenger	On–farm staff–transport to town.	24	102
Casual off-farm	Light passenger	Staff–transport to work.	9	38
Deliveries				
Farm produce transportation	Light truck (10 tonnes)		4	17
Prawn feed deliveries	Light truck (10 tonnes)	Occasionally back loads for produce deliveries.	6	25
Fuel deliveries	Fuel tanker		1.5	3
	Total Vehicle Movements	**- Per month** **- Per day**	**135 - 175** **4.5 –6**	**565 – 735** **18 – 24**