Prawn Farm, Doctors Creek, Derby

Kimberley Prawn Company

Report and recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 918
December 1998

ISBN. 0 7309 8120 7
ISSN. 1030 - 0120
Assessment No. 976

Summary and recommendations

The Kimberley Prawn Company proposes to establish a prawn farm on the tidal mud flats of Doctor's Creek near Derby. This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on the environmental factors, conditions and procedures relevant to the proposal.

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

Relevant environmental factors

Although a number of environmental factors were considered by the EPA in the assessment, it is the EPA's opinion that the following are the environmental factors relevant to the proposal, which require detailed evaluation in the report:

a) terrestrial fauna - impact on migratory birds and water birds;

b) terrestrial environment - impact on the proposed nature reserve and environmental values of the area;

c) groundwater - impact on groundwater resource for Derby residents and dependent vegetation;

d) aquatic vegetation and flora - impact on mangrove and samphire communities;

e) noise and dust control - during construction and operation;

f) water quality within Doctors Creek - from discharge water; and

g) decommissioning - rehabilitation of the prawn farm site should operations cease.

The EPA has also provided advice in relation to cumulative impacts in the Doctors Creek area.

Conclusion

The EPA has considered the proposal by the Kimberley Prawn Company Pty Ltd to construct and operate a prawn farm on the tidal flats of Doctors Creek near Derby.

The EPA is of the opinion that all stages of the proposal can be managed to meet the EPA's objectives for terrestrial fauna, terrestrial environment, aquatic vegetation and flora, noise and dust control and decommissioning.

The EPA is also of the opinion that Stage 1 of the proposal can be managed to meet the EPA's objectives for groundwater and water quality within Doctors Creek.

The EPA recommends that "in principle" approval only be given for the development of Stages 2 and 3 at this stage. Approval to commence the development of these stages should only be provided after the results of monitoring during Stage 1 are completed that demonstrate adequate performance and that subsequent development is unlikely to cause a significant environmental impact.

The EPA further recommends that the issue of cumulative impacts in Doctors Creek need to be addressed through joint management by proponents and through the development of a Management Plan for the area.

The EPA recommends that the Minister for Lands require a performance bond be placed on the lease for the prawn farm site to ensure decommissioning of the site is carried out to a satisfactory level.

Recommendations

The EPA submits the following recommends to the Minister for the Environment:

1. That the Minister considers the report on the relevant environmental factors of terrestrial fauna, terrestrial environment, groundwater, aquatic vegetation and flora, noise and dust control, water quality in Doctors Creek and decommissioning as set out in Section 3.
2. The Minister notes that the EPA has concluded that Stage 1 of the proposal can be managed and subsequent stages are likely to be managed in an environmentally acceptable manner, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Section 4.
3. The Minister for Lands require a performance bond be placed on the lease for the prawn farm site to ensure decommissioning of the site is carried out to a satisfactory level.
4. The Minister imposes the conditions and procedures recommended in Appendix 3 of this report.

Conditions

Having considered the proponent's commitments and information provided in this report, the EPA has developed a set of conditions which the EPA recommends be imposed if the proposal by Kimberley Prawn Company Pty Ltd to construct and operate a prawn farm is approved for implementation. These conditions are presented in Appendix 3. Matters addressed in the conditions include:

(a) the proponent shall fulfil the commitments in the Consolidated Commitments statement set out as an attachment to the recommended conditions in Appendix 3;

(b) In order to manage the environmental impacts of the project, and to fulfil the requirements of the conditions and procedures in this statement, prior to construction, the proponent shall demonstrate that there is in place an environmental management system which includes the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation and operation of environmental requirements;
- measurement and evaluation of environmental performance; and
- review and improvement of environmental outcomes.

(c) the proponent shall develop and implement an Environmental Management Plan that incorporates the following elements:

- a Groundwater Monitoring and Management Plan (GWMP);
- a Vegetation Monitoring and Rehabilitation Plan (VMRP);
- a Dust Management Plan (DMP);
- a Water Quality Monitoring and Management Programme (WQMMP); and
- a Decommissioning Management Plan (DCMP).

(d) staged approval, with development of Stages 2 and 3 being dependent on the proponent demonstrating compliance with requirements of previous stages.

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1. Introduction and background

The Kimberley Prawn Company, the proponent, proposes to construct and operate a prawn farm, hatchery and associated infrastructure on the mud flats to the north of the Derby peninsula (Figure 1).

The proposal is designed to be developed by staged expansion over ten years with full expansion proposed to be 650 one hectare ponds, water intake and discharge canals, hatchery, accommodation, laboratory, storage sheds, workshop, settling pond and biological filtration pond on a 2000 hectare lease site.

At maximum production the farm intends to produce approximately 6500 tonnes of Black Tiger Prawns (*Penaeus monodon*) per year primarily for the high quality Asian market. The Australian prawn farming industry is centred in Queensland. Western Australia currently does not have any commercial prawn farms operating in the state.

The proposal by Kimberley Prawn Company was referred to the Environmental Protection Authority (EPA) on 24 May 1995. The level of assessment was set at Consultative Environmental Review (CER) because of the potential impacts on the intertidal area, water quality in Doctors Creek, mangroves and samphire communities, coastal processes, disease risk, waste disposal and cumulative impacts.

Further details of the proposal are presented in Section 2 of this Report. Section 3 discusses environmental factors relevant to the proposal. Conditions and procedures to which the proposal should be subject if the Minister determines that it may be implemented are set out in Section 4. Section 5 presents the EPA's conclusion and Section 6 the EPA's recommendations.

A list of people and organisations that made submissions is included in Appendix 1. References are listed in Appendix 2, and recommended conditions and procedures and proponent's commitments are provided in Appendix 3.

The DEP's summary of submissions and the proponent's response to those submissions has been published separately and is available in conjunction with this report.

2. The proposal

Kimberley Prawn Company proposes to establish a prawn farm on Doctors Creek outside Derby on the hypersaline mud flats with the land-based buildings on the site of an experimental brine shrimp farm, Figure 1. The project involves the growing of Black Tiger Prawns (*Penaeus monodon*) primarily for the high quality Asian market and other secondary species native to the King Sound area for use in the biological filtration system as part of the secondary water treatment of the discharge water. A hatchery may be developed during stage 2 or 3 to ensure a continuous supply of prawn stock.

The town of Derby is sited on a peninsula that extends across the mudflats that border King Sound. King Sound is described as macrotidal with Derby subject to tidal ranges of up to 10.5 metres (Semeniuk, 1997). The mudflats that border the peninsula are subject to periodic inundation by the highest of high tides that occur between six and twelve times per year. East and West Doctors Creek occur to the north of the Derby peninsula and extend into the mudflats, refer to Figure 2. They are tidal creeks with little or no freshwater input, except from runoff from the mudflats after heavy monsoonal rains that can occur during the "wet season" of December to April.

The Land Act lease area sought by the Kimberley Prawn Company includes areas subject to tidal movement every tidal cycle, higher area subject to tidal inundation during the highest high tides (6 to 12 times per year) and a small peninsula raised above the mud flats that is proposed to site the associated buildings.

The main characteristics of the proposal are summarised in Table 1.

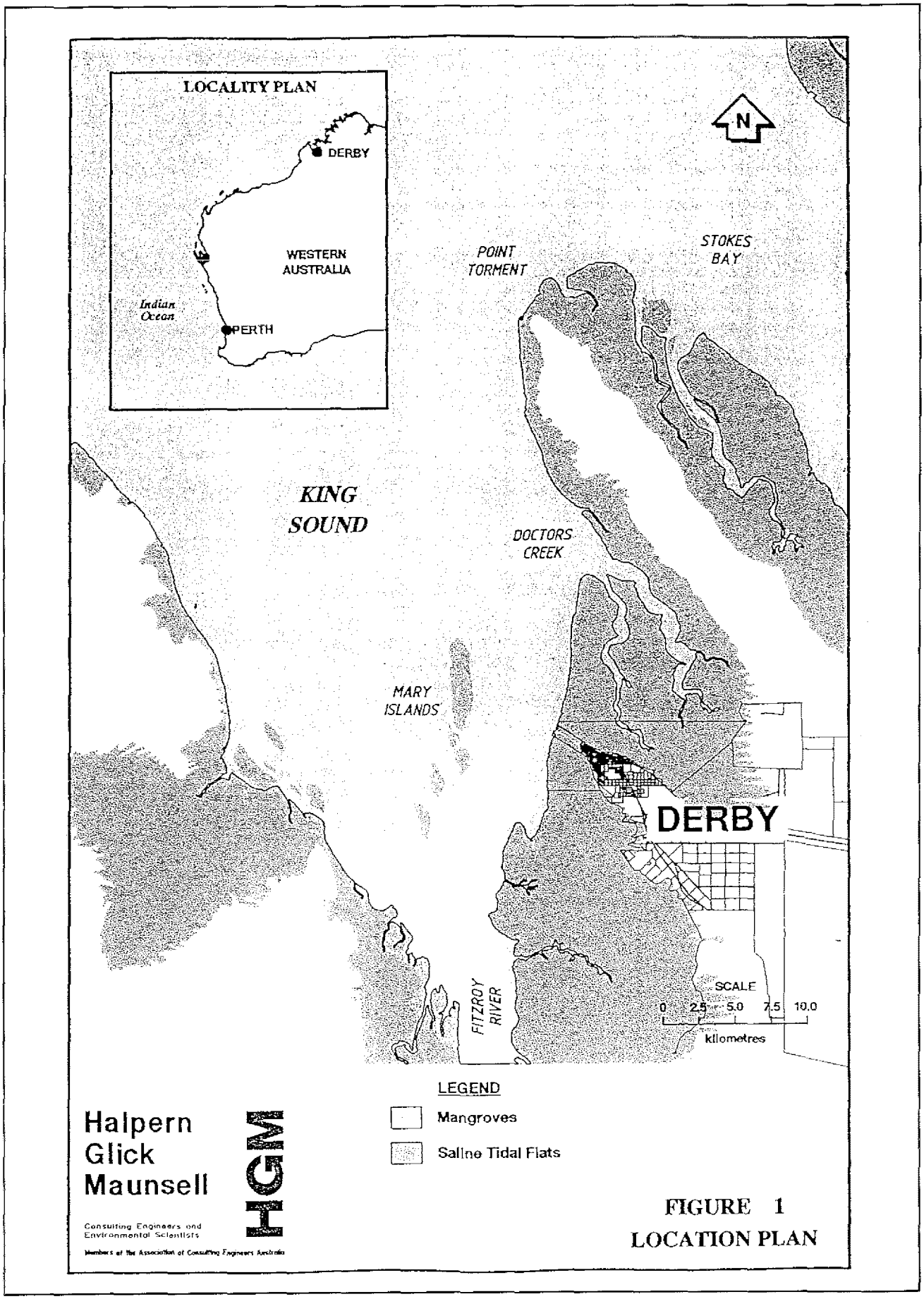

Figure 1. Location map of Doctors Creek.

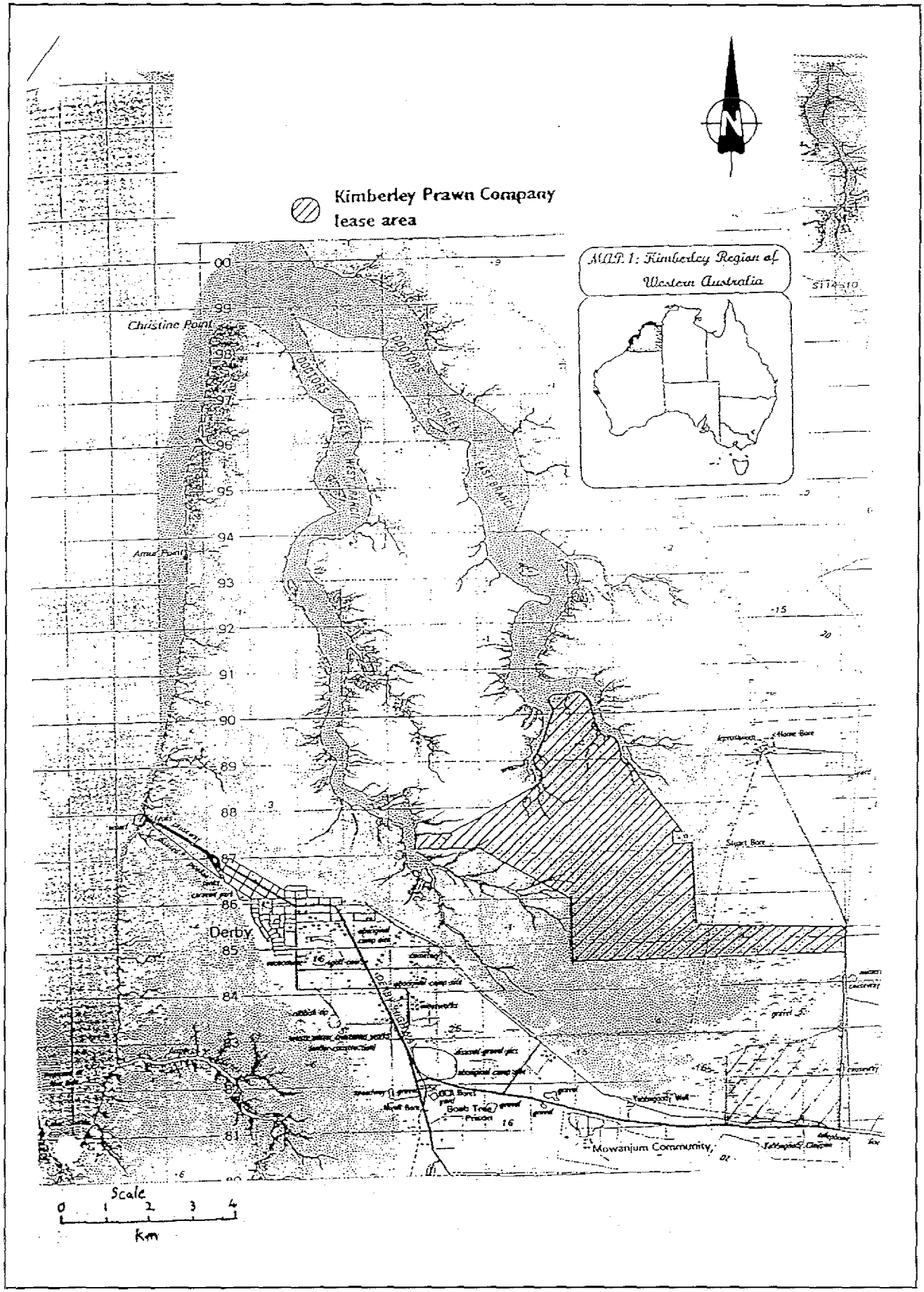

Figure 2. Site map of the lease area for the proposed prawn farm.

Table 1. Summary of key proposal characteristics

Element	Description
Project development (650 hectares in total)	Stage 1 (year 1) 20 x 1 hectare ponds Stage 2 (years 2 & 3) 80 x 1 hectare ponds Stage 3 (years 4 to 10) 550 x 1 hectare ponds
Hatchery development	Stage 3
Area of lease	2000 hectares
List of major components • ponds • bunding of lease boundary • inlet canal • infrastructure (water supply, roads, power) • distribution channel • outflow canal • workshop • process shed • office • accommodation	To be developed for Stage 1
Employment • up to 35 Full Time Employees and some seasonal employment	By stage 2
Species to be used • *Penaeus monodon* (Black leader prawn) • *Saccostrea echinata* (King Sound Rock Oyster) • *Amusium balloti* (Saucer scallop) • *Artemia salina* (Brine shrimp)	Sourced from local hatcheries and/or wild collection under licence from Fisheries WA.
Feed supply • Pelletised fish meal • lupins • super phosphate (for phytoplankton production)	Quantity to be determined during production
Vehicle fuel storage	In accordance with the Department of Mineral and Energy requirements
Electrical power	Taken from existing power lines at the land-based site and power line in Sutherland Street

Since release of the CER a number of modifications to the proposal have been made by the proponent. The most important of these relates to:

- originally: Stage 1 = 6 ha of ponds, Stage 2 = 20 ha of ponds, Stage 3 = 80 ha of ponds, Stage 4 = 550 ha of ponds;
- current: Stage 1 = 20 ha ponds, Stage 2 = 80 ha of ponds, Stage 3 = 550 ha of ponds.

A tidal power station is proposed to be constructed at the entrance to East and West Doctors Creek, refer to Derby Hydro Power (1997) for detailed design. If implemented, the proposal will alter the hydrological processes currently occurring in both East and West Doctors Creek. If the tidal power station is approved Kimberley Prawn Company will locate the inlet canal at West Doctors Creek and discharge to East Doctors Creek. Alternatively the inlet canal will be located at East Doctors Creek and the discharge canal at West Doctors Creek. The potential environmental impacts from either design are not considered to be significantly different. The tidal power station proposal is currently subject to formal environmental impact assessment by the EPA.

3. Environmental considerations

3.1 Relevant environmental factors

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

It is the EPA's opinion that the following are the environmental factors relevant to the proposal, which require detailed evaluation in this report:

a) terrestrial fauna - impact on migratory birds and water birds;

b) terrestrial environment - impact on the proposed nature reserve and environmental values of the area;

c) groundwater - impact on groundwater resource for Derby residents and dependent vegetation;

d) aquatic vegetation and flora - impact on mangrove and samphire communities;

e) noise and dust control - during construction and operation;

f) water quality within Doctors Creek - from discharge water; and

g) decommissioning - rehabilitation of the prawn farm site should operations cease.

The above relevant factors were identified from the EPA's consideration and review of all environmental factors (preliminary factors) generated from the CER document and the submissions received, in conjunction with the proposal characteristics (including significance of the potential impacts), the adequacy of the proponent's response and commitments, the effectiveness of current management and alternative approval processes which ensure that the factors will be appropriately managed. On this basis, the EPA considers that protection of significant and/or rare aquatic species, disease management, translocation of non-endemic species, pest control, flood management, and social environment factors and other issues raised in the submissions do not require further evaluation by the EPA. The identification process is summarised in Table 2 and a summary of the EPA's assessment is set out in Table 3.

The relevant environmental factors are discussed in Sections 3.2 to 3.8 of this report.

