RED OCTOBER GOLD PROJECT 80KM SOUTH OF LAVERTON

CONSULTATIVE ENVIRONMENTAL REVIEW

EPA ASSESSMENT NO. 1245

Sons of Gwalia Ltd

January 1999

Invitation to make a submission

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

Sons of Gwalia Ltd and Mt Burgess Mining Ltd, (the Proponents) propose to develop a gold mine on Lake Carey in the Shire of Laverton. In accordance with the Environmental Protection Act, a Consultative Environmental Review (CER) has been prepared which describes this proposal and its likely effects on the environment. The CER is available for a public review period of 4 weeks from 25th January 1999 closing on 22 February 1999.

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

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 in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions 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 is 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 elements of the CER:

- Clearly state your point of view;
- Indicate the source of your information or argument if this is applicable;
- 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 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.

The closing date for submissions is 22 February 1999.

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: Mr Mark Jefferies

Contents

1.0 SUMMARY

Sons of Gwalia Ltd with joint venture partner Mt. Burgess Mining Ltd (the Proponents) propose to develop the Red October gold mine approximately 80km south of Laverton. The mine will be situated on the bed of Lake Carey approximately 1km off shore and several hundred metres from an island known as Angelfish Island, situated in the lake.

The proponents propose to mine approximately 550,000t of gold ore plus associated waste rock material over a 2-year period commencing in mid-1999.

Ore will be transported to Sons of Gwalia's existing treatment plant at the Laverton mine 10km east of Laverton. No ore treatment will take place at Red October. Mine infrastructure will be constructed on Angelfish Island, adjacent to the proposed open pit.

A causeway will be constructed across the lake to enable ore to be hauled to the mill on roads along the eastern side of Lake Carey. The existing Bindah Road will be used and upgraded as necessary. In other locations private roads will be used and approximately 30km of haul road will be constructed.

Approximately 40ha of land will be disturbed on Angelfish Island for the construction of the mine operating infrastructure. Infrastructure at this location will include workshops, hardstand areas, fuel storage facilities, a site office, haul roads and borrow pits to obtain material for causeway construction.

The waste dump will be constructed on the lake floor and will be designed to be geomorphologically similar to natural islands and placed so as not to confine the main north/south drainage channel of the lake.

The project has been discussed with the Laverton Shire Council. Their original concerns related to the construction of haul roads have now been addressed and the Shire has agreed that we proceed with the project. Issues related to the project have also been discussed with the pastoralists on whose leases the mine infrastructure and haul roads will be constructed. A copy of the Consultative Environmental Review has been provided to the Laverton Shire Council, local pastoralists and local Aboriginal communities.

The following table summarises the key elements of the Red October project.

Key Characteristics Table

Element	Description
Life of project	2 years continuous operation (minimum)
Typical Mine Operation	7 days a week, 24 hours a day
Size of Ore Body	550,000 tonnes (minimum)
Depth of Mine Pit	Approximately 100m
Water table depth	At surface
Area of Disturbance Haul Roads & Causeway Open Pit Waste dumps Infrastructure & Borrow Pits TOTAL	 56ha 36ha 80ha 40ha 212ha
Mine Operation	Open Pit – truck and shovel operation
Mining rate	15.2mt of waste and 550,000t of ore over two years.
Mine Dewatering Discharge (to L. Carey)	Estimated 2,400 kL/day
Water supply	Dust suppression – saline mine dewatering water: approx. 800kL/day Potable – from nearby fresh water dam: approx. 2kL/day
Fuel storage capacity	Fuel storage - 180,000L

1.1 Summary of Key Environmental Issues

The key environmental impacts from this project are associated with the operation of the mine on and near the lake and the disposal of dewatering water onto the lake. These include:-

- the risk of flooding and changing surface flow within the subcatchment and the construction of mine infrastructure including the road and causeway;
- increased brine and salt crusting over the area covered by the discharge water;
- introduction of contaminants onto the lake bed from mining operations, waste rock and discharge water;
- aesthetic issues.

Several studies have been undertaken to obtain information on lake surface hydrological processes and the impacts of discharging saline dewatering water on the lake. These studies show that the mine exists within the Linden subcatchment of Lake Carey. This subcatchment generates approximately 3% of the total catchment runoff. This suggests that obstruction to surface flow between Angelfish and Treasure Islands resulting from construction of the mine is not significant.

Studies have shown that the significant flow in the lake is in a north to south direction and therefore all mine infrastructure has been located within the extremities of the islands so as not to impede major lake flow.

A study has also investigated the potential impacts from the discharge of mine dewatering water onto the lake. This study shows that the volumes to be discharged from the mine are insignificant compared to the runoff within the Linden subcatchment. The study also shows that the discharge water would not significantly effect the hydroperiod of the lake.

The chemistry of the discharge water is also similar to the chemistry of the lake surface and subsurface water.

While some of the impacts of the discharge are not fully understood, it is proposed to minimise potential risk by discharging into natural depressions in open areas of the lake. This strategy will protect near-shore vegetation and relatively-fresh water bodies from direct impacts of the saline water during low-rainfall periods, and dilution by normal runoff and lake throughflow (generally to the south) during higher rainfall events will restrict salinity impacts to the immediate area of discharge. The discharged water will first be passed through a settling pond to remove sediment and hydrocarbons.

Mining infrastructure areas on Angelfish Island will be contoured to enable the collection of runoff water into central sumps.

The waste rock dump will be constructed on the lake adjacent to the open pit and will extend to cover part of Croissant Island. Some of Croissant Island will be excavated to provide fill material for the construction of causeways to enable the dumping of waste rock.

The dump will be constructed in a form to match the profile of surrounding islands so as to maximise the potential of natural wind accretion and deposition processes. The waste rock material has been analysed and the results show that the material is not acid producing.

Application has been made to the Aboriginal Cultural Materials Committee to disturb two archaeological sites identified on Croissant Island. 19 other archaeological sites and two anthropological sites, located more to the east, will not be disturbed.

Two causeways will be constructed across the lake bed. The causeways will include culverts designed to maintain flow from north to the south and also to allow routine wind driven circulation to occur while maintaining equilibrium between both sides of the causeways.

1.2 Completion Criteria

The roads and causeways developed for the operation of the Red October mine will significantly upgrade access to this region and may be useful infrastructure post mining. Some consideration will therefore be given to whether they should remain after mining is completed. Mine infrastructure areas on Angelfish Island will be decommissioned, ripped and revegetated.

During mining the open pit will be enclosed on three sides by causeways and waste dumps. On the completion of mining a bund wall will be constructed to close off the pit, to provide a safety barrier and to prevent flooding of the pit void.

In the absence of topsoil material the waste dump will not be rehabilitated in the normal sense. The design of the dump will mimic the geomorphological shape of the surrounding islands and will be constructed so as to minimise erosion and to maximise the effects of depositional and accretionary processes.

1.3 Issues Identified by the EPA

In setting a Consultative Environmental Review (CER) as the level of assessment for this project, the EPA identified a number of environmental factors it sees as significant for management of the potential impacts of the project. These factors are identified in the EPA Guidelines for preparation of this CER, which are contained in Appendix 4 below. The following table summarises Sons of Gwalia's impact assessment of the environmental factors and objectives set by the EPA:

Environmental factors and management

Environmental factor	EPA Objective	Existing Environment	Potential Impact	Environmental management	Predicted outcome
BIOPHYSICAL					
Terrestrial flora	Maintain abundance, diversity and geographic distribution of vegetation communities	Vegetation is generally typical of the region. Communities C5 and C6 (Mattiske 1998) may be locally restricted, and contain two Priority species	Loss of generally-well-represented vegetation. Possible impacts on C5 and C6 communities on Angelfish Island.	Restrict clearing and disturbance to practicable minimum. Liaise with CALM on management of poorly-represented communities and Priority species. Undertake further survey work during Spring 1999 to determine the full extent of restricted communities and priority species. Conserve topsoil for post-decommissioning rehabilitation.	No significant loss of vegetation on a regional basis
Terrestrial fauna	Maintain abundance, diversity and geographic distribution of terrestrial fauna	Vegetation and fauna habitats of the Red October area shown to be similar to comparable ones in the area and region. Fauna surveys in those areas showed habitats to have no special regional significance, represented in reserves elsewhere, or present to varying degrees in surrounding pastoral land.	Localised loss of habitat, which would be replaced at least partly by rehabilitation after decommissioning. Survey in nearby area showed no vertebrates of special regional significance found – occur elsewhere in arid zone of WA.	No special programs considered to be required.	No significant impacts.
Salt lakes	Maintain the integrity, functions and environmental values of Lake Carey.	Lake Carey is a large salt lake on which ecological studies by several mining companies acting in concert have only recently commenced	Potential impact unknown, as little is know of the lake's ecology. Post-mining pit void will provide source of saline water, which could affect nearby, relatively fresh water ponds after moderate rainfall events	Continue with ecological studies on Lake Carey. Ensure that causeways do not prevent natural drainage of lake waters. Discharge mine water so that risks of impact on near-shore vegetation and relatively-fresh ponds are practicably minimised. Pit void will be surrounded by earth/rock bund which will prevent saline water from pit affecting small freshwater ponds resulting from moderate rainfall events; water level in pit will be several metres below top of surrounding bund.	To be assessed progressively as studies continue, but management plans are designed to reduce risks.

BIOPHYSICAL (cont'd)					
Land	Establish stable, sustainable landform consistent with surroundings. Ensure that, as far as practicable, the post-mining landform is stable and integrated into the surrounding environment.	Lake areas are relatively flat, with occasional inundation. Land areas are generally flat, with occasional gypsiferous dunes.	Erosion (water and wind), with associated silting of the lake.	Waste stockpiles will be low and shallow-sided, and sheeted with competent rock. Causeways will include culverts to allow normal lake water flow. Disturbed land areas will be landscaped and revegetated. Decommissioning plan will cover all project facilities.	Insignificant erosion; minor visual impact.

POLLUTION MANAGEMENT					
Air	(i) Ensure that dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of dust.	Air quality is generally of high quality in this remote location, although high levels of fugitive dust are a common occurrence during regular periods of high wind-speed, especially in summer.	Limited potential for environmental impact, but moderate potential for impacts on human health.	Haul-roads and other trafficked areas will be regularly sprayed with water to control fugitive dust emissions.	Inconsequential.
	(iii) Ensure that Greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause and environmental or human health problem; and (iv) Use all reasonable and practical measures to minimise the discharge of greenhouse gases		Carbon dioxide, a greenhouse gas will be emitted either directly or indirectly as a result of the implementation of the proposal.	The primary source of greenhouse gas will result from internal combustion engines in mining equipment and vehicles. Where possible contract guidelines will select appropriate machinery with from an efficiency prospective. The rehabilitation of cleared areas will reduce total carbon dioxide losses in the long term.	The proposal is not a significant source of greenhouse emissions.

POLLUTION MANAGEMENT					
Groundwater quality	Maintain the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected.	Water table is within a few metres of the surface, and is hypersaline. No other human uses exist, or considered likely, from this very large resource.	No processing on site, so risks of chemical contamination are small. Largest risk is hydrocarbon contamination from vehicles and equipment used and serviced on site.	Water potentially carrying hydrocarbons will be treated with oil/water separation equipment to remove hydrocarbons.	No significant effects on groundwater quality.
Surface water quality	Maintain the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, are protected.	Lake Carey is an ephemerally-filled salt lake in which irregular rainfall events provide relatively fresh water bodies of significance to water birds. After filling (often only partial), prolonged drought results in progressively-increasing salinity and declining value as waterbird habitat; protracted periods of lake dryness (several years) is not uncommon.	Mine water discharge could increase the salinity of freshwater ponds formed after moderate rainfall events. After decommissioning, saline water from the refilled pit void could have the same impact.	Mine water will be discharged in natural basins on the lake floor away from shorelines. Seepage into the hypersaline groundwater and evaporation during drought will reduce short-term risks of fresh-water salinisation. Salt crusts formed through evaporation of discharged water during drought will be resolubilised and diluted into the vast volume of the lake by the moderate and high volume rainfall events that occur with a return frequency of more than 3-5 years. The decommissioned pit void will be surrounded by an earth and rock bund which will protect nearby fresh water ponds formed after moderate rainfall events from the effects of the hypersaline water which will naturally refill the pit void.	No significant impairment of surface water quality.

SOCIAL SURROUNDINGS					
Public health and safety.	Ensure that risk is managed to meet the DME's requirements in respect of public safety	There is currently little human activity in the area; almost all activity that exists is mining-related.	Public safety associated with the pit void, which will refill naturally with saline water after decommissioning	The pit void will be surrounded with an earth and rock bund which will prevent inadvertent public access. Other public safety initiatives will be agreed with DME.	Risk to public is probably less than for decommissioned mine pits on dry land.
Social	Ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings.	Traffic in the area is almost wholly mining related. The additional transport corridors opened for this project may, as decided with the local government authority and pastoralists, remain after project decommissioning if they have ongoing value as local infrastructure.	Normal road safety issues are the major risks.	In consultation with the local government authority and the DME, roads will be appropriately sign-posted and managed.	Improved local and regional infrastructure.
Culture and heritage	(i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and (ii) Ensure that changes to the biological and physical environment resulting from project development do not adversely affect cultural associations with the area.	Archaeological and anthropological studies have been conducted. Application has been made to disturb two sites on Croissant Island.19 other archaeological sites and two anthropological sites, located more to the east will be protected from disturbance. Notably, the Mt Margaret Community has provided written support for the project's go-ahead.	Potential for negative impacts are limited, as there is no on-site processing of the ore extracted at Red October. More probable are positive social impacts through employment and improved local and regional infrastructure.	Liaison and consultation with relevant groups will be maintained, and the mine workforce will be made aware of archaeological and cultural values of the project area.	Employment and other opportunities for the local community.

2.0 INTRODUCTION

2.1 Proposal

Sons of Gwalia Ltd and joint venture partner Mt Burgess Mining Ltd ("the proponents") propose to develop an open cut gold mine at the Red October project on the western shore of Lake Carey approximately 80km south of Laverton. The project is proposed to commence in 1999 following receipt of project approvals and, based on current reserves, will have a life of approximately 2 years.

The Red October project involves the mining of approximately 15.7Mt of ore and waste material over the 2-year period by open cut mining. The pit will be approximately 600m long, 100m deep and up to 600m wide. Mining will be a conventional truck and shovel operation.

Exploratory drilling has shown that the lake clays vary in depth from 5m-15m and overlays tertiary material from 5m-50m thick. The upper mud layers will be removed using the truck and shovel operation and dumped on the areas to be covered by waste rock. In the harder rock, conventional drilling and blasting will be required.

The pit will be accessed from Angelfish Island where the mining infrastructure will be established. Waste rock dumps will be established on the lake and ore stockpile areas will be located within the beach zone. A haul road will be constructed behind the dunal system and a causeway will be constructed across the lake to the eastern shore.

The following table summarises the key elements of the Red October project.

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Life of project	2 years continuous operation (minimum)
Typical Mine Operation	7 days a week, 24 hours a day
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Mine Dewatering Discharge	Estimated 2,400 kL/day
Water supply	Dust suppression – saline mine dewatering water: approx. 800kL/day Potable – from nearby fresh water dam: approx. 2kL/day
Fuel storage capacity	Fuel storage - 180,000L

2.2 Location

The Red October project is located within the Mount Margaret Mineral Field and the Mount Morgan district. It is located approximately 80km south of Laverton and 110km east of Leonora.

The AMG grid reference for the project is 6 767 600 N and 442 950 E. The project can be accessed from Leonora via the Leonora/Laverton Road and the Glenorn/Yundamindra Road and along secondary tracks to the edge of Lake Carey east of Yundamindra homestead. The mine will be serviced by upgraded and constructed roads from Sons of Gwalia's Laverton mine near Laverton and from Leonora via the Butcher Well mine haul road.

The project location is shown on Figures 1 and 2.

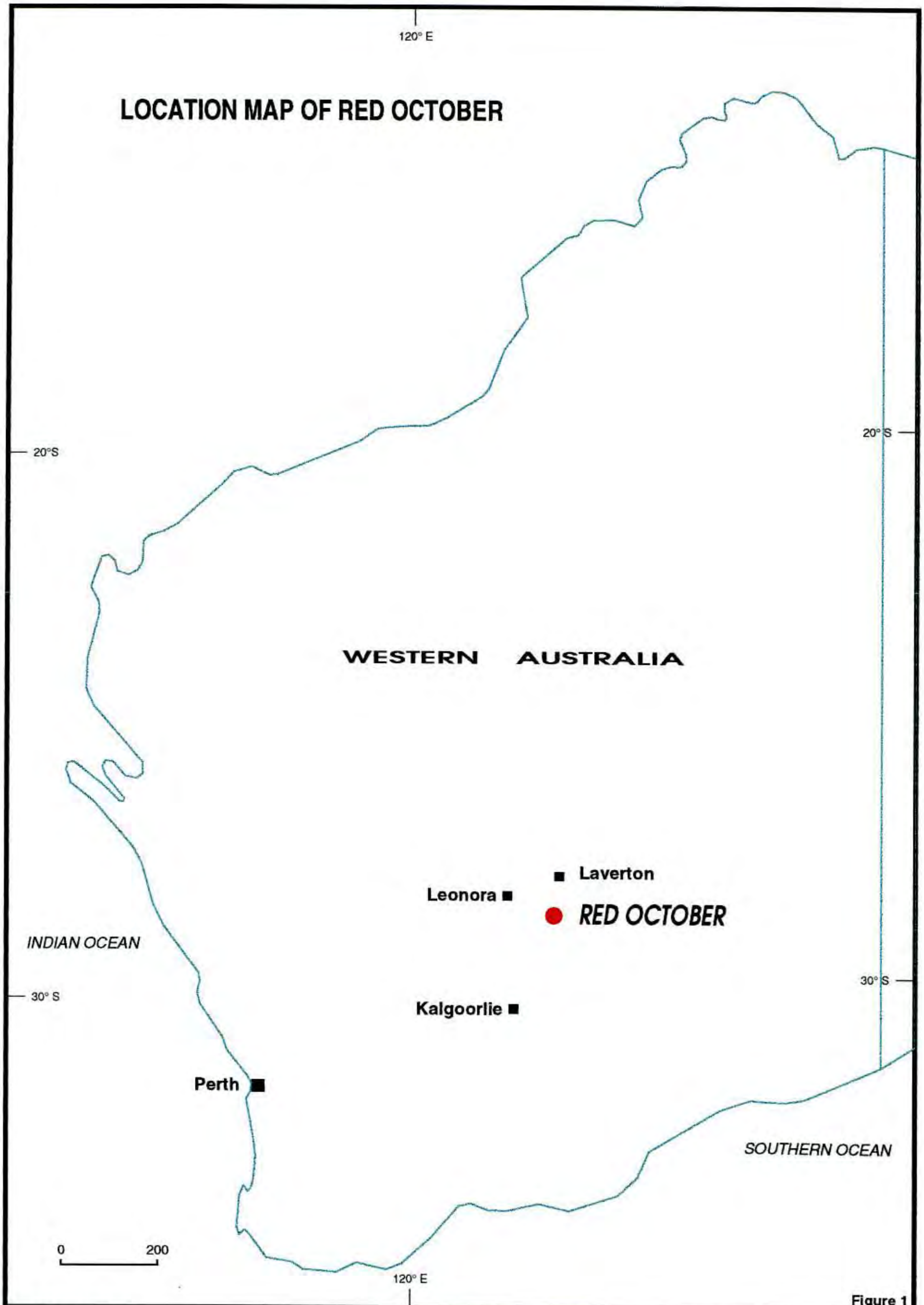

Figure 1

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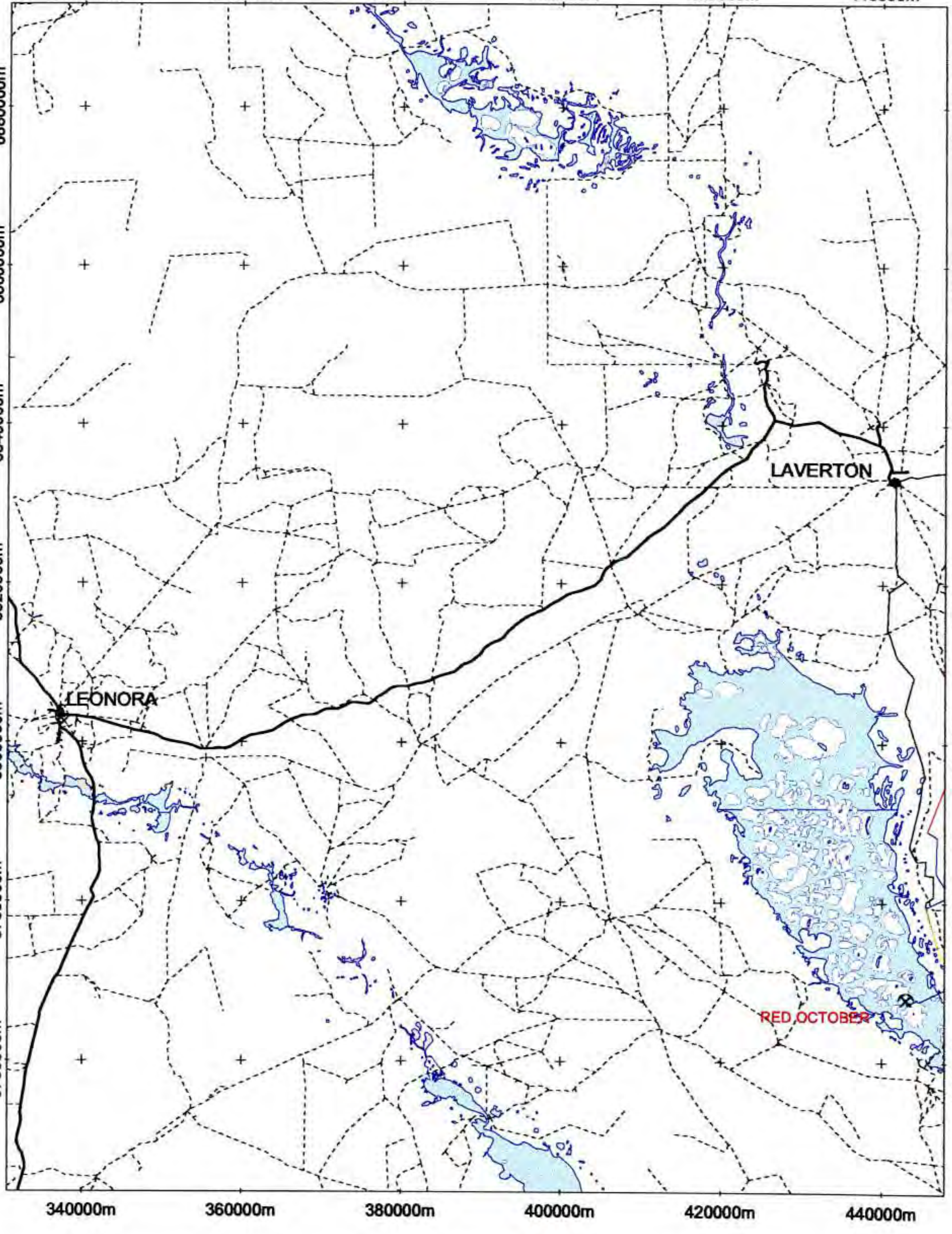


REGIONAL MAP

10 0 10 20 30 Kilometers

Compiled by PL, 7/9/1998

Figure 2

2.3 Ownership

The project is owned under a joint venture arrangement between Sons of Gwalia Ltd (50%) and Mt Burgess Mining Ltd (50%).

