Leslie Salt project, expansion of ponds, Port Hedland

Leslie Salt

Report and recommendations of the Environmental Protection Authority

Environmental Protection Authority
Bulletin 506
March 1991

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ISBN 0 7309 3548 5
ISSN 1030 - 0120
Assessment number 376

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Summary and recommendations

Leslie Salt proposes to expand its salt mining operation by constructing a new primary concentration pond (which would lie outside the existing mining leases) and additional brine, bitterns and crystallization ponds within the existing leases. The current operation is located on coastal flats near Port Hedland with the primary concentration ponds 30 km to the east and the brine ponds 10 km to the east connected by an aqueduct (Figure 1). Once the brine is fully saturated it is pumped to crystallisation ponds at the main plant, which is on the outskirts of Port Hedland, for harvesting and trucking to the port for shipment.

The proposal was received in March 1990, and a formal assessment was initiated at a level of Consultative Environmental Review. Leslie Salt submitted the Consultative Environmental Review in July and it was released for four weeks review till the end of August. The current mining operation is regulated by the Leslie Solar Salt Industry Agreement Act which was declared in July 1966, and, under that Act, is regulated by the Mining Act. The present lease expires in 1997, after which two renewals of 21 and 11 years can be negotiated.

The key environmental issues identified for the proposal relate to the protection of the mangrove ecosystems, including the maintenance of the freshwater floodout regime, the location and operation of the new pump facility, the new bitterns discharge regime, the rehabilitation of the areas disturbed in association with the proposal (such as the proposed borrow pits and quarries), the development of an Environmental Management Programme, loss or isolation of the sandplain areas within the proposed ponds, and developing a decommissioning plan.

The mangroves and algal mats of the coast form an ecosystem that is a particularly valuable environmental resource because it is a diverse, primary production zone and forms a complete food chain supporting both terrestrial and marine life in the area. In addition, the mangroves stabilise the coast along a high energy coastline and the ecosystem supports a rich and abundant range of other flora and fauna. Significant areas of mangroves in the Pilbara region have already been lost due to this and the other salt mining proposals, as well as other urban and industrial developments. Consequently the Environmental Protection Authority believes that the remaining mangrove ecosystems warrant a high level of protection.

In order to implement this protection, the Environmental Protection Authority has concluded that any proposed direct loss of mangroves and algal mats should be identified by the proponent and minimised, that the freshwater floodout regime should be essentially maintained to the headwaters of all the tidal creeks and that there should be no adverse, indirect impacts upon the mangrove ecosystems arising from the proposed modifications to the existing environment.

The Environmental Protection Authority believes that the issue of the protection of the mangrove ecosystems could be resolved by a modification to the original design, as described in the Consultative Environmental Review, of the primary concentration and bitterns ponds. Accordingly, the Environmental Protection Authority makes the following recommendation.

Recommendation 1

The Environmental Protection Authority concludes that the proposal, as outlined in the Consultative Environmental Review, to construct additional salt production ponds, would only be environmentally acceptable if the proposal is modified according to the recommendations in this report to provide the appropriate level of protection to the mangrove ecosystems.

The Environmental Protection Authority identified the main environmental factors requiring detailed consideration as: protection of the mangrove ecosystems; maintenance of freshwater floodout; location and operation of the new pump facility; the new bitterns discharge regime; rehabilitation of disturbed areas such as the proposed borrow pits and quarries; development of an Environmental Management Programme; loss or isolation of the sandplain areas; and the development of a decommissioning plan.

The Environmental Protection Authority considers that, apart from the mangrove ecosystem protection as noted above, the other issues have been addressed by either the proponent's commitments or by the recommendations in this report.

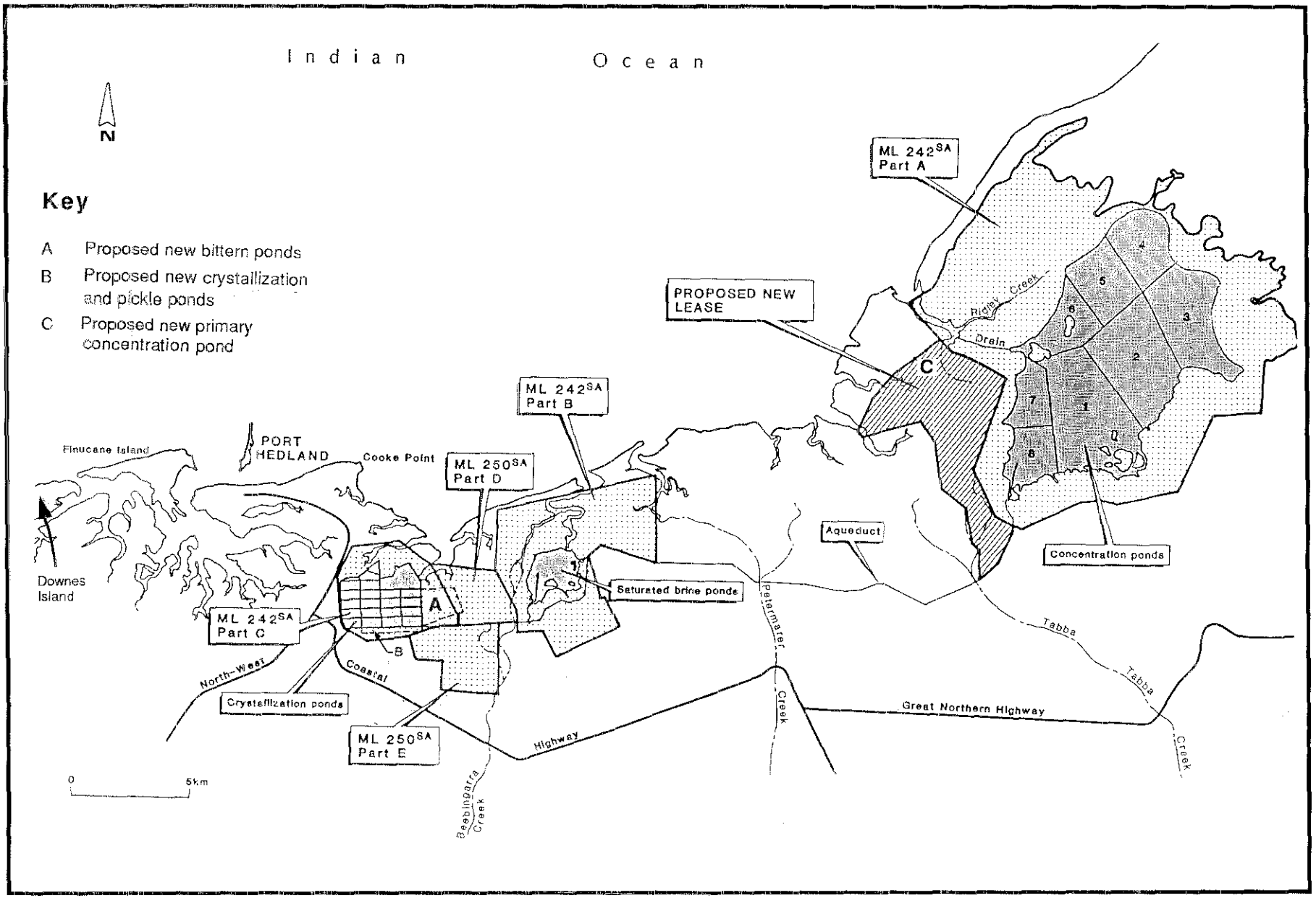

Figure 1: Leslie Salt mine location

Accordingly, the Environmental Protection Authority recommends that the proposal could proceed subject to the:

- **proponent's commitments (Appendix 2); and**
- **Environmental Protection Authority's recommendations in this report.**

Protection of the mangrove ecosystems

The mangrove ecosystems of the Pilbara are nationally important because they are the only mangroves inhabiting a tropical-arid coastline in Australia. Two key components of the mangrove ecosystems which warrant protection are the algal mats and the freshwater floodout regime. The Environmental Protection Authority concludes that modifications to the original designs, as proposed in the Consultative Environmental Review, of the primary concentration and bitterns ponds are warranted in order to protect the mangrove ecosystems.

