ALLIED ENEABBA LIMITED
PROPOSED RARE EARTH PROCESSING PLANT

REPORT AND RECOMMENDATIONS
BY THE
ENVIRONMENTAL PROTECTION AUTHORITY

Department of Conservation and Environment
Western Australia
Bulletin 236 November 1985

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i SUMMARY

Allied Eneabba in conjunction with Asahi Chemical Industry Co Ltd is currently assessing the feasibility of treating monazite and xenotime to produce a variety of rare earth products.

The Company has proposed a treatment plant for its Narngulu property with disposal of the low level radioactive waste from the project either at its Eneabba Mine Site or at Narngulu.

The major environmental issues include considerations of thorium residue disposal, evaporation pond management and radiation safety. The good groundwater, and difficulty in modelling groundwater movement at Eneabba and generally poor groundwater at Narngulu were major factors determining the outcome of the environmental impact assessment.

As there is some uncertainty as to the final ownership of the monazite processing plant, the Authority stresses that its conclusions and recommendations should apply, no matter what the ownership might be, assuming that the environmental management commitments remain valid.

It is concluded that the project would be environmentally acceptable and construction could commence prior to finalising residue disposal and evaporation pond details if the Company abides by its environmental management commitments as described in the ERMP/draft EIS and Supplement, and if the following recommendations are followed:

1. **The Company should develop the detailed design of a waste management system for the processing plant, including liquid, solid and gaseous wastes, in accordance with the Code of Practice on the management of Radioactive Wastes from the Mining and Milling of Radioactive Ores and its Guidelines.**

2. **The State should establish a specialist committee to review the design of a waste management system for the processing plant and to assess the environmental effects of the development of the project and the results of monitoring programmes.**

3. **The Environmental Protection Authority believe that thorium residue disposal at Eneabba would not be environmentally acceptable and recommends that it not be approved at that location.**

4. **The Company should investigate the suitability of sites in the vicinity of the Narngulu industrial area for thorium residue disposal.**

5. **The State's investigation for a Government radioactive waste disposal site should not be constrained to the Narngulu site but be guided by the criteria of the specialist Group Report. Consideration could be given to siting within an economic distance of the Narngulu site.**

6. The Company should include a study of the mobility of uranium and its decay products in its thorium residue study programme.

7. The Company's proposed evaporation pond should incorporate refinements, as indicated by the results of the proposed studies.

8. The Company should dispose of material from the evaporation pond in accordance with relevant codes of practice applying at the time of decommissioning.

9. The Company should provide the State, for its approval, with details of plant design and radioactive material transport prior to commencement of construction.

10. The Company should prepare brief annual reports and comprehensive triennial reports on environmental management for consideration by the State. The triennial reports should be public documents.

11. The Company should compile the results of the evaporation pond and residue disposal studies as a coherent report for State consideration prior to construction.

1. BACKGROUND

Allied Eneabba Limited produces mineral sands from deposits 270 km north of Perth at Eneabba. The mineral sands are mined by open cut methods and are concentrated at Eneabba prior to shipment by rail to the company's separation plant at Narngulu, near Geraldton (Figure 1). The final products are the minerals ilmenite, rutile, zircon, monazite and kyanite.

The mining and processing of mineral sands by the Company are subject to the provisions of the Mineral Sands (Allied Eneabba) Agreement Act, 1975. Under the provisions of the Act, Allied Eneabba in conjunction with Asahi Chemical Industry Co Ltd is currently assessing the feasibility of further treatment of monazite and xenotime to produce a variety of rare earth products.

Monazite and xenotime are now exported overseas for processing. In Australia monazite processing to extract rare earths was undertaken from 1969 to 1972 by the Rare Earth Corporation of Australia. The plant was closed after it became uneconomic.

The Company submitted a brief Notice of Intent and in March 1984 the Authority recommended that an Environmental Review and Management Programme should be prepared. Subsequently in January 1985 the Commonwealth Government advised that the ERMP should also comply with the requirements for a draft Environmental Impact Statement. The eight-week public review period was completed in late June, 1985.

As a result of comments received during the review period, the Authority commissioned a Specialist Group to study thorium hydroxide waste disposal. Their report was publicly released and distributed to all who had made submissions on the ERMP/draft EIS. Comments were requested by late August 1985.

The Company subsequently produced a Supplement to the draft EIS in September 1985, addressing the public responses and Government Department submissions. The Authority has used the Supplement, together with the ERMP/draft EIS and comments received, as a basis for its assessment.

At this stage there is some uncertainty as to the final ownership of the monazite processing plant. The Authority considers that its conclusions and recommendations should apply, no matter what the ownership might be, and has assumed that commitments given will remain valid.

2. THE PROPOSAL

2.1 INTRODUCTION

The Company proposes converting 12 000 tpa of monazite and 100 tpa of xenotime to high purity rare earth products at its Narngulu property. Monazite is a phosphate of rare earths and thorium while xenotime is an yttrium phosphate. The estimated project life is 20 years. It is envisaged that the minerals would be predominantly supplied from the Company's existing dry separation plant, with the balance from other Western Australian producers.

