KEYSBROOK MINERAL SAND PROJECT, KEYSBROOK, WESTERN AUSTRALIA: PUBLIC ENVIRONMENTAL REVIEW

JUNE 2006

PREPARED FOR

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INVITATION TO MAKE A SUBMISSION

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

Olympia Resources Limited is proposing to develop a mineral sand mine and primary processing plant in a rural area near Keysbrook, 70kms south of Perth. Land within the mine area is predominately used for dairy cattle grazing

The proposal is to extract minerals progressively across the mine area, by developing shallow pits, average 2 metres depth and constructing a primary processing plant. Residual quartz sand and clay will be returned and the landform reinstated to approximately pre-mining contours. Heavy mineral concentrate will be transported off-site for secondary processing.

In accordance with the Environmental Protection Act, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 8 weeks from 26 June 2006**,** closing on 21 August 2006.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government. If you are able to, the EPA would welcome electronic submissions in particular, emailed to the project assessment officer or via the EPA's Website (see address below).

Where to get copies of this document

Printed copies of this document may be obtained from Sandra Jamieson at Olympia Resources, Level 4, 25 Walters Drive, Herdsman WA 6016. Phone 9244 1411 at a cost of $10. Electronic copies on a CDROM are available at a cost of $4.50.

Copies may also be downloaded from www. olympiaresources.com

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 each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups 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 PER 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 environmentally more acceptable.

When making comments on specific proposals in the PER:

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

Points to keep in mind

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

- Attempt to list points so that issues raised are clear. A summary of your submission is helpful.
- Refer each point to the appropriate section, chapter or recommendation in the PER.
- If you discuss different sections of the PER, 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: 21 August 2006

The EPA prefers submissions to be sent in electronically. You can either e-mail the submission to the project officer at the following address:

ruwani.ehelepola@environment.wa.gov.au

OR

use the submission form on the EPA's website:

www.epa.wa.gov.au/submissions.asp

OR

if you do not have access to e-mail then please post your submission to:

Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842

Attention: Ms Ruwani Ehelepola

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3 Surface Hydrology (MBS Environmental, 2006)

4 Hydrogeological Assessment (Rockwater Pty Ltd, 2006)

5 Vegetation and Fauna Assessment (MBS Environmental, 2004)

6 Vegetation and Flora Report (Bennett Environmental Consulting, 2004)

7 Floristic Community Type Analysis (E.A. Griffin & Associates, 2005)

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

Olympia Resources Limited (Olympia) proposes to develop an open cut mineral sand mine and primary processing plant within an area of rural land near the small township of Keysbrook. Keysbrook is located approximately 70 kilometres south of Perth, on the eastern edge of the Swan Coastal Plain (Figures 1 and 2). Main access to the project site is from the South Western Highway and Elliot Road or Readheads Road.

1.2 SCOPE OF PROJECT

The mine area is 1,234 hectares. Of this, 930 hectares (75.4%) is open pasture, 244 hectares (19.8%) is parkland cleared remnant vegetation and 60 hectares (4.8%) is good quality remnant vegetation.

The land use within the mine area is agriculture, specifically grazing of dairy cattle, with a small area of intensive horticulture.

The methods used for mineral sand mining and processing operations have been in use in the Western Australian mineral sand mining industry for many decades and are well proven. Olympia intends to carry out its mineral sand mining and processing operations in a manner similar to current practices used by mining companies in the southwest of Western Australia.

The proposal is to extract minerals from a series of locations across the Keysbrook mine area. This will require development of shallow pits to access the ore body and construction of a screening, concentration and separation plant. Ore will be mined by a scraper and screened before being processed and the heavy mineral concentrate (HMC) component separated from the quartz sand and clay fractions.

The quartz sand and clay will be returned to mined areas and the landform reinstated to approximately pre-mining contours.

The HMC will be transported to an off-site processing plant for secondary separation using gravity, magnetic and electrostatic methods to produce individual mineral products for sale.

The conceptual layout of the proposed Keysbrook project is shown in Figure 3 and will comprise the following major components:

- Mining to an average depth of two metres, with a maximum of five metres.
- Mining of approximately 4.25 million tonnes of ore per year.
- Construction and operation of a HMC plant producing approximately 115,000 tonnes of HMC per year.
- Construction of a water supply borefield, water containment ponds, associated support facilities and access roads.

Project components are discussed below.

1.2.1 Mining

The proposed Keysbrook mine has an expected operational life of up to eight years. The mine will utilise a contract mining operator and proponent operation of the HMC plant.

The open mine pit will be approximately 30 hectares in area (Figure 4). The mining method entails excavation of the leading edge of the mine pit while backfilling of the retreating edge occurs with waste sand from the processing plant.

A general description of the mining sequence is described below:

1. *Land clearing:* The proponent will undertake periodic stripping of open pasture and clearing of trees, as required, in advance of the mine path.
2. *Topsoil stripping:* Approximately 200 millimetres of topsoil will be stripped progressively from the mine path using scrapers. During early stages of mining, topsoil will be stockpiled until sufficient area has been mined to allow respreading for subsequent rehabilitation. Seasonal weather conditions will also constrain the times topsoil can be directly returned to completed areas.
3. *Mining:* Dry mining methods will be utilised in the extraction of ore. Scrapers will dig the ore and deliver it to a screening and feed preparation plant located near the mining area. The plant will screen oversized material (root fragments and rocks) from the ore and pump the remaining material as raw feed to the processing plant.

1.2.2 Pit Dewatering

The individual requirements for pit dewatering will vary with season. The general principles for pit dewatering for the mine are:

- In summer, the groundwater level will usually be below the level of the pit floor. Little dewatering will be required.
- In winter, the higher groundwater level will generally necessitate dewatering of the pit.
- In autumn and spring, dewatering will be required of a lesser proportion commensurate with the water table at that time.

Pit dewatering water will be pumped from in pit sumps into the mining and processing operations and replace bore water, thus lowering bore water usage, especially in winter.

1.2.3 Processing

Processing of the ore occurs in two stages.

1. *Screening and feed preparation:* The dry screening and wet feed preparation plant removes material greater than two millimetres. The oversize is returned to the pit floor and buried as part of the backfilling process. The remaining sand is mixed with water and pumped as a slurry to the wet concentration plant.

2. *Wet concentration:* The processing capacity of the wet concentration plant is approximately 600 tonnes per hour. At the wet concentrator the clay is removed from the slurry using hydrocyclones and is fed into the clay fines thickener. The valuable heavy mineral fraction is separated from quartz sand using wet gravity spirals. The residue quartz sand is mixed with thickened clay from the thickener and is pumped from the wet concentrator plant back into the mined area of the open pit to backfill the retreating edge of the pit to approximately pre-mining levels. A proportion of the thickened clay may be placed on top of the backfilled sand to add extra clay at the surface of the re-contoured area. This aids moisture and nutrient retention in the rehabilitated land. The HMC is pumped onto a stockpile to drain off water prior to being transported off-site to a dry mineral separation plant.

1.2.4 Water Supply

An estimated process water requirement of 1.5 to two gigalitres per annum will be met by two bores to be constructed on Lot 59 on the mine area (Figure 5). Groundwater will be pumped from the Leederville aquifer with the bores being 80-100 metres deep. An extraction licence will be obtained before operations start.

During winter, a large proportion of process water will be sourced from pit dewatering. In summer, this will dramatically reduce, if not cease. A greater proportion of process water will then need to be sourced from the bores.

The water requirement for mining and processing is estimated at 1,820 kilolitres per hour. Of this volume, about 1,600 kilolitres per hour is recycled within the process and 220 kilolitres per hour is added via pit inflow water or bore water, i.e. 88% of water usage is recycled.

The site water storage dam will have the capacity to store 74,000 kilolitres and will be constructed near the thickener and wet concentrator.

1.2.5 Waste Materials

The waste products from the ore fall into one of three categories:

1. Organic material and coarse fragments (about 2%).
2. Fine clay and silt (about 8%).
3. Quartz sand (about 90%).

Organic material (mostly tree roots) and coarse fragments comprise greater than two millimetre particles. This fraction is rejected by the screening process at the feed preparation plant. The material will be placed directly back into mine void areas under reclamation.

Fine clay and silt particles less than 20 micrometres are separated at the wet concentration plant. The material exits the plant as a slurry and is pumped along with quartz sand to mine void areas under reclamation.

The quartz sand is a free draining material ranging from 20 micrometres to two millimetres, which is separated from the heavy mineral at the wet concentrator. Waste sand exits the wet concentrator plant as a slurry and is pumped back to mine void areas under reclamation.

1.2.6 Support Infrastructure

The mining contractors will provide a workshop to maintain their vehicles. Included in the workshop facilities will be a bunded washdown pad with an attached oil/water separation system.

1.2.7 Power Supply

The main electrical power for the wet concentrator, screening plant, transfer pumps and bores will be provided from the mains power supply. Usage is estimated at about 2.5 megawatts. With total load running at 70-80% of connected load, the connected total power supply for the mine is anticipated to be 3.15 megawatts.

Small stand-alone diesel generators may be required to supply power to moveable pumps used for in-pit dewatering.

1.2.8 Fuels and Oils

A licence will be obtained from Department of Consumer and Employment Protection (DOCEP) for the storage of all dangerous goods on-site.

Fuel storage facilities will be provided by the mining contractor for use by the mining equipment. Fuel will be stored on-site in on ground self-bunded bulk storage tanks. Bulk fuel storage facilities will comply with AS 1940:2004 and Department of Environment (DoE) requirements. The bulk fuel storage capacity will be a 55,000 litre tank.

Any lubricants stored in 1,000 bulk pods or 200 litre drums will be held in bunded areas. Fuel and lubricant dispensing will occur on a bunded hardstand area, to contain accidental spillage.

Other than diesel fuel and oil, no bulk volumes of dangerous goods or hazardous substances will be stored on-site.

1.2.9 Workforce

The mine will require a workforce of about 30-35, which will be sourced locally where possible.

The site will operate on a commute basis with a continuous roster of 12-hour shifts.

1.2.10 Waste Disposal

There will be no on-site disposal of waste. A commercial waste disposal company will be contracted to supply bulk bins for removal of all rubbish from site. A licenced commercial waste disposal company will also be contracted to supply appropriate contains to store waste oil, grease and fuel/oil filters and remove these items on a regular basis.

1.2.11 Roads and Transport

The transport route selected by Olympia is Atkins Road, Readheads Road, South Western Highway.

Approximately 115,000 tonnes per annum of HMC will be produced at Keysbrook and trucked to Picton. This represents about 2,200 tonnes per week of HMC cartage or six to seven 50-tonne truckloads per day. Truck movements to and from the Keysbrook mine site will therefore be between 12 and 14 per day. All loads will be covered prior to leaving the site.

1.3 EXISTING ENVIRONMENT

1.3.1 Regional Setting

The mine is situated along the eastern edge of the Swan Coastal Plain, about 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook. The area for mining is 1,234 hectares, located on privately-owned land. Figure 3 shows the mine site layout.

Ninety five percent of the mine area has been completely cleared or parkland cleared for grazing activities. The remaining 5% of remnant vegetation consists of trees with a partially intact understorey.

The topography of the mine area is flat to very gently undulating plain. The lowest elevations are in the south-west of the mine area at approximately 22 metres Australian Height Datum (AHD), gradually sloping to approximately 48 metres AHD in the north-east.

1.3.2 Surface Hydrology

At a regional level, all the surface drainage ultimately flows to Peel-Harvey estuary. Streams from the Darling Scarp and foothills flow through the mine area.

The mine area and surrounds are characterised by low relief topography that results in a landscape that becomes flatter and increasingly poorly draining westward from the scarp. In the pastured areas, most of the low-lying areas, creeks and wetlands have been cleared and drained. Downstream of the mine area west of Hopelands Road the low relief is even more pronounced, resulting in a wetland chain all the way to Peel Harvey estuary.

The mine area can be subdivided into three major drainage areas; each with a number of minor subcatchments. The major drainage areas are:

- Balgobin/Nambeelup Brook (90.5 percent of project area).
- North Dandalup Tributary (4.5 percent of project area).
- Dirk Brook Tributary (5.0 percent of project area).

The watercourses can be split into three categories:

1. **Major Water Courses - Peak flows of two to five cubic metres per second.**

   These are Balgobin Brook and North Dandalup River Tributary. These watercourses have substantial bridges (up to 15 metres wide) at the downstream road crossing. Both watercourses also contain Draft EPP-listed wetlands that are outside the mine area.

2. **Medium Watercourses - Peak flows of one to two cubic metres per second.**

   These are Dirk Brook Tributary, Nambeelup Brook North Tributary, Balgobin Brook South Tributary and Nambeelup Brook South Tributary. Culvert sizes on adjacent roads are in the range of dual 1,050 millimetre circular pipes and they are still well defined watercourses. Dirk Brook Tributary and Nambeelup Brook South Tributary also contain Draft EPP-listed wetlands that are outside the mine area.

3. **Minor Watercourses - Peak flows of less than one cubic metre per second.**

   The minor watercourses are generally shallow and poorly defined. Diversion of these watercourses will be manageable with earthworks such as bunds and drains around mine pits.

1.3.3 Groundwater

The mine area is located within the Proposed Karnup – Dandalup Underground Water Pollution Control Area. The area has been allocated a policy use of Priority 2 (P2). The groundwater area has not been formally gazetted as a public water source protection area.

Priority 2 source protection areas are defined to ensure there is no increase in risk of pollution to the water source. This is declared over land where low intensity development already exists. Priority 2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines (DoE, 2005).

Two aquifers of the Perth Basin are relevant to the project. Firstly, the shallow superficial formation containing both the Bassendean Dunes and Guildford Formation. This aquifer will be affected by the mining operations as it contains the mineral deposit.

Mining operations during the winter will result in the groundwater levels in the Bassendean Sand being temporarily lowered to the base of the unit, in and around individual mining cells. Water levels will start recovering as mining moves to new cells, excavated cells are backfilled, and rainfall recharges the reconstituted aquifer.

The second relevant aquifer is the Leederville Formation, extending to about 100 metres depth. It will be utilised as a water source for the mining operation.

Water salinities in the Superficial aquifer range from 200 to 1,000 milligrams per litre total dissolved solids (TDS), while in the Leederville Formation they are generally less than 1,000 milligrams per litre TDS.

1.3.4 Vegetation and Flora

The mine area is 1,234 hectares. Of this, 930 hectares (75.4%) is open pasture, 244 hectares (19.8%) is parkland cleared remnant vegetation and 60 hectares (4.8%) is remnant vegetation in good condition.

The mine area is located on the Pinjarra Plain sub unit of the Swan Coastal Plain (Beard, 1981). The vegetation of the mine area is described as being Marri (*Corymbia calophylla*) woodland. Heddle *et al.* (1980) undertook vegetation mapping of the Darling System on a finer scale than Beard (1981). They identified four distinct vegetation complexes that occur on the project area. These were the Forrestfield Complex, the Guildford Complex, the Bassendean Complex (South and Central) and the Southern River Complex.

Three vegetation and flora surveys of the project area have been undertaken; in May 2004, October 2004 and October 2005.

No declared rare or priority flora were located during the surveys.

A total of 40 vascular plant families, 119 genera and 169 taxa were recorded in the survey. The dominant plant families were Poaceae (21 taxa), Myrtaceae (13 taxa), Asteraceae (12 taxa), Cyperaceae and Papilionaceae (11 taxa). These five families represent 43% of the total number of taxa surveyed.

Three of the vegetation units located during the Bennett (2004) survey were inferred to be potential Threatened Ecological Communities (TECs). Bennett (2004) concluded the vegetation condition of FCT 3a and 3c were recorded as mainly degraded to completely degraded and are not considered worthy of conservation.

Statistical analysis of the main potential TEC concluded that the sites are more likely to belong to FCT 21a or 21c than to FCT 20b. Other quadrats in the survey were also inferred as FCT type 21c.

1.3.5 Fauna

The majority of the area to be mined (95%) has been either totally or parkland cleared for agricultural purposes, with the remaining native vegetation areas highly fragmented. As such, the amount of habitat available has been severely reduced. The primary issue for fauna in fragmented agricultural landscapes is connectivity of remnant vegetation. Relatively few species use cleared areas, and those that do usually require areas of native vegetation to supply at least some of their needs.

A fauna habitat assessment was conducted in May 2004. A total of three amphibian species, one reptile species, 41 bird species and two mammal species were identified in the survey.

This included one Priority 3 species (Red-tailed Black Cockatoo), one Priority 4 species (Quenda) and one introduced species (Kookaburra).

Of particular interest is the potential presence of the Short-billed (Carnaby's) Black Cockatoo (*Calyptorrhynchus latirostris*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). A survey was undertaken to identify cockatoo species and potential breeding sites in October 2005.

The only species of cockatoo observed directly during the survey was the Forest Red-tailed Black-Cockatoo. The presence of the Baudin's Black-Cockatoo was inferred through the presence of Marri nuts that were marked distinctively by feeding birds. Only a few potential nesting hollows were identified in the survey. None of the potential hollows identified showed evidence of current occupation.

Overall, the potential of the vegetation remnants to provide breeding habitat for cockatoos is low, with Lot 56 showing the highest potential.

1.3.6 Aboriginal Heritage

Olympia commissioned Australian Interaction Consultants to carry out a preliminary study relating to the proposed Keysbrook project.

Before any disturbance of the site occurs, in consultation with the appropriate Aboriginal people, Olympia will undertake an archaeological survey of the proposed project area to determine the location and nature of any unrecorded sites and ensure that all requirements of the *Aboriginal Heritage Act 1972* (Western Australia) are met. The survey will be undertaken and the results provided to the EPA prior to the release of the EPA report and recommendations bulletin.

1.4 STAKEHOLDER CONSULTATION

A public consultation programmeme has been undertaken to consult with:

- State Government departments, agencies and organisations.
- Local Government authorities.
- Landholders in and around the project site.
- Community groups.
- Special interest groups.

Objectives of the community consultation programme for the Keysbrook project are to:

- Identify key stakeholders.
- Ensure that appropriate information regarding the proposed project is communicated to all stakeholders.
- Determine the key concerns of stakeholders regarding the proposed project.

- Involve interested stakeholders in project planning.

Communication methods include a public information session, one-on-one discussions and small group discussions. A monthly newsletter is distributed to a mailing list, with recipient numbers increasing. Newsletters are posted on the company's website, with provision for interactive feedback from interested parties. Individual information sheets have been prepared in response to specific questions or concerns. Olympia will continue to liaise closely and regularly with interested and affected stakeholders throughout the planning, development and operational stages of the project.

1.5 SUMMARY OF ENVIRONMENTAL FACTORS

The main environmental factors and impacts associated with the Keysbrook project were identified by Olympia in consultation with DoE and Department of Conservation and Land Management (CALM) and through discussions with relevant stakeholders. They are summarised in Table 1.

Table 1: Environmental Factors Relevant to the Keysbrook Mineral Sand Project

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Biophysical					
Vegetation Communities	To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities through the avoidance or management of adverse impacts and improvement of knowledge.	Over 95% of the mine area is either cleared pasture or fragmented remnant vegetation with a condition score of completely degraded. The major consolidated area of remnant vegetation in generally good condition is most likely FCT 21a or 21c. Small areas of TEC types 3a and 3c were recorded. These had a condition score of degraded to completely degraded.	About 60ha of remnant vegetation and 244ha of parkland cleared vegetation is present within the proposed mine area and will need to be progressively cleared during the life of the project.	The amount of vegetation to be cleared will be minimised as far as practicable. The principle of avoidance has been used to excise significant vegetation areas and wetlands from the mine area. Mining areas will be rehabilitated upon completion using retained topsoil and seed collected from local species. The principle of no net loss of native vegetation will be implemented over the mine site. A vegetation management plan will be developed, including monitoring of areas cleared, to ensure no unnecessary clearing is undertaken.	There will be a temporary loss of vegetation by implementing the proposal. Local seed will be used in the rehabilitation to return the same tree species. Rehabilitation will also return low-lying vegetation species currently absent or existing as isolated trees in consolidated corridor planting, providing a net increase of this vegetation than currently exists. The rehabilitation plan will replace the same vegetation at the site than cleared.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Flora	To maintain the abundance, diversity, geographic distribution and productivity of flora at species ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.	No declared rare flora or priority species were identified. The remnant vegetation areas in the mine area are fragmented. There are no established corridor linkages within the mine area and from the mine area to other vegetated areas.	There is potential for flora of conservation significance to occur in the mine area. Mining activities may result in the removal of these species.	A vegetation management plan will be developed with an objective to minimise impact to significant flora species and communities and include trials on relocation of selected species (such as *Xanthorrhoea preissii*) in advance of mining, seed collection for rehabilitation programmes using tubestock planting and direct seeding. The management plan will stipulate consultation with CALM and DoE on aspects of vegetation management and rehabilitation strategies.	Avoidance of significant vegetation areas has been accommodated by not mining 48.7ha from Lot 56 and Lot 3 to conserve important attributes. The rehabilitation plan will return an equal area of vegetation that is cleared and also locate it to function as corridor linkages, therefore providing an improvement over the current fragmented remnants.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	The remnant vegetation areas in the mine area are fragmented. There are no established corridor linkages within the mine area and from the mine area to other vegetated areas. The majority of the mine area is cleared farm paddocks. The remaining native vegetation areas are actively grazed, with most now containing tree overstorey over pasture grass. The more significant fauna habitat locations, containing dense understorey and wetland habitats, are located outside the mining area and will not be disturbed. A cockatoo survey identified birds feeding in the area. No active nest sites were identified although possible nest sites were located.	Progressive clearing of up to 304ha has the potential to reduce the available habitat of fauna species. Reduction in habitat may reduce the local populations of fauna species of conservation significance.	The amount of vegetation to be cleared will be minimised as far as practicable. Clearing will be progressive, so not all the vegetation will be cleared at once. Rehabilitation will follow after mining.	The principle of avoidance has been used for significant fauna habitats identified in the flora survey, such as wetlands and stands of mature trees with nest hollows, by excising them from the mine plan to conserve these habitats. The rehabilitation plan will establish corridor linkages to increase the mobility of fauna. Although there will be temporary loss of fauna habitat and food resources during the project, implementation of progressive rehabilitation will re-establish fauna habitat, food source and the provision of vegetation corridors for native fauna species.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Wetlands	To maintain the integrity, ecological functions and environmental values of wetlands.	There are listed EPP wetlands on the periphery of the mine area. Another wetland, not listed in the EPP, was identified on Lot 64. The wetlands are subject to grazing by stock.	In the progressive mining of the area, groundwater may be temporarily impacted.	All EPP wetlands are located on the edge of resource areas and will be avoided and retained. No disturbance to listed EPP wetlands will occur. Modelling of pit dewatering has shown that effects of water table drawdown are confined to levels less than the seasonal water table fluctuation beyond the immediate extent of the mine pit.	The principle of avoidance has been used to ensure all wetlands will not be directly disturbed by mining activity and the maximum possible indirect effects from pit dewatering are consistent with natural seasonal fluctuations. The rehabilitation plan will enhance riparian vegetation corridors to ensure wetland biodiversity values are maintained, or improved, at a regional scale.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Surface Water	To maintain the quantity of surface water so that existing and potential environmental values, including ecosystem maintenance, are protected.	The surface hydrology is characterised by a number of major drainage lines, running through the mine area from upstream catchments and minor channels with localised catchments. Many of the existing drainage lines, major and minor, have been modified into agricultural drains. The vast majority of all riparian vegetation along the drainage lines has been cleared. Stock has unimpeded access to almost all the drainage lines through the mine area.	Changes in the local surface runoff regime resulting in contamination of surface water runoff with sediment.	Waters from potentially contaminated catchments will be captured and treated prior to release to natural catchments where necessary. The principle of avoidance has been used to ensure no disturbance to the major drainage lines, avoiding any impact to these waterways. Mitigation and management strategies will be implemented for the minor drainage lines impacted by the proposal to ensure water quality meets discharge criteria.	Impact to the major drainage lines will be avoided. There will be negligible effect on surface water by the project. Progressive rehabilitation with pasture will stabilise mined areas quickly, minimising the risk to surface water quality, in order to maintain discharge water quality to within acceptable standards.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Groundwater	The project is located within the proposed Karnup Dandalup Underground Water Pollution Control Area (UWPCA). The project is to be implemented to maintain the quality and quantity of groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected.	The two major aquifers affected by the proposal are the superficial aquifer and the deeper Leederville aquifer. The superficial aquifer will be affected by dewatering of the mine pit. The Leederville aquifer will be affected by abstraction of the required 2GL of water for mineral processing and dust suppression.	Temporary groundwater depression in the superficial aquifer as a result of pit dewatering extending to adjacent users or natural systems. Abstraction of groundwater from the Leederville aquifer having an effect on adjacent users.	Groundwater modelling has shown superficial groundwater dewatering for pit operation to have only a temporary and geographically narrow effect. Groundwater abstraction for the processing operation will be licensed and monitoring conducted to ensure there is no adverse effect to other licensed users. Abstraction volumes and water quality monitoring will occur and be reported to regulatory authorities. Water will be recycled to minimise abstraction volumes.	Dewatering of the mine pit will only have a temporary and localised drawdown of the superficial aquifer that will not extend beyond the boundary of the resource area. Adjacent undisturbed natural systems are predicted to experience fluctuations in ground water levels no greater than normal seasonal water table movement (see charts 4 and 5), resulting in negligile anticipated impact. Water extraction from the Leederville aquifer is not anticipated to impact on other licensed users.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Soil	To maintain the integrity, ecological functions and environmental values of the soil.	The majority of the mine area is cleared pasture. The mine area is hosted in the Bassendean sand unit that does not have a distinct soil horizon profile. Dieback disease has been identified in selected upland native vegetated areas on the site. Indications are that the disease has been present on the site for many years. A baseline investigation for Potential Acid Sulfate Soils (PASS) was conducted. The results confirmed low acid risk over the mine area.	Alteration of the soil profile in mined areas. Spread of *Phytophthora cinnamomi* (dieback) in native vegetation areas. Disturbance of PASS and possible increase in soil acidity.	Topsoil will be stripped, re-used or stockpiled for later re-use in rehabilitation. Waste sand material from the plant will be returned to areas where mining has been completed. Develop dieback management procedures for mining and rehabilitation, including monitoring of susceptible species' survival in rehabilitated areas. If required, an acid soils management plan will be prepared including the monitoring of discharge water and the implementation of management methods to ensure the project does not result in the generation of acid soils.	Topsoil will be either directly returned to completed areas undergoing rehabilitation or stockpiled for later use. Management measures will be implemented to minimise the risk of dieback impact on existing and rehabilitated vegetation in the mine area. Management measures will be implemented if monitoring of discharge water confirms acid generation is occurring. The mitigation measures identified will ensure the environmental values of the soil are maintained.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Landform	To maintain the integrity, ecological functions and environmental values of landforms.	The heavy minerals are hosted in the Bassendean sand unit. This unit will be most impacted by the mine. Southern River and Guildford units occur in the edges of the mining area. Minor impacts to these units also occur. The Forrestfield unit is outside the mine area and will not be disturbed.	Alteration of the local topography and landforms due to mining activities.	The post-mining landform shall be returned as close as possible to the pre-mining state. Pre-existing drainage patterns will be maintained. Rehabilitation and landform design plans will be developed. Erosion control measures will be implemented during mining and maintained until rehabilitation has fully established.	The post-mining landform will be returned to a similar state as existed pre-mining. Original drainage patterns will be reinstated. All landforms will be stabilised with either pasture or native vegetation. The landform values will not be adversely affected by the mining activities.
Rehabilitation	To ensure that rehabilitation of completed mine areas achieves a stable landform that is consistent with the surrounding landscape and is compatible with the pre-mining land use.	The existing land use over the mine area is agriculture, predominantly cattle grazing. The primary rehabilitation objective is to return the land to its pre-mining use. Also refer to the above sections on vegetation, flora, soils and landforms.	Up to 304ha of remnant native vegetation is expected to be cleared for the project. Rehabilitation will occur using the 'no net loss' principle to progressively replant this area.	Prepare a Rehabilitation Management Plan to address planting locations, species selection, rehabilitation monitoring and annual planting programme. The management plan will stipulate consultation with landowners, CALM and DoE on rehabilitation strategies, implementation and monitoring.	Rehabilitation will replace at least as much native vegetation as removed for mining. Rehabilitation will focus on corridor linkages with increased community diversity by both upland and lowland planting, to provide an improved environmental outcome over the current fragmented upland landscape and totally cleared lowland landscape.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Weeds	To ensure weeds are controlled in native revegetation areas to allow establishment of planted trees. The majority of the mine area is to be returned to its pre-mining land use of pasture. In these areas, weed management is to be restricted to the control of declared pest plant species.	The majority of the mine area is open pasture. Most of the native vegetation remnants consist of trees over pasture grass.	Weed infestation can inhibit establishment and survival of planted trees, decreasing the effectiveness of the rehabilitation programme.	Selective application of herbicides, if required, to allow establishment of planted trees. Areas rehabilitated with pasture species will only receive management of declared pest species.	Weeds will be controlled in native vegetation areas to allow establishment of native species.
Conservation Areas	To protect the environmental values of areas identified as having significant environmental attributes.	These are no conservation or nature reserves in the mine area. Significant vegetation areas on-site comprise remnant areas in good condition, wetlands and mature trees suitable for bird nesting sites.	A portion of the remnant vegetation areas with high environmental attributes may need to be cleared during the life of the mine.	Avoid impact to good quality remnant vegetation areas if possible. Implement strategies to rehabilitate remnant vegetation areas that are to be impacted by the project.	Olympia has used the principle of avoidance to excise 48.7 from Lot 56 and Lot 3 as a concession to conservation area planning. The mitigation measures identified will ensure the environmental values of local conservation areas are maintained.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Pollution Management					
Air Quality	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	The mine area is in a rural environment. There are no existing issues of deterioration in air quality from a major contributor. Localised emissions of dust and smoke would be related to specific activities.	Mining activities will result in airborne dust particles. Minor release of greenhouse gases from mining equipment.	Dust suppression procedures applied in line with industry best practice. All practicable measures will be taken to reduce energy consumption. Completed areas will be rehabilitated and revegetated as soon as practicable.	Management of dust emissions are to be controlled by a number of measures. Monitoring will be implemented to confirm the success of the management programme. The mitigation measures identified will ensure the environmental values of air quality are maintained.
Surface Water Quality	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	The mine area is in a rural environment. There are no existing issues of deterioration in surface water quality from a major contributor. Localised discharge of turbid water would be related to existing activities such as access to waterways by stock and runoff from newly ploughed paddocks.	Degradation of quality of surface runoff by sediments and hydrocarbon spillages.	A hydrocarbon management procedure will be prepared in consultation with DoW and implemented. Waters from potentially contaminated catchments will be captured and treated prior to release to natural catchments where necessary.	Hydrocarbon storage and handling will be managed to minimise the risk of contamination of surface waters. There will be negligible effect on surface water quality by mine activities.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Groundwater Quality	The mine is located within the proposed Karnup Dandalup UWPCA. The project is to be implemented to ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	The mine area is in a rural environment. There are a number of licensed users for both the superficial and Leederville aquifers.	Contamination of groundwater by chemicals and hazardous substances.	The project is to be implemented in accordance with the proposed Priority 2 (P2) land use management guidelines to ensure activities do not adversely affect groundwater quality. A hydrocarbon management procedure will be prepared in consultation with DoW and implemented, including a monitoring regime, to ensure contamination of groundwater does not occur.	Hydrocarbon storage and handling will be managed to minimise the risk of contamination of groundwaters. Groundwater quality will not be adversely affected by mine activities.
Soil Quality	To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.	The existing land use over the mine area is agriculture, predominantly cattle grazing. The primary rehabilitation objective is to return the land to this purpose.	Deterioration in topsoil quality with stockpiling. Deterioration in nutrient and water holding capacity after mining.	Topsoil will be directly returned to completed areas when possible. Storage in stockpiles will be to industry best practice. Development of a rehabilitation management plan.	Rehabilitation to pasture will involve two seeding years to establish good quality pasture and include application of lime and fertilizer as needed to generate good pasture growth. No deterioration in soil quality from the project.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal be ensuring the noise levels meet Noise Regulations.	The mine area is in a rural environment. There are no existing issues of noise generation from a major contributor. Localised noise generation would be related to specific activities.	Noticeable increase in noise levels for nearby residents.	Implement a work plan to operate in different locations, times and wind directions in order to comply with statutory requirements. Location of noise-generating equipment within enclosed structures. Placement of topsoil stockpiles to buffer emissions.	Operations on-site will be scheduled to minimise noise to adjacent residents. Compliance with statutory noise requirements.
Road Transport	Ensure that noise and dust levels meet acceptable standards and that an adequate level of service, safety and public amenity is maintained.	The mine area is in a rural environment. There are no existing issues of road transport disturbance from a major contributor. Localised traffic impacts would be related to specific activities.	Increases in noise and dust along the haulage route. Increase in traffic volume on local roads and highways.	Only 12-14 truck movements per day are proposed. All trucks will be well maintained and be operated by appropriately licensed operators. Local public roads will be maintained to a suitable standard as agreed with local councils. Appropriate permits will be obtained from relevant agencies for the truck configuration.	There will be minimal impact on the local road system and the level of public safety from the low number of trucks used for the project.
Light	To avoid or manage potential impacts from light overspill and comply with acceptable standards.	The mine area is in a rural environment. There are no existing issues of light overspill from a major contributor.	24-hour processing will require lighting to enable a safe working environment. Light overspill may be visible from nearby residences.	Orientate lights to minimise impacts on residences.	The large lot sizes generally through the mine area minimise the impact of light overspill. No significant adverse impacts are anticipated.

Environmental Factor	Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Social Surrounds					
Heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	The mine area is in a rural environment that is mostly cleared.	There are no known heritage sites located on the Keysbrook site.	A heritage survey will be conducted prior to commencement of site works to ensure no sites of significance are disturbed by the project. Olympia will ensure that all of its staff and contractors engaged on the project are aware of their obligations and responsibilities under the legislation.	No impact to any sites of significance.
Visual Amenity	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape.	The mine area is located in a gently undulating to flat landscape. Some residents will have views of the mine area.	Mining areas may be visible from secondary roads at the edges of the mine area and nearby residences.	The active mine envelope rapidly moves through the landscape. Progressive rehabilitation will reinstate the visual amenity soon after mining is complete.	Visual impact will be reduced to as low as reasonably practical. The mining is a temporary land use, with rehabilitation re-establishing a rural visual aspect.

1.6 SUMMARY OF ENVIRONMENTAL MANAGEMENT ACTIONS

Environmental management actions proposed by Olympia are listed in Table 2. For each action, reference is made to the section in which it occurs within this report. It is anticipated these will form part of the conditions of approval from DoE.

Table 2: Summary of Environmental Management Actions

No.	Management Action
Vegetation and Flora	
9.1.4a	A range of development options has been considered and reasonable steps taken to avoid native vegetation as required by element one of the EPA Position Statement 2: 1. The wet concentrator plant, process water dam, supporting infrastructure and stockpiles have been located to minimise impacts on native vegetation by preferentially locating them in existing cleared areas. 2. Listed EPP wetlands will not be disturbed by mining activities. All EPP wetlands are located on the periphery of the mine area. Mine planning will ensure the wetlands, plus an identified buffer zone, will be retained (Figures 11, 12 and13). 3. A remnant vegetation area of 33.7 hectares on Lot 56 that contains approximately half the mature trees with suitable hollows for cockatoo nesting, vegetation in good-very good condition has been excised from the mine area. With the addition of the vegetated non-mineralised exclusion areas and the EPP wetland exclusion area, a total of 48.7 hectares of the 108.1 hectares (45 per cent) of the vegetation on Lots 56 and 3 will not be disturbed. The 48.7 hectare exclusion area includes; • 2.45 hectares of the 3.20 hectares (76 %) of the CcXp community (Table 33) inferred as FCT 3c. Only 0.75 hectares of this FCT will be impacted by the minining operation. Bennett (2004); pg 7, records the condition of both the 3c and 3a community types as degraded to completely degraded. The community type 3c was of a larger area than FCT3a but it also adjoined paddocks with most of the understorey replaced by pasture (weed) species. • 25.71 hectares of the 61.3 hectares (42%) of the BaBm community in Lots 56 and 3, attributed by Griffin (2005) as 21a/c. This also includes mature trees, potentially suitable as cockatoo nest sites (Figure 14). Only 40.2 hectares will be impacted by the mining operation.
9.1.4b	Areas to be cleared will be delineated in the field with survey pegs and flagging tape before clearing commences. Company supervisors will oversee the clearing works.
9.1.4c	Olympia has prepared a Vegetation Management Plan. The plan establishes a recording, monitoring and reporting framework for site activities that may impact on vegetation. The plan includes: • Recording areas of vegetation cleared. • A schedule of any surveys and monitoring required to be undertaken. This will include monitoring the health of riparian vegetation in the EPP wetlands surrounding the mine area as mining passes these locations. Monitoring will continue until groundwater levels return to pre mining levels.

No.	Management Action
	• Preparing a rehabilitation plan that includes recording local seed collection, species used in rehabilitation, trials undertaken, plant relocation, fencing and weed control. • A reporting and review schedule for the plan.
Fauna	
9.2.4a	Olympia has prepared a Fauna Management Plan which identifies: • Target areas for further surveys and possible fauna relocation programmes. • A schedule of any monitoring that is required. • A reporting and review schedule for the plan.
9.2.4b	Clearing of mature trees will only occur outside the known breeding season for cockatoos, to avoid any risk to hatchling birds.
Rehabilitation and Closure	
9.3.4a	Olympia has prepared a Rehabilitation Management Plan which includes the following: • Progressive rehabilitation. • Seed collection. • Species selection for rehabilitation. • Detailed rehabilitation plans for each property. • Recording and monitoring of any trials undertaken. • Fencing. • Weed control. • A monitoring schedule for works completed. • A reporting and review schedule for the plan.
9.3.4b	Selective application of herbicides will occur in the spring of the first year of planting to improve establishment of planted trees. Further application of herbicide in the second year will be undertaken if required.
9.3.4c	Olympia has prepared a Decommissioning and Closure Plan which includes the following provisions: • Prior to shutdown, clean-up the process facilities and process any materials, including the run-of-mine ore storage pad. • Ensure that, once infrastructure is no longer required, it is removed. • The final open pit is to be backfilled to approximately pre-mining landform levels • Salvage pumps and other equipment. • Remove all hazardous materials, machinery and equipment. • Remove remaining buildings and infrastructure, and dispose of any demolition waste off-site. • Decommission bores, seal and plug below ground. • Decommission non-essential roads including re-establishment of natural drainage lines. • Rehabilitate all disturbed areas as specified in the RMP.

No.	Management Action
Acid Soils	
9.4.4a	During operations Olympia will implement a monitoring programme to detect any changes in pH, electrical conductivity (EC) and TAA as a result of generation of acid soil effects.
9.4.4b	A number of management measures are to be implemented that will serve to buffer against acid formation. These include: • Add a limestone bed in the water dam, to serve as a buffer to acidification of the water. • Add a limestone rubble-lined spillway for any surplus water requiring to be discharged during peak flow periods. • Add agricultural lime during the reseeding and fertilising programme, as part of the rehabilitation to pasture.
9.4.4c	Trigger levels of key parameters will be defined. Olympia will prepare and implement an ASSMP if these are exceeded. Initial trigger levels are TAA > 60 milligrams per litre (as $CaCO_3$) and a pH variance >10% acid trend (reducing pH level) of background levels. These trigger levels will be reviewed annually against monitoring data to ensure their relevance and accuracy during the life of mine.
Dieback Disease	
9.5.5	Implementing the management measures in Table 42 will minimise the risk of introduction and spread of the fungus in upland rehabilitation sites.
Groundwater	
9.6.4a	Olympia will prepare and implement a hydrocarbon management procedure in consultation with DoW.
9.6.4b	Olympia will prepare and implement a water operating strategy. The DOE site licence will also stipulate a monitoring and reporting requirement.
9.6.4c	Olympia will implement measures to recycle as much water as possible.
9.6.4d	Monitoring groundwater quality will continue until such time that groundwater levels have recovered following cessation of operations, to provide post-closure data**.**
9.6.4.e	Fuel storage and workshop facilities will be located on elevated ground to ensure a two metre separation distance to the highest water table level, thus complying with the Waters and Rivers Commision (WRC) guidelines.
9.6.4f	There will be no storage of hydrocarbons on the floor of the mine pit.
9.6.4g	The wet concentrator plant will be located on elevated ground and have hardstand areas draining to sediment sumps to prevent uncontrolled drainage from the plant site.
Surface Water	
9.7.4a	Olympia will obtain the required permit to implement any diversions of minor watercourses around active mine areas.
9.7.4b	Olympia will manage impacts on surface water quality by implementing the following: • Isolating infrastructure areas that have the potential to contaminate surface water. • Constructing sediment sumps, silt and oil traps where necessary to remove sediments or pollutants from runoff before water enters local drainage. • Any spills of contaminants such as oil or fuel will be cleaned up immediately. • Monitor surface water quality around the active mine area.