With regard to the design of the primary concentration pond, the Authority considers that the area between Rock Cod Hole and Catfish Creeks should not be impounded in order to conserve the algal mats in the area and to allow freshwater floodout to reach the headwaters of Catfish Creek. With regard to the design of the bitterns pond, the Authority considers that the pond should not extend to the north so as to surround the mangroves at the headwaters of Paradise Creek, that drainage channels should be constructed in order to allow freshwater floodout to reach the headwaters of Paradise Creek and that as much as possible of the algal mats in the north-eastern corner of the current pond design should be conserved by being excluded from the proposed pond (Figures 2 and 3). The Environmental Protection Authority considers that these measures would adequately address the potential, long-term, indirect impacts from the proposed modifications to the mangrove ecosystems and, accordingly, makes the following recommendations.

Recommendation 2

The Environmental Protection Authority recommends that the proponent be required to construct and manage the facility such that there would be no secondary impacts off the actual site, including no indirect loss of or detriment to mangroves or algal mats off-site, to the satisfaction of the Environmental Protection Authority.

Recommendation 3

So as to ensure there is minimal direct loss and no indirect loss of the mangrove ecosystems, the Environmental Protection Authority specifically recommends that the proponent should develop and subsequently implement modified designs for the primary concentration and bitterns ponds to the satisfaction of the Minister for the Environment. These designs should include provisions to ensure the maintenance of freshwater floodout to the headwaters of Catfish and Paradise Creeks and avoid impoundment of some of the algal mats.

Environmental management

The construction phase of the project would involve large, earth-moving equipment operating within the mangrove ecosystems on the coastal flats. This has resultant actual and potential impacts related to direct damage (to algal mats), dust, noise and petrochemical pollution, for example. The Environmental Protection Authority considers that these impacts should be avoided or minimised such that there is as little disturbance as possible to the mangrove ecosystems.

Following commissioning of the new ponds, there is potential for long-term impacts on the mangrove ecosystems from groundwater seepage from the ponds, bitterns discharge, diversion of tidal water by the pumping and the loss or modification of some of the nutrient and hydrologic support systems. The Environmental Protection Authority considers that these impacts should be monitored and managed.

The Environmental Protection Authority considers that it is necessary for the proponent to design and implement an Environmental Management Programme to ensure that, firstly, the construction and commissioning phases of the project are carried out with due care and with adequate monitoring to give early warning of any adverse effects upon the mangroves, particularly in the vicinity of the bitterns

