DAMPIER SALT (OPERATIONS) PTY LTD

DAMPIER DIVISION

SALT FIELD EXPANSION

CONSULTATIVE ENVIRONMENTAL REVIEW

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1. Summary

The Proponent, Dampier Salt Limited, proposes to expand its Dampier Salt field operation to produce an additional 1.5 million tonnes of salt per year.

1.1 The Proposal

This review discusses the planned expansion of the Dampier Salt field, from its current annual production of 2.5 million tonnes (MTA), up to 4 MTA of salt. The 1.5 MTA increased production will be made in 0.5 MTA stages to meet salt market demand, with the first stage being completed by early 1991.

The principal changes to the current field operations involve the conversion of 1,060 ha of disused Bitterns Holding Pond lease area into additional brine concentrating ponds and bitterns crystallisers and the provision of a continuous seawater supply from Nickol Creek (Figures 1-4, Appendices 1-4).

The new bitterns crystallisers allow the recovery of additional sodium chloride from the normally discharged waste bitterns. The
controlled growth of non-marketable grade salt for subsequent redissolution in seawater gives a secondary brine source for the production of additional high grade salt.

To accommodate the additional brine, further production crystallisers will be built within the existing operating field pond area.

1.2 Reasons for the Proposal

As both the Dampier Salt Limited production sites at Dampier and Lake MacLeod are producing at full capacity, and in order to maintain the Company's industry position, it is intended to expand the production capacity of the Dampier Salt field to cater for projected increases in salt demand.

1.3 Existing Environment

The Dampier solar saltfield is located in the Pilbara region of Western Australia, approximately midway between the towns of Dampier and Karratha.

The saltfield is positioned on a tidal mudflat area between the western end of Dampier Island
pits and increased bird activity with respect to Karratha Airport operation. Although of minimal potential impact, these aspects have been addressed with respect to management, and commitments have been made to correct for any possible effects.

1.5 Conclusions

The saltfield expansion proposal will permit an increase in salt production of 1.5 million tonnes per annum, through the full utilisation of disused Bitterns Pond area, within the existing Dampier Salt lease.

The expansion will have minimal potential adverse environmental impacts and will be beneficial in improving the visual impact of the previously disused pond's desolate salt flat appearance, into well set out operating pondage.

Dampier Salt's existing record in saltfield and bitterns operation, monitoring and reporting (Appendix 14), and its known interest in environmental improvement will give an indication of the Company's expected responsible attitude towards meeting its environmental obligations.
## INDEX

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Summary</td>
<td>i</td>
</tr>
<tr>
<td>1.1 The Proposal</td>
<td>i</td>
</tr>
<tr>
<td>1.2 Reasons for the Proposal</td>
<td>ii</td>
</tr>
<tr>
<td>1.3 Existing Environment</td>
<td>ii</td>
</tr>
<tr>
<td>1.4 Potential Environmental Impacts</td>
<td>iii</td>
</tr>
<tr>
<td>1.5 Conclusions</td>
<td>iv</td>
</tr>
<tr>
<td>2. Information</td>
<td>1</td>
</tr>
<tr>
<td>2.1 Background and Objectives</td>
<td>1</td>
</tr>
<tr>
<td>2.2 Timing</td>
<td>2</td>
</tr>
<tr>
<td>2.3 Land Tenure</td>
<td>3</td>
</tr>
<tr>
<td>2.4 Legislative Requirement and Approval Processes</td>
<td>4</td>
</tr>
<tr>
<td>3. Need for the Project</td>
<td>6</td>
</tr>
<tr>
<td>4. Evaluation of Alternatives</td>
<td>7</td>
</tr>
<tr>
<td>4.1 Seawater Access</td>
<td>8</td>
</tr>
<tr>
<td>4.2 Levee Construction Material</td>
<td>9</td>
</tr>
<tr>
<td>4.3 Stormwater Diversion</td>
<td>11</td>
</tr>
<tr>
<td>5. Description of Proposal</td>
<td>13</td>
</tr>
<tr>
<td>5.1 Current Operation</td>
<td>13</td>
</tr>
<tr>
<td>5.2 Planned Development</td>
<td>14</td>
</tr>
<tr>
<td>5.3 Production Crystallisers</td>
<td>17</td>
</tr>
<tr>
<td>5.4 Construction Details</td>
<td>18</td>
</tr>
<tr>
<td>5.4.1 Levees</td>
<td>18</td>
</tr>
<tr>
<td>5.4.2 Expansion Areas</td>
<td>19</td>
</tr>
<tr>
<td>5.4.3 Flood Levees</td>
<td>19</td>
</tr>
<tr>
<td>5.4.4 Brine Channels</td>
<td>21</td>
</tr>
<tr>
<td>5.4.5 Project Timetable</td>
<td>22</td>
</tr>
</tbody>
</table>

cont'd/..
6. Existing Environment
   6.1 Land Tenure
   6.2 Adjacent Land Use
   6.3 Environmental Aspects

7. Environmental Impacts
   7.1 Stormwater Collection Channels and Discharge Areas
      7.1.1 Northern Stormwater Levee/Channel
      7.1.2 Southern Stormwater Levee/Channel
   7.2 Seawater Storage Pond
   7.3 Seawater Access Channel
   7.4 Nickol Creek
   7.5 Borrow Pit Operation
      7.5.1 Western Lease Area Construction Materials
      7.5.2 Eastern Lease Area Construction Materials
   7.6 Bitterns Discharge
   7.7 Aqua-Carotene Industries (Aust.) Pty Ltd
   7.8 Aboriginal Sites
   7.9 Traffic Movement
   7.10 Access to Bitterns Pond North Shore Area
   7.11 Seabird Hazard to Karratha Airport Traffic
   7.12 Employment/Social Impact

8. Environmental Management
   8.1 Stormwater Collection Channels/Levees and Discharge Areas
   8.2 Seawater Storage Pond
   8.3 Seawater Access Channel

cont'd/...
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.4</td>
<td>Borrow Pits</td>
<td>54</td>
</tr>
<tr>
<td>8.5</td>
<td>Bitterns Discharge</td>
<td>56</td>
</tr>
<tr>
<td>8.6</td>
<td>Aboriginal Sites</td>
<td>57</td>
</tr>
<tr>
<td>8.7</td>
<td>Access to North Shore Facilities</td>
<td>58</td>
</tr>
<tr>
<td>8.8</td>
<td>Seabird Hazard to Karratha Airport Traffic</td>
<td>59</td>
</tr>
</tbody>
</table>

9. Summary of Commitments  
60

- Figure 1: Dampier Salt Field Stage 1 Expansion  
- Figure 2: Dampier Salt Field Stage 2 Expansion  
- Figure 3: Dampier Salt Field Stage 3 Expansion  
- Figure 4: Dampier Salt Field Stage 4 Expansion  
- Figure 5: Levee Cross Sections  
- Figure 6: Seawater Pond/Channel Cross Sections  
- Figure 7: Western Lease Borrow Pit Areas  

Appendices:

- Appendix 1: Dampier Salt Field Operations  
- Appendix 2: Dampier Salt Eastern Lease Area  
- Appendix 3: Nickol Creek and Dampier Salt Eastern Boundary  
- Appendix 4: Nickol Creek, Seawater Storage Pond and Access Channel  
- Appendix 5: Stage 1 Construction Schedule  
- Appendix 6: EPA Consultative Environmental Review Guidelines  
- Appendix 7: Department of Aboriginal Sites Correspondence  
- Appendix 8: Civil Aviation Authority/Bird Hazard Correspondence  
- Appendix 9: South Borrow Pit Flora List  
- Appendix 10: North Shoreline Flora List  
- Appendix 11: South Shoreline Flora List  

cont'd/...
Appendix 12  Seawater Pond/Channel Flora List
Appendix 13  Public Damage to Mangroves
Appendix 14  Revegetation
Appendix 15  Minister for Minerals and Energy Correspondence
Appendix 16  Aqua-Carotene Industries (Aust.) Pty Ltd
Appendix 17  Calculations of Stormwater Catchment Flows
2. Information

2.1 Background and Objectives

It is intended to expand the production capacity of the Dampier Salt field to cater for projected increases in salt demand.

Current field operating capacity at Dampier is 2.5 million ship product tonnes per annum (MSPTA).

The total additional production capacity covered by this proposal is 1.5 MSPTA, however, actual expansion will be in incremental stages to meet salt market demand.

The first stage (Stage 1) will make 0.5 MSPTA additional salt available in 1992 through the redissolution of previously deposited salt, retained in the disused Bitterns Holding Pond. This increased production is sustained in Stage 2 through conversion of the Bitterns Holding Pond area into conventional brine concentrating ponds (Figures 1 and 2).

The further expansion stages would be initiated against market demand, with the earliest likely
programme being seen as 1.0 MSPTA extra capacity (Stage 3) by 1995 and the full expansion capacity of 1.5 MSPTA (Stage 4) by 1997 (Figures 3 and 4).

These later stages require the construction of bitterns crystallisers to permit the controlled growth of non-marketable grade salt, for subsequent redissolution by seawater, to give supplementary brine.

To utilise the additional brine from each expansion stage, further production crystallisers will be built within the existing operating field, adjacent to the current production crystallisers.

2.2 Timing

The planned Stage 1 expansion construction period is 8 months. A construction schedule is appended (Appendix 5).

Construction of additional salt crystallisers within the existing saltfield (western lease) area will be completed first, allowing the commencement of salt pavement growth.
Levee construction in the Bitterns Holding Pond (eastern lease) area, together with seawater and brine transfer pump facilities, would then be progressed.

It is proposed to commence the crystalliser levee construction during the third quarter of 1990, giving 0.5 MSPTA additional saleable salt available during the last quarter of 1991.

Additional earthworks and brine pumping facilities for the subsequent expansion Stages 2, 3 and 4 are less, to the extent of 3 months maximum construction time for any stage. Stage 2 construction is expected to commence in late 1993. Later expansion stage timing will depend on salt market demand, with likely commencement times of 1995 and 1997 for Stages 3 and 4 respectively.

2.3 Land Tenure

The major portion of the development is within the existing Dampier Salt Limited lease, ML 253SA. The only additional areas involved outside this lease are for a brine transfer
channel across the Dampier-Karratha causeway (Miscellaneous Licences 43/13, 0.68 ha.) and a seawater access channel to Nickol Creek (General Purpose Lease 43/11, 1.75 ha.).

An application has been made for a Mining Lease (200 ha.) south of Karratha Airport Reserve (Appendix 2). This will be a source of clay for levee construction.

The tenure of the land immediately surrounding the eastern lease development area are:

. Vacant Crown Land
. Karratha Airport Reserve
. Aqua-Carotene Special Lease
. Several Sand Mining Leases
. Speedway and Gun Ranges
. Karratha-Dampier Causeway Easements

2.4 Legislative Requirements and Approval Processes

This project, involving the expansion of the saltfield production, is under the provisions of the Dampier Solar Salt Industry Agreement Act, 1967-1974.
3. Need for the Project

As both the Dampier Salt's production sites at Dampier and Lake MacLeod are producing at full capacity, it is intended to expand the production capacity of the Dampier Salt field to cater for projected increases in salt demand.