No.	Management Action
9.7.4c	Surface water management structures will be designed and constructed to ensure minimum erosion potential. Diversion drains will be constructed so that water re-enters natural drainage lines at a velocity and depth that can be accommodated by the natural stream line without increased scouring.
9.7.4d	As a result of heavy rainfall events, there is the potential for increased turbidity off recently-rehabilitated areas that are not yet fully stabilised. Sedimentation basins will be constructed where required to reduce turbidity before release to the environment.
Air Emission	
9.8.4a	If diesel emissions prove to be an issue, Olympia will employ selective mining near the property to mine only when prevailing wind blows away from the property.
9.8.4b	The following management and mitigation measures will be implemented to minimise and control air emissions. • Vehicles and power generating equipment will be regularly maintained and serviced to manufacturer's specifications to ensure efficient running of equipment and optimum fuel consumption, thereby minimising exhaust emissions. • Emissions will be reported as part of the National Pollutant Inventory.
9.8.4c	Any required permits will be obtained for burning conducted on-site. Burning will be scheduled to occur during periods when local wind forecasts show prevailing winds blowing away from adjacent residents.
Dust Management	
9.9.4	Olympia has developed a Dust Management Plan (DMP) to manage particulate emissions so they do not cause environmental or human health problems. Dust control measures will include: • Minimising clearing and open area. • Not stripping topsoil during periods of high winds. • Watering of internal traffic areas as required. • Growing of temporary 'stubble' crops to bind soil and decrease wind velocity at ground level. • Re-establishment of pasture as soon as possible after mining has been completed. • Using sprinkler systems around high activity infrastructure areas. • Installing a high wind warning system to enable the site to initiate dust control mechanisms in a timely manner. • Utilising clay and mulch to stabilise stockpile and non-vegetated backfill areas. The DMP includes: • Continuous wind monitoring on site linked to a warning system when threshold values are exceeded, to provide a proactive and real time management system. • The establishment of dust monitoring sites at strategic locations around the operation. • Regularly review monitoring data and investigate high results. Implement corrective actions to eliminate the causal factors.

No.	Management Action
	• Reporting of monitoring results will occur as required in the DoE operating licence, expected to be on an annual basis. • Regular communications will be held with adjacent landowners and a complaints management system, including investigation, action and feedback, implemented.
Noise	
9.10.5	Olympia will implement the following noise management measures to ensure that: • Noise control equipment on stationary and mobile equipment is operating correctly. • Mine planning will take into consideration the noise model results, prevailing wind direction and time (day or night operation) to schedule the location of operating plant to comply with noise standards at adjacent noise sensitive premises. • Noise emissions comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* and the *Mining Act 1978*.
Waste Products	
9.11.4	Olympia will implement management measures to minimise the potential for contamination of the surrounding environment due to general waste disposal as follows: • There will be no on-site disposal of wastes. • Wastes will be stored in appropriate containers and locations including bunded areas (for hazardous materials) and bulk bins or rubbish bins (for general domestic and office refuse) • Wastes will be recycled where practicable. • General domestic and office waste will be disposed to an approved off-site landfill. • Effluent disposal systems will comply with local government health department requirements.
Dangerous and Hazardous Substances	
9.12.4	Olympia will implement management measures to minimise the risk of contamination of soil, surface water and groundwater at the site: • Develop and maintain a register of all hazardous materials imported to the site or generated as a result of activities undertaken at the site. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers. • Locate fuel storage areas and workshops to comply with the two metre minimum separation distance to groundwater as described in WRC Policy No 1. • Fuel storage areas and workshops will be bunded in accordance with DoIR and DoE requirements. • Treat runoff contaminated with hydrocarbons prior to discharge. • Clean up hydrocarbon spills and remove contaminated soil from site. • Transport hazardous wastes generated by the operation off-site to licensed waste disposal facilities. This is likely to include waste oil, grease and mobile equipment filters. • Bring hazardous materials to the site in bulk packaging wherever possible. This will minimise the number of containers and reduce the risk of spillage.

No.	Management Action
	• Complete major mechanical servicing and overhauling of mining equipment off-site. Conduct routine equipment and vehicle servicing activities including washdown on impermeable surfaces. • Obtain a Licence to Store Dangerous Goods for the storage of diesel fuel on-site.
Heritage	
10.1.3	Olympia will avoid any unnecessary disturbance to any identified Aboriginal heritage sites. Management and mitigation measures that will be implemented to achieve this will include: • Conduct an Aboriginal heritage survey of the mine area, in conjunction with Aboriginal representatives, prior to site works commencing. • Comply with the requirements of the *Aboriginal Heritage Act* 1972 and seek advice from the Department of Indigenous Affairs in the event that any Aboriginal heritage sites are identified during the life of the project. • Olympia will ensure that all its staff and contractors on site receive an induction that includes their obligations and responsibilities under the *Aboriginal Heritage Act* 1972.
Transport	
10.2.3a	Olympia will obtain the necessary transport permits from the Shires of Murray and Serpentine Jarrahdale for transport on local roads, and Main Roads WA, for transport on the South Western Highway.
10.2.3b	Olympia will consult with the Shire of Murray on any required signage, upgrading of local intersections or road pavement that is needed for safe movement of all traffic on local roads.
10.2.3c	Olympia will consult with Main Roads WA on the intersection requirement of Readheads Road with the South Western Highway. Any required upgrade works will be undertaken to ensure safe traffic access and egress.

1.7 SUMMARY OF COMMITMENTS

Environmental commitments made by Olympia in regards to the Keysbrook project are outlined in Table 3.

Table 3: Summary of Commitments

No.	Topic	Objective	Action	Timing	Advice
1	Environmental Management	To avoid, minimise or mitigate impact to the environment	Implement environmental procedures and management plans that address the management or avoidance of impacts to the environment such as impacts to: • Weeds. • Groundwater quantity and quality.	Prior to Construction	

No.	Topic	Objective	Action	Timing	Advice
			• Surface water. • Vegetation and flora. • Fauna. • Air, including dust impact. • Heritage. • Surrounding land use. • Noise. • Waste. • Dangerous and hazardous substances.		
2	Environmental Management	To avoid, minimise or mitigate impact to the environment	Environmental performance achieved as a result of the environmental procedures and management plans will be audited, and procedures reviewed as necessary	During Construction	
3	Environmental Management	To avoid, minimise or mitigate impact to the environment	Implement environmental procedures and management plans that address the management or avoidance of impacts to the environment such as impacts to: • Weeds. • Groundwater quantity and quality. • Surface water. • Vegetation and flora. • Fauna. • Air, including dust impact. • Heritage. • Surrounding land use. • Noise. • Waste. • Dangerous and hazardous substances.	During Operation	
4	Environmental Management	To avoid, minimise or mitigate impact to the environment	Environmental performance achieved as a result of the environmental procedures and management plans will be audited, and procedures reviewed as necessary	During Operation	

2. INTRODUCTION

2.1 BACKGROUND

Olympia was incorporated in 1997 to carry out exploration and develop mineral sand deposits within Australia into profitable mining operations.

Initially, Olympia concentrated on developing the Harts Range abrasives deposit near Alice Springs in the Northern Territory. In 2003 Olympia discovered the Keysbrook mineral sand deposit in the south-west of Western Australia. The mine area is located approximately 70 kilometres south of Perth and four kilometres west of Keysbrook (Figure 1).

The mine area and surrounding land is currently used for agricultural purposes. The northern section of the mine area is dominated by a few large landholdings while the southern portion consists of many smaller landholdings. The dominant industry of the area is dairy and beef cattle farming; although there is a small area of intensive horticulture and horse keeping and agistment is common.

The land in the mine area is held in private ownership under pre-1898 title. These titles grant ownership of the heavy minerals to the landowner, rather than the State. For this reason, the grant of a Mining Lease under the *Mining Act 1978* is not required.

The mine area covers 1,234 hectares. The proposed timing of operations is to complete the environmental assessment process by mid-2006, with construction of plant and infrastructure following soon after. Proposed commencement of mining operations is early 2007, with an expected mine life of up to eight years. The project will require a workforce of 30-35 people, which will be sourced locally where possible.

2.2 OBJECTIVES

The objectives of this PER are to:

- Describe all components of the proposal.
- Place this proposal in context of the local and regional environment.
- Outline potential environmental impacts resulting from the proposal and develop management and mitigation measured to minimise these impacts.
- Communicate clearly with stakeholders (including the public and government agencies), so the Environment Protection Authority (EPA) can obtain informed comment to assist in providing advice to government.
- Provide a document that clearly sets out the reason why the proposal should be judged by the EPA and the Minister for the Environment to be environmentally acceptable.

2.3 THE PROPONENT

The proponent is Olympia Resources Limited (ABN 52 077 221 722).

Address: PO Box 1341
Osborne Park WA 6916

Phone: (08) 9244 1411

Email: peter.gazzard@olympiaresources.com.au

Contact Person: Mr Peter Gazzard

Position: Managing Director

Olympia has appointed MBS Environmental as environmental consultants to help them gain environmental approvals for the Keysbrook project. Enquiries regarding environmental matters should be directed to:

Company: Martinick Bosch Sell Pty Ltd (trading as MBS Environmental)

Address: 4 Cook Street
West Perth WA 6005

Phone: (08) 9226 3166

Fax: (08) 9226 3177

Email: prokich@mbsenvironmental.com.au

Contact Person: Mr Paul Rokich

Position: Senior Environmental Scientist

2.4 LOCATION

The mine area is located approximately 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook (Figure 1). The following coordinates denote the north-east and south-west corners of the project area, respectively:

North-east corner of project area	-32.424ºS, 115.915ºE
South-west corner of project area	-32.518ºS, 115.975ºE

The mine area is situated approximately 50% in the Shire of Serpentine Jarrahdale and 50% in the Shire of Murray. Both Shires are dominated by rural landscapes with small to medium-sized towns. The main accesses are off the South Western Highway at Elliott Road and Readheads Road.

2.5 LAND TENURE

The mine area is in private ownership with multiple landowners. The land in the mine area is on pre-1898 titles. These titles impart ownership of the mineral rights to the landowner, not the State.

The area potentially available for mining will be governed by the number of land access and compensation agreements that can be entered into between Olympia and individual landowners. Olympia may also purchase properties in the mine area. It is considered highly likely that agreements will not be entered into with all landowners in the mine area. Where agreements cannot be made, these properties will be excluded from mining operations. Not all properties within the project area have sufficient grade or quantity of resource to warrant mining. These properties will also be excluded from mining operations.

Table 4 and Figure 2 show the land tenure over the proposed mining area.

Table 4: Land Tenure over the Proposed Mining Area

Lot Number	Ownership
Shire of Serpentine Jarrahdale	
Lots 3, 63	Hill
Lot 56	Mostert
Lot 57	Del Borello
Lot 112	Olympia Resources Limited
Lots 1, 6, 52, 111, 113	Furfaro
Shire of Murray	
Lot 62	Thorndale Pty Ltd
Lots 59, 300	Lanstal Pty Ltd
Lot 44	Kelliher
Lots 6, 7	Hicks
Lot 49	Mostert

2.6 PER PURPOSE AND STRUCTURE

On 30 May 2005, the proponent submitted a referral document to the EPA under provisions in Section 38(1) of the *Environmental Protection Act 1986*.

On 25 July 2005 the EPA set a level of assessment for the proposal at a Public Environmental Review (PER) with an eight-week public review period.

The level of assessment of PER is typically applied to proposals "of local or regional significance that raise a number of environmental factors, some of which are considered to be complex and require detailed assessment to determine whether, and if so how, they can be managed" (Government of Western Australia, 2002).

On 7 July 2005, the Commonwealth Department of the Environment and Heritage (DEH) declared that the proposal is a Controlled Action under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*). In accordance with the Bilateral Agreement (16 August 2002) between the Commonwealth and the State, formal assessment of the proposal by DEH under Part 8 of the *EPBC Act 1999* is not required. Schedule 1 of the Bilateral Agreement provides accreditation of the State assessment procedure, at the level of PER, by the Commonwealth.

A scoping document was submitted to the EPA on 14 September 2005 and was approved by the EPA on 19 January 2006.

This PER aims to identify and assess the environmental effects of the proposal and to describe the strategies to manage and minimise any environmental effects. The PER is structured into 11 sections as shown in Table 5.

A range of technical studies has been completed in preparing this document. A number of management plans have been prepared for key environmental factors. The technical studies are provided as supporting documents on a compact disc that accompanies the PER.

Table 5: Structure of the PER

Section	Title	Description
Section 1	Executive summary	Provides a summary overview of the proposal and contents of the PER.
Section 2	Introduction	Provides background information relevant to the environmental assessment of the project.
Section 3	Proposal	Summarises the key characteristics of the proposal and alternative options that have been considered.
Section 4	Project Description	Describes the individual elements of the project and a detailed description of the processes.
Section 5	Existing environment	Describes the physical, biological and social characteristics of the project area.
Section 6	Stakeholder consultation	Describes the community and government consultation programme undertaken during preparation of the PER.
Section 7	Sustainable development	Describes the proponent's actions related to ecological sustainability principles.
Section 8	Identification of environmental factors	Describes how environmental factors relevant to the proposal were identified.
Section 9	Environmental management	Summarises the proponent's environmental management processes and expected outcomes.
Section 10	Social issues and management	Summarises the proponent's social management process.
Section 11	References	List of references used in the document.

2.7 ABBREVIATIONS

AHC	Australian Heritage Council
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASSMAC	Acid Sulfate Soils Management Advisory Committee
CALM	Department of Conservation and Land Management
DEH	Commonwealth Department of Environment and Heritage
DIA	Department of Indigenous Affairs
DoA	Department of Agriculture
DoE	Department of Environment
DoIR	Department of Industry and Resources
DOCEP	Department of Consumer and Employment Protection
DoW	Department of Water
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
ha	hectares
m^3/hr	cubic metres per hour
MRWA	Main Roads of Western Australia
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measures
NHMRC	National Health and Medical Research Council
NPI	National Pollutant Inventory
t/hr	tonnes per hour
t/m^3	tonnes per cubic metre
UWA	University of Western Australia
WAM	Western Australian Museum

2.8 RESPONSIBLE AUTHORITIES

The main agencies with an interest in the environmental assessment and management of the proposal are:

- EPA.
- DoE.

- DoW.
- CALM.
- DoIR.
- DOCEP.
- DIA.
- DoA.
- MRWA.
- DEH.
- Shire of Murray.
- Shire of Serpentine Jarrahdale.

2.9 RELEVANT LEGISLATION AND GUIDELINES

The proposal is being assessed under Part IV of the *Environmental Protection Act 1986* (WA) (as amended). If the Minister for the Environment, Racing and Gaming decides that the proposal may proceed after considering the EPA assessment report on the proposal, the Minister will issue a statement that allows the proposal to be implemented. This statement may contain conditions that will apply to the project when implemented.

In addition to approval from the Minister for the Environment, Racing and Gaming, the proponent will also need to obtain other statutory approvals administered by State and Local Government agencies. Relevant legislation, policies and guidelines applicable to the proposal are listed in Table 6.

Table 6: Legislation, Policies and Guidelines Applicable to the Proposal

Title	Applicability
Commonwealth Legislation and Documents	
Environment Protection and Biodiversity Conservation (EPBC) Act 1999.	The EPBC Act protects the environment, particularly matters of National Environmental Significance. Approval is required for actions that are likely to have a significant impact on: a matter of national environmental significance; the environment of Commonwealth land; and the environment anywhere in the world (if the action is undertaken by the Commonwealth). An action includes a project, development, undertaking, activity, or series of activities.
Australian Heritage Council Act 2003.	Establishes the Heritage Council and its function of keeping the Register of the National Estate.
The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) November 1983.	International convention, to which Australia is a signatory, on the protection of migratory species.
Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA) February 1974.	International agreement, to which Australia is a signatory, on the protection of migratory species.
Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA) October 1986.	International agreement, to which Australia is a signatory, on the protection of migratory species.
National Water Quality Management Strategy (1994)	The Strategy was introduced to provide a process to manage the nation's water bodies in an environmentally sustainable way. The main policy objective of the NWQMS is, "to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development."
State Legislation and Documents	
Environmental Protection Act 1986 (as amended).	The project is being formally assessed under Part IV of this Act. Any works approvals or licences required for the project are issued under Part V of the Act.
Environmental Protection (Noise) Regulations 1997.	Represents the prescribed standards for noise under the *Environmental Protection Act 1986*. Acceptable noise levels for different times of the day are specified.

Title	Applicability
Mines Safety and Inspection Act 1994.	Relates to the safety of mines and mining operations and the inspection and regulation of mines, mining operations and plant and substances supplied to or used at mines.
Rights in Water and Irrigation Act 1914.	Applies to the management of water resources and the equitable and efficient use of water resources.
Aboriginal Heritage Act 1972.	Relates to the protection and preservation of Aboriginal sites.
Wildlife Conservation Act 1950.	Applies to the protection of wildlife in Western Australia.
Dangerous Goods Safety Act 2004.	The Act relates to the safe storage, handling and transport of dangerous goods.
Town Planning and Development Act 1928.	The Act relates to obtaining planning approval for development within the Shires of Murray and Serpentine Jarrahdale.
Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004.	Identifies conservation category wetlands on the Swan Coastal Plain.
Environmental Protection Authority Position Statement "Environmental Protection of Native Vegetation in Western Australia": No 2 (December 2000).	Applies to proposals to clear remnant native vegetation in Western Australia as it aims to protect biodiversity. Key criteria applied include: The "threshold level" below which species loss appears to accelerate exponentially at the ecosystem level is regarded as being at a level of 30% of the pre-clearing extent of the vegetation type. A level of 10% of the original extent is regarded as being a level representing "endangered" and should be avoided.
Environmental Protection Authority Position Statement "Terrestrial Biological Surveys as an Element of Biodiversity Protection": No 3 (March 2002).	Highlights the significance of biodiversity and the need to develop and implement best practice in terrestrial biological surveys.
Environmental Protection Authority Position Statement "Environmental Protection of Wetlands": No 4 (November 2004).	Applies to proposals containing wetlands focussing on terrestrial wetlands with permanent or temporary inundation.
Environmental Protection Authority Position Statement "Towards Sustainability": No 6 (August 2004).	Applies to all proposals. It discusses the concept of sustainability and draws attention to a range of global issues. It introduces sustainability issues in a number of sectors such as natural resource management, delivery and use of energy, communities, transport, and the production and use of minerals.
Environmental Protection Authority Position Statement "Principles	Applies to all proposals. It discusses the concept of sustainability and draws attention

Title	Applicability
of Environmental Protection" No 7 (August 2004).	to a range of global issues. It then introduces the reader to sustainability issues in a number of sectors such as natural resource management, delivery and use of energy, communities, transport, and the production and use of minerals.
Environmental Protection Authority Position Statement "Environmental Protection in Natural Resource Management (Preliminary)" No 8 (June 2004).	This Position Statement sets out the EPA's views on Natural Resource Management (NRM) and the role of the EPA in NRM with respect to environmental performance evaluation. It also sets out the minimum environmental management procedures for NRM agencies for proper integrated NRM, including public consultation.
Guidance for the Assessment of Environmental Factors "Level of Assessment for Proposals Affecting Natural Areas within the System 6 region and Swan Coastal Plain Portion of the System 1 Region": No 10 (January 2003).	Provides guidance about the assessment of proposals by the EPA that may potentially impact on bushland within the Bush Forever area and regionally-significant natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region. The guidance aims at ensuring that developments are compatible with the intent of the recommendations for and/or conservation values of these areas.
Guidance for the Assessment of Environmental Factors "Guidance Statement for Minimising Greenhouse Gas Emissions": No12 (October 2002).	Addresses the minimisation of greenhouse gas emissions from significant new or expanding operations.
Guidance for the Assessment of Environmental Factors "Assessment of Aboriginal Heritage": No 41 (April 2004).	Considers 'Aboriginal Heritage' as a relevant environmental factor in circumstances where it is linked directly to physical and biological attributes of the environment and when the protection and management of those attributes are threatened as a result of a proposed development. The Statement provides information that the EPA will consider when assessing proposals where Aboriginal Heritage is a relevant factor.
Guidance for the Assessment of Environmental Factors "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia": No 51 (June 2004).	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia's terrestrial flora and vegetation and their ecosystems.
Guidance for the Assessment of Environmental Factors "Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process": No 55 (December 2003).	Provides guidance on what the EPA means by the term 'best practice' when used in the EIA process.
Guidance for the Assessment of Environmental Factors "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia": No 56 (June 2004).	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia's terrestrial faunal biodiversity and its habitat.

Title	Applicability
Guidelines for Mining and Mineral Processing: Mine Site Water Quality Monitoring. Water Protection Guideline No 5. June 2002.	These guidelines are to apply where a programme is used to monitor changes in water quality resulting from a mining operation involving, for example, handling of chemicals and the disposal of wastes. They apply to samples taken for physical and chemical analyses only, not to bacteriological or biological samples.
Guidelines for Mining and Mineral Processing: Mine Site Stormwater. Water Protection Guideline No 6. January 2000.	These guidelines are to apply where rainfall on mine site areas is likely to impact on the quality of water resources. This includes runoff generated from land such as stockpiles, process plants, dumps, haul roads and rehabilitated areas.
Guidelines for Mining and Mineral Processing: Above-ground Fuel and Chemical Storage. Water Protection Guideline No 10. January 2000.	These guidelines are designed to minimise the potential impacts on water resources from poorly managed above-ground fuel and chemical storage facilities. These guidelines apply to all mine sites where the volume of above-ground storage of fuel or toxic/ harmful chemicals exceeds 250 litres.
Guidelines for Mining and Mineral Processing: Mine Dewatering. Water Protection Guideline No 11. January 2000.	These guidelines are designed to be used to manage the impact of mine site dewatering on the quality of the region's water resources. These guidelines apply to the discharge of water pumped as part of mining or mineral processing operations.
EPA (June 2005) Preliminary Position Statement No. 9: Environmental Offsets. Version 2	To provide guidance to the community, government agencies, industry, developers, consultants, business and other key stakeholders with overarching advice about the intent and appropriate use of environmental offsets.
CALM Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan 2002 – 2012. April 2003.	Recovery plan, co ordinated by CALM for Carnaby's Cockatoo.
CALM Policy Statement No 3 "Threat abatement for *Phytophthera cinnamomi*. Draft for Public Comment. March 2004.	This policy provides guidance to CALM with a view to limiting the threat posed by *Phytophthora cinnamomi* and disease caused by it to the biodiversity conservation values of native vegetation in Western Australia.
Western Australian Planning Commission. Planning Bulletin No. 64. Acid Sulfate Soils. November 2003.	The purpose of this Planning Bulletin is to provide advice and guidance on matters that should be taken into account in the rezoning, subdivision and development of land that contains acid sulfate soils.
Western Australian Planning Commission. Statement of Planning Policy (5AA Policy) 2.1. The Peel-Harvey Coastal Plain Catchment Policy (February 1992).	The policy applies to land uses within the Peel Harvey portion of the Swan Coastal Plain with the objective of ensuring land uses are controlled so as to avoid and minimise environmental damage.
Australian Drinking Water Guidelines (ADWG) (2004)	The ADWG incorporates the "Framework for the Management of Drinking Water

Title	Applicability
	Quality" and provides the Australian community and the water supply industry with guidance on what constitutes good quality drinking water.
State Water Quality Management Strategy for Western Australia (2001)	The Strategy has been drafted with the primary objective to ensure that an administrative structure for water quality management is established in Western Australia.
Department of Water - Water Quality Protection Notes.	Guidance notes on a range of activities with the potential to contaminate water supplies.

3. PROPOSAL

3.1 KEY CHARACTERISTICS OF THE PROJECT

The key characteristics of the Keysbrook project are presented in Table 7. The conceptual site layout is presented in Figure 3.

Table 7: Characteristics of the Proposed Keysbrook Mineral Sand Project

Element	Description
Life of project	Up to 8 years
Size of orebody: • Ore reserve • Grade • Product	 34Mt 2.7% 0.92Mt HMC
Depth of mine pit	Average 2m. Maximum 5m below ground level on sandy dunes
Area of disturbance: • Native vegetation in good condition • Native vegetation parkland cleared • Cleared paddocks • Total mine area	 60ha 4.8% 244ha 19.8% 930ha 75.4% 1,234ha 100%
Mine operation	24 hours, 7 days a week
List of major components: • Topsoil removal and stockpiling • Mining in open cut pit • Dump hopper and screening plant • Heavy mineral concentration plant • Clay fines thickener • Backfilling mined pits with clay and sand • Ground contouring, stabilisation, topsoil replacement and rehabilitation after mining	See Conceptual Site Layout (Figure 3). Mining will occur within a continually moving open pit of approximately 30 hectares in area. The dump hopper, screening plant and heavy mineral concentration plant are mobile.
Supporting Infrastructure components: • Transportable offices • Transportable storage facilities • Water storage dam (capacity 74,000 Kl)	
Processing: • Design rate • Annual rate	 600 tonnes per hour 4.25 million tonnes per annum

Element	Description
• Process circuit water requirement • Make-up water requirement	1,820 kL per hour 220-240 kL per hour
Waste: • Organic matter and coarse material (>2mm) • Fine clay and silt (<53µm) • Quartz sand	 Backfilled into completed mine voids. Backfilled into completed mine voids. Backfilled into completed mine voids.
Water supply: • Source • Annual requirement	 Mine pit dewatering: Bassendean system Bore: Leederville aquifer 2.0GL per annum
Pit dewatering: • Method	 In-pit sumps
Power supply	Reticulated mains supply
Self bunded fuel storage capacity Quantity used	55,000L 2,000 kL per annum
Transport route and truck movements	See Figure 19. Truck movements of 12-14/day.

3.2 ALTERNATIVE OPTIONS CONSIDERED

Several alternatives have been examined in developing this proposal. The alternatives considered were:

Mining

- **Do not mine the resource**

  This would not satisfy Olympia's objective to produce mineral sand products.

- **Fully mine the resource**

  The extent of the economic resource is well defined. The amount potentially available for mining will be governed by the amount of land access and compensation agreements that can be entered into with private landowners. To secure full rights, Olympia could choose to purchase all freehold land containing heavy minerals. This is unlikely to be a desirable option for all current landowners and would have a detrimental effect on the economics of the project. Time delays likely to acquire all land would also make this alternative undesirable.

- **Partially mine the resource**

  The preferred /most likely mining option. Following from the previous option, the area potentially available for mining will be governed by the amount of land access and

compensation agreements that can be entered into with the private landowners. In reality, it is considered highly likely that agreements will not be entered into with all landowners that have heavy minerals on their property. Where agreements cannot be made, these areas will be excluded from mining operations.

Mining Methods

- **Mine the resource using dredging (wet mining) methods**

  This would require additional water to be extracted for use in the dredging operation. The shallow nature of the ore body and the topography would make this option economically and practically undesirable.

- **Mine the resource using conventional earthmoving equipment (dry mining) techniques**

  The preferred mining method. This will, during the winter months, require dewatering of the mineralised zone to allow vehicle movement on the pit floor. The shallow nature of the ore body and lack of overburden means that conventional dry mining techniques will be the most effective and efficient in terms of production, cost and environmental management.

Processing

- **Undertake primary concentration on-site and secondary separation off-site**

  The preferred processing option. It is uneconomic to transport the very large tonnages of ore mined off-site for primary concentration and transport the waste sand back to the site to refill mine areas. Consequently, the decision has been made to carry out primary concentration at the Keysbrook minesite. Due to the location of other potential ore bodies further south in the Capel/Busselton area it has been decided to site the secondary separation plant centrally at Picton near the Port of Bunbury. The HMC produced in the Keysbrook primary concentration plant will be transported by truck to Picton for secondary separation.

Transport

- **Method of HMC transport to off-site secondary treatment plant**

  Given the proximity of the railway line, the option of using rail to transport HMC to the secondary treatment plant was considered. The cost of establishing rolling stock capable of transporting HMC and the cost required to establish storage and loading facilities at the siding were not able to be sustained for the project given the estimated eight year project life and the quantities of HMC product involved. Also, the rail option still requires road transport of HMC from the mine site to the rail siding, using local roads thus not avoiding the road transportation issues.

  A number of alternative road transport routes for HMC are available. Olympia has discussed the various options with both Shire Councils and Main Roads. The preferred route selected is Westcott Road, a private road through Lot 300, from the south-east corner of Lot 300 south on Atkins Road to Readheads Road and east along Readheads Road to the South West Highway then south on the South Western Highway to Picton.

Environmental

- **Mine the entire mineral reserve, on land accessible to Olympia**

  This would maximise the financial return to Olympia however result in unacceptable environmental impacts to wetlands and significant vegetation areas.

- **Do not mine the section of orebody located underneath significant remnant vegetation areas**

  The preferred environmental option. Significant remnant vegetation areas may contain significant species (e.g. priority species), communities (e.g. TECs) or structural elements (e.g. mature trees with potential for bird nesting sites). The heavy minerals are located on private freehold land. Access to the minerals is subject to entering into land access and compensation agreements with the private landowner. Negotiations with relevant landowners will need to be completed before mining on a specified property can be undertaken. Avoiding locations of significant environmental value that are identified on a specified property will result in a balanced environmental – economic outcome.

3.3 SUMMARY OF ENVIRONMENTAL FACTORS

The environmental factors considered relevant to the proposed mining activities within the Keysbrook mine area are detailed in Table 1.

Olympia considers the highest-priority potential environmental impacts of the project to be:

- Removal of remnant areas of native vegetation.
- Dust and noise issues during operation.
- Scheduling of rehabilitation to quickly re-establish pre-mining land use over completed areas.
- Management of water in terms of retaining moisture in the backfill, discharging water to the drainages and drawdown of the water table.

While all the environmental factors listed are important, the other factors are considered to be less significant for this proposal. This is because experience gained from similar mining operations indicates that effective management and mitigation measures can be more readily implemented to ensure adverse environmental impacts are prevented or minimised and the stated EPA environmental objectives are met.

Additional surveys and investigations related to specific environmental factors have been conducted:

- Ground truth wetland boundaries.
- Collect additional information about the Short-billed Black Cockatoo and the Forest Red-tailed Black Cockatoo within the mine area.
- Collect information and model the surface and groundwater hydrology of the mine area.
- Produce a noise model for the proposed operations.

- Assess the potential acid sulfate soil status in the mine area.
- Assess the presence of *Phytophthora cinnamomi* (dieback) in the mine area.

4. PROJECT DESCRIPTION

4.1 SITE SELECTION AND LAYOUT

The proposed mine area covers a number of rural properties in private ownership. Access to the mineral reserve on each property is dependent on landowner agreement. Complete implementation of the designed mine plan is predicated on finalisation of agreements with all nominated landowners.

Figure 4 shows the proposed mining schedule in annual stages. The wet concentrator will be relocated three times during the life of mine. All three locations of the wet concentrating plant are shown, although only one will be operating at any time.

The screening plant is mobile and will be moved as the mine pit progresses through the ore body.

Supporting mine infrastructure, such as fuel storage and administration facilities, will be located adjacent to the wet concentrator plant. The facilities will be transportable and consist of portable offices, storage facilities and self-bunded fuel tanks.

Where required, booster pumps for primary feed, backfill sand and water will be located along the respective pipeline routes.

The location of the screening plant in each mining cell has taken into account environmental constraints that include:

- Major drainage lines to be left undisturbed.
- Distance to adjacent residents.

4.2 SITE PREPARATION

Site preparation activities will be conducted prior to, and concurrent with, the mining operations. Areas to be cleared will be delineated in the field with survey pegs and flagging tape before clearing commences. Company supervisors will oversee the clearing works.

Suitable trees will be salvaged from remnant vegetation areas for timber, fence posts and firewood before the remaining vegetation is removed. Some vegetation will be mulched. Remaining vegetation and stumps that cannot be economically salvaged or reused will be burnt.

Topsoil will be removed to a depth of 200 millimetres from mined areas and directly returned to backfilled cells that are ready for final rehabilitation. If not, it will be stockpiled and stabilised to prevent wind erosion, in windrows not exceeding two metres in height, for use in future rehabilitation work. No overburden is present. There is no requirement for overburden stripping.

Site preparation works in advance of mining involves the following elements:

1. Provide power and water services to the mining areas.
2. Disconnect the screening plant from power and water services, relocate to the newly-prepared site and reconnect within one day.
3. The wet concentrator is significantly larger than the screening plant and less mobile. Relocation of the wet concentrator will also require relocation of supporting infrastructure such as power, water, the water storage dam, administration, contractor servicing and fuel facilities. This all needs to happen in advance of the wet concentrator plant relocation. The relocation process for the concentrator may take one week.

4.3 MINING OPERATIONS

4.3.1 Mining Schedule and Method

The Keysbrook orebody has a calculated reserve of 0.92 million tonnes of heavy mineral concentrate, in an orebody of about 34 million tonnes of predominantly quartz sand. Approximately 4.25 million tonnes of ore will be mined per annum over a mine life of up to eight years.

Keysbrook will produce 115,000 tonnes per annum of HMC and truck it to Picton. This represents about 2,200 tonnes per week of HMC cartage or six to seven 50-tonne truckloads per day. Truck movements to and from the Keysbrook mine site will therefore be between 12 and 14 per day.

The mine schedule proposes commencement of mining on Lot 112 in the eastern side near the centre of the deposit. After mining Lot 112 the mine will relocate south to Lot 300. The mine path then traverses across the deposit from east to west and back as the operations generally move in a northerly direction. When the northern extremity of the deposit has been mined, the mining operation relocates to mine a small pocket of ore in the far south of the deposit.

At the commencement of operations, there will be no completed excavation for simultaneous backfilling of waste and direct return of topsoil. Dry mining will initially stockpile topsoil, excavate the resource profile and stockpile the material near the wet concentrator plant in a run-of-mine (ROM) stockpile. Once an initial excavation has been constructed, standard mining operations as described below can be undertaken.

Mining occurs within a continually moving open pit of approximately 30 hectares in area. The ore is excavated from the advancing edge of the pit by scraper and transported to a combined dump hopper and screening plant located on the pit floor. After being unloaded into the dump hopper, the ore is conveyed to the screening plant where it is washed through the screen. Oversize (>2mm) material comes off the end of the screen and is deposited on the mined out pit floor. The screened <2mm sand and clay is pumped in a water slurry to the wet concentrator plant. At the wet concentrator the clay is removed from the slurry using

hydrocyclones and is fed into the clay fines thickener. The sand from the slurry is pumped into the wet concentrator where the valuable heavy mineral fraction is separated from quartz sand using wet gravity spirals. The residue quartz sand is mixed with thickened clay from the thickener and is pumped from the wet concentrator plant back into the mined area of the open pit to backfill the retreating edge of the pit to pre-mining levels. A proportion of the thickened clay may be pumped into shallow dams on top of the backfilled sand to add extra clay at the surface of the re-contoured area to aid moisture and nutrient retention in the rehabilitated land.

Dry mining techniques will be implemented in open pits with an average depth of two metres, to a maximum of five metres on sand ridges. The mining sequence developed for Keysbrook is typical of mineral sand mining in Western Australia and consists of the following steps:

- Topsoil removal by scrapers.
- Mining with scrapers at 600 tonnes per hour (tph) into a drive-over dump hopper.
- Removal of >2mm oversize in a feed preparation plant (screening plant).
- Removal of clay using hydrocyclones.
- Separation of the heavy minerals from quartz sand in a wet spiral concentrator to make a HMC.
- Replacement of clay and quartz sand as backfill into the mining void.
- Contouring of backfilled areas using a grader or dozer.
- Replacement of topsoil with scrapers and rehabilitation of land to original land use using normal agricultural machinery.

Table 8 demonstrates the rapid rate of mining progression through the landscape. Backfilling of completed pits will be equally rapid.

Table 8: Mining Rate

Mining	Variable
Mining rate (t/hr)	600
Ore bulk density (t/m^3)	1.5
Mining rate (m^3/hr)	400
Days to mine 1ha at av. 2 m deep (at 85% operating time availability)	2.5
Av. area mined per week (ha)	2.8
Av. area mined per month (ha)	12

For a given area, it is anticipated mining, primary backfilling and stabilisation can occur within three months. Final rehabilitation earthworks and revegetation are season dependent, so revegetation may take up to eight months. Areas rehabilitated back to pasture will also be reseeded and fertilised in the autumn of the second year after rehabilitation, to ensure a fully established pasture is returned to the landowner.

Mining will be carried out on a continuous basis - 24 hours per day, seven days per week using a self-elevating scraper. During the day other equipment such as dozers, front-end loaders, trucks and additional scrapers will be used to carry out topsoil removal, land clearance and re-contouring and other mine site tasks such as pipeline laying. Mining operations will stop for scheduled maintenance shutdowns and screen plant moves approximately twice per month for a period of 10-12 hours.

4.3.2 Pit Design

The footprint and depth of the mining pit will vary in response to the ore reserve at that location. The average pit depth will be two metres, with depth increasing to five metres on hills and ridgelines.

The pit floor will generally be above the summer groundwater level with only occasional need for pit dewatering. In winter, dewatering of the pit will usually be required. To dewater the pit a drainage sump will be located in the floor of the pit. Groundwater inflow and seepage water from the backfill material will be directed to the drainage sump. Recovered water will be re-used in the mining and processing operations. During times of heavy rainfall there may too much water recovered from the pit for use in the operations and storage in the site water dam. In such situations water will be discharged from the water dam into a natural drainage channel through a discharge point that will be monitored for water quality.

Pit wall batters will generally be formed at 45 degrees.

Temporary diversion drains and/or low bund walls where required will be constructed around the mining pit to prevent any surface stormwater from minor drainage channels entering the pit. Given the general flat topography of the mine site, drains or bund walls will generally need to be less than one metre and they will be backfilled to natural ground level during pit rehabilitation.

Active mining areas will be temporarily fenced to stop stock and prevent non-mining personnel inadvertently coming into the active mining and rehabilitation areas. The operation is being undertaken on private property farmland, which itself is fenced and inaccessible to the general public.

4.3.3 Pit Dewatering

The individual requirements for pit dewatering will vary with seasons. The general principles for pit dewatering for the mine are:

- In summer, the groundwater level will usually be at or below the level of the pit floor. Little dewatering will be required.
- In winter, the higher groundwater level will generally necessitate dewatering of the pit.
- In autumn and spring, dewatering will be required of a lesser proportion commensurate with the watertable at that time.

Pit dewatering water will be used in the mining and processing operations and replace bore water, thus lowering bore water usage.

A numerical model was constructed to represent aquifers of the Bassendean Sand, Guildford Formation, and Leederville Formation, and to predict changes in groundwater levels as a result of the operation of the Keysbrook project. It was designed to evaluate water-level changes in the Bassendean Sand when mining cells are dewatered to the base of the mineral-bearing formation and to estimate rates of water flow into the excavations.

Details of the model design are given in the Rockwater (2006) report in Appendix 2. Modelling simulated two seasons per year: a wet season of five months and a dry season of seven months. The model was run to simulate mining/dewatering for seven of the eight years planned. In the eighth year the mine area is above the water table. Twenty-eight periods, four per year, were assigned to represent the operation.

Average rates of pumping to keep mine pits dewatered are calculated to range from 130-2,400 kilolitres per day, with the rates generally being higher in winter than summer because of recharge from rainfall. There are exceptions in which the summer rates were higher than those for winter, as a result of re-location of the assigned mine position. The results of the modelled pit dewatering are shown in Table 9.

Based on the calculated values, the dewatering rates are generally less than the estimated rate of water supply required for mineral processing (about 5,300 kilolitres per day), taking account of water returns. Under these circumstances, there will be no requirement to discharge excess water. However, the calculations are based on average values for rainfall recharge, at certain times there could be excess water generated directly by heavy rainfall or indirectly by seepage in very wet periods.

The Guildford Formation is calculated to exhibit up to four metres drawdown at the location of the excavations during local dewatering of the Bassendean Sand, but water levels then recover by similar amounts to the recovery in the Bassendean Sand.

The Leederville Formation is calculated to show negligible change in groundwater level as a result of the mining/dewatering operation.

Table 9: Modelled Pit Dewatering and Bore Makeup Requirement

Period	Year	Season	Average Pumpage Rate (kL/day	Site Water Requirement (kL/day)	Percentage of Water from Dewatering (%)	Bore Make Up (kL/day)	Bore Make Up (kL/hr)
1	1	Winter	134	5,300	3	5,166	215
2	1	Winter	403	5,300	8	4,897	204
3	1	Summer	351	5,300	7	4,949	206
4	1	Summer	1,081	5,300	20	4,219	176
5	2	Winter	421	5,300	8	4,879	203
6	2	Winter	981	5,300	19	4,319	180
7	2	Summer	536	5,300	10	4,764	199
8	2	Summer	581	5,300	11	4,719	197
9	3	Winter	1,397	5,300	26	3,903	163
10	3	Winter	1,024	5,300	19	4,276	178
11	3	Summer	498	5,300	9	4,802	200
12	3	Summer	473	5,300	9	4,827	201
13	4	Winter	515	5,300	10	4,785	199
14	4	Winter	421	5,300	8	4,879	203
15	4	Summer	434	5,300	8	4,866	203
16	4	Summer	1,518	5,300	29	3,782	158
17	5	Winter	2,384	5,300	45	2,916	122
18	5	Winter	2,397	5,300	45	2,903	121
19	5	Summer	921	5,300	17	4,379	182
20	5	Summer	1,451	5,300	27	3,849	160
21	6	Winter	900	5,300	17	4,400	183
22	6	Winter	703	5,300	13	4,597	192
23	6	Summer	418	5,300	8	4,882	203
24	6	Summer	1,064	5,300	20	4,236	177
25	7	Winter	2,317	5,300	44	2,983	124
26	7	Winter	1,865	5,300	35	3,435	143
27	7	Summer	978	5,300	18	4,322	180

4.3.4 Equipment and Machinery

The final inventory of machinery and equipment required for mining has not been determined but is expected to be finalised following receipt of proposals from contractors. It is likely that machinery and equipment will include the following or similar:

1. Mining - Caterpillar 633 single engine elevating scraper.
2. Clearing and re-contouring backfill – Caterpillar D10N and D7 dozer.

3. Screen oversize removal and general site work - Caterpillar 988 front end loader.
4. Water cart - converted Caterpillar 631 scraper.
5. Pit and general site drainage - Caterpillar 330 excavator.
6. Pipe laying and all purpose work - Caterpillar IT 28 tool carrier.
7. Cartage trucks – assumed to be 50 tonne capacity road trains.
8. General purpose farm tractor.
9. Dewatering pump - Varisco Model J4-315TWGS or similar.
10. Skid mounted, self bunded fuel tank of 55,000 litres capacity.