The operation will be managed by Sons of Gwalia Ltd of 16 Parliament Place, West Perth, 6005.

The project comprises the tenements listed in Table 1.

Table 1 – Red October Project Tenements

Tenement Number	Purpose
L38/76	To construct a haul road
L38/72 & L38/98	To construct a haul road
L39/99	To upgrade an existing road to create a haul road
L39/100	To upgrade an existing track to construct a haul road
ML39/411 – 413	To develop a mine
L39/86	To construct a causeway across Lake Carey

The boundaries of the leases have been surveyed.

2.4 History

The Red October gold deposit is situated on ML39/411 – 413 (previously E39/344 which was pegged by Mount Burgess Mining Company N.L. in 1992). The lease largely covers the southwest part of Lake Carey. At the time, Mount Burgess was developing the nearby Butcher Well deposit where mining commenced in April 1993. The area was selected because regional aeromagnetic data showed an extension under Lake Carey of the Laverton Tectonic Zone, a major longitudinally trending geological structure that hosts the 2.5Moz Sunrise Dam gold deposit, 15km to the north.

Mount Burgess then conducted a helicopter-borne magnetic survey over the lease. Analysis of the data acquired identified fifteen prospective areas.

A track mounted aircore rig was built by Zenith Drilling specifically to drill on Lake Carey. In February 1994, it drilled a nominal 400m by 100m grid over three of the prospective areas. Follow up drilling on 50m centres led to the discovery hole at Red October Zone 1. Sons of Gwalia Ltd entered into a joint venture with Mount Burgess encompassing the Red October and Butcher Well areas.

A decision was made in early 1995 to continue drilling using conventional truck mounted drill rigs accessing the drill sites on causeways built on the lakebed. These causeways are built from gypsiferous sand mined from Angelfish Island, and are nominally 1.5m high and 5m wide. Permission to extract 50,000t of material to construct these causeways was granted by the Department of Minerals and Energy (DOME) on 3rd April 1995.

Extensions to the causeways were constructed in early 1997, permission to extract a further 50,000t having been granted by DOME on 10th June 1996.

Resource definition drilling took place in 1996 and 1997. To date, a total of 612 holes for 47,039m have been drilled in the Lake Carey project area.

2.5 Existing Facilities

There are no substantial facilities at the Red October site. During the exploration program a small operating base was established on Angelfish Island, however most of the exploration program was run from the Pennyweight Point camp some 40km to the north.

A graded haul road is constructed to the Butcher Well project, approximately 15km west of Red October.

Existing access roads to the operation and in the region in general could best be described as tracks.

3.0 EXISTING ENVIRONMENT

3.1 Regional Setting

Lake Carey is situated south of Laverton in the North Eastern Goldfields region of Western Australia. The region is largely unpopulated with surrounding land use consisting of low intensity rangelands pastoral activity and significant mineral exploration. A number of other mining operations also exist around the shores of Lake Carey. These include Acacia Ltd's Sunrise Dam mine on the eastern shore of the lake, Placer Pacific Ltd's Granny Smith mine and associated satellite operations several kilometres east of the lake and Anaconda Nickel Ltd's Eucalyptus project to the west of the lake.

Timms (1992) in Actis Environmental Services (1998) describes Lake Carey as one of a chain of lakes, which follow an ancient drainage basin called the Carey Palaeoriver. The Carey Palaeoriver is one of five parallel palaeo-drainage systems that eventually drain into the Great Australian Bight. The area containing these systems is known as Salinaland and stretches roughly from Wiluna to Kalgoorlie. The lakes in these ancient drainage systems are slowly moving westward, with the westward ends being deflated by prevailing winds, and the resulting sand accumulating at the eastern end.

The low lying islands within Lake Carey are, in some cases, capped with a gypsum crust several metres thick which shows signs of being formed beneath a saline lake.

It would appear the islands are remnants of sediments which for one reason or another, have not eroded. The base of the islands are alluvial/colluvial dunes, typically sickle shaped with a concurve side to the northwest. The dunes on the lake and along the shores are typically coarse grained and have a high gypsum content. The deposits and the playa surface are quite distinct and discrete.

There is no vegetation on the lake surface. Vegetation starts in the dunal zone along the boundary of the lake and is discussed in more detail later in this report.

3.1.1 Catchment Characteristics

Lake Carey has been estimated to cover an area of approximately 750km^2 and includes a multitude of islands. The lake is within an internally draining catchment of approximately 9,000km^2.

Topographic analysis suggests that surface water is likely to drain to the lake from the west and the east. Major catchment divides approximately follow the alignment of the lake to the west and east and occur at distances from the lake of around 5km-25km. To the west, the catchment divide separates the Lake Carey and Lake Raeside catchments while to the north and south of Lake Carey the locations of catchment divides are less clear, partly due to the low relief and lack of topographic data in these areas.

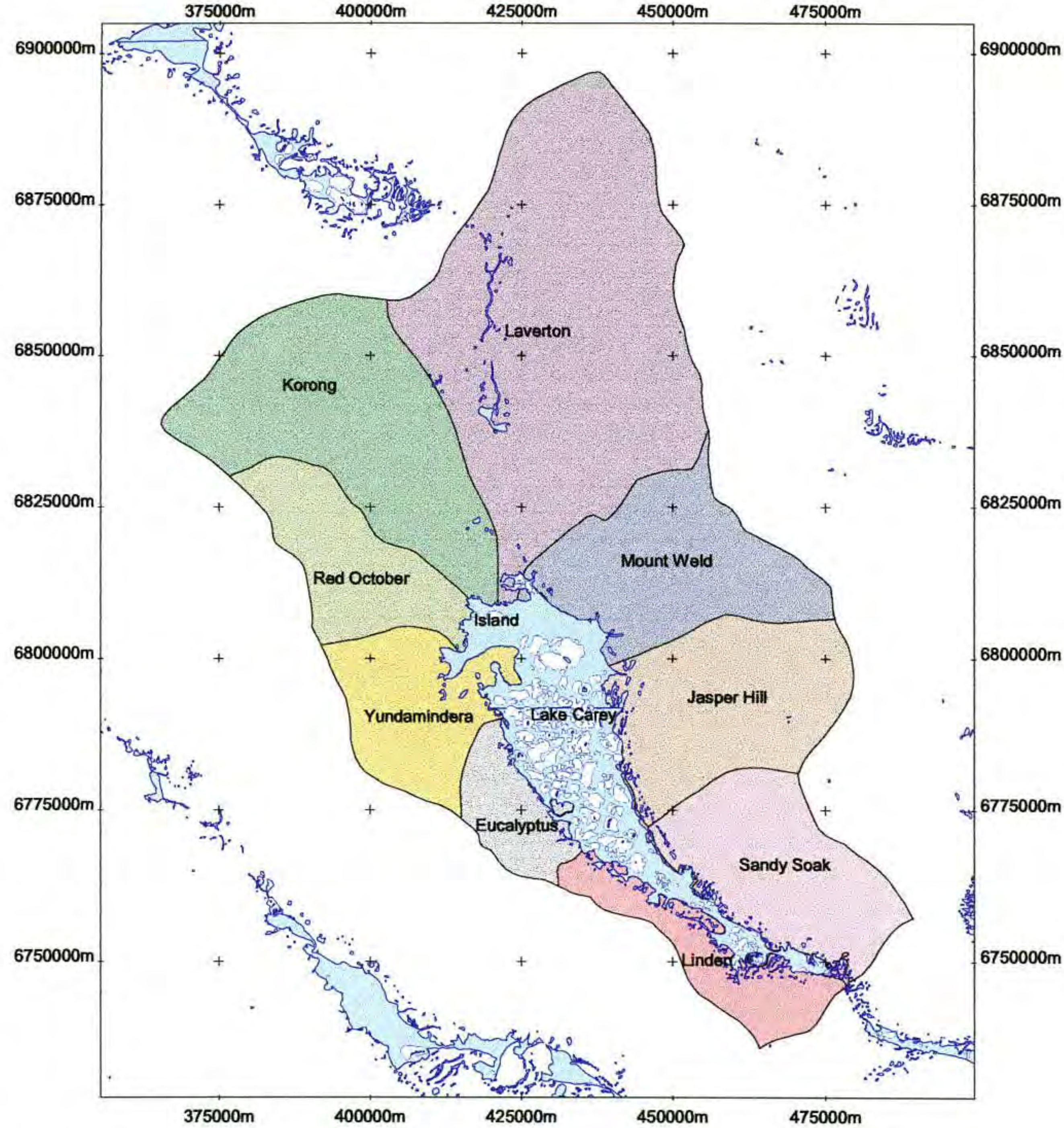
The catchment has a maximum elevation of about 410m AHD to the north falling to 385m AHD in the southern part of Lake Carey.

Nine subcatchments have been identified within the Lake Carey catchment on the basis of major creek systems and topographic data. These vary in size and in percentage contribution to runoff. The lake subcatchments are shown in Table 3 and Figure 3.

3.1.2 Topography, Landforms and Soils

Surface topography is characterised by low relief. The local ranges of outcropping bedrock and adjacent erosional escarpments form high areas in the landscape whereas the large playa lake systems and related systems form the low areas.

The geomorphology of the region has been characterised by Howes (1994) in a study which provided a pastoral inventory and condition report of the north-eastern goldfields. A total of nine land surface types have been identified within the Lake Carey catchment. A summarised description is contained in Table 2.



250K-Waterbodies
- lake
- reservoir
- island

Lkccatchment.shp
- Eucalyptus
- Island
- Jasper Hill
- Korong
- Lake Carey
- Laverton
- Linden
- Mount Weld
- Red October
- Sandy Soak
- Yundamindera

LAKE CAREY SUBCATCHMENTS

20 0 20 40 Kilometers

Compiled by TD, 10/9/98

Figure 3

Table 2 - Land Surface Types and Runoff Coefficients

Land Surface Type	Runoff Ranking (1=High, 9=Low)	Calibrated Volumetric Runoff Coefficient (%)
Hills and Ridges	1	80
Breakaways and Lower Plains	2	65
Erosional Surface of Low Relief (<20m)	3	70
Hardpan Wash Plains	4	75
Plains with Deeper Coarser Soils than in Hardpan Wash Plains	5	55
Plains with Saline Alluvium	6	60
Depositional Plains with Calcareous Red Earth's	7	30
Lake Country	8	25
Sandplains	9	10

According to Howes (1994), soils in the region are characteristic of those found in other arid zones. Howes identified and grouped six primary soil types- red soils, lithosols, calcareous, red earths, duplex soils and clays. In general, they are red and show weakly developed soil structure due to a lack of organic matter. The soils are vesicular in appearance when dry and often possess a thin crust in the upper horizons. A hardpan layer occurs below many soils found in the region.

The soils adjacent to the mine site on Angelfish Island are dominated by the salt lake processes of Lake Carey. The landforms and soil types are regular and linear running parallel with the lake shore. A loamy sand soil exists along the fringe of the lake grading into sandy lunettes and fringing kopi or gypsiferous dunes. Behind the dunes is a loamy saltpan area which is joined to the south and south west by alluvial sand dunes covering rock outcrops.

3.2 Geology

The Red October gold deposit lies within greenstones of the North Eastern Goldfields Province of the Archaean Yilgarn Craton. It is in Laverton Tectonic Zone (LTZ), a major longitudinally trending deformational feature that hosts the significant gold deposit at Sunrise Dam (2.5Moz), as well as the Mount Weld carbonatite hosted REE-P-Y-U-Th deposit. The LTZ is sinuous, and varies from 5km to 15km wide, and is marked by faulting, shearing and folding of the greenstone sequence, which has been metamorphosed into greenschist and amphibolite facies.

Outcrop in the Lake Carey area is poor and restricted to small areas on islands. The Red October area is covered by approximately 10m of Quaternary lake sediments in the bed of Lake Carey. Below the lake sediments is up to 30m of transported Tertiary material, which rests on weathered Archaean rock. A gravel zone at the base of the Tertiary has been interpreted as a transported pisolite layer. Weathering in the Archaean extends to 70m below the lake surface.

The main mineralised zone at Red October (Zone 1) occurs at and subparallel to an ultramafic-mafic contact within a northeast-trending unit of mafic and ultramafic rocks.

The hanging wall comprises a mixed pyroxenite-peridotite-high-Mg basalt sequence, with minor interflow sediments and graphitic shale. The footwall consists of massive ocellar high-Mg basalt.

The mineralisation is at least 650m long, and dips north-westerly at moderate to steep angles. The width of the main zone varies from 1-10m, and drilling has demonstrated downdip continuity to at least 350m below the surface. It consists of a quartz-carbonate vein, containing brecciated and sericitised rafts of wallrock. Economic gold grades are also found in the halo to the vein and in subordinate parallel shear structures.

Pyrite is the most common sulphide mineral, followed by pyrrhotite, with accessory arsenopyrite and chalcopyrite. Gold grains up to 1mm are occasionally found. An alteration halo around the vein comprises a proximal quartz-sericite-biotite-calcite zone and a distal weak quartz-carbonate$\pm$pyrrhotite zone. The alteration assemblage suggest depositional temperatures of 400-450°C.

3.3 Hydrology

The surface hydrology of the catchment is characterised by episodic rainfall events that can result in runoff. The nature and occurrence of rainfall coupled with low relief and relatively shallow soil profile suggests that a majority of runoff occurs as "Hortonian" runoff and sheet flow. It is likely that heavier rainfall events exceed the infiltration capacity of surface soils, producing localised runoff within discrete periods. Major storms can cause widespread runoff and flooding.

The catchment of Lake Carey has a variety of land surface types as previously described. These land surface types have a different but unquantified response to rainfall and contribute various proportions of runoff to Lake Carey.

The runoff coefficients for the various land surface types have been estimated by consultants Golder Associates (1998) based on descriptions in Howes (1994) (Table 2). These runoff coefficients have been used to estimate subcatchment runoff to estimate rainfall runoff for the catchment and various subcatchments. These are shown in Table 3. The lake subcatchments are shown on Figure 3.

Table 3 - Sub-Catchment Runoff Contributions

Sub-Catchment Name	Area (km^2)	Equivalent "Impervious" Area (km^2)	Sub-Catchment Runoff Coefficient (%)	% of Total Catchment Runoff
Laverton	2,590	1,388	54	32
Mount Weld	901	583	65	14
Jubilee Hill	921	465	51	11
South Soak	793	145	18	3
Linden	415	148	36	3
Eucalyptus	294	201	68	5
Yundamindra	400	370	93	9
Red Knob	581	363	63	8
Korong	1,362	612	45	14
Lake Carey	750	750	-	-

3.3.1 Saltlake Hydrology

Lake Carey has a shallow water table beneath the lake surface. Prior to rainfall, the lake typically has a thin crusted layer over the red/brown surface muds as a result of evaporation of runoff and near surface groundwater. During rainfall, even with little or no runoff to the lake, the crusted salts are dissolved and some infiltration may occur.

The consequence of the variable and intermittent nature of the inflows of surface water to Lake Carey is that the salinity of any surface water in the lake will vary enormously. In general it can reasonably be expected that major rainfall events, such as the runoff from Cyclone Bobby, would result in the formation of a large, fresh water or brackish water body which would gradually become saline through evaporation. This is typical behaviour of the large inland lakes, and is well documented, for example for Lake Eyre in South Australia (Actis Environmental Services 1998).

Actis Environmental Services (1998) consider that the lack of a thick salt crust suggests that one or both of two mechanisms for removal of salt from the lake surface are active. These are overflow to the south east during major rainfall events and refluxing of dense brines.

The hypothesis of the movement of surface water and salts on Lake Carey in relation to evaporation, seepage and precipitation is shown in Figure 4. Briefly, the lake dries, forming a crust of salt that accumulates throughout the dry period. Subsequent rainfall dissolves the salt, recharging the subsurface zone and creating a virtual stratification of high salinity brine beneath the surface and low salinity ponding on the surface.

Around the fringe of the lake is a zone of saturated sandy alluvial soil as distinct from the lake clay bed. *Halosarcia* species occur within this fringe. As evaporation takes place, salts accumulate on the surface of the soil between the lake playa and the sandy zone.

3.4 Climate

3.4.1 Rainfall and Evaporation

The nearest weather station to the Red October minesite is the Laverton townsite. Long term average annual rainfall at this point is 225 mm per year. Analysis of the rainfall records shows that October has the minimum monthly average of 7mm with a standard deviation of 10mm. March has the maximum monthly average rainfall of 30mm with a standard deviation of 39mm.

Further analysis of the results indicate that the months of January to March contain the highest monthly rainfall totals while the most consistent rainfall occurs in the months of July to August. The median rainfall values are quite different from the mean values indicating that summer rainfall is characterised by infrequent large events. The winter rainfall pattern is more consistent but the records indicate that any month of the year can pass without any rain.

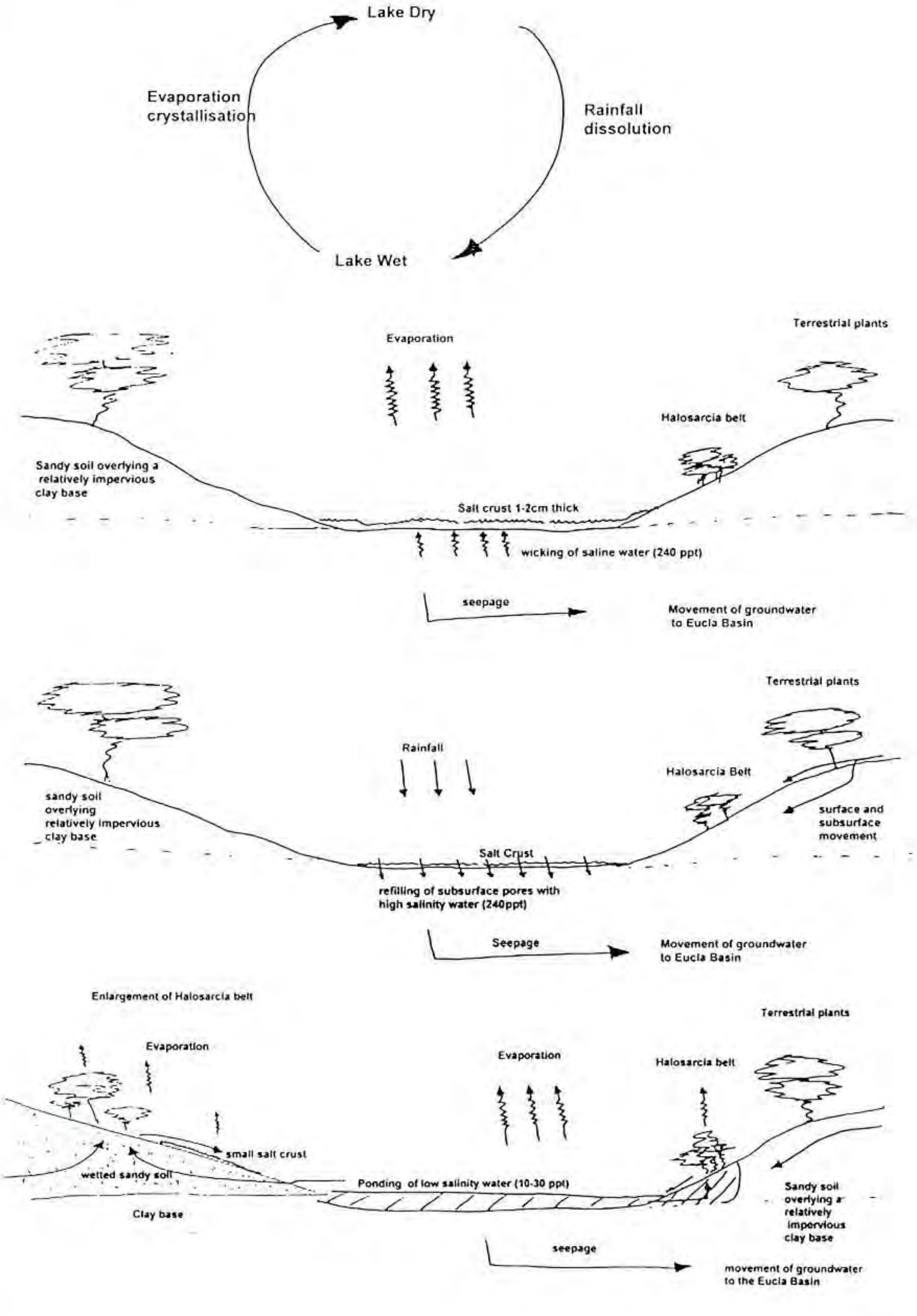
The area is characterised by high daily evaporation rates. Mean potential annual evaporation is estimated at 3,040mm.