Expansion of capacity at the Dampier Salt field, has been selected in preference to expansion at Lake MacLeod because of substantial capital and operating cost savings. Although there are different environment issues between the two sites, there is no significant environmental benefit in choosing between either site.
4. **Evaluation of Alternatives**

The principal change to the current operation involves utilisation of the existing 1,060 ha. Bitterns Pond area to operate partly as additional standard brine concentrating ponds and partly as bitterns crystallisers. The bitterns crystallisers will permit growth of non-marketable grade salt, for subsequent redissolution by seawater. This will generate a supplementary brine source for the growth of additional high grade salt.

To utilise the additional brine, further production crystallisers will be built within the existing operating field, adjacent to the current product crystallisers.

The technique of generating supplementary brine is based on new technology, where by extracting sodium chloride normally dumped to waste, will greatly increase the productivity of the land area used. For a given salt production level, it will reduce the volume of bitterns brine and sodium chloride discharged while leaving unchanged the amount of other salts discharged.

The design of the field expansion is such that it:

- can be progressed in stages to give incremental increases in salt production capacity, to meet increasing salt market demand.
- gives maximum utilisation of the area within the existing saltfield lease.

- does not require extra operating land area (other than for channel lease) and thereby cause greater environmental disturbance or impact.

- gives maximum recovery of saleable salt from the seawater input, through developed technology.

- allows recovery of existing non-harvestable salt in the disused Bitterns Holding Pond.

4.1 Seawater Access

The location of the Seawater Holding Pond and Seawater Access Channel, on relatively bare mudflat, has been selected such as to minimise disturbance to and blend in with the mangrove/samphire flat between the Dampier Salt eastern lease area and a seawater access point in Nickol Creek, while still allowing the introduction of seawater into the operation at the required location along the southern shoreline of the Bitterns Pond area.

The use of a seawater holding pond and seawater access channel was considered preferable to the
construction of a causeway to locate pumps in Nickol Creek and deepening of the creek to give a continuous seawater supply over the whole tidal range.

4.2 Levee Construction Material

The full saltfield expansion requires the construction of 43.0 km of concentrating pond and crystalliser levees. Of this length, 26.5 km of levees will be constructed for the Stage 1 operation and 5.8 km, 4.9 km and 5.8 km for the subsequent expansion stages.

The major material usage is in Stage 1 construction. The types and quantities for each construction stage have been detailed below as western lease area crystalliser construction and eastern lease area Bitterns Pond subdivision.

Western Lease Area (cubic metres)

<table>
<thead>
<tr>
<th>Stage</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
<td>Clay core</td>
<td>163,000</td>
<td>-</td>
<td>-</td>
<td>52,400</td>
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<tr>
<td>Pavement</td>
<td>31,400</td>
<td>-</td>
<td>-</td>
<td>11,200</td>
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<tr>
<td>Rock Armour</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6,000</td>
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Eastern Lease Area (cubic metres)

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<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
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<td>Clay Core</td>
<td>222,100</td>
<td>89,800</td>
<td>79,900</td>
<td>37,000</td>
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<tr>
<td>Pavement</td>
<td>30,000</td>
<td>3,000</td>
<td>6,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Rock Armour</td>
<td>19,000</td>
<td>7,000</td>
<td>9,000</td>
<td>-</td>
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</table>

The fill material used for levee construction requires particular properties such that after moisture conditioning, placement and compaction, the material gives the levee a strong, impervious clay core. This is protected by an all weather surface pavement material and side batter rock armouring where required. A typical levee cross-section is given in Figure 5.1.

The clay fill and surface pavement materials have to be obtained from borrow pits within reasonably close distance of their placement locations. Suitable clay fill material occurs in layers or lenses in the soil profile, at varying depth, usually in localised areas.

Geotechnical soil surveys are being progressed. These surveys have indicated sufficient
quantities of clay and pavement materials, suitably located for the western lease crystalliser construction.

Insufficient clay materials are present in the eastern lease area, for the Bitterns Pond levee construction. Suitable clay materials were located south of the Karratha Airport Reserve and a Mining Lease over the area has been applied for (Appendix 2). This area is located within suitable haulage distance to placement sites, does not require truck movement on public roads and is more than 700 metres from the closest public thoroughfare.

A further clay material source may be from the Karratha Airport runway development. This is being pursued (refer 7.5.2).

Flora associated with these borrow pit areas is given in Appendix 9. Revegetation after material removal is discussed in Sections 7.5, 8.4 and 9.

4.3 Stormwater Diversion

To prevent uncontrolled dilution and loss of density control of the eastern lease pond and
crystalliser brines, through stormwater inflow from the surrounding catchment area, it is necessary to divert this stormwater run-off.

The most suitable diversion means is the use of collection channels behind levees in low lying areas, or through high ground, to discharge at each end of Levee 24 (Appendix 2).

The channels/levees will generally follow the shoreline and have the advantage of preventing saline brine encroachment back into dry stream entrance beds (refer 5.4.3). Following the shoreline will be the least environmentally disruptive route for the channels/levees.

No suitable alternatives for managing stormwater runoff is available.
5. Description of Proposal

5.1 Current Operation

Full details of the saltfield operation are given in Appendix 1.

Briefly, the current 2.5 million ship product tonnes per annum (MSPTA) saltfield operation utilises 7,390 ha. of brine concentrating ponds and 880 ha. of salt crystallisers.

Seawater introduced at Pump Station 0 (PS 0) is progressively concentrated through six ponds (Ponds 0, 1A, 1B, 2, 3 and 4) to reach salting point density of 1.215 g/cm³ (25.7% salinity) at Pump Station 3 (PS 3).

This brine is distributed over 36 crystallisers (twelve rows of three crystallisers, in series) where salt is crystallised out at increasing density stages, until the brine is finally discharged as "bitterns" of density 1.25 g/cm³ (29.0% salinity).

The bitterns still retain approximately 25% of the salt in the original seawater, but this is not normally recovered as harvestable
The Bitterns Holding Pond will be divided by levees, as shown in Figure 1. Because of the tidal range in Nickol Creek, a Seawater Holding Pond, which is topped up with fresh seawater at each high tide, will be used to give a continuous seawater source.

The Seawater Pond is filled from Nickol Creek via a channel, having an invert level which permits seawater inflow down to Neap High Tide level.

Dissolution brine is pumped, on demand, through Pump Station 2B (PS 2B) into Pond 3. Through wind induced mixing, the density of the brine over the whole salt dissolution pond will be relatively high, at greater than 1.18 g/cm³ (22.1% salinity).

The extra salt available from this seawater dissolution should provide four years operation at a planned field production of 3.0 MSPTA (up to 1994-5). Stage 1 operation will continue until all the deposited salt is dissolved.

Stage 2 of the expansion utilises most of the Bitterns Pond area as brine concentration ponds, in a conventional brine concentrating
circuit (Figure 2). Brine from Pond 2, density $1.14 \ g/cm^3$ (17.8% salinity), is transferred to the new concentrating ponds at PS 2A and reintroduced back into Pond 3 through PS 2B.

The increased concentrating pond area (8,750 ha.), which includes operating Pond 0 at its maximum area of 5,200 ha., will give sufficient brine to produce salt at a sustainable 3.0 MSPTA.

During both Stages 1 and 2, one bitterns crystalliser (BC5 or BC6) will be operated for test purposes, in either a bitterns salt crystallisation or seawater redissolution mode, to develop full scale operating techniques for bitterns salt recovery.

Stage 3 and Stage 4 expansion use three concentrating ponds, in the eastern lease area, as shown in Figures 3 and 4. The remaining area is divided into three or six bitterns crystallisers (BC1-BC6) where either:

- salt is being crystallised from bitterns over the density range $1.25 \ g/cm^3$ to $1.30 \ g/cm^3$ (29.0% to 33.5% salinity), or
in sequence, salt in one crystalliser is being dissolved in seawater to give a brine which is blended into the concentrating pond circuit.

Stages 3 and 4 will give a salt production capacity of 3.5 MSPTA and 4.0 MSPTA respectively; that is, an additional 1.0 MSPTA and 1.5 MSPTA to the current field capacity.

5.3 Production Crystallisers

With increases in brine supply from each field expansion stage, additional production crystallisers will be required.

These additional crystallisers (Rows R, S and T) will be constructed adjacent to the existing crystallisers (Rows A through to Q) (Figure 4). For field operating reasons, R and S Rows will be constructed during the Stage 1 expansion, with T Row being completed for Stage 4.
5.4.2 Expansion Areas

The Bitterns Holding Pond area is approximately 1,060 ha. The final subdivision for Stage 4 (Figure 4) gives:

- Pond 2A: 238 ha.
- Pond 2B: 203 ha.
- Pond 2C: 176 ha.

Redissolution crystallisers each approximately 72 ha.

The areas of the western lease production crystalliser Rows R, S and T are 136 ha. each.

5.4.3 Flood Levees

The Bitterns Holding Pond has previously been subjected to stormwater flooding from cyclonic or extended periods of heavy rain, particularly from the north shore catchment area and foothills.

The north and south shore catchment area stormwater, combined with that collected on the 1,060 ha. Bitterns Holding Pond, with dissolved salt, currently discharges into
Nickol Bay, in total, through the Bitterns Channel (Appendix 2).

To maintain brine density control in the new concentrating ponds and bitterns crystallisers, it will be necessary to divert catchment area stormwater away from the pond area, and directly into Nickol Bay. Stormwater levees and collection channels are to be constructed along both shorelines of the Bitterns Holding Pond area, as shown in Appendix 2.

The southern shoreline channel, which will be subjected to a much lower stormwater ingress, will also serve as a bitterns bypass channel, in support of the normal bitterns channel feeding the planned bitterns crystallisers. Southern catchment area stormwater will be channelled to the existing Bitterns Channel at Levee 24 and into Nickol Bay (Appendix 2). Extreme excess stormwater would flow between Banana Island and the mainland to combine with Seven Mile Creek discharge into Nickol Bay.

The northern shoreline stormwater channel will discharge natural freshwater runoff at the northern end of Levee 24 (Appendix 2) where it
will flow out over samphire and mangrove flats into Nickol Creek.

The southern shoreline levee/channel will be constructed during Stage 1 and the northern shoreline levee/channel during Stage 2.

5.4.4 Brine Channels

To transfer brine to the new brine concentrating ponds (Stages 2-4), it is necessary to install Pump Station 2A (PS2A) and a connecting brine transfer channel across the Dampier-Karratha causeway, similar to the current PS 5 bitterns channel.

Channel construction will similarly be by boxed culverts or open channel passing below the existing railway lines, road and services. Approval has been obtained for this construction from the Roebourne Shire, Hamersley Iron, Main Roads, SECWA (Gas and Electricity), Telecom and Water Authority.

