Millennium

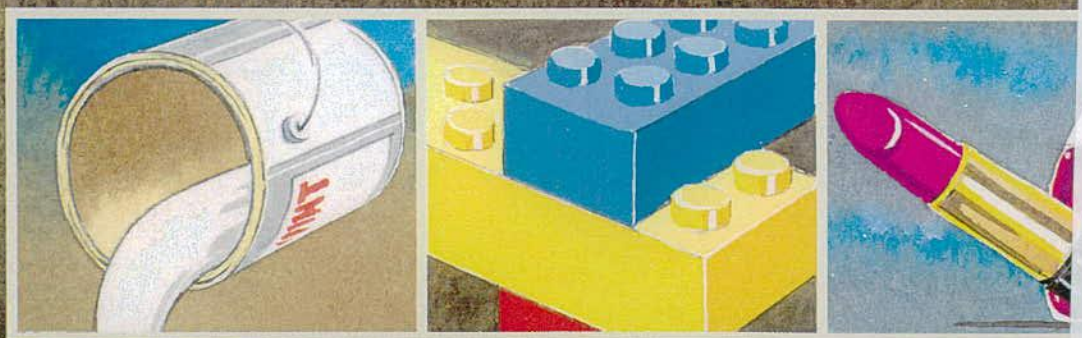
Inorganic Chemicals

EXPANSION OF KEMERTON PIGMENT PLANT

CONSULTATIVE ENVIRONMENTAL REVIEW

SUMMARY

TITANIUM DIOXIDE - WE'VE GOT YOU COVERED



Responsible Care

Quality Endorsed Company ISO 9002 / AS/NZS 9002 Standards Australia

KINHILL

HOW TO MAKE PUBLIC SUBMISSIONS

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

SCM Chemicals Ltd (now known as Millennium Inorganic Chemicals) is proposing to expand its existing chloride process titanium dioxide plant at Kemerton to permit an increase in production to 195,000 tonnes per annum, and to establish a new finishing plant at Kemerton with a capacity to process up to 116,000 tonnes per annum of pigment. This Consultative Environmental Review (CER) has been prepared by SCM Chemicals to meet the requirements of the Western Australian Government. This CER describes the proposal, examines the key environmental factors and discusses the proposed environmental management procedures. The CER will be available for comment for 4 weeks commencing Monday 3 November 1997.

Comments from Government agencies and the public will assist the EPA to prepare an assessment report in which it will make recommendations to the Minister for the Environment.

Copies of the CER may be obtained from:

Millennium Inorganic Chemicals Ltd
PO Box 245
BUNBURY WA 6231
(08) 9780 8333

WHY WRITE A SUBMISSION

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act*, and may be quoted in full or part in each report.

WHY NOT JOIN A GROUP?

If you prefer not to write your own comments, it may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submission may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group in larger, please indicate how many people your submission represents.

DEVELOPING A SUBMISSION

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

WHEN MAKING COMMENTS ON SPECIFIC PROPOSALS IN THE CER

- clearly state your point of view:
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind, you will make it easier for your submission to be analysed.

- Attempt to list points so that the issues raised are clear. A summary of your submission is helpful.
- Refer each point to the appropriate section, chapter or recommendation in the CER.
- If you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering.
- Attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

REMEMBER TO INCLUDE:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

More information on how to make a submission can be obtained from the free pamphlet *Environmental Impact Assessment - How to Make a Submission* available from the Library of the Department of Environmental Protection. Telephone (08) 9222 7127.

The closing date for submission is Monday 1 December 1997.

