5. ENVIRONMENTAL MANAGEMENT PLAN

5.1 TERMS OF REFERENCE

This Environmental Management Plan (EMP) will be structured to address potential environmental impacts identified in the PER for the construction and operation phases of the proposed prawn farm. Management of other aspects of the proposal, such as workplace health and safety, domestic hard rubbish and AQIS regulations relevant to the packing factory, are discussed in the PER.

5.2 INTRODUCTION

Phelps/Panizza is committed to achieving and maintaining environmental standards, such that any adverse environmental impacts resulting from the construction and operation of the aquaculture project are minimised. Phelps/Panizza is committed to the implementation of on-going environmental monitoring programs to ensure the farm does not detrimentally impact its natural surrounds.

In addition to Phelps/Panizza's responsibility to the preservation of the immediate environment of the proposed project, the proponents are committed to working in partnership with the community and other stakeholders to ensure the preservation of the adjacent Blackmore River and mangrove systems. It is recognised that the long term success of the prawn farm is highly dependent on the quality of the receiving water.

The prawn farm will be operated in accordance with Territory and Commonwealth legislation and regulations, and in accordance with the Phelps/Panizza's objective of sustainable development. To this end, Phelps/Panizza has investigated current environmental best practice methods for prawn farming through a variety of professional organisations, including:

- Department of Lands Planning & Environment, Northern Territory.
- Department of Primary Industry & Fisheries, Northern Territory.
- CSIRO Marine Research, Cleveland, Queensland.
- Co-operative Research Centre (CRC) for Aquaculture.
- Great Barrier Reef Marine Park Authority (GBRMPA).
- Australian Prawn Farmers Association (APFA).
- Queensland Environment Protection Agency.

The principals of Phelps/Panizza, Greg Phelps and Albert Panizza, have traveled extensively in Australia to investigate environmental management practices and reported environmental impacts of established aquaculture projects. Prawn farms in Central America (Belize, Panama and Mexico), reputed to employ world's best practice, have also been inspected. Information relating to disease control was obtained during these site visits, and during a visit to Thailand (March 2001) the "damage control" measures undertaken by large prawn farming operations in response to the White Spot Syndrome Virus (WSSV) were reviewed.

Many of the farm design parameters and management commitments outlined in the EMP are consistent with advice received from the above-mentioned sources. However, the EMP also recognises and acknowledges the influence of site-specific factors, and recognises that the EMP will be dynamic, requiring some alteration/refinement if unforseen site-specific environmental considerations are encountered.
For each developmental stage of the prawn farm the EMP will:

- identify potential environmental impacts associated with the development;

- incorporate a planned strategy to minimise/prevent adverse environmental impact;
- provide a schedule for the implementation of management strategies;
- detail a program for on-going monitoring;
- require periodic reporting to relevant government agencies, detailing works undertaken and an assessment of the effectiveness of the management strategies employed; and
- specify site management roles and responsibilities with respect to management procedures.

Expansion of the pond area to Stage 2 will only be undertaken if results of the monitoring programs indicate that no significant detrimental impact has occurred, and if analysis of data indicates that such an expansion will not lead to significant detrimental impact.

5.3 ENVIRONMENTAL MANAGEMENT MEASURES

Environment management measures relating to the farm's intake water, production ponds and discharge are outlined in the following sections. These measures will be implemented to minimise adverse environmental impact resulting from the prawn farm's operation.

5.3.1 Intake Water Settlement

The level of suspended solids in the Blackmore River water varies considerably due to a large variation in tidal range. However, the water will be of a more consistent quality with a lower level of solids after it has passed along the supply channel to the prawn farm's production ponds. The supply channel is greater than 2,000 m in length and approximately 30 m wide. Given these dimensions, water will flow through the channel at a rate of less than 0.1 m/s, even when the farm has reached full scale of 115 hectares of production ponds. The length of channel and slow rate of flow will result in the settling of suspended solids from the intake water prior to the water's release into the production ponds.