Construction will meet all specifications and requirements of the Company and Authorities.
5.4.5 **Project Timetable**

The Stage 1 Project Construction Schedule is given in Appendix 5. Timing is dictated by several requirements. These are:

- marketing requirements, of having an extra 0.5 MSFTA production capacity available by the beginning of 1992.

- the need to have the new S Row crystallisers completed in time to gain the important benefit of the 1990-1991 summer salt growth period.
6. **Existing Environment**

The Dampier solar saltfield is located 1,300 km north of Perth on the north-west coast of Australia.

The saltfield is positioned on a tidal mudflat area between the western end of Dampier Island and the mainland (Figure 1, Appendix 1). The island's high rocky outcrops protect the saltfield from seaward cyclonic weather and effects. A continuous underlying rock-shelf and silt/clay base minimises brine seepage losses from the ponds and below surface brine flows.

The average annual rainfall at the saltfield for the last twenty years is 241 mm, with extremes of 47 mm and 488 mm. Average annual evaporation is 3,530 mm and ranged from 3,070 mm to 3,840 mm. Tidal range at Dampier is 0.2 metres to 5.1 metres Dampier chart datum (DCD).

The existing saltfield concentrating ponds are highly productive, supporting many diverse biological communities within their boundaries. Abundant growth of sea-grasses, seaweeds and micro-algae in the primary ponds feed a variety of fish, marine worms and crustaceans, which in turn support birds and larger fish.
Large numbers of birds reside and breed within the saltfield and additionally many thousands of migratory wading birds appear seasonally.

The surrounding land area is rocky and dry with little natural fresh water, however, it supports a large number of native flora. Flora listings for the areas relating to the eastern lease's northern and southern shoreline stormwater channels, seawater channel and pond and proposed borrow pit area are included in Appendices 9 to 12.

The Company has a programme of on-going environmental research into the Dampier saltfield to ensure that its flora, fauna and marine species are adequately conserved.

There are many thousands of Aboriginal rock engravings around the small gullies and rock outcrops within the boundaries of the Dampier Salt lease. It is one of the more important representations of rock engravings in the region. Many shell middens and old camp sites are also present. The Company is active in ensuring the protection and preservation of these sites.

No Aboriginal sites will be affected by the proposed expansion activities.
6.1 Land Tenure

The main Dampier saltfield area is located on Mining Lease ML 253 SA, covering a total of 14,715 ha. This lease is divided by the Dampier-Karratha causeway into the referred to eastern and western lease areas.

Other tenements/easements to cover the bitterns and brine channels, power-lines, Mistaken Island shiploader, connecting causeways and quarry areas are:

Land Leases 3116/4976, 3116/4977, 3116/10252
General Purposes Leases 47/2, 47/3
Miscellaneous Licences 47/10, 47/11, 47/14
Mining Leases 47/76, 47/77, 47/197, 47/229

The areas required to locate the new brine transfer channel and the seawater access channel to Nickol Creek have been applied for as Miscellaneous Licence 47/13 and General Purpose Lease 47/11.

A 200 ha. Mining Lease, to provide a source of clay for levee construction, has been applied for (Section 2.3).
6.2 Adjacent Land Use

The land area affected by the expansion is that adjacent to the eastern lease area (Bitterns Holding Pond). This involves:

- the Dampier-Karratha causeway, and affecting the Company and Authorities referred to in Section 5.4.4.

- North shore area, including Karratha speedway, pistol club, rifle club, Pioneer concrete quarry, several sand and soil mining operations, and Aboriginal sites in the foothills and associated gullies.

- South shore area, with the Aqua-Carotene (Australia) Pty Ltd facility, and Karratha airport and ancillary operators.

6.3 Environmental Aspects

Possible environmental aspects of the expansion which have been identified are:

- stormwater collection channels and discharge areas
- seawater storage pond
- seawater access channel
- Nickol Creek
- borrow pits for levee construction materials
- change in Bitterns discharge regimes
- aboriginal sites
- traffic movement
- access to north shore sporting facilities and mining operations
- seabird hazard to Karratha airport traffic
- employment and social impacts

These items are further discussed in Section 7.
7. Environmental Impacts

As the physical changes resulting from the staged field expansion are principally within existing operational and lease areas, environmental effects are minimal. Preliminary discussions have been held with officers of EPA and any concerns raised have been addressed.

A number of environmental aspects were noted in Section 6.3. These are individually discussed.

7.1 Stormwater Collection Channels and Discharge Areas

The requirement for and paths of the northern and southern shoreline stormwater levee/channels were described in Section 5.4.3.

7.1.1 Northern Stormwater Levee/Channel

The path of the northern stormwater levee (Levee 37) and drainage channel is just behind the Bitterns Pond shoreline or across the major sand spit, as shown in Figure 2 and aerial photograph Appendix 2.
The northern channel will have a falling grade towards Nickol Bay of 1:5000 with discharge at the northern end of Levee 24. Peak discharge flow volume resulting from rainfall for an Average Recurrence Interval (ARI) of 10 years is 20 m³/sec and an ARI of 100 years, 92 m³/sec. The flow volume calculations for the catchment area described have been done by Consulting Engineers, G B Hill and Partners Pty Ltd, and are attached (Appendix 17). These flows were used for the design of the stormwater channel.

Unforeseen overflow of the levee would cause disruption to the brine concentrating pond operation only, with no effects external to the field.

Normal channel discharge will fan out across algal, samphire and mangrove flats into extension of Nickol Creek.

The discharge area will be designed to minimise the possibility of scouring (refer 8.1). Stormwater discharge effects will be monitored and corrective measures taken, if necessary (refer 9.1).
The planned stormwater levee and drainage channel will traverse vegetation which is primarily salt-bush and samphire in low lying areas and spinifex grassland with areas of Acacia scrub (predominently Acacia bivenosa and Acacia translucens) on sandy higher ground. Disturbance to the area will be minimal and affecting less than 2 ha.

A full listing of plant species along the path of and behind the stormwater channel is given in Appendix 10.

The placement of the stormwater levee and channel will prevent encroachment of saline brines into creek beds leading into the Pond, and allow leaching from the creek bed soils, of salt already present. This will permit revegetation of these saline areas.

The channel will continue to allow discharge of rain water collected between the Dampier-Karratha causeway easements.

7.1.2 Southern Stormwater Levee/Channel

The path of the southern stormwater levee (Levee 34) and drainage/bitterns bypass
channel is just behind the Bitterns Pond shoreline and then through a cutting across Banana Island, as shown in Figure 1 and aerial photograph Appendix 2.

The channel will have a falling grade of 1:5000 towards Nickol Bay and discharge into the existing Bitterns Channel at the southern end of Levee 24. Extreme excess stormwater would flow between Banana Island and the mainland to combine with Seven Mile Creek discharge into Nickol Bay. No scouring of the discharge areas is expected (refer 8.1)

Peak discharge volume for an ARI of 10 years is 16.3 m$^3$/sec, and an ARI of 100 years, 73 m$^3$/sec. This can be accommodated within the levee design.

The planned stormwater and drainage channel will traverse areas that are vegetated with mixed spinifex/tussock grassland and salt bush. Minimal disturbance will occur. A full listing of plant species in this area is given in Appendix 11.
7.2 **Seawater Storage Pond**

The seawater storage pond is required to provide a continuous source of seawater, irrespective of the tide level in Nickol Creek. It will be constructed outside Levee 24, but within the current lease boundary (Figure 1 and Appendices 2, 3 and 4).

The area disturbed by pond construction is 830 metres by 56 metres of predominantly bare algal mudflat. A cross-section of the pond is shown in Figure 6.

The main pondage is 32 metres wide, including a side batter slope of 1:4, and will have a mean seawater depth of 2.60 metres. This depth is achieved from a tide level of 3.50 metres Dampier chart datum (DCD). Outside the 32 metre width, ground slope is lessened to a batter of 1:10, to allow soil stabilisation (Section 9.4, Appendix 14).

Normal ground surface level at the location of the pond is 2.05 metres A.H.D., which is equivalent to a tide level of 4.75 metres DCD. The total area is covered during occasional spring high tides.
Seawater flow into the pond will only be through the seawater channel during the rising tide, so that no erosion of the area surrounding the pond is anticipated. The spillway at the pond inlet will be protected by placed rock to prevent entry erosion.

Seawater will be retained in the pond by means of a one-way flap gate at the channel entry location. All material excavated during construction (90,000 m³) will be removed from the vicinity of the pond and either used as filling to build up mudflat areas bounded by road causeways and levees between Banana Island and the mainland or used as backfill base in appropriate borrow pits (Appendix 2).

The pond excavation will be below natural surface level and will therefore blend into the existing landscape.

7.3 Seawater Access Channel

The seawater channel permits refilling of the storage pond during tidal periods above 2.00 metre DCD.
The path of the channel (Appendix 4) is across samphire mudflats and is positioned to avoid any significant numbers of mangroves and minimise disturbance to the existing community. A plant species listing for this area is given in Appendix 12.

The channel length is 300 metres with an expected overall width of 12 metres, using a 1:2 embankment batter (Figure 6).

Every attempt will be made to minimise the channel width and physical disturbance to the existing system during excavation, although this will depend on the nature of the embankment soils.

Mangroves and other vegetation are expected to colonise the banks of the new channel and re-growth will be promoted (Section 9.3, Appendix 14).

No erosion is expected around the seawater channel as a result of tidal drain-off from the surrounding mudflats. The presence of other existing creek tributaries adjacent to the channel, will continue to collect this drainage. Additionally, the mudflats are only flooded during the highest spring tides.
7.4 Nickol Creek

Extra upstream flow of seawater in the creek, due to the planned saltfield operation will be very low. For Stage 3 of the expansion, average seawater demand would range from 80 m$^3$/hour during winter, up to 800 m$^3$/hour during summer. For the fourth, extra 1.5 MSPTA stage, this would increase to 1,000 m$^3$/hour during summer.

These quantities will have a negligible effect on the normal upstream flow velocities within the creek and this would only occur during the higher part of a rising tide.

There would be no measurable effect on water flows in the 80 metre wide lower reaches of Nickol Creek.

7.5 Borrow Pit Operation

The quantities of levee construction materials required for the four field expansion stages have been detailed in Section 4.2.

Geotechnical surveys have been made by Coffey Partners (International) Pty Ltd to locate
and quantify suitable levee construction materials, within the existing Dampier Salt lease and suitable adjacent areas. The requirement is for sufficient quantities of readily recoverable and conditionable material, within short haulage distance of the placement sites.

7.5.1 Western Lease Area Construction Materials

Sufficient clay core and surface pavement material has been proven for the western lease R, S and T Rows crystalliser levee construction.

The areas indicated in Figure 7 contain approximately 200,000 cubic metres of suitable clay and 50,000 cubic metres of weathered granite pavement materials. Additionally, there are known deposits of clayey gravel, suitable as sub-pavement layer material, currently open for general field repair purposes.

The clay material is present as a single 0.8 to 1.5 metre thick layer below thin topsoil. After scraping away of topsoil for later re-spreading, the clay layer is progressively ripped and water conditioned before loading
out. After all suitable clay is removed the floor is ripped and the topsoil re-spread and contoured before revegetation seeding.