4.4 PROCESSING OF ORE

At a 2.7 per cent average grade of HMC, 97.3 per cent of the material excavated will be returned to the mined areas as backfill.

The screening plant is mobile and will be relocated within the pit as mining progresses through the orebody. This will require relocation of pipeline and powerline infrastructure.

A flocculant for removing clay from water in the thickener is the only chemical additive used in the processing of the ore. Water is the main additional input to the processing circuit. The water is sourced locally, from dewatering of the mine pits and from a local bore.

Output from the process plant comprises heavy mineral concentrate product, quartz sand, oversize screening products, fines concentrate (silt and clay) and water.

4.4.1 Run-of-Mine, Screening and Concentration

The mining scraper digs ore off a batter at the front edge of the mining pit. The scraper then transports the ore and drops the ore directly into a drive over feed hopper. The ore is conveyed from the hopper to the wet screening plant for separation of oversize waste (greater than two millimetres) from undersize sand and clay. The oversize material is deposited on the floor of the mined out pit. The undersize and clay is pumped to the wet concentration plant.

4.4.2 Wet Concentration Plant

The undersized material pumped from the screening plant contains quartz sand, heavy mineral sand and clay. This material is pumped through hydrocyclones to remove clay from the sand. The clay is fed into the clay fines thickener. The sand fraction from the hydrocyclones is pumped over wet spiral concentrators where the valuable heavy mineral sand are separated from the waste quartz sand. The HMC is stockpiled near the concentration plant prior to trucking to the separation plant at Picton.

The quartz sand is mixed with thickened clay from the thickener and pumped to backfill the mined out pit. A proportion of the thickened clay may be pumped into shallow dams on top of the backfilled sand to add extra clay at the surface of the re-contoured area to aid moisture and nutrient retention in the rehabilitated land.

The backfilled areas are re-contoured with a dozer and stabilised prior to topsoil replacement and revegetation.

Cleaned water from the thickener will pass by gravity into the adjacent site water storage dam to be reused in the processing operations. The site water storage dams provide temporary storage for water which is pumped back into the processing operations. Water from the site bores is pumped into this dam as required to make up the volume required for the mine site operations.

4.4.3 Ancillary Services

The mining contractors will provide a workshop to maintain their vehicles. Included in the workshop facilities will be a bunded washdown pad with an attached oil/water separation system.

4.5 WATER REQUIREMENTS

4.5.1 Process Water

An estimated process water requirement of 1.5 to two gigalitres per annum will be met by two bores located on Lot 59 on the mine area. Groundwater will be pumped from the Leederville aquifer with the bores being approximately 80-100 metres deep. The DoE has confirmed that sufficient water allocation is currently available from the Leederville aquifer. An extraction licence will be obtained prior to operations commencing.

The water requirement for mining and processing is estimated at 1,820 kilolitres per hour. Of this volume approximately 1,600 kilolitres per hour is recycled within the process and 220 kilolitres per hour (5,300 kilolitres per day) is added via pit inflow water or bore water, i.e. 88 per cent of water usage is recycled.

The site water storage dam will have the capacity to store 74,000 kilolitres and will be constructed near the thickener and wet concentrator.

Significant design effort has been made to manage water in a sustainable manner. Eighty eight percent of the water will be recycled through the processing plants.

4.5.2 Potable Water

Potable water will be sourced from independent commercial suppliers. Potable water will be delivered to site in a water tanker and stored in a covered water tank. Water used for ablutions, irrigation and washdown will be sourced from the bores.

4.6 PROCESS WASTE MANAGEMENT

Process wastes from ore processing will fall into one of the following categories:

- Organic matter and coarse materials (greater than two millimetres).
- Fine silt and clay (less than 20 micrometres).
- Quartz sand.

4.6.1 Screen Oversize: Organic Matter and Coarse Materials

Screen oversize of greater than two millimetres in diameter comprise less than five percent of the ore mined. In one year this will represent less than 220,000 tonnes. The oversize will be comprised of stones and rocks as well as organic matter such as tree roots. The oversize will be screened out of the ore and be re- deposited on the floor of the mined pit.

4.6.2 Fine Clay

The ore contains approximately eight percent fine clay and will be removed from the sand via hydrocyclones situated at the wet concentrator. The clay will come off the hydrocyclone as an overflow, along with most of the water pumped from the screening plant. This water and clay will gravitate to the clay thickener where anionic acrylamide-based flocculants will flocculate the clay and it will drop to the bottom of the thickener to be pumped out as thickened clay underflow. The water from the thickener will flow out the top of the thickener as overflow into the site water storage dam.

Most of the thickened clay underflow will be mixed with the quartz sand reject from the wet concentrator and pumped back into the mined-out pit as backfill. Some thickened clay will be pumped to shallow dams built on the backfilled areas to provide extra clay at the surface to improve the moisture and nutrient retention of the rehabilitated land.

4.6.3 Quartz Sand from the Wet Concentrator

Approximately 85 per cent of the ore mined is comprised of quartz sand. This represents about 3.61 million tonnes per annum which will be re-deposited with thickened fine clay in the mined-out pit as backfill.

4.7 DRAINAGE AND SURFACE WATER DIVERSION

Hydrocarbon storage areas and mechanical servicing/parking areas will be located on elevated ground to achieve a minimum separation distance of two metres above winter groundwater levels. Construction of containment bunding to statutory and guideline requirements for all hazardous materials will occur.

As these facilities are located on elevated, water-shedding ground, they will not be subject to surface water inflow. Surface water diversion drains and/or bunds around the mine pit will be constructed where necessary to prevent flooding of the mine pit. Drainage diversions and sediment sumps may also be required around rehabilitation areas until they become established.

4.8 POWER SUPPLY

The main electrical power for the wet concentrator, screening plant, transfer pumps and bores will be provided from the mains power supply. Usage is estimated at about 2.5 megawatts. With total load running at approximately 70-80 per cent of connected load, the connected total power supply for the mine is anticipated to be 3.15 megawatts.

Small stand-alone diesel generators may be required to supply power to moveable pumps used for in-pit dewatering.

4.9 TRANSPORT ROUTES

A number of alternative road transport routes for HMC are available. Olympia has discussed the various options with both Shire Councils and Main Roads. The preferred route selected is to utilise Westcott road through the mine area, a private road through Lot 300, from the south-east corner of Lot 300 onto Atkins Road and south to Readheads Road then east along Readheads Road to the South Western Highway. The trucks would then travel south on the South Western Highway to Picton. This route is depicted in Figure 22.

4.10 MINE INFRASTRUCTURE

The following infrastructure will be established within the mine area.

4.10.1 Heavy Mineral Concentrator Plant

The Heavy Mineral Concentrator Plant (also referred to as the Wet Concentrator) comprises hydrocyclones to remove clay from the sand, a clay thickener and wet spiral concentrators that remove the heavy mineral from the quartz sand.

The heavy mineral concentrate product is stockpiled near the plant prior to trucking to the separation plant at Picton.

The water storage dam is located near the HMC plant. Cleaned water from the thickener flows to the water storage dam to be reused in the processing operations. Water from the site bores is pumped into this dam as required to make up the volume required for mine site operations.

4.10.2 Screening Plant

The Screening Plant consists of a drive over feed hopper, where ore from the scraper is dumped. The ore is fed from the hopper to the wet screening plant for separation of oversize waste (greater than two millimetres) from the remaining material. The oversize material is deposited on the floor of the mined pit. The remaining material is pumped to the Wet Concentrator.

4.10.3 Workshops/Store

A steel-framed shed for the contractor's workshop and a yard will be established with sufficient hardstand to park the mining equipment safely. The contractor's yard will include a washdown bay connected to an oil water separator. Hydrocarbon storage facilities will comply with AS 1940:2004 and be self-bunded tanks or tanks within lined bunded compounds.

4.10.4 Offices

Offices at the Keysbrook mine site will consist of:

- Transportable office and crib block, plus a male/female transportable ablution block, plumbed to a Biocycle wastewater system.
- Contractor office and crib room plus a male/female transportable ablution, plumbed to a Biocycle wastewater system.
- Screen Plant office and crib room plus a male/female transportable ablution, plumbed to a Biocycle wastewater system.

All building and ablution facilities will be approved by Local Government building and health departments.

The location of all the facilities described above will be at the wet concentrator 'complex', which includes the administration offices, contractor office, workshop and yard. These facilities will be relocated with the wet plant as it is relocated throughout the mine life. The Biocycle system is preferred as the tank can be re-excavated and moved along with the other infrastructure. The surface irrigation system also maximises the separation distance to groundwater and can also be relocated. The exact size of each of the systems has not yet been determined – and will be confirmed as part of the application/approval process submitted to the relevant local government. The total workforce consists of 30-35 on 2 shifts, with day

shift the larger of approximately 20 people. This equates to 6-7 people per effluent disposal unit, so it is anticipated that each system will be about the size of a normal domestic unit.

4.10.5 Pipelines

Pipeline locations will change as the operation proceeds through the ore reserve. The general pipeline system is shown in Figure 5 and consists of:

1. Water supply line from the bore to the water storage dam.
2. Water supply line from the water storage dam to the screening plant.
3. Water supply line from the water storage dam to the wet concentrator plant.
4. Pit dewatering line to in-pit screening plant.
5. Return surplus water line from pit dewatering to the water storage dam.
6. Raw feed slurry line from the screening plant to the wet concentrator.
7. Return quartz sand and clay fines backfill slurry line from the wet concentrator to the pit backfill site.
8. Surplus water discharge line from the site water storage dam to the licensed site discharge point.

4.11 WORKFORCE

The project will require a workforce of 30-35 people, which will be sourced locally where possible. The site will operate on a commute basis with a continuous roster of 12-hour shifts.

4.12 COMMUNICATIONS

The telephone system and data communication for the site will be via existing commercial service providers. In-plant communications between plant operators and the control room and between maintenance personnel will generally be by UHF radios. The project site is within mobile phone coverage area.

4.13 MOBILE EQUIPMENT

Mobile equipment will be provided to support the processing plant and mining operations. Supervisory staff will be provided with vehicles.

It is anticipated that the following mobile equipment will be required:

- 2 x 4WD utility vehicles.
- 1 x fire tender trailer.

- 1 x 4WD pipe laying truck.

4.14

4.15 SEWERAGE

A biocycle sewerage system will be provided for the processing plant site and administration office ablutions. This will be designed and operated in compliance with the health requirements of the Health Department of Western Australia and the local Shire.

4.16 SOLID WASTE DISPOSAL

4.16.1 Domestic Waste

Very little domestic waste will be produced on-site. The site is not a remote mine, with its own accommodation camp, mess and 'live-in' shift workforce. Only small amounts of office and food waste are anticipated to be generated on-site.

There will be no on-site disposal of domestic waste. A commercial waste disposal company will be contracted to supply bulk bins for the removal of all rubbish from site.

4.16.2 Tyres

Used tyres will be removed from site and disposed at approved landfill facilities.

The mining contract will stipulate that all used tyres generated by the mining contractor are sent off-site for disposal or recycling.

4.17 DANGEROUS GOODS AND HAZARDOUS SUBSTANCES

4.17.1 Fuels and Oils

A licence will be obtained from DOCEP for the storage of all dangerous goods on-site.

Fuel storage facilities will be provided by the mining contractor for use by the mining equipment. Fuel will be stored on-site in self bunded bulk storage tanks. Bulk fuel storage facilities will comply with AS 1940:2004 and DoE requirements. The bulk fuel storage capacity will be a 55,000 litre tank.

Any lubricants stored in 1,000 bulk pods or 200-litre drums will be held in bunded areas. Fuel and lubricant dispensing will occur on a bunded hardstand area, to contain accidental spillage.

Other than diesel fuel and oil, no bulk volumes of dangerous goods or hazardous substances will be stored on-site.

4.18 NOISE

All mining and processing operations at Keysbrook will comply with DOCEP and DoE noise regulations. Periodic noise surveys will be undertaken to ensure compliance with noise regulations and to identify where noise controls need to be improved.

Scheduling of day and night operations will occur to minimise noise to adjacent residents.

All machines and equipment used for mining will be fitted with appropriate mufflers to reduce noise levels, and in designated areas all operators will be required to wear accepted noise protection equipment.

4.19 INDUCTION AND TRAINING

On commencement of employment, all personnel will be inducted by Olympia in compliance with the Company's Procedures and as required by the Mines Safety and Inspection Act 1994. The occupational hazards, environmental requirements and social/community issues associated with the project will be included in the induction. Ongoing training and meetings for review of work practices and safety issues will be conducted on a regular basis under the auspices of the Mine Manager. Regular operational meetings will be held to cover immediate requirements.

4.20 SAFETY AND RISK MANAGEMENT

In common with all mining and processing operations, the mine will present hazards and risks. First aid kits will be located in designated locations in the HMC plant and in all vehicles.

All contractors will be required to have their own documented safe work practices and procedures which must be acceptable to Olympia.

5. EXISTING ENVIRONMENT

5.1 REGIONAL SETTING

The mine is situated along the eastern edge of the Swan Coastal Plain approximately 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook. The mining area of 1,234 hectares is located on privately owned land.

A large portion of the mine area has been cleared for grazing activities. Patches of remnant native vegetation also remain. The remnant vegetation ranges from stands of trees over pasture grass with little to no understorey to areas of trees with a partially-intact understorey.

The topography of the mine area is flat to very gently undulating plain. The lowest elevations are in the south-west of the mine area at approximately 22 metres AHD, gradually sloping to approximately 48 metres AHD in the north-east.

5.2 CLIMATE

The area experiences a Mediterranean climate characterised by cool wet winters and warm to hot dry summers. The mine area lies between the 1,000 and 1,100 millimetres rainfall isohyets (Heddle *et al*., 1980).

The nearest meteorological monitoring station is located at Karnet, approximately nine kilometres to the east. This weather station is located in the Darling Scarp and experiences a slightly different climate to the mine area, with an annual average rainfall of 1,200 millimetres. The nearest meteorological monitoring station on the Swan Coastal Plain is located at the Medina Research Centre, about 28 kilometres north-west of the mine area, which has a 800 millimetre annual rainfall. Wokalup, although a further 80 kilometres south of Keysbrook, has an annual rainfall of 964 millimetres as shown in Chart 1. This is closer to Keysbrook's total than either Karnet or Medina. The average annual evaporation rate of approximately 1,800 millimetres exceeds the precipitation rate of 960 millimetres by a factor of about 2 to 1.

There is no wind data available for the Keysbrook area. Wind data representative of the local area, which include the katabatic winds off the escarpment, require a site to be located in close proximity to the foothills of the escarpment. The Perth airport was selected as it had a higher number of observations than Wokalup. Appendix 1 shows monthly and annual wind roses and frequency analysis from 170,515 observations, from May 1944 to December 2005. A summer (January) and winter (July) month are shown in Chart 2 to demonstrate the differences in wind strength, predominant direction and calm conditions (centre circle) between these months. The annual wind rose is shown in Chart 3. Table 10 shows the Beaufort scale, which provides a description of wind speed.

Chart 1: Wokalup Climate Data

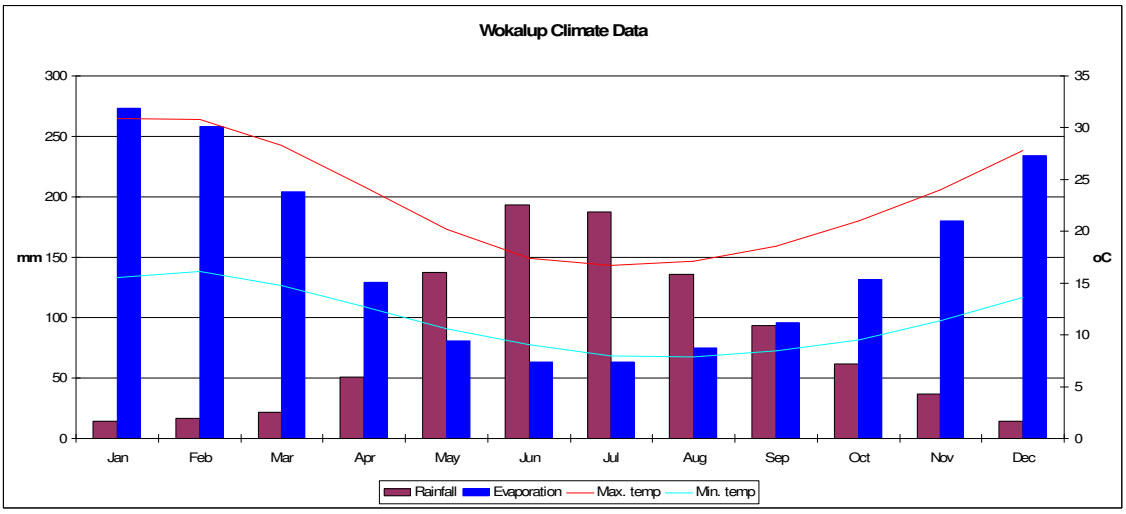
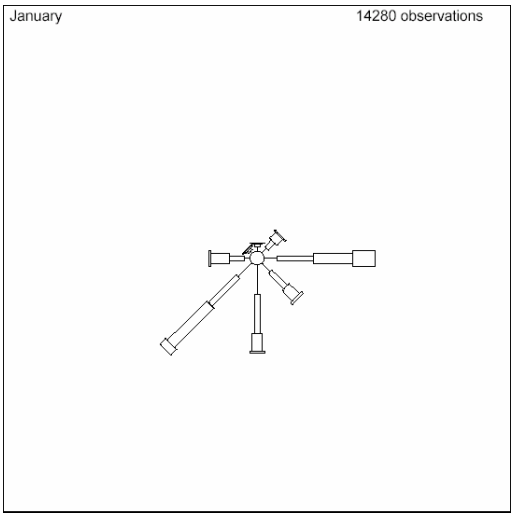
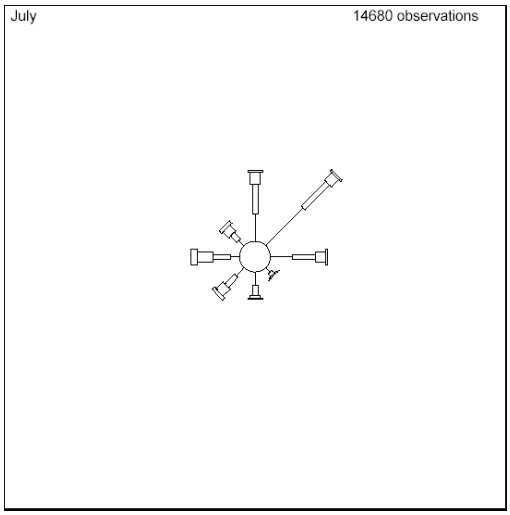


Chart 2: Summer and Winter Wind Roses for Perth Airport





January

Calm 11	A total of 14280 observations analysed								
km/h	N	NE	E	SE	S	SW	W	NW	All
1–10	1	1	3	2	6	4	1	*	18
11–20	1	2	7	4	8	8	3	*	33
21–30	*	2	8	3	4	11	4	*	31
>30	*	*	4	1	*	2	*	*	7
All	2	5	22	10	17	24	8	1	100

July

Calm 25	A total of 14680 observations analysed								
km/h	N	NE	E	SE	S	SW	W	NW	All
1–10	6	11	4	1	3	2	2	2	30
11–20	6	7	5	1	2	3	4	2	28
21–30	2	2	2	*	1	2	3	2	14
>30	*	*	*	*	*	1	1	1	4
All	14	20	11	2	5	7	10	6	100

Chart 3: Annual Wind Rose for Perth Airport

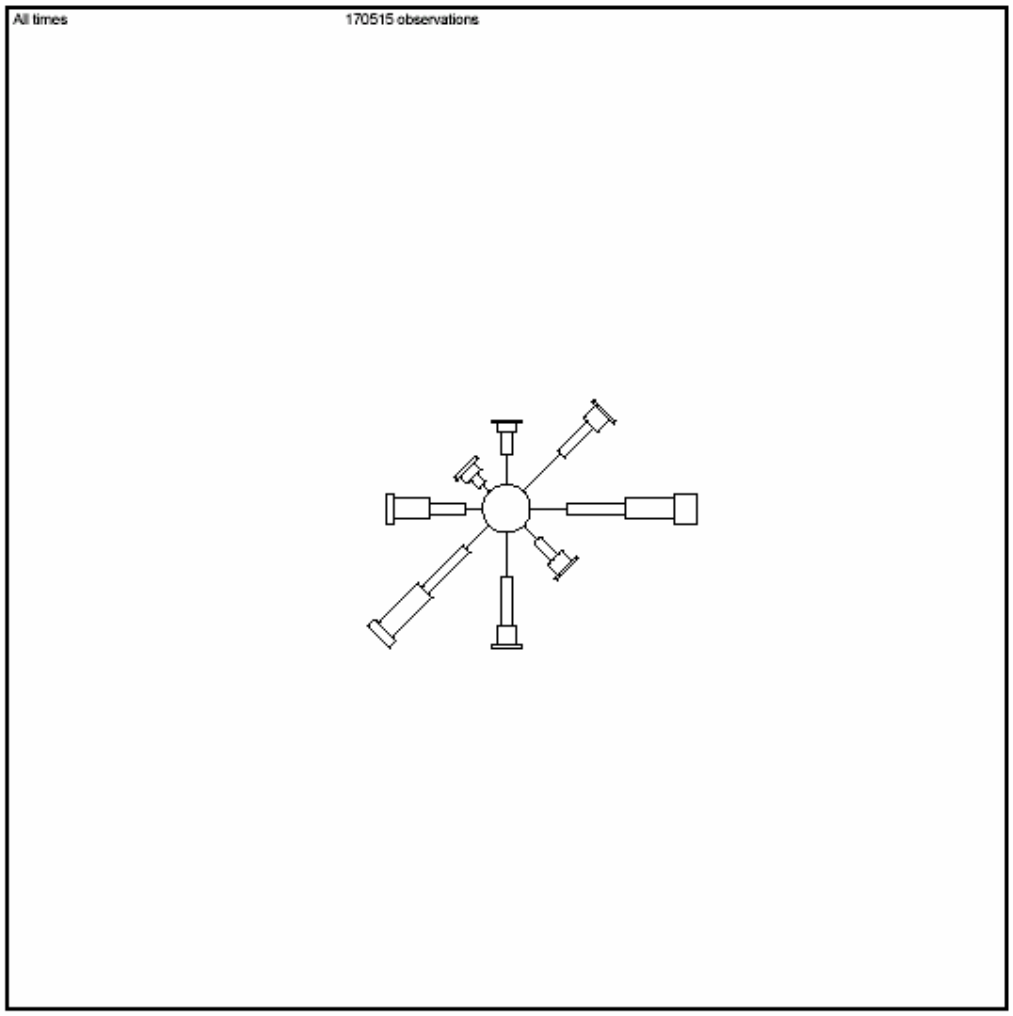


Table 10: Wind Speeds (Beaufort Scale) Related to Readily Observed Field Conditions

	Beaufort No.	Description	Wind Speed Equivalent*		Specification for Estimating Speed over Land
			m/sec	km/hr	
	0	Calm	0-0.2	<1	Calm, smoke rises vertically
	1	Light air	0.3-1.5	1-5	Direction of wind shown by smoke drift but not by wind vanes
	2	Light breeze	1.6-3.3	6-11	Wind felt on face, leaves rustle, ordinary vane moved by wind
	3	Gentle breeze	3.4-5.4	12-19	Leaves and small twigs in constant motion, wind extends light flag
	4	Moderate breeze	5.5-7.9	20-28	Raises dust and loose paper, small branches move
Erosive winds	5	Fresh breeze	8.0-10.7	29-38	Small trees in leaf begin to sway, crested wavelets form on inland waters
	6	Strong breeze	10.8-13.8	39-49	Large branches in motion, whistling heard in telegraph wires, umbrellas used with difficulty
	7	Near gale	13.9-17.1	50-61	Whole trees in motion, inconvenience felt when walking against the wind
	8	Gale	17.3-20.7	62-74	Twigs break off trees, generally impedes progress
	9	Strong gale	20.8-24.4	75-88	Slight structural damage occurs (chimney pots and slates removed)
	10	Storm	24.5-28.4	89-102	Seldom experienced inland, trees uprooted, considerable structural damage occurs
	11	Violent storm	28.5-32.6	103-117	Very rarely experienced. Accompanied by widespread damage
	12	Hurricane	>32.7	>118	Severe and extensive damage

* Wind speed equivalent at a standard height of 10 m above the ground.

Source: Moore, G (2004) Table 7.1.2 pg 214

5.3 LAND SYSTEMS

The geomorphology of the Swan Coastal Plain is comprised of a series of accretionary marine deposits eroding a gently dipping Tertiary alluvial surface. The whole marine assemblage is overprinted by Quaternary fluvial and Aeolian deposits. On the eastern side of the Swan Coastal Plain the marine deposits and dunes are interlayered with fluvial deposits producing a strongly variable sequence with depth, but broad areas of similar deposits in horizontal layers.

On the eastern side of the Swan Coastal Plain there is some connectivity between the surface units and the underlying Cretaceous units that allows recharge of the aquifers below the mine area (Figure 6).

In the mine area there is complicated distribution of sandy dunal deposits and sandy clay of alluvial deposits. The dunes are correlated with the Bassendean Unit where the sand is thick and the Southern River Unit where the sand is thin. The alluvial deposits are correlated with the Guildford Unit (Churchward and McArthur, 1980) (Figure 7).

The Bassendean Unit covers the central portion of the mine area. It consists of low dunes of leached siliceous sand interspersed with sand flats and seasonal swamps. The Bassendean Unit is the main source for the heavy mineral.

The Southern River Unit encompasses the western portion of the mine area. It consists of sand plain with low dunes and many intervening swamps. The soils of the Southern River Unit are similar to those of the Bassendean Unit. In the vicinity of swamps the Southern River Unit has iron and humus podzols, peats and clays deposited.

The Guildford Unit encompasses the southern and north-eastern portions of the mine area. The landscape is characterised by flat plains with medium textured deposits and yellow duplex soils.

The Department of Agriculture undertook soil mapping of the Swan Coastal Plain to a finer scale than Churchward and McArthur (1980).

Van Gool, D (1990) undertook mapping in the northern section of the Peel Harvey catchment, which includes the portion of the project site in the Shire of Serpentine Jarrahdale. Wells, M.R and Hesp, P.A. (1989) undertook mapping in the southern section of the Peel Harvey catchment, which includes the portion of the project site in the Shire of Murray (Figure 8). The mapping shows elements of Bassendean soils within the more broadly mapped Guildford and Southern River units. This has significant implications for the current proposal in the categorisation of areas of landform and vegetation to be disturbed as a result of mining.

Table 11 compares the landform units in the mining area, as described by Churchwood and McArthur (1980) (Figure 7) against the mapping done by Van Gool, D (1990) and Wells, M.R and Hesp, P.A. (1989) (Figure 8). The data confirms that almost all the mine area within the Guildford landform, as mapped in Figure 7, is actually in the Bassendean landform as mapped in Figure 8. All the remnant vegetation corresponds to Bassendean (B1) or (B2) subunits as mapped in Figure 8. There is very little area within the mine envelope that is mapped in Figure 8 as Guildford landform.

The exploration drilling has confirmed the heavy minerals are hosted within the Bassendean sands. The mapping shown in Figure 8 would therefore more correctly correspond to the mine extraction areas.

Table 11: Comparison of Landform Types within the Mine Area

Landform Units	Churchwood and McArthur (1980) (Figure 7)		Van Gool, D (1990) and Wells, M.R and Hesp, P.A. (1989) (Figure 8)	
	Cleared (ha)	Trees (ha)	Cleared (ha)	Trees (ha)
Bassendean	681.2	236.8	826.9	303.6
Guildford	185.7	66.8	37.5	2.5
Southern River	63.6	0.0	63.6	0
	1234.1		1234.1	

5.4 SOILS

The Keysbrook project is situated on the Swan Coastal Plain between 2-7 kilometres west of the Darling Fault and between 22 and 48 metres AHD. The soils of the mine area are discussed in detail by Doepel (2003) following extensive drilling associated with development of the project. Degraded dunes of the Bassendean Sand partly cover a mottled clayey sand or a pisolitic ironstone-clay unit.

Bassendean Dunes

The dominant soil parent materials within the Bassendean system are highly leached quartzose sands. The dune sands contain potentially economic heavy mineral mineralisation. The more easterly dunes are higher, at up to six metres above the plain level, and better defined. The Bassendean Dunes form a series of subdued low relief dunes, sandplains and intervening swamps adjacent to and partly overlying the finer textured soils of the Pinjarra Plain (Guildford Unit). Some inland movement by wind action has also occurred. The majority of the soils are podzols. Soil in the eastern part of the unit are more severely leached than those to the west. The mine is within the eastern part of the unit.

Pinjarra Plain

The soils of the Pinjarra Plain have largely formed from unconsolidated alluvial material of Tertiary and Quarternary age. The depositional systems can be grouped into three main types based on soil parent material.

- The older alluvium occurring in extensive flat plains and forming imperfect to poorly drained soils - mottled yellow duplex soils and mottled yellow or greyish brown gradational earths.
- Fine textured alluvium of generally intermediate age, in areas of lowest relief and forming very poorly drained soils - uniform cracking black grey or yellow-grey clays.
- The youngest alluvium occurring along the major present river systems and forming well to moderately well-drained soils - red duplex or gradational soils and uniform reddish brown loams or earthy sands.

5.4.1 Acid Sulfate Soils

The DoE (2003) describes acid sulfate soil (ASS) as the common name given to naturally occurring soil or sediment containing iron sulfides over extensive low-lying areas under waterlogged (i.e. anaerobic) conditions. These soils may be found close to the natural ground level but may also be found at depth in the soil profile. When sulfides are exposed to air, oxidation takes place and sulphuric acid is produced when the soil's capacity to neutralise the acidity is exceeded.

In Western Australia, ASS is known to have formed in estuarine areas and coastal lowland areas such as mangroves, tidal flats, salt marshes and swamps, wetland areas, saline inland areas and near mining operations.

Particular areas of concern in Western Australia include:

- Estuarine, floodplain and wetland areas between Perth and Busselton, such as the Peel-Harvey estuarine system and the Vasse River area.
- The northern coastline, including the Pilbara and Kimberley coasts.
- The Scott River Plain, including Toby Inlet.
- Parts of the wheatbelt where land salinisation has occurred.

The mine area is located within the Peel Harvey catchment portion of the Swan Coastal Plain. The acid sulphate soils map of Western Australian Planning Commission (WAPC) Planning Bulletin 64 (2003) show most of the mine area as moderate to low risk of acidity, with two specific areas shown as high risk. A third, larger, high risk site is outside the mine area and will not be disturbed. The high risk mapped areas correspond to the Peaty Sand (Sp1) unit of the Environmental Geology Series (Geological Survey 1986).

A meeting was held with DoE representatives on 24 October 2005 to determine the scope of soil assessment to be conducted over the mine site. It was determined to undertake an initial survey over a range of different soil types, focusing on the low-lying landforms that are the most likely sources of Potential Acid Sulfate Soils (PASS). If this initial investigation identified high PASS in the mining area, further sampling may be required to quantify the extent of potential acid forming locations at a more detailed level.

Testing was conducted on 23 November 2005 by drilling holes to three metres below surface at selected locations (Figure 18). The resource drilling indicates the heavy minerals are located within the superficial sand layer, generally no deeper than two metres below surface within the low-lying profiles. PASS testing extended to one metre below the resource/excavation zone as identified in the DoE Identification and Investigation of ASS (October 2004). Table 12 describes the soils that were sampled.

Samples were analysed by the Western Australian Chemistry Centre. The test methods of the Acid Sulfate Soils Laboratory Methods Guidelines manual were used, specifically Method Code 23 – Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS).

Interpretation of results from SPOCAS test methods involves determining action criteria and comparing the test results with the criteria. Table 13 shows the NSW Acid Sulfate Soils Management Advisory Committee (ASSMAC) published action criteria. Exceeding these

criteria indicates risk of an acid sulfate soil issue and the need for an acid sulfate soil management plan with development approval.

Table 12: Description of Soils Sampled

Site	Soil Type	Description	ASS Risk Category[4]
1	P8[2]	Broad imperfectly to poorly-drained flats and ill-defined stream channels with moderately deep to deep sands over mottled clays; acid grey and yellow duplex soils to uniform bleached pale brown sands over clays.	Moderate-Low
2	P8[2]	As above.	Moderate-Low
3	B6[2]	Sand plain similar to B4 with imperfectly-drained soils.	Moderate-Low
4	B4[2] Sp2[3]	Broad poorly-drained sand plain with deep grey silicous sands or bleached sands, underlain at depths generally greater than 1.5m by clay or less frequently a strong iron organic pan. Peat Sand. Fine to medium-grained quartz sand with much brown to black organic material, grades to peat of, of lacustrine origin.	High
5	P1b[2]	Gently undulating plain with deep acid mottled duplex yellow soils having sand to sandy loam surfaces and generally moderately deep topsoil over clay subsoil.	High
6	B6[1]	Sand plain similar to B4 with imperfectly-drained soils.	Moderate-Low

Notes:

1. Van Gool (1990) Land Resources in the Northern Section of the Peel-Harvey Catchment, Swan Coastal Plain, WA. See Figure 8
2. Wells (1989) Land Resources of the Mandurah-Murray Region WA. See Figure 8
3. Geological Survey of Western Australia (1986) Environmental Geology Series: Serpentine.
4. Western Australian Planning Commission. Planning Bulletin No. 64. Acid Sulfate Soils. (November 2003).

Table 13: ASSMAC Action Criteria

Type of Material		Action Criteria, <1,000 tonnes		Action Criteria, >1,000 tonnes	
Texture	**Approx Clay Content (%<0.002 mm)**	**Sulfur Trail S_{POS} %**	**Acid Trail TPA (mole H^+/t)**	**Sulfur Trail S_{POS} %**	**Acid Trail TPA (mole H^+/t)**
Coarse, e.g. sands	□5	0.03	18	0.03	18
Medium, e.g. loams/ light clays	5 – 40	0.06	36	0.03	18
Fine clays/ silts	□40	0.1	62	0.03	18

Table 14 shows the results of the sampling programme. The full analysis and report is presented in Appendix 7. The results indicate the PASS occurrence across the area is generally as described in the DoE ASS maps, of low to moderate risk, with most results less than half the action criteria. These generally low results, of targeted soil types where the highest acid potential would be expected, indicates the mine area is of low to moderate risk. There is no indication that mining should be avoided in the area.

Sites four and five targeted locations within the mine area that are shown on the DOE ASS map as High Risk. The results shown in Table 14 do not support this classification, with TPA levels generally a quarter to a half of the action criteria. An additional sampling program complying with the DOE (2003) guidelines will be undertaken to provide more detailed results on these two areas. The results will be incorporated into the final PER.

Sites two, three and six targeted lowlying landform soils B6 and P8 (Table 12). Due to their lowlying nature, the mineral resource in these locations is minimal. Figure 18 shows all these sites to be outside or on the edge of the mine area. Even if some of these soil types are not directly impacted by mining some indirect impact may occur as a result of pit dewatering, so knowledge of the acid potential of these soils was considered important. Site two recorded Titratable Peroxide Acidity (TPA) just above the action criteria, within a one metre zone of the sampled profile, between 1.5-2.5 metres below surface. The Total Actual Acidity (TAA) is only 66 percent of the action criteria, indicating a current but low level of acidity in this profile. This zone would normally be exposed to annual groundwater level fluctuations (see charts 4 and 5). The zone below this elevated layer has TPA levels well within action criteria levels. This result demonstrates the variability that can be found within a soil profile. The low value from the base of the tested profile indicates a low risk of continued acid generation as a result of dewatering activities potentially exposing this layer to oxidation effects.

The variability both within a soil profile and between sampling locations indicate some potential for low level acidification. Monitoring is required to ensure a trend towards acidification does not continue to occur as a result of mining. In discussion with DOE representatives it was communicated that monitoring should focuss on any discharge water from the operations, as this is the mechanism for off site impacts to occur. As shown in Table 9, modelling predicts a major water deficit, with dewatering volumes predicted to average only about 20% of the water needs. As such, it is considered there would generally

be no need, under normal operating conditions, to discharge any water to the environment. A discharge licence will be applied for, as a precaution, to cater for any rare major rainfalls or extended plant breakdown that may lead to the need to discharge water. Such events are not considered 'normal state'. Monitoring of this water will be undertaken and can be regulated through site Licence conditions. In addition, monitoring of groundwater around the mining operations will also occur, to establish pH and TAA levels in pre and post mining areas.

Table 14: Results from Test Sites

Test site	Depth	Soil Type	Description	pH KCl	pHox	SKCl	Sp	Spos	ANC	TPA	TAA	TPA Action Criteria for Sand
						%	%	%	moles H+/tonne			
1:H2	0-0.5	P8	Broad poorly-drained flats and stream channels. Moderately deep sands over mottled clays	5.3	4.7	<0.01	<0.01	<0.01		6	<2	18
	0.5-1			5.1	4.3	0.01	0.01	<0.01		15	4	18
	1-1.5			5.1	4.5	<0.01	0.01	0.01		15	5	18
	1.5-2			5.4	4.4	0.01	0.01	<0.01		12	5	18
	2-2.5			5.5	4.7	0.01	0.01	<0.01		8	3	18
	2.5-3			6.2	5.6	0.02	0.02	<0.01		<2	<2	18
2:H2	0-0.5	P8	Broad poorly-drained flats and stream channels. Moderately deep sands over mottled clays	4.9	4.9	0.01	0.01	<0.01		3	6	18
	0.5-1			5.1	4.5	0.01	0.02	0.01		5	4	18
	1-1.5			4.9	4.4	0.02	0.03	0.01		13	8	18
	1.5-2			4.8	4.2	0.03	0.04	0.01		20	13	18
	2-2.5			4.8	4.3	0.02	0.03	0.01		19	12	18
	2.5-3			5.3	4.5	0.01	0.02	0.01		9	<2	18
3:H4	0-0.5	B6	Broad poorly-drained sandplain with deep grey siliceous sands, underlain at depths generally greater than 1.5m by clay	5	4.7	<0.01	0.01	0.01		6	4	18
	0.5-1			5.4	4.4	<0.01	0.01	0.01		4	5	18
	1-1.5			5.5	4.7	0.01	0.02	0.01		5	2	18
	1.5-2			5.7	5.5	0.03	0.03	<0.01		<2	<2	18
	2-2.5			5.6	4.8	0.02	0.02	<0.01		7	3	18
	2.5-3			5	5	0.01	0.01	<0.01		4	6	18
4: H4	0-0.5	B4	Broad poorly-drained sandplain with deep grey	5.5	5	<0.01	0.01	0.01		<2	3	18
	0.5-1			5.1	4.4	0.01	0.01	<0.01		8	4	18

Test site	Depth	Soil Type	Description	pH KCl	pHox	SKCl	Sp	Spos	ANC	TPA	TAA	TPA Action Criteria for Sand
						%	%	%	moles H+/tonne			
	1-1.5		siliceous sands, underlain at depths generally greater than 1.5m by clay. Cs (Clayey sand) unit on Enviro Geology Maps and High Risk ASS on DoE map	5	4.4	<0.01	0.01	0.01		6	8	18
	1.5-2			4.7	4.4	0.01	0.01	<0.01		8	5	18
	2-2.5			4.7	4.6	0.01	0.01	<0.01		5	9	18
	2.5-3			4.6	4.6	0.01	0.01	<0.01		8	6	18
5:H4	0-0.5	P1b	Flat to gently undulating plain with deep acidic mottled yellow duplex soils comprising moderately deep pale sand to sandy loam over clay. Cs unit on Enviro Geology Maps and High Risk ASS on DoE map	5.6	4.3	<0.01	<0.01	<0.01		5	<2	18
	0.5-1			5.5	4.5	<0.01	0.01	0.01		4	2	18
	1-1.5			5.9	4.5	<0.01	<0.01	<0.01		3	<2	18
	1.5-2			5.8	4.7	<0.01	0.01	0.01		3	<2	18
	2-2.5			5.5	4.5	0.01	0.01	<0.01		10	3	18
	2.5-3			5.4	5.4	0.01	0.01	<0.01		5	<2	18
6:H2	0-0.5	B6	Broad poorly-drained sandplain with deep grey siliceous sands, underlain at depths generally greater than 1.5m by clay	4.8	4.4	<0.01	<0.01	<0.01		15	6	18
	0.5-1			5.1	4.7	<0.01	<0.01	<0.01		4	3	18
	1-1.5			4.6	5.7	0.01	0.02	0.01		<2	8	18
	1.5-2			4.5	6.5	<0.01	0.03	0.03	12	<2	12	18
	2-2.5			4.5	6.5	0.01	0.02	0.01	9	<2	10	18
	2.5-3			4.7	6.5	<0.01	<0.01	<0.01	11	<2	9	18

5.4.2 Dieback Disease

CALM (2004) describe dieback as the introduced soil borne water mould *Phytophthora cinnamomi* is known for its capacity to invade and destroy the function of the root systems of a wide range of Western Australia's native plants across numerous ecosystems. This slow moving epidemic of root disease in native vegetation in Australia is known as "*Phytophthora* dieback". The impact of this now widespread pathogen varies greatly across the landscape but almost always results in the permanent removal from infested sites of one or more susceptible species. Dieback caused by the root-rot fungus *P. cinnamomi* has been listed as a 'key threatening process' under the Commonwealth's *EPBC Act 1999*.