When the sediment is cleaned from the channel the material can be removed to the solids desalination bays for desalination.

Water samples will be collected from the Blackmore River at the pump jetty and at the second stage lift pumps on a daily basis and tested for pH, DO, EC, salinity and temperature. The proposed monitoring of water quality is discussed in **Section 5.4.1**.

Management Commitments

- All material removed from the intake channel is to be deposited in the desalination bays.
- Intake water testing and logging will be undertaken daily, prior to pumping in the Blackmore River.

5.3.2 Production Pond Operation

Pond Sludge

Research by the CRC for Aquaculture has found that the majority of sediment accumulated on the floor of aquaculture ponds originates from erosion of pond walls (Robertson 2000). To reduce erosion and so minimise the volume of solid pond waste consideration will be given to planting vegetation on the pond walls, the type of aerator employed and its placement. Water flow through the ponds will be directed to maintain flow and destratification but to avoid scouring of the banks.

The management of sludge produced in the production ponds is outlined in **Section 5.3.4**.

Water Quality

Management of DO levels within the production ponds will, where practical, be achieved through aeration before the use of water exchange. This will result in a more constant water quality, a more stable algal bloom and a reduction in the quantity of water discharged. The employment of this management strategy on some prawn farms in Queensland over the last decade has resulted in a reduction of water exchange.

In the production pond, overfeeding is one of the major causes of poor water quality, ill health of prawns and elevated nutrient levels. To avoid overfeeding the feed uptake rates will be closely monitored by farm management personnel, and feed rates adjusted to maintain a minimal feed supply to ensure that quality of water and health of stock is not compromised.

Phelps/Panizza will aim to adopt new developments, as they are made available, relating to prawn feed types that reduce wastage and so reduce the build up of nutrient levels. For example, Phelps/Panizza are currently investigating a program to develop a new variation of pelletised prawn feed, with the aim to reduce the waste of feed and the subsequent build up of nutrient levels. This is a project, in collaboration with leading nutrionalists and experienced prawn farmers, which is expected to produce higher efficiencies in the medium term.

Management Commitments

- Aerators are to be positioned to avoid the scouring of banks.
- Pond DO levels will, where practical, be achieved through aeration before the use of water exchange.
- All pond discharge is to be directed to the discharge water treatment ponds.
- Overfeeding of prawn stock will be avoided to reduce the build up of nutrients in the pond water.

5.3.3 Discharge Water Treatment

Discharge water from the 27 hectares of production ponds operational during Stage 1 will flow to a 20 hectare exchange water treatment pond, providing a ratio of production to treatment of 1:0.74, or 74 %. It is proposed to expand the production pond area to 115 hectares in Stage 2, discharged into an 80 hectare exchange water treatment pond. The ratio of production to treatment in Stage 2 would be 1:0.7, or 70 %. The ratio of production to treatment varies from farm to farm, and although an

ideal ratio has not been determined, work undertaken by the Queensland EPA and CRC for Aquaculture has nominated targets of 10 % to 30 % as being effective.

The area of the exchange water treatment pond proposed for the prawn farm exceeds the current status in Queensland of existing prawn farms and the targets set by the EPA for new farms. In addition, the greater tidal range of the Blackmore River lease area (approximately 8.0 m) as compared to that of most prawn farms in Queensland (approximately 3.0 m) will aid the dilution and flushing of any discharge from the Phelps/Panizza farm.

The discharge water from the production ponds will spend an average of 16 days passing from the production pond, through the discharge treatment pond, to eventual discharge into Middle Creek. In this time the settling out of solids will be extensive and the reduction of nutrients significant. Discharge water quality will be tested on a daily basis, as detailed in **Section 5.4.1**. Data obtained will be reviewed in consultation with DLPE, and the requirement (if any) for improved environmental performance will be addressed.