After completion and revegetation growth the borrow pit will be an extensive, relatively level, approximately one metre deep low lying area, suitable for water retention and plant growth.

The weathered granite gravel deposit underlies approximately 0.5 metres of sandy clay. The deposit is 1 to 2 metres thick on an uneven base. Similar retention and re-spreading of overburden and top-soil after material removal, will leave an undulating low lying area suitable for revegetation.

7.5.2 Eastern Lease Area Construction Materials

Soil surveys have indicated that there is insufficient clay material within the Dampier Salt Eastern Lease Area. Locations containing approximately 50,000 cubic metres only of suitable clay are shown in Appendix 2. The clay layers range from 0.5 to 1.0 metres thick, under typically 0.3 to 0.8 metres of sand or sandy clay.
Greater than 50,000 cubic metres of clayey gravel to calcrete gravel, suitable for pavement material, is located as shown.

No suitable clay materials exist on Banana Island, the northern shoreline of the Bitterns Pond area or other previously suggested eastern lease locations.

To obtain suitable clay materials within practical distance to placement sites and avoid the safety and other problems associated with the trucking of large quantities of material across and along a busy public roadway, an additional Mining Lease has been applied for. This consists of 200 ha. to the south of Karratha Airport Reserve (Appendix 2).

Suitable clays have been proven within the applied for Mining Lease area. The clay layer is 1 metre to 1.5 metres thick, below a thin topsoil. The total area required for clay extraction, to supply all expansion stages, is approximately 40 ha.

A proposed Karratha Airport Development will involve the construction of a second runway
parallel with, and south of, the present runway. This construction requires the removal of clay materials from beneath and adjacent to the proposed new runway. Discussions have been initiated with Roebourne Shire Council on the timing and use of this material for levee construction. Some clays are present at the eastern end of the proposed runway area, representing a significant fraction of material requirements for the eastern lease construction. The quantity and suitability of the clay from this source has yet to be determined.

As previously described, the means of clay extraction is to remove and retain the topsoil layer, then progressively rip, water condition and remove the moistened clay. On completion the floor is ripped and topsoil replaced and contoured, leaving a relatively level low lying area suitable for revegetation.

During borrow pit material ripping, preparation and loading, very little dust is generated due to the required wetness of the conditioned materials. Trucking of the levee fill material to the placement site is planned to be by a
perimeter route around the eastern side of the Karratha Airport Reserve. Regular watering of the road will be used to prevent road dust generation. This will be done in liaison with Airport Operators, and increased when necessary (refer 9.12).

All temporary roads will be restored and revegetated to blend with the natural landscape.

7.6 Bitterns Discharge

The several stages of expansion will give different bitterns discharge flows and bitterns compositions, to those currently being discharged through the existing bitterns channel, into Nickol Bay.

A tabulation of expected monthly and annual bitterns discharge flows in cubic metres and major ion concentrations in gram ions/litre is given in Table 1.

Further concentration of bitterns to higher densities gives substantially the same mass of each ion (except Na⁺) being discharged with
### DAMPIER SALT EXPANSION - BITTURNS DISCHARGE

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<td>Density g/cm³</td>
<td>Flow m³x10⁶/mth</td>
<td>Density g/cm³</td>
<td>Flow m³x10⁶/mth</td>
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<td>1.250</td>
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<td>0.41</td>
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#### Discharge Bitterns Analysis - gm ions / litre

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<td>Na⁺</td>
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<td>8.1 - 10.9</td>
<td>13.6</td>
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<td>188.5 - 188.4</td>
<td>192.6</td>
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<tr>
<td>SO₄²⁻</td>
<td>38.1 - 50.9</td>
<td>50.9</td>
<td>38.1 - 50.9</td>
<td>62.5</td>
<td>85.5</td>
<td>85.5</td>
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</table>

Table 1
time, in a reduced volume of bitterns. The Na\(^+\) content is reduced in both mass and concentration.

The final Stage 4 expansion gives a 70% reduction in total mass of Na\(^+\) ion being discharged in bitterns compared with the current operation and a 28% increase in the other major ions. Accompanying reduction in discharge flow is 35%.

Early testwork on trial releases of bitterns into Nickol Bay showed only minor increases in salinity.

Since continuous discharge of bitterns commenced, flow volume and density data has been collected. Additionally, prawn population surveys have been conducted at the mouths of Nickol Creek and the Nickol River, for comparison. Four net trawls per month on Spring and Neap low tides, during December through to April have been conducted each year.

Regular aerial photographs of the bitterns channel and Nickol Bay western shoreline, have been taken using infrared and natural colour.
After a five year period of required monitoring was completed (Appendix 15), these surveys have been continued at Dampier Salt's initiative to provide an ongoing environmental data bank of the discharge area.

Continuing studies are being done into the mixing of discharged bitterns into seawater, along the bitterns channel, over the whole tide cycle.

This ongoing monitoring, together with observation of the bitterns discharge area, has demonstrated that there is no detrimental effect to either marine life or vegetation. Recent observations on the condition of marine life and vegetation along the bitterns channel are:

1. Fish and prawns are regularly pumped into the Aqua-Carotene (Australia) seawater pond from the Bitterns Channel, during high tide.

2. Survey nettings by a commercial WA bait company at the mouth of the bitterns channel have yielded large catches of
threadfin salmon (their prime target) and catfish (bottom dwelling). The area is considered to be much better than the other side of the Burrup for this type of catch.

Young mangroves are vegetating the channel, as far up the channel as culverts located 200 metres from Levee 24.

The changes in bitterns volume and ion concentration are not expected to change the situation with respect to marine life and vegetation.

7.7 Aqua-Carotene Industries (Aust.) Pty Ltd (Aqua-Carotene) Operations

Currently approximately 1% of the discharged saltfield bitterns is used by Aqua-Carotene (Appendix 3) for Dunaliella/Beta-carotene production. The bitterns are pumped from the adjacent Bitterns Channel, as required. Planned expansion by Aqua-Carotene would increase their bitterns requirements to 10% of current discharge.
The planned change to higher ion concentration in discharge bitterns is considered by Aqua-Carotene to be of major benefit to their operation through decreased pumping requirements and better ion ratios. There will be no adverse effects to Aqua-Carotene (Appendix 16).

7.8 Aboriginal Sites

Known aboriginal sites and rock art in the Burrup foothills and associated gullies are well clear of any expansion works north of the Bitterns Pond area.

The Department of Aboriginal Sites has been notified, and an inspection made by the Heritage Officer, Pilbara, along the paths of the Stormwater Levees/Channels and lease areas originally proposed as possible sources of levee construction materials.

No evidence of Aboriginal occupation was found in locations to be involved in the expansion construction (Figure 4, Appendices 2, 7).
Evidence of occupation was found on the large sand spit extending from the Bitterns Pond northern shoreline. This site is clear of any proposed construction activity, but will be isolated to ensure that no disturbance occurs (Section 9.9).

7.9 Traffic Movement

The field expansion of the eastern lease area requires only brine transfer by channel/culvert across the Dampier-Karratha causeway, between the eastern and western lease areas. No vehicular haulage of salt or other materials is involved in the expanded operation.

Haulage of levee construction fill and pavement materials will not involved truck movement on public roads. Haulage will be within the lease boundary or around a perimeter road east of the Karratha airport.

The relatively small quantity of levee armour rock (550 mm maximum size) will be obtained from either the operating Pioneer Concrete quarry on the north side of the Bitterns Pond area (Appendix 2) or from an existing stockpile.
of suitable quarried rock on East Middle Intercourse Island (EMI). The latter would require haulage trucks to make direct crossings of the Dampier-Karratha road, at the northern end of the road causeway. About 1,900 round trips would be required for Stage 1 construction.

Haulage of materials for the western lease area construction will be completely within Dampier Salt's lease boundary.

7.10 Access to Bitterns Pond North Shore Area

There are a number of activities on the north shore area which currently use the road inside the Dampier Salt lease to gain access. The facilities involved are the Karratha speedway, pistol and rifle club ranges and several sand mining leases.

Dampier Salt has discussed access with Karratha speedway, and will assist in grading an alternate road to the speedway and ranges. Access to the mining leases, which have no alternate route, will not be restricted.
Public access by road to the Burrup foothills, mudflats and mangrove areas behind Nickol Creek and Nickol Bay will be through the Dampier Salt lease, which will require permission for access. This is seen as being beneficial, in that it will restrict illegal removal of material from sand mining leases, trail bike and 4 WD vehicle damage to algal mudflat areas, damage to aboriginal sites and damage to the mangrove system on the creek and bay foreshores by the cutting of paths, as currently occurs (Appendix 13).

Access to these areas along the outside of the Dampier Salt lease boundary fence line will still be possible.

7.11 Seabird Hazard to Karratha Airport Traffic

The possibility of increased seabird activity as a result of the expanded field operations, was mooted by the Civil Aviation Authority and the Roebourne Shire Council.

Because the brine densities of all concentrating ponds and crystallisers within the Bitterns Pond area are too high (>1.14
g/cm$^3$, 17.8% salinity) to support marine life (including brine midge larvae), these areas will not be attractive to seabirds.

The seawater storage pond, which is 1.7 km from the closest aircraft flight path, has tidal inflow and outflow. Although entering seawater will be screened, there will be fish present in the pond. Experience with a similarly sized (2.6 ha.) and located seawater storage pond at the Aqua-carotene (Australia) Pty Ltd facility has demonstrated that there is no significant seabird attraction, providing the seawater depth is not permitted to decrease to less than 300 mm.

The above authorities are satisfied that either it is unlikely that any hazard would be caused or measures can be taken to prevent seabird attraction. Related correspondence is included in Appendix 8.

7.12 Employment/Social Impact

As a result of productivity and field operating improvements, the number of employees at Dampier site has progressively decreased from 211 in 1986 to 162 in 1990.
Without expansion of field capacity, planned productivity improvements would result in further reductions of workforce numbers.

Increased production will partially offset these reductions but even at a maximum increase of 1.5 million tonnes, numbers would still be approximately 9% less than current levels.

The proposed expansion will have no impact on public recreational levels.

No social impact problems are foreseen.
8. **Environmental Management**

Of the eleven environmental aspects discussed in Section 7, Environmental Impact, the following are considered as requiring management:

8.1 **Stormwater Collection Channels/Levees and Discharge Areas**

The channels/levees as discussed in Section 7.1 will pass across both high and low ground. High ground areas will involve cuttings, with soil bank slope to channel of 1 in 3., through to low ground areas comprising levees combined with the channels as shown in Figure 5.2. Because of the channels/levees location along the Bitterns Pond shoreline, the features would not be readily visible from public roadways.

To prevent stream erosion, junctions and channel sections subjected to major stormwater inflow will be protected by rock pitching. Other sections of channels, cuttings and levees not so protected, will retain the exposed ground or levee fill materials and be vegetated by seed, where appropriate, using the specific
seed blend detailed in Appendix 14, at a rate of 15 kg/ha. Methods, timing and follow up monitoring will be as described (Section 9.4).