SUBMISSIONS SHOULD BE ADDRESSED TO

Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000

Attn: Xuan Nguyen

MILLENNIUM INORGANIC CHEMICALS LTD

EXPANSION OF KEMERTON PIGMENT PLANT

CONSULTATIVE ENVIRONMENTAL REVIEW

SUMMARY

Prepared for:

Millenium Inorganic Chemicals Ltd
PO Box 245
Bunbury, WA 6231
Telephone (08) 9780 8333; Facsimile (08) 9780 8555

Prepared by:

Kinhill Pty Ltd
ACN 007 660 317
47 Burswood Road, Victoria Park, WA 6100
Telephone (09) 362 5900; Facsimile (09) 362 5627

October 1997

SUMMARY

SCM Chemicals Ltd—Asia/Pacific (SCM) (now known as Millennium Inorganic Chemicals Ltd) wishes to obtain environmental approval to expand its existing chloride process titanium dioxide plant at Kemerton, near Bunbury. SCM is seeking to increase the production capacity of the Kemerton plant from its current level of 79,000 t/a of titanium dioxide to 195,000 t/a, and to establish a new finishing plant at Kemerton with a capacity to process up to 116,000 t/a of pigment (see Table S1). The existing Australind finishing and packaging plant, and all support facilities for SCM's operations in the Bunbury region at the Australind site, would remain. The Kemerton and Australind plants combined would then have the capacity to produce a total of 195,000 t/a of finished pigment.

The original application for expansion of the pigment plant was for a total production capacity of 190,000 t/a. However, during the design stages, investigation showed that the plant output could reach 195,000 t/a. All the discussion in this document is based on the higher figure for the expected total output, i.e. on 195,000 t/a. While this figure is marginally higher (by 5,000 t/a) than that quoted in the Guidelines for the preparation of this document, it is not anticipated that this will have any impact on the issues to be addressed by the proponent.

It is proposed to commence construction to upgrade the titanium dioxide processing facilities in mid-2000, to enable production to start by early 2002.

The purpose of this document is to describe the proposal, to review the environmental impacts of the current operation at Kemerton, and to identify the environmental implications associated with the construction and operation of the facilities required to provide an additional 116,000 t/a of finished titanium dioxide pigment.

PROPOSAL

Titanium dioxide is a non-toxic, white pigment used in the manufacture of a wide range of products—including, paint, paper, plastics and rubber—to make them opaque. Titanium dioxide pigment is produced from synthetic rutile, which is produced from mineral sands by a variety of suppliers in western australia.

The chloride process for the preparation of titanium dioxide from synthetic rutile is based on the production of titanium tetrachloride by chlorination of the ore. The purified titanium tetrachloride is subsequently oxidised, yielding titanium dioxide and

allowing recovery of chlorine. The raw titanium dioxide pigment is then treated with chemicals and dried to form various grades of finished pigment.

It is proposed to increase pigment production by installing two new chlorinators and associated collection systems with larger capacities than those presently used. As part of the expansion, it is also planned to duplicate the titanium tetrachloride purification equipment. It is proposed to duplicate most of the items of equipment in the titanium tetrachloride oxidation system with units of increased capacity. Some of the items of the expanded chloride process plant can be accommodated alongside the existing units. However, the new chlorination and oxidation stream and plant support facilities would be sited south of the existing chlorinator section.

The finishing plant would be a completely new facility. This would include pigment treatment and vacuum filters, driers, pigment mills and packaging equipment. The finishing plant would be sited to the west of the existing plant.

Extra chlorine, compressed nitrogen and compressed oxygen would be required to serve the proposed expansion. It is proposed to obtain these from external suppliers.

ENVIRONMENTAL AND SOCIAL ISSUES

General

SCM has an exemplary environmental record attained through conscientious and consistent management of its existing operations. SCM has implemented environmental management programmes in accordance with its quality control system and environmental policy. Integrated environmental management systems have been developed for all phases and facets of SCM's Western Australian operations. SCM has a firm corporate commitment to responsible environmental management, striving to achieve full compliance with regulatory requirements and minimise impacts on the surrounding environment. SCM has initiated a programme of continuous improvement and accountability for the entire life cycle of all its sites.

Regular internal audits are undertaken to ensure adherence to the environmental management plan and systems. SCM reports regularly to, and is also audited by, Government authorities and its parent company. Monitoring results demonstrate excellent compliance with regulatory limits and conditions. An environmental performance index, developed by SCM, shows a significant improvement since the plant was commissioned, reflecting a reduction in solid residue generated and an improvement in control of gaseous emissions. No adverse long-term environmental impact has resulted from SCM's operations at Kemerton.