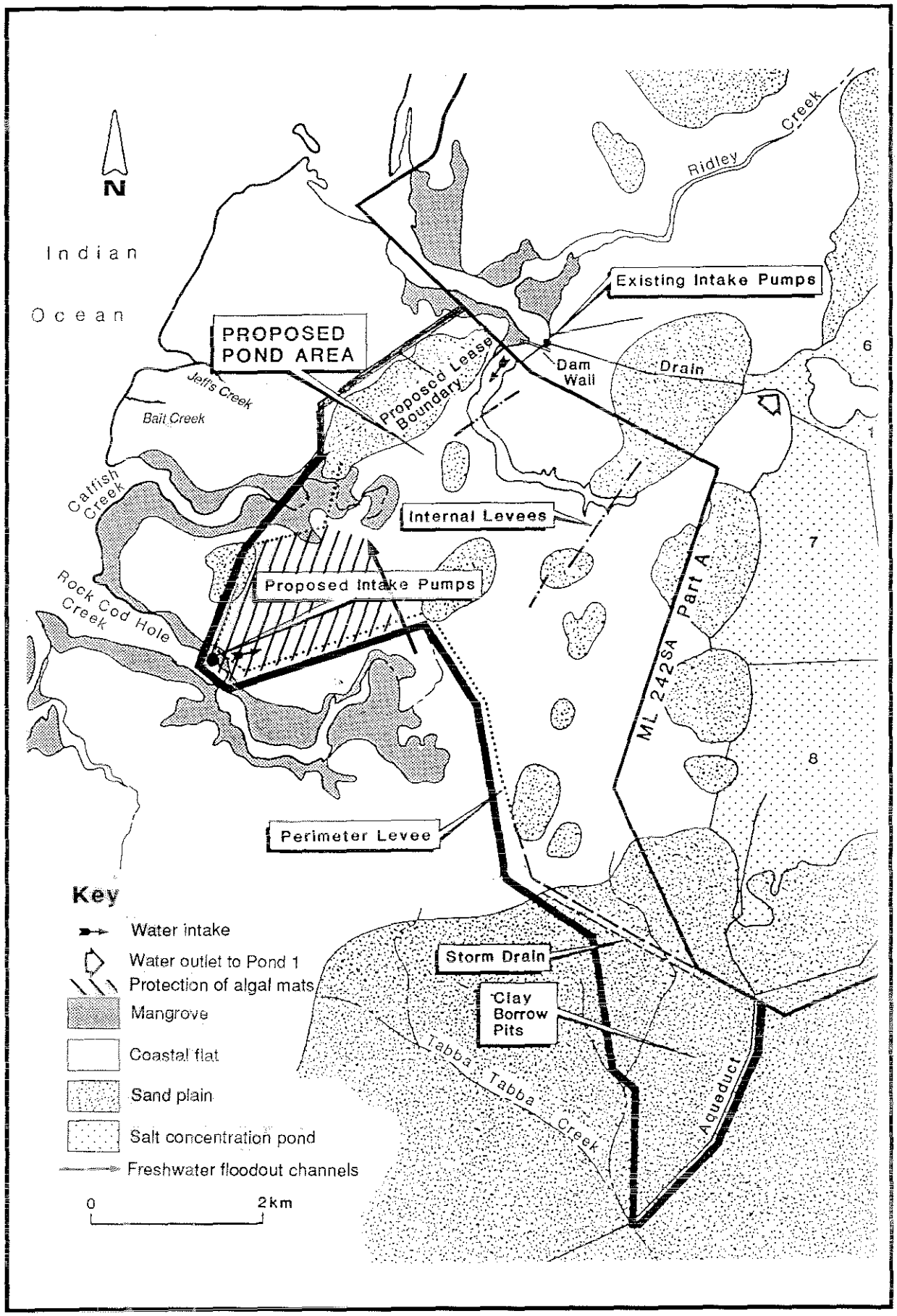

Figure 2: Proposed primary concentration pond

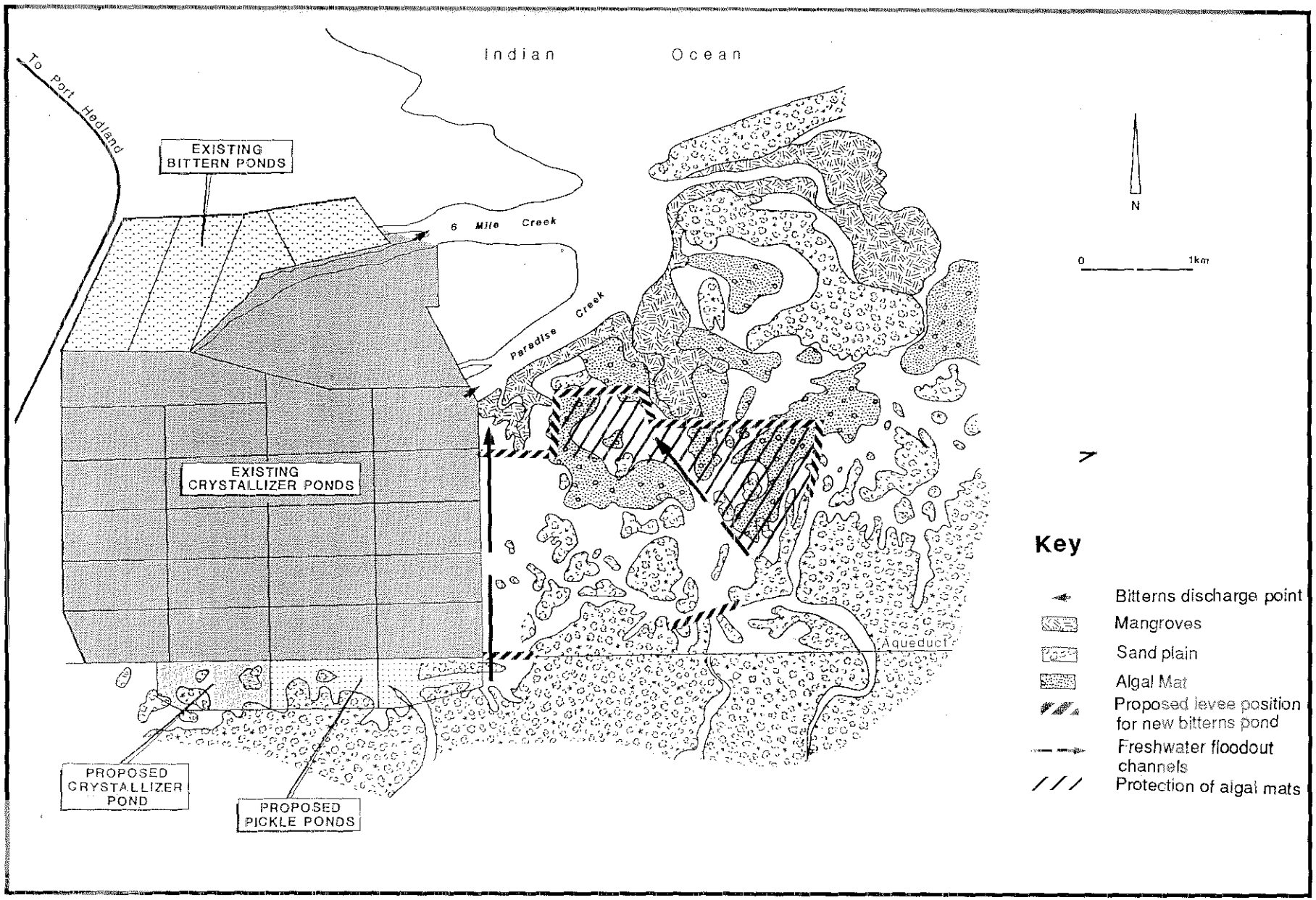

Figure 3: Proposed bitterns pond

pond and discharge point,and, secondly, that good environmental management and monitoring should continue during the operational life of the project.

The Environmental Management Programme should address the management, monitoring, auditing and reporting of all environmental factors including the construction procedures and workforce management, the location, operation and rehabilitation of all borrow pits, quarries and other disturbed sites, the seawater intake pumping regime, the survey and relocation plan for all fauna on the sandplain areas within the proposed ponds, the ongoing monitoring of the health of the mangrove ecosystems in Ridley, Catfish, Rock Cod Hole (if the pump station is installed), Paradise and Six Mile Creeks and the bird habitats formed by the new primary concentration pond.

Recommendation 4

The Environmental Protection Authority recommends that, prior to the commencement of construction, the proponent should submit and subsequently implement an Environmental Management Programme to monitor the effects of the proposal and provide for appropriate management based on the monitoring results, to the satisfaction of the Environmental Protection Authority.

The Environmental Management Programme should address, but not necessarily be limited to, the management, monitoring, auditing and reporting requirements of the following issues:

- **the construction procedures and workforce management;**
- **the monitoring of the health of the mangrove ecosystems; and**
- **the monitoring of the bird habitats.**

In the event that monitoring shows that any areas of the mangrove ecosystems are likely to be or have been adversely affected by the project, the Environmental Protection Authority recommends that the proponent submit and implement a plan for the rehabilitation of these mangrove ecosystems to the satisfaction of the Environmental Protection Authority.

New pump facility

The proposal involves an increase in the capacity of the seawater pumping operation and, in the Consultative Environmental Review, it is proposed to install a second pumping station on Rock Cod Hole Creek to supplement the existing intake pumps on Ridley Creek. The existing facility involved damming Ridley Creek with the subsequent loss of mangroves and algal mats, though this has since been partially compensated by the formation of another branch of Ridley Creek and its subsequent colonisation by mangroves.

The Environmental Protection Authority is concerned that the installation of a new pumping facility does not produce adverse, indirect impacts upon the mangrove ecosystems by reducing the wetted area of algal mats. For example, pumping on an incoming tide could reduce the level to which the tide rises and, hence, the tidally wetted area of coastal flats, including the algal mats. The Environmental Protection Authority considers that, unless the proponent can demonstrate that the proposed pumping regime will have no effect upon the algal mats, there should be pumping only on out-going tides.

Recommendation 5

The Environmental Protection Authority recommends that a pumping regime plan be submitted and subsequently implemented, as part of the Environmental Management Programme, prior to the commissioning of the pumps, to the satisfaction of the Environmental Protection Authority such that there are no adverse environmental impacts upon the mangrove ecosystems.

Bitterns discharge

The proposal involves an increase in bitterns discharge in both volume (772,700 megalitres per year) and concentration above the projected 1991 discharge level of 3,477,200 megalitres per year. Prior to 1984, the proponent discharged bitterns onto the tidal flats with the subsequent loss of some of the adjacent mangrove ecosystem. Since 1984, the method of disposal has been altered and the proponent reports that natural rehabilitation of the mangroves has occurred.

No specific biological monitoring has been carried out to determine the actual effects of bitterns discharge and the Environmental Protection Authority believes that monitoring of the proposed bitterns discharge regime should be carried out.

Recommendation 6

The Environmental Protection Authority recommends that a bitterns discharge and monitoring plan be submitted and subsequently implemented, prior to the commissioning of the ponds, as part of the Environmental Management Programme, to the satisfaction of the Environmental Protection Authority. If the monitoring results show that the mangrove ecosystems are likely to be or have been affected by the discharge of bitterns, the proponent should prepare and implement a revised plan for bitterns discharge and for the rehabilitation of any affected areas, to the satisfaction of the Environmental Protection Authority.

Rehabilitation of disturbed areas

The construction of the pond embankments would require large quantities of earthen materials, which would be extracted from local borrow pits and quarries. It is important that these disturbed areas be left in a safe and stable, rehabilitated condition. The proponent has made a commitment to achieving this objective, but the details have not yet been finalised. Other temporary disturbances such as access tracks, etc, should also be rehabilitated to an appropriate standard.

Recommendation 7

The Environmental Protection Authority recommends that, prior to the commencement of construction, the proponent should submit and subsequently implement a rehabilitation plan, as part of the Environmental Management Programme, for any disturbed areas, including all borrow pits and quarries, to the satisfaction of the Environmental Protection Authority.