The northern stormwater channel discharge, at the end of Levee 24, is into a shallow depression with a relatively wide outflow (Appendices 2, 3), then onto algal/samphire flats, behind a mangrove lined tributary of Nickol Creek. This outflow can be widened to give a larger fanned distribution, if necessary. The depression will serve to retain heavier sediments and reduce deposition across the mudflats (Section 9.1).

The action of stormwater discharges will be monitored and corrective measures taken to better manage discharge effects, if necessary.

The southern stormwater discharge volumes are low and are not expected to cause difficulties in control. Direct discharge is into a contained area with weir flow into the operating Bitterns Channel at Banana Island. Extreme excess stormwater can flow over a low level causeway, south-eastwards towards the 7 Mile Creek discharge into Nickol Bay.
8.2 **Seawater Storage Pond**

The Seawater Pond is below ground level and will be visually similar to the existing creek system and landscape. Embankment batter is 1 in 4 over the normal operating depth of the pond and then 1 in 10 up to existing ground level (Figure 6).

Excavated material, totalling approximately 95,000 cubic metres, including material from the seawater access channel, will be removed from the area. The spoil will be either used as filling to build up mudflat areas bounded by road causeways and levees between Banana Island and the mainland or used as backfill base in appropriate eastern lease area borrow pits (Appendix 2).

Excavation of both pond and channel is expected to be by placing a central gravel working path, which will be progressively removed as the excavator and haulage vehicles work back over the path.

Seawater inflow is through the Nickol Creek access channel, so that no inflow over the embankments will occur during spring high
tides. On falling spring high tides, mudflat drainage will be shared between the pond and other surrounding creek tributaries and the existing Bitterns channel.

The seawater channel/pond junction area will be protected from erosion by an entry culvert and rock pitching of the inlet floor and embankments.

The pond embankments, particularly the 1 in 10 batter areas, are expected to be colonised by mangroves and other vegetation. Regrowth will be promoted (Section 9.3, Appendix 14).

The effects of cyclonic wave action and surges are expected to present operating problems through the accumulation of driftwood, vegetation and other flotsam, rather than cause excessive erosion of the mudflat embankments. If wave action reaches the pond area, the pond, by that time, would be filled.

8.3 Seawater Access Channel

Excavation methods and spoil disposal are discussed in Section 8.2 above. By using 1 in 2 embankment batter, the channel width should
be kept to a minimum, of approximately 12 metres.

No erosion from tidal drainoff of surrounding mudflats is expected along the seawater channel, as the presence of other existing creek tributaries adjacent to the channel will share this drainage.

Natural colonisation of embankments by mangroves and samphire is expected and regrowth will be promoted (Section 9.3, Appendix 14).

8.4 Borrow Pits

Borrow pit operation has been detailed in Section 7.

Because of the layered occurrence of the borrow pit materials, particularly the larger volume material, clay; the resulting pit, after final grading and replacement of topsoil, will be a relatively level, low lying area. Depending on the location and whether backfilling is used, the floor could be, typically, one metre below the normal ground level.
All the proposed borrow pits are above the level of the groundwater table and will not be subject to brackish water ingress. The completed pit areas will be suited to rainwater retention and revegetation. Provision will be made to allow excess rainwater to drain away to natural ground contours, so that no pondage or stagnant water is retained.

Revegetation will be by seeding and the seed mix and quantities, timing and method of application is given in Appendix 14.

The selection of revegetation species has been on the basis of salt tolerance, colonising ability and general suitability to the area. All seed to be used will be collected locally. Revegetation progress at the borrow pit locations will be monitored (including photographically) at least on a monthly basis for the first twelve months and then annually.

A number of existing borrow pits on the Dampier Salt lease area will also be contoured and revegetated similarly to the above. These are:
all disused borrow pit areas on the southern side of the eastern lease Bitterns Pond area.

all disused borrow pit areas east of the Dampier Salt Administration Building on the western lease area including the borrow pit/dumping area north of visitors observation platform.

8.5 Bitterns Discharge

Ongoing monitoring together with observation of the bitterns discharge area has demonstrated that there is no detrimental effect to either marine life or vegetation.

The final Stage 4 expansion operation will give a reduction in both the bitterns volume by 35% and the total mass of sodium ion by 70%, accompanied by an increase in the mass of other major ions by 28%. The changes in bitterns volume and ion concentration are not expected to change the situation with respect to detrimental effects on marine life or vegetation.
The current range and level of bitterns discharge monitoring, as detailed in Section 7.6, will be continued. Further studies into the mixing of discharged bitterns into channel seawater for different bitterns volume, density and ion concentration regimes, of each expansion stage, will be done.

However, if adverse effects from the changed bitterns regimes are identified, corrective measures will be taken. This would involve either improved blending of bitterns brine with seawater in the Bitterns Channel by baffle or mechanical agitation, or blending the bitterns with seawater from the Seawater Holding Pond, before discharge into the Bitterns Channel.

8.6 Aboriginal Sites

Only one significant aboriginal occupancy site was located within the eastern lease Bitterns Pond expansion area. This site is away from construction activity and planned pond operations.

The site will be fenced off to prevent any accidental encroachment or damage by vehicles.
The Company will comply with requirements set out by the Department of Aboriginal Sites (Appendix 7) and will notify the Department if channel excavation or other works reveals any significant material.

8.7 Access to North Shore Facilities

With the eastern lease area becoming an active operating site, there is a necessity to restrict public access onto the Dampier Salt mining lease. The current road along the north shore of the Bitterns Pond area is within the lease boundary for much of its length.

The Company has offered to assist in grading a road to allow access to the speedway and gun ranges. The Company will not restrict access to operators of sand mining leases in the area.

Public access to areas behind Nickol Creek and Nickol Bay will still be possible, along the outside of the Dampier Salt lease boundary, although no tracks currently exist.
8.8 **Seabird Hazard to Karratha Airport Traffic**

Although considered unlikely, there is the possibility of increased seabird activity around the proposed Seawater Storage Pond, resulting in increased seabird movements in the vicinity of aircraft flight paths at a 1.7 km distance.

Seabird activity in the vicinity of the Seawater Pond will be monitored by Dampier Salt, Roebourne Shire Council and CAA officers. Dampier Salt guarantees that it will install CAA recommended deterrent methods if it is deemed necessary (Appendix 8).
9. **Summary of Commitments**

The following commitments are made by Dampier Salt (Operations) Pty Ltd. As a result of the proposed saltfield expansion the Company will:

9.1 *Monitor effects of discharge flow from Stormwater Channel outlets to identify scouring or sedimentation of adjacent mudflats, and report as required. Redesign discharge to better manage outflow effects to the satisfaction of the Environmental Protection Authority, if deemed necessary.*

9.2 *Remove excavated material from the Seawater Storage Pond and Seawater Channel and use it to either build up mudflat areas contained by levees and road causeways, between Banana Island and the mainland or as backfill base in appropriate eastern lease area borrow pits, before replacing topsoil (Appendix 2).*

9.3 *Promote vegetation of Seawater Storage Pond and Seawater Channel embankments through seeding with Mangroves, Samphire and Sueda as described in Appendix 14. Monitor long term stabilisation of embankments, and report as*
required. Embankment stabilisation to be to the satisfaction of the Environmental Protection Authority.

9.4 Stabilise and vegetate stormwater containment levees on North and South shorelines of Bitterns Pond area, to the satisfaction of the Environmental Protection Authority, using seed mix and methods as described in Appendix 14. Monitor long term stabilisation of stormwater levees, and report as required.

9.5 Restore new borrow pit areas after removal of materials. This will include:

. contouring and floor preparation as described in Sections 7.5 and 8.4.

. seeding of prepared ground using method and seed mix as described in Appendix 14.

. seed using minimum mix quantity of 5 kg/ha.

The completed revegetation operation will be to the satisfaction of the Environmental Protection Authority.
9.6 Restore old disused borrow pits identified in Section 8.4. These areas will be:

- contoured.
- surfaced with previously retained topsoil or adjacent materials obtained as part of the area contouring
- surface ripped where necessary
- seeded as for 9.5 above

9.7 Monitor growth of vegetation on seawater pond and channel embankments, stormwater levees and regrowth of vegetation in prepared borrow pits. Results will be made available to the Environmental Protection Authority as required.

9.8 Continue monitoring bitterns discharge, and make data available to the Environmental Protection Authority, on request. This will include:

a. from the operating field:
   - densities on a daily basis
volumes as monthly totals

compositions, following changes in regime, to establish relationship to density

b. in the Bitterns Channel and outflow area:

two yearly aerial photographs, including infra red exposures of the Bitterns Channel and adjacent mangrove areas.

continue yearly prawn surveys comparing prawn numbers in Nickol Creek with a control, Nickol River, for three years after each expansion stage.

bitterns mixing studies in the Bitterns Channel, following changes in discharge regime.

reporting any significant effects on marine life and vegetation.
9.9 Fence off single aboriginal occupancy site in expansion area. Comply with Department of Aboriginal Sites requirements as in Appendix 7.

9.10 Assist Karratha Speedway in preparing new access road to their facility. Allow access to operators of sand mining leases.

9.11 Monitor seabird activity relating to the Seawater Pond, in conjunction with Roebourne Shire Council and CAA officers.

Install CAA recommended bird deterrent methods, if deemed necessary by these Authorities.

9.12 Monitor dust generation from haulage truck movement on earth roads adjacent to Karratha Airport, during field construction stages. Improve dust suppression if deemed necessary by Karratha Airport Officers.
DAMPRIER SALT FIELD
STAGE 1 EXPANSION

RED - NEW EXPANSION - COMPLETION MID 1991
Dampier Salt Field
Stage 3 Expansion

Blue - Previous Expansion Stages
Red - New Expansion - Planned Completion Mid 1985
The Dampier solar saltfield located 1300 km north of Perth on the north-west coast of Australia was built in the late 1960's as a result of increased demand for industrial salt by the Japanese chemical industry.

Dampier is ideal for the solar production of salt because of its hot dry climate, good port, extensive support infrastructure and its relative closeness to markets in Japan and South-East Asia. As the area is subject to cyclones, all plant and facilities have been built to withstand their effects.

Salt is produced by the solar evaporation of seawater and is further processed to achieve high quality for export.

Salt was first shipped from Dampier Salt's loading facility in April 1972. By 1988 more than 28 million tonnes had been shipped from the field.

The workforce of about 180 people live in the nearby town of Karratha which has extensive modern facilities and amenities.

The use of up to date technology makes the Dampier saltfield one of the most advanced and efficient in the world. This position is maintained by a Research team developing improved methods, equipment and controls.
Seawater is pumped into the first pond, Pond Zero, and undergoes progressive concentration by evaporation as it flows through successive concentrating ponds. In the sixth pond, the brine reaches “salting” point (sodium chloride saturation). At this stage it has been reduced to 11% of its original volume and has deposited most of its calcium. Sixty-five tonnes of seawater are pumped in for every tonne of salt shipped out. Dampier’s evaporating area is sufficient to produce 2.4 million tonnes of salt a year.