To ensure that the quality of the discharge water is known and within acceptable ranges and to maximise the flushing and dilution characteristic of the receiving waters, the release of water from the exchange water treatment pond to Middle Creek will be controlled by the following conditions.

- Discharge will only be permitted when the DO and pH levels of the discharge water have been tested, logged and found to be within an acceptable range (as determined by DLPE in consultation with Phelps/Panizza).

- Release of discharge water is to be effected only between 20 minutes and 5 hours after the Darwin high tide (based on Tidal Predictions from the published charts of DTW).

- Release of discharge water is to be effected only when the outgoing tidal range will be greater than 2m.

- Release will only occur if it has been authorised by management.

Implementation of these management commitments will reduce the chance of undiluted discharge water lying for an extended period in the adjacent mangrove stand.

Other possible measures, which will be considered, are:

- Re-use of discharge water; once the water discharged from production ponds has passed through the discharge treatment pond it may be pumped back to the production ponds for re-use. This may be difficult at certain times during the Dry Season, because it could lead to escalating salinity, but it has both economic and environmental benefits and the re-use of discharge water will be incorporated into the farm's operation where practical.

- Convert the discharge treatment pond from passive to active. The treatment pond will be first used in a passive capacity, relying on the settling action to reduce solids and nutrients absorbed by the particles of solids. It is planned to trial the introduction of marine species into the discharge system to make the treatment active. Such marine species may include a low stocking density of crustaceans (including prawns), finfish, biovalves and/or seaweed.

Management Commitments

- The quality of discharge water from the production ponds will be tested on a daily basis when any release is made to Middle Creek.
- Water will not be released from the exchange water treatment pond unless –
  - levels of DO and pH are within acceptable limits;
  - the release occurs between 20 minutes and 5 hours after the Darwin high tide;
  - the release occurs when the outgoing tidal range is greater than 2m; and
  - the release has been authorised by management.
- All pond discharge is to be directed to the exchange water treatment pond.
- All solid waste from ponds is to be removed to the solids desalination bays.

5.3.4 Waste Disposal

Solid Waste (Pond Sludge) Disposal

The operation of the farm will generate solid waste or sludge in the settling channel and the production ponds.

Suspended marine sediment will settle out in the supply channel, especially on days when the Blackmore River water has a high turbidity due to heavy rain or large tides. After a period of time, possibly a number of years the supply channel will need to be desilted to maintain proper function. This material will contain salt and will require desalinating. The material will be removed from the settling channel by excavator and hauled to the solids desalination bay by dump truck.

A small volume (approximately 50 m^3 per crop) of solid waste material will require removal from the production ponds after each harvest. The sludge in the production ponds will contain higher levels of nutrients. An excavator will be used to remove the sludge from the ponds, and a dump truck will transport and deposit the sludge to the solids desalination bays.

The desalination bays, covering an area of 5 hectares, will be bunded and divided. The sludge from the production ponds will be deposited into these bays sequentially, so seperate bays will contain material from different seasons. Once dumped the material will be spread to a shallow depth (approximately 200 -300 mm) and left to be exposed to Wet Season rains. The sludge material will be retained in the solids desalination bays for up to five years and turned over in the Dry Season to enhance desalination by Wet Season rains. Once the salinity is lowered the material will be removed by front end loader and spread over a 26 hectare pasture area as a soil improver. Runoff from the desalination bays will be directed to the exchange water treatment ponds.

The emphasis of farm management will be to reduce the amount of solid waste, by vegetation on production pond banks and aeration placement as well as avoidance of overfeeding. Whilst it is anticipated that the volume of pond sludge will be able to be handled in the proposed desalination bays and pasture area, if more area of these structures is required the lease area holds sufficient space to expand as needed.

Run-off from the desalination area will be contained by a low bund (approximately 750 mm in height) and flow discharge via regulated release through drop structures (500 mm) and 150 mm piping. This will act to slow the rate of flow, minimising the carriage of solids. This water will be directed into the discharge treatment ponds and will be released with other farm discharge after settling.