Sandplain areas

As a result of the creation of the new ponds, several sandplain areas on the coastal flats would be removed during construction and/or a number of sandplain islands would be formed. The fauna which inhabit these areas would require relocation and any Aboriginal heritage sites would need to be protected. The proponent has already conducted an archaeological survey of the area, but specific surveys of any sandplain areas proposed to be removed may have to be carried out under the requirements of the Aboriginal Heritage Act.

With regard to the fauna inhabiting the sandplain areas, a plan needs to be in place to aid their resettlement where excessive numbers would be confined to islands created by the project. Accordingly, the Environmental Protection Authority makes the following recommendation.

Recommendation 8

The Environmental Protection Authority recommends that, before any site works commence, the proponent should submit and subsequently implement a plan, as part of the Environmental Management Programme, to ensure that populations of fauna on any sandplain areas which would be affected by the construction of the ponds are suitably relocated, to the satisfaction of the Environmental Protection Authority, on advice from the Department of Conservation and Land Management.

Decommissioning plan

The operation of the primary concentration pond involves maintaining a diverse, biologically-productive ecosystem. The successive ponds are progressively less diverse as the concentration of the brine increases and are not as important with regard to the potential environmental impact if the ponds were allowed to dry up. The Environmental Protection Authority is particularly concerned about the potential environmental impact of allowing either the existing or the proposed primary concentration pond to dry up. The concern is both for the preservation of the birdlife habitats as well as the potential effect of the formation of a large area of decomposing organic material. It is important that a contingency plan be developed which ensures that the proponent and relevant state government agencies have an agreed operational plan to stop the pond drying up or to manage the care and maintenance of the pond.

Recommendation 9

The Environmental Protection Authority recommends that, at least six months before the end of the life of the project, the proponent submit and subsequently implement a plan to manage the decommissioning and rehabilitation of the entire project area to the satisfaction of the Environmental Protection Authority. In the event of the project being placed on a short-term, care and maintenance basis, it is recommended that a plan to ensure that adverse environmental effects will be managed should be submitted and implemented, at least three months prior to the suspension of operations, to the satisfaction of the Environmental Protection Authority.

Minor and non-substantial changes

The Environmental Protection Authority notes that during the detailed implementation of proposals, it is often necessary or desirable to make minor and non-substantial changes to the designs and specifications which have been examined as part of the Authority's assessment. The Authority believes that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

Lapsed proposal

The Environmental Protection Authority believes that any approval for the proposal based on this assessment should be limited to five years. Accordingly, if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should occur only following a new referral to the Authority.

1. Introduction

The Environmental Protection Authority received a proposal from Leslie Salt in March 1990, to expand the existing salt mining operation at Port Hedland from 2.25 million tonnes per annum (mta) to 2.75 mta. This proposal is specifically considered in this report. It is one of four recent solar salt development proposals, firstly, for a new salt field at Onslow and, secondly, from the three other existing producers in the State to expand their existing operations.

Solar salt proposals typically affect large tracts of coastal tidal flats which have special environmental values. Past experience has shown that premature termination of proposals without appropriate decommissioning and rehabilitation procedures can result in major environmental impacts. The Environmental Protection Authority was therefore concerned to establish that each of the proposals would be unlikely to close prematurely and that each company could guarantee to undertake appropriate decommissioning or mothballing if necessary.

As part of its assessment of the environmental effects of this and other current proposals for expanded solar salt production in Western Australia, the Environmental Protection Authority called for information regarding market factors, broad regional environmental setting and relative productivity in relation to the overall environmental impact. The Department of State Development provided the information below on the market factors and their view on the need for expansion (Department of State Development, *pers comm).*

1.1 The market for salt and the need for expansion

The total world output for salt is around 180 million tonnes per year, of which 22 million tonnes is traded internationally. Western Australia supplies 27% of this and is the largest exporter of salt in the world. In 1989 this amounted to nearly 6 million tonnes, worth about $112 million.

The 1989-90 period was characterised by continuing interest in capacity expansion throughout the industry in Western Australia, brought about by improved world prices for salt, as increasing demand relieved the over-supply problems common to the 1970s and early 1980s. The current situation in Western Australia is:

- Dampier Salt at Lake Macleod has increased capacity to 1.5 million tonnes per annum (mta);
- Dampier Salt at Karratha, from 2.5 to 3.0 mta (granted environmental approval 23 November 1990);
- Shark Bay Salt at Useless Inlet, from 0.65 to 1.2 mta, currently under Environmental Protection Authority assessment;
- Leslie Salt near Port Hedland, from 2.25 to 2.75 mta, currently under Environmental Protection Authority assessment (this proposal);
- Gulf Holdings' new proposal at Onslow, for 1.5 mta, assessment complete, awaiting Ministerial decision.

Overall the demand for salt in the major consuming Asian countries is expected to increase by no more than 2% compound for the next few years. However, domestic salt production in Taiwan and Korea is very inefficient and takes place upon increasingly scarce and valuable coastal land. The eventual closure of these fields is likely, resulting in an increased demand for imported salt, predominantly from Australia, for the large chemical (chlor-alkali) industries in those countries.

If all the current salt proposals world-wide come to fruition in the next year or so it is certain that there will be an over-supply of salt in 1993/4. However, the operators have the following options if demand is poor:

- taking excess crystallisers temporarily out of the brine cycle;
- leaving a thicker salt floor in the crystallisers as an unharvested stockpile; and
- increasing harvested stockpiles.

Salt production is an activity in which Western Australia, and specifically the large areas of the Pilbara, enjoys significant advantages due to the favourable climate, terrain and coastline. While Mexico can

compete with Western Australia in this regard it is further from the major North Asian markets and transport costs become a significant economic factor.

Existing producers have operational and commercial reasons to expand; these being:

- the need for a 20-25% buffer of excess capacity; this may be necessary to build up stocks in case the operation is affected by cyclonic rain, or to meet a sudden surge in demand caused by adverse climatic conditions elsewhere;
- the solar salt industry could be selling to its theoretical capacity in under three years, which is a serious constraint given the two to three year lead time for saltfield expansion to become productive; and
- the need to reduce unit costs and so improve world-wide competitiveness.

1.2 Regional setting

The Leslie Salt project expansion is proposed for saline tidal flats adjacent to communities of mangrove trees which characteristically line coastal creeks along the Pilbara coastline. These mangals are the only mangroves in Australia which inhabit a tropical-arid zone coastline and they form part of an ecosystem which includes algal mats and the nearshore marine environment. This ecosystem is responsible for binding substrate, reducing erosion of the tidal flats and creek banks (especially important along this cyclone-prone coastline), and for acting as a generator and repository of nutrients such as nitrogen and phosphorus (Paling, 1986). The nutrients form the food base for micro-organisms, which live in the algal mats and mangroves, and which are preyed upon by creatures higher up the food chain, culminating with predation by crabs, birds, fish and man.

In recognition of the high environmental significance of the mangrove ecosystems, the Conservation Through Reserves Committee recommended to the Environmental Protection Authority that, in the coastal region from Exmouth Gulf to Mary Anne Islands, **"... development for solar salt production be restricted to the supra-tidal zone landward of the mangrove thickets, and that any extension (to the existing operations) require the approval of the Environmental Protection Authority."**. This recommendation was subsequently endorsed by the Environmental Protection Authority in its report to Government in 1975 (Environmental Protection Authority, 1975) and is an important cornerstone in the Environmental Protection Authority's assessment of this proposal.