The saturated brine is pumped into crystallising ponds where further evaporation occurs and salt is deposited on top of a pre-formed floor of salt which acts as a pavement for harvesting equipment. Deposition is stopped when about three quarters of the sodium chloride has been deposited and before other dissolved salts come out of solution in significant quantities. The residual brine called bitterns contains high concentrations of potassium, magnesium and other salts and is a potential source of these minerals.

Each crystalliser is harvested once a year. Salt is removed from the drained crystallisers by mechanical harvesters and is fed directly into road trains comprising a prime mover and either two or three trailers with gross weights of up to 140 tonnes. The harvester units which are specially built to Dampier Salt’s requirements harvest at a continuous rate exceeding 1,000 tonnes per hour. Laser equipment enables accurate control of harvester cutting depth, leaving an even surface for the next year’s growth of crystals.

To ensure high quality salt with minimum impurity levels the salt is washed immediately after harvesting. Road trains dump the freshly harvested salt into hoppers feeding the washplant which has a peak capacity in excess of 1,000 tonnes per hour. The salt moves onto six stainless steel mesh washing belts where a series of sprays wash the salt with brine removing potassium and magnesium as well as gypsum and other solid impurities.

After washing, the product is conveyed to the 1,000,000 tonne wet salt stockpile. Salt must be well drained before shipment and it takes about two months for the moisture content to fall below 2.6%.

Salt is then reclaimed by large front-end loaders into 100 tonne road trains and carried 16km over a causeway to a dry salt stockpile of 250,000 tonnes capacity at the Company’s shiploading facility at Mistaken Island, to await shipment.

Reclaim for shiploading is by dozers and front-end loaders feeding through chutes to a conveyor under the stockpile.

At present the shipping berth can accommodate vessels of up to 75,000 DWT. The berth has been designed to allow future dredging for vessels up to 100,000 DWT.

Fully equipped laboratories maintain stringent quality control to ensure only the highest grade of salt is produced.

**Biological Environment**

The biology of the Dampier saltfield is of great interest in its own right. Pond Zero accommodates the most conspicuous concentration of fish life in the Pilbara region. But of greater interest to the Company are the many species of green and blue-green algae which proliferate in the various ponds and which can affect the quality of the brine and salt produced.

Our Research team has pioneered an active biological monitoring programme. Out of these investigations have come an increased understanding of the minute organisms involved in the saltfield, which has led to increased control and quality.

**Regional Environment**

The Dampier Archipelago is rocky and dry with little natural water. Despite this stark outlook the Archipelago abounds with a rich variety of animals, birds, fish and native plants.

The Company has a programme of on-going environmental research into the Dampier saltfield to ensure that its flora, fauna and marine species are preserved.

Art is an essential component of Aboriginal life and there are more than 6,000 rock engravings along the sides of several small valleys within the boundaries of Dampier Salt’s lease. It is one of the most important ranges of Aboriginal rock engravings in the region. The area was part of the Ngaluma tribal ground and there are also shell middens and old camp sites.

The Company helps ensure the protection and preservation of these sites.
Dampier
PROCESS OVERVIEW

Saltfield Data

- Design production
  2.4 million tonnes/year
- Preconcentration area
  8 200 hectares
- Crystalliser area
  880 hectares
- Length of levees & causeways
  85 km
- Area rainfall
  240 mm/year
- Area evaporation (fresh water)
  3 500 mm/year
- Average evaporation of field
  420 000 tonnes of water/day
- Peak evaporation of field
  1 000 000 tonnes of water/day
- Salt deposited in crystallisers
  250 - 300 mm/year
- Brine depth in crystallisers
  270 - 300 mm
- Peak shiploading rate
  3 300 tonnes/hour
- Average shiploading rate
  2 500 - 3 000 tonnes/hour
- Berth depth at low water
  12 metres
Appendix 2

Dampier Salt Eastern Lease Area
Appendix 3

Nickol Creek and Dampier Salt Eastern Boundary
Nickol Creek, Seawater Storage Pond and Access Channel
Figure 5

Typical Cross Section
For Levees 34, 35A, 36, 38, 39, 40, 41, 33, 2A

Fig. 5.1

Typical Cross Section
For Levees 37 & 44

Fig. 5.2

Levee Cross Sections
DAMPIER SALT (OPERATIONS) PTY LIMITED – SALT FIELD UPGRADE PROGRAMME

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Appendix 5
Preface

These guidelines are issued as a checklist of matters which the Environmental Protection Authority considers should be addressed in the CER. They are not exhaustive and other relevant issues may arise during the preparation of the document: these should also be included in the CER.

It should also be noted that the guidelines are not intended to convey the Authority's wishes with respect to the format of the document. The format is a matter for the proponent.

A copy of these guidelines should appear in the CER.

These guidelines may be amended if a joint State/Commonwealth environmental assessment is necessary by virtue of the Commonwealth's Environment Protection (Impact of Proposals) Act applying to the project through, for example, the requirement for export approval.

1. Summary

This section should contain a brief summary of:

- salient features of the proposal;
- reason for the proposal;
- description of receiving environment and analysis of potential impacts and their significance;
- environmental management, and commitments thereto; and
- conclusions.

2. Information

- background and objectives of the proposal including brief description of current operation and how it relates to the proposal;
- brief description of documentation relating to the original proposal;
- timing of this proposal;
- relevant legislative requirements and approval processes;

3. Need for the Development

This section is to enable the proponent to provide the justification for the project.

4. Evaluation of Alternatives

A discussion of the possible alternatives, especially with regard to construction materials and borrow pits, and their potential impacts.

It may also be appropriate to discuss various development options including different scales.

5. Description of Proposal

It is important to set the context by briefly describing the existing facility and indicating how the proposed expansion relates to this:

- project timetable;
6. Existing Environment

This section should provide a brief description of land tenure, the environment and the physical and ecological systems likely to be affected by the expansion, supported by appropriate maps/airphotos as supplied in your ‘Environmental Aspects’ document.

It should then discuss aspects of the environment likely to be impacted by the development. Only the habitats, resources and potential resources which could be influenced should be defined.

This section should include an overview of:

- adjacent land uses (e.g., railway, main road, airport, caarine ponds)
- conservation, archaeological and recreational values

7. Environmental Impacts

This section of the CER should show the overall effect on the total ecosystem and social surroundings of the proposal, as it relates to the staged expansion.

The objective of this section is to briefly synthesise all information and predict potential impacts (both adverse and beneficial) upon the environment in the short and long terms. This should include an assessment of the resilience of the systems to natural and man-induced pressures associated with the proposal, with the benefit of several years of salt production and monitoring of impacts to draw from.

Impacts on those environmental values identified in Section 6 should be discussed. The effects of increased road usage by construction traffic and salt trucks need to be quantified.

8. Environmental Management

Environmental management should be described on the basis of (and cross-referenced to) the potential environmental impacts described in 7.

The purpose of management is to demonstrate the manner in which potential environmental impacts can be ameliorated either through design or specific ongoing management. The issue of management of the adverse impacts of the proposal should be specifically addressed in detail, including who will be responsible. Commitments as to bittern discharge and rehabilitation of disturbed ground should be made, including those made in your original document.

9. Summary of Commitments by Proponent

A summary of commitments made should be included as an appendix to the CER. The commitments should be numbered and include: who makes the commitment; the nature of the commitment; when it will be carried out, and to whose satisfaction.

10. References

All references should be listed.

11. Consultations

A list of agencies or groups consulted in the preparation of the CER and for the purposes of foreshadowing issues arising out of the proposed expansion should be included.
Mr E Bernard
Dampier Salt
PO Box 1619
Karratha WA 6714

Dear Mr Bernard,

DAMPIER SALT FIELD EXPANSION

I have now received a report from our Pilbara Heritage Officer, Mr Roger Solomon, on his inspection of proposed work for the new stage of the Dampier Salt fields.

On the basis of his advice I can inform you that Levee 34 is clear of sites. However, the point which extends into the Bitterns Pond from the north shore, has evidence of Aboriginal occupation in the form of midden material and other artefacts. Should this area be impacted in any way by the construction of the levees you will need to arrange for a consultant archaeologist to record the site in detail and then submit a notice under Section 18 of the Aboriginal Heritage Act 1972-80 seeking Ministerial consent for the use of the land.

It is also possible that sub surface material, including burials, may occur in the area and be uncovered during your proposed work. Should this occur, you should stop work immediately and advise us.

Yours sincerely,

Robert Reynolds
Acting Assistant Registrar
DEPARTMENT OF ABORIGINAL SITES
Attention: Mr R Copeland

Dear Sir,

DAMPIER SALT - PROPOSED FIELD EXTENSION

I refer to your letter of 16 May 1990 (your reference PA/1/7 & TX/2/5:RC) to our Western Australia Field Office, regarding the proposed extension of Dampier Salt (Operations) Limited saltfield near Karratha Airport.

Normal seawater consists of about 3.8% salt, and has a density of 1.027g/cm3. Salt crystallises from seawater (brine) at a concentration of about 25.7%, or 1.215g/cm3.

Saline waters (up to about 14% salt, or 1.107g/cm3, which is about 3.7 times normal seawater salinity) support many prey items attractive to waterfowl and wading birds. The brine shrimp Artemia salina, which is a major food source for some species of birds occurs in waters between about 1.5 and 3.5 times the salinity of seawater (1.041g/cm3 to 1.101g/cm3).

Ducks and many small wader species are commonly associated with brine concentration ponds, up to about 6% salinity, or 1.043g/cm3. At higher salinities up to 14%, Avocets, stilts, and a few wader species can still occur in large numbers.

According to information recently provided to me by Dampier Salt, the proposed Stage 1 salt dissolution pond would have a relatively high brine density of more than 1.18g/cm3, which would preclude marine life attractive to seabirds. Brine densities of between 1.138g/cm3 and 1.30g/cm3 are planned in the brine concentration ponds and bitterns crystallisers proposed for Stages 2 to 4.

It is therefore unlikely that significant numbers of birds would be attracted to the proposed salt dissolution and brine concentration ponds or bitterns crystallisers.

The seawater storage pond, which will be filled by tidal inflow from Nickol Creek, is planned to have an average area of 2.56 ha (800m x 32m), a minimum depth of 500mm, and shallowly-sloping edges (1 in 4 below 3.5m, and 1 in 10 above).

Such a pond can be expected to support a variety of marine life which would be attractive to many species of birds. Dampier Salt believes that the seawater pond would be similar in nature to Nickol Creek, and to the 2.7 ha seawater...
storage pond on the adjacent Aqua Carotene Industries lease, commissioned in January 1990.

According to Peter Minchliffe, Site Manager, Aqua Carotene Industries, some small fish have been drawn into its seawater storage pond via the seawater pump, but birds (Caspian Terns) have been observed at the pond on only two occasions, when the pond was drained to a depth of about 200mm. No bird activity has been observed since the minimum depth of the pond has been set at 400mm. Mr Minchliffe considers that the (high) turbidity of the seawater in the pond (resulting from algal growth?) together with "floor camouflage", prevent birds from taking the small fish in deeper water.