3.4.2 Wind

The wind pattern in the region is bimodal with a dominant wind direction from either the east or north west. A feature of the wind pattern in the region is that a gentle easterly of less than 10km/h occurs in warmer months and is more obvious in the morning observations. The renowned strong easterlies occur within the summer months and usually lessen by evening. The easterlies may reach speeds greater than 30km/h but generally is less than 20km/h.

The north west winds are a feature of the winter months and although they can also be moderate with a speed less than 20km/h most of the north west to west winds blow stronger than 30km/h. It is suggested that the strong north westerly winds are more common during winter when Lake Carey is more likely to contain water and the easterlies are more common during the dry periods. This theory fits with the shape of the lakes in the region and is important when comparing the fate of discharge and precipitation volumes.

Figure4 - Lake Carey Wetting Cycle



Taken from Actis Environmental Services (1998)

3.5 Flora and Fauna

3.5.1 Terrestrial Flora

Mattiske Consulting Pty Ltd was commissioned in May and November 1998 to undertake a flora survey of areas likely to be disturbed by infrastructure associated with the Red October Project on Angelfish Island (Mattiske, 1998). The proposed haul roads between Butcher Well and Laverton were also surveyed. The study area encompassed lease areas L38/76, L38/72, L39/98, L39/99, L39/86 and L39/100. The study area is located on several pastoral leases, with some areas disturbed by grazing. The survey was restricted to areas potentially impacted on by the development of the project and are therefore appropriate to the scale of the project.

The study area is included in the Laverton and Edjudina Subregions of the Austin Botanical District of the Eremaean Province, as defined by Beard (1990). Maps of the study area and photographs of the plant communities are included in Appendix 2.

The Eremaean Botanical Province is typified by plants from the families Mimosaceae (*Acacia* spp.), Caesalphiniaceae (*Senna* spp.), Myoporaceae (*Eremophila* spp.), Chenopodiaceaes (samphires, bluebushes, saltbushes), Asteraceae (daisies) and Poaceae (grasses). The Austin Botanical District is essentially the mulga (*Acacia aneura*) region of Western Australia. *Acacia aneura* is dominant or a significant component in most plant communities in this District. Perennial grasses such as *Triodia* spp. are usually confined to patches of sandy soil in which the sands tend to occur in low, raised banks. Annual grasses and daisies are common in spring and late winter.

The vegetation units in the study area as mapped by Beard (1974, 1975) at a scale of 1:1,000,000 are:

> Low Woodland (a1Li) – Mulga Low Woodland, *Acacia aneura*
>
> Succulent Steppe (a1Si.x.Ci) – Mulga and Saltbush, *Acacia aneura, Atriplex* sp., *Maireana* sp., *Sclerolaena* sp.

According to the land mapping of Pringle *et al.* (1994) the lease areas occur on a variety of land systems. Lease L38/76 crosses the Bevon, Sunrise, Gundockerta and Nubev land systems. The Sunrise land system was the most common and is characterised by stony plains and occasional low rises with *Acacia-Eremophila* Shrublands. This land system is also the most regionally restricted of the five land systems encountered.

Lease areas L38/72 and L39/98 occur exclusively on the Rainbow Island system, which is common regionally and is characterised by wash plains on hardpan with mulga Shrublands. Lease areas L39/99 and L39/86 occur on the Carnegie land system, which is typical of salt lakes and the sandy dunes associated with these. Angelfish Island and L39/100 are also dominated by the Carnegie land system.

Also present on Angelfish Island are the rocky hills of the Leonora land system, while some low breakaways of the Yilgarn land system are present on L39/100. None of these are restricted.

A total of 30 families, 57 genera, 122 species and 129 other plant taxa (including varieties and subspecies) was recorded in the study area in June 1998. A list of species is included in Appendix 2. No Declared Rare Flora were located in the study area. One Priority Three species was located in the study area, within plant community C5. The most common families recorded were Chenopodiaceae and Mimosaceae, a flora composition typical of the Austin Botanical District.

This total included one introduced species. Due to the impact of grazing in parts of the study area the number of introduced species present would be expected to be higher following a Spring survey. Very few annual species were recorded during the study due to the seasonal timing of the field survey. The relatively low number of species recorded reflects the small total area surveyed rather than low species diversity.

The diversity of the underlying geology of the study area, as reflected in the high number of land systems mapped, has resulted in a diversity of plant communities in the study area. The conservation significance of the plant communities has been defined in a regional context by comparison with regional surveys (Hall *et al.* 1994; Pringle *et al.* 1994, Beard 1974, 1975) and in a local context by comparison with other studies by Mattiske Consulting Pty Ltd (1994, 1996, 1997).

Overall, all communities recorded in the study area are typical of the margins and surrounding vegetation of salt lakes that are widely distributed throughout the Murchison Region. The *Eucalyptus* Woodland is regionally widespread on sand or kopi dune systems associated with salt lakes, hollows and streamlines. All of the mulga Woodlands recorded are widespread regionally and have been recorded during other studies by Mattiske Consulting Pty Ltd in the local area (Mattiske Consulting Pty Ltd 1994, 1996, 1997). The impact of grazing has also reduced the conservation status of these communities, and none should be considered to be regionally significant. The *Casuarina* pauper Woodland recorded on gypsiferous dunes (Community A6) has been found to be common both locally and regionally. It is described by Hall *et al.* (1994) as being associated with most salt lakes in the region and has also been previously recorded by Mattiske Consulting Pty Ltd (1994) on the eastern side of Lake Carey.

Of the three Shrubland communities recorded during this study, plant community B2 was found to be locally restricted. This community was only recorded from one area on Angelfish Island and has not been recorded during previous studies by Mattiske Consulting Pty Ltd in the area. On a regional scale this community is not described in Hall *et al.* (1994) or Beard (1974, 1975) due to the scale of the mapping. Pringle *et al.* (1994) describes the land system underlying this community (Leonora) as being common on larger islands throughout both Lake Carey and other salt lakes in the region. The other shrubland communities recorded in the study area are common both locally and regionally.

Five Low Shrubland communities, most dominated by chenopods, were recorded during this survey. Within the study area, plant communities C1 and C2 were locally restricted, with only small pockets recorded. However, similar communities have been recorded by Mattiske Consulting Pty Ltd (1996, 1997) in the area, and they have also been recorded regionally (Hall *et al.* 1994, Mattiske, 1998). Plant community C3 is common both locally and regionally and is present around all salt lakes in the region. The distribution of plant community C4 is restricted to the occurrence of low-lying intermittently wet zones and it has been recorded throughout this and other regions (Beard 1990, Mattiske, 1998). The regional distribution of plant communities C5 and C6 are unknown due to the scale of regional mapping undertaken. These communities have also not been recorded previously in the area by Mattiske Consulting Pty Ltd and may be locally restricted.

In summary, the vegetation described and mapped in all lease areas surveyed does not appear to be locally or regionally significant. The only possible exception is plant communities C5 and C6, which may be locally restricted.

3.5.2 Aquatic Flora

The salt lake ecology study carried out by Actis Environmental Consultants (1998) also discovered a poorly known *Halosarcia* species around the fringes of Angelfish Island and Lake Carey and the plant has been given a Priority 1 rating. However, CALM has advised that, as it appears that the species is secure at the site at present, additional surveys are not required for the currently-proposed level of disturbance; but further survey and investigation will be needed if disturbance expands to threaten the population.

Further field survey work to investigate the range of this species will proceed during the project life. Initially, wider surveys will be conducted in the spring of 1999, to determine if the species is more widely distributed in the area and region.

3.5.3 Terrestrial Fauna

The terrestrial vertebrate fauna of the Red October project area has not been surveyed directly. Such a survey was considered to be unnecessary in light of the similarity of vegetation and habitats of the Red October area with those of other comparable ones in the region which have been surveyed and shown to be typical of the region as a whole.

A 1995 survey of the nearby Sunrise Dam gold project area (Ninox Wildlife Consulting 1995) showed that, in common with comparable surveys in the Eastern Goldfields, the gypsiferous dune areas bordering Lake Carey are the least rich habitats and the low Mulga communities the richest. The Red October project will mostly affect near-lake communities.

Ninox (1995) noted that, while grazing and poor seasons had affected the local environment, the vertebrate fauna appeared to be relatively intact. The Ninox survey results compared well with those of a larger series of surveys conducted by the WA Biological Surveys Committees in less-disturbed areas of the Eastern Goldfields. Ninox concluded that the habitats of the Sunrise Dam area (which are comparable with those of the Red October area) had no special regional significance, are represented in reserves elsewhere, or are present to varying degrees in surrounding pastoral land. Considered either individually or as a group, no vertebrates of special regional significance were exclusive to the area; they occur elsewhere throughout the arid zone of WA.

Ninox (1995) noted eight rare or endangered species which, on the basis of published reports, could potentially occur in the project area but were not observed in their survey. Six of these species are nomadic or highly mobile birds with wide distribution throughout the arid zone, so that little or no impact of mine development was considered likely. The two remaining species – the marsupial Mulgara *Dasycerus cristicauda* and the Woma Python *Aspidites ramsayii* – might suffer some impact from the project, but that impact would be minimal and involve strictly localised loss of habitat.

On this basis, it was considered that Sons of Gwalia's resources for this marginal project would be better directed towards issues such as impacts on the surface and groundwater and ecology of Lake Carey.

3.5.4 Aquatic Fauna

Similarly, aquatic fauna studies have not been undertaken at this stage. It is recognised that aquatic ecosystems may be significant and may potentially be impacted by discharges of saline water, and Sons of Gwalia is proposing to undertake studies on lake fauna along with a number of other companies working on or around Lake Carey. The lack of knowledge of these systems have been taken into account when considering the management of discharge water detailed further in this report.

It is also recognised that even a basic understanding of faunal ecology of Lake Carey (or indeed of any salt lake) will take many years of study: the secular wetting/drying cycle of such ecosystems, and the variation in extent of wetting (lake filling) for individual rainfall events, makes for a complex and dynamic system. Sons of Gwalia's approach to management of impacts of aquatic fauna is therefore a precautionary one, recognising the potential for impacts and designing the operation, particularly the discharge of mine water, to practicably minimise risks of disturbance, while participating in salt-lake-ecology studies in cooperation with other mining companies. Those studies, which also include terrestrial biology work on islands and saltmarsh communities, will investigate micro-algae, aquatic birds and aquatic invertebrates. Study locations will be established for the regular sampling for physical limnological parameters (water depth, salinity, dissolved oxygen, pH, temperature and turbidity), micro-flora (surface phytoplankton and benthic-mat plankton) and micro-invertebrates (halobionts). Sediment core samples will also be taken and examined for micro-flora and micro-invertebrates when there is no standing water. Standard bird census will be taken at selected study locations, and a general survey made of the lake and constituent islands, focussing on breeding colonies.

3.6 Social Environment

The Leonora/Laverton region is rich in mining history. The historical mining centres of Malcolm and Kookynie, and the remains of Eulaminna, a copper mining town of the early 1900's are to the west of Lake Carey and are remote from the proposed mine site and associated infrastructure.

The Mt Margaret Aboriginal community is some 50km north of the mine at the head of Lake Carey and similarly will not be disturbed by the mining operation.

The mine infrastructure will cover areas of both Yundamindra and Mt Weld pastoral leases, however it will not have an economic impact on these operations.

The infrastructure established as part of this operation will make a useful contribution to the region by upgrading the road network from Laverton south across Lake Carey to the Yundamindra Road.

The mine is shown in relation to cadastral and social features on Figure 5.

3.7 Description of the Red October Site

The Red October mine will be situated on the lake bed several kilometres from the western shore of the lake and adjoining an island informally known as Angelfish Island. Angelfish and Treasure Islands are low lying islands on Lake Carey.

The northern and western areas of Angelfish Island which will be disturbed by the construction of the site, are typically flat to gently undulating with a surface of gypsiferous material to a depth of up to 2m. The islands have a gently sloping beach some 200m wide vegetated by low chenopod shrubland. A regular gypsiferous dune system occurs inland from the beach.

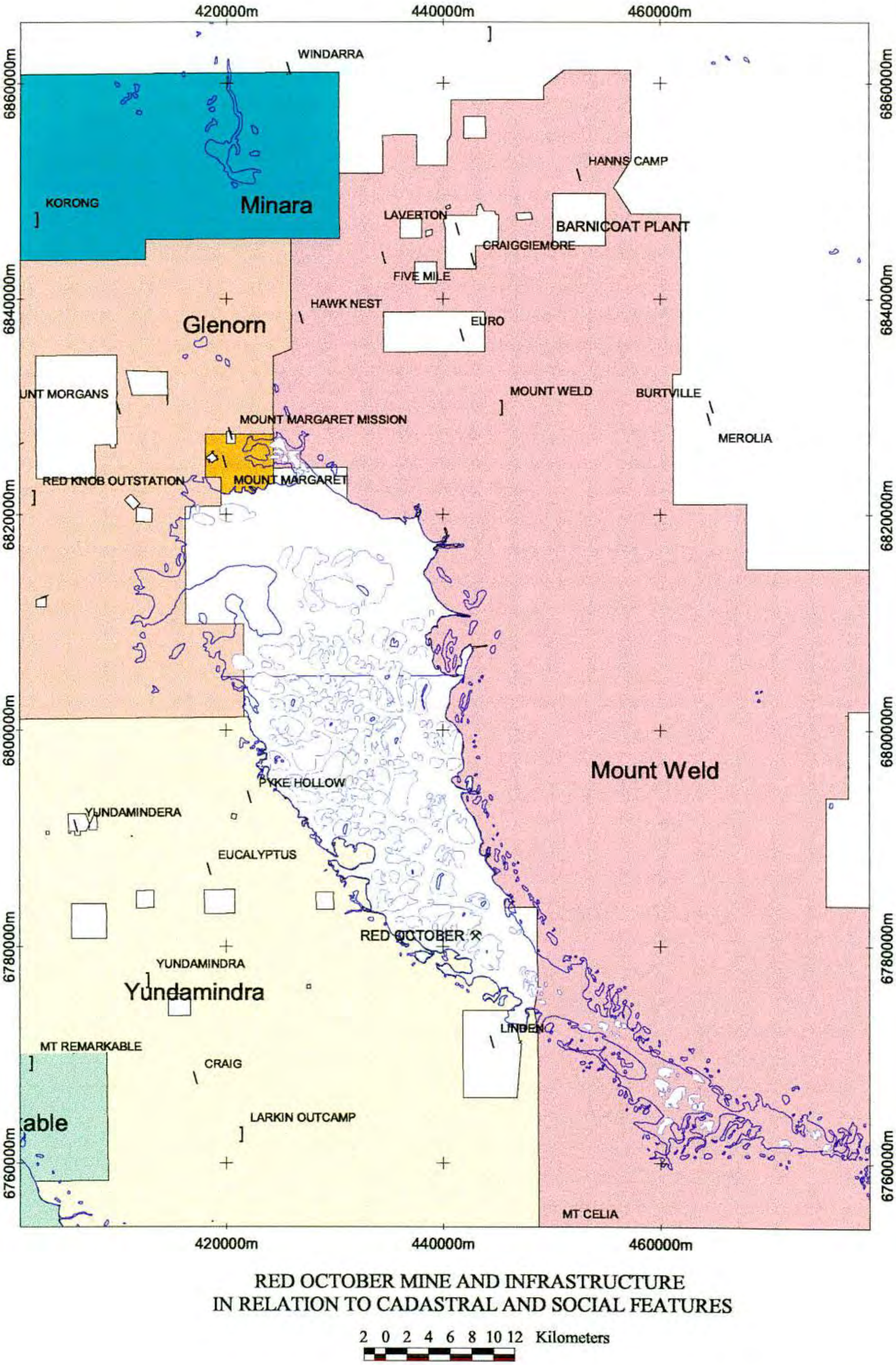
The southern and eastern areas of Angelfish and Treasure Island are dominated by rock outcrops and exhibit more relief. These areas are vegetated by shrubs dominated by *Acacia, Eremophila* and *Hakea* species.

Croissant Island is a small remnant gypsiferous dune to the north west of Angelfish Island. It is vegetated with shrubs dominated by *Atriplex and Maireana species.*

In the area proposed to be mined the lakebed is flat with no obvious basins.

The mine area is situated within the Linden subcatchment. This catchment has been estimated to have a runoff area of 415km^2 and is estimated to contribute 3% of total lake catchment runoff.

In this region of the lake the major movement of water is considered to be north to south within the main channel to the east of Angelfish Island. This is confirmed to some extent by the shape of the shoreline features of the island. Movement of shallow water on the lake however is dominated by the prevailing wind.



RED OCTOBER MINE AND INFRASTRUCTURE
IN RELATION TO CADASTRAL AND SOCIAL FEATURES

Compiled by PL, 7/9/1998

Figure 5

4.0 PROJECT DESCRIPTION

4.1 Mining

The Red October project involves the mining of approximately 15.7Mt of ore and waste material over a 2-year period by open cut mining. The pit will be approximately 600m long, 100m deep and up to 600m wide. Mining will be a conventional truck and shovel operation.

The pit will be accessed from Angelfish Island where the mining infrastructure will be established. Waste rock dumps will be established on the lake and ore stockpile areas will be located within the beach zone. A haul road will be constructed behind the dunal system and a causeway will be constructed across the lake to the eastern shore.

Exploratory drilling has shown that the lake clays vary in depth from 5m-15m and overlays tertiary material from 5m-50m thick. The upper mud layers will be removed using the truck and shovel operation and dumped on the areas to be covered by waste rock. In the harder rock, conventional drilling and blasting will be required.

4.1.1 Conceptual Mine Plan

A project plan and a conceptual mine plan is shown in Appendix 3.

The Red October pit will be mined in three stages. Mining will commence at the southern end of strike moving in a northerly direction along strike to fully extend the pit.

The following general concept has been proposed for the development of the mine:-

A causeway system will be developed out from Angelfish Island around the deposit and back to the island. This causeway will be approximately 15m wide and 1.5m high and will parallel the pit void. The construction of this wall will prevent the flow of water into the pit and provide access to waste dumps which are situated directly outside the bund wall. The source for the material for the causeway will be a borrow pit on Angelfish Island.

A causeway system will be developed in a north westerly direction from the bund wall in a herringbone design to be used as a waste dump for loose lake clay material from the pit. The spacing of the dump fingers will be empirically determined depending on the nature of the material. The source for the material for the dump fingers will be a small feature known as Croissant Island and from a borrow pit on Angelfish Island.

The initial cut will then be developed in the location of the main ramp. This will be developed by dumping material from the borrow pit on Angelfish Island to form a trafficable surface and then digging this back out to form the drop cut. This process will be repeated until the floor is trafficable (6 to 10 m deep) whereupon the first bench will be established. Once a fully trafficable surface within the pit has been developed a conventional open pit operation will proceed. As required, a swamp dozer will be used to reduce the height of the face and prevent slumping.

Loose clay generated from the upper bench will be dumped from the dump finger in a specific location. Stiffer clays will then be progressively dumped from the dump fingers and be ultimately sheeted with waste rock.

Further material will be taken from Angelfish Island as required for the construction of dump fingers and causeways until sufficient suitable material is generated from within the pit.

Dewatering will be limited to sumps within the pit. Discharge water from the pit will be directed through a settling pond into an open part of Lake Carey. This option has been chosen after evaluating a range of options, as discussed in Section 5.2 below. The point of discharge will be selected and, as necessary, changed throughout the life of the operation, to minimise the risks of impacts on near-shore ecosystems. Based on the lake hydrology discussed in Section 3.3 above, it can reasonably be expected that natural processes of infiltration into the lake floor (and consequent mixing with the already hypersaline groundwater) and dilution by the much larger volumes of runoff associated with rainfall events in the Lake Carey catchment, will restrict the impacts of mine-water discharge to the area immediately adjacent to the discharge. The basis of this expectation is detailed in Section 5.2 below.

4.1.2 Waste Dump

Waste rock will be stockpiled on the bed of the lake. The waste dumps will be constructed so that they are geomorphologically similar to the existing small islands in the area. It is proposed to establish two waste dumps which will be located to the north west of the pit between the pit and Treasure Island. The dumps will be constructed within the inside the eastern extremity of the islands and therefore outside of the main flow channel. The final location of the dumps has been decided on the basis of surface hydrological modelling of the lake. This suggests that infrastructure and waste dumps should be located so as to minimise obstruction to the north-south flows of the lake.