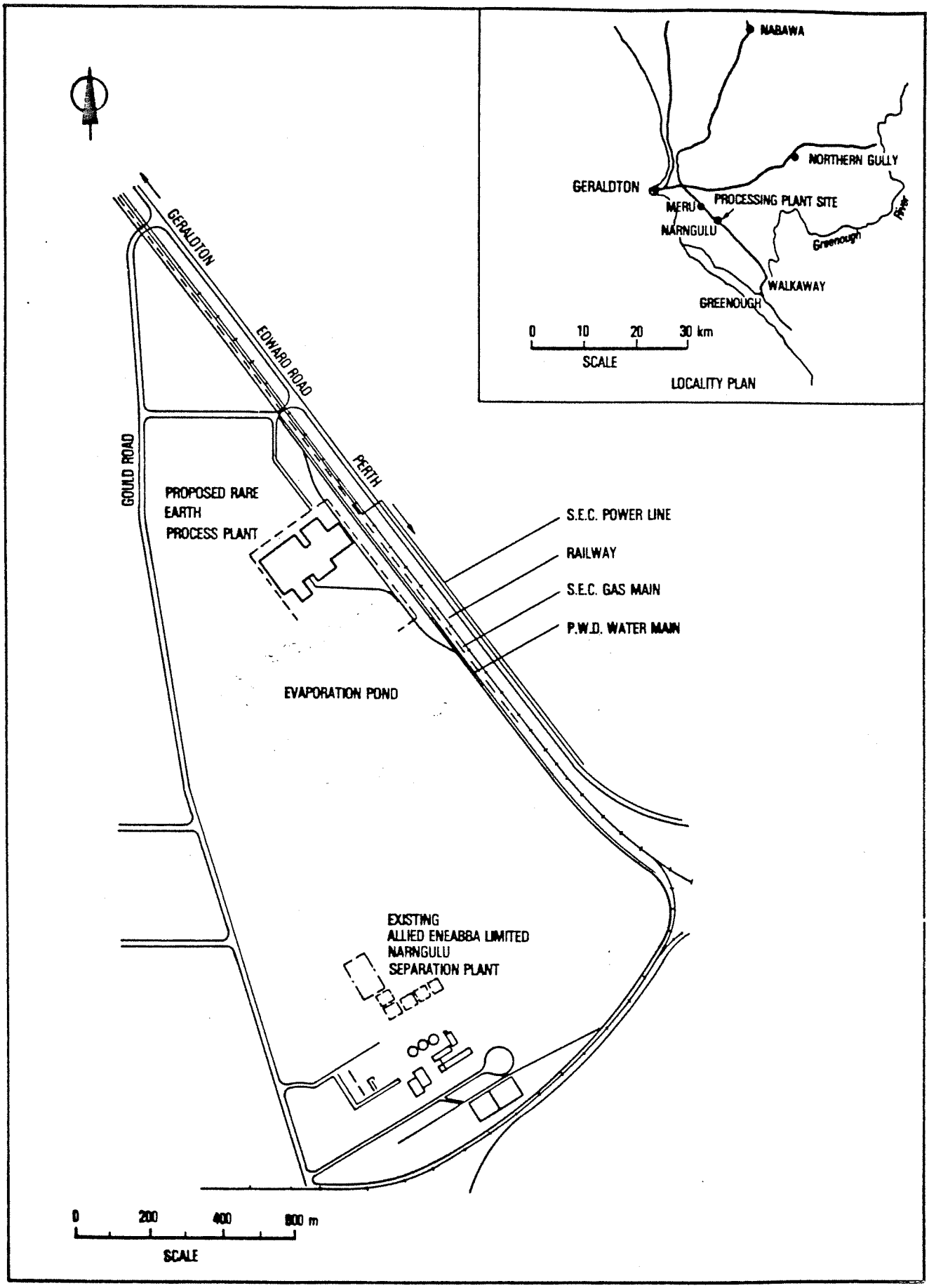

Figure 1. Narngulu Processing Plant, Locality Plan.

2.2 TREATMENT PROCESS

The proposed treatment process is summarised in Figure 2. Before chemical cracking, the process would require wet grinding to reduce the mineral particle size. The cracking stage of the process, using heated caustic soda, would break down the binding phosphate matrix of the monazite and xenotime and enable the separation of the rare earths. The sodium phosphate liquor from the cracking and phosphate removal stage of the process would be reacted with quicklime to recover caustic soda for reuse in the process. Calcium phosphate produced at a rate of 6 000 tpa in the form of a wet filter cake would be a waste material.

Insoluble rare earths and thorium hydroxides would be recovered as filter cake from the phosphate filter. The uranium and radium contents of the original monazite and xenotime would also occur in the filter cake. The rare earths would be separated using hydrochloric acid which dissolves the rare earths and radium hydroxides. The radium compounds would be subsequently immobilised using sulphuric acid and barium chloride.

Solvent extraction would be used to separate light and heavy rare earths from the filtrate of the thorium filter. The individual heavy rare earths would then be separated using ion exchange resins.

2.3 WASTES

The major waste products from the treatment process are summarised in Table 1.

2.3.1 EVAPORATION POND

A shallow clay based evaporation pond 36 ha in area adjacent to the proposed plant would be used to dispose of all the unused waste water and the non radioactive solid process wastes. The pond would incorporate two 5 m deep sections, excavated to accumulate suspended solids.

The waste water would be handled in two separate streams. Water driven off from the evaporator used to concentrate the caustic soda in the caustic recovery section would be collected by condensation for re-use in the process. 15 ML pa would be used as a transport medium for the calcium phosphate residue. This slurry would be pumped to one of the deep sections of the evaporation pond.

The balance of the waste water (565 ML pa) would be mixed with calcium oxide for pH control. The water would then enter the evaporation pond via a separate deep section to accumulate settled suspended solids. Associated with this waste water would be the dissolved short lived radionuclide content of the cracking and phosphate removal stage. Further, filtrate resulting from ion exchange separation would contain residual radionuclides. Concentration by evaporation over the life of the project would result in the radionuclides exceeding public drinking water standards.