The major potential environmental and social issues arising from the proposed development relate to gaseous emissions, dust, saline water disposal, solid residue disposal, radiation, noise, and risks and hazards. These issues are discussed in more detail in the following sections.

Gaseous emissions

Apart from boilers, heaters and driers, which would emit carbon dioxide, nitrogen oxides and water vapour as a result of the combustion of natural gas, the only gaseous emissions from the chloride process would be produced at the exit of the titanium tetrachloride purification section. The exit gases would be scrubbed with water to remove residual titanium tetrachloride, metal chlorides, and hydrogen chloride. An additional scrubbing train, consisting of a spray tower, a venturi scrubber and a packed tower, would be installed to cater for the expanded plant.

With the expansion of the plant, it is proposed to expand the current suction vent system to collect potential fugitive emissions which would be scrubbed and released to the atmosphere via the existing process stack. It is also planned to direct all scrubbed process emissions to a thermal converter where they would be burnt and to direct all the hot exhaust gases from the thermal converter to a waste heat boiler to generate steam. The steam generated in the waste heat boiler would be used to supplement boiler steam.

The installation of a thermal converter prior to the new main process stack would result in reduced emissions from the entire plant, particularly of carbon monoxide, carbonyl sulphide and hydrogen sulphide. The combustion gases would be scrubbed in a caustic scrubber before they are discharged to the atmosphere through the main process stack in order to remove 95% of the sulphur dioxide produced by the oxidation of the sulphur gases. The resulting solution would be oxidised in a process developed by SCM, to produce a sulphate solution that would be injected into the saline water for disposal. The atmospheric emissions would then consist mainly of carbon dioxide and nitrogen with minor proportions of nitrogen oxides and sulphur dioxide (the 5% that is not removed by the scrubber).

Increased efficiency in the process would reduce the emission of sulphur oxides per unit of finished pigment. Reuse of heat in the process through the thermal converter would reduce the plant's requirement for natural gas and reduce the associated production of carbon dioxide, a greenhouse gas. The specification of efficient, low nitrogen oxide-generating gas burners would also reduce greenhouse gas emissions.

The expected result would be a significant overall reduction in the total atmospheric emissions from the plant per tonne of pigment produced, compared to the total emissions of the present operations at Kemerton. Since all emissions from the current plant have been considerably below licence conditions, where they have been set, as well as SCM's internally imposed goals, it is anticipated that gaseous emissions would have negligible impact on the environment.

Dust emissions

The main potential source of dust from the proposed expanded plant is from the finishing section.

Measures to control dust would include the use of dust extraction systems with bag filters on the product pneumatic conveying system, on the driers, on the bagging

machines and on all conveying transfer points. The design emission from the bag filters would be 100 mg/m^3, which is 40% of national guidelines for control of emission of particulate air pollutants from new stationary sources of 250 mg/m^3. Actual dust emissions are likely to be much lower.

As a consequence of these measures, dust generated from the site during operation is not expected to increase ambient levels of suspended particulates in areas outside the boundaries of the plant.

Saline water disposal

The plant would generate wastewater from a number of sources including process water treatment, scrubbing of waste gases and pigment washing. In addition, the plant would accept wastewater from the external suppliers of chlorine, compressed nitrogen and oxygen, and lime.

The chloride process plant at Kemerton currently incorporates extensive internal water recycling. This recycling results in 60% of all water used being recycled within the current plant. The recycling means the current plant uses only 40% as much water per tonne of pigment produced as other plants using the chloride process. A similar water recycling and reuse system would be incorporated into the proposed expansion.

Water treatment plant wastes, which includes filter backwash water and ion exchange regeneration water, would be used to sluice solid residue or prepare lime slurry. In addition, some water generated by the proposed finishing plant would be recirculated or reused.