The mine area is located in predominantly cleared private property. The land use is dominantly grazing by cattle and sheep. Creek lines from the Darling Ranges flow through the mine area. These creeks drain catchments that are infected by dieback, however as the low-lying land within the mine area is almost exclusively cleared and developed as pasture, no visible effect of dieback is present in these locations. The isolated trees and remnant vegetation remaining in these locations are species resistant to the disease.

Remnant native vegetation stands exist as fragmented islands on upland sandy Bassendean dunes. Most are completely degraded by grazing activity with little, if any native understorey remaining. The remnants contain both resistant species, such as *Corymbia calophylla* and susceptible species, such as *Banksia attenuatta*, *Banksia menziesii* and *Eucalyptus marginata subsp. marginata*.

Within the remnant vegetation areas, tree decline and death has been occurring over many years, from factors common to tree decline in rural landscapes. These can include physical damage by stock, salinity and changes in hydrological and nutrient regimes. The presence of dieback disease is another factor that can contribute to tree decline of susceptible species in remnant areas.

A survey and sampling programme was undertaken on 30 January 2006, targeting native remnant vegetation fragments that exhibited symptoms of dieback disease with recent deaths of susceptible species (Figure 19). Soil and root samples were taken from recently dead Banksias. The samples were analysed for the presence of *P. cinnamomi* by CALM's Vegetation Health Services.

The purpose was to confirm whether dieback was present in the upland native vegetation remnants. Not all remnants contained observable symptoms of disease and not all deaths of susceptible species, such as Banksias, are attributable to dieback.

Photographs of the sampled trees and the results of the laboratory analysis are provided below. The results confirm that dieback disease is present in some upland sites of the mine area. Continued presence of stock, use of farm machinery within the paddocks and the autonomous spread from existing infection sites will result in ongoing expansion of the disease and further decline of susceptible species in infected areas.

Sample L1. Negative for *P.cinnamomi*

Sample L2. Positive for *P.cinnamomi*

Sample M1. Positive for *P.cinnamomi*

5.5 GEOLOGY

The topsoil in the Bassendean Dunes contains organic matter to a depth of about 15 centimetres and is noticeably lower in heavy mineral grade than in the underlying sand. The sand unit has a consistently low clay content (less than eight per cent) and virtually no oversize material. At the base of the Bassendean Dunes there is a clayey sand bed. This bed, where present, follows two different patterns in terms of heavy mineral content. In the higher grade more easterly dunes it has a consistently higher grade than the overlying sand, but in the lower grade more westerly dunes it has a consistently lower grade than the overlying sand.

The dunes can be divided into two categories. The more westerly dunes are more degraded and lower. The easterly dunes tend to have higher heavy mineral grades than do the westerly dunes. They have a long axis orientation to the north-northeast. Within the easterly dunes there is a clear increase in grade from surface to base and also from west to east, the western slope being less steep than the eastern slope.

5.6 HYDROGEOLOGY

The Superficial formations and the underlying Leederville Formation and Yarragadee Formation are the main aquifers containing fresh groundwater that is tapped for water supplies (Allen, 1981). These aquifers and their inter-relationships are listed in Tables 15 and 16 and illustrated in Figure 6.

Table15: Stratigraphic Sequence in the Serpentine Area

Age	Strata	
Quarternary	Superficial Formations	Bassendean Sand Guildford Clay
----------Unconformity----------		
Cretaceous	Leederville Formation	Wanneroo Member
	South Perth Shale	Mariginup Member
	Gage Formation	
----------Unconformaty----------		
Jurassic	Yarragadee Formation	
	Cattamarra Coal Measures	

Table 16: Aquifers in the Serpentine Area

Aquifer	Geological Formation(s)	Maximum Thickness (m)	Aquifer Type	Thickness of Sand/Sandstone Beds (m)	Salinity (mg/L TDS)
Superficial aquifer	Superficial formations	15	Unconfined	up to 12	200 – 1,500
Leederville aquifer	Leederville Formation	130	Semi-confined	up to 30	500 – 3,000
Yarragadee aquifer	Gage Formation Yarragadee Formation Cattamarra Coal Measures	1,500	Confined, multi-layer	10 – 100	250 – 3,000

Two aquifers of the Perth Basin are relevant to the project. Firstly, the shallow Superficial Formation containing both the Bassendean Dunes and Guildford Formation. The upper four to eight metres of Bassendean Sand in this Formation are moderately permeable material. In the mine area the water table in this aquifer ranges from zero to 10 metres below ground surface. There is zero to about two metres saturation above the base of the Bassendean Sand, depending on the season and the local aquifer geometry. This aquifer will be affected by the mining operations as it contains the mineral sand deposit.

Mining operations during the winter will result in the groundwater levels in the Bassendean Sand being temporarily lowered to the base of the unit, in and around individual mining cells. Water levels will start recovering as mining moves to new cells, excavated cells are backfilled, and rainfall recharges the reconstituted aquifer.

The second relevant aquifer is the Leederville Formation extending to about 100 metres depth. It will be utilised as a water source for the mining operation.

Water salinities in the Superficial Formation range from 200 to 1,000 milligrams per litre TDS, while in the Leederville Formation they are generally less than 1,000 milligrams per litre TDS.

5.6.1 Groundwater

5.6.1.1 Groundwater Areas

The mine area is located within the Proposed Karnup – Dandalup Underground Water Pollution Control Area. The area has been allocated a policy use of P2. The groundwater area has not been formally gazetted as a public water source protection area.

P2 source protection areas are defined to ensure that there is no increase in risk of pollution to the water source. They are declared over land where low intensity development already exists. P2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines (WRC, 2004).

5.6.1.2 Superficial Aquifer

An unconfined aquifer averaging about 12 metres in thickness occurs beneath the Serpentine area within the Superficial formations. The lithological log from a monitoring bore (WIN ID 3111) indicates that here the upper four metres of the Superficial formations consist of Bassendean Sand; a fine- to coarse-grained, poorly-sorted quartz sand, with common heavy minerals in the lower two metres.

Mineral and exploration drilling data collected by Olympia indicate that the thickness of Bassendean Sand in the mining area ranges from zero to eight metres, with an average of about 2.2 metres. The base of the Bassendean Sand broadly slopes down to the west in a similar manner to the ground surface contours. Data collected from production and monitoring bores within a four-kilometre radius of the site indicate that the thickness of the Superficial formations is variable, ranging between 10 and 15 metres.

A groundwater flow system bounded by the Serpentine River to the north and west, and the South Dandalup River in the south occurs in the Superficial aquifer; it is referred to as the Serpentine Area flow system (Davidson, 1995). The watertable here slopes from about 60 metres AHD near the Darling Scarp to about 10 metres AHD along the discharge boundaries formed by the Serpentine and South Dandalup rivers. Groundwater in the Superficial aquifer flows mainly westwards under the prevailing hydraulic gradient.

The Superficial aquifer in the Serpentine area acts as a recharge source for the underlying Leederville aquifer. Groundwater in the Superficial aquifer is derived from recharge resulting from direct rainfall on the ground surface, and local stream runoff from ephemeral drainage networks flowing from the Darling Plateau. Recharge occurs mainly between May and September.

The watertable across the Serpentine area ranges from zero depth at the wetlands to about five metres below ground level. It varies seasonally by about 0.2 to 1.5 metres, being highest in September/October and lowest in March/April. Charts 4 and 5 show data from 1975 from the Lake Thompson Superficial-aquifer monitoring bores near the mine site indicate water levels range from 0.35 metre below ground level in winter to 3.2 metres below ground level in summer.

Chart 4: Lake Thompson Monitoring Bore 3089

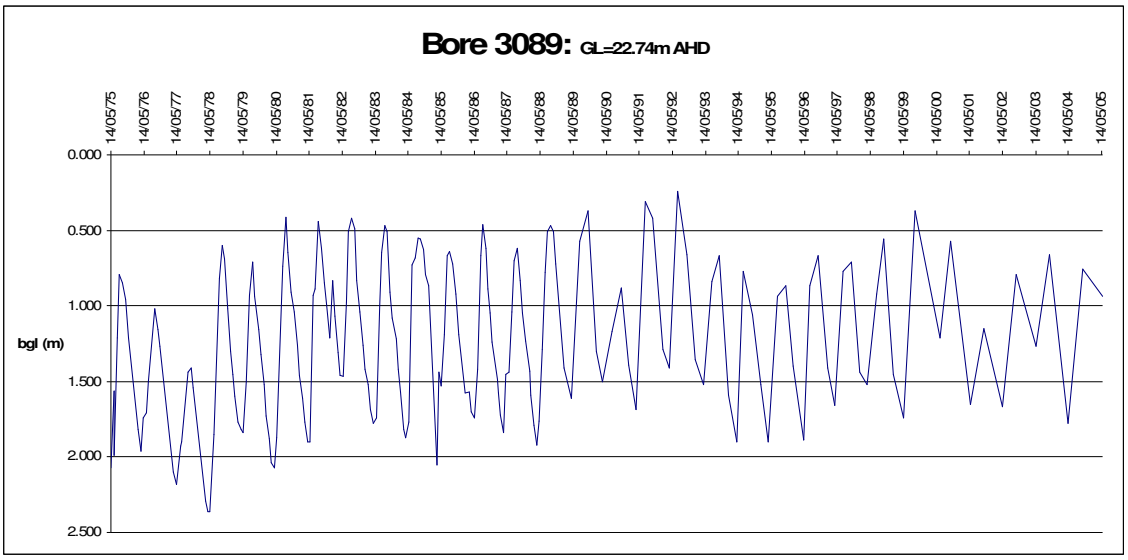
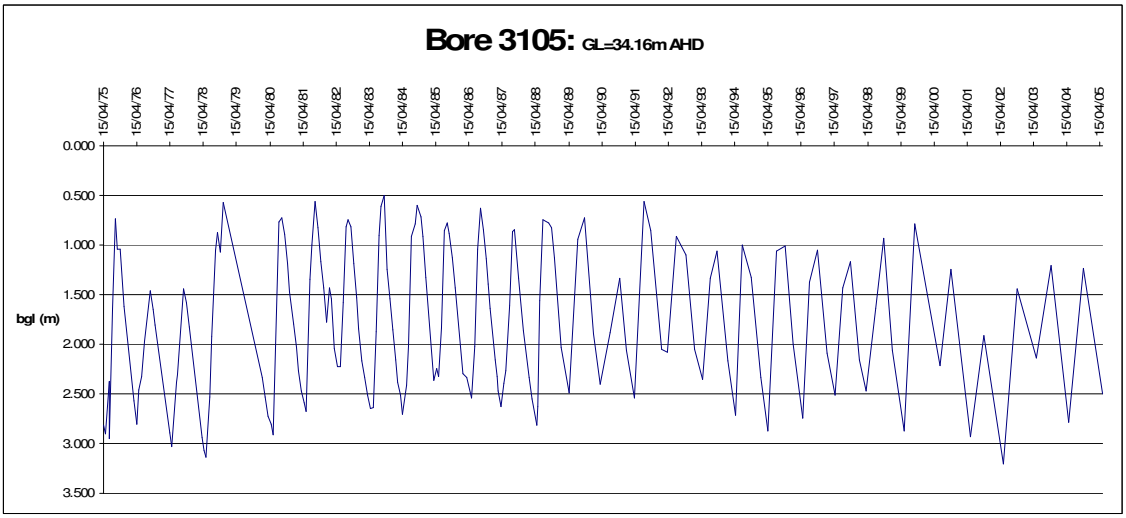


Chart 5: Lake Thompson Monitoring Bore 3105



5.6.1.3 Leederville Aquifer

In the Serpentine area, the Leederville aquifer is a multi-layered aquifer up to 130 metres thick, consisting of discontinuous interbedded sandstone, siltstone and shale of the Wanneroo and Mariginiup Members (of the Leederville Formation). Interfingering of the strata causes the aquifer to be locally confined by shale (Allen, 1981). The proposed mine site is located within a recharge area for the Leederville and Yarragadee aquifers; both are in hydraulic connection with their respective overlying aquifer, and there are downward hydraulic gradients. Thus the Leederville aquifer receives groundwater from the superficial aquifer and transmits it mainly westwards. Downstream, some of the Leederville groundwater discharges into the Superficial and Rockingham aquifers.

Information from a production bore (WIN ID 20024619, GWL 54304) constructed in the Leederville aquifer about 400 metres north-north-west of the proposed initial plant site indicates that the Leederville Formation at that location is about 75 metres thick, overlain by eight metres of Superficial formations. The lithological log shows that there are about 52 metres of available aquifer material (from 31-83 metres below ground surface), consisting mainly of medium-grained sandstone with silt or shale interbeds. The bore was test-pumped at 2,994 cubic metres per day (34.5 litres per second).

5.6.1.4 Water Quality

In the project vicinity, groundwater salinities in the Superficial aquifer range from 200-1,000 milligrams per litre TDS in the four Lake Thompson bores (Figure 9), although in the wider Serpentine area they range up to 2,700 milligrams per litre TDS. Higher-salinity groundwater is generally found near discharge areas of the aquifer. Partial analyses for water samples taken from the local Lake Thompson bores are given in Table 17. They show that colour, turbidity, and iron content vary strongly over the area, and locally one or more of these factors would determine that the water was not suitable for some uses (e.g. potable supply) unless treated.

Table 17: Water Quality Data from Lake Thompson Bores

Bore	TDS (mg/L)	Colour (APHA)	Turbidity (APHA)	Fe (mg/L)	Free CO_2 (mg/L)	Comments
3105 (LT 570)	180	<5	<10	0.64	66	After pumping 1 hr @ 16 m^3/day
3089 (LT610)	240	580	440	3.1	119	After pumping 1 hr @ 37 m^3/day
3111 (LT 620)	950	<10	1800	5.6	159	After pumping 1 hr @ 37 m^3/day
3098 (LT 670)	300	70	330	19	56	After pumping 1 hr @ 16 m^3/day

5.6.1.5 Water Resources

The groundwater resources in the Superficial Formation, as adopted by DoE, are as follows:

- Serpentine Groundwater Area – Keysbrook 1 and 2 Sub-areas:
  5.32 x 10^6 m^3/yr total, with 2.24 x 10^6 m^3/yr currently allocated (42%). *
- Murray Groundwater Area – Nambeelup Sub-area:
  11.8 x 10^6 m^3/yr total, with 1.08 x 10^6 m^3/yr currently allocated (9%). *

* These values are subject to change.

In the vicinity of the proposed mine area there are 25 licensed draw-points tapping the Superficial aquifer. The current licensed production rates from these draw-points range from 500-210,000 cubic metres per year and the total is 560,000 cubic metres per year. Given that the aquifers are the Bassendean Sand – with only one to six metres of saturation generally,

and the Guildford Formation of low permeability, the amounts of water available from individual locations is not very large. The most productive draw-points would be drains, dams or ditches of significant length.

The groundwater resources of the Leederville aquifer, as adopted by DoE, are as follows:

- Serpentine Groundwater Area – Keysbrook 1 and 2 Sub-areas:

  Leederville: 1.76 x 10^6 m^3/yr total, with 0.80 x 10^6 m^3/yr currently allocated (45%).*

- Murray Groundwater Area – Nambeelup Sub-area:

  Upper Leederville: 6 x 10^6 m^3/yr total, with 1.44 x 10^6 m^3/yr currently allocated (24%).*

  Lower Leederville: 3 x 10^6 m^3/yr total, with 0.11 x 10^6 m^3/yr currently allocated (4%).*

* These values are subject to change

The southern section of the mining zone lies within the Nambeelup Sub-area of the Murray Groundwater Resources Allocation Area and is favoured for developing groundwater supplies, as it contains the largest unallocated groundwater resource. For management purposes a green clay marker, of about five to 10 metres in thickness, divides the Leederville aquifer into upper and lower units. The upper Leederville aquifer, located along the western margin of the mining area, has an allocation limit of six gigalitres per annum, of which about 24 per cent has been allocated. The lower Leederville aquifer has an allocation limit of three gigalitres per annum, of which about only four per cent has been allocated. It is proposed that application be made to draw the project's expected water requirements of up to two gigalitres per annum from the lower Leederville Formation in the Nambeelup Sub-area.

5.7 SURFACE HYDROLOGY

At a regional level, all of the surface drainage ultimately flows to the Peel-Harvey estuary. Streams from the Darling Scarp and foothills flow through the mine area. Figure 9 shows the surface drainage lines through the mine area.

Balgobin Brook is the main drainage feature that passes through the central portion of the project area. Approximately 90 per cent of the project area is situated within this catchment. Balgobin Brook flows south-west into Nambeelup Brook, which flows to a series of major lakes (Black Lake and Goegrup Lake).

Myara Brook flows through the northern portion of the project area. It flows north-west into Dirk Brook, which flows to the Serpentine River.

North Dandalup River flows along the southern edge of the project area. It flows south-west into the Murray River, which flows to the Peel inlet.

The mine area and surrounds are characterised by low relief topography that results in a landscape that becomes flatter and increasingly poorly draining westward from the scarp. In the pastured areas, most of the low-lying areas, creeks and wetlands have been cleared and

drained. Downstream of the mine area, west of Hopelands Road, the low relief is even more pronounced, resulting in a wetland chain all the way to the Peel Harvey estuary.

Appendix 9 provides a detailed analysis of the surface hydrology of the mine area and surrounding catchments. A summary of the analysis is provided below.

Nambeelup Brook has a DoE stream gauging station 614063 located about 10 kilometres downstream (south-west) of the mine area. Streamflow data was collected at this station from May 1990 to January 1995 and provides a record of flows in the catchment area. The gauging station has a catchment area of 114.95 square kilometres, meaning 78 per cent of the gauging station's catchment area is within or upstream of the project area.

Nambeelup Brook gauging station has recorded an average annual flow volume of 24,920 megalitres, and a mean peak annual discharge of 15.7 cubic metres per second. Annual average runoff depth is 216 millimetres. Flows are typically close to zero from January to April; high flows occur consistently from June to October. November, December and May are transitional months with flows varying from negligible to considerable from year to year.

The Statewide River Water Quality Assessment (DoW 2004) shows water quality data for Nambeelup Brook (Site 614063), located 10 kilometres downstream (south-west) of the project area is of neutral pH, with very high Nitrogen and Phosphorus and high turbidity.

Analysis using a hand held water quality meter to measure conductivity of water at 15 locations across the project area on 13 October 2005 provided ranges from 0.28 to 0.90 millisiemens per centimetre (168 to 540 milligrams per litre) with a median of 0.6 millisiemens per centimetre (360 milligrams per litre). This confirms all surface water in the project area is fresh. The ANZECC (2000) guideline trigger value for salinity in lowland rivers in south-west Australia is 0.12 to 0.30 millisiemens, and for wetlands is 0.30 to 1.50 millisiemens per centimetre. The measured salinity was mostly above the guidelines for rivers but well within the guidelines for wetlands.

The mine area can be subdivided into three major drainage areas, each with a number of minor subcatchments as shown in Figure 9. The major drainage areas are:

- Nambeelup Brook (90.5% of project area).
- North Dandalup Tributary (4.5% of project area).
- Dirk Brook Tributary (5.0% of project area).

The watercourses have been split into three categories:

1. **Major Watercourses - Peak flows of two to five cubic metres per second.**

   These are Balgobin Brook and North Dandalup River Tributary, and are shown in red in Figure 9. These watercourses have substantial bridges (up to 15 metres wide) at the downstream road crossing. Both watercourses also contain Draft EPP-listed wetlands.

2. **Medium Watercourses - Peak flows of one to two cubic metres per second.**

   These are Dirk Brook Tributary, Nambeelup Brook North Tributary, Balgobin Brook South Tributary and Nambeelup Brook South Tributary, and are shown in yellow in

Figure 9. Peak flows for these watercourses are more manageable than for the major water courses (culvert sizes on adjacent roads are in the range of dual 1,050 millimetre circular pipes). The watercources still have well defined creek channels. Dirk Brook Tributary and Nambeelup Brook South Tributary also contain Draft EPP-listed wetlands.

3. **Minor Watercourses - Peak flows of less than one cubic metre per second.**

   The minor watercourses, no highlighting in Figure 9, are generally shallow and poorly defined. Diversion of these watercourses will be manageable with earthworks such as bunds and drains around mine pits.

5.8 WETLANDS

A search on matters of national environmental significance and other matters protected by the *EPBC Act 1999* over the project area resulted in the project being located within the catchment of the Peel-Yalgorup System, the Becher Point Wetlands and Thompsons Lake. These wetlands are all Ramsar sites and are listed in "*A Directory of Important Wetlands in Australia*" (Environment Australia 2001). Though the project area is located within these catchments, the actual wetlands are at least 20 kilometres from the project site (Table 18).

Table18: Distance of the Project Area from Listed Ramsar Sites

Ramsar Wetland	Approximate Distance from Project Area (km)
Peel-Yalgorup System	20
Becher Point Wetlands	20
Thompsons Lake	37

The Biodiversity Audit of Western Australia (Mitchell *et al.* 2002) lists eutrophication, changed hydrology, urban development and modification of the tidal flats as threatening processes for the Peel-Yalgorup System. Exotic weeds have been listed as a threatening process for both the Becher Point Wetlands and Thompsons Lake, which is also threatened by feral animals, eutrophication and changed hydrology (Mitchell *et al.* 2002).

Figure 10 shows the wetlands listed in the *Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004* are all outside the mine area and will not be disturbed.

The initial flora survey included properties that, at the time, were part of the resource plan. The survey of Lot 64 identified a wetland and good condition remnant vegetation on the property. Revision of the resource plan excluded this property from the final mine plan. Waypoint 25 on Lot 56 is located in the gazetted wetland shown in Figure 10 and 11. This wetland is outside the mining area and will not be disturbed. Two EPP wetlands on Lot 62 (Figure 12) and Lots 6 and 7 (Figure 13) are highly disturbed, with only remnant trees around the creekline over a pasture understorey.

Typically, wetlands in the area are seasonal; becoming inundated in winter and drying out during the summer months. Much of the mine area has been cleared for pasture and cattle grazing, with many of the original wetlands being totally cleared.

Figures 11, 12 and 13 show the gazetted boundaries of the EPP wetlands. All these wetlands have some level of disturbance from agricultural activities. Buffer distances are shown from the edge of the mine pit to the wetland boundary and also distances within the gazetted wetland boundary to remnant vegetation.

The northern wetland (Figure 11) is grazed by stock. Quadrat 6, Relevee A and Figure 4 in Bennett (2004) show the creekline through this wetland as being heavily degraded. The mine area avoids the wetland in all but the western boundary of Lot 56. This location is in open pasture, so a minimum mine exclusion zone of 10 metres has been applied. For the remainder of the wetland, the buffer ranges from a minimum of 21 metres to 67 metres.

Figure 12 shows buffer distances from the mine area boundary to the wetland boundary ranging from 17 metres to 43 metres. Within the wetland boundary, areas of cleared pasture cover distances from 21 metres to 51 metres to the creekline itself or to remnant vegetation. Figure 13 shows the southern wetland located adjacent to a farm shed and access track. A mine exclusing zone around the farm infrastructure also results in a buffer to the southern wetland from 22 metrs to 46 metres. A mine exclusion zone has also been located to maintain the mine area at a minimum of 25 metres from the northern wetland. As with the wetland shown in Figure 12, the area within the wetland boundary has also been significantly cleared. Pasture areas from 21 metres to 65 metres cover the distance to remnant vegetation within the wetland area.

Groundwater modelling of pit dewatering (Appendix 2) indicates only localised drawdown around the active mine pit, with groundwater levels not exceeding normal annual water table fluctuations. During winter, as all these wetlands are on watercourses that will not be disturbed by mining activity, the normal creek flow would be maintained through the wetland. With such minor groundwater impacts beyond the boundary of the mine pit, minimal buffer distances are required.

There are a number of environmental factors influencing the identification of buffers to wetlands. Balla (1994); page 69 describes a surface catchment buffer zone as “a zone of vegetation which begins at the transition from wetland vegetation to upland vegetation and extends radially outwards from a wetland and ends at the interface with another land use.” Thus, most of the examples described by Balla (1994) are for wetlands containing intact vegetation and surrounded by contiguous native vegetation. As shown in Figures 11, 12 and 13, the wetlands around the mine area are all within an agricultural landscape, with cleared pasture providing “another land use” both surrounding and within the gazetted wetland boundary. Management of the environmental factors identified by Balla (1994) are described below:

Wildlife Habitat. Pasture areas surrounding wetlands are considered to have minimal habitat value in relation to providing a habitat buffer for the wetland. The only wetland with contiguous native vegetation to the mine area is the northern wetland on Lot 56. The

identified buffer distance ranges from 21 to 67 metres, with most of the buffer zone being nominally 50 metres.

Water Quality Maintenance. The management of surface water addressed in Section 9.7, specifically in Management Actions 9.7.4b, 9.7.4c and 9.7.4d also addresses surface water quality issues to wetlands. Balla (1994) identifies buffers for maintaining surface water quality in wetlands in agricultural environments relating to nutrient inflow as a result of fertiliser application. No fertilisers are used within the mining operations. Fertiliser application as a component of the rehabilitation programme will be defined in the Rehabilitation Management Plan, which will be developed in consultation with DOE and DOA. It is considered the buffers identified in Figures 11, 12 and 13 are sufficient to minimise impacts to the wetlands. It should be noted that fertiliser application by property owners is not regulated, with fertilisers being applied across all streams feeding the nominated EPP wetlands.

Bank Erosion Control. The wetlands and the major streams through the mine area will not be disturbed by mining activities. The defined buffers (Figures 9, 11, 12 and 13) ensure the wetland and creek banks remain in their current state.

Reducing Surface Flows to Wetlands. Section 5.8 shows there will be no discharge of surplus water to local creeks and wetlands during normal operations of the mine. Diversion of minor water courses around active mine pits will redirect the flow back into the natural drainage path below the mine. During winter, as all these wetlands are on watercourses that will not be disturbed by mining activity, the normal creek flow would be maintained through the wetland. There will be no change of surface flows to wetlands as a result of the mine activity. No specific buffers are required to be identified to manage this environmental factor

Visual and Noise Screening. Section 4.3.1 and Table 8 describe the rate of mine progression. Mining in close proximity to each of the EPP wetlands is a transient land use and would be completed within a three to six month period. Any impacts will be temporary. In the case of wetlands situated within an open pasture landscape, such as shown in Figures 11 and 12, there is no opportunity for visual screening. It is considered the buffers identified will provide adequate visual screening, where trees exist, for the short period of time that mining occurs in close proximity to the wetland.

5.9 VEGETATION AND FLORA

The mine area is 1,234 hectares. Of this, 930 hectares (75.4 per cent) is open pasture, 244 hectares (19.8 per cent) is parkland cleared remnant vegetation and 60 hectares (4.8 per cent) is remnant vegetation in good condition. Three vegetation and flora surveys have been undertaken of the project area by MBS Environmental (May 2004), Bennett Environmental Consulting (October 2004 and October 2005)and a statistical analysis of threatened ecological communities by E.A. Griffin and Associates.

MBS Environmental (2004) undertook a vegetation and habitat assessment between 19 and 20 May 2004. The full report is provided in Appendix 5. The assessment was conducted at the level of reconnaissance survey as specified in EPA Guideline 51, targeting the areas of

remnant native vegetation on the properties of interest (EPA 2004a). Botanist Ms Eleanor Bennett identified the flora specimens collected on site. The study focussed mainly on the properties in the resource zone at that time, being lots 56, 64, 59, 300, 6, 7, 57 and62. Subsequently the mining area has been reduced. The vegetation units of the surveyed properties were described and the condition rated according to Bush Forever (WAPC, 2000).

Bennett Environmental Consulting (2004) undertook a more detailed survey over the mine area in October 2004. The full report is provided in Appendix 3. The survey results were compared with the previous MBS Environmental (2004) survey. Three of the vegetation units located during October 2004 were inferred to be potential TEC's. FCT 20b was considered to be in good condition.

In order to more accurately define the inferred status of the FCT 20b, statistical analysis of the six quadrats was undertaken to compare the surveyed results with the data from Gibson *et al*. (1994). The full report by Griffin (2005) is provided in Appendix 4.

Bennett Environmental Consulting undertook an additional survey on 27 October 2005 of two properties not visited the previous year. Lot 3 is located at the northern end of the mine area, immediately west of the inferred FCT 20b. The second property, Lot 506, is located outside the southern extent of the mine area and includes mapped wetlands that have been listed in the *Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004*. The results of this additional survey were appended to the Bennett (2004) report (Appendix 3).

5.9.1 Vegetation

The mine area is located on the Pinjarra Plain subunit of the Swan Coastal Plain (Beard, 1981). The vegetation of the mine area is being described as being Marri (*Corymbia calophylla)* woodland. Heddle *et al* (1980) undertook vegetation mapping of the Darling System on a finer scale than Beard. They identified four distinct vegetation complexes that occur on the project area. These were Forrestfield, Guildford, Bassendean (South and Cental) and Southern River (Figure 7).

A large portion of the area has been cleared for agricultural use. Small areas of remnant mnative vegetation remain. The remnant vegetation ranges from stands of trees over pasture with very little to no understorey to areas of trees with degraded understorey. The area of interest for development of a mineral sands deposit consists of farmland on freehold titles.

A total of 21 quadrats and three relevees were surveyed by Bennett Environmental Consulting (2004) that identified nine different vegetation units representing six inferred Floristic Community Types (FCT) following Gibson *et al.* (1994). Table 19 provides the results of the survey.

Table 19: Description of Vegetation Areas within the Mine Area

Code	Description	Quadrat	Inferred FCT	Condition	Comment
CcXp	Tall closed forest of *Corymbia calophylla* or occasionally Eucalyptus patens over tall shrubland of *Xanthorrhoea preissii* over weeds and bare ground.	7,8	3c	4-5	This vegetation unit merged into remnant areas of the low open woodland of *Corymbia calophylla* over tall shrubland of *Pericalymma ellipticum* over low shrubland of *Hypocalymma angustifolium.*
Cc	Closed forest of *Corymbia calophylla* over a closed grassland/herbland of weeds.	20, RC	-	5-6, 6	The vegetated remnant over pasture in many areas of the project site. Too degraded to infer a FCT.
CcKa	Open forest of *Corymbia calophylla* over tall open shrubland of *Kingia australis* over closed grassland of weeds.	11	3a	6	
BiKg	Closed to low open forest of *Banksia ilicifolia* and *Kunzea glabrescens* over open grassland.	18,19	21c	5	
BaBm	Low closed forest of *Banksia attenuatta* with scattered *Banksia menziesii* and *Eucalyptus marginata subsp. marginata* over shrubland of *Xanthorrhoea brunonis* over open low heath dominated by *Hibbertia hypericoides.*	1,2,9,10 ,12,16	20b	3, 3-4, 4-5, 5-6, 6	This vegetation unit was recorded from the low sandy dunes in Lot 56, Lot 64 and Lot 59, Lot 300 properties. This same vegetation unit in the remainder of the study area was completely degraded with remnant, scattered trees over pasture species.
Mp	Low open forest of *Melaleuca preissiana* over sedgeland.	4,17,21, RA,RB	4	3-4, 4-5, 6	The drains through the lease included several of the understorey species.
CcPe	Low open woodland of *Corymbia calophylla* over tall shrubland of *Pericalymma ellipticum* over a low shrubland of *Hypocalymma angustifolium.*	3,6	5	4, 4-5	The remnants of this vegetation unit were small as most of the lower lying areas are paddocks.
Rc	Closed tall scrub of *Regelia ciliata, Kunzea micrantha subsp. micrantha* and *Pericalymma ellipticum.*	13,15	5	2-3, 3-5	This vegetation unit was only recorded from Lot 64 property and consisted of vegetated areas with open areas between.
Aa	Open heath of *Astartea affinis* over open	5,14	5	3-4	Small remnants only of this vegetation unit remain, most

Code	Description	Quadrat	Inferred FCT	Condition	Comment
	sedgeland/grassland.				have been developed as pasture.
CEBM	Scattered trees of *Corymbia calophyll, Eucalyptus marginata subsp. marginate,* Banksia species *and Melaleuca preissiana*		-		The vegetated remnant over pasture in many areas of the project site. Mostly in the central and southern areas. Too degraded to infer a FCT.

The condition of each site was rated according to the scale used for assessing Bush Forever sites (WAPC, 2000). The scale is summarised in Table 20.

Table 20: Bush Forever Rating of Site Condition

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species
3	Very Good	Vegetation structure altered, obvious signs of disturbance
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species

Source: WAPC (2000).

Much of the resource area has been cleared for grazing dairy cattle and a small area of intensive agriculture. There are some areas of native vegetation remaining, though much of this is in a degraded condition. All the remnant vegetation had cattle in it at the time of the survey or not long previously. Kangaroos were dominant in the remnant bushland and had caused damage to several plants. In particular, the drains crossing the paddocks still contained water and were heavily used by cattle. When the Bennett Environmental Consulting survey (2004) was undertaken many cattle had congregated in these areas.

In total, about 304 hectares of native vegetation was remaining. Of this about 244 hectares has been parkland cleared, assessed to have a vegetation condition rating of 6: completely degraded. The remaining 60 hectares has been assessed as remnant vegetation with native understorey in a range of conditions. Table 21 shows that only two of the 21 quadrats surveyed scored a condition rating above 3: very good.

Table 21: Vegetation Condition Recorded during the Survey

Rating	Description	Quadrats(Q) and Relevees(R)
2-3	Very good to excellent	Q13
3	Very good	Q1
3-4	Good to very good	Q2,Q5,Q14,Q15,Q17
4	Good	Q3
4-5	Good to degraded	Q4,Q6,Q7,Q8,Q12
5	Degraded	Q18,Q19
5-6	Degraded to completely degraded	Q9,Q16,RC
6	Completely degraded	Q10,Q11,Q20,Q21,RA,RB

Source: Bennett (2004)

The Bennett (2004) survey identified additional variations in the vegetation to the MBS(2004) survey. Generally, the vegetation condition allocated in the MBS survey was rated higher than the Bennett survey. The MBS survey was undertaken in May 2004, prior to the winter rains and the germination of weeds. This most probably accounts for the variation in condition score.

The vegetation of Lot 3 was the same as that described for the adjoining property on lot 56 but in a more degraded condition, scoring a rating of 4-5. Most of the surrounding area has an understorey of weeds and therefore a vegetation condition of 5. Cattle and sheep graze the area.

This vegetation unit was described in Bennett (2004) as Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides.* It is representative of the same FCT as those identified in the earlier report and is adjacent to Quadrants 1 and 2 (Bennett 2004). This vegetation unit was inferred to be Floristic Community Type 20b but which Griffin (2005) attribute to be more likely 21a/c. This extends the distribution in the area of this FCT.

On Lot 506, a detailed survey was not undertaken, only a walk through the area to note the dominant vegetation of the property. The vegetation consisted of a Tall Open Scrub dominated by *Kunzea glabrescens* with scattered trees of *Banksia ilicifolia* over scattered low shrubs and sedges. The condition varied between good and very good. The area represents the transition zone between the wetland (on an adjoining property to the south) and the higher ground of the *Banksia* species Woodland.

All the mapped conservation category wetlands on the lot occurs within the interzone of the wetland (to the south) and high land ground (to the north and east). It is in good or better condition (condition rating <4).

5.9.2 Flora

A total of 40 vascular plant families, 119 genera and 169 taxa were recorded in the survey. The dominant plant families were Poaceae (21 taxa), Myrtaceae (13 taxa), Asteraceae (12 taxa), Cyperaceae and Papilionaceae (11 taxa). These five families represent 43 per cent of the total number of taxa surveyed.

5.9.3 Significant Flora

A total of 13 rare, endangered or otherwise specially protected flora may occur in the mine area. Table 22 lists these species and gives an indication of their likelihood of occurring in the project area.

Table 22: Rare, Threatened or Otherwise Specially Protected Flora that may Occur in the Mine Area

Species	CALM	DEH	Habitat and Comments	Likelihood of Occurrence on Project Area
Acacia oncinophylla subsp. *patulifolia*	P2		Shrub, 0.5–2.5(–3) m high, 'mini-ritchi' bark, phyllodes 4–9 cm long, 3–6 mm wide. Fl. yellow, Aug–Dec. Granitic soils, occasionally on laterite.	Low. Unsuitable soil type
Anthocercis gracilis (Slender Tailflower)		Vulnerable	Erect, spindly shrub, to 0.6(–1) m high. Fl. yellow, green, Sep–Oct. Sandy or loamy soils. Granite outcrops.	Low. Soil type unsuitable
Anthotium junciforme	P4		Open, erect to prostrate perennial, herb, 0.05–0.4 m high, leaves linear to terete, 0.5–1 mm wide; flowering stems 12–40 cm long. Fl. blue, violet, purple, Nov–Mar. Sandy clay, clay. Winter-wet depressions, drainage lines.	Moderate. Vague possibility in damp areas
Aponogeton hexatepalus	P4		Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans	Moderate. If there is a wetland that contains standing water there is a possibility of being present
Boronia tenuis	P4		Procumbent or erect & slender shrub, 0.1–0.5 m high. Fl. blue, pink, white, Aug–Nov. Laterite, stony soils, granite.	Low. Unlikely as unsuitable soil type
Caladenia arrecta	P4	Vulnerable	Tuberous, perennial, herb, 0.12–0.35 m high. Fl. yellow, red, Aug–Oct. Loam, gravel, laterite. Moist situations.	Low. Unlikely as unsuitable soil type. Probably confined to the scarp

Species	CALM	DEH	Habitat and Comments	Likelihood of Occurrence on Project Area
Calothamnus graniticus	P4		Shrub, 1–2.5 m high. Fl. red, May–Aug. Skeletal sandy soils, clay, laterite. Granite outcrops, hillsides.	High. subsp *leptophyllus* has been recorded from private property at Keysbrook
Drakea elastica (Glossy leaved Hammer-orchid)		Endangered	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow, Oct–Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.	Moderate. May occur in damp areas at the site
Drakea micrantha		Vulnerable	Tuberous, perennial, herb, 0.15–0.3 m high. Fl. red, yellow, Sep–Oct. White-grey sand.	Low. Recorded from Pinjarra in Banksia woodland so may occur at the site. Most records are from further south
Lambertia multiflora var. *darlingensis*	P3		Many-stemmed shrub, to 2 m high. Fl. yellow, Jun–Nov. Deep white-yellow sands or loamy, clayey or gravelly soils, laterite, granite. Flats, gorges, base of scarp, rocky hills, plateaus, roadsides.	Low. Occurs at the base of the Darling Scarp and therefore unlikely to occur in area
Lasiopetalum pterocarpum		Endangered	Open shrub 0.2-1.2 m high x ca 0.2-0.5 m wide, growing through other plants. Riverbank. Brown clay-sand over granite.	Low. Unlikely to occur in area.
Synaphea sp. Pinjarra	DRF		Compact shrub, to 0.4 m high, to 0.5 m wide. Fl. yellow, Sep. Grey clayey sand. Swamp. Recorded from Dandalup and Pinjarra.	Low. Unlikely to occur in the area.
Tetraria australiensis	DRF		Rhizomatous, tufted perennial, grass-like or herb (sedge), to 1 m high. Fl. brown, Nov–Dec.	Low. Unlikely to occur at site.

Sources: CALM (2005a); DEH (2005); Likelihood of occurrence on project area provided by Dr Eleanor Bennett and DoE.

No declared rare or priority flora were located during either the 2004 or 2005 surveys.

5.9.4 Threatened Ecological Communities (TEC's)

Three of the vegetation units located during the Bennett (2004) survey were inferred to be potential TECs. These are shown in Table 23.

Table 23: Potential TECs Located During the Survey

Community Identity	General Description	Project site survey description	WA criteria	EPBC Act
20b	*Banksia attenuatta* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain.	Low closed forest of *Banksia attenuatta* with scattered *Banksia menziesii* and *Eucalyptus marginata subsp. marginata* over shrubland of *Xanthorrhoea brunonis* over open low heath dominated by *Hibbertia hypericoides.*	EN B)i), EN B)ii)	Not listed
3a	*Corymbia calophylla – Kingia australis* woodlands on heavy soils, Swan Coastal Plain.	Open forest of *Corymbia calophylla* over tall open shrubland of *Kingia australis* over closed grassland of weeds.	CR B)ii)	EN
3c	*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain.	Tall closed forest of *Corymbia calophylla* or occasionally *Eucalyptus patens* over tall shrubland of *Xanthorrhoea preissii* over weeds and bare ground.	CR B)ii)	EN

Bennett (2004) concluded the vegetation condition of FCT 3a and 3c (quadrats 11, 7 and 8) were recorded as mainly degraded to completely degraded and are not considered worthy of conservation. FCT 20b, quadrats 1, 2, 9, 10, 12 and 16 varied in vegetation condition from very good to completely degraded. Where the vegetation was recorded as very good the area was small and surrounded by degraded vegetation or pasture. The good to very good covers of this FCT covered an area of under two hectares, less than the Urban Bushland Strategy's lowest preferred area limit of 20 hectares (EPA 2003).

The statistical analysis of the inferred status of FCT 20b by Griffin (2005) concluded that the new sites are somewhat similar to the SCP 'low' group of sites, many of which are attributed to FCT 21a or 21c. It is possible that they belong to FCT 20b but it is more likely that they belong to FCT 21a or 21c.

Vegetation type FCT 21c was also inferred in the survey from quadrats 18 and 19 (Table 19).

5.9.5 Weeds

Bennet (2004) identified a total of 34 weed species in the survey. Only weeds recorded in the quadrats and relevees were noted. The list does not include all pasture species. The weeds were rated on the CALM (1999) scale, which is based on three criteria.

1. **Invasiveness**

   Ability to invade natural bushland in good to excellent condition or ability to invade waterways.

2. **Distribution**

   Wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.