The mangal system around Port Hedland extends from Downes Island to Ridley Creek and comprises about 1900 hectares (ha) of mangroves and an equivalent area of blue-green algal mats. The system forms the bulk of the northern-most communities of the arid zone mangrove ecosystems, with only the De Grey River mangal system being further north. These ecosystems are characterised as forming in deltaic/barrier island geomorphic settings and, because of their high biological productivity, are very important to the fisheries of the region and to other flora and fauna.

1.3 Productivity

Solar salt production is inherently attractive from an environmental viewpoint, in that it uses solar energy and is sustainable, apart from the resources consumed in pumping and harvesting.

However, it requires large areas of concentration ponds which have the potential for major environmental impacts and, clearly, ponds located on land of low environmental sensitivity are preferred. Also, the productivity of the operation is highly relevant in that it should be maximised such that it offsets the environmental impacts of the ponds or negates the necessity for further ponds if there is scope for increasing the productivity of the existing ponds. A proposal which is environmentally efficient in that it avoids environmentally sensitive land, or at least maximises productivity relative to minimised environmental impacts, is inherently more environmentally acceptable.

For example, the Dampier "process enhancement" proposal recently assessed by the Authority proposes to increase productivity by the expansion of the ponds into a previously disturbed area and, therefore has few associated environmental impacts. The Leslie Salt project has undertaken similar measures to maximise efficiency within the existing ponds.

2. The proposal

Leslie Salt proposes to expand its salt mining operation by expanding its primary concentration, brine, crystallization and bitterns ponds (Figures 2 and 3). The objective of the expanded facilities is to enable production to be increased by 0.5 mta in addition to the 2.25 mta currently produced.

A new intake pumping station is proposed to be constructed on Rock Cod Hole Creek to supplement the existing intake pump on Ridley Creek. Sea water would be pumped into the new pond and brine would then move through the existing pond system as it becomes concentrated. Clay material to construct the primary concentration pond embankments would be obtained from borrow pits at the southern end of the proposed new lease, as well as from existing borrow areas; rock material would be obtained from existing quarry sites within the existing leases. Much less material is required to construct the other ponds and the material would be obtained from existing borrow areas within the leases.

A full description of the project proposal is presented in the Consultative Environmental Review.

2.1 Need

Leslie Salt states the need for the expansion as a desire to exploit the growth in the demand for salt in the Asian market which is expected to continue into the near future. Also, the proponent indicates that the economic viability of the present operation is being compromised by the higher rate of increase in production costs versus the increase in the selling cost of the product.

2.2 Alternatives

An alternative to the need for the expansion of the ponds involves increasing the efficiency of the existing ponds to boost production. Leslie Salt report that it has undertaken appropriate measures over the previous two years and is currently operating at close to maximum efficiency.

Alternatives to the location of the proposed primary concentration pond have been considered but no suitable areas have been identified either within or outside the existing leases. Alternatives to the size of the primary pond are under consideration in response to the environmental factors arising from the assessment process, but with the constraint that any reduction in size leads to a decrease in the amount of additional salt which could be produced.

Alternatives to the locations of the proposed bitterns and crystalliser ponds have been examined but the preferred locations are clearly the most suitable on both economic and engineering grounds. Alternatives to the size of the ponds affect the production capacity of the operation and would be considered only in response to the environmental factors arising from the assessment process.

3. Existing environment

The project area extends from Six Mile Creek to Ridley Creek and is part of a coastal plain which comprises Quaternary alluvial and coastal plain sediments that form barrier islands and associated tidal embayments and salt flats. This coastal type occurs at few localities along the Pilbara coast and can be subdivided into salt/mud tidal flats, sand plains, tidal creeks, mangrove flats, limestone barrier islands and hinterland drainage channels. The feature which distinguishes this coastal plain is the type of flood-out from the hinterland drainage; the major creeks, the Beebingarra, Petermarer and the Tabba Tabba, flood the coastal flats mainly by sheet flow rather than by defined drainage channels.

The salt/mud tidal flats are generally of low biological productivity except where blue-green algal mats form around the fringes of the samphire vegetation in the more frequently inundated sections of the flats. The tidal creeks/mangrove areas have a high biological productivity and function as a nursery area for the offshore fisheries. The blue-green algal mats support the function of the mangroves and may be regarded as an integral part of the chain of biological productivity represented by the mangroves. The sand plain and limestone barrier islands are covered with a mixture of low shrubland and grassland assemblages.

The climate of the area is typical of the Pilbara with an annual rainfall of 307 mm, annual evaporation of 3497 mm and 31 rain days per year. About 40% of the rain is associated with cyclones and the remainder with thunderstorms; thus most rain is heavy and of short duration. Storm surges can elevate the sea level to heights of 7 m above Australian Height Datum (11.6 m above Chart Datum). Spring tides of at least 6.9 m above Chart Datum are required to inundate the salt flats.

Aboriginal heritage in the region was investigated and both archaeological and ethnographic surveys were done. The information is presented in the Consultative Environmental Review and has been used in designing the layout of the proposed facilities.

The existing salt producing operation extends from Six Mile Creek to Ridley Creek, which is a distance of about 30 km, and comprises a tract of coastal plain that includes the floodout areas of four large creeks and is dissected by eleven tidal creeks. The operation has had a direct effect on four of the tidal creeks resulting in a net loss of about 136 ha of mangroves and an indeterminate amount of algal mat; the estimation of the net loss takes into account the regeneration of mangroves which has occurred in the inlet channel of pond 1 and in the extension of the north arm of Ridley Creek. The net loss of mangroves represents about 7.2% of the mangroves of the local coastal plain (Downes Island to Ridley Creek). An indeterminate amount of the regional algal mat resource has been destroyed by the existing operation.

4. Assessment and recommendations

The Consultative Environmental Review was distributed to the following relevant agencies for comment (Table 1), and their submissions, along with unsolicited submissions from several sources who provided information for the Environmental Protection Authority's assessment process.

Table 1: Agencies consulted

Department of State Development

Department of Mines

Department of Land Administration

Fisheries Department

Department of Main Roads

Department of Conservation and Land Management

Aboriginal Affairs Planning Authority

Social Impact Unit, Department of State Development

Port Hedland Port Authority

Department of the Arts, Sport, the Environment, Tourism and Territories

Town of Port Hedland

Western Australian Fishing Industry Council

Australian Conservation Foundation

Conservation Council of Western Australia

Local Environment Affinity Force, Port Hedland

The key environmental issues identified for the proposal relate to the protection of the mangrove ecosystems, including the maintenance of the freshwater floodout regime, the location and operation of the new pump facility, the new bitterns discharge regime, the rehabilitation of the disturbed areas such as the borrow pits and quarries, the development of an Environmental Management Programme, loss or isolation of the sandplain areas and developing a decommissioning plan.

The Environmental Protection Authority sought advice from experts throughout Australia on the issue of the protection of the mangrove ecosystems. That advice confirmed both the importance of the mangroves to the fisheries and their conservation status, though the detailed technical and scientific evidence is scanty for any particular mangrove ecosystem. The observation was also made that the

indirect impacts on mangrove ecosystems arising from modifications to the hydrologic and nutrient support systems were as much of a threat to their long-term survival as were the direct impacts.

The Environmental Protection Authority concluded that the most appropriate position to hold was that the mangrove ecosystems required protection and that it would be incumbent upon the proponent to show that any proposal did not pose an unacceptable threat, either directly or indirectly, to the mangroves. The Environmental Protection Authority believes that the issue of the protection of the mangrove ecosystems could be resolved by a modification to the original design, as described in the Consultative Environmental Review, of the primary concentration and bitterns ponds. An indication of the modifications which would provide an adequate level of protection to the mangrove ecosystems is provided in Figures 2 and 3 and in the text below.