Table 2: Identification of Relevant Environmental Factors

FACTOR	PROPOSAL COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
BIOPHYSICAL			
Terrestrial fauna	The construction of up to 650 ha of ponds over a lease area of 2000 ha could impact on mangrove habitat and the use of mud flats by protected migratory birds and other water birds.	The potential impacts on the feeding grounds of migratory birds protected under JAMBA and CAMBA and the use of predatory bird control devices were raised as issues in public submissions.	*Considered to be a relevant factor.*
Terrestrial environment	Potential changes in groundwater quality and surface hydrology may affect a proposed nature reserve.	CALM and two public submissions raised concern over the lack of credible information on the potential impacts on the proposed nature reserve.	*Considered to be a relevant factor.*
Groundwater	The abstraction of groundwater and the construction of permanently inundated areas of the mud flats (ponds) may lead to salt water intrusion of the peninsula aquifer and / or salt water percolating into groundwater supplies.	CALM and two public submissions expressed concern over the potential impact on groundwater resources. WRC has previously stated that groundwater may be available from the unconfined aquifer so long as the Lower Erskine Aquifer is not affected and the aquifer is not polluted. A groundwater abstraction licence from WRC will be required.	*Considered to be a relevant factor.*
Aquatic fauna	Discharge to the upper reaches of Doctors Creek may impact on aquatic fauna in the area.	Two public submissions raised concern over the potential impacts on fish species from discharge water, the lack of monitoring or description of species in the creek, and concern was also expressed over the potential impacts on recreational fishing in the upper reaches of the creek.	The potential impacts on marine species are likely to result from discharge water quality and potential disease introduction. These issues will be dealt with in the following pollution issues section and through FWA and AQIS requirements on disease risk. *Not considered to be a relevant factor.*
Aquatic vegetation and flora	Discharge water may impact on mangrove communities.	Concern was expressed in 2 submissions on the impact on mangroves from discharge water and changes in flushing regimes of the creek. A report was also provided that status the mangroves of Doctors Creek and King Sound in general are of global importance as they represent the southern limit of the species *Bruguiera parviflora* and the mangroves are related to habitats generated by erosional processes.	*Considered to be a relevant factor.*

FACTOR	PROPOSAL COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
Commercial faming of crustaceans and molluscs	The use of non-native crustaceans and molluscs may impact on the natural environment if they escape.	The issue of translocation of *Artemia* was raised as a concern by Edith Cowan University.	The proponent has committed to using native species in this operation. Any translocation of species (including *Artemia*) will be subject to the translocation protocol administered by FWA. *Not considered to be a relevant factor.*
Commercial faming of crustaceans and molluscs	The use of inappropriate feed sources or contaminated product could introduce pathogens into the environment.	The issue of disease control was raised as a concern in 3 public submissions.	Disease risk in feed stock is controlled by AQIS (if imported) and can be regulated by FWA and AgWA *Not considered to be a relevant factor.*
Construction of fish farm	The inappropriate sourcing of construction material, in particular clay for bund and pond walls may lead to the creation of ponded water and potential mosquito breeding grounds.	The issue of mosquito breeding areas and associated mosquito-borne diseases was raised as a concern by the Health Department.	The proponent has committed to manage and monitor the levels of mosquitoes and take appropriate action. It is envisaged that this action would include ensuring drainage of excavated areas to reduce mosquito breeding areas. *Not considered to be a relevant factor.*
Pest control	Excavation of mud for construction may lead to ponding of water and mosquito breeding habitat.	The issue of mosquito breeding areas and associated mosquito-borne diseases was raised as a concern by the Health Department.	The proponent has committed to manage and monitor the levels of mosquitoes and take appropriate action. It is envisaged that this action would include ensuring drainage of excavated areas to reduce mosquito breeding areas. *Not considered to be a relevant factor.*

FACTOR	PROPOSAL COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
Flood management	Inappropriate design of facility or materials could lead to failure of the integrity of the pond walls and bunding.	The issue of flood management and impact on structural integrity was raised as an issue in 2 public submissions.	The tidal range in Doctors Creek is up to 10m (5m AHD). If the tidal power station is constructed the high basin will contain up to 8m (3m AHD). The construction of barrages should prevent inundation of the ponds. Little information is presented on the suitability of the mud flat clay for construction. If the pond walls are breached all species farmed will be native to the area so escape into Doctors Creek will not result in a significant environmental impact. *Not considered to be a relevant factor.*
Long term management	The long term management of the prawn farm will need to ensure the conservation values of the adjacent marine and terrestrial environment is not threatened.		The management of impacts relating to water quality, groundwater, noise and dust control etc will continue through the life of the project and will ensure appropriate long term management. Issues addressed through Ministerial conditions for specific issues and Part V processes. *Factor does not require separate EPA evaluation.*
POLLUTION			
Noise and dust control	Construction and operation of this facility may impact on the amenity of residents of Derby.	The issue of dust generation caused by changes in inundation of the mud flats hence drying and cracking was raised as a concern in 2 submissions.	*Considered to be a relevant factor.*
Water quality within Doctors Creek	The water quality within Doctors Creek could be impacted by quality of the discharge water.	CALM and 2 public submissions raised the issue of wastewater discharge and potential impact on water quality in Doctors Creek.	*Considered to be a relevant factor.*

FACTOR	PROPOSAL COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF RELEVANT ENVIRONMENTAL FACTORS
SOCIAL SURROUNDINGS			
Land use	The construction and operation of the farm could have an adverse impact on existing land use in the area.		The elements of this project that may have an impact on existing land uses such as groundwater, dust generation etc will be assessed under each individual factor. *Factor does not require separate EPA evaluation.*
Social environment	The construction and operation of the facility could potentially impact on the amenity and recreational use of residents in the area.	The issue of impact on recreational use of the mud flats and access across the mud flats was raised as an issue in 1 public submission.	The proponent has realigned the lease area to allow recreational use of the mud flat near Hamlet Grove (closest residential area), access to East Doctors Creek by fishermen and will allow access over the inlet canal to allow access to the mud flats between East and West Doctors Creek. *Factor does not require EPA evaluation.*

Table 3: Summary of Assessment of Relevant Environmental Factors

RELEVANT FACTOR	RELEVANT AREA	EPA OBJECTIVES	EPA ASSESSMENT	EPA ADVICE
Terrestrial fauna	The 2000 ha lease area and surrounds.	Protect significant and/or rare species.	• During a November survey 16 species of migratory birds were recorded using the intertidal area for foraging (DHP, 1997). 1 species was identified as using Australia as a breeding ground. • The project will not directly impact on mangrove communities, there will be approximately 16 000 ha of tidal flats remaining between Christine Point and Derby for foraging. • The Terek Sandpiper and the Common Sandpiper were represented by greater than 1% of their known Australian population. Given the relatively narrow intertidal area available and the high turbidity and hence low invertebrate fauna, Doctors Creek is likely of limited value to shorebirds (DHP, 1997). The lease area represents about 10% of tidal flats at the southern end of King Sound.	Having particular regard to: • the fact that this project will not directly impact on the mangrove communities of Doctors Creek; and • the lease area represents only approximately 10% of the tidal flats at the southern end of King Sound, it is the EPA's opinion that this proposal will not compromise the EPA's objective of protecting significant and/or rare species.
Terrestrial environment	The 2000 ha lease area and surrounds, including the proposed nature reserve.	Maintain the environmental values of the terrestrial environment by minimising clearing and destruction of vegetation or impacting on the environmental values of the area.	• The project will be constructed on tidal mud flats, predominantly devoid of vegetation. • A proposal for an A-class nature reserve exists west of Bungarun Road, approximately 2 km from the project site. This area could be affected by increased salinisation of groundwater or changes in surface water flow but evidence suggests that this is unlikely. • Concern was expressed over impact on the international and heritage significance of King Sound. Given the expanse of mud flats and number of tidal creeks in King Sound and similar processes are occurring within these creeks, Doctors Creek does not necessarily warrant protection against all development to	Having particular regard to the: • evidence that suggests there is unlikely to be a change in surface or groundwater hydrology in the vicinity of the proposed nature reserve; • the environmental values identified by Semeniuk (1997) will either not be significantly affected or are represented elsewhere in King Sound; and • the MPRA do not believe that the Doctors Creek system is of such significance as to warrant recommendation for reservation, it is the EPA's opinion that the prawn farm can be constructed and managed to ensure that the significant environmental values identified for Doctors Creek, King Sound, and the proposed Nature Reserve will be retained provided that:

			ensure the environmental values of the area are retained.	• bunding around the site is designed to ensure there is no restriction of water run-off from the mud-flats that may result in ponding of water around bund walls.
Groundwater	The relevant area for this factor is the unconfined aquifer and the Lower Erskine Aquifer in the vicinity of the prawn farm lease area.	Protect groundwater reliant environmental values and groundwater resources.	• The WRC expects the town to rely on its water supply from the Lower Erskine Aquifer. • Over abstraction of the unconfined aquifer could result in salt water intrusion into the peninsula and subsequent salinisation of domestic bores and impacts on phreatophytic vegetation. • No estimation of the quantity of groundwater required is provided in the CER, although comment is made that the project may not need groundwater at all. Estimated quantities will need to be provided before the WRC will consider issuing a groundwater licence. • Rockwater (1998) suggests that there is very little likelihood of movement of the saltwater interface due to more frequent inundation of the mudflats. • The unconfined aquifer at the margin of the Derby peninsula has been subject to salt water encroachment in the past due to excessive abstraction of groundwater.	Having particular regard to: • the relatively small scale development of Stage 1 of the prawn farm (approximately 20 ha of ponds) and the monitoring that will be required prior to approval to expand to subsequent stages; • the extent of existing knowledge of the hydrogeology of the Derby peninsula; • the reliance of the Derby town water supply and residential bores on the Lower Erskine and unconfined aquifers; and • the other regulatory processes available to control groundwater abstraction, it is the EPA's opinion that the proposal can meet the EPA's objective during Stage 1 provided that the proponent develop and implement a groundwater management and monitoring plan. The EPA is also of the opinion that the further development of Stages 2 and 3 are likely to be able to meet the EPA's objective and recommends in principle approval be given at this stage with final approval to develop Stages 2 and 3 given subject to: • the monitoring results undertaken during preceding stages indicating no significant impact from the prawn farm operations on the Derby groundwater reserves; and • approval for groundwater abstraction having being granted from relevant agencies.
Aquatic vegetation and flora	East and West Doctors Creek including the catchments to these creeks.	Protect locally and regionally significant vegetation associations and habitats, including mangroves and samphires.	• No mangroves will be directly impacted by the construction of this facility. If the water quality is maintained to the criteria specified in the Bulletin 711 for the protection of aquatic ecosystems, the impacts on mangrove systems in Doctors Creek are unlikely to be significant. • Construction of bunding and ponds has shown to detrimentally affect mangroves	Having particular regard to: • the commitment to avoid direct loss of mangrove and samphire communities from direct disturbance; and • the demonstrated ability of similar mangrove communities in the area to tolerate high levels of nutrients in surrounding water, the EPA is of the opinion that the proposal will not significantly impact on the aquatic flora of Doctors

			within 100 m in the Pilbara due to changes in groundwater depth and increases in salinity. • If the tidal power proposal is implemented the mangroves of East Doctors Creek will be under extreme stress and high mortalities are likely (in the short term). The tidal power project proposes to regenerate the mangroves. The impacts from the prawn farm discharge water on mangrove recolonisation/regeneration is not likely to be significantly detrimental.	Creek provided that: • a vegetation monitoring and rehabilitation plan is developed that details the health of samphire and mangrove communities and is able to record changes to the community health or structure over time, rehabilitation measures for areas of samphire or other communities disturbed during construction and are no longer needed during operation, and requires a set-back of at least 150 m from mangrove growth of pond bunding and pond walls (excluding intake and discharge pipes; and • discharge water quality is managed to appropriate levels (detailed below) during each stage of operation.
Noise and dust control	Residential areas including the Derby townsite near the lease site.	Comply with statutory requirements.	• All land developments in Western Australia have to comply with the guidelines for the prevention of dust and smoke (DEP, 1996). • The proponent has committed to resealing the dried surface with water and salt and monitoring the generation of dust during construction and operation of the farm. At full production there will be approximately 650 ha of ponds within the 2000 ha lease area. There is some concern that the dust control measures will not be effective. • Due to the low level of noise generation and the power available to the Local Shire to control excessive noise levels, this factor is not likely to cause a significant impact to nearby residents.	Having particular regard to: • the proponent has committed to measures to reduce dust generation; • the DEP guidelines set criteria to manage dust generated during construction activities; • the existing dust problems that occur in Derby at certain times of the year; and • the distance to residential areas, the EPA is of the opinion that dust and noise from this proposal can be managed to acceptable levels provided that: • a dust management plan be prepared that identifies appropriate dust suppression techniques during construction and operation, to the requirements of the DEP. The effectiveness of the dust suppression techniques are to be monitored and reported to the DEP annually with modification to the techniques used if required. The method used could include design techniques such as construction of bunding to encompass only the area needed for the development of Stage 1, associated infrastructure and/or development planned for the proceeding year. This would prevent large areas of tidal flats drying out and causing a potential problem while

				allowing for the imminent development areas to be prepared for use.
Water quality within Doctors Creek	The waters of Doctors Creek East and West and immediately adjacent to the mouth of both creeks in King Sound.	Manage wastewater discharge into Doctors Creek to ensure that acceptable water quality within the Creek is maintained.	• The proponent has provided a commitment to comply with the water quality for the protection of aquatic ecosystems as specified in EPA Bulletin 711 for stage 1, to be reviewed when monitoring results are available. • The proponent will install secondary species ponds which will act as settling and water treatment ponds. • The EPA is aware of the lack of available information regarding the effectiveness of this type of water treatment system in this environment and as such the staged development of the proposal will require extensive monitoring to ensure effectiveness of this method. • If the tidal power station is constructed the water flow in Doctors Creek will be altered. This is likely to result in an increase in leaf litter from dying mangroves and could lead to a significant water quality problem in the short term, particularly in the upper reaches of Doctors Creek. This issue will require further evaluation with the assessment of the tidal power station project.	Having particular regard to: • the flushing characteristics of both arms of Doctors Creek (including East Doctors Creek if the tidal power station is approved); • the very high suspended solids in the creeks which reduce the depth of light penetration and primary productivity in the water column; • the tolerance of mangroves to very high nutrient concentrations; and • the commitment to the installation of secondary water treatment using bivalve filtration ponds, the EPA is of the opinion that the nutrient concentrations and total nutrient loads expected from Stage 1 are unlikely to significantly impact on the water quality or mangrove growth in Doctors Creek or King Sound provided that: • the proponent prepares a water quality monitoring and management program that includes detailed design of the water treatment system with substantiating information on the effectiveness of the design, monitoring parameters and frequency, background water quality monitoring and contingency plan if water quality falls below accepted criteria (as outlined in the draft WA Water Quality Guidelines, EPA Bulletin 711). Monitoring during Stage 1 may show the need for refinement to discharge water quality criteria to ensure the maintenance of the environmental values of the creek, such as a water bird habitat and nursery area for some fish species. • The EPA is also of the opinion that the further development of Stages 2 and 3 are likely to be able to meet the EPA's objective and recommends in principle approval be given at this stage with final approval to develop Stages 2 and 3 given on the proviso that: • the proponent is able to meet water quality

				guidelines, as stated in the water quality monitoring program (and amended as deemed appropriate by the DEP), in the discharge water and Doctors Creek prior to the development of stages 2 and 3; and • if the tidal power station should be approved for development, then Kimberley Prawn Company enter into discussions for joint management of water quality in the creek. It is envisaged that such discussions would include water quality criteria, monitoring of impacts on fish health in the creeks, impacts of wastewater discharge on mangrove colonisation and management of water levels within the creeks to improve flushing if needed.
Decommissioning	The 2000 ha lease site and surrounds, including all, infrastructure.	Ensure that the site is returned to a state approaching pre-construction, when operations cease.	• Concern has been raised about the clean-up of the site should the project prove unviable. • Stagnant water from site abandonment could pose an environmental and health.	Having particular regard to: • the length of time natural forces would take to erode the structures; and • the potential mosquito breeding areas that could develop in the mean time; the EPA is of the opinion that the decommissioning of this site can be managed to meet the EPA's objectives provided that: • a decommissioning management plan be prepared at least 1 year prior to decommissioning.

3.2 Terrestrial fauna

Description

The prawn farm has the potential to impact on mangrove communities and tidal mud flats which can represent important roosting and feeding grounds for migratory birds and other waterbirds.

The potential impact on shorebirds and their habitat and the method of controlling birds preying on prawns were raised as issues of concern in the public submissions.

Assessment

The area considered for assessment of this factor is the 2000 hectare lease area and surrounds.

The EPA's objective in regard to this environmental factor is to protect significant and/or rare species.

During a November 1997 survey 16 species of migratory shorebirds were recorded using the intertidal area for foraging (DHP, 1997). A number of these species are protected under Japan and Australia Migratory Bird Agreement and China and Australia Migratory Bird Agreement. Of these species, 15 were Asian breeding and only one species of migratory bird was identified as using Australia as a breeding ground. Therefore the predominant use of the area is as a feeding and resting area.

The Kimberley region of Australia lies in the Siberian - Australasian flyway. The mudflats of Roebuck Bay and the tidal flats of Eighty Mile Beach have been identified as two of three outstanding shorebirds sites in Australia and are both recorded as RAMSAR wetlands, ie. "Wetlands of International Importance" (MPRSWG, 1994). The mudflats of Doctors Creek have not been identified by either MPRSWG (1994) or "A Directory of Important Wetlands" (Usback and James, 1993) as being of special significance to shorebirds.

Two species of sandpiper were represented at the Doctors Creek mud flats by greater than 1% of their known Australian population, which is one of the criteria for classification of the site as of national importance. The two species were the Terek Sandpiper (*Tringa terek*) and the Common Sandpiper (*Terek hypoleucos*). In previous studies, areas that have high tidal flows and hence high accretion and erosion rates, and very fine and mobile sediments such as Doctors Creek, are relatively depauperate in invertebrate fauna (Shaw, 1986; Goss-Custard et al., 1991). In a recent study organised by CALM, 181 invertebrate species were identified in Roebuck Bay, while 20 species were identified in King Bay. This is consistent with the findings of Shaw (1986) and Goss-Custard et al. (1991) (extract from Kimberley Soc. Journal, 1998). Due in part to the relatively narrow intertidal flat available, the evidence available suggests that the Doctors Creek system is of limited value to shorebirds (DHP, 1997).

This proposal will alienate approximately 2000 ha of the 18000 ha tidal flats available in the area for use as feeding/breeding grounds. There is no evidence to suggest this 2000 ha provides unique avian habitat not represented among the remaining 18000 ha of tidal mud flats.

Salt water crocodiles (*Crocodylus porosus*) have been identified in the waters of Doctors Creek however the tidal mud flats have not been identified as a significant habitat for any other terrestrial fauna species.

Having particular regard to:

(a) the fact that this project will not directly impact on the mangrove communities of Doctors Creek; and

(b) the lease area represents only approximately 11% of the tidal flats at the southern end of King Sound,

it is the EPA's opinion that this proposal will not compromise the EPA's objective of protecting significant and/or rare species.