Chemical analysis of the waste rock was undertaken to provide information on the potential for acid mine drainage. The results show that the waste material does not present an acid mine drainage hazard to the lake system.

The waste dumps will be constructed by first building a series of causeways across the dump area. The surface muds will then be dumped onto the lake and confined by the causeways. The mud will be covered by layers of later-mined competent waste rock material. From observations of WMC's mining operations at Lake Lefroy this appears to be an appropriate strategy with the muds being well contained by the other waste material; it will also protect against erosion of the stockpiled muds, which could otherwise affect flow patterns and water quality in Lake Carey.

4.2 Ore Processing and Tailings Disposal Management

There will be no milling carried out at the Red October site. Ore will be trucked to Sons of Gwalia's Laverton mill.

4.3 Support Facilities

The facilities and infrastructure at Red October will be limited to onsite offices, workshops, fuel storage facilities and a power supply.

The facilities will include a workshop consisting of covered work areas and concreted work areas, a fuel and oil storage facility including facilities to manage waste oil and oily waste and a washdown bay. A earthmoving equipment parking area will also be constructed. A number of transportable huts will also be positioned as a site office. The facilities will not include accommodation units as all personnel will be accommodated at the Pennyweight Point camp approximately 40km to the north of the Red October mine.

Water storage facilities and a truck fill up point will also be established for dust suppression on site.

The infrastructure and lay down areas will be located on Angelfish Island on the beach area and inland behind the dunal system. This area has previously been disturbed by exploration activities and quarrying of fill material for causeways. The workshop and laydown areas will be contoured to manage runoff to avoid contamination of the lakebed. In each area runoff will be directed to a constructed sump which will contain silt and the residue of any spilt material.

The workshop area will be concreted and graded so that any runoff is contained in a constructed sump. A concrete washdown bay will be constructed and will include an oil – water separator which will also be used to treat any contaminated runoff from the workshop area. Excess water collected in the sumps will be recycled for vehicle washdown.

4.4 Workforce

The workforce will include staff from Sons of Gwalia and the mining contractor.

Sons of Gwalia's team will include a mining engineer/registered quarry manager, a geologist and grade control assistants and a surveyor and surveying assistants.

The contractor's team is likely to comprise a project manager (preferably a holder of a restricted quarry managers certificate of competency), two leading hands/operators (one per shift) plant operators and truck drivers, fitter and service person and shot firer.

4.5 Transportation Corridors

Access to the camp and the mine-site will be via upgraded tracks along the western side of the lake from the Leonora – Laverton road and from Laverton along the haul roads down the eastern side of the lake.

Ore from the Red October site will be trucked along upgraded and constructed haul roads along the east of Lake Carey to the Laverton mill just east of Laverton. The haul road will include upgraded sections of track and a section of especially constructed road. A map of the proposed route is shown in Appendix 3.

4.5.1 Haul Road

A haul road will be constructed from the mine site to the Barnicoat mill. The road consists of a number of sections that are considered separately below.

Angelfish Island Section

A haul road will be constructed along the northern shore of Angelfish Island from the stockpile area to the eastern end of the island. It is proposed to construct the road behind the dunal system that runs parallel to the shoreline up to 200m inland. A roadway up to 15m wide will be constructed along the southern edge of a clay pan on firm alluvial sand dunes. This option is considered to have the least impact as constructing the road on the loamy salt flats in front of or behind the dunes would cause considerably more disturbance as fill material would need to be imported to build up the roadway.

Lake Causeway

A causeway will be constructed across the lake from the eastern tip of Angelfish Island to the east shore of the lake crossing a small kopi island on route. The causeway will be constructed using appropriate engineering design to ensure adequate drainage.

A quarry will be created on Angelfish Island to provide fill material for the causeways across the lake and around the mine area. Material will also be quarried from the dunes on the eastern fringe of the lake.

Eastern Haul Road

The eastern haul road requires the upgrading of the existing Bindah Road and the construction of new haul road.

A flora survey of the road corridor has identified that road construction will not destroy any rare or priority flora.

Drainage in the area is directed toward the salt lake. Drainage along the southern portion of the haul road on the eastern side of the lake is diffuse and ill defined. The current roadway does not appear to have caused problems by obstructing flow toward the lake. At several points along the central and northern sections of the road the road crosses a number of more defined drainage lines, and culverts will be installed to maintain drainage.

Western Access Road

The existing roads and tracks from Pennyweight Point will also be upgraded to provide better access to the mine.

Quarries

Approximately 500,000BCM of earth is required to construct causeways and infrastructure to enable mining to commence. Two areas have been identified as potential quarry sites on Angelfish Island and it is also proposed to quarry material from Croissant Island to the west of the open pit which will be disturbed by the construction of the waste dump. Quarrying from Croissant Island will occur in preference to quarrying from Angelfish Island. Where quarrying occurs on Angelfish Island vegetation will be cleared and some topsoil stockpiled. At the conclusion of the quarrying the quarry banks will be battered down and vegetation and topsoil replaced.

4.6 Resource Requirements

4.6.1 Fuel

Fuel for the project will be trucked from Kalgoorlie. An onsite fuel storage facility for 180,000L will be constructed. The fuel storage facility will be constructed to meet Australian Standards requirements for storage and bunding.

4.6.2 Water

Potable water for equipment washdown and other uses will be piped from a fresh water dam to the east of the mine. Saline water for road construction and dust suppression will be taken from pit dewatering water.

4.6.3 Communications

A microwave telephone and UHF radio communications system will be established.

4.6.4 Power supply

A small power generating plant will be established on site to provide power for the office and workshops.

4.7 Housing and Accommodation

The Sons of Gwalia's management workforce will be resident in Laverton and will commute from the site camp at Pennyweight Point. The contractor workforce will be based at the Pennyweight Point Camp and will be fly in – fly out from Leonora.

5.0 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT COMMITMENTS

This section identifies the environmental impacts arising from various elements of project construction, discusses the significant environmental impacts arising from these activities and details how these impacts will be managed. In some instances it is not possible to provide the details of the environmental impacts and rehabilitation programs, and in these instances management and rehabilitation principles are stated.

5.1 Land Clearing

Land will be cleared to enable the construction of the mine infrastructure site and the haul roads and for the quarrying of material to construct roads and causeways. The total area likely to be disturbed has been estimated and is shown in Table 4. This table includes the areas that will be disturbed on the lake by mining and waste dumps, but do not require clearing.

Table 4: Areas of Disturbance

Haul Roads & Causeway	56ha
Open Pit	36ha
Waste dumps	80ha
Infrastructure & Borrow Pits	40ha
Total	***212ha***

Total disturbance of Angelfish Island will be minimized by establishing mine infrastructure and ore stockpiles over previously disturbed areas and by minimizing the extraction of borrow material by extracting as much material as possible from Croissant Island and existing causeways.

Disturbance on the Island and the lake will also be minimized through the application of management procedures restricting vehicle movement in areas outside of the mine site.

In spring of 1999, a wider regional survey will be conducted with the aim of confirming a qualitative view that communities C5 and C6, and priority species *Acacia kalgoorliensis* and *Halosarcia* sp. ?Angelfish Island are generally well represented in the region.

5.2 Changes to the Lake System

5.2.1 Mine Dewatering

Safe construction of the open pit will require dewatering. The drilling carried out for geotechnical assessment has identified dewatering would be required to create a draw down zone to enable the pit to be dug. The likely rates of groundwater inflow to the Red October mine has been estimated by Golder Associates at up to 2,500kL/d. This estimate may vary as a result of the nature of the substrate and the presence of preferred drainage pathways within the water table.

It is proposed that the groundwater discharge be disposed of onto Lake Carey.

5.2.2 Predicting the Impact of Dewatering Discharge on to Lake Carey

While it is apparent that discharging mine dewatering water onto the surface of Lake Carey may have some impact, the quantitative effects of discharging volumes of saline water on to a lake surface are largely unknown. The impacts are likely to include an increase in the wetting period and the volume of total dissolved salts of the area of lake directly affected by the discharge. However the scale of these impacts on the function of the salt lake are largely unknown and difficult to predict.

On this basis the approach taken to predicting the impact of the discharge has been to consider the physical and chemical aspects of the discharge and to compare this to the physical and chemical characteristics of the natural system at subcatchment and catchment level, assuming that if the chemical characteristics are similar and the lake has the capacity to absorb the volume of discharge water and salts, the discharge will not have a long term detrimental effect. To further manage the impact some consideration has also been given to the advantages and disadvantages of containing the discharge water to minimise the area physically affected by the discharge.

It can quickly be determined that mine-water discharge is unlikely to have ecological impacts during and in the period after large rainfall events. The volume of mine-water discharge is dwarfed by the natural runoff (see below).

At the other end of the scale, periods of prolonged drought (a regular occurrence in this region) will result in discharges being confined to a relatively small area compared with the total area of Lake Carey. A combination of seepage into the existing hypersaline groundwater and evaporation will, based on experience at the nearby Granny Smith and Sunrise Dam operations, result in a pond of 100-200 hectares at most, with extended drought resulting in a wet area of a few tens of hectares. The resultant salt crust (evaporation during drought will far exceed infiltration) would be washed away and vastly diluted into the much larger lake volume in the subsequent event of a large rainfall event.

Meteorological scenarios more likely to pose an ecological threat are those involving moderate rainfall: Average Recurrence Intervals (ARIs) of around 5 years. This assessment is supported by the observation that the Cyclone Bobby event of 1995, estimated to have an ARI of between 50 and 100 years, resulted in widespread flooding which would have completely swamped any volumetric or salinity impacts of mine discharges to Lake Carey. As shown below, 5-year ARI involves a runoff into Lake Carey 4-5 times smaller than the 50- and 100-year events; the 5-year event would therefore have a much smaller dilution and volumetric effect on mine-water discharge.

On this basis, assessment of likely mine-water discharge impacts on the hydrology and salinity of Lake Carey has followed two approaches:

1. an "average rainfall" approach; and
2. a "rainfall probability" approach.

5.3 The Average Rainfall Assessment

Two studies were commissioned to review the hydrology of Lake Carey and consider the impact of the mining development on the lake. The following section summarises the findings and draws from the reports submitted.

5.3.1 Volumetric Comparison

Golder Associates (1998) have estimated that the seepage into the Red October mine would be approximately 2,400kL/d. This estimate may vary considerably due to the non-homogenous nature of the substrate and the presence of 'pipes' of gravel within the water table.

A conservative approach has been adopted to compare the volume of water discharged onto the lake with a predicted runoff to Lake Carey to consider the impact of the volume of discharge water onto the lake. Predicted mine discharge rates have been compared with the runoff from the Linden subcatchment and the whole Lake Carey catchment, for the runoff that would be generated by an October rainfall for a recurrence interval of two years and for the annual average rainfall/runoff.

The month of October has been chosen for the comparison because it has the minimum average rainfall of any month and the runoff would also be expected to be the lowest on a monthly basis. The Linden subcatchment directly contributes runoff from the west to the area of the lake to be affected by the mine. The results which are shown in Tables 5 and 6, show a comparison between predictions of runoff and dewatering discharge. The predicted dewatering discharge is much lower than runoff to the lake from its entire catchment, and smaller even than the runoff from the Linden subcatchment, and is unlikely to have an impact on the volumetric capacity of the lake.

Table 5 - Estimates of Pit Groundwater Inflow

Time	Approximate Rate of Inflow (ML/d)	
	'average' case	'high' case
3 months	0.75	2.6
6 months	0.60	2.2
1 year	0.40	1.7
2 years	0.30	1.5
3 years	0.30	1.3

Table 6 - Comparison of Mine Discharge with Runoff to Lake Carey

	Red October "High" Discharge Estimate (ML/d)	Whole Catchment Runoff (ML/d)	Linden Subcatchment Runoff (ML/d)
October 2 year ARI	2.6	650	19
Annual average	2.6	3,030	58

ARI = Average Recurrence Interval

5.3.2 Validation of Surface Water Model

In order to understand the changes to Lake Carey's hydroperiod from the discharge to the lake a model of the wetland's hydrology was constructed using evaporation, rainfall, seepage and the expected discharge into the lake. The model is quite complex and has proven to be reliable in modeling evaporating ponds and similar.

The modeling of Lake Carey was difficult for a number of reasons but one major reason was that the area available for evaporation and seepage is very large and undefined. The area available for evaporation and seepage is theoretically limited to the basin size of 75,000ha but in practice will be a lot less. In an unrestrained discharge scenario, the effective area affected by the discharge in a dry period is expected to be less than a few hundred hectares.

In order to validate the model real data was obtained from the Granny Smith mine site. The data is both quantitative and anecdotal. Granny Smith discharges from a mine a few kilometres from the edge of the Lake Carey. The discharge water is pumped to an area of the lake that also receives discharge from Acacia's Sunrise Dam mine. The total discharge is 27L/s at 260,000mg/L. The observations are that in summer 100 to 150ha of the area will be covered by 1-2 cm of salt with less over the remaining area.

The model predicts that after one year at the discharge rate of 27 L/s at 260,000mg/L, about 2cm of salt will cover 200ha. If the modelled area is expanded to an area affected of 250ha, the depth of salt generated by the model stays less than 1cm for the period of three years modelled. That is, the model over-predicts the area affected by the discharge.

There are two possible reasons why the model and observations vary.

1. The groundwater mound is expected to be much larger than the observed area of impact and therefore the seepage area is very likely to be 250ha or more.
2. The periodic flooding, of say once a year, is again a *de facto* increase in the area available for seepage. The model, as yet, does not account for episodic events.

Whatever the reason for variation between the observed and modelled, given the magnitude of possible error, the modelled and observed are within the same 'ball park'.

5.3.3 Hydroperiod

Water level changes have been identified as a critical function of a wetland. The term hydroperiod is used to describe changes in water level over time. Most plants and animals use the hydroperiod of a wetland to govern their life cycle. Plants, in particular, are usually located in the wetland where their requirement for water is satisfied but they will not be affected by water logging. Hydroperiod is a relative term and there is no generic hydroperiod that is good or bad. It is known that a change in hydroperiod will change the distribution of species of plants and animals. Therefore it is generally accepted that a significant change to a wetland's hydroperiod will be detrimental.

The model highlights that seepage from the Lake is a major function of the surface hydrology, driven by the low input from precipitation (average, median) and the expected discharge from the mine site even at low seepage rates of 0.0005 m/d, due to the large area involved. Under these conditions the hydroperiod will not be significantly changed from its natural state, except in the area immediately adjacent to the discharge point. Therefore the discharge point should be well away from the shore to avoid flooding of the fringe zone.

Under conditions of runoff from the nearby catchment, the discharge will again have an insignificant impact on the hydroperiod. Again, this is due to the relatively small volumes of discharge compared to the natural fluxes of runoff into the Lake, and evaporation and seepage from the area.

It is notable that even moderate increases in the volume of discharge will not significantly affect the hydroperiod.

5.3.4 Salt Load and Salt Concentration

Salt load and concentration have been considered together because the complexity of modeling such a shallow system does not allow for the subtle distinction between the two interrelated factors. An increase in salt load can be assumed to be an increase in salt concentration in one or more possible scenarios.

The expected scenario for discharging brine onto the surface of Lake Carey is that an area surrounding the discharge site will be covered in salt of an undetermined thickness. Beneath the salt surface will be interstitial brine that will not be influenced by evaporation but will contribute to the recharge of the groundwater. The actual quantity recharging the groundwater will depend on the area covered by brine, the depth of salt and a number of other factors.

Currently salt from the surrounding catchment accumulates on the lake, but because the area is so arid and the fluxes of water are low seepage or groundwater recharge dominate the process (Figure 4). A small amount of salt is brought to the surface of the lake by evaporation/wicking during the long dry periods creating a crust of salt. Moderate rainfall dissolves the salt, returning it to below the surface. Subsequent rainfalls cause ponding of relatively low salinity pools on the surface.

The model and anecdotal evidence of observed changes to the Lake both support this theory. Whilst undertaking investigations during 1998, it was reported that a crust of salt covered the Lake over most of the surface. At the time of a field trip, after rain, the ponds on the surface had sub-marine salinities whilst the groundwater 50-70 cm below the surface was hypersaline (approximately 200,000 mg/L).

The initial question is, will the salt load from the discharge brine significantly increase the salinity of the ponded water after a moderate rainfall? The answer is that it will over a small area of indeterminate size. This leads to the further question of how much area will be affected to a significant degree?

Figure 6 and Figure 7 are graphical representations of attempts to estimate the amount of salt on the surface of the lake under different scenarios. It was originally estimated that the seepage rate through the surface of the lake would be in the region of 1mm per day.

As pointed out in an earlier section, the seepage rate may vary considerably across the lake and some areas, such as beneath gypsum banks, may be very rapid recharge zones. However a seepage of 0.0005m per day over an area of 150ha was chosen to be conservative.

Figure 6 - Lake Carey Mass Balance

1,200kL/d, 150ha area, seepage 0.0005m/d, 234,000 mg/L

At the lower rate of discharge at 1,200kL/d, approximately 110,000t of salts will be discharged into the lake each year, of which approximately 8,000t will remain on the surface given average rain patterns. If the seepage is assumed to be 0.001m/d the quantity of salt remaining on the surface is much lower with no salt remaining on the surface for half of the year.

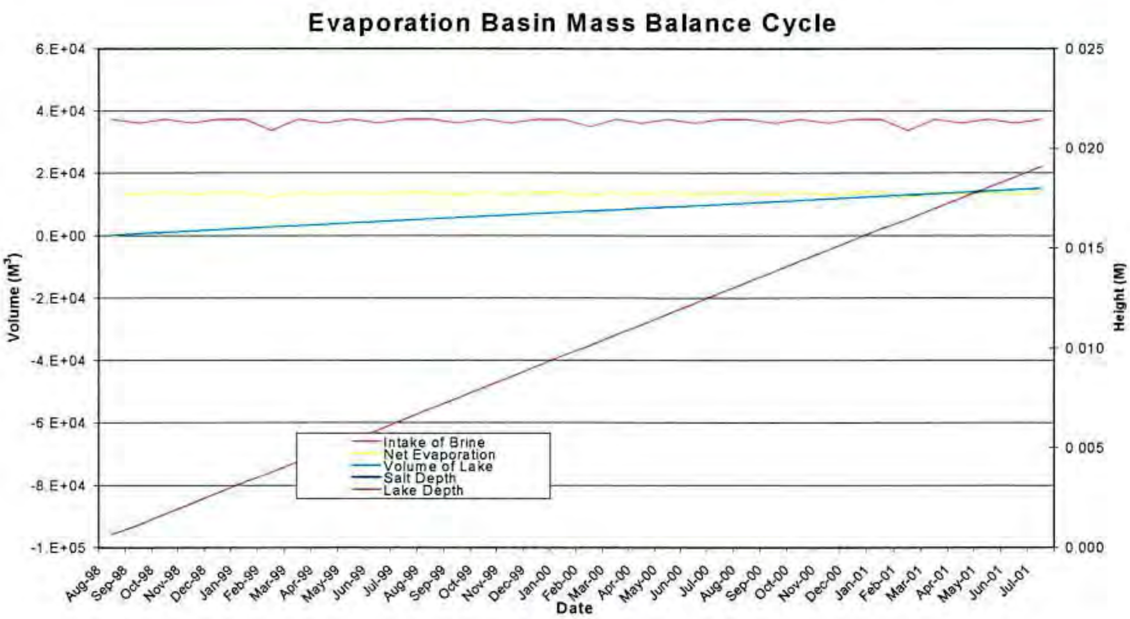
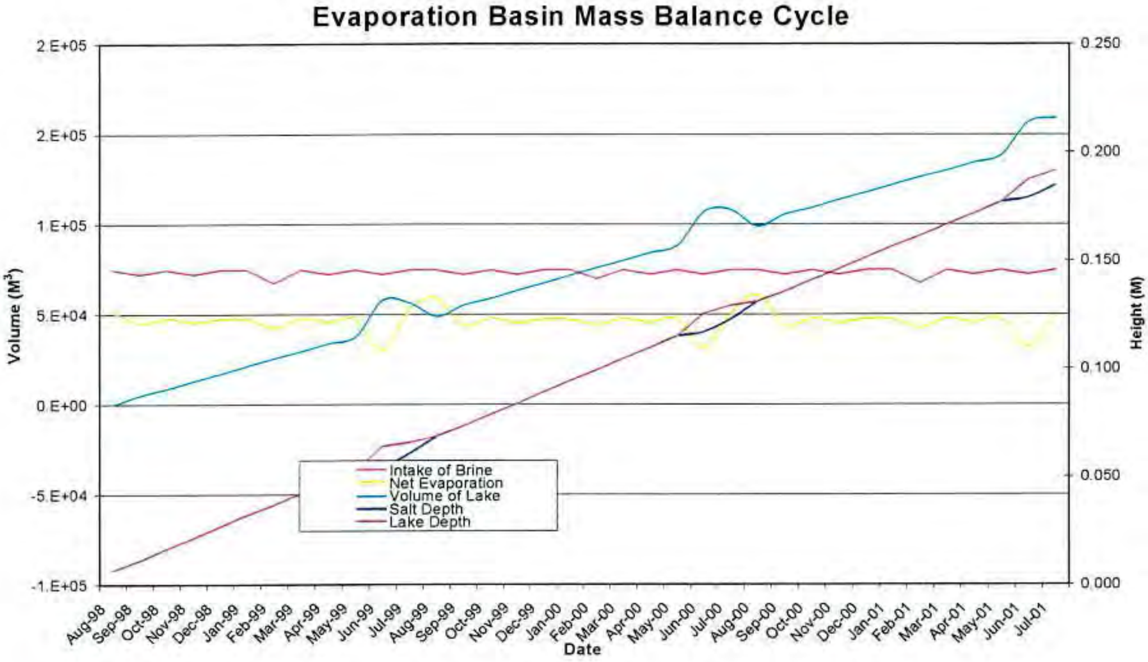


Figure 7 - Lake Carey Mass Balance

2,400kL/d, 150ha area, seepage 0.0005m/d, 234,000 mg/L



At the higher rate of discharge at 2,400kL/d, approximately 220,000t of salts will be discharged into the lake each year, of which approximately just less than half will remain on the surface given average rain patterns. If a higher seepage rate is assumed, then approximately 22,000t of salt would remain on the surface after a year.