3. Environmental impacts

Ability to change the structure, composition and function of ecosystems. In particular, an ability to form a monoculture in a vegetation community

The rating scale for the weeds is:

High	Weed is prioritised for control and /or research.
Moderate	Weed should have control or research effort directed to it, however, it should be monitored.
Mild	Monitoring of the weed and control where appropriate.
Low	A low level of monitoring required.

The total list of weeds identified is provided in Appendix 3. Four weeds were rated as high. These are **Bromus diandrus* (Great brome), **Ehrharta calycina* (Perennial veldt grass), **Leptospermum laevigatum* (Victorian teatree) and **Romulea rosea* (Guildford grass).

5.10 FAUNA

5.10.1 Regional Surveys and Information.

In terms of fauna surveys conducted at a regional level, relatively little survey work on ground-dwelling fauna, including native mammals, has been carried out on the southern Swan Coastal Plain. Iluka (2005) reviewed a small number of published papers and some unpublished data in their PER for the Waroona mineral sand project. This is summarised in the two paragraphs below.

Intensive, seasonal trapping in an almost pristine remnant of 75 hectares of Banksia woodland near Keysbrook (West Kingia - part of Bush Forever site 77) resulted in only two native mammal species being captured: the Honey Possum *Tarsipes rostratus* and Southern Brown Bandicoot *Isoodon obesulus fusciventer* (Ninox unpublished data). Western Grey Kangaroos were relatively common in the study area. Further north, in the much larger remnant bushland at Lowlands near Serpentine (Bush Forever site 368 and 372), only two native mammal species were recorded during trapping: the Chuditch *Dasyurus geoffroii* and Common Brushtail Possum *Trichosurus vulpecula*). The Western Grey Kangaroo was also observed (Ninox unpublished data).

In addition, field surveys of three locations on the southern Ridge Hill Shelf and Pinjarra Plain (Brickwood Reserve (BushForever site 321), Cardup Nature Reserve (BushForever site 352) and Norman Road bushland (BusgForever site 361 and 354) between Byford and Mundijong, resulted in the capture of only two species of small native mammal: the Mardo *Antechinus flavipes* and Western Pygmy Possum *Cercartetus concinnus*; and the observation of only two additional species, the Western Grey Kangaroo and Southern Brown Bandicoot (Harvey *et al.* 1997).

5.10.2 Surveys of the Mine Area

MBS Environmental (2004) undertook a fauna habitat assessment in May 2004 that was conducted at the level of reconnaissance survey, targeting the areas of remnant vegetation on the properties of interest as specified in EPA Guideline 56 (EPA 2004b). Ms Kate George of MBS Environmental and Mr Robert Davis, Zoologist of Western Wildlife on behalf of Bamford Consulting Ecologists, conducted the assessment. Mr Mike Bamford of Bamford Consulting Ecologists peer reviewed the habitat assessment and fauna sections of the report. The complete report is presented in Appendix 5. Fauna work carried out in the field included:

- Opportunistic observations of fauna at each site, including tracks and scats, were recorded.
- Fallen logs and other debris were also searched for reptiles and other fauna.
- Spotlighting was undertaken on the evening of 19 May 2004 for 30 minutes within two hours of dusk.

An additional survey was conducted, for potential cockatoo nesting hollows in mature trees, on 20 and 21 October 2005 (Appendix 6). The fieldwork was carried out by Ms Jenny Wilcox of Western Wildlife and Ms Lisa Boulden of MBS Environmental. In addition, the expert advice of Mr Ron Johnstone (Curator of Ornithology, WA Museum) was sought prior to the survey and on the survey report.

5.10.3 Habitat

The majority of the mine area (over 95 per cent) has been either totally or parkland cleared for agricultural purposes, with the remaining native vegetation areas highly fragmented. As such, the amount of habitat available has been severely reduced. The primary issue for fauna in fragmented agricultural landscapes is connectivity of remnant vegetation. Any reduction in the number of remnants may lead to the reduction in value of the remaining remnants, as the movement of fauna will be impeded. Relatively few species use cleared areas, and those that do usually require areas of native vegetation to supply at least some of their needs.

5.10.4 Fauna Species Listed under Commonwealth and State Acts

Table 24 lists the species that are protected under State or Commonwealth Acts, or listed on CALM's Priority List and expected to occur in the region.

Table 24: Fauna Species that are listed under State or Commonwealth Acts and are Expected to Occur in the Region

Species	Common Name	Conservation Category
Apus pacificus	Fork-tailed Swift	Migratory (CAMBA, JAMBA), CS1
Ardea alba	Great Egret	Migratory (CAMBA, JAMBA),CS1
Ardea ibis	Cattle Egret	Migratory (CAMBA, JAMBA),CS1
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	CALM Priority 3, CS1

Species	Common Name	Conservation Category
Calyptorhynchus baudinii	Long-billed (Baudin's) Black-Cockatoo	Vulnerable (EPBC), CS1 Endangered (WA), CS1
Calyptorhynchus latirostris	Short-billed (Carnaby's) Black- Cockatoo	Endangered (EPBC), CS1 Endangered (WA), CS1
Dasyurus geoffroii	Chuditch	Vulnerable (EPBC), CS1 Vulnerable (WA), CS1
Falco peregrinus	Peregrine Falcon	Other Specially Protected Species (WA), CS1
Isoodon obesulus fusciventer	Quenda	CALM Priority 5, CS2
Merops ornatus	Rainbow Bee-eater	Migratory (JAMBA), CS1
Phascogale tapoatafa	Brush-tailed Phascogale	CALM Priority 3, CS2

Fauna of conservation significance is typically assigned a significance rating from 1 to 3, with category 1 being of greatest significance. This assessment significance is described more fully below.

Conservation Significance (CS1): Species Listed Under State or Commonwealth Acts
The conservation status of fauna species is assessed under Commonwealth and State Acts such as the Commonwealth *EPBC Act 1999* and the Western Australian *Wildlife Conservation Act 1950*. The significance levels for fauna used in the *EPBC Act 1999* are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The Western Australian *Wildlife Conservation Act 1950* uses a set of schedules but also classifies species using some of the IUCN categories.

The *EPBC Act 1999* also has lists of migratory species that are recognised under international treaties such as CAMBA, JAMBA and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The list of migratory species under the *EPBC Act 1999* has been revised to include listed species only, thus excluding family listings (DEH, pers. comm.). Those species listed in JAMBA are also protected under Schedule 3 of the Western Australian *Wildlife Conservation Act 1950*. In addition, DEH has supported publication of reports on the conservation status of most vertebrate fauna species, e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999). These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates Mace and Stuart's review (1994).

Conservation Significance (CS2): Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by CALM
In Western Australia, CALM has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the Western Australian Act, but for which the Department feels there is cause for concern. Species listed only as Priority by CALM, or included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993), but

not in State or Commonwealth Acts, are also of recognised conservation significance. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category.

Conservation Significance (CS3): Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution
In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance. This level of significance has no legislative or published recognition and is based on interpretation of distribution information. The Western Australian Department of Environmental Protection (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan.

5.10.5 Fauna Expected to Occur Within the Mine Area

There are 10 species of amphibians, 39 species of reptiles, 92 species of birds (six introduced), and 24 species of mammals (five introduced) that are expected to occur within the project area. A complete list of the species expected to occur within the project area and their conservation status is given in Appendix 5.

A total of three amphibian species, one reptile species, 41 bird species and two mammal species were identified in the May 2004 Habitat Assessment. This included one Priority 3 species (Red tailed Black Cockatoo), one Priority 4 species (Quenda) and one introduced species (Kookaburra).

Amphibians
There were three amphibians recorded during the site visit. The Moaning Frog *Heleioporus eyrei* was recorded in paddocks near Lot 56, and at Lot 64. The Sandplain Froglet *Crinia insignifera* was recorded at Lot 56, Lot 64 and remnant 1 and 10 of Lot 59 and Lot 300. Guenther's Toadlet *Pseudophryne guentheri* was recorded at Lot 56.

Some species of frog will only occur near wetlands such as the seasonal streams to the north of Lot 56 or the damp land at Lot 64. Many species may also use roadside ditches to breed, such as those observed near Lot 64.

Some of the species listed, such as the Pobblebonk and the Moaning Frog, utilise areas away from wetlands during the non-breeding season and access to these upland areas of native vegetation is important for their lifecycle. The Turtle Frog is a strictly terrestrial breeder and may be resident in the project area in Banksia woodland and other areas with sandy soils.

None of the amphibians expected to occur in the project area are of conservation significance.

Reptiles
One reptile species, the Fence Skink, was observed during the site visit. Most reptile species could be found anywhere in the project area, but some have more specific habitat requirements. Wetland-dependent species such as the Long-necked Tortoise, Tiger Snake, South-west Cool-Skink and Glossy Swamp Egernia, will only occur near wetlands such as at Lot 64.

Most species of reptile rely on areas of native vegetation for survival. Degraded areas, such as paddocks or heavily grazed remnants such as at Lot 59 and Lot 300 with no understorey or leaf litter, will support only a limited number of disturbance-tolerant species. Species tolerant of disturbance include the Marbled Gecko, Dwarf Skink, Fence Skink, West-coast Four-toed Lerista, Two-toed Earless Skink, Bobtail and Dugite.

Birds

As birds are highly mobile, almost any species that occurs in the general region could occur at some time in the mine area. During the May 2004 survey, 41 species were observed (Table 25).

There are 40 bird species of conservation significance that are expected to occur on the site. Of these, a total of 32 species are listed as being of Conservation Significance Level 3, with most of these being species listed in Bush Forever (WAPC, 2000). Many of the species have restricted populations on the Swan Coastal Plain either naturally or as a result of European settlement and the associated issues of introduced predators, e.g. foxes and cats, and habitat loss/degradation.

Table 25: Birds Observed on the Keysbrook Mine Area

Species	Common Name	Status	Observed
Tadorna tadornoides	Australian Shelduck		+
Falco cenchroides	Nankeen Kestrel		+
Phaps chalcoptera	Common Bronzewing	CS3	+
Ocyphaps lophotes	Crested Pigeon		+
Calyptorhynchus banksii	Red-tailed Black-Cockatoo	CS1	+
Glossopsitta porphyrocephala	Purple-crowned Lorikeet		+
Purpureicephalus spurius	Red-capped Parrot		+
Polytelis anthopeplus	Regent Parrot		+
Barnardius zonarius	Australian Ringneck		+
Neophema elegans	Elegant Parrot		+
Dacelo novaeguineae	Laughing Kookaburra	Int.	+
Malurus splendens	Splendid Fairy-wren	CS3	+
Pardalotus striatus	Striated Pardalote		+
Sericornis frontalis	White-browed Scrubwren	CS3	+
Smicrornis brevirostris	Weebill	CS3	+
Gerygone fusca	Western Gerygone		+
Acanthiza apicalis	Inland thornbill	CS3	+
Acanthiza chrysorrhoa	Yellow-rumped thornbill	CS3	+
Anthochaera carunculata	Red Wattlebird		+
Anthochaera lunulata	Western Wattlebird	CS3	+
Lichenostomus virescens	Singing Honeyeater		+
Manorina flavigula	Yellow-throated Miner		+

Species	Common Name	Status	Observed
Melithreptus lunatus	White-naped Honeyeater	CS3	+
Lichmera indistincta	Brown Honeyeater		+
Phylidonyris novaehollandiae	New Holland Honeyeater	CS3	+
Acanthorhynchus superciliosus	Western Spinebill		+
Epthianura albifrons	White-fronted Chat		+
Petroica multicolour	Scarlet Robin	CS3	+
Daphoenositta chrysoptera	Varied Sittella	CS3	+
Pachycephala rufiventris	Rufous Whistler		+
Pachycephala pectoralis	Golden Whistler	CS3	+
Colluricincla harmonica	Grey Shrike-thrush	CS3	+
Grallina cyanoleuca	Magpie-lark		+
Rhipidura fuliginosa	Grey Fantail		+
Rhipidura leucophrys	Willie Wagtail		+
Coracina novaehollandiae	Black-faced Cuckoo-shrike		+
Artamus cinereus	Black-faced Woodswallow	CS3	+
Cracticus torquatus	Grey Butcherbird		+
Gymnorhina tibicen	Australian Magpie		+
Strepera versicolor	Grey Currawong	CS3	+
Corvus coronoides	Australian Raven		+

Of particular interest is the potential presence of the Short-billed (Carnaby's) Black Cockatoo *Calyptorrhynchus latirostris* and the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*. The Carnaby's Cockatoo is likely to utilise the remnants for feeding. Given the paucity of remnant vegetation in the area, these remnants are probably important for this species. Loss of feeding habitat for Carnaby's Cockatoo is identified as a key threatening process under the Commonwealth *EPBC Act 1999*. The Forest Red-tailed Black-Cockatoo may similarly utilise remnants in the area for feeding, but additionally this species may breed in suitable nest hollows in the region.

Wilcox carried out a specific survey to identify cockatoo species and potential breeding sites on 20 and 21 October 2005, although other bird species observed were also recorded. The properties surveyed were Lot 56, Lot 59, Lot 300, Lot 3, and Lot 506 St Blaize Grove. Each property retains areas of native vegetation of various sizes. The complete report is attached as Appendix 6. Summary points from the report are provided below:

- The only species of cockatoo observed directly during the survey was the Forest Red-tailed Black-Cockatoo. There was evidence of these birds feeding in most areas where Marri was present, with the ground under particular trees covered with fruits that had been broken open. Red-tailed Black-Cockatoos were observed as single birds or in small groups of up to 20 individuals. Most of the sightings were from Lot 56, Lot 59 and Lot 300. This is because these properties were larger (and therefore may support

more birds) and more time was spent on these larger sites looking for potential nest hollows (therefore increasing the chance that birds would be observed).

- The presence of the Baudin's Black-Cockatoo was inferred through the presence of Marri nuts that were marked distinctively by feeding birds. The Carnaby's Black-Cockatoo was not observed in the study area. However, local residents reported seeing large flocks of 'white-tailed black-cockatoos' in the area, which were probably either flocks of Carnaby's Black-Cockatoo or mixed flocks of the two white-tailed black-cockatoos.
- Only a few potential nesting hollows were identified in the survey. It is likely that this is an incomplete list, as hollows are sometimes not visible from the ground (R. Johnstone pers. comm.). Although none of the potential hollows identified showed evidence of occupation, this is also difficult to discern, as the adult birds are not obvious at the nest, moving under the cover of darkness.
- As the study area is on the coastal plain, and the Forest Red-tailed Black-Cockatoo and Baudin's Black-Cockatoo generally nest in the ranges, it could be argued that the area has a low potential to support breeding of these species. However, it is possible that low numbers of any of the cockatoos may breed in the area. Most potential hollows identified were on Lot 56. This property appeared to have the largest trees, and has a higher potential to support breeding cockatoos than any of the other properties.
- Overall, the potential of the vegetation remnants to provide breeding habitat for cockatoos is low, with the Lot 56 property showing the highest potential.

Mammals

The characteristic diggings of the Quenda, Southern Brown Bandicoot, were recorded near the wetland at Lot 64, although the animal was not sighted. The Western Grey Kangaroo was recorded at Lot 56 and Lot 64. Western Grey Kangaroos are likely to be present at all sites although the Quenda is likely to be patchily distributed in areas of dense understorey such as around wetlands.

There are 24 species of mammal that may occur in the project area. Five of the expected species are introduced and almost a third of the native species are bats. With the exception of the Western Grey Kangaroo, all the native mammals can be considered to be at least of regional conservation significance. The scarcity of information available for some taxa such as bats makes it difficult to be certain of their distribution and the likely impact of development in the region. Bats rely heavily on old trees that have crevices and hollows to provide shelter. Other native mammal species, such as the Chuditch and Brush-tailed Possum, also rely on tree hollows for shelter, while the Quenda utilise dense understorey vegetation. Both old stag trees and dense understorey areas are limited in number within the project area, indicating the preferred habitat for these species is limited.

5.10.6 Additional Surveys of the Mine Area

Additional fauna assessments are proposed to be undertaken during June 2006. The assessment will be conducted at the level of detailed survey as specified in EPA Guideline 51 (EPA 2004a). The additional assessments would not be general in nature, but would target

significant species, habitats, locations and processes. The scope of work for the additional assessments is;

- Short Range Endemic Invertebrates. Discuss the likelihood of the presence of suitable habitat with WA Museum staff. Winter/early spring survey if necessary.
- Systematic bird surveys. To compare habitat value of different remnants, including any with linkage value. Winter survey.
- Reptiles and frogs. Searching, habitat assessment and aural surveys in winter to early spring. Focus on significant species and to provide assessment of value of habitat and remnants.
- Bats. Aural surveys in late spring/summer.
- Mammals, such as the Quenda. Searching for diggings to confirm the distribution from the level 1 survey. Winter survey.
- Habitat trees and vegetation important for fauna. Inspection of remnants to add to existing records of potential nest trees to include other significant trees, thickets of significant vegetation, etc. This can take place in winter.
- Black-cockatoo nests. Annual survey and monitoring by staff from WA Museum to suplement data already collected.
- Wildlife corridors/habitat linkage. Observations to be made that contribute to an understanding of how wildlife makes use of the total landscape, with importance of remnants as stepping stones, and linear remnants along road verges, to be investigated.

Most of the above investigations are to take place in a planned late June/early July field trip. The results will be submitted to DOE and CALM for consideration in the assessment of the PER.

The investigations that fall outside the June/July period are included in the Fauna Management Plan (FMP), as part of Olympia's ongoing fauna studies during the life of mine. Results will be submitted to DOE and CALM. The FMP is also reviewed annually to enable surveys to be scheduled and any outcomes incorporated into the relevant mine planning process. These investigations are:

- aural survey for frogs (late winter to early spring when most species are calling),
- survey for bats (from late spring to early autumn),
- survey for black-cockatoo nests (spring), in conjunction with an existing programme being undertaken in the region by the WA Museum.

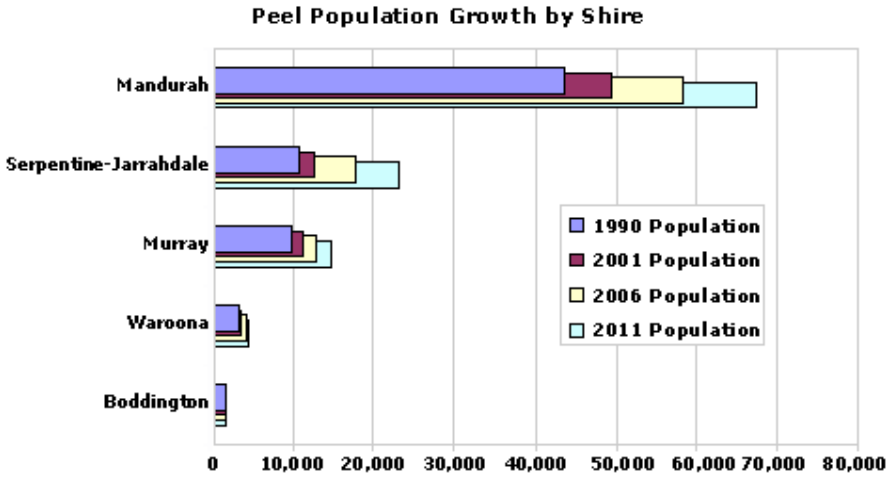
5.11 SOCIAL ENVIRONMENT

The Peel region incorporates the geographical boundaries of five local municipalities; the City of Mandurah together with the Shires of Boddington, Murray, Serpentine Jarrahdale and Waroona. Table 26 shows the Peel region has a population of almost 88,000 (mostly within the City of Mandurah), and continues to be one of the fastest growing regions in Western Australia and in Australia. It recorded a population growth rate of 5.9 per cent between 2003 and 2004.

Table 26: Peel Population Distribution

	1991	1996	2001	2003	2004	% of Region
Boddington	1,341	1,540	1,440	1,374	1,375	1.6
Mandurah	29,223	40,460	48,877	54,291	58,587	66.7
Murray	8,797	9,510	10,875	11,543	11,831	13.5
Serpentine-Jarrahdale	8,244	10,227	11,704	12,178	12,443	14.2
Waroona	3,010	3,194	3,524	3,497	3,555	4.0
Peel Region	**50,615**	**64,931**	**76,420**	**82,883**	**87,791**	**100**

Source: ABS Estimated Resident Population *(published March 2005)*



Source: http://www.peel.wa.gov.au/content/discoverPeel/factsFigures/population.cfm

The mine area overlaps the Shires of Serpentine Jarrahdale and Murray, both predominantly rural Shires with discrete town sites.

RBA (2003) provide the following information on the Shire of Serpentine Jarrahdale. The Shire is 905 square kilometres, has a population of 12,443 (ABS 2004). Town sites and localities include Byford, Serpentine, Jarrahdale, Oakford, Oldbury, Mundijong, Mardella, Karrakup, Whitby, Keysbrook, Cardup, Hopeland and Darling Downs. Reflecting its rural base, the major local industries within the Shire have typically been focused upon primary production with a more recent focus emerging upon the horse industry, orchards, market gardens and tourism.

The Murray Shire, with a population of 11,881 (ABS 2004), is situated one hour's drive south of Perth along the South Western Highway. Its predominantly rural industries include beef and dairy farming, however bauxite mining and processing is a major industry within the region.

5.11.1 Transport

The South Western Highway, approximately two kilometres from the eastern side of the mine area, is the main arterial transport route running north to south. The remaining roads around the mine area are local roads, varying in standard from dual-width sealed pavements, single-width sealed pavements and unsealed roads.

5.11.2 Powerlines

Two high voltage powerlines, running north-south, traverse the project site. There are 21 pylons within the mine area. A 35-metre radius mine exclusion zone has been identified by Olympia around each pylon.

5.11.3 Aboriginal Heritage

Olympia commissioned Australian Interaction Consultants to carry out a preliminary Aboriginal Heritage study relating to the proposed Keysbrook project.

Before any disturbance of the site occurs, in consultation with the South West Land and Sea Council (SWALC) Olympia will undertake the following:

- An archaeological survey of the proposed project area to determine the location and nature of any unrecorded sites and ensure that all requirements of the *Aboriginal Heritage Act 1972* (WA) are met.
- That appropriate Aboriginal people will be consulted as required by the Act regarding the existence of any ethnographic sites in the area.
- Olympia will ensure all staff and contractors engaged on this project are made aware of their obligations and responsibilities under the *Aboriginal Heritage Act 1972*.

The survey will be undertaken and the results provided to the EPA prior to the release of the EPA report and recommendations bulletin.

5.11.4 European Heritage

The project is located within pasture areas in a rural landscape.

A search was conducted of the Register of the Heritage Council of Western Australia for heritage sites within the mine area. No sites were identified as being located within the mine area.

6. STAKEHOLDER CONSULTATION

6.1 BACKGROUND

Olympia's relationship with its neighbours and the wider community is recognised as important to the long-term success of its operations. The company aims to be a valuable corporate citizen by:

- Working closely with neighbours.
- Supporting the community through sponsorship and resources.
- Providing public information about its activities.

In Western Australia the environmental approvals process requires the proponent to demonstrate that consultation has been undertaken and that relevant environmental concerns have been addressed in the design and management of the proposal.

A public consultation programme was undertaken to consult with:

- State Government departments, agencies and organisations.
- Local Government authorities.
- Landholders in and around the project site.
- Community groups.
- Special interest groups.

The public consultation included:

- Establishment of a list of all relevant stakeholders.
- Meetings with government agencies.
- Meetings with community and other stakeholder groups.

6.2 OBJECTIVES

The objectives of the community consultation programme for the Keysbrook project are to:

- Identify key stakeholders.
- Ensure that appropriate information regarding the proposed project is communicated to all stakeholders.
- Determine the key concerns of stakeholders regarding the proposed project.
- Address stakeholder's issues in project plans.

6.3 CONSULTATION PROGRAMME

Consultation with local residents, organisations and community groups started early in the project planning process. This consultation allows individuals, groups and agencies that will potentially be affected by the proposal to have their interests considered during the environmental assessment process. This ensures that issues raised are addressed in this public environmental review and that they will be addressed during the operation of the project. The stakeholders for the Keysbrook project are identified in Table 27 below.

Table 27: Keysbrook Project Stakeholders

Community	Statutory	Corporate	Employees
Private landowners within the mining area	Department of the Environment and Heritage	Olympia Resources	Staff
Adjacent landowners	Environment Protection Authority	ASX	Contractors
WA Conservation Council	Department of Environment	Customers	Consultants
The Wildflower Society of Western Australia	Department of Conservation and Land Management	Analysts	
Keysbrook and North Dandalup local businesses	Main Roads	Shareholders	
Media	Western Power	Financial institutions	
Politicians	Water Corporation	Mining industry peers	
Local Community groups	Shire of Serpentine Jarrahdale	Future Shareholders	
Landcare Groups	Shire of Murray		
Birds Australia	Department of Industry and Resources		
Keysbrook North Dandalup Action Group (KNAG)	Department of Consumer and Employment Protection		
Peel Harvey Catchment Council	Department of Planning and Infrastructure		
Peel Development Commission	Bunbury Port Authority		
	Department of Water		

Consultation sessions have been conducted with a range of individuals, government agencies and community groups interested in, or affected by, the Keysbrook project. Communication methods used include public information sessions, one-on-one discussions and small group discussions. The consultation framework to date is summarised in Table 28.

Table 28: Consultation Methods and Events

Groups Consulted	Channels	When	Comments/Issues
Private Landowners	One-on-one Newsletters Meetings Website	Ongoing (July 2005 – present)	Comprehensive discussions, project briefing, land access, compensation, environmental impact and rehabilitation.
Adjacent Landowners	One-on-one Project briefings Newsletters Website Public meetings	Ongoing (October 2005 – present)	Project briefing, gathering and responding to queries and concerns raised.
State Government Departments	Meetings Project briefings One-on-one Newsletters Website	Ongoing (August 2005 – present)	Project briefing, administrative inquiries and advice.
Shires	Meetings Project briefings One-on-one Newsletters Website	Ongoing (August 2005 – present)	Project briefing, administrative inquiries and seeking advice.
Community Groups	Attending meetings Project briefings Newsletters One-on-one Website	Ongoing (October 2005 – present)	Project briefing, gathering concerns and issues, discussing community support opportunities, consulting with opposing groups.
Environmental Groups	Attending meetings Project briefings Newsletters Letters	Ongoing (October 2005 – present)	Project briefing, gathering concerns and issues, conservation and rehabilitation planning, discussing community support opportunities.
Corporate Stakeholders	Project briefings Media releases Website news	Ongoing (August 2005 – present)	Providing timely and accurate information.

A regular newsletter is distributed to a mailing list, which is expanding. The newsletters along with Frequently Asked Questions are posted on the company's website, with provision for interactive feedback from interested parties. Individual information sheets have been prepared in response to specific questions or concerns. Olympia will continue to liaise closely and regularly with interested and affected stakeholders throughout the planning, development and operational stages of the project.

6.4 ISSUES RAISED DURING STAKEHOLDER CONSULTATION

The environmental issues raised during the stakeholder consultation programme are listed in Table 29.

Table 29: Environmental Issues Raised During Stakeholder Consultations

No.	Issue	Stakeholder	Olympia Response	PER Section
	Topsoil			
1	Amount of overburden and topsoil. The issue of organic matter and seed bank available in the topsoil.	Serpentine Jarrahdale Shire	Mineral resource is on or near the surface. No overburden is present. Topsoil will be stockpiled or directly returned (season dependent). The majority of the mine area is pasture, so most of the topsoil seed bank will be grass species.	4.2
	Rehabilitation			
2	Timing of mining and the gap between end of mining/rehabilitation and return to pre-mining use (agriculture).	Serpentine Jarrahdale Shire, KNAG, Peel Development Commission, Conservation Council	Both mining and rehabilitation is progressive. Rehabilitation is staged to reflect seasonal constraints. Reseeding to pasture will occur annually. Two reseedings are proposed before complete 'handback' to landowner. Native vegetation areas will be monitored for two years to ensure successful establishment.	9.3
3	Possibility of acid mine drainage.	Serpentine Jarrahdale Shire, Peel Development Commission, Conservation Council, KNAG	Very remote as no sulphur in the ore and organic content extremely low. A sampling programme has been undertaken and results confirm a low potential acid risk across the mine site.	5.4.1 and 9.4

No.	Issue	Stakeholder	Olympia Response	PER Section
4	The southern portion of the mine area is zoned for further subdivision. Need to examine the proposed timeline of the project for possible conflict with further subdivision.	Murray Shire Planning Dept.	The proposed mine life is approximately eight years.	3.1
5	Examples of sand mining rehabilitation requested.	KNAG	This will be Olympia's first mineral sand mining operation. Other mineral sand companies in the south-west have many 50 years experience with successful rehabilitation in rural environments. Olympia staff and consultants have extensive experience in the industry.	
	Fauna			
6	Cockatoo survey.	Peel Development Commission, Conservation Council	Survey has been undertaken and 33.7 hectares with the greatest concentration of potential nesting trees has been excised from the mine plan.	5.10.2
	Flora			
7	Vegetation clearing. Even 'parkland' cleared has a value.	Conservation Council	Noted. These values can be replaced with rehabilitation and improved values created by increasing corridor linkages throughout the project area.	5.9 and 9.3
8	Where is Kingia Reserve (Alan Elliott's property) in relation to the project?	Conservation Council	Two kilometres west of the mine site.	9.1.4
9	How much clearing of vegetation is required. Where is the existing Landcare planting in the area. Where? How much?	Peel Development Commission, KNAG	A total of 304 hectares over the mine life is proposed to be cleared. A PRMP has been prepared. This plan will be reviewed and additional, detailed lot plans developed in consultation with landowners.	9.3

No.	Issue	Stakeholder	Olympia Response	PER Section
10	Priority plant species and TECs.	Peel Development Commission, Conservation Council	No priority species were identified in the flora surveys conducted. The inferred TEC 20b community is statistically more likely to be either FCT 21a or 21c.	5.9.4
11	Trees, particularly Jarrah and Marri. View expressed that the mature trees are irreplaceable and have a significant ecological role in maintaining soil stability, fauna habitat and aesthetic appeal.	KNAG	There are very few (approximately 20-30) mature 'stag' trees in the mining area with hollows suitable as cockatoo nest sites. An area in the south-west of Lot 56 has been identified as having a concentration of at least 11 such trees (approximately 50% of the total in the mine area). Olympia has excised 48.7ha from the mine plan to conserve these trees, the surrounding vegetation and a nearby wetland.	5.10
12	The operation will contribute to the spread of dieback by: • Operating vehicles in infected areas. • Constructing haul roads with infected gravel. • Releasing contaminated water from the site.	Conservation Council, KNAG	No haul roads and no use of gravel as a road base will occur on site. Dieback disease is already present on the site and has been there for many years. Water leaving the site potentially carrying dieback zoospores (contaminated water) currently occurs from both infected catchments in the Darling Range and existing infected areas on site. The project will not alter this existing situation. Mud/soil on stock hooves and agricultural vehicle use in paddocks can equally contribute to the spread of dieback. This situation has existed for many years Management measures to minimise the risk of spread of the fungus during the project are provided in the PER.	5.4.2 and 9.5

No.	Issue	Stakeholder	Olympia Response	PER Section
	Dust			
13	Easterly winds during summer: dust and erosion.	Serpentine Jarrahdale Shire, Chad Smith, KNAG, landowners, community groups, neighbouring landowners	Water sprays will be used as required in the mining operation. Mining operations will take consideration of wind direction and speed. The processing is a wet operation as is backfilling of pit voids. Rehabilitation will include both clay and vegetative stabilization to account for seasonal constraints. Dust monitoring will occur.	9.9
	Water			
14	Issue of water use during the operation (2GL required). Will be sourced from the Leederville formation.	Serpentine Jarrahdale Shire	The bores are proposed to be located in the Murray Shire as the present information from DOE indicates there is greater availably in this subcatchment.	5.6.1
15	Questioned whether groundwater will be addressed in the PER.	Serpentine Jarrahdale Shire	Yes.	5.6.1
16	Anticipated water use (2GL). Does this include dust suppression?	Serpentine Jarrahdale Shire	Yes.	5.6.1 and 9.9
17	Is the water supply secured from the DoE currently? What happens if the required 2GL cannot be sourced?	Serpentine Jarrahdale Shire	No. Appropriate licences and permits are required to drill bores and obtain an extraction allocation. Applications will be made at an appropriate time. This would alter the mining rate which would increase the life of mine.	9.6

No.	Issue	Stakeholder	Olympia Response	PER Section
18	Groundwater levels in the project area? Will the pits be below the water table?	Murray Shire Planning Dept, Serpentine Jarrahdale Shire Planning Dept, Peel Development Commission, Conservation Council	Exploration drilling indicates that during summer, the watertable is below the mine pit floor. During winter, the water table is above the base of the mineral zone. Dewatering of about 1– .5m will be required during winter.	4.3.3
19	Water requirements for the project. Will the project be using scheme water?	Murray Planning, KNAG, Peel Development Commission	No. Potable water for drinking will be trucked in and stored in a water tank. All other water requirements will use recycled pit dewatering water or bore water.	5.3.3 and 4.5
20	Quantity. Possible effect on his bore, also in the Leederville at about 60m.	Robert Guira	During construction of new bores, test pumping is required to demonstrate use of the new bore is not having a detrimental effect on other licensed users and environmental values (adjacent wetlands etc), prior to an extraction licence being issued.	9.6
21	Recontoured drainage marrying in to existing system. Effect on diversions around pits and dewatering of pits in winter.	Robert Guira, KNAG	Major creek-lines will not be mined. Minor creeks will be diverted around the pit and returned to natural path downstream. Post-mining landforms will return surface drainage to pre-mining situation.	5.7 and 9.7
22	Effect of water use on local bores. Will company compensate owners if bores are affected?	Annette Bain KNAG	See also response No 20. It is not anticipated the bores will affect adjacent users.	9.6
23	Will recycling be utilised?	Serpentine Jarrahdale Shire	All waste will be disposed off-site by licensed contractors. Recycling of suitable materials will be undertaken.	9.11

No.	Issue	Stakeholder	Olympia Response	PER Section
24	How is water available for the project when the Government has told owners to not use groundwater?	KNAG	Appropriate licences and permits will be applied for at the appropriate time, subject to testing showing no detrimental effects. See response No. 17	5.6.1 and 9.6
25	Will the dewatering process – or stream diversion – affect surface water quality – and will the disturbance of salts, pyrites and existing fertilizer banks contaminate the groundwater?	Conservation Council, KNAG	See also response No 18. Monitoring of water quality criteria will be undertaken to ensure discharge water meets acceptable standards See also response No 3. Testing of nutrient levels in the Bassendean subsoils has shown very low levels of the major nutrients N, P and K. Any discharge water is not anticipated to contain high levels of nutrients.	5.7, 9.7, 9.4, 9.3
26	Water requirements. Management. In proposed P2 areas.	Conservation Council	Mining within the water table zone is temporary and pits are backfilled to pre-mining levels. Storage of hazardous materials will comply with WRC guidelines.	9.6.4
	PER Process			
27	Question on the process of setting guidelines / scoping document / issues to address in the PER.	Serpentine Jarrahdale Shire, KNAG	The process of formal assessment by the EPA is available on the EPA's website.	
28	EPBC Act referral and trigging of Controlled Action re wetlands	Peel Devt	The process of *EPBC Act* referral is available on the DEH's website. The Commonwealth has a Bilateral Agreement with the State such that projects assessed by the State at the levels of PER or ERMP level do not require further assessment by the Commonwealth.	
	Transport			
29	In the PER, examine option of railway transport of HMC to Picton vs road transport.	Serpentine Jarrahdale Shire, KNAG	This alternative was examined and determined to not be viable for the project.	3.2

No.	Issue	Stakeholder	Olympia Response	PER Section
30	Road transport: Is the route identified and finalised yet?	Serpentine Jarrahdale Shire, KNAG, neighbouring landowner	Alternative transport routes were examined. Olympia's preferred route is provided in the PER.	10.2
31	In addition to HMC transportation, PER needs to address ALL traffic; workforce, supplies etc.	Serpentine Jarrahdale Shire, KNAG	Transport routes and traffic movements to and from the project site are addressed in the PER.	10.2
32	Transport issues a big issue with the Shire. They are trying to get Government support to bring forward the timeline to construct the Pinjarra bypass. They would look to industry to also lobby for the bypass.	Murray Shire Planning Dept	Olympia will undertake to support the Shire of Murray in their discussions with the State Government on the Pinjarra bypass.	10.2
33	Narrow local roads (Readheads Road) not suitable for large trucks.	KNAG	Olympia will upgrade and maintain the local roads used for product haulage to a safe standard, as required by the local Shires and Main Roads	5.11.1 and 10.2
34	Are road trains planned to be used? If so, what steps would be taken to ensure the safety of school buses and other road users?	KNAG	The final configuration of product haulage trucks has not been determined and will not be known until a haulage contract is finalised. See also response 33.	10.2
35	Road upgrade required and effect on road verge vegetation. Discussion with Shire and MRD.	Peel Devt	See response 33.	10.2
	Mining and Infrastructure			
36	Processing plant. Fixed or mobile?	Serpentine Jarrahdale Shire	The wet concentration plant is planned to be relocated three times during the life of mine.	9.10

No.	Issue	Stakeholder	Olympia Response	PER Section
37	Mining sequence and timeline.	Serpentine Jarrahdale Shire, KNAG	Mining will occur on Lot 112, in the Shire of Serpentine Jarrahdale and Lot 300, in the Shire of Murray in year one. The mining sequence for the life of mine is detailed in the PER.	4
38	Power supply: diesel or electric?	Serpentine Jarrahdale Shire	The majority of fixed plant will be electric. Small generators may be required to power sump pumps that are regularly being relocated.	4.8
39	What are the mining methods?	Serpentine Jarrahdale Shire	Scraper operating to a movable screening plant. Sand slurry pump back to the washing plant. Pipelines up to 2km.	4.3
40	What are the processing methods?	Serpentine Jarrahdale Shire	Screening and washing/separation of heavy mineral concentrate. Thickeners used to recover water. Recycling of as much water as possible.	4.4
41	Issue of financial security and bonds to ensure rehabilitation is undertaken.	Serpentine Jarrahdale Shire	The access agreements with landowner require satisfactory rehabilitation before the land is returned to the owner.	
42	What is the anticipated life of mine?	Serpentine Jarrahdale Shire, Murray Planning, KNAG, Peel Devt	Approximately eight years.	3.1
43	Does the Picton plant exist yet? Why Picton?	Serpentine Jarrahdale Shire	No. The location is close to port facilities and central to other resource areas held by the company.	3.2
	Community Concerns			
44	Valued part of the community: what does Olympia propose to do to achieve this?	Serpentine Jarrahdale Shire	A range of appropriate local programmes will be supported during the project.	7
45	Community: a secondary school is proposed for the area. Mundijong Council will be looking at financial support for this.	Serpentine Jarrahdale Shire	A range of appropriate local programmes will be supported during the project.	7

No.	Issue	Stakeholder	Olympia Response	PER Section
46	Devaluation of land during time of mining, for properties close to active mine area.	Serpentine Jarrahdale Shire, Chad Smith	Operation moves quickly through the reserve. Mine cells have approximately three months duration. Rehabilitation back to pasture results in rapid return to pre-mining visual effect. Effect will be short-term.	4.3
47	Are there other areas of resources identified in the Shire?	Murray Shire Planning Dept KNAG	Yes.	3.2
48	Local Government approval also needed.	North Dandalup, Peel Development Commission	Olympia will submit relevant applications at the appropriate time.	
49	Will the reputation of local beef producers be threatened by public perceptions of radiation contamination from monazite?	KNAG	Testing conducted in the orebody has detected no Monazite.	
	Noise			
50	Need to do modelling when close to residents and for night time operation.	Serpentine Jarrahdale Shire, Chad Smith, North Dandalup, Conservation Council	Noise modelling has been undertaken. Mine scheduling will ensure the operations comply with regulations.	9.10
	Landowners			
51	Landowner access agreements: What timeline are these for?	Serpentine Jarrahdale Shire, Murray Shire Planning Dept.	The duration of the mine.	
52	Land clearing permission for the project vs farmers not being able to clear their land.	Murray Planning	The approved PER represents approval for the clearing operations specified in the PER.	
53	How many landowners have currently signed access agreements?	KNAG	This is commercially confidential information.	

No.	Issue	Stakeholder	Olympia Response	PER Section
	EPA Wetlands Policy			
54	Wetlands. Where are they located and how will they be protected.	Conservation Council	All EPP wetlands are outside the mining area. Site surveys have identified a wetland not listed on the DoE maps. This wetland is also outside the mining area.	5.8

7. SUSTAINABLE DEVELOPMENT

The EPA Position Statement No. 6 *Towards Sustainability* (EPA, 2004) discusses the concepts of sustainability and outlines that sustainable development requires the integration of ecological thinking into all social and economic planning and actions. The EPA objective for sustainability is to ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the National Strategy for Ecological Sustainable Development (Council of Australian Governments, 1992).

The National Strategy for Ecologically Sustainable Development outlines three objectives for the mining industry in addressing sustainable development. These are:

1. To ensure mine sites are rehabilitated to sound environmental and safety standards, and to a level at least consistent with the condition of surrounding land.
2. To provide appropriate community returns for using mineral resources and achieve better environmental protection and management in the mining sector.
3. To improve community consultation and information, improve performance in occupational health and safety and achieve social equity objectives.

Concepts raised for the resource industry in the above guidelines have been integrated into the planning of the Keysbrook project. In producing mineral products at the Keysbrook project, a number of sustainable principles are considered and applied. These are detailed in Table 30.