3.3 Terrestrial environment

Description

The terrestrial environment relates to the potential impacts on an A-class nature reserve proposed for the west of Bungarun Road, approximately 2 km from the edge of the lease site (refer to Figure 3). The terrestrial environment also encompasses the geoheritage values of the area and how the prawn farm may alter geological and erosional processes occurring at the site.

The main issues raised in the public submissions related to the significance of the Doctors Creek setting, the geoheritage significance and the lack of information about the potential impacts on the proposed nature reserve.

Assessment

The area considered for assessment of this factor is the 2000 hectare lease area and surrounds, including the proposed nature reserve.

The EPA's objective in regard to this environmental factor is to maintain the values of the terrestrial environment by minimising clearing and destruction of vegetation or affecting on the environmental values of the area.

Nature reserve
An A-class nature reserve is proposed for the west of Bungarun Road, approximately 2 km from the edge of the lease site. The area is mainly a sub-coastal black-soil plain supporting a typical south-west Kimberley grassland and interrupted by red sand dunes supporting a mixed woodland (McKenzie, 1982).

It is envisaged that the proposed nature reserve could be affected in three ways:

a) *Change in saline surface water flow, ie a change in tidal inundation patterns:*
The tidal flats of Doctors Creek, which includes the northern part of the proposed nature reserve, is inundated during highest spring tides which occur about 6 to 12 times per year. The prawn farm will not restrict inundation or retreat of water from the mudflats in the vicinity of the proposed nature reserve and therefore will not affect the surface water flow to the nature reserve.

b) *Change in groundwater flow and the position of the saline water / fresh water interface:*
The larger, mature vegetation species such as the boab are dependent on the quality of local groundwater for survival. The groundwater utilised beneath the site is the upper part of the unconfined Erskine Aquifer and water retained within the Wallal Sandstone formation.

A groundwater report prepared by Rockwater Pty Ltd (1998) states that the high basin of West Doctors Creek is underlain by estuarine muds of low permeability. A shale aquiclude is likely to occur between the Wallal Sandstone and the Erskine Sandstone and the presence of the low permeability muds and the shale aquiclude means there is probably little or no natural discharge of groundwater to West Doctors Creek. The

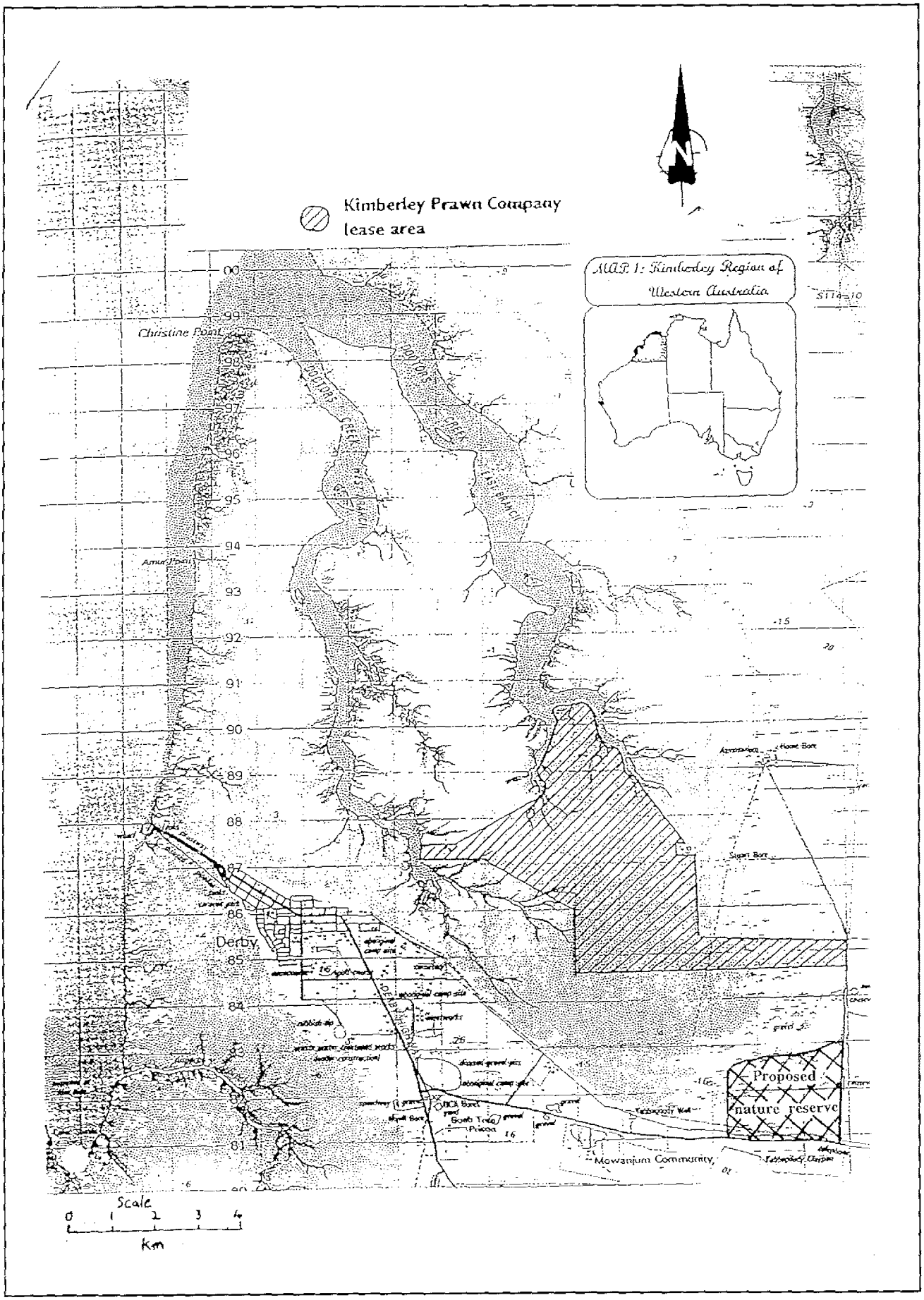

Figure 3. Area proposed for an A-class nature reserve.

natural discharge from the Wallal/Erskine aquifer beneath the peninsula can be interpreted from the position of the springs that occur around the margin of the peninsula and include areas within the proposed nature reserve. Therefore the presence of prawn ponds on the mud flats, even if there is some leakage of pond water, is unlikely to impact on the salinity of the groundwater in the vicinity of the proposed nature reserve.

However, if groundwater abstraction is required to reduce salinity in the ponds, this may have the potential to cause drawdown and movement of the saline water / fresh water interface. This issue is discussed further in Section 3.4.

c) *Change in fresh water runoff during high rainfall events:*
The proposed nature reserve is further up the catchment and hence is situated on higher ground than the nearby mud flats and proposed prawn farm operations. Therefore fresh water flow off the peninsula that is likely to occur during events of high rainfall, will drain through the surrounding samphire community including the area proposed for the nature reserve, across the mud flats and to Doctors Creek, as is the current situation.

The design of the bunding wall will be required to ensure that 'back-up' of water behind the farm and hence potential inundation of the area behind the wall does not occur.

As flow of surface water off the peninsula will not be affected, there will be no impact on the proposed nature reserve from altered surface water flow patterns.

Geoheritage

A report prepared by V&C Semeniuk Research Group and EnviroEng Consulting P/L was presented during the public submission period that stated the terrain into which the prawn farm is proposed to be sited is significant at levels ranging from International, to National to State-wide. It is claimed that the International and heritage significance (or environmental values) of Doctors Creek is related to:

a) *Its setting as a macrotidal tropical semi-arid mangrove coast:*
King Sound has tidal ranges in excess of 10 m, has a tropical / semi-arid climate with mangrove-lined coast. The construction of a prawn farm at the upper reaches of one of the tidal creeks that open to King Sound will not alter the setting as described. There will be some visual impact from the south east margin of the peninsula and from the mud flats in the vicinity of the prawn farm and the recreational use of this area is low.

b) *Its erosional patterns:*
The King Sound area is a net erosional situation (Semeniuk, 1980). Semeniuk (1997) describes the area as being of global significance because this area presents a model of coastal erosion wherein sheet, tidal creek and cliff erosion singularly, or in combination act to develop coastal landforms.

Given that the prawn farm will be constructed on the tidal flats in an area that is inundated only on high spring tides, it is not likely to significantly alter the erosional processes occurring within either Doctors Creek or King Sound. There will be some reduction in the area of tidal mud flats available for the formation of the deep cracks that occur in the clays during drying (described as the first stage of the six stage erosional process (Semeniuk, 1980)). However as Doctors Creek has progressed to the sixth stage of the erosional processes it is unlikely to significantly alter the creek patterns or processes. Further, the prawn farm is set back from the tidal creeks, reducing potential changes in this landform.

c) *Its tide-dominated deltaic estuarine setting:*
Semeniuk (1997) describes King Sound as a global example of a high-tidal estuarine delta.

The construction of a prawn farm at the upper reaches of one of the tidal creeks of the Sound will not detrimentally affect the nature of King Sound as an area where the tidal forces are the dominant process.

d) *The fractal laboratory therein:*
Within the tidal creeks of King Sound the small-scale patterns reflect the large-scale patterns and also control the development of large-scale forms (Semeniuk, 1997). As such, Semeniuk argues that this 'fractal property' is a powerful and internationally significant feature of the natural history of the area and provides important insights into the processes shaping tidal flat forms.

The fractal patterns described by Semeniuk begin in the deep cracks developed on the mudflats. The prawn farm will effectively prevent the deep cracks from developing over the prawn farm lease area. This will change the formation of the fractal patterns at the upper reaches of East and West Doctors Creek.

The Marine Parks and Reserves Authority (MPRA) has recently reviewed Doctors Creek with respect to possible recommendation for reservation. The MPRA has stated that it is not convinced that the geological and scientific values of Doctors Creek are of such importance at State, national and international levels as to warrant its preservation at this time (MPRA, 1998)

Having particular regard to:

(a) the evidence that suggests there is unlikely to be a change in surface or groundwater hydrology in the vicinity of the proposed nature reserve;

(b) the conclusion that the environmental values identified by Semeniuk (1997) will either not be significantly impacted or are represented elsewhere in King Sound; and

(c) the advice of the MPRA that it did not believe that the Doctors Creek system is of such significance as to warrant recommendation for reservation,

it is the EPA's opinion that the prawn farm can be constructed and managed to ensure that the significant environmental values identified for Doctors Creek, King Sound, and the proposed Nature Reserve will be retained provided that:

(a) bunding around the site is designed to ensure there is no restriction of water run-off from the mud-flats that may result in ponding of water around bund walls.

3.4 Groundwater

Description

At full expansion, the prawn farm will include 650 hectares of open water in ponds which has the potential to seep into the upper unconfined aquifer and contaminate potable groundwater below the peninsula. Groundwater may also be required to counter the effects of evaporation by reducing the salinity in pond water. Excessive abstraction will move the fresh / salt water interface and could effect Derby's groundwater supplies.

The WRC and members of the public expressed concern over the lack of detail about groundwater requirements, potential bore locations and monitoring methods. WRC also highlighted the need for the proponent to apply for a bore licence. CALM expressed concern about the potential impact on Derby's groundwater supplies from abstraction and potential contamination.

Assessment

The area considered for assessment of this factor is the unconfined aquifer and the Lower Erskine Aquifer in the vicinity of the prawn farm lease area.

The EPA's objective in regard to this environmental factor is to protect the groundwater reliant environmental values and groundwater resources.

The Derby town water supply is drawn entirely from groundwater. The confined Lower Erskine Aquifer is the main source for the town water supply. The unconfined upper aquifer is the primary source for private bore users. Both aquifers are susceptible to salt water intrusion if abstraction is excessive (WAWA, 1992).

The proponent has indicated that it may be necessary to abstract low salinity groundwater to reduce salinity build up in ponds. No estimation of the amount required has been indicated as this will be determined by the proponent during the development of Stage 1 and will need to be detailed in the groundwater monitoring programme prior to the development of Stage 2

The groundwater in the vicinity of the ponds may also be subject to contamination or movement of the saltwater interface from seepage of pond water and induced hydrostatic head pressures. At maximum expansion there will be 650 ha of open water approximately 2m deep on the mud flats of Doctors Creek.

The unconfined aquifer is subject to a brief influx of saline water at the peninsula margins during high spring tides when the tidal flats are inundated (WAWA, 1992). A report by Rockwater (1998) suggests that more frequent inundation of the mudflats, likely to occur if the proposed tidal power station is approved, is unlikely to produce a detectable change in the position of the saltwater interface of the unconfined aquifer due to:

- the low permeability of estuarine muds;
- the likelihood that there is very little natural groundwater discharge in the vicinity of West Doctors Creek and hence any rise in heads will be attenuated and not directly affect the fresh groundwater flow system; and
- much of the natural discharge from the upper aquifer beneath the peninsula occurs around the margins of the peninsula.

Rockwater (1998) considers that there is no possibility that the saltwater interface in the lower Erskine Aquifer could be affected by increased inundation of the mudflats because:

- the aquifer is bounded by a shale aquiclude so any interchange of water between the two aquifers is likely to be very small or non-existent; and
- the discharge of the lower Erskine Aquifer probably occurs off-shore in King Sound.

The above information suggests that the risk of contamination of the potable water resources below the peninsula is low. However the lack of detailed information about the hydrogeology beneath the tidal flats themselves and the importance of the Lower Erskine Aquifer (and to a slightly lesser extent the upper unconfined aquifer) for fresh water for Derby residents would suggest the need for caution. Therefore the EPA recommends that a detailed groundwater management and monitoring plan be implemented during Stage 1 to detect any changes in groundwater quality around the ponds.

Subsequent expansion to Stage 2 and/or the granting of licence for groundwater abstraction would be dependent on the results of groundwater monitoring showing the fresh groundwater reserves will not be impacted.

Having particular regard to:

(a) the relatively small scale development of Stage 1 of the prawn farm (approximately 20 ha of ponds) and the monitoring that will be required prior to approval to expand to subsequent stages;

(b) the existing knowledge of the hydrogeology of the Derby peninsula;

(c) the reliance of the Derby town water supply and residential bores on the Lower Erskine and unconfined aquifers; and

(d) the other regulatory processes available to control groundwater abstraction,

it is the EPA's opinion that the proposal can meet the EPA's objective during Stage 1 provided that the proponent develop and implement a groundwater management and monitoring plan. The EPA is also of the opinion that the further development of Stages 2 and 3 are likely to be able to meet the EPA's objective and recommends in principle approval be given at this stage with final approval to develop Stages 2 and 3 given subject to:

(a) the monitoring results undertaken during preceding stages indicating no significant impact from the prawn farm operations on the Derby groundwater reserves; and

(b) approval for groundwater abstraction having being granted from relevant agencies.

3.5 Aquatic vegetation and flora

Description

The prawn farm site will encompass an area of 2000 hectares of predominantly unvegetated hypersaline tidal mud flats. The lease site will include access to East and West Doctors Creek with some associated mangrove and samphire communities that have the potential for direct impact from construction activities. There is also potential for indirect impact through groundwater shallowing and from contaminated discharge water.

Concern was expressed from members of the public on the potential impacts on mangroves from altered flow rates in the creeks and the impacts on mangrove communities from the discharge water.

Assessment

The area considered for assessment of this factor is East and West Doctors Creeks and the catchments to the creeks.

The EPA's objective in regard to this environmental factor is to protect locally and regionally significant vegetation associations and habitats, including mangroves and samphires.

The construction of levee banks and canals will avoid areas of mangroves. However similar constructions on salt flats in the Pilbara have shown localised changes such as elevated salinity and chronic shallowing of the groundwater up to 100 m from bund walls (Gordon, 1998a). If mangroves occur in the zone of impact they are usually lost through die-back. The site changes can persist for years and have important implications for management of rehabilitation (Gordon, 1998a).

The discharge water could potentially affect mangroves in East Doctors Creek through a potential increase in nutrients and increase in flow through the upper reaches of the creek as a result of discharge from the ponds. Present nutrient levels in King Sound are approximately 0.4 mg/L nitrogen (N) and 0.2 mg/L phosphorous (P). Mangroves in the vicinity of the discharge from the Derby sewage outfall are subject to levels up to 55 mg/L N and 11 mg/L P with no obvious deleterious effects (Kinhill, 1997). Other prawn farming operations have measured maximum nutrient concentrations in discharge water of 0.80 mg/L total N and 0.27 mg/L total P (Ziemann et al., 1992).

Background water quality information will be gathered prior to commissioning of Stage 1 and a comprehensive water quality monitoring program will be required during Stage 1, prior to expansion to subsequent stages. This is dealt with in more detail in Section 3.7.

If the proposed tidal power project is approved there will be a loss of up to 1500 ha of mangroves in the two arms of Doctors Creek, in the short term (DHP, 1997). The tidal power project proposes to regenerate the mangrove systems.

Having particular regard to:

(a) the commitment to avoid loss of mangrove and samphire communities from direct disturbance;

(b) the demonstrated ability of similar mangrove communities in the area to tolerate high levels of nutrients in surrounding water,

the EPA is of the opinion that the proposal will not significantly impact on the aquatic flora of Doctors Creek provided that:

(a) a vegetation monitoring and rehabilitation plan is developed that details the health of samphire and mangrove communities and is able to record changes to the community health or structure over time, rehabilitation measures for areas of samphire or other communities disturbed during construction and are no longer needed during operation, and requires a set-back of at least 150 m from mangrove growth of pond bunding and pond walls (excluding intake and discharge pipes); and

(b) discharge water quality is managed to appropriate levels (detailed below) during each stage of operation.

3.6 Noise and dust control

Description

The prawn farm site will encompass an area of 2000 hectares. It is proposed in Stage 1 to bund off the entire lease area from tidal waters to ensure the area is kept dry for subsequent development. Dust problems already exist in the town when seasonal wind conditions blow across the dry mud flats. Keeping an area of approximately 2000 ha that is within 2 km of the Derby townsite permanently dry, prior to the development of Stages 2 and 3, could increase the dust levels experienced in the town under north and north-easterly wind conditions.

The issues of dust generation has been identified by town residents as of significant concern.

Assessment

The area considered for assessment of this factor is residential, rural and other settlement areas including the Derby townsite near the lease area.

The EPA's objective in regard to this environmental factor is to comply with statutory requirements with regard to dust and noise generation.

The enclosing of the lease area with bunding to exclude tidal waters and hence allowing the area to dry may cause an increase in dust levels in the nearby Derby townsite, under certain wind conditions. The proponent has committed to resealing the dried areas with salt water and to monitor the generation of dust during construction and operation of this project.