Various scenarios have been generated to consider how much of the lake will be affected by increased salinity. The variables and the area affected are shown in Table 7.

Table 7 - Surface area affected by increased salinity[1]

Depth of Lake Water[2] (m)	Volume of Lake Water per Hectare (m^3)	Increase[3] in salinity (mg/L)	Tonnes of Salt per hectare	Tonnes Discharged on Lake surface	Area[4] Affected (ha)	Lake Carey %	Seepage (m)	Discharge Volume (kL/d)
0.05	500	10,000	5	100,000	20,000	27%	0.0005	2,400
0.1	1,000	10,000	10	100,000	10,000	13%	0.0005	2,400
0.05	500	10,000	5	8,000	1,600	2%	0.0005	1,200
0.1	1,000	10,000	10	8,000	800	1%	0.0005	1,200
0.05	500	10,000	5	20,000	4,000	5%	0.001	2,400
0.1	1,000	10,000	10	20,000	2,000	3%	0.001	2,400
0.05	500	10,000	5	1,000	200	0%	0.001	1,200
0.1	1,000	10,000	10	1,000	100	0%	0.001	1,200
1	10,000	5,000	50	110,000	2,200	3%	0.0005	2,400

1 Using a discharge area of 150ha
2 Assumed depth
3 Estimated increase in TDS without major detrimental changes
4 Area of Lake Carey covered by depth (column 1) with elevated TDS (column 3) to absorb discharge tonnes not returned to groundwater (column 5).

It should be noted that, if the depth of Lake Carey in Table 7 is taken to indicate the amount of rainfall/runoff, then it could be seen that a moderately sized event would have a greater impact than a wetter event.

5.4 The Rainfall Probability Assessment

5.4.1 Impacts of mine dewatering on groundwater

Hydrogeological investigations undertaken and documented in Golder Associates (1998a) have shown that the local groundwater system broadly comprises three hydrogeological units:

- an upper, deeply weathered zone (including the "lake clays" and the uppermost part of the weathered rock)
- a middle, weathered rock (oxide) zone
- a lower, fresh rock zone.

The water table is at or close to the lake surface and all of these zones are saturated with groundwater. The upper and lower zones appear from the recent drilling to be less permeable than the lower part of the oxide zone, from which the observed water flows were produced during hydrogeological investigations.

Numerical modelling of the groundwater system has been undertaken to estimate likely mine water discharge quantities and groundwater level drawdown and recovery, prior to and after mine closure, respectively. The modelling assumes that surface water is prevented from entering the pit with the construction of a bund. In summary it has been predicted that:

- mine water discharge reaches a maximum rate of 2.6 ML/day after 3 months of mining
- at the end of mining, the water table at the western edge of the pit would have declined approximately 10 metres in the lake clays
- at the end of mining, the cone of depression predicted to be associated with dewatering would have extended a radial distance of about 600 m in the lake clays
- following mine closure, 95% recovery of groundwater levels (9.5 m in the lake clays) is predicted within approximately 12 years, as the mine void fills. Faster recovery may be expected if Lake Carey floods.

It is proposed that groundwater pumped during the course of dewatering would be discharged to the bed of the lake, probably within the area of the cone of depression. Infiltration of some discharge water into the unsaturated lake clays is expected, the rest evaporating. This recirculation of pumped water may somewhat reduce water table drawdowns in the lake clays.

The effect of lowering the water table in the lake clays will be to increase the potential for infiltration of surface water from direct rainfall and from surface water flowing across the lake. This increased potential for infiltration of rainfall and surface water will be reduced by the effects of mine water discharge within the cone of depression. Water not infiltrating will evaporate and tend to increase the salinity of the near-surface materials.

Dewatering of groundwater in the area of the mine is believed unlikely to significantly impact on surface water due to the small predicted extent of the cone of depression in the lake clays relative to the area of the lake and the low permeability of the clay material.

5.4.2 Impacts of mine water discharge on surface water resources

A previous hydrological assessment of the impacts of dewatering discharge has been made and documented in Golder Associates (1998).

Based on the assessment of rainfall, surface hydrological characteristics and estimates of mine water discharge, it was concluded that:

i. the maximum likely dewatering discharge (2.6 ML/day after three months of mining) represents a maximum of about 14% of the total lake sub-catchment runoff likely for the lowest monthly rainfall-runoff (using the minimum 2 year average recurrence interval rainfall-runoff of 19 ML/day for the month of October)

ii. if it is assumed that infiltration of mine water discharge to the lake sediments is negligible, an area of approximately 0.5 km^2 would be required to evaporate the discharge water (this area could be accommodated within the predicted extent of the water table cone of depression caused by mine dewatering)

iii. using a salt load approach and excluding evaporation and salt accumulation from runoff, the maximum annual salt load from dewatering discharge is approximately 240,000 tonnes, while annual salt deposition from rainfall-runoff is likely to be about 4,500 tonnes.

iv. the lack of a permanent salt crust suggests that Lake Carey has sufficiently frequent throughflow of surface water and reflux brine formation to prevent salt accumulation

v. given the temporal and spatial variability of runoff to the lake, it is judged that three years of mine water discharge would have little effect on lake hydrology except in the immediate area of discharge, due to redistribution of this water and its dissolved salt during rainfall and runoff and infiltration of reflux brine.

A further analysis of likely impacts of mine water discharge on surface water for different return period runoff events has been undertaken. The analysis includes estimated likely runoffs from a proportional area of Lake Carey. A summary of estimated local sub-catchment runoff events and salt loads for the months with generally the lowest (October) and highest (February) rainfall is provided in Table 8.

The table shows that that estimated minimum and maximum monthly salt loads from runoff into the lake for the recurrence intervals presented are less than 100 tonnes. Over the life of the mine, it is estimated that the average monthly salt load due to mine water discharge is approximately 11,700 tonnes. Using this comparative assessment, it is clear the mine water discharge will significantly increase the total salt loads within the area of mine water discharge, particularly in dry periods where no surface water throughflow and dilution is possible.

Table 8 - Estimated Minimum and Maximum Monthly Runoff Totals and Salt Loads

Storm ARI (years)	Minimum and Maximum Monthly Rainfall (mm)	Minimum Monthly Sub-Catchment Runoff (ML)	Estimated Minimum Monthly Salt Load (tonnes)	Maximum Monthly Sub-Catchment Runoff (ML)	Estimated Maximum Monthly Salt Load (tonnes)
2	4 and 16	750	5	2,980	10
5	13 and 36	2,420	5	6,700	15
10	16 and 74	2,980	10	13,750	30
50	47 and 144	8,740	20	26,800	60
100	50 and 205	9,300	20	38,130	90

Note: ARI is the Average Recurrence Interval (in years)
Runoff is estimated by multiplying rainfall by the equivalent 'impervious' area of the Linden sub-catchment (148 km^2) and a proportional area of Lake Carey (38 km^2)
Salt load is estimated solely on the basis of soluble salts in rainfall, about 5 kg/ha/year with average annual rainfall assumed to be 220 mm/year (compared with 225mm/year for Laverton)

During and immediately following periods of prolonged rainfall, most likely in the months from November to March, it is predicted that mixing of mine water with surface runoff will occur on the lake. The speed and degree to which mixing would occur is not known, but is expected to occur every few years across the entire area of the lake and more frequently within individual parts of the lake. This redistribution of surface water across the lake by wind and the development of reflux brines (i.e. recycling of brine into the groundwater system following lake level rises) prevents a simple relationship being made between salt load, runoff volume/depth and lake surface elevation.

Evaporation of groundwater from within the lake sediments is a major contributor to temporary salt accumulation on the surface of Lake Carey. The potential monthly rate of salt accumulation across the area of the lake due to groundwater evaporation is conservatively estimated to average about 106,500tonnes, assuming:

- a Class A Pan evaporation of 2,500 mm/year,
- a pan to lake evaporation factor of 0.7
- actual to potential evaporation ratio of 0.01 (consistent with the findings of Schmid (1986) and incorporated in the calculation to allow for an anticipated net reduction in evaporation as a result of hypersaline groundwater quality).

This process is expected during prolonged dry periods and the calculation illustrates that the monthly salt load from mine water discharges is likely to be a small component of the lake's salt balance.

It is concluded that while mine water discharge is a significant contributor of salt in the immediate area of the mine, intermittent throughflow of surface water from the upstream (north-west) parts of Lake Carey across the area of discharge (for a period of just 3 years) and salt concentration due to groundwater evaporation are such that the significance of mine water discharge is small in the overall context of the lake's surface water resources. This conclusion is supported by the observations of the seasonal disappearance of the salt crust which forms on the surface, made by site staff at the nearby Granny Smith mine which discharges mine water on the lake surface.

5.5 Summary Of Hydrological Assessment

It is intuitively clear, and confirmed by both the "average rainfall" and the "rainfall probability" approaches, that the ecology of Lake Carey is unlikely to be significantly affected by the discharge of mine water from Red October during periods of prolonged drought and during periods of high rainfall. During drought, discharged water infiltrates into the already-saline, near-surface groundwater and evaporates to leave a salt crust; subsequent wetter conditions result in the resolubilisation of the salt crust and its incorporation into the vastly larger and diluting fresh-water inflows to the lake. In less frequent, high-rainfall circumstances, the salt and volumetric load of the discharge will be greatly exceeded by natural flows and runoff.

In the median circumstance, estimated at the 3-5 year events, both the "average rainfall" and "rainfall probability" approaches show that, provided the discharge point is well away from the lake shores dilution, natural runoff and lake throughflow provides sufficient attenuation of the salinity of discharged mine water to guarantee that lake waters are not significantly affected.

It is on this basis that it proposed that mine water from the Red October pit be discharged into natural depressions in the lake floor well away from the shores of the lake and its islands.

5.5.1 Nutrients and Pollutants

Chemical analysis of the lake water determined that the nitrate concentration varied between 0.03 and 0.17mg/L and the phosphate concentration between 0.02 and 0.62mg/L. This large range is due to the variety of surface water types found in small sub basins in the lake and it is not expected that the discharge will be outside this range. Significant variations in nitrates may be caused when the groundwater is pumped from sumps in the mine rather than bores. Experience has shown that these discharges can be high in nitrates and hydrocarbons. An intermediate storage pond will be constructed to reduce the level of nitrates and will include suitable pollution control equipment to contain hydrocarbons.

5.5.2 Ionic Composition

Brine from the surface and immediate subsurface of Lake Carey was analysed for both major and minor ions. A sample of brine from Bore GAP5A was included in the analysis. Golder and Associates provided the bore water analysis as typical for the proposed dewatering discharge. The major ions are listed in Table 9 and the minor ions in Table 10.

Table 9 - Major ions

Sample		pH	Conductivity	TDS	Salinity	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	SO_4^{2-}	Alkalinity
Date	Location	#	mS/cm	ppm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10-Jun-98	Site 2	7.5	22.2	20,000	13,000	4,100	86	200	1,400	8,200	1,500	32
10-Jun-98	Site3	7.69	38.4	27,000	22,000	6,400	120	380	1,100	13,000	2,000	33
10-Jun-98	Site 7 (GW)	7.22	25.6	210,000	180,000	47,000	820	2,800	3,300	120,000	12,000	52
10-Jun-98	Site 8	9.06	46.5	37,000	29,000	8,100	190	460	1,600	17,000	3,600	28
10-Jun-98	Lake Carey 1	9.49	16.6	15,000	12,000	2,500	77	130	1,100	5,600	2,500	20
6-Jul-98	Lake Carey 2	6.8		85,000	85,000	25,000	440	1,300	1,300	49,000	8,400	
6-Jul-98	GAP5A bore	6.8		250,000	25,000	80,000	1,300	4,700	600	130,000	26,000	

Table 10 - Minor ions

Sample		**Al**	**As**	**Ba**	**Cd**	**Cu**	**Fe**	**Pb**	**Mn**	**Ni**	**Zn**	**Resistivity**	**Hardness**	**Nitrate N**	**Phosphate**	**Hydroxide**	**Carbonate**	**Bicarbonate**
Date	**Location**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**ohm.cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
10-Jun-98	Site 2	0.2	0.01	0.2	0.002	0.01	1.15	0.01	0.03	0.01	0.01	0.045	4,400	0.03	0.02	10	10	32
10-Jun-98	Site3	0.1	0.01	0.1	0.002	0.01	51	0.01	0.03	0.01	0.01	0.026	4,300	0.13	0.31	10	10	33
10-Jun-98	Site 7 (GW)	0.3	0.01	0.2	0.013	0.01	110	0.01	0.4	0.01	0.01	0.004	20,000	0.17	0.61	10	10	52
10-Jun-98	Site 8	0.1	0.01	0.1	0.002	0.01	1.5	0.01	0.05	0.01	0.01	0.022	5,900	0.13	0.07	10	10	28
10-Jun-98	Lake Carey 1	0.1	0.03	0.2	0.002	0.01	1.6	0.01	0.01	0.01	0.01	0.06	3,300	0.02	0.06	10	10	20
6-Jul-98	Lake Carey 2													0.14	0.6		10	60
6-Jul-98	GAP5A bore													1.1	0.02		10	40

The ionic composition of the lake water varied significantly from that recorded for brine evaporated from seawater. The results of the comparison are listed in Table 11. Both ratios of common couples and basic ions were included in the analysis.

The lake water has significantly higher concentration of calcium and sulphate and lower concentrations of the more soluble ions, magnesium and potassium. In retrospect, this is not surprising considering the large deposits of gypsum around the lake, and the theory that the lake is seepage driven, making it likely that the more soluble ions will be the first to seep into the groundwater. This theory is supported by the much lower concentrations of calcium in the bore water.

Table 11 - Comparisons with Seawater

Date	Location	Mg^{2+}/ Na^{+}	Na^{+}/Cl^{-}	Ca^{2+}/ SO_4^{2-}	Mg^{2+}/ SO_4^{2-}	Mg^{2+}/ Cl^{-}	Ca^{2+}	SO_4^{2-}	Mg^{2+}	Cl^{-}	K^{+}	Na^{+}
10-Jun-98	Site 2	40%	91%	594%	28%	37%	773%	130%	36%	99%	52%	90%
10-Jun-98	Site3	49%	89%	359%	40%	44%	428%	119%	47%	108%	50%	96%
10-Jun-98	Site 7 (GW)	50%	70%	357%	40%	35%	324%	91%	36%	103%	35%	72%
10-Jun-98	Site 8	47%	86%	287%	27%	41%	383%	133%	35%	88%	49%	75%
10-Jun-98	Lake Carey 1	43%	81%	280%	11%	35%	608%	217%	24%	68%	46%	55%
6-Jul-98	Lake Carey 2	43%	92%	103%	33%	40%	131%	127%	42%	104%	47%	96%
6-Jul-98	GAP5A bore	49%	111%	39%	29%	54%	70%	179%	52%	96%	48%	106%

It is <u>not</u> important that the discharge water has the same composition as seawater; the important comparison is between the discharge sample, and the range of samples taken from the surface and immediate subsurface brine.

Tables 8 and 9 also allows the comparison between the receiving and discharge water. The only significant variation between the discharge and the surface samples ionic composition is the Ca^{2+}/SO_4^{2-} 'couple' and the Ca^{2+} ion ratios. All the rest of the ionic concentrations fall within the ionic composition scatter for the surface samples when they have been adjusted for different salinities.

It is not known what changes will be made to Lake Carey if the discharge brine is significantly different from the lake brine. Information on the effect of ionic composition on species is scanty at best.

In conclusion, it can be said that the ionic composition of the surface and discharge brine is not significantly different with the exception of calcium concentrations. The surface water has an unusually high calcium level due to the large deposits of gypsum/anhydrite on the surface and the differential solubility of the salts. The discharging of brine with lower concentrations of calcium is unlikely to have any impact given the large deposits of gypsum on the surface and the relatively small discharge volumes to lake area.

5.5.3 Surface Hydrological Process

The project will cause a number of changes to the lake surface and it is important the resulting landforms are located so as to minimise the interference with surface hydrological process. The most obvious sign of hydrological processes is the deposition of alluvial sediments on the northwestern face of the islands and shores. The orientation of these alluvial deposits suggests that the sediment is moving in a southwesterly direction. It also suggests that, on average, the water moves in a southwesterly direction during a wind event and northwesterly in a lull. The direction is changed when the currents come against more solid barriers such as islands.

Angelfish Island shows signs of a strong current from west to east on the northern shore forming the dorsal fin, and strong southerly current on the western side of the island. It is likely that the movement of brine creates these patterns in the alluvial deposits as it moves to the south of the lake during high wind events. The movement along the top of Angelfish Island is caused by the constriction of flow between Angelfish and the mainland on the western side - this is compounded by the existing causeway.

The mine will take up the major part of the lakebed between Angelfish Island and Treasure Island. There seems little point in preserving what would be left of the passage between the two islands once the mine is in place. As far as practical, the remaining infrastructure and waste dumps will be placed within this area to cause minimal obstruction to the north/south flow.

The proposed causeway between Angelfish Island and the eastern shore will further restrict the movement of brine from north to south and will be designed to allow the free flow of brine. The causeways will be designed to allow for wind-driven water movement.

5.5.4 Evaluation of Discharge Options

There are a number of options for discharging the dewatering brine from the Red October Mine. A brief description of the potentially feasible options has been included below. The advantages and disadvantages of the options are also discussed.

1. Unconfined Dispersal across Lake Carey

   The brine from the mine dewatering is drained or pumped via a pipeline to the edge of the lake. The discharge should clear the fringing vegetation by at least 200m to minimise impact. Ideally a sub basin of suitable size should be identified and utilised within the lake to contain the discharge while it evaporates and seeps into the lake surface.

   The model predicts that the affected area would be about 150ha assuming a discharge of 2,400 m^3 per day at 230,000mg/L. This is the method that most mining companies use to discharge their dewatering brine and is the lowest cost option with the least engineering.

2. Constructed Seepage/Evaporation Pond on Land

   This option entails the construction of a large level pond on land. It may be 150ha in size with banks of 1m to 2m. The banks will need to be impervious to seepage. It would have a large engineering component and therefore be expensive to implement. The brine would be discharged into this pond and the lake would be superficially unaffected by the discharge. The design of this pond would be similar to tailing dams used to retain wastewater from mining operations.

3. Enclosed Bay within Lake Carey

   There are a number of bays within Lake Carey of sufficient size that would, according to the proposed model, be of a suitable size to receive mine discharge water (150ha). A suitable bay could then be enclosed by a bund, and the dewatering brine discharged into this enclosed area.

4. Enclosed Bunded Area within Lake Carey

   In this option an area on the lake would be enclosed by a bund. This area might be within a bay or in the lake proper. The concept is for the area to be as great as that affected by the discharge calculated by the model (150ha). The banks would be less than a half a metre high and would not have the structural strength to contain more than 10cm of brine. The bank could be constructed by either a dozer or, in good conditions, a grader. The banks will only act to contain the brine during moderate rainfall events.

   During low rainfall events, the water will not reach the banks and in high rainfall events the banks may be allowed to breach. In fact, it may be possible to discharge the brine for a time during the dry period, determine the likely coverage and then run a small containment bank around the discharge zone in time for the next wet period.

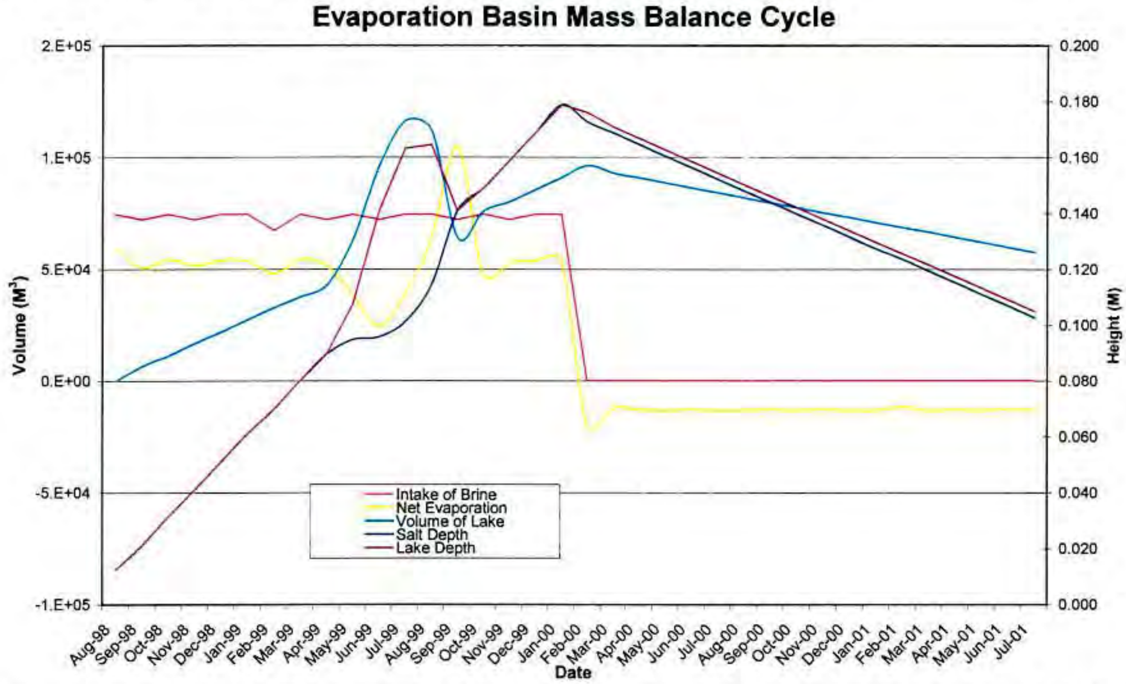
5.5.5 Confined versus Unconfined Discharge

The main advantage of discharging into a confined area is that whatever the discharge rate or net evaporation, the impact is confined to a limited area. During rainfall events the high salinity brine will not meander over the lake, dictated by the direction of the wind. Depending on the area chosen, the salt may gradually accumulate in the bunded area over the life of the mine. However, as soon as the discharge stops, the salt load in the bunded area will decrease and within a reasonable amount of time the recharge will be complete with no or very little accumulated salt.