Table 31 describes the principles of environmental protection and the manner in which each is addressed in the PER

Table 30: Implementation of Sustainability at Keysbrook

Sustainable principles	Keysbrook Project Implementation
Ensure that mining operations enhance existing biological diversity where possible.	Existing biological diversity will be enhanced through the establishment of corridor linkages. Rehabilitation will include the replanting of both upland and lowland vegetation associations.
Ensure the mining areas are rehabilitated to sound environmental and safety standards, and to a level at least consistent with the condition of the surrounding land that enables the agreed post-mining land use.	The mining area will be rehabilitated to its pre-mining land use of agriculture.
Provide for effective involvement and prior informed consent of communities regarding all decisions and actions that affect them, and engage stakeholders and government in order to gain their views and take their interests into account.	A comprehensive community consultation programme has been conducted during the assessment process and will be ongoing. This is detailed in Section 6.
Provide support to communities through community development programmes.	A range of appropriate local programmes will be supported during the project.
Ensure that current and future economic growth of WA and Australia will benefit from developments by Olympia and optimise economic return to local communities from mining.	Mining of the resource will provide economic benefit to Olympia, the State and the local community. Local employment and services will be utilised where possible.
Efficiently manage resources and wastes.	Mining allows for the efficient management of the mineral resource. Wastes will be minimised and managed as outlined in sections 4.14, 4.15 and 9.11.
Be accountable for all our actions by regularly reporting to the community, stakeholders and the government on performance.	An annual report will be prepared and submitted to government detailing performance against Ministerial conditions and licence commitments. Company environmental performance and management is also reported in the Olympia Annual Report. Community consultation will be ongoing.
Support sustainable development through commitment towards continual improvement in all aspects of environmental, health and safety programmes.	The management plans and annual reporting process provide a regular review and improvement programme.

Table 31: Principles of Environmental Protection

Principle	Relevance	Comments
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by – (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk – weighted consequences of various options.	Yes	The precautionary principle has relevance to the project, through the protection of the region's flora and fauna. Refer to: • Vegetation and Flora (Sections 5.9 and 9.1). • Rehabilitation, Decommissioning and Closure (Section 9.3). • Figure 15 Vegetation communities in the mine area.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	The principle of intergenerational equity has a relevance to the project's overall level of environmental management and particular relevance to processes employed for site rehabilitation, decommissioning and closure. Refer to: • Rehabilitation, Decommissioning and Closure (Section 9.3). • Environmental Management (Section 9). • Social Issues and Management (Section 10).
3. This principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	The principle of conservation of biological diversity and ecological integrity has relevance to the project, through the protection of the region's flora and fauna and processes employed for site rehabilitation, decommissioning and closure. Refer to: • Vegetation and Flora (Sections 5.9 and 9.1).

Principle	Relevance	Comments
		• Fauna (0 5.12 and 9.2). • Rehabilitation, Decommissioning and Closure (Section 9.3).
4. Principles relating to improved valuation, pricing and incentive mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximize benefits and/or minimize costs to develop their own solutions and responses to environmental problems.	Yes	The principles relating to improved valuation, pricing and incentive mechanisms have relevance to the project, through the management of the project's wastes and hazardous materials, and the project's rehabilitation, decommissioning and closure. Refer to: • Solid Waste Disposal (Section 4.15). • Waste Products (Section 9.11). • Dangerous and Hazardous Substances (Sections 4.16 and 9.12). • Rehabilitation and Closure (Section 9.3).
5. The principles of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment.	Yes	The principles of waste minimisation have relevance to the project, through the management of the project's wastes and the project's rehabilitation, decommissioning and closure. Refer to: • Water Requirements (Section 4.5). • Process Waste Management (Section 4.6). • Waste Products (Section 9.11).

8. ENVIRONMENTAL FACTORS AND MANAGEMENT PLANS

A scoping document was developed in consultation with the EPA to identify environmental factors applicable to the project. Factors were identified through preliminary investigations and consultation with key stakeholders. The factors listed in Table 1 have been identified as relevant to the project. Objectives, existing environment, potential impact, environmental management and predicted outcome relating to each factor are shown.

Olympia considers the studies undertaken for the project and industry experience gained from similar mining operations indicates that effective management and mitigation measures can be implemented to ensure adverse environmental impacts are prevented or minimised and the stated EPA environmental objectives met.

8.1 ENVIRONMENTAL IMPACTS

An 'environmental impact' is defined as a modification in the status of the environment by a proposed action. Environmental impacts may affect the natural or social components of the environment and may be positive (beneficial) or negative (adverse). They may occur either as a primary result (direct) or as a secondary result (indirect) of the action, and may be temporary/short duration or permanent/long-lasting. Impacts may vary in magnitude from no change or only a slight discernable change, to a significant change in the status of the environment.

The main environmental factors and impacts associated with the Keysbrook project were identified by Olympia in consultation with DoE and CALM and through discussions with relevant stakeholders. They include:

- Loss of or disturbance to remnant vegetation.
- Dust.
- Noise.
- Potential impacts to groundwater quantity and quality as a result of abstraction for water supply and pit dewatering.
- Potential pollution to surface and groundwater sources.
- Surface water (quality).
- Closure and rehabilitation.
- Potential for acid generation.
- Loss of habitat and disturbance to fauna species.
- Waste generation and management.

8.2 MANAGEMENT PLANS AND PROCEDURES

Olympia has prepared management plans and procedures for key environmental factors and activities associated with the construction and operation of the project. The plans and procedures will be subject to audits and reviews at regular intervals.

The management plans are included in Volume 2 of the project assessment documentation. The plans are:

1. Vegetation Management Plan (VMP). (Volume 2.1).

   The VMP will establish a recording, monitoring and reporting framework for site activities that impact on vegetation. The plan includes:

   - Recording areas of vegetation cleared.
   - A schedule of any surveys and monitoring required to be undertaken.
   - The preparation of a rehabilitation plan that includes recording local seed collection, species used in rehabilitation, trials undertaken, plant relocation, fencing and weed control.
   - A reporting and review schedule for the plan.

2. Rehabilitation Management Plan (RMP). (Volume 2.2).

   Separate to the VMP, although related to it, the RMP will focus on the rehabilitation strategy and schedule. The plan includes:

   - Seed collection.
   - Species selection for rehabilitation.
   - Detailed rehabilitation plans for each property.
   - Recording and monitoring of any trials undertaken.
   - Fencing.
   - Weed control.
   - A monitoring schedule for works completed.
   - A reporting and review schedule for the plan.

3. Fauna Management Plan (FMP). (Volume 2.3).

   The FMP will establish a recording, monitoring and reporting framework for site activities that impact on fauna. The plan includes:

   - Recording areas of vegetation cleared.
   - A schedule of any further surveys, monitoring or relocation programme that are required.
   - A reporting and review schedule for the plan.

4. Dust Management Plan (DMP). (Volume 2.4)

   The DMP will establish a recording, monitoring and reporting framework for site activities that have the potential to generate dust. The plan includes:

   - Recording areas of vegetation cleared.
   - Recording completed areas stabilised.
   - On-site monitoring of weather parameters, including wind speed and direction, which is linked to an early warning alarm system when threshold values are reached.
   - A site visual monitoring and recording schedule for dust expression.
   - A dust monitoring programme.
   - Dust management measures including use of water sprays and other stabilisation methods to minimise the generation of dust.
   - A reporting and review schedule for the plan.

5. A Decommissioning and Closure Plan (DCP). (Volume 2.5).

   The DCP includes the following provisions:

   - Prior to shutdown, clean up the process facilities and process any materials, including the run-of-mine ore storage pad.
   - Ensure that, once infrastructure is no longer required, it is removed.
   - The final open pit is to be backfilled to pre-mining landform levels.
   - Salvage pumps and other equipment.
   - Remove all hazardous materials, machinery and equipment.
   - Remove remaining buildings and infrastructure, and dispose of any demolition waste off-site.
   - Decommission bores, seal and plug below ground.
   - Decommission non-essential roads including the re-establishment of natural drainage lines.
   - Rehabilitate all disturbed areas as specified in the RMP.

In addition to the above management plans, procedures will be prepared for specific activities on-site with the potential for environmental impact. These include:

- Machinery inspection.
- Hazardous materials management.
- Topsoil storage

9. ENVIRONMENTAL MANAGEMENT

9.1 VEGETATION AND FLORA

9.1.1 EPA Objectives

- To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
- Protect declared rare flora, priority flora and flora species of conservation significance consistent with the provisions of the *Wildlife Conservation Act 1950* and the *Environment Protection and Biodiversity Conservation Act 1999.*

9.1.2 Relevant Standards

The Environmental Protection (Clearing of Native Vegetation) Regulations 2004 came into operation in June 2004. Under the regulations, areas subject to the formal environmental approvals process do not require a separate clearing permit. This PER document, if approved, represents the approval for clearing associated with the project.

EPA Position Statement 2. The EPA has developed Position Statement No 2 for the Environmental Protection of Native Vegetation in Western Australia, Clearing of Native Vegetation with particular reference to the agricultural region of Western Australia (EPA, 2000). The agricultural area as defined in the position statement covers the wheatbelt area, however, the position statement also covers clearing in other areas of Western Australia.

In assessing a proposal outside of the defined agricultural area, the EPA's consideration of biological diversity will include the following elements:

1. Different development options have been considered and reasonable steps have been taken to avoid disturbing native vegetation.
2. No species or community of plants or animals is likely to become extinct as a consequence of the development and risks to threatened species are considered to be acceptable.
3. No association or community of indigenous plants or animals ceases to exist as a result of the project.
4. Demonstration that the proposal does not compromise any vegetation type by taking it below the 'threshold level' of 30 per cent of the pre-clearing extent of vegetation.
5. Where a proposal would result in a reduction below the 30 per cent level it is expected that alternative mechanisms are developed to address the protection of biodiversity.
6. Scarce or endangered habitats are comprehensively, adequately and securely represented within or in areas biologically comparable to the project area.

7. In a large project area, there is a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity is secure and protected.
8. The on-site and off-site impacts are identified and the proponent demonstrates that these impacts can be managed.

EPA Guidance Statement 10. The EPA has developed a guidance statement No. 10 on the level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region (EPA, 2003). The guidance aims to ensure that developments are compatible with the intent of the recommendations for and/or conservation values of these areas. The project is situated within the System 6 region and the northern half of the project is also in the Bush Forever region.

9.1.3 Potential Issues

The majority of the mine area has been extensively cleared for agricultural purposes, with 930 hectares as open pasture. All the parkland cleared area of the mine area (244 hectares) is condition Category 6 - Completely Degraded. This gives a total of 1,174 hectares of the 1,234-hectare resource area (95.2 per cent) on cleared or completely degraded land. Additional clearing for the mine will further reduce the stands of native vegetation in the region until rehabilitation of completed areas becomes established.

Significant vegetation, comprising declared rare, priority species, listed TECs and significant structural elements, such as mature trees, may occur within the mine area. Clearing for the mine may impact on specific areas that contain these elements.

The remnant native vegetation is fragmented throughout the mine area and surrounding farmland. Further clearing will exacerbate the fragmentation.

Almost all riparian vegetation within the mine area has already been cleared. The EPP-listed wetlands (Figure 10) are all located outside the mine area. No EPP wetland will be directly disturbed by the mining activity; however, there is the potential for indirect impacts to occur from related factors such as pit dewatering and dust.

Dewatering and discharge may impact on water availability for riparian vegetation.

Clearing and earthworks resulting in the potential for the spread of weeds and erosion.

Implementing the project will impact on the Bassendean, Guildford and Southern River landform units.

9.1.4 Assessment and Management

The majority of the mine area has been extensively cleared for agricultural purposes. The project therefore complies with the general policy position of guidance statement 10 in preferentially locating developments in cleared areas. The potential for the spread of weed species and erosion as a result of clearing is addressed in the rehabilitation factors in Rehabilitation and Closure, section 9.3.

The assessment and management of dewatering of the mine pit and discharge of surplus water that may impact on water availability for riparian vegetation has been addressed by the following.

- Groundwater modelling (Appendix 2) predicts only localised water table drawdown as a result of mine pit dewatering. The extent of drawdown is limited to the range normally experienced in the annual water table movement, as shown in charts 4 and 5. The main creeks throught the mine area will not be disturbed (Figure 9), so winter flows, which pass through listed EPP wetlands on the perimeter of the mine area, will continue unaffected by the mine operations.

- It is anticipated there will be no, normal state, discharge of water during the mine life. Table 9 shows that pit dewatering will only produce an average of 20% of the site's water needs. As such, the potential for discharge water to effect riparian vegetation is negligible.

The EPA guidance statement.10 is relevant to proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region (EPA, 2003). The guidance statement aims to ensure that development is compatible with the intent of the recommendations for and/or conservation values of these areas. The mine is situated within the System 6 region and the northern half of the mine is also in the Bush Forever study area.

Tables 32 and 33 list the guidance statement 10 criteria, area attributes and exclusion guidelines with comments that the project complies with most of the exclusion guidelines within the statement. In essence, the exclusion guidelines recognise significantly degraded areas as having reduced importance for conservation, with significantly greater difficulty in being able to achieve rehabilitation and restoration targets close to original condition levels.

Table 32: Guidance Statement 10

No.	Criteria	Policy	Policy Applicability	Applicable Exclusion Guidelines
1	Representation of Ecological Communities	The general protection of remnant native vegetation on the Swan Coastal Plain portion of the system 6 and system 1 regions can be achieved through preferential location of developments in cleared areas (guidance 10 pg 43).	75.4% of the resource area is in cleared pasture. A further 19.8% is in completely degraded (Category 6) vegetation condition, giving a total of 95.2% of the mine area on cleared or completely degraded land. *Comment: The project complies with the intent of the policy.*	
				Areas which are not the best available examples of particular ecological communities because there are more appropriate areas elsewhere. *Comment: The project complies with the intent of this exclusion. The mine area was not identified in Bush Forever, indicating other sites in the region (e.g. 77 and 368) represented better examples of this community type.*
2	Diversity			Significantly altered or man-made landform units. *Comment: The project complies with the intent of this exclusion. All the mine area is in farmland and 95% of the mine area is cleared or completely degraded.*
				Areas with low to moderate diversity at the community, species or generic level. *Comment: The project complies with the intent of this exclusion. Botanical assessment indicates reduced species diversity with increasing level of disturbance.*
3	Rarity			Habitats of species or communities whose significance is not established. *Comment: The project does not comply with the intent of*

No.	Criteria	Policy	Policy Applicability	Applicable Exclusion Guidelines
				this exclusion. Less than 30% of this community remains, although in the Bush Forever portion,>10% of the Bassendean Central and South unit (the unit subject to disturbance by the mine) is reserved.
4	Maintaining Ecological Processes			Areas not recognised as being of national or international significance for migratory birds. *Comment: The project complies with the intent of this exclusion. There are no RAMSAR, CAMBA or JAMBA wetlands within or near the project area.*
5	Scientific or Evolutionary Importance			Areas not identified as important geological and geomorphical sites. *Comment: The project complies with the intent of this exclusion.*
6	Wetlands, Streamlines			Significantly altered wetlands. *Comment: The project complies with the intent of this exclusion. Almost all the riparian vegetation within the mine area has been totally cleared. EPP wetlands will not be disturbed.*

Table 33: Individual Area Attributes

No	Individual Area Attributes	Description	Explanation	Comment
1	Size and Shape	The lower size limit of 20ha given in the Urban Bushland Strategy is accepted as a preferred lowest area limit, but smaller areas are significant where a community is seriously threatened or poorly reserved (less than 10% protected).	The remnants are fragmented, with pasture interspersed with vegetated islands.	*The project is not consistent with this attribute.*
2	Vegetation Condition	Remnants in largely undisturbed condition, which retain the highest values, are preferred; remnants with basic vegetation structure and floristics intact (bushland) are the next best alternative.	All the 'parkland cleared' area (244ha) is Category 6 - Completely Degraded, described as: "The structure of the vegetation is no longer intact and the area is completely or almost completely without native species". Individual areas of higher rating (Category 2-4) are small areas of less than 20ha.	*The project is consistent with this attribute.*
3	Uplands and Wetlands	Natural areas containing both ecological community groups (uplands and wetlands) support the highest biodiversity and are a focus for protection.	95.2% of the mine area is in cleared or completely degraded states. Remnant vegetated areas in the resource zone are fragmented and mostly contain upland vegetation. Almost all lowland and wetland areas have been cleared.	*The project is consistent with this attribute.*
4	Ecological Communities below 10% and TECs	There is a presumption that all areas of remnant native vegetation containing TECs or vegetation of the major landform elements of which less than 10% currently remains will be retained and conserved.	The majority of the mine area is on the Bassendean central and south community type, which is greater than 10% reserved [1]. Fringe areas of the mine occur in the Southern River (10% reserved) and Guildford (3% reserved). In both these cases, mine areas are in cleared paddocks or isolated remnants and scattered trees.	*The project is consistent with this attribute.*
5	Relationship to other areas	Opportunities outside System 6 and part of System 1 region. Ownership or reservation status.	Options to protect or restore remnant native vegetation areas outside the mine area will be explored in conjunction with CALM and community LCDC groups.	*The project is consistent with this attribute.*

Notes:

1: WAPC (2000), Table 4.

The flora surveys undertaken have not identified any declared rare or priority species in the mine area. Bennett (2004) inferred a number of the quadrats surveyed to be floristic community type (FCT) 20b, which is listed as a TEC. Griffin (2005) undertook subsequent statistical analysis on the survey data and concluded there was a higher probability the FCT is either 21a or 21c, rather than the inferred 20b. The degraded nature of the survey sites (the six sites had an average of 26 species with the richest 41, compared to the Gibson et al (1994) average of 62, suggests that 'absolute' comparison can not be made. However, the conclusion reached is that it is inconclusive that the surveyed sites are FCT 20b and there is a higher probability they are either FCT 21a or 21c.

A range of development options has been considered and reasonable steps taken to avoid native vegetation as required by element one of the EPA Position Statement 2 **(Management Action 9.1.4a)**:

4. The wet concentrator plant, process water dam, supporting infrastructure and stockpiles have been located to minimise impacts on native vegetation by preferentially locating them in existing cleared areas.

5. Listed EPP wetlands will not be disturbed by mining activities. All EPP wetlands are located on the periphery of the mine area. Mine planning will ensure the wetlands, plus an identified buffer zone, will be retained (Figures 11, 12 and13).

6. A remnant vegetation area of 33.7 hectares on Lot 56 that contains approximately half the mature trees with suitable hollows for cockatoo nesting, vegetation in good-very good condition has been excised from the mine area. With the addition of the vegetated non-mineralised exclusion areas and the EPP wetland exclusion area, a total of 48.7 hectares of the 108.1 hectares (45 per cent) of the vegetation on Lots 56 and 3 will not be disturbed. The 48.7 hectare exclusion area includes;

    - 2.45 hectares of the 3.20 hectares (76 %) of the CcXp community (Table 34) inferred as FCT 3c. Only 0.75 hectares of this FCT will be impacted by the minining operation. Bennett (2004); pg 7, records the condition of both the 3c and 3a community types as degraded to completely degraded. The community type 3c was of a larger area than FCT3a but it also adjoined paddocks with most of the understorey replaced by pasture (weed) species.
    - 25.71 hectares of the 61.3 hectares (42%) of the BaBm community in Lots 56 and 3, attributed by Griffin (2005) as 21a/c. This also includes mature trees, potentially suitable as cockatoo nest sites (Figure 14). Only 40.2 hectares will be impacted by the mining operation.

The southern portion of the mine area scored a vegetation condition rating of 6, completely degraded, with the level of disturbance too high to confidently infer a FCT over the majority of the area. The majority of the vegetation is described as scattered Marri, Jarrah, Banksia and Melaleuca over a pasture understorey. Table 34 summarises the community type, condition and area within the mine area. Figure 15 and 16 shows the community types over the whole mine area and in more detail over Lots 56 and 3 respectively

Table 34: Vegetation Types and Areas within the Mine Area.

Code	Description	Inferred / Assessed FCT	Condition	Area (ha)
CcXp	Tall closed forest of *Corymbia calophylla* or occasionally Eucalyptus patens over tall shrubland of *Xanthorrhoea preissii* over weeds and bare ground.	3c	4-5	0.75
Cc	Closed forest of *Corymbia calophylla* over a closed grassland/herbland of weeds.	-	5-6, 6	31.6
CcKa	Open forest of *Corymbia calophylla* over tall open shrubland of *Kingia australis* over closed grassland of weeds.	3a	6	0.25
BaBm	Low closed forest of *Banksia attenuatta* with scattered *Banksia menziesii* and *Eucalyptus marginata subsp. marginata* over shrubland of *Xanthorrhoea brunonis* over open low heath dominated by *Hibbertia hypericoides.*	21a/c	3, 3-4, 4-5, 5-6, 6	40.2
Mp	Low open forest of *Melaleuca preissiana* over sedgeland.	4	3-4, 4-5, 6	2.49
CcPe	Low open woodland of *Corymbia calophylla* over tall shrubland of *Pericalymma ellipticum* over a low shrubland of *Hypocalymma angustifolium.*	5	4, 4-5	3.64
Aa	Open heath of *Astartea affinis* over open sedgeland/grassland.	5	3-4	0.21
CEBM	Scattered trees of *Corymbia calophylla, Eucalyptus marginata subsp. marginata,* Banksia species *and Melaleuca preissiana*	-	6	224.8

No Priority Species or Declared Rare Flora will be impacted as a result of the project. No species is likely to become extinct and there is no risk to threatened species. This meets the requirements of elements two and three of the EPA Position Statement 2.

Most clearing will take place in vegetation that is part of the Bassendean Complex. Areas to be cleared will be delineated in the field with survey pegs and flagging tape before clearing starts. Company supervisors will oversee the clearing works **(Management Action 9.1.4b)**. The Bassendean Complex is already below the 30 per cent threshold level as identified by element four of EPA Position Statement 2, identifying it as regionally significant vegetation. Retaining at least 30 per cent of each ecological community is a target to protecting Australia's biodiversity (Commonwealth of Australia 2001). Due to the regional significance of the remnant vegetation, alternative mechanisms must be developed to address the impact on conservation values and the protection of biodiversity as required by element five of EPA Position Statement 2.

Although the project will not contribute to lowering this complex type below 30 per cent and the mine is mostly operating in completely degraded portions of the complex type, management measures are required to ensure that no further reduction in biodiversity will occur as a result of implementation of the project. These measures have been developed broadly in line with the EPA Draft Guidance Statement 6: Rehabilitation of Terrestrial Ecosystems (January 2006).

Clearing for the project is temporary, with rehabilitation following after mining. Section 9.3, Rehabilitation and Closure, proposes use of seed from existing plants in the rehabilitation to minimise any reduction in biodiversity and fencing of the rehabilitated areas. Fencing will provide an improvement over the current situation where all remnant vegetation areas in the mine envelope are currently subject to grazing by stock. Additional environmental improvements are proposed by also planting lowland species within the appropriate locations in the corridor linkages, thus returning or increasing the number of species now absent or almost completely absent from the mine area. The project does not propose a permanent reduction in vegetation.

The northern half of the mine area is within the Bush Forever study area. The policy objectives of this study included establishing a conservation and reservation system to achieve a target of at least 10 per cent of each vegetation complex within the study area. The proposed Bush Forever study area for reservation within the Bassendean Central and South complex is 13 per cent, therefore exceeding the study's target for this vegetation complex.

There are no areas within the mine site that are nominated Bush Forever sites.

The nearest Bush Forever site (site 77) is located approximately two kilometres west of the mine site. Trudgen and Archer (2001) undertook a botanical assessment of a portion of this site that focused almost exclusively within the B1 subunit of the Bassendean Dune system.

Bush Forever site 77 differs from the mine site in that "the survey area … was used for grazing cattle until about 15-20 years ago" (Trudgen and Archer, pg 1; 2001). The vegetation condition of the different survey sites was recorded from 'very good' to 'excellent' and 'pristine': "The condition ratings given do indicate that the remnant is in very good condition overall, generally with low weed invasion and little in the way of very obvious degradation" (Trudgen and Archer, pg 29; 2001).

In contrast, all the mine area is actively used for agricultural uses; predominantly cattle and sheep grazing, with some intensive horticulture. There is significant intrusion of pasture species throughout the area.

The inclusion of site 77 in Bush Forever and the proximity of this area to the mine site addresses exclusion guideline number 1 in Table 32 as 'areas which are not the best available examples of particular ecological communities because there are more appropriate areas elsewhere'.

Bush Forever (2000) Volume 1 Map Sheet No 2 shows the northern half of the mine area (that includes the major consolidated block of vegetation on Lots 56 and 3) as Bassendean Complex-Central and South. Map Sheet No82 shows this vegetation as "Other Native Vegetation". As such, the site was not included in the BushPlan-Bush Forever process as

worthy of conservation. Bush Forever (2000) Volume 1, Table 4 records Bassendean Complex _Central and South as 13% proposed protection – above the 10% target for the study.

Figure 17 shows the mine site in relation to surrounding regional environmental features. These include the proposed Karnup-Dandalup Underground Water Pollution Control Area, surrounding Bush Forever sites, the escarpment and Jarrah forest. The figure shows the mine envelope within a predominantly cleared portion of the Swan Coastal Plan. There is very limited opportunity to establish regional corridor linkages. The most likely regional corridor linkage from the scarp through the Swan Coastal Plain would appear to comprise the Serpentine River, Lowlands (BushForever 368) and the remnant vegetation and wetland chain (that includes the West Kingia Reserve:BushForever 77), that is coloured green in Figure 17, to Yunderup and the Peel Inlet. This corridor is approximately 10 kilometres to the north and approximately 5 kilometres to the west of the mine site.

Olympia has prepared and will implement a VMP **(Management Action 9.1.4c)**. The plan establishes a recording, monitoring and reporting framework for site activities that may impact on vegetation. The plan includes:

- Recording areas of vegetation cleared.
- A schedule of any surveys and monitoring required to be undertaken. This will include monitoring the health of riparian vegetation in the EPP wetlands surrounding the mine area as mining passes these locations. Monitoring will continue until groundwater levels return to pre mining levels.
- Preparing a rehabilitation plan that includes recording local seed collection, species used in rehabilitation, trials undertaken, plant relocation, fencing and weed control.
- A reporting and review schedule for the plan.

Olympia has prepared a RMP (see Section 9.3). The plan establishes the process of returning, at a minimum, the amount of vegetation area cleared during mining. The final plan also establishes native vegetation planting for landform types of high conservation significance and improvements in corridor linkages over the existing remnants that are highly fragmented. The plan includes the following:

- Progressive rehabilitation.
- Seed collection.
- Species selection for rehabilitation.
- Detailed rehabilitation plans for each property.
- Recording and monitoring of any trials undertaken.
- Fencing.
- Weed control.
- A monitoring schedule for works completed.
- A reporting and review schedule for the plan.

9.1.5 Mitigation Measures and Environmental Outcome

Olympia will minimise the impact on vegetation and flora through the following measures:

1. Olympia has implemented the principle of avoidance to excise portions of higher conservation value from the mine plan. The concession to forgo considerable heavy minerals for the environmental benefit of retaining these locations complies with principle 2 of EPA Position Statement 3 and the general principles of the EPA Position Statement No 6 Towards Sustainability (EPA, 2004).
2. Areas to be cleared will be delineated in the field with survey pegs and flagging tape before clearing starts. Company supervisors will oversee clearing works.
3. Olympia has prepared a PVMP, which will be reviewed in consultation with regulatory agencies within the first year of operations. Olympia will implement the VMP.
4. Olympia has prepared a PRMP, which will be reviewed in consultation with regulatory agencies, landowners and other stakeholders within the first year of operation. Olympia will implement the RMP.

Olympia expects to obtain acceptable environmental outcomes because:

- The land systems and vegetation communities within the total project area are mostly cleared or completely degraded remnants.
- Higher quality remnant vegetation areas, with remaining understorey and wetlands will not be mined.
- Mining impacts to land systems with less than 10 per cent remaining on the Swan Coastal Plain are mostly on cleared pastures with only isolated remaining trees.
- Rehabilitation will be undertaken using seed collected from plants within the project area.
- The project will not result in a significant loss of biodiversity, as most of the mine area is pasture or completely degraded remnant vegetation, with the remnant species able to be regenerated from seed preserved in the topsoil and returned during the rehabilitation programme.
- The spread of weeds in the areas under native vegetation rehabilitation will be controlled by a herbicide spraying programme.

Olympia considers implementing the management measures described above will serve to mitigate any negative impacts associated with implementing the proposal and result in an outcome with improved environmental values of the revegetated landscape.

9.2 FAUNA

9.2.1 EPA Objectives

To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

9.2.2 Standards and Legislation

- *Environmental Protection Act 1986*.
- *Wildlife Conservation Act 1950*.
- *EPBC Act 1999*.
- *EPA Position Statement 3*.
- *EPA Guidance Statement 10*.
- *EPA Guidance Statement 56*.

Wildlife Conservation Act 1950 **(WA)** provides for the protection of rare fauna and birds protected under an international agreement and other special fauna that are listed on specified schedules. Other species for which the status of abundance is unclear and there is some concern, are listed as Priority Fauna by CALM.

The ***EPBC Act 1999*** provides for the protection of threatened flora and communities.

EPA Position Statement 3 highlights the significance of biodiversity and the need to develop and implement best practice in terrestrial biological surveys. In assessing a proposal, the EPA will consider the following principles relating to biological diversity:

1. The EPA adopts the definition of biological diversity and the principles as defined in the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia, 1996) and will have regard for these in undertaking its role.
2. The EPA expects proponents to demonstrate in their proposals that all reasonable measures have been undertaken to avoid impacts on biodiversity. Where some impact on biodiversity cannot be avoided, it is for the proponent to demonstrate that the impact will not result in unacceptable loss.
3. The EPA aims to ensure that the information gathered for environmental impact assessment in Western Australia meets state, national, and international agreements, legislation and policy in regard to biodiversity conservation.
4. The EPA requires that the quality of information and scope of field surveys meets the standards, requirements and protocols as determined and published by the EPA.
5. The EPA will use the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for EIA decision-making in relation to the conservation of biodiversity. The

IBRA has identified 26 bioregions in the state that are affected by a range of different threatening processes and have varying levels of sensitivity to impact.

6. The EPA expects proponents to ensure that terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment.
7. The EPA expects that terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region, to aid the overall biodiversity understanding and assessment by facilitating transfer into state biological databases.
8. In the absence of information that could provide the EPA with assurance that biodiversity will be protected, the EPA will adopt the precautionary principle.

EPA Guidance Statement 10 highlights the level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region (EPA, 2003). The guidance aims to ensure that developments are compatible with the intent of the recommendations for and/or conservation values of these areas.

EPA Guidance Statement 56 provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with protecting Western Australia's terrestrial faunal biodiversity and its habitat.

9.2.3 Potential Issues

Underlying any discussion on the value of the mine area for fauna is the extent of existing clearing, the predominant land use of agriculture and the degraded and fragmented nature of the remaining native vegetation areas. Further fragmentation and isolation of habitat can have further impacts to fauna.

The Darling Scarp and Plateau, a few kilometres east of the site, is likely to provide significantly more fauna habitat than that present in the mine area. Within the mine area, the more diverse habitats are located within the more consolidated, less degraded native vegetation remnants that have a higher floral species diversity and remaining understorey.

The clearing of vegetation within parts of the mine area has the potential to disturb fauna in the short-term by;

- direct displacement or loss of individuals
- removing fauna habitat which further reduces the ability of fauna to move between the remaining fragments.
- increasing resource competition in remaining fragments, for those fauna that have moved to new locations.

No specific habitats of national or regional significance occur within the mine area.

Diggings of the Quenda, a Priority 4 species, have been noted in a remnant wetland area outside the mine area. This wetland will not be disturbed by mining activities, however, potential related effects from pit dewatering may have an impact on the wetland.

The more intact remnant vegetation in the north of the mine area has the highest potential to provide habitat for a range of species, though it is not well connected with other vegetated areas.

Of particular interest is the potential presence of the Short-billed (Carnaby's) Black-Cockatoo and the Forest Red-tailed Black-Cockatoo. The Carnaby's Cockatoo is likely to utilise the remnants for feeding. Loss of feeding habitat for Carnaby's Cockatoo is identified as a key threatening process under the Commonwealth *EPBC Act 1999*. The Forest Red-tailed Black-Cockatoo may similarly utilise remnants in the area for feeding, but additionally this species may breed in suitable nest hollows in the region.

9.2.4 Assessment and Management

Within the mine area, the extent of clearing and degradation of the remaining native vegetation areas is described in Section 5.9. As a result of grazing, there is little regrowth or recruitment outside of fenced zones actively part of Landcare and tree planting programmes. Outside protected areas, gradual decline of trees continues to occur by cattle bark-stripping and other factors. While dead and hollow trees do provide habitat for fauna, the ongoing slow degradation in the remnant patches has a corresponding reduction in vegetation structure and density that sees a decline in the biodiversity of resident fauna. This, coupled with the lack of understorey shrubs and groundcover species across most of the mine area, reduces the habitat value present over the site.

Olympia proposes to clear 304 hectares of remnant vegetation over an eight year period and implement a progressive rehabilitation programme post-mining to ensure no net loss of vegetation in the longer term. The rehabilitation programme aims to achieve a net environmental gain over the present situation by consolidating rehabilitation areas and establishing corridor linkages, to reduce the fragmentation that currently exists.

Of the areas surveyed in the mine area, the northern portion, on Lot 56 and Lot 64, showed the healthiest vegetative cover, presence of understorey and the greatest concentration of mature trees. High numbers of cockatoo sightings and evidence of the Quenda were observed in the area. The parkland cleared areas with pasture groundcover in the central–south portion of the mine area had reduced fauna habitat.

Only a few potential nesting hollows were identified in the cockatoo survey (October 2005) with none showing evidence of current occupation. Most hollows observed were in large eucalypts, and most were located on Lot 56 (Figure 14).

Other properties had a greater proportion of younger smaller eucalypts, or areas of Banksia or She-oak woodland, which were less likely to have suitable trees present. Some of the trees may not be suitable due to the presence of feral honeybees *Apis mellifera*. Some hollows had evidence of use as a nest in the past, such as a 'squared off' entrance but there was no evidence of fresh chewing, despite the survey being in October when breeding occurs.

Overall, the survey concluded it is possible that low numbers of any of the cockatoos may breed in the area. The potential of the vegetation remnants to provide breeding habitat for cockatoos is low, with the highest potential being in the less degraded remnant vegetation areas in the north of the project area.

At a regional level, fauna surveys of remnant vegetation areas on the Swan Coastal Plain around the project site have recorded low mammal numbers. The regional surveys of five separate bushland areas, all of which are listed Bush Forever sites, indicate the low numbers of mammals in remnant areas on the Swan Coastal Plain. These five sites cover remnant bushland within and an area up to 25 kilometres from the project site. When compared to the project site, these areas collectively have vegetation in better condition, are less fragmented, are larger and are not subject to horticultural and grazing pressure. The habitats of the project site would arguably contain fewer fauna than the regional survey sites.

The most significant fauna habitats located in the total project area have been excluded from the mine area and so will not be mined. These include Lot 64, (Figure 2) which includes a wetland, the EPP wetlands on Lot 62 (Figure 12), Lot 56 (Figure 11), Lot 6, Lot 7 (Figure 13) and 33.7 hectares of good condition remnant vegetation on Lot 56 (Figure 4) containing potential cockatoo nesting site trees. Retaining these refuges will help recolonise the rehabilitated areas post-mining. Avoiding these areas supports Principle 2 of EPA Position Statement 3.

Additional fauna surveys are proposed to be undertaken during June 2006, to a detailed, Level 2, as defined in EPA Guidance Statement 56. The surveys will cover a range of small, medium and large vegetated fragments, to provide additional information on the species composition of these areas. The results of the survey will be submitted to the EPA prior to the EPA report and recommendations bulletin.

The FMP identifies survey's to be conducted in future mine areas, review of information by CALM and DoE and management strategies implemented prior to mining commencing. This process supports principles 3, 4, 5 and 6 of EPA Position Statement 3.

Olympia has prepared and will implement the FMP **(Management Action 9.2.4a)** which identifies:

- Target areas for further surveys and possible fauna relocation programmes.
- A schedule of any monitoring that is required.
- A reporting and review schedule for the plan.

The area containing a concentration of mature eucalypt trees that contain hollows of various sizes has been excluded from the mine plan. However, implementation of the project will result in some mature trees being cleared. It is considered the number of trees involved will only have a minor potential impact on the available nesting sites for cockatoo and other avian fauna. Clearing of mature trees will only occur outside of the known breeding season for cockatoos, to avoid any risk to hatchling birds **(Management Action 9.2.4b)**.

Disturbed areas will be progressively rehabilitated after mining. As a result, the longer-term impact of clearing on habitat is expected to be limited. Recolonisation of disturbed areas by fauna will occur, as vegetation is progressively re-established on cessation of activities. There are many studies that have been undertaken on the recolonisation of fauna in rehabilitated mine areas. Kimber et. al (1999) reviewed a number of studies in mine areas and also noted fundamental differences between rehabilitation and fauna recolonisation in a mine environment, surrounded by unmined forest that provides a source of colonists for the revegetation and revegetation in agricultural landscapes.

Kimber et al (1999) states "the major difference between mine-site rehabilitation and agricultural revegetation is the landscape context in which they occur. In the Jarrah forest of Western Australia, for example, sites rehabilitated following bauxite mining are surrounded by, or in close proximity to, extensive areas of native vegetation which provide a suitable source for recolonisation and maintain natural ecological processes. In contrast, agricultural revegetation is frequently surrounded by a production landscape, hostile to most faunal species, and containing only small fragments of the original vegetation dispersed across the landscape.

Successful recolonisation of revegetated sites by animals in agricultural landscapes relies on species being able to traverse the intervening matrix, with the chance of successful recolonisation decreasing as isolation of revegetated sites increases. While the careful placement of revegetated patches within networks of remnant vegetation, or the establishment of corridors may reduce these difficulties, rarely will the situation in agricultural landscapes approximate that of mine sites. Consequently, the apparently successful restoration of mine sites with functioning ecosystems that resemble the original habitat must be treated with caution when setting goals for revegetation in agricultural landscapes."

The RMP proposes both placement of revegetated patches and the establishment of corridors, that link remaining vegetation fragments with creeklines and wetlands, to provide connectivity with a range of habitat types. This is currently absent from the existing landscape.

Seed from trees to be cleared will be collected and used in the rehabilitation programme. This will aid in the return of Marri, Jarrah and Banksia trees in the longer term and mitigate the loss of food sources for cockatoos and other species.

Ordinarily, creek lines provide important linkages through the landscape, but as evident in Figure 9 all of the creeks and tributaries in the mine area have been severely impacted by clearing and drain construction. There are no established linkages remaining within the mine area and between the mine area and surrounding remnant areas. Implementation of the rehabilitation plan will establish creek-line and corridor plantings to provide improved fauna movement linkages compared to the current fragmented situation.

9.2.5 Mitigation Measures and Environmental Outcome

In summary, the mine site is considered to have low specific value for fauna, as it is typical of habitat that has been severely degraded by previous clearing and fragmentation practices. Minimal impact on fauna species is expected as the highest quality habitat identified by the surveys conducted, that are suitable for most of the species identified as existing or potentially existing in the project area, will not be mined.

Olympia has prepared and will implement a FMP, which will be reviewed in consultation with DoE, CALM and the WA Museum during the life of mine.

Olympia considers implementing the management measures described above will serve to mitigate any negative impacts associated with implementing the proposal and result in an outcome with improved environmental values of the revegetated landscape.

9.3 REHABILITATION AND CLOSURE

9.3.1 EPA Objectives

The EPA objective is to ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.

9.3.2 Relevant Standards

- The Australia and New Zealand Minerals and Energy Council (ANZMEC) standard Strategic Framework for Mine Closure (2000) outlines a range of objectives and principles relevant to rehabilitation, including planning, financial provisioning, implementation and standards.
- Draft Guidance for the Assessment of Environmental Factors No.6: Rehabilitation of Terrestrial Ecosystems (January 2006).
- The Commonwealth Environmental Protection Agency series Best Practice Environmental Management in Mining.
- Australian Minerals Industry Code for Environmental Management (2000).
- Department of Minerals and Energy of Western Australia Draft Criteria for Mine Closure (2001).
- Chamber of Minerals and Energy WA Inc Mine Closure Guideline for Mineral Operations in Western Australia (2000).
- Minerals Council of Australia Mine Closure Policy (1999).
- Minerals Council of Australia Mine Rehabilitation Handbook (1998).
- Western Australian Planning Commission. Statement of Planning Policy (5AA Policy) 2.1. The Peel-Harvey Coastal Plain Catchment Policy (February 1992).

9.3.3 Potential Issues

The project area is located within the Peel Harvey catchment portion of the Swan Coastal Plain. Mining and dewatering may adversely impact the catchment.

Mining will result in further clearing in an already heavily-cleared landscape. Rehabilitation will take time to establish and must be of a standard that meets regulatory, company and community objectives.

9.3.4 Assessment and Management

Olympia has prepared and will implement the RMP **(Management Action 9.3.4a)**. The RMP includes the following:

- Progressive rehabilitation.
- Seed collection.

- Species selection for rehabilitation.
- Detailed rehabilitation plans for each property.
- Recording and monitoring of any trials undertaken.
- Fencing.
- Weed control.
- A monitoring schedule for works completed.
- A reporting and review schedule for the plan.

The RMP is based on undertaking progressive rehabilitation during mining in line with the following principles.

1. **Return land to its pre-mining use**

   The current land use over the mine area is agriculture; predominantly grazing of cattle and sheep, but also some intensive horticulture.

   The mining area comprises paddocks in a range on conditions, from paddocks that are totally cleared, paddocks that are parkland cleared with a pasture understorey (scoring a remnant vegetation condition rating of 6 – completely degraded) or paddocks that are parkland cleared with remnant native understorey (scoring a remnant vegetation condition rating ranging from 3 to 6 – very good to completely degraded). All are currently grazed by stock.