Other Wastes

Packaging and production waste generated during farm operations will be either disposed on-site through burial or off-site by licenced contractor. Handling of solid and process wastes will be conducted in accordance with relevant regulatory requirements and Shire of Litchfield by-laws.

Domestic sewage effluent will be treated by septic tanks and associated absorption trench systems in accordance with the relevant Territory Health Services Code of Practice.

Management Commitments

- Sludge from the production ponds will be deposited sequentially and retained in the desalination bays for up to five years.
- All rainwater run-off from the desalination bays is to be directed to the discharge treatment pond.
- The placement of any deposit of solid waste in the desalination bays must be undertaken with instruction from the General Manager.
- All relevant legislative requirements, by-laws and codes of practice with respect to waste disposal will be adhered to.

5.3.5 Post Larvae Quarantine

Post larvae will be purchased only from hatchery suppliers who provide a veterinarian certificate of disease free status. However, as a precautionary measure a quarantine facility will be established on farm for the holding of new post larvae (juvenile) prawns to safeguard against the introduction of disease to the farm. The quarantine facility will consist of a covered steel frame shed, with a series of holding tanks. Each batch of new arrivals will have isolated reticulation and discharge to prevent the spread of disease to the farm or to natural waterways.

The post larvae will be tested for disease on arrival, held in the quarantine tanks until laboratory results are obtained and retested immediately prior to stocking. Disease testing will be carried out with the cooperation of the Darwin Aquaculture Centre of DPI&F.

Management Commitments

- Post larvae will be purchased only from hatchery suppliers who provide a veterinary certificate of disease-free status.
- Post larvae will be tested for disease upon arrival at the farm, held at the quarantine and re-tested prior to release into the production ponds.
- Post larvae will not be placed into or removed from the quarantine facility without instruction and authority from the General Manager.
- Reticulation and discharge from the quarantine facility will be isolated.
- No water discharge from the quarantine holding pond is to be released without instruction and authority from the General Manager.

5.3.6 Fuel Storage

Diesel required for power generation for the farm's operation will be stored in three 55,000 L above ground storage tanks. The tanks and associated bunding will be constructed in accordance with AS1940-1988 *The Storage and Handling of Flammable and Combustible Liquids.*

5.3.7 Archaeological Sites

Six archaeological sites have been identified as prescribed archaeological places or objects and are legally protected under the *Northern Territory of Australia Heritage Conservation Act, 1991*. These sites have been assessed to be of low archaeological significance. Phelps/Panizza intend to seek approval for the destruction of these sites.

Phelps/Panizza will consult with Heritage Branch of DLPE on an "as needs" basis with regard the archaeological sites and associated issues.

5.4 ENVIRONMENTAL IMPACT MONITORING

To assess the effectiveness of the environmental management measures implemented, on-going monitoring of key environmental indicators, such as water quality, mangrove health and aquatic communities will be conducted. Data obtained from these monitoring programs will be used to assess the need for any variations to the environmental management measures being employed at the farm.

Recent on-going research by CRC for Aquaculture has concentrated on the use of "ecological health indicators". This system of monitoring is currently being undertaken as part of a Prawn Discharge Study Program being conducted by the University of Queensland. This work will be tracked by management of the Blackmore River development and, if practical, will be included with conventional ecological assessment as the practical application of ecological health indicators is better developed.

5.4.1 Water Quality Monitoring

An on-going Water Quality Monitoring Program will be conducted to monitor nutrient levels and general variables in Middle Creek, the Blackmore River and at control locations. This program will be developed in consultation with DLPE, DPI&F and CSIRO Marine Research, CRC. The purpose of the monitoring program will be to identify any changes to baseline water quality resulting from the aquaculture farm's operation.

