

Acid Sulfate Soil Management Plan

Keysbrook Mineral Sands Project

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1.0 INTRODUCTION

This plan describes the Acid Sulfate Soil (ASS) management practices that will be implemented during operation of the open cut mineral sand mine and primary processing plant at Keysbrook by MZI Resources Ltd (MZI). The mining area of 1,366 hectares is located on privately owned land, actively used for grazing.

The following characteristics of the project are important in regard to the risk of generating Acid Sulfate Soils (ASS):

- The portion of the elevated dunes which are permanently above the winter water table are considered to be low ASS risk.
- The potential for higher risk ASS layers are predicted at depths greater than three metres below ground level. This profile consists of the clay layers of the Guildford Formation. This zone will not be impacted or disturbed by mining as the mineralised profile is confined to the Bassendean sands above this zone.
- Collection of water within the open pit occurs using drains and sumps. This will have minimal effect on dewatering the profile below the pit floor. All water is pumped to a lined dam for use in the process.

1.1 Purpose, Objectives and Targets

This plan has been prepared to comply with Condition 12 of Ministerial Statement 810. The purpose of this Acid Sulfate Soils Management Plan (ASSMP) is to outline the management strategies and procedures to assess and manage possible formation of acid sulfate soils associated with the operation. MZI will make the ASSMP and the results of the monitoring publicly available.

The plan has been developed in accordance with guidelines provided by the Department of Environment and Conservation (DER). The guiding principles are:

- Planning mining operations to minimise potential disturbance of ASS materials.
- Outline design and management strategies to avoid, minimise or mitigate the formation of ASS.
- Implementing appropriate monitoring programs to measure soil and water quality.
- Establish appropriate 'Action Criteria' to provide an early warning system for disturbance of ASS materials.
- Identify appropriate remediation strategies to minimise potential environmental impacts resulting from ASS disturbance.

The objective of this plan is to ensure that all mining activities with the potential to disturb ASS materials protect environmental values. The objectives and targets for ASS management are outlined in Table 1.

Table 1: Keysbrook Mineral Sand Mine ASS Management Objectives and Targets

Objective	Target
Avoid disturbance of PASS soils.	No inadvertent disturbance of PASS soils.
Prevent acid generation from disturbed soils.	Acidity and metal concentrations in surface and groundwater to be maintained at pre-mining levels.
All employees and contractors will be aware of ASS issues relating to the project and their responsibilities.	All employees and contractors instructed on content of the ASSMP in the induction process.

2.0 EXISTING ENVIRONMENT

2.1 Regional Setting

The project is situated along the eastern edge of the Swan Coastal Plain approximately 70 kilometres south of Perth, near the small townships of Keysbrook and North Dandalup (Figure 1). It is located two to seven kilometres west of the Darling Scarp and between 22 and 48 metres AHD. The topography of the mine area is flat to very gently undulating. A cross section of the open pit and its relationship to local topographic features and the annual water table fluctuation is shown in Figure 2.

The mining area of 1,366 hectares is located on privately owned rural zoned land. A large portion of the mine area has been cleared for grazing activities. Patches of remnant native vegetation also remain, ranging from stands of trees over pasture grasses with little to no understorey to areas of trees with a partially intact understorey.

2.2 Land Systems

The geomorphology of the Swan Coastal Plain comprises 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.

2.3 Soils

The heavy mineral resource is hosted within the dunes of the Bassendean Sand, which partly covers mottled clayey sand or a pisolitic ironstone-clay unit of the Guildford Formation, also referred to as the Pinjarra Plain.

2.3.1 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, 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 Formation). Some inland movement by wind action has also occurred. The

majority of the soils are podzols. Soils 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.

2.3.2 Pinjarra Plain

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

- 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.

The Department of Agriculture and Food (DAFWA) published a series of land resource maps for the Swan Coastal Plain, which have now been reproduced and can be accessed electronically from NRM Info (DAFWA, 2008). Soil units are shown in Figure 3 and descriptions are presented in Table 2.

Table 2: Description of Soil Types

Soil Units	Description
Bassendean Dune and Sandplains	
B1	Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than two metre; Banksia dominant.
B1a	Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with an intensely coloured yellow B horizon occurring within one metre of the surface; Marri and Jarrah dominant.
B2	Flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan one to two metres.
B4	Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 metres by clay or less frequently a strong iron-organic hardpan.
B5	Shallowly incised stream channels of minor creeks and rivers with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 metres by clay or less frequently a strong iron-organic hardpan.
B6	Sandplain similar to B4 with imperfectly drained deep or very deep grey siliceous sands.
Pinjarra Plain	
P1a	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
P1b	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Moderately deep pale sand to loamy sand over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P1c	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Deep pale brown to yellowish sand to sandy loam over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P2	Flat to very gently undulating plain with deep alkaline mottled yellow duplex soils which generally consist of shallow pale sand to sandy loam over clay.
P7	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and grey sandy duplex and effective duplex soils.
P8	Broad poorly drained flats and poorly defined stream channels with moderately deep to deep sands over mottled clays; acidic or less commonly alkaline grey and yellow duplex soils to uniform bleached or pale brown sands over clay.
P11	Shallow brown loamy soils or less commonly, very shallow sands over ironstone pavement which is a clear barrier to drainage.

2.4 Hydrogeology

The main aquifers in the project area are the Superficial Formation containing both the Bassendean Dunes and Guilford Formation, the underlying Leederville Formation and below that, the Yarragadee Formation (Allen, 1981). Information on the aquifers of the project area is presented in Table 3 and Table 4.

The upper four to eight metres of Bassendean Sand in the Superficial Formation is moderately permeable material. In the project area, depending on the season and the local aquifer geometry, there is zero to approximately two metres saturation above the base of the Bassendean Sand. This aquifer will be affected by the mining operations as it contains the mineral sand deposit.

Table 3: Stratigraphical Sequence in the Serpentine Area

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

In relation to the ASSMP, dewatering of this aquifer during the winter period represents the impact most relevant to the possible generation of acidity. The open pit mining operation will have no direct effect on aquifers in the underlying Leederville and Yarragadee Formation. These aquifers will not be addressed further in the ASSMP.

Mining operations during winter will temporarily lower the groundwater level in and around the active mining cell to the base of the Bassendean Sand unit. The backfilling operation after mining re-saturates the mined profile.

Table 4: 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 Formation	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

2.5 Ground Water

2.5.1 Superficial Aquifer

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

Information on the four DoW monitoring bores, referred to as the Lake Thompson monitoring bores, located around the project site is presented in Table 5. They were constructed in 1975 and have recorded water levels since that time.

Data from two Lake Thompson Superficial Formation monitoring bores near the mine site indicating water levels ranging from 0.35 metre below ground level in winter to 3.2 metres below ground level in summer is shown in Chart 1 and Chart 2.

Table 5: Lake Thompson Monitoring Bores

Name	WIN Site ID	Location	Drilled Depth (m)
T610	3089	Hopelands Road (west side of project)	22
T670	3098	Readhead Road (south side of project)	15.5
T570	3105	Elliott Road (north side of project)	22
T620	3111	Westcott Road (east side of project)	24

Chart 1: Lake Thompson Monitoring Bore 3089

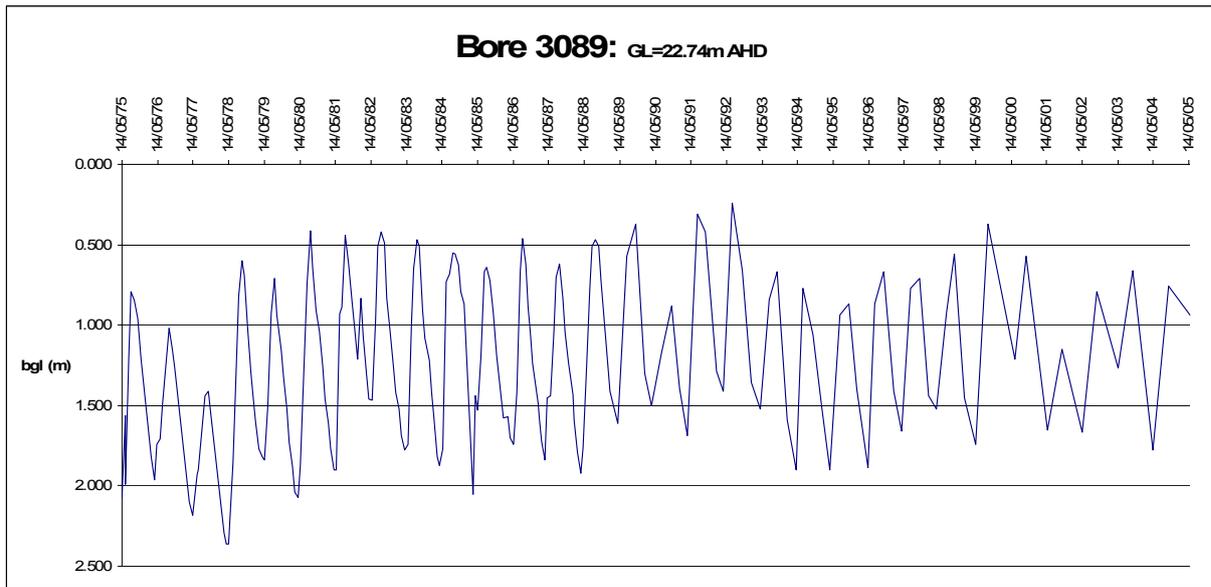
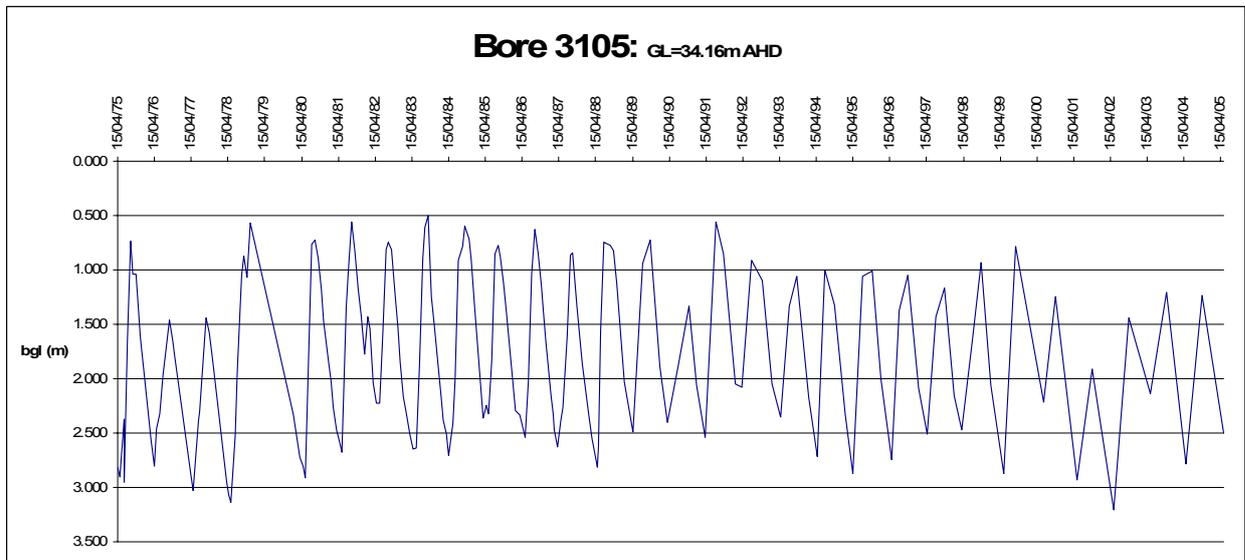


Chart 2: Lake Thompson Monitoring Bore 3105



2.6 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 project area. All surface drainage through the project area is ephemeral. Creek lines and damp lands in the area dry out over the summer months.

The project area and surrounds are characterised by low relief topography 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.

3.0 ACID SULFATE SOILS

3.1 Definitions

ASS is the common name given to naturally occurring soil and sediments containing iron sulfides. These naturally occurring sulphides are generally formed under anaerobic conditions such as swamps and estuarine sediments. Although benign in their natural state, when exposed to air they oxidise and produce sulphuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic (Planning Bulletin Western Australia Number 64, WA Planning Commission, November 2003). For a full list of impacts see the WA Planning Commission Bulletin Number 64 as well as other government publications covering ASS listed in Section 3.2.

ASS materials include both Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). AASS are Acid Sulfate Soil materials that have been previously oxidised. PASS are Acid Sulfate Soil materials that have not been oxidised, but have the potential to produce acid when oxidised.

Identification of AASS and PASS materials is based on results from two field tests:

- pH_F is the field pH of the soil, measured on a 1:5 soil to water paste.
- pH_{FOX} is the pH of the soil after oxidation with hydrogen peroxide solution.

AASS soils are characterised by pH_F values of <4 .

PASS samples are typically neutral to alkaline, but react with peroxide to produce free sulphuric acid. pH_{FOX} values for PASS materials are usually <3 .

It is important to note that whilst a useful exploratory tool, soil field pH_F and pH_{FOX} tests are indicative only and cannot be used as a substitute for laboratory analysis to determine the presence or absence of ASS. Recent review of field pH_F and pH_{FOX} tests in Western Australian soils indicates that these tests provide an accurate identification of ASS in only 60% to 80% of cases and are capable of providing both false positives and false negatives (i.e. may underestimate or overestimate acid-generating potential).

3.2 Relevant Standards and Guidelines

The following documents were used in the preparation of this ASSMP.

- *Preparation of Acid Sulfate Soil Management Plan (ASSMP)*. DER Acid Sulfate Soils Guideline Series, April 2003.
- *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*. DER Acid Sulfate Soils Guideline Series, May 2009.
- *General Guidance on Managing Acid Sulfate Soils*. DER Acid Sulfate Soils Guideline Series, August 2003.
- Western Australian Planning Commission (WAPC) *Planning Bulletin No. 64. Acid Sulfate Soils*. (November 2003).

3.3 Desktop Study

The WAPC (2003) Bulletin 64 provides broad scale mapping of the ASS risk status of the Swan Coastal Plain. An extract from the Bulletin 64 maps which also shows the lot numbers of properties included in the project area is provided as Figure 4. The ASS map from

Planning Bulletin 64 shows the project area as low to moderate risk of acidity, with two small areas shown as high risk. A larger high risk site, partially located on Lot 63 is outside the project area and will not be disturbed. The high risk mapped areas correspond to B4 unit of Table 2.

Within the project area, the available information indicates there are three separate zones, each with different potential to generate ASS (Figure 5). These are described in Table 6.

Table 6: Zones of ASS Generating Potential

Zones	Risk Level	Description
Zone 1	Very low	The elevated Bassendean Dunes permanently above the highest water table level. Dry mining will always occur in this zone. Mining will occur in this zone.
Zone 2	Low to moderate	The profile between Zones 1 and 3. This zone represents the zone of annual water table fluctuation. This comprises the lower 1.5 to 2 metres of the Bassendean sand profile. The interface of the Bassendean Sand and Guildford Formation represents the floor level of the open pit and the general level of the summer water table. Dewatering of the mine pit will need to occur in this zone during winter.
Zone 3	High	The profile three metres or more below ground level in the flat part of the mine area. This zone is generally one metre below the pit floor and into the Guildford Formation, comprising sandy clay, gravels and iron stone (coffee rock). This zone will not be impacted by the operation as no mining will occur in this profile.

3.4 Site Specific ASS Surveys

Two site specific ASS surveys were undertaken as part of baseline environmental surveys for the Keysbrook project. These were discussed in Sections 5.4.1 and 9.4 of the PER and the initial 2005 survey included as Appendix 2.

A summary of the findings of both surveys are provided in the following subsections to provide context for the site risk of ASS.

3.4.1 Initial 2005 Survey

An initial survey was undertaken in 2005 over a range of different soil types, focusing on the identified high risk sites as mapped in WAPC Bulletin 64 and on low-lying landforms that are the most likely sources of PASS. Results for laboratory analysis of the samples collected are presented in Appendix 1. The results indicated PASS occurrence across the general area is as described in the WAPC Bulletin 64 maps, of low to moderate risk, with most results less than half the Action Criteria (Table A1 in Appendix 1).

The assessment of the two high risk sites shown in the WAPC Bulletin 64 maps demonstrated that they were not high risk sites, with Titratable Peroxide Acidity (TPA) levels generally a quarter to a half of the action criteria. An additional sampling program was

undertaken to provide more detailed results on these two areas (Table A2 in Appendix 1). The results of the additional sampling program were consistent with the first assessment and confirmed the low to moderate risk status of these sites.

3.4.2 Follow Up 2007 Survey

Further field assessment sampling for ASS was undertaken in February 2007 at locations shown in Appendix 2. Eighteen holes were drilled to depths of up to 4.6 metres, using a Geoprobe Macro-core. The results of the sampling program are consistent with the previous assessments and confirm the general low to moderate risk status of the site.

Soil samples were tested in the field for field pH (pH_F) and pH after oxidation (pH_{FOX}). The complete results of both field testing and laboratory analysis of selected samples are presented in Appendix 2. Results indicated PASS occurrence is of low to moderate risk.

Sixteen samples were selected and submitted for laboratory analysis. This confirmed that three samples, in two separate holes, exceeded the target values for sand presented in Section 5. Comparison with the geological database confirmed the elevated result for Hole 10 at 1.9 metre depth is below the base of the pit floor at this location. The result for Hole 8 at 2.4 metres depth is within the mine profile, however the TPA value measured is only just above the Action Criteria.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

Mining within an area in which ASS materials exist can result in acidic drainage from either AASS materials or oxidation of PASS materials. Acidic drainage from soil can result in adverse effects on groundwater, surface water quality, mining infrastructure, environmental values and the success of post-mining rehabilitation.

Oxidation of ASS materials at Keysbrook can occur by either:

- Exposure of ASS materials in soil stockpiles to air.
- Lowering of the water table to allow exposure of ASS materials previously located in an anaerobic environment to air.

The potential environmental impacts associated with the proposal are:

- The effect dewatering the Bassendean Sand profile during the winter will have on activating potential acidity in the sand profile to be mined.
- The effect dewatering the Bassendean Sand profile has on activating potential acidity in the underlying Guildford Formation.
- The effect dewatering the Bassendean Sand profile within the open pit has on adjacent land.

5.0 TRIGGER SETTING (ACTION CRITERIA)

5.1 Soil

Although Western Australia was the first Australian state to recognise the impact of disturbance of ASS, most of the recent research into ASS has been conducted in Queensland and New South Wales. The Western Australian DER has adopted Action Criteria adopted by Queensland regulators based on the recommendations provided by Ahern *et al.* (1998).

These Action Criteria are based on the sum of existing plus potential acidity. Different values have been established for different soil types, depending on the texture or clay content of the soil.

Target Level:	Less than 18 moles H ⁺ /tonne (0.03%S).
Limit:	No sample shall exceed 25 moles H ⁺ /tonne (0.04%S).
Trigger Level:	If any sample exceeds 18 mol H ⁺ /tonne, then the average of any six consecutive samples (including the exceeding sample) shall have an average content not exceeding 18 moles H ⁺ /tonne (0.03%S). If more than one sample in every six consecutive samples exceed 25 moles H ⁺ /tonne, then the average of any six consecutive samples (including the exceedance sample) shall have an average content not exceeding 18 moles H ⁺ /tonne (0.03%S).

The Target, Limit and Trigger levels have been applied to a monitoring and response strategy which is detailed below.

5.2 Water

Interim trigger levels have been developed in consultation with DER for the project. These are:

- Total Titratable Acidity >60 milligrams per litre (as CaCO₃).
- pH variance >10% acid trend (DER raising pH values) of background levels.

The Environmental Officer is responsible for developing site specific water trigger levels when sufficient data becomes available to assign statistically valid values.

If results from either field testing or laboratory analysis exceed assigned trigger values, the Environmental Officer is responsible for ensuring that management responses provided in Section 7.2 are implemented.

6.0 MANAGEMENT AND MITIGATION MEASURES

The principal strategy to manage ASS and acid drainage issues at Keysbrook will be to:

- Identify ASS risk areas
- avoid disturbance of these soils where practicable, and
- where ASS material is excavated, treat risk areas to manage soil pH and buffer against acidification of soils.

Mitigation strategies will involve:

- Minimising exposure of AASS materials to the atmosphere by storage beneath the water table.
- Use of acid neutralising materials to prevent production of acid drainage.
- Use of acid neutralising materials to treat acidic waters.

These strategies are described in more detail in the following sub sections.

6.1 Visual Checks

MZI shall complete regular (generally daily) checks within the mining area to identify pyrite and marcasite in ore by way of visual observance when panning. Should suspect material be identified, the Site Manager will commence a process to isolate the area from disturbance, undertake pH_F and pH_{FOX} field testing and determine whether the material shall be mined or avoided.

6.2 Soil Survey

The Environmental Officer will ensure that monitoring of soil pH is regularly undertaken within the active mining area.

The Environmental Officer will communicate results of the soil survey to the Site Manager who shall then ensure the treatment of applicable production streams and excavations is undertaken.

6.3 Water Table Management

The mineralised profile is confined to the Bassendean Sand. The underlying clay layers in the Guildford Formation will not be disturbed. In summer, the pit floor will be above the water table however collection of groundwater flowing into the mine pit will be required during winter.

Dewatering of the mine pit will be achieved via drains on the pit floor directing inflow water to collection sumps (i.e. passive means). This type of pit dewatering will have minimal effect on the profile below the pit floor. It is the profile one metre below the pit floor that is accepted as the most likely source of ASS. Oxidation of this material due to dewatering is unlikely as this material shall not be excavated and will likely remain saturated.

6.4 Lime Treatment

Buffering of any acidity generated above the established trigger levels for either soil or groundwater will occur through;

- The addition of ground lime ($CaCO_3$) into the process tails that returns with the mine void (washed quartz sand and clay fraction) as backfill.
- The application and incorporation of lime directly to disturbed areas.

The Environmental Officer is responsible for regularly reviewing monitoring data to determine if relevant soil or groundwater trigger criteria are being exceeded or not. The Environmental Officer is responsible for advising the Site Manager when lime treatment is required.

The Site Manager is responsible for ensuring that sufficient lime supplies are maintained on site to allow addition when monitoring results indicate it is required.

The Site Manager is responsible for ensuring lime is added in sufficient quantities to process water being used to return waste materials to the pit. The rate of lime addition will be calculated on the net acidity of the identified soil profile and include a safety factor of two. The quantity of lime added will be calculated to reduce the net acidity to levels below the trigger levels stated in Section 5.

6.5 Assay Review

MZI will undertake regular assay of its HMC and Leucoxene products. MZI will monitor trends in reported Sulfur to reconcile against acid sulphate risk areas that have been identified. This information may then be used to assess lime application and improve rehabilitation.

6.6 Monitoring Programs

Preliminary assessment of soil generally showed that the predominantly low/medium risk mapping of the Project Area was accurate on a broad scale. 2007 sampling showed that within the ore zone, a single sample exceeded the Target Level of 18 moles H⁺/tonne (0.03%S), recording 19 moles H⁺/tonne (0.03%S). Additional monitoring shall be undertaken during mining to ensure that ASS risk is identified and managed to avoid residual environmental impacts.

6.6.1 Soil Sampling

During the mining process, regular soil sampling shall be undertaken to monitor ASS risk. As part of Operational activities, MZI will undertake soil sampling of Ore, Tails and Mine Pit Floor material and undertake field pH testing of this material.

The ore body is typically homogenous and characterised by yellow or grey sands. Sampling shall target the Low to Moderate Risk zone identified in Figure 5. Where multiple horizons are present within the Low to Moderate Risk zone, sampling shall be applied to each additional horizon.

6.6.1.1 Ore Sampling

A single soil sample per horizon shall be taken routinely each week to confirm the ASS risk of the ore body at the current mining location. It is in the seasonally saturated Low to Moderate Risk zone that sampling shall be targeted. Ore samples shall be field tested according to the Procedure below.

6.6.1.2 Tails Sampling

A soil sample shall be taken from the tails discharge stream each week. Assessment of the tails shall be undertaken to verify that the backfill material is suitably low risk material that will not acidify. Tails samples shall be field tested according to the Procedure below.

6.6.1.3 Mine Void Floor Sampling

A sample shall be taken from the mine pit floor each week to determine whether AASS material has been exposed. This sample shall be tested for AASS by completing a pH_F test. A pH_F result of less than or equal to 4.0 will verify the presence of AASS. In this situation the Site Manager shall;

- ensure that lime is applied to the exposed base of the mine void prior to backfilling. This will ensure the neutralisation of any acidification, and

- where practicable, manage dewatering activities in the void to maintain a saturated condition of the mine void basement.

6.6.1.4 Field Test Procedures

Soil samples taken from the ore body and the tails stream shall be field tested for pH_F and pH_{FOX} . The procedure for conducting field tests for pH_F and pH_{FOX} is described in Appendix 1 of the *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* Guidelines (DER 2009). Personnel involved in field testing must be made aware of the hazardous nature of the hydrogen peroxide reagent and wear appropriate personal protective equipment.

A brief description of each soil profile including soil texture, grain size, roundness, sorting, colour (using a Munsell colour chart), mottling, organic matter, moisture content, water table level and other diagnostic features (e.g. jarosite, shell fragments).

6.6.1.5 Criteria for Selection of Samples Requiring Laboratory Analysis

Ore and tails samples shall be subject of laboratory testing should field test results indicate AASS or PASS characteristics.

The Environmental Officer is responsible for ensuring that samples requiring laboratory analysis to verify the presence of AASS or PASS materials will be identified by:

- A pH_F value of less than 4.5 to verify suspected presence of AASS materials.
- A difference between pH_F and pH_{FOX} of greater than 3.0 verify suspected presence of PASS materials.

Samples requiring laboratory analysis are required to be placed in a plastic snap-lock bag with exclusion of air and then transferred to a field freezer or an esky with sufficient ice to keep the samples cool for at least 24 hours. The Environmental Officer is responsible for ensuring that samples requiring analysis are submitted to a NATA accredited laboratory within 24 hours. All samples submitted to the laboratory require testing by the S_{Cr} method.

The Environmental Officer is responsible for ensuring that all samples are carefully marked using a waterproof pen for easy identification and kept out of direct sunlight.

The Environmental Officer is responsible for ensuring that samples not submitted for laboratory testing are frozen and retained until the ASS assessment is complete.

6.6.2 Groundwater Monitoring Program

The Environmental Officer is responsible for implementing the groundwater monitoring program to determine whether mining operations are having measurable effects on groundwater level and water quality.

6.6.2.1 Monitoring Locations

The groundwater monitoring program with respect to determining ASS impacts will include fortnightly assessment of field measurements from three key sampling locations defined below:

- Sampling Location 1 is groundwater inflow collected by the drainage system in the active mine pit(s), and represents existing groundwater quality (the 'before' state).

- Sampling Location 2 is process water recovered by the drainage system in the mine pit(s) as backfilling occurs and represents the water quality after it has been through the process (the 'after' state).
- Sampling Location 3 is from the Process Water Dam. This water includes water sourced from the Leederville bores and represents the 'average' water quality from all sources on site.

As the position of the active and backfilled pits will change during the course of the project, the actual location of Sampling Locations 1 and 2 will also change. The Environmental Officer will assign unique monitoring location names as the monitoring program is implemented.

6.6.2.2 Groundwater Quality

The groundwater monitoring program relating to ASS management is as follows:

- pH, EC and Total Titratable Acidity (TTA) will be monitored in the field fortnightly at the two sampling locations for each pit and the Process Water Dam as defined in Section 6.6.2.1.
- Groundwater samples will be collected quarterly from all monitoring bores. These will be submitted to a laboratory to be analysed for total acidity, total alkalinity, pH and EC, Fe, Mn, Cl, SO₄ and Al to assess potential impacts from ASS disturbance. Further details are provided in the Water Management Plan (MBS 2010).

6.6.2.3 Groundwater Level

The Environmental Officer is responsible for ensuring groundwater levels are monitored Monthly from all monitoring bores as described in the Water Management Plan.

6.7 Data Review and Reporting

The Environmental Officer will be responsible for ensuring that all laboratory ASS soil assessment and water quality results are reviewed within one week of receipt. The review of groundwater quality results will allow determination of whether or not mining operations are responsible for long term changes in groundwater quality.

If review of groundwater monitoring results indicates acidification of groundwater or soil is occurring, they shall notify the Site Manager immediately.

The General Manager is responsible for ensuring OEPA is advised immediately in the event of any indication of acidification of soil, groundwater or surface water at Keysbrook.

7.0 MANAGEMENT RESPONSE

7.1 Soil

If unexpected soil materials are encountered in the mining operations or a need arises to stockpile suspected ASS materials, the Site Manager is responsible for ensuring the contingency plan outlined below is implemented.

- Where field testing of the mine void basement shows a pH_F value of less than or equal to 4.0 the Site Manager shall ensure that lime is applied to the base of the mine void prior to backfilling.

- Where the trigger of 25 moles H⁺/tonne (0.04%S) is reached, further soil testing shall be undertaken by sampling the ore zone in 6 locations immediately ahead of the Mining face. The soil samples shall be field tested and submitted to for further S_{Cr} testing if they report:
 - A pH_F value of less than 4.5, or
 - A difference between pH_F and pH_{FOX} of greater than 3.0.
- If the field testing results do not trigger the threshold for additional laboratory S_{Cr} testing Operations shall revert to routine monitoring and management.
- If additional testing is required, the results shall be assessed against the Trigger Criteria.
- If any sample exceeds 25 mol H⁺/tonne and the average of the six samples (including the exceeding sample) has an average content exceeding 18 moles H⁺/tonne (0.03%S), the Site Manager shall ensure that crushed lime is added to the tails stream and/or tail discharge in suitable quantities as to buffer the material against acid generation.
- Depending on the size, location and quantity of ore contained within the high risk area, the Site Manager will determine whether the site is to be avoided (and adjust the future mine plan accordingly) or to proceed with mining the area and provide sufficient lime treatment through the process plant to buffer any potential acidity from this material. The lime treatment process is detailed in Section 6.4.
- Upon identifying tailings indicating exceedance of 25 moles H⁺/tonne (0.04%S), the Site Manager will ensure:
 - The monitoring results are reported to the OEPA within seven days.
 - Details of the management measures proposed to be implemented to address the exceedance are submitted to the Contaminated Sites Branch within seven days.
 - The management measures proposed to address the exceedance are implemented.
- If extended exposure to air cannot be avoided, samples suspected of containing PASS material from the results of the field test will be collected by the Environmental Officer and submitted to a NATA accredited laboratory for analysis by the S_{Cr} procedure. Criteria for selection of samples for laboratory testing are described in Section 6.6.1.5.
- The effectiveness of the remedial procedures will be assessed by the Site Manager and Environmental Officer through additional field testing. A second application of neutralising material may be required if the Action Criteria specified in Section 5 are exceeded.

The management flow process is shown in Figure 6,7 and 8.

7.2 Groundwater

If results from fortnightly field tests or quarterly groundwater quality monitoring trigger any of the Action Criteria defined in Section 5.2, the Site Manager is responsible for ensuring the contingency plan outlined below is implemented.

- The Environmental Officer will advise MZI Management immediately of the issue.
- Additional water samples will be collected and analysed to confirm the original results and identify the source of contamination.
- The Site Manager will confirm that sufficient lime has been added to neutralise acidity and increase the dosage rate if required.

- The Site Manager will increase the groundwater level by pumping water from the Leederville aquifer production bores to ensure that all PASS material is below the water table where feasible.

8.0 RECORDS, REVIEW AND REPORTING

The Environmental Officer is responsible for ensuring that the ASSMP is reviewed annually and amended if necessary to ensure that it remains relevant, practical and effective.

The Environmental Officer is responsible for ensuring that all results for soil and groundwater monitoring undertaken in the year are included in MZI’s Annual Environmental Report (AER) for DER. The AER will also present the findings from any ASS related investigations resulting from exceedence of relevant trigger levels. The report will propose any amendments to the ASSMP.

The Site Manager shall ensure all records are kept in accordance with the site document control procedure. Records relevant to this Management Plan that shall be maintained include the items listed in Table 7.

Table 7: ASS Record to be Kept at Keysbrook

Record	Responsibility
Results of water monitoring	Environmental Officer
Results of ASS sampling	Environmental Officer
Lime usage: – Volume – Date – Location	Site Manager
Locations of PASS ore & topsoil stockpiles	Site Manager
Non-compliance Reports	Site Manager

9.0 RESPONSIBILITIES

9.1 General Manager

The General Manager is responsible for the following:

- Ensuring the project has adequate resources to meet the requirements of this Management Plan.
- In consultation with the Site Manager, determining areas of PASS to be managed.

9.2 Site Manager

The Site Manager is responsible for the following:

- Recording topsoil removed and stockpiled in the Topsoil Stockpile Register.
- Ensuring earthworks operators are appropriately trained and competent to operate the machinery, and have been informed of the conditions of clearing and locations of any environmentally significant sites.

- Regularly inspect excavation activities..
- Ensuring PASS material is managed in accordance with this Management Plan.
- In conjunction with the Environmental Officer, assess the effectiveness of contingency actions.
- Ensuring that sufficient lime supplies are maintained on site to allow addition when monitoring results indicate it is required.
- Ensuring that lime is crushed or ground.
- Ensuring ground lime is added in sufficient quantities to process water being used to return waste materials to the pit. The rate of lime addition will be calculated on the net acidity of the identified soil profile and include a safety factor of two. The quantity of lime added will be calculated to reduce the net acidity to levels below the trigger levels.
- Providing relevant training and awareness to all site employees and contractors to ensure they comply with the requirements of this Management Plan.
- Reviewing and approving ASS management information presented in the AER.
- Ensuring investigations into non-compliance with this plan are conducted.
- Ensuring management actions are put in place if Action Criteria are exceeded.
- Ensuring non-compliance with this Management Plan are rectified and reported to the relevant authorities.

9.3 Environmental Officer

The Environmental Officer is responsible for:

- Ensuring the site induction contains information regarding ASS.
- Ensuring appropriate ASS surveys are undertaken.
- Ensuring regular monitoring is carried out according to the Management Plan.
- Ensuring that water levels in monitoring bores are monitored in accordance with procedures.
- Ensuring that standing water levels and water quality data is reviewed..
- Regularly reviewing monitoring data to determine if relevant soil or groundwater trigger criteria are being exceeded or not.
- Advising the Site Manager when lime treatment is required.
- Ensuring that the management responses are implemented.
- Developing site specific water trigger levels when sufficient data becomes available to assign statistically valid values.
- Ensuring that the ASSMP is reviewed annually and amended if necessary to ensure that it remains relevant, practical and effective.
- Ensuring that all results for soil and groundwater monitoring undertaken in the year are included in MZI's Annual Environmental Report (AER).

10.0 REFERENCES

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11.0 GLOSSARY OF TERMS

AASS	Actual Acid Sulfate Soils.
ANC	Acid Neutralising Capacity.
ASS	Acid Sulfate Soils.
NATA	National Association of Testing Authorities.
PASS	Potential Acid Sulfate Soils.
pH _F	pH of a soil paste measured under field conditions.
pH _{FOX}	pH of a soil paste measured in the field following reaction with hydrogen peroxide.
pH _{KCl}	pH of a soil paste in 1 M KCl measured in the laboratory.
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfate method.
S _{POS}	Peroxide-oxidisable sulphur in soil samples.
TAA	Total Actual Acidity of soil samples.
TPA	Titratable Peroxide Acidity of soil samples.
TTA	Total Titratable Acidity of water samples.

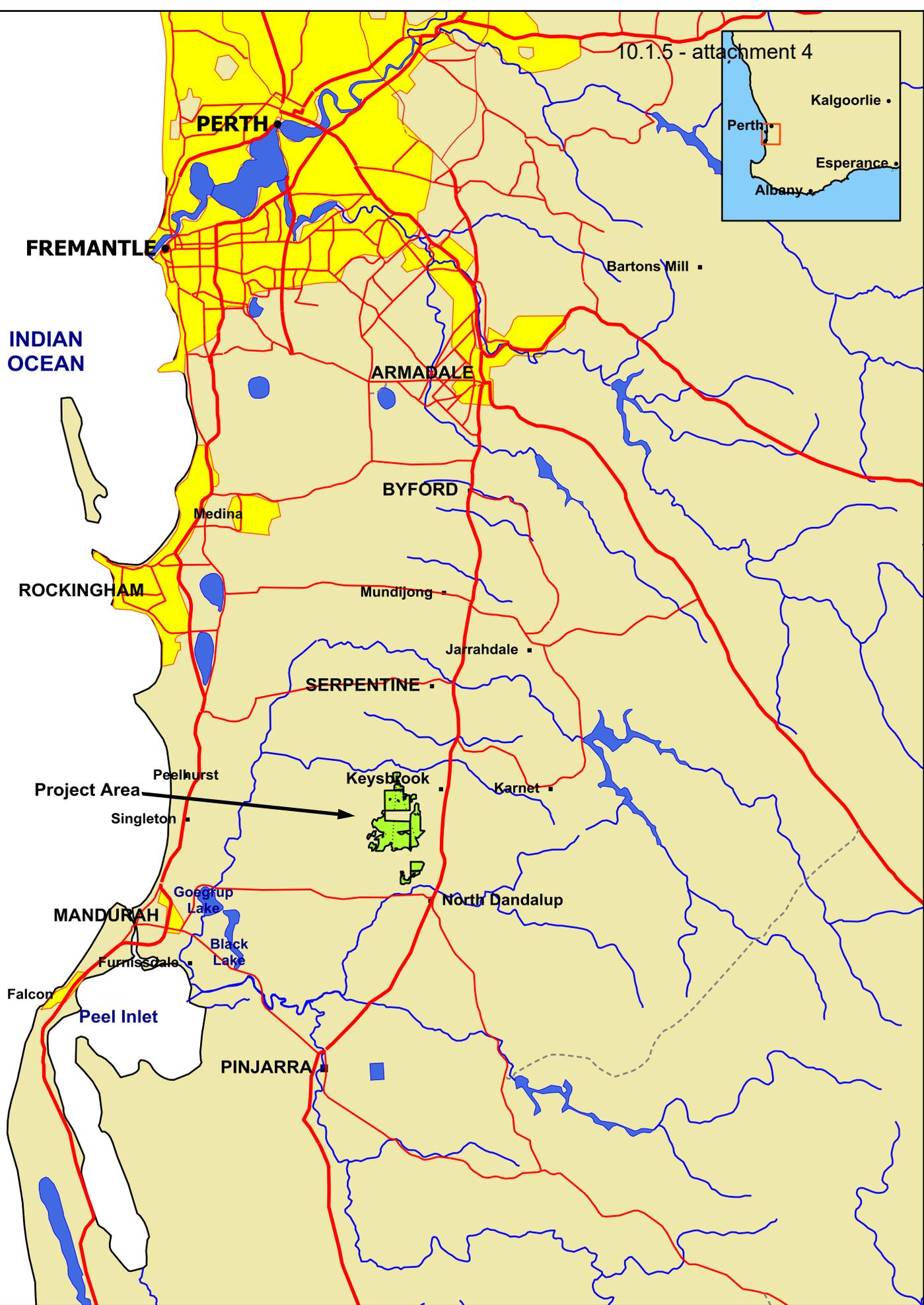
10.15-attachment 4

Figures

Figure 1: Location of Project



10.1.5 - attachment 4



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Scale 1:400000
Original Size: A4

0 10 km

Matilda Zircon Limited
Keysbrook
Mineral Sands Project
Ordinary Council Meeting - 17 February 2010

Location Plan

Figure 1

Figure 2: Cross Section of Mine Pit

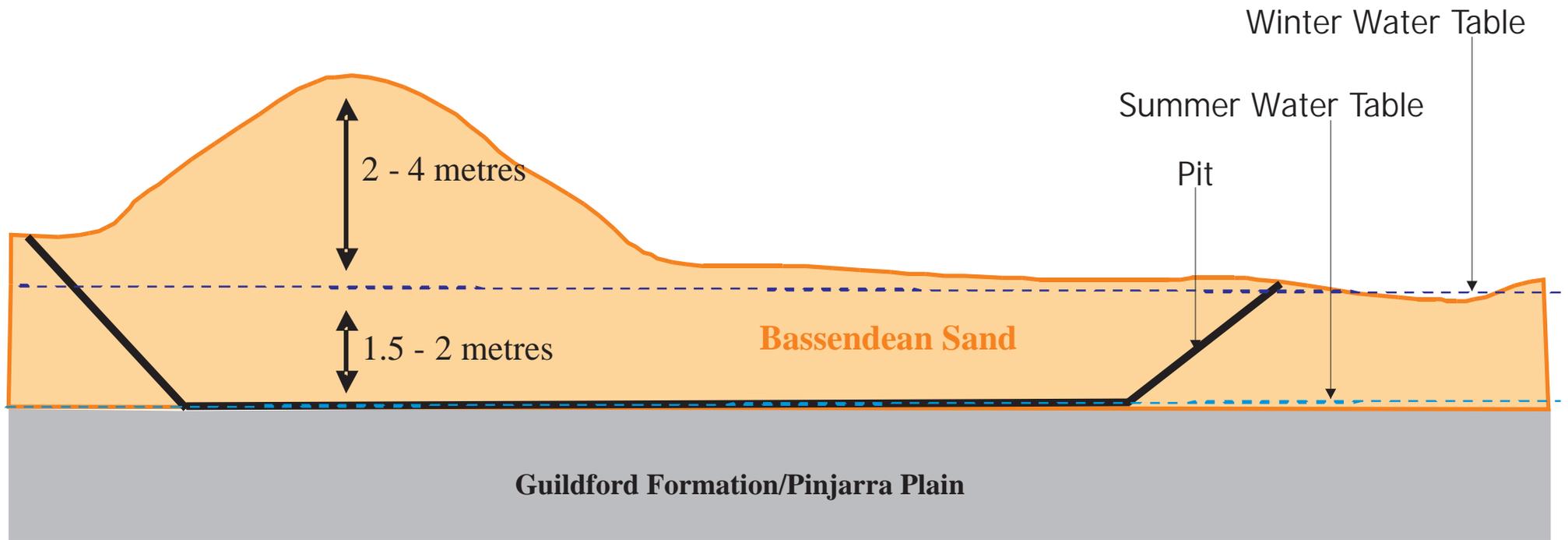
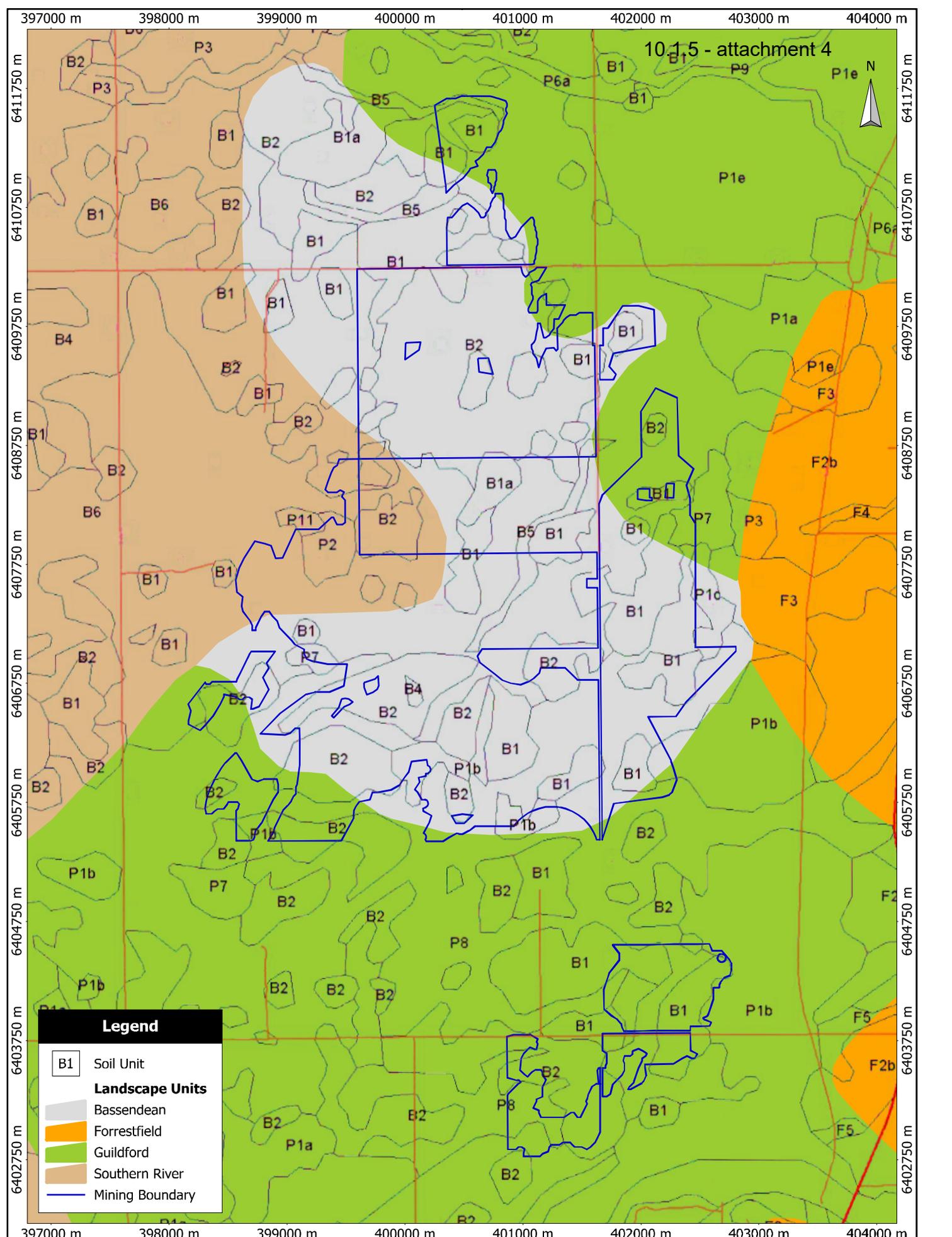


Figure 3: Soil Units in the Project Area



10.15 - attachment 4



Legend

- B1 Soil Unit
- Landscape Units**
- Bassendean
- Forrestdfield
- Guildford
- Southern River
- Mining Boundary



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Scale: 1:40000
Original Size: A4
Air Photo Date:
Grid: Australia MGA94 (50)

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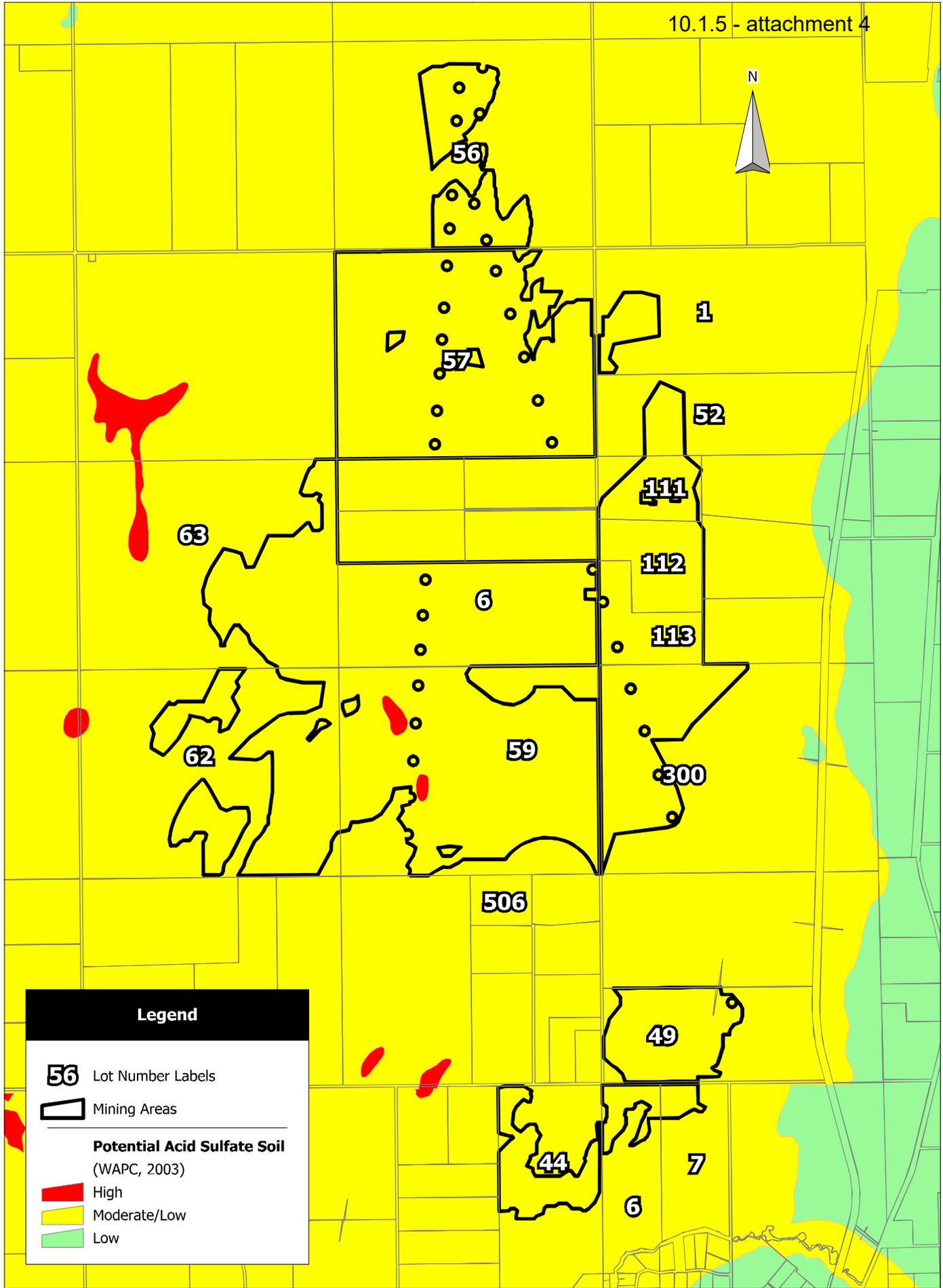
Matilda Zircon Ltd
Nutrient Management Plan

Soil Units in the
Project Area

Ordinary Council Meeting 17 February 2010

Fig 203

Figure 4: WAPC Potential Acid Sulfate Soil Risk Areas Within Keysbrook Mineral Sands



Legend

56 Lot Number Labels

Mining Areas

Potential Acid Sulfate Soil
(WAPC, 2003)

High

Moderate/Low

Low

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Scale: 1:40000
Original Size: A4
Grid: Australia MGA94 (50)

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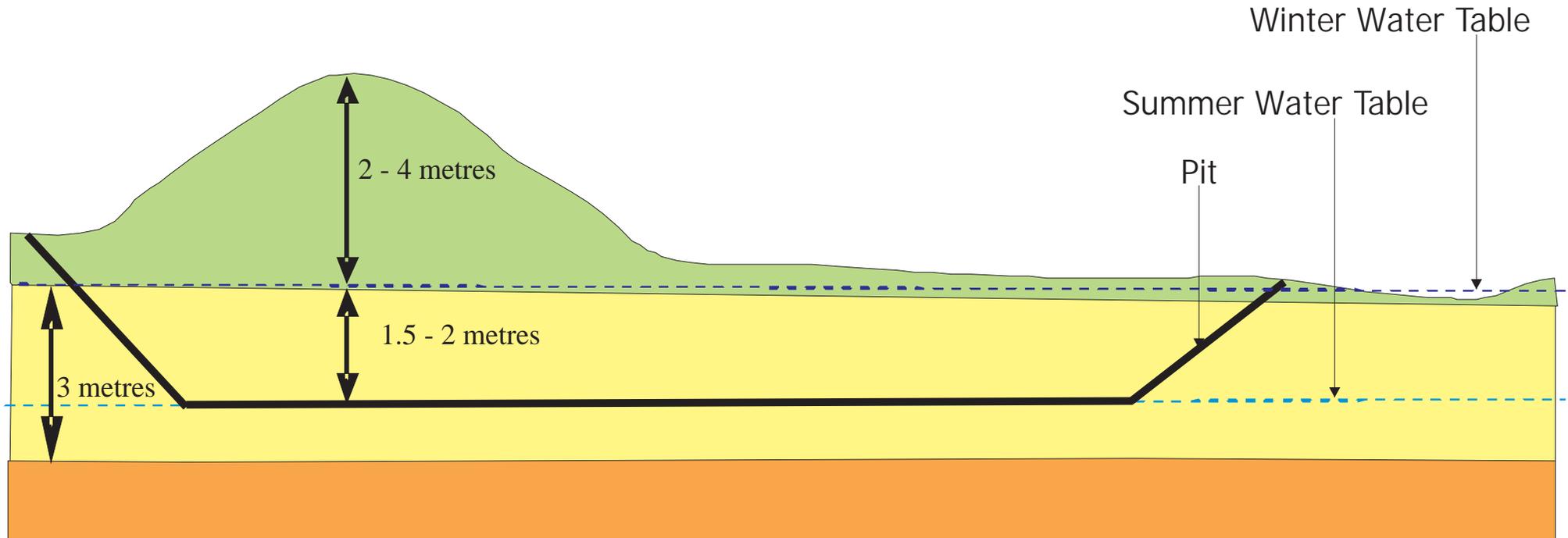
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Keysbrook

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WAPC Potential Acid Sulfate
Soil Risk Areas Within
the Project Area