Concern has been expressed that proposed dust management measures will not be effective and will add to the already high dust levels in the town at certain times of the year, particularly for the residents of Hamlet Grove that are approximately 2 km from the lease site. The development will, however, be staged which will allow for determination of the extent of the impacts from dust prior to development to subsequent stages.

All land development sites in Western Australia are required to comply with DEP (1996) guidelines for the prevention of dust and smoke pollution.

Noise will only be generated from water and aeration pump use which will be reduced if the tidal power station is approved. The DEP considers that noise from pump use is unlikely to cause a significant impact. The local Shire has delegated power to manage noise complaints and implement mitigation strategies (such as noise housing for pumps) if it is deemed to be a problem.

Having particular regard to:

(a) the proponent has committed to measures to reduce dust generation;

(b) the DEP guidelines set criteria to manage dust generated during construction activities;

(c) the existing dust problems that occur in Derby at certain times of the year; and

(d) the distance to residential areas,

the EPA is of the opinion that dust and noise from this proposal can be managed to acceptable levels provided that:

(a) a dust management plan be prepared that identifies appropriate dust suppression techniques during construction and operation, to the requirements of the DEP. The effectiveness of the dust suppression techniques are to be monitored and reported to the DEP annually with modification to the techniques used if required. The method used could include design techniques such as construction of bunding to encompass only the area needed for the development of Stage 1, associated infrastructure and/or development planned for the proceeding year. This would prevent large areas of tidal flats drying out and causing a potential problem while allowing for the imminent development areas to be prepared for use.

3.7 Water quality within Doctors Creek

Description

The water quality in the discharge arm of Doctors Creek could be impacted by the prawn farm effluent. Little information has been provided by the proponent as to the current water quality of Doctors Creek and estimated nutrient levels in the discharge water. Previous studies have shown that water quality problems can occur as a result of inappropriately managed prawn farms (Musig et al., 1995).

West Doctors Creek is the favoured 'discharge' creek however, if the proposed tidal power station is approved, effluent will be discharged to East Doctors Creek. The potential environmental impacts are similar and hence the assessment below relates to both designs.

The WRC, CALM and members of the public raised concern about the potential quality of discharge water and the subsequent impact on marine flora and fauna.

Assessment

The area considered for assessment of this factor is the waters of East and West Doctors Creek and immediately adjacent to the mouth of both creeks in King Sound.

The EPA's objective in regard to this environmental factor is manage wastewater discharge into Doctors Creek to ensure that acceptable water quality within the creek is maintained.

The key parameters of water quality that could be affected by prawn farm effluent are dissolved oxygen (DO), biological oxygen demand (BOD), suspended solids (SS), and inorganic nitrogen and phosphorous (Gordon, 1998a). The preliminary estimates of these water quality parameters are discussed below and summarised in Table 4.

The initial information available shows the background DO and BOD levels in King Sound as 7.6 mg/L and 7.4 mg/L (Kinhill, 1997). No estimation of these levels after treatment have been provided however other studies on prawn farms have shown a nett increase in DO in the outflow water when compared to the inflow water (Briggs & Funge-Smith, 1994; Paez-Osuna

et al., 1997). These levels would be compliant with the figures presented in the guidelines for the protection of aquatic ecosystems in the draft Western Australian Water Quality Guidelines for Fresh and Marine Waters (EPA, 1993).

Biological oxygen demand (BOD) is also likely to be higher in the outflow water than the background water levels (Briggs & Funge-Smith, 1994). Given the relatively high DO levels and the very strong water movement and flushing of the creeks the levels of BOD that might be expected are unlikely to significantly affect the water quality in the creeks.

The information available on suspended solids (SS) shows levels of 363 mg/L in King Sound. These natural levels are very high and will need to be reduced before inflow into the ponds to ensure maintenance of the health of the prawns. Given the degree of water treatment the outflow water is likely to have a lower SS load than intake water.

Gordon (1998b) reviewed a number of nutrient exchange budgets developed to predict prawn farm effluent before and after secondary treatment and modified a model developed by Briggs and Funge-Smith (1994) for coastal intensive shrimp farms. Given the information available for the proposed Derby prawn farm, the estimated nutrient load after secondary treatment was predicted to be 810 µg/L total N and 110 µg/L total P which are both approximately 10 % above indicative nutrient concentrations for the protection of aquatic ecosystems in rivers (EPA, 1993).

The initial figures available suggest that the background nutrient concentrations in King Sound are approximately 400 µg/L nitrogen and 200 µg/L phosphorous (seasonal variation is not known at this stage) (Kinhill, 1997). Mangroves in the vicinity of the discharge from the Derby sewage outfall are subject to levels up to 55000 µg/L N and 11000 µg/L P with no obvious deleterious effects (Kinhill, 1997). The naturally high levels of SS in Doctors Creek reduce the photic zone (depth of light penetration) to approximately 0.3 m which limits the primary productivity in the water column (DHP, 1997) and hence the levels predicted above are unlikely to significantly increase algal growth in the creeks.

Total nutrient loads per year (based on two harvests per year) for Stage 1 only were 17080 kg per year total nitrogen and 2320 kg per year total phosphorous (for 650 ha production ponds, 555100 kg per year total nitrogen and 75400 kg per year total phosphorous).

Table 4. Preliminary estimates of water quality based on available background information and a report prepared by Gordon (1998b).

Water quality criteria (mg/L)	**Before treatment (background)**	**After treatment (discharge)**
Dissolved oxygen	7.6	>7.6
Biological oxygen demand	7.4	>7.4
Suspended solids	363	<363
Total nitrogen	2.71	0.81
Total phosphorous	0.27	0.11

The proponent has committed to the development of secondary treatment ponds and the implementation of a water quality monitoring programme, specifying water quality criteria, to the satisfaction of the DEP. This water quality monitoring programme will be reviewed at the end of each stage of development and prior to the development of subsequent stages in light of the monitoring information collected and the detection of any potential environmental impacts. The programme will also be required to develop contingency plans to be implemented if there are breaches of water quality criteria.

Acid sulfate soils (ASS) have been identified in small areas within the proposed lease site. Given that the discharge canal is the only part of the prawn farm that may expose ASS the

potential environmental impacts are unlikely to be significant. However the water quality monitoring programme should include ASS to ensure that this issue is appropriately managed.

Having particular regard to:

(a) the flushing characteristics of both arms of Doctors Creek (including East Doctors Creek if the tidal power station is approved);

(b) the very high suspended solids in the creeks which reduce the depth of light penetration and primary productivity in the water column;

(c) the tolerance of mangroves to very high nutrient concentrations; and

(d) the commitment to the installation of secondary water treatment using bivalve filtration ponds,

the EPA is of the opinion that the nutrient concentrations and total nutrient loads expected from Stage 1 are unlikely to significantly impact on the water quality or mangrove growth in Doctors Creek or King Sound provided that:

(a) the proponent prepares a water quality monitoring and management program that includes detailed design of the water treatment system with substantiating information on the effectiveness of the design, monitoring parameters and frequency, background water quality monitoring and contingency plan if water quality falls below accepted criteria (as outlined in the draft WA Water Quality Guidelines, EPA Bulletin 711). Monitoring during Stage 1 may show the need for refinement to discharge water quality criteria to ensure the maintenance of the environmental values of the creek, such as a water bird habitat and nursery area for some fish species.

The EPA is also of the opinion that the further development of Stages 2 and 3 are likely to be able to meet the EPA's objective and recommends in principle approval be given at this stage with final approval to develop Stages 2 and 3 given subject to:

(b) the proponent being able to meet water quality guidelines, as stated in the water quality monitoring program (and amended as deemed appropriate by the DEP), in the discharge water and Doctors Creek prior to the development of stages 2 and 3; and

(c) if the tidal power station should be approved for development, Kimberley Prawn Company entering into discussions for joint management of water quality in the creek. It is envisaged that such discussions would include water quality criteria, monitoring of impacts on fish health in the creeks, impacts of wastewater discharge on mangrove colonisation and management of water levels within the creeks to improve flushing if needed.

3.8 Decommissioning

Description

Pond walls, bunding, inlet and discharge canals will all be established on tidal mud flats. If abandoned, these structures could remain visible for many years before they are 'reclaimed' by the erosional forces of the tidal waters.

The issue of decommissioning of the project was raised by members of the public.

Assessment

The area considered for assessment of this factor is the 2000 ha lease area and surrounds, including all infrastructure.

The EPA's objective in regard to this environmental factor is to ensure that the site is returned to a state approaching pre-construction when operations cease.

Should operations cease, the site infrastructure such as inlet canals, pond walls and bunding would gradually be eroded by tidal and weather events. However this would take a very long time, as evident by the remaining infrastructure from the failed artemia brine shrimp production facility at the south east end of the lease site. It is likely that the site would create potential mosquito breeding grounds from stagnant water etc. prior to the tidal flats being returned to their natural state.

The proponent will require a lease from Department of Land Administration (DOLA) to gain access to area for the intended use. As part of the lease agreement DOLA can require the applicant to lodge a 'performance bond' or similar to ensure there are sufficient funds to rehabilitate the site on completing of the project. The EPA would strongly encourage the requirement for such a bond being included in any Land Act lease.

Having particular regard to:

(a) the length of time natural forces would take to erode the structures; and

(b) the potential mosquito breeding areas that could develop in the mean time;

the EPA is of the opinion that the decommissioning of this site can be managed to meet the EPA's objectives provided that:

(a) a decommissioning management plan be prepared at least 1 year prior to decommissioning.

4. Conditions

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

In developing recommended conditions for each project, the EPA's preferred course of action is to have the proponent provide an array of commitments to ameliorate the impacts of the proposal on the environment. The commitments are considered by the EPA as part of its assessment of the proposal, and following discussion with the proponent the EPA may seek additional commitments.

The EPA recognises that not all of the commitments are written in a form which makes them readily enforceable, but they do provide a clear statement of the action to be taken as part of the proponent's responsibility for and commitment to continuous improvement in environmental performance. The commitments then form part of the conditions to which the proposal should be subject if it is to be implemented.

The EPA may, of course, also recommend conditions additional to that relating to the proponent's commitments.

Having considered the proponent's commitments and the information provided in this report, the EPA has developed a set of conditions which the EPA recommends be imposed if the proposal by the Kimberley Prawn Company Pty Ltd to construct and operate a prawn farm, is approved for implementation. These conditions are presented in Appendix 3. Matters addressed in the conditions include:

(a) the proponent shall fulfil the commitments in the Consolidated Commitments statement set out as an attachment to the recommended conditions in Appendix 3;

(b) In order to manage the environmental impacts of the project, and to fulfil the requirements of the conditions and procedures in this statement, prior to construction, the proponent shall demonstrate to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection that there is in place an environmental management system which includes the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation and operation of environmental requirements;
- measurement and evaluation of environmental performance; and
- review and improvement of environmental outcomes.

(c) the proponent shall develop and implement an Environmental Management Plan that incorporates the following elements:

- a Groundwater Monitoring and Management Plan (GWMP);
- a Vegetation Monitoring and Rehabilitation Plan (VMRP);
- a Dust Management Plan (DMP);
- a Water Quality Monitoring and Management Programme (WQMMP); and
- a Decommissioning Management Plan (DCMP).

5. Other Advice

5.1 Cumulative impacts

Although not considered to be a relevant environmental factor it is important to recognise the potential cumulative impacts of other developments, specifically the proposed tidal power project. These particularly relate to water quality and, to a lesser extent, mangroves.

The management of some issues such as water quality would best be addressed through joint management by both proponents.

The EPA has not yet completed its assessment of the proposed tidal power project.

It may also be appropriate for the development of a Management Plan for the whole Doctors Creek system to ensure other projects attracted to the area do not compromise the environmental values of the area or the sustainability of present uses.

5.2 Performance bond

The EPA recommends that the Department of Land Administration require a performance bond be placed on the lease by the Kimberley Prawn Company Pty Ltd to ensure that the land will be returned to a state similar to pre-construction upon decommissioning of the project.

6. Conclusions

The EPA has considered the proposal by the Kimberley Prawn Company Pty Ltd to construct and operate a prawn farm on the tidal flats of Doctors Creek near Derby.

The EPA is of the opinion that all stages of the proposal can be managed to meet the EPA's objectives for:

a) terrestrial fauna - impact on migratory birds and water birds;

b) terrestrial environment - impact on the proposed nature reserve and environmental values of the area;

c) aquatic vegetation and flora - impact on mangrove and samphire communities;

d) noise and dust control - during construction and operation; and

e) decommissioning - rehabilitation of the prawn farm site should operations cease.

The EPA is also of the opinion that Stage 1 of the proposal can be managed to meet the EPA's objectives for:

a) groundwater - impact on groundwater resource for Derby residents and dependent vegetation; and

b) water quality within Doctors Creek - from discharge water.

The EPA recommends that "in principle" approval only be given for the development of Stages 2 and 3 at this stage. Approval to commence the development of these stages will be provided after the results of monitoring during Stage 1 are completed that show subsequent development is unlikely to cause a significant environmental impact.

7. Recommendations

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA submits the following recommends to the Minister for the Environment:

1. That the Minister considers the report on the relevant environmental factors of terrestrial fauna, terrestrial environment, groundwater, aquatic vegetation and flora, noise and dust control, water quality in Doctors Creek and decommissioning as set out in Section 3.

2. The Minister notes that the EPA has concluded that Stage 1 of the proposal can be managed and subsequent stages can likely be managed in an environmentally acceptable manner, provided there is satisfactory implementation by the proponent of the recommended conditions set out in Section 4.

3. The Minister for Lands require a performance bond be placed on the lease for the prawn farm site to ensure decommissioning of the site is carried out to a satisfactory level.

4. The Minister imposes the conditions and procedures recommended in Appendix 3 of this report.

Appendix 1

List of submitters

Organisations:

Conservation Council of Western Australia
Department of Conservation and Land Management
Department of Land Administration
Derby Residents Action Group
Health Department of Western Australia
Kimberley Development Commission
Transport

Individual:

Ambrose Cummins

Appendix 2

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Appendix 3

Recommended Environmental Conditions and proponent's consolidated commitments

Statement No.

RECOMMENDED ENVIRONMENTAL CONDITIONS

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

PRAWN FARM, DOCTORS CREEK, DERBY

Proposal: The construction of a prawn farm in stages on the mud flats east of Derby. The final stage of the project will involve 650 hectares of prawn ponds on a 2000 hectare lease area with a prawn hatchery on-site. Seawater will be drawn from East Doctors Creek and discharged to West Doctors Creek (if a proposed tidal power station is approved in the area water will be drawn from West Doctors Creek and discharged to East Doctors Creek) after passing through a treatment system that consists of a settling pond and filter feeders to act as algal scrubbers, as documented in schedule 1 of this statement.

Proponent: Kimberley Prawn Company

Proponent Address: PO Box 867, Derby, WA 6728

Assessment Number: 976

Report of the Environmental Protection Authority: Bulletin 918

The proposal to which the above report of the Environmental Protection Authority relates may be implemented subject to the following conditions and procedures:

1 Implementation

1-1 Subject to these conditions and procedures, the proponent shall implement the proposal as documented in schedule 1 of this statement.

1-2 Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority.

1-3 Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

2 Proponent Commitments

2-1 The proponent shall implement the consolidated environmental management commitments documented in schedule 2 of this statement.

2-2 The proponent shall implement subsequent environmental management commitments which the proponent makes as part of the fulfilment of conditions and procedures in this statement.

3 Environmental Management System

3-1 In order to manage the environmental impacts of the project, and to fulfil the requirements of the conditions and procedures in this statement, prior to ground-disturbing activity, the proponent shall demonstrate to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection that there is in place an environmental management system which includes the following elements:

1. environmental policy and commitment;
2. planning of environmental requirements;
3. implementation and operation of environmental requirements;
4. measurement and evaluation of environmental performance; and
5. review and improvement of environmental outcomes.

3-2 The proponent shall implement the environmental management system referred to in condition 3-1.

4 Groundwater Monitoring and Management Plan

4-1 Prior to commencement of construction of Stage 1 (as defined in Schedule 1), the proponent shall prepare a Groundwater Monitoring and Management Plan to protect the groundwater reliant values and the groundwater resources, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Water and Rivers Commission.

This Plan shall address:

1 the water requirements at maximum production;

2 environmental management of groundwater quality at the perimeter of ponds, at the lease boundary and around the abstraction bore(s); and

3 contingency plans, including, for example, the sealing of ponds, in the event that monitoring shows salt water leaching into groundwater.

4-2 The proponent shall implement the Groundwater Monitoring and Management Plan required by condition 4-1.

4-3 Prior to commencement of Stages 2 and 3 (as defined in Schedule 1), the proponent shall review and modify the Groundwater Monitoring and Management Plan given the results of monitoring during Stage 1, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Water and Rivers Commission.

4-4 The proponent shall implement the appropriately modified Groundwater Monitoring and Management Plan required by condition 4-3.

4-5 The proponent shall make the Groundwater Monitoring and Management Plan required by condition 4-1 publicly available, to the requirements of the Environmental Protection Authority.

5 Water Quality Monitoring and Management Program

5-1 Prior to commencement of construction of Stage 1 (as defined in Schedule 1), the proponent shall prepare a Water Quality Monitoring and Management Program to ensure that acceptable water quality is maintained in Doctors Creek, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Water and Rivers Commission.

This Program shall address:

1 the background water quality of East and West Doctors Creek;

2 monitoring parameters and frequency;

3 the water quality criteria to be maintained in Doctors Creek during Stage 1 and modified as required for subsequent stages using information gained during monitoring;

4 volume of discharge water expected during Stage 1;

5 impacts on water quality from acid sulfate soils;

6 the size and design of water treatment systems to show that the water quality criteria can be met and subsequent modifications to water treatment design based on information gained during monitoring and operations; and

7 the preparation of a contingency plan in the event that the proponent is unable to meet the water quality criteria.

5-2 The proponent shall implement the Water Quality Monitoring and Management Program required by condition 5-1.

5-3 Prior to commencement of Stages 2 and 3 (as defined in Schedule 1), the proponent shall review and modify the Water Quality Monitoring and Management Program given the results of monitoring during Stage 1, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Water and Rivers Commission.

5-4 The proponent shall implement the appropriately modified Water Quality Monitoring and Management Program required by condition 5-3.

5-5 The proponent shall make the Water Quality Monitoring and Management Program required by condition 5-1 publicly available, to the requirements of the Environmental Protection Authority.

6 Vegetation Monitoring and Rehabilitation Plan

6-1 Prior to commissioning, the proponent shall prepare a Vegetation Monitoring and Rehabilitation Plan to protect locally and regionally significant vegetation associations and

habitats to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection.