One of the key objectives for the proposed water quality monitoring program will be the protection of the aquatic ecosystem into which discharge water is released. Retaining water quality parameters within specified criteria levels will assist in ensuring the protection of aquatic wildlife. Criteria levels will be developed in accordance with the principles of the draft National Water Quality Management Strategy guidelines (NWQMS 1999), which provide guidance in the setting of site-specific water quality objectives.

Sampling will be undertaken at a total of ten locations: one in the Blackmore River (SW1), four along Middle Creek (SW2-SW5), two from unnamed creeks (SW6 & SW7) and three from various locations within the farm area. Sampling from these locations enables the collection of background water quality data (from Middle Creek and the control creek) and the collection of data from water at various points along the farm's production stream (at intake, production ponds and discharge points).

Recent research by the CRC for Aquaculture, demonstrated that the quality of discharge water from production ponds is highly variable over short time periods (daily or even hourly). The function of the

exchange water treatment ponds is expected to buffer quality variations of discharged water to Middle Creek. In order to compile representative water quality results, the water at the Middle Creek discharge point will be tested on a daily basis, as will samples from the pump jetty.

The monthly water testing is to be carried out on the half moon day as listed in published tidal prediction data. Samples will be collected in numerical order, that is SW 1 to SW 7, with the first sample (SW 1) to be drawn 2 hours after the late morning high tide. This tide event has been chosen as the starting point for sampling as it is at the beginning of the neap tide period and should enable the full effect of a month of discharge to be measured. Monthly on-farm discharge water testing will be undertaken at this time.

Samples will be tested for a range of the following parameters: DO, pH, EC, temperature, salinity, TSS, TN and TP. Measurement of DO, pH, EC and temperature levels will be determined on-site through *in-situ* testing at the time of sampling.

Sampling will be undertaken using portable multi-probe water quality testing equipment (Horiba or similar). Samples requiring laboratory testing will be dispatched to a NATA accredited laboratory for analysis.

A summary of the proposed Water Quality Monitoring Program, detailing sampling frequency, locations and analytical schedule, is presented in **Table 23**.

Table 23

Stage 1 - Proposed Water Quality Monitoring

Sampling Location	Site Reference	Site Description	Sampling Frequency	Testing Schedule
Blackmore River	SW 1	Pump jetty.	Monthly	TSS, TN, TP, DO, pH, EC, temperature, salinity.
			Daily	DO, pH, EC, temperature, salinity.
Middle Creek	SW 2	Upstream from discharge.	Monthly	TSS, TN, TP, DO, pH, EC, temperature, salinity.
Middle Creek	SW 3	Downstream from discharge.		
Middle Creek	SW 4	Downstream from discharge.		
Middle Creek	SW 5	Downstream from discharge.		
"Control Creek"	SW 6	Creek discharging to Blackmore River on opposite bank.		
Unnamed Creek (North of jetty)	SW 7	Creek adjacent to farm ponds & structures.		
On Farm	Discharge	Discharge from treatment ponds to Middle Creek.	Monthly	TSS, TN, TP.
			Daily	DO, pH, EC, temperature, salinity.
On Farm[1]	Supply Channel	2nd Stage lift pumps.	Daily	DO, pH, EC, temperature, salinity.

Note: 1. Proposed Stage 2 sampling location.

Management Commitments

- A Water Quality Monitoring Program will be undertaken at designated locations on Blackmore River, Middle Creek, unnamed creeks and farm areas, and will be utilised as an indication of aquatic ecosystem health.
- Samples will be collected and analysed on either a daily or monthly basis.
- Monthly samples will be tested for a range of parameters, including DO, pH, EC, TSS, TN and TP.
- Daily samples will be tested for a range of parameters, including DO, pH and EC.
- Develop appropriate water quality criteria levels in accordance with NWQMS guidelines.

5.4.2 Mangrove Monitoring

A mangrove monitoring program will be developed by Phelps/Panizza in consultation with DLPE. The objective of the program will be to monitor mangrove health, structure and composition.