Figure 8 models the change in salt height in the scenario with the higher discharge rate and smallest recharge after eighteen months of discharge and an equal period of no discharge. The model predicts that three years after starting the project about 100,000t of salt would be still left in the bunded area. However this is a worst case scenario to illustrate a point in which uncontrolled discharge would have altered significant areas of the lake, but is being contained and there has not been a significant impact on the lake's function.

Figure 8 Decrease in salt height after eighteen months of discharge

2,400kL/d, 100ha area, seepage 0.0005mg/d



The disadvantages of discharging into a bunded area are the impacts and the cost of constructing the bund and an access way to the discharge point. If a bunded bay is used to confine the discharge and water floods the shore fringe line some vegetation loss may occur.

Table 12 models the scenario where the discharge from the minesite is stopped after three years. For different discharge rates, seepage rates and area covered, it presents the depth and amount of salt at mine closure and at one year after mine closure, as well as the number of years before the salt load from discharge becomes insignificant.

Table 12 - Groundwater Recharge Basin Scenarios

Area of Basin	Seepage	Discharge Rate	TDS	Depth of Salt at closure	Salt at Closure	Depth of Salt 1 year after Closure	Salt 1 year after Closure	Years before no salt
ha	mm/day	kL/day	Ppt	(cm)	Tonnes	(cm)	Tonnes	
100	0.0005	1,200	234	10	103,000	5	53,000	2
150	0.0005	1,200	234	2	29,000	0	0	1
100	0.001	1,200	234	0.3	2,500	0	0	1
150	0.001	1,200	234	0	0	0	0	0
100	0.0005	2,400	234	33	335,000	30	300,000	10
150	0.0005	2,400	234	18	260,000	13	205,000	5
200	0.0005	2,400	234	10	206,300	5	105,000	2
100	0.001	2,400	234	20	200,000	10	105,000	2
150	0.001	2,400	234	4	60,000	0	0	1

It is difficult to calculate the length of time permissible for a discharge to remain within a bunded area. However, a discharge pond of an area of 150ha returns a zero salt load after two years in most cases. It can be expected that any reasonably constructed banks of a pond will remain intact after two years of no maintenance. Only in the worst case scenario does the discharged salt load take five years to disperse. On the other hand, in several scenarios the discharge would have seeped away at the time of decommissioning the mine, in which case the bunds could be removed at the same time.

5.5.6 Relative advantages and disadvantages of options

It is not possible to quantify the environmental impact of each option. Clearly, however there are advantages and disadvantages for each option. Table 13 compares the options in a qualitative fashion. This comparison precludes the land-based option as having little merit. The unconfined option results in very little physical disturbance on the lake bed, but higher levels of salinity has the potential to cause currently undetermined impacts on lake fauna and fringing vegetation if the discharge location is not carefully managed. The bunded pond within the Lake will require significant earthworks to construct the pond and a causeway to access the area for maintenance, but will limit short-term impacts of increased salinity to a limited and controlled area.

Of these two options the unconfined scenario would be the best option, except for the potential for the impact on the shore vegetation during intermediate wet periods. It is considered that this risk can be managed by careful management of the discharge point

The third alternative is to enclose a bay of an appropriate size with a bund. This alternative reduces the physical disturbance on the lake to the construction of a shorter bund and allows all maintenance activity to be shore based. The disadvantage is the potential for impacts on shore based vegetation.

Table 13 - Relative merits of options

Option	Relative Construct-ion Cost	Relative Pumping Cost	Risk to environment during dry episode	Risk to environment during moderate wet episode	Risk to environment during very wet episode	Aesthetic Impact	Rehabilitation Effort
1. Unconfined	Negligible	Low	Low	Medium	Low	Low	Negligible
2. Landbased pond	High	Variable	Medium	Low-Medium	Negligible	High	High
3. Enclosed bay	Medium	Low	Low	Localized High	Low	Moderate	Moderate
4. Bunded pond	Medium	Low	Low	Low	Low	Moderate	Low to Negligible

On the basis of environmental risk, there is little difference between the four options, although the enclosed bay option does involve relatively high risks associated with moderate wet episodes. As well as environmental risk during operations, it is necessary also to consider operational issues such as the costs of construction of bunds and causeways and maintenance and management of the facility, and the risks associated with the decommissioned system. At least on aesthetic grounds, the closed bay and bunded pond options rate poorly; moreover, the disturbance associated with removal of bunds after decommissioning must be considered.

It is therefore proposed to discharge in an unconfined manner at a point or points in Lake Carey so that near-shore vegetation and, after moderate wet episodes, near shore ponds of relatively fresh water, are not significantly at risk. There are several suitable discharge points near Angelfish Island; one particularly attractive one is a shallow but large depression located several hundred metres north-west of the island.

The brine will be initially discharged into a settling dam before discharge. An absorbent boom or similar would be installed to collect hydrocarbons from the discharge.

5.6 Aquatic Ecology Studies

To allow assessment of impacts on aquatic fauna and ecosystems, micro-algae, micro-invertebrates and aquatic birds a number of studies will be implemented as part of a joint effort by several mining companies operating in the region. An outline of those studies is set out in Section 3.5.4.

5.7 Waste Products

Waste management in this relatively pristine environment is considered critical to minimise degradation and to maximise environmental rehabilitation post mining.

Apart from waste rock from the mining operation, the significant waste stream from the mine will consist of industrial waste from the operation of the earthmoving equipment. This will include waste oil, oily waste and workshop waste.

In order to minimise the impact of these materials on the aquatic environment strict waste management procedures will be outlined in the earthmoving contract and will include the following:

1. Hydrocarbon Waste

Facilities will be installed to manage waste oil and oily waste including oil filters and other materials contaminated with waste oil and grease. These will be separated from the general waste stream and disposed of off site via an approved waste oil contractor.

2. Washdown Bay

A concreted washdown facility will also be installed. The facility will consist of a mechanical oil/water separating unit with the opportunity to recycle the water for use within the washdown facility. Silt and mud accumulating in the washdown bay will be disposed of on the waste rock stockpile and the oily waste separated from the water will be returned to the bulk waste oil facility. Runoff from the concreted work areas will also be directed to the washdown bay for the removal of any hydrocarbons.

3. Site Runoff

The workshop and hardstand areas will be graded so that runoff is directed to a central collection pond where runoff water can be evaporated and silts and any contaminated material can be collected.

4. Industrial Waste

A rubbish pit will be constructed on the island to receive all other non polluting waste including office and putrescible waste and other industrial materials. The pit is likely to be constructed inland from the shore of the island where there is limited likelihood of pollution or leachate impacting the aquatic system.

The rubbish pit would be fenced to ensure that rubbish from the pit would not litter the island and rubbish will be burned and compacted to reduce volume.

5.8 Dangerous Goods and Hazardous Substances

The main dangerous or hazardous materials required for operation of the site are explosives and diesel fuel. Both materials will be carted to the site via Laverton and our private haul road. Fuel will be stored in a facility designed to comply with the requirements of the Environmental Protection Act and the Explosives and Dangerous Goods Act.

An explosives magazine will also be constructed to comply with the Explosives and Dangerous Goods Act.

5.9 Atmospheric Pollution

Atmospheric pollution from the site will be minimal. Effective dust suppression will be achieved by the use of a water cart utilising water from the mine dewatering.

Given the remoteness of the site there is no possibility that the dust will be of nuisance to any neighbours and is not likely to be significant compared with the background dust levels from the adjacent rangelands.

However, it is important that effective dust suppression be achieved to provide for safe operation around the site. It is envisaged that using the saline water will be adequate to meet this requirement.

5.10 Noise

Given the remoteness of the site environmental noise levels will not be an issue. Noise control procedures in relation to operating equipment will be appropriate so as to maintain safe occupational noise levels.

5.11 Greenhouse Gases

The impact of greenhouse gas emissions is a global issue, and not restricted to the local or regional environments.

The Red October project will directly result in emissions of carbon dioxide from two sources:

- diesel-fuelled internal combustion engines in mining equipment and vehicles; and
- clearing and subsequent decomposition of vegetation and soil organic matter

CO_2 emissions associated with freight and other transport-related activities for the project are difficult to estimate, but are in any event extremely small when compared to those associated with mining equipment. Note that no mineral processing or other activity likely to result in significant CO_2 emissions will be conducted at Red October.

It is estimated that the peak rate of dieseline use in mining at Red October will be approximately 5 million litres (5ML) per year. This equates to CO_2 emissions of 14.5 tonnes per year. WA's annual CO_2 emissions are of the order of 25-30 million tonnes per year, and Australia's are or the order of 300-375 million tonnes per year.

The vegetation to be disturbed for the project is typical of the semi-desert region: sparse woodland and salt flat. CO_2 emissions associated with project clearing are thus inordinately small in comparison with other vegetation-clearing activities on local, regional, national or global scales. Moreover, rehabilitation and revegetation of disturbed areas can reasonably be expected to result in ultimate re-establishment of carbon sinks on the areas.

Thus, even on a regional scale, the CO_2 emissions associated with the Red October will be small and of little regional, national or global significance. Nonetheless, Sons of Gwalia will:

- restrict clearing to that required for safe and efficient operations, and rehabilitate and revegetate disturbed areas at or after decommissioning;
- encourage the mining contractor to use the most fuel-efficient equipment that is practicable; and
- ensure that regulations governing the use of chlorofluorocarbons in air-conditioning and pressure-pack sprays are complied with.

5.12 Mine Closure

The development on the mine on the salt lake raises a number of unique aspects for mine closure. In the absence of guidelines from the Department of Environmental Protection and the Department of Minerals and Energy the normal completion criteria for open cut operations on land have been adopted.

Within 12 months of the start of operations, Sons of Gwalia will submit a Mine Closure and Rehabilitation Plan to DEP and DME. That plan will address the decommissioning, rehabilitation and, as appropriate, revegetation, of all disturbed areas. Progressive rehabilitation of areas no longer required for project activities will be an important element of the Plan.

5.12.1 Open Pit

During mining the open pit will be enclosed on three sides by causeways and waste dumps. On the completion of mining it is proposed that a bund wall will be constructed to close off the open side of the pit to provide a safety barrier and to prevent flooding. As the causeways will be significant structures they are likely to provide a reasonable barrier against any significant flood event. The bund to be created post mining will not be constructed to the level of the existing causeways but will be more substantial than the usual paddock bund protection barrier constructed around an open pit on dry land.

5.12.2 Waste Dump

The waste dump will be designed to resemble the geomorphological shape of the surrounding islands, minimise visual impact. In the absence of topsoil material, the waste dump will not be rehabilitated in the normal sense: the first-mined muds will then be covered with competent, later-mined waste rock. The maximum height of the dump will be approximately 10m, and batters will be no more than 20°. The competent-rock finishing cover will prevent erosion of the underlying muds.

5.12.3 Mine Access

The causeway linking the open pit to Angelfish Island will be removed to reinstate drainage between the open pit and Angelfish Island.

5.12.4 Haul Roads

The haul roads and causeways across Lake Carey developed for the operation of the Red October mine will significantly upgrade transport infrastructure in the region. Sons of Gwalia propose to consult with local authorities, pastoralists and regulatory agencies over the status of these roads post mining as it may be appropriate they remain in place for the public benefit. If they are not required Sons of Gwalia commit to decommissioning and rehabilitating the areas as appropriate.

5.12.5 Mine Infrastructure Areas

Mine infrastructure areas on Angelfish Island will be decommissioned, ripped and revegetated.

5.13 Potential for Future Operations and Consideration of Cumulative Impacts

The proponents have a large tenement holding over Lake Carey. Currently there are no identified resources other than Red October. The proponents will continue to explore with the aim of carrying out mining operations where appropriate.

The development of further mining operations on Lake Carey will have different levels of impact depending on their location relevant to the Red October mine and associated infrastructure. Operations close to Red October could share existing causeways and presents the opportunity to backfill mined out open pits where logistically feasible. (The work carried out by WMC Ltd on Lake Lefroy demonstrates that back-filling of open pits on the lake bed is achievable.)

Future mining operations on Lake Carey remote from Red October may require the construction of further causeways and other infrastructure and this would prompt some consideration of the need for rationalization. However it is meaningless to speculate further than this on the extent of future requirements at this stage.

While ore from the proposed Red October operation will be treated at Laverton it may be feasible in the future, given the development of sufficient resources, to establish treatment facilities closer to the mine. If this situation arose it would be more likely the mill would be located some distance away from the lake rather than on the lake or on the island because of the reduced risk and better geotechnical conditions.

6.0 SOCIAL IMPACTS

6.1 Heritage

There are no recorded European heritage sites of significance in the vicinity of the proposed mine or infrastructure.

6.2 Aboriginal Sites

Heritage surveys of the Red October minesite and the proposed haul road have been carried out. The findings of these surveys are detailed below.

6.2.1 Archaeological Survey – Haul Road

Archaeological surveys were carried out over three sections of the proposed haul road from the proposed minesite to the Barnicoat mine, near Laverton (Mattner & Corsini, 1998) . The Laverton survey corridors were 200m wide and covered those sections which need to be constructed to link existing roads. The total length of the three sections was approximately 35km.

No Aboriginal Archaeological sites or artifactual material were discovered despite searches across the three survey areas. Previous heritage studies in the region have demonstrated that the colluvial plains with mulga woodland generally have a very low incidence of archaeological sites.

6.2.2 Archaeological Survey –Red October Mine site

A survey for Aboriginal archaeological sites over the Red October project area was conducted in February 1996 (Quartermaine and Mattner). The bulk of the survey was carried out on Angelfish and Treasure Islands.

21 archaeological sites were discovered and were recorded in the course of the survey. A very sparse background scatter of isolated artifacts was also noted. The sites have been recorded and located using a handheld GPS unit. The location of the sites is shown on the Conceptual Mine Plan in Appendix 3.

All the sites are artifact scatters with one site also containing a quarry for quartz crystals and vein quartz, one probable stone arrangement and possible other evidence of past Aboriginal activities. All the sites occur on the islands with 18 of them located on Treasure and Angelfish Islands. Virtually all of the sites situated near the shore line there was only one being more than 200m inland. Nine of the 21 sites are located on kopi dunes, generally near the base. A further five sites occur directly on the exposed gypsum of the kopi dunes.

Two sites are situated on red sand dunes and rocky promontories whereas three occur on sandy terraces on the shores of Lake Carey. Of the two largest sites one is located on a stony terrace and slope and the other on the red sands and gypsum slopes of a quartz blow.

The artifact assembly indicate that occupation of the project area was transitory and brief. Most sites are small to very small. The largest site, with thousands of artifacts, was frequently occupied for extended periods but the absence of grindstones indicate that it was not a major campsite. Occupation of this site was probably tied to the availability of water in the neighbouring drainage lines. The smaller artifact assemblage at the quartz blow suggests that this area was visited to collect crystals and rocks for artifacts but was not used as a campsite.

From these results it is apparent that Aboriginal occupation of the islands and the project area was spasmodic and transient, while usage of the western shore of Lake Carey was very sparse. It is likely that small parties visited the islands to hunt and gather, most probably immediately following rains when water was available. At other times the aridity of the area prevented occupation.

Sons of Gwalia propose to disturb two sites on Croissant Island to allow for extraction of borrow material and the construction of the waste dump. The sites have been described as artifact scatters of very low significance. Disturbance of the two sites will reduce the amount of quarrying on Angelfish Island and allow for better protection of more important sites.

Application has been made to the Aboriginal Cultural Materials Committee to disturb the sites.

6.2.3 Anthropological Survey

An ethnographic survey for Aboriginal sites at the Red October mining area has been carried out with Aboriginal representatives of the North Eastern Independent Body. Two ethnographic sites were identified. These are Mount Lucky and a site located at AMG 6 787 220N 445 850E, part of the Wati Kutjara Dreamtime Story. The Aboriginal informants advised that these sites have to be avoided. These sites occur outside of the corridor identified for the construction of the haul road and will not be disturbed and Sons of Gwalia will provide a sufficient buffer so as to avoid these areas.

6.2.4 Dealings with the Mt Margaret Aboriginal Community

As part of the dealings with the North East Independent Body, Sons of Gwalia has spoken extensively with the Mt Margaret Community. During discussions at Mt Margaret in early December 1998, community representatives expressed their strong support for the Red October project, and provided written confirmation that the community wished the project to proceed. Community members observed that, as the project involved no chemical discharges to Lake Carey and no mineral processing on site, they could see nothing but benefit for the community from the implementation of the project.

6.3 Social Environment

The Red October mine is situated in a relatively remote area of Western Australia. It is only in recent times that significant development has occurred in the region with the development of the Placer Granny Smith and Acacia Sunrise Dam mining projects. Like these projects the Red October project will contribute to the region through the upgrading and construction of road networks which will benefit future exploration, local pastoralists and tourism.

6.4 Workforce Induction and Training

Environmental awareness training will be provided to the mine construction and mine operating workforce to ensure the workforce is aware of the environmental aspects of the operation so as to minimise environmental degradation where possible.

The discussion will focus on the minimisation of impacts on the aquatic and terrestrial environment and increase the awareness of activities to reduce degradation in these areas. The induction will be based on Sons of Gwalia's corporate environmental induction program and will include additional information focusing on protection of the aquatic environment.

Sons of Gwalia will aim to provide environmental awareness training to all personnel working on site including contractors.

7.0 Summary of proponents' commitments

The following table summarises the proponents' commitments to environmental management for the Red October project.

Summary of proponents' commitments

Commitment	Objective	Action	Timing	Advice from	Measurement/ Compliance
1. Conduct studies into the ecological values of Lake Carey.	To understand salt lake flora and fauna and facilitate development of appropriate management programs.	Sons of Gwalia will participate with other mining companies in study program in progress.	Immediate, and ongoing.	CALM, DEP	Annual Environmental Report to Government' on progress and findings of the studies.
2. Protect near-shore vegetation and fresh-water ponds from impacts of mine water discharge.	To maintain habitats for water-birds in fresh-water ponds formed after moderate rainfall events.	Mine water will be discharged into natural depressions in the floor of Lake Carey, and near-shore water quality (salinity and metal composition) will be monitored on a monthly basis when freshwater ponds exist.	Immediate, and through life of project.	DEP	Annual Environmental Report.
3. Ensure that north-south water flow in Lake Carey is maintained.	To allow natural hydrological processes to continue.	Provide culverts in causeways to permit throughflow of 100-year flood.	Design to be completed before start of construction.	DME	Approval by DME of culvert design.
4. Manage impacts on flora communities and species with Priority status.	To protect abundance, diversity and geographical distribution of vegetation communities C5 and C6, and of *Acacia kalgoorliensis* and *Halosarcia* sp. ?Angelfish Island.	(i) Minimise disturbance of vegetation communities C5 and C6. (ii) In spring of 1999, conduct wider regional survey with view of confirming qualitative view that communities C5 and C6, and priority species *A. kalgoorliensis* and *Halosarcia* are generally well represented in the region.	(i) Before construction. (ii) August 1999	CALM	(i) Review with CALM of potential impacts on vegetation and Priority species. (ii) CALM review of report on wider vegetation and priority species survey.
5. Minimise land disturbance	To prevent unnecessary impacts on vegetation and reduce erosion risks.	Total disturbance on Angelfish Island will be minimized by establishing mine infrastructure and ore stockpiles over previously disturbed areas and by minimizing the extraction of borrow material by extracting as much material as possible from Croissant Island and existing causeways. Disturbance on the Island and the lake will also be minimized through the application of management procedures restricting vehicle movement in areas outside of the mine site and authorised access-ways.	During construction and throughout project.		Progress to be reported in Annual Environmental Report.
6. Rehabilitate disturbed areas to safe, stable and sustainable landforms.	To control erosion (wind and water) and provide acceptable visual impact.	Develop a Mine Closure Rehabilitation Plan for waste stockpiles, access-ways and other disturbed areas.	Within 12 months of the start of mining operations.	DME and DEP	Progress to be reported in Annual Environmental Report.

7. Manage hydrocarbon use to prevent contamination of ground and surface water.	To prevent diminution of quality of water resources.	Develop Hydrocarbon Management Plan for the collection and management of waste hydrocarbons and spills, including potentially-contaminated runoff around workshops and wash-down area(s), and treat water with oil/water separation equipment prior to release or recycling	Before construction.	DEP	Effectiveness of Plan reported on in Annual Environmental Report.
8. Comply with the requirements of the *Aboriginal Heritage Act 1972*.	To protect Aboriginal culture and heritage.	Ensure preserved sites are not disturbed, and continue established liaison with the North East Independent Body and the Mt Margaret Community.	Ongoing.	Local Aboriginal bodies	By exception.