This Plan shall include:

1 a monitoring program which details the health of samphire and mangrove communities and will be able to record changes to the community health or structure over time;

2 rehabilitation measures for areas of samphire or other communities disturbed during construction which are no longer needed during operation; and

3 a setback of 150 metres from mangrove growth for the bunding and pond construction;

6-2 The proponent shall implement the Vegetation Monitoring and Rehabilitation Plan required by condition 6-1.

6-3 The proponent shall make the Vegetation Monitoring and Rehabilitation Plan required by condition 6-1 publicly available, to the requirements of the Environmental Protection Authority.

7 Dust Management Plan

7-1 Prior to construction, the proponent shall prepare a Dust Management Plan to ensure statutory requirements for dust and noise management are being met, to the requirements of the Environment Protection Authority on advice of the Department of Environmental Protection.

This Plan shall address:

1 monitoring methods to detect dust levels;

2 dust suppression techniques to be implemented during construction to minimise dust generation; and

3 dust suppression techniques to be implemented during operation to minimise dust generation.

7-2 The proponent shall implement the Dust Management Plan required by condition 7-1.

7-3 The proponent shall make the Dust Management Plan required by condition 7-1 publicly available, to the requirements of the Environmental Protection Authority.

8 Decommissioning Management Plan

8-1 At least twelve months prior to decommissioning, the proponent shall prepare a Decommissioning Management Plan to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection.

This Plan shall address:

1 removal or, if appropriate, retention of plant and infrastructure;

2 rehabilitation of all disturbed areas to a standard suitable for an agreed new land use(s);

3 identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.

8-2 The proponent shall implement the Decommissioning Management Plan required by condition 8-1.

8-3 The proponent shall make the Decommissioning Management Plan required by condition 8-1 publicly available, to the requirements of the Environmental Protection Authority.

9 Performance Review

9-1 Each six years following the commencement of construction, the proponent shall submit a Performance Review to the Department of Environmental Protection:

- to document the outcomes, beneficial or otherwise;
- to review the success of goals, objectives and targets; and
- to evaluate the environmental performance over the six years;

relevant to the following:

1 environmental objectives reported on in Environmental Protection Authority Bulletin 918;

2 proponent's consolidated environmental management commitments documented in schedule 2 of this statement and those arising from the fulfilment of conditions and procedures in this statement;

3 environmental management system environmental management targets;

4 environmental management programs and plans; and/or

5 environmental performance indicators;

to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection.

Note: The Environmental Protection Authority may recommend changes and actions to the Minister for the Environment following consideration of the Performance Review.

10 Proponent

10-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the Environmental Protection Act is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person in respect of the proposal.

10-2 Any request for the exercise of that power of the Minister referred to in condition 11-1 shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.

10-3 The proponent shall notify the Minister for the Environment of any change of proponent contact name and address within 30 days of such change.

11 Commencement

11-1 The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposal has been substantially commenced.

11-2 Where the proposal has not been substantially commenced within five years of the date of this statement, the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment will determine any question as to whether the proposal has been substantially commenced.

11-3 The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in conditions 11-1 and 11-2.

11-4 Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.

12 Compliance Auditing

12-1 The proponent shall submit periodic Performance and Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection.

12-2 Unless otherwise specified, the Chief Executive Officer of the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal clearances.

12-3 Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.

Note

1 The proponent is required to apply for a Works Approval and Licence for this project under the provisions of Part V of the Environmental Protection Act.

2 Co-operative management of water quality in Doctors Creek, to maintain acceptable water quality criteria, may be required if the proposed tidal power station (Assessment Number 1073) is to be implemented.

Schedule 1

The Proposal

A prawn farm is to be developed in stages on the mud flats east of Derby. The final stage of the project will involve 650 hectares of prawn ponds on a 2000 hectare lease area with a prawn hatchery on-site. Seawater will be drawn from West Doctors Creek and discharged to East Doctors Creek (if a proposed tidal power station is approved in the area water will be drawn from West Doctors Creek and discharged to East Doctors Creek) after passing through a treatment system which consists of a settling pond and filter feeders to act as algal scrubbers.

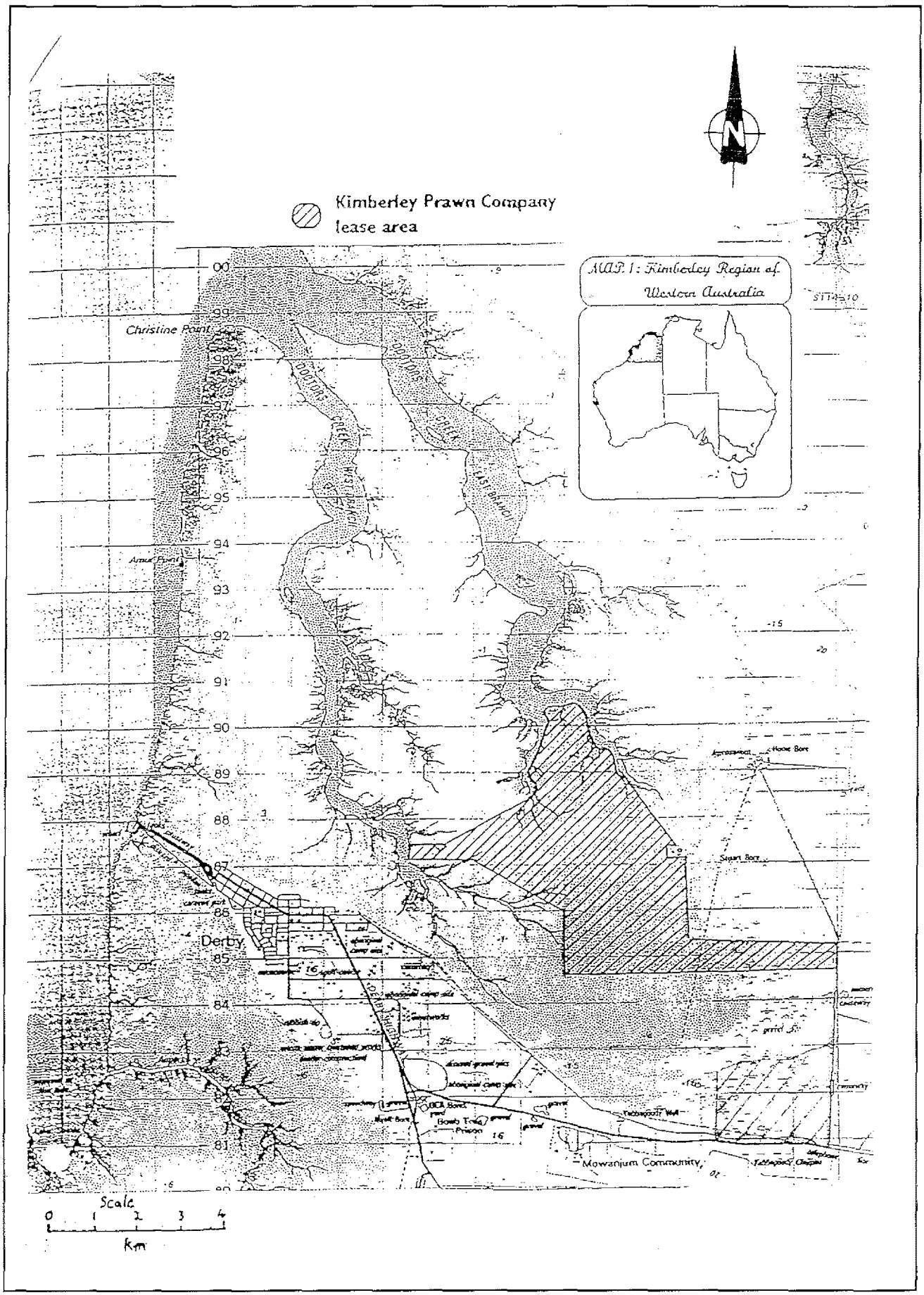
Key characteristics table

Element	Description
Project development	Stage 1 (year 1) 20 x 1 hectare ponds Stage 2 (years 2 & 3) 100 x 1 hectare ponds Stage 3 (years 4 to 10) 650 x 1 hectare ponds
Hatchery development	Stage 3
Area of lease	2000 hectares
List of major components • ponds • bunding • inlet canal • infrastructure (water supply, roads, power) • distribution channel • outflow canal • workshop • process shed • office • accommodation	refer to attached maps
Employment • up to 35 Full Time Employees and some seasonal employment	By stage 2

Species to be used • *Penaeus monodon* (Black leader prawn) • *Saccostrea echinata* (King Sound Rock Oyster) • *Amusium balloti* (Saucer scallop) • *Artemia salina* (Brine shrimp)	Supplied from local hatcheries and/or wild collection under licence from Fisheries WA.
Feed supply • Pelletised fish meal • lupins • super phosphate (for phytoplankton production)	Quantity to be determined during production
Vehicle fuel storage	In accordance with the Department of Mineral and Energy requirements
Electrical power	Taken from existing power lines at the land-based site and power line in Sutherland Street, Derby.

Map

A map of the region and lease area of the prawn farm is shown in Map 1. The grey shaded areas show approximate mangrove distribution, dotted areas show extent of mud flats and cross-hatched area shows proposed lease site.


Kimberley Prawn Company lease area
MAP 1: Kimberley Region of Western Australia
Christine Point
Derby
Mowanjum Community
Scale
0 1 2 3 4
km

Map 1.

Schedule 2

Proponent's Consolidated Environmental Management Commitments

2 December 1998

Prawn Farm, Doctors Creek, Derby (976)

Kimberley Prawn Company Pty Ltd

Table 1: Proponent's Environmental Management Commitments

TOPIC	COMMITMENT	OBJECTIVE	ACTION	TIMING	WHOSE ADVICE	MEASUREMENT/ COMPLIANCE CRITERIA
Public Access	1. Maintain public access to the two arms of Doctors Creek.	To maintain existing recreational access to Doctors Creek.	Construct a raised crossing over the canal to West Doctors Creek.	Before the start of the operation phase.	Shire of Derby - West Kimberley	Letter to DEP from Shire confirming construction of accessway.
Drainage	2. Construction design to minimise erosion, all internal drainage, including from processing shed, directed to settling ponds and oil interceptors in workshop drainage.	To ensure protection against erosion, storm surge, cyclonic flooding and dust and noise protection.	Incorporate appropriate design considerations.	During design phase.	DEP	Not audited by DEP.
Imported feed	3. All imported feed to be held under strict import quarantine arrangements.	To minimise the risk of introducing disease.	Liaise with AQIS as to quarantine requirements.	Before and during operation phase.	Fisheries WA / AQIS	AQIS approval to import.
Mangroves	4. No mangrove or samphire will be cleared during the construction or operation phase.	To protect mangrove and samphire communities.	Avoid areas of mangroves and samphire during construction.	During design and construction phase.	DEP	Before and after photographic monitoring.
	5. The quality, physical appearance, and health of mangroves in the discharge creek will be monitored to ensure the discharge water from the prawn farm is having no	To protect the mangrove communities.	Undertaken mangrove monitoring.	During construction and operation phases.	DEP	On-going photographic monitoring.

	adverse effects on mangroves of Doctors Creek.					
Rehabilitation	6. As required rehabilitation will be carried out and monitored to ensure that the vegetation approaches pre-construction conditions.	To rehabilitate disturbed areas of vegetation.	Undertake replanting, reseeding or other rehabilitation work, including monitoring, as required.	During construction and operation phases.	DEP	Results of monitoring included in annual progress and compliance report. Rehabilitated areas to approach similar condition to pre-construction.
Decommissioning	7. On decommissioning of any part of the project, the decommissioned area will be rehabilitated to pre-construction conditions, in accordance with Best Practices for the prawn industry.	To ensure there are no long-term impacts to the site after decommissioning.	Decommissioned areas will be rehabilitated to pre-construction conditions.	On decommissioning of any or all of the project.	DEP, Shire of Derby - West Kimberley, Department of Land Administration.	Letter of compliance from DOLA and the Shire.
Aboriginal heritage	8. A heritage survey will be commissioned over the lease area.	To identify any areas of Aboriginal significance.	Undertake heritage survey.	Before construction.	DEP and Aboriginal Affairs Department.	Copy of heritage survey report to the DEP or letter of a approval from Aboriginal Affairs Department.
	9. In compliance with Aboriginal Heritage Act of WA, construction work in the immediate area will cease until approval to re-commence is given by the Aboriginal Affairs Department if any Aboriginal	To protect any areas of Aboriginal significance.	Stop construction in vicinity if significant Aboriginal site is discovered.	During construction.	DEP and Aboriginal Affairs Department.	Letter of advice from Aboriginal Affairs Department.

	artefacts or burial sites are discovered or inadvertently disturbed.					
Water quality	10. Kimberley Prawn Company will prepare a water quality monitoring program to ensure that water quality in the discharge creek is not compromised and any adverse effects are detected and rectified quickly.	To protect water quality in the discharge creek.	Prepare and implement a water quality monitoring program that sets out water quality criteria, details of monitoring sites, frequency of monitoring and reviews of monitoring as required.	Prior to operation.	DEP	Copy of monitoring results as evidence of compliance with water quality criteria.
Disease Management	11. Kimberley Prawn Company will implement a disease contingency plan to control the possible escape of disease into wild stock, should an outbreak of disease occur.	To protect wild prawn stocks from introduced disease.	Prepare a disease contingency plan.	Prior to operation.	DEP and Fisheries WA.	Letter of acceptance from Fisheries WA.
Code of Practice	12. The Kimberley Prawn Company will comply with all the requirements of the draft Environmental Code of Practice for Prawn Farmers.	Minimise environmental impacts from prawn farming.	Comply with draft Code of Practice.	At all times.	DEP and Fisheries WA.	Demonstrated by compliance with other conditions and commitments.

(part of 3824)

Kimberley Prawn Company CER, Doctors Creek (976)

Response to sumissions

1. Concern that the CER does not meet the EPA guidelines :

The document "*Environmental Review Guidelines for Proponents* " EPA 1993 states on page 5 that "*These guidelines offer suggestions on how environmental review documents might look, though their preparation and structure depends on the projects proposed .*"

The Kimberley Prawn Company CER does not follow the EPA guidelines word for word at the request of the Department of Environment Protection who asked KPC to follow the CER of a proposed prawn farm CER for Cape Seafarms at Exmouth.

- On page 9 of the EPA Guidelines, under "*4. Location* " are the words "*The proposed location ... should be described, and include where relevant :*
  - contour maps "

The KPC CER shows a contour map (Map 1 on page 2) showing the proposed site in relation to WA and to the town of Derby. The layout of the works proposed in stage 1 is shown on the map on page 16 of the CER.
The nature and extent of the works is shown in the Figures 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, of the CER. We can find no reference to scaled aerial photographs in the Guidelines.

- The ponds drawn on page 16 are approximately to scale. They are also shown in Figures 1 and 1a after page 70. The ponds are described on page 13 of the CER, at 3.2.5 on page 18. Other details are shown in drawing 1 on page 19 and drawing 2 on page 22 of the CER. A plan view was presented in the "*Application for a Fish Farm Licence to Inter Department al Committee on Aquaculture* " page 8.

- Details of the siting of buildings is contained in the map on page 16, Figure 1 and 1a, Figure 15 and Figure 16 after page 70. A description of the buildings is at 3.2.9 of the CER on page 23, in Commitment 2 on page 24.

- References used to draw conclusions made in section 7.1.1 of the CER on page 52 are contained in the body of the CER and are to published sources and KPC's monitoring though not all published material read by the proponents is cited. Published information

that is cited is found at 8.1 on page 64 of the CER.

- The receiving environment is described in the CER in the site summary on page 14 and by description in section 4, pages 30-31 of the CER. It is also extensively described in published reports (Jennings and Coventry 1973; Semeniuk, Kenneally and Wilson 1978; Semeniuk 1980a, 1980b, 1981,1982; Johnstone 1990; Water Authority of Western Australia 1992, 1993; Gutteridge, Haskins and Davey Pty Ltd (1983); Martinick and Associates Pty Ltd 1995; Halpern Glick Maunsell Pty Ltd 1997.

The project should take seawater from the Doctors Creek system and return it to that system removing suspended solids and filtering out phytoplankton and nutrients on the way. Since application to the interdepartmental Committee on Aquaculture, the KPC has been in contact with the Derby Hydro Power Pty Ltd. As the receiving environment of East Doctors Creek will be changed at least physically under their proposal a detailed study of the existing environment has not been undertaken, as any impact of the prawn farm is likely to be minimal. The aim of KPC is to ensure that the receiving environment is not affected by the operations of the prawn farm. Once approval is given for the prawn farm to proceed, monitoring of the Doctor's Creek system will be extended beyond the data collected by the Company to date. These data are summarised on page 30 for 3 years of data. The monitoring program is outlined in the CER at 7.1-7.3 on pages 52-56. Commitments 10, 11 on pages 53, 54 commit KPC to ensure that the prawn farm has no adverse affects on mangroves in Doctors Creek and to a water monitoring program to be undertaken to the satisfaction of the DEP.

2. Change in receiving environment

As indicated in issue 1, the changes that would occur in the receiving water have been considered. The first change would be that the water returned to East Doctors Creek would be much clearer than the water in the Creek but KPC is confident that the original sediment load would quickly reestablish itself. If the water from the prawn farm were let into East Doctors Creek without passing through the secondary species ponds, then there would also be some phytoplankton in the water and some primary productivity; however, since the turbulent tidal flow will entrain the mud from the Creek bed, the light attenuation in the Creek should quickly return to its normal value of 90% extinction in 0.1-0.3m and the phytoplankton could not photosynthesize unless in the top 0.1-0.3m of the water.
Because of the effect of the DHP proposal, a drop of 3.5- 4 m in East Doctors Creek would

result in drying out of the existing mangrove forest and a relocation of mangroves to the new water level. KPC water being returned to the East Doctor's Creek would counteract the drying out of the upper reaches of East Doctors Creek to some extent. The water quality should be undiminished, due to the clarifying effects of the secondary species ponds. Should the DHP project proceed, the salinity of West Doctor's Creek would increase due to evaporation from the high basin., but stratification if it were to occur would encourage water of greater salinity to sink provided the temperature difference between the surface and lower depths was not too great. The effects of DHP's high basin should be a reduction in turbidity of the intake water with a slight increase in salinity. The tidal flushing of the discharge water will be slightly reduced by DHP's activity but drainage from the secondary species ponds should be achieved at all stages of the tidal cycle. Eutrophic conditions could not exist with the existing tidal exchange nor that proposed by DHP for East Doctors Creek. In any event, the secondary species ponds are designed to remove all algae and nutrients from the prawn pond effluvium.

3. Destruction and alternative sites

There is no basis for an assertion that KPC will destroy an "*internationally significant mangrove and coastal system.* " or of "*Nationally to State-wide significant geoheritage sites and destruction of the tidal flat to hinterland inter-relationships* ".