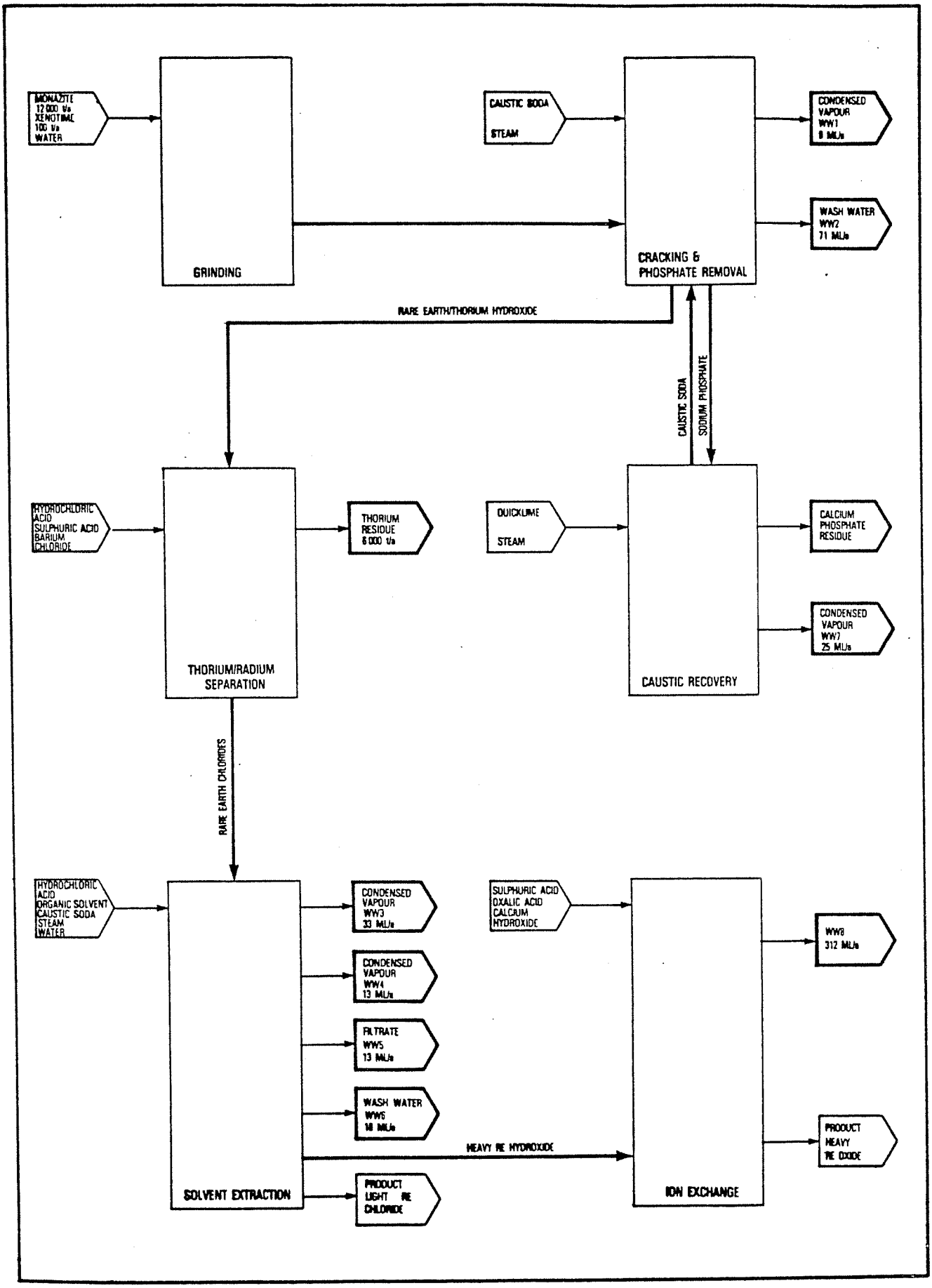

Figure 2. Narngulu Processing Plant, Conceptual Flow Sheet.

Table 1. Annual Quantities of Waste

WASTE	QUANTITY
Waste water to evaporation pond	580 ML/a
Water vapour from cooling tower	178 ML/a
Suspended and dissolved solids in water	12 300 t/a
Calcium phosphate residue	6 000 t/a
Thorium residue (50% solids by weight)	6 000 t/a
SOLIDS IN WASTE WATER FROM COLLECTION TANK	
SOLID	QUANTITY (t/a)
Suspended:	
. rare earth hydroxide	38
. calcium sulphate	1 684
. calcium phosphate	267
. others	41
Subtotal	2 030
Dissolved:	
. ammonium sulphate	7 300
. sodium chloride	975
. nitrates	1 270
. others	725
Subtotal	10 270
TOTAL	12 300

The Company has calculated that the radon and thoron gas emanations from the evaporation pond would be dissipated to safe levels in a layer only 1.5 mm thick over the pond surface.

At the cessation of processing, a large pit would be excavated adjacent to this pond into which all the suspended and precipitated solids would be pushed while moist. The pit would then be covered by topsoil and revegetated while the excess spoil from the disposal pit would be spread over the pond area.

A study programme has been proposed for the intended evaporation pond site.

2.3.2 THORIUM RESIDUE

The 6 000 tpa of thorium residue from the process would be a low level radioactive waste*, classified as of low specific activity for transport purposes. The residue would have 50% solids of which thorium hydroxide (907 tpa) and uranium (20 tpa) would be the principal radioactive materials along with 7 g of radium in a barium sulphate precipitate.

A range of options for thorium residue disposal was considered by the Company. A summary of the major options is provided in Table 2. The Company has proposed that it will investigate shallow land burial of this material at either its Eneabba mine site or at the Narngulu plant site. Deposition would be in two clay lined pits with minimum free water and a possible addition of chemicals to promote binding.

The Company has calculated that radon and thoron gas would be dissipated to publicly acceptable levels within a millimetre of the residue surface.

A broad ranging hydrogeological and geochemical study programme has been developed for the proposed site alternatives.

* Low level radioactive wastes are those wastes, which because of their low level of radionuclide content, do not require shielding during normal handling and transport.

Table 2. Company Thorium Residue Disposal Options

DISPOSAL OPTION	COMPANY COMMENT
Ocean Disposal	Rejected because of Commonwealth Government policy.
Remote Disposal	Cannot accept long-term management commitment. Another site at which radioactive materials to be handled. Residue transport on public roads. Residue deposited in a contained area, hence storage and possibly community concerns. Would only be feasible if Government controlled.
Government Repository	Would consider using if economic and had lower environmental impact or higher social acceptance.
Concretisation	Not technically possible.
Narngulu Plant Site	Favoured.
Eneabba Mine Site	Transport by rail to mine site and disposal. Favoured.