* Government includes EPA, DEP, DME, CALM, Water and Rivers Commission and others as appropriate.

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9.0 APPENDICES

Appendix 1	**-**	**Photographs of Site**
Appendix 2	**-**	**Vegetation Maps, Flora Lists and Photographs**
Appendix 3	**-**	**Project Plan and Conceptual Mine Plan**
Appendix 4		**EPA Guidelines for this CER**

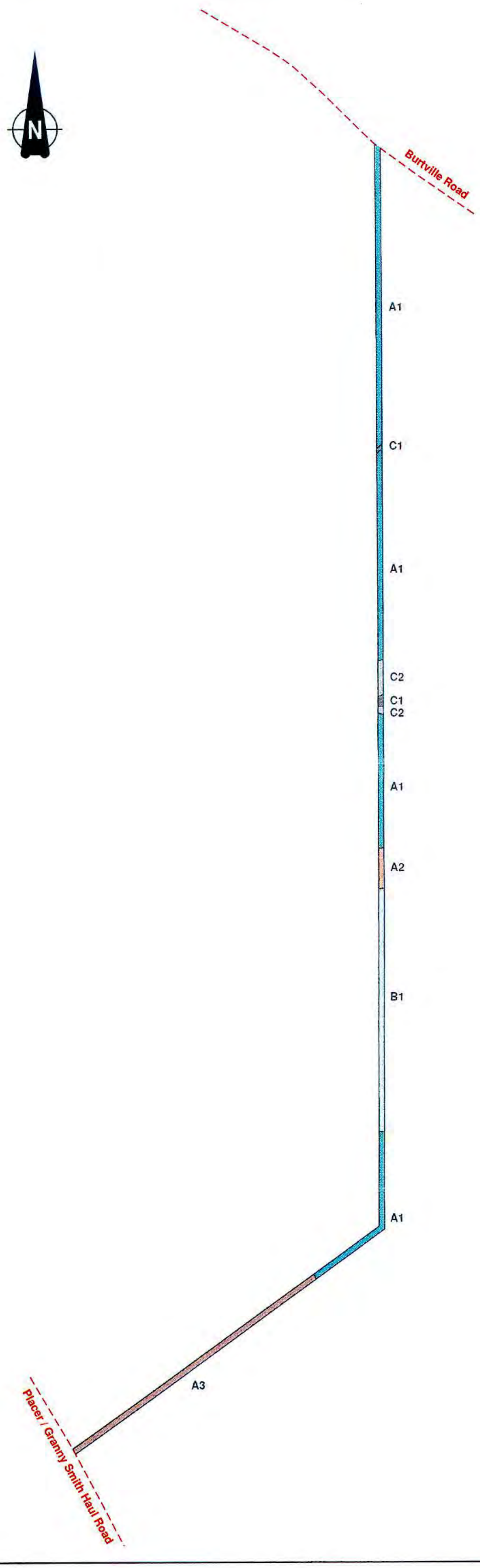
Appendix 1 – Photographs of Site

Appendix 1

Photo 1 - View south from causeway towards Angelfish Island

Photo 2 - View north from causeway towards Treasure Island

Appendix 2 – Vegetation Maps, Flora Lists and Photographs



LEGEND

A Woodlands

A1 Open Woodland of *Acacia aneura* var. *aneura*, *Acacia aneura* var. *latifolia* and *Casuarina pauper* over *Acacia tetragonophylla*, *Scaevola spinescens*, *Ptilotus obovatus* and *Enneapogon caerulescens* var. *caerulescens* on loam with a moderate covering of banded ironstone rocks.

A2 Open Low Woodland of *Acacia aneura* var. *latifolia* and *Acacia acuminata* subsp. *burkittii* over a very sparse understorey dominated by *Aristida contorta* on loam with scattered ironstone pebbles.

A3 Open Low Woodland of *Acacia aneura* var. *aneura* over a very sparse understorey of low, mixed shrubs with a dense covering of banded ironstone rocks.

B Shrublands

B1 Shrubland of *Hakea preissii* and *Acacia tetragonophylla* over low mixed shrubs dominated by *Maireana pyramidata* on clay loam.

C Low Shrublands

C1 Open Low Shrubland of *Maireana glomerifolia*, *Maireana georgei* and *Atriplex lindleyi* subsp. *inflata* with emergent, scattered *Acacia aneura* var. *latifolia* on loamy sand with scattered banded ironstone and quartz pebbles.

C2 Open Low Shrubland dominated by *Maireana sedifolia* and other mixed chenopods with emergent, scattered *Brachychiton gregorii*, *Casuarina pauper* and *Acacia aneura* var. *latifolia* on loamy sand with scattered laterite and quartz pebbles.

NOTES

This map is to be read in conjunction with Mattiske Consulting Report numbered SOG002/34/98

0 500 1000 1500 2000 2500m

SCALE

SONS OF GWALIA LTD

VEGETATION MAP
L38/76 HAUL ROAD

MATTISKE CONSULTING PTY LTD
28 Central Road, Kalamunda
ACN 063 507 175
Phone: 9257 1625 Fax: 9257 1640

Author: EMM, DW	MCPL Ref: SOG002/34/98	Scale: 1:50,000
Drawn: CAD Resources 9246 3242	Date: July 98	Figure: 1
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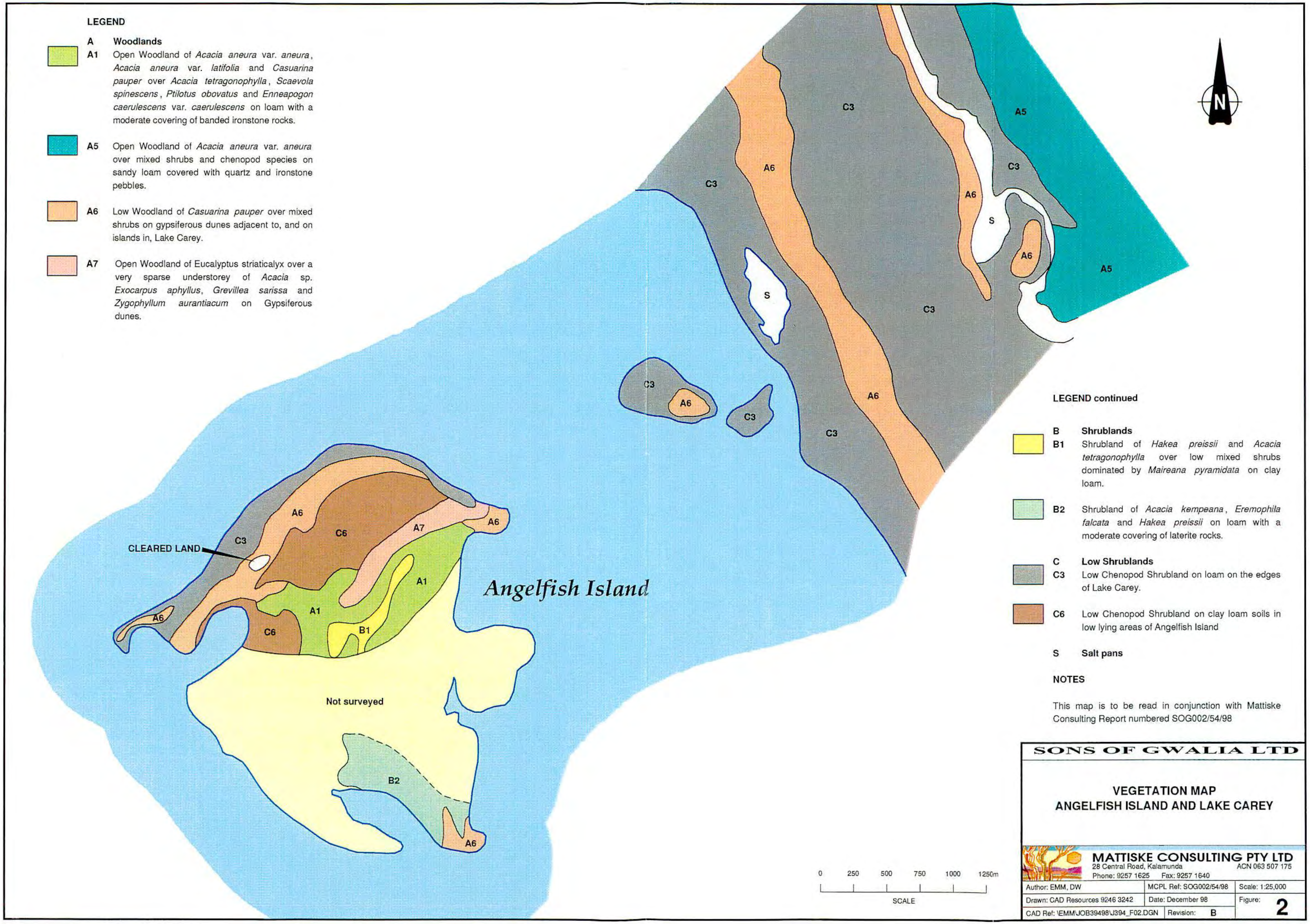

LEGEND
A Woodlands
A1 Open Woodland of Acacia aneura var. aneura, Acacia aneura var. latifolia and Casuarina pauper over Acacia tetragonophylla, Scaevola spinescens, Ptilotus obovatus and Enneapogon caerulescens var. caerulescens on loam with a moderate covering of banded ironstone rocks.
A5 Open Woodland of Acacia aneura var. aneura over mixed shrubs and chenopod species on sandy loam covered with quartz and ironstone pebbles.
A6 Low Woodland of Casuarina pauper over mixed shrubs on gypsiferous dunes adjacent to, and on islands in, Lake Carey.
A7 Open Woodland of Eucalyptus striaticalyx over a very sparse understorey of Acacia sp. Exocarpus aphyllus, Grevillea sarissa and Zygophyllum aurantiacum on Gypsiferous dunes.
LEGEND continued
B Shrublands
B1 Shrubland of Hakea preissii and Acacia tetragonophylla over low mixed shrubs dominated by Maireana pyramidata on clay loam.
B2 Shrubland of Acacia kempeana, Eremophila falcata and Hakea preissii on loam with a moderate covering of laterite rocks.
C Low Shrublands
C3 Low Chenopod Shrubland on loam on the edges of Lake Carey.
C6 Low Chenopod Shrubland on clay loam soils in low lying areas of Angelfish Island
S Salt pans
NOTES
This map is to be read in conjunction with Mattiske Consulting Report numbered SOG002/54/98
N
Angelfish Island
CLEARED LAND
Not surveyed
A1
A5
A6
A7
B1
B2
C3
C6
S
0 250 500 750 1000 1250m
SCALE
SONS OF GWALIA LTD
VEGETATION MAP
ANGELFISH ISLAND AND LAKE CAREY
MATTISKE CONSULTING PTY LTD
28 Central Road, Kalamunda
ACN 063 507 175
Phone: 9257 1625 Fax: 9257 1640
Author: EMM, DW
MCPL Ref: SOG002/54/98
Scale: 1:25,000
Drawn: CAD Resources 9246 3242
Date: December 98
Figure: 2
CAD Ref: \EMM\JOB39498\J394_F02.DGN
Revision: B

APPENDIX A: VASCULAR PLANT SPECIES FOR RED OCTOBER AND ASSOCIATED HAUL ROADS

FAMILY	GENUS	SPECIES
POACEAE	*Aristida*	*contorta*
	Aristida	*holathera* var. *holathera*
	Austrostipa	*elegantissima*
	Austrostipa	*nitida*
	Enneapogon	*caerulescens* var. *caerulescens*
	Eragrostis	*falcata*
	Eriachne	*flaccida*
	Eriachne	*mucronata*
	Triodia	*basedowii*
	Poaceae	sp.
COLCHICACEAE	*Wurmbea*	*tenella*
CASUARINACEAE	*Casuarina*	*pauper*
PROTEACEAE	*Grevillea*	*acuaria*
	Grevillea	*berryana*
	Grevillea	*?juncifolia*
	Grevillea	*sarissa*
	Hakea	*preissii*
SANTALACEAE	*Anthobolus*	*leptomerioides*
	Exocarpos	*aphyllus*
	Santalum	*murrayanum*
	Santalum	*spicatum*
LORANTHACEAE	*Amyema*	*fitzgeraldii*
	Amyema	*maidenii*
POLYGONACEAE	*Muehlenbeckia*	*florulenta*
CHENOPODIACEAE	*Atriplex*	*?bunburyana*
	Atriplex	*lindleyi* subsp. *inflata*
	Atriplex	*?nana*
	Atriplex	*nummularia* subsp. *spathulata*
	Atriplex	*semilunaris*
	Atriplex	*vesicaria*
	Atriplex	sp.

APPENDIX A: VASCULAR PLANT SPECIES FOR RED OCTOBER AND ASSOCIATED HAUL ROADS

FAMILY	GENUS	SPECIES
CHENOPODIACEAE	*Enchylaena*	*tomentosa*
(Continued)	*Halosarcia*	*halocnemoides* subsp. *tenuis*
	Halosarcia	*indica*
	Halosarcia	*pruinosa*
	Halosarcia	sp. ?Angelfish Island
	Maireana	*georgei*
	Maireana	aff. *georgei*
	Maireana	?*georgei*
	Maireana	*glomerifolia*
	Maireana	*pyramidata*
	Maireana	*sedifolia*
	Maireana	*thesioides*
	Maireana	*triptera*
	Maireana	sp.
	Rhagodia	*drummondii*
	Rhagodia	*spinescens*
	Salsola	*kali*
	Sarcocornia	*blackiana*
	Sclerolaena	*cuneata*
	Sclerolaena	*fimbriolata*
	Sclerolaena	*fusiformis*
	Sclerostegia	*tenuis*
AMARANTHACEAE	*Hemichroa*	*diandra*
	Ptilotus	*helichrysoides*
	Ptilotus	*obovatus*
	Ptilotus	*schwartzii* var. *schwartzii*
AIZOACEAE	*Carpobrotus*	sp. (C6.17)
PORTULACACEAE	*Calandrinia*	*polyandra*
PITTOSPORACEAE	*Pittosporum*	*phylliraeoides*
MIMOSACEAE	*Acacia*	*acuminata* subsp. *burkittii* (ms)
	Acacia	*aneura* var. *aneura*
	Acacia	*aneura* var. *aneura* (terete leaf)
	Acacia	*aneura* var. *latifolia*
	Acacia	*craspedocarpa*
	Acacia	*grasbyi*

APPENDIX A: VASCULAR PLANT SPECIES FOR RED OCTOBER AND ASSOCIATED HAUL ROADS

FAMILY	GENUS	SPECIES
MIMOSACEAE	*Acacia*	*kalgoorliensis*
(Continued)	*Acacia*	*kempeana*
	Acacia	*oswaldii*
	Acacia	*platycarpa*
	Acacia	*quadrimarginea*
	Acacia	*ramulosa*
	Acacia	sp. (A7.4)
	Acacia	*tetragonophylla*
	Acacia	*tysonii*
CAESALPINIACEAE	*Senna*	*artemisioides* subsp. x *artemisioides*
	Senna	*artemisioides* subsp. *filifolia*
	Senna	*artemisioides* subsp. aff. *glaucifolia*
	Senna	*artemisioides* subsp. x *sturtii*
	Senna	sp.
PAPILIONACEAE	*Swainsona*	*purpurea*
	Templetonia	*egena*
ZYGOPHYLLACEAE	*Zygophyllum*	*apiculatum*
	Zygophyllum	*aurantiacum*
	Zygophyllum	*eremaeum*
EUPHORBIACEAE	*Euphorbia*	*drummondii*
SAPINDACEAE	*Dodonaea*	*lobulata*
	Dodonaea	*rigida*
MALVACEAE	*Abutilon*	sp.
	Lawrencia	*densiflora*
	Lawrencia	*squamata*
	Sida	*calyxhymenia*
	Sida	*intricata*
STERCULIACEAE	*Brachychiton*	*gregorii*
FRANKENIACEAE	*Frankenia*	*cinerea*
	Frankenia	*desertorum*
	Frankenia	*interioris* var. *interioris*
	Frankenia	*pauciflora* var. *pauciflora*
	Frankenia	*setosa*

APPENDIX A: VASCULAR PLANT SPECIES FOR RED OCTOBER AND ASSOCIATED HAUL ROADS

FAMILY	GENUS	SPECIES
MYRTACEAE	*Eucalyptus*	*striaticalyx*
LOGANIACEAE	*Phyllangium*	*paradoxum*
CONVOLVULACEAE	*Porana*	*sericea*
	Wilsonia	*humilis*
CHLOANTHACEAE	*Spartothamnella*	*teucriiflora*
SOLANACEAE	*Solanum*	*lasiophyllum*
	Solanum	*orbiculatum* subsp. *orbiculatum*
MYOPORACEAE	*Eremophila*	*?alternifolia*
	Eremophila	*falcata*
	Eremophila	*forrestii*
	Eremophila	*granitica*
	Eremophila	*latrobei*
	Eremophila	*longifolia*
	Eremophila	*margarethae*
	Eremophila	*?margarethae*
	Eremophila	*oldfieldii* subsp. *angustifolia* (ms)
	Eremophila	*pantonii*
	Eremophila	*platycalyx*
	Eremophila	*scoparia*
RUBIACEAE	*Canthium*	*attenuatum*
	Canthium	*lineare*
GOODENIACEAE	*Scaevola*	*spinescens*
ASTERACEAE	Asteraceae	sp. (C6.2)
	Asteraceae	sp. (C6.12)
	Angianthus	sp. (C6.13)
	* *Arctotheca*	*calendula*
	Asteridea	*chaetopoda*
	Olearia	*lanuginosa*
	Podolepis	*capillaris*
	Senecio	*gregorii*
	Senecio	*magnificus*

APPENDIX B: PLANT SPECIES RECORDED IN EACH PLANT COMMUNITY IN THE STUDY AREA

Species	Plant Community															
	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	C1	C2	C3	C4	C5	C6
Abutilon sp.											+					
Acacia acuminata subsp. *burkittii* (ms)	+	+														
Acacia aneura var. *aneura*	+		+	+	+											
Acacia aneura var. *aneura* (terete leaf)											+					
Acacia aneura var. *latifolia*	+	+		+		+		+			+	+		+		
Acacia craspedocarpa				+	+											
Acacia grasbyi										+					+	
Acacia kalgoorliensis															+	
Acacia kempeana									+							
Acacia oswaldii	+			+							+					
Acacia platycarpa	+															
Acacia quadrimarginea	+															
Acacia ramulosa	+			+		+										
Acacia sp. (A7.4)							+									
Acacia tetragonophylla	+	+	+	+	+	+		+		+	+					
Acacia tysonii						+							+			
Amyema fitzgeraldii				+												
Amyema maidenii						+		+								
Angianthus sp. (C6.13)																+
Anthobolus leptomerioides				+	+											
**Arctotheca calendula*								+								
Aristida contorta	+									+						
Aristida holathera var. *holathera*														+		+
Asteraceae sp. (C6.2)																+
Asteraceae sp. (C6.12)																+
Asteridea chaetopoda						+							+			

APPENDIX B: PLANT SPECIES RECORDED IN EACH PLANT COMMUNITY IN THE STUDY AREA

Species	Plant Community															
	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	C1	C2	C3	C4	C5	C6
Atriplex ?bunburyana							+									
Atriplex lindleyi subsp. *inflata*								+			+					
Atriplex ?nana													+			+
Atriplex nummularia subsp. *spathulata*						+									+	
Atriplex semilunaris	+										+	+				
Atriplex vesicaria					+											
Atriplex sp. (A82)													+			
Austrostipa elegantissima										+						
Austrostipa nitida	+					+										
Brachychiton gregorii	+								+			+				
Calandrinia polyandra																+
Canthium attenuatum				+												
Canthium lineare				+												
Carpobrotus sp. (C6.17)																+
Casuarina pauper	+					+			+			+				
Dodonaea lobulata	+								+							
Dodonaea rigida	+									+						
Enchylaena tomentosa					+		+									
Enneapogon caerulescens var. *caerulescens*	+					+			+		+					
Eragrostis falcata						+							+			+
Eremophila ?alternifolia												+				
Eremophila falcata									+						+	
Eremophila forrestii	+			+		+								+		
Eremophila granitica	+			+	+											
Eremophila latrobei	+															
Eremophila longifolia				+												

APPENDIX B: PLANT SPECIES RECORDED IN EACH PLANT COMMUNITY IN THE STUDY AREA

Species	Plant Community															
	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	C1	C2	C3	C4	C5	C6
Eremophila margarethae				+	+											
Eremophila ?margarethae	+															
Eremophila oldfieldii subsp. *angustifolia* (ms)		+			+				+	+						
Eremophila pantonii															+	
Eremophila platycalyx								+			+					
Eremophila scoparia	+					+	+					+				
Eriachne flaccida						+										
Eriachne mucronata	+															
Eucalyptus striaticalyx							+									
Euphorbia drummondii																+
Exocarpos aphyllus	+			+	+	+	+	+							+	
Frankenia cinerea	+												+			
Frankenia desertorum						+										
Frankenia interioris var. *interioris*																+
Frankenia pauciflora var. *pauciflora*													+			+
Frankenia setosa												+				
Grevillea acuaria											+					
Grevillea berryana	+													+		
Grevillea ?juncifolia						+										
Grevillea sarissa				+	+		+									
Hakea preissii			+		+	+		+	+		+			+		
Halosarcia halocnemoides subsp. *tenuis*						+					+		+			
Halosarcia indica															+	
Halosarcia pruinosa													+			+
Halosarcia sp. ?Angelfish Island																+
Hemichroa diandra																+

APPENDIX B: PLANT SPECIES RECORDED IN EACH PLANT COMMUNITY IN THE STUDY AREA

Species	Plant Community															
	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	C1	C2	C3	C4	C5	C6
Lawrencia densiflora													+			
Lawrencia squamata									+							+
Maireana georgei	+		+			+					+					
Maireana aff. *georgei*	+															
Maireana ?*georgei*												+				
Maireana glomerifolia											+	+	+			
Maireana pyramidata			+					+			+	+				
Maireana sedifolia	+				+							+				
Maireana thesioides															+	
Maireana triptera									+	+					+	
Maireana sp.													+			
Muehlenbeckia florulenta														+		
Olearia lanuginosa																+
Phyllangium paradoxum	+															
Pittosporum phylliraeoides	+					+		+		+				+		
Poaceae sp.												+				
Podolepis capillaris	+	+	+			+			+		+		+		+	+
Porana sericea	+							+								
Ptilotus helichrysoides											+					
Ptilotus obovatus	+			+	+			+	+	+						
Ptilotus schwartzii var. *schwartzii*	+															
Rhagodia drummondii								+							+	
Rhagodia spinescens	+	+						+		+						
Salsola kali						+										
Santalum murrayanum											+					
Santalum spicatum	+			+	+				+							

APPENDIX B: PLANT SPECIES RECORDED IN EACH PLANT COMMUNITY IN THE STUDY AREA

Species	Plant Community															
	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	C1	C2	C3	C4	C5	C6
Sarcocornia blackiana													+			
Scaevola spinescens	+		+		+	+	+		+	+	+				+	
Sclerolaena cuneata			+													
Sclerolaena fimbriolata						+							+			
Sclerolaena fusiformis					+						+	+				
Sclerostegia tenuis																+
Senecio gregorii																+
Senecio magnificus													+			
Senna artemisioides subsp. x *artemisioides*	+															
Senna artemisioides subsp. *filifolia*	+					+						+				
Senna artemisioides subsp. aff. *glaucifolia*	+															
Senna artemisioides subsp. x *sturtii*	+		+						+	+						
Senna sp.					+											
Sida calyxhymenia	+															
Sida intricata								+								
Solanum lasiophyllum	+		+		+	+		+	+	+	+	+			+	+
Solanum orbiculatum subsp. *orbiculatum*		+				+			+							+
Spartothamnella teucriiflora	+															
Swainsona purpurea																+
Templetonia egena				+												
Triodia basedowii				+												
Wilsonia humilis						+							+			
Wurmbea tenella		+														
Zygophyllum apiculatum									+							
Zygophyllum aurantiacum							+									
Zygophyllum eremaeum						+										

APPENDIX C: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES IN THE STUDY AREA

Photograph 1: Plant community A1 - Open Woodland of *Acacia aneura* var. *aneura*, *Acacia aneura* var. *latifolia* and *Casuarina pauper*.