Fig 20.4

Figure 5: PASS Zones Within the Mine Pit



- Zone 1: Very Low Risk
- Zone 2: Low - Moderate Risk
- Zone 3: High Risk

not to scale

Figure 6: Ore Sampling Management Process

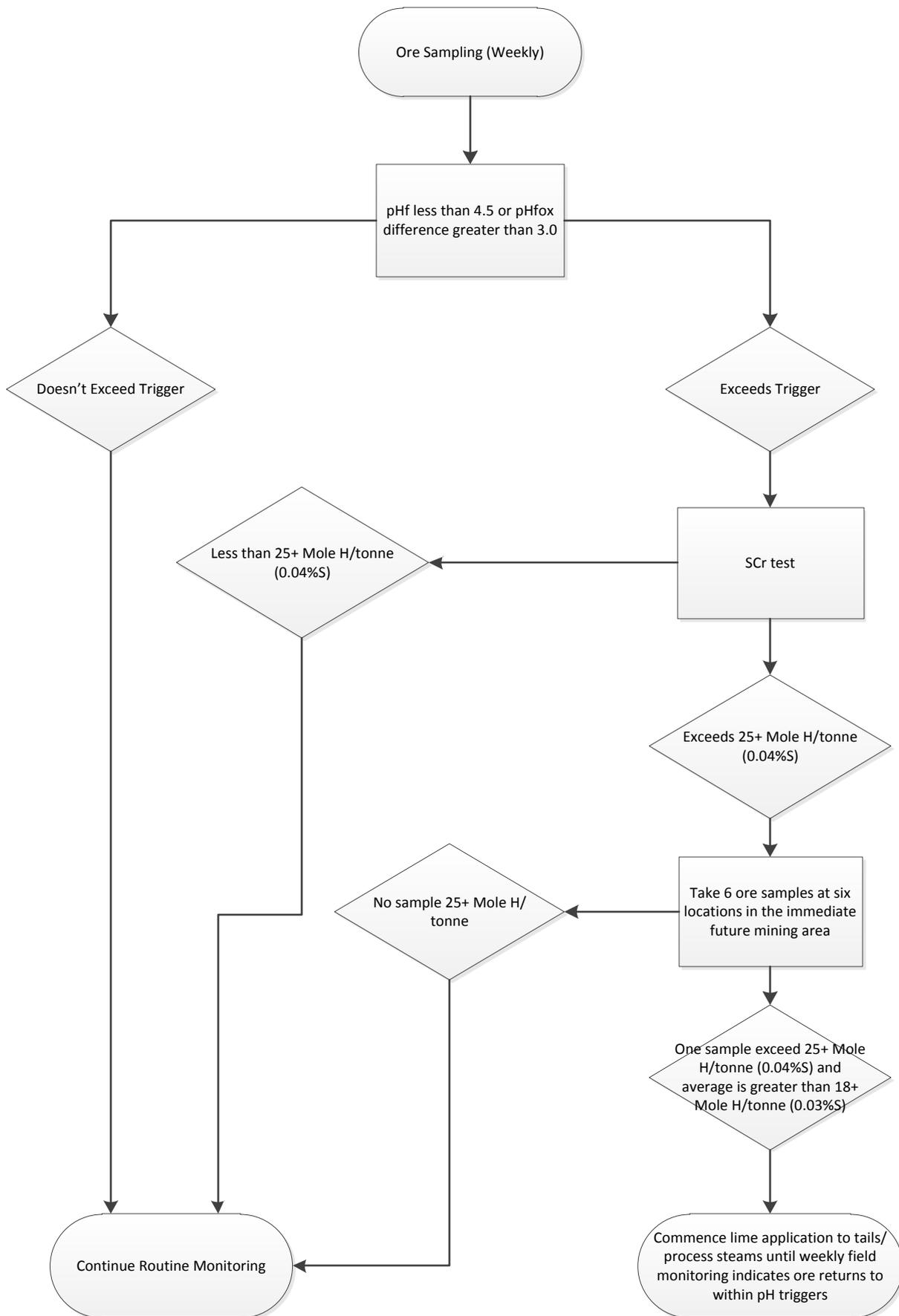


Figure 7: Tails Sampling Management Process

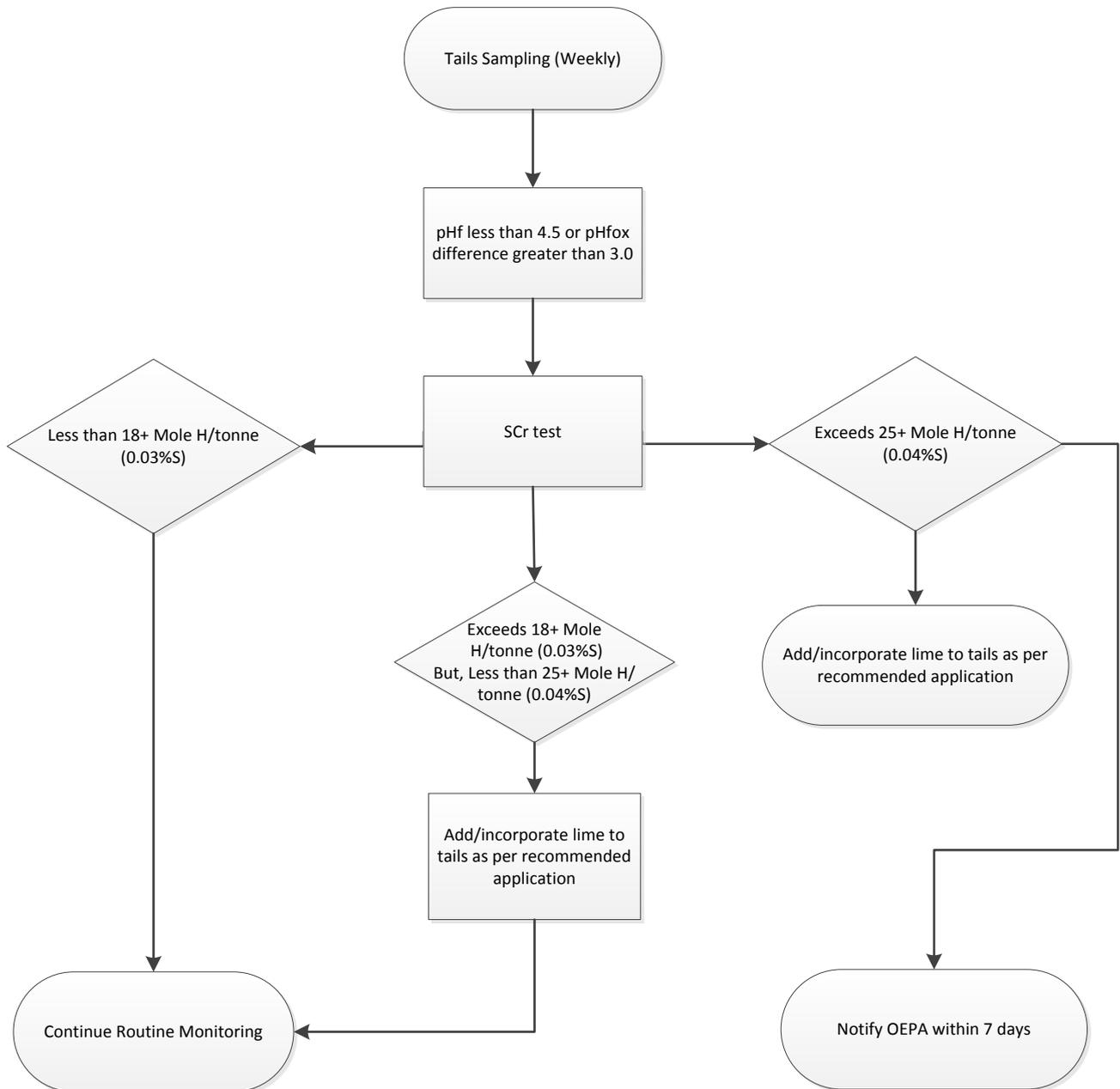
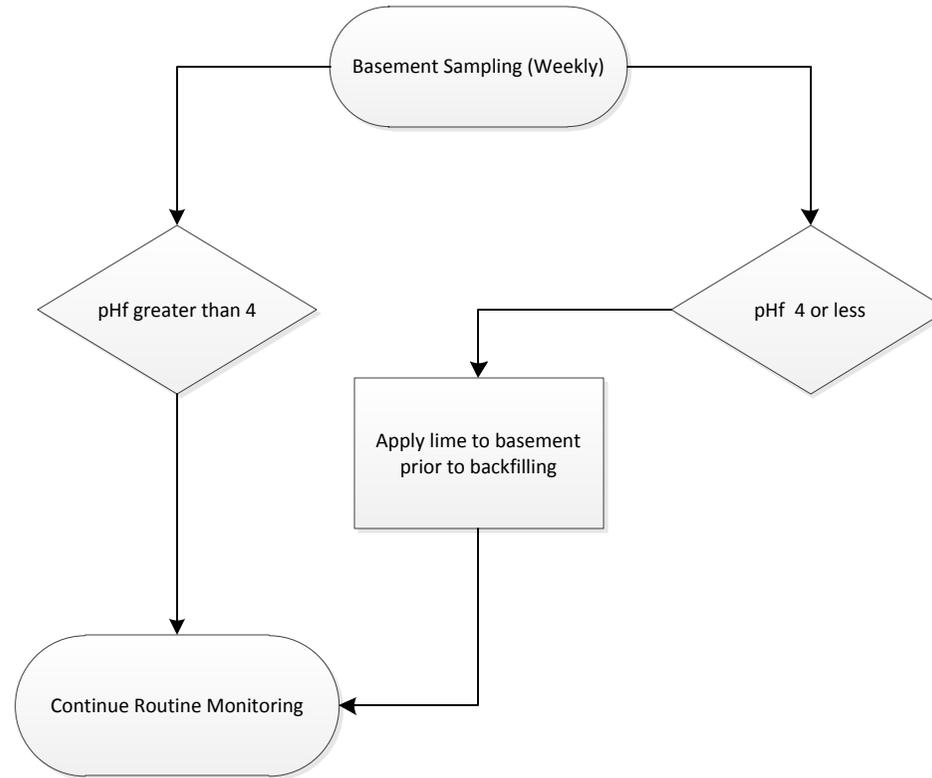


Figure 8: Mine Void Basement Sampling Management Process

Basement Sampling

August 2014



APPENDICES

APPENDIX 1:
Acid Sulfate Soil Survey 2005

Table A1: 2005 Survey Results, Initial Sampling

Test Site	Depth	pH _{KCl}	pH _{ox}	S _{KCl}	S _p	S _{pos}	ANC	TPA	TAA	TPA Action Criteria for Sand
				%	%	%	moles H ⁺ /tonne			
1:H2	0-0.5	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	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	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	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
	1-1.5	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	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	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

Table A2: 2005 Survey Results, Initial Sampling

Client ID		pH _{KCl}	pH _{ox}	S _p	S _{KCl}	S _{pos}	ANC	TPA	TAA
Site	Sample			%	%	%	Moles	H ⁺ /tonne	
Site 1	Hole 1(H1) 0.5	5.4	4.7	0.01	0.01	<0.01	<2	8	5
	Hole 1(H1) 1.0	5.0	4.6	0.03	0.03	<0.01	<2	17	7
	Hole 1(H1) 1.5	4.9	4.7	0.04	0.04	<0.01	<2	15	13
Site 1	Hole 3(H2) 0.5	5.7	6.0	<0.01	<0.01	<0.01	<2	<2	<2
	Hole 3(H2) 1.0	5.9	6.4	<0.01	<0.01	<0.01	<2	3	<2
	Hole 3(H2) 1.5	5.8	6.3	0.01	<0.01	0.01	<2	10	3
	Hole 3(H2) 2.0	5.9	6.5	0.01	<0.01	0.01	<2	2	<2
Site 2	Hole 2(H2) 0.5	6.0	5.7	<0.01	<0.01	<0.01	<2	2	<2
	Hole 2(H2) 1.0	5.6	5.8	0.01	0.01	<0.01	<2	10	5
	Hole 2(H2) 1.5	5.4	5.6	0.01	0.01	<0.01	<2	13	8
Site 2	Hole 4(H2) 0.5	6.0	6.1	<0.01	<0.01	<0.01	<2	<2	<2
	Hole 4(H2) 1.0	5.9	6.1	<0.01	<0.01	<0.01	<2	<2	<2
	Hole 4(H2) 1.5	5.5	5.7	0.01	0.01	<0.01	<2	<2	3
	Hole 4(H2) 2.0	5.7	6.0	0.01	0.01	<0.01	<2	<2	<2

APPENDIX 2:
Acid Sulfate Soil Survey 2007

Table A3: 2007 Survey Results, Field Tests

Date	Hole Number	Sample Depth	Texture and colour	Field Results		
				pH _F	Peroxide Reaction	pH _{Fox}
27/02/2007	1	0.2	black sand and organics	5	X	3.7
27/02/2007	1	0.7	grey sand	5	X	4.1
27/02/2007	1	1.2	grey sand	5.2	X	5.2
27/02/2007	1	1.9	grey/yellow sand	5.8	X	5.2
27/02/2007	1	2.4	grey/black sand	5.9	X	4.5
27/02/2007	1	2.9	grey/black sand	6.1	X	3.3
27/02/2007	1	3.4	grey/black sand	6	X	5
27/02/2007	1	4	grey sand/clay	5.5	X	4.9
27/02/2007	1	4.6	grey sand/clay	4.9	X	4.4
27/02/2007	2	0.7	black sand and organics	6.2	X	5.3
27/02/2007	2	1.2	yellow sand	5.8	X	5.1
27/02/2007	2	1.9	yellow sand	6	X	5.2
27/02/2007	2	2.4	grey sand/clay	6.1	X	5.4
27/02/2007	2	2.9	yellow sand/clay	6.1	X	5.4
27/02/2007	2	3.4	grey sand/clay	5.7	X	5.1
27/02/2007	3	0	black sand and organics	5.2	X	4.3
27/02/2007	3	0.5	yellow sand	5.2	X	4.8
27/02/2007	3	1	yellow sand	4.6	X	4.8
27/02/2007	3	1.5	yellow sand	5.6	X	5
27/02/2007	3	1.9	red clay	5.9	X	5.1
27/02/2007	3	2.4	yellow clay/sand	6.2	X	5.5
27/02/2007	4	0.2	black sand with organic matter	4.9	X	3.5
27/02/2007	4	0.7	grey sand	4.7	X	4.5
27/02/2007	4	1.2	yellow sand	5.2	X	4.6
27/02/2007	4	1.9	yellow/white sand	5.2	X	4.3
27/02/2007	4	2.4	white clay	5.7	X	4.5
27/02/2007	4	2.9	white clay	5.3	X	4.2
27/02/2007	4	3.4	white clay/gravel	5.4	X	4.4
27/02/2007	5	0.2	black sand and organics	6	X	4.2
27/02/2007	5	0.7	yellow/black sand	6	X	4.8

Date	Hole Number	Sample Depth	Texture and colour	Field Results		
				pH _F	Peroxide Reaction	pH _{FOX}
27/02/2007	5	1.2	yellow sand	6.2	X	5.1
27/02/2007	5	1.9	yellow sand	5.6	X	4.5
27/02/2007	5	2.4	yellow sand	5.5	X	4.2
27/02/2007	5	2.9	grey/yellow sand/clay	5.4	X	4.3
27/02/2007	5	3.4	grey/yellow sand/clay	5.3	X	4.4
27/02/2007	6	0.2	black sand and organics	5.6	X	5.2
27/02/2007	6	0.7	yellow sand	5.6	X	5.2
27/02/2007	6	1.2	yellow sand	5.9	X	5.4
27/02/2007	6	1.9	yellow sand	6	X	5.3
27/02/2007	6	2.4	yellow sand	5.9	X	5.4
27/02/2007	6	2.9	yellow sand	6	X	5.4
27/02/2007	6	3.4	yellow/black sand	5.9	X	5.3
27/02/2007	6	4	grey clay/sand	6	X	5.3
27/02/2007	6	4.6	grey clay/sand	6.2	X	5.3
27/02/2007	7	0.2	black sand and organics	5.7	X	4
27/02/2007	7	0.7	grey/black sand	5.2	X	3.4
27/02/2007	7	1.2	grey/yellow sand	5	X	4
27/02/2007	7	1.9	white/yellow sand	4.9	X	4.6
27/02/2007	7	2.4	yellow sand	5.4	X	4.2
27/02/2007	7	2.9	yellow/black sand	6	X	4.9
27/02/2007	7	3.4	grey/black sand	5	X	3.1
27/02/2007	7	4	yellow sand/ coffee rock	5.7	X	4.7
27/02/2007	7	4.6	yellow/red clay	5.9	X	4.8
27/02/2007	8	0.2	yellow/grey sand	4.3	X	2.4
27/02/2007	8	0.7	grey sand	4.7	X	3.5
27/02/2007	8	1.2	black sand	4.9	X	3.5
27/02/2007	8	1.9	yellow sand	4.2	XX	3.1
27/02/2007	8	2.4	yellow sand	4	X	2.9
27/02/2007	8	2.9	yellow clay	4.7	XX	4.3
27/02/2007	8	3.4	yellow clay	5	XX	4.5
22/02/2007	9	0.2	black sand and organics	5.4	X	5.5
22/02/2007	9	0.7	yellow sand	4.9	X	4.6

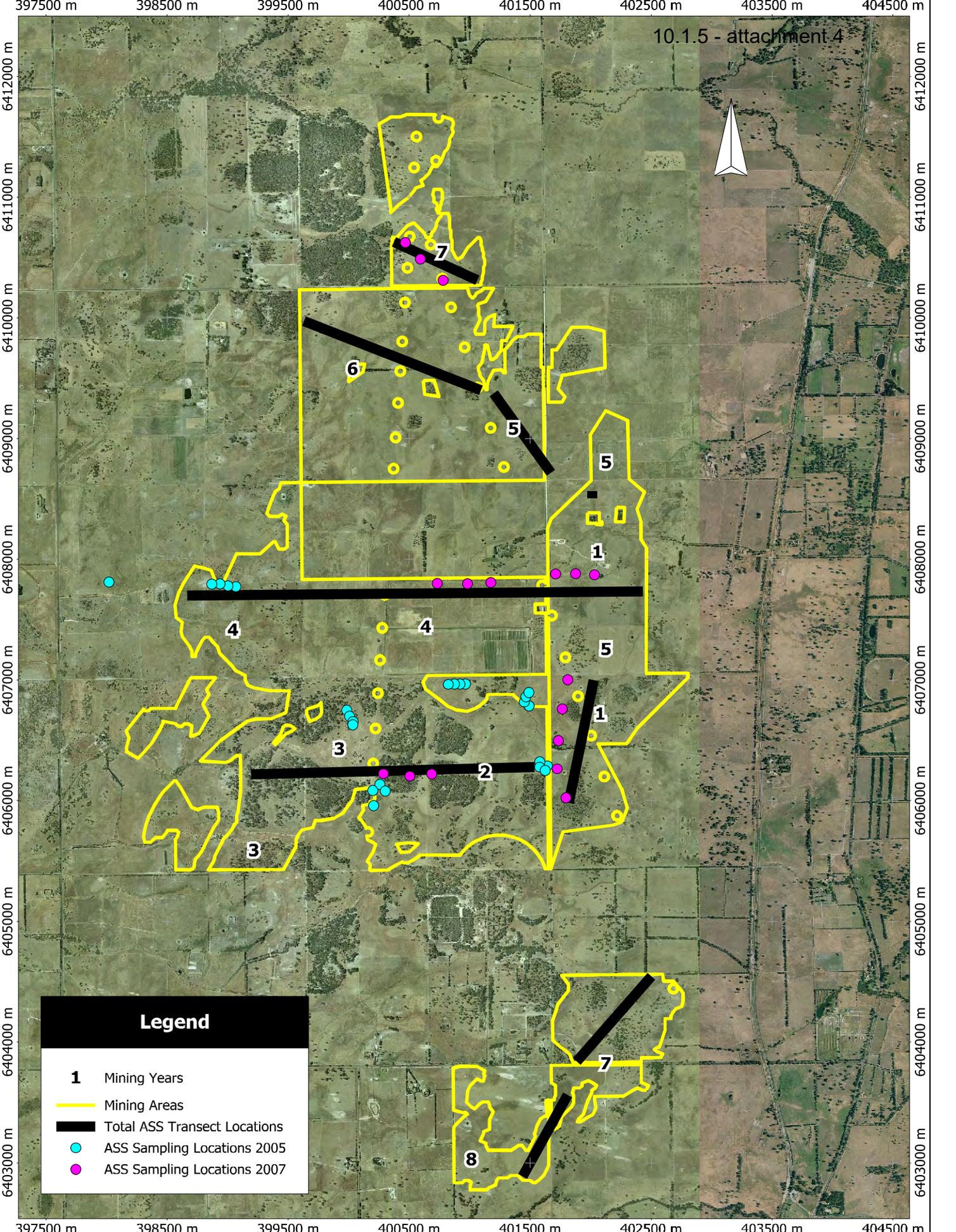
Date	Hole Number	Sample Depth	Texture and colour	Field Results		
				pH _F	Peroxide Reaction	pH _{FOX}
22/02/2007	9	1.2	black/yellow sand	5.2	X	5.1
22/02/2007	9	1.9	yellow sand	6	X	5.3
22/02/2007	9	2.4	yellow/white sand	5.6	X	5.3
22/02/2007	9	2.9	grey sand/clay	5.4	X	4.8
22/02/2007	9	3.4	grey sand/clay	4.9	X	3.3
22/02/2007	9	4	grey sand/clay	5.5	X	3.3
22/02/2007	9	4.6	grey sand/clay	5.7	X	4
22/02/2007	10	0.2	black sand and organics	4.6	X	4.1
22/02/2007	10	0.7	grey sand	4.7	X	4.8
22/02/2007	10	1.2	yellow sand	5.6	X	5.4
22/02/2007	10	1.9	grey sand/clay	5.5	XXX	2.9
22/02/2007	10	2.4	grey sand/clay	5.6	XX	2.8
22/02/2007	10	2.9	grey sand/clay	5.7	XX	2.7
22/02/2007	10	3.4	grey sand/clay	5.2	XX	3.5
22/02/2007	11	0.2	black sand and organics	4.7	X	4.3
22/02/2007	11	0.7	white sand	4.6	X	4.7
22/02/2007	11	1.2	yellow sand	4.9	X	5
22/02/2007	11	1.9	yellow sand/clay	5.3	X	5
22/02/2007	11	2.4	yellow sand/clay	5	X	4.1
22/02/2007	11	2.9	yellow sand/clay	5.3	X	5
22/02/2007	11	3.4	orange gravel	5.6	X	5
22/02/2007	12	0.2	black sand and organics	5.3	X	4.8
22/02/2007	12	0.7	white sand/clay	4.9	X	4.5
22/02/2007	12	1.2	white sand/clay	5.8	X	5.1
22/02/2007	12	1.9	white sand/clay	5	X	4.1
22/02/2007	12	2.4	white sand/clay	5.4	X	4.5
22/02/2007	13	0.2	black sand and organics	5.1	X	4.5
22/02/2007	13	0.7	yellow sand/clay	4.8	X	4.5
22/02/2007	13	1.2	yellow sand/clay	5.3	X	4.9
22/02/2007	13	1.9	orange clay/gravel	5.1	X	4.7
22/02/2007	14	0.2	black sand and organics	5	X	4
22/02/2007	14	0.7	yellow sand	4.6	X	4.6

Date	Hole Number	Sample Depth	Texture and colour	Field Results		
				pH _F	Peroxide Reaction	pH _{FOX}
22/02/2007	14	1.2	yellow sand/clay	6.1	X	5.5
22/02/2007	14	1.9	yellow/brown clay	6.2	X	5.6
22/02/2007	14	2.4	yellow/brown clay	6.1	X	6
1/03/2007	15	0.2	black sand and organics	4.5	X	4.7
1/03/2007	15	0.7	white sand	4.6	X	5.2
1/03/2007	15	1.2	yellow sand/gravel	5.6	X	5.1
1/03/2007	15	1.9	yellow sand/gravel	6.1	X	5.3
1/03/2007	15	2.4	white sand/gravel	6.2	X	5.3
1/03/2007	16	0.2	black sand and organics	5.3	X	4.7
1/03/2007	16	0.7	yellow sand	4.5	X	5.1
1/03/2007	16	1.2	yellow sand	5.9	X	5.4
1/03/2007	16	1.9	red clay	6.2	X	5.1
1/03/2007	16	2.4	red clay	5.6	X	4.7
22/02/2007	17	0.2	black sand and organics	4.5	X	3.9
22/02/2007	17	0.7	grey sand	4.3	X	4.6
22/02/2007	17	1.2	white sand/clay	5.5	X	4.9
22/02/2007	17	1.9	white sand/clay	5.7	X	4.8
22/02/2007	17	2.4	gravel clay	5.6	X	4.8
22/02/2007	18	0.2	black sand and organics	5.5	X	5.2
22/02/2007	18	0.7	yellow sand	4.5	X	4.7
22/02/2007	18	1.2	yellow sand	4.2	X	3.9
22/02/2007	18	1.9	yellow sand	5.5	X	4.5
22/02/2007	18	2.4	grey sand/clay	5.6	X	5

Table A4: 2007 Survey Results, Laboratory Analysis

No	Sample ID	pH _{KCl}	pH _{ox}	S _p	S _{KCl}	S _{pos}	S _{ras}	ANC	TAA	TPA	TPA Action Criteria
				%	%	%	%	Moles H ⁺ /tonne			
1	Hole 1-3.1m	5.6	5.9	0.01	<0.01	0.01			<2	6	18
2	Hole 7-0.7m	9.3	5.2	<0.01	<0.01	<0.01			<2	<2	18
3	Hole 7-3.6m	6.0	6.4	<0.01	<0.01	<0.01			<2	3	18
4	Hole 8-0.7m	5.0	6.3	<0.01	<0.01	<0.01			5	<2	18
5	Hole 8-1.2m	5.0	4.8	0.01	0.01	<0.01			5	<2	18
6	Hole 8-1.9m	4.9	5.2	0.01	0.01	<0.01			8	6	18
7	Hole 8-2.4m	4.6	4.7	0.02	0.02	<0.01			15	19	18
8	Hole 8-3.1m	4.4	5.2	0.04	0.04	<0.01			30	32	18
9	Hole 8-3.6m	4.5	6.5	0.02	0.02	<0.01			21	16	18
10	Hole 9-3.6m	5.9	7.5	<0.01	<0.01	<0.01		<2	<2	<2	18
11	Hole 9-4.3m	5.6	6.6	<0.01	<0.01	<0.01		<2	<2	16	18
12	Hole10-1.9m	5.3	3.9	0.03	<0.01	0.03	<0.01		2	40	18
13	Hole 10-2.4m	5.2	4.9	0.02	<0.01	0.02			3	10	18
14	Hole 10-3.1m	5.3	6.3	0.01	<0.01	0.01			3	9	18
15	Hole 10-3.6m	4.7	5.8	0.01	0.01	<0.01			9	14	18
16	Hole 18-1.2m	4.7	5.2	0.01	0.01	<0.01			10	17	18

Figure A1: 2007 ASS Sampling Locations



Legend

- 1** Mining Years
-  Mining Areas
-  Total ASS Transect Locations
-  ASS Sampling Locations 2005
-  ASS Sampling Locations 2007

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Scale: 1:40000
Original Size: A4
Air Photo Date: 2005
Grid: Australia MGA94 (50)

0 1000 m



Matilda Zircon Limited
Keysbrook

Ordinary Council Meeting - 17 February 2009

Initial Acid Sulfate Soil
Survey Sampling Locations

Fig 2006

**APPENDIX 3:
SOIL SAMPLING FIELD RECORD FORM**

Field Observations				Field Test							
Sample ID		Soil Description		Depth to Water	pH _F	pH _{FOX}	pH _F - pH _{FOX}	Reaction Rate	Temperature	Reference # of Photograph	Sample collected for Laboratory Analysis Y/N
Location	Depth/mBGL										
	From			To							

Reaction Rate Descriptions:
 L = Low reaction
 M = Medium reaction
 H = High reaction
 X = Extreme reaction
 V = Volcanic reaction

Sampling Conducted by: _____
 Date Sampled: _____
 Date Entered into Database: _____
 Entered by: _____

Sample ID			Field Observations				Field Test				
Location	Depth/mBGL		Soil Description	Depth to Water	pH _F	pH _{FOX}	pH _F - pH _{FOX}	Reaction Rate	Temperature	Reference # of Photograph	Sample collected for Laboratory Analysis Y/N
	From	To		mBGL	pH units	pH units	pH units	LMHXV	°C		
MZ01: 395565.32mE / 6390725.45mN											
MZ01	0.00	0.25	Silty sand. Grass root zone. Sand fraction mostly fine grained, well sorted, angular. Munsell colour 7.5YR 3/2 dark brown.		5.85	3.14	2.71	L	-		
MZ01	0.25	0.50	Peaty silty clay. Minor roots (fine fibrous). Munsell colour 7.5YR 2.5/1 black.	0.40	4.76	2.47	2.29	M	42		
MZ01	0.50	0.75	Clayey sand. Minor root material. Greyish brown sand to fine grained, angular, moderately sorted. Munsell colour 2.5Y 5/1 grey.		3.92	2.95	0.97	M	39		

Reaction Rate Descriptions:
 L = Low reaction
 M = Medium reaction
 H = High reaction
 X = Extreme reaction
 V = Volcanic reaction

Sampling Conducted by: _____
 Date Sampled: _____
 Date Entered into Database: _____
 Entered by: _____



**AIR QUALITY & DUST
MANAGEMENT PLAN
ADDENDUM**

Keysbrook Mineral Sands Project
October 2013

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Rev	Date	Description	By	Check	Approved
A	08/10/2013	Revised CH 8	MM	OEPA	OEPA

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1.0 PURPOSE

This addendum to the Air Quality & Dust Management Plan (AQDMP) provides a revised Chapter 8 of the OEPA approved AQDMP (2012). The revision is required to accurately reflect equipment selection opportunities and application of Australian Standards to accurately report against trigger values.

2.0 CHAPTER 8 – AMENDED

8.0 MONITORING

8.1 Australian Standards

Dust monitoring will be undertaken in accordance with the applicable Australian Standards applicable to the technology used, including:

- AS/NZS 3580.1.1:2007 - Methods for Sampling and Analysis of Ambient Air – Guide to Siting Air Monitoring Equipment.
- AS 3580.9.8:2008 - Determination of Suspended Particulate Matter - PM10 Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance (TEOM) Analyser.
- AS 3580.9.11:2008 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 beta attenuation monitors (BAM)
- AS/NZS 3580.9.7:2009 Methods for Sampling and Analysis of Ambient Air - Determination of Suspended Particulate Matter - Dichotomous Sampler (PM10, coarse PM and PM2.5) - Gravimetric Method.
- AS 3580.12.1: 2001 - Methods for sampling and analysis of ambient air - Determination of light scattering - Integrating nephelometer method.
- AS/NZS 3580.10.1:2003 - Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method.
- AS 2923-1987 – Guide for Measurement of Horizontal Wind for Air Quality Applications.

8.2 Monitoring Equipment

A selection of equipment shall be employed consistent with Australian Standard requirements for measurement of Total Suspended Particulates (TSP) and PM10.

TSP shall be measured, according to Australian standards, for a 12 month period adjacent a TEOM, BAM or similar monitoring device that will measure PM10, with a correlation factor developed to determine TSP against measured field measured PM10 data.

A network of Nephelometer devices shall be located on the project boundary adjacent to the active mining areas to indicate PM10. An additional Nephelometer device shall be located adjacent the HiVol sampler and TEOM, BAM (or similar), which will be used to calibrate and verify the Nephelometer PM10 readings against the measured PM10. The units will be equipped with the following accessories:

- Automated remote warning system that can send simultaneous emails and SMS alerts when dust concentrations exceed the trigger values.
- Remote telemetry system to allow for remote downloading of monitoring data.
- Solar power and high capacity battery system to provide continuous power.

A standard three-cup and vane anemometer will be used as part of the Keysbrook dust monitoring program. The anemometer will provide real time continuous monitoring of wind speed and direction and will be linked to an automated alarm system for when wind speeds exceed the trigger values detailed in

Table 1. The weather station can be powered by a number of sources including solar, generator or mains, depending on its location.

8.3 Monitoring Site Locations

The TEOM, BAM or similar monitoring site will be adjusted periodically to coincide with the active mining area and to ensure that all potentially sensitive receptors are covered under the monitoring program. Specific location of dust monitoring units will be determined in accordance with Australian Standards AS 2922-1987 and AS/NZS 3580.1.1:2007.

Nephelometers shall generally be deployed at or near the project boundary adjacent the active mining area and positioning shall reflect the mining schedule.

A summary of the monitoring site locations will be detailed in each Annual Environmental Report along with the proposed locations for the following year.

8.4 Monitoring Equipment Calibration

In addition to the field calibration, all dust monitoring equipment will be factory calibrated prior to first use and serviced and recalibrated annually, or as recommended by the manufacturer.

The Environmental Officer shall ensure that all dust monitoring equipment is correctly calibrated.

8.5 Dust Fractions

In accordance with Ministerial Statement 810, dust monitoring at the Keysbrook project will be undertaken for the following dust fractions:

- Total Suspended Particulates (TSP).
- Particulate matter smaller or equal to 10 microns (PM10).

TSP shall be measured by HiVol dust sampler and reported as calculated based on the measured correlation to PM10.

8.6 Trigger Values

Dust concentrations will be referenced against two trigger values; a lower value (or management level) that when exceeded indicates that further dust management is required, and an upper value (investigation level) that when exceeded indicates a potential breach of the Ministerial Conditions. Should the upper trigger value be exceeded, an investigation will be undertaken to determine the cause of the high dust concentrations and recommend additional abatement strategies to prevent any reoccurrences. Note that if the investigation level is determined to be as a result of high background no further abatements will be recommended.

During the first 12 months of operations the calibration correlation factor of TSP to PM10 will be developed. During this initial period, TSP shall be calculated as 200% of the measured PM10 value. This will be adjusted following analysis of the TSP data collected in the first 12 months of operations.

Any excursion of the upper trigger value will be reported to the Office of the Environmental Protection Authority in compliance with Ministerial Statement conditions. These incidences will also be reported in the Annual Environmental Report. The trigger values for both PM10 and TSP are provided in

Table 1.

Table 1: Dust Monitoring Trigger Values

Category	Trigger Value	
	Management Required	Investigation Required
Total Suspended Particles (TSP)	800 µg/m ³ 15 minute average	1,000 µg/m ³ 15 minute average
Particulate Matter less than 10 micron	40 µg/m ³ 24 hour average	50 µg/m ³ 24 hour average

8.7 Monitoring Procedures

The Environmental Officer is responsible for calibrating, siting and configuring the monitoring equipment. Equipment will be sited according to the mining schedule and proximity of the active mining area to sensitive receptors. The specific siting of each monitoring unit will be determined in accordance with Australian Standards AS 2922-1987 and AS/NZS 3580.1.1:2007.

The Environmental Officer is responsible for all data collection, assessment and reporting within the Annual Environmental Report. Dust monitoring will be undertaken in accordance with the Australian Standard 3580 series.

The Monitoring units will be configured to provide automated warnings to operations personnel should the “Management Required” trigger values be exceeded (refer

Table 1). The Site Manager is then responsible for implementing additional management measures or assessing if work in a particular area should be suspended until conditions abate. If the “Investigation Required” trigger values are exceeded, all work in the relevant area will cease and the Site Manager will initiate an investigation into the cause of the elevated dust concentrations. Additional management measures will be implemented as required. Work in the affected area will be allowed to re-commence at such a time as the Site Manager is confident that re-commencement of works will not result in dust emissions exceeding the “Investigation Required” trigger value. Where it can be demonstrated that work an adjacent areas does not result in dust emissions above the “Investigation Required” trigger value, work in these areas can continue.

The Environmental Officer will undertake periodic reviews of peak dust concentrations with respect to meteorological conditions, site activities and time to ensure the effectiveness of the Air Quality and Dust Management Plan. A review will also be conducted should multiple trigger value excursions occur within the same reporting period. The results of these reviews or any changes to dust management procedures resulting from a review will be detailed within the Annual Environmental Report.

Air Quality and Dust Management Plan Keysbrook Mineral Sand Project Keysbrook, Western Australia

Prepared for:

Matilda Zircon Limited



March 2012

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MBS
ENVIRONMENTAL

**AIR QUALITY AND DUST MANAGEMENT PLAN
KEYSBROOK MINERAL SAND PROJECT
KEYSBROOK, WESTERN AUSTRALIA**

MARCH 2012

PREPARED FOR

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Appendix 1:	Complaint Form
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1. INTRODUCTION

Matilda Zircon Limited (Matilda Zircon) proposes to develop an open cut mineral sand mine and primary processing plant within an area of rural land near the small townships of Keysbrook and North Dandalup (Figure 1). The Project is known as the Keysbrook Mineral Sands Project (Keysbrook). The project area is located on privately owned land, actively used for grazing. The project area covers 1,354 hectares. Of this, 1,174 hectares (87%) is open pasture and 180 hectares (13%) is native vegetation ranging in condition from good to completely degraded. Of the 180 hectares of native vegetation, 75 hectares will be protected for conservation in the long term. The expected mine life is up to eight years.

A Public Environmental Review (PER) has been conducted for the project and was approved by the WA Minister for the Environment on 19 October 2009 via Ministerial Statement 810 and by the Commonwealth Minister for the Environment on 16 February 2010. Details of the project may be found in the PER. Other documents relevant to the PER process include the Report and Recommendations of the EPA (Bulletin 1269) and the Appeals Report against the recommendation of the EPA. Both documents are available on the EPA webpage. Changes to Ministerial Statement 810 were authorised by the Minister for Environment; Water on 19 June 2011 to correct administrative errors within Condition 15. These have been taken into account within this Plan.

1.1 PURPOSE, OBJECTIVES AND TARGETS

This Air Quality and Dust Management Plan (AQDMP) has been prepared to comply with Condition 15 of Ministerial Statement 810. This plan applies during the construction, operation and decommissioning phases of the project.

The purpose of this AQDMP is to minimise significant impacts on air quality on the surrounding environment and the health, welfare and amenity of residents at neighbouring properties. The main issue of concern is the generation of dust from the project area. The air quality objectives and targets of this AQDMP are outlined in Table 1.

Table 1: Air Quality and Dust Objectives and Targets

Objective	Target
Ensure dust emissions from activities undertaken in implementing the proposal do not cause ambient dust concentration levels outside the boundary of the proposal area that are higher than:	
<ul style="list-style-type: none"> 1,000 micrograms per cubic metre of Total Suspended Particulates as a 15 minute average. 	Ambient dust concentrations do not exceed 1,000 $\mu\text{g}/\text{m}^3$ at the nearest sensitive receptor or beyond the site boundary.
<ul style="list-style-type: none"> 50 micrograms per cubic metre of Particulate Matter smaller than 10 microns as a 24 hour average, no more than five times per year. 	Ambient dust concentrations do not exceed 50 $\mu\text{g}/\text{m}^3$ PM_{10} at the nearest sensitive receptor or beyond the site boundary.
Identify measures to reduce dust emissions.	Implement measures to reduce dust emissions as identified in this AQDMP.
Ensure that dust emissions do not harm or adversely affect environmental values or the health, welfare and amenity of people and land uses.	Less than 2 valid complaints related to dust and air quality received in a calendar year.



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Scale 1:400000
Original Size: A4

0 10 km

Matilda Zircon Limited
Keysbrook
Mineral Sands Project
Ordinary Council Meeting - 17 February 2010

Location Plan

Figure 1

2. ENVIRONMENTAL CONSIDERATIONS

2.1 CLIMATE AND WINDS

The severity and extent of dust emissions is largely influenced by climate. Hot, dry conditions result in more favourable conditions for dust lift, while dust deposition is strongly influenced by wind strength and direction.

Climate and wind data for air quality and dust modelling has been taken from measurements made at Mundijong, approximately 15 kilometres north of Keysbrook.

Mundijong has a major valley system off the Darling Scarp located immediately south east of the town. Katabatic winds flowing down this valley would produce south easterly winds at Mundijong. At Keysbrook, a similar major valley off the Darling Scarp is also located south east of the project site. This may produce similar (south easterly) prevailing winds at the Keysbrook site.

Data from Mundijong will be used in conjunction with an on site weather station to obtain local wind speed and direction recordings to aid in implementing site dust management measures. The onsite weather station was established in 2006 and will be operated for the duration of the project. Site activities will therefore be determined by local weather parameters.

Data from the on site weather station indicates that during the summer months winds are predominantly from the south and east, though afternoon westerly winds are common. During autumn, morning winds are predominantly from the north to south east with occasional strong westerlies while afternoon winds tend to be from the east and south east with light southerly winds also common. Winds during the spring months are predominantly from the south and east in the morning and from the west in the afternoon.

2.2 SOILS

The soils of the Keysbrook project area consist mainly of Bassendean Sands. These sands are pale grey to white and can include fine to coarse particle sized, but are predominantly medium grained (Davidson, 1995). The mineralogy of Bassendean Sand is dominated by quartz, with minor feldspar, goethite (limonite) and heavy mineral sands. The quartz is present as fine to coarse rounded sand grained particles, and is not present as respirable quartz (Dr David Allen, pers com).

Dust emanating from the Keysbrook operation is likely to consist mainly of humified organic matter, with the inorganic component reflecting the mineralogy described above.

3. POTENTIAL ENVIRONMENTAL IMPACTS

Dust associated with mining activity is usually generated as a result of the disturbance of fine soil particles and the handling of bulk materials. Removal of vegetation and topsoil also contributes to this process. Consequent environmental effects are usually localised and depend on the size of the dust particles and the strength of the wind, usually decreasing rapidly with distance from the source.

The project is located in a Mediterranean climate region, experiencing dry summer months, during which time dust generation is expected to be at a peak. The closest permanently occupied house adjacent to an active mine pit will be approximately 100 metres from the mine boundary, located in the southeast of the mine area. A temporary dwelling exists within 80 metres of the mine boundary in the northern part of the project, however, this will not be occupied while mining occurs. Adjacent houses in other parts of the mine area are approximately 170 metres to more than 300 metres from active mine locations. Potential impacts to residents include:

- Reduced visual amenity.
- Risk to human health through inhalation.
- Nuisance.
- Risk to stock health.

In the immediate vicinity of the source, dust can cause stress to vegetation through:

- Blocking stomata (adversely affecting gas exchange).
- Reducing light availability (reducing photosynthetic ability and limiting plant growth).

Mining may potentially generate dust through wind dispersal as a result of activities such as:

- Removal of vegetation and topsoil.
- Erosion of disturbed areas.
- Vehicle movement (particularly at higher speeds) over unsealed surfaces.
- Excavation operations (especially during windy conditions).
- Storage of concentrate at the plant.
- Ore handling and transport. The final HMC product is stockpiled for transport to the secondary processing plant located at Bunbury. During loading, stockpiles may dry sufficiently that dust may be generated. Spillages of HMC product in the loading area may also dry sufficiently to generate dust, however as the HMC product is heavy, the risk of significant dust generation from these sources is considered low.

4. DUST MODELLING

SKM (2007) modelled air quality impacts from the proposed mining operations at Keysbrook using the Victorian EPA's AUSPLUME (Version 6.0) computer dispersion model. The model is designed to predict potential worst case ground-level concentrations of pollutants emitted from one or more sources. The report was compiled using three years of meteorological data from Mundijong.

This worst case scenario modelling indicates that, without management and mitigation measures, there is potential for air quality and dust impacts on those residences that are within 300 metres of active mining.

The modelled figures do not represent annual exceedances of the National Environmental Protection Measure (NEPM) and should only be used to indicate which receptors may potentially be negatively affected during each mining period.

The report highlights that the area of most concern is dust lift off from cleared areas due to easterly winds and recommends that long range forecasts be used as an aid to plan mining activities on a day to day basis. The report further recommends the following management measures be used to control dust emissions:

- Higher rate of water application on active areas.
- Consideration of the use of chemical or polymer stabilisers on non-active areas.
- Hydro mulching of rehabilitated areas.

In areas where residences are relatively close to operations, it was recommended that a monitoring network be established between the operations and the nearest residence such that if high dust concentrations occur, an alert is raised and additional management measures can be implemented.

5. BASELINE DUST MONITORING

Baseline monitoring for particulate matter less than 10 microns in diameter (PM₁₀) was carried out by SKM between 21 February and 17 April 2007. A Tapered Element Oscillating Microbalance (TEOM) fitted with a PM₁₀ inlet was located in an open paddock, with no livestock in the immediate vicinity, south west of the Keysbrook townsite. The unit was located far enough from the South West Highway that vehicle emissions from this road would not be a factor, although it was noted that some local vehicle emissions may still be experienced at the monitoring site.

Readings were taken every five minutes, with these values used to calculate hourly and daily averages.

All averaged 24-hour readings for PM₁₀ were below the NEPM value of 50 micrograms per cubic metre with the highest recording being 37.9 micrograms per cubic metre (79.4% of the NEPM value).

A comparison between dust concentrations and wind speed and direction indicated that the highest dust concentrations occurred with southerly or westerly winds, in contrast with the modelling which predicted easterly winds would generate higher dust concentrations. Additionally, the majority of high concentration readings coincided with wind speeds between 0.9 and 2.3 metres per second, though the highest concentrations were recorded during much higher wind speeds of 4.4 metres per second.

6. MANAGEMENT ACTIONS

6.1 MINING ACTIVITIES NEAR RESIDENCES

There are six residences within 300 metres of the project boundary. When these areas are being actively mined there is potential for dust impacts to these residences. Figure 2 shows the location of houses in relation to the project area.

Based on the result of modelling undertaken by SKM in 2007, an air quality buffer of 300 metres between mining active mining areas and occupied houses has been established. Mining may occur up to these buffers under any wind conditions. These air quality buffers correspond to the buffers established by noise modelling for the Noise Management Plan. Under the Noise Management Plan, no mining can only occur within 300 metres of occupied residences during night time and only in daytime hours if winds are calm or upwind and a 3.2 metre noise bund is in place. Current mine plans do not allow for the placement of noise bunds and therefore it is unlikely that these areas will be mined.

If mining does occur within these areas (i.e. within 300 metres of a residence), additional dust management measures may be required depending on the weather, wind direction and speed and moisture content of the soil materials.

Mining may occur within 300 metres of a residence if:

- The residence is not occupied. This may be as a result of a commercial agreement between Matilda Zircon and the residences owner and occupier; or
- Mining is undertaken during times of wet soil and/or conditions i.e. winter and autumn. Any such decision to mine within these areas would be based on assessment of the moisture content at the time as this is likely to be highly variable depending on climatic conditions; or
- Mining is undertaken during periods where winds are away from residences. Any such decision would be assessed at the time and would be subject to air quality standards documented in this Plan being complied with.

It is not expected that additional measures will be required during the winter months (May to October) as soil moisture and rainfall will be sufficient to minimise dust lift off. During late spring, summer and early autumn (mid October to late April) it is expected that soil conditions will be dry with insufficient moisture to prevent dust lift off during windy conditions. Figure 2 shows those mining areas that fall within the 300 metre buffer. These areas have been further defined according to the wind direction required to cause dust impacts at the nearest residence.

6.1.1 Timing of Mining in Buffer Areas

Air quality buffer areas have been defined based on the location of the residence and wind direction required to cause an impact at the nearest residence. These buffer areas, together with the likelihood of winds above 23 kilometres per hour and management implications are shown in Table 2. A threshold wind speed of 23 kilometres per hour has been selected in line

with the dust lift off threshold value of 6.5 metres per second (approximately 23.4 kilometres per hour) used by SKM during dust emission modelling.

Table 2: Likelihood of Wind Directions within Air Quality Buffer Zones.

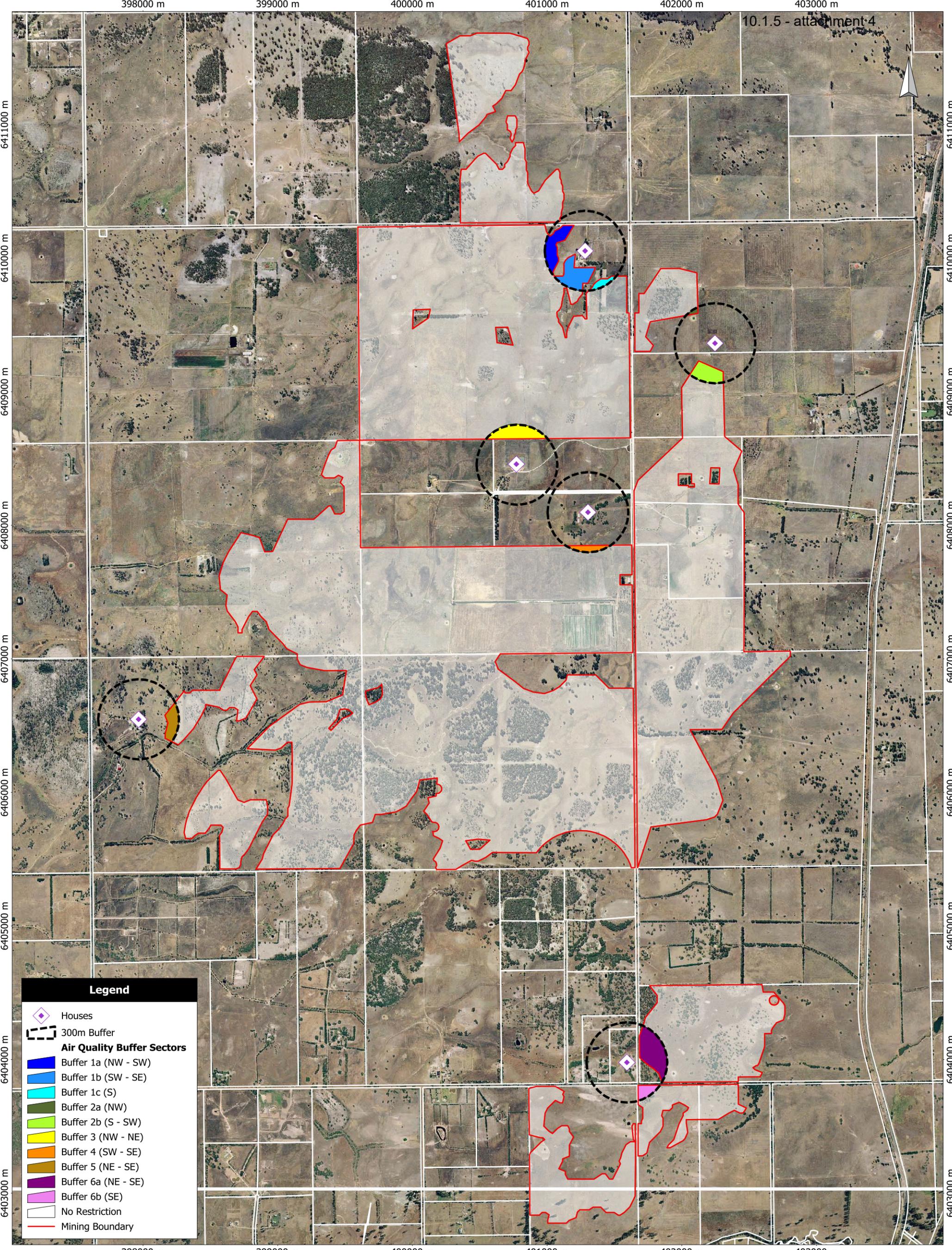
Buffer ID	Impacting Wind Direction	Likelihood of Winds >23 km/h – Morning	Likelihood of Winds >23 km/h – Afternoon	Management
1a	South West to North West	Likely: March – May	Likely: March – May	Avoid mining during March and April unless additional management measures are undertaken.
1b	South West to South East	Likely: September – May	Likely: December – February	Avoid mining during mornings from October to April and afternoons during summer unless additional management measures are undertaken.
1c	South	Likely: September – May	Likely: December – February	Avoid mining during mornings from October to April and afternoons during summer unless additional management measures are undertaken.
2a	North West	Likely: March – May	Likely: March – May	Avoid mining during March and April unless additional management measures are undertaken.
2b	South to South West	Unlikely	Unlikely	No additional management measures required
3	North west to North East	Likely: March – May	Unlikely	Avoid mining during mornings in March and April unless additional management measures are undertaken.
4	South West to South East	Likely: September – May	Likely: December – February	Avoid mining during mornings from October to April and afternoons during summer unless additional management measures are undertaken.
5	North East to South East	Likely: September – May	Likely: September – May	Avoid mining between October and April unless additional management measures are undertaken.
6a	North East to South East	Likely: September – May	Likely: September – May	Avoid mining between October and April unless additional management measures are undertaken.
6b	South East	Likely: September – May	Likely: September – May	Avoid mining between October and April unless additional management measures are undertaken.

6.1.2 Management of Mining Areas

Where wind speeds on site are expected to (or actually do) exceed 23 kilometres per hour and are from the pre-determined “Impacting Wind Direction” for that buffer sector as outlined in Table 2, additional management is required. The Site Manager is responsible for implementing the following hierarchy of management actions:

- Reduce vehicle speeds in the area until wind speeds reduce.
- Where reduction of vehicle speed does not result in decreased dust generation, increase the rate of watering to prevent dust lift off.
- When all other management actions have not resulted in decreased dust generation, cease mining activities within the buffer area and/or move to areas outside of the buffer.

To assist in managing dust impacts, a series of real time dust monitors will be established to provide a warning if dust emissions exceed trigger values outlined in Section 8. The Site Manager is responsible for implementing additional management measures once an alert is raised. If these measures do not result in a decrease in dust emissions, the Site Manager is responsible for moving mining operations outside of the 300 metre buffer area until wind conditions abate. Management measures may still be required within the buffer if conditions are such that wind generated dust lift off creates high dust concentrations in the absence of excavation activities.



10.1.5 - attachment 4



Legend

- Houses
- 300m Buffer
- Air Quality Buffer Sectors**
- Buffer 1a (NW - SW)
- Buffer 1b (SW - SE)
- Buffer 1c (S)
- Buffer 2a (NW)
- Buffer 2b (S - SW)
- Buffer 3 (NW - NE)
- Buffer 4 (SW - SE)
- Buffer 5 (NE - SE)
- Buffer 6a (NE - SE)
- Buffer 6b (SE)
- No Restriction
- Mining Boundary

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info@mbsenvironmental.com.au

Scale: 1:25000
Original Size: A3
Air Photo Date 2006
Grid: Australia MGA94 (50)

Matilda Zircon Ltd
Air Quality and Dust
Management

Air Quality Buffer Areas
Ordinary Council Meeting - 17 February 2020
Figure 20

6.2 GENERAL DUST MEASURES

6.2.1 Use of Weather Forecasts

Long range weather forecasts will be obtained and used on site as a proactive management tool to schedule tasks and to implement dust reduction activities. Table 3 shows publicly available information on the Bureau of Meteorology (BOM) website that will be accessed by site personnel to provide forecast information. The Special Services Unit, Western Australia (SSUWA) of BOM has confirmed that the unit provides a service with a detailed 72 hour local area forecast, with general format forecasts beyond that.

Table 3: Long Range Weather Information

Description	Reference / Link
4 day forecast charts	http://www.bom.gov.au/products/IDG00073.shtml
6 day (brief) Perth weather forecast	http://www.bom.gov.au/products/IDW12300.shtml
4 day southwest land division forecast	http://www.bom.gov.au/cgi-bin/wrap_fwo.pl?IDW10310.txt
3 day local water forecast	http://www.bom.gov.au/cgi-bin/wrap_fwo.pl?IDW11400.html
3 day local area forecast	ssuwa@bom.gov.au

6.2.2 Minimising Dust

The area disturbed will be kept to a minimum. Dust generation from cleared areas will be minimised by:

- Ensuring areas of native vegetation are not clear more than six months in advance of planned mining operations.
- Areas of pasture will be cleared between May and October when soil moisture is high and dust generation unlikely.
- Where mining activities are not expected to commence directly following topsoil stripping, cleared areas will be stabilised with hydromulch to minimise dust generation.

The Site Manager will ensure that activities are planned in such a way as to minimise the area of disturbance.

The Site Manager shall ensure that regular communications are held with neighbouring landowners and a complaints management system, including investigation, action and feedback, is implemented.

The Site Manager shall ensure the following general dust minimisation measures are implemented:

- No stripping of topsoil during periods of high winds.
- Watering of internal roads and disturbed (dust generating) areas as required.
- Using mulch, chemical or polymer suppressants where suitable, and surface spraying of clay to control dust prior to rehabilitation.