It is proposed to conduct mangrove community monitoring in the area of Middle Creek and a second control creek approximately 2 km to the north of the pump jetty (Figure 17). A monitoring round will be undertaken prior to commencement of development to obtain background data and subsequently on an annual basis. Photographic records will be compiled at the time of each monitoring event. Data collected will be considered prior to any expansion of pond area beyond Stage 1.

Management Commitments

- Survey works involving an assessment of mangrove health, structure and composition in the area of Middle Creek and subsequent comparative surveys will be undertaken annually.
- The prawn farm will not be developed to Stage 2 until any significant environmental impacts identified through survey works have been addressed.

5.4.3 Weed Species

Annual weed surveys will be conducted in consultation with DPI&F, DLPE and Parks and Wildlife Commission of the Northern Territory, to monitor species composition and spread. Areas to be monitored will include all fire breaks and trails to reduce the possibility of destructive fires fuelled by exotic grasses.

Management Commitments

- Weed survey works will be undertaken annually. Survey works will involve data collection relating to species composition and spread.

5.4.4 Biting Insect Monitoring

Biting insect monitoring will be undertaken by Phelps/Panizza personnel in consultation with the Medical Entomology Branch of' THS.

The most likely structures on the farm that may lead to an increase in the numbers of biting insects, most notably mosquitoes, are the proposed freshwater dams. The potential for mosquito infestation in the freshwater dams is considered limited, but monitoring of insect numbers will be periodically undertaken in this area by trapping and logging.

Management Commitments

- Survey works involving trapping and logging will be undertaken to monitor the numbers of biting insects, in particular mosquitoes.

5.5 DECOMMISSIONING AND REHABILITATION

The proposed development is considered to be a permanent development, which will be retained in its entirety. Should abandonment of the aquaculture development (or parts thereof) be required, then the following decommissioning and rehabilitation practices will be applied.
The pumps and jetty will be decommissioned and removed from the Blackmore River. The supply channel, production and treatment ponds will be leveled with a D8 dozer or similar. Concrete and piping will be removed for salvage. Miscellaneous materials such as power lines, pumps, above ground storage tanks and small concrete structures will be removed from the lease area.

In the initial stage, the wall of the freshwater dam will be around 7.5 m in height and this would be leveled by dozer back to the surrounding ground level. The Stage 2 freshwater dam will have a maximum wall height of 13 m and would be difficult to flatten. Should the dam be decommissioned from its full-scale size a feasibility study will be conducted, in consultation with relevant Authorities, to evaluate the potential benefits of converting the structure into a conservation and recreational area.

All buildings (except concrete footings) and equipment will be removed. On-site access roads will be ripped and graded flat and the regeneration of the vegetation encouraged.

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GLOSSARY

AAPA	Aboriginal Areas Protection Authority
AHD	Australian Height Datum
AASS	Actual Acid Sulfate Soils
ASS	Acid Sulfate Soils
ASSMAC	Acid Sulfate soils Management Advisory Committee
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific & Industrial Research Organisation
dbh	Diameter at Breast Height
DLPE	Department of Lands, Planning and Environment
DO	Dissolved Oxygen
DPI&F	Department of Primary Industry & Fisheries
EMP	Environmental Management Plan
IQF	Individual Quick Freezing
LAT	Lowest Astronomical Tide
MAGNT	Museums & Art Galleries of the Northern Territory
NPK	Nitrogen Phosphorous Potassium
PASS	Potential Acid Sulfate Soils
PAWA	Power and Water Authority
PER	Public Environmental Report
POCAS	Peroxide Oxidation Combined Acidity & Sulfate
ppm	Parts Per Million
TDS	Total Dissolved Solids
TIT	Triple Interceptor Trap
TN	Total Nitrogen
TP	Total Phosphorous
TP1	Test Pit 1
TPA	Total Potential Acidity
TSS	Total Suspended Solids