First, KPC is not going to remove or destroy mangroves (CER page 11, at 4:1 on page 30, at 6.1 on page 39, commitment 6 on page 40 and at 6.7 on page 47).
Second, the mangroves of East Doctors Creek will be affected by Derby Hydro Power changing the height of the eastern arm not by KPC. As indicated in the Halpern Glick Maunsell report "*Derby Tidal Power Project , Doctors Creek Kimberley* ", Derby Hydro Power Pty Ltd expect 3 ha of mangroves to be directly affected and 1819 ha in East Doctors Creek to be affected by a change in the height of the mangroves within the Doctors Creek system. They expect however a greater area of mangroves will re-establish lower down the creek walls.

Adjacent to KPC's site the mangroves are in a band some 5-20m in width. The area of mangroves in Doctors Creek is some 0.7% of north-west WA mangroves (HGM 1997). Similarly, the area that KPC seeks to use as its prawn farm is a very small proportion of mudflats of similar type in north-west WA and NT. KPC has no knowledge of heritage listing of the hypersaline mudflat. It is not intended that any destruction should occur, but

some modification. At present the mudflat is inundated by tides 1% of the time (Semeniuk 1981) and is also subject to monsoon rain. Under KPC's proposal, some of the mudflat (that part under the ponds, canals and channels) will remain under saline water for longer periods and that part to be made into walls will only be subject to salt water on the inside of the walls and subject only to monsoonal rain on the outside of the walls as well as spindrift from the King Sound.

KPC does not anticipate destroying '*tidal flat to hinterland ground water inter-relationship* '. The hypersaline mudflat upon which and with which the ponds will be built is above that part of the stratigraphy that interacts with groundwater. The water table is 2-3m below the mudflat surface (Semeniuk 1981) and the pond excavations will only go down to a depth of 0.5m from the current mudflat surface. Groundwater relationships are also discussed at issues 13, 19, 30. Alternative sites were considered and are listed in the CER at 2.8 on page 10.

4. Land base site

The old *Artemia* site was chosen for the location of the buildings due to the existing concrete pads and close power lines. The logistics of running the farm with real time laboratory analyses required for the monitoring program dictate that buildings must be on-site. The old *Artemia* site will keep buildings off the mudflat and the buildings will be surrounded by trees and shrubs. No cumulative impacts are mentioned.

5. Understanding Draft Environmental Code

"*Ecology* " is that branch of biology that relates to organisms and their interaction with their habitat. Because of hypersalinity on the mudflat there is an absence of organisms and hence no important aspects of ecological value. The site was particularly chosen to avoid "*ecological* " problems. As stated by Semeniuk (1982) page 53, "*Groundwater hypersalinity precludes biota over most of the flat.* " One of the reasons for choosing this area was that environmental values were not as important as at some other sites being considered. It is 2,000 ha of some 2600 km^2 (260,000 ha) of mudflat in King George Sound. As indicated in the CER at 2.8 on pages 10-11, five alternatives were considered and this site was preferred due to an absence of vegetation and other biota.

The draft Environmental Code of Practice for Australian Prawn Farmers was developed in

NSW and Qld where vegetation and fauna occur naturally on the farm sites. Compare Figures 5-14 of KPC's CER, photographs taken on Qld prawn farms, with Figures 4, 15, 16 and 17 photographs taken at the Doctors Creek site.

6. Draft Code of Practice

- Tidal hydrology of King Sound and Doctors Creek is reasonably well known. Tide tables are available for the area and inundation of the hypersaline mudflat can be predicted from the tables. The CER discusses tidal hydrology at 4.1, 4.2, 4.3 on pages 30 and 31. Semeniuk 1982, discusses tides, turbidity and erosion processes. Tides and tidal streams are also discussed by Martinick and Associates Pty Ltd (1995). Halpern Glick Maunsell Pty Ltd (1997) page 26, include a section on "Hydrodynamics and Water Quality". In this section, results of field surveys are reported as well as the use of a hydrodynamic model the Environmental Fluid Dynamics Code.

If the Derby Hydro Power Project proceeds, then the tidal hydrology will be changed (HGM page 25-28).

- KPC has measured salinities in the mud on the mudflat at 180 parts per thousand up to 240 parts per thousand; which is why there is no existing flora and fauna on the mudflats. Semeniuk (1982) also recorded 240 parts per thousand salt in groundwater on the mudflat. The samphire occurs on the seaward side of the mudflat just above the mangal where tidal inundation and receding rain enables the samphire to survive. Samphire also occurs at the landward side of the mudflat and presumably survives on rainfall and runoff. Other flora and fauna of the mangal are summarised by KPC in the CER at 5.0 on pages 36-38. Summaries of flora and fauna of the estuary can be found in Semeniuk 1980a, Johnstone 1990 and Martinick and Associates 1995.

- Acid sulphate soils occur in some mangrove areas of Queensland. There are no known acid sulphite soils on the Doctors Creek mudflat. If they were, they could be ameliorated. All soils sampled by KPC were in the pH range of 7-8.5. Semeniuk (1982) found gypsum on the mudflats.

- KPC has had the mudflat clay tested for its suitability for pond walls (see CER site details p14). As the clay of the creeks is currently subject to much higher volumes in each tidal cycle than is proposed by KPC, erosion is not expected to be an insurmountable

problem.

- There is little surface runoff in this area; most freshwater exists as groundwater (see CER page 28, 4.4 on pages 32-35). After heavy rain, some surface pooling of water occurs on the mudflat but within days this water is absorbed/evaporated.

- The only expected difference between intake water and effluvium is (1) lower suspended particulate matter and (2) a slightly higher salinity. Due to the volumes of water entering East Doctors Creek each tidal cycle, the ability of the system to assimilate the clearer more saline water is high. In West Doctors Creek there is 7 km^2 of water and in East Doctors Creek there is 12 km^2 of water. For a 10m tidal cycle some 120 x 10^6 m3 are exchanged. For an average daily exchange of pond water of 15%, then for one pond there is a 40,000 times dilution factor, for 6 ponds there is a 6,666 times dilution factor, for 20 ponds a 2,000 times dilution factor, for 100ha a 400 times dilution factor and for 640 ponds a dilution factor of 63.

- The concept of "*environmental value* " is subjective and like beauty is in the eye of the beholder. The area chosen for the prawn farm site is a hypersaline mudflat. Semeniuk (1981) on page 210 states that "*Hypersalinity, infrequent tidal recharge and infrequent wetting results in absence of biota over much of the flat* ". Accordingly the environmental value of the mudflat is not because of some unique or rare wildlife. Visually it its a shimmering flat plain. It is not unique in the region being but a small proportion of 2600 square kilometres of hypersaline mudflat in King Sound and a smaller proportion of similar mudflats of the entire north-west of Australia from Port Hedland to Darwin. The Draft Environmental Code of Practice for Australian Prawn Farmers calls for site specific performance indicators using "*environmental values of the receiving environment* " (page 6). This is referring to the measurement of parameters as outlined in Section 7 of the CER on pages 52-57.
- As outlined above, in the CER at 4.4 on page 32, and quoted by Semeniuk (1982) on page 51, salinities on the mudflat are up to 240 parts per thousand or 24 % salt. Accordingly the mudflat is devoid of life except right at the creek margins. That is why there can be no impact on biodiversity or environmental values. Section 6.0 of the CER on page 39 deals with environmental impact and management. One possible impact is visual; due to the usual heat haze and distance of any observer outside the lease area, it is not expected to be a problem; one method of managing that visual impact is to vegetate the canal margins. KPC intends to experiment with suitable species. At present, all vegetation is outside the area of proposed pond construction.

7. Baseline studies and effluent

There are no algae in the soil on the site because the mudflat is hypersaline. Any oceanic phytoplankton would find growth difficult in King Sound as 99% of the incident light is attenuated in the top 0.1-0.3m (4-12 inches)(Halpern Glick Maunsell 1997). Under the current tidal regime in King Sound, primary production through photosynthesis must be minimal. Phytoplankton chlorophyll levels expected in the effluvium from the prawn farm are of the order of 1-10 µg/ L as indicated in the CER on page 57. The operations of Derby Hydro Power will physically alter the level of water in East Doctors Creek. Any baseline data collected prior to a decision to proceed on that project would be of diminished usefulness for the purpose of determining the effects of the prawn farm effluvium on the receiving waters of East Doctors Creek. The two effects would be confounded.

8. Sediment load in Doctor Creek

Yes. KPC has conducted experiments on sedimentation rates and within a few hours, the suspended sediment in the waters of Doctors Creek will settle out. In the Halpern Glick Maunsell CER on Derby Hydro Power's Doctors Creek Project, on page 64 is the assertion that "*the high basin will result in a decreased silt load* ". No, the project is based not an assumption that entrained sediment will drop out of the intake water. KPC is of the opinion that this is an engineering problem to be solved with or without Derby Hydro Power's high basin.

9. Dredge spoil

Dredge spoil was intended to be placed onto the outside of canal walls, and pond walls <u>not</u> the bund walls (CER at 2.1 on page 7). It is appropriate placement when its purpose is the management of a possible environmental impact namely visual. The concept is to use the detrital material to assist the vegetation of the outside of the walls. No dust problem is expected but if that occurs then the detrital material will be used as fertiliser on terrestrial farms. The amount of material in each cycle from a pond is less than a cubic metre.

10. Secondary species ponds

There is a body of literature on the pumping rates and feeding efficiencies of bivalve molluscs. Other species which will eat phytoplankters include *Artemia* , *Trochus* and larval finfish. Jones and Preston 1996 presented a paper at the World Aquaculture Society meeting in Bangkok in 1996 on biofiltration of shrimp pond effluent by oysters. A preçis of their findings is presented in the CER at 3.2.7 on page 20 and their paper is cited in the references of the CER at 8.1 on page 64. They found that 80% of phytoplankton could be cleared in three passes of a race filled with oysters. One of the Directors of KPC visited the Mexican government's CIBNOR laboratories at Ensanada de La Paz in 1997 and saw shrimp ponds where scallops of the species *Argopecten ventricosus* were grown at a density of 4 million per one hectare pond. For KPC, if the shellfish do not remove sufficient phytoplankton then the water can be recycled through the secondary treatment ponds and the ponds can be used in series. The number of secondary species ponds will increase as the number of prawn ponds increases. They will be sited near East Doctors Creek as indicated in Figure 1a in the CER. A description of cleaning of ponds and disposal of solids is contained in the CER at 2.1 on page 7. "mechanical extraction " will probably be an excavator but it could be a dragline and Clarke shovel. The solids will be disposed of on the site to encourage vegetation and to improve the aesthetic appeal of the site.

11. Feed analysis

Feed will be sourced from Thailand and Indonesia initially then later from Australia. Feed is predominantly fish meal that has been mixed with vitamins and carbohydrates, heat treated and pelletised. All feeds imported are subject to Australian Quarantine Inspection Service checks for disease etc. It is not intended by KPC to feed antibiotics to prawns; see CER section 3.3 on page 24 and Commitment 3.

12. Farm escapees

Fisheries West have a requirement that farmed species should where possible be native to the area. These details are contained in the Fish Farm Licence when issued. In the CER at 2.1 on page 6, the principle species to be farmed is *Penaeus monodon* or leader prawns native to northern Australia. Acquisition of stock is dealt with in the CER at 3.4 on page 25. In Asia, this species is known as black tiger. The potential impact of escapees is that they could

augment the local population of leader prawns in King Sound. If they were not local stock there could be other genetic implications. It is not in KPC's interests to have any escapees. If there were any, Doctors Creek would not be particularly suitable but other areas of King Sound may support a population.

The outlet of each pond will have a screen to prevent escapes; any that do would perish in the discharge canal to the secondary species ponds. As indicated in the CER at 3.2.7 on page 20, the secondary species pond sluice gate will have fine mesh screens and a one-way valve. This is shown in Drawing 2 on page 27. After the discharge canal, the return channel will hold water until tested and accepted for release.

13. Fresh water requirements

No estimates of fresh water requirements were given. As indicated at 2.3 on page 8 of the CER, it seems from calculations done on temperature/salinity data collected by the Company over the last 3.5 years that freshwater may not be required for reducing salinity in ponds. However if the Derby Hydro Power Doctors Creek Project proceeds, then the salinity of West Doctors Creek may rise sufficiently for 'fresh' water to be required. KPC have kept in contact with Water Resources over the last three years of its application to proceed with the prawn farm project. Water Resources will set limits to extraction as they see fit.
As observed on page 35 of the CER, KPC will, by extracting slightly saline (unpotable) water from the unconfined aquifer, help halt the inland migration of the saltwater interface caused by too much extraction inland. This subject is also addressed in the CER at 6.5.5 on page 43 and 6.5.6 on page 44. Accordingly it is an appropriate use of water resources on the Derby mudflats.

14. Organic waste

There is little smell from the detritus from prawn farms. Any smell has usually dissipated after a few days; only the employees will be able to smell it. On Drawing 1 on page 19 and Drawing 2 on page 22 of the CER, it can be seen that any material washed off the outside of the pond wall would settle in the discharge canal and be transported to the secondary species ponds where nutrients would be removed. The potential does **not** exist for the material to wash directly into neighbouring waterways.

15. Research, tidal flat and marine ecosystems

Data collected by the Company remains commercially in-confidence and includes temperature, salinity, water analyses including pH, suspended solids, BOD, nitrogen, phosphorous. KPC has also had soils tested for suitability for pond construction etc. The hypersaline mudflat and the mangal have been extensively researched by others (Jennings and Coventry 1973; Semeniuk 1980a, 1980b, 1981,1982; Water Authority of Western Australia 1992, 1993; Martinick and Associates 1995; Halpern Glick Maunsell 1997). The CER refers to this research at 4.3 on page 31 and 4.4 on pages 32-33 at 5.1 and 5.2 on page 36, at 5.3 on page 37, 5.4 on page 38, 6.1 and 6.2 on pages 39 and 40.

No research was attempted on the marine ecosystems (a) because there would be no anticipated effects on them or neritic ecosystems and (b) the Derby Hydro Power Project will significantly change the hydrological regime of East Doctors Creek rendering any such research otiose. Once approval is given for the prawn farm to proceed, environmental monitoring research will be undertaken in accordance with section 7.0 on pages 52-57 of the CER and in accordance with EPA licence conditions.

16. Climate change

Cyclones are discussed in the CER at 4.2 on page 30-31. The prawn industry world-wide occurs in equatorial, tropical and sub-tropical areas where diurnal downpours, monsoonal rains and cyclones occur. The industry in eastern Australia is spread from Port Stevens in NSW to Mossman in Queensland, all localities subject to heavy cyclonic rain. The batters on the walls and the slopes of the canals and channels have been designed to cope with cyclonic rain and high water flows.

There is no consensus among climatologists as to the extent of a sea level rise caused by global warming. Recent international conferences have reduced the forecast rise of sea level to about 0.3m over the next 30 years. Also climatologists do not agree on the effect that global warming might have on the amount of precipitation. As an example, with increased temperatures there would initially be greater thermal activity in tropical regions and more rain and increased evaporation from water surfaces leading to a greater cloud buildup and cloud cover which would reduce ground temperatures and thermal activity and diminish the intensity of storms. Rainfall may actually decline in a warmer and more humid world.

17. Earthquakes

Derby is not considered to be in an earth quake zone. All of Australia is not considered to be particularly vulnerable to earthquakes though they do occur. Damage from earth quakes is usually more severe when a building or structure is over or near the plate boundaries or fault lines in rock. Derby is built on quaternary alluvium deposits and earthquakes which may occur in the rock strata to the north or east of Derby will be felt as ripples or shock waves across the mudflat. Heaving damage would be much less severe than over the rock strata. Derby buildings suffered no damage in the August 1997 tremor because of this. The only implications for an aquaculture development would be that in a severe earthquake breaches could occur in pipes and power could be temporarily cut off. Given that prawn farms operate successfully in Japan, Taiwan, China, Thailand, Vietnam, Malaysia and Indonesia as well as Ecuador and Mexico would indicate that earthquakes are not a serious problem.

18. Changes in Tidal Flow

The Draft Environmental Code of Practice for Australian Prawn Farmers mentions on page 8, that "*The intake and discharge of seawater for a prawn farm has the potential to impact on estuaries and creeks through an increase in the tidal flow and subsequently the tidal prisms of the estuaries and creeks. Significant changes have the ability to impact on stream bank stability, which in turn may indirectly impact on the aquatic flora and fauna of the affected estuaries* ." Nowhere in that document can KPC find a recommendation for research into impacts of changes in tidal flow and prisms etc. Note that the Draft Code is a document written for Queensland and NSW prawn farmers where typically the tidal amplitudes are 1.5-2m and the saltwater creeks from which they source their seawater are narrow and steep sided alongside cane farms and other agriculture. The rough nature of Doctors Creek and King sound with a 10m tidal amplitude is a far cry from the gentle laminar flow tidal creeks in Queensland. The effects described in the quotation above would not be seen in Doctors Creek because the return flow from the Kimberley Prawn Company's farm would be such a small proportion of the existing robust turbulent tidal flow in Doctors Creek. In contrast, the amount of water pumped in some eastern State prawn farms is large in comparison with the usual tidal flow.

This quote from the Draft Environmental Code of Practice for Australian Prawn Farmers comes from the section heading on page 7 of 'Potential Environmental Impacts' and the opening paragraph of the section implies that most of these potential problems have not yet

been seen in Australia. No research on these issues is recommended by the Draft Environmental Code.
As indicated in several issues above, the changes to tidal levels and tidal stream flows would have made such research redundant.

19. Hydrological effects

The Freshwater requirements of the prawn farm will be as described in the CER at 2.3 on page 8, the table on page 28, at 4.4 on pages 32-35, 6.5.6 on page 44, and table 6.7 on page 51.
Prawns breed and eggs hatch at sea in salinities of 33-35 part per thousand. The problem of obtaining high quality hatchery water will not be fresh water but seawater with a low suspended particulate matter as possible.