3. ENVIRONMENT

3.1 NARNGULU

The proposed Narngulu plant site is about 15 km south-east Geraldton in an industrial estate. The industries within the estate include an abattoir, a road transport depot, a garnet processing plant, a seed cleaning plant, motor body builders and the Company's mineral sands dry separation plant.

North-west of the industrial estate, towards Geraldton, is a mixture of rural, residential and agricultural users. The Geraldton airport is about 2 km to the north. Land to the east, south and west of the industrial estate is used for cereal cropping and sheep grazing.

The main aquifers in the area contain brackish water which is not suitable for human or stock consumption. Potable groundwater, of quality less than 1 000 mg/L TDS can occur in isolated pockets of sand or limestone, generally at a depth of less than 20 m. These pockets have limited recharge capacity. The majority of bores within 5 km of Narngulu, used principally for stock water and saltine turf irrigation, provide brackish waters.

Limited investigations at the Narngulu site have indicated that clay predominates in the first 30 m although shingle and sand was encountered at 5 to 8 m and clay with limestone rubble at 13 to 15.5 m.

3.2 ENEABBA

The Allied Eneabba mineral leases extend for 16 km southwards from Eneabba. Immediately adjacent to these leases, another mineral sands mining operation is being carried out by Associated Minerals Consolidated. The Company's mining operation is mainly on the South Eneabba Nature Reserve although vacant crown land and some freehold land is also involved.

Adjoining the mineral leases are the Eneabba townsite and its water supply bores to the north. Agriculture land is to the west and east, coal reserves in the Cockleshell Gully Reserve area to the southwest and deep (700 m) coal reserves to the west on the coast near Leeman.

The mineral sand mining areas are located in surficial sands, clays and heavy mineral deposits overlying interbedded sandstones and claystones of the Jurassic Yarragadee Formation. The Yarragadee Formation in the Eneabba area is a very important aquifer, providing high yields of low salinity groundwater. However the groundwater is high in carbon dioxide and hydrogen sulphide and is very aggressive. The area lies within a proclaimed groundwater area.

The surficial deposits extending to a depth of 25 to 40 m are highly variable with common lenses of clay. A chain of wetlands to the west appears to be fed by surface drainage and shallow groundwater from the east.

4. PUBLIC AND GOVERNMENT COMMENTS

During the review period, seven public submissions were received together with twelve Government responses. The majority of submissions, summarised in Tables 3 and 4, were concerned with perceived impacts of the proposal to transport thorium residue from Narngulu to a disposal site at the Eneabba mine site and the proposal to dispose of solid and liquid wastes at the Narngulu plant site. The need to ensure that radiation exposures to workers were within safe levels was also raised. Individual submissions commented on the need to be satisfied with rehabilitation and protection of biological resources at Eneabba, Narngulu and offshore from the Greenough River.

The Company has provided a comprehensive summary of the various submission in Appendix B of its Supplement to the ERMP/draft EIS.

Table 3. Summary of Submissions

ISSUE OF CONCERN	NO OF RESPONDENTS
Evaporation Pond Narngulu (effects on groundwater, Greenough River, air quality)	4
Thorium Residue Disposal Eneabba (effects on groundwater, alternatives, codes of practice, worker perception of risk, transport)	11
Radiation Aspects of Plant	3
Biological Resources (Rehabilitation, rare plants, birdlife, fisheries)	3

Table 4. Respondents

Submissions were received from the following organisations/ individuals:

Associated Minerals Consolidated Ltd
Australian Atomic Energy Commission
Australian Heritage Commission
Bureau of Mineral Resources
Conservation Council of South Australia
Conservation Council of Western Australia
Department of Arts, Heritage and Environment
Department of Conservation and Land Management
Department of Land and Surveys
Department of Public Health
Department of Resources and Energy
Friends of the Earth
Professor P Jennings
Dr R T Pidgeon
Public Works Department of Western Australia
State Energy Commission of Western Australia
Trades and Labour Council of Western Australia
Western Australian Department of Agriculture
Western Australian Government Railways Commission

In addition to the above comments, the Authority commissioned a Specialist Group to report on thorium residue disposal. The report is included in Appendix 1 and covered the following topics:

Principles for management of thorium residue.

The acceptability of the proposed thorium residue disposal method at Eneabba.

Permanent disposal options if the proposed method was unacceptable.

The acceptability of temporary storage while a permanent option was being defined.

The philosophy of considering longterm thorium residue placement as either disposal, storage or a combination of the two.

The Specialist Group's conclusions were of some concern to four respondents who did not believe that the Company should be encouraged to conduct further thorium residue disposal investigations at Eneabba.

5. ENVIRONMENTAL IMPACT ASSESSMENT

5.1 MAJOR ISSUES

The main issues with this project are thorium residue disposal, the Narngulu evaporation pond, and radiation protection and chemical handling aspects of plant operation.

A large proportion of the wastes produced from the radioactive monazite would be low level radioactive wastes. The Commonwealth has described the means of developing a waste management system as part of its Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive ores and associated Guidelines. The approach includes a consideration of a range of options and the selection of an appropriate system based on the use of best practicable technology and consultation with appropriate authorities. The Company should follow this approach when finalising its waste management system.

RECOMMENDATION 1

The Company should develop the detailed design of a waste management system for the processing plant, including liquid, solid and gaseous wastes, in accordance with the Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive ores and its Guidelines.

A specialist committee should be established to review the information provided by the Company and give advice to the State and Commonwealth. The committee could consist of officers from the Departments of Resources Development, Conservation and Environment, Health, Mines and Resources and Energy (Commonwealth) and the Water Authority of Western Australia.

It would be important that this committee continues to review the project once in operation, assessing the environmental effects of the project's development and the results of monitoring programmes.

RECOMMENDATION 2

The State should establish a specialist committee to review the design of a waste management system for the processing plant and to assess the environmental effects of the development of the project and the results of monitoring programmes.