- Installing a high wind warning system to enable the site to initiate dust control mechanisms in a timely manner.
- Using sprinkler systems to minimise dust generation around the plant and infrastructure area.

The Environmental Officer shall ensure the following general management measures are implemented to minimise dust:

- Re-establishment of pasture and native vegetation as soon as possible after mining has been completed.
- Growing of temporary 'stubble' crops to bind soil and decrease wind velocity at ground level.
- The establishment of dust monitoring sites at strategic locations around the operation.
- Regularly review monitoring data and investigate results that indicate high dust levels. Implement corrective actions to eliminate the causal factors.
- Reporting of monitoring results in the Annual Environmental Report.

6.2.3 Topsoil Stripping

Topsoil stripping in dry conditions is recognised as an activity with a high risk of generating dust. The Site Manager shall ensure the following management measures are undertaken:

- Vegetation clearing and topsoil stripping activities in areas of native vegetation will not be undertaken more than six months prior to planned mining activities.
- In areas of pasture, clearing and topsoil stripping will be undertaken between May and October when soil moisture is high and dust generation unlikely.
- Cleared areas will be stabilised using hydromulch unless mining activities are to immediately follow clearing and topsoil stripping.
- Topsoil stripping will be conducted in calm wind conditions or when winds are blowing away from adjacent residents.
- A dedicated water truck will be in operation during stripping.
- Monitoring will be conducted and stripping will cease if suppression methods are unsuccessful in preventing excessive dust concentrations from crossing the site boundary.

6.2.4 Product Loading

The Heavy Mineral Concentrate (HMC) is produced in a wet process, with negligible risk of dust generation.

The Site Manager shall ensure the following routine practices are implemented to ensure dust generation from the product stockpile area is minimised:

- Spillages of HMC product in the stockpile area will be collected at the end of each shift and returned to the main product stockpile.
- Water carts or fixed sprinklers will be used to keep the work area damp.
- All loads of HMC are covered prior to leaving the stockpile area.

6.2.5 Operational Management

The Site Manager shall ensure the following operational management measures are implemented on site:

- Bund walls will be stabilised by grass, vegetation mulch or hydromulch to form an erosion resistant surface.
- Water trucks and water sources are available on site for dust suppression as required.
- Water will be sprayed onto internal traffic areas to minimise dust generated by vehicle movement.
- Ensuring that all site traffic adheres to the site speed limits to minimise dust generated by vehicle movement.
- Clay fines, a by-product of the mineral processing will be utilised on open areas during the summer period to form an erosion resistant crust.
- If meteorological conditions develop which result in the potential for dust generation, operations may be temporarily halted while dust control measures are implemented.
- Initiate proactive additional dust control measures and visual inspections when the site wind speed alarm indicates erosive wind speeds. In high risk dust generation locations or weather events, additional water suppression resources will be employed to suppress dust.

The Environmental Officer shall ensure:

- Hydromulch or a temporary stubble crop is used on open areas as temporary stabilisation.
- Topsoil stockpiles are sown with appropriate pasture species or hydromulched to form an erosion resistant surface.

6.3 EMISSIONS FROM VEHICLES, EQUIPMENT AND MECHANICAL PLANT

Emissions of air pollutants other than dust are expected to be minimal. The main source of such pollutants will be though the combustion of diesel fuel in light vehicles, earth moving equipment and stationary plant (such as pumps). Combustion of diesel fuel results in the production of nitrous oxides, carbon monoxide, volatile organic compounds and sulfur dioxide.

In order to minimise emissions, the Site Manager will ensure all plant and vehicles are serviced and maintained as per the manufacturer's instructions.

7. PERFORMANCE INDICATORS

7.1 GENERAL INDICATORS

Matilda Zircon will ensure that all realistic, best practice measures to prevent or minimise the generation of dust from mining activities will be implemented for the duration of the project. The effectiveness of the Air Quality and Dust Management Plan will be reviewed against the following indicators:

- Compliance with Ministerial Statement conditions for ambient air quality.
- Compliance with internal target values for ambient air quality (Table 4).
- The level of complaints received and validated.
- The level of complainant satisfaction achieved.

Using these performance indicators, this AQDMP will undergo continuous review of its dust management procedures and will adjust target levels and management practices as site based information and experience dictate.

7.2 DUST COMPLAINTS

The Environmental Officer is responsible for ensuring that all complaints are recorded, investigated and that feedback is provided to the complainant.

The Environmental Officer is responsible for ensuring that:

- All dust complaints from members of the public and landowners are documented on the site complaint form (Appendix 1).
- Completed forms are filed in the Environmental Records file.
- Once a complaint is received, the complaint is investigated. This will include accessing dust monitoring and wind direction and wind speed records to determine the likely validity of the complaint.
- The results of the investigation are fully documented and communicated to relevant Matilda Zircon personnel.
- Changes to management practices (if necessary) are communicated to the relevant operations personnel.
- Feedback on the complaint is provided to the complainant.
- Actions arising from the investigation which lead to amendments to site procedures are recorded and reported in the AER.

A blank pro-forma complaint form will be posted on the Matilda Zircon website, along with site contact details, when these are known. The website address is <http://www.matildazircon.com.au/>.

8. MONITORING

8.1 AUSTRALIAN STANDARDS

All dust monitoring will be undertaken in accordance with the following standards:

- AS/NZS 3580.1.1:2007 – Methods for Sampling and Analysis of Ambient Air – Guide to Siting Air Monitoring Equipment.
- AS 3580.9.8:2008 – Determination of Suspended Particulate Matter - PM10 Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance (TEOM) Analyser.
- AS/NZS 3580.9.7:2009 Methods for Sampling and Analysis of Ambient Air - Determination of Suspended Particulate Matter - Dichotomous Sampler (PM10, coarse PM and PM2.5) - Gravimetric Method.
- AS 3580.12.1: 2001 - Methods for sampling and analysis of ambient air - Determination of light scattering - Integrating nephelometer method.
- AS 2923-1987 – Guide for Measurement of Horizontal Wind for Air Quality Applications.

8.2 MONITORING EQUIPMENT

A combination of Tapered Element Oscillating Microbalances (TEOM) and DustTrak units (laser photometers) will be used to monitor dust emissions from the site to ensure compliance with the ministerial conditions and to provide a proactive dust management strategy for the Keysbrook operations. These are detailed within the following subsections.

8.2.1 TEOM

TEOM provides a continuous, real time dust concentration measurement and is sufficiently accurate to be used for compliance reporting. Each TEOM will be setup to monitor both TSP and PM10 simultaneously and will be configured with an alarm system in the event of a trigger level excursion (refer Table 4). The TEOM system requires a continuous power supply of approximately 1,000 watts which will be provided by the mains or a portable generator unit. The generator will be positioned such that exhaust emissions do not interfere with the monitoring results. A stable concrete base is also required for the TEOM to operate correctly. This will be constructed at each TEOM site.

8.2.2 DustTrak

The DustTrak unit, manufactured by TSI Inc, is the most industry tested laser photometer and can be configured for almost any dust monitoring application. The DustTrak units employed at the Keysbrook operation will be established to provide a high level of dust management. Each unit will be configured to simultaneously monitor both TSP and PM10 and will be equipped with the following accessories:

- A warning beacon for when dust concentrations exceed the trigger levels detailed in Table 4.

- Automated remote warning system that can send simultaneous emails and SMS alerts when dust concentrations exceed the trigger values.
- Remote telemetry system to allow for remote downloading of monitoring data.
- Solar power and high capacity battery system to provide continuous power.

8.2.3 Weather Station

A standard three-cup and vane anemometer will be used as part of the Keysbrook dust monitoring program. The anemometer will provide real time continuous monitoring of wind speed and direction and will be linked to an automated alarm system for when wind speeds exceed the trigger values detailed in Table 4. The weather station can be powered by a number of sources including solar, generator or mains, depending on its location.

8.3 MONITORING SITE LOCATIONS

The TEOM is not portable and is typically established to form a permanent monitoring site. The TEOM sites will therefore be established at high risk areas only, at occupied residences located within or adjacent to the active project area. The location and number of TEOM monitoring sites will be adjusted periodically to coincide with the active mining area and to ensure that all potentially sensitive receptors are covered under the monitoring program. Specific location of dust monitoring units will be determined in accordance with Australian Standards AS 2922-1987 and AS/NZS 3580.1.1:2007.

A summary of the TEOM monitoring site locations will be detailed in each Annual Environmental Report along with the proposed locations for the following year.

Monitoring of low risk areas with no adjacent receptors will be monitored using the DustTrak system. A DustTrak unit will be established on each cardinal side of the active 30 hectare mining area, either within or on the project boundary. These will be relocated frequently as the active mining area moves.

The weather station will be situated adjacent to a TEOM monitoring site.

8.4 MONITORING EQUIPMENT CALIBRATION

A DustTrak unit will be situated immediately adjacent to each TEOM and will be used to determine a calibration factor for the DustTrak units situated in low risk project areas. The calibration factor will be adjusted regularly on each of the low risk area DustTrak units to ensure their accuracy.

In addition to the field calibration, all dust monitoring equipment will be factory calibrated prior to first use and serviced and recalibrated annually, or as recommended by the manufacturer.

The Environmental Officer shall ensure that all dust monitoring equipment is correctly calibrated.

8.5 DUST FRACTIONS

In accordance with Ministerial Statement 810, dust monitoring at the Keysbrook project will be undertaken for the following dust fractions:

- Total Suspended Particulates (TSP).
- Particulate matter smaller or equal to 10 microns (PM10).

Both the TEOM and DustTrak units will be configured to simultaneously monitor these dust fractions.

8.6 TRIGGER VALUES

Dust concentrations will be referenced against two trigger values; a lower value that when exceeded indicates that further dust management is required, and an upper value that when exceeded indicates a breach of the Ministerial Conditions. Should the upper trigger value be exceeded, an investigation will be undertaken to determine the cause of the high dust concentrations and prevent any reoccurrences. Any excursion of the upper trigger value will be reported to the Office of the Environmental Protection Authority in compliance with Ministerial Statement conditions. These incidences will also be reported in the Annual Environmental Report. The trigger values for both PM10 and TSP are provided in Table 4.

Table 4: Dust Monitoring Trigger Values

Category	Trigger Value	
	Management Required	Investigation Required
Total Suspended Particles (TSP)	800 µg/m ³ 15 minute average	1,000 µg/m ³ 15 minute average
Particulate Matter less than 10 micron	40 µg/m ³ 24 hour average	50 µg/m ³ 24 hour average
Wind Speed	23 kilometres per hour	

8.7 MONITORING PROCEDURES

The Environmental Officer is responsible for calibrating, siting and configuring the monitoring equipment. Equipment will be sited according to the mining schedule and proximity of the active mining area to sensitive receptors. The specific siting of each monitoring unit will be determined in accordance with Australian Standards AS 2922-1987 and AS/NZS 3580.1.1:2007.

The Environmental Officer is responsible for all data collection, assessment and reporting within the Annual Environmental Report. Dust monitoring will be undertaken in accordance with the Australian Standard 3580 series.

The DustTrak units will be configured to provide an email and SMS warning to the Environmental Officer and Site Manager should the “Management Required” trigger values be exceeded (refer Table 4). The Site Manager is then responsible for implementing additional management measures or assessing if work in a particular area should be suspended until conditions abate. If the “Investigation Required” trigger values are exceeded, all work in the relevant area will cease and the Site Manager will initiate an investigation into the cause of the elevated dust concentrations. Additional management measures will be implemented as required. Work in the effected area will be allowed to re-commence at such a time as the Site Manager is confident that re-commencement of works will not result in dust emissions exceeding the “Investigation Required” trigger value. Where it can be demonstrated that work an adjacent areas does not result in dust emissions above the “Investigation Required” trigger value, work in these areas can continue.

The Environmental Officer will undertake periodic reviews of peak dust concentrations with respect to meteorological conditions, site activities and time to ensure the effectiveness of the Air Quality and Dust Management Plan. A review will also be conducted should multiple trigger value excursions occur within the same reporting period. The results of these reviews or any changes to dust management procedures resulting from a review will be detailed within the Annual Environmental Report.

9. RESPONSIBILITIES

Overall responsibility for ensuring that the site environmental management requirements are met during the life of the operation will rest with Matilda Zircon's Site Manager, ensuring that:

- Construction and operational personnel, both the proponent's workforce and contract personnel, conform with requirements in the AQDMP.
- Personnel on site are fully inducted and aware of their environmental responsibilities and obligations.
- Monitoring requirements are being met.

Contracting and consulting companies undertaking construction or operational roles will be required to:

- Maintain routine contact with the Site Manager to ensure that environmental objectives, management aims and monitoring requirements of this Plan are being met.
- Provide reports to the Site Manager on environmental issues and conduct regular audits.
- Ensure they have sufficient resources to adequately conduct the tasks required.

9.1 SITE MANAGER

The Site Manager is responsible for:

- Ensuring that regular communication is conducted with neighbouring landowners regarding mine operations and environmental monitoring results.
- A complaints management system, including investigation, action and feedback, is implemented and maintained.
- Reviewing the Annual Environmental Report prior to submission to DEC.
- Ensuring all employees and contractors are provided with inductions and training.
- Reviewing long range weather forecasts as part of planning mining activities.
- Ensuring that additional dust management measures are put in place while mining within buffer areas that correspond to the wind direction experienced or expected.
- Ensuring additional management measures are put in place once a high wind alert is raised.
- Ensuring that mining operations are moved outside of the 300 metre buffer area until wind conditions abate if management measures do not result in decreased dust emissions.
- Planning mining activities in such a way as to minimise the area of disturbance.
- Planning clearing and topsoil stripping activities such that areas of native vegetation are not cleared more than six months prior to planned mining activities.
- Planning clearing and topsoil stripping activities in areas of pasture such that clearing and topsoil stripping are undertaken between May and October when soil moisture is high and dust generation unlikely.

- Ensuring cleared areas are stabilised using hydromulch unless mining activities are to immediately follow clearing and topsoil stripping.
- Ensuring topsoil stripping is conducted in calm wind conditions or when winds are blowing away from adjacent residences.
- Ensuring that a dedicated water truck is in operation during topsoil stripping and excavation.
- Conducting visual monitoring and halting stripping if suppression methods employed are unsuccessful in preventing dust from crossing the boundary of the premises.
- Watering of internal roads and dust generating disturbed areas as required.
- Ensuring that all site traffic adheres to the site speed limits to minimise dust generated by vehicle movement.
- Ensuring topsoil stockpiles are sown with appropriate stubble crop (e.g. cereal rye or oats) or hydromulched to form an erosion resistant surface.
- If meteorological conditions develop which result in the potential for dust generation, temporarily halting operations while dust control measures are implemented.
- Sprinkler systems being operated to minimise dust generation around the plant and infrastructure area.
- Collection of spillages of HMC product in the stockpile area at the end of each shift and returned to the main product stockpile.
- Use of water carts or fixed sprinklers to keep the work area damp.
- Ensuring loads of HMC are covered prior to leaving the stockpile area.

9.2 ENVIRONMENTAL OFFICER

The Environmental Officer is responsible for:

- Ensuring mulch, chemical or polymer suppressants or surface spraying of clay are used where suitable to control dust prior to rehabilitation.
- Bund walls are stabilised by grass, vegetation mulch or hydromulch to form an erosion resistant surface.
- Re-establishment of pasture and vegetation as soon as possible after mining has been completed.
- Growing of temporary 'stubble' crops to bind soil and decrease wind velocity at ground level.
- Establishment and operation of dust monitoring sites at strategic locations around the project area.
- Installation and operation of a high wind warning system to enable the site to initiate dust control mechanisms in a timely manner.
- Compiling the Annual Environmental Report and providing it to the Site and Resident Manager for review.
- Reporting of monitoring results in the Annual Environmental Report.

- Investigating all complaints, completing the complaints form and responding to the complainant.
- Investigating excursions of the “Investigation Required” trigger values for air quality and dust and to liaise with the Site Manager to implement additional management measures if required.
- Reviewing weather data.
- Siting of dust monitors and undertaking dust sampling.
- Ensuring dust monitoring equipment is correctly calibrated.
- Managing dust monitoring data within a dedicated database.
- Reporting to the Site Manager as appropriate when trigger values are exceeded.
- Tracking the number of exceedances of the PM10 target in a calendar year.
- Ensuring four continuous particle monitors are established and operated within Air Quality buffer areas when active mining is occurring in these areas.
- Conduct internal audits annually.
- Ensuring the site induction contains information on the environmental aspects of the project.
- Providing environmental educational materials to supervisors for toolbox meetings.
- Ensuring the site weather station is operational.
- Filing electronic and hardcopy weather data.

10. MANAGEMENT PLAN REVIEW

It is the responsibility of the General Manager to ensure that the AQDMP is reviewed annually. This will enable the continual review and adjustment where necessary of annual plans, including inputs of the results of monitoring assessments and feedback from relevant stakeholders.

The review will occur in June – August of each year, to enable review of the success of dust management efforts of the past year prior to commencement of the next likely dry climatic period where there is greater risk of dust emissions occurring.

11. RECORD KEEPING, REPORTING AND AUDITING

11.1 RECORD KEEPING

Records relevant to the AQDMP that shall be maintained include items listed in Table 5.

Table 5: Air Quality Records to be Maintained at Keysbrook

Record	Responsibility
Area Cleared	Site Manager
TEOM Monitoring Results	Environmental Officer
DustTrak Monitoring Results	Site Manager
Meteorological Monitoring Results	Environmental Officer
Equipment Calibration Records	Environmental Officer
Complaints	Environmental Officer
Annual Environmental Reports	Environmental Officer
Exceedance of Trigger Levels and Corrective Actions	Site Manager
Performance Reviews	Environmental Officer

11.2 ENVIRONMENTAL REPORTING

All dust and air emissions are estimated on an annual basis as part of National Pollutant Inventory (NPI) reporting for the Federal Department of Sustainability, Environment, Water, Populations and Community. These reports are publically available on the NPI website (<http://www.npi.gov.au/>).

All records of dust monitoring kept in accordance with this plan will be summarised in the Annual Environmental Report (AER), which will be submitted to DEC.

All non-compliances with the objectives and targets listed in Table 1 will be reported to the OEPA within two business days of the non-compliance being known, including all exceedances of the 50 $\mu\text{m}/\text{m}^3$ target for PM10. The number of exceedances of the PM10 target per calendar year will be tracked by the Environmental Officer. Where there are more than five exceedances in a calendar year, this will be reported to OEPA as a non-compliance with Ministerial Statement 810 Condition 15-3(e).

All dust complaints and remedial actions undertaken will also be summarised in the AER.

Where confidentiality clauses allow, agreements with landowners in regards to dust and air quality will be summarised in the AER for the area proposed to be mined in the coming year.

The Environmental Officer is responsible for compiling the AER and providing it to the Site Manager to review prior to submission to DEC and the local Shire Councils.

11.3 PERFORMANCE REVIEW

Performance reviews will be undertaken following audits in accordance with Section 7 above.

Should audits or monitoring results show an increasing frequency of exceedence of the targets in Table 4, or should there be an increase in the frequency of complaints, additional modelling work and/or improvements to dust mitigation measures may be implemented. Improvements to dust mitigation measures may include the following:

- Use of dust barriers in specific locations.
- Seal topsoil stockpiles with hydromulch.
- Increased water application.

11.4 AUDITING

The Environmental Officer will conduct internal compliance audits on a periodical basis in accordance with company standards. External audits will be undertaken by regulatory agencies as required as well as independent third parties.

12. INDUCTION AND TRAINING

All employees and contractors will be required to undergo a comprehensive induction program outlining the specific safety and environmental issues at the site. The induction program will contain specific information on dust management measures, internal procedures and employee's responsibilities in reducing dust generation.

Regular toolbox meetings will also be held to reinforce a responsible attitude towards dust management and to highlight any issues that arise during the course of operation.

The Site Manager is responsible for ensuring all personnel are provided with the appropriate inductions and training. The Environmental Officer is responsible for the environmental component of the induction and providing supervisors with appropriate environmental educational materials for toolbox meetings.

13. REFERENCES

AS 2923-1987 – Guide for Measurement of Horizontal Wind for Air Quality Applications.

AS/NZS 3580.1.1:2007 – Methods for Sampling and Analysis of Ambient Air – Guide to Siting Air Monitoring Equipment.

AS 3580.9.8:2008 – Determination of Suspended Particulate Matter - PM10 Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance (TEOM) Analyser.

AS 3580.12.1: 2001 - Methods for sampling and analysis of ambient air - Determination of light scattering - Integrating nephelometer method.

Bureau of Meteorology. 2006. *Wind Frequency Analysis*. Web based summary of wind records: http://www.bom.gov.au/climate/averages/wind/selection_map.shtml.

MBS Environmental. 2006. *Keysbrook Mineral Sand Project; Public Environmental Report*.

14. DEFINITIONS

Definitions relevant to this Plan include:

- **Boundary** – The outer edges of the area of land in which Matilda Zircon has approvals to mine.
- **Dust** – is considered to be any particle suspended within the atmosphere. Particles can range in size from as small as a few nanometres to 100 microns (μm) and can become airborne through the action of wind turbulence, by mechanical disturbance of fine materials or through the release of particulate rich gaseous emissions. Dust particles are generally solid and irregular in shape. Dust is measured using a variety of methods, the most common being Total Suspended Particulates (TSP), which nominally measures up to 50 microns, and PM_{10} or $\text{PM}_{2.5}$ (particulate matter less than 10 microns or 2.5 microns in size, respectively).
- **Katabatic winds** - Cooling of the air near the ground surface results in the denser, cooler air draining to areas of lower relief. For areas on the coastal plain, these winds drain down the escarpment with flows concentrating in the valleys, such as the Dandalup River. Katabatic drainage flows for the small terrain of the escarpment will result in light winds, and a tendency for night time winds under near calm conditions to turn easterly.
- **PM_{10}** –refers to dust particles/particulate matter with an equivalent aerodynamic diameter of up to less than or equal to 10 microns.
- **$\text{PM}_{2.5}$** –refers to dust particles/particulate matter with an equivalent aerodynamic diameter of up to less than or equal to 2.5 microns.
- **Sensitive Receptor** – Individuals, communities or components of the environment which could be adversely affected by dust emissions, such as people in dwellings, schools, hospitals, childcare facilities, offices, public recreation areas that exist now or in the future.
- **TEOM** – Tapered element oscillating microbalance. Form of dust monitoring equipment.
- **Trigger Levels** –The trigger level is the dust concentration which if exceeded will result in corrective action being taken to reduce dust emissions until the dust level falls below the trigger level.
- **TSP** – Total Suspended particulates – all particles entrained or suspended in the atmosphere and includes the fine, respirable particles (PM_{10} and $\text{PM}_{2.5}$) and larger sized particles that may settle out of the air causing nuisance impacts. Usually measured as those particles having an aerodynamic diameter of 50 micrometres or less.

APPENDICES

**APPENDIX 1:
Complaint Form**

Complaint Report Form.

Date: _____ Time: _____ Received by: _____

Complaint from

Name: _____ Tel No: _____

Address: _____

Type of complaint: (dust, noise, water, other): _____

Details (effect, frequency etc):

Action taken:

Response to Complainant: (date): _____ By: _____

STATUS OF THIS DOCUMENT

This document has been produced by the Office of the Appeals Convenor as an electronic version of the original Statement for the proposal listed below as signed by the Minister and held by this Office.

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Published on 19 October 2009

Statement No. 810

**STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED
PURSUANT TO THE PROVISIONS OF THE
ENVIRONMENTAL PROTECTION ACT 1986**

**KEYSBROOK MINERAL SANDS MINE
SHIRE OF SERPENTINE-JARRAHDAL AND SHIRE OF MURRAY**

Proposal: To develop a mineral sands mine near the Keysbrook township. The proposal involves the excavation and processing of a low-grade heavy mineral sands deposit. The proposal is described further in schedule 1 of this document.

Proponent: Matilda Zircon Ltd (formerly Olympia Resources Ltd)
(ACN: 077 221 722)

Proponent Address: 1st Floor, 143 Hay Street, Subiaco Western Australia

Assessment Number: 1580

Report of the Environmental Protection Authority: Bulletin 1269

Appeal Numbers: 99-109 of 2007

The proposal referred to in the report of the Environmental Protection Authority may be implemented subject to the following conditions and procedures:

1 Proposal Implementation

1-1 The proponent shall implement the proposal as documented and described in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Nomination and Contact Details

2-1 The proponent for the time being nominated by the Minister under sections 38(6) or 38(7) of the Act is responsible for the implementation of the proposal.

2-2 The proponent shall notify the CEO of any change of the name and address of the proponent for the serving of a notice or other correspondence within 30 days of such change.

Date published:

3 Time Limit of Authorisation

- 3-1 The authorisation to implement the proposal provided for in this statement shall lapse and be void within five years after the date of this statement if the proposal to which this statement relates is not substantially commenced.
- 3-2 The proponent shall provide the CEO with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of five years from the date of this statement.

4 Compliance Reporting

- 4-1 The proponent shall prepare and maintain a compliance assessment plan to the requirements of the CEO.
- 4-2 The proponent shall submit to the CEO the compliance assessment plan required by condition 4-1, at least six months prior to the first compliance report required by condition 4-6, and prior to ground-disturbing activity, whichever is sooner.

The compliance assessment plan shall indicate:

- a. the frequency of compliance reporting;
 - b. the approach and timing of compliance assessments;
 - c. the retention of compliance assessments;
 - d. reporting of potential non-compliances and corrective actions taken;
 - e. the table of contents of compliance reports; and
 - f. public availability of compliance reports.
- 4-3 The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 4-1.
 - 4-4 The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by condition 4-1 and shall make those reports available when requested by the CEO.
 - 4-5 The proponent shall advise the CEO of any potential non-compliance within two business days of that non-compliance being known.
 - 4-6 The proponent shall submit a compliance assessment report annually from the date of issue of this Implementation Statement addressing the previous twelve month period or other period as agreed by the CEO. The compliance assessment report shall:
 - a. be endorsed by the proponent's Managing Director or a person, approved in writing by the CEO, delegated to sign on the Managing Director's behalf;
 - b. include a statement as to whether the proponent has complied with the conditions;

- c. identify all potential non-compliances and describe corrective and preventative actions taken;
- d. be made publicly available in accordance with the approved compliance assessment plan; and
- e. indicate any proposed changes to the compliance assessment plan required by condition 4-1.

5 Performance Review and Reporting

- 5-1 The proponent shall submit to the CEO a Performance Review Report at the conclusion of the first year after the start of implementation and then, at a minimum of triennial intervals, which addresses:
- a. the major environmental risks and impacts; the performance objectives, standards and criteria related to these; the success of risk reduction/impact mitigation measures and results of monitoring related to management of the major risks and impacts;
 - b. the level of progress in the achievement of best practice environmental performance, including industry benchmarking, and the use of best available technology where practicable; and
 - c. improvements gained in environmental management which could be applied to this and other similar projects.

6 Protection of native vegetation

- 6-1 Prior to the commencement of clearing, the proponent shall, in consultation with the DEC, ensure that a minimum of 75 hectares of native vegetation within the area cross-hatched red in Figure 3 is protected in perpetuity by an instrument or instruments approved by the CEO.
- 6-2 The instrument or instruments referred to in 6-1 shall include the following:
- a. measures to protect the area from grazing stock; and
 - b. measures which have the objective of maintaining a functioning and self sustaining vegetation community.
- 6-3 The proponent shall not clear any native vegetation within the proposal area unless the land to be cleared is required for the extraction of mineral ore within six months of the date of the clearing.

7 Protection of watercourses and wetlands

- 7-1 The proponent shall not clear vegetation or undertake mining activities:
- a. within 20 metres of the banks of watercourses shown in Figure 9 of the PER document;

b. within 100 metres of the boundary a conservation category wetland.

7-2 The proponent shall implement management measures (including but not limited to weed and disease control, revegetation and monitoring) in respect to the areas under 7-1 to achieve a functioning and self sustaining vegetation community.

8 Rehabilitation management plan

8-1 Prior to the commencement of operations, the proponent shall submit a Rehabilitation Management Plan to the requirements of the CEO.

8-2 The objectives of the Plan are to:

a. re-establish self-sustaining local provenance native vegetation cleared in the implementation of the proposal, at a ratio of not less than 1.4:1 (1.4 hectares of revegetation per 1 hectare of vegetation cleared); and

b. re-establish functioning pasture.

8-3 The Rehabilitation Management Plan shall:

a. describe measures to protect the areas to be revegetated from access, including grazing by stock;

b. identify measures to translocate native plant species cleared for mining into revegetated areas;

c. identify measures to eradicate weeds in the revegetated areas;

d. identify measures to use dieback un-infested topsoil and dieback resistant species in the revegetated areas;

e. describe a strategy to revegetate areas, including the use of local species of local provenance, and establishment of middle storey and understorey species;

f. identify completion criteria for revegetation; and

g. outline a revegetation monitoring programme.

8-4 The proponent shall implement the Rehabilitation Plan.

8-5 The proponent shall review and revise the Rehabilitation Plan as and when directed by the CEO.

8-6 The proponent shall implement revisions of the Rehabilitation Plan required by condition 8-5.

8-7 The proponent shall make the Rehabilitation Plan (including all amendments) publicly available in a manner approved by the CEO.

8-8 The proponent shall ensure grazing stock are excluded from areas described in condition 8-2(a)

9 Weed and Dieback Management

9-1 Prior to the commencement of operations, the proponent shall prepare and submit a Dieback and Weed Management Plan to the requirements of the CEO.

9-2 The proponent shall implement the Plan.

10 Nutrient mobilisation

10-1 Prior to the commencement of operations, the proponent is to submit a Nutrient Management Plan to the requirements of the CEO.

10-2 The objective of the Plan is to ensure the proposal assists in meeting the water quality objectives of the Peel-Harvey Water Quality Improvement Plan.

10-3 The Plan shall:

- a. outline a programme to monitor nutrient levels within the proposal area and at the downstream boundary of the proposal area;
- b. identify nutrient trigger levels consistent with the Peel-Harvey Water Quality Improvement Plan; and
- c. identify management actions should a trigger level be reached.

10-4 The proponent shall implement the Nutrient Management Plan.

10-5 The proponent shall make the Nutrient Management Plan available to the public in manner approved by the CEO.

11 Water Management

11-1 The abstraction of any groundwater required for the implementation of this proposal shall not materially effect on the quality or quantity of groundwater available to other users in the area, or adversely effect the health and condition of native vegetation and ecosystems in the area.

11-2 Prior to the commencement of operations, the proponent shall revise the Water Management Plan to the requirements of the Department of Water.

11-3 The objective of the Plan is to comply with condition 11-1.

11-4 The Plan shall:

- a. outline a programme to monitor groundwater quality and quantity, including monitoring of bores located on surrounding properties, and at the downstream boundary of the project area;
- b. monitor the health and condition of native vegetation within the project area to ensure that it is not affected by groundwater drawdown associated with the proposal;
- c. identify groundwater trigger levels and management actions should a trigger level be reached;
- d. identify measures to provide an alternative source of water, particularly to surrounding groundwater users, where monitoring in item (a) indicates that mining activities has adversely affected water quality to the point where it cannot be used for its intended purpose or ecosystem maintenance;
- e. identify measures to ensure that the quality and quantity of groundwater is maintained post-mining;
- f. identify measures to minimise impacts associated with the discharge of excess water;
- g. outline a monitoring programme to detect any adverse impacts to the water quality, water levels or vegetation health of the conservation category wetlands adjacent to the mine area; and
- h. identify management measures in the event that monitoring in item (g) detects adverse impacts to conservation category wetlands adjacent to the mine area as a result of the proposal.

11-5 The proponent shall implement the Water Management Plan.

11-6 The proponent shall review and revise the Water Management Plan as and when directed by the CEO.

11-7 The proponent shall implement revisions of the Water Management Plan required by condition 11-6.

11-8 The proponent shall make the Water Management Plan (including amendments) publicly available in a manner approved by the CEO.

12 Acid Sulphate Soils Management

12-1 The proponent shall not:

- a. lower the depth of the watertable to below that required for accessing the orebody;
- b. cause acid sulphate soil contamination either within the proposal area or elsewhere.

12-2 The proponent shall implement the Acid Sulphate Soils Management Plan.

12-3 Upon identifying monitoring results indicating exceedance of trigger levels specified in the Acid Sulphate Soils Management Plan the proponent shall:

- a. report the monitoring results to the CEO within seven days;
- b. submit details of the management measures proposed to be implemented to address the exceedance results to the CEO within seven days; and
- c. implement the management measures proposed to address the exceedance..

12-4 Details of any reports under the Management Plan or condition 12-3 shall be publicly available in a manner approved by the CEO.

13 Performance Bond

13-1 As security for the due and punctual observance and performance by the proponent of the requirements of conditions 6, 7, 8, 9, 10, 11, 12 and 15, the proponent shall, prior to commencement of operations, provide to the CEO, to be replaced every five years in accordance with 13-2, a financial assurance for the benefit of both the Minister and the CEO and which is in the form of an unconditional and irrevocable bank guarantee, from a guarantor acceptable to the CEO and in a form acceptable to the CEO, in the amount specified in condition 13-2.

13-2 The financial assurance shall be for an initial amount of AU\$3 million and shall be substituted on 1 July every year of operations in accordance with the following schedule:

- a. \$5.568 million for the year commencing on 1 July after a minimum of 12 months from the commencement of operations (year 2);
- b. \$6.356 million for the subsequent year commencing on 1 July (year 3);
- c. \$7.552 million for the subsequent year commencing on 1 July (year 4);
- d. \$8.304 million for the subsequent year commencing on 1 July (year 5);
- e. \$6.772 million for the subsequent year commencing on 1 July (year 6);
- f. \$5.584 million for the subsequent year commencing on 1 July (year 7);
- g. \$3.795 million for the subsequent year commencing on 1 July (year 8),

with the fixed initial amount of each successive guarantee being indexed to inflation (being the Consumer Price Index, Perth).

13-3 In the event that the guarantor referred to in condition 13-1 terminates its liability under the bank guarantee by paying to the Minister or the CEO the balance of the financial assurance remaining unpaid, the CEO will hold the financial assurance (being the amount paid by the guarantor upon termination), as security for the due and punctual observance and performance by the proponent of the requirements of conditions 6, 7, 8, 9, 10, 11, 12 and 15, in an interest bearing account nominated by the CEO, with the interest accruing for the benefit of the Minister or the CEO.

13-4 The financial assurance may be called on or used in accordance with section 86E of the Act if the proponent fails to implement the proposal in accordance with conditions 6, 7, 8, 9, 10, 11, 12 and 15.

13-5 The financial assurance shall be discharged by the CEO and the Minister when the CEO has given the proponent written notice pursuant to section 86F(1) of the Act.

14 Noise Management

14-1 Unless otherwise agreed in writing between the proponent and the owner and any occupier of noise sensitive premises:

- a. the proposal must comply with the Noise Regulations at any building associated with a noise sensitive use at any noise sensitive premises; and
- b. outside the hours 0700 to 1900 Monday to Saturday, or on public holidays, no mining activity is to be undertaken within 1,500 metres of any building associated with a noise sensitive use at any noise sensitive premises.

14-2 Prior to an agreement being executed under 14-1, the proponent is to ensure owners and occupiers obtain independent legal advice on the meaning and effect of any such agreement.

14-3 Unless registered on the relevant land title, an agreement obtained under 14-1 does not bind successive owners or occupiers.

14-4 Noise monitoring shall be undertaken in a manner consistent with the Noise Monitoring Plan, and shall include monitoring of noise levels at a location or locations representative of the noise sensitive premises closest to the active mining area for which the proponent does not have written agreement in place under 14-1.

14-5 The proponent shall submit quarterly reports to the CEO, prepared by an independent acoustic expert, which include the following:

- a. reviews noise monitoring methodology and results for the quarter;
- b. an assessment of the extent to which noise emissions from the proposal comply with the Noise Regulations; and
- c. details of any management or other measures that the proponent has implemented, or proposes to implement, to abate emissions, and to prevent non-compliance with the Noise Regulations, and the effectiveness of any measures that have been implemented.

14-6 The report referred to in 14-5 is to be provided to the CEO within four weeks of the end of the quarter to which it relates, with the first report due within four months of the commencement of operations.

14-7 Within six weeks of the end of the first 12 months following the commencement of operations, the proponent is to submit a report to the CEO, prepared by an independent acoustic expert, which includes the following:

- a. an assessment of the extent to which noise emissions from the proposal comply with the Noise Regulations;

- b. details and effectiveness of management or other measures the proponent has implemented to reduce or abate noise emissions;
- c. details of what, if any, modifications are recommended to these conditions to more effectively manage noise emissions from the proposal.

14-8 The reports referred to in condition 14-5 and 14-7 shall be made available to the public in a manner approved by the CEO.

15 Air Quality and Dust Management

15-1 Prior to the commencement of operations, the proponent shall revise the Air Quality and Dust Management Plan to the requirements of the CEO.

15-2 The objectives of the Plan are to:

- a. ensure dust emissions from activities undertaken in implementing the proposal do not cause ambient dust concentration levels outside the boundary of the proposal area that are
 - i. higher than 1 ug/m^3 of Total Suspended Particulates as a 15 minute average; or
 - ii. higher than 50 ug/m^3 of Particulate Matter smaller than 10 microns as a 24 hour average, in excess of five times per year;
- b. identify measures to reduce dust emissions; and
- c. ensure that dust emissions do not harm or adversely affect environmental values or the health, welfare and amenity of people and land uses.

15-3 The Plan shall:

- a. outline the results of on-site baseline dust monitoring and modelling;
- b. identify dust management measures for a range of predicted weather forecasts, including avoiding, ameliorating and protecting from dust impacts;
- c. identify dust management measures according to actual winds experienced at the site;
- d. identify a plan for each pit, which details the times of day and weather conditions under which parts of the pit could be mined;
- e. identify a monitoring program, incorporating trigger values for the implementation of management measures to ensure dust emissions from activities undertaken in implementing the proposal do not cause ambient dust concentration levels outside the boundary of the proposal area that are:
 - i. higher than 1 ug/m^3 of Total Suspended Particulates as a 15 minute average; or
 - ii. higher than 50 ug/m^3 of Particulate Matter smaller than 10 microns as a 24 hour average, in excess of five times per year;

- e. identify management measures to ensure dust emissions from activities undertaken in implementing the proposal do not cause ambient dust concentration levels outside the boundary of the proposal area that are:
 - i. higher than 1 ug/m³ of Total Suspended Particulates as a 15 minute average; or
 - ii. higher than 50 ug/m³ of Particulate Matter smaller than 10 microns as a 24 hour average, in excess of five times per year;
- f. identify a complaint management procedure; and
- g. describe the outcomes of landowner agreements when mining in close proximity to occupied residences.

15-4 The proponent shall implement the Air Quality and Dust Management Plan.

15-5 The proponent shall review and revise the Air Quality and Dust Management Plan as and when directed by the CEO.

15-6 The proponent shall implement revisions of the Air Quality and Dust Management Plan required by condition 15-5.

15-7 The proponent shall make the Air Quality and Dust Management Plan (including any revisions) and the results of monitoring publicly available in a manner approved by the CEO.

15-8 To the extent that the proposal is subject to a licence issued under Part V of the Act, that licence may impose conditions which are different from, or additional to, the requirements of this Statement.

16 Definitions

In these conditions, unless the contrary intention appears:

“Acid Sulphate Soils Management Plan” means the *Keysbrook Mineral Sand Project Acid Sulfate Soils Management Plan*, prepared for Olympia Resources Ltd by MBS Environmental, May 2007, and referred to in Appendix 2 of EPA Report 1269;

“Act” means the *Environmental Protection Act 1986*;

“CEO” means the chief executive officer of the Department of Environment and Conservation;

“commencement of operations” means the date on which the first ground disturbing activities commence for the implementation of the proposal, but does not include minor preliminary works such as erection of fencing and undertaking sampling;

“conservation category wetland” has the meaning given in regulation 6(7)(c) of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*;

“DEC” means the Department of Environment and Conservation;

“Minister” means the Minister for Environment;

“Noise Monitoring Plan” means the *Noise Monitoring Plan, Keysbrook Titanium Minerals Proposal*, prepared for Olympia Resources Ltd by Lloyd George Acoustics, October 2008;

“Noise Regulations” means the *Environmental Protection (Noise) Regulations 1997*;

“noise sensitive premises” has the same meaning as in Schedule 1 of the Noise Regulations;

“Peel-Harvey Water Quality Improvement Plan” means the *Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management*, EPA, November 2008;

“PER document” means the *Keysbrook Minerals Sand Project, Keysbrook Western Australia Public Environmental Review*, prepared for Olympia Resources Ltd by MBS Environmental, West Perth, WA, June 2006;

“proposal area” means the boundaries of the mining area shown in Figure 2;

“revegetated areas” refers to those areas that have been revegetated by the proponent following clearing, or as replacement for clearing done, by the proponent during the implementation of the proposal;

“watercourse” has the meaning given in section 3 of the *Rights in Water and Irrigation Act 1914*;

“Water Management Plan” means the *Keysbrook Mineral Sand Project Water Management Plan*, prepared for Olympia Resources Ltd by MBS Environmental, May 2007, and referred to in Appendix 2 of EPA Report 1269.

Notes

1. Where a condition for a Management Plan states "to the requirements of the CEO", the proponent shall consult with the DEC during preparation of the Management Plans.
2. The Minister will determine any dispute between the proponent and the CEO over the fulfilment of the requirements of the conditions.

Hon Donna Faragher JP MLC
MINISTER FOR ENVIRONMENT; YOUTH

Schedule 1

Keysbrook Mineral Sands Mine (Assessment No. 1580)

The proposal is to develop a mineral sands mine near the Keysbrook township. The proposal involves the excavation and processing of a low-grade heavy mineral sands deposit. Local roads would be upgraded to facilitate the transport of the heavy mineral concentrate to South Western Highway.

An area of 30 hectares will be progressively mined at any time. Waste from the processing will be used as backfill in the mined areas. Backfilled areas will be progressively re-contoured and stabilised prior to topsoil replacement and return to pasture or native vegetation. The wet concentrator plant will be relocated three times throughout the life of mine. Support infrastructure, such as pipelines, offices and workshops will also be relocated with the wet concentrator plant. A site dam will be constructed at each of the three locations.

The main characteristics of the proposal are summarised in Table 1 below.

Table 1 - Key Proposal Characteristics (Assessment No. 1580)

Element	Description	
Land tenure over the mining area	Keysbrook	North Dandalup
	Part Lot 56 Westcott Rd Part Lot 57 Elliott Rd Part Lot 1 Elliott Rd Part Lot 52 Westcott Rd Part Lot 111 Westcott Rd Lot 112 Westcott Rd Lot 113 Westcott Rd Part Lot 6 Westcott Rd Part Lot 63 Hopeland Rd	Part Lot 62 Hopeland Rd Part Lot 59 Westcott Rd Part Lot 300 Westcott Rd Part Lot 49 Readheads Rd Part Lot 7 Readheads Rd Part Lot 6 Readheads Rd Part Lot 44 Readheads Rd
Life of mine	Approximately 8 years	
Product quantity	approximately 920,000 tonnes of heavy mineral concentrate	
Pit depth	average 2 metres below ground level, and up to 6 metres on sandy dunes	
Proposal area	1366 hectares	
Dewatering	in-pit sumps to dewater the superficial Bassendean Sand aquifer at 0.2 gigitalitres per annum	
Bore abstraction	up to 1.8 gigitalitres per annum from two bores into the deep Leederville aquifer	
Road upgrades	upgrades of existing roads; Westcott Rd, Atkins Rd, Readheads Rd and intersection of Readheads Rd and South Western Hwy	

Figures

Figure 1 – Regional location

Figure 2 – Mine Boundaries

Figure 3 – Area within which minimum of 75ha of native vegetation to be retained



Figure 1 – Regional location

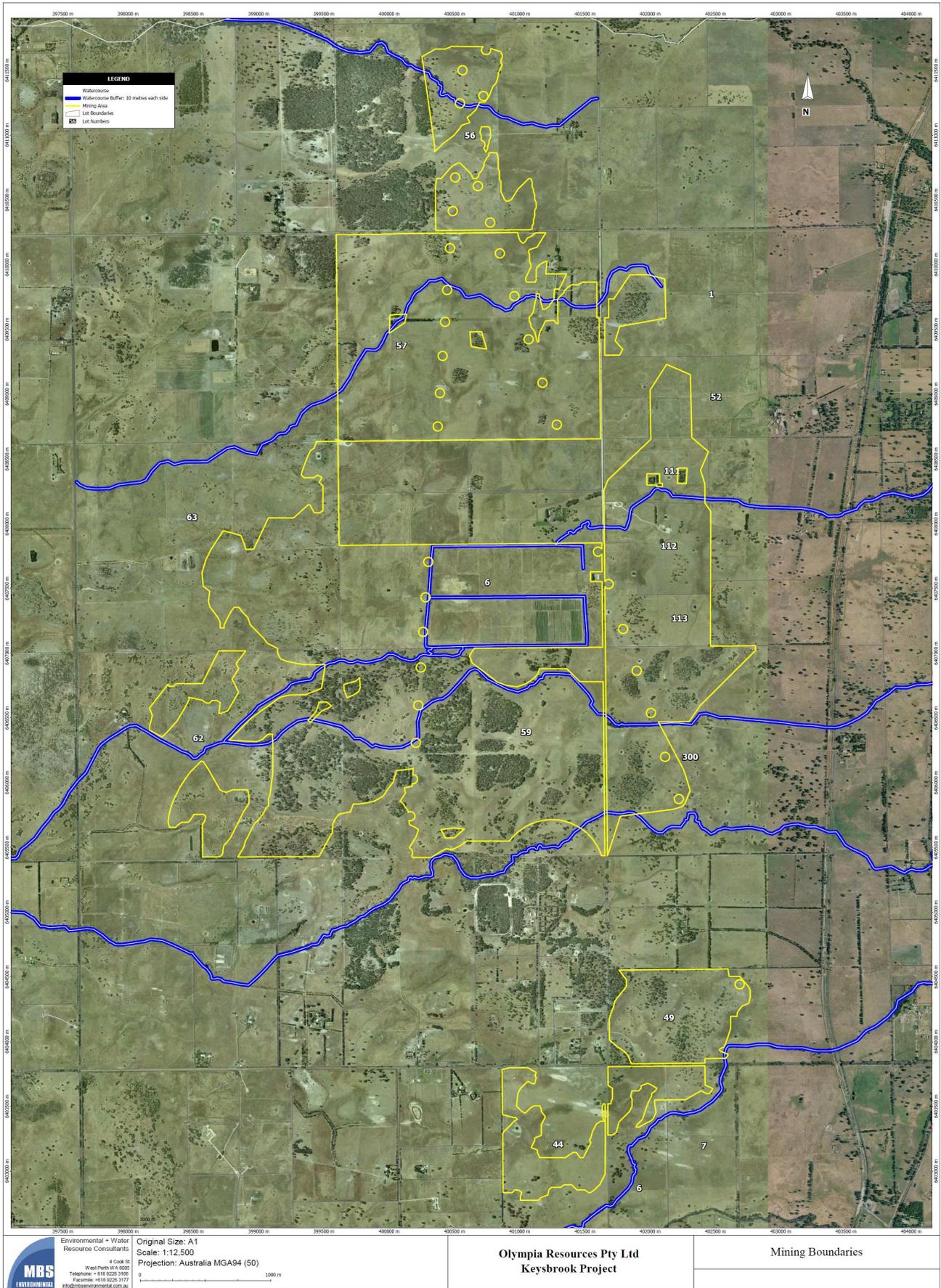


Figure 2 – Mine boundaries

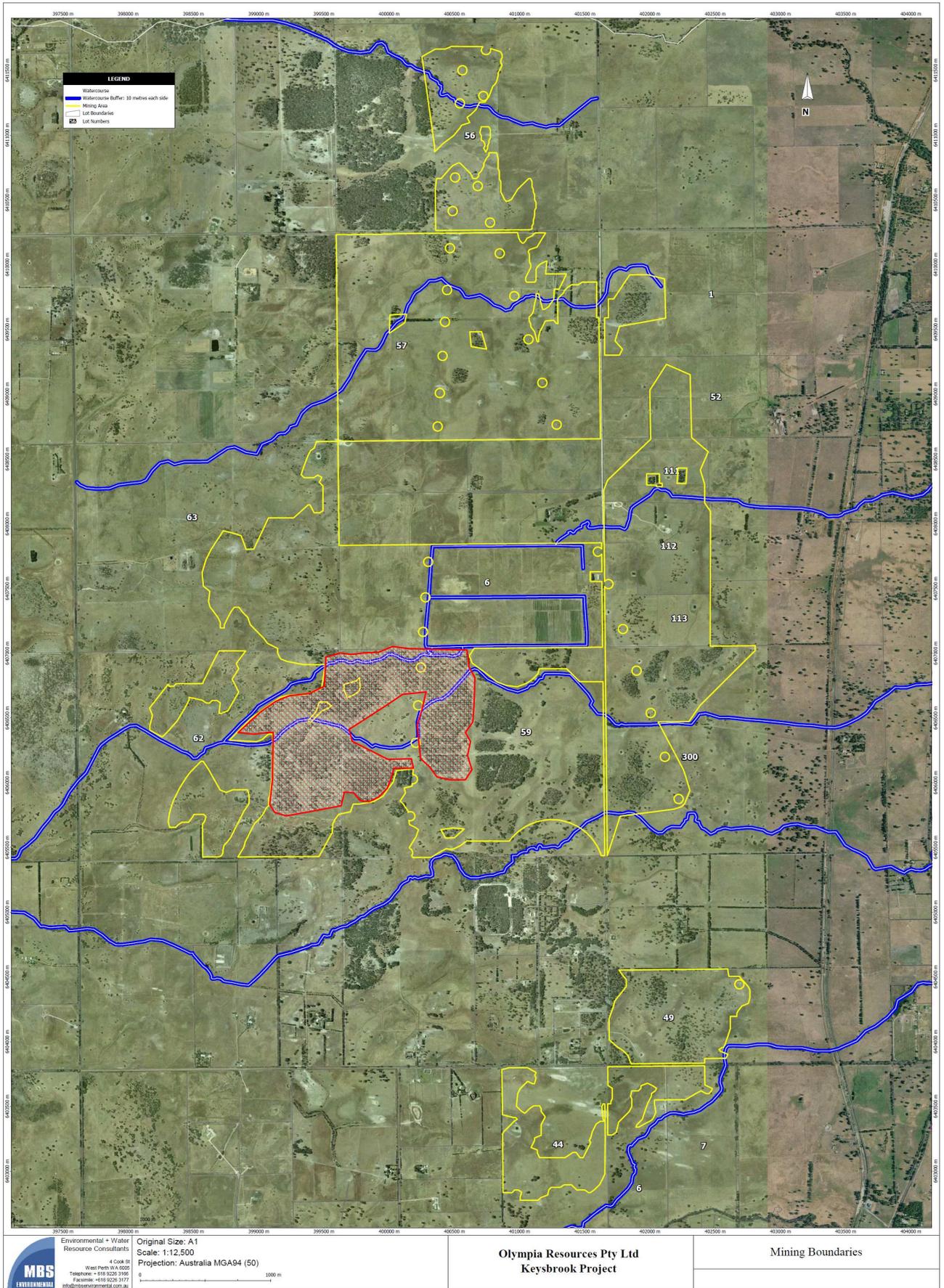


Figure 3 – Area within which minimum 75ha native vegetation to be retained (condition 6-1)

ATTACHMENT 1 TO MINISTERIAL STATEMENT 810

Section 46C
Environmental Protection Act 1986

**NOTICE OF CHANGES TO IMPLEMENTATION CONDITIONS
MINISTERIAL STATEMENT 810**

KEYSBROOK MINERAL SANDS MINE
SHIRE OF SERPENTINE-JARRAHDAL AND SHIRE OF MURRAY
MATILDA ZIRCON LTD

Pursuant to section 46C(1)(b)(i) of the *Environmental Protection Act 1986*, the implementation conditions applying to the above proposal are changed in accordance with the Schedule to this Notice. I consider these changes to be of a minor nature which are necessary or desirable to correct a clerical mistake or unintentional error.

Hon Bill Marmion BE MBA MLA
MINISTER FOR ENVIRONMENT; WATER
19 June 2011

Schedule

1 Condition 15 amended

Condition 15 of Ministerial Statement 810 is amended as follows:

- (a) The figure '1 ug/m³' is replaced with '1000 ug/m³'
- (b) The lettering of the second '(e)' in Condition 15-3 will be replaced by '(f)' and thereafter; '(f)' with '(g)' and '(g)' with '(h)'

Attachment 2 to Ministerial Statement 810

Change to proposal under s45C of the *Environmental Protection Act 1986*

Proposal: Keysbrook Mineral Sands Mine

Proponent: MZI Resources Ltd

Change: Increase in proposal area to accommodate wet processing plant adjacent to the mining area, and change to area of vegetation to be protected.

The following text replaces the proposal description in Schedule 1:

The proposal is to develop a mineral sands mine near the Keysbrook township. The proposal involves the excavation and processing of a low-grade heavy mineral sands deposit.

An area of up to 30 hectares will be progressively mined at any time. Waste from the processing will be used as backfill in the mined areas. Backfilled areas will be progressively re-contoured and stabilised prior to topsoil replacement and return to pasture or native vegetation.

Key Characteristics Table: This table replaces Table 1 in Schedule 1

Element	Description of proposal		Description of approved change to proposal	
	Keysbrook	North Dandalup	Keysbrook	North Dandalup
Land tenure over the mining area	Part Lot 56 Westcott Road	Part Lot 62 Hopeland Rd	Part Lot 56 Westcott Road	Part Lot 62 Hopeland Rd
	Part Lot 57 Elliott Rd	Part Lot 59 Westcott Rd	Part Lot 57 Elliott Rd	Part Lot 59 Westcott Rd
	Part Lot 1 Elliott Rd	Part Lot 300 Westcott Rd	Part Lot 1 Elliott Rd	Part Lot 300 Westcott Rd
	Part Lot 52 Westcott Rd	Part Lot 49 Readheads Rd	Part Lot 52 Westcott Rd	Part Lot 49 Readheads Rd
	Part Lot 111 Westcott Rd	Part Lot 7 Readheads Rd	Part Lot 111 Westcott Rd	Part Lot 7 Readheads Rd
	Lot 112 Westcott Rd	Part Lot 6 Readheads Rd	Lot 112 Westcott Rd	Part Lot 6 Readheads Rd
	Lot 113 Westcott Rd	Part Lot 44 Readheads Rd	Lot 113 Westcott Rd	Part Lot 44 Readheads Rd
	Part Lot 6 Westcott Rd		Part Lot 6 Westcott Rd	
	Part Lot 63 Hopeland Rd		Part Lot 63 Hopeland Rd	

Life of mine	Approximately 8 years	Approximately 8 years
Product quantity	Approximately 920 000 tonnes of heavy mineral concentrate	Approximately 920 000 tonnes of heavy mineral concentrate
Pit depth	Average 2 metres below ground level, and up to 6 metres on sandy dunes	Average 2 metres below ground level, and up to 6 metres on sandy dunes
Proposal area	1366 hectares	Up to 1379 hectares
Dewatering	In-pit sumps to dewater the superficial Bassendean Sand aquifer at 0.2 gigalitres per annum	In-pit sumps to dewater the superficial Bassendean Sand aquifer at 0.2 gigalitres per annum
Bore abstraction	Up to 1.8 gigalitres per annum from two bores into the deep Leederville aquifer	Up to 1.8 gigalitres per annum from two bores into the deep Leederville aquifer
Road upgrades	Upgrades of existing roads; Westcott Rd, Atkins Rd, Readheads Rd and intersection of Readheads Rd and South Western Hwy	Deleted – not an environmental factor

Note: Text in **bold** in the Key Characteristics Table, indicates change/s to the proposal.