- As indicated in responding to issue 13 above, Water and Rivers Commission expect that by KPC extracting brackish water from the unconfined aquifer, fresh water will be drawn towards the bore from inland reducing the salinity of the aquifer inland. Salt water may also be drawn to the bore from seaward but it would only affect the farm.
- If the level of seawater drops in both arms of Doctors Creek as indicated in the Derby Hydro Power Project CER (Halpern Glick Maunsell 1997), then the saltwater will have less hydrostatic pressure and the direction of flow should be from the land, provided that other users do not overuse the aquifer. KPC could utilise brackish water that would be useless to others. The water extracted would lower the water table if the level of extraction exceeded its replenishment. Any water extracted would be under licence from the Water and Rivers Commission.
- No fringing vegetation will be affected by KPC as no mangroves will be disturbed and water taken from Doctors Creek will be returned to Doctors Creek with parameters within the values quoted for Western Australian Water Quality Guidelines for Fresh and Marine Waters. (EPA 1993). KPC's commitment to Environmental Monitoring is found at 7.0,7.1,7.2 on pages 52-57 of the CER. Fringing vegetation will be affected by Derby Hydro Power not KPC.
- There will be no effects on freshwater springs. The springs are below the level of the mudflat on the inclined slope of the double knob formation and possibly between the Doctors Creek formation and the Christine Point Clay (Semeniuk 1982, p 51 Figure 3 A, D, H, Figure 13) . Semeniuk describes the water table as being within 30cm of the surface in the mangal. KPC's construction will be above the samphire above the mangal. The freshwater is below the half metre or so of disturbed clay to be use for the ponds and walls

(CER at 3.1 on page 13).

- As detailed by Semeniuk's manuscripts (Semeniuk 1980a, 1980b, 1981, 1992 and KPC's own results (CER page 32) the mudflat contains up to 240 parts per thousand salt or 24% salt. This is caused by tidal inundation an evaporative loss of the water leaving the salt behind in the top metre or so of clay. At tides above MHWS the 50km^2 of mudflats in this area are covered with seawater. If 6 ponds (6ha) were covered by seawater, this represents just 0.0012 % of the mudflat and if 640 ha were covered in seawater, this represents some 0.128% coverage, hardly a significant change. The saltwater above the clay is not going to reach the aquifer which is 2-3 m below the surface in the middle of the mudflat (Semeniuk 1981).

20. Birds

Bird usage of the area is described by Johnstone (1990) and referred to in the CER at 5.2 on pages 36 and 37, at 6.5.4 on page 42. He found only 14 species of birds in the mangal near Derby which nest in the mangal. Johnstone (*pers. comm.*) suggested that 97 species of mangrove birds is an exaggeration and that he expected the 14 species listed in his published paper. He said that the red-capped plover and dotterel may be found on the edge of the mudflat after inundation. If one looks at the Derby Hydro Power CER (Halpern Glick Maunsell) the figure 97 was an expectation of the birds which might occur in the mangroves. The actual number of species they observed in the mangroves was 12 (Appendix 4, HGM 1997). The site of KPC's prawn farm is not in the mangal but above the samphire so the birds which might be affected are those mentioned by Johnstone.

- Waterbirds and waders will only feed where there is water. Behind the bund there will be no water other than in channels, canals and ponds.

- Priority four species are those birds which need monitoring for population numbers. They are not usually of concern because of what happens in Australia, but in their northern Palaearctic nesting areas or what occurs in Asia as they migrate through. They are not resident birds but temporary feeding immigrants.

- The terricks and sandpipers are not residents, but temporary visitors. Again these birds will not be detrimentally affected by the prawn farm . Some birds will be attracted by the prawn farm and they will feed happily in the secondary species ponds and the return

canals.

21. Algal Blooms

In most Australian marine waters, nutrients are far lower than in equivalent latitudes overseas (Rochford 1975). This is partly due to the relatively infertile soils and lower runoff and lower upwelling. Natural algal blooms are therefore of a lesser intensity. Toxic algal blooms are most often in temperate regions of the world where anthropogenic influences are high. The usual algal group causing them, the dinoflagellates are ubiquitous and are utilised as a food source by both filter feeding shellfish and larval finfish. The toxins do not usually affect the fish, but higher animals that eat the fish. Because of the high suspended particulate matter in King Sound, primary productivity through phytoplankton is low. Phytoplankton in King Sound must have been carried in from the sea, been flushed from a stream or exist in the top 0.1-0.3m of water (see issue 7 above). Due to the turbulent tidal mixing in King Sound and Doctors Creek it is not possible even for phytoplankton like the swimming dinoflagellates to maintain position in the water column and so blooms cannot occur.

Accordingly any algae that entered King Sound would be enhancing productivity there. Because of the turbulent tidal streams, eutrophication is also virtually impossible. The Western Australian Water Quality Guidelines for Fresh and Marine Waters (EPA 1993) limit the chlorophyll a to 1-10µg/L. This is shown in the CER at 7.1 on pages 52-57. Commitment 12 on page 57 gives an undertaking by KPC to abide by these levels. Phytoplankton which grow in the ponds are utilised by the prawns as food (CER 3.3 on page 24). Management of algae in the effluvium will be by hydrocyclone separator and secondary species ponds where shellfish will remove phytoplankton and hence nutrients like nitrate and phosphate.

22. Visual impact

KPC have tested the whether walls can be seen on the mudflat by observing the remnant walls at the old *Artemia* site from varying distances. KPC has measured the distance where objects become clearly visible and have accordingly given the assertion at 6.0 in the CER on page 39, that 300m is the distance at which an object becomes clear. Also KPC's experience on the mudflat suggests that due to the mirage effect, objects can be seen at a greater distance but are then blurred and indistinct and cannot make an impact on anyone outside the proposed lease boundaries. KPC has suggested (CER page 39) that any visual effects could be

mitigated by vegetating the pond and canal margins.

23. Mangroves

As indicated in issues 15 and 18, the Draft Environmental Code of Practice for Australian Prawn Farmers does not recommend anything. On page 18 of that Draft Environmental Code is the following : "*Prawn Farmers should implement an appropriate environmental monitoring program to quantify changes in the receiving environment attributable to the prawn farming operation* ." Once the appropriate licences are granted and KPC are prawn farmers, the Environmental Monitoring Program referred to in the CER at 7.1 on page 52-7.3 on page 57 will be implemented. The Environmental Monitoring Program will have been approved by the Department of Environmental Protection. The program will include control sites as indicated in the Draft Environmental Code of Practice.

- Mangroves and samphire are mentioned in the CER at 2.7 on page 10, at Commitment 2 on page 24, at 4.1 on page 30, at 5.1 on page 36, at 6.1 on page 39 at 6.2 on page 40, Commitment 6 on page 40, 6.5.4 on page 42, 43.

The water pumped either out of West Doctors Creek or into East Doctors Creek will not have any significant effect on the Creek until the farm is almost fully developed. At that time the volume of seawater that passes the mangroves at the head of West Doctors Creek would be greater than before the prawn farm construction began and similarly for the mangroves at the head of East Doctors Creek. The tidal prism change will delay high water in the West arm but there should no change to salinity in this well mixed estuary. The flow of East Doctors Creek will be somewhat extended on the ebb tide.

If Derby Hydro Power gains approval, then any activity of KPC will have insignificant effects by comparison. If DHP does not go ahead, then a more intensive mangrove study will need to be undertaken in East Doctor's Creek. If DHP does proceed then tidal prisms will change in that a smaller tidal range will be evident in both basins but the salinities should change only marginally.

There will be no alienation of wetlands as such, only the mudflat which will now be dry until it rains. Creek morphology will change if DHP proceeds in accordance with their CER. If their project does not proceed, then the only change to the morphology of the Creek might be a deepening of both the prawn farm inlet and outlet tributaries of West and East Doctors

Creeks respectively due to increased stream flows there. All construction of ponds and canals for the prawn farm will be on the hypersaline mudflat, and the bund wall will reduce inundation and flow in other tributaries. This altered tidal movement at MHWS tides could affect the gutters that are the sources of the Creeks and could fill them in through slower stream velocities and sedimentation thus reversing the natural erosion currently being experienced on the mudflat (Semeniuk 1982).

- The present zonation of mangroves on the Doctors Creek depends on their position relative to the mean tides and to the proportion of freshwater (Semeniuk 1980a). The return of saline water from the prawn farm is expected to be within EPA guidelines and so there should be little or no change to mangrove speciation caused by KPC. If DHP proceed, then the mangrove forest lining the Creek will change its level on the Creek banks (HGM page 60). Any seawater discharge from KPC will enable those mangroves in the upper Creek to live rather than die. The current mangrove communities in Doctors Creek are sparse and should increase in area if DHP go ahead (HGM 1997, page 45).

- Saline water flow will be almost constant in KPC's upper outlet tributary rather than in a tidal cycle particularly if DHP proceed. The saline outlet water mixed with the groundwater should keep mangroves alive (Semeniuk 1982 Fig. 3, page 51). Erosion will be reduced because of laminar flow rather than turbulent flow in East Doctors Creek. Erosion is already the dominant geomorphological feature of this landform (Semeniuk 1982, page 59). The creation of a high and low basin by Derby Hydro Power will reduce erosion caused by the turbulent flow of seawater with a high particulate load. The only erosion that could occur from KPC would be localised stream bed erosion near the inlet and outlet. This will be monitored and an appropriate response made if erosion were to occur; see Commitment 10 page 53 of the CER and Table 6.7 on page 47.
- KPC is at a loss to understand where the dust will come from that is not already there. First, there will be a small amount of 'dust' created at construction (see CER Figure 5). Second the amount of exposed mudflat will be <u>less</u> **after** pond construction than **before.** The pond and canal walls will be vegetated if possible to reduce dust and trap it (see Table 6.7 on page 48, section 6.5.1 on page 41).
  The lease area is to the east of Derby and the mangroves that could be affected by dust from the lease are those on West Doctors Creek affected by south-easterly winds from May to October. The area of mangroves is 5-7 km north of Derby. But the area of the lease will have the ponds on it so as the prawn farm is developed there will be less and less exposed mudflat surface to turn into dust (see CER Maps 1 between pages 2 and 3 and page 16 and see 6.5.1 on page 42).

24. Mudflat stabilisation

By placing ponds on top of the mudflat it will be stabilised. The effect of saturation with water followed by desiccation seals the surface. Walls of ponds and canals will be machine compacted.

25. Salt water couch

According to the Department of Agriculture, the answer is yes. Salt water couch (*Sporobolus virginicus*) is a rhizomatous perennial grass growing to 30cm high. It occurs in all Australian States. In Western Australia it is found mainly in the coastal areas from Cambridge Gulf to 80 Mile Beach. In the King Sound it grows on all the salt estuarine systems. A sub species also grows in the fresh to brackish waters at Wellare. At Derby salt water couch grows between the arms of the two Doctors creeks and along the pindan margins. It can be seen growing on the edge of Derby township as well (Rye, Koch and Wilson).

26. Decommissioning plan

Decommissioning is covered at 6.4 of the CER page 40 and page 41 is Commitment 8 to rehabilitate any decommissioned area of the lease to its pre-construction conditions. Rehabilitation is covered on page 21 of the Draft Environmental Code of Practice for Australian Prawn Farmers.

27. Dust

As responded to at issue 23, there will be less mud exposed, the same amount of rain will fall but there will be less saltwater inundation. See Figure 5 and Figure 1a after page 70. Sealing the surface with water may be simplistic but it works. KPC have conducted experiments. As indicated by the CER at 6.5.1 on page 41, south-east winds and east winds blow dust over Derby, but south-east winds from the prawn farm would blow dust 5-7km to the north of Derby (see Map 1 after page 2). Only the mudflat south of the lease area could blow dust onto derby with the prevailing south-east winds. Northerly winds could only blow dust to

Mowanjum not to Derby. Easterlies do blow in the mornings later in the year but they are not strong - less than 30km/hr or 15kts (GHD 1983) and Derby is 4-5 km from the lease site.

28. Mosquitoes and midges

KPC will not be disturbing any marshland. The settlement pond has some potential for creating a new breeding area for mosquitoes; however if Derby Hydro Power Project proceeds, then the time of settlement will decrease because as they assert (HGM page 64) there will be a decreased silt load in the West Doctors Creek water which will be at a high level for a longer period. KPC experiments indicate that suspended particulate material will precipitate over a period of hours. Mosquitoes require at least 7-10 day period for development in still water. The growout ponds themselves will be a poor environment for the development of mosquitoes because (a) the water will be constantly moving, (b) the prawns will eat the mosquitoes.

Water flow in the secondary species ponds will be less than in the prawn ponds but will be substantial, sufficient to discourage mosquitoes from laying their eggs. *Artemia* could also eat mosquito larvae and KPC will be experimenting with this.

Farm management will examine its phytoplankton water samples for mosquitoes. No pesticide is proposed for control. Refer to CER 6.5.3 on page 42, 6.7 on page 49. KPC believes that biting midges require static water for development. KPC intends not to provide any static water. Biting midges breed in the mangrove forest. KPC will have the problem of biting midges *Culicoides* within 1 km of the mangroves but will not exacerbate the problem.

29. Disturbance to birds

The bird species that are expected in the mangroves are those listed in the CER at 5.2 on pages 36-37. These birds are mangrove dwellers and are not expected on the prawn farm on the mudflat. KPC does not intend monitoring all birds "*in the area* " but will utilise known experts to survey bird on the prawn farm during the development phases; see 6.5.4 on pages 42-43, 6.5.7 on page 44. As stated on page 43 of the CER, "*workers will be discouraged from entering the mangal zone and hence disturbing the local bird life.* " KPC will keep away from the present bird habitat.

30. Effects on fringing vegetation

Is this fringing vegetation of the Doctors Creeks or the hypersaline mudflat? If (1), then as

brackish water from the mudflat, groundwater will be induced to flow from inland; this would be particularly so if the DHP project proceeds and the low basin reduces the likelihood of an egress of salt water from East Doctors Creek into the mudflat groundwater. The groundwater arriving at East Doctors Creek would be lower in salinity than at present and would mix with the effluvium from the prawn farm to promote the growth of mangroves

If (2), and fringing vegetation refers to the samphire and pindan vegetation, then the extraction of groundwater from the unconfined aquifer will have no effect on the supra tidal flats.

The question of groundwater is discussed by Semeniuk (1982, page 51); by KPC's CER at 4.3, 4.4 pages 31-35, at 6.5.6 on page 44 in Table 6.7 on page 51. A reduction of tidal inundation should lead to no great changes. At present the mudflat is inundated only 1% of the time (Semeniuk 1981 page 210). The salinity of the surface soil and groundwater should remain the same. Fresh water will fall on the surface as rain, it will absorb in the surface and then evaporate leaving salt behind. The gutters which currently are the headwaters of the tidal creeks may fill in over time.

31. Consultation

Public consultation has been by way of public meetings, newspaper articles, radio interviews, Aquaculture Council of Western Australia News, Derby-West Kimberley Shire meetings newspaper advertisements. Ian Crimp ran Derby Photographics from 1993-1997 and openly discussed his prawn farming ideas with anyone who called at his shop. Mr Carl Drysdale aired the project in the Boab Babbler and on ABC radio. DEP and DOLA advertised 2.5 years ago and a lively discussion has ensued since. KPC would have concern that recreational fishermen may disturb the mangal birdlife (see 29 above). However in the CER, KPC have mentioned at 6.6.1 on page 45 that the northern boundary of the prawn farm lease was moved south to allow access to fishing spots on East Doctors Creek. The southern boundary was moved north to allow recreational use of the mudflat near Hamlet Grove. KPC has agreed to maintain access to the mudflat between the two arms of Doctors Creek mainly for recreational fishing purposes.

32. Impact on recreational fishing

Given the response above, there are no potential impacts. However, if Derby Hydro Power proceed, then fishing will presumably improve in West Doctors Creek and possibly decline in East Doctors Creek where it will be more difficult to access the water. Near KPC's inlet and outlet, the stream flows will be greater and this should encourage greater populations of juvenile finfish.

33. Fitzroy location numbers 263,264

Information from DOLA is that these numbers 263, 264 are Fitzroy location numbers for a proposed reserve. A cadastral survey was done in the 1980's but the proposed reserve was not gazetted. The area of land in question is in two parcels either side of the Gibb River Road. 264 is entirely south of the Gibb River Road, while 263 encompasses the existing reserve at 87 shown in KPC's CER in Figure 1a. The northern boundary of 263 runs along the boundary of the pindan from the Bungarun Road and is just south of the existing power line as it runs from east to west along the mudflat. The western boundary of 263 runs down to the Gibb River Road a few hundred metres west of the pindan tongue. The western boundary of 263 is almost a kilometre east of Yabbagoody Well. Location 263 is over 1.5 km from the southern boundary of the area set aside by DOLA for the prawn farm lease and the prawn farm would not interfere with the formerly proposed reserve if it were to be proclaimed. As most of the proposed reserve is pindan, the prawn farm would not affect surface flows and because of the distance from a likely bore on the prawn farm (4km) it would not affect groundwater either.

34. Nutrient discharge and sea grass

Nutrients should not be discharged from the prawn farm above the levels allowed by the 'Western Australian Water Quality Guidelines for Fresh and Marine Waters' (EPA 1993). These figures are quoted in the CER at section 7.2 on page 57. Given the volume of turbulent water in King Sound, then the impact on sea grass beds will be nil. If the nutrients in the secondary species ponds could be transported to the seagrass beds, then the effects on the seagrass would be beneficial.

35. Mangrove monitoring

This issue has been canvassed at 15, 19, 23 and 30 above. (a) If there is no Derby Hydro Power project, then Western Doctors Creek will be the 'control' for the monitoring of East Doctors Creek mangroves. Kimberley Prawn Company will monitor East Doctors Creek mangroves near the prawn farm effluvium. (b) If Derby Hydro Power project proceeds, they will monitor mangroves in both arms of the Creek. Mangroves are discussed in KPC's CER at 6.0-6.1 on page 39, 6.5.4 on page 43, 6.7 on page 47, Commitment 10, on page 53 : "*Kimberley Prawn Company will monitor the water quality and physical appearance of East Doctor's Creek and the health of the mangroves to ensure that the discharge water from the prawn farm is having no adverse effects on the mangroves of Doctor's Creek. The monitoring programme will be implemented to satisfy the Fisheries Department and the DEP.*"

36. Tropical Diseases

It is assumed that the "*tropical diseases* " are diseases that affect estuarine organisms and not human pathogens. The prawn food will be heat treated and imported under AQIS supervision. In their investigations, AQIS have not found any problems with imported prawn feed; see CER 3.3 on pages 24-25, Commitment 3 on page 25. Any other diseases will come from the environment at Doctors Creek ie the water, the mud, the biota, or possibly from the broodstock. Diseases may be at a low level or indiscernible at low population densities in the wild, but become readily apparent once semi-intensive husbandry is practised. Diseases can be introduced from another farm. As there are no other prawn farms operational yet in WA, this is not a likely source of disease. Accordingly the receiving environment will not be susceptible to disease because any pathogens will have originated there.