5.2 THORIUM RESIDUE DISPOSAL

6 000 t of thorium residue, a low level radioactive waste, would be generated each year over the 20 year project life. Disposal of this material has been of particular concern during the environmental impact assessment.

5.2.1 PRINCIPLES FOR MANAGEMENT

The Specialist Group concluded that the only practical disposal approach would be by shallow land burial in the zone above the water table, at a location and within a facility designed for that purpose.

The disposal site would require some continuing surveillance and control of future land use. As a result the Specialist Group recommended that the land should eventually be owned by the Government and disposal should be secure enough so that monitoring and ongoing care would be minimised.

5.2.2 SITES FOR RESIDUE DISPOSAL

The Company has proposed that shallow land burial of the waste would be either at its Eneabba minesite or at the Narngulu plant site.

The geology at Eneabba is not ideal for the disposal of radioactive waste because of the presence of discontinuous bedding and permeable sand horizons, poorly suited for waste containment and groundwater movement modelling. Furthermore the surficial sediments are underlain by important groundwater aquifers.

Currently the hydrology and geology of the surficial sediments at Eneabba are poorly known. The Company has proposed a study programme to define the acceptability of the site and disposal approaches. However the nature of the area strongly suggests that disposal of the waste at Eneabba would not be environmentally acceptable.

RECOMMENDATION 3

The Environmental Protection Authority believes that thorium residue disposal at Eneabba would not be environmentally acceptable and recommends that it not be approved at that location.

The Narngulu treatment plant site area appears to have much more acceptable hydrogeological conditions with a preponderance of clay and poor quality groundwaters. The Specialist Group recommended that this area be seriously considered for the residue disposal and the Company has undertaken to carry out the necessary studies.

With the Narngulu site there is a possibility of concern about waste disposal by the local population. This would need to be resolved by the Company if the site was found to be technically acceptable for waste disposal.

The Company, in discussing remote disposal options gave a number of reasons for rejecting this approach. The major concern would appear to be that the company would have to manage another site, outside that already involved with its operations. Following from this was the perception that there would be concern about public road transport and storage in a contained area. It is considered that the Company should not necessarily restrict its investigation to the Narngulu plant site but should investigate the suitability of sites in the Narngulu area.

RECOMMENDATION 4

The Company should investigate the suitability of sites in the vicinity of the Narngulu industrial area for thorium residue disposal.

The Specialist Group indicated that disposal in a Government controlled repository could be an attractive approach. Currently, State Governments are participating with the Commonwealth in the investigation of areas for the safe disposal of radioactive wastes. These investigations are at an early stage and it would be unlikely for a facility to be available when the project commences. However one could be operating during the project lifetime. The Company has stated that it would consider using such a repository if it was economic and had a lower social impact or higher social acceptance than its own disposal site.

The project would be the main forseeable source of low level radioactive waste in Western Australia, all other contributions only amounting to a cubic metre or so per year. As a result it could be desirable for a Government disposal site to be within an economic distance of this project.

RECOMMENDATION 5

The State's investigation for a Government radioactive waste disposal site should not be constrained to the Narngulu site but be guided by the criteria of the Specialist Group Report. Consideration could be given to siting within the economic distance of the Narngulu site.

The Authority agrees with the Specialist Group's belief that any disposal of thorium residue should be viewed as permanent. As a consequence, removal of emplaced waste to a Government facility should not be contemplated. Any disposal site and management decided upon by the Company should be acceptable to the State as

a permanent site, with the State being willing to accept responsibility for ongoing monitoring and management at the completion of the project.

5.2.3 STUDIES

The Company has proposed a broad ranging study programme for both Eneabba and Narngulu to define the hydrogeological and geochemical parameters necessary to decide on disposal site and waste management system suitability. Recommendations 1 and 3 should be recognised in the undertaking of this programme. However the parameters to be included in the study are acceptable to the Authority.

The Company has also proposed validating the solute transport groundwater model through use of the fieldwork results and the results of further chemical and physical testing of the thorium residue. In this study there does not appear to be a consideration of uranium and uranium decay products mobility. This matter should be addressed as part of the work because uranium is known to be mobile under oxidising conditions.

RECOMMENDATION 6

The Company should include a study of the mobility of uranium and its decay products in its thorium residue study programme.

The results of the various studies will need to be assessed by the specialist committee and State approval of a thorium residue disposal system given prior to commencement.

The Authority notes that the Specialist Group considered from the point of view of thorium waste disposal that approval for commencement of construction should not be withheld. It was considered that the necessary investigation for a disposal site should be possible within the two year construction period.

5.3 EVAPORATION POND AT NARNGULU PLANT SITE

The material entering the evaporation pond will contain high concentrations of ammonium sulphate as well as sodium chloride and nitrates. However, because of the predominantly poor quality of ground waters in the Narngulu area there is not the concern for groundwater pollution that would prevail if the groundwaters were generally suitable for stock or human use. Despite this, there are locally good pockets of shallow ground water with limited recharge capacity. It will be necessary, during the Company's proposed studies of the Narngulu site, to ensure that disposal will not downgrade the limited sources of good quality water.

Because of the level of radionuclides, the evaporation ponds will need to be engineered to ensure that seepage rates are acceptable to the State. The Company has undertaken to investigate the need for clay lining or bentonite treatment of the deeper sections of the evaporation ponds as a part of the testing programme.

RECOMMENDATION 7

The Company's proposed evaporation pond should incorporate refinements, as indicated by the results of the proposed studies.

At decommissioning it is proposed that the precipitates and suspended material from the evaporation pond would be excavated and placed in a large pit adjacent to the pond. This pit would contain soluble salts and possibly low level radioactive wastes and this would need to be sited and engineered according to codes of practice applying at the time. Further, the actual volume of material disposed of may exceed that estimated by the Company. This would occur if unsatisfactory radiation or salinity levels were found in the clay lining of the pond.