Reuse of the water increases its salinity. SCM would continue to explore opportunities to recycle and reuse process water within the expanded Kemerton plant, but reuse of all the water produced would not be economic as the water would become too saline for further use. Following reuse of water in as many applications as possible, the saline water that could not be reused would be treated. It is proposed to upgrade the current wastewater treatment section associated with the production of titanium dioxide to cater for the expanded production and to construct a wastewater treatment plant to handle liquid wastes arising from the finishing plant

The treated saline water would be collected in a holding pond and pumped approximately 9 km to an existing ocean outfall located west of the northern extremity of the Leschenault Peninsula. To cater for the increased amount of saline water to be pumped to the ocean from the plant expansion, the pipeline and the ocean outfall would be upgraded. The saline water would be discharged to the ocean via a 'multi-port tee' diffuser. The diffuser has been designed to ensure mixing with sea water occurs within 20 m of the discharge points.

Following mixing of the saline water with seawater, the water quality near the outfall would fall within the limits specified by the EPA for the protection of aquatic ecosystems and human consumers of fish and other aquatic organisms.

SCM is currently licensed to discharge saline water into the ocean off the Leschenault Peninsula. Measurement of the quantity and quality of the discharge, and a monitoring programme within the receiving environment of the outfall, have been undertaken in accordance with these licence conditions. The data from the monitoring programme show that the concentration of all chemical parameters in the saline water have been considerably below the licence conditions. Sampling of the ocean near the marine outfall indicates that outside the mixing zone (a radius of 20 m), there are no significant adverse effects of the discharge on water quality, sediment quality or marine life.

Solid residue disposal

As a result of treating the process water streams from the plant, approximately 340,000 t/a of washed solid residue slurry containing 11–15% solids would be produced. This slurry would be transported by tanker to an existing solid residue storage area at Dalyellup, south of Bunbury. At Dalyellup, the slurry would be discharged into a pond to allow the solids to separate from the supernatant water. Progressive dewatering of the solids would occur through evaporation and seepage.

The solid waste would consist mainly of unreacted ore and coke, and metal hydroxides from the raw pigment process. The potential impacts of the disposal of solid residue include incompatibility with neighbouring land uses, erosion and dust generation, groundwater contamination from the slightly brackish slurry water and increased background radiation levels.

Monitoring data shows that impacts of the existing disposal practice on groundwater are minimal, and no adverse impacts have been observed from the slightly radioactive nature of the solid residue. The rate of deposition of the residue slurry would increase with the increased production rate, but the quality of slurry water would be similar. Consequently, it is anticipated that there would be no adverse environmental impacts from the continuing disposal of solid residue at the Dalyellup site.

SCM has approval to use the site for the 'life of the site'. The increased solid residue production rates associated with the expanded pigment plant would reduce the life of the Dalyellup disposal site. Under current production rates, the existing areas would be full within ten years. The company has in place approvals for the 'life of the site' and the actual time when the site would be fully utilised would be dependent on the expansion commissioning time frame. However, the proposal for expansion of the plant does not involve construction of any more storage areas at this time.

SCM and relevant Government authorities are actively investigating alternatives for the long-term management of the solid residue produced by the plant. This includes investigations into residue minimisation, recycling, alternative uses, alternative residue disposal methods and alternative sites.

SCM has already achieved a 40% reduction in the quantity of solid residue produced since 1988, primarily through recovery of unreacted ore and coke in the residue.

Alternative uses currently under investigation include the potential for use of the residue in brick manufacture, as a pavement base course for roads, and for soil conditioning and nutrient retention, particularly phosphorus.

Trials conducted to date indicate the solid residue performs favourably in all these applications, with little risk of dust, solute leaching or radiation exposure, and SCM has received provisional approval to use the solid residue in bricks and for road base course. However, the cost of transporting the material to Perth could limit its use to the local region, which is probably not a large enough market to use all the residue generated. In addition, the low radiation levels in the material may make it difficult to obtain permission for the use of the solid residue for some of these purposes.

In addition to research into possible uses for the solid residue, SCM is committed to continuing its research into residue minimisation, recycling and alternative methods of disposal.