Direct inflow of tidal waters from Nickol Creek into the proposed Dampier Salt seawater storage pond may result in less turbidity than is apparently the case in the Aqua Carotene storage pond. Larger fish which may not be drawn into a pump may also gain access to the proposed Dampier Salt pond.

The shallowly-sloping shores of the proposed pond would also provide easy access to prey for wading and diving birds.

It is therefore likely that birds such as terns, gulls, egrets, herons, cormorants, and some migratory waders would, at times, be attracted to the proposed seawater storage pond. The number of birds attracted would probably be fairly low much of the time, but may occasionally become quite large and could present a hazard to aircraft using Karratha Airport.

Wires and other obstructions, such as "para-web" fencing strung over the storage pond would be likely to effectively deter birds from wading along the shores or diving for prey.

In the interests of aircraft safety, the Shire of Roebourne should only give its approval for the proposed salt field extension if it is satisfied that Dampier Salt (or any future owner of the salt field) can, in practice, take steps to prevent birds which may be a hazard to aircraft from being attracted to the proposed seawater storage pond, and has a guarantee from the company that it will take such action, if the Council considers it is necessary at the time.

Yours faithfully,

P M Davidson
for Group General Manager
SAFETY REGULATION

10 July 1990
10 July 1990

Your Ref: TX/2/5, PA/1/7:RC
Our Ref: 30/42
Attention: E. Burnard

The Shire Clerk
Shire of Roebourne
PO Box 219
KARRATHA WA 6714

ATTENTION: MR R C COPELAND

Dear Sir,

RE: SALT FIELD EXPANSION

Further to our correspondence and your discussions with our Mr Ed Burnard on the proposed salt field extensions and the seawater holding pond adjacent to the southern end of Levee 24 in particular.

We believe that there will be no significant increase in seabird activity resulting from the construction of our 2.56 ha seawater pond. This is based on observations of a similar sized seawater storage pond on the Aquacarotene Industries lease and the regularly isolated ponds in the upper reaches of Nickol Creek.

We have discussed the situation with Mr Peter Davidson of the Civil Aviation Authority Airport Safety Group and he has responded with the attached letter, dated 10th July 1990.

The letter refers to the possibility that, at times, seabirds could be attracted to the seawater pond and also effective deterrent methods that can be employed.

Dampier Salt will guarantee that it will take action to prevent any excessive seabird activity around the proposed Seawater Pond, by the installation of recommended obstruction methods, if it is considered necessary by Roebourne Shire Council Officers. To this end we would seek discussions with the Shire as to what is considered appropriate.
To assure the Shire that no problem will arise, Dampier Salt guarantees that in the extreme it would be willing to totally cover the pond in netting should this prove necessary.

Neil Swan
General Manager
SHIRE OF ROEBOURNE

KARRATHA OFFICE
P.O. BOX 319, KARRATHA 6714
Telephone 091-368655
Telex 05606
Fax 091-361626
All correspondence to be addressed to Shire Clerk

19th July 1990

The General Manager
Dampier Salt (Operations) Pty Limited
PO Box 1619
KARRATHA WA 6714

ATTENTION: MR ED BURNARD

Dear Sir

SALT FIELD EXPANSION

Council have considered your request and guarantee detailed in your letter of 10 July, 1990, and subject to the following, have agreed to your Company proceeding with the applications for Miscellaneous Licences 47/13 and 47/14, together with the General Purpose Lease from Nickol Creek.

Council's approval is conditional upon:

(a) Dampier Salt's guarantee as outlined in your letter is unconditional, and the opinion of the Shire of Roebourne with regard to any bird activity which may be excessive or potentially hazardous to aircraft operations shall be final and binding.

(b) Such bird activity mitigation measures shall relate to all or any bird activity and not restricted to seabird activity. Further, bird activity which may be excessive or potentially hazardous to aircraft covered by Dampier Salt's guarantee shall not be restricted to the Seawater Pond, but the vicinity of the Seawater Pond and channel.

(c) The right is reserved for Council to require or subsequently require Dampier Salt to undertake such measures Council may, from time to time deem necessary, and further, Council reserve the right to require Dampier Salt to modify, improve or upgrade any previously installed mitigation measures as it may, from time to time direct, all at no cost whatsoever to Council, and Dampier Salt shall comply with such directions within such time scales Council may require.

(d) Dampier Salt agree to allow unrestricted access to its areas of planned expansion for such personnel the Shire may request.
Council do not, at present, require Dampier Salt to install any devices to prevent or limit the accumulation of birdlife in its expansion plans. However, this situation and the need for such devices will be monitored.

It would be appreciated if Dampier Salt would signify its written acceptance to the above conditions.

Yours faithfully

[Signature]
F. [Name]
SHIRE CLERK
AQUA CAROTENE INDUSTRIES

MEMORANDUM

TO: Ed Bernard - Research Manager
    Dampier Salt Operations

COPY: Peter Davidson - Ornithologist
      Bird Hazard Investigation Unit
      Airport Systems Branch

FROM: Peter Hinchliffe - Site Manager
      Aqua Carotene Industries

SUBJECT: Bird Life Effects on 2.7ha Sea Water Storage Pond at Aqua Carotene Industries

Our 2.7ha sea water storage pond was initially commissioned in January 1990. The pond design requires that the maximum operating depth should not exceed 850mm which allows for a maximum sea water storage of 23,000m³.

On site observations of the pond have observed that some fish have been drawn into the pond via the sea water pump. These fish although relatively small in number and very hard to spot do tend to graze on the green algae and keep the pond acceptably clean. So far all attempts to capture one of these fish for identification have failed. They are very fast and can readily camouflage and hide on the pond floor.

Bird life effects on the pond have been observed on only two occasions. Both of these occasions were when the pond was drained to a minimum depth of only 200mm, whereby a few Caspian Terns attempted to dive and capture the fish. The pond was quickly refilled again to increase depth. Observations then demonstrated that at 300mm, turbidity and floor camouflage protected the fish from any further bird problems.

We have now set our minimum operating standard of pond depth to 400mm and all bird activity has completely ceased.
Flora present in area to be disturbed by Burrow Pit excavations on Southern side of Eastern lease area

Area typical of "Crab hole country", which is an indicator of underlying clay layers

**Family Amaranthaceae**

Ptilotus exaltatus Nees Purple Mulla Mulla

**Family Asteraceae**

Pterigeron bubakii (Domin) Dunlop Daisy

**Family Chenopodiaceae**

Salsola kali L. Roly-poly
Scerolaena sp.

**Family Papillionaceae**

Indigofera trita L.f. Rhynchosia minima (L.) DC.

**Family Poaceae**

Aristida browniana Henrard Windmill Grass
*Eragrostics japonica (Thunb.) Trin. Tussock Grass
Panicum decompositum R.Br. Native Millet
Sorghum plumosum (R.Br.) Beauce Plume Sorghum

**Family Tiliaceae**

Corchorus aff. walcotti F. Muell. Northern Buttercup

*Dominant species
Flora present in area to be disturbed by Eastern Lease
Area North Shoreline rain water diversion channel and levee.

Family Aizoaceae
Trianthema turgidifolia F. Muell.

Family Amaranthaceae
* Aerva javanica (Burm.f.) Juss. ex Schult.
Ptilotus axillaris (F.Meull. ex Benth.) F. Muell.
* Ptilotus exaltatus Nees
Ptilotus gaudichaudii Nees (Steud.) J.M. Black

Family Boraginaceae
Heliotropium spp. (5 species)
Trichodesma zeylanicum (L.) R. Br

Family Caesalpinaceae
Cassia notabilis F.Muell.
Cassia oligophylla F.Muell.

Family Capparidaceae
Capparis spinosa L.nummularia
Cleome viscosa L.

Family Chenopodiaceae
Atriplex inflata F.Muell.
Atriplex semilunaris Aellen
Dysphania plantaginella F.Muell.
Enchylaena tomentosa R.Br.
Salsola kali L.

Family Convolvulaceae
Bonamia pannosa
Ipomoea costata F.Muell. ex Benth.
Ipomoea muelleri Benth.
Polymeria ambigua

Family Euphorbiaceae
Euphorbia australis Boiss.
Euphorbia drummondii Boiss.
Phyllanthus spp. (2 unidentified)

Family Frankeniaceae
Frankenia pauciflora DC.
Family Goodeniaceae
Scaevola spinescens R.Br.

Family Lauraceae
Cassytha capillaris Meisn.
Cassytha filiformis L.

Family Malvaceae
Lawrenicia sp.

Family Menispermaceae
Tinaspora smilacina Benth.

Family Mimosaceae
* Acacia bivenosa DC.
Acacia coriacea DC.
Acacia ligulata A.Cunn. ex Benth.
Acacia translucens A. Cunn.
Dichrostachys spicata (F.Muell.) Domin
Neptunia dimorphantha Domin

Family Nyctaginaceae
Boerhavia diffusa

Family Poaceae
Aristida browniana Henrard
Aristida contorta F.Muell.
* Cenchrus ciliaris L.
Dactyloctenium radulans (R.Br.) Beauv.
Eragrostis eriopoda Benth.
Eragrostis japonica (Thunb.) Trin.
Eulalia fulva (R.Br.) O. Kuntze
Panicum decompositum R.Br.
Triodia longiceps J.M. Black
* Triodia pungens R.Br.

Family Portulacaceae
Portulaca oleracea L.

Family Proteaceae
Grevillea pyramidalis A.Cunn.
Family Papilionaceae
Clianthus formosus (G.Don.) Ford et Vickery
Crotalaria cunninghamii R.Br.
Indigofera monophylla DC.
Rhyncosia minima DC.
Sesbania cannabina (Retz.) Poir.var.cannabina
Swainsonia pterostyris (DC.) Bakk.f.

Family Sapindaceae
Diplopeltis eriocarpa (Benth.) Hemsl.

Family Scrophulariaceae
Stemodia viscosa Roxb.

Family Solanaceae
Nicotiana occidentalis Wheeler subsp. occidentalis
Solanum phlomoides A. Cunn. ex Benth.

Family Stylobasiaceae
Stylobasium spathulatum Desf.

Family Tiliaceae
Corchorus walcottii F.Muell

Family Violaceae
Hybanthus aurantiacus (F.Muell. ex Benth.) F. Muell.

Family Zygophyllaceae
Kallstroema terrestris L.
Kallstroema occidentalis R.Br.

* indicates dominate species.
Appendix 11

Flora present in areas to be disturbed by Eastern Lease
Area South Shoreline bitterns channel, rainwater diversion
channel and levee, and burrow pits excavations.

Family Aizoaceae

Trianthema turgidifolia F. Muell.