RECOMMENDATION 8

The Company should disposed of material from the evaporation pond in accordance with relevant codes of practice applying at the time of decommissioning.

As a result of concerns about bird life using the evaporation pond the Company has proposed taking reasonable measures to restrict their usage of the pond area.

5.4 EMPLOYEE HEALTH AND PUBLIC HEALTH

The Company has made a commitment to ensure that the design of the project is in accordance with the latest radiation protection and chemical handling standards.

Plant design and transport of radioactive materials would need to be part of a full radiological programme for the plant. These will need to be examined and approved by the State prior to commencement of construction to ensure that the best practicable technology is used.

RECOMMENDATION 9

The Company should provide the State, for its approval, with details of plant design and radioactive material transport prior to commencement of construction.

The Company has stated that any movement of thorium residue by rail would be to the satisfaction of Westrail.

The Company has proposed a comprehensive radiation monitoring programme around the plant, evaporation pond, thorium residue disposal area and surrounding areas. Monitoring bores are proposed for the evaporation pond and thorium disposal area.

If radionuclides in excess of those predicted are found, the Company has commited itself to remedial work. The details of the radiation and chemical monitoring programme and assessment of results should be to the satisfaction of the State. This review should involve an assessment of any changes necessary to maintain acceptable radiation or chemical levels.

Large volumes of chemicals would be transported and it is considered that safe transport should be used to minimise the risk of accidents.

5.5 REPORTING

In order that there be a coordinated review of the progress of the project, it is considered that brief annual and comprehensive triennial reports should be prepared for consideration by the State. The annual reports should summarise the environmental management activity over the previous year and plans for the coming year, identifying any issues of note. The triennial reports should detail the results of environmental management of the previous three years and discuss plans for the next triennium. Because of the public interest shown in this project, the triennial reports should be public documents.

RECOMMENDATION 10

The Company should prepare brief annual reports and comprehensive triennial reports on environmental management for consideration by the State. The triennial reports should be public documents.

In addition to this reporting it would be desirable for the various studies concerning the evaporation pond and residue disposal area to be presented as a coherent report for consideration by the State.

RECOMMENDATION 11

The Company should compile the results of the evaporation pond and residue disposal studies as a coherent report for State consideration prior to construction.

6. CONCLUSION AND RECOMMENDATIONS

The major environmental issues of the proposed rare earth processing plant at Narngulu include consideration of thorium residue disposal, evaporation pond management and radiation and chemicals safety. The good groundwater quality and difficulty in modelling groundwater movement at Eneabba and generally poor groundwater at Narngulu were major factors determining the outcome of this environmental impact assessment.

As there is some uncertainty as to the final ownership of any monazite processing plant in Western Australia, the Authority stresses that its conclusions and recommendations should apply, no matter what the ownership might be. The Authority has assumed that commitments already given will remain valid.

It is concluded that the project would be environmentally acceptable and construction could commence prior to finalising residue disposal and evaporation pond details if the Company

abides by its environmental management commitments as described in the ERMP/draft EIS and Supplement, and if the following recommendations are followed:

1. The Company should develop the detailed design of a waste management system for the processing plant, including liquid, solid and gaseous wastes, in accordance with the Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive ores and its Guidelines.

2. The State should establish a specialist committee to review the design of a waste management system for the processing plant and to assess the environmental effects of the development of the project and the results of monitoring programmes.

3. The Environmental Protection Authority believe that thorium residue disposal at Eneabba would not be environmentally acceptable and recommends that it not be approved at that location.

4. The Company should investigate the suitability of sites in the vicinity of the Narngulu industrial area for thorium residue disposal.

5. The State's investigation for a Government radioactive waste disposal site should not be constrained to the Narngulu site but be guided by the criteria of the Specialist Group Report. Consideration could be given to siting within an economic distance of the Narngulu site.

6. The Company should include a study of the mobility of uranium and its decay products in its thorium residue, study programme.

7. The Company's proposed evaporation pond should incorporate refinements, as indicated by the results of the proposed studies.

8. The Company should dispose of material from the evaporation pond in accordance with relevant codes of practice applying at the time of decommissioning.

9. The Company should provide the State, for its approval, with details of plant design and radioactive material transport prior to commencement of construction.

10. The Company should prepare brief annual reports and comprehensive triennial reports on environmental management for consideration by the State. The triennial reports should be public documents.

11. The Company should compile the results of the evaporation pond and residue disposal studies as a coherent report for State consideration prior to construction.

APPENDIX 1

ALLIED ENEABBA - DISPOSAL OF THORIUM RICH WASTE FROM PROPOSED MONAZITE TREATMENT PLANT

SPECIALIST GROUP REPORT TO THE ENVIRONMENTAL PROTECTION AUTHORITY

Department of Conservation and Environment
Perth, Western Australia

Environmental Note 174
July 1985

ALLIED ENEABBA - DISPOSAL OF THORIUM RICH WASTE FROM PROPOSED MONAZITE TREATMENT PLANT

A Specialist group comprising Mr. R. Fry, Supervising Scientist for the Alligators Rivers Region, Dr. B. Hartley, Senior Physicist, Radiation Health Branch of the W.A. Health Department and Mr. P. Mulvey, Geochemical Consultant, Golder Associates, was set up to investigate the proposed disposal of thorium rich waste to be generated by the processing of monazite by Allied Eneabba at a plant to be constructed at Narngulu close to Geraldton.

This group discussed the thorium waste disposal with the Company and their consultants Kinhill Stearns and with Government department officers, Harry Ventris from the Water Authority and Tony Allen from Geological Surveys. The group (with the exception of Mr. Fry) visited the site of the proposed plant at Narngulu and the site of the proposed disposal at Eneabba. The group also visited two locations previously designated as possible remote disposal sites (East of Pindar and South of Mullewa).

This report addresses the areas designated in the brief from the E.P.A., which was to provide a report covering the following topics:-

1.1 Principles for management of the thorium residue.

1.2 The acceptability of the proposed thorium residue disposal method at Eneabba.

1.3 Consider what permanent disposal option is available if the proposed method is unacceptable. The Company has described a range of options as part of its ERMP/draft EIS.