Radiation

Synthetic rutile, the feedstock for the process plant, contains low levels of thorium and uranium impurities from the original mineral sands. The majority of the radiation associated with these contaminants ends up in the solid residue. However, during processing into raw pigment, the potential exists for these contaminants to become concentrated in certain areas of the plant.

SCM's policy is to ensure that all exposures to radiation are kept 'As Low As Reasonably Achievable'. This includes a decision to adopt the limits of exposure for members of the public for its own personnel, rather than industrial or mining industry exposure limits which are substantially higher. Radiation management procedures have been developed to ensure compliance with appropriate regulations, and to minimise radiation doses to personnel.

As part of the Radiation Management Plan developed by SCM, radiation levels are measured in the plant, in the waste water, in marine sediments and at the Dalyellup solid residue disposal site. Monitoring results indicate that there are no concerns for occupational or environmental radiation exposure from any of SCM's activities, and this is not expected to change as a result of the proposed expansion.

Noise

In designing the new plant, particular attention would be paid to the major noise contributing items to ensure the plant is as quiet as can be reasonably achieved by incorporating Best Practice design features into the new plant. With these measures, it is anticipated that noise levels close to SCM's plant and at the boundary of the Kemerton Industrial Park may increase as a consequence of the plant's expansion. However, on most occasions, the large buffer zone that surrounds the Kemerton Industrial Park, and the location of the plant within SCM's site, would ensure any noise generated meets current and proposed regulations and does not cause disturbance to residences outside the Kemerton Industrial Park.

Risks and hazards

Risks and hazards at the Kemerton plant are controlled in accordance with a comprehensive Total Hazard Control Plan, developed to the requirements of the Department of Minerals and Energy. The Total Hazard Control Plan and safety programmes are regularly audited, internally and externally, to ensure compliance to, and adequacy of, both these systems.

The Kemerton plant's safety record is very good. It is highly rated under the International Safety Rating System. The effectiveness of the Total Hazard Control Plan and SCM's safety system is reflected in the fact that there have been only two 'lost time' accidents since the plant was commissioned in 1989, none of which were related to process-type events.

A Preliminary Risk Assessment (PRA) of the proposed expanded plant has been carried out. This assessment showed that the one-in-a-million risk contour for the proposed SCM plant and the neighbouring Nufarm chlor-alkali plant combined falls almost entirely within the SCM property boundary, thereby easily meeting EPA risk criteria.

MONITORING

SCM currently undertakes regular monitoring of all facets of its operation at Kemerton. This includes stack monitoring for a variety of gaseous emissions, monitoring of production bores and groundwater around its plant site at Kemerton and around the solid residue disposal site at Dalyellup, emission and ambient noise monitoring, monitoring of the quantity and quality of the treated saline water discharged to the ocean, and monitoring of the seawater and sediments surrounding the ocean outfall. Personnel radiation exposure monitoring and radiation surveys at the plant and the solid residue disposal area at Dalyellup are also undertaken regularly.

This programme would continue following the expansion of the plant and would be expanded to include dust emission monitoring from the finishing plant stacks.

Table S1 **Inputs and outputs from current and proposed titanium dioxide plant***

Material	Unit	Current	Proposed expansion		
			Proposed	Absolute Variance	% Variance
Production	tpa	79,000	195,000	111,000	147
Inputs					
Synthetic Rutile	tpa	84,000	206,000	122,000	145
Petroleum Coke	tpa	18,000	42,000	24,000	133
Chlorine	tpa	16,000	35,000	19,000	119
Oxygen	tpa	39,000	96,000	57,000	146
Nitrogen	tpa	59,000	145,000	86,000	146
Water	tpa	1,500,000	5,000,000	3,500,000	233
Natural Gas	Gjpa	370,000	980,000	610,000	165
Electricity	Mwh	29,000	97,000	68,000	234
Outputs					
Wastewater	m^3	950,000	3,000,000	2,050,000	216
Residue Slurry	tpa	141,000	397,000	256,000	182
CO	tpa	6,700	3,600	(3,100)	(46)
CO_2	tpa	70,000	194,000	124,000	177
$TiCl_4$	tpa	<0.5	<0.5	nil	nil
Cl_2	tpa	<0.5	<0.5	nil	nil
HCl	tpa	<0.5	<0.5	nil	nil
COS	tpa	540	540	nil	nil
SO_2	tpa	200	240	40	20
H_2S	tpa	<0.5	<0.5	nil	nil
NO_X	tpa	25	60	35	140
N_2	tpa	59,000	145,000	86,000	146