Family Amaranthaceae

* Aerva javanica (Burm.f.) Juss. ex Schult.
* Ptilotus axillaris (F.Meull. ex Benth.) F. Muell.
* Ptilotus exaltatus Nees
Ptilotus gaudichaudii Nees (Steud.) J.M. Black

Family Boraginaceae

Heliotropium spp. (5 species)
Trichodesma zeylanicum (L.) R. Br

Family Caesalpinaceae

Cassia notablis F.Muell.
Cassia oligophylla F.Muell.

Family Capparidaceae

Capparis spinosa L.nummularia
Cleome viscosa L.

Family Chenopodiaceae

Atriplex inflata F.Muell.
Atriplex semilunaris Aellen
Dysphania plantaginella F.Muell.
Enchylaena tomentosa R.Br.
Salsola kali L.

Family Convolvulaceae

Bonamia pannosa
Operculina brownii Oostrtr.
Polymeria ambiguà

Family Euphorbiaceae

Euphorbia australis Boiss.
Euphorbia drummondii Boiss.
Phyllanthus spp. (2 unidentified)

Family Goodeniaceae

Scaevola spinescens R.Br.
Family Lauraceae
Cassytha capillaris Meisn.
Cassytha filiformis L.

Family Malvaceae
Lawrenzia sp.

Family Mimosaceae
* Acacia bivenosa DC.
Acacia coriacea DC.
Acacia ligulata A.Cunn. ex Benth.
Acacia translucens A. Cunn.
Dichrostachys spicata (F.Muell.) Domin
Neptunia dimorphantha Domin

Family Nyctaginaceae
Boerhavia diffusa

Family Poaceae
Aristida browniana Henrard
Aristida contorta F.Muell.
* Cenchrus ciliaris L.
Dactyloteniun radulans (R.Br.) Beauv.
Eragrostis eriopoda Benth.
Eragrostis japonica (Thunb.) Trin.
Eulalia fulva (R.Br.) O. Kuntze
Panicum decompositum R.Br.
Triodia longiceps J.M. Black
* Triodia pungens R.Br.

Family Portulacaceae
Portulaca oleracea L.

Family Papilionaceae
Clianthus formosus (G.Don.) Ford et Vickery
Indigofera monophylla DC.
Rhynchosia minima DC.
Swainsonia pterostylis (DC.) Bakk.f.

Family Sapindaceae
Diplopeltis eriocarpa (Benth.) Hemsl.

Family Scrophulariaceae
Stemodia viscosa Roxb.

Family Solanaceae
Nicotiana occidentalis Wheeler subsp. occidentalis
Solanum phlomoides A. Cunn. ex Benth.
Family Tiliaceae
Corchorus walcottii F. Muell.

Family Violaceae
Hybanthus aurantiacus (F. Muell. ex Benth.) F. Muell.

Family Zygophyllaceae
Tribulis terrestris L.
Tribulis occidentalis R. Br.

* indicates dominate species
Flora present in area to be excavated for seawater channel from Nickol Creek and seawater storage pond.

**Family Avicenniaceae**

* Avicennia marina (Forsk.) Vierh.

**Family Chenopodiaceae**

* Halosarcia halocnemoides (Nees) PG Wils. ssp. tenuis PG Wils
  Sueda australis

**Family Rhizophoraceae**

Bruguiera exaristata Ding Hou.
Ceriops tagal C.B.Rob.

**Family Plumbaginaceae**

Limonium salicorniaceum (F.Muell.) Kuntze

* indicates dominant species
Disturbance to Mangrove Community

Track through Mangroves

Severed Mangroves
REVEGETATION

Three zones within the Dampier Salt lease area are subject to revegetation. These are:

- general borrow pit areas
- stormwater levees and channels
- seawater pond and channel

The composition of seed blend and method of application will differ for each zone.

1. Borrow Pit Areas

Including requirements of both clay and gravels borrow pits for the four expansion stages and revegetation of earlier borrow pits, approximately 100 ha. will need to be revegetated.

The prepared areas will be relatively level and low lying, which will aid in both seed and water retention. Seed broadcasting will be by vehicle mounted centrifugal spreader.

A minimum quantity of 5 kg seed blend/ha. will be required for satisfactory results.
The seed blend will consist of:

500 g/ha. each of

- Enchylaena tomentosa
- Gomphrena affinis
- Ptilotus axillaris
- Ptilotus exaltatus
- Swainsona pterostylis (pods)
- Triodia pungens

250 g/ha. each of

- Acacia ampliceps
- Acacia bivenosa
- Acacia coriacea
- Acacia translucens
- Cassia oligophylla
- Cassia notabalis
- Canavalia maritima
- Gomphrena canescens
- Sesbania cannabina
- Trichodesma zeylanicum

125 g/ha. each of

- Clianthus formosus
- Ptilotus polystachyus

Representative quantities (about 25 g/ha.) each of

- Cassia venusta
- Corchorus walcottii
- Indigofera monophylla
Ipomoea brasiliensis
Ipomoea costata
Ipomoea muelleri
Kallstroemia spp.
Neptumia dimorphantha
Portulaca spp.
Solanum phloinoides
Solanum diversiflorum

Seed will be locally picked. Pea, wattle and cassia seed will be scarified before application.

2. Stormwater Levees

A vegetation cover on appropriate stormwater levee and channel embankments will be applied for both aesthetic appearance and erosion control.

Application rate will be approximately 15 kg/ha. and comprise:

3 kg/ha. each of Canavalia maritima
Ipomoea brasiliensis
Ptilotus spp. (mixed)

2 kg/ha. of Enchylaena tomentosa
1 kg/ha. each of: Acacia translucens
Cassia oligophylla
Clianthus formosus
Trodia pungens

3. Seawater Pond and Channel

The White Mangrove (Avicennia marina) produces large floating seeds during the summer period. These will become lodged in the mud banks of the seawater channel and pond, enabling the plant to colonise these areas. This process can be actively assisted by collecting the floating seeds from areas where they accumulate and planting them on the periodically inundated channel and pond periphery.

The other local salt tolerant species, Samphire (Halosarcia halocnemoides) and Sueda (Sueda australis), will be established by directly seeding the areas above the level of periodic inundation.

Details of species quantities and planting are:

Avicennia marina - 2,000 seeds and seedlings, hand placed every 1-2 metres along channel and pond periphery.
Halosarcia halocnemoides - 10 kg dried articles collected when Samphire is seeding (March/April).

500 g crumbled articles hand spread/100 metres.

Sueda australis - Self seeding from existing plants on mangrove flats. Rapid regeneration occurred following bitterns channel placement. This was monitored and data is on file.
Dear Mr Cusack,

DAMPIER SOLAR SALT INDUSTRY AGREEMENT - BITTERNS DISPOSAL MONITORING

I refer to the approval granted on 30 November, 1981 by the Minister for Resources Development for the continued discharge of bitterns from Dampier Salt's work site into Nickol Bay.

This approval was on the basis that Dampier Salt undertook further monitoring of post larval prawns and mangrove vegetation as an extension of the monitoring programme that had been undertaken at that time. From an examination of the annual reports that Dampier Salt has since submitted I have been advised that there is no evidence to indicate any adverse effect on the environment as a result of the continued discharge of bitterns under the current regime. As a consequence I advise that under the present circumstances I do not require the submission of further monitoring reports, provided Dampier Salt undertakes to:

- maintain a record of the volumes and concentrations of continued bitterns discharges
- provide prompt advice of any substantial change to the bitterns discharge regime from that which was used in the monitoring programme
- on my request, conduct further monitoring work, in particular repetition of controlled aerial photography.

Notwithstanding the above I would direct your attention to Clause 30A of the Dampier Agreement and advise that should at any time the discharge of bitterns give cause for concern for the environment I require notice of any such concern.
Finally I would like to record the co-operative and responsible manner in which your company personnel have undertaken the past monitoring work. I look forward to your acceptance of the above undertakings.

Yours sincerely,

DAVID PARKER, M.L.A.
MINISTER FOR MINERALS AND ENERGY
13 MAR 1986
TO: Ed Burnard - Research Manager
    Dampier Salt Operations
FROM: Peter Hinchliffe - Site Manager
       Aqua Carotene Industries
SUBJECT: Bitterns Flow

After discussions with yourself and the recent announcement of
D.S.O.'s intention to expand and utilize the bitterns pond area
for the re-enhancement of sodium chloride growth partly by use
of the initial discharged bitterns.

The planned change to higher ion concentration in discharged
bitterns is considered by Aqua Carotene to be of major benefit
to our operation through decreased pumping requirements and
better ion ratios.

There will be no adverse effects to Aqua Carotene, provided
that the flow of bitterns through the existing channel is not
discontinued.

Peter Hinchliffe
Site Manager.
### Rainfall Intensity-Frequency-Duration Chart for Campier Salt Expansion

**Date:** 5-Dec-1989  
**Time:** 3:26 a.m.

**Job No.:** 4072-01  
**Client:** Campier Salt Operations  
**Prepared:** PJG

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**Durations of 5 Minutes to 22 Minutes, Interval: 0.5 Mins.**

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**Summary:** Durations from 5 minutes up to 7.5 hours are given.
### RAINFALL INTENSITY-FREQUENCY-DURATION CHART FOR LISPERT SALT EXPANSION

**Rainfall Intensity-Frequency-Duration Chart**

**Date:** 5 - DEC - 1969

**Time:** 8:39 a.m.

**Job No.:** 4672-69

**Client:** LISPERT SALT OPERATIONS PO BOX 1142 WEST PERTH 6005

**Prepared:** PJE

**Telephone:** (09) 922 5990

**Facsimile:** (09) 921 6385

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**Durations of 25 Minutes to 57 Minutes. Interval: 1 Mins.**

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- **min**
- **hrs**

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**Duration:** from 5 minutes up to 72 hours are valid.
**Rainfall Intensity-Frequency-Duration Chart for Dapple Salt Expansion**

**Job No.:** 4072-01  
**Client:** Dapple Salt Operations  
**Prepared by:** PJG

**Date:** 5-Dec-1989  
**Time:** 8:29 a.m.

**Durations of 60 Minutes to 200 Minutes, Interval: 5 Mins.**

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*Note: Values are per cent in excess to the 100-year value.*

**Client:** Dapple Salt Properties  
**Telephone:** (09) 322 5990  
**Facsimile:** (09) 321 6385

---

Appendix 17.3
### Rainfall Intensity-Frequency-Duration Chart for Dampier Salt Expansion

**G & H Hill & Partners Pty Ltd**

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**Durations of 4 Hours to 12.5 Hours, Interval = 15 Mins.**

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*Duration from 5 minutes up to 72 hours are valid.*
## RAINFALL INTENSITY-FREQUENCY-DURATION

**Chart for Campier Salt Expansion**

**G & B Hill & Partners Pty Ltd**

**Job No.: 4072-01**

**Client:** Campier Salt (Operations)Pty Ltd

**Prepared:** PJG

**Date:** 5-Dec-1989

**Time:** 9:33 a.m.

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### Durations of 4 Hours to 72 Hours. Interval = 120 Mins.

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**Durations from 5 minutes up to 72 hours are valid.**