List of Replacement Figures:

Figure 2 of Schedule 1 is replaced with Figure 2 of this attachment.

Figure 3 of Schedule 1 is replaced with Figure 3 of this attachment.

Dr Paul Vogel
CHAIRMAN
Environmental Protection Authority
under delegated authority

Approval date: 4 February 2013

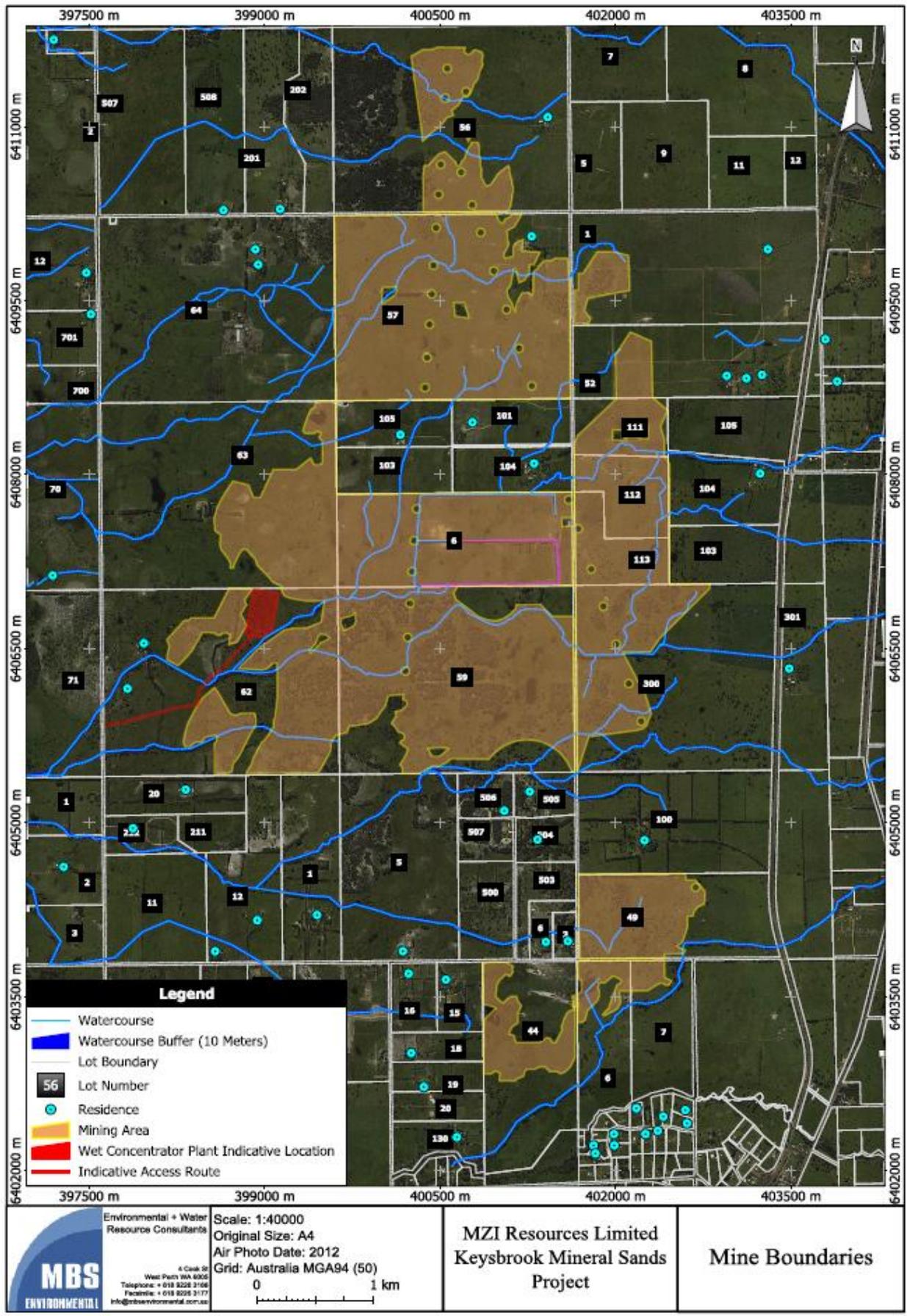


Figure 2. Mine boundaries

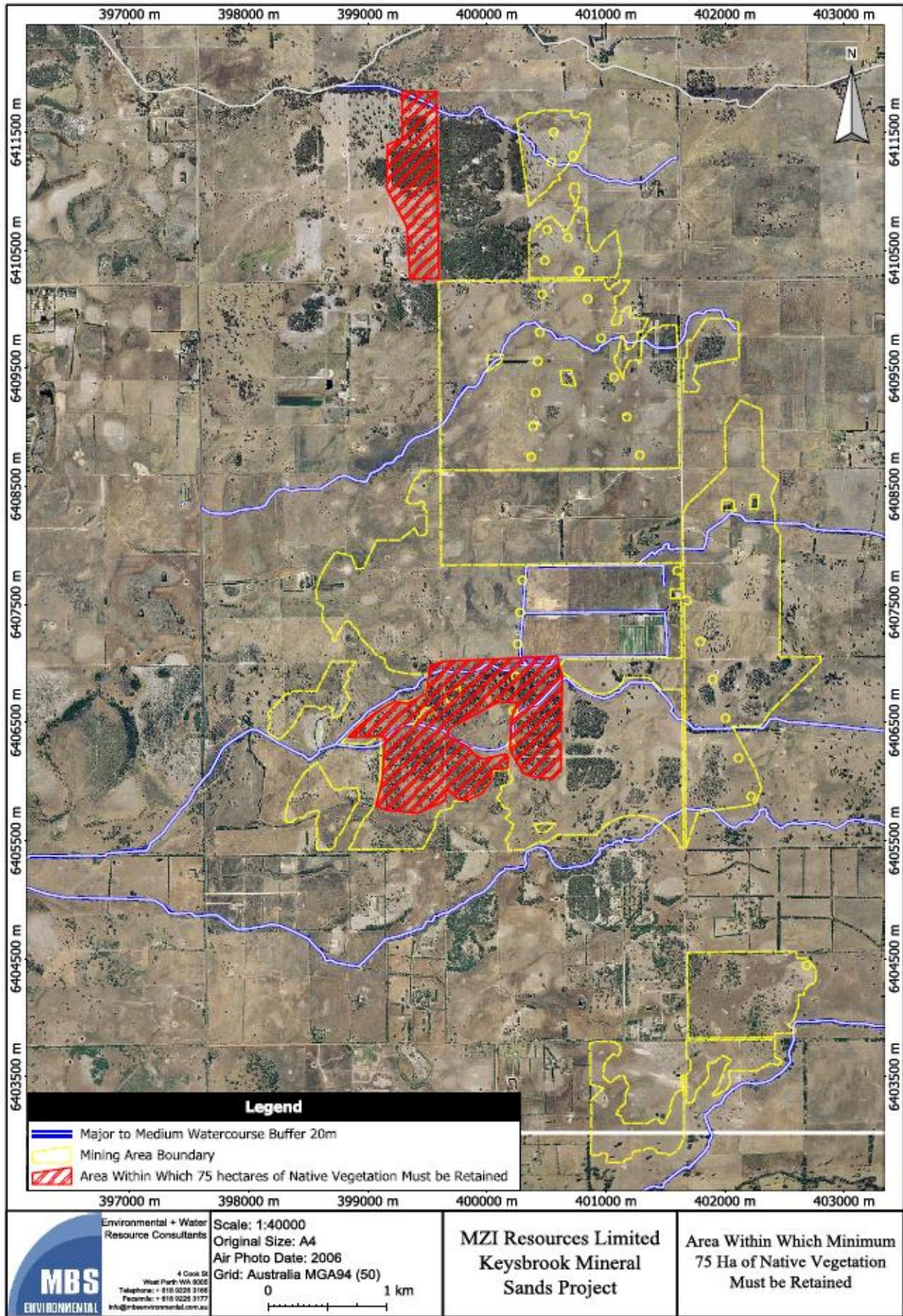


Figure 3. Area Within Which Minimum 75 hectares of Native Vegetation Must be Retained (Condition 6-1).



**Minister for Environment; Disability Services; Electoral Affairs
Deputy Leader of the Legislative Council**

Statement No.1089

**STATEMENT TO AMEND CONDITIONS APPLYING TO A PROPOSAL
(PURSUANT TO THE PROVISIONS OF SECTION 46
OF THE *ENVIRONMENTAL PROTECTION ACT 1986*)**

**KEYSBROOK MINERAL SANDS MINE
SHIRE OF SERPENTINE JARRAHDALE AND SHIRE OF MURRAY**

Proposal: To develop a mineral sands mine near the Keysbrook township. The proposal involves the excavation and processing of a low-grade heavy mineral sands deposit. The proposal is described further in Schedule 1 of Statement 810.

Proponent: MZI Resources Ltd
Australian Company Number 077 221 722

Proponent Address: Level 2, 100 Royal Street
EAST PERTH WA 6004

Assessment Number: 2110

Report of the Environmental Protection Authority: 1627

Previous Assessment Numbers: 1580, 2020

Previous Report Numbers: 1269, 1528

Preceding Statements Relating to this Proposal: 810, 984

Pursuant to section 45 of the *Environmental Protection Act 1986*, as applied by section 46(8), it has been agreed that the implementation conditions set out in Ministerial Statement No. 810 (as amended by Ministerial Statement 984) be changed as specified in this Statement.

Published on:

Condition 14 of Ministerial Statement 810 is deleted and replaced with:

14 Noise Management

Interim Period

14-1A During the period up to twelve (12) months from the date of this Statement, the proponent shall manage the proposal as follows:

- (1) Unless otherwise agreed in writing between the proponent and the owner and any occupier of noise sensitive premises:
 - (a) the proposal must comply with the Noise Regulations at any building associated with a noise sensitive use at any noise sensitive premises; and
 - (b) outside the hours 0700 to 1900 Monday to Saturday, Sunday, or on public holidays, no mining activity is to be undertaken within 1,500 metres of any building associated with a noise sensitive use at any noise sensitive premises.
- (2) The requirement in condition 14-1A(1) does not apply in respect of noise sensitive premises that are not being used for a noise sensitive purpose.

Separation Distances

14-1 After the period up to twelve (12) months from the date of this Statement, the proponent shall manage the proposal as follows, unless varied by condition 14-2 or 14-3:

- (1) no Mineral Processing Activity is to be undertaken at any time within two (2) kilometres of a highly sensitive area;
- (2) during the Day and Evening periods, no Mining Operations are undertaken within two (2) kilometres of a highly sensitive area; and
- (3) during the Night period, no Mining Operations are undertaken within three point three (3.3) kilometres of a highly sensitive area.

Amenity Agreements

14-2 The requirements in condition 14-1 do not apply in respect of a particular highly sensitive area if:

- (1) the proponent and the landowner and occupier of that highly sensitive area have agreed otherwise in writing; and
- (2) notwithstanding any agreement referred to in condition 14-2(1):

- (a) Noise Emission levels received Indoors during the Evening period do not exceed 30 dB LA10 + Influencing factor (Tonal adjustment is applicable).
- (b) Noise Emission levels received Indoors during the Night period do not exceed 25 dB LA10 + Influencing factor (Tonal adjustment is applicable).
- (c) The proponent shall ensure that highly sensitive areas have appropriate acoustic attenuation to demonstrate that Noise Emission levels received Indoors as defined in conditions 14-2(2)(a) and 14-2(2)(b) can be met at all times.
- (d) The proponent shall assume worst case conditions for modelling and attenuation, to be verified by an Independent acoustic expert, and reported in accordance with condition 14-9.

Noise Management and Monitoring Plan

14-3 The requirements in condition 14-1 may be varied or substituted if:

- (1) the proponent prepares and submits a Noise Management and Monitoring Plan (NMMP) to the CEO, in accordance with condition 14-4, which demonstrates that reduced distances will achieve compliance with the Noise Regulations;
- (2) the CEO approves in writing the NMMP for the purpose of varying condition 14-1; and
- (3) the proponent implements the provisions of the approved NMMP.

14-4 The NMMP submitted under condition 14-3(1) must include:

- (1) a calibrated noise model that assumes worst case meteorological conditions for noise propagation and tonal characteristics at all times, that is validated by an independent acoustic expert;
- (2) noise monitoring to include noise levels at a location or locations representative of the highly sensitive area closest to the area for which varied distances to those defined in condition 14-1 are proposed to apply;
- (3) details of management measures, including but not limited to, any actions undertaken to reduce noise emissions from the proposal, monitoring, and reporting;
- (4) community consultation that has been undertaken, including any agreement on implementation of noise mitigation measures with residents; and

- (5) the procedure and data reporting to demonstrate compliance in the event of a community complaint regarding operational noise, or at the request of the CEO.
- 14-5 The proponent shall review and revise the NMMP as and when directed by the CEO.
- 14-6 Any approved NMMP shall be made available to the public in a manner approved by the CEO.
- 14-7 Any changes to management measures, including actions, monitoring and reporting in the NMMP must be approved by the CEO in writing, including any scheduled movements of the Wet Concentrator Plant and Mine Field Unit elements of the proposal.

Noise Monitoring and Reporting

- 14-8 The proponent shall monitor noise and submit annual noise reports to the CEO from the issue of this Statement that shall be submitted as part of the proponent's compliance assessment reporting process, conditioned under 4-6 of Statement 810.
- 14-9 The report referred to in condition 14-8 shall address operations, noise management, and noise emissions for each time period (Day, Evening, and Night) for the purpose of demonstrating compliance with condition 14-1A and 14-1, 14-2 and 14-3 (as applicable) and shall include the following:
 - (1) a description of the equipment and methods used for monitoring and modelling of operational noise emissions, to a level of detail that would enable them to be independently reproduced by an acoustic expert;
 - (2) an assessment prepared by an independent acoustic expert which demonstrates to a reasonable and practical extent (or otherwise satisfactorily to the CEO) the level of compliance with applicable noise levels at all nearby noise sensitive premises; and
 - (3) a description of the noise management measures employed during the period.
- 14-10 In the event of a potential breach of these conditions, the proponent shall investigate the incident(s) and report the exceedance in writing to the CEO within two (2) business days of the breach being identified.



Hon Stephen Dawson MLC
MINISTER FOR ENVIRONMENT

- 8 FEB 2019

Table 1: Abbreviations and definitions

Acronym or abbreviations	Definition or term
CEO	The Chief Executive Officer of the Department of the Public Service of the State responsible for the administration of section 48 of the <i>Environmental Protection Act 1986</i> , or its delegate.
Day period	Monday to Saturday between the hours of 0700 to 1900 Australian Western Standard Time.
dB	decibels
Evening period	Monday to Saturday between the hours of 1900 to 2200 Australian Western Standard Time; and Sundays and public holidays between the hours of 0900 and 2200 Australian Western Standard Time.
Highly sensitive area	Has the same meaning as defined by regulation 8(1) of the <i>Environmental Protection (Noise) Regulations 1997</i> .
Independent acoustic expert	A person qualified and experienced in the area of environmental noise assessment and who by their qualifications and experience is eligible to hold membership of the Association of Australasian Acoustical Consultants. The acoustic expert must be without conflict of interest or any business or financial relationship with the proponent or its associates other than being recompensed for professional services rendered to the proponent.
Indoors	Locations which reasonably represent human occupation of an enclosed space within a highly sensitive area as defined in regulation 8 of the <i>Environmental Protection (Noise) Regulations 1997</i> , with all windows and doors in their closed position.
Influencing factor	Determined under Schedule 3 of the <i>Environmental Protection (Noise) Regulations 1997</i> .
LA10	Has the same meaning as defined by regulation 8(1) of the <i>Environmental Protection (Noise) Regulations 1997</i> .
Mineral Processing Activity	Use of equipment in the processing of minerals, which includes: <ul style="list-style-type: none"> • loading of ore to the Mine Field Unit; • operation of the Mine Field Unit; • associated motors delivering ore from the Mine Field Unit to the Wet Concentrator Plant and movement of tailings and water between the Wet Concentrator Plant and mine void; • operation of the Wet Concentrator Plant; and • fixed equipment associated with the Wet Concentrator Plant (cyclones and thickener).
Mining Operations	Use of equipment in the extraction and haulage of earth bearing minerals, including: <ul style="list-style-type: none"> • the removal of overburden by mechanical or other means and the stacking, deposit, and storage of any substance considered to contain any mineral; • field pumps, including production bores with surface mounted motors/pumps; • the use of mobile mining fleet (graders, bulldozers, excavators and haul trucks within the disturbance footprint); and • any works associated with rehabilitation of land disturbed in the extraction and processing of the mineral resource, except land disturbed prior to 31 December 2019.

Acronym or abbreviations	Definition or term
Night Period	Monday to Saturday between the hours of 2200 to 0700 Australian Western Standard Time; and Sundays and public holidays until 0900 Australian Western Standard Time.
Noise Emissions	Noise emitted from premises occupied by the Keysbrook Mineral Sands Mine.
Noise Regulations	<i>Environmental Protection (Noise) Regulations 1997.</i>
Noise sensitive premises	Has the same meaning as defined by regulation 2(1) of the <i>Environmental Protection (Noise) Regulations 1997.</i>
Noise sensitive purpose	Has the same meaning as defined by regulation 2(1) of the <i>Environmental Protection (Noise) Regulations 1997.</i>
Tonal adjustment	Determined under regulation 9 of the <i>Environmental Protection (Noise) Regulations 1997.</i>



Environmental Protection Authority

Mr Andrew Templeman
General Manager
Doral Mineral Sands
PO Box 9155
PICTON WA 6229

Our Ref: DWERT4079
Enquiries: Stuart Simmonds, 6364 6781
Email: stuart.simmonds@dwer.wa.gov.au

Dear Mr Templeman

Keysbrook Mineral Sands Mine – Ministerial Statement 810 – Change to proposal approved under section 45c of the *Environmental Protection Act 1986*

Thank you for your letter of 12 August 2019 requesting approval of changes to the Keysbrook Mineral Sands Mine (Ministerial Statement 810).

I consider the changes, as described in Attachment 3 to Ministerial Statement 810 are unlikely to result in a significant detrimental effect on the environment in addition to, or different from, the effect of the original proposal. Approval of the changes is therefore granted under section 45C of the *Environmental Protection Act 1986*. This approval does not replace any responsibilities you may have for seeking approvals from other government agencies to implement the changes.

Please note implementation of the Keysbrook Mineral Sands Mine proposal, including the approved changes described in Attachment 3 is subject to the conditions of Ministerial Statement 810. The Chief Executive Officer of the Department of Water and Environmental Regulation may monitor the implementation of the proposal for the purpose of determining whether the implementation conditions are being complied with.

Yours sincerely

Tom Hatton
CHAIRMAN

17 October 2019

Encl. MS 810 - Attachment 3

Prime House, 8 Davidson Terrace Joondalup, Western Australia 6027.
Postal Address: Locked Bag 10, Joondalup DC, Western Australia 6919.

Telephone: (08) 6364 7000 | Facsimile: (08) 6364 7001 | Email: info.epa@dwer.wa.gov.au

Attachment 3 to Ministerial Statement 810

Change to proposal approved under section 45C of the
Environmental Protection Act 1986

This Attachment replaces Schedule 1 and Attachment 2 of Ministerial Statement 810

Proposal: Keysbrook Mineral Sands Mine

Proponent: Keysbrook Leucoxene Pty Ltd

Changes:

- Amend the approved mining area from 1379 hectares to 1532 hectares and include Lots 101, 103, 104 and 105 Westcott Road, Keysbrook.
- Relinquish several minor areas from the approved mining area totalling 7.2 ha.
- Increase the Life of Mine from 8 to 9 years (approx.)
- Increase product quantity from 920,000 tonnes to 1,020,000 tonnes of heavy mineral concentrate.
- Amend the figures of MS 810 to include the Development Envelope and additional mining area.

Table 1: Summary of the Proposal

Proposal Title	Keysbrook Mineral Sands Mine
Short Description	The proposal is to develop a mineral sands mine near the Keysbrook township. The proposal involves the excavation and processing of a low-grade heavy mineral sands deposit. An area of up to 30 hectares will be progressively mined at any time. Waste from the processing will be used as backfill in the mined areas. Backfilled areas will be progressively re-contoured and stabilised prior to topsoil replacement and return to pasture or native vegetation.

Table 2: Location and authorised extent of physical and operational elements

Element	Description of Proposal		Proposed Description	
	Keysbrook	North Dandalup	Keysbrook	North Dandalup
Land tenure over the mine area	Part Lot 56 Westcott Rd	Part Lot 62 Hopeland Road	Part Lot 56 Westcott Rd	Part Lot 31 Hopeland Rd
	Part Lot 57 Elliott Rd	Part Lot 59 Westcott Rd	Part Lot 57 Elliott Rd	Part Lot 32 Hopeland Rd
	Part Lot 1 Elliott Rd	Part Lot 300 Westcott Rd	Part Lot 1 Elliott Rd	Part Lot 33 Hopeland Rd
	Part Lot 52 Westcott Rd		Part Lot 52 Westcott Rd	Part Lot 34 Hopeland Rd

Element	Description of Proposal	Proposed Description
	Part Lot 111 Westcott Rd Lot 112 Westcott Rd Lot 113 Westcott Rd Part Lot 6 Westcott Rd Part Lot 63 Hopeland Rd	Part Lot 49 Readheads Rd Part Lot 7 Readheads Rd Part Lot 6 Readheads Rd Part Lot 44 Readheads Rd
		Part Lot 111 Westcott Rd Lot 112 Westcott Rd Lot 113 Westcott Rd Part Lot 6 Westcott Rd Part Lot 63 Hopeland Rd Lot 101 Westcott Rd Lot 103 Westcott Rd Lot 104 Westcott Rd Lot 105 Westcott Rd
Life of Mine	Approximately 8 years	Approximately 9 years
Product quantity	Approximately 920,000 tonnes of heavy mineral concentrate	Approximately 1,020,000 tonnes of heavy mineral concentrate
Pit depth	Average 2 metres below ground level, and up to 6 metres on sandy dunes	Average 2 metres below ground level, and up to 6 metres on sandy dunes
Proposal Area	Up to 1379 hectares	Up to 1532 hectares
Dewatering	In-pit sumps to dewater the superficial Bassendean Sand aquifer at 0.2 gigalitres per annum	In-pit sumps to dewater the superficial Bassendean Sand aquifer at 0.2 gigalitres per annum
Bore abstraction	Up to 1.8 gigalitres per annum from two bores into the deep Leederville aquifer	Up to 1.8 gigalitres per annum from two bores into the deep Leederville aquifer

Note: Text in **bold** in Table 2 indicates a change to the proposal.

Table 3: Abbreviations

Abbreviation	Term
CEO	Chief Executive Officer
GL	gigalitre
ha	hectare
km	kilometre

Figures (attached)

Figure 1 Keysbrook Mineral Sands Mine - Regional Location

Figure 2 Keysbrook Mineral Sands Mine - Development Envelope and Mining Area



Dr Tom Hatton

CHAIRMAN

Environmental Protection Authority
under delegated authority

Approval date: 14 Oct 2019

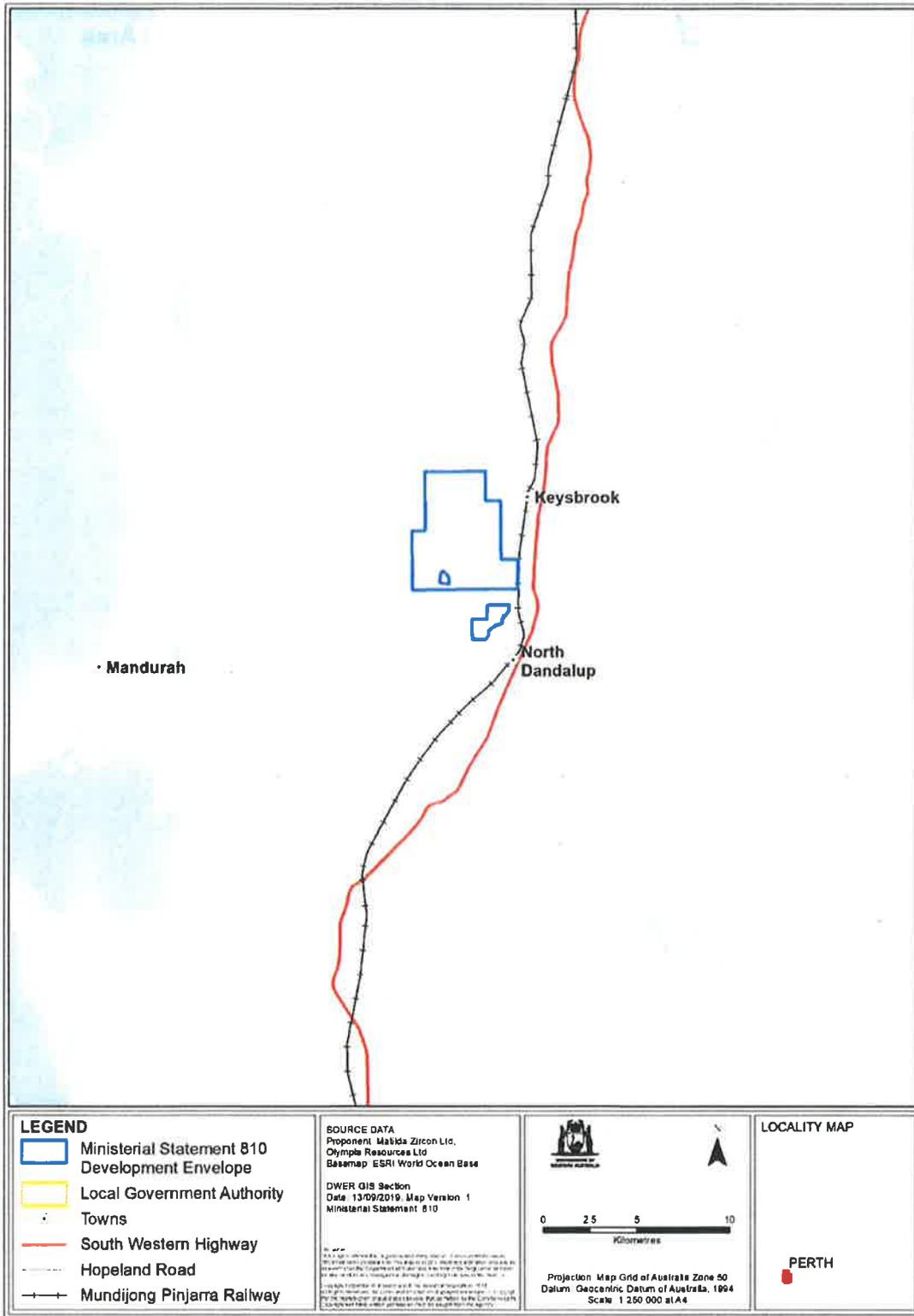


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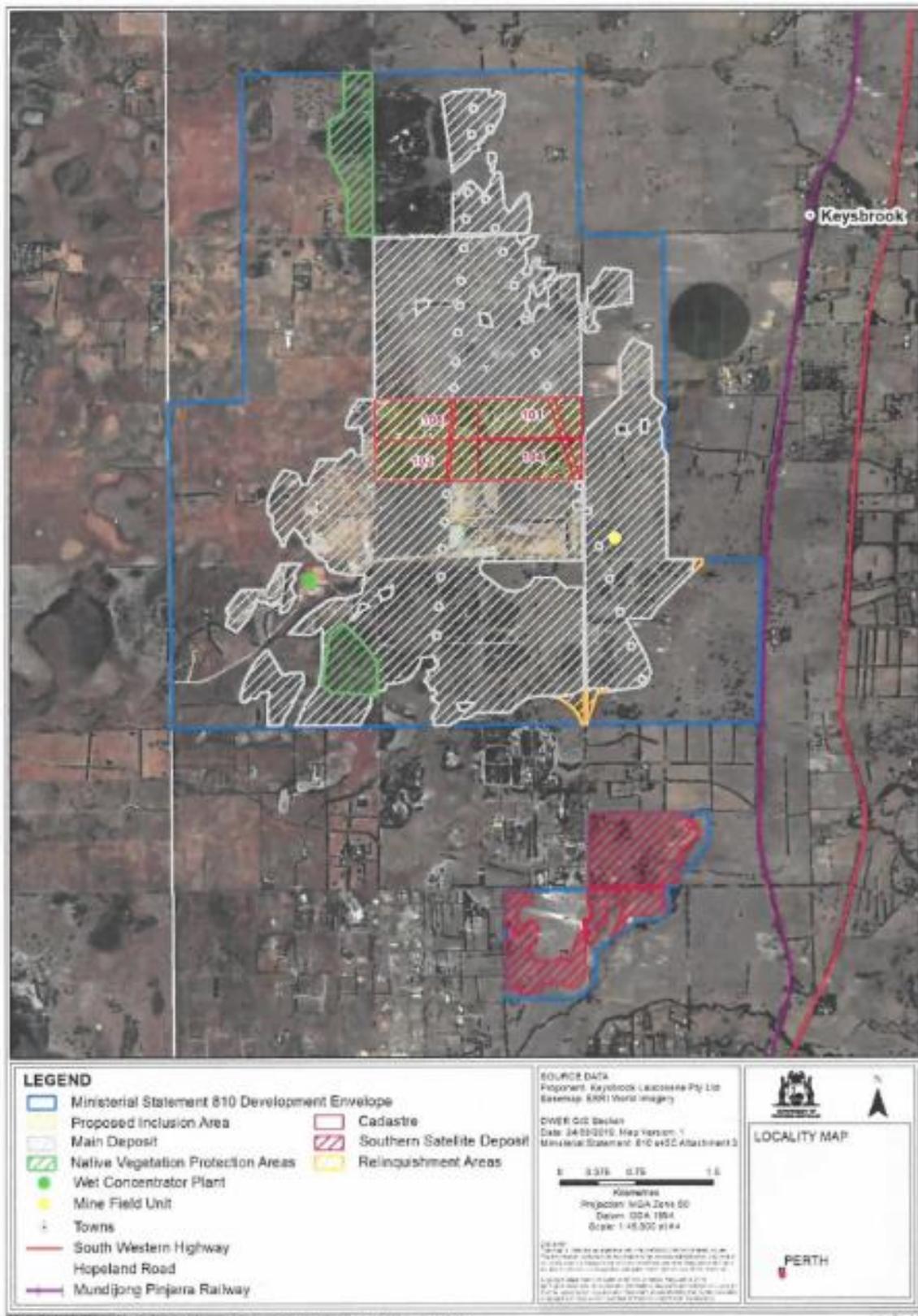


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Dr Tom Hatton

CHAIRMAN

Environmental Protection Authority
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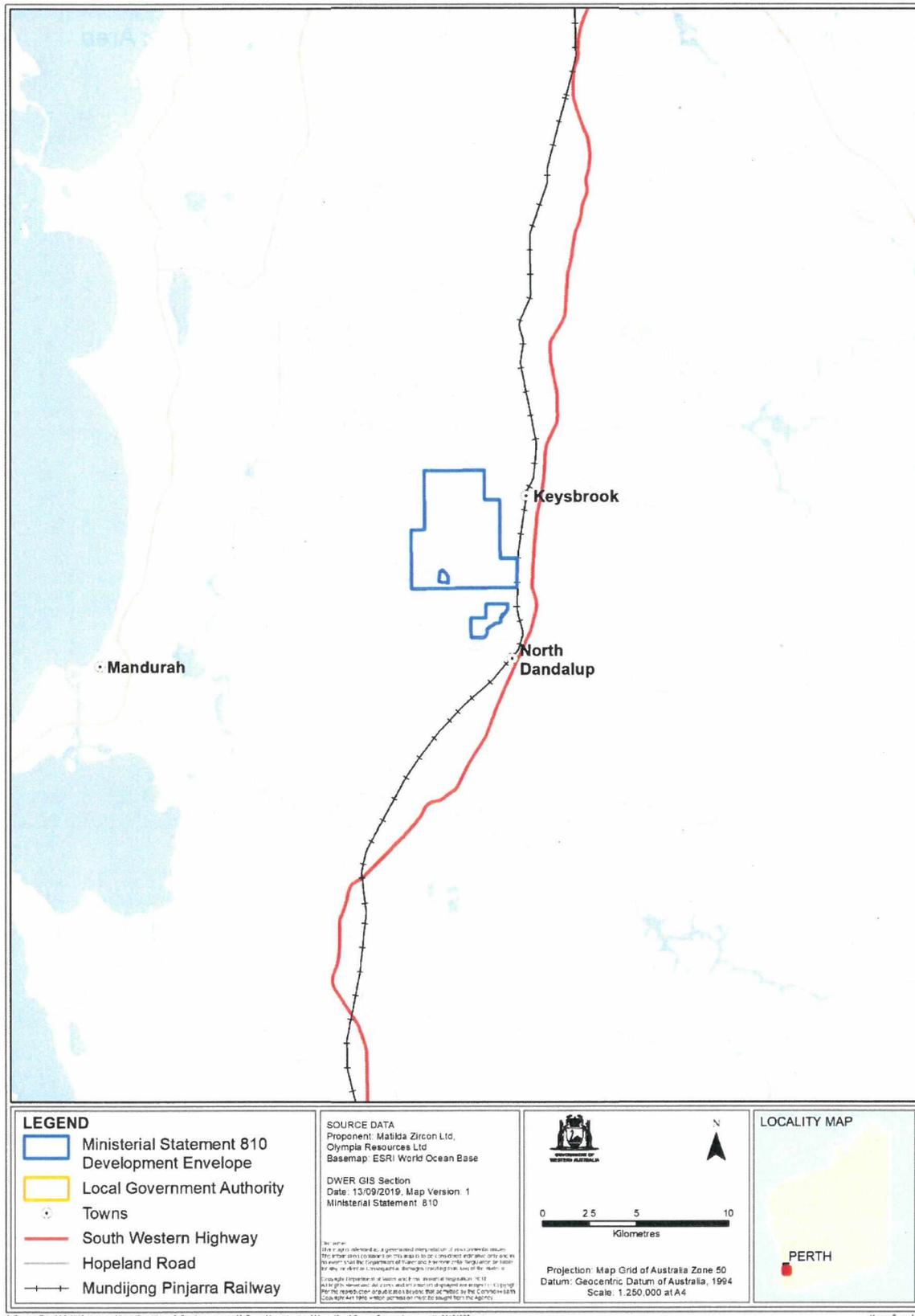


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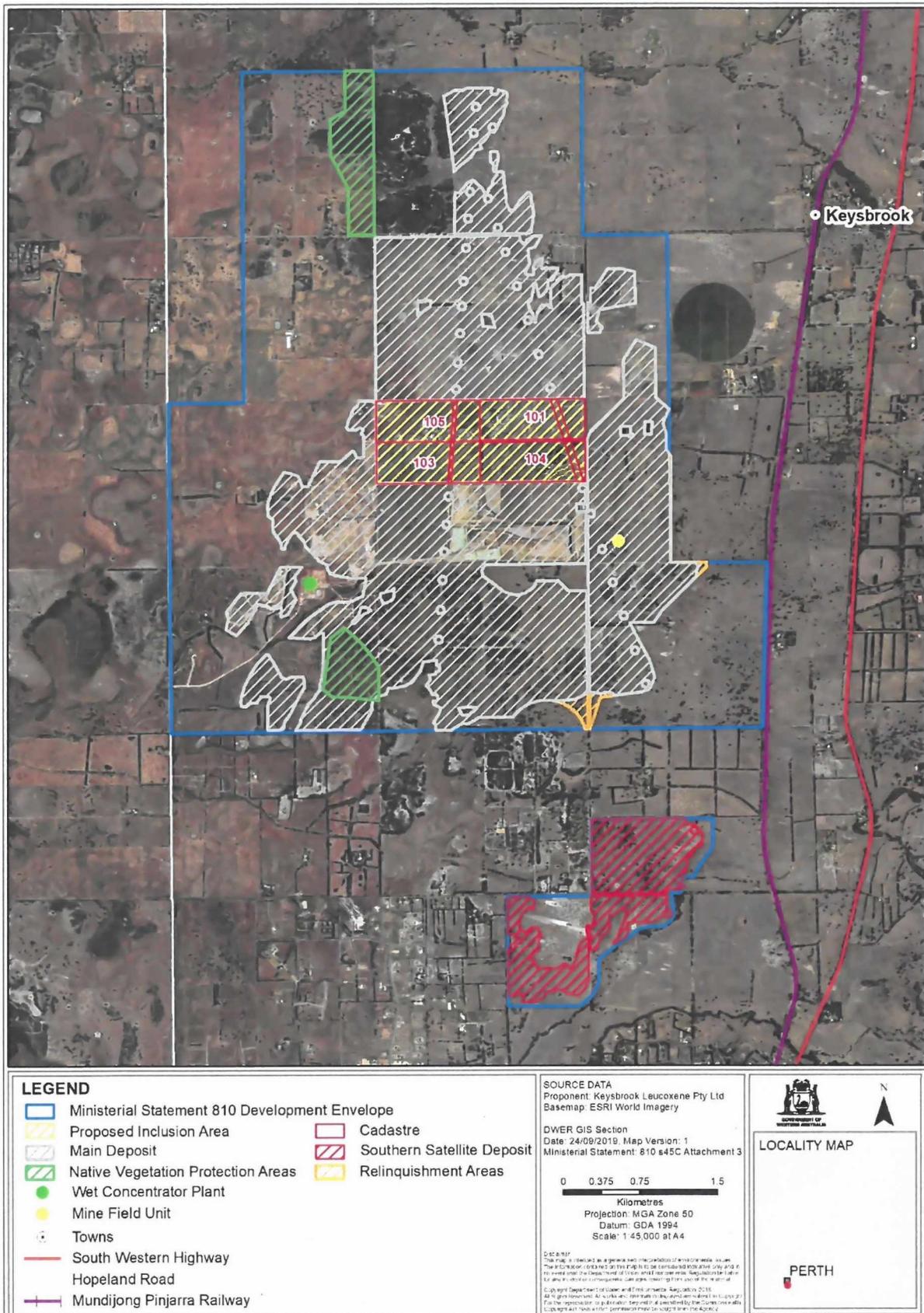


Figure 2: Keysbrook Mineral Sands Mine - Development Envelope and Mining Area

Nutrient Management Plan

Keysbrook Mineral Sand Project Keysbrook, Western Australia

Prepared for:

Matilda Zircon Limited



May 2012

Prepared by:

Martinick Bosch Sell Pty Ltd
4 Cook Street
West Perth WA 6005

Ph: (08) 9226 3166

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MBS
ENVIRONMENTAL

NUTRIENT MANAGEMENT PLAN

KEYSBROOK MINERAL SAND PROJECT KEYSBROOK, WESTERN AUSTRALIA

MAY 2012

PREPARED FOR

MATILDA ZIRCON LIMITED



BY

MBS ENVIRONMENTAL

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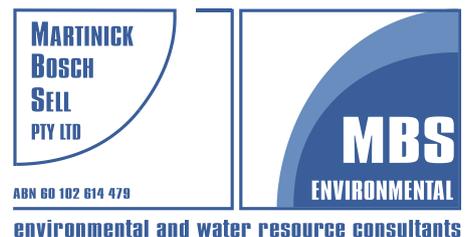


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1. INTRODUCTION

Matilda Zircon Limited (Matilda Zircon) are planning to develop an open cut mineral sand mine and primary processing plant within an area of rural land near the small townships of Keysbrook and North Dandalup (Figure 1). The project area is located within the Peel Harvey catchment of the Swan Coastal Plain. The mining area of 1,354 hectares is located on privately owned land, actively used for grazing.

The project will involve extraction of mineral sands 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 primary processing plant. Ore will be mined by a scraper and screened before being processed. The heavy mineral concentrate (HMC) will be separated from the quartz sand and clay fractions. The quartz sand and clay waste will be returned to the mined areas and the landform will be reinstated to approximately pre-mining contours.

The ore is hosted totally within the superficial (Bassendean sand) profile on the site. The depth of the open pit will range from one to two metres in the flat sandplain locations up to six metres in the undulating dunal rises.

Mining of the Keysbrook mineral sand deposit involves clearing of some remnant native vegetation. The local landscape has already been heavily cleared for agricultural uses.

As the project lies within the Peel Harvey catchment, a Nutrient Management Plan (NMP) is required to ensure that nutrient export from the project area does not increase the nutrient load to the Peel Harvey estuarine system. The Peel Inlet and Harvey Estuary are subject to annual blooms of nuisance algae resulting from leaching of soluble phosphorus and nitrogen from the sandy soils within the catchment area on the Swan Coastal Plain.

1.1 PURPOSE

This NMP has been developed to satisfy the requirements of a condition of approval of the project according to Ministerial Statement 810 pursuant to the provisions of the Environmental Protection Act 1986. The purpose of this NMP is to ensure the proposal assists in meeting the water quality objectives of the Peel-Harvey Water Quality Improvement Plan (EPA, 2008).

According to Ministerial Statement 810, the objectives of this NMP are to:

- Outline a program to monitor nutrient levels within the proposal area and at the downstream boundary of the proposal area.
- Identify nutrient trigger levels consistent with the Peel-Harvey Water Quality Improvement Plan.
- Identify management actions should a trigger level be reached.

Upon approval from the CEO of the Department of Environment and Conservation (DEC), Matilda Zircon shall implement this NMP and make it publicly available (including any revisions).

The primary objective of the NMP is to minimise the export of nutrients, especially phosphorus and nitrogen, from the project area during operational and decommissioning phases of the project.

1.2 RELEVANCE TO OTHER PLANS

As a condition of approval of the project, Ministerial Statement 810 also required the development of a Weed and Dieback Management Plan (WDMP), a Rehabilitation Management Plan (RMP), a Water Management Plan (WMP) and an Acid Sulphate Soils Management Plan (ASSMP). Implementation of this NMP will require consideration of objectives in these other management plans.

In particular, the objectives of the NMP are closely aligned to those of the WMP.

1.3 SITE CLEARING

The total project area is 1,354 hectares. Of this, 1,174 hectares (87%) is open pasture with scattered trees and 180 hectares (13%) is parkland cleared native vegetation ranging from good to completely degraded condition. Of this, 180 hectares, 75 hectares will be protected for conservation in the long term.

Matilda Zircon proposes to clear the remaining 105 hectares of parkland cleared vegetation over an eight year period and to implement a progressive rehabilitation program to ensure no net loss of vegetation in the longer term. The rehabilitation program aims to achieve a net environmental gain over the present situation by consolidating vegetated areas and establishing corridor linkages, in contrast to the fragmentation that currently exists.

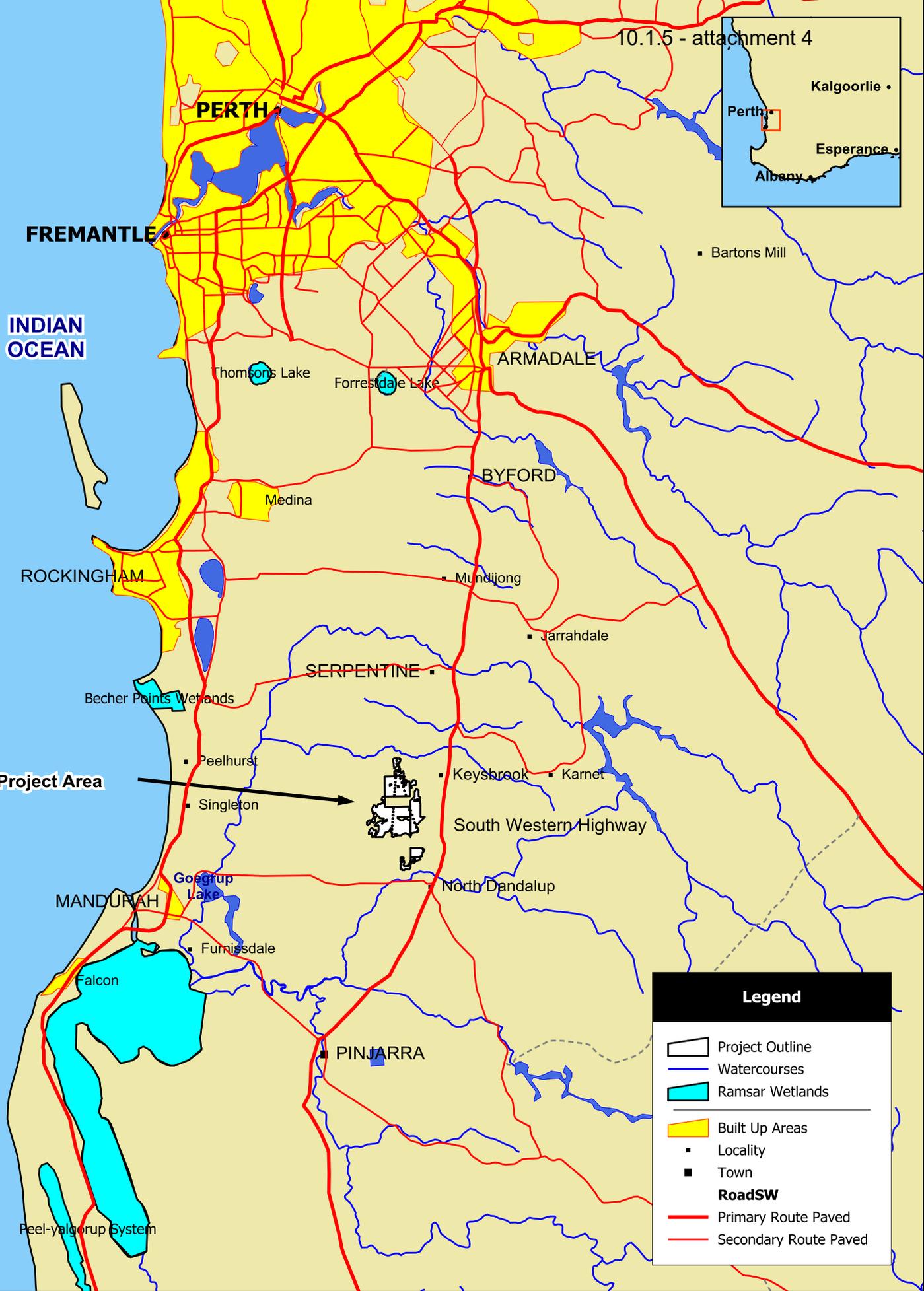
1.4 ANNUAL PLAN AND SCHEDULE

The mining operation is a continuous process, with the rate of movement of the mine cell dependent on the depth of the orebody in a particular location. At an average pit depth of two metres, the mine will advance at approximately 10 to 12 hectares per month.

With 87% of the mine area in existing cleared paddocks, much of the pre-mining preparation work will only involve stripping of pasture and topsoil from the area to be mined.

As a normal part of mine management, a detailed annual mine plan will be prepared. This annual plan is required in order to:

- Detail the location of orebodies, anticipated tonnes and grade and to establish production targets for the year.
- Plan and schedule the rate of movement of the mine cell and relocation of infrastructure required to support the mine extensions.
- Liaise with relevant landowners on the location of activity on individual properties.



Legend

- Project Outline
- Watercourses
- Ramsar Wetlands

- Built Up Areas
- Locality
- Town

RoadSW

- Primary Route Paved
- Secondary Route Paved

Environmental + Water
Resource Consultants

MBS
ENVIRONMENTAL

4 Cook St
West Perth WA 6005
Telephone: + 618 9226 3166
Facsimile: + 618 9226 3177
info@mbsenvironmental.com.au

Scale 1:400000
Original Size: A4

0 10 km

Matilda Zircon Limited
Keysbrook
Mineral Sands Project
Ordinary Council Meeting - 17 February 2010

Location Plan

Figure 1

2. EXISTING ENVIRONMENT

2.1 REGIONAL SETTING

The proposed mine is situated along the eastern edge of the Swan Coastal Plain approximately 70 kilometres south of Perth, near the small townships of Keysbrook and North Dandalup. It is located two to seven kilometres west of the Darling Scarp and elevation in the area varies between 22 and 48 metres AHD. The topography of the mine area is flat to very gently undulating.

The mining area of 1,354 hectares is located on privately owned rural zoned land. A large portion of the mine area has been cleared for grazing activities. Patches of remnant native vegetation also remain, ranging from stands of trees over pasture grass with little to no understorey to areas of trees with a partially-intact understorey.

2.2 LAND SYSTEMS

The geomorphology of the Swan Coastal Plain comprises 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.

2.3 SOILS

The heavy mineral resource is hosted within the dunes of the Bassendean Sand, which partly covers mottled clayey sand or a pisolitic ironstone-clay unit of the Guildford Formation, also referred to as the Pinjarra Plain. Figure 2 shows the distribution of these soils through the mine area. Table 1 describes the soil types shown in Figure 2.

Table 1: Description of Soil Types

Soil Type	Description
Bassendean Dune and Sandplains	
B1	Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than two metres; banksia dominant.
B1a	Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with an intensely coloured yellow B horizon occurring within one metre of the surface; marri and jarrah dominant.
B2	Flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan one to two metres.
B4	Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 metres by clay or less frequently a strong iron-organic hardpan.
B5	Shallowly incised stream channels of minor creeks and rivers with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 metres by clay or less frequently a strong iron-organic hardpan.
B6	Sandplain similar to B4 with imperfectly drained deep or very deep grey siliceous sands.
Pinjarra Plain	
P1a	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
P1b	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Moderately deep pale sand to loamy sand over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P1c	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or 'effective duplex') soils. Deep pale brown to yellowish sand to sandy loam over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P2	Flat to very gently undulating plain with deep alkaline mottled yellow duplex soils which generally consist of shallow pale sand to sandy loam over clay.
P7	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and grey sandy duplex and effective duplex soils.
P8	Broad poorly drained flats and poorly defined stream channels with moderately deep to deep sands over mottled clays; acidic or less commonly alkaline grey and yellow duplex soils to uniform bleached or pale brown sands over clay.
P11	Shallow brown loamy soils or less commonly, very shallow sands over ironstone pavement which is a clear barrier to drainage.

2.3.1 Bassendean Dunes

The dominant soil parent materials within the Bassendean system are highly leached quartzose sands. 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 Formation). Some inland movement by wind action has also occurred. The majority of the soils are podzols. Soils 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.

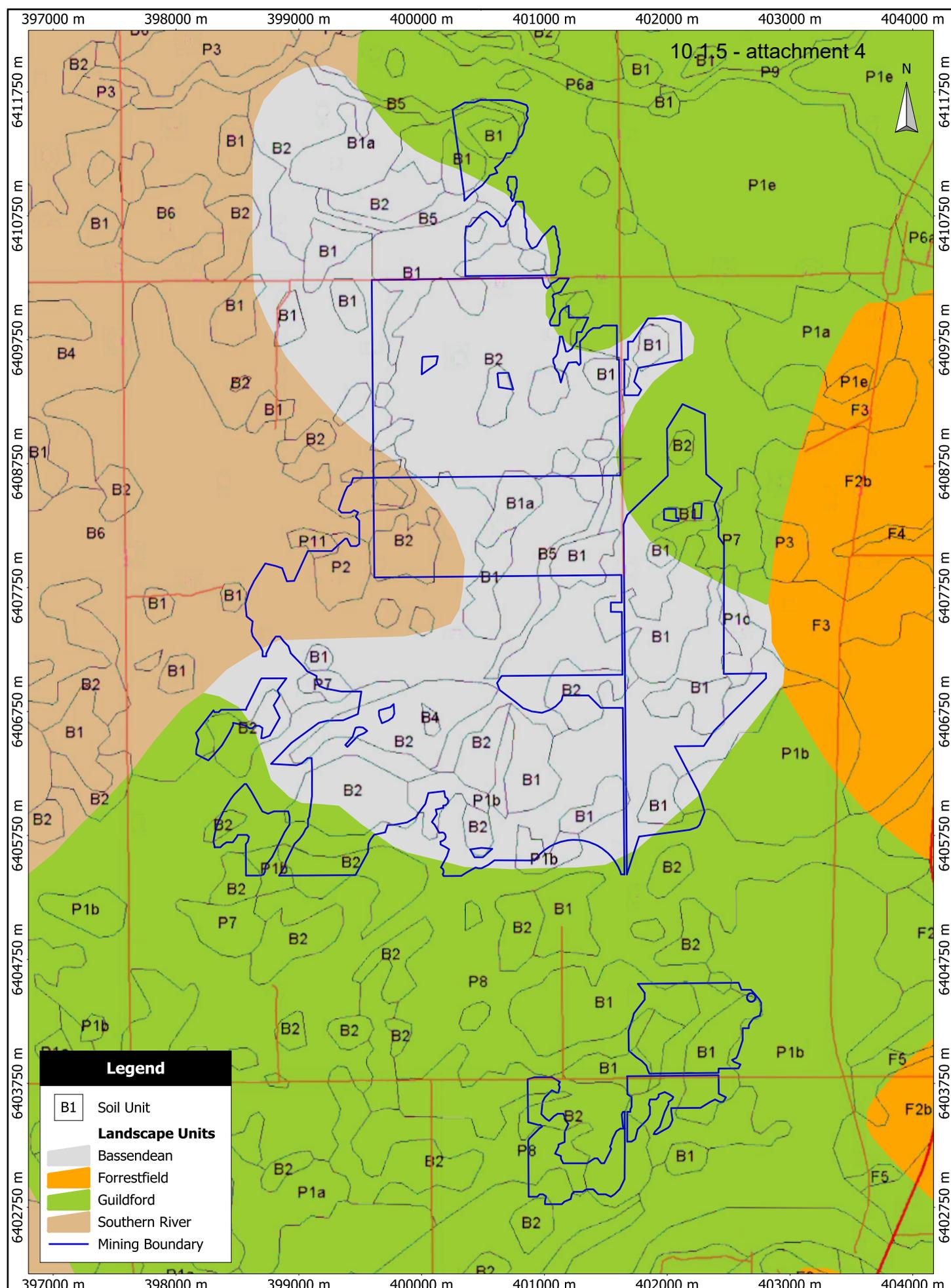
In their natural state, soils within the Bassendean system are extremely infertile and have a limited low stock carrying capacity unless supplemented with fertilisers containing phosphorus, nitrogen, sulphur and potassium. The high silica content results in poor nutrient retention capacity which leads to high losses of mobile nutrients, including nitrate-nitrogen and soluble phosphate, by leaching. Other limitations to high productivity include natural soil acidity and a propensity for being water repellent (hydrophobic).