* *Assumes thermal converter on-line 75% of the time*

Table S2 **Summary of key environmental factors, environmental management objectives, management actions and monitoring, and predicted outcomes**

Key Environmental Factor	Environmental Management Objective	Environmental Management Actions and Monitoring	Predicted outcome
Atmospheric emissions	SCM's management objective is to: • ensure that atmospheric emissions comply with current standards and do not adversely affect the environment, or the health, welfare or amenity of nearby land users; • maintain or reduce stack emissions and ground level concentrations of licensed gases; • reduce fugitive emissions within the plant; • ensure there is no unacceptable odour impact outside the boundary of the Kemerton Industrial Park; • minimise emissions of greenhouse gases; • minimise dust emissions during operation; • minimise dust during construction.	Install a thermal converter to oxidise carbon monoxide, carbonyl sulphide and hydrogen sulphide to carbon dioxide and sulphur dioxide. Install a scrubber to remove 95% of the resultant sulphur dioxide. Scrub the exit gases to remove hydrochloric acid. Utilise hot waste gases from the thermal converter to produce steam. Optimise process and thermal converter efficiency to reduce emissions. Install low NOx emitting burners to gas fired systems. Install chlorine detectors in main process stack. Install a suction vent system to remove fugitive emissions and direct them to the current 66 m stack and associated scrubbing system. Install bag filters on finishing plant stack. Regularly monitor bag filter integrity. Undertake stack and ambient air quality monitoring in accordance with any license conditions. Use water sprays and minimise surface area exposed to control dust during construction.	Reduced emissions of carbonyl sulfide, carbon monoxide and hydrogen sulphide. Ground level concentrations of licensed emissions would not exceed current levels. Recover hydrochloric acid for commercial use. Reduced use of natural gas per unit product. Reduced output of greenhouse gases per unit product. Automatic shutdown of plant and no chlorine releases. Reduced incidence of fugitive emissions. No increase in ambient dust concentrations during normal operation. Compliance with license conditions Minimal increase in ambient dust concentrations.

Table S2 **Summary of key environmental factors, environmental management objectives, management actions and monitoring, and predicted outcomes**

Key Environmental Factor	Environmental Management Objective	Environmental Management Actions and Monitoring	Predicted outcome
Saline water	SCM's management objective is to: • reduce overall water usage and saline water production; • maintain ocean water quality within the levels specified in the draft Western Australian Water Quality Guidelines for Fresh and Marine Waters (EPA Bulletin 711) • minimise impact of saline water disposal on the terrestrial environment.	Continue recycling of process water and seek further opportunities to reduce water usage. Maintain saline water quality to a standard consistent with current DEP licence. Develop a new outfall diffusion system to maintain or improve dispersion of the saline water into the marine environment. Monitor environmental impact by continuing the current water and sediment sampling programme. Construct expanded or duplicate pipeline in same alignment. Bury and mark pipe and rehabilitate any disturbed areas.	Through a continuous improvement programme, water usage has reduced by 32% since 1989. Further reductions in water usage per unit of production are expected. No significant change to ocean water quality outside 20 m mixing zone. No significant change to sediment quality. No significant impact on marine fauna. Minimal disturbance during construction. No change to existing land use or amenities along pipeline route after rehabilitation.
Solid residue	SCM's management objective is to: • dispose of solid residue by utilising methods that minimise environmental impact; • ensure the integrity of the disposal site by continuing the current monitoring and audit programme; • reduce the amount of solid residue produced per tonne of product;	Fully neutralise, treat and wash solid residue. Continue disposal at the Dalyellup site which has an expected life of 10 years at current rates. Use pond management techniques to minimise leaching. Undertake monitoring of groundwater in accordance with Environmental Management Plan and systems manual.	Insoluble metal oxides in the solid phase. Minimal leaching beneath ponds. Minimal impact since 1989. No adverse long term environmental impact to site or surrounding land uses.