37. Baseline studies fish

It is not intended to carry out baseline studies on fish in Doctors Creek. From experience on prawn farms in Queensland, gross effects on marine life are not apparent. The changes that occur are related to increased water flows in narrow creeks with alteration of stream erosion and bank stability. There is also the possibility of an increase in nutrients in the receiving waters. In the case of Doctors Creek this would probably not present a problem, but the KPC will conduct an environmental monitoring program in accordance with the requirements of both the DEP and Fisheries Department and abide by the 'Western Australian Water Quality

Guidelines for Fresh and Marine Waters' (EPA 1993). Baseline monitoring is expected to begin during the construction phase, once licence approvals have been given for the prawn farm to commence.

38. Creek frontage

The proponent is not certain yet whether the water intake and outlet sites chosen are the best sites for these activities. The option for a slight shift in location needs to remain open. Second, as the lease area is filled with ponds a further egress point may be required if the Derby Hydro Power project does not proceed. An outlet might be needed to both branches of East Doctors Creek. Thirdly, another reason for having the creek frontage is to prevent other harmful activities occurring there such as industrial processes or other non-compatible aquaculture. Fourthly, the Creek is a natural boundary.

39. Lease area

The Kimberley Prawn Company have applied to the DOLA for a lease to conduct aquaculture. The area applied for takes into account KPC's requirements for access to a suitable site for pond construction, access to salt water, access to groundwater, drainage of salt water, consideration of aboriginal heritage, electric power, sites for buildings. The site selection criteria are found at 3.0 on page 12 of the CER.

- the area of land to the east of the *Artemia* site is to allow a buffer zone between the prawn farm and potential residential areas on the other side of Bungarun Road, to ensure access to the prawn farm by linking to Bungarun Road and to use the Bungarun Road as a 'natural' boundary.
- the land to the north and west of the sluice gate will be kept empty initially and filled with ponds after the other areas. It is more undulating, is more complex from the perspective of sediment type and groundwater. That area may be developed as a self contained module. As was stated in 38 above, more than one outlet to East Doctors Creek may be required.
- In the expansion phase, the area between the southern levee bank / internal road and the area of ponds shown on Figure 1a will be filled with ponds.

It should be noted that the area applied for in the lease has decreased to take into account the requirements of others in the community like the recreational fishermen, users of the mudflat outside Hamlet Grove and the native title claimants.

40. Lease information

EPA are not the lease issuers. That is handled by DOLA. Generally leases have been commercial documents and so are confidential. The proposed lease was advertised in the Broome Advertiser on July 18, 1996 stating that DOLA was intending to "grant a special lease for aquacultural purposes". The actual lease has not yet been signed.

41. Decommissioning Plan

A decommissioning plan is contained in the CER in response to the Draft Environmental Code of Practice for Australian Prawn Farmers; the Draft Code suggests on page 21 that : "*Where a prawn farmer chooses to terminate the operation of a prawn farm and not continue with a similar use, the prawn farm site must be rehabilitated to the extent that no further impacts to the environment result from the development site* ". In the CER the decommissioning plan is found at 6.3 on page 40, 6.4 on page 40 and in Commitment 8 on page 41. A better description of the environment on the mudflat might be 'rugged', 'robust' or even 'harsh'.

42. Commitment 8 decommissioning

The rehabilitation of leased land is a responsibility the lessee has to DOLA. As advertised on 18 July 1986, the proponents may disturb the land and make construction on the land consistent with the specified purpose, namely aquaculture. The Australian Prawn Farmers Association have recommended the steps in their Draft Code quoted in issue 41 above. KPC have given a commitment to rehabilitate even sections of the farm that may not continue to be used.

- KPC would carry out the work. To restore the area to pre-construction conditions requires earthworks which would be carried out by KPC or its contractors. The Draft Code suggests that site rehabilitation may include restoration of topography, burying of pond sediments, revegetation of site, closure of farm intake and discharge channels and restoration of Crown Land. The agency involved would be DOLA but DEP and Fisheries Department may also have an interest.
- Normally for aquaculture ventures a contingency fund is set up by the farmers association to deal with any unfunded decommissioning. The Western Australian branch of the

Australian Prawn Farmers Association is being formed and a fund will be set up.

- The impacts of failure to rehabilitate can be seen at the *Artemia* site. The walls above the mudflat would gradually erode and fill the ponds and canals over a 20-30 year timespan. The erosion process would be hastened by re-establishment of the tidal movement. It is a harsh environment and would quickly reclaim its own.

43. Disease Contingency Plan

The Fisheries Department is the Department that manages aquaculture in this State. They issue a licence subject to a satisfactory disease contingency plan being extant. The details of the plan are not required until operations are about to begin. Part of the reason for that is the length of time for an aquaculture application to become a lease. Kimberley Prawn Company first applied for this lease over 3 years ago. At that time no Australian prawn farm had had a disease problem. Two years ago a hatchery in Queensland unwittingly spread a viral disease to its customers. The identification in prawns of viral diseases in particular, is an ongoing research project involving several laboratories in Queensland including CSIRO. New diagnostic techniques will dramatically alter identification of disease and perhaps the treatment. The Disease Contingency Plan contained in the CER at 7.4 on pages 58-59 is similar to the approved prawn farm at Exmouth. It is expected that which ever Disease Contingency Plan is approved, it will need at least annual revision.
Part of the reason for establishing a prawn farm at Derby is that it is remote from other aquaculture and particularly other prawn farms; this isolation should keep the prawn farm clean and free from diseases.

The Draft Environmental Code of Practice for Australian Prawn Farmers asserts on page 17 that : "*Members of the Australian prawn farming industry must ensure that in the event of a disease outbreak, the threat of disease spread within a farm and spread from a farm is minimised and that disease pathogens are not discharged, in concentrations which are likely to cause unacceptable changes, to the receiving environment* ."

Fisheries West have fish pathologists, CSIRO and AIMS are working on prawn disease diagnostics. It is the belief of KPC that these professionals will give a better assessment of the risk of disease introduction into the local environment than the well-intentioned public.

44. Pond cleaning

The method of cleaning a diseased pond as proposed in the CER is standard industry practice in Queensland and throughout the world. Drying of ponds and cleaning with chlorine usually atones for bacterial diseases. Viral diseases may take longer with the chlorine treatment. Steam is useful in treating soil, and so is desiccation for bacteria. The solar heating found on the mudflat would be conducive to such treatment. Ponds are usually treated with lime and tea-seed cake in Asia to combat disease.
The Draft Environmental Code discusses the removal of sediment from ponds on pages 14 and 15 and suggests that if these sediments are stock-piled they should be on an impervious floor, that bund walls should be used and siltation of waterways should be prevented.

45. Nutrient removal

At this juncture, no firm figures can be provided. Any figures provided would just be guesstimates. That is one of the reasons that KPC have proposed a staged development.
In a study in Hawaii, Ziemann et al (1992) found that nitrate and nitrite concentrations were lower in prawn pond effluent than in the intake water. Phytoplankton are presumed responsible for removal of nitrates from the pond water. In our secondary species ponds, bivalves will remove the phytoplankters and the nutrients from the water before discharge to East Doctors Creek.

Data cannot be provided yet because this system has only been tried experimentally and is not yet fully commercial. We will be at the cutting edge of this technology. As indicated at issue 10, Jones and Preston have presented a paper on preliminary research findings. As an example in issue 10, 4 million scallops can grow in a one hectare pond in Mexico.
Yes the species can be cultivated. Scallop *Amusium balloti* may not be able to be cultivated in ponds but they can be cultivated in the ocean. The oysters can be cultivated successfully in ponds and these will be obtained under permit from the Fisheries Department. If successful, the oysters will be hatched on site and collection will not need to continue.
The size of the secondary species ponds are large in Figure 1a, larger to scale than their 3ha. To enable the measurement of the amount of chlorophyll a / phytoplankton in the prawn ponds and the ability of the secondary species to reduce the phytoplankton in the effluvium, full-scale experiments are required. There are literature values for efficiency of bivalve feeding and the volumes of water bivalves can pump. They lead us to be confident that the secondary species will 'clear' the phyoplankton from the effluvium. As an example, 10 million oysters can filter 2.4 million m^3 of seawater per day (ie 2,400 million litres per day,

Galtsoff 1964).
The quantity of feed required for prawns of a given size and number is known in theory. However, there may be a batch of feed which is different (% protein etc) requiring more or less feed; perhaps the prawns won't feed; there may be a sudden decrease in temperature of the pond water associated with the 'wet' which may reduce feeding. In practice to avoid over or under feeding, experimental trays are used to gauge the feed requirements on a daily basis. Checking these feeders prevents overfeeding with a buildup of uneaten food and consequent increased oxygen demand in the bottom of the ponds. The uneaten food would also contribute to an increase in phytoplankton. As prawns also eat the phytoplankton in the ponds it is difficult to give a definitive answer for the 'Y' amount of nutrients and therefore the "Z' is also unknown but KPC will err on the high rather than low side.

46. Suitability of the clay

The clay has been tested for KPC by the Main Roads laboratories and the results shown on page 14 of the CER. Visually the silt fraction looks high, but the samples tested as shown. The engineers reported that using standard dam construction compaction rates, this clay "*can be considered to be impermeable* ". It must be remembered that this material is 10-12m thick. Semeniuk 1980(b) on page 73 shows that the clay on the lease area is Christine Point Clay, with Doctors Creek Formation between the arms of Doctors Creek. The Doctors Creek formation on its surface is clay and silt (Semeniuk 1982, page 51) which overlies sandy and gravelly strata.
The pond excavation will only be 0.5m depth and the permeable layers are some 10-12m below. Water on the surface can be absorbed into the clay but the clay becomes saturated and swells making it impermeable to both fresh and salt water, so the surface water will not reach to the groundwater layers. As shown in Figure 3 H,I on page 51 (Semeniuk 1982), the water table is between 2 and 3 m below the surface.

47. Prawn loss in flood

The issue of escapees was raised in 12 above. There are no streams behind this embayment to flood the mudflat. The Fitzroy River might flood and so might the May or Meda Rivers. If one of the rivers flooded, there is a large area of mudflat for it to flood onto - 2600 square kilometres some two thirds the size of King Sound.
The Draft Environmental Code of Practice for Australian Prawn Farmers deals with this

subject on page 12: "*Prawn farmers must take all reasonable and practical measures to ensure that no animals (endemic or non-endemic) are released into the environment from a prawn farm .*"

Initially a bund wall will be used to prevent tidal inundation of the construction site (CER 3.2.1 on page 18). The dimensions of the walls of the canals, channels and ponds are described at 3.2.3, 3.2.4, 3.2.5 on pages 17-18 and shown in drawings 1, 2 on pages 19 and 22 respectively. Cyclones and storm surges are discussed in the CER at 4.2 on pages 30-31; in the design of the farm, wall heights have been increased by half a metre to allow for a combination storm surge and flooding of the Fitzroy. Table 6.7 on page 50 also deals with this issue.

48. Environmental Code of Practice

The respondent has not indicated why he/she believes the site is unique and complex nor has the respondent indicated the kind of environmental problems that he/she thinks could arise in Doctors Creek and King Sound. As indicated in issue 6 above, the lease area is a small proportion of approximately 2600 square kilometres of hypersaline mudflat in King Sound and a smaller proportion of similar mudflats of the entire north-west of Australia from Port Hedland to Darwin. What is it that makes this area so "*unique and complex* "? It is because it is the area with the highest tides in Australia and the second highest tides in the world? In the Bay of Fundy with the highest tides in the world, people live and work, fishermen fish, farmers farm, electricity is generated by tidal flow and fish farms greatly contribute to the economy of New Brunswick. There are extensive intertidal mudflats in the Bay of Fundy and yet they are not destroyed by the kinds of activities listed above.
The area north and east of Derby has been extensively studied by Jennings and Coventry 1973; Semeniuk, Kenneally and Wilson 1978; Semeniuk 1980a, 1980b, 1981,1982; Johnstone 1990; Water Authority of Western Australia 1992, 1993; Gutteridge, Haskins and Davey Pty Ltd (1983); Martinick and Associates Pty Ltd 1995; Halpern Glick Maunsell Pty Ltd 1997. There could be more research work undertaken in the marine and neritic areas of King Sound and in the estuary of Doctors Creek to advance scientific knowledge, but Kimberley Prawn Company is proposing to build a farm on the land. Most of that farm will be over a kilometre from the upper reaches of the estuary. The areas of complexity from a geomorphologoical perspective are further north and west in the Doctors Creek Formation. The farm will be built on the bare hypersaline mudflat. The mangroves with their attendant birds, bats and fishes are remote from the farm. The KPC deliberately chose the farm site to

avoid environmentally sensitive areas and environmental problems.

KPC's commitment to environmetally sustainable development is contained in its Commitments including Commitment 2 on page 24, Commitment 4 on page 25, at 6.4 on page 40, Commitment 8 on page 41, Commitment 10 on page 53 and 7.1.2 on page 53.

49. Bird Predation

Birds currently on the mudflat are discussed at 6.5.7 on page 44 of the CER. Predation by birds is discussed at 6.7 on page 49. Commitment 14 on page 59 of the CER commits KPC to follow the Draft Environmental Code of Practice for Australian Prawn Farmers On page 16 of the Draft Code under the heading Predator Management is this : "*A range of predators have the potential to impact on prawn farming operations. The management of predators will vary considerably depending on the species, region and operator preference. The appropriate management of predators is likely to increase profitability and minimise the potential environmental impacts to predator species.*
Predators must be managed, where reasonable and practical, to minimise impacts to native fauna species while protecting the economic viability of the prawn farm.
In order to appropriately manage predators, prawn farmers should utilise on or more of the following practices :...

Avifauna

- *Overhead netting of ponds;*
- *Installation of waterline nets;*
- *Installation of overhead wires;*
- *Use of repellent sound emissions;*
- *Use of repellent light emissions;*
- *culling of target species, under an appropriate permit as issued by the Administering Authority;*
- *Increased personnel around ponds at peak feeding times for birds;*
- *Installation of predatory images or models.* "

KPC has sought the advice of an ornithologist who will monitor birdlife during the farm's establishment and will recommend management practices.

50. Performance Bond

As outlined in issues 41 and 42 above, KPC would prefer to contribute to an industry-wide contingency fund for rehabilitation and decommissioning.

51. Storage and handling of fuels

Fuel oils and chemicals will be stored in accordance with appropriate regulations. 'Vehicle fuel storage' is outlined in the CER on page 29. Commitment 2 on page 24 outlines fuel storage and drainage arrangements, with workshop drainage through oil interceptors, oils and fuel will be stored on concrete floors with bunds. Table 6.7 on page 51 refers to Dangerous Goods Regulations of the Mining Act. KPC will comply with these regulations.

52. Samphire vegetation

The samphire vegetation occurs both seaward and landward of the hyper-saline mudflat. ie between the mangal and the mudflat, and between the mudflat and the pindan. The higher samphire receives Equinoctial High Water Spring Tides (Semeniuk 1982) and rainfall and runoff from the pindan or Mowanjum sand. However the 10.5m+ tides actually reach the landward samphire. According to Semeniuk (1981) the high tide mudflats are inundated for about 1% of the time, so the seaward samphire must survive on rainwater plus the dampening effects of equinoctial spring tides. The bund wall proposed to be erected by KPC will be above (ie to the landward) of the seaward samphire so it should not be affected by altered inundation; see Map on page 16, Figures 2, 4, 16, 17 in the CER. Note mangroves and samphire in Figure 16, and the position of the bund wall which will be near the vehicle.

53. Particulate matter in effluvium

The suggestion for the settlement ponds came from Diamond Island Pty Ltd with their experience in monitoring industrial processes on estuaries. As indicated in issue 10 and issue 45, other researchers have had similar views and Jones and Preston (1996) have presented their preliminary findings of 80% phytoplankton being cleared by three passes of a raceway. As indicated in issue 45, 10 million oysters can pump and filter 2,400 million litres of seawater per day. To remove phytoplankton to acceptable levels, secondary species ponds in

series will probably be necessary. The inorganic particulate matter will initially be settled in either Derby Hydro Power's high basin or the inlet canal of KPC. Particulate matter in the ponds is collected in the centre of the ponds due to the motion of the water in the ponds. Inorganic particulates that leave the ponds will settle in the discharge canal and the secondary species ponds. If necessary the inorganic particulate matter will be separated by hydrocyclone. This is really just an engineering problem. KPC's belief based on observation and past experience is that secondary species ponds will be desirable if not necessary. On page 14 of the Draft Environmental Code of Practice for Australian Prawn Farmers, is the following :

"*Prawn farmers must, where reasonable and practical implement pond effluent management procedures which minimise the potential environmental impacts from increases in the suspended solid and nutrient levels of discharge waters.*

Where appropriate, prawn farmers should utilise one or more of the following practices :

- *Installation and use of an appropriately designed settlement pond;*
- *Reduction of discharge points from erosion;*
- *Installation of pond recirculation systems;*
- *Retain pond discharge water for a suitable period after pond draining;*
- *Use biological filtration mechanisms, such as bacteria, macroalgae and bivalves .*"

As the prawn farm development will be in stages experimentation will be conducted to determine the efficiency of the settlement ponds.

54. Pond sediment disposal

The practice of drying ponds and physically removing sediment is standard industry practice in Queensland and worldwide. The Draft Environmental Code has a section on sediment management on page 14. On page 15 the Code says : "*Sediment production should be minimised using appropriate operational erosion control, feed management and stocking density techniques.*

On removal of sediment from ponds, prawn farmers must store or dispose of the sediment in a manner that will minimise any potential environmental impacts from erosion or leachate. "

This issue was also covered in issues 9 and 44 above and in the CER at 2.1 on page 7 and on page 29 under 'Marketing'. The sediment will be used to fertilise vegetation on canal and pond walls. This will help stabilise the walls from wind and water erosion and make the site more aesthetically pleasing. The erosion of the material placed on the walls will be prevented

by the plant material and if it is eroded from the walls, the sediment will be prevented from moving further by suitable earthworks. KPC believes that its proposal to use the sediment to fertilise vegetation on canal and pond walls is in conformity with the Code provided the material cannot enter the surrounding waterways. This will be prevented by drainage into secondary species ponds.

55. Pooled Water, Ross River Virus

With the bund wall in place there will be no pooling of water on the mudflat behind the wall. The mosquito life cycle is at best 7-10 days in summer for egg to adult not 4 days. In winter it is longer. There are normally 1-2 days before mating, 2-3 days resting for egg maturation before ovipositing. From egg to pupa is from 8-10 days with another 24 hours after emergence before mating and biting a host for the females. KPC will commit to ensuring that water can drain away from behind bund walls. The CER at 3.2.1 on page 15 describes the use of drains under the bund walls. This is also made clear at 4.3 on page 32 and there is also Commitment 2 to have internal drainage flow to the secondary species ponds.

It should be recognised that after high tides above Mean High Water Springs, or after heavy rain, that water currently lays in natural depressions on the mudflat for more than a mosquito life cycle; see Figure 17 in the CER.

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