2.3.2 Pinjarra Plain

The soils of the Pinjarra Plain have largely formed from unconsolidated alluvial material of Tertiary and Quaternary Age. The depositional systems can be grouped into following 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.

Pinjarra Plain soils are more fertile than the leached sands of the Bassendean system. The higher silt and clay contents provide increased water holding capacity and nutrient adsorption.



10.15 - attachment 4



Legend

- B1 Soil Unit
- Landscape Units**
- Bassendean
- Forrestdfield
- Guildford
- Southern River
- Mining Boundary

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Scale: 1:40000
Original Size: A4
Air Photo Date:
Grid: Australia MGA94 (50)

0 1 km

Matilda Zircon Ltd

Nutrient Management Plan

Ordinary Council Meeting 17 February 2020

Soil Types in the
Mine Area

Fig 2020 2

3. NUTRIENT EXPORT RISKS

3.1 NUTRIENT EXPORT PATHWAYS

The following pathways for export of nutrients from the project area to the environment have been identified:

- Erosion of organic matter and fine soil particles from topsoil stockpiles.
- Wind erosion of organic matter and fine soil particles from recently rehabilitated land surfaces.
- Removal of nutrients in vegetation by clearing. Although this process will not necessarily result in direct transport of nutrients into the Peel Harvey catchment, it is likely to reduce base saturation of the soil, particularly the poorly buffered Bassendean sands. This may result in soil acidification and hinder rehabilitation efforts.
- Mineralisation of soil organic matter following vegetation clearing and disturbance of topsoil.
- Transport of nutrients from grazing areas to riparian zones in faeces and urine from cattle.
- Inefficient use of chemical fertilisers to maintain or increase livestock production. This may occur by:
 - Selection of inappropriate fertilisers, such as those containing high concentrations of water-soluble phosphorus or other nutrients that are not limiting productivity.
 - Excessive application rates, especially on soils with very low adsorption capacity.
 - Applying water soluble fertilisers immediately before or during high rainfall events.
- Treatment and disposal of waste water including sewage.
- Processing chemicals containing nitrogen or phosphorus compounds.

3.2 SOILS IN THE MINING AREA

According to the map presented as Figure 3 based on information provided by the Natural Resource Assessment Group of the Department of Agriculture and Food, the soil types situated within the project area have a moderate to extremely high risk of phosphorus export. The risk is slightly lower in the southern and eastern sections of the project area in which the soils are dominated by duplex soils of the Pinjarra Plain. The dominant soil types of the north western section are deep sands of the Bassendean dune series. These soils are composed mainly of silica sands, which have very low assimilative capacity for phosphorus.

Composite samples of the sand profile (generally the top two metres) were collected as part of baseline studies to analyse the major nutrients nitrogen (N), phosphorus (P) and potassium (K). The results indicated a very low nutrient bank available in the sand profile of the site.

To provide more detailed information on the potential of an immobile nutrient bank within the Bassendean sand profile that could be mobilised during mining and processing operations, additional soil sampling was undertaken in September 2006. Samples were collected at 0.5 metre intervals and a composite sample for the entire hole. One profile (Hole 1) was sampled to 3.5 metres below ground level on a dunal rise. Two other profiles (Holes 2 and 3) were collected in low lying sand profiles within the water table.

Parameters tested were total phosphorus, Phosphorus Retention Index (PRI), water soluble phosphorus [P (H₂O)] and phosphorus extractable in 0.01 M CaCl₂ [P (CaCl₂)]. The results are presented in Table 2.

The results indicate the following:

- The total phosphorus values are consistent with those reported in the first study.
- The surface layer of Hole 1 has an elevated total phosphorus value which suggests it has received an application of fertiliser at some time.
- The surface layer of Hole 1 has a very low PRI, consistent with the soil characteristics of the B1 unit.
- Consistent with the elevated phosphorus value and the very low PRI, the surface layer of Hole 1 also has the highest water soluble (leachable) value tested.
- There are no other elevated banks of total phosphorus in Hole 2 or 3.
- Holes 2 or 3 have very high PRI values when compared to typical values for Bassendean Sands. This suggests the presence of iron minerals or iron-organic materials in the B-horizon, which are often found in B4 and B5 phases of the Bassendean Sands.
- The composite sample of each hole showed similar results to the individual samples.
- The water soluble values are extremely low, indicating there is no significant leachable fraction.

The total phosphorus values therefore dominantly comprise phosphorus in a form that is not water soluble. It is most likely in forms such as organic material (fine roots) and bound onto clay, iron and aluminium complexes. This phosphorus can only be exported from the site as physical particles (i.e. in sediment) rather than as soluble phosphorus dissolved in water.

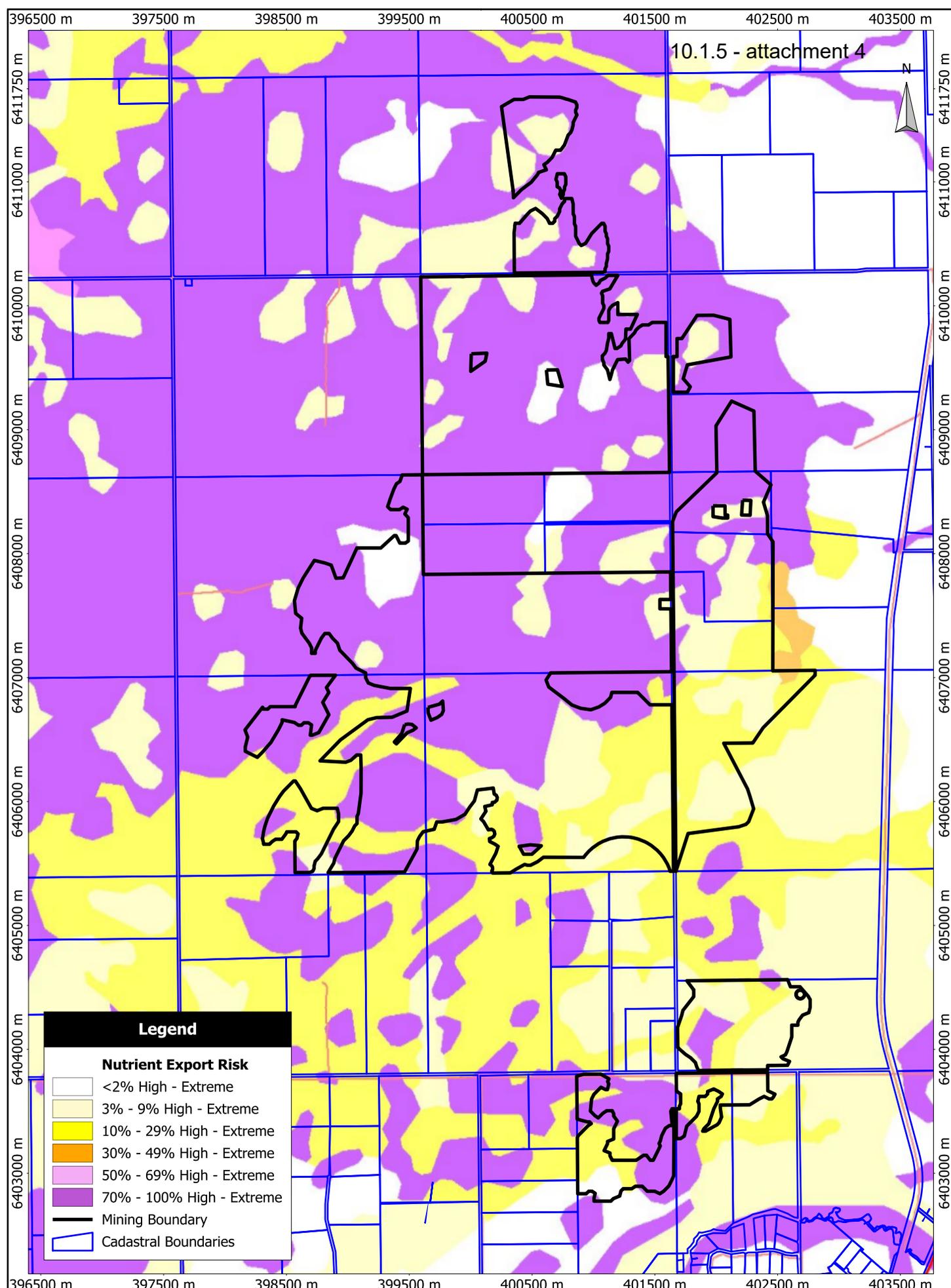
This data is consistent with findings from many studies on the nutrient leaching problems of the sandy coastal plain soils. In summary, these findings are:

- The dominant source of nutrients is from applied agricultural fertilisers.
- The high porosity and poor nutrient retention capability of the sandy soils result in rapid leaching and export of the predominantly water soluble forms of nutrients in fertiliser.
- The majority of this nutrient leaching and transport process occurs in surface water flow and in the surface soil layers.

Sand returned to the mine site after processing will have a higher content of fine particles and iron minerals than the original topsoil as a result of blending with materials from the original B horizon. While this will result in a dilution of nutrients originally stored in the A horizon, the replaced soil will have improved water holding and nutrient retention characteristics. This is expected to increase the production potential for grazing by cattle.

Table 2: Nutrient Analyses of Soils in the Mine Area

Sample Location and Depth (m)	P (total)	(PRI)	P (H ₂ O)	P (CaCl ₂)
	mg/kg	mL/g	mg/kg	mg/kg
H1 0.5	39	2.0	1.5	0.3
H1 1.0	14	3.6	<0.1	0.2
H1 1.5	16	4.6	<0.1	0.2
H1 2.5	18	9.2	0.3	0.2
H1 3.5	19	11	0.1	0.2
H1 Bulk	24	5.3	<0.1	0.2
H2 0.5	22	13	<0.1	0.2
H2 1.0	13	16	<0.1	0.2
H2 Bulk	20	17	<0.1	<0.1
H3 0.5	22	5.7	<0.1	0.2
H3 1.0	17	38	<0.1	0.2
H3 1.5	17	34	<0.1	0.2
H3 Bulk	18	18	<0.1	0.2



Legend

Nutrient Export Risk

- <2% High - Extreme
- 3% - 9% High - Extreme
- 10% - 29% High - Extreme
- 30% - 49% High - Extreme
- 50% - 69% High - Extreme
- 70% - 100% High - Extreme
- Mining Boundary
- Cadastral Boundaries

	Environmental + Water Resource Consultants 4 Cook St West Perth WA 6005 Telephone: + 618 9226 3186 Facsimile: + 618 9226 3177 info@mbsenvironmental.com.au	Scale: 1:40000 Original Size: A4 Air Photo Date: Grid: Australia MGA94 (50)	<p>Matilda Zircon Ltd</p> <p>Nutrient Management Plan 7 February 2020</p>
			<p>Nutrient Export Risk Map</p> <p>Fig 2020 3</p>

4. LAND CLEARING

The Environmental Officer shall be responsible for ensuring the area to be cleared is clearly marked in the field and earthworks operators informed such that only the area proposed for clearing is disturbed.

The Environmental Officer will be responsible for ensuring that a Clearing Register is maintained and that it records:

- The location of all land clearing.
- Total surface area of clearing.
- Type and volume of topsoil removed.
- Dieback status of topsoil removed.
- Location of direct re-application or where topsoil was stockpiled.

The Environmental Officer will be responsible for ensuring that the total area of land cleared is reported in the Annual Environmental Report (AER).

The project will be designed, constructed and operated to minimise the impacts on remnant vegetation and nutrient export by:

- Defining the area to be cleared on maps and supervising clearing activities.
- Ensuring that effective dust control measures are implemented.
- Progressively rehabilitating and monitoring disturbed areas.
- Salvaging millable and firewood timber in Dieback free areas of the site for use prior to land clearing occurring.
- Stockpiling vegetation from Dieback free areas to be cleared not useful for millable or firewood purposes for later use in rehabilitation. Vegetation stockpiles will be located adjacent to cleared areas.
- Stockpiles of vegetation from known Dieback infected areas will be burned and not used for rehabilitation. Phosphorus in the resulting ash is expected to be present in a highly insoluble form. Most of the nitrogen will be volatilised.
- Topsoil will be recovered and stockpiled separately from vegetation areas, or where possible replaced immediately on backfilled areas ready for rehabilitation. The Site Manager shall be responsible for ensuring that topsoil stockpiles are:
 - No greater than two metres high.
 - Located away from water inundation or vehicle traffic.
- A topsoil stockpile register shall be maintained by the Environmental Officer.

5. SOIL AND VEGETATION NUTRIENT MANAGEMENT

The RMP provides a detailed discussion of the rehabilitation process. To summarise, the rehabilitated landform will be similar to pre-mining levels, but not always identical. In most locations, post-mining landforms will be similar to existing (pre-mining) contour levels. In other locations variations in surface levels between active mining areas and backfill locations will mean some difference in post-mining levels. In all cases, the post-mining ground level will re-establish pre-mining regional surface drainage.

Land rehabilitation will consist of landform and soil profile restoration. Restored surfaces will be stabilised with vegetation, in most instances pasture. Rehabilitation will also include protection and enhancement of remnant vegetation as well as the establishment of shelter belt plantings and more complete communities of native vegetation within the mine site.

5.1 LANDFORM RESTORATION

Waste materials from the plant are returned to the mined out areas to reform land for post mining land use. The quartz sand component of the waste (about 90% by volume) is mixed with the thickened clay component from the thickener (about 8% by volume) and pumped to backfill the mined out areas. 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. As a result of the waste material return process, the post mining soil characteristics will have altered and are likely to have increased moisture and nutrient retention characteristics.

Earthworks will be undertaken to return the completed mine area to as close as possible to pre-mining levels, but recognising that some minor changes to existing topography will occur. The restored landforms will be shaped to direct surface drainage towards existing major creek lines running through the mine area. The restored mine landform will not create drainage barriers that result in localised flooding in areas not previously subjected to water inundation.

Where necessary, temporary erosion control measures will be implemented to minimise water erosion of restored landforms prior to establishment of a stabilising vegetative cover. This may include construction of shallow contour banks, sumps and drains in the first year of rehabilitation to prevent scouring and release of suspended sediments and associated nutrients to natural waterways. With the stabilisation of the landform by pasture species or native vegetation after the first year, these temporary structures will be removed during the second year's pasture reseeding process.

Risk of wind erosion will be reduced by scheduling earthmoving for landform restoration, as far as is practically possible, to periods when the soil is moist. Cover crops, binding agents or mulches will be used where necessary to minimise dust emissions until more favourable conditions prevail for vegetation establishment.

5.2 REVEGETATION

Land access and compensation agreements are required in order for Matilda Zircon to conduct mining operations on each property. Matilda Zircon may also purchase properties in the mine area. Individual landowners have agreed on the rehabilitation strategy for their property.

Although several types of vegetation will be established during rehabilitation, the majority of the land disturbed by mining activities will be returned to pasture. Methods of establishing and assessing success of rehabilitation will vary with vegetation types. These are described in further detail below. Wherever possible, revegetation with native species will be focused on the deeper Bassendean sands, while restoration to grazed pasture will be more successful on the duplex sandy soils of the Pinjarra Plain.

5.2.1 Pasture

Topsoil from agricultural lands affected by mining operations consists mainly of a thin organic rich A-horizon over deep grey sand in Bassendean sand or sandy clay loam B-horizons in the Pinjarra Plain duplex soils. These areas will be rehabilitated to pasture. Pasture will be sown mechanically into the restored landforms using standard agricultural machinery. Consultation will occur with the landowner and the Department of Agriculture and Food (DAF) on the appropriate pasture species in particular areas, seeding rates, fertiliser types and application rates.

The use of fertilisers on agricultural land on the Swan Coastal Plain is expected to become highly regulated when the Fertiliser Action Plan (FAP) is implemented by the Western Australian Government in the near future. This NMP adopts the principles of the FAP as summarised below:

- Selection of appropriate fertilisers and application rates will be based on results from soil testing.
- No fertiliser will be applied if the pH of the soil (as measured by extraction in 0.01 M CaCl₂) is below 4.5. If it is decided to grow pastures on such acidic soils, application of two tonnes of agricultural lime per hectare will be required to increase the pH above 4.5.
- Recommendations for application rates of phosphatic fertilisers will be based on use of a recognised calibrated soil test for plant-available phosphorus (such as the Colwell, Olsen or Mehlich-3 tests) and a measure of phosphate adsorption capacity of the soil. Recognised tests for phosphate adsorption capacity by commercial soil testing laboratories in Western Australia are the Phosphorus Retention Index (PRI) and Phosphorus Buffering Index (PBI).
- Recommendations for application rates of nitrogenous fertilisers will be based on use of recognised Decision Support Systems developed in Western Australia. Decision Support Systems based on soil test results typically require analysis of the soil for organic carbon and mineral forms of nitrogen (ammonium and nitrate forms of extractable nitrogen).
- All soil samples will be tested for plant-available potassium and sulphur to determine if these nutrients need to be supplied by fertilisers.
- Fertiliser application rates based on soil testing will be calculated by recognised Decision Support Systems developed in Western Australia for low production livestock grazing enterprises.
- If application of phosphatic fertilisers is indicated, preference will be given to 'slow release' formulations rather than water-soluble fertilisers such as superphosphate.
- Fertilisers will only be applied in autumn, preferably before the onset of winter rainfall.

- Symptoms of nutrient deficiencies, toxicities or imbalances in pastures or native plants will be confirmed by tissue testing for major and minor nutrients (nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulphur, boron, copper, iron, manganese, molybdenum and zinc).

Grazing of re-established pastures will be minimised during the first and second years to allow plant establishment and seed set. Reseeding will also occur in the second year to ensure full establishment of pasture to sustain grazing and be self-sustaining by natural seeding.

It is anticipated that pasture areas will be fully returned to the landowner for recommencement of normal grazing activities after the two year reseeded process.

It has been demonstrated in other mineral sand mines operating in sandy soils that recombine clay, which has been separated during the process, back into the top of the soil profile improves the water and nutrient retention ability of the soil, overcomes the problem of non-wetting (hydrophobic) soils and reduces the potential for erosion. This improves the quality of pasture on the completed mine areas. The Environmental Officer will ensure that any clay materials used for soil amendment (that is, clay contained within the shallow dams) will be tested for acidity (pH) and the presence of any acid producing sulphide minerals such as pyrite.

Apart from the use of clay residues produced by the project, there is no requirement for application of other soil amendment materials such as bauxite residue ('red mud'), compost or animal manures.

5.2.2 Native Vegetation

Nutrient requirements of native vegetation are significantly lower than those of pasture for grazing by livestock. However, revegetation by native plants may be accelerated by application of low rates of fertilisers or liming materials, especially on impoverished sandy soils following disturbance of topsoil, blending with subsoil materials during processing or clearing of vegetation.

The Environmental Officer is responsible for ensuring soil testing is undertaken prior to revegetation of areas using native plant species. If required, application rates of fertiliser or agricultural lime will be determined using the procedures described in Section 5.2.1.

5.3 GRAZING PROTECTION FOR REHABILITATED AREAS

The Environmental Officer is responsible for ensuring that rehabilitation areas planted with native vegetation and riparian zones are fenced to prevent access by stock and associated transport of nutrients in faeces and urine.

6. OTHER NUTRIENT SOURCES

6.1 PROCESS CHEMICALS

The beneficiation process uses gravity separation as the means to extract the heavy mineral concentrate from the quartz sand. The only chemical used in the process is a flocculant to remove suspended clays from process water. The flocculant used in the process is a polyacrylamide, which contains some nitrogen. Nitrogen in polyacrylamide polymers is very stable and can only become mobilised by microbial degradation. The contribution of nitrogen from flocculants to the total soil nitrogen pool is insignificant.

6.2 WASTE WATER AND SEWAGE

The Environmental Officer will ensure that a biocycle sewerage system is used for the processing plant site and administration office ablutions. This will be designed, located and operated in compliance with the requirements of the Health Department of Western Australia and the local Shire. The system treats sewage effluent before discharging treated water to a contained area, which will be elevated to ensure a minimum two metre separation distance to the water table is maintained.

The proposed waste treatment system has been specifically designed with consideration of potential of nutrient leaching in sandy soils with shallow water tables. The system contains an amended soil with a high capacity for removing phosphate by surface adsorption.

Discharge of treated water will be conducted in accordance with Water Quality Protection Note 22 (WQPN22) provided by the Department of Water (DoW, 2008). According to Table 1 of WQPN22, the Risk Category based on soil type and location is Category A. This restricts the annual application loadings of inorganic nitrogen and reactive phosphorus to 140 kilograms of nitrogen per hectare per year and 10 kilograms of phosphorus per hectare per year.

7. MONITORING

7.1 LOCATIONS FOR SOIL AND WATER MONITORING

7.1.1 Water Quality Monitoring

Regular monitoring will be required to demonstrate that mining operations do not adversely affect groundwater and surface water quality.

The Environmental Officer will be responsible for ensuring that regular water samples are collected from shallow groundwater monitoring bores and surface draining lines as shown in Figure 4 and Figure 5. Descriptions of these sampling locations, testing frequency and quality parameters are presented in the Water Management Plan for the project.

Nitrate-nitrogen, soluble phosphorus and total phosphorus will be included as quality parameters for water samples collected from these sites as indicators of nutrient export.

7.1.2 Soil Quality Monitoring

The Environmental Officer will be responsible for ensuring soil samples are taken from areas where landform restoration for return to pasture has occurred prior to any revegetation works proceeding. The soil samples will be analysed to determine whether fertiliser or other soil amendments are required and, if so, suitable application rates. The analysis required for such samples is as described in Section 5.2.1.

The Environmental Officer will be responsible for ensuring soil samples taken for the purposes of determining the need for soil amendments prior to revegetation are also analysed for the standard contaminated sites suite of elements (DEC, 2010). This typically includes antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, tin and zinc.

7.2 TRIGGER VALUES

7.2.1 Water Quality

A target set by Peel-Harvey Water Quality Improvement Plan (EPA 2008) is to reduce the median winter concentration of total phosphorus in major rivers and drains with the Peel-Harvey catchment below 0.1 milligrams per litre. Matilda Zircon will adopt this value as an interim 'trigger value' for monitoring the effectiveness of nutrient management within the project area.

It is recognised that total phosphorus concentrations may exceed 0.1 milligrams per litre at upstream boundary of the project area as a result of nutrient management practices adopted by other land managers in the catchment area. For this reason, Matilda Zircon will compare water quality for upstream and downstream boundary monitoring locations. Management responses will be triggered under the following circumstances:

- Phosphorus concentrations at the downstream boundary surface monitoring location exceed the corresponding upstream locations by more than 10%.
- Phosphorus concentrations at the downstream boundary groundwater monitoring location exceed the previous result at that location by more than 10%.

The Australian and New Zealand Guidelines for Fresh and Marine Quality (ANZECC 2000) provide three potential ‘trigger values’ that may be appropriate for this particular project and environment. They are:

- The Australian Drinking Water Guideline (ADWG) value of 50 milligrams per litre as nitrate (NO₃).
- Protection of natural freshwater ecosystems in southwest Australia (lowland). The ‘trigger value’ is 150 micrograms per litre as nitrate-nitrogen (NO₃-N).
- The livestock drinking water quality guideline of 400 milligrams per litre as nitrate (NO₃).

As the surface and groundwater at the project site does not constitute a ‘natural freshwater ecosystem’ and nitrate concentrations at the ADWG or livestock drinking water quality guideline are much higher than levels required for algal blooms, these ‘trigger values’ were not considered appropriate. For this reason, Matilda Zircon will compare water quality for upstream and downstream boundary monitoring locations. Management responses will be triggered under the following circumstances:

- Total nitrogen and nitrate-nitrogen concentrations at the downstream boundary surface monitoring location exceed the corresponding upstream locations by more than 10%.
- Total nitrogen and nitrate-nitrogen concentrations at the downstream boundary groundwater monitoring location exceed the previous result at that location by more than 10%.

Water quality and groundwater level Trigger Levels and Contaminant Limits are presented in Appendix 3 of the Water Management Plan.

7.2.2 Soil Quality

The Environmental Officer will be responsible for comparing soil results with the relevant reference materials listed in Section 5.2.1 to determine the need for fertiliser or other soil amendment application.

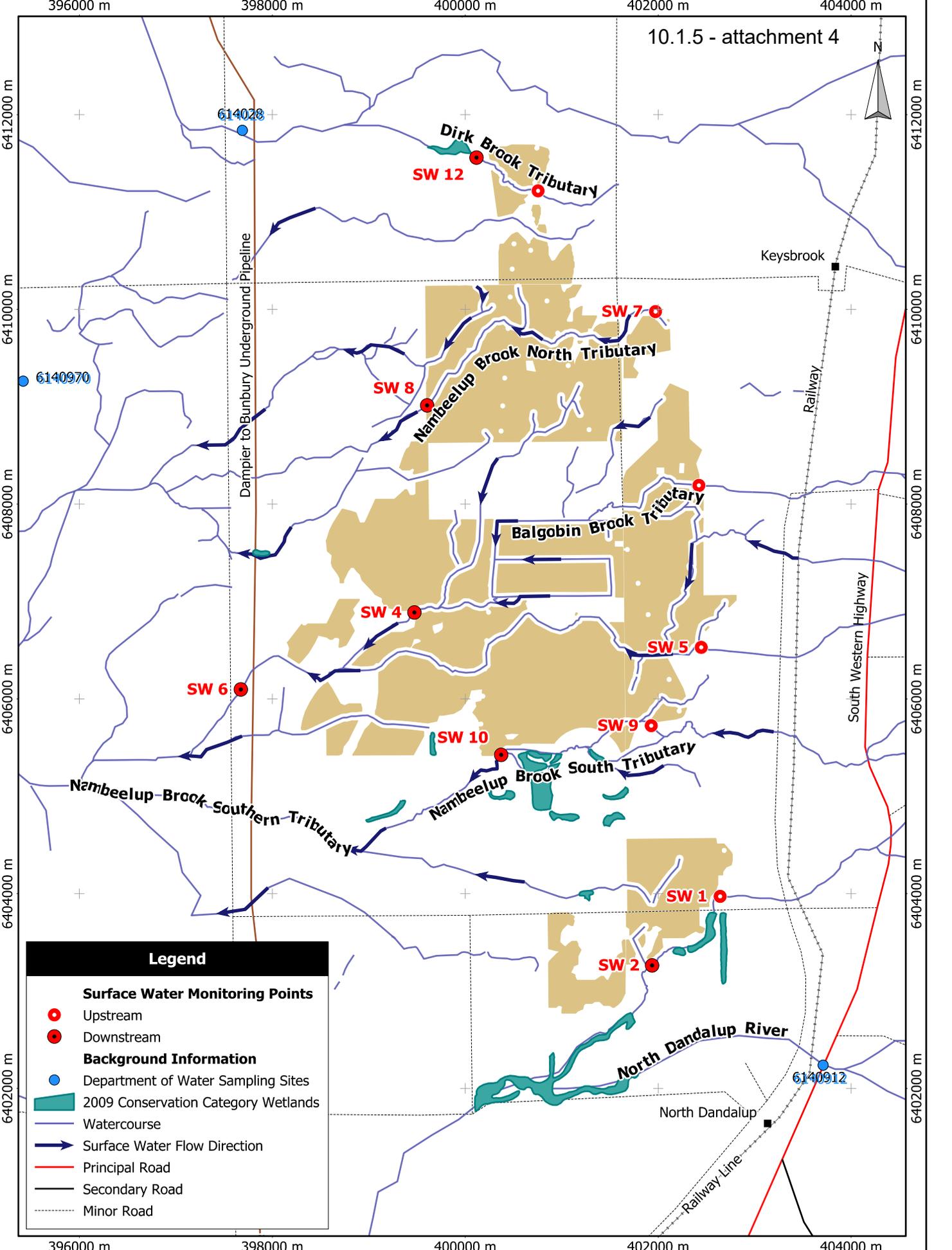
Soil from the designated irrigation site for disposal of treated water from the biocycle sewerage system will be sampled annually and analysed for total nitrogen and phosphorus by a NATA accredited laboratory. The sampling depth will be 0 to 100 millimetres.

The Environmental Officer will be responsible for comparing the soil analysis results with the Environmental Investigation Limits (EIL) contained in the Department of Environment and Conservation Contaminated Lands Series information (DEC, 2010).

7.3 MANAGEMENT ACTIONS

If a water quality trigger value for nutrients (Appendix C of Water Management Plan) or soil metal concentrations is exceeded, the Environmental Officer will be responsible for ensuring the following actions are taken:

- The Site Manager is advised.
- Confirming the test results by collecting additional samples from locations at which the trigger values were exceeded and where relevant corresponding upstream locations.
- If the results from the additional analyses confirm exceedance of the trigger values, then:
 - Reviewing any recent mining or rehabilitation activities that may be responsible for nutrient mobilisation or elevated metal concentrations.
 - Checking fencing to ensure animals have no access to waterways.
 - Checking stockpiles of soil or mulched organic material to ensure they are stable.
 - Undertaking additional soil and water testing to identify the source of excess nutrients or elevated soil metals.



Legend

- Surface Water Monitoring Points**
 - Upstream (Red circle with dot)
 - Downstream (Red circle)
- Background Information**
 - Department of Water Sampling Sites (Blue circle)
 - 2009 Conservation Category Wetlands (Green area)
 - Watercourse (Blue line)
 - Surface Water Flow Direction (Blue arrow)
 - Principal Road (Red line)
 - Secondary Road (Black line)
 - Minor Road (Dotted line)

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Scale: 1:50000
Original Size: A4
Grid: Australia MGA94 (50)

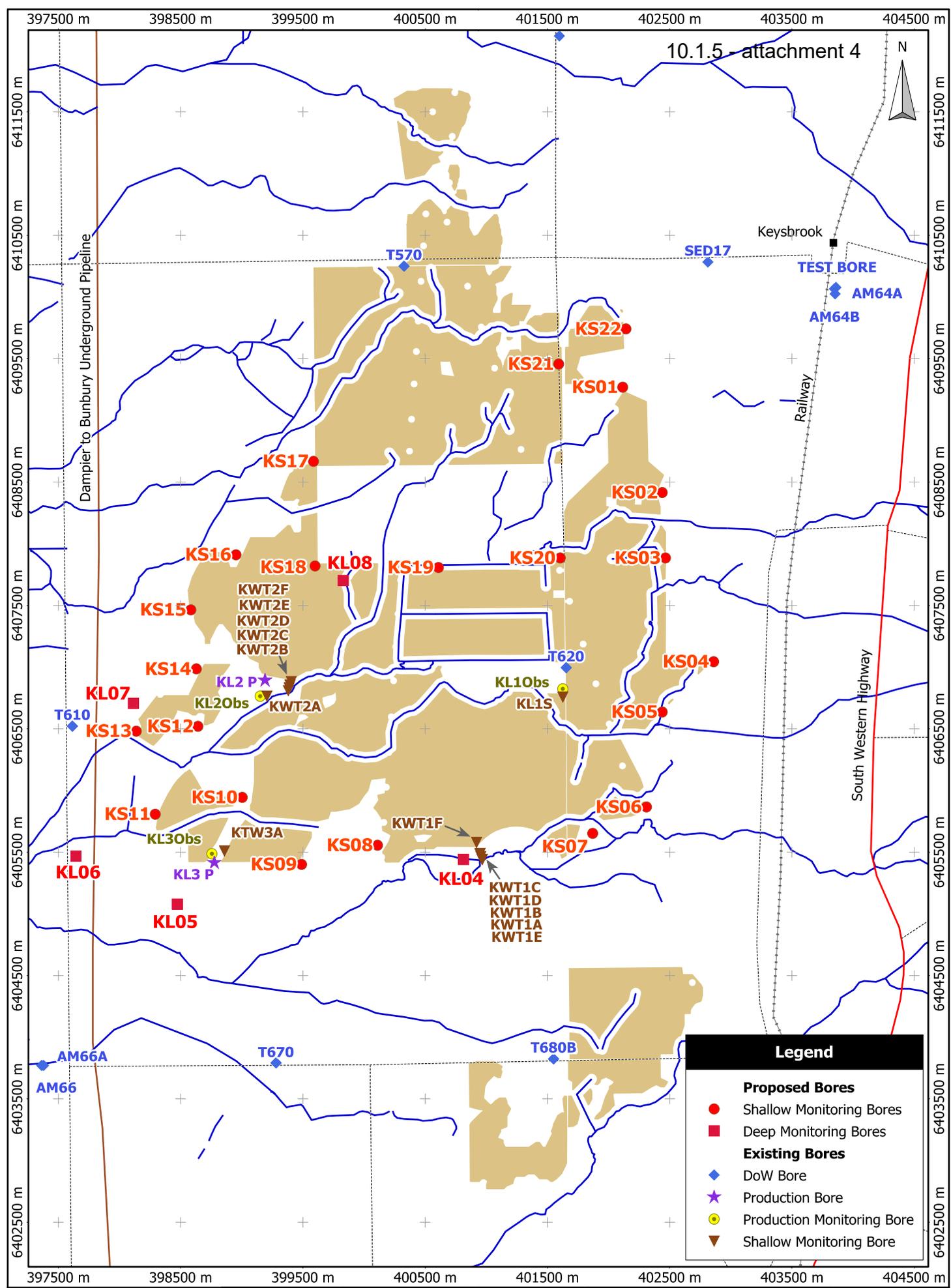
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Matilda Zircon Ltd

Keysbrook Mineral Sands Project

Surface Water Monitoring Locations

Figure 4



8. RECORDS, REVIEW AND REPORTING

The Environmental Officer is responsible for recording the results of water and nutrient monitoring conducted on site. In addition to management items specified in the WMP and RMP, records will need to be maintained for the following activities to ensure compliance with the NMP:

- Laboratory soil test reports.
- Reports provided by suitably trained agronomists for fertiliser application rates.
- Any fertiliser or soil ameliorant applied.

The Environmental Officer is responsible for ensuring that the NMP is reviewed annually and amended if necessary to ensure that it remains relevant, practical and effective.

The Environmental Officer is responsible for ensuring that all results for soil and groundwater monitoring undertaken in the year are included in Matilda Zircon's Annual Environmental Report (AER) for DEC. The AER will also present the findings from any related investigations resulting from exceeding relevant trigger levels. The report will propose any amendments to the NMP.

9. RESPONSIBILITIES

9.1 SITE MANAGER

The Site Manager is responsible for ensuring topsoil stockpiles are no greater than two metres high and are located away from water inundation or vehicle traffic.

9.2 ENVIRONMENTAL OFFICER

The Environmental Officer is responsible for:

- Ensuring the area to be cleared is clearly marked in the field and earthworks operators informed such that only the area proposed for clearing is disturbed.
- Ensuring that a Clearing Register is maintained and that it records:
 - The location of all land clearing.
 - Total surface area of clearing.
 - Type and volume of topsoil removed.
 - Dieback status of topsoil removed.
 - Location of direct re-application or where topsoil was stockpiled.
- Reporting the total area of land cleared in the Annual Environmental Report (AER).
- Maintaining a topsoil stockpile register.
- Testing any clay materials used for soil amendment for acidity (pH) and the presence of any acid producing sulphide minerals such as pyrite.
- Ensuring soil testing is undertaken prior to revegetation of areas using native plant species.
- Ensuring that rehabilitation areas planted with native vegetation and riparian zones are fenced to prevent access by stock and associated transport of nutrients in faeces and urine.
- Ensuring soil samples are taken for areas to be revegetated to pasture prior to any revegetation works taking place. The soil samples are required to be tested for a range of nutrients and metals as described in Section 7.1.2.
- Ensuring that regular water samples are collected from existing shallow groundwater monitoring bores and surface draining lines. The sampling frequency for nutrient testing is identical to that for other water quality parameters listed in the WMP.
- Ensuring soil samples are collected from the treated waste water irrigation area.

- Undertaking the following actions if a water quality trigger value for nutrients (Appendix C of Water Management Plan) or soil EIL is exceeded:
 - The Site Manager is advised.
 - Confirming the test results by collecting additional samples from locations at which the trigger values were exceeded and where relevant the corresponding upstream locations.
 - If the results from the additional analyses confirm exceedance of the trigger values, then:
 - Reviewing any recent mining or rehabilitation activities that may be responsible for nutrient mobilisation or elevated metal concentrations.
 - Checking fencing to ensure animals have no access to waterways.
 - Checking stockpiles of soil or mulched organic material to ensure they are stable.
 - Undertaking additional soil and water testing to identify the source of excess nutrients.
- Undertake annual review of the NMP.

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KEYSBROOK MINERAL SANDS PROJECT

REHABILITATION MANAGEMENT PLAN

PREPARED FOR:

MZI RESOURCES LIMITED



MARCH 2013

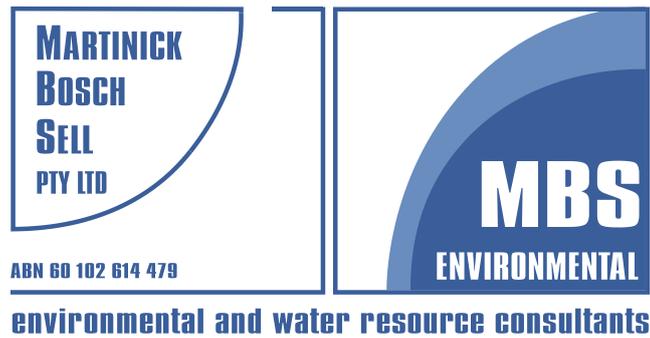
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Ordinary Council Meeting - 17 February 2020

MBS
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KEYSBROOK MINERAL SANDS PROJECT

PREPARED FOR

MZI RESOURCES LIMITED

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1. INTRODUCTION

MZI Resources Limited (MZI) are planning to develop an open cut mineral sand mine and primary processing plant within an area of rural land near the small townships of Keysbrook and North Dandalup (Figure 1). The project, known as the Keysbrook Mineral Sands Project was approved by the Western Australian Minister for Environment through the issue of Ministerial Statement 810 on 19 October 2009 and by the Federal Minister for Environment with *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)* Approval 2005/2163 on 16 February 2011. Minor project amendments relating to the process plant location and change in location of the offset area were approved by the EPA on 4 February 2013 and SEWPAC on 13 August 2012.

The project area is located within the Peel Harvey catchment portion of the Swan Coastal Plain. The approved mining area of 1,354 hectares is located on privately owned land, actively used for grazing. Of this, 1,174 hectares (87.0%) is open pasture with scattered trees and 180 hectares (13.0%) are remnant vegetation in good to completely degraded condition. A total of 75 hectares of remnant vegetation is to be retained and protected in perpetuity in compliance with EPBC Approval 2005/2163 and Ministerial Statement 810. Twenty five hectares are to be retained within the mining area; the remaining 155 hectares of native vegetation within the mining area will be cleared. The additional 50 hectares to be retained are located outside of the approved mining area.

The project 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 primary processing plant. Ore will be excavated from the advancing edge of the pit with excavators into dump trucks and screened before being processed. The heavy mineral concentrate (HMC) will be separated from the quartz sand and clay fractions. The quartz sand and clay waste will be returned to the mined areas and the landform will be reinstated to approximately pre-mining contours.

The ore is hosted totally within the superficial (Bassendean sand) profile. The depth of the open pit will range from one to two metres in the flat sandplain locations and up to six metres in the undulating dunal rises.

The local landscape has already been heavily cleared for agricultural uses. However, mining of the Keysbrook mineral sand deposit involves clearing of some remnant, mostly parkland cleared native vegetation.

As a result of extensive grazing, there is little regrowth or vegetation recruitment outside of fenced areas. Outside these protected areas, gradual decline of vegetation continues to occur by cattle bark-stripping and other factors. While dead trees provide habitat for fauna, the ongoing degradation of remnant vegetation has a corresponding reduction in vegetation structure, density and species diversity that has resulted in a commensurate decline in the diversity of resident fauna. This coupled with the lack of understory shrubs and groundcover species across most of the mine area has reduced the habitat value of the site.

MZI proposes to implement a progressive rehabilitation program to ensure no net loss of vegetation in the longer term. The post-mining land use will be a combination of pasture and native vegetation.

The rehabilitation program aims to achieve a net environmental gain compared to the present situation by consolidating native vegetation areas and establishing corridor linkages in contrast to the fragmentation that currently exists.

1.1 PURPOSE, OBJECTIVES AND TARGETS

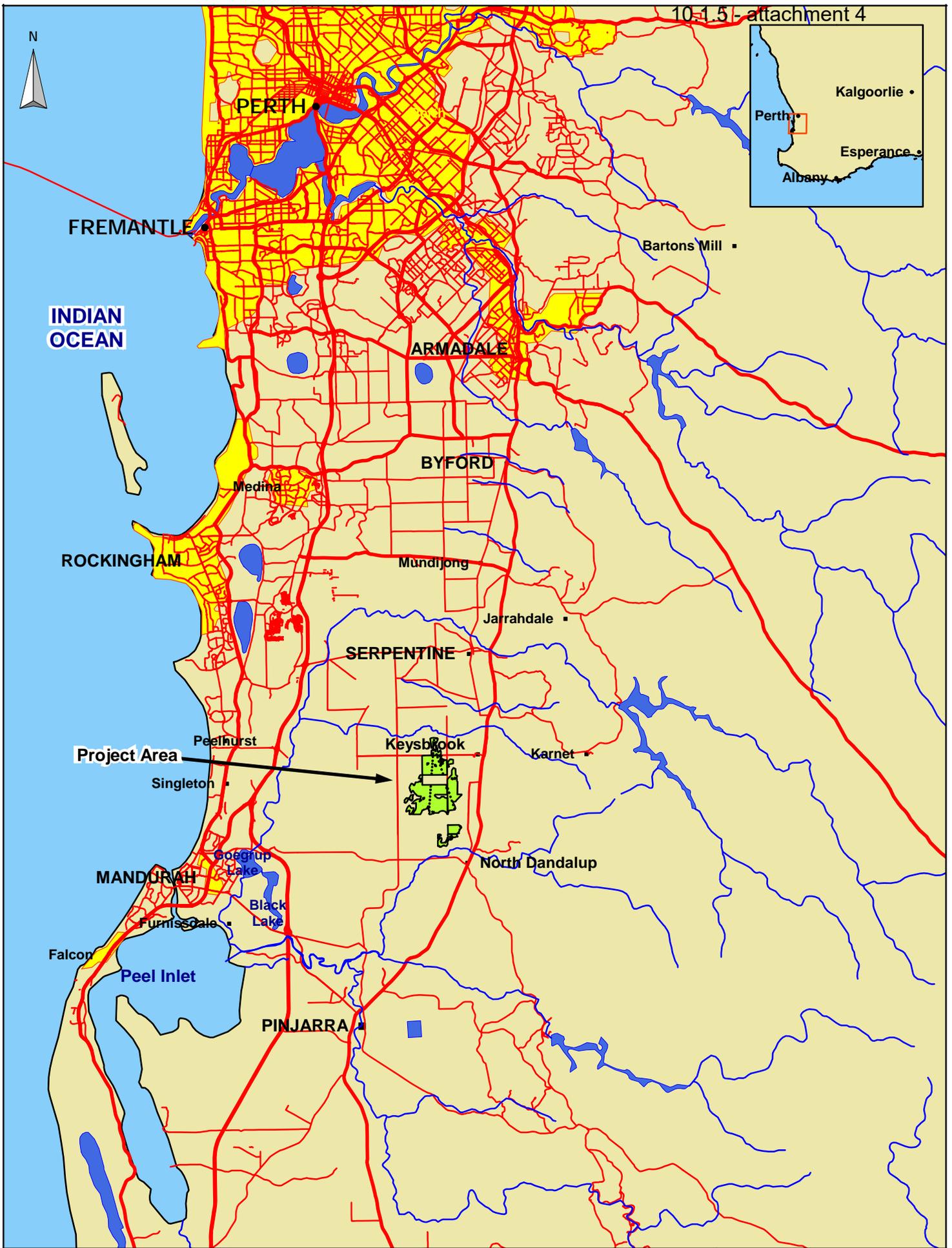
This Rehabilitation Management Plan (RMP) has been developed to comply with Ministerial Statement 810, specifically Condition 8. The purpose of this RMP is to outline the management strategies, actions and procedures that will be used to manage rehabilitation activities and achieve the rehabilitation objectives for the Keysbrook Mineral Sand Project.

The rehabilitation objectives and targets of this RMP are outlined in Table 1.

Table 1: Rehabilitation Objectives and Targets

Objective	Target
Re-establish self-sustaining local provenance native vegetation cleared in the implementation of the proposal, at a ratio of not less than 1.4 to 1 (1.4 hectares of revegetation per 1 hectare of vegetation cleared).	Self-sustaining local provenance native vegetation re-established at a ratio of greater than 1.4 to 1 (1.4 hectares of revegetation per 1 hectare of vegetation cleared) within five years of mining each area.
Re-establish functioning pasture.	Pasture established after two years of mining each area and land handed back to landowner.

Upon approval from the CEO of the Department of Environment and Conservation (DEC), MZI shall implement this RMP and make it publicly available (including any revisions). This RMP shall be reviewed and revised as directed by the CEO of the DEC and annually or as required by MZI.



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Scale 1:400000
Original Size: A4

0 10 km

MZI Resources Limited
Keysbrook
Mineral Sands Project

Location Plan

Figure 1

1.1 RELEVANCE TO OTHER PLANS

As a condition of approval of the project, Ministerial Statement 810 also required the development of several other management plans.

The Weed and Dieback Management Plan (WDMP) (MBS 2011) discusses mitigation measures to prevent the spread of weeds and dieback during the active phases of mining and management to ensure successful revegetation occurs after mining. Revegetation strategies include topsoil management and the use of dieback resistant native plant species for rehabilitation areas.

The Nutrient Management Plan (NMP) (MBS 2012a) outlines a program to monitor the nutrient levels within the mining area and identifies management actions should a trigger level be reached. The aim of the NMP is to minimise the export of nutrients from the mining area during operational and decommissioning phases of the project.

The Air Quality and Dust Management Plan (AQDMP) (MBS 2012b) addresses issues related to dust creation and management. It discusses the potential for dust list-off and generation from rehabilitation areas.

The Acid Sulfate Soils (ASS) Management Plan (ASSMP) (MBS 2010) discusses management of ASS in relation to mining and processing activities. The presence of ASS can have implications for rehabilitation of those soils.

Conditions of approval for the planning process also required development of other management plans.

The Visual Management Plan (EPCAD 2010) discusses establishment of vegetative corridors to assist with screening of mining related activities. Establishment and maintenance of these plantings is directly relevant to measures discussed within the Rehabilitation Management Plan.

The Conservation, Offset and Rehabilitation Management Plan (CORP) (MBS 2013) discusses revegetation and habitat improvement to be undertaken within the offset and project areas to ensure there is a net gain in the extent and quality of breeding and foraging habitat for Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo (Black Cockatoos).

2. EXISTING ENVIRONMENT

2.1 REGIONAL SETTING

The project area is situated along the eastern edge of the Swan Coastal Plain approximately 70 kilometres south of Perth, near the small townships of Keysbrook and North Dandalup (Figure 1). It is located two to seven kilometres west of the Darling Scarp and the landform in the area varies between 22 and 48 metres Australian Height Datum. The topography of the project area is flat to very gently undulating.

The project area of 1,354 hectares is located on privately owned, rural zoned land. A large portion of the area has been cleared for agricultural activities. Patches of remnant native vegetation also remain, ranging from stands of trees over pasture grass with little to no understorey to areas of remnant vegetation in good condition.

2.2 SOILS

The heavy mineral resource is hosted within the dunes of the Bassendean Sand, which partly covers mottled clayey sand or a pisolitic ironstone-clay unit of the Guildford Formation, also referred to as the Pinjarra Plain.

2.2.1 Bassendean Dunes

The dominant soil parent materials within the Bassendean system are highly leached quartzose sands. 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 Formation). The majority of the soils are podzols. Soils in the eastern part of the unit are more severely leached than those to the west. The project area is within the eastern part of the unit.

2.2.2 Pinjarra Plain

The soils of the Pinjarra Plain have largely formed from unconsolidated alluvial material of Tertiary and Quaternary Age. The depositional systems can be grouped into following 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.

2.2.3 Soil Nutrient Levels in the Project Area

During soil sampling for ASS determination, composite samples of the sand profile (generally the top two metres) were collected and analysed for the major nutrients nitrogen (N), phosphorous (P) and potassium (K). The results indicated a very low nutrient bank available in the sand profile of the site. The results of the soil sampling were not unexpected.

The composite sample of the two metre sand profile was tested in order to mimic the homogenisation of the soil profile as a result of mining. The result was intended to provide an 'average' of the soil profile, as would exist post mining.

To provide more detailed information related to the potential of a currently immobile nutrient bank within the Bassendean sand profile that could be mobilised during mining and processing operations, additional soil sampling was undertaken in September 2006. The results of this are discussed in the NMP.

2.3 VEGETATION IN THE PROJECT AREA

Some 1,174 hectares (87.0%) of the mine area is open pasture with scattered trees while 180 hectares (13 %) are remnant vegetation in varying condition from good to completely degraded. Of this, 75 hectares will be set aside and protected for conservation in perpetuity in line with Condition 6 of Ministerial Statement 810. A total of 155 hectares of native vegetation will be cleared.

Three vegetation surveys of the mining area and one vegetation survey of the northern offset area have been undertaken in accordance with Environmental Protection Authority Guideline 51 (Bennett Environmental Consulting Pty Ltd 2004, 2006; MBS Environmental 2004; MBS Environmental 2012c). No Declared Rare or Priority flora was located during the surveys. A total of 40 vascular plant families, 119 genera and 169 taxa were recorded in the surveys.

A total of nine vegetation units were mapped in the mining area. One vegetation unit within the revised mining area was inferred to be a potential Threatened Ecological Community (TEC), correlating to Swan Coastal Plain Floristic Community Types (FCT) 3a (Gibson *et al*, 1994). The area FCT3a is less than 0.25 hectares in size and although there were several *Corymbia calophylla*, there were very few *Kingia australis*. Most of the adjoining paddock would possibly have previously been representative of this Floristic Community Type. The survey recorded the vegetation condition of FCT3a as completely degraded and concluded that it was not considered worthy of conservation (Bennett Environmental Consulting Pty Ltd 2006).

3. MINE PLANNING AND LAND CLEARING

3.1 ANNUAL MINE PLAN

A detailed annual mine plan will be prepared by the Site Manager in conjunction with the annual review of this RMP in September/October each year. This annual plan is required in order to:

- Detail the location of orebodies, anticipated tonnes and grade and to establish production targets for the year.
- Plan and schedule the rate of movement of the mine cell and relocation of infrastructure required to support the mine extensions.
- Liaise with relevant landowners on the location of activity on individual properties.
- Co-ordinate and schedule other supporting rehabilitation activities and contractors that will include items discussed in Section 4.8.

3.2 LAND CLEARING

Land clearing shall be undertaken as outlined in the Land Clearing Procedure.

The Environmental Officer is responsible for informing the Site Manager of areas where dieback, weed or acid sulphate soil management measures need to be incorporated.

The Site Manager shall be responsible for ensuring the mine area to be cleared is clearly marked in the field and earthworks operators informed such that only the area proposed for clearing is disturbed.

The area cleared shall be recorded by the Site Manager in the Clearing Register (Appendix 1). The register shall record the location of land clearing, surface area, volume and Dieback status of topsoil removed and where it was stockpiled. The Environmental Officer shall report the total area of land cleared in the Annual Environmental Report (AER) submitted to DEC.

3.3 IDENTIFICATION AND CONSERVATION OF REHABILITATION RESOURCES

During the land clearing and mining processes, potential exists for loss or degradation of a number of rehabilitation resources. These resources are primarily topsoil, cleared vegetation and flora of special significance such as cockatoo hollows and grass trees. Preservation of these resources will increase the probability of success of the rehabilitation process.

In the interest of resource conservation, the Site Manager shall be responsible for ensuring:

- The earthworks operators are informed in person of any clearing conditions (including topsoil and vegetation removal requirements) prior to commencement of work.
- Native vegetation is removed from the clearing area and stockpiled adjacent to the clearing area.

- Topsoil is recovered and stockpiled separately from vegetation areas, or where possible replaced immediately on backfilled areas ready for rehabilitation.
- Topsoil stockpiles are no greater than two metres high and located away from water inundation or vehicle traffic.

The Environmental Officer is responsible for ensuring:

- Millable and firewood timber is salvaged from areas planned to be cleared in advance of clearing.
- That native species such as *Xanthorrhoea* and *Kingia* are salvaged in advance of clearing operations and transplanted into areas identified for rehabilitation.
- Areas infested with weeds are pre-treated with a knockdown herbicide prior to clearing as specified in the WDMP.
- Quantities of mulched or chipped material required for use in rehabilitation are sourced from cleared vegetation in dieback free areas only.
- Potential Black Cockatoo nest hollows in trees removed for mining are relocated to remnant vegetation areas that will not be mined and are mounted in suitable sized trees.
- Constructed nest boxes are used to replace potential nest hollows that are not able to be relocated.

4. REHABILITATION PROCESS

4.1 LANDFORM RESTORATION

Ore to be mined consists of the heavy minerals (2.7%), clay (7-8%) plus sand and other coarse materials (90%). Of these, all of the materials except the heavy minerals will be returned to the pit after ore processing.

The mineral separation process involves firstly separating the clay from the other materials to allow the heavy minerals to be more readily separated from the sand particles. In this separation process, about 20% of the clay will remain with the sand; the remainder is thickened prior to replacement in the mined out area.

The sand material will be pumped back into the mined out voids. This will form the bulk of the material used to fill the mine voids. The thickened clay material from the initial separation process will be pumped over the sand material and allowed to drain and dry by evaporation. Once sufficiently dried, the clay will be mixed into the upper sand surface by mechanical means e.g. ploughing. The resultant soil profile will have a more homogeneous mix of sand and clay through its full depth than what existed pre mining where the clay materials tended to be located more at depth.

Final shaping and grading of filled cells will be undertaken by bulldozer or grader.

The Site Manager will ensure that the rehabilitated landform is similar to pre-mining levels. In most locations, post-mining landforms will match the existing contour levels pre-mining. In some locations variations in surface levels between mining areas and backfill locations will result in lower post-mining elevation. In all cases, the Site Manager will ensure the post-mining ground level re-establishes pre-mining regional surface drainage and the restored mine landform does not create drainage barriers resulting in localised flooding in areas not previously subjected to water inundation.

Where necessary, the Site Manager will ensure temporary erosion control measures are implemented to minimise water erosion of restored landforms prior to establishment of a stabilising vegetative cover. This may include:

- Construction of shallow contour banks, sumps and drains to prevent scouring and release of suspended sediments to natural waterways.
- Stabilisation of soils by application of vegetative mulch or hydromulch or clay fines from processing operations.
- Use of quick growing stubble crops to stabilise soils until permanent vegetation or pasture can be established.