Table S2 **Summary of key environmental factors, environmental management objectives, management actions and monitoring, and predicted outcomes**

Key Environmental Factor	Environmental Management Objective	Environmental Management Actions and Monitoring	Predicted outcome
Solid residue (continued)	• continue research into potential uses of the solid residue.	Undertake monitoring for radiation in accordance with Radiation Management Plan. Undertake annual audit at disposal site and associated processes. Report annually to DEP and RCWA. Continue to pursue residue minimisation programmes. Identify and pursue markets for proven potential uses of solid residue. Explore options, and seek approval from relevant authorities, for beneficial use of the solid residue. Locate and seek approval for alternative disposal sites in consultation with the Government task force. Continue research into suitable rehabilitation techniques for the Dalyellup site.	Significant usage of the solid residue in various applications. Completed site rehabilitated to meet the requirements of the EPA and Capel Shire Council.
Groundwater	SCM's management objective is to prevent groundwater contamination from process areas.	Seal and bund process area. Direct all process area drainage to wastewater treatment pond. Direct stormwater to infiltration ponds. Continue groundwater monitoring. near the process plant and the solid residue disposal area. Prepare and submit an annual report to the DEP and Water and Rivers Commission.	No significant adverse impact on groundwater quality beneath the process area.

Table S2 **Summary of key environmental factors, environmental management objectives, management actions and monitoring, and predicted outcomes**

Key Environmental Factor	Environmental Management Objective	Environmental Management Actions and Monitoring	Predicted outcome
Noise	SCM's management objective is to: • ensure that noise levels due to SCM's operations meet acceptable criteria at residential areas adjacent to the Kemerton Industrial Park; • minimise noise generation during construction.	Consider noise emission factors during design phase. Enclose noisy machinery, position equipment or fit suppression devices where required. Undertake regular ambient and source noise monitoring. Fit noise suppression devices to construction machinery.	There are no noise problems from the existing plant. Noise levels from the proposed plant will be low and will continue to meet statutory and licence conditions.
Off-site risks and hazards	SCM's management objective is to ensure off-site risk is as low as reasonably achievable and complies with EPA Bulletin 611 which establishes levels of individual and cumulative risk which is considered acceptable by the EPA.	Prepare and maintain Total Hazard Control Plan. Maintain high plant safety rating through plant design and maintenance planning. Undertake regular internal and external audits to ensure Total Hazard Control Plan remains effective. Undertake Quantitative Risk Analysis (QRA) to confirm the results of the Preliminary Risk Analysis to the satisfaction of the Department of Minerals and Energy and to meet EPA criteria.	Preliminary Risk Analysis has shown that plant will meet EPA's risk criteria. The one in a million risk contour falls within the property boundary.
Radiation	SCM's management objective is to ensure that all radiological impacts are in accordance with the ALARA (as low as reasonably achievable) principle and comply with currently accepted standards and Codes of Practice.	Maintain an up-to-date Radiation Management Plan and ensure personnel are aware of its content and responsibilities. Dispose of waste material in accordance with the Radiation Management Plan, Environmental Management Plan and Environmental Systems Manual.	No adverse impacts on employees or the general public. Compliance with statutory requirements

Table S2 **Summary of key environmental factors, environmental management objectives, management actions and monitoring, and predicted outcomes**

Key Environmental Factor	Environmental Management Objective	Environmental Management Actions and Monitoring	Predicted outcome
Radiation (continued)		Install warning signs and control employee exposure to the public limit. Measure radiation levels on all process vessels. Monitor radiation levels and personnel radiation exposure in accordance with the Radiation Management Plan. Implement decontamination procedures.	