The other issues are considered to be adequately resolved by the Environmental Protection Authority's recommendations in this report or by the proponent's commitments. Accordingly, the Environmental Protection Authority makes the following recommendation.

Recommendation 1

The Environmental Protection Authority concludes that the proposal, as outlined in the Consultative Environmental Review, to construct additional salt production ponds would only be environmentally acceptable if the proposal is modified according to the recommendations in this report to provide the appropriate level of protection to the mangrove ecosystems.

The Environmental Protection Authority identified the main environmental factors requiring detailed consideration as: protection of the mangrove ecosystems; maintenance of freshwater floodout; location and operation of the new pump facility; the new bitterns discharge regime; rehabilitation of disturbed areas such as the proposed borrow pits and quarries; development of an Environmental Management Programme; loss or isolation of the sandplain areas; and the development of a decommissioning plan.

The Environmental Protection Authority considers that, apart from the mangrove ecosystem protection as noted above, the other issues have been addressed by either the proponent's commitments or by the recommendations in this report. Accordingly, the Environmental Protection Authority recommends that the proposal could proceed subject to the:

- **proponent's commitments (Appendix 2); and**
- **Environmental Protection Authority's recommendations in this report.**

Protection of the mangrove ecosystems

The mangroves and associated biological communities, such as the algal mats, are fundamentally important in the biological production cycle of the coastline and are vital for the maintenance of the offshore fisheries (Kenneally, 1982). The mangrove ecosystems assume relatively more importance in the arid zone because of the low productivity of the other biological systems in the hinterland.

The status of the mangrove ecosystems of the arid zone of Western Australia is that they are unique within Australia because they are the only mangroves which inhabit a tropical-arid zone coastline. They are therefore of national importance and the conservation of the bulk of the remaining mangrove ecosystems has a high priority. In addition, the importance of the mangrove ecosystems to other flora and fauna cannot be overstated and their conservation acts to conserve numerous other species.

The importance of the mangrove ecosystems to the fisheries, whether they be commercial or recreational, also cannot be overstated. They are vital as nursery areas for the prawns and fish of the fisheries of the offshore region as well as for the more numerous species which are not the target for commercial exploitation.

The loss of mangroves from the entire arid zone region, which extends from Exmouth Gulf to the De Grey River, has not been completely assessed but, for example, over 16% of the mangroves from Cape Preston to Cape Lambert have been destroyed (Gordon, 1987) and over 7% of the mangroves between Downes Island and Ridley Creek are reported by Leslie Salt as having been destroyed. Other loss of mangroves throughout the region from urban and industrial development and other causes has been noted and the Environmental Protection Authority has concluded that no further significant loss of the mangrove ecosystems would be environmentally acceptable.

Freshwater floodout

The tropical-arid zone mangroves inhabit an ecological niche which is characterised by a salinity regime whereby the soil water salinity ranges from the concentration of seawater (35 parts per thousand, [ppt]) to about 90 ppt. The main hydrological factor is the daily inundation by tidal waters though the overall hydrological regime which supports the mangrove ecosystems includes periodic freshwater flushing from both surface run-off and groundwater sources. Little research data are available to document the degree of importance of the periodic freshwater flushing, but it is likely to be important as it has been observed that mangrove communities can be severely affected by changes to hinterland drainage (Semeniuk, 1983). Effects such as decreased biomass production under salinity stress have also been documented for some species of mangrove (Field, 1985) and the mortality of mangroves due to the restriction of hinterland drainage and changes to sea water flushing has also been documented in many parts of northern Australia (Gordon, 1987).

The Leslie Salt proposal, as outlined in the Consultative Environmental Review, would restrict the freshwater drainage to at least 300 ha of mangroves at Catfish and Paradise Creeks and would have a direct impact on about 23 ha of mangroves and 216 ha of algal mat. The mangroves at Paradise Creek would also be subjected to high salinity bitterns discharge and groundwater seepage from the bitterns pond, which would further stress the mangrove ecosystem.

The Environmental Protection Authority considers that the overall environmental impacts, both direct and indirect, of the proposal, as originally presented in the Consultative Environmental Review, would be significant upon substantial proportions of the local mangrove ecosystems. The Environmental Protection Authority concludes that modifications to the original designs of the primary concentration and bitterns ponds, as outlined in the Consultative Environmental Review, are warranted in order to protect the mangrove ecosystems.

With regard to the design of the primary concentration pond, the Authority considers that the area between Rock Cod and Catfish Creeks should not be impounded in order to conserve the algal mats in the area and to allow freshwater floodout to reach the headwaters of Catfish Creek. With regard to the design of the bitterns pond, the Authority considers that the pond should not extend to the north so as to surround the mangroves at the headwaters of Paradise Creek, that drainage channels should be constructed in order to allow freshwater floodout to reach the headwaters of Paradise Creek and that as much as possible of the algal mats in the north-eastern corner of the current pond design should be to conserved by being excluded from the proposed pond (Figures 2, 3). The Environmental Protection Authority considers that these measures would adequately address the potential, long-term, indirect impacts from the proposed modifications to the mangrove ecosystems and, accordingly, makes the following recommendations.

Recommendation 2

The Environmental Protection Authority recommends that the proponent be required to construct and manage the facility such that there would be no secondary impacts off the actual site, including no indirect loss or detriment to mangroves or algal mats off-site, to the satisfaction of the Environmental Protection Authority.

Recommendation 3

So as to ensure there is minimal direct loss and no indirect loss of the mangrove ecosystems, the Environmental Protection Authority specifically recommends that the proponent should develop and subsequently implement modified designs for the primary concentration and bitterns ponds to the satisfaction of the Minister for the Environment. These designs should include provisions to ensure the maintenance of freshwater floodout to the headwaters of Catfish and Paradise Creeks and avoid impoundment of some of the algal mats.

Environmental Management

The construction phase of the project would involve large, earth-moving equipment operating within the mangrove ecosystems on the coastal flats. This has resultant actual and potential impacts related to direct damage (to algal mats), dust, noise and petrochemical pollution, for example. The Environmental Protection Authority considers that these impacts should be avoided or minimised such that there is as little disturbance as possible to the mangrove ecosystems.

Following commissioning of the new ponds, there is potential for long-term impacts on the mangrove ecosystems from groundwater seepage from the ponds, bitterns discharge, diversion of tidal waters by the pumping and the loss or modification of some of the nutrient and hydrologic support systems. The Environmental Protection Authority considers that these impacts should be monitored and managed.

The Environmental Protection Authority considers that it is necessary for the proponent to design and implement an Environmental Management Programme to ensure, firstly, that the construction and commissioning phases of the project are carried out with due care and with adequate monitoring to give early warning of any adverse effects upon the mangroves, particularly in the vicinity of the bitterns pond and discharge point, and, secondly, that good environmental management and monitoring should continue during the operational life of the project. The construction and commissioning phases of the project will require close supervision by suitably qualified personnel to ensure that all aspects are carried out with due recognition of environmental impacts and processes.

The Environmental Management Programme should address the management, monitoring, auditing and reporting of all environmental factors including the construction procedures and workforce management, location, operation and rehabilitation of all borrow pits, quarries and other disturbed sites, the survey and relocation plan for all fauna on the sandplain areas within the proposed ponds, the ongoing monitoring of the health of the mangrove ecosystems in Ridley, Catfish, Rock Cod Hole (if the pump station is installed), Paradise and Six Mile Creeks and the bird habitats formed by the new primary concentration pond.