Once stabilisation of the landform by pasture species or native vegetation has been achieved, these temporary measures will be removed.

The risk of wind erosion will be reduced by scheduling earthmoving for landform restoration to periods when winds are below 20 kilometres per hour and the soil is moist. If soil

conditions are too dry, the Mining Manger will ensure additional water is added to reduce potential dust creation.

4.2 TOPSOIL MANAGEMENT

Topsoil will be stripped ahead of mining and respread over rehabilitated areas. The Manager shall ensure that topsoil from dieback infected areas is not spread on dieback free areas. The Site Manager will ensure the requirements of the WDMP are complied with in so far as they relate to rehabilitation activities.

Once topsoil has been spread, the Environmental Officer will ensure that all sites are ploughed prior to seeding or planting.

The Site Manager will ensure topsoil is directly returned when possible, however, outside the vegetation rehabilitation season (from April to August), topsoil will be stockpiled. The Environmental Officer shall ensure the following management actions are undertaken when topsoil is stockpiled:

- Separate management procedures for topsoil from Dieback Infected Areas and Dieback Free Areas are followed as outlined in the WDMP.
- Management of topsoil to limit weed spread and reduce weed seed bank loads in stored topsoil stockpiles as outlined in the WDMP.
- Limit as far as possible the time that topsoil is stored to optimise on use of soil biota present in the topsoil.
- Restrict height of topsoil stockpiles to less than two metres to limit impacts of stockpiling on soil biota.

4.3 REVEGETATION

4.3.1 General Provisions

Seeding/planting will generally be undertaken in May for pasture, Shelter Belts and Native Vegetation and August for stubble crops. The Environmental Officer will ensure climatic conditions are considered on an annual basis when planning the revegetation process.

The Site Manager shall ensure that the following process is completed for all areas to be rehabilitated:

- Topsoil is replaced.
- Deep ripping/ploughing is undertaken. Recombining clay into the top of the soil profile during seeding will improve the water and nutrient retention ability of the soil (see NMP for more detail).

The Environmental Officer will ensure the following activities are undertaken once earthworks have been completed:

- Seeding with an appropriate seed mix or direct planting of native vegetation and shelter belt vegetation.

- Rehabilitated areas are fertilised as required by the NMP.
- Areas of Native Vegetation and Shelter Belts are fenced. Stock is to be excluded from all areas of rehabilitation for a minimum of five years.

During spring, the Environmental Officer shall liaise with the Site Manager to determine the likely area available for rehabilitation in the coming rehabilitation cycle. The Environmental Officer is responsible for ensuring that sufficient quantities of seed and tubestock are available for forecast rehabilitation requirements.

If mining cells are completed outside of the rehabilitation/planting window, the Site Manager shall ensure the completed landform is stabilised as per Section 4.1.

4.3.2 Establishment of Pasture and Stubble Crops

The Environmental Officer will ensure that consultation has occurred with the landowner and the Department of Agriculture and Food (DAFWA) on the appropriate pasture species in particular areas, seeding rates, fertiliser types and application rates.

Pasture will be sown mechanically into the restored landforms using standard agricultural machinery. The annual rainfall and temperature of the mine area limits the growth season of annual species from approximately May to October. Within this time window, two seeding measures will be undertaken:

- ‘Full’ pasture species mix, to be planted in mid to late May. This allows the maximum time for germination, establishment and seed set, to re-establish a self-sustaining pasture.
- Where landforms are completed outside of May, a temporary ‘stubble crop’ may be planted in August. An August planting allows sufficient time to establish a stubble crop with sufficient root growth for soil stabilisation and plant height to provide wind break cover at ground level. Other forms of stabilisation, such as hydromulch, may be used as an alternative to stubble crops.

Reseeding will also occur in the second year to ensure full establishment of pasture to sustain grazing and enable self-sustaining pasture through natural re-seeding.

Completed mine areas will not be handed back to the landowner until a self-sustaining pasture has been established. This is expected to take two years. During this period, stock will be excluded from rehabilitation areas via fencing.

4.3.3 Establishment of Shelter Belts

Shelter belts will be designed and planted in three to four rows with two metres between plants within rows and three metres between rows. This provides an overall planting density of 1,600 plants per hectare, comprising trees and tall shrubs. Where possible, the width of shelter belts and any adjacent remnant vegetation or pre mining plantings will be configured so that a minimum width of 100 metres is achieved.

Shelter belts will be established during and after mining using a selection of fast growing species recommended by local landholders, the Serpentine Jarrahdale Shire and Shire of Murray. The Environmental Officer will be responsible for ensuring that consideration is

given to local reference materials such as the “Keeping it Local” publication produced by the Serpentine Jarrahdale Shire.

Shelterbelts will potentially be accessible to stock in the longer term. For this reason, understorey and herbaceous layer plants will not be used. Fencing of these areas will be undertaken to exclude stock while plants become established. Once plants are established and will not be damaged or killed by grazing, fences may be removed in consultation with landowners.

Shelter planting will occur in two discrete areas:

- Areas outside the mining envelope. These are to be planted as a matter of priority (within three years of the project commencing) to provide screening for mining operations.
- Areas within the mining envelope. Planting of these areas will be scheduled for the first growing season following the completion of mining.

4.3.4 Native Vegetation Re-establishment and Habitat Improvement Areas

4.3.4.1 Native Vegetation Re-establishment Areas

The Environmental Officer shall ensure that the return of native vegetation is undertaken in the following areas:

- Pasture areas outside the mine boundary. These areas will be planted and/or seeded with native species, including understorey and herbaceous layer species in an “early rehabilitation” process. These will be planted within three years of the project commencing. Relocation of *Xanthorrhoea* and *Kingia* from Dieback Free Areas will also occur.
- Cleared areas within the mine boundary as specified in the Conceptual Rehabilitation Plan (Section 5). These areas will be planted and seeded with native species which are not susceptible to dieback. Planting of these areas will be scheduled for the first growing season following completion of mining.

The Environmental Officer is responsible for ensuring that a density of one stem per square metre (10,000 stems per hectare) for native vegetation areas is achieved within five years of mining. This shall be achieved through use of direct topsoil return, transplanting of appropriate species, broadcast seeding and planting of tubestock.

The Environmental Officer shall ensure weed control is undertaken during spring (August to September) in native vegetation areas if required.

The Environmental Officer is responsible for ensuring infill planting is undertaken on an annual basis to replace dead plants. Infill planting will typically be undertaken in May to ensure native vegetation areas have at least 75% survival each year.

The Environmental Officer shall ensure that all native vegetation rehabilitation areas are fenced to exclude stock.

4.3.4.2 *Habitat Improvement Areas*

Habitat improvement areas have been identified as part of the Conceptual Rehabilitation Plan (Section 5) as being:

- Undisturbed remnant vegetation areas outside the mine boundary.
- The 75 hectare offset within the project area.
- Defined watercourse and wetland buffer areas.

The aim of rehabilitation in these areas is to improve the quality of native vegetation. Target density will be as for native vegetation re-establishment areas (i.e. 10,000 stems per hectare).

Habitat improvement areas will be planted within three years of the project commencing. Planting will also include transplanting of *Xanthorrhoea*, *Kingia* and other transplantable species from Dieback Free areas that will be disturbed by mining. Relocation or installation of nest hollows will also occur on suitably sized trees in these locations.

4.3.4.3 *Revegetation Species*

The Environmental Officer shall ensure that local provenance seed is used for rehabilitation of native vegetation to ensure self-sustaining vegetation.

The Environmental Officer shall ensure that seed is collected from remaining native vegetation on site as well as collecting seed from species within a radius of 10 kilometres from the site. Bush Forever sites within 10 kilometres of the project area include Kingsbury Drive Bushland (Site 76, Forrestfield/Guildford Vegetation Complex), Myara Brook Bushland (Site 426, Guildford Vegetation Complex) and Yangedi Swamp (Site 77, Bassendean –Central and South Vegetation Complex).

The Environmental Officer shall ensure that seed is sourced from an appropriate soil type and vegetation complex to match existing values. Table 2 lists the species proposed to be used for the native vegetation rehabilitation program.

Table 2: List of Potential Species to be used in Native Vegetation Rehabilitation

Upland Species *	Lowland Species *
Trees	
<i>Allocasuarina fraseriana</i> [%]	<i>Eucalyptus patens</i> [^]
<i>Banksia attenuata</i> [%]	<i>Eucalyptus rudis</i> [^]
<i>Banksia grandis</i> [%]	<i>Melaleuca lateritia</i>
<i>Banksia ilicifolia</i> [%]	<i>Melaleuca preissiana</i> [^]
<i>Banksia menziesii</i> [%]	<i>Melaleuca raphiophylla</i>
<i>Corymbia calophylla</i> [^]	<i>Melaleuca viminea</i>
<i>Eucalyptus marginata</i> [%]	
<i>Xylomelum occidentale</i> [%]	
Shrubs	
<i>Acacia extensa</i> [^]	<i>Adenanthos cygnorum</i> ^{#%}
<i>Acacia pulchella</i> [^]	<i>Beaufortia squarrosa</i>

Upland Species *	Lowland Species *
<i>Acacia saligna</i> [^]	<i>Jacksonia furcellata</i> [%]
<i>Allocasuarina humilis</i> [%]	<i>Kingia australis</i> (transplant)
<i>Calothamnus quadrifidus</i> [^]	<i>Kunzea glabrescens</i>
<i>Hypocalymma angustifolium</i> [^]	<i>Kunzea micrantha subsp. micrantha</i>
<i>Styphelia tenuiflora</i> [%]	<i>Pericalymma ellipticum</i> [%]
<i>Xanthorrhoea brunonis</i> (transplant)	<i>Regelia ciliate</i>
<i>Xanthorrhoea preissii</i> [%] (transplant)	
Herbs	
<i>Conostylis juncea</i>	
<i>Hardenbergia comptoniana</i> [^]	
<i>Hibbertia hypericoides</i> [%] (possible transplant)	
<i>Hypocalymma robustum</i> [%]	
<i>Kennedia coccinea</i> [^]	
<i>Petrophile linearis</i> [#]	
<i>Patersonia occidentalis</i> ^{§%} (possible transplant)	
Sedges and Rushes	
<i>Desmocladius fasciculatus</i> [^]	<i>Cyathochaeta avenacea</i> [^]
<i>Hypolaena exsulca</i>	<i>Juncus pallidus</i>
<i>Loxocarya cinerea</i> [%]	<i>Lepidosperma longitudinale</i>
<i>Meeboldina cana</i>	
<i>Mesomelaena tetragona</i> [^]	
<i>Tetraria octandra</i> [^]	

* Seed mix subject to change based on seed availability.

[^] Dieback resistant species.

[§] Extremely problematic to grow from seed.

[#] Sufficient seed in topsoil.

[%] Dieback susceptible species

4.3.4.4 Transplanting Species

The Environmental Officer shall ensure that grasstrees (*Xanthorrhoea priessii* and *Xanthorrhoea brunonis*) and Kingia (*Kingia australis*) are transplanted between Autumn and Spring (April to October) to rehabilitation or habitat improvement areas ahead of mining.

The Environmental Officer shall also ensure that populations of *Hibbertia hypericoides* and *Patersonia occidentalis* are transplanted to rehabilitation or habitat improvement areas ahead of mining.

4.3.5 Potential Cockatoo Nest Relocation

The Environmental Officer shall ensure that potential nest hollows are relocated to remnant vegetation areas that will not be mined, and are mounted in suitably sized trees. The Environmental Officer shall ensure that constructed nest boxes will be used to replace potential nest hollows that are not able to be relocated. This is discussed further within the CORP (MBS 2013).

4.4 GRAZING PROTECTION FOR REHABILITATED AREAS

The Site Manager shall ensure that areas where native vegetation rehabilitation works (including habitat improvement areas) have been undertaken are fenced for a minimum of five years after planting to exclude livestock. Fencing of these areas will be maintained by MZI until agreed completion criteria have been obtained and the land handed back to the landowner. Fencing will not be removed by MZI.

The Environmental Officer shall ensure that stock is excluded from pasture rehabilitation areas to allow pasture establishment. When monitoring against closure criteria indicates the rehabilitation no longer has management requirements in areas rehabilitated to pasture or shelter belts, the removal of fences will be carried out by Site Manager if so requested by the land owner.

4.5 FERTILISER

Fertiliser will be added to pasture rehabilitation areas as specified in the NMP. The Environmental Officer will ensure the landowner and DAFWA are consulted on the appropriate fertiliser types which will also be verified through soil testing.

Nutrient requirements of native vegetation are significantly lower than those of pasture. However, revegetation by native plants may be accelerated by application of low rates of fertilisers or liming materials. The procedure for the use of fertiliser for rehabilitation of native vegetation areas is documented in the NMP.

4.6 WEED CONTROL

No Declared Plants have been located within the project area.

In areas to be returned to pasture, weed management will be restricted to control of Declared Plant species.

In native vegetation rehabilitation areas, weed infestation can inhibit establishment and survival of planted trees and seedlings, decreasing the effectiveness of the rehabilitation program. Weed management in these areas will be undertaken in accordance with the WDMP.

It is the responsibility of the Site Manager to inform all earthworks contractors that equipment must be free of weeds prior to it arriving on site. All equipment entering the mine area shall be inspected by the Environmental Officer to ensure it is free of soil or vegetative matter. The Vehicle Inspection Checklist (Appendix 2) shall be completed each time a vehicle enters the project area and a copy shall be filed in the Environmental Monitoring file on site.

4.7 MAINTENANCE

Vegetation re-establishment will require ongoing maintenance to ensure successful re-establishment. Maintenance procedures will be carried out as determined by the Environmental Officer and may include:

- Replanting areas that may not have regenerated.
- Weed control.

- Repair of significant erosion.
- Fire management.
- Fence repair.
- Nest box repair.

Maintenance will continue to be undertaken as required until monitoring shows the completion criteria listed in Section 7 (and as updated) have been met.

4.8 SUMMARY OF REHABILITATION ACTIVITIES

Table 3 outlines the rehabilitation activities discussed above and provides timelines for completion of these activities.

Table 3: Schedule of Rehabilitation Activities

Action	Tasks	Timing	Outcome
Plant relocation	Relocation of Kingia, Xanthorrhoea and other plants that can be successfully transplanted	April to October.	Transplant to areas that will be fenced to exclude stock.
Rehabilitation activities	Seed collection	Main periods October and January, some species year round and others require fire.	Local seed collected for use in rehabilitation.
	Plant propagation	September to November.	Seedlings planted in May.
	Landform Restoration	Immediately on completion of backfill operations.	Final Landforms are as close as possible to pre-mining contours.
	Landform Stabilisation	Directly following landform restoration.	Avoid erosion of surfaces.
	Topsoil spreading	April/May.	Topsoil re-used as soon as practical.
	Seeding/Direct Planting	May (August for stubble crops).	Rehabilitation to pasture/native vegetation/shelter belt.
	Fencing	As required.	Fences constructed following completion of rehabilitation activities.
Maintenance	Follow-up seeding/planting	May – August.	Achieve 75% survival rate.
	Weed Control	As required.	Limit weed presence in rehabilitated areas.
Seasonal dependent activities	Selectively remove any large mature trees within the annual mine plan that contain potential cockatoo nesting hollows.	January to June.	Avoid harm to cockatoo hatchlings during the nesting period.

5. CONCEPTUAL REHABILITATION PLAN

A Conceptual Rehabilitation Plan (CRP) has been developed according to Ministerial Statement 810 with the primary objective of re-establishing self-sustaining local provenance native vegetation at a ratio of not less than 1.4 to 1 (that is 1.4 hectares of revegetation per hectare of vegetation cleared) (Figure 2). Re-establishment of pasture is a key component of the CRP as the project area will predominantly be returned to a grazing land-use on completion of mining.

The CRP is based on the following principles:

- Conserve existing remnant native vegetation areas inside and outside the mine boundary and augment these locations with additional planting and fencing to exclude stock.
- Plant as a priority, areas outside the mine boundary with both native vegetation and stock shelter planting.
- Plant as a priority, areas outside the mine boundary with native vegetation to provide visual screening of mining operations.
- Fence rehabilitated areas planted with native vegetation to exclude stock.
- Provide a combination of block planting and corridor linkages through the project area. Where possible corridor linkages will be formed with a minimum width of 100 metres to minimise potential edge effects and maximise biodiversity outcomes.
- Replace native vegetation at a ratio of not less than 1.4 to 1.0 (that is 1.4 hectares of revegetation per hectare of vegetation cleared).
- Enhance species diversity within the mine site after rehabilitation by returning native species currently poorly represented or absent.

The CRP is subject to change and will be reviewed on an annual basis in conjunction with this RMP.

Table 4 outlines the proposed composition of rehabilitation in the CRP. Given 155 hectares of native vegetation will be cleared within the project area, a total of 217 hectares is required to be re-established to comply with Ministerial Statement 810.

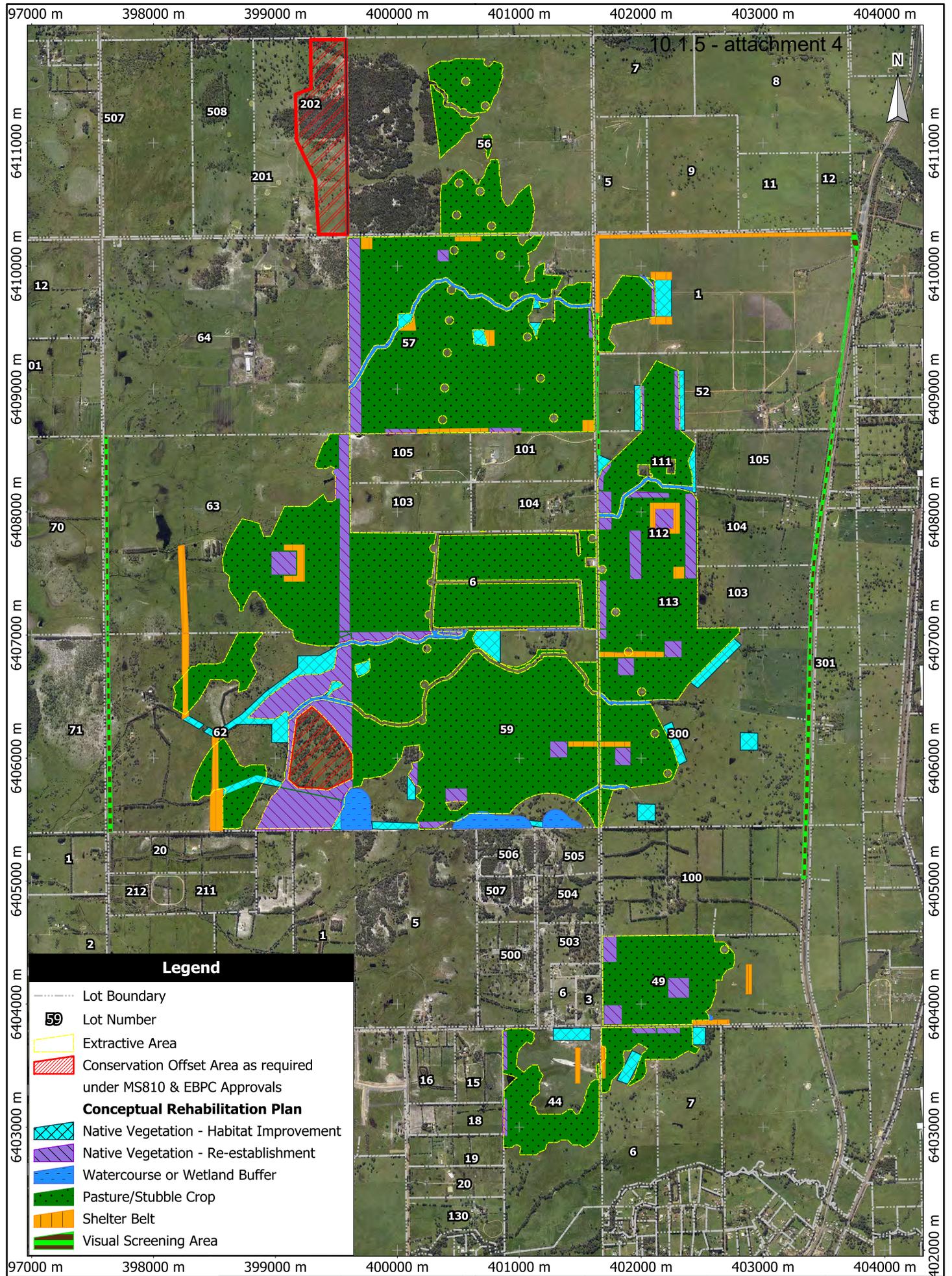
Revegetation areas outside the mine boundary are proposed to be implemented within the first three years of the project, which will allow for at least five years of monitoring and maintenance to ensure successful vegetation establishment.

The CRP proposes to establish a total of 233.5 hectares of self-sustaining, local provenance native vegetation on completion of the project (Table 4). This is a ratio of 1.5 to 1. This excludes:

- Vegetation to be established for shelterbelts.
- Vegetation to be established for visual screening purposes.
- Vegetation to be protected as part of a conservation offset package required by State and Federal environmental approvals.

Table 4: Proposed Composition of Rehabilitation

Vegetation Type	Area (Ha)
Native Vegetation – Habitat Improvement	60
Native Vegetation – Re-establishment	131
Watercourse Buffers – Habitat Improvement	25
Wetland Buffers – Habitat Improvement	17.5
<i>Sub Total</i>	233.5
Pasture Areas	1,110.5
Shelter Belts	46.5
Visual Screens	56
Conservation Offset	75
Grand Total	1,521.5



10.1.5 - attachment 4

Legend

- Lot Boundary
- Lot Number
- Extractive Area
- Conservation Offset Area as required under MS810 & EBPC Approvals
- Conceptual Rehabilitation Plan**
- Native Vegetation - Habitat Improvement
- Native Vegetation - Re-establishment
- Watercourse or Wetland Buffer
- Pasture/Stubble Crop
- Shelter Belt
- Visual Screening Area

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Scale: 1:40000
Original Size: A4
Air Photo Date: 2012
Grid: Australia MGA94 (50)

0 1 km

MZI Resources Limited
Keysbrook

Ordinary Council Meeting 17 February 2013

Conceptual Rehabilitation Plan

Figure 2

6. MONITORING

Rehabilitation monitoring is critical to assess the effectiveness of the rehabilitation program and to enable adaptive management of rehabilitation. Table 5 outlines the proposed schedule of monitoring. The Environmental Officer is responsible for ensuring that monitoring is carried out in accordance with the Rehabilitation Monitoring Procedure to assess:

- The physical stability of the landform of rehabilitated areas.
- The success of vegetation establishment in rehabilitated areas.

Monitoring programs will be tailored to the desired end land use i.e. pasture, native vegetation or shelter belts.

The frequency of monitoring is expected to decrease over time in individual areas and will cease in consultation with regulators when rehabilitation objectives and completion criteria have been achieved.

The Environmental Officer will be responsible for notifying the General Manager when monitoring demonstrates that completion criteria for individual areas have been met.

The results of monitoring will be reported to regulatory authorities through the Annual Environmental Report (AER). The AER will also be made available to the Serpentine Jarrahdale Shire and the Shire of Murray. Landowners will be advised the AER is available on the MZI website.

Table 5: Rehabilitation Monitoring Schedule

Pasture	Native Vegetation	Shelter Belts
First Year After Rehabilitation		
Establishment of permanent monitoring transects and or quadrats in each area of rehabilitation.		
Determine germination success rate.	Determine seedling survival/germination success rate.	Determine seedling survival rate.
Determine percentage cover of pasture species.	Determine percentage cover and density of each species.	Assess overall plant density of windbreak.
Identify weed species and determine percentage cover.		
Assess plant health and monitor for pests and/or pathogens.		
Soil testing – texture, organic carbon, pH, conductivity and nutrients.		
Soil and landform stability.		
Annually until Area is Handed Back to Landowner		
Determine percentage cover of pasture species.	Determine percentage cover and density of each species.	Assess overall plant density of Shelter Belt.
Identify weed species and determine percentage cover.		
Assess plant health and monitor for pests and/or pathogens.		
Determine sustainable carrying capacity	Assess species richness, diversity and density against analogue sites.	
Soil Testing – nutrients and compaction levels.		
Soil and landform stability.		



7. COMPLETION CRITERIA

EPA (2006) requires that completion criteria must be sufficiently stringent to ensure that the overall objectives of rehabilitation have been met. These criteria must also be designed to allow effective reporting and auditing to define an endpoint for rehabilitation activities. Guidelines published by ANZMEC/MCA (2000) for completion criteria state they should be:

1. Specific enough to reflect unique set of environmental, social and economic circumstances.
2. Flexible enough to adapt to changing circumstances without compromising objectives.
3. Include environmental indicators suitable for demonstrating that rehabilitation trends are heading in the right direction.
4. Undergo periodic review resulting in modification if required due to changed circumstances or improved knowledge.
5. Based on targeted research which results in more informed decisions.

Completion criteria, objectives and interim targets specific to the project including consideration of soil stability, vegetation cover, diversity, species richness and hydrology criteria are presented in Table 6.

The General Manager shall be responsible for ensuring land access agreements entered into between MZI and individual landowners reflect continued management of land by MZI until the relevant completion criteria have been demonstrated to be met.

The Environmental Officer is responsible for notifying the General Manager that completion criteria for a specific area have been met so that hand back of management responsibility for that area to the landowner can be initiated. Rehabilitation, closure planning and completion criteria are adaptive processes that change during the project life, in the light of results of rehabilitation monitoring, research and evolving industry best practice. MZI will continue to update these aspects in operational documents, such as the RMP, during the life of the project.

Table 6: Completion Criteria and Interim Targets

Criteria	Objective	Interim Targets
Social Surrounds		
Safety and stability of landforms	The overall stability of soils, landforms and hydrology and long-term sustainability without additional management inputs and suitability for agreed land uses.	Monitoring showing soils and landforms stable and capable of sustaining agricultural use.
Visual amenity and heritage	Recovering visual amenity is a key objective. Visual amenity is defined by community expectations.	Visual amenity comparable to pre-mining condition.
Pollution Management		
Pollution	Pollutants due to chemical spillage, excavation of substrates or changes to hydrology (e.g. acid drainage) prevented or managed within rehabilitated areas as required.	Monitoring showing that pollution levels are within parameters set by regulatory agencies.
Off-site impacts	Significant adverse off-site impacts prevented.	No off site impacts recorded.
Hydrology		
Water quality and quantity	Quality and flows of surface and groundwater are to be consistent with pre-mining values.	Monitoring showing surface water quality consistent with pre-mining levels or licensed values. Monitoring showing groundwater levels consistent with modelled or forecast levels. Temporary creek diversions rehabilitated and original pathway restored.
Landform		
Soil stability	Soil structures reconstructed to ensure vegetation establishment and landform stability.	Rehabilitated areas should have no active erosion rills greater than 10 metres long by 0.1 metres deep.



Criteria	Objective	Interim Targets
Vegetation – Pasture and Shelter Belts		
Pasture and tree establishment	Pasture re-established to enable return to agricultural use. Shelter belts established to reduce wind erosion.	Fully established pasture returned to landholder by the end of the second growing season. Plant survival rate greater than 75% in shelter belts within two years of planting.
Vegetation – Native Vegetation		
Diversity	Total number of plant species in rehabilitated areas 75 to 80% of analogue sites.	Rehabilitated native vegetation areas achieving progressive targets with an interim target of 50% species diversity to analogue sites after two years.
Density	Total number of plant species at least one stem per square metre.	Target of plant species at least one stem per square metre within five years of planting.
Plant cover	Plant cover similar to those in reference plots in surrounding remnant vegetation.	Rehabilitated native vegetation areas achieving a 25% foliage cover of native species after two years and a 50% foliage cover after five years. Photographic monitoring points installed within six months of rehabilitation establishment.
Weeds	Effective weed management to ensure the relative cover of weeds is low.	Monitoring and photographic records showing weed species in native vegetation rehabilitation areas limited to less than 10% cover.
Pests and diseases	Limited dieback deaths due to mining.	Deaths of dieback susceptible species attributable to mining or rehabilitation activities limited to 10% after the first two years and 25% after the first five years.
Stock	Restrict stock access to native vegetation rehabilitated areas for a minimum of five years post mining.	Installation of fencing around native vegetation rehabilitation and preservation areas once works are completed for a minimum of five years.

8. MANAGEMENT PLAN REVIEW

It is the responsibility of the Environmental Officer to ensure that the RMP is reviewed annually. This will enable the continual review and adjustment where necessary of annual plans, including inputs of the results of monitoring assessments and feedback from relevant stakeholders.

The review will occur in September to October of each year, to enable review of the rehabilitation efforts of the past year and to include planning for the next years' rehabilitation in May to June.

9. RECORDS AND REPORTING

9.1 RECORD KEEPING

The Site Manager in conjunction with the Environmental Officer is responsible for recording rehabilitation activities conducted on site. Appendix 2 shows the proposed record check list of the rehabilitation works for each mine area. This includes:

- Information on the pre-mining vegetation, topsoil removal, handling and storage techniques utilised.
- The extent and timing of each activity.
- Details on the rehabilitation treatments, including:
 - Rehabilitation earthworks.
 - Seed bed preparation.
 - Species used in the rehabilitation program.
 - Any fertiliser or soil ameliorant applied.
- Results of the rehabilitation monitoring program.
- Scope of any remedial work.

Records relevant to the RMP that shall be maintained include items listed in Table 7.

Table 7: Rehabilitation Records to be Maintained at Keysbrook

Record	Location	Responsibility
Area Cleared	Appendix 1	Site Manager
Vehicle inspection checklist	Appendix 2	Site Manager
Record of Rehabilitation	Appendix 3	Environmental Officer
Weed control activities	Appendix 4	Environmental Officer

9.2 ANNUAL ENVIRONMENT REPORT (AER)

The following land management information shall be reported in the AER:

- Total land cleared in the reporting year including information regarding the vegetation type removed (pasture or native vegetation).
- Area rehabilitated within and adjacent to mining areas.
- Rehabilitation monitoring results.
- Weed control activities.
- Any non-compliance and corrective actions with respect to land management.

10. RESPONSIBILITIES

10.1 GENERAL MANAGER

The General Manager is responsible for the following:

- Ensuring relevant training and awareness is provided to all site employees and contractors to ensure they comply with the requirements of this Management Plan.
- Ensuring the project has adequate resources to meet the requirements of this Management Plan.
- Ensuring land access agreements include provision for management of land by MZI until completion criteria have been met.
- Reviewing and approving rehabilitation management information presented in the AER.
- Reviewing and approving this Management Plan on an annual basis.
- Ensuring investigations into non-compliance with this plan are conducted.
- Ensuring non-compliance with this Management Plan are rectified and reported to the relevant authorities.

10.2 SITE MANAGER

The Site Manager is responsible for the following:

- Preparing the annual mining plan and ensuring activities are planned such that any required survey can be conducted in advance of mining.
- Defining the area to be cleared on maps, ensuring they are clearly marked in the field and supervising clearing activities.
- Confining temporary work areas to previously disturbed areas or cleared pasture areas.
- Ensuring vehicles and machinery are parked in designated areas.
- Ensuring that effective dust control measures are implemented as per the AQDMP.
- Ensuring topsoil and cleared vegetation are retained in designated areas for use in rehabilitation.
- Ensuring earthworks operators are appropriately trained and competent to operate the machinery.
- Informing all earthworks contractors that equipment must be free of weeds prior to it arriving on site.
- Informing earthworks operators in person of any clearing conditions (including topsoil and vegetation removal requirements) prior to commencement of work.
- Ensure cleared areas are recorded in the Clearing Register (Appendix 1).
- Restricting height of topsoil stockpiles to less than two metres to limit impacts of stockpiling on soil biota.
- Ensuring that the rehabilitated landform is similar to pre-mining levels.

- Ensure post-mining ground level re-establishes the pre-mining regional surface drainage and the restored mine landform does not create drainage barriers resulting in localised flooding in areas not previously subjected to water inundation.
- Ensure temporary erosion control measures are implemented to minimise water erosion of restored landforms prior to establishment of a stabilising vegetative cover.
- Ensure the requirements of the WDMP are complied with in so far as they relate to rehabilitation activities.
- Ensure that the following process is completed for all areas to be rehabilitated:
 - Replacement of topsoil.
 - Fencing.
 - Deep-ripped (ploughed).
 - Recombining clay into the top of the soil profile during seeding will improve the water and nutrient retention ability of the soil (see NMP for more detail).
- If mining cells are completed outside of the planting window, ensure the following processes are implemented:
 - Ploughing in clay capping from the HMC plant or temporary cover crop into the underlying sand.
 - Replacement of topsoil.
 - Fencing.
- In conjunction with the Environmental Officer, ensure rehabilitation activities are managed in accordance with this Management Plan and recorded in the rehabilitation register (Appendix 3).

10.3 ENVIRONMENTAL OFFICER

The Environmental Officer is responsible for:

- Reviewing and approving this Management Plan on an annual basis.
- Informing the Site Manager of areas where dieback, weed or acid sulphate soil management measures need to be incorporated.
- Ensuring separate management procedures for topsoil from Dieback Infected Areas and Dieback Free Areas are followed as outlined in the WDMP.
- Management of topsoil to limit weed spread and reduce weed seed bank loads in stored topsoil stockpiles as outlined in the WDMP.
- Limiting as far as possible the time that topsoil is stored to optimise on use of soil biota present in the topsoil.
- During spring, liaise with the Site Manager to determine the likely area available for rehabilitation in the coming rehabilitation cycle.
- Ensuring soil compaction measurements are taken annually for areas rehabilitated to pasture.

- Once topsoil has been spread, ensuring that all sites which are direct seeded are ploughed prior to seeding and then raked following seeding.
- Ensure that local provenance seed is used for rehabilitation of native vegetation to ensure self-sustaining vegetation.
- Ensure that seed is collected from remaining species on site as well as collecting seed from species within a radius of 10 kilometres from the site.
- Ensure that seed is sourced from an appropriate soil type and vegetation complex to match existing values.
- Ensure that sufficient quantities of seed and tubestock are available for forecast rehabilitation requirements.
- Ensure weed control is undertaken during spring (August to September) if required and recorded in the weed control register (Appendix 4).
- Ensure that the following process is completed for all areas to be rehabilitated:
 - Seeding with a full pasture species mix or planting native vegetation or shelter belt vegetation.
 - Fertilised.
- Ensure that grasstrees (*Xanthorrhoea priessii* and *Xanthorrhoea brunonis*) and Kingia (*Kingia australis*) are transplanted between April to October to rehabilitation areas ahead of mining.
- Ensure that populations of *Hibbertia hypericoides* and *Patersonia occidentalis* are transplanted to rehabilitation areas ahead of mining.
- Ensure that consultation has occurred with the landowner and DAFWA on the appropriate pasture species in particular areas, seeding rates, fertiliser types and application rates.
- Ensure that consideration is given to local reference materials such as the “Keeping it Local” publication produced by the Serpentine Jarrahdale Shire when determining the species composition for shelterbelts.
- Ensure that potential nest hollows from clearing areas are relocated to remnant vegetation areas which will not be mined and mounted in suitable sized trees.
- Ensuring employees and contractors participate in the site environmental induction.
- Ensuring employees and contractors comply with their responsibilities within this Management Plan.
- Ensuring that all vehicles entering the site are inspected to ensure they are free of soil or vegetative matter. The Vehicle Inspection Checklist (Appendix 2) shall be completed each time a vehicle enters the project area and a copy shall be filed in the Environmental Monitoring file on site.
- Ensure maintenance procedures are carried out as required and may include:
 - Replanting areas that may not have regenerated.
 - Weed control.
 - Repair significant erosion.

- Fire management.
- Ensure that the return of native vegetation will be undertaken in the following areas:
 - Undisturbed remnant vegetation areas outside the mine boundary.
 - Pasture areas outside the mine boundary.
 - Cleared native vegetation areas within the mine boundary.
- Ensure interim targets specified in Table 6 are achieved. Notifying the General Manager of achievement of completion criteria for specific areas of land to enable initiation of hand back of land to the relevant land owner.
- Ensure that constructed nest boxes will be used to replace potential nest hollows that are not able to be relocated.
- When monitoring against closure criteria indicates the rehabilitation no longer has management requirements, remove fences if so requested by the pastoralist.
- In conjunction with the Site Manager, ensure rehabilitation activities are managed in accordance with this Management Plan and recorded in the rehabilitation register (Appendix 3).
- Preparation of the AER submitted to the Serpentine Jarrahdale Shire, Shire of Murray and DEC.

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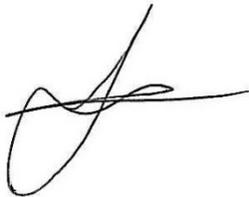
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REHABILITATION MANAGEMENT PLAN****PROJECT CODE: MATRMP**

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APPENDICES

**APPENDIX 1:
CLEARING REGISTER**

**APPENDIX 2:
MACHINERY AND VEHICLE INSPECTION CHECKLIST**

MZI MACHINERY AND VEHICLE HYGIENE CERTIFICATE CHECKLIST

It is important that all earthmoving machinery, vehicles and equipment are in an acceptable condition before entering the Keysbrook Mineral Sands Project area in relation to weeds and Dieback.

This inspection must be completed upon entry to the site and submitted to the Environmental Officer. A sticker confirming this inspection has been passed will be issued.

Date of inspection:

Company requesting equipment import to Keysbrook:

Name of person conducting inspection:

What kind of vehicle / machine /equipment is it?

Serial or registration No of equipment/machine:

Was the vehicle / machine cleaned before it left the last site? Yes No

Are buckets, tracks, blades, grills, utility tray-back free of soil and vegetation? Yes No

Are the tyres free of vegetation and soil? Yes No

Work required/comments:

If you have answered **NO** to any of these questions, please carry out the required cleaning and/or maintenance before the machine is transported onto Keysbrook Mineral Sands Project. Entry of the machinery will not be permitted until evidence of cleaning can be provided. No machines may enter site until authorised by the Environmental Officer.

Based on inspection of the specified equipment/machinery, I confirm the item is free of vegetative and soil material and is suitable for entry into the Keysbrook Project area.

Signed:

Name:

Position:

Date:

KEYSBROOK MINERAL SANDS PROJECT USE ONLY

Evidence of cleaning provided is satisfactory and the equipment is suitable for entry to Keysbrook Mineral Sands Project.

Signed:

Position:

Date:



**APPENDIX 3:
REHABILITATION RECORD**

RECORD OF REHABILITATION

No	Rehabilitation Documentation	Factor
Location: _____		
1	Clearing (Date)	
Topsoil Management		
2	Topsoil removal (Date)	
3	Topsoil deposition (Location)	
4	Topsoil storage (Location)	
5	Topsoil dieback status. (Free = Green), (Positive or indeterminate = Yellow)	
Landform Design		
6	Land forming earthworks (Date)	
7	Clay capping or other soil stabilization (e.g. hydromulch) utilised	
8	Planting /seeding soil preparation technique	
Erosion Control		
9	Surface drainage controls constructed	
Soil Nutrition		
10	Fertiliser / soil ameliorants used	
Rehabilitation and Completion Criteria		
11	Planting /seeding species used	
12	Rehabilitation monitoring	See Section 6.
13	Remediation and maintenance	See Section 6.
14	Completion criteria assessment	

**APPENDIX 4:
WEED INSPECTION CHECKLIST AND MANAGEMENT
REGISTER**

KEYSBROOK MINERAL SANDS PROJECT WEED MANAGEMENT SITE ASSESSMENT

Name of Inspector (Print): _____

Date: _____

Weather Conditions Prior to Inspection: _____

Weed Inspection Areas	Date Completed	Weeds Present (Yes/No)	Weed Cover (%)	Actions to be Taken
Primary Processing Area				
Wash down bay				
Office and Car Park area				
Access Roads				
Monitoring/Production Bores				
CoE Points				
Other				

**WATER MANAGEMENT PLAN
KEYSBROOK MINERAL SANDS PROJECT**

KEYSBROOK, WESTERN AUSTRALIA

REVISION B SEPTEMBER 2015

PREPARED FOR

MZI RESOURCES



BY

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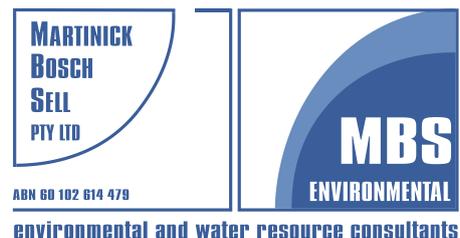


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1. INTRODUCTION

MZI Resources Limited (MZI) plans to develop an open cut mineral sand mine and primary processing plant within an area of rural land near the small townships of Keysbrook and North Dandalup (Figure 1). The Project is known as the Keysbrook Mineral Sands Project (Keysbrook). The project area of 1,354 hectares is located on privately owned land, actively used for grazing.

A Public Environmental Review (PER) has been conducted for the project and was approved by the WA Minister for the Environment on 19 October 2009 via Ministerial Statement 810 and by the Federal Minister for the Environment on 16 February 2010. Details of the project may be found in the PER (MBS 2006). Other documents relevant to the PER process include the Report and Recommendations of the Environmental Protection Agency (EPA) (Bulletin 1269) and the Appeals Report against the recommendation of the EPA. Both documents are available on the EPA webpage.

1.1 PURPOSE

The Water Management Plan (WMP) addresses the requirements of Ministerial Statement 810, namely Condition 11-2 which outlines the required structure of the WMP. The purpose of this WMP is to ensure the abstraction of groundwater required for the implementation and operation of this project does not materially affect the quality or quantity of groundwater available to other users in the area, or adversely affect the health and condition of native vegetation and ecosystems in the area.

The WMP also outlines how the performance of the Keysbrook Project will be monitored and reported against the objectives and targets (Section 1.2) of this Management Plan.

1.2 OBJECTIVES AND TARGETS

The WMP objectives and targets for water management are outlined in Table 1.

Table 1: Water Management Objectives and Targets

Objective	Target
Abstraction of groundwater does not materially affect the quality of groundwater available to other users in the area.	Monitoring indicates groundwater remains fit for applicable beneficial uses.
Abstraction of groundwater does not materially affect the quantity of groundwater available to other users in the area.	Monitoring indicates the quantity of groundwater remains above that allocated to other users in the area.
Abstraction of water does not cause adverse, long term impacts to the water quality or levels of Conservation Category wetlands.	Monitoring indicates water quality and levels are within trigger levels.
Abstraction of groundwater does not adversely impact on the health and condition of native vegetation associated with Conservation Category wetlands.	Monitoring indicates no adverse, long term impact on native vegetation or groundwater dependant ecosystems.

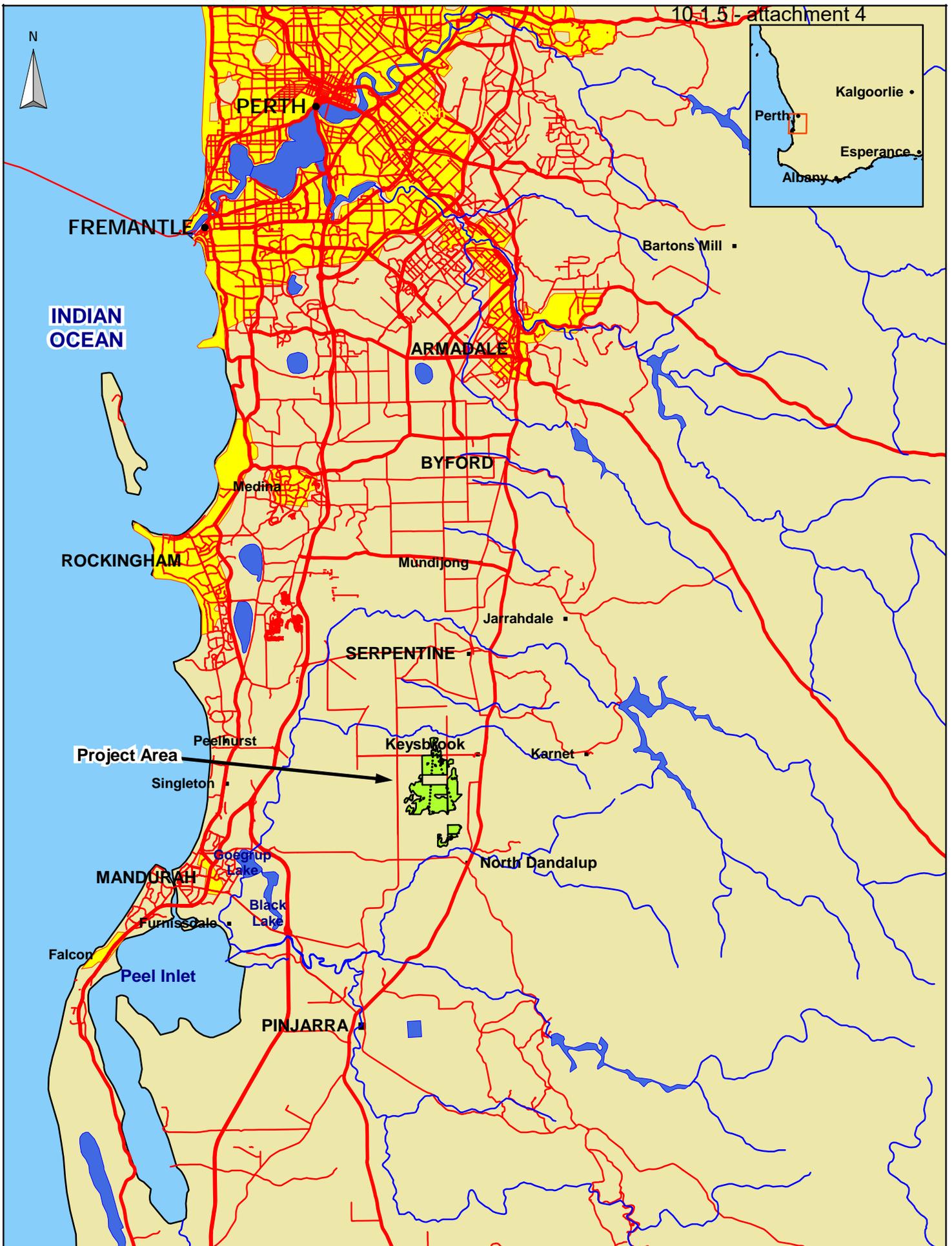
Objective	Target
To prevent or minimise any deterioration in surface water quality.	All stormwater runoff from HMC stockpiles and plant areas to pass through sediment control structures. All sewage wastewater treated in approved waste water systems. No effluent discharged to surface water. Quality of water leaving the project area within trigger levels.
Monitor surface and ground water quality.	All specified water monitoring carried out in accordance with monitoring procedures.
Comply with regulatory requirements.	Compliance with all statutory conditions on water management and monitoring at Keysbrook.

1.3 RELEVANCE TO OTHER PLANS

As a condition of approval of the Project, Ministerial Statement 810 also required the development of several other management plans. Plans that are directly relevant to the WMP include the Nutrient Management Plan and Acid Sulfate Soil Management Plan.

The Nutrient Management Plan (NMP) (MBS 2012a) outlines a program to monitor the nutrient levels within the mining area and identifies management actions should a trigger level be reached. The aim of the NMP is to minimise the export of nutrients from the mining area during operational and decommissioning phases of the project.

The Acid Sulfate Soil Management Plan (ASSMP) (MBS 2010) outlines the management strategies and procedures to assess and manage possible disturbance of acid sulfate soils associated with the operation. The objective of the plan is to ensure that all mining activities with the potential to disturb Acid Sulfate Soil materials are conducted in a manner to protect environmental values.



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MZI Resources Limited
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Location Plan

Figure 1

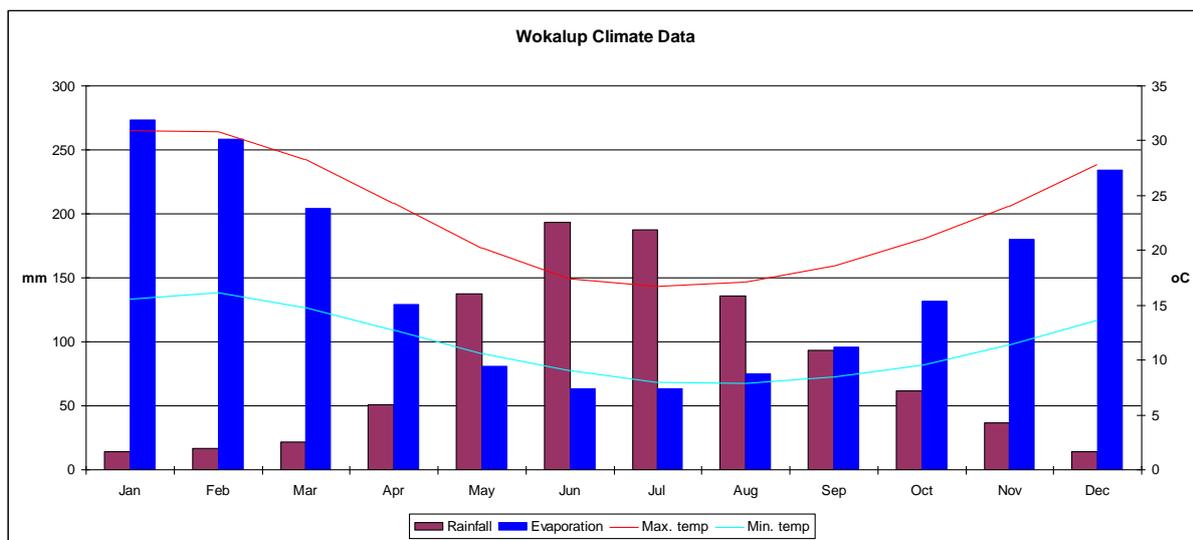
2. EXISTING ENVIRONMENT

2.1 CLIMATE

The Keysbrook 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 on 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 two to one.

Chart 1: Wokalup Climate Data



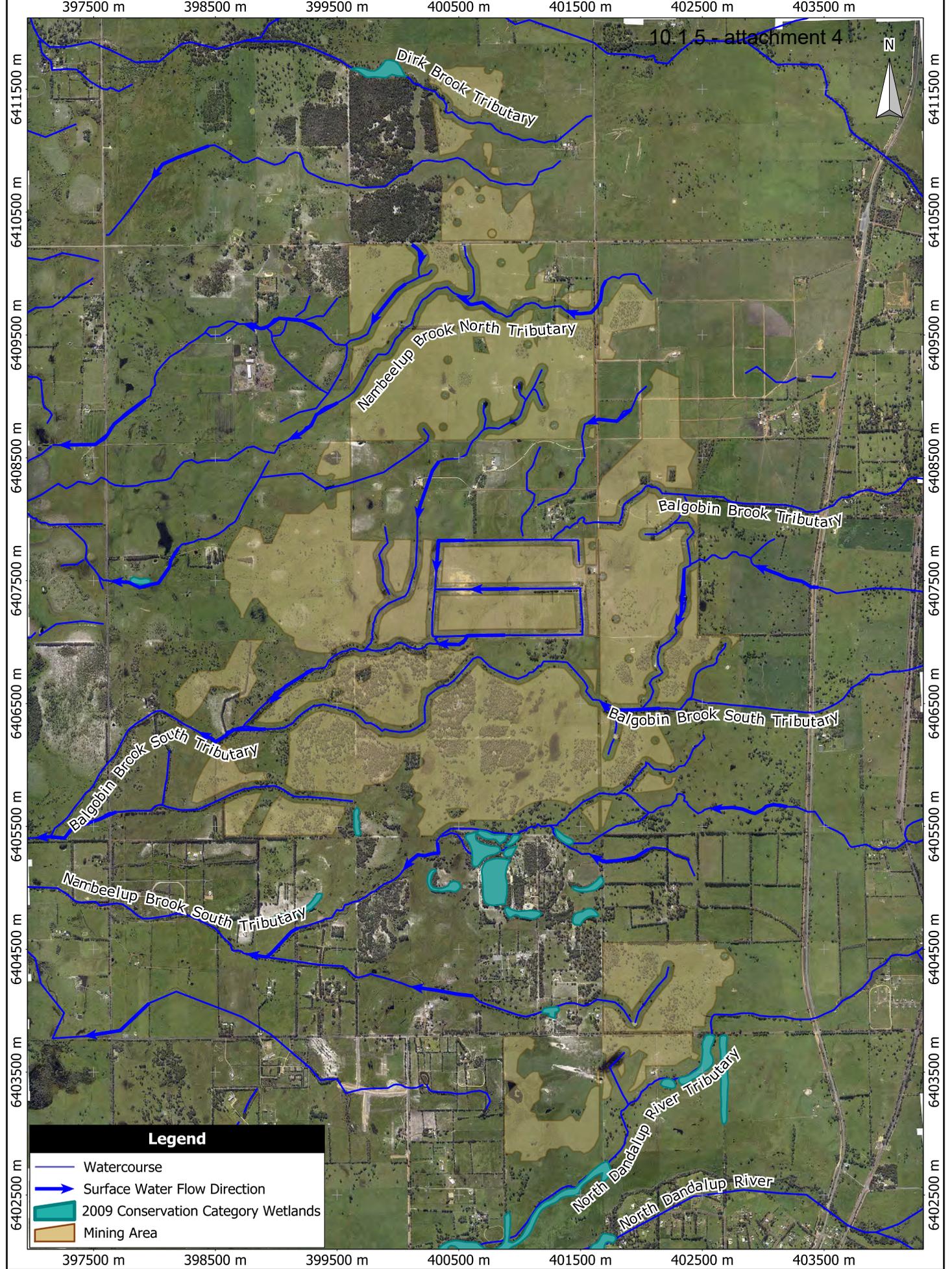
2.2 CONSERVATION CATEGORY WETLANDS AND NATIVE VEGETATION

Several Conservation Category wetlands are adjacent to the project area, but will not be directly disturbed by earthmoving activities (i.e. these wetlands will not be mined). The locations of these wetlands are shown on Figure 2.

Vegetation associated with the wetlands has been mapped by Bennet Environmental Consulting in 2005. The conservation category wetland to the south of the mine area is primarily Tall Open Scrub dominated by *Kunzea glabrescens* with scattered trees of *Banksia ilicifolia* over scattered low shrubs and sedges covering about 25 hectares. The Conservation Category wetland to the north of the mine area is primarily Low Open Forest of *Melaleuca*

preissiana over Sedgeland and covers about four hectares. The condition varied between good and very good.

Approximately 180 hectares of native vegetation occurs across the project area. This ranges in condition from good to completely degraded. Ministerial Statement 810 requires that 75 hectares of this is set aside and protected in perpetuity. Additionally, there is a remnant area of native vegetation adjacent to the most northern mining areas that will not be cleared.