1.4 The acceptability of temporary storage while a permanent option is being defined if the proposed method is unacceptable.

1.5 The philosophy of considering long term thorium residue placement as either disposal, storage or a combination of the two.

This report should be read in conjunction with the Company's ERMP, particularly in regard to the suitability of the disposal method at Eneabba.

Localities discussed in this report can be found in Fig.1.

Principles for the Management of Thorium Residue

Disposal of radioactive waste can be achieved by one of two methods, either by dispersal into the environment at concentrations which do not give rise to unacceptable radiation exposures, or by isolation and containment. Depending on the type and longevity of the containment some type of surveillance and maintenance of the disposal facility may be necessary. The method of disposal will depend on the nature of the waste in terms of its total activity and its radiotoxicity. The disposal method may also be influenced by other contaminants in the waste.

We find that either of the above methods would be applicable to the thorium waste generated by the treatment of monazite. Due to factors discussed by the company in the ERMP the only practical operational method of disposal is by isolation and burial at a suitable location and in a manner designed to minimise environmental impact (due largely to seepage of radionuclides out of the repository), by the use of best practicable technology as defined in the Code of Practice on the Management of Radioactive Waste from the Mining or Milling of Radioactive Ores (1982).

The thorium residue will ultimately reach the sea and it might be considered attractive to dispose of the waste by dispersal in the sea. This option is ruled out by the policy of the Australian Government which opposes the sea dumping of radioactive materials.

Dispersal of the material at the mine site with the mine tailings, whilst an attractive alternative, was ruled out because of perceived operational difficulties which could result in non uniform dilution of the waste and possible areas on the surface where radiation dose rates were unacceptable.

It is concluded that the waste generated in the treatment of monazite can be safely disposed by shallow land burial in the zone above the water table at a location and with a facility designed for that purpose. A stabilized cover of a few metres thickness of clay, sand and soil as proposed by the company should be adequate for such disposal.

The disposal site will require some continuing surveillance and control of future land use. The responsibility for surveillance and control of use will finally devolve to government. It is important therefore that the ownership of land finally be returned to the government and that the disposal be secure enough so that monitoring requirements and ongoing care are minimised.

Acceptability of the Disposal Method at Eneabba

We find that the suitability of the proposed disposal method at Eneabba has not yet been adequately demonstrated by the company in regard to radionuclide release to ground water. The site geology at Eneabba is not ideal for the disposal of radioactive waste as the sedimentary deposition has resulted in non-continuous bedding which is not well suited for the containment of the waste. It is considered possible that by investigation of Eneabba, disposal sites could be found which have better characteristics than those which were seen during our inspection. At this time no such sites have been identified though a single bore log suggests their presence. The company has in addition suggested some engineering controls and structures to enhance the suitability of the site and such engineering together with site selection may make the disposal method suitable.

To adequately demonstrate the suitability of an Eneabba site the company would need to investigate the geology of the area so that the behaviour of the waste in relation to the environment can be more adequately modelled. It is also necessary to investigate the quality of the local shallow ground water and the rate of leakage of the shallow aquifers.

The chemical and physical characteristics of the natural clays in the area need to be investigated to determine their ability to retard the dispersal of the radionuclides or other potentially hazardous material in the waste. This would include the clays in situ below a disposal site and in addition any clays introduced to enhance containment characteristics of the site or to act as an infiltration barrier.

It is recommended that the company investigate the relative merits of having one or a few disposal sites at Eneabba rather than some 20 as proposed in the ERMP.

It is recommended that the company investigate different engineering methods of disposal of the waste such as sub-saturated deposition so as to reduce the hydrostatic pressure above the waste during the disposal operation and subsequent burial with tailings so as to minimise the potential for undesirable seepage.

Furthermore the operation should be conducted so as to ensure that infiltration barriers maintain their integrity particularly since site investigation indicate a potential for cracking of the slimes as they dehydrate.

Coprecipitation of radium with barium sulphate necessitates, in the long term, that the disposal methods be designed both physically and chemically to inhibit the development of a reducing environment. As the local ground water appears to be reducing, care should be exercised in its use for the disposal method adopted.

It is recommended that the company investigates methods of treating the waste so as to enhance its self-cementing properties so that it will be geochemically durable and that the leaching of hazardous materials from the waste will be minimised.

To establish the suitability or otherwise of the proposed disposal option, it is recommended that the company model more accurately the leaching of radionuclides from the waste taking into account site specific geology and the chemical and physical characteristics of materials in the seepage pathway and of the waste itself. This modelling should comprise measurements and calculation which would quantify the probable leaching of all radiologically significant radionuclides (especially ^{232}Th), from the waste and comparison of the levels calculated with current standards.

To establish the method of waste treatment and disposal both chemical and physical engineering details need to be considered. We recommend that the company seek professional advice which will establish the method which will be required to yield a satisfactory engineering and environmental result.

It is concluded that the details of the site characteristics are insufficient to recommend that the proposal for disposal at Eneabba as stated in the ERMP be approved for the disposal of the thorium rich residues until further investigations are done to either identify a site with suitable characteristics or to establish other disposal method or methods to compensate for poor site characteristics.

Availability of alternative permanent disposal sites

It is highly likely that a permanent disposal site suitable for the waste can be found which is not too far from the treatment plant to be uneconomic. This may be within the Eneabba mine leases but could be another site closer to or at the Narngulu treatment plant.

Considering only the thorium residue waste disposal, there would appear to be no need to withold approval for the commencement of construction of the plant. It should be possible for a disposal site to be identified and the necessary investigations done within the two year period planned for the construction of the processing plant.

We recommend that the company seriously consider permanent disposal of the waste at Narngulu where reconnaissance of the site indicates geological features superior to those at Eneabba for the entrainment of the waste.