Recommendation 4

The Environmental Protection Authority recommends that, prior to the commencement of construction, the proponent should submit and subsequently implement an Environmental Management Programme to monitor the effects of the proposal and provide for appropriate management based on the monitoring results, to the satisfaction of the Environmental Protection Authority.

The Environmental Management Programme should address, but not necessarily be limited to, the management, monitoring, auditing and reporting requirements of the following issues:

- **the construction procedures and workforce management;**
- **the monitoring of the health of the mangrove ecosystems; and**
- **the monitoring of the bird habitats.**

In the event that monitoring shows that any areas of the mangrove ecosystems are likely to be or have been adversely affected by the project, the Environmental Protection Authority recommends that the proponent submit and implement a plan for the rehabilitation of these mangrove ecosystems to the satisfaction of the Environmental Protection Authority.

New pump facility

The proposal involves an increase in the capacity of the seawater intake pumping operation and, in the Consultative Environmental Review, it is proposed to install a second pumping station on Rock Cod Hole Creek to supplement the existing intake pumps on Ridley Creek. The existing facility involved damming Ridley Creek with the subsequent loss of mangroves and algal mats, though this has since been partially compensated by the formation of another branch of Ridley Creek and its subsequent colonisation by mangroves. The Environmental Protection Authority is concerned that the installation of a new pumping facility does not produce adverse, indirect impacts upon the mangrove ecosystems by reducing the wetted area of algal mats. For example, pumping on an incoming tide could reduce the

level to which the tide rises and, hence, the tidally-wetted area of coastal flats, including the algal mats. The Environmental Protection Authority considers that, unless the proponent can demonstrate that the proposed pumping regime will have no effect the viability of the algal mats, there should be pumping only on the out-going tides, so that all areas currently wetted remain so.

Recommendation 5

The Environmental Protection Authority recommends that a pumping regime plan be submitted and subsequently implemented, as part of the Environmental Management Programme, prior to the commissioning of the pumps, to the satisfaction of the Environmental Protection Authority such that there are no adverse environmental impacts upon the mangrove ecosystems.

Bitterns discharge

The proposal involves an increase in bitterns discharge in both volume (772,700 megalitres per year) and concentration above the projected 1991 discharge of 3,477,200 megalitres per year. Prior to 1984, the proponent discharged bitterns onto the tidal flats with the subsequent loss of some of the adjacent mangrove ecosystem. Since 1984, the method of disposal has been altered and the proponent reports that natural rehabilitation of the mangroves has occurred.

No specific biological monitoring has been carried out to determine the actual effects of bitterns discharge and the Environmental Protection Authority believes that monitoring of the proposed bitterns discharge regime should be carried out.

Recommendation 6

The Environmental Protection Authority recommends that a bitterns discharge and monitoring plan be submitted and subsequently implemented, prior to the commissioning of the ponds, as part of the Environmental Management Programme, to the satisfaction of the Environmental Protection Authority. If the monitoring results show that the mangrove ecosystems are likely to be or have been affected by the discharge of bitterns, the proponent should prepare and implement a revised plan for bitterns discharge and for the rehabilitation of any affected areas, to the satisfaction of the Environmental Protection Authority.

Rehabilitation of disturbed areas

Expansion of the existing borrow areas and the development of new borrow areas would be required for the levee bank construction of the ponds and, in addition, there would be other temporary disturbances such as access roads. It is important that the borrow pits and quarries in particular be left in a safe and stable, rehabilitated condition.

The proponent has detailed certain rehabilitation procedures and has indicated that adequate rehabilitation techniques, such as those provided in guidelines from the Department of Mines, could be implemented. Details of the rehabilitation programme could be defined if the proposal proceeds.

Recommendation 7

The Environmental Protection Authority recommends that, prior to the commencement of construction, the proponent should submit and subsequently implement a rehabilitation plan, as part of the Environmental Management Programme, for any disturbed areas, including all borrow pits and quarries, to the satisfaction of the Environmental Protection Authority.

Sandplain areas

As a result of the creation of the new ponds, several sandplain areas on the coastal flats would be removed during construction and/or a number of sandplain islands would be formed. The fauna which inhabit these areas would require relocation and any Aboriginal heritage sites would need to be protected. The proponent has already conducted an archaeological survey of the area, but specific surveys of any sandplain areas proposed to be removed may have to be carried out under the requirements of the Aboriginal Heritage Act.

With regard to the fauna inhabiting the sandplain areas, a plan needs to be in place to aid their resettlement where excessive numbers are confined to islands created by the project. Accordingly, the Environmental Protection Authority makes the following recommendation.

Recommendation 8

The Environmental Protection Authority recommends that, before any site works commence, the proponent should submit and subsequently implement a plan, as part of the Environmental Management Programme, to ensure that populations of fauna on any sandplain areas which would be affected by the construction of the ponds are suitably relocated, to the satisfaction of the Environmental Protection Authority, on advice from the Department of Conservation and Land Management.

Decommissioning plan

The temporary or permanent rehabilitation and decommissioning plans for the ponds and the rest of the project area have not been developed apart from some general clauses under the Leslie Salt Agreement Act. The project area has disturbed a total area of over 70 km^2 and the proposal will affect a further 18 km^2, and the Environmental Protection Authority believes it is important for an adequate plan to be in place to manage both the possible care and maintenance situation and the final decommissioning and rehabilitation of the project area.

The operation of the primary concentration pond involves maintaining a diverse, biologically-productive ecosystem. The successive ponds are progressively less diverse as the concentration of the brine increases and are not as important with regard to the potential environmental impact if the ponds were allowed to dry up. The Environmental Protection Authority is particularly concerned about the potential environmental impact of allowing either the existing or the proposed primary concentration pond to dry up. The concern is both for the preservation of the birdlife habitats as well as the potential effect of the formation of a large area of decomposing organic material. It is important that a contingency plan be developed which ensures that the proponent and the relevant state government agencies have an agreed operational plan to stop the pond drying up or to manage the care and maintenance of the pond.

Recommendation 9

The Environmental Protection Authority recommends that, at least six months before the end of the project, the proponent develop and subsequently implement a plan to manage the decommissioning and rehabilitation of the entire project area to the satisfaction of the Environmental Protection Authority. In the event of the project being placed on a short-term, care and maintenance basis, it is recommended that a plan to ensure that adverse environmental effects will be managed should be submitted and implemented, at least three months prior to the suspension of operations, to the satisfaction of the Environmental Protection Authority.

4.1 Other issues

Numerous other issues were raised in the public submissions and assessment of the proposal. These have been summarised and, together with the response from the proponent, are presented in Appendix 1. The issue regarding the birdlife was the most significant and the Environmental Protection Authority received a detailed submission from the Royal Australasian Ornithologists Union.

4.1.1 Birdlife

The artificial wetlands of the existing ponds have become internationally important for trans-equatorial migratory birds as well as endemic species. The Federal Government has signed three international conventions which commit Australia to conserving habitats which are important for these migratory birds. The Royal Australasian Ornithologists Union has advised the Environmental Protection Authority that management procedures to ensure that the habitats are preserved should be implemented. The proponent is committed to liaising with the Royal Australasian Ornithologists Union in the design and operation of the proposed pond system. Leslie Salt has supported the use of the existing primary concentration pond by ornithologists to study the birds and has indicated that it will continue to do so. The decommissioning plan referred to in Recommendation 9 would take the issue of the birdlife into account.