   Olympia's rehabilitation goal is to return the land to agriculture use. Within this broad goal, there are other principles, detailed below, that relate to specific objectives to ensure no net loss of native vegetation.

2. **No net loss of remnant vegetation in the mine area**

   The total area of remnant vegetation, in any condition rating, to be cleared during the life of the mine is 304 hectares.

   The objective of the rehabilitation plan is to replace, at a minimum, this area of native vegetation over the mine area. However, it is not proposed to always replant the exact area where trees were removed.

   The RMP identifies a combination of major corridor linkages of up to 150 – 200 metres wide, minor creekline corridors and strategic block planting to produce a total rehabilitation area at least equal to that cleared. Revision of the preliminary plan is proposed, in consultation with landowners and regulatory agencies which, during thecourse of the mine life, may produce a different combination to the preliminary plan, while still maintaining the overall target. The corridors and block planting would be fenced to exclude stock. This is considered to be a significant environmental gain over the existing situation where all the remaining fragmented remnants are open to continued grazing. After consultation with landowners, the proponent considers that the corridor-style rehabilitation, linking creeklines, retained and rehabilitated vegetation fragments has a more realistic chance of long term success in a working farm environment than scattered vegetated islands which are not protected from stock.

   The EPA has supported the process of corridor linkages of the small remaining remnants on the coastal Plain. EPA Bulletin 1108 (2003) on the Greater Bunbury Region Scheme provides specific policy direction in the case of the Bunbury Region.

The application of the same principles to connect and restore the remaining remnants on the eastern side of the Swan Coastal Plain in the Keysbrook area is considered by the proponent to provide significant environmental benefit.

The Preliminary EPA Position Statement 9 (2005) deals with the issue of environmental offsets. Eight principles are listed. The first principle states that "Environmental offsets should only be considered after all other reasonable attempts to mitigate impacts have been exhausted". Explanation of this principle includes that on site environmental impacts must first be addressed using the mitigation sequence of avoidance, minimise, rectify, reduce and offset in that order. Offsets are then used to address any significant residual environmental impacts following mitigation considerations.

The proponent has made every reasonable effort to follow the mitigation sequence. This includes the following:

- Avoidance: Management Action 9.1.4a details the avoidance mechanisms to be implemented.
- Minimise: By minimising the areas required to be cleared during the project using internal procedures and forms to ensure remnant vegetation areas and wetlands outside the mine area are not disturbed. This is detailed in Management Action 9.1.4b and 9.1.4c.
- Rectify: By implementing the no net loss principle to rehabilitate an equal area on site as disturbed, no long term reduction in vegetated area will occur. This is detailed in Management Action 9.3.4a

By implementing the actions above, it is considered no outstanding significant residual environmental impact remains to warrant the consideration of an offsets strategy.

3. **Progressive rehabilitation to minimise the open mining area**

The mining method used to extract HMC is a continuous process of washing the heavy minerals (approximately three per cent by weight) from the mined sand and returning the residue sand (92 per cent) and clay (eight per cent) back to the extraction area. This also implements a progressive rehabilitation strategy, as completed areas are continually being refilled as new areas are excavated.

The annual rainfall and temperature pattern of the mine area limits the growth season of annual species, and therefore the ability to achieve vegetative stabilisation using pasture grasses, from approximately May to October. Within this time window, two seeding periods are proposed:

- Final 'full' pasture species mix, in approximately mid to late May. This allows the maximum time for germination, establishment and seed set, to re-establish a self-sustaining pasture and return the land to its pre-mining land use.
- Late seeding a temporary 'stabilisation' pasture species mix with quick growing, erect plants, in approximately August. This provides sufficient time to establish a stubble crop, with sufficient root growth for soil stabilisation and plant height to provide wind break cover at the ground surface.

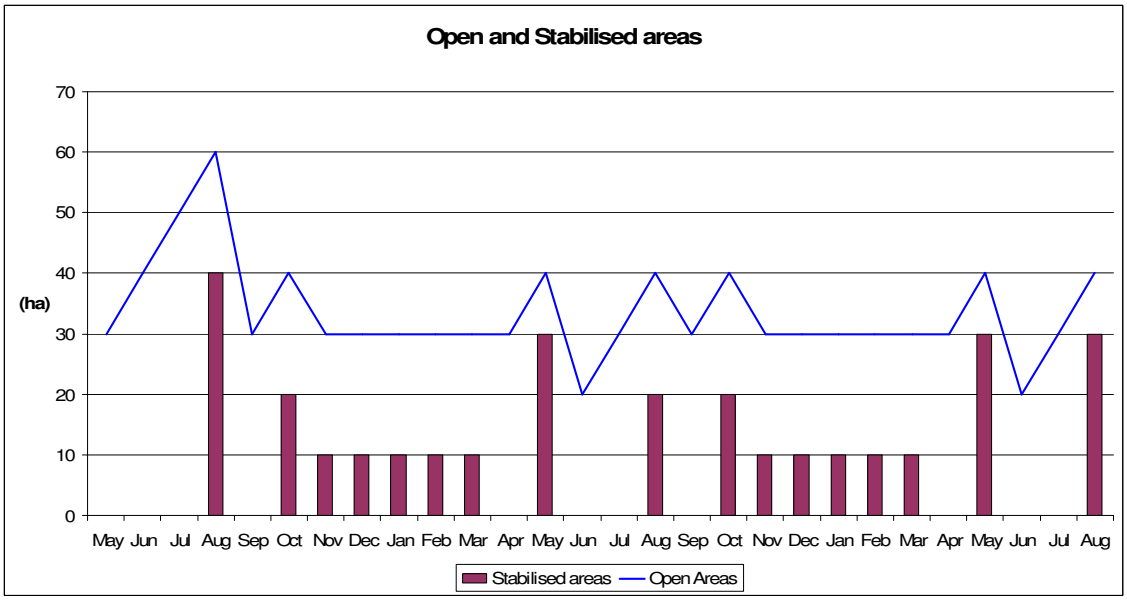
Outside the pasture species growth period, from October to May, non-vegetative methods of temporary stabilisation are required for mine areas continually being refilled and contoured, ready for rehabilitation. Landform Design (below) describes capping

these areas with a layer of clay from the HMC plant, in order to dramatically increase the stability of the landform against wind erosion.

In May, the cumulative rehabilitation areas from approximately September the previous year to April, comprising previous areas 'temporarily stabilised' with either a pasture stubble crop or clay capping plus any newly refilled areas, are seeded with the final pasture species mix. Table 35 and Chart 6 depict this progressive rehabilitation model over a 29-month period, to show the cyclic nature of the rehabilitation activities.

The result of implementing this progressive rehabilitation model is that completed mine areas are stabilised with either a final or temporary prescription at the same rate as new mining areas are developed. The net result is that only the minimum practical area to allow mining is open at any time. Chart 6 (blue line) shows this area to be averaging 30 hectares, with minimum and maximum values generally 10 hectares either side of this value.

Chart 6: Model of Progressive Rehabilitation Pattern



4. Corridor linkages

The rehabilitation plan will focus on establishing corridor linkages through the mine area, rather than the existing fragmented pockets of parkland cleared trees. Olympia's objective is to establish corridor linkages running north–south in the mine area, to connect the drainage lines, generally running east–west. Riparian vegetation planting in the east–west drainage lines will rehabilitate sections that are now completely cleared. The benefits of implementing this principle include:

- Establishing streamzone/riparian vegetation corridors, where few now exist.
- Nutrient attenuation by streamzone vegetation.
- Return of local native flora species .
- Fauna refuge and movement.
- Erosion control against both wind and water.

5. **Return of local native species**

The use of seed collected from trees within the mine area addresses one aspect of the National Strategy for the Conservation of Australia's Biological Diversity (1996), namely to 'achieve the conservation of biological diversity through the adoption of ecologically sustainable agricultural and pastoral management practices'. The use of local seed in rehabilitating native vegetation areas restricts impacts to individual plants and animals. Impacts to biodiversity are minimised.

In addition to using the existing local native species, Olympia's rehabilitation objective is to enhance biodiversity within the mine area by returning species currently absent or poorly represented. Most riparian vegetation has been cleared through the mine area. By implementing corridor linkage planting, both upland and lowland species will be replanted, rather than the dominance of the existing upland community remnants. This will be achieved by collecting seed from remaining lowland species on site (such as *Melaleuca preissiana*) as well as collecting seed from species such as *Eucalyptus rudis* and other species within a radius of 10 kilometres from the site.

6. **Grazing protection for rehabilitated areas**

Native vegetation areas will be fenced off to prevent access by stock.

Pasture revegetation areas will also require temporary isolation from grazing, to allow pasture establishment, although the time required for pasture species is dramatically shorter. Some grazing in late winter-early spring may be permitted but removal of stock will follow to allow maximum seed set.

7. **Monitoring and maintenance**

Rehabilitated areas will be monitored to ensure the success of the rehabilitation programme. Monitoring the rehabilitated areas will ensure that any areas requiring remedial work are identified. Monitoring on a regular basis will assess:

- The physical stability of the landform of rehabilitated areas.
- The characteristics of the vegetation in rehabilitated areas.
- Water drainage from the site.

Maintenance procedures will be carried out where necessary and may include:

- Replanting areas that may not have regenerated.
- Weed control.
- Repairing any erosion problems.
- Fire management.

The frequency of monitoring and maintenance will decrease as rehabilitation progresses and will cease when the rehabilitation objectives and completion criteria have been achieved. Results of these management and monitoring activities will be reported as required by DoE.

8. **Documentation**

Records of the planning and implementation of all rehabilitation works will be maintained for each rehabilitated area and will include:

- Information on the vegetation, topsoil removal, handling and storage techniques utilised.
- The extent and timing of each activity.
- Details on the rehabilitation treatments, including:
  - The rehabilitation earthworks.
  - Seed bed preparation.
  - The species used in the rehabilitation programme.
  - Any fertiliser or soil ameliorant applied.
- The results of the rehabilitation monitoring programme.
- The scope of any remedial work.

Table 35: Model of Progressive Rehabilitation Pattern

	Approx. ha/month	"Core" Mining Area	Stabilisation = reveg or clay or mulch	Cumulative Open Area	Details
May	10	20	0	30	
Jun	10		0	40	
Jul	10		0	50	
Aug	10		40	60	Seed with oats/rye covercrop.
Sep	10		0	30	
Oct	10		20	40	Clay or mulch.
Nov	10		10	30	
Dec	10		10	30	
Jan	10		10	30	
Feb	10		10	30	
Mar	10		10	30	
Apr	10		0	30	
May	10		30	40	Seed; plus all previously stabilised areas. Commence tree planting as scheduled.
Jun	10		0	20	
Jul	10		0	30	
Aug	10		20	40	Seed with oats/rye covercrop.
Sep	10		0	30	
Oct	10		20	40	Clay or mulch.
Nov	10		10	30	
Dec	10		10	30	
Jan	10		10	30	
Feb	10		10	30	
Mar	10		10	30	
Apr	10		0	30	
May	10		30	40	Seed; plus all previously stabilised areas. Commence tree planting as scheduled.
Jun	10		0	20	
Jul	10		0	30	
Aug	10		30	40	Seed with oats/rye covercrop.
Sep	10		0	20	
Oct	10		0	30	

Seeding and planting season
Seeding with a stubble covercrop
Ongoing stabilisation with clay or mulch during the dry months
Full pasture seeding including previously stabilised areas

Specific rehabilitation factors are also addressed in the rehabilitation plan:

1. **Topsoil management**

   Topsoil will be stripped and respread over rehabilitated areas. Due to the dominance of pasture species over most of the mine area, it is expected the vast majority of the topsoil available will be dominated by pasture seed species.

   Topsoil will be directly returned when possible, however, outside the vegetation rehabilitation season (from April to August), topsoil will be stockpiled. Strong summer winds create the need to stockpile topsoil and stabilise it either behind windbreak earthen bunds covered with a seed/mulch or a clay capping layer.

2. **Landform design**

   Earthworks will be undertaken to return the completed mine area to as close as possible to pre mining levels. Residue sand and clay from the wet concentrator plant is pumped back into completed mine cells, the voids filled and allowed to dry. Final shaping and grading of filled cells into the adjacent in situ surface will be undertaken by bulldozer or grader. Restoration of pre-mining surface features such as drainage lines will occur and construction of erosion control structures as may be required.

   Separation of the clay component from the sand during the mineral sand processing stage enables some tailoring of the product mix in the backfilling and surface preparation phase of rehabilitation. The dry summer period between November and April is not conducive to seeding achieving vegetative stabilisation of completed areas. The prevailing easterly winds would also severely erode loose topsoil placed over refilled areas. Temporary stabilisation of mine cells refilled in this period can be achieved by applying a thin 'capping layer' of the separated clays over the final surface, to form an erosion resistant clay seal. Table 36 shows the contrast in surface texture to erosion (shaded cells) between a hardsetting clay cap and a medium sand (common in the mine area).

   The data in Table 36 is for a dry soil. It is unlikely that a moist soil will erode, even if it is loose. Sand and clay residue from the HMC wet processing plant is pumped back to completed mine areas as a slurry, of approximately 45 per cent solids and 55 per cent water. It is considered this material would be non-erodible.

   In autumn, the clay capping layer is incorporated into the underlying sand using standard agricultural machinery, prior to spreading of topsoil and seeding. The concentration of clay within the surface zone has been used in other sand mining operations and has been shown to have additional benefits in increased pasture productivity by increasing the water and nutrient holding capacity within the pasture root zone. This also achieves objectives outlined in the Statement of Planning Policy (SPP) 2.1 by reducing the export of nutrients in the Peel Harvey catchment.

Table 36: Assessing the Susceptibility of a Dry Soil to Wind Erosion using Surface Texture and Surface Condition

Surface texture	Susceptibility rating				
	Surface condition *				
	Loose	Soft	Firm	Hardsetting	Self-mulching
Very fine sand	v	iv	iii	-	-
Fine sand					
Medium sand					
Loamy sand	v	iv	iii	iii	-
Clayey sand					
Coarse sand					
Sandy loam	v	iii	ii	i	-
Light sandy clay loam					
Loamy sand					
Sandy clay loam	v	iii	ii	i	i - iv
Sandy clay loam					
Clay loam					
Clay					
Silty clay					

* Assessing the surface condition of a dry soil based on McDonald et al (1990):

Loose	Incoherent [1] mass of individual particles or very small aggregates. Surface easily disturbed by pressure of forefinger.
Soft	Coherent [2] mass of individual particles or aggregates. Surface easily disturbed by pressure of forefinger.
Firm	Coherent mass of individual particles or aggregates. Surface disturbed or indented by moderate pressure of forefinger.
Hardsetting	Compact, hard, apparently apedal condition forms on drying. Surface not disturbed or indented by pressure of forefinger.
Self-mulching	Highly pedal, loose surface mulch forms on drying.
1	Incoherent means that less than two thirds of the soil material, whether composed of peds or not, will remain united at a given moisture state without the significant force (very weak or less) having been applied
2	Coherent means that two thirds of the soil material, whether composed of peds or not, will remain united at a given moisture state unless force is applied
Source:	Moore, G (2004). Table 7.1.3 pg 215

3. Minimising Erosion

The project is located within a climatic zone characterised by high intensity rainfall events during winter and periods of high intensity winds during summer. Therefore, the

prevention and management of erosion by wind and water is important. Olympia will reduce the potential for erosion by:

- Restricting clearing and disturbance to the minimum required for safe and efficient operations.
- Undertaking stabilisation and rehabilitation progressively to minimise the open disturbed areas. A number of methods will be adopted to allow stabilisation to occur throughout the year (Table 35).
- Avoiding disturbance to the major drainage corridors through the mine area, allowing flow-through drainage to continue unimpeded by the mining activity.
- Minimising alteration to minor drainage patterns during mining and reinstating the drainage patterns during rehabilitation.
- Establishing the north-south corridor linkages during rehabilitation will provide windbreaks against the prevailing easterly summer winds. Table 37 shows the estimated effect of windbreak plantings. The preliminary rehabilitation plan proposes to select rapid-growing species, in addition to the native species, to provide a fast-growing windbreak for both the slower-growing native species and the paddock. Heights of 10-15 metres are anticipated to be achieved within five years, achieving protection rates of between 10-24 per cent of the paddock, as indicated by the shaded cells in Table 37.

Table 37: Estimate of the Percentage of a Paddock Effectively Protected by Windbreaks at Right Angles to the Wind Direction

Height of Windbreak (m)	Slope of Paddock											
	<1%				≈ 3%				≈ 6%			
	Distance Downwind or Between Windbreaks (m)											
	200	300	500	800	200	300	500	800	200	300	500	800
3	15	10	6	4	12	8	5	3	9	6	4	2
4	20	13	8	5	16	10	6	4	12	8	5	3
5	25	16	10	6	20	13	8	5	15	10	6	4
6	30	20	12	8	24	16	10	6	18	12	7	5
10	50	33	20	13	40	27	16	10	30	20	12	8
15	75	50	30	19	60	40	24	15	45	30	18	11
20	100	67	40	25	80	53	32	20	60	40	24	15
30	100	100	60	38	100	80	48	30	90	60	36	23

Source: Moore, G (2004). Table 7.1.5 pg 220.

4. Soil Nutrition

During soil sampling for ASS determination, composite samples of the sand profile (generally the top two metres of the hole) were also collected, to be analysed for the major nutrients nitrogen (N), phosphorous (P) and potassium (K). Table 38 shows results from three locations compared with benchmark values. Results indicate a very low nutrient bank available in the sand profile of the site.

Table 38: Nutrient Analysis of Soils in the Keysbrook Project Area

	N (total)			P (total)			K (HCO3)		
	%			mg/kg (ppm)			mg/kg (ppm)		
Site 1		0.01			23			18	
Site 2		0.01			22			12	
Site 6		0.017			87			22	
Comparison levels [1]	Low	Medium	High	Low	Medium	High	Low	Medium	High
	<0.15	0.15 -0.25	>0.25	<200	200-800	>800	<70	70-200	>200

Notes:

1 Moore G, (2004) Table 10.1a, pg 326.

This is not unexpected. Wells (1989, p84) describes the Bassendean dune and plain system as: "soils of the Bassendean System have low inherent fertility and low water holding capacity. Because of the low water holding capacity and low nutrient retention, these soils require heavy applications of fertilizer and water to achieve satisfactory horticultural production levels. Fertilizer nutrient loss through leaching and drainage in these soils is a major contributing factor to the Peel Harvey eutrophication problem". Table 39 shows general land capability qualities of the Bassendean soils.

Table 39: Land Qualities

Bassendean Dunes	Nutrient Availability	Topsoil Nutrient Retention	Nutrient Retention Ability	Moisture Availability
B1	Low	Very low	Very low	Very low
B2	Low	Very low	Very low	Very low
B3	Low	Low	Low	High
B4	Low	Low	Low	Moderate
B5	Low	Low	Low	Moderate

Source: Wells (1989), table 16b pg 61.

5. **Weed control**

Most of the mine area is to be returned to its pre-mining land use of pasture. In these areas, weed management is to be restricted to the control of declared pest plant species.

For the areas rehabilitated with native vegetation, weed infestation can inhibit establishment and survival of planted trees and seedlings; decreasing the effectiveness of the rehabilitation programme. Selective application of herbicides will occur in the spring of the first year of planting to improve establishment of native species. Further application of herbicide in the second year will be undertaken if required **(Management Action 9.3.4b)**.

6. **Completion criteria**

Completed areas to be returned to pasture will be seeded and fertilised in May and allowed to establish throughout the growing season. Some minor grazing may be permitted in this first year. The areas will receives a second seeding and fertilising in May the following year, to ensure a fully-established pasture is returned to the landowner by the end of the second growing season.

Assessment of pasture establishment success will be undertaken by Olympia and the landowner during this period.

Completed mine areas rehabilitated to native vegetation will be deep ripped, planted, seeded, fertilised and fenced in May–June. Weed control will be undertaken during spring (August-September). Infill planting to replace dead trees will be undertaken in May-June the following year, to ensure native vegetation areas have at least 75 per cent survival of planted trees after the first summer.

Establishment of additional species from the topsoil seed bank or from the added seeding will augment the planting density and diversity. No minimum criteria for this have been established.

9.3.4.1 Project Specific Areas

Throughout the mine life, locations will be identified where specific rehabilitation prescriptions are required. These will normally form part of the detailed planning in the reviewed and updated RMP. Examples of such project-specific areas are provided below:

1. **Exclusion Areas**

These will include:

- Major creek lines (Figure 9).
- Wetlands (Figure 10).
- Buffer areas and screening belts.

2. **Infrastructure**

During the life of the mine, site infrastructure will be relocated. Abandoned sites will be fully decommissioned and rehabilitated, to return the area to productive agriculture pasture.

At the conclusion of the project, all infrastructure including the processing plants, offices and workshops, power cables and borefields equipment, will be removed from the site.

Olympia has prepared and will implement the DCP **(Management Action 9.3.4c)**. Decommissioning and closure will include the following provisions:

- Prior to shutdown, clean-up the process facilities and process any materials, including the run-of-mine ore storage pad.
- Ensure that, once infrastructure is no longer required, it is removed.
- The final open pit is to be backfilled to approximately pre-mining landform levels
- Salvage pumps and other equipment.

- Remove all hazardous materials, machinery and equipment.
- Remove remaining buildings and infrastructure, and dispose of any demolition waste off-site.
- Decommission bores, seal and plug below ground.
- Decommission non-essential roads including re-establishment of natural drainage lines.
- Rehabilitate all disturbed areas as specified in the RMP.

9.3.5 Mitigation Measures and Environmental Outcomes

Olympia has prepared and will implement a RMP, which will be reviewed in consultation with regulatory agencies, landowners and other stakeholders during the life of mine.

Olympia has prepared and will implement a DCP, which will be reviewed in consultation with regulatory agencies during the life of mine.

Olympia considers implementing the management measures described above will serve to mitigate any negative impacts associated with implementing the proposal and result in an outcome with improved environmental values of the revegetated landscape.

9.4 ACID SOILS

9.4.1 EPA Objectives

The EPA objective is to maintain the integrity, ecological functions and environmental values of the soil and landform.

9.4.2 Relevant Standards

Western Australian Planning Commission. Planning Bulletin No. 64. Acid Sulfate Soils. (November 2003). This document provides advice and guidance on rezoning, subdivision and development of land that may disturb ASS.

General Guidance on Managing Acid Sulfate Soils DoE (August 2003). The provides a framework for decision-making associated with ground-disturbing activities in ASS risk areas. The guideline is aimed at minimising the risk to the environment resulting from the potential exposure of any PASS, to be achieved by implementing appropriate detection and management strategies.

9.4.3 Potential Issues

The mine area is located within the Peel Harvey catchment portion of the Swan Coastal Plain. The acid sulphate soils map of Planning Bulletin 64 shows the mine area as low to moderate risk of acidity, with two small areas shown as high risk. A third larger high risk site is outside the mine area and will not be disturbed.

9.4.4 Assessment and Management

The initial survey results indicate a low acid formation potential, with no requirement to develop an Acid Sulphate Soil Management Plan (ASSMP). However, during operations Olympia will implement a monitoring programme to detect any changes in pH, electrical conductivity (EC) and TAA as a result of generation of acid soil effects **(Management Action 9.4.4a)**.

A number of management measures are to be implemented that will serve to buffer against acid formation **(Management Action 9.4.4b)**. These include:

1. Addition of a limestone bed in the water dam, to serve as a buffer to acidification of the water.
2. Addition of a limestone rubble lined spillway for any surplus water requiring to be discharged during peak flow periods.
3. Addition of agricultural lime during the reseeding and fertilising programme, as part of the rehabilitation to pasture.

Trigger levels of key parameters will be defined. Olympia will prepare and implement an ASSMP if these are exceeded. Initial trigger levels are TAA > 60 milligrams per litre (as $CaCO_3$) and a pH variance >10% acid trend (reducing pH level) of background levels. These trigger levels will be reviewed annually against monitoring data to ensure their relevance and accuracy during the life of mine. **(Management Action 9.4.4c)**.

9.4.5 Mitigation Measures and Environmental Outcomes

Although the initial assessment indicates the soil types within the mine area have a generally low PASS risk, there are individual results and variations that indicate a low level of PASS could occur in specific locations. Olympia will implement a monitoring programme to detect any changes attributable to the generation of acid. An ASSMP will be prepared and implemented if monitoring results indicate increasing acid generation.

Olympia will use lime applications in specific locations to further buffer against the low risk of acid formation.

It is considered the mitigation measures described will maintain the environmental values of the landform against acid formation.

9.5 DIEBACK DISEASE

9.5.1 EPA Objectives

The EPA objective is to maintain the integrity, ecological functions and environmental values of the soil and landform.

9.5.2 Relevant Standards

CALM Policy Statement No 3 "Threat abatement for *Phytophthora cinnamomi*. Draft for Public Comment. March 2004.

9.5.3 Potential Issues

Mining activities such as clearing and movement of soil can spread dieback disease into locations previously dieback free.

Introducing dieback disease can limit the success of susceptible species establishment during the rehabilitation phase.

9.5.4 Assessment and Management

The CALM Policy Statement No 3 document, 2004, supercedes versions dated 1998 and 1991. The policy principally applies to CALM-managed land and conservation areas. An important term within the document, as it relates to the Keysbrook project is:

Protectable area: an area, including areas of high conservation and/or socio-economic value (e.g. a small uninfested area which contain a known population of a susceptible species of threatened flora) within the vulnerable zone that is:

1. Situated in zones receiving greater than 600 millimetres per annum rainfall or are water-gaining sites (e.g. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600 millimetres per annum rainfall zone.
2. Not calcareous soil (e.g. not a Quindalup dune system).
3. Determined to be free of *P. cinnamomi* by a qualified disease interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *P. cinnamomi* are evident).
4. Positioned in the landscape and are of sufficient size (e.g. greater than four hectares with axis greater than 100 metres) such that a qualified disease interpreter judges that *P. cinnamomi* will not autonomously engulf them in the short-term (a period of a few decades).
5. Where human vectors are controllable (e.g. not an open road, private property).

Points 4 and 5 above are both applicable over the Keysbrook mine area. The conclusion is that the mine area cannot be classed as a Protectable Area under the CALM draft Policy No 3. The 1998 version of the policy statement included points on managing lands already infested with *P. cinnamomi* or those that are not protectable as follows:

- Develop and maintain a set of protocols, founded on science and logic, which establish guidelines for identifying and managing infested and unprotectable areas and for setting priorities among management options for them.
- Where appropriate, provide protection through the application of phosphite.
- Provide appropriate management guidelines and training programmes.

The dieback survey (January 2006) as described in Section 5.4.2 confirmed the presence of disease in some upland sites of the mine area. The mining operation extends on a front that makes separate mining of diseased and disease-free areas impractical. Table 40 lists the management measures that are proposed, to minimise the risk of dieback effect on the mine area.

Table 40: Management Measures to Minimise the Risk of Impact from Dieback Disease

	Management Measures	Result	Outcome
1	The site induction programme is to include a section on dieback and the management measures being implemented to minimise its impact in the mine area.	Educate the workforce on dieback and management practices that need to be implemented.	No access to remnant vegetation areas that are outside the current mine envelope, to minimise the risk of introducing or spreading the fungus. Topsoil handling methods to maintain the dieback-free status of topsoil to be used on upland sites.
2	Isolation of remnant areas not to be impacted by mining.	No mining-related activity within native remnant areas that are excluded from the mine area; to minimise the risk of introducing the fungus or contributing to its spread.	Selected native vegetation areas remain disease free or if already infected, the rate of spread of the disease is based on the growth of the fungus.
3	Screened oversize returned to the pit floor.	Any infected root material that is the source of inoculum, is placed in low-lying landscapes during the recontouring and rehabilitation process. The upland locations remain free from introduction of the fungus from this source.	Minimise the risk of introduction of the fungus to upland rehabilitation sites.
4	Topsoil used on upland locations to come from dieback-free areas.	The dieback status of remnant vegetation areas is to be assessed for visual expression of disease symptoms by the death of susceptible species (if present). Topsoil stockpiles, or topsoil being directly returned to upland locations, are to be sourced from dieback-free areas wherever possible.	Use of dieback-free topsoil will avoid the risk of dieback being introduced on upland sites from this source.
5	Planting and seeding of susceptible species only on upland sites that are freely draining.	The main susceptible species used in rehabilitation will be *Eucalyptus marginata, Xanthorrhoea priessii, Kingia australis, Banksia attenuata, B. menziesii B. grandis* and *B. ilicifolia*. These susceptible species will be interspersed with dieback-resistant species such as *Corymbia calophylla* and *Allocasuarina fraseriana.*	Maximise the chance of survival of susceptible species in the longer-term.
6	Trial the use of phosphite fungicide as a spray or stem injection on susceptible species in rehabilitated areas.	Increase the resistance of dieback infection for susceptible species.	Maximise the chance of survival of susceptible species in the longer-term.

9.5.5 Mitigation Measures and Environmental Outcomes

Implementing the management measures in Table 40 will minimise the risk of introduction and spread of the fungus in upland rehabilitation sites **(Management Action 9.5.5)**. The upland locations will include rehabilitation with both dieback-resistant and susceptible species, such that the rate of autonomous spread of the disease, if introduced, is slowed by the resistant species. Lowland sites will be rehabilitated with resistant species.

Rehabilitation to pasture is not affected by dieback.

The measures above are considered sufficient to enable the return of a vegetation structure, similar to that existing pre-mining, maintaining the ecological functions and environmental values of the landform.

9.6 GROUNDWATER

Olympia commissioned Rockwater to complete a hydrological review of the potential impacts of the project. A full report (Appendix 2) presents the results of hydrogeological investigations.

9.6.1 EPA Objective

To maintain the quantity and quality of groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected.

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

9.6.2 Relevant Standards and Legislation

- *Environmental Protection Act* 1986
- *Rights in Water and Irrigation Act* 1914.
- EPA Position Statement No 4
- WRC, DME and DEP: Water Quality Protection Guidelines No 11, Mining and Mineral Processing – Mine Dewatering, 2000.
- Australian Drinking Water Guidelines (ADWG) (2004)
- State Water Quality Management Strategy for Western Australia (2001)
- National Water Quality Management Strategy (1994)
- Department of Water - Water Quality Protection Notes.

The use of groundwater is controlled under the Rights in Water and Irrigation Act 1914, administered by the DoE. The Act requires regulation of water systems in certain localities, a

licence for abstraction that specifies extraction quantity and requires monitoring and reporting.

The EPA's Position Statement No .4 Environmental Protection of Wetlands, identifies activities with the potential to degrade wetlands and the EPA's principles for protecting wetlands.

Water Quality Protection Guideline 11 addresses the issue of mine dewatering on the quality and quantity of the region's water resources to minimise off-site impacts.

The ADWG incorporates the "Framework for the Management of Drinking Water Quality" and provides the Australian community and the water supply industry with guidance on what constitutes good quality drinking water.

The State Water Quality Management Strategy has been drafted with the primary objective to ensure that an administrative structure for water quality management is established in Western Australia.

The Water Quality Protection Notes provide guidance on a range of activities with the potential to contaminate water supplies.

9.6.3 Potential Issues

During construction, predicted water supply requirements are minor and restricted to localised dust suppression and washdown. The estimated quantity required is 100 kilolitres per day. Once operational, it is anticipated that Olympia's processing operations will require up to two gigalitres per annum. This water will be sourced from pit dewatering and licensed bores.

Part of the mineral reserve is beneath the winter watertable of the superficial aquifer. During this period groundwater will ingress into the pit void, requiring dewatering to enable dry mining to occur. Potential impacts resulting from mine pit dewatering drawdown are impacts on neighbouring bores, surrounding vegetation, wetlands and surface water bodies.

Potential impacts to groundwater quality due to mining activities within the mine area relate to migration of pollutants from the surface into the groundwater system through infiltration.

There is a potential for acidification of shallow groundwater through changes in groundwater levels due to dewatering.

9.6.4 Assessment and Management

An assessment has been conducted on the impact of dewatering activities on the superficial groundwater resources to characterise the pre-mining hydrology, simulate the mine dewatering schedule and model the groundwater contours during and after mining (Rockwater 2006).

The modelling shows that groundwater abstraction rates vary with season and specific topography of each mine cell. The abstraction rates range from 130-2,400 kilolitres per day (Table 9). Generally, the quantities obtained from pit dewatering are about 20 per cent of the daily water requirement for the operation. The balance will be sourced from bores.

Figure 20 shows the modelled groundwater drawdown effect from pit dewatering is very localised. Groundwater drawdown a few hundred metres from the pit boundary is generally between 0.5-1.0 metre. These values are within the normal seasonal groundwater movement as shown in Charts 4 and 5. It is not expected that this fluctuation will impact on adjacent vegetation, wetlands or the ability of neighbours outside the mine area to access the aquifer.

The localised drawdown effect will also have no effect on the Peel-Yalgorup System, Betcher Point Wetlands and Thompsons Lake; the three Ramsar wetlands identified in the search of matters of national significance other matters protected by the *EPBC Act 1999.*

Once mining is complete, backfilling of completed mine areas occurs with a slurry of approximately 50 per cent water, which serves to recharge the superficial layer within the refilled mine pit. This produces a temporary water mound up to 0.5 metre above surrounding groundwater levels. With the rapid mining rate anticipated (Table 8), the period between localised dewatering and recharge at a given location is anticipated to be approximately three to six months months. This period is within normal seasonal fluctuations, so no long term impact to adjacent vegetation, wetlands or neighbours is anticipated.

Process water from the wet concentration plant contains no hazardous chemicals. A biodegradable flocculant is added to the thickener to help precipitate fine clay. The main potential source of pollution from the operations is from hydrocarbons. Operating within the Proposed Karnup-Dandalup Underground Water Pollution Control Area will require preparation and implementation of a hydrocarbon management procedure, in consultation with DoW, to address issues described in Water Quality Protection Guidelines 7 and 10 **(Management Action 9.6.4a)**. The storage of hydrocarbons will be designed to comply with AS 1940:2004.

The potential for acid generation from the mine is addressed in Section 9.4.

The exact location of the bores is yet to be determined. Application is required to be made under the Rights in Water and Irrigation Act 1914 to construct a bore or well. It is likely that two bores will be constructed to minimise reliance from one source of supply. The location of the bores is anticipated to be on Lot 59. Test pumping from constructed bores will serve to verify the accuracy of the modelling and also ensure there is no impact to surrounding users, prior to the issue of an abstraction licence and operational use of the bores.

The abstraction licence will require the preparation of a Groundwater Operating Strategy that will define a monitoring regime for ongoing review of drawdown effects. Olympia will prepare and implement an operating strategy and site licence monitoring and reporting requirements **(Management Action 9.6.4b)**.

The current modelling indicates a water deficit in all periods, however, the model is based on average flow rates. To cater for possible situations when additional water from heavy rainfall events produces a surplus above process plant usage and dam storage capacity, a discharge

licence will also be obtained from the DoE. Any discharge water will be passed through the process water dam to settle sediment before discharge to the environment.

Olympia will implement measures to recycle as much water as possible **(Management Action 9.6.4c)**. Tailings will be thickened and discharged at about 45 per cent solids density to minimise loss of water. Process water will, in the first instance, be sourced from dewatering of the pit. Collection of surplus water during backfilling of completed areas will also occur. Additional process water sourced from the bores will only be used after the other resources have been fully utilised.

Monitoring
The monitoring of groundwater abstraction and discharge (if required) will be undertaken according to DoE licence requirements.

Water quality results will be compared with existing baseline data and trends analysed as part of the monitoring programme. Monitoring of the groundwater quality will continue until such time that groundwater levels have recovered following cessation of operations, to provide post-closure data **(Management Action 9.6.4d).**

The WRC Water Quality Protection Note: Extractive Industries within Public Drinking Water Source Areas (PDWSAs) (2000) and the Statewide Policy No. 1 for Construction and Silica Sand Mining in PDWSAs (1999) provide guidance on factors also relevant to this proposal.

The current proposal for heavy mineral sand mining has significant differences to the operations that are referred to in the above documents. The main difference is these operations are quarries that permanently remove the identified resource (sand, clay, gravel, limestone), leaving a final surface profile significantly different to the pre-mining landform. The proposed heavy mineral sand mine will temporarily remove the resource profile, extract the minerals and return the remaining material to the extraction site, to leave the final landform at approximately the same level as existed pre-mining.

The mineral to be removed averages 2 – 3%, with the remaining 97%, comprising oversize, quartz sand and clay fines being returned to the mined pit to be rehabilitated. Over the very shallow pits (average depth 2 metres) a 2-3% removal represents approximately five centimetres. The bulking factor associated with excavating soil in situ from its compacted state to a loose state varies with rock/soil type, but ranges of 10%-30% are common. This bulking factor would more than compensate for the loss of material by removing the mineral.

This has important considerations for factors identified in the WRC documents, specifically relating to minimum separation distance to ground water levels. In the case of the Proposed Karnup Dandalup UWPCA, the minimum two-metre separation to groundwater cannot be achieved. Charts 4 and 5 show highest water table levels generally within one metre of the surface over most of the mine area (excluding the sandy rises) during the winter months. Extraction of the heavy minerals will not alter the current separation distance. The post-mining landform will be the same as the pre-mining landform.

In line with the principle of risk minimisation applying to Priority 2 (P2) protection areas, management measures are required to be implemented at all times to ensure pollution of the ground water does not occur. This is especially important for the period of time a mine cell is

operating within the minimum separation zone as the distance to groundwater and the response time to clean up and remove spills is reduced.

The key potential pollutant is hydrocarbons. Olympia will prepare and implement a hydrocarbon management procedure to address issues described in Water Quality Protection Guideline 7 - Mechanical servicing and workshop facilities and Water Quality Protection Guideline 10 - Above ground fuel and chemical storage. The on ground fuel storage and workshop facilities will be located on elevated land to ensure a two metre separation distance to the highest water table level, thus complying with the guidelines **(Management Action 9.6.4e)**. Within the mine cell, where the pit floor will be within the minimum separation zone, the screening plant and all transfer pumps are electrically powered. There will be no storage of hydrocarbons on the floor of the mine pit **(Management Action 9.6.4f)**. Hydrocarbons within the mine pit will be limited to that contained in the mobile equipment. Portable enclosed direct diesel pumps or generators used to power electrical water recycling and recovery pumps will be located above the pit, on natural ground level. The storage of hydrocarbons will also be designed to comply with AS 1940:2004.

The wet concentrator plant will be located on elevated ground and have hardstand areas draining to sediment sumps to prevent uncontrolled drainage from the plant site **(Management Action 9.6.4g)**. Transport of HMC product from the site and trucks delivering supplies to site will all occur from the HMC plant. There will be no general access across the site for these vehicles. This is another difference between this project and the quarries, defined in the WRC guidelines, where mobile equipment and trucks traverse the pit floor, increasing the risk of hydrocarbon spills and leaks in uncontrolled areas.

9.6.5 Mitigation Measures and Environmental Outcomes

Management measures will ensure the project is implemented in line with the principle of risk minimisation for operations within the proposed P2 water source protection area to minimise possible pollution of the water resource.

It is not expected that the quality of the groundwater will be affected from the operation because:

- No chemicals are used during processing that have the potential to pollute water supplies.
- Process wastes have a low risk of generating acid. Water discharged from the site will be monitored and measures implemented to balance pH if monitoring results show an increase in acid generation.
- Location and storage of hydrocarbons and mechanical servicing facilities will comply with the minimum separation distances of WRC guidelines.

Groundwater reserves within the Leederville aquifer will not be significantly reduced. Water level drawdown within the Leederville aquifer will be localised and over time will recover to pre-mining levels on cessation of mining.

The installation of monitoring bores will allow monitoring of aquifer water levels in response to pit dewatering and production bore abstraction to ensure that no adverse impacts are occurring to the region's groundwater quantity.

The above measures will ensure the project has no adverse effect on the area's groundwater resources.

9.7 SURFACE WATER

9.7.1 EPA Objectives

The EPA objective for surface water quantity is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

The EPA objective for surface water quality is to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

9.7.2 Relevant Standards

- *Environmental Protection Act 1986.*
- *Rights in Water and Irrigation Act 1914.*
- WRC, DME and DEP: Water Quality Protection Guidelines No 6. Mining and Mineral Processing: Minesite Stormwater, 2000.
- ANZECC, ARMCANZ: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.
- Australian Drinking Water Guidelines (ADWG) (2004)
- State Water Quality Management Strategy for Western Australia (2001)
- National Water Quality Management Strategy (1994)
- Department of Water - Water Quality Protection Notes.

The site licence, issued under Part V of the *Environmental Protection Act 1986* is likely to include conditions on surface water, drainage and waste management.

Water Quality Protection Guideline 6 (2000) provides guidance on managing stormwater so the region's water resources are protected.

Water Quality Protection Guideline 11 (2000) details general release criteria from mine sites.

The Australian and New Zealand Water Quality Guidelines (2000), while not a regulation, provide trigger levels for assessing water quality and developing appropriate water management strategies.

The ADWG incorporates the "Framework for the Management of Drinking Water Quality" and provides the Australian community and the water supply industry with guidance on what constitutes good quality drinking water.

The State Water Quality Management Strategy has been drafted with the primary objective to ensure that an administrative structure for water quality management is established in Western Australia.

The Water Quality Protection Notes provide guidance on a range of activities with the potential to contaminate water supplies.

9.7.3 Potential Issues

- Mining will interrupt overland surface water flows across the resource area.
- Runoff and erosion from disturbed areas has the potential to increase turbidity and suspended solids in surface water flows.
- Potential contamination from hydrocarbons.
- At some stages during mining, groundwater dewatering and stormwater flows may exceed site water requirements. Discharge of excess water will be required.
- The seasonal dewatering required for the mining operation may affect surface flows in adjacent drainage lines.