If the government or the company are opposed to the use of the Narngulu site for waste disposal it is recommended that a suitable alternative site be sought. It is likely that a geologically suitable disposal site could be found sufficiently close to make its use economically feasible.

One option for the disposal of the thorium waste proposed and not considered further by the company was disposal in a government controlled repository. Such a repository does not at present exist but could represent an attractive disposal method. At present State Governments are being asked to investigate the potential of areas for the safe disposal of radioactive wastes. These investigations are not likely to proceed to a stage where a facility would be available by the time of the commencement of this project but if early decisions were made by government to proceed in such a direction, a facility could be operating during its lifetime. The company would be able to dispose of the thorium waste at its approved site until the government operated facility was available.

Notwithstanding that a government site may operate in the future, any disposal of the thorium waste should be viewed as permanent and removal of the waste once in place for transfer to a government facility should not be contemplated.

Acceptability of Temporary Storage

We believe that the investigation required to prove the suitability of a site would not be so difficult or long as to make temporary storage necessary awaiting the establishment of a permanent disposal method. Such storage could increase radiological hazard to the workers and to the general public.

Philosophy of Storage and Disposal

Irretrievable disposal of the waste could be the most desirable option. Such disposal can only be achieved by widespread dispersal at sea or on land. These options are ruled out by operational difficulties or international agreements or government policy.

Burial at shallow depth cannot be viewed as irretrievable disposal. It would always be possible for the waste to be recovered whether the disposal was over a number of different cells as proposed in the ERMP or within one or a few disposal sites. The occasion may arise when the thorium or some other component of the waste becomes a valuable material and may be recovered.

As the thorium in the residue has a very long lifetime (in excess of many millions of years) the waste will eventually be released to the environment and dispersed. The release of the waste will result in elevated radiation levels within the immediate area but this will not be outside the normal fluctuations of radiation levels which result from natural accumulations of radioactive minerals in ore bodies. In the very long term erosion and exposure of the waste might be expected to occur, although an increasing depth of cover could occur in certain deposition areas. The consequences of exposure of the waste could not be considered dangerous and the integrity of the disposal facility could readily be restored by reburying the waste.

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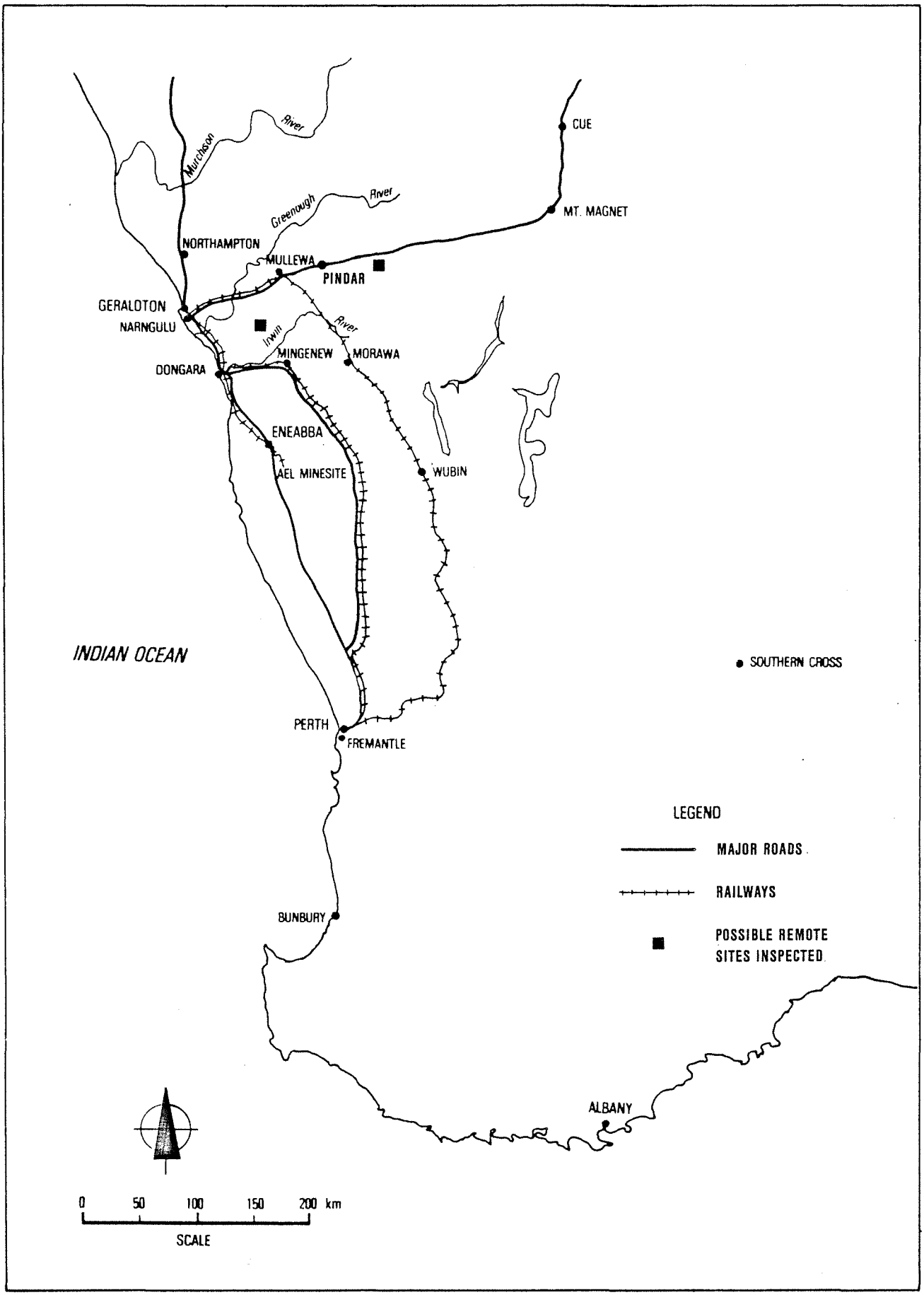

Figure 1. Locality Plan