4.1.2 Minor and non-substantial changes

The Environmental Protection Authority notes that during the detailed implementation of proposals, it is often necessary or desirable to make minor and non-substantial changes to the designs and specifications which have been examined as part of the Authority's assessment. The Authority believes that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

4.1.3 Lapsed proposal

The Environmental Protection Authority believes that any approval for the proposal based on this assessment should be limited to five years. Accordingly, if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should occur only following a new referral to the Authority.

5. Conclusions

The Environmental Protection Authority concludes that, subject to modifications to the pond designs to provide an appropriate level of protection to the mangrove ecosystems and the Environmental Protection Authority's other recommendations in this report, the proposal to expand the salt production ponds could be environmentally acceptable. All the issues could be resolved by either the recommendations in this report or by the proponent's commitments.

5.1 References

1. Department of State Development, *pers comm.* Extracts from unpublished notes provided to the Environmental Protection Authority.
2. Paling, E I, 1986. Ecological significance of Blue-green Algal Mats in the Dampier Mangrove Ecosystem. Department of Conservation and Environment Technical Series 2.
3. Environmental Protection Authority, 1975. Conservation Reserves for Western Australia, Systems 4, 8, 9, 10, 11, 12.
4. Kenneally, K F, 1982. Mangroves of Western Australia. In Mangrove Ecosystems in Australia. B F Clough (ed).
5 Semeniuk, V, 1983. Mangrove Distribution in Northwestern Australia in relationship to regional and local freshwater seepage. Vegetation 53, pages 11-31.
6 Field, C D, 1985. Salt Tolerance in Mangroves. In Mangrove Ecosystems of Asia and the Pacific. C D Field and A J Dartnall (eds). Australian Institute of Marine Science.
7 Gordon, D M, 1987. Disturbance to Mangroves in Tropical-Arid Western Australia. Environmental Protection Authority Technical Series No 12.

Appendix 1

Issues raised in submissions and proponent's response

1. Query the need for the triangular piece of land between Catfish and Rock Cod Hole Creeks, incorporating the proposed second intake pump, on the grounds that there is a direct loss of mangroves, a loss of freshwater flushing and entrapment of fauna.

A. The proponent has agreed to avoid the loss of mangroves except for 0.2 ha at the second intake pump; the proponent requires the second intake pump to increase the availability of water at lower tidal regimes and as an emergency back-up; and the proponent believes fauna could move freely along the levees. The proponent admits there will be a restriction to freshwater flushing but considers that it is not significant to the health of the mangroves.

2. The monitoring commitments for bitterns discharges should be sufficient to detect any effect upon the mangroves.

A. The proponent agrees and will design an appropriate programme.

3. The increase in trucking movements should be monitored.

A. The proponent agrees and will report trucking statistics in an annual report.

4. Query the comprehensiveness of the survey of Aboriginal sites.

A. The proponent believes that the survey conducted by the consultants recommended by the Western Australian Museum is sufficient.

5. Biological surveys of the sandy islands within the proposed ponds and the eastern arm of Tabba Tabba Creek should be conducted.

A. The proponent considers that site surveys are not required because the land systems are regionally extensive and no records of rare or endangered flora and fauna species are known from the area.

6. No estimate of the amount of blue-green algal mats which would be lost has been made.

A. An estimated total of 210 ha of algal mats would be lost, which represents about 11% of the regional algal mat resource. Slightly lesser amounts would be lost from other options of the positioning of the ponds.

7. The amount and proportion of mangroves already destroyed by the existing salt mine and the proportion under threat from the proposal has not been estimated.

A. Under the preferred option (now superseded by the option to avoid all direct loss of mangroves) an estimated total of 23 ha of mangroves would be destroyed, which represents 1.2% of the regional mangroves (Downes Island to Ridley Creek). The salt mine has already destroyed 169.3 ha of mangroves, which is 8.9% of the regional mangroves, though recruitment in new areas has gained 32.8 ha; therefore, there has been a net loss of 7.2% of the regional mangal.

8. Rehabilitation measures for the quarries, access tracks and stormwater drains need to be stipulated.

A. The proponent makes a commitment to adhere to Mines Department guidelines and any other relevant guidelines on rehabilitation techniques in arid zone areas for all sites disturbed by the proposal.

9. The modification in habitats may have an effect upon wading birds which currently use the existing ponds and inlet channel.

A. The proponent will consult with the Royal Australasian Ornithologists Union on the design of structures and monitoring techniques to minimise and assess the impact on birdlife.

10. Decommissioning or care and maintenance scenarios are not presented.

A. The proponent considers that there is a very low chance of ever decommissioning the project or placing it on a care and maintenance basis. However, the proponent has made a commitment that any proposed cessation of normal productive operations will be co-ordinated with the appropriate regulatory authorities and that satisfactory short and long-term management strategies would be developed.

11 The Agreement Act should be modified to permit the leases to be tied to the 1978 Mining Act rather than the 1904 Mining Act.

A Negotiations with the Departments of State Development and Mines are continuing on this matter.

Appendix 2

Leslie Salt's environmental management commitments

Management commitments

1. Leslie Salt proposes to minimise the effect of the proposed development on the existing environment by the implementation of a management programme and to design and implement a monitoring programme.
2. Protection of Aboriginal Sites

   The proponent endorses the recommendations of Appendix 3 of the Consultative Environmental Review and will ensure that the significant Aboriginal sites identified within the proposed pond area are left undisturbed. Temporary barriers will be erected around Aboriginal sites of significance.
3. Rehabilitation of Borrow Pits

   During excavation of borrow pits, the top soil will be stripped and stockpiled. Pits would be left with a 3:1 batter (slope) and top soil will be replaced.
4. Erosion Control Measures for the Stormwater Drain

   Stormwater drains will be covered with topsoil to encourage revegetation and reduce erosion.
5. Workforce Management

   Workforce education and induction at both the contractor and operator level will establish a philosophy of environmental care, preservation and restoration as being an essential and integral part of the project.
6. Trucking Movements

   Should it become necessary, the proponent proposes to reduce trucking movements during peak traffic hours.
7. In consultation with the Royal Australasian Ornithologists Union, the proponent will implement design features and management practices aimed at encouraging shorebird usage of the pond system and maintaining habitats used by shorebirds.
8. The proponent will comply with guidelines of the Department of Occupational Health, Safety and Welfare concerning dust levels for employees involved in construction works. During construction, dust levels adjacent to sensitive areas (eg mangroves) will be minimised by the watering of construction roads and levee tops.

Monitoring commitments

1. Bitterns Discharge

   A biological monitoring programme will be established at the bitterns discharge site to provide confirmation that adjacent mangrove assemblages are not adversely affected by the discharge.
2. Aerial Photography

   Low level photography (1:5000) of Catfish Creek, Rock Cod Hole Creek, clay borrow pits and the bitterns discharge areas will be conducted to facilitate the mapping of changes to creek drainage and vegetation patterns.
3. Inspection of Borrow Pits

   A site inspection will be made on an annual basis to monitor the revegetation of borrow pits.
4. Biological Productivity of Ponds 0 and 1

   A fish and benthic fauna survey will be conducted three years after construction of Pond 0.
5. Shorebird Monitoring Programme

   A monitoring programme will be designed in consultation with the Royal Australasian Ornithologists Union to examine shorebird usage of the pond system and the impact of Pond 0 on current shorebird usage of the area.

Reporting

1. An annual report outlining the effectiveness of the management plan and the results of the monitoring programme will be prepared and forwarded to the Environmental Protection Authority, the Department of State Development and the Department of Mines.

Decommissioning procedure

1. The company confirms a commitment to notify the relevant regulatory authorities at the earliest possible date if it intends to cease operations.