Photograph 2: Plant community A2 - Open Low Woodland of *Acacia aneura* var. *latifolia* and *Acacia acuminata* subsp. *burkittii*.

APPENDIX C: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES IN THE STUDY AREA

Photograph 3: Plant community A3 - Open Low Woodland of *Acacia aneura* var. *aneura*.

Photograph 4: Plant community A6 - Low Woodland of *Casuarina pauper* on gypsiferous dunes.

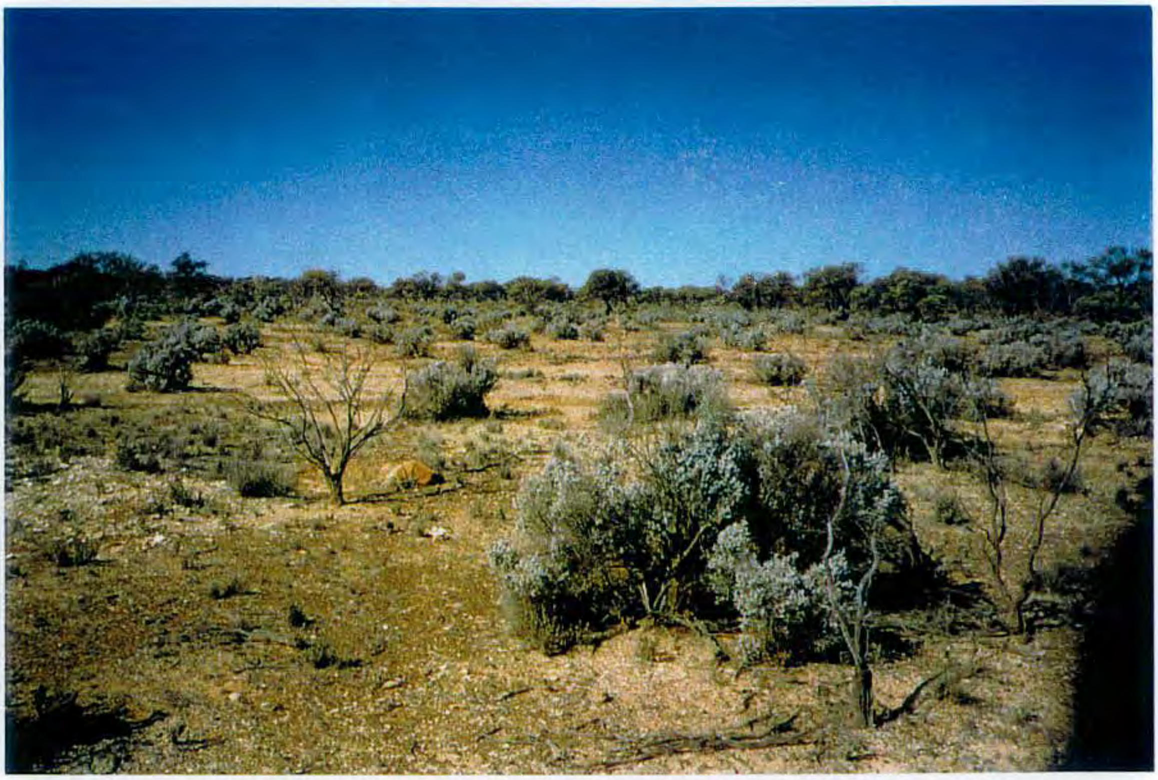
APPENDIX C: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES IN THE STUDY AREA

Photograph 5: Plant community B1 - Shrubland of *Hakea preissii* and *Acacia tetragonophylla*.

Photograph 6: Plant community B2 - Shrubland of *Acacia kempeana, Eremophila falcata* and *Hakea preissii*.

APPENDIX C: PHOTOGRAPHIC RECORD OF PLANT COMMUNITIES IN THE STUDY AREA

Photograph 7: Plant community C1 – Open Low Shrubland of *Maireana glomerifolia*, *Maireana georgei* and *Atriplex lindleyi* subsp. *inflata*.



Photograph 8: Plant community C2 – Open Low Shrubland dominated by *Maireana sedifolia*.

Appendix 3 – Project Plan and Conceptual Mine Plan

Appendix 4 – EPA Guidelines for this CER

Environmental Protection Authority
Guidelines

RED OCTOBER GOLD PROJECT
80 KM SOUTH OF LAVERTON

(Assessment Number 1245)

Part A	Specific Guidelines for the preparation of the Consultative Environmental Review
Part B	Generic Guidelines for the preparation of an environmental review document
Attachment 1	Example of the invitation to make a submission
Attachment 2	Advertising the environmental review
Attachment 3	Project location map

These guidelines are provided for the preparation of the proponent's environmental review document. The specific environmental factors to be addressed are identified in Part A. The generic guidelines for the format of an environmental review document are provided in Part B.

The environmental review document <u>must</u> address all elements of Part 'A' and Part 'B' of these guidelines prior to approval being given to commence the public review.

CONTENT		SCOPE OF WORK	
Element of the Environment	**Environmental Factor**	**Preliminary Environmental Objective**	**Work required for the environmental review**
BIOPHYSICAL			
Terrestrial Flora	Vegetation communities	Maintain the abundance, species diversity and geographic distribution of vegetation communities.	Baseline studies to identify existing vegetation communities. Assessment of potential impacts (direct and indirect) on vegetation communities (local and regional) as a result of mining and associated activities. Specifically for: • the areas potentially impacted by the construction of infrastructure to support the mine; and • for the location of borrow pits used as a source of material for construction of access roads and causeways Proposed measures to mitigate impacts.
	Declared Rare and Priority Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950.	Baseline studies to identify any Declared Rare and/or priority flora. Assessment of potential impacts (direct and indirect) on vegetation communities as a result of mining activities and infrastructure. Analysis of likelihood of occurrence of taxa not flowering at time of survey. Proposed measures to manage impacts.
Terrestrial Fauna	Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna.	Baseline studies to identify existing terrestrial fauna in the project area. Assessment of potential impacts (direct and indirect) on terrestrial fauna (local and regional) as a result of mining and associated activities. Specifically consider the likelihood of avian fauna utilising areas impacted by the proposal as breeding habitat. Proposed measures to manage impacts.

CONTENT		SCOPE OF WORK	
Element of the Environment	**Environmental Factor**	**Preliminary Environmental Objective**	**Work required for the environmental review**
Salt lakes	Lake Carey	Maintain the integrity functions and environmental values of lakes	Assessment of the potential impacts on lake Carey due to mining operations occurring on the lake and from construction of associated facilities. Specifically: • the potential impacts on the lake's hydrology arising from mining in the lake bed and abandonment of the pit, and from construction of the waste dumps and causeway; and • assess the impacts on lake ecology from discharges to the lake from dewatering operations. Consider impacts of discharges during normal annual Lake fluctuations and periodic flooding events known to be important triggers of biological activity. Evaluation of the effects of the potential impacts on the functions and environmental values of lake Carey. Propose measures to manage impacts.
Land	Landform	Establish stable, sustainable landform consistent with surroundings. Ensure that, as far as practicable, the post-mining landform is stable and is integrated into the surrounding environment.	Assessment of potential impacts of the proposal on existing landforms. Detail of management of the waste dumps and final void with regard to pit integrity and potential for the waste dump to erode. Proposed measures to manage impacts.
	Rehabilitation	Ensure proposal area, and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long-term land use.	Detail of measures proposed to rehabilitate the impacted area to an acceptable standard which will integrate the post mining landform with the surrounding environment. Specifically, investigate the chemical composition of soils deposited on the waste dump and the potential for these soils to support vegetation. Detail of rehabilitation programmes to include the waste dumps, mining pit, causeway and borrow areas. Detail of removal of infrastructure and clean-up of any contaminated areas.

CONTENT		SCOPE OF WORKS	
Element of the Environment	**Environmental Factor**	**Preliminary Environmental Objective**	**Work required for the environmental review**
SOCIAL SURROUNDINGS			
Public health and safety	Risk and hazard	Ensure that risk is managed to meet the DME's requirements in respect of public safety.	Description of the methods proposed to manage the final void.
Social	Road transportation	Ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings.	Detail of transport requirements for the proposal, including anticipated impact on local authority roads
Culture and Heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Identify any Aboriginal cultural and heritage sites of significance through archaeological and ethnographical surveys of the project area and through consultation with local Aboriginal groups and the Department of Aboriginal Affairs. Consult with the Aboriginal people of the area to determine potential impacts of the proposal on cultural associations with the project area . Proposed measures to manage impacts.

These factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA anticipates addressing these factors in its report to the Minister for the Environment.

The EPA expects the proponent to take due care in ensuring all other relevant environmental impacts which may be of interest to the public are addressed and that management is covered in the environmental review.

3. Availability of the environmental review

3.1 Copies for distribution free of charge

Supplied to DEP:

- Library/Information Centre....9
- EPA members....6
- Officers of the DEP (Perth & Kalgoorlie)....8

Distributed by the proponent to:

Government departments

- Department of Minerals and Energy....3
- Water and Rivers Commission....3
- Department of Conservation and Land Management....3
- Department of Land Administration....1
- Aboriginal Affairs Department....1
- Department of Resources Development....1
- Environment Australia....1

Local government authorities

- Shire of Laverton....1

Libraries

- J S Battye Library....3
- The Environment Centre....2
- Goldfields Regional Library....2

Other

- Conservation Council of WA....1
- North East Independent Body....1
- Aboriginal Legal Service of Western Australia (Inc)....1

3.2 Available for public viewing

- Department of Environmental Protection Library, Perth;
- Department of Environmental Protection Goldfields Region Office;
- Goldfields Regional Library;
- J S Battye Library, Perth;
- Laverton Shire Office; and
- Leonora Shire Office.

Part B: Generic Guidelines for the preparation of an environmental review document

1. Overview

All environmental reviews have the objective of protecting the environment. Environmental impact assessment is deliberately a public process in order to obtain broad ranging advice. The review requires the proponent to describe:

- the proposal;
- receiving environment;
- potential impacts of the proposal on factors of the environment; and
- proposed management strategies to ensure those environmental factors are appropriately protected.

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to improve the proposal so the environment is protected. The DEP will co-ordinate, on behalf of the EPA, relevant government agencies and the public in providing advice about environmental matters during the assessment of the environmental review for this proposal.

The primary purpose of the environmental review is to provide information on the proposal within the local and regional framework to the EPA, with the aim of emphasising how the proposal may impact the relevant environmental factors and how those impacts may be mitigated and managed.

The language used in the body of the environmental review should be kept simple and concise, considering the audience includes non-technical people, and any extensive, technical detail should either be referenced or appended to the environmental review. It should be noted that the environmental review will form the legal basis of the Minister for the Environment's approval of the proposal and therefore the environmental review should include a description of all the main and ancillary components of the proposal, including options where relevant.

Information used to reach conclusions should be properly referenced, including personal communications. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

2. Objectives of the environmental review

The objectives of the environmental review are to:

- place this proposal in the context of the local and regional environment;
- adequately describe all components of the proposal, so that the Minister for the Environment can consider approval of a well-defined project;
- provide the basis of the proponent's environmental management program, which shows that the environmental impacts resulting from the proposal, including cumulative impact, can be acceptably managed; and

5. Contents of the environmental review document

The contents of the environmental review should include an executive summary, introduction and at least the following:

5.1 The proposal

A comprehensive description of the proposal including its location (address and certificate of title details where relevant) is required.

Justification and alternatives

- justification and objectives for the proposed development;
- the legal framework, including existing zoning and environmental approvals, and decision making authorities and involved agencies; and
- consideration of alternative options.

Key characteristics

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[2] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

Include a description of the components of the proposal, including the nature and extent of works proposed. This information must be summarised in the form of a table as follows:

[2] Changes to the key characteristics of the proposal following final approval, would require assessment of the change and can be treated as non-substantial and approved by the Minister, if the environmental impacts are not significant. If the change is significant, it would require assessment under section 38 or section 46. Changes to other aspects of the proposal are generally inconsequential and can be implemented without further assessment. It is prudent to consult with the Department of Environmental Protection about changes to the proposal.

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	< 5 years (continual operation)
Size of ore body	682 000 tonnes (upper limit)
Depth of mine pit	less than 30 m
Water table depth	50 m below ground surface
Area of disturbance (including access)	100 hectares
Mine operation	Only during daylight hours Only Monday to Friday
List of major components • pit • waste dump • infrastructure (water supply, roads, etc)	refer plans, specifications, charts section immediately below for details of map requirements
Ore mining rate • maximum	 • 200 000 tonnes per year
Solid waste materials • maximum	 • 800,000 tonnes per year
Water supply • source • maximum hourly requirement • maximum annual requirement	 • XYZ borefield, ABC aquifer • 180 cubic metres • 1 000 000 cubic metres
Fuel storage capacity and quantity used	litres; litres per year

Plans, Specifications, Charts

Adequately dimensioned plans showing clearly the location and elements of the proposal which are significant from the point of view of environmental protection, should be included. The location and dimensions (for progressive stages of development, if relevant) of plant, amenities buildings, accessways, stockpile areas, dredge areas, waste product disposal and treatment areas, all dams and water storage areas, mining areas, storage areas including fuel storage, landscaped areas etc.

Only those elements of plans, specifications and charts that are significant from the point of view of environmental protection are of relevance here.

Figures that should always be included are:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;
- a map showing the proposal in the regional context; and, if appropriate,
- a process chart / mass balance diagram showing inputs, outputs and waste streams.

The plan/s should include contours, a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, and a title. If the data is overlaid on an aerial photo then the date of the aerial photo should be shown.

Other logistics

- timing and staging of project; and
- ownership and liability for waste during transport, disposal operations and long-term disposal (where appropriate to the proposal).

5.2 Environmental factors

The environmental review should focus on the relevant environmental factors for the proposal, and these should be agreed in consultation with the EPA and DEP and relevant public and government agencies. Preliminary environmental factors identified for the proposal are shown in Part A of these guidelines.

Further environmental factors may be identified during the preparation of the environmental review, therefore on-going consultation with the EPA, DEP and other relevant agencies is recommended. The DEP can advise the proponent on the recommended EPA objective for any new environmental factors raised. Minor matters which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

Items that should be discussed under each environmental factor are:

- a clear definition of the area of assessment for this factor;
- the EPA objective for this factor;
- a description of what is being affected - why this factor is relevant to the proposal;
- a description of how this factor is being affected by the proposal - the predicted extent of impact;
- a description of where this factor fits into the broader environmental / ecological context (only if relevant - this may not be applicable to all factors);
- a straightforward description or explanation of any relevant standards / regulations / policy;
- environmental evaluation - does the proposal meet the EPA's objective as defined above;
- if not, environmental management proposed to ensure the EPA's objective is met;
- predicted outcome.

The proponent should provide a summary table of the above information for all environmental factors, under the three categories of biophysical, pollution management and social surroundings:

Table 2: Environmental factors and management (example only)

Environ-mental Factor	EPA Objective	Existing environment	Potential impact	Environ-mental management	Predicted outcome
BIOPHYSICAL					
vegetation community types 3b and 20b	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation community types 3b and 20b	Reserve 34587 contains 45 ha of community type 20b and 34 ha of community type 3b	Proposal avoids all areas of community types 20b and 3b	Surrounding area will be fully rehabilitated following construction	Community types 20b and 3b will remain untouched Area surrounding will be revegetated with seed stock of 20b and 3b community types
POLLUTION MANAGEMENT					
Dust	Ensure that the dust levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards	Light industrial area - three other dust producing industries in close vicinity Nearest residential area is 800 metres	Proposal may generate dust on two days of each working week.	Dust Control Plan will be implemented	Dust can be managed to meet EPA's objective
SOCIAL SURROUNDINGS					
Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal	Area already built-up	This proposal will contribute negligibly to the overall visual amenity of the area	Main building will be in 'forest colours' and screening trees will be planted on road	Proposal will blend well with existing visual amenity and the EPA's objective can be met

5.3 Environmental management commitments

The implementation of the key characteristics of the proposal and the consolidated environmental management commitments made by the proponent become legally enforceable under the conditions of environmental approval issued in the statement by the Minister for the Environment. All the key environmental management commitments should be consolidated in the public review document in a list (usually in an Appendix). This list is attached to the Minister's statement and becomes part of the conditions of approval.

The proponent's compliance with the consolidated environmental management commitments will be audited by the DEP, so they must be expressed in a way which enables them to be audited.

A commitment needs to contain most of the following elements to be auditable:

- who (eg. the proponent)

- will do what (eg. prepare a plan, take action)
- why (to meet an environmental objective)
- where/how (detail the action and where it applies)
- when (in which phase, eg. before construction starts)
- to what standard (recognised standard or agency to be satisfied)
- on advice from (agency to be consulted).

The proponent may make other 'commitments', which address less significant or non-environmental matters, to show an intention to good general management of the project. Such 'commitments' would not be included in the consolidated list of environmental management commitments appended to the statement.

Continuous improvement during the implementation of the consolidated commitments may necessitate changes, which can be made in updates to the environmental management plan, whilst ensuring the environmental objective is still achieved. Additional proponent commitments arising from the fulfilment of environmental conditions will be audited by the DEP.

Once the proposal is approved, changes to the consolidated commitments constitute a change to the proposal and should be referred to the EPA.

Examples of the preferred format for typical commitments are shown in the following table:

Table 3: Summary of proponent's commitments (example only)

Commitment (Who/What)	Objective (Why)	Action (How/Where)	Timing (When)	Whose advice	Measurement/ Compliance criteria
1. XYZ Mining will develop a rehabilitation plan	to protect the abundance, species diversity, geographic distribution and productivity of the vegetation community types 3b and 20b	by limiting construction to a small area (10 ha) of Reserve 34587 and rehabilitating the area	before construction	CALM, NPNCA	fences built; species distribution and density consistent with vegetation community types 3b and 20b
2. XYZ Mining will minimise dust generation	to maintain the amenity of nearby land owners	by preparing and implementing a Dust Control Plan which meets EPA Dust Control criteria	before the start of construction phase	preparation: DEP; implementation: Shire	Letter from Shire submitted with Performance and Compliance Report.

Commitments should be written in tabular form, preferably with some specification of ways in which the commitment can be measured, or how compliance can be demonstrated.

Draft commitments which are not in a format that can be audited will not be accepted by project officers for public review documentation. Proponents will be assisted to revise inadequate commitments.

5.4 Public consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the environmental review. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the EPA process can be noted and referenced.

5.5 Other information

Additional detail and description of the proposal, if provided, should go in a separate section.