9.7.4 Assessment and Management

There are three major catchment drainage areas within the mine site, each with a number of minor subcatchments as shown in Figure 9.

The flows in the watercourses within the project area have been estimated from the Department of Environment streamflow gauging station data from station 614063 on Nambeelup Brook. The surface drainage lines through the project area have been subdivided into three categories:

1. **Major Water Courses - Peak flows of two to five cubic metres per second**

   These are highlighted in red on Figure 9. There are two watercourses in this category, Balgobin Brook and North Dandalup River Tributary. These watercourses have substantial bridges (up to 15 metres wide) at the downstream road crossings. Both watercourses also contain Draft EPP-listed wetlands within the project area. These watercourses and a 10-metre buffer each side of the creek line will not be disturbed by the mining operations.

2. **Medium Watercourses - Peak flows of one to two cubic metres per second**

   These are highlighted in yellow in Figure 9. Watercourses in this category are Dirk Brook Tributary, Nambeelup Brook North Tributary, Balgobin Brook South Tributary and Nambeelup Brook South Tributary. Culvert sizes on adjacent roads are in the range of dual 1,050-millimetre circular pipes and they are generally well-defined watercourses. Dirk Brook Tributary and Nambeelup Brook South Tributary also

contain Draft EPP-listed wetlands. These watercourses and a 10-metre buffer each side of the creek line will not be disturbed by the mining operations.

3. **Minor Watercourses - Peak flows of less than one cubic metre per second**.

   The minor watercourses are not highlighted in Figure 9. They are generally shallow and poorly-defined. Many have been formalised into agricultural drains, at least over part of their length. Diversion of these watercourses around operating mine cells is achievable with minimal earthworks. On completion of mining, the landform profile and watercourse will be returned to its original location.

Under the *Rights in Water and Irrigation Act 1914*, a permit is required to alter the bed or banks of a watercourse. Olympia will obtain the required permit to implement any diversions of the minor watercourses around active mine areas **(Management Action 9.7.4a)**.

Effects of drainage diversions on runoff volumes and flow rates at the regional scale are expected to be minor because:

- Only a small proportion of the total project area catchments will be disturbed at any time.
- Surface water diverted around an active mine pit will be redirected back into the natural drainage line downstream.

Olympia will manage impacts on surface water quality by implementing the following **(Management Action 9.7.4b)**:

- Isolating infrastructure areas that have the potential to contaminate surface water.
- Constructing sediment sumps, silt and oil traps where necessary to remove sediments or pollutants from runoff before water enters local drainage.
- Any spills of contaminants such as oil or fuel will be cleaned up immediately.
- Monitor surface water quality around the active mine area.

The flocculant used in the process has a chemical classification of Non Hazardous. As such, there are no specific regulations or standards covering the storage of this material. Oylmpia implements standard 'duty of care' practices for all chemicals used on-site. The property of this chemical is that it binds irreversibly to both inorganic sediment matter (such as clays and silt) and to natural humic and fulvic acids, leaving negligible residue with the supernatant water.

Surface water management structures will be designed and constructed to ensure minimum erosion potential. Diversion drains will be constructed so that water re-enters natural drainage lines at a velocity and depth that can be accommodated by the natural stream line without increased scouring **(Management Action 9.7.4c)**.

As a result of heavy rainfall events, there is the potential for increased turbidity off recently rehabilitated areas that are not yet fully stabilised. Sedimentation basins will be constructed where required to reduce turbidity to discharge licence criteria before release to the environment **(Management Action 9.7.4d)**. The site's DoE licence is anticipated to specify water quality discharge criteria that would include suspended solids. The WRC Water

Quality Protection Guideline 11 lists criteria for TDS and total suspended solids (TSS) in mine discharge water to not cause an increase above 10 per cent of seasonal background levels.

Contamination of water from hydrocarbons is also addressed in Section 9.6. Hydrocarbon storage areas and workshops will be constructed to DoE and DoIR standards and be on elevated, water shedding locations. Minor spillage that occurs as a result of accidents or breakdowns will be addressed and reported through Olympia's accident/incident report procedure. Spillages will be removed and disposed off-site.

Heavy rainfall events may produce a surplus above process plant usage and dam storage capacity, requiring discharge of the surplus quantity. A discharge licence will be obtained from the DoE. Discharge water will be passed through a sediment control basin and comply with licence quality criteria before discharge.

The effect of winter dewatering of mine pits adjacent to drainage lines is expected to have negligible effect on the creek flow. The major drainage lines (red and yellow, Figure 9) plus a 10-metre buffer will not be disturbed by mining.

9.7.5 Mitigation Measures and Environmental Outcome

Olympia will implement the management measures described above to mitigate any impact to surface water quality and quantity. Site licence conditions are anticipated to require a monitoring regime and establish compliance criteria. The discharge licence is also expected to establish monitoring of quantities discharges.

Olympia considers the mitigation methods and controls established are sufficient to safeguard against any negative impact on water flows or quality downstream of the project site.

9.8 AIR EMISSIONS

9.8.1 EPA Objectives

Air Quality

To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

Greenhouse Gases

To minimise emissions to levels as low as practicable on an ongoing basis and consider offsets to further reduce cumulative emissions.

9.8.2 Relevant Standards and Legislation

Standards

- World Health Organisation Guidelines for Air Quality 2000.

Legislation

- *Environmental Protection Act* 1986.
- National Environmental Protection Measures (NEPM) outlined in the *National Environment Protection Council (Western Australia) Act* 1996. These are:
  - Ambient Air Quality NEPM.
  - Diesel Vehicle Emissions NEPM.
  - National Pollutant Inventory NEPM.
  - EPA Guidance Statement 12.

9.8.3 Potential Issues

Gaseous emissions will result from burning of fuel for the portable generator sets, earthmoving equipment and mine vehicles on site. Gaseous emissions will also be generated from vehicles transporting heavy mineral concentrate and vehicles delivering supplies to site.

An estimated 2,000 kilolitres per annum of fuel is expected to be burnt at the site.

Some burning of non-salvageable timber and stumps will occur on site. Smoke from fires may cause a local nuisance effect.

9.8.4 Assessment and Management

Greenhouse gas emissions will result primarily from exhausts of vehicles and mobile equipment and minor generation of power from portable generators. There are no major point source or stack emissions. It is not anticipated that the additional greenhouse gas emissions resulting from this project will have an adverse impact on local or regional air quality.

A resident south of the initial mining area has informed Olympia of suffering from multiple chemical sensitivity. Mining at its closest point will be 400 metres from the residence. Diesel engine emissions, although predicted to be very low at the property, have the potential to cause health issues. Consultation with residents and community groups will be maintained during the mining process. A complaints register will be maintained and the company will respond to all issues raised. If the diesel emissions prove to be an issue Olympia will employ selective mining near the property to mine only when the prevailing wind blows away from the property **(Management Action 9.8.4a)**.

The following management and mitigation measures will be implemented to minimise and control air emissions **(Management Action 9.8.4b)**:

- Vehicles and power-generating equipment will be regularly maintained and serviced to manufacturer's specifications to ensure efficient running of equipment and optimum fuel consumption, thereby minimising exhaust emissions.
- Emissions will be reported as part of the National Pollutant Inventory.

Any required permits will be obtained for burning conducted on site. Burning will be scheduled to occur during periods when local wind forecasts show prevailing winds blowing away from adjacent residents **(Management Action 9.8.4c)**.

9.8.5 Mitigation Measures and Environmental Outcome

Greenhouse gas emissions will be minimised by regular maintenance and efficient use of plant, vehicles and equipment. Salvage and mulching of cleared vegetation will be maximised, in order to minimise the quantity of material required to be burnt.

The management measures proposed will ensure air quality standards to not adversely effect surrounding residents.

9.9 DUST

9.9.1 EPA Objectives

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land use by meeting statutory requirements and acceptable standards.

9.9.2 Relevant Standards and Legislation

There is no single regulatory standard for ambient dust levels for residential areas. A review of a range of standards is provided below.

1. The Environmental Protection (Kwinana Atmospheric Wastes) Policy 1992 (Kwinana EPP) has specified levels of pollutants (including particulates) in defined zones around the Kwinana industrial area are shown in Table 41.

Table 41: Kwinana EPP Atmospheric Wastes Policy

Area	Description	Standard (TSP ug/m3)	Limit (TSP ug/m3)	Averaging Period
A	Central industrial area	150	260	1 day
B	'Transition area'. Some residential	90	260	1 day
C	Residential areas	90	150	1 day

2. The National Environment Protection Council (NEPC), in 1998, set health-based ambient air quality standards for six pollutants, including particles as PM_{10}. The standards and goal are shown in Table 42.

Table 42: NEPC Air Quality Standard

Pollutant	Averaging Period	Maximum Concentration	Goal within 10 years – Maximum Allowable Exceedences
Particles as PM10	1 day	50ug/m^3	5 days per year

3. The National Pollution Inventory (NPI) emission estimation techniques provide a relationship between Total Suspended Particulates (TSP) and PM_{10} for fugitive dust emissions as shown in Table 43.

Table 43: NPI Conversion factors

Factor	Reference	
Blasting	A1.1.1.9	PM_{10} = 52% of TSP
Drilling	A1.1.1.8	PM_{10} = 0.31/0.59 (52.5%) of tsp
Wind erosion	A1.1.15	PM_{10} = 50% of TSP

Using the NPI factor of PM_{10} = 52%xTSP, the Kwinana EPP standards and limit can be converted as shown below.

- Area B & C standard: TSP 90 micrograms per cubic metre equates to PM_{10} 47 micrograms per cubic metre
- Area A standard & Area C limit: 150 micrograms per cubic metre equates to PM_{10} 78 micrograms per cubic metre
- Area A & B limit: 260 micrograms per cubic metre equates to PM_{10} 135 micrograms per cubic metre

4. The DoE (1996) established an interim PM_{10} target of 150 micrograms per cubic metre for Port Hedland. This equates to approximately 290 micrograms per cubic metre using the above conversion factor.

The review of various guidelines, targets and standards above demonstrates:

- There is no single standard currently being applied specifying 'acceptable' residential/ sensitive area dust levels.
- There is currently a three fold range in standards currently being applied (50 to 150 micrograms per cubic metre PM_{10}).

In 1996, the DoE published a guideline for land development sites and impacts on air quality. Although directed mostly at the urban development industry in Perth, it contains information for all projects that have the potential to generate dust.

9.9.3 Potential Issues

Dust may be generated from the following:

- Earthworks undertaken during the construction and operation of the mine.
- Topsoil stripping.
- The mining of ore.
- The movement of vehicles.
- Wind erosion of exposed surfaces.

Dust generated from the mine area has the potential to affect environmental values and the health, welfare and amenity of people and land uses.

9.9.4 Assessment and Management

Fugitive dust will be generated from mining activities, vehicular movement and wind erosion. The degree of dust generated is expected to be minor and localised. However, it will depend on the moisture content of the ground surface during mine activities and other management practices.

The open pit represents the largest area that will be exposed during mining operations. Completed areas will be stabilised with either completed pasture or native vegetation rehabilitation, temporary stabilisation stubble pasture or a clay-capping layer forming a non-erosive surface.

The implementation of a progressive rehabilitation programme (Section 9.3) will also reduce the risk of dust generation. Completed mine areas undergoing backfilling is undertaken using water that will maintain the fill in a moist state.

Assessing the potential impact of the mine using the DoE (1996) guidelines result in a site classification score of 756. The guidelines have four category ratings:

1. Score <199. Negligible risk
2. Score 200 - 399 Low risk
3. Score 400 - 799 Medium risk
4. Score >800 High risk

The guidelines specify provisions and contingencies to manage and mitigate dust nuisance. The strategies proposed in the dust management plan and real time weather monitoring on-site, with early warning alarm systems, will implement the key provisions and contingencies in the guidelines.

Olympia has developed a Dust Management Plan (DMP) to manage particulate emissions so they do not cause environmental or human health problems **(Management Action 9.9.4)**. Dust control measures will include:

- Minimising clearing and open area.

- Not stripping topsoil during periods of high winds.
- Watering of internal traffic areas as required.
- Growing of temporary 'stubble' crops to bind soil and decrease wind velocity at ground level.
- Re-establishment of pasture as soon as possible after mining has been completed.
- Using sprinkler systems around high activity infrastructure areas.
- Installing a high wind warning system to enable the site to initiate dust control mechanisms in a timely manner.
- Utilising clay and mulch to stabilise stockpile and non-vegetated backfill areas.

The DMP includes:

- Continuous wind monitoring on site linked to a warning system when threshold values are exceeded, to provide a proactive and real time management system.
- The establishment of dust monitoring sites at strategic locations around the operation.
- Regularly review monitoring data and investigate high results. Implement corrective actions to eliminate the causal factors.
- Reporting of monitoring results will occur as required in the DoE operating licence, expected to be on an annual basis.
- Regular communications will be held with adjacent landowners and a complaints management system, including investigation, action and feedback, implemented.

9.9.5 Mitigation Measures and Environmental Outcome

With the above management measures in place, it is anticipated there will be no adverse impacts from dust on environmental values or the health, welfare and amenity of people and land uses.

9.10 NOISE

9.10.1 EPA Objectives

To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

9.10.2 Relevant Standards and Legislation

Standards

- *Environmental Protection (Noise) Regulations* 1997.
- *Mines Safety and Inspection Regulations* 1995.

Legislation

- *Environmental Protection Act* 1986.
- *Mines and Safety Inspection Act* 1994.
- *Mining Act* 1978.

9.10.3 Potential Issues

Noise generated as a result of the project will be primarily due to:

- Operation of mobile plant.
- Operation of fixed plant and pumps.

9.10.4 Assessment and Management

Noise assessment modelling has been undertaken for the Keysbrook project. As the mining operation is mobile, during the life of mine, the location of fixed plant, pumps and mobile equipment will change. The noise modelling focussed on defining scenarios for active mining areas when they are the closest to neighbouring houses.

There are a number of houses within the mine area, on properties subject to access agreements by Olympia. These houses are considered to be caretaker residences under the noise regulations.

There are also neighbouring houses, which are located on properties outside those being actively mined by Olympia. The closest houses to the operating mine areas are shown in Figure 21. The houses are generally 200-300 metres from the property boundary of lots being mined. Mining equipment and plant are located at further distances again from the boundary, resulting in total distances of most plant and equipment being 400-500 metres from the nearest noise-sensitive premises.

The full report is included as Appendix 8. A summary of the report is provided in the twelve paragraphs below.

The analysis determined distances that are required in order to achieve 30 decibel (dB) $_{LA10}$ for fixed plant and 30 dB $_{LA10}$ and 45 dB $_{LA10}$ for the scraper. The 30 dB(A) value is 5 dB less than the assigned night-time noise level, thus allowing for the + 5 dB tonal penalty, which may be applicable in some instances. The 45 dB $_{LA10}$ is also examined for the scraper as there may be areas which would be unacceptable to mine during the night-time, but acceptable during the daytime.

Noise levels from the fixed plant are required to comply with the most stringent night-time operation. The three fixed parts of the operation examined were as follows:

1. Wet Concentrator Plant.
2. Hopper/Screen and Pump.
3. Booster Pumps.

Each of the above items is discussed separately below:

1. **Wet Concentrator Plant**

   It was determined that a distance of approximately 1000 metres was required from the wet concentrator plant, in order to achieve a noise level of 30 dB $_{LA10}$. Based on this, three locations were found where the concentrator could be positioned and the mine still operated efficiently. Note that only one location will operate at any one time with the same plant being moved as required.

2. **Hopper / Screen and Pump**

   To achieve a noise level of 30 dB $_{LA10}$ from the hopper/screen and pump, it was determined that a distance of 215 metres was required. This prediction includes a two metre high bund around the plant, which is already two metres below ground level. This plant may be situated in a number of locations so management will ensure that the above minimum distance is maintained.

3. **Booster Pumps**

   Booster pumps will only be required if the distance between the wet concentrator plant and hopper is greater than 750 metres. A noise level of 30 dB $_{LA10}$ is achieved at a distance of 200 metres.

The Scraper

The scraper will operate in the open pit, transporting the ore to the hopper. The scraper has the highest noise emission of all the plant on the site and therefore needs to be managed carefully. Initially two contours were calculated being for worst-case (downwind) wind conditions and calm conditions. When winds blow from a residence to the scraper, noise levels will be less than those shown.

From the two noise contour plots, the following was determined:

1. Under downwind conditions, a distance of 2.1 kilometres is required to achieve 30 dB $_{LA10}$.
2. Under downwind conditions, a distance of 640 metres is required to achieve 45 dB $_{LA10}$
3. Under calm conditions, a distance of 1.0 kilometres is required to achieve 30 dB $_{LA10}$.
4. Under calm conditions, a distance of 300 metres is required to achieve 45 dB $_{LA10}$ boundary.

To supply ore to the wet concentrator plant on a continuous basis, the implication for mine planning include options such as separate day and night pits being located within the appropriate zones, to provide the flexibility required for continuous scraper operation. In some locations, the proximity of adjacent houses may prevent scraper operations at night.

Ancillary Equipment.

A range of ancillary plant and equipment will be used on an intermittent basis throughout the mine. Unlike the scraper, screening plant and wet concentrator plant that are required to operate continuously in order for the mine to continue production, flexibility exists in the use of other plant and equipment to manage their activity to times and wind direction that result in the minimum noise exposure to adjacent residents. Types of ancillary plant and equipment include:

- The pit dewatering pump will either be an enclosed diesel–centrifugal pump or an enclosed diesel generator supplying electricity to a pump. The dewatering pump will be required to be rated at a sound pressure level of 75 dB(A) at 1 metre, the same as the booster pumps. The same management practices will apply to both of these types of pumps.

- Various mobile equipment that includes a bulldozer, front end loader (FEL), integrated toolcarrier (IT), excavator and water cart. The scraper, for which the detailed modeling was undertaken, is considered to be the noisiest of all mobile equipment at a sound power level of 113 dB(A) and the most critical since it will operate day and night on a continuous basis. Sound power levels for the other plant range from 109 dB(A), for the excavator and IT to 112 dB(A) for the bulldozer (Cat D10). The main issue with the ancillary equipment would be where more than one item of equipment is contributing to noise levels at a residence. In the case of the bulldozer, activity will be during the day and it will be working ahead of the mining activities for clearing or behind the mining activities for rehabilitation. The FEL, IT and excavator have no defined roles for extended periods in specific locations. As such this equipment can be located intermittently throughout the mine site undertaking a range of tasks. As previously stated, the variability of these tasks allows management flexibility to minimise noise exposure to adjacent residents. Other support equipment, such as the pipe laying truck will be a small (two to four tonne) four wheel drive truck that will only operate during the day and undertake maintenance and relocation work on the pipeline systems, as the mine pit traverses through the landscape. It is considered noise levels from this equipment will be negligible in comparison to the other sources.

Construction Noise.
Construction work will be carried out in accordance with Regulation 13 of the *Environmental Protection (Noise) Regulations 1997*, namely following the guidelines of AS2436-1981 where practicable and using the quietest reasonably available equipment. All construction activities will be restricted to daytime operations only (between 7am and 7pm). There are limited construction activities since most items are mobile or modular and will simply be transported to site. The wet concentrator plant will be mobile but likely arrive on site in modules that will be connected. Site offices and crib rooms will be transportable buildings. There will be some construction activity associated with the building of a rural type shed to be used as a site workshop.

As the construction activities will be daytime only, relatively limited since most plant will arrive whole on site and not involve any significantly noisy operations (e.g. pile driving), it is considered the scale and nature of any construction activity does not warrant the preparation of a specific noise management plan and can be appropriately managed through the Regulations.

Transport Noise.
Noise from vehicles transporting supplies to site and HMC product off-site is expected to be minor. As discussed in section 10.2, twelve to fourteen vehicles per 12-hour day, which equates to one vehicle per 45 minutes, is expected to leave or enter the site.

Trucks will be travelling on gazetted roads for most of the time and their noise is therefore exempt from the Regulations. Nevertheless, 1 truck movement in a 45-minute period is not

considered to cause any significant impacts given the residences are at least 300 metres away. Drivers will be instructed to use good neighbourly driving techniques including low speed, low engine rpm and no engine braking.
Olympia will implement the following noise management measures **(Management Action 9.10.5)** to ensure that:

- Noise control equipment on stationary and mobile equipment is operating correctly.
- Mine planning will take into consideration the noise model results, prevailing wind direction and time (day or night operation) to schedule the location of operating plant to comply with noise standards at adjacent noise sensitive premises.
- The noise emissions comply with the requirements of the *Environmental Protection (Noise) Regulations* 1997 and the *Mining Act* 1978.

9.10.5 Mitigation Measures and Environmental Outcome

Noise emissions generated by the construction and operation of the project are expected to be localised and not create a nuisance beyond the boundary of the project area.

9.11 WASTE PRODUCTS

9.11.1 EPA Objectives

Soil Quality
To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

Water Quality
To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

9.11.2 Relevant Standards and Legislation

Standards

- Relevant standards and guidelines in regards to waste storage, transport, and management, include but are not limited to:
  - Guidelines for Controlled Waste Generators.
  - Guidelines for Controlled Waste Treatment and Disposal Sites.
  - Guidelines for Acceptance of Solid Waste to Landfill.

Legislation
The key legislation regarding waste management is administered by the Waste Management Branch and is contained within the *Environmental Protection Act* 1986. This includes the:

- *Environmental Protection Act* 1986 – Part VIIA.

- *Environmental Protection (Landfill) Levy Act* 1998.
- *Environmental Protection Amendment Regulations (No. 2)* 1998.
- *Environmental Protection (NEPM - UPM) Regulations* 2003.

The following legislation relates to the transport of waste that may cause environmental or health risk:

- *Environmental Protection (Controlled Waste) Regulations* 2004.
- *Health Act* 1911.

9.11.3 Potential Issues

Various wastes will be generated by the project. These include:

- General domestic and office refuse.
- Industrial wastes (e.g. tyres, plant, infrastructure and machinery components).
- Hazardous wastes (e.g. oils, grease, lubricants, batteries).
- Sewage effluent.

9.11.4 Assessment and Management

Olympia will implement management measures to minimise the potential for contamination of the surrounding environment due to general waste disposal as follows **(Management Action 9.11.4)**:

- There will be no on-site disposal of wastes.
- Wastes will be stored in appropriate containers and locations including bunded areas (for hazardous materials) and bulk bins or rubbish bins (for general domestic and office refuse)
- Wastes will be recycled where practicable.
- General domestic and office waste will be disposed to an approved off-site landfill.
- Effluent disposal systems will comply with local government health department requirements.

9.11.5 Mitigation Measures and Environmental Outcome

Through appropriate management measures in accordance with standard industry practices there is expected to be no impact on the environment through generation of waste products.

9.12 DANGEROUS AND HAZARDOUS SUBSTANCES

9.12.1 EPA Objectives

Soil Quality
To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

Water Quality
To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

9.12.2 Relevant Standards and Legislation

Standards
Relevant Australian standards in regards to the storage, handling, and management of dangerous and hazardous substances include, but are not limited to:

- AS 1940 - The storage and handling of flammable and combustible liquids.
- AS 1692 - Tanks for flammable and combustible liquids.

Legislation

- *Environmental Protection Act* 1986.
- *Environmental Protection (Controlled Waste) Regulations* 2004.
- *Environmental Protection (Liquid Waste) Regulations* 1996.
- *Explosives and Dangerous Goods Act* 1961.
- *Dangerous Goods (Transport) Act* 1996.

9.12.3 Potential Issues

There is the potential for incorrect storage of dangerous and hazardous substances to result in the contamination of soil, surface water and groundwater.

9.12.4 Assessment and Management

Hydrocarbons are the primary type of hazardous material anticipated to be required on site. The correct implementation of standard storage and handling measures will ensure that adverse impacts are prevented or minimised. The storage and handling of hazardous materials is also addressed in section 9.12.

Olympia will implement management measures to minimise the risk of contamination of soil, surface water and groundwater at the site **(Management Action 9.12.4)**:

- A register of all hazardous materials imported to the site or generated as a result of activities undertaken at the site will be developed and maintained. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers.
- Hydrocarbon storage areas and workshops will be located to comply with the two-metre minimum separation distance to groundwater as described in WRC Policy No 1.
- Hydrocarbon storage areas and workshops will be bunded in accordance with DoIR and DoE requirements.
- Runoff from the workshop and office hardstand areas potentially contaminated with hydrocarbons will be directed to containment sumps prior to discharge.
- Hydrocarbon spills will be cleaned up and contaminated soil will be removed from site.
- Hazardous wastes generated by the operation will be transported off-site to licensed waste disposal facilities. This is likely to include waste oil, grease and mobile equipment filters.
- Hazardous materials will be brought to the site in bulk packaging wherever possible. This practice will minimise the number of containers and reduce the risk of spillage.
- Major mechanical servicing and overhauling of mining equipment will be done off-site. Routine equipment and vehicle servicing activities including washdown will be conducted on impermeable surfaces.
- A Licence to Store Dangerous Goods will be obtained for the storage of diesel fuel on-site.

9.12.5 Mitigation Measures and Environmental Outcome

By implementing appropriate storage and handling measures in accordance with industry standards and practices, dangerous goods and hazardous substances used in the operations will not present a hazard or cause environmental harm.

10. SOCIAL ISSUES AND MANAGEMENT

10.1 HERITAGE

10.1.1 EPA Objectives

To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

10.1.2 Relevant Standards and Legislation

- *National Environment Protection Council (Western Australia) Act* 1996.
- *Aboriginal Heritage Act* 1972.
- *Heritage of Western Australia Act* 1990.

10.1.3 Assessment and Management

Olympia will avoid any unnecessary disturbance to any identified Aboriginal heritage sites **(Management Action 10.1.3).** Management and mitigation measures that will be implemented to achieve this will include:

- Conduct an Aboriginal heritage survey of the mine area, in conjunction with Aboriginal representatives, prior to site works commencing.
- Comply with the requirements of the *Aboriginal Heritage Act* 1972 and seek advice from the Department of Indigenous Affairs in the event that any Aboriginal heritage sites are identified during the life of the project.
- Olympia will ensure that all its staff and contractors on site receive an induction that includes their obligations and responsibilities under the *Aboriginal Heritage Act* 1972.

10.1.4 Mitigation Measures and Environmental Outcome

No site of heritage value has been identified through appropriate studies and consultations. The proposed project is expected to have no impact on any Aboriginal cultural or heritage sites or sites of European cultural significance.

10.2 TRANSPORT

10.2.1 EPA Objectives

Ensure that noise and dust levels meet acceptable standards and that an adequate level of service, safety and public amenity is maintained.

10.2.2 Potential Issues

- Increases in noise and dust on traffic areas.
- Increase in traffic volume on local roads and highways.

10.2.3 Assessment and Management

Internal traffic noise and dust issues are addressed in Sections 9.10 and 9.9, respectively.

The mine will produce 115,000 tonnes per annum of HMC to be trucked to Picton. This represents approximately 2,200 tonnes per week of HMC cartage or six to seven 50 tonne truckloads per day. Truck movements to and from the Keysbrook mine site will therefore be between 12-14 per day. All loads will be covered prior to leaving the site.

The transport route selected by Olympia is shown in Figure 22. Olympia will obtain the necessary transport permits from the Shire of Murray, the Shire of Serpentine Jarrahdale, for transport on local roads, and Main Roads WA, for transport on the South Western Highway **(Management Action 10.2.3a)**. At this point in time, the exact truck configurations have not been determined and will not be known until a haulage contract is finalised. The configurations under consideration are shown in Figure 23. The most likely configurations, that achieve the maximum load per truck and hence minimise the number of truck movements from the site, are either vehicle classes 10 or 11.

Table 44 shows traffic count data of heavy vehicle usage on South Western Highway. The results show that the 12-14 vehicle movements proposed from the operation is approximately a 5 per cent increase on the current traffic count for the possible configurations. This increase will not create any significant additional impact.

The distance travelled on local roads between the South Western Highway and the mine site is approximately two kilometres. Olympia will consult with the Shire of Murray on any required signage, upgrading of local intersections or road pavement that is needed for the safe movement of all traffic on local roads **(Management Action 10.2.3b)**.

Olympia will consult with Main Roads WA on the intersection requirement of Readheads Road with the South Western Highway. Any required upgrading works will be undertaken to ensure safe traffic access and egress **(Management Action 10.2.3c)**.

In addition to the HMC haulage, there will be some truck movements associated with delivery of supplies to the site. The most regular delivery will be for diesel fuel. It is anticipated one semi-trailer per week will be required. Other deliveries of parts or supplies are anticipated to average one vehicle per day, ranging from a utility to a small truck.

Commuting of the workforce will also occur. It is anticipated all these vehicles will be light vehicles, class 1 in the Austroads classification system.

Figure 23: Vehicle Classes and Configurations

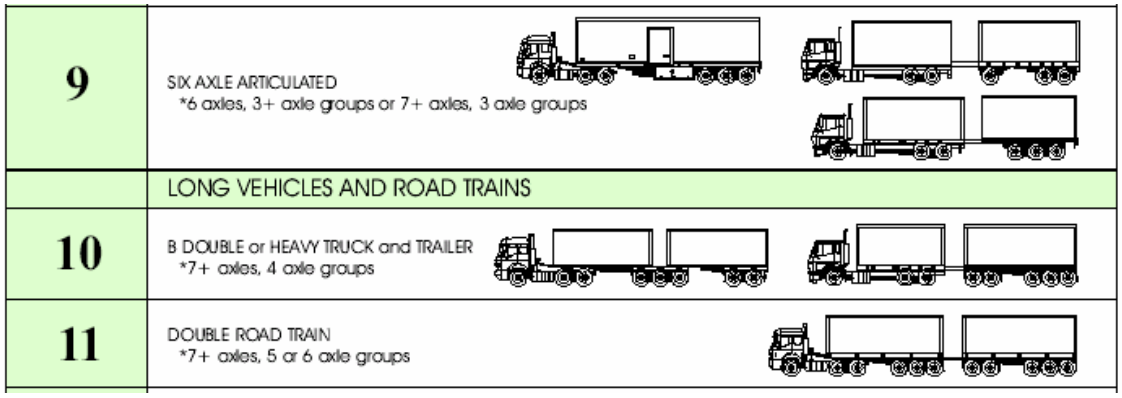


Table 44: Heavy Vehicle Traffic Counts of South Western Highway

South Western Hwy- South of Karnup Road.	C9	C10	C11	Total
18/03/2004	197	110	194	**501**
19/03/2004	229	85	185	**499**
20/03/2004	73	37	106	**216**
21/03/2004	22	30	69	**121**
22/03/2004	211	104	187	**502**
23/03/2004	198	105	168	**471**
24/03/2004	205	111	174	**490**
Average	**162**	**83**	**155**	**400**
South Western Hwy- South of Del Park Road.				
10/03/2004	155	95	127	**377**
11/03/2004	158	108	150	**416**
12/03/2004	145	108	146	**399**
13/03/2004	58	62	51	**171**
14/03/2004	33	25	48	**106**
15/03/2004	133	100	109	**342**
16/03/2004	136	108	137	**381**
Average	**117**	**87**	**110**	**313**

10.2.4 Mitigation Measures and Environmental Outcome

Olympia considers the management measures identified above will ensure all vehicle movement to and from the site will occur in a safe manner.

11. REFERENCES

ABS Estimated Resident Population *(published March 2005* . Peel Development Commission [online] http://www.peel.wa.gov.au/content/discoverPeel/factsFigures/population.cfm

Allen, A.D. 1981: Groundwater resources of the Swan Coastal Plain, near Perth, Western Australia. In: Proceedings of the Groundwater Resources of the Swan Coastal Plain (1981). CSIRO Division of Land Management and West. Australian Committee of the Water Research Foundation, p 29 – 74. In: Rockwater (2006) Keysbrook Mineral Sand Project. Hydrological Assessment for Dewatering of Mineral Sand Mine.

Balla, S (1994). *Wetlands of the Swan Coastal Plain: Their Nature and Management.* Vol 1. Water Authority of Western Australia and the Department of Environmental Protection.

Beard, J.S. 1981, *Vegetation survey of Western Australia, Swan*, 1:1000 000 Vegetation Series, Explanatory Notes to Sheet 7, University of Western Australia Press, Perth.

Bennett Environmental Consulting (2004) Vegetation and Flora of Exploration Licence 70/2407, Keysbrook, Western Australia. Unpublished Report for MBS Environmental.

CALM Policy Statement No 3 (2004). Threat abatement for *Phytophthera cinnamomi*. Draft for Public Comment.

Churchward, H.M. and McArthur, W.M. (1980) *Landforms and Soils of the Darling System, Western Australia*. In Department of Conservation and Environment (1980). Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Perth.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. and Eggler, P. 1993, *The Action Plan for Australian Reptiles, Endangered Species Programme Project Number 124*, Australian Nature Conservation Agency, Canberra. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Commonwealth of Australia 2001 *National Objectives and Targets for Biodiversity Conservation 2001-2005*. Commonwealth of Australia, Canberra. In: Environmental Protection Authority: Guidance for the Assessment of Environmental Factors No 51 (2004). "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia"

Council of Australian Governments 1992, *Inter-Governmental Agreement on the Environment*, AGPS, Canberra. In: Environmental Protection Authority Position Statement No 6 (2004). "Towards Sustainability"

Davidson, W.A., (1995): Hydrogeology and Groundwater Resources of the Perth Region, Western Australia. Geological Survey of West. Australia, Bull. 142. In: Rockwater (2006) Keysbrook Mineral Sand Project. Hydrological Assessment for Dewatering of Mineral Sand Mine.

Department of Conservation and Land Management (2005a) Declared Rare Flora and Priority Flora Database 2005. Search area 32.41666S, 115.9166E/32.51666S, 115.9833E.

Department of Conservation and Land Management (1999). Environmental Weed Strategy for Western Australia. Department of Conservation and Land Management, Western Australia. In: Bennett Environmental Consulting (2004) Vegetation and Flora of Exploration Licence 70/2407, Keysbrook, Western Australia. Unpublished Report for MBS Environmental.

Department of Environment (2003). General Guidance on Managing Acid Sulfate Soils.

Department of Environment (2004). Identification and Investigation of ASS .

Department of Environment (2003b) General Guidance on Managing Acid Sulfate Soils,. August 2003, Department of Environment, Perth.

Department of the Environment and Heritage (2005). Protected matters search tool [Online], available: http://www.deh.gov.au. Search area 32.41666S, 115.9166E/32.51666S, 115.9833E with a 1-kilometre buffer.

Department of Water (2004). Statewide River Water Quality Assessment 2004. Available online at:
http://portal.environment.wa.gov.au/portal/page?_pageid=55,770316&_dad=portal&_schema=PORTAL (Accessed 20.03.2006).

Doepel, JJG (2003). Mid 2003 Drilling Report EL70/2407, 2417 Keysbrook Project WA. Report Number WA03/022. Continental Resource Management. Report for Olympia Resources Limited

Duncan, A., Barry Baker, G., Montgomery N. 1999, *The Action Plan for Australian Bats*, With assistance from the Editorial Panel Biodiversity Group Environment Australia, Canberra. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Environment Australia (2001). A Directory of Important Wetlands in Australia, Third Edition. Environment Australia, Canberra.

Environment Australia (2001). A Directory of Important Wetlands in Australia, Third Edition. Environment Australia, Canberra.

Environmental Protection Authority: Guidance for the Assessment of Environmental Factors No 51 (2004). "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia"

Environmental Protection Authority: Guidance for the Assessment of Environmental Factors No 55 (2003). "Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process"

Environmental Protection Authority: Guidance for the Assessment of Environmental Factors No 56 (2004). "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia"

Environmental Protection Authority: Guidance for the Assessment of Environmental Factors No 10 (2003). "Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1Region"

Environmental Protection Authority: Draft Guidance for the Assessment of Environmental Factors No 6 (2006). "Rehabilitation of Terrestrial Ecosystems"

Environmental Protection Authority (1992). Development of an Environmental Protection Policy for air quality at Kwinana. Bulletin 723. Environmental Protection Authority, Western Australia.

Environmental Protection Authority Position Statement No 2. (2000) "Environmental Protection of Native Vegetation in Western Australia".

Environmental Protection Authority Position Statement No 3 (2002). "Terrestrial Biological Surveys as an Element of Biodiversity Protection"

Environmental Protection Authority Position Statement No 4 (2004). "Environmental Protection of Wetlands":

Environmental Protection Authority Position Statement No 6 (2004). "Towards Sustainability"

Environmental Protection Authority Position Statement No 7 (2004). "principles of Environmental Protection"

Environmental Protection Authority Position Statement No 8 (2004). "Environmental Protection in Natural Resource Management (Preliminary)"

Garnett, S. and Crowley, G. 2000, *The Action Plan for Australian Birds*, Environment Australia and the Royal Australasian Ornithologists Union. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Geological Survey of Western Australia (1986) Environmental Geology Series: Serpentine. Department of Industry and Resources Western Australia.

Gibson N, Keighery B, Keighery G, Burbidge A and Lyons M (1994) *A Floristic Survey of the southern Swan Coastal Plain.* Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.)

Government of Western Australia (2002). Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2001. Government of Western Australia, Perth.

Government of Western Australia (1995) Urban Bushland Strategy

Griffin,EA and Associates (2005). *FCT Analysis of sites for E Bennett.* Unpublished report prepared for MBS Environmental.

Harvey MS, Dell J, How, RA & Waldock JM, (1997). Ground fauna of Bushland remnants on the Ridge Hill Shelf and Pinjarra Plain landforms, Perth. Western Australian Museum & Western Australia Naturalists' Club. In: Iluka (2005) Waroona Mineral Sands Project. Public Environmental Review

Heddle, E.M., Loneragan, O.W. and Havel, J.J (1980). *Vegetation Complexes of the Darling System, Western Australia*. In Department of Conservation and Environment (1980). Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Perth.

Iluka (2005) Waroona Mineral Sands Project. Public Environmental Review

Kimber S,L Bennett, A,F and Ryan, P,A. (1999). *Revegetation and Wildlife: What Do We Know About Revegetation and Wildlife Conservation in Australia?*: A Report to Environment Australia.

Lee, A.K. 1995, *The action plan for Australian rodents,* Australian Nature Conservation Agency, Canberra. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Mace, G. and Stuart, S. 1994, 'Draft IUCN Red List Categories, Version 2.2,' *Species; Newsletter of the Species Survival Commission, IUCN – The World Conservation Union*, no. 21-22, pp. 13-24. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Maxwell, S., Burbidge, A. & Morris, K. (Eds) 1996, *The 1996 Action Plan for Australian Marsupials and Monotremes*, Wildlife Australia, Canberra. In: MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

MBS Environmental (2004). Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook. Prepared for Olympia Resources Limited

Mitchell, D., Williams, K. and Desmond, A. (2002) *Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion)*. In Department of Conservation and Land Management (2002) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth.

McDonald, R.C.,Isbell,, R.F.,Speight, L.G., Walker,J. and Hopkins, M.S.(1990). Australian soil and land survey, field handbook. 2nd edition. Inkata Press, Melbourne. In: Moore G ed. (2004). Soil Guide: A handbook for Understanding and Managing Agricultural Soils. The Department of Agriculture, Western Australia. Bulletin 4343.

Moore G ed. (2004). Soil Guide: A handbook for Understanding and Managing Agricultural Soils. The Department of Agriculture, Western Australia. Bulletin 4343.

RBA Consulting (2003). The Shire of Serpentine Jarrahdale Tourism Strategy 2003-2008

Rockwater (2006) Keysbrook Mineral Sands Project. Hydrological Assessment for Dewatering of Mineral Sand Mine. Report for MBS Environmental

Trudgen, M and Archer, R (2001). The vegetation and flora of the bushland on the Elliott's property 'West Kingia", Shire of Serpentine Jarrahdale, with an assessment of conservation value. Report for the Wildflower Society of Western Australia.

Van Gool, D (1990). Land resources in the Northern section of the Peel Harvey catchment: Swan Coastal Plain, Western Australia. Department of Agriculture, WA.

Water and Rivers Commission (WRC) 2004. Statewide Policy No.1 Policy and Guidelines for Construction and Silica Sand Mining in Publi8c Drinking Water Source Areas.

Wells, M.R and Hesp, P.A. (1989). Land resources of the Mandurah – Murray region, Western Australia. Sheet2. Department of Agriculture, WA

Western Australian Planning Commission (2000) Bush Forever. State of Western Australia.

Western Australian Planning Commission. (2003) Planning Bulletin No. 64. Acid Sulfate Soils.

Western Australian Planning Commission (2003) Acid Sulphate Soils. Planning Bulletin No 64. Government of Western Australia, Perth.

Wells, M.R (1989). Land capability study of the Shires of Mandurah and Murray. Land Resources Series No.2 Department of Agriculture.

Wilcox, J.A., 2005. The value of remnant vegetation in the Keysbrook area to three species of threatened cockatoo. Western Wildlife report for MBS Environmental.

FIGURES

APPENDICES

APPENDIX 1

Wind Rose Data

APPENDIX 2

Acid Sulfate Soils Assessment (MBS Environmental, 2006)

APPENDIX 3

Surface Hydrology (MBS Environmental, 2006)

APPENDIX 4

Hydrogeological Assessment (Rockwater Pty Ltd, 2006)

APPENDIX 5

Vegetation and Fauna Assessment (MBS Environmental, 2004)

APPENDIX 6

Vegetation and Flora Report (Bennett Environmental Consulting, 2004)

APPENDIX 7

Floristic Community Type Analysis (E.A. Griffin & Associates, 2005)

APPENDIX 8

Value of Remnant Vegetation to Cockatoos (Western Wildlife, 2005)

APPENDIX 9

Noise Impact Assessment (Lloyd Acoustics, 2006)