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Grid: Australia MGA94 (50)

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Surface Drainage Locations
February 17 2020
Page 2

2.3 SURFACE WATER RESOURCES

2.3.1 Catchment Information

At a regional level, all surface drainage ultimately flows to the Peel-Harvey estuary. Streams from the Darling Scarp and foothills flow through the mine area. Figure 2 shows surface drainage lines in the vicinity of the mine area.

The watercourses have been split into three categories:

- **Major Watercourses** - Peak flows of two to five cubic metres per second.
These are Balgobin Brook and North Dandalup River Tributary.
- **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. These water courses still have well defined creek channels.
- **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.

Balgobin Brook is the main drainage feature that passes through the central portion of the project area. Approximately 80% 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).

2.3.2 Stream Flow Information

Fifteen Department of Water (DoW) Stream Gauging Stations are located in and around the project area. Of these, only five stations have a useful period of record and similarity of catchment to the project area. These five stations are listed in Table 2.

Table 2: Stream Gauging Stations

Station No.	Watercourse Name	Station Name	Catchment Area (km ²)	Specific Mean Discharge (m ³ /s/km ²)	Years of Record	Peak Discharge	Distance from Project (km)	Type
614005	Dirk Brook	Kentish Farm	35.19	0.007	30		5	Hills
614021	North Dandalup Tributary	Lewis Catchment	2.00	0.003	27	0.042	11	Hills
614013	Peel Drain	Hope Valley	10.35	0.005	23	0.66	25	Coastal Plain

Station No.	Watercourse Name	Station Name	Catchment Area (km ²)	Specific Mean Discharge (m ³ /s/km ²)	Years of Record	Peak Discharge	Distance from Project (km)	Type
614030	Serpentine Drain	Dog Hill	469.7	0.005	27	18.44	10	Coastal Plain
614063	Nambeelup Brook	Kielman	114.95	0.006	5	0.969	10	Coastal Plain

The Nambeelup Brook stream gauging station is located about 10 kilometres downstream (south-west) of the mine area. Stream flow 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% of the gauging station's catchment area is within or upstream of the project area. The 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?

2.3.3 Water Quality Information

Limited water quality information is available in the DoW's Water Information System (WIN) for a number of locations adjacent to the mining area. Seven monitoring locations with more than three water quality records are located within seven kilometres of the project area. Approximately 70 'one-off' samples have also been recorded within and adjacent to the project area.

The Statewide River Water Quality Assessment (DoW 2007) shows water quality data for Nambeelup Brook (Site 614063), located 10 kilometres downstream (south-west) of the project area was of neutral pH, with very high nitrogen and phosphorus concentrations and high turbidity. Water quality for Dirk Brook at Punrak Road (Site 6142593), located 6 kilometres downstream (east-northeast) of the project area was of neutral pH, with high nitrogen and phosphorus concentrations and high turbidity. This information is useful in that it shows water quality has been affected by historic and existing land uses prior to any mining taking place.

Field 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 confirmed all surface water in the project area is fresh. The ANZECC (2000) guideline trigger value for salinity in lowland rivers of south-west Australia is 0.12 to 0.30 milliSiemens per centimetre, and for wetlands is 0.30 to 1.50 milliSiemens per centimetre. This means that the measured salinity was generally above the guideline for rivers in this region, but well within the guideline for wetlands.

2.4 GROUNDWATER RESOURCES

Two aquifers of the Perth Basin are relevant to the project. Firstly, the shallow Superficial Formation containing both the Bassendean Sand and Guildford Formation. The upper four to eight metres of the Bassendean Sand unit 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 and will therefore at times require localised dewatering.

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. Groundwater modelling (Rockwater, 2007) indicates that the impact will not extend much more than several hundred metres beyond the mine void and will be of a temporary nature (in the order of three to four months). The placement of wet tailings material in the adjacent previously mined area will also result in the artificial recharging of the local superficial aquifer.

The second relevant aquifer is the Leederville Formation extending to at least 130 metres below ground level. It will be utilised as a water source for the mining operation. Hydrological modelling shows that the expected pumping from two bores will after eight years impact groundwater levels in surrounding production bores to be less than 4 metres (Rockwater, 2007). The predicted impact on the upper superficial aquifer is less than 0.1 metres at the edge of any potentially groundwater sensitive wetlands.

Water salinities in the Superficial Formation 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.

2.4.1 Superficial Aquifer

Mineral and exploration drilling data collected by MZI 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 thickness of the Superficial formation 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 water table 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 groundwater resources in the Superficial Formation, as adopted by DoW, are as follows:

- Serpentine Groundwater Area – Keysbrook 1 and 2 Sub-areas:
5.32 x 10⁶ m³/yr totals, with 2.24 x 10⁶ m³/yr currently allocated (42%). *
- Murray Groundwater Area – Nambeelup Sub-area:
13.5 x 10⁶ m³/yr totals, with 1.31 x 10⁶ m³/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. 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 are not very large. The most productive draw-points would be drains, dams or ditches of significant length.

2.4.2 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 Keysbrook mine site is located within a recharge area for the Leederville and deeper Yarragadee aquifers. Both are in hydraulic connection with their respective overlying aquifer and there are downward hydraulic gradients. However, at some localities there are upwards heads from the Leederville to the Superficial aquifer. Thus as a rule 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.

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

- Serpentine Groundwater Area – Keysbrook 1 and 2 Sub-areas:
Leederville: 1.76 x 10⁶ m³/yr total, with 0.80 x 10⁶ m³/yr currently allocated (45%).*
- Murray Groundwater Area – Nambeelup Sub-area:
 - Upper Leederville: 4 x 10⁶ m³/yr total, with 1.98 x 10⁶ m³/yr currently allocated (49%).*
 - Lower Leederville: 3 x 10⁶ m³/yr total, with 1.1 x 10⁶ m³/yr currently allocated (36%).*

* These values are subject to change by the DoW

Within the Murray Groundwater area - Nambeelup sub-area, a green clay marker of about 5 to 10 metres in thickness, divides the Leederville aquifer into upper and lower units. Within this region, 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 49% has been allocated. The lower Leederville aquifer has an allocation limit of three gigalitres per annum, of which about 36% has been allocated.

2.4.3 Groundwater Areas

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

The project area has been allocated a policy use of P2. 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, 2002).

2.4.4 Groundwater Monitoring Information

DoW has a number of groundwater monitoring bores in close proximity to the project area.

Two artesian monitoring bores, AM64 (site number 61415037) and AM66 (site number 61415027) immediately border the mining area and are approximately 350 metres in depth being constructed between 1980 and 1986. Monitoring data and details of licensed bores are held in the DoW database.

Table 3 provides information on four existing monitoring bores, referred to as the Lake Thompson monitoring bores, located around the project site. These were constructed in 1975 and have recorded water levels since that time.

Table 3: Lake Thompson Bores

Name	WIN Site ID	Location	Drilled Depth (m)
LT610	3089	Hopelands Road (west side of project).	22.0
LT670	3098	Readhead Road (south side of project).	15.5
LT570	3105	Elliott Road (north side of project).	22.0
LT620	3111	Westcott Road (East side of project).	24.0

Data from the Lake Thompson monitoring bores indicate that water levels range from 0.35 metres below ground level in winter to 3.2 metres below ground level in summer.

MZI has installed a number of groundwater monitoring bores and two potential production bores within and adjacent to the project area. Table 4 lists the bores installed to date.

Table 4: Bores Drilled by Project Team

Name	Aquifer	Monitoring Purpose	Drilled Depth (m)	Date Installed
KWT1A	Superficial	Impact on wetland	2.0	May 2007
KWT1B	Superficial	Impact on wetland	2.0	May 2007
KWT1C	Superficial	Impact on wetland	2.0	May 2007
KWT1D	Superficial	Impact on wetland	6.0	May 2007
KWT1E	Superficial	Impact on wetland	4.0	May 2007
KWT1F	Superficial	Impact on wetland	4.0	May 2007

Name	Aquifer	Monitoring Purpose	Drilled Depth (m)	Date Installed
KWT2A*	Superficial	GW abstraction	3.0	June 2012
KWT2B	Superficial	GW abstraction (previously Impact on wetland)	3.5	May 2007
KWT2C	Superficial	GW abstraction (previously Impact on wetland)	3.0	May 2007
KWT2D	Superficial	GW abstraction (previously Impact on wetland)	3.0	May 2007
KWT2E	Superficial	GW abstraction (previously Impact on wetland)	6.0	May 2007
KWT2F	Superficial	GW abstraction (previously Impact on wetland)	1.8	May 2007
KWT3A*	Superficial	GW abstraction	4.0	June 2012
KL1S	Superficial	GW abstraction	3.0	May 2007
KL1Obs	Leederville	GW abstraction	90.0	March 2007
KL2Obs	Leederville	GW abstraction	144.0	April 2007
KL3Obs	Leederville	GW abstraction	156.0	April 2007
KL1	Leederville	Abandoned production bore		May 2007
KL2P	Leederville	Production bore	144.0	April 2007
KL3P	Leederville	Production bore	150.0	May 2007
KL3	Leederville	GW abstraction	26.0	June 2012
KL4	Leederville	GW abstraction	31.0	June 2012
KL7	Leederville	GW abstraction	37.0	June 2012
KL8	Leederville	GW abstraction	25.0	June 2012
KS1	Superficial	Impact on other users	2.9	June 2012
KS2	Superficial	Impact on other users	2.8	June 2012
KS3	Superficial	Impact on other users	2.8	June 2012
KS4	Superficial	Impact on other users	2.9	June 2012
KS5	Superficial	Impact on other users	2.9	June 2012
KS6	Superficial	Impact on other users	2.9	June 2012
KS7	Superficial	Impact on other users	2.9	June 2012
KS8	Superficial	Impact on other users	2.8	June 2012
KS9	Superficial	Impact on other users	4.5	June 2012
KS10	Superficial	Impact on other users	2.8	June 2012
KS11	Superficial	Impact on other users	4.5	June 2012
KS12	Superficial	Impact on other users	5.8	June 2012
KS13	Superficial	Impact on other users	5.0	June 2012
KS14	Superficial	Impact on other users	4.5	June 2012
KS15	Superficial	Impact on other users	4.3	June 2012
KS16	Superficial	Impact on other users	4.0	June 2012
KS17	Superficial	Impact on other users	4.5	June 2012

Name	Aquifer	Monitoring Purpose	Drilled Depth (m)	Date Installed
KS18	Superficial	Impact on other users	4.5	June 2012
KS19	Superficial	Impact on other users	2.9	June 2012
KS20	Superficial	Impact on other users	3.0	June 2012
KS21	Superficial	Impact on other users	4.1	June 2012
KS22	Superficial	Impact on other users	2.9	June 2012

* Bores KWT2A and KWT3A are replacement for the two bores drilled previously in 2007

2.4.5 Groundwater Quality

In the project vicinity, groundwater salinities in the Superficial aquifer range from 200 to 1,000 milligrams per litre Total Dissolved Solids (TDS) in the four Lake Thompson bores, 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 5. They show that colour, turbidity, and iron content vary strongly over the area, and locally one or more of these factors would determine that water from the Superficial aquifer was not suitable for some uses (e.g. potable supply) unless treated.

Table 5: 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 (T 570)	180	<5	<10	0.64	66	After pumping 1 hr @ 16 m ³ /day.
3089 (T610)	240	580	440	3.1	119	After pumping 1 hr @ 37 m ³ /day.
3111 (T 620)	950	<10	1,800	5.6	159	After pumping 1 hr @ 37 m ³ /day.
3098 (T 670)	300	70	330	19	56	After pumping 1 hr @ 16 m ³ /day.

2.5 WETLAND HYDROLOGY

A number of shallow bores have been drilled (Rockwater, 2007) to assist in gaining a better understanding of the hydrological processes present in the wetland areas. The 2007 investigation focused on the Nambeelup Brook South Tributary wetlands and Balgobin Brook South Tributary (Figure 2) as these are closest to the proposed mining blocks. In both areas the drill logs showed that the Bassendean Sand unit (the formation that hosts the mineral deposit) is relatively thin (<1.5 metres) and underlain by more than 5 metres of the more argillaceous Guildford Formation. The Guildford Formation which has much lower permeability (0.001 to 2 metres/day) effectively impedes groundwater flow between the highly permeable Bassendean sands (5-10 metres/day) and deeper regional Leederville aquifer. Groundwater levels in the bores show that for much of the year the local water table is below the base of the Bassendean Sands and even with a one metre rise during the wet season is unlikely to reach the natural ground surface in the wetlands. This is illustrated diagrammatically in the hydrogeological cross-section Figure 3 taken from Rockwater (2007).

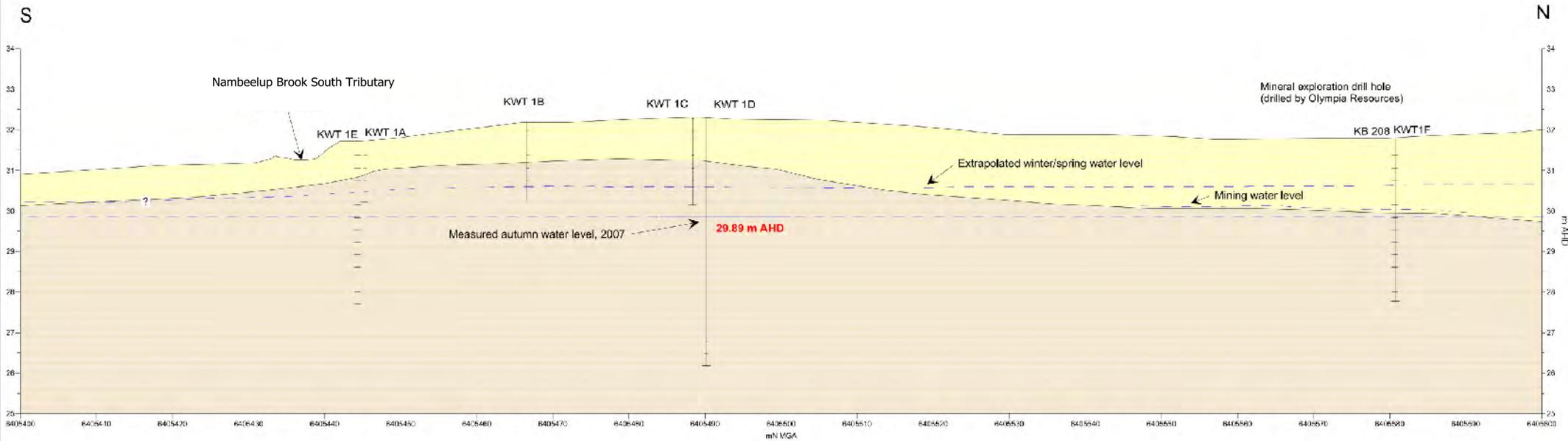
Drilling also suggests that a slight 'ridge' (divide) occurs in the Guildford Formation between the proposed mining area and the wetlands. The creek is located between the wetlands and the proposed mine dewatering area and will therefore act to counter any drop in the shallow (perched) water table. A further mitigating factor is that mine dewatering is only planned for the wetter winter months when surface drainages are known to recharge the wetlands. Subsequent groundwater level monitoring has confirmed the suspected seasonal groundwater level fluctuation in this shallow aquifer system.

The natural wetlands are therefore not considered groundwater dependent but rather surface water dependent. The wetlands are generally recharged during the wet season (winter) and sporadically during the rest of the year as a result of storm runoff and direct rainfall. The wetlands probably represent a source of recharge to the shallow groundwater system rather than the reverse.

Conservation Category
Geomorphic Wetland

Mining Area

106 m



I: 321.0\Surfer\Wetlands X-section 400550E.srf

LEGEND

- Bassendean Sand
- Guildford Formation (clayey sand to sandy clay)
- 27.0 m AHD
- Water level (16/5/2007)

- Hole uncased
- Hole cased, blank
- Hole cased, slotted

Figure 3: Hydrogeological Cross-section at the Nambeelup Brook South Tributary Wetlands (CCW 14472)



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3. WATER USE IN OPERATIONS

3.1 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 process supply.

3.2 SEWERAGE

A biocycle sewerage system will be used for the processing plant site and administration office ablutions. This will be sited, designed and operated in compliance with the health requirements of the Health Department of Western Australia and the local Shire. The system treats sewage effluent before discharging treated water to a contained area, which will be elevated to ensure a minimum two metre separation distance to the water table is maintained. The limited size of the package treatment plant means that effluent volumes are expected to be small with minimal risk of potential impact much beyond the contained area.

Discharge of treated water will be conducted in accordance with Water Quality Protection Note 22 (WQPN22) provided by DoW (DoW, 2009). According to Table 1 of WQPN22, the Risk Category based on soil type and location is Category A. This restricts the annual application loadings of inorganic nitrogen and reactive phosphorus to 140 kilograms of nitrogen per hectare per year and 10 kilograms of phosphorus per hectare per year. Higher loadings are permissible if the water is used to irrigate pasture for hay production.

3.3 WATER DISCHARGE

The average daily process water use will be approximately 53 Megalitres. Modelled pit dewatering rates ranged from 134 – 2,397 kilolitres (3% to 45% of the average daily needs). Therefore, under normal circumstances there will be a significant water deficit that requires to be made up from bore water supply. Water storage capacities are based on the need to maximising water retention for reuse and 1:100 year ARI storm event design requirements. As a result there will be no necessity for routine discharge of surplus water to the environment.

However, to cater for the possibility that heavy rainfall events coincide with extended plant downtime, resulting in the Process Water Dam freeboard capacity being exceeded, the Health, Safety, Environment and Community (HSEC) Advisor shall ensure that a discharge licence is obtained from Department of Environment and Conservation (DEC). All surface water runoff from the processing area will be directed to pass through either the Process Water Dam or stormwater settling ponds to allow sediment to settle out prior to discharge.

The Process Water Dam will be situated near the primary processing plant. Excess water will flow over a lined spillway on the Process Water Dam to nearby watercourses. If monitoring results indicate it is necessary, the Site Manager will ensure additional sediment sumps are installed between the Process Water Dam and the creek line to further decrease turbidity of discharge water.

3.4 PROCESS WATER AND WATER BALANCE

The water requirement for mining and processing is estimated at 2,210 kilolitres per hour. Of this volume, approximately 1,140 kilolitres per hour is recycled within the process and 1,070 kilolitres per hour is added via pit inflow water or bore water. The site Process Water Dam, located near the primary processing plant, will have capacity to store 74,000 kilolitres.

Approximately 52% of the water will be recycled. This is achieved by discharging thickened tailings at about 45% solids density. Recovering surplus water during backfilling of mined areas will also occur and supplement pit dewatering providing an additional 38% make up water. Additional process water sourced from the production bores will only be used after these water resources have been fully utilised.

A basic water balance has been developed for the operation and is summarised in Table 6, Table 7, Table 8 and Table 9 below. A schematic diagram is presented in Figure 4.

Table 6: Water Inputs to Mine Water Circuit

Source	ML/year	GL/yr (@90% availability)
Mine Pit Dewatering (potentially*).	811	0.7
Production Bore extraction (potentially*).	1,181	1.1
Rainfall within mine catchment.	20	<0.1
Total	2,012	1.8

Note: * Prediction based on hydrogeological modelling

Table 7: Water Recovery within Mine Water Circuit

Source	ML/year	GL/yr (@90% availability)
From backfilled tailings.	6,723	6.1
Process Plant Thickener.	9,262	8.3
Total	15,985	14.4

Table 8: Mine Water Use

Water Use	ML/year	GL/yr (@90% availability)
In Pit Screening Plant.	11,722	10.5
Wet Concentrating Plant.	6,057	5.4
Dust Suppression.	176	0.1
Total	17,955	16.0

Table 9: Site Annual Water Balance

Units	Site Water Requirement	New Input Water	Amount Recycled
Per annum	18 GL	2.0 GL	16 GL
% of all water	100%	11%	89%

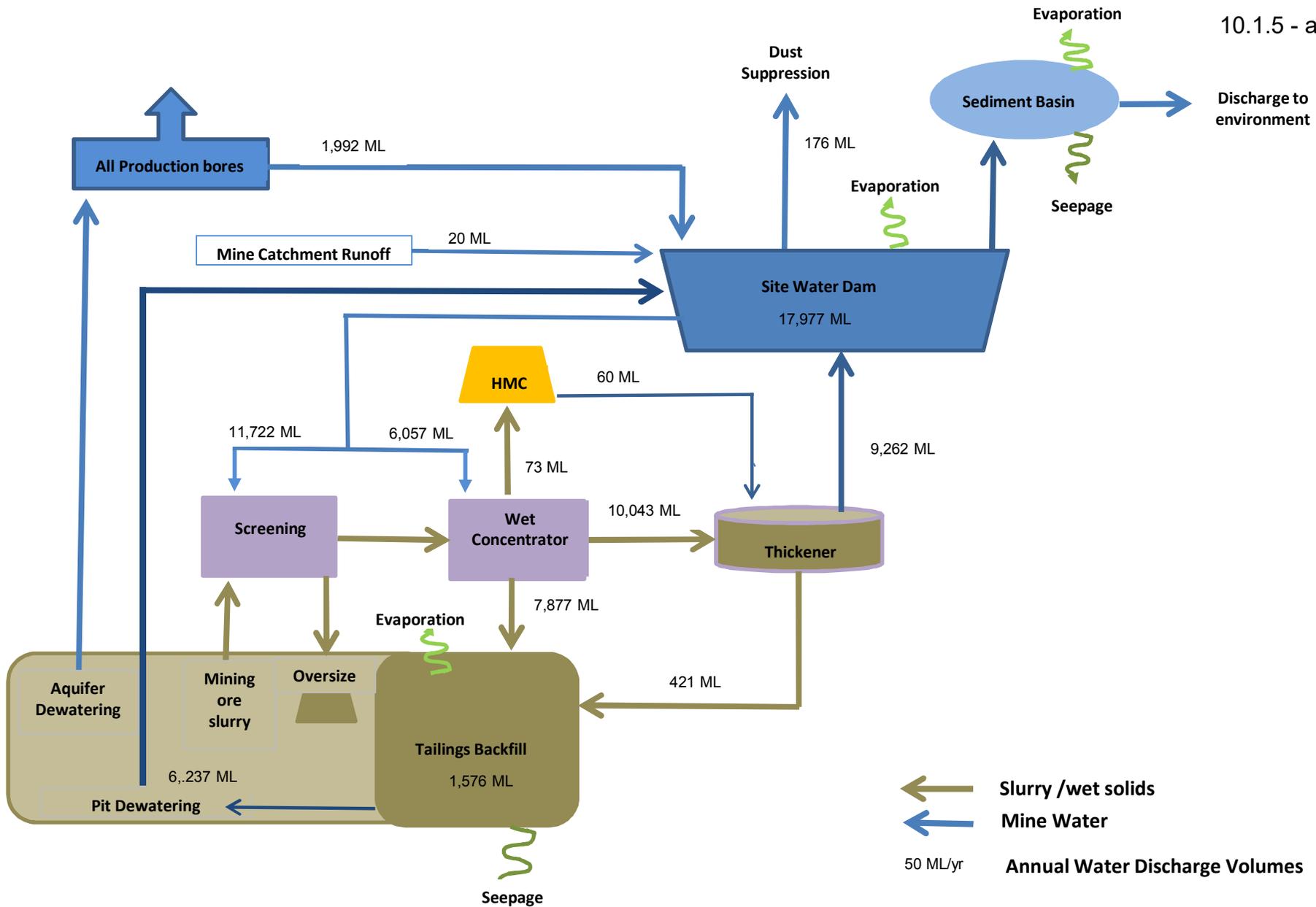


Figure 4: Schematic Water Budget

4. SURFACE WATER MANAGEMENT

4.1 POTENTIAL IMPACTS

The following issues could potentially arise from mining and processing operations in the absence of mitigation and management measures:

- Temporarily reducing surface water volume to watercourses by diverting runoff from operational areas for use in the process water circuit.
- Contaminating surface water by releasing contaminants associated with earthmoving, excavation and stockpiling. Potential contaminants include sediment and hydrocarbons from spills.
- Increase in acidity of surface waters through disturbance of acid sulfate soils.
- Contaminating surface water runoff from flow over stockpiles.
- Contaminating surface waters due to release of partially treated sewage effluent.
- Potential to spread Dieback disease through poorly planned surface water management.
- As a result of heavy rainfall events, there is the potential for increased turbidity off recently rehabilitated areas that are not yet fully stabilised.

4.2 MANAGEMENT MEASURES

Mining areas will have ring drains installed with a sump on the pad perimeter. Tails decant sumps will be installed in tailing areas within the mine void. Water from these sumps will be transferred to the process circuit.

The mine void will be bunded to prevent surface inflows from adjacent areas. V drains will be installed to divert surface flows around assets and operating areas. Surplus process water will pass through two settling ponds before discharge to the adjacent watercourse at the discharge point which will be rock armoured to prevent erosion.

The HSEC Advisor is responsible for ensuring the surface water quality monitoring program is undertaken as detailed in Appendix 1 and that water management infrastructure is monitored in accordance with Appendix 2 on a monthly basis and following significant rainfall events.

The Site Manager is responsible for ensuring diversion drains are constructed and maintained so that water re-enters natural drainage lines at a velocity and depth similar to the original channel to ensure minimum erosion potential. Surface water diversions shall also be designed such that runoff from Dieback infested areas does not enter Dieback free areas (see the Weed and Dieback Management Plan (MBS 2011) for further information).

Surface water runoff from infrastructure areas such as the primary processing plant and administration offices will be directed to settling ponds to allow sediment to drop out of suspension prior to discharge. The Site Manager is responsible for ensuring settling ponds are constructed to reduce turbidity to target trigger levels shown in Appendix 3 before release to the environment. The HSEC Advisor is responsible for ensuring monitoring of this water is undertaken.

Detailed designs of drainage diversions and water management infrastructure were referred to DoW before construction commenced. The Site Manager will ensure that if any significant changes to drainage diversions and water management infrastructure are planned then detailed designs will be referred to DoW prior to construction.

The process water pond will be managed to at all times have sufficient freeboard to contain the 1:100 year 72 hour storm.

Spills of hydrocarbons or other potential contaminants will be cleaned up immediately and reported to the supervisor and HSEC Advisor. The HSEC Advisor is responsible for ensuring any follow up actions or monitoring is undertaken.

If emergency discharges to surface water occur, they will be managed according to the emergency discharge procedure (Appendix 5).

During landform restoration, drainage will be re-established along original drainage lines as per the Rehabilitation Management Plan (RMP) (MBS 2012b). Contours of the restored landforms and drainage lines will be returned to as close as possible to pre-mining levels. The Site Manager will ensure restored landforms are treated as detailed in the RMP to minimise the risk of erosion.

5. CONSERVATION CATEGORY WETLANDS AND NATIVE VEGETATION

5.1 POTENTIAL IMPACTS

The following issues could potentially arise from mining operations in the absence of mitigation and management measures:

- Lowering of the water table in Conservation Category wetlands adjacent to the project area. Hydrological modelling of predicted drawdown has been completed (Rockwater 2007) which indicates there will be no impact on wetlands in the dry season but a minor impact is possible during winter and spring.
- Change to water quality in Conservation Category wetlands.
- Reduced health and condition of native vegetation.

5.2 MANAGEMENT MEASURES

5.2.1 Groundwater Monitoring

Groundwater levels and quality will be recorded at the monitoring bores located adjacent to the Conservation Category wetlands as shown on Figure 5 and detailed in Appendix 1. Figure 6 and Figure 7 provide a more detailed view of the monitoring bores in and around the two key wetland areas.

The presence or absence of standing surface water in the Conservation Category wetland adjacent to the project will be also be recorded monthly.

MZI commits to installation of three additional monitoring bores:

- One shallow wetland monitoring bore at wetland 14920, to be installed within the first 12 months of operations, or prior to mining operations being undertaken within 500 meters of the wetland (whichever comes first).
- One shallow wetland monitoring bore at wetland 14887, installed 12 months prior to mining lot 56, Elliott Road.
- One shallow wetland monitoring bore at a southern wetland (14635 or similar adjacent wetland), installed 12 months prior to mining south of Redheads Road. MZI will determine the exact location of the bore in liaison with landowners and the DoW.

The monitoring bore schedule will be reviewed and revised annually in consultation with the DoW and Office of the EPA to ensure that adequate monitoring bores are in place with regard to the mining schedule.

5.2.2 Wetland Vegetation Monitoring

MZI shall develop and implement a Wetland Vegetation Health Monitoring Programme which includes:

Pre-operational baseline survey and 6-monthly (spring and autumn) vegetation health assessments in Conservation Category Wetlands (UFI nos. 14472, 14473 and 14465) for the first 3 years of operations and ongoing annual assessment so long as MZI continue groundwater abstraction from the KLP2 and KLP3.

Pre-operational baseline survey and vegetation health assessments in Conservation Category Wetlands (UFI nos.) 7603, 7604, 7617 and 14920. Ongoing monitoring of vegetative health at these wetlands would only be triggered by an unacceptable decline in water levels at bores KWT3A, KS9, KS8 and KWT1A-1F to the north, or by an identified decline in health of wetland vegetation in wetlands 14472, 14473 and 14465. The baseline survey provides a pre-mining dataset for comparison with any future vegetation monitoring and trigger levels will be set following an assessment of baseline water and vegetation data, in line with accepted methods used for studies of GDE on the Swan Coastal Plain (e.g. Froend et al. 2004).

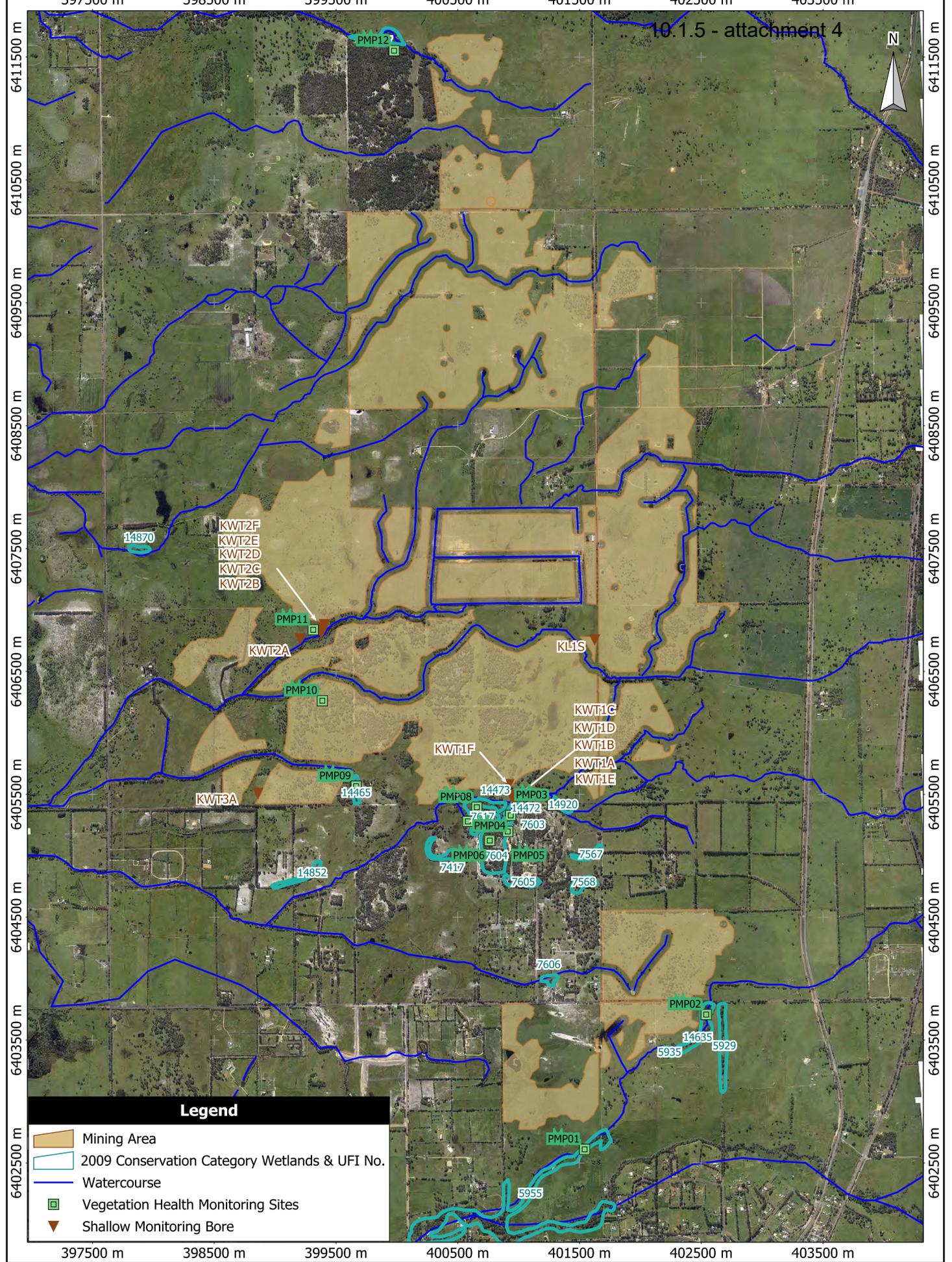
Baseline survey and 6-monthly (spring and autumn) vegetation health assessments in Conservation Category Wetland UFI 14887, with the baseline conducted 12 months prior to mining of lot 56, and monitoring continuing for one year post completion of mining this area.

Baseline survey and 6-monthly health assessments at two proposed sites in wetlands south of the southern mine area along Redhead Road. Although there is not planned to be any dewatering in this area, the baseline study should be conducted prior to commencement of mining so that these sites can provide reference data for trends in regional vegetation condition. Monitoring will continue for one year post completion of mining this area.

The locations shown on Figure 5 and detailed in Appendix 1 will be used to assess the vegetation and condition of vegetation, with these locations to be reviewed or altered if necessary in consultation with the DoW.

If monitoring shows a breach of trigger groundwater levels, water quality or a decline in vegetation health within a Conservation Category wetland, the HSEC Advisor is responsible for reporting this to the General Manager and Site Manager. The Site Manager will ensure an investigation into the cause is instigated. If deemed necessary by the General Manager, mining in the pit nearest the wetland will be suspended until the results of the investigation are known. If the investigation shows beyond all scientific doubt that the water level or quality changes can be attributed to mining activity, and that vegetation health may suffer should MZI continue to operate as per the current mining schedule, MZI shall investigate contingency measures to maintain water levels and vegetation health.

If necessary the impacted wetland can be recharged with mine dewatering discharge. MZI shall evaluate such opportunities in liaison with the DoW.



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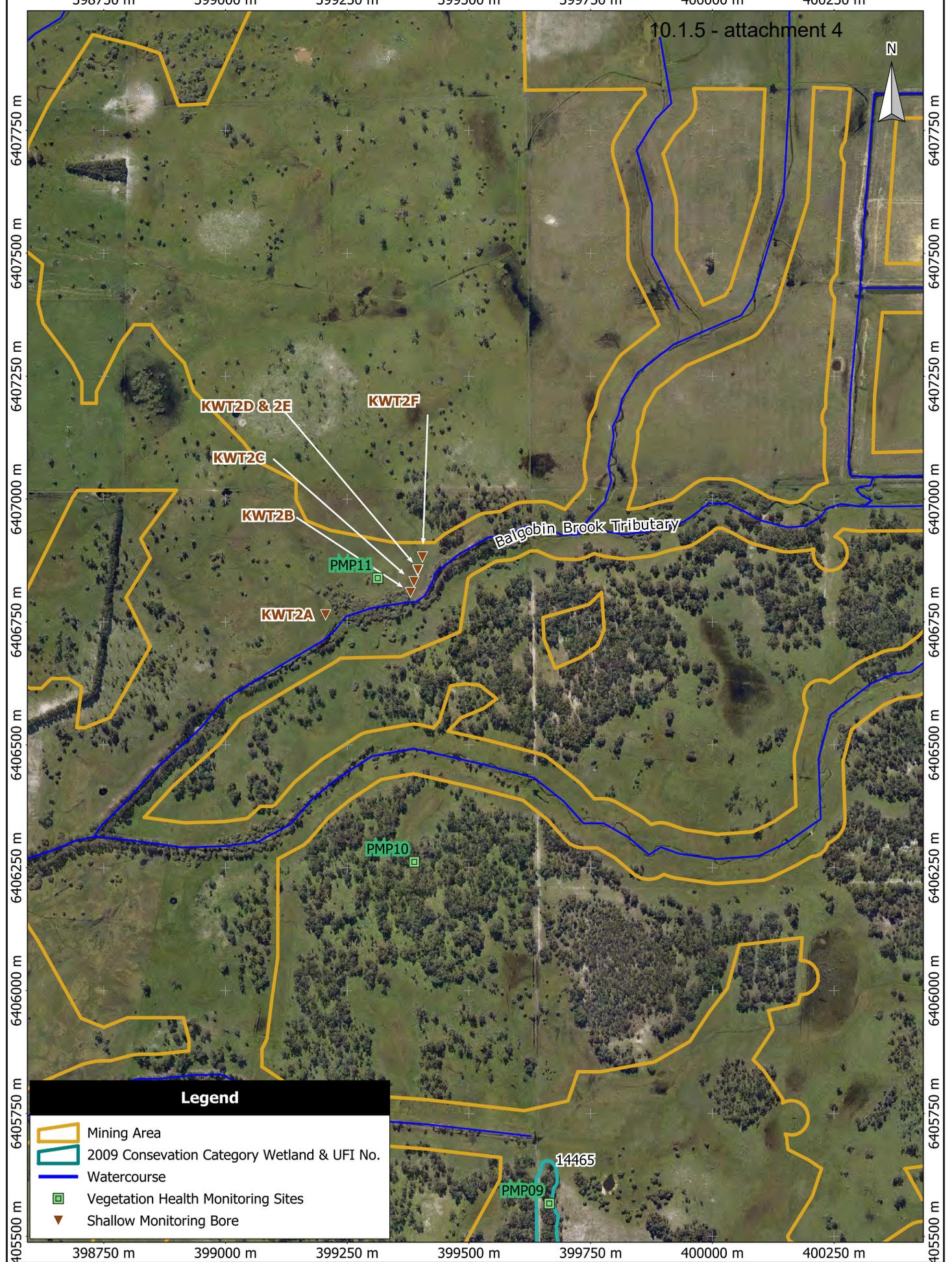
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Wetland Health Monitoring Locations

Page 5



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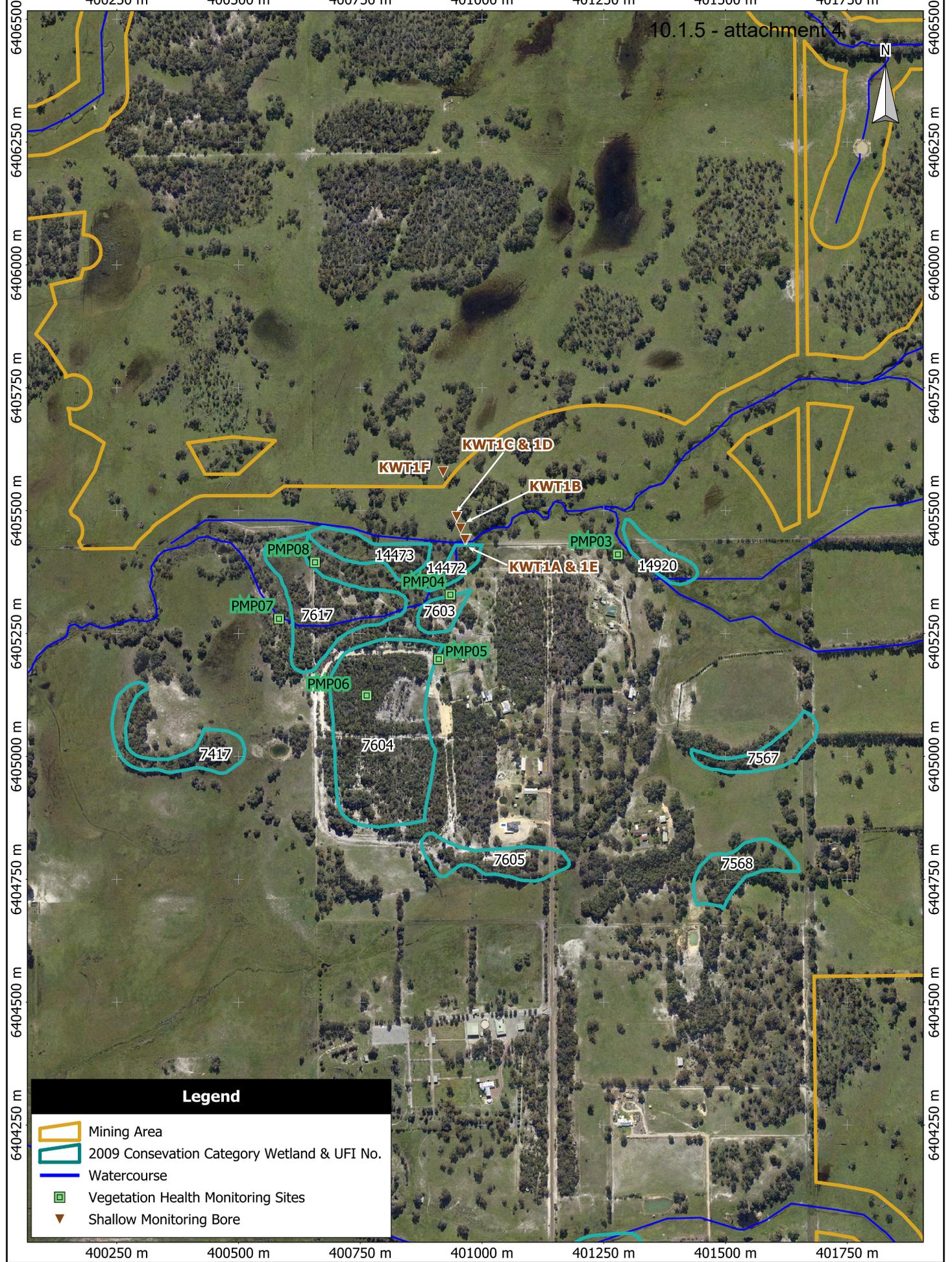
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Wetland Health Monitoring
Locations
Northern Bore Cluster

Figure 6



Legend

- Mining Area
- 2009 Conservation Category Wetland & UFI No.
- Watercourse
- Vegetation Health Monitoring Sites
- Shallow Monitoring Bore

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Wetland Health Monitoring
Locations
(Southern Bore Cluster)

Figure 7

6. GROUNDWATER MANAGEMENT

6.1 POTENTIAL IMPACTS

Potential exists for the following groundwater quality and quantity issues to occur:

- Lowering of localised groundwater levels as a result of dewatering and/or pumping from project water-supply bores in the Leederville aquifer. Hydrological modelling of predicted drawdown has been completed (Rockwater 2007) including calculation of cones of depression during mining and water level recovery post mining. The modelling indicates the impact will be minor and short term.
- Backfilling of completed pits with 45% slurry causing localised recharge of groundwater.
- Changes to groundwater quality due to hydrocarbon spills within active pits.
- Changes in groundwater quality due to altered levels and flows.
- Changes in groundwater quality due to disturbance of acid sulfate soils.
- Changes in groundwater quality following mining during the period of recovery of the water table.
- Changes in groundwater quality and quantity may impact other users in the area and lead to complaints.

6.2 MANAGEMENT MEASURES

Abstraction of groundwater will be kept to the minimum required for the project. The water table will not be lowered further than the bottom of the pit, corresponding to the base of the Bassendean Sands.

The HSEC Advisor will be responsible for ensuring the water monitoring program outlined in Section 8.2 is carried out. Where monitoring indicates a decrease in water quality or quantity, the HSEC Advisor is responsible for reporting this to the Site Manager.

To ensure complaints from other groundwater users in the area are dealt with in an effective and timely manner, a system for logging, actioning and following up on groundwater related complaints will be incorporated into the overall complaints management system for the project. The HSEC Advisor will be responsible for managing this system. The HSEC Advisor is responsible for reviewing, actioning and closing out complaints received.

Where it has been identified that the water quantity or quality of other groundwater users has been adversely affected by the mining operation such that it is no longer available in the same quantities or can no longer be used for its originally intended purpose, the General Manager will instigate measures to provide an alternative water source. This may include providing a supply of water from the process water bores or arranging for water to be provided to the user by tanker.

The General Manager will be responsible for ensuring that potential changes to localised groundwater levels are considered during mine scheduling, particularly when potential changes may occur during critical agricultural periods such as pasture or crop growth. Groundwater monitoring results from previous mining areas will be assessed to ascertain likely drawdown impacts in the Superficial aquifer and compared with the Rockwater (2007) hydrogeological model predictions. The General Manager will be responsible for:

- Discussing with potentially affected landowners their short term land management plans to determine whether cropping or pasture activities are planned to be undertaken adjacent to mining areas and if so for what duration.
- Determining whether a change to the mining or dewatering activities is required to be implemented to minimise potential impacts during the critical growth period.
- Determining whether compensatory actions are required to be implemented i.e. provision of alternate water supply if monitoring shows that impacts are being realised or maintenance or replacement of any adversely impacted groundwater bore.

7. HYDROCARBON MANAGEMENT

7.1 POTENTIAL IMPACTS

The use of hydrocarbons on site may lead to the following impacts:

- Contamination of surface waters due to hydrocarbon spills.
- Contamination of groundwater due to hydrocarbon spills.

7.2 MANAGEMENT MEASURES

It is the responsibility of all employees and contractors to ensure spills are contained and cleaned up immediately. All spills are to be reported via MZI's internal incident reporting system.

The Site Manager will ensure that the following management measures are established to reduce the risk of hydrocarbon spills to the environment:

- Hydrocarbon storage areas and workshops will be constructed near the primary processing plant in elevated locations.
- Hydrocarbon contaminated runoff will be treated prior to discharge. Washdown of equipment will result in the production of contaminated wastewater. Washdown will be done on hardstand areas, (either limestone roadbase or concrete) and directed to a triple interceptor or plate separator.

The Site Manager will ensure the following management measures are implemented:

- A register of all hazardous materials on site is 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.
- The storage of hydrocarbons will be designed to comply with AS 1940:2004. Generally this will mean they are to be stored in either self bunded (double lined) bulk tanks or in bunded compounds.
- Hydrocarbon wastes generated by the operation will be transported off-site to licensed waste disposal facilities.
- 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.

The Site Manager will ensure the following management measures are implemented:

- Within the mine pit, where the pit floor will be within the minimum two metre groundwater separation zone recommended by the DoW (DoW, 2009), the screening plant and all transfer pumps will be electrically powered where possible. Where this is not possible, all pumps and generators will be placed within impermeable bunds.
- There will be no storage of hydrocarbons on the floor of the mine pit. Hydrocarbons within the mine pit will be limited to that contained in mobile equipment.
- Portable pumps or generators used to power water recovery pumps will be located above the pit, on natural ground level where possible and placed within impermeable bunds.
- Spill kits will be placed in strategic locations within operational areas and on board service vehicles. All staff will be trained in the use of these kits.

8. MONITORING

8.1 RAINFALL

Rainfall is measured automatically by the site weather station. The information is automatically downloaded onto computer and stored as an electronic file. The HSEC Advisor is responsible for ensuring the weather station is operational and for filing electronic and hardcopy data. The Environmental Officer is responsible for reviewing weather station data.

8.2 WATER MONITORING

8.2.1 Surface Water

To ensure that negative impacts to surface water quality are prevented or minimised, and background water quality is understood, a surface and discharge water monitoring program will be implemented and will be updated as necessary.

Indicative surface water quality monitoring sites are shown on Figure 8 and detailed in Appendix 1. Appendix 2 provides an inspection checklist for monitoring of site water management infrastructure.

Two levels of surface quality water monitoring will occur:

- Regular laboratory analysis monitoring.
- Opportunistic monitoring.

8.2.1.1 *Regular Laboratory Analysis Monitoring*

The HSEC Advisor will collect samples monthly, when streams are flowing, for laboratory analysis to allow a more complete understanding of water quality. This in turn will allow refinement of management strategies and trigger levels over time.

Monitoring will be undertaken for all surface water sites (indicative sites are listed in the schedule in Appendix 1).

The HSEC Advisor shall undertake monthly monitoring of the volume of water extracted from pit sumps. Water recovered from pit sumps shall report to the process water ponds. The HSEC advisor shall monitor the water quality in the process water dam as specified in Appendix 1.

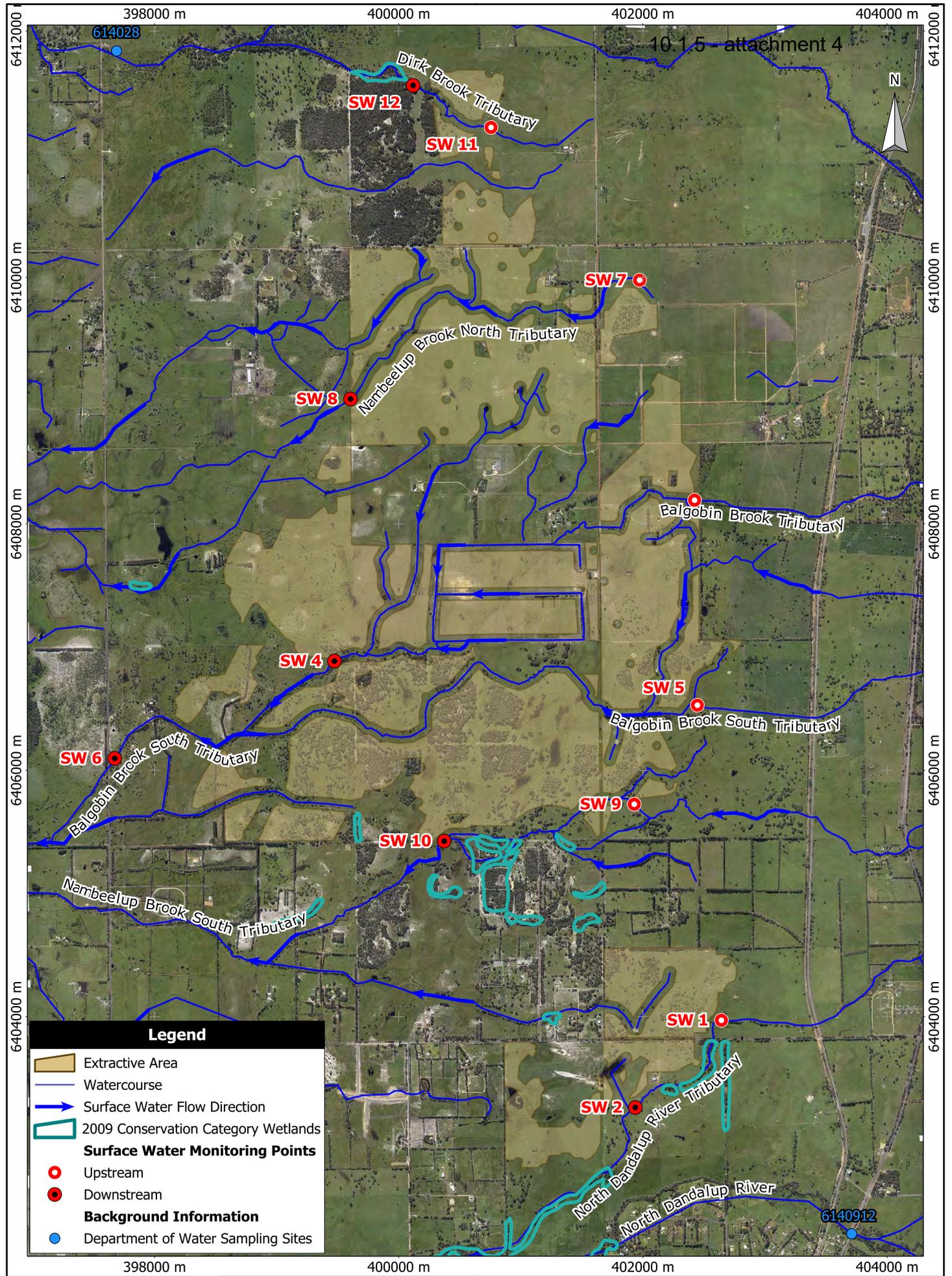
8.2.1.2 *Opportunistic Monitoring*

To provide a greater understanding of water quality on site it is necessary to collect samples from areas with flows which are too irregular to be effectively monitored on a regular basis.

Water samples will be collected opportunistically by the HSEC Advisor from areas with irregular flows such as overflow from the Process Water Dam. This will include turbidity

measurements. Opportunistic sampling will be undertaken to provide information on quality response to a range of hydrologic events.

Opportunistic samples may also be collected in response to *in situ* monitoring indicating trigger levels are being exceeded.



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Surface Water
Monitoring Locations

Figure 8

8.2.2 Groundwater

Groundwater monitoring will be undertaken by the HSEC Advisor in accordance with the site's groundwater monitoring procedure. Groundwater monitoring bores have been installed to evaluate changing groundwater levels and allow early detection of any change in water quality as a result of mining-related activities (Table 4).

Groundwater monitoring site locations are detailed in the Groundwater Monitoring Procedure. Water samples shall be collected from these locations at the frequency identified in the Groundwater Monitoring Schedule of the Groundwater Monitoring Procedure and analysed for the parameters listed in the Water Analysis Schedule of the Groundwater Monitoring Procedure.

These schedules provide generally for monthly monitoring of static water levels and quarterly collection of water samples from selected bores for laboratory quality analysis. Samples for laboratory quality analysis will also be collected monthly for a period of six months prior to planned mining in that area adjacent to respective groundwater monitoring bores.

Indicative groundwater monitoring locations are shown on Figure 9 and detailed in Appendix 1. The proposed purpose for the monitoring bore dictates the monitoring frequency and type of analysis to be done. These can be summarised as follows:

1. Impact of groundwater abstraction from the two established production bores on the local Leederville Aquifer – Bores KL2P, KL3P, KL3, KL4, KL7, KL8, KL1 Obs, KL2 Obs and KL3 Obs. Several of these bores are positioned between the projects production bores and neighbouring privately owned bores operating in the same aquifer.
2. Possible impact of groundwater abstraction at the two established production bores on the local Superficial Aquifer - KWT2A, KWT3A, and KL1S. These bores are in close proximity to the production bores. The key purpose is to monitor any water table response.
3. The four existing DoW bores in the area will continue to function as monitoring sites. These are labelled T610(3089), T670(3098), T570(3105) and T620(3111) on Figure 9.
4. Twenty two additional shallow monitoring bores have been installed in the superficial aquifer near to the mining area boundary – Bores KS1 to KS22 as shown in Figure 9. The locations of these bores are based on the location of other bores used by adjacent landowners. The bores will be monitored prior to commencing any mine dewatering.. The primary purpose is to monitor any water table response.
5. Two suites of five and six shallow monitoring bores have been installed at two sites adjacent to areas identified as wetlands. They are numbered KWT1A–1F and KWT2B–2F. Due to changes to the planned mine schedule, mining adjacent to the wetland monitored by the latter set of bores is no longer planned and these bores will now be used to monitor the impact of groundwater extraction in close proximity to site production bore. Locations are shown in Figure 9. The suites comprise three or four “shallow” bores between two and four meters in depth, and one “deep” bore six meters in depth. The primary purpose is to monitor any water table response.

6. Groundwater bores on neighbouring properties may be monitored for water level and quality subject to agreement being reached with individual landowners. The locations of such bores will be added to the monitoring schedule contained in Appendix 1 after agreements are reached.

Additional bores may be constructed once operations have commenced based on observed impacts during initial dewatering activities. MZI have also committed to installation of three additional monitoring bores at wetlands. The final monitoring network design will be based on field measurement rather than conceptual models.

Samples collected under Schedule B (Appendix 1) will be sent to a NATA accredited laboratory for analysis. Analysis results will be entered into the MZI Water Monitoring Database and the hard copy laboratory results filed in the Water Monitoring File by the HSEC Advisor.

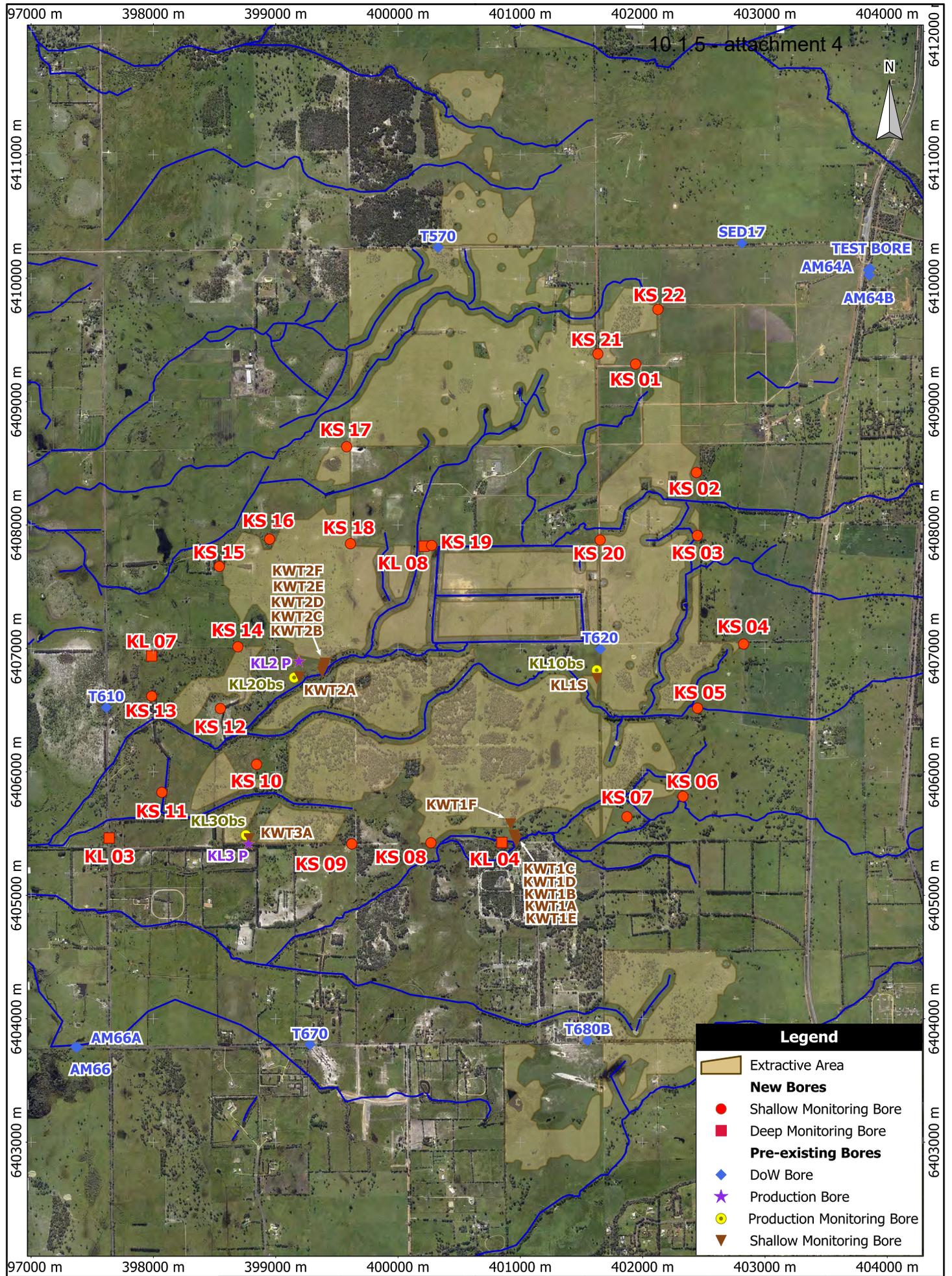
Monitoring of the groundwater quality will continue until such time that groundwater levels have recovered to within five percent of pre-mining levels following cessation of operations.

8.3 VEGETATION MONITORING

In addition to the Wetland Vegetation Health Monitoring Programme, Photographic monitoring points will be established at the two remnant vegetation areas within the project area. These are shown on Figure 5 as PMP10 and PMP11 and detailed in Appendix 1. These sites are subject to change.

On a six monthly basis (September and March), the HSEC Advisor will take photographs at each of these photographic monitoring points such that vegetation change can be assessed as per the Photographic Monitoring Programme. The health of the vegetation within a 20 metre by 20 metre quadrat, centred on the monitoring point, will also be assessed according to the form provided in Appendix 4.

Monitoring shall be carried out while those pits within one kilometres of the photographic monitoring point are active. Monitoring shall begin at the scheduled monitoring period prior to mining and until groundwater levels in the area return to pre-mining levels.



Legend

- Extractive Area
- New Bores**
- Shallow Monitoring Bore
- Deep Monitoring Bore
- Pre-existing Bores**
- DoW Bore
- Production Bore
- Production Monitoring Bore
- Shallow Monitoring Bore

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Groundwater Monitoring
Locations

Figure 9

8.4 TRIGGER LEVELS

Trigger Levels for each of the analysed water quality parameters are specified in Appendix 3. In most cases, trigger values are based on:

- Differences between upstream and downstream surface water nutrient concentrations exceeding 10% (if the measured concentration is more than twenty times the reporting limit for the method).
- Surface water physio-chemical water quality parameters outside the range of the mean value plus or minus three standard deviations based on historical data.
- Differences between downstream groundwater nutrient concentrations for the current and previous samplings exceeding 10% (if the measured concentration is more than twenty times the reporting limit for the method).
- Groundwater physio-chemical water quality parameters outside the range of the mean value plus or minus three standard deviations based on historical data.

Contaminant Levels are specified for four different categories: DoW's Lake Thompson Monitoring Bores, drinking water, lowland stream freshwater and stock water for cattle. Limits for the protection of 95% of species are used as the Keysbrook site is classified as moderately to slightly disturbed using the ANZECC (2000) criteria.

Specific physico-chemical water quality trigger values will be established for each bore once sufficient monitoring data is available to determine statistically valid levels. The methodology is as per ANZECC (2000) (Appendix 3). Trigger values shall be reviewed and amended to reflect site data after 12 months of monitoring. An Excel based model has been established to automatically do these statistical calculations after each sampling run. The actual trigger value will change with every additional data point and revised trigger values will be submitted to the DoW and the OEPA for approval.

The exceedance of a Trigger Level for a specific parameter within the respective water quality category will activate an investigation into the use of that particular water type and the possible source of the elevated level.

Trigger Drawdown Values have been specified for groundwater levels in superficial aquifer and Leederville aquifer monitoring bores. These values have been determined by assessing modelled predictions of drawdown, the intent being that should water levels not react as per model assumptions, MZI shall investigate and respond to mitigate the potential for impacts to vegetation and other groundwater users in the region. Triggers, defined as AHD levels for each trigger bore, have been set using collected site summer water level data (the minimum annual levels) less a nominated and agreed drawdown value. Table 10 summarises the current Trigger Drawdown Values which when exceeded will prompt an investigation into the significance of the drawdown.

Table 10: Groundwater Trigger Drawdown Values

Bore ID	Bore Type	Coordinates (MGA)		Collar RL	Top of Casing	Trigger Drawdown (from min water level)	Trigger Water Level	
		m Easting	m Northings	(m AHD)	m agl	m	m AHD	m btoc
DEEP MONITORING BORES (LEEDERVILLE AQUIFER)								
KL1 Obs	Monitoring, Leederville	401,625	6,406,792	34.00	0.57	3.0	26.80	7.20
KL2 Obs	Monitoring, Leederville	399,186	6,406,766	27.64	0.44	10.0	15.77	11.87
KL3 Obs	Monitoring, Leederville	398,778	6,405,465	26.10	0.63	15.0	10.11	15.99
KL 3	Monitoring, Leederville	397,639	6,405,465	21.95	0.40	3.0	17.16	4.79
KL 4	Monitoring, Leederville	400,850	6,405,429	31.75	0.42	3.0	23.41	8.34
KL 7	Monitoring, Leederville	397,986	6,406,940	24.15	0.40	3.0	18.37	5.78
KL 8	Monitoring, Leederville	400,213	6,407,829	31.74	0.40	3.0	26.12	5.62
SHALLOW MONITORING BORES (SUPERFICIAL AQUIFER)								
KL1S	Shallow Monitoring	401,628	6,406,792	33.86	0.43	0.8	31.43	2.43
KWT1A	Monitoring, Superficial	400,968	6,405,442	32.22	0.44	0.3	NA ¹	
KWT1B	Monitoring, Superficial	400,956	6,405,464	32.41	0.36	0.3	NA ²	
KWT1C	Monitoring, Superficial	400,948	6,405,487	32.57	0.39	0.3	NA ¹	
KWT1D	Monitoring, Superficial	400,948	6,405,488	32.70	0.59	0.3	29.60	3.10
KWT1E	Monitoring, Superficial	400,965	6,405,441	32.37	0.58	0.3	29.93	2.44
KWT1F	Monitoring, Superficial	400,920	6,405,579	32.25	0.47	0.3	29.39	2.86
KWT2B	Monitoring, Superficial	399,380	6,406,810	28.16	0.64	0.8	NA ²	
KWT2C	Monitoring, Superficial	399,387	6,406,832	28.43	0.72	0.8	25.48	2.95
KWT2D	Monitoring, Superficial	399,395	6,406,854	28.40	0.65	0.8	25.47	2.93
KWT2E	Monitoring, Superficial	399,395	6,406,856	28.28	0.49	0.8	25.86	2.42
KWT2F	Monitoring, Superficial	399,404	6,406,883	28.72	0.59	0.8	NA ¹	
KS 1	Monitoring, Superficial	401,942	6,409,304	37.79	0.40	0.8	NA ²	
KS 2	Monitoring, Superficial	402,440	6,408,426	38.90	0.40	0.8	NA ²	
KS 3	Monitoring, Superficial	402,448	6,407,915	38.19	0.40	0.8	35.54	2.65
KS 4	Monitoring, Superficial	402,825	6,407,036	39.51	0.45	0.8	NA ¹	
KS 5	Monitoring, Superficial	402,449	6,406,517	37.08	0.45	0.8	NA ¹	
KS 6	Monitoring, Superficial	402,330	6,405,802	36.79	0.40	0.8	33.63	3.16
KS 7	Monitoring, Superficial	401,872	6,405,637	35.26	0.40	0.8	NA ²	
KS 8	Monitoring, Superficial	400,269	6,405,426	29.91	0.40	0.8	27.53	2.38
KS 9	Monitoring, Superficial	399,622	6,405,417	28.21	0.40	0.8	25.26	2.95
KS 10	Monitoring, Superficial	398,844	6,406,061	25.95	0.40	0.8	23.27	2.68
KS 11	Monitoring, Superficial	398,069	6,405,835	23.50	0.42	0.8	21.00	2.50
KS 12	Monitoring, Superficial	398,548	6,406,514	27.52	0.40	0.8	23.40	4.12
KS 13	Monitoring, Superficial	397,986	6,406,614	23.80	0.40	0.8	21.17	2.63
KS 14	Monitoring, Superficial	398,691	6,407,014	26.06	0.30	0.8	23.58	2.48
KS 15	Monitoring, Superficial	398,539	6,407,665	26.35	0.46	0.8	23.50	2.85

Bore ID	Bore Type	Coordinates (MGA)		Collar RL	Top of Casing	Trigger Drawdown (from min water level)	Trigger Water Level	
		m Easting	m Northings	(m AHD)	m agl	m	m AHD	m btoc
KS 16	Monitoring, Superficial	398,950	6,407,886	28.01	0.37	0.8	25.47	2.54
KS 17	Monitoring, Superficial	399,580	6,408,635	31.25	0.40	0.8	28.57	2.68
KS 18	Monitoring, Superficial	399,611	6,407,849	30.69	0.40	0.8	28.13	2.56
KS 19	Monitoring, Superficial	400,275	6,407,835	31.77	0.40	0.8	29.16	2.61
KS 20	Monitoring, Superficial	401,653	6,407,879	34.78	0.40	0.8	32.02	2.76
KS 21	Monitoring, Superficial	401,634	6,409,387	37.74	0.40	0.8	33.68	4.06
KS 22	Monitoring, Superficial	402,125	6,409,747	37.79	0.40	0.8	NA ²	
KWT 2A	Monitoring, Superficial	399,195	6,406,770	27.54	0.40	1.2	NA ²	
KWT 3A	Monitoring, Superficial	398,784	6,405,459	25.79	0.40	1.2	23.04	2.75

¹ Water level previously below base of bore
² Appropriate trigger level below base of bore

8.5 MANAGEMENT RESPONSE TO TRIGGER LEVEL EXCEEDANCES

Exceedance of pre-determined water quality Trigger Levels serves only as an indicator of changes in water quality. An appropriate management response is to review the water quality data and identify potential causes for the change, which may include natural variation, sampling and laboratory errors, chemical spills or mining activities. The objective of the management response is to ensure that contaminant levels are not exceeded and water quality parameters return to levels below Trigger Levels (or if scientifically justified the Trigger Levels are reviewed in consultation with DoW).

A typical sequence of management responses to exceedance of a Trigger Level is outlined below:

- Review recent sampling data to determine whether the exceedance is a random event or continuation of a trend (at least three consecutive anomalous readings).
- Review water quality data to determine if the exceedance is localised or widespread.
- Submit additional sample(s) to the laboratory to confirm the original results.
- Review recent mining activities and incidents to determine whether or not the exceedance is linked to mining operations.
- Evaluate the significance of the exceedance. This may require independent assessment of the data by a water quality specialist or hydrogeologist in the case of water levels.
- Undertake additional water and soil sampling to identify the source and extent of contamination.
- Provide reports of significant exceedances and subsequent investigations to appropriate stakeholders (Section 11).

- Plan and implement appropriate remediation or prevention strategies and improvements to ongoing water management measures.
- Continue monitoring to confirm the effectiveness of implemented remediation or prevention strategies and improvements.

Continued exceedance after implementation of appropriate remediation strategy will trigger site inspection/investigation by relevant Government Department to determine follow-up action to be taken by Mine.

9. RESPONSIBILITIES

9.1 GENERAL MANAGER

The General Manager is responsible for:

- Determine if mining needs to be modified to avoid impacts to Conservation Category Wetlands.
- Instigate measures to provide an alternative water source where it has been identified that the water quality or quantity of other groundwater users has been adversely affected by the mining operation.

9.2 MINING MANAGER

The Mining Manager is responsible for ensuring:

- Ensure that groundwater abstraction, mine dewatering and process water use volumes are routinely collected such that an annual site water balance can be prepared.
- Settling ponds are constructed to reduce turbidity to target trigger levels before release of water to the environment.
- Diversion drains are constructed prior to mining commencing in an area so that water re-enters natural drainage lines at a velocity and depth similar to the original channel to ensure minimum erosion potential.
- Appropriate engineering designs for all drainage diversions and water management infrastructure are prepared ahead of construction. Once constructed water management infrastructure comply with approved design drawings.
- Surface water diversions are designed such that runoff from Dieback infested areas does not enter Dieback free areas.
- Cause(s) of trigger level exceedance are investigated.
- Within the mine pit, where the pit floor will be within the minimum two metre groundwater separation zone, the screening plant and all transfer pumps are electrically powered.
- There is no storage of hydrocarbons on the floor of the mine pit.
- Self banded portable pumps or generators used to power water recovery pumps are located above the pit, on natural ground level where possible.
- Ensure drainage paths are restored to pre-mining conditions and landform restoration is undertaken in accordance with the RMP.
- Hydrocarbon storage areas and workshops are constructed near the primary processing plant in elevated locations.
- Hydrocarbon contaminated runoff is treated prior to discharge.
- Washdown is undertaken on hardstand areas, (either limestone roadbase or concrete) and directed to a triple interceptor or plate separator.

- A register of all hazardous materials on site is 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 are designed to comply with AS 1940:2004. Generally this will mean they are to be stored in either self bunded (double lined) bulk tanks or in bunded compounds.
- Hydrocarbon wastes generated by the operation are transported off-site to licensed waste disposal facilities.
- Hazardous materials are 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 is done off-site.
- Routine equipment and vehicle servicing activities including washdown are conducted on impermeable surfaces.
- Reviewing Annual Environmental Reports prior to submission.
- Preparation and submission of annual borefield/aquifer review as per DoW Licence conditions.
- Ensure that waste water treatment plant monitoring data is routinely submitted to the Health Department of Western Australia as per operating licence conditions.

9.3 HSEC ADVISOR

The HSEC Advisor is responsible for:

- In the event that the freeboard capacity of the Process Water Dam is likely to be exceeded, a discharge licence is obtained from DEC.
- In the case of unforeseen spillage from the Process Water Dam (extreme climatic conditions), initiate water quality monitoring at point of discharge and downstream creek sampling point. Notify DEC and DoW within 24 hours.
- Undertaking water and vegetation monitoring, collecting samples and sending samples for laboratory analysis.
- Establishing Photographic Monitoring Points.
- Ensure follow up actions and monitoring is undertaken after contaminant spills as required.
- Where monitoring results show trigger levels are exceeded, reporting this to the Site Manager.
- Ensuring the weather station is operational.
- Reviewing weather station data.
- Filing laboratory water analysis results.
- Reviewing laboratory results of water analysis.
- Reviewing, actioning and closing out complaints received.
- Preparing quarterly internal reports.
- Preparing the Annual Environmental Report.

10. RECORD KEEPING

Records relevant to this WMP are listed in Table 11.

Table 11: Water Management Records to be Kept at Keysbrook

Record	Responsibility
NATA Laboratory groundwater bore sample analysis.	HSEC Advisor
NATA Laboratory surface water sample analysis.	HSEC Advisor
Production bore flow meter readings.	HSEC Advisor
MZI Groundwater Bore Monitoring Record Sheets.	HSEC Advisor
MZI Surface Water Monitoring Record Sheets.	HSEC Advisor
WWTP water quality results	HSEC Advisor
Rainfall records.	HSEC Advisor
Annual Environmental Reports.	Site Manager
Aquifer Review Reports.	Site Manager
Accident/Incident reports and investigation reports.	Site Manager
Exceedance of Trigger Levels and Corrective Actions.	Site Manager
MZI Site Water Management Inspection Checklist.	HSEC Advisor
Quarterly internal reporting for Management.	HSEC Advisor

11. REVIEW AND REPORTING

The HSEC Advisor is responsible for ensuring that all monitoring results are reviewed within one week of receipt from the laboratory to ensure regulatory conditions or internal trigger values are not exceeded. Where exceedances are detected, the HSEC Advisor will inform the Site Manager who will then ensure an investigation report is prepared to determine the cause and actions implemented if remedial action is necessary. This will follow the procedure outlined in Section 8.5.

An annual review of the WMP will be conducted. The review will:

- Examine all monitoring results and determine if amendments to the location, frequency and parameters are required.
- Identify priority stormwater management issues.
- Propose improvements to address priority issues identified.
- Define an implementation schedule for the identified improvements.

MZI will ensure the following internal and external environmental reports are prepared and distributed to the appropriate parties:

- An internal quarterly monitoring report will be prepared by the HSEC Advisor and submitted to the Site Manager. The report will summarise environmental management, monitoring activities and interpretation of the quarter's monitoring results. The report will contain information on the current environmental performance of the site and status of compliance with approval conditions.
- An Annual Environmental Report (AER) detailing environmental management and monitoring activities will be prepared by the HSEC Advisor and reviewed by the Site Manager for distribution to DoW, OEPA, the Shire of Serpentine-Jarrahdale, Shire of Murray and DEC.

The following monitoring results will be reported in the AER:

- All groundwater monitoring bore and surface water quality results.
- All groundwater monitoring bore standing water levels.
- Production bore abstraction volumes.
- Records (dates) of surplus water discharge, if this occurs.
- Result of wetland standing water level monitoring.
- Results of vegetation monitoring.

Results will be reported graphically where possible, and a standard graph format presented each year to allow for ease of comparison.

- An annual monitoring summary detailing all water abstraction, diversion and use will be prepared by the HSEC Advisor and reviewed by the Site Manager for distribution to DoW.
- Monthly waste water treatment works effluent quality data to be submitted quarterly to the Health Department of Western Australia. Summary of data to be included in AER.

12. REFERENCES

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APPENDICES

**APPENDIX 1:
SITE WATER MONITORING SCHEDULE**

Site Water Monitoring Schedule				
	Weekly	Monthly	Quarterly	Annually
Operational Production Bores (KL2P & KL3P)				
Volumes		X		
Water Quality		Schedule A	Schedule B	
In-pit Sumps and Process Water Dam				
Volumes		X		
Water Quality		Schedule D	Schedule B Schedule C	
Production Monitoring Bores (KL2Obs & KL3Obs)				
Water Level	X (First 3 months)	X		
Water Quality		Schedule A		
Shallow Monitoring Bores (KS 1, 2, 3, 17, 21, 22)				
Water Level		X		
Water Quality		Schedule A		
Shallow Monitoring Bores (KS 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20)				
Water Level		X		
Water Quality		Schedule A	Schedule B Schedule C	
Wetland Monitoring Bores (KWT)				
Water Level	X (First 3 months)	X		
Water Quality		Schedule A	Schedule B	
Deep Monitoring Bores (KL)				
Water Level		X		
Water Quality		Schedule A	Schedule B	
DoW Monitoring Bores (T610, 670, 570, 620)				
Water Level			DoW Monthly SWL Data Review	
Water Quality				Schedule B
Surface Drainage Lines (SW 3, 4, 5, 6, 9 & 10)				
Water Quality		Schedule D & E During flow periods	Schedule B	

Vegetation health monitoring	
Wetland/GDE PMP1 – 09 & PMP12	Vegetation health monitoring programme in accordance with the Water Management Plan.
Remnant Vegetation Photographic Monitoring	Photographic Monitoring using Appendix 4.

Schedule A	Schedule B	Schedule C	Schedule D	Schedule E
Groundwater			Surface Water	
Field Based	Laboratory Based	Laboratory Based	Field Based	Laboratory Based
Standing Water Level pH Electrical Conductivity Total Dissolved Solids Temperature	pH Electrical Conductivity TDS Total Acidity Total Alkalinity Iron (Total and soluble) Manganese Major Ions (K, Ca, Na, Mg, HCO ₃ , Cl & SO ₄) Aluminium Hardness (CaCO ₃ equivalent)	Total Nitrogen, Nitrate Soluble Reactive Phosphate Total Phosphorus	pH Electrical Conductivity Total Dissolved Solids Temperature Turbidity	pH Electrical Conductivity Total Acidity Total Alkalinity TSS TDS Turbidity Total Phosphorus Nitrate Total Nitrogen

APPENDIX 2:
SITE WATER MANAGEMENT INSPECTION CHECKLIST

SITE WATER MANAGEMENT INSPECTION CHECKLIST

Name (Print): _____

Date: _____

Inspection Areas	Description	Status Satisfactory (✓) or Action Required
Workshop / Admin		
Washdown bay	Freeboard in sump and wedge pit.	
	Oil water separator functioning; no hydrocarbons in third chamber.	
Drainage sumps	Inflow clear.	
Process Plant		
Drainage sumps	Inflow clear.	
	Return pumps (if fitted) tested.	
HMC stockpile pad	Drainage lines to containment sumps clear.	
Water Dam		
Eastern bund wall	Dam wall intact. Discharge drainage lines clear.	
Haul Roads		
Roadside drains	Drainage lines clear.	
Sediment sumps	Inflow clear.	
	Outflow spillway intact.	
Mining Area		
Drainage	Installed and free of blockages. No erosion to sides of drains.	
Sumps	Installed and operating effectively.	
Rehabilitation/Backfilled Areas		
General	No evidence of erosion.	



**APPENDIX 3:
TRIGGER LEVELS AND CONTAMINANT LIMITS**

Trigger Levels for Water Quality Monitoring at Keysbrook

Parameter	Trigger Level	Contaminant Limits				
		DoW Lake Thompson Monitoring Bores	Drinking Water Trigger Values	SW Australia Lowland Freshwater Ecosystems ¹	Stock Trigger Values	Potential Acid Sulfate Soils ²
pH	Mean value plus (or minus) three standard deviations based on historical data.	7.3	6.5 - 8.5	6.5 - 8.0	6.5 - 8.5	
Electrical Conductivity			-	-	-	
Total Dissolved Solids		1,400	(500) mg/L		4,000 (cattle)	
Turbidity				15 ¹ NTU		
Total Acidity						18 mol H ⁺ /Tonne (0.03%) See ASSMP Section 6.5
Total Alkalinity						To be determined.
Total Actual Acidity (TAA)						>60 mg/L (as CaCO ₃) pH reducing trend >10 %
Iron (soluble)		28	(0.3) mg/L	-	none	
Manganese			0.5 mg/L	1.9 mg/L	none	
Chloride			(250) mg/L	-		
Sulfate			500 mg/L	-	1,000 mg/L	
Aluminum			0.2 mg/L	0.5 mg/L	5	
Hardness (CaCO ₃ equivalent)		280	(200) mg/L	-	none	
Nitrate	10% difference (if greater than 20 times the laboratory reporting limit).		50 mg/L	150 µg N L ⁻¹	400 mg/L	
Soluble reactive phosphate				65 µg P L ⁻¹		
Total nitrogen						
Total phosphorus						

1. Midrange of ANZECC 2000 default trigger value range of 10-20 NTU for Upland and Lowland rivers (Table 3.3.7).
2. Acid Sulfate Soil Management Plan.
- () aesthetic trigger value.



Trigger Drawdown Values for Vegetation Health and Conservation Category Wetlands

Parameter	Trigger Drawdown Values
SWL at Conservation Category Wetland	0.3 metres or more lower than pre-mining annual average water level.
Vegetation Health	1 tree or shrub death. 10% decline in cover of herbaceous species.

Trigger Drawdown Values for Groundwater Levels *

Parameter	Trigger Drawdown Values
GWL in regional Leederville aquifer monitoring bores	>3 metres – increased observations. >5 metres - investigate cause. >7 metres – activate remediation measures.
GWL in Leederville aquifer monitoring bores alongside production bores	>6 metres – increased observations. >8 metres - investigate cause. >10 metres – activate remediation measures.
GWL in regional Superficial aquifer monitoring bores	>0.8 metres – increased observations. >1.2 metres - investigate cause.
GWL in Superficial aquifer monitoring bores alongside production bores	>1.2 metres – increased observations. >1.5 metres - investigate cause.

**APPENDIX 4:
VEGETATION HEALTH ASSESSMENT FORM**

VEGETATION HEALTH ASSESSMENT

Name (Print): _____

Date: _____

Photographic Monitoring Point (PMP): _____

Photographs Taken: _____

Parameter	Description	Result
% Herbaceous Cover	What percentage of the ground is covered by native grasses and herbs	
% Weed Species	What percentage of the ground is covered by weed species	
Recent Plant Deaths	Are there any dead plants within the quadrat? If so, how many?	
Plant Stress	Are there any dead branches or areas evident on trees or shrubs? If so, how many plants are effected?	
Insects	Is there evidence of insect pests on the leaves of trees and shrubs? If so is this Minor, Moderate or Severe?	



APPENDIX 5: EMERGENCY DISCHARGE PROCEDURE

Keysbrook Mineral Sand Operation Emergency Discharge Procedure

1. Purpose

The purpose of this procedure is to define the actions required when emergency discharge of water to environmental surface water occurs at the Keysbrook Mineral Sand Operations.

2. Objectives

To minimise adverse environmental effects of discharges
To ensure correct reporting of discharges
To ensure adequate monitoring of discharges and response.

3. Responsibilities

Health Safety and Environment Manager

The Health, Safety and Environment Manager is responsible for ensuring the requirements of this procedure are met.

4. Definition

An emergency discharge is defined as any discharge to surface water that is not a licensed discharge under the site Environmental Licence or Works Approval.

Emergency discharge may be undertaken during inundation rainfall events for the purposes of asset protection and maintaining a safe work environment. Discharge may be by way of direct overflow of containment facilities or by facilitated pumping.

The licenced discharge of excess water from the process pond via the licensed discharge point and of treated sewage effluent to the designated effluent discharge area are not considered emergency discharges providing quality and quantities are within licensed limits.

Discharge of clean surface runoff intercepted by drains and diverted around operations is not considered emergency discharge.

5. Potential sources of discharge.

Potential sources of discharge are:

- Process water.
- Tailings decant water.
- Solar Pond decant water.

6. Actions to be taken in event of discharge.

6.1. Prevention and Reduction Measures

If an emergency discharge is identified as occurring or likely to occur, immediate action should be taken to prevent or minimise the discharge.

Actions taken will depend on the nature of the event but may include.

- Construction of temporary bunding or drains.

- Pumping water to the process circuit
- Shutting down pumps supplying the area discharging.

6.2. Recording.

If discharge occurs records should be kept of:

- Location of discharge.
- Time and duration of discharge event.
- Estimate of quantity discharge.
- Photographs of discharge.
- If the size and duration of the spill permit, opportunistic water samples should be taken of
 - Source of discharge
 - Receiving waters (upstream of discharge)
 - Receiving waters downstream of discharge.
- Water Samples should be analysed in accordance with Schedule C and Schedule D of the Water Monitoring Schedule (Appendix 1).

6.3 Reporting

Emergency discharges may trigger reporting requirements under *Section 72 of the Environmental Protection Act 1986*.

Discharges must be reported to DER as soon as practicable in accordance with the Waste Discharge or Pollutant Spill Reporting Guide.

<http://www.der.wa.gov.au/your-environment/reporting-pollution/111-duty-to-notify-discharges-of-waste>

Minor spills or discharges which are inconsequential in terms of pollution or environmental harm can be reported to the DER Industry Regulation Greater Swan Region Office.

Email: industry.regulation@der.wa.gov.au

Phone: 08 6467 5000,

Address: 181-205 Davy Street, Booragoon, Perth WA 6850

More serious spills or discharges must be reported to the DER in two stages.

- 1 **Verbal/electronic initial reporting.** Report to either the DER office as above or the Pollution watch line 1300 784 782.
- 2 **Written Formal Reporting.** Follow up written formal reporting by mail or fax is required to be done as soon as practical.
The report must contain the following details:
 - The time and the address of the premises on or from which the discharge occurred and a map of the premises showing the location of the discharge.
 - If the discharge of the waste was a result of the operation of equipment or otherwise, the name of the person operating the equipment or otherwise responsible for the discharge of the waste.

- The quantity of the waste discharged.
- Whether or not the discharge caused pollution and, if so, the nature and extent of the pollution.
- The action taken by the occupier of the premises to minimize the effect on the environment of the discharge of waste.
- Whether or not the waste involved in the discharge has been removed, dispersed, destroyed, disposed of or otherwise dealt with, and if so, the manner in which the waste was removed, dispersed, destroyed, disposed of or otherwise dealt with.

A form to assist with written reporting (Section 72 Waste Discharge Notification form) can be downloaded from the DER at <http://www.der.wa.gov.au/your-environment/reporting-pollution/111-duty-to-notify-discharges-of-waste>.

Weed and Dieback Management Plan

Keysbrook Mineral Sand Project Keysbrook, Western Australia

Prepared for:

Matilda Zircon Limited



January 2011

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**WEED AND DIEBACK MANAGEMENT PLAN
KEYSBROOK MINERAL SAND PROJECT
KEYSBROOK, WESTERN AUSTRALIA
JANUARY 2011**

PREPARED FOR

MATILDA ZIRCON LIMITED

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WEED AND DIEBACK MANAGEMENT PLAN

**KEYSBROOK MINERAL SAND PROJECT
KEYSBROOK, WESTERN AUSTRALIA**

JANUARY 2011

PREPARED FOR

MATILDA ZIRCON LIMITED



BY

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1. INTRODUCTION

Matilda Zircon Limited (Matilda Zircon) are planning to develop a mineral sand mine and primary processing plant within an area of rural land near the small townships of Keysbrook and North Dandalup (Figure 1).

The mining area of 1,354 hectares is located on privately owned land actively used for grazing. Of this, 1,174 hectares (87%) is open pasture with scattered trees and 180 hectares (13%) is remnant vegetation in good to a degraded condition of which 105 hectares will be cleared. Figure 2 shows the proposed mining area.

Patches of remnant native vegetation occur on upland sandy Bassendean dunes. Most of these patches are completely degraded by grazing activity with little, if any native understorey remaining. The vegetation comprises both of *Phytophthora cinnamomi* (Dieback) resistant species, such as *Corymbia calophylla* and Dieback susceptible species, such as *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata*.

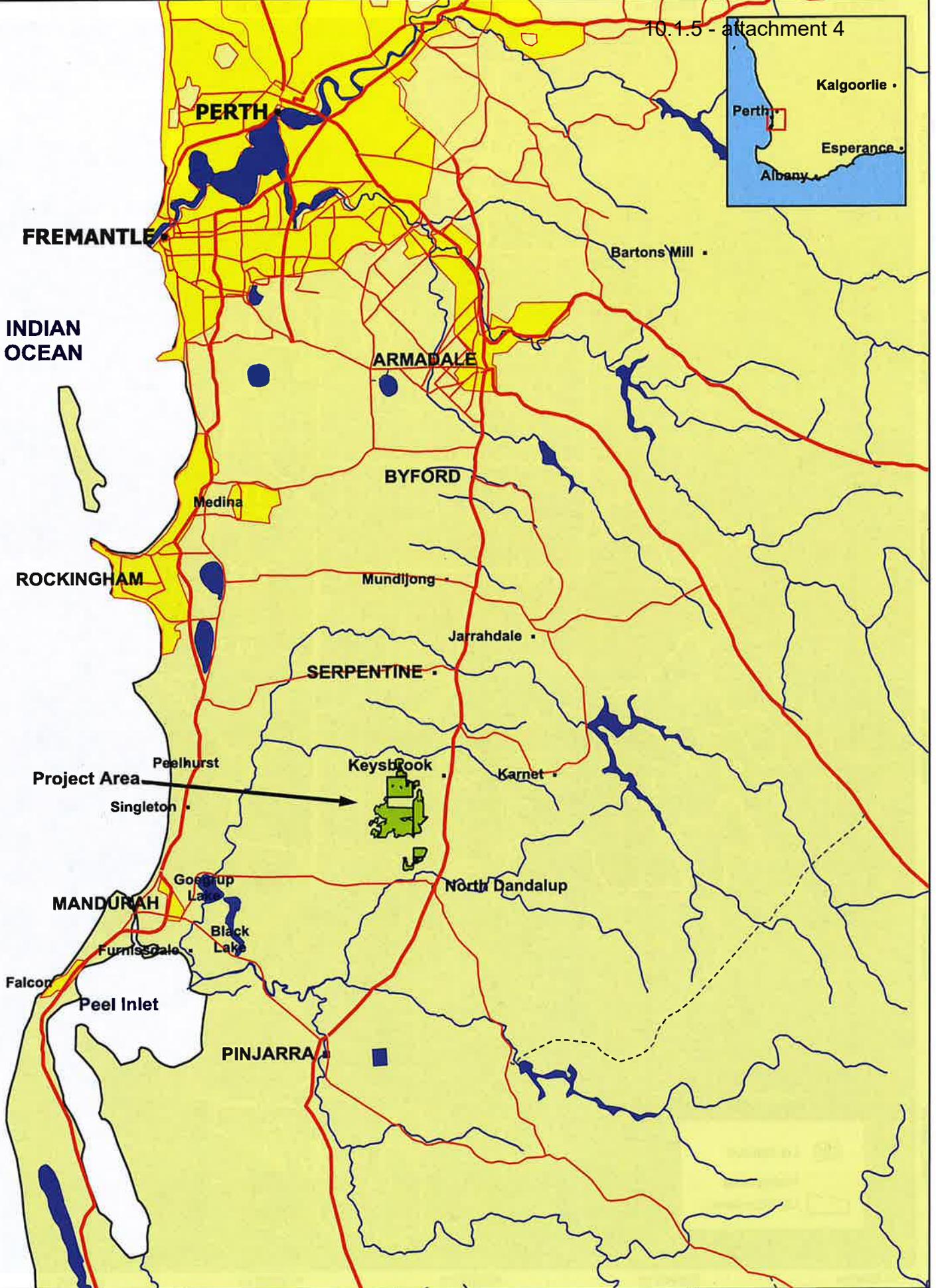
Drainage lines from the Darling Scarp flow through the mine area. These drain catchments are infected by Dieback, however as the low-lying land within the mine area is almost exclusively cleared and developed as pasture, no visible effect of Dieback is present in these areas. Any native vegetation in these low lying areas are species resistant to the disease.

The ore is hosted totally within the superficial (Bassendean sand) profile. The depth of the open pit will range from one to two metres in the flat sandplain locations and up to six metres in the undulating dunes.

The proposed mine has an expected operational life of up to eight years. The mineral sand resource will be progressively mined through a series of stages with no more than 30 hectares being actively mined at any one time. Each stage will be progressively rehabilitated once mining of that block is completed.

1.1 PURPOSE

This Weed and Dieback Management Plan (WDMP) has been prepared to comply with Ministerial Statement 810, Condition 9. It also addresses requirements relating to Conditions 6, 7 and 8. This Plan is applicable to all phases of the project, including planning, construction, operation and closure.

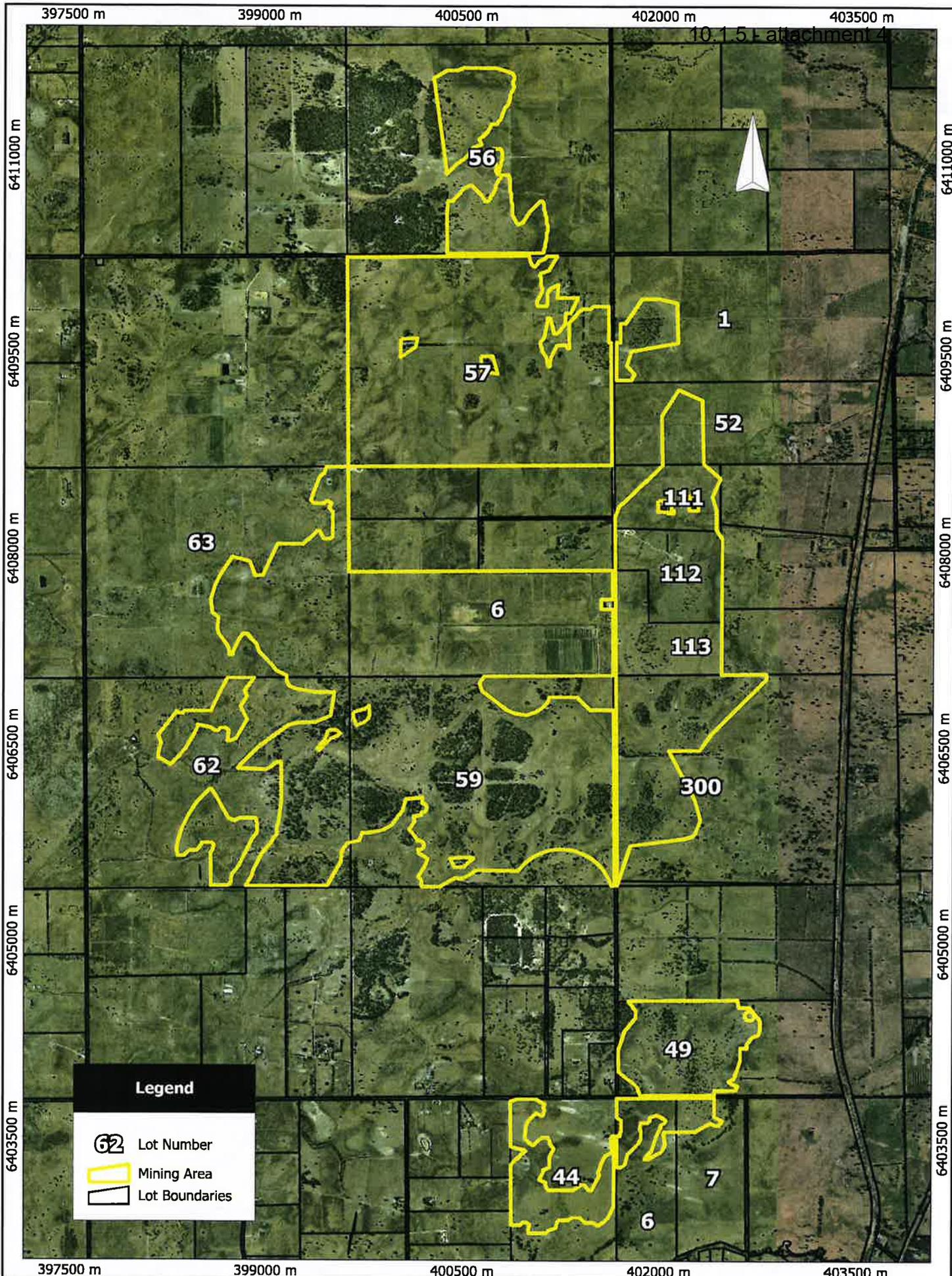


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Scale 1:400000
Original Size: A4
0 10 km

Matilda Zircon Limited
Keysbrook
Mineral Sands Project

Location Plan
Figure 1



Legend

- Lot Number
- Mining Area
- Lot Boundaries

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Scale: 1:38000
Original Size: A4
Air Photo Date: 2005
Grid: Australia MGA94 (50)

0 1000 m

Matilda Zircom Limited
Keysbrook
Mineral Sands Project

Mining Area

Figure 2

1.2 OBJECTIVES AND TARGETS

The objectives and targets of this WDMP are outlined in Table 1.

Table 1: Weed and Dieback Management Objectives and Targets

Objectives	Target
Weed Management	
Prevent introduction of new weed species and/or spread of existing weed species as a result of mining.	No new weeds species or infestations as a result of mining practices.
Control of weeds to ensure the protection of remnant vegetation and vegetation within twenty metres of the banks of watercourses or within 100 meters of the boundary of the conservation category wetland.	No new weeds species or infestations in remnant vegetation or watercourse/wetland vegetation as a result of mining practices.
Weeds in newly disturbed areas will be controlled as rehabilitation behind mining progresses.	6 months after rehabilitation, less than 10% weed species in rehabilitated areas.
Dieback Management	
Prevent spread of Dieback from Dieback Infected areas to Dieback Free Areas as a result of mining activities.	No spread of Dieback within the mine areas as a result of mining.
Identify and implement measures to limit Dieback through the movement of topsoil.	Topsoil from Dieback infected areas not utilised in rehabilitation of Dieback free areas.
Identify and implement measures to protect Dieback free topsoil from contamination.	All topsoil from Dieback free areas stockpiled separately to topsoil from Dieback infected areas. All topsoil stockpiles signposted correctly.
Include awareness training into site induction and training programs.	100% inclusion of all site personnel in induction programs.

1.3 RELATIONSHIP TO OTHER MANAGEMENT PLANS

This WDMP has elements in common with the Rehabilitation Management Plan and Water Management Plan. Weed management is a crucial factor in the success or otherwise of rehabilitation while movement of topsoil, translocation of flora and species selection for rehabilitation must be undertaken with Dieback management in mind. The potential for Dieback to be spread through water movement also needs to be addressed as part of landform design and site water management.

2. LEGISLATIVE AND POLICY CONTEXT

2.1 LEGISLATIVE AND REGULATORY REQUIREMENTS

The Keysbrook Mineral Sand Projects is subject to the following legislation and regulations relating to weeds and Dieback:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Environmental Protection Act 1986 Western Australia* (EPA Act).
- *Agriculture and Related Resources Protection (ARRP) Act 1976* (Part V _Control of Declared plants. Division 4 49 refers to occupiers of private land and control of declared plants and animals) (ARRP Act).
- *Local Government Act 1996*.

The relevance of legislation and regulations in the context of this management plan are briefly described.

2.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

Under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, any activity that may have a significant impact on matters of national environmental significance must be approved by the Department of the Environment, Water, Heritage and the Arts (DEWHA). Controlling provisions for the Keysbrook Mineral Sand Project were deemed to be wetlands of international importance (Section 16 and 17B) and listed threatened species and communities (Section 18 & 18A).

On 16 February 2010, DEWHA granted conditional approval of the Keysbrook Mineral Sand Mine.

2.1.2 *Environmental Protection Act 1986 Western Australia (EP Act)*

Under the *Environmental Protection Act 1986 Western Australia (EP Act)*, the Department of Environmental and Conservation (DEC) can give notice, orders and or directions in respect to protection of the environment and native vegetation.

Section 38(1) of the *EP Act* provides that where a development proposal could have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the Act.

Conditional approval for the project was given by the Minister on 19 October 2009 under Ministerial Statement 810. Conditions in the statement relevant to this plan include Conditions 6, 7, 8 and 9.

2.1.3 *Agriculture and Related Resources Protection Act 1976 (ARRP Act)*

The Department of Agriculture and Food is responsible for overseeing the *ARRP Act* requiring management of Declared Plants in Western Australia. The *ARRP Act* lists gazetted Declared Plants that require control in Western Australia.

No Declared Plant species listed under the *ARRP Act* were identified during the flora survey conducted by Bennett Consulting in 2004 and updated in 2006.

2.1.4 *Local Government Act 1996*

The *Local Government Act 1996* allows a local authority to declare plants as “pest plants” which requiring control on all lands within the local authority boundary. This legislation is used for environmental weeds.

There are no weeds declared under this Act for the Shire of Murray. A number of weed species have been declared under this Act by the Shire of Serpentine Jarrahdale as detailed in Council Policy E204 – Control of Weeds.

2.2 ENVIRONMENTAL POLICY AND MANAGEMENT STRATEGY

The following publications provide additional information on weed and Dieback management:

- Commonwealth National Weeds Strategy.
- Weed Plan for Western Australia prepared by the State Weed Plan Steering Group 2001.
- Western Australia Environmental Weed Strategy 1999 (WAWS).
- Dieback Working Group Guidelines for Local Government.

3. EXISTING ENVIRONMENT

3.1 REGIONAL SETTING

The project 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 1,354 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.

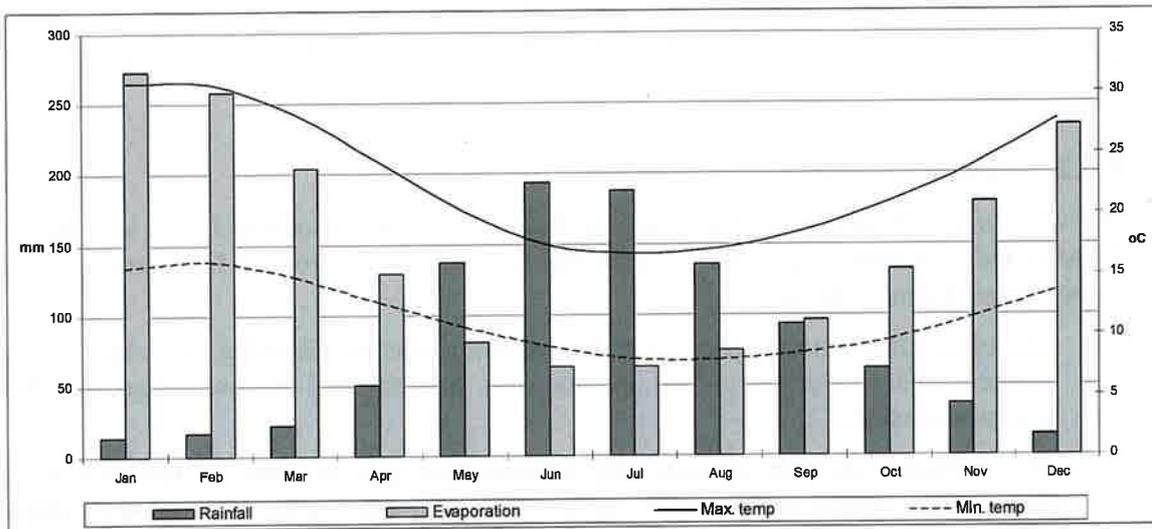
3.2 CLIMATE

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).

Average maximum and minimum temperatures at Keysbrook range from 30.6 degrees Celsius to 15.2 degrees Celsius (Australian Meteorology, 2010). The warmest months are December to February with rainfall peaking during the winter months of June to August.

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 two to one.

Chart 1: Wokalup Climate Data



3.3 LAND SYSTEMS

The Keysbrook project area is situated across three Land Systems. The Bassendean Land System consists of low dunes of leached siliceous sand interspersed with sand flats and seasonal swamps. This Land System is the main source of the heavy mineral sands. The majority of the project area lies within this Land System and all remnant vegetation related to the project occurs within the Bassendean Land System.

The Southern River Land System consists of sand plain with low dunes and many intervening wetlands. The soils of this Land System are similar to those of the Bassendean Land System. In the vicinity of swamps the soils of the Southern River Land System has iron and humus podzols, peats and clays deposited.

The Guildford Land System (also referred to as the Pinjarra Plain) is characterised by flat plains with medium textured deposits and yellow duplex soils.

3.4 SOILS

The heavy mineral resource is hosted within the dunes of the Bassendean Sand, which partly covers mottled clayey sand or a pisolitic ironstone-clay unit of the Guildford Formation, also referred to as the Pinjarra Plain.

3.4.1 Bassendean Dunes

The dominant soil parent materials within the Bassendean system are highly leached quartzose sands containing potentially economic heavy mineral mineralisation. The most easterly dunes are well defined in the landscape, are higher, up to six metres above the plain level. 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. Soils in the eastern part of the area are more severely leached than those to the west. The mine is within the eastern part of the unit.

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 (MBS, 2006).

3.4.2 Pinjarra Plain

The soils of the Pinjarra Plain have largely formed from unconsolidated alluvial material of Tertiary and Quaternary 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.

3.5 VEGETATION OF THE PROJECT AREA

Some 1,174 hectares (87.0%) of the mine area is open pasture with scattered trees and 180 hectares (13%) is remnant vegetation in varying condition. In accordance with Ministerial Statement 810, 75 hectares of remnant native vegetation within the project area will be retained and protected in perpetuity. A total of 105 hectares of native vegetation in varying condition will be cleared.

Nine vegetation units have been mapped across the project area. One vegetation unit within the project area was inferred to be a potential Threatened Ecological Community (TEC), correlating to Swan Coastal Plain Floristic Community Types (FCT)3a. The area FCT3a is less than 0.25 hectares in size and although there were several *Corymbia calophylla* plants, there were very few *Kingia australis*. The vegetation condition of FCT3a is completely degraded and is therefore not considered worthy of conservation (Bennett Environmental Consulting Pty Ltd 2006).

4. WEED MANAGEMENT

4.1 DEFINITIONS OF WEEDS

An **Environmental Weed** is an introduced plant that is established in a natural ecosystem and adversely modifies natural processes, resulting in decline of invaded communities (EPA, 2009).

A **Declared Plant** is a plant that impacts on individual people, agricultural production and the community. These are plants declared under *ARRP Act* and all landholders are obliged to control these on their properties according to the rankings and information provided by the Department of Agriculture and Food. No declared Plants have been recorded from the project area.

4.2 MANAGEMENT CLASSIFICATION OF WEEDS SPECIES

A total of 34 weeds species were recorded from the site by Bennett Consulting (2004, revised 2006). Weeds recorded were rated according to three criteria defined in the Environmental Weed Strategy for Western Australia (1999) and are shown in Table 2.

Weed species rated High will be prioritised for control. In addition, *Rumex crispus* (Curled Dock) will also be prioritised. The 29 species rated Moderate or Low will be included into the general rehabilitation monitoring program.

Table 2: Weeds Recorded in the Project Area and Classification According to the Environmental Weed Strategy for Western Australia (1999) (DEC)

Scientific Name	Common Name	DEC Rating	Invasiveness	Impacts
Environmental Weeds				
<i>Bromus diandrus</i>	Great brome	High	✓	✓
<i>Ehrharta calycina</i>	Perennial veldt grass	High	✓	✓
<i>Leptospermum laevigatum</i>	Victorian teatree	High	✓	✓
<i>Romulea rosea</i>	Guildford grass	High	✓	✓
Weeds				
<i>Aira carophyllea</i>	Silvery hairgrass	Moderate	✓	
<i>Aira cupaniana</i>	Hairgrass	Moderate	✓	
<i>Artotheca calendula</i>	Cape weed	Moderate	✓	
<i>Avena barbata</i>	Bearded oat	Moderate	✓	
<i>Briza maxima</i>	Blowfly grass	Moderate	✓	
<i>Briza minor</i>	Shivery grass	Moderate	✓	
<i>Callitriche stagnalis</i>	Common starwort	Moderate	✓	
<i>Carduus pycnocephalus</i>	Slender thistle	Moderate	✓	
<i>Cynodon dactylon</i>	Slender thistle	Moderate	✓	
<i>Cyperus tenellus</i>	Tiny flat sedge	Moderate	✓	

Scientific Name	Common Name	DEC Rating	Invasiveness	Impacts
<i>Disa bracteata</i>	South African orchid	Moderate	✓	
<i>Ehrharta longiflora</i>	Annual veldt grass	Moderate	✓	
<i>Hordeum leporinum</i>	Barley grass	Moderate	✓	
<i>Hypochaeris glabra</i>	Flat weed	Moderate	✓	
<i>Juncus bufonius</i>	Toad Rush	Moderate	✓	
<i>Juncus capitatus</i>		Moderate	✓	
<i>Lolium rigidum</i>	Annual ryegrass	Moderate	✓	
<i>Orobanche minor</i>	Lesser broom rape	Moderate	✓	
<i>Parentucellia latifolia</i>	Red Bartsia	Moderate	✓	
<i>Solanum nigrum</i>	Black berry nightshade	Moderate	✓	
<i>Trifolium campestre</i>	Hop clover	Moderate	✓	
<i>Ursinia anthemoides</i>	Ursinia	Moderate	✓	
<i>Vulpia bromoides</i>	Squirrels tail fescue	Moderate	✓	
<i>Vulpia myuros</i>	Silvery grass	Moderate	✓	
<i>Rumex crispus</i>	Curled dock	Mild		
<i>Aira praecox</i>	Early hairgrass	Low		
<i>Bromus hordeaceus</i>	Soft brome	Low		
<i>Lotus suaveolens</i>	Hairy birdsfoot trefoil	Low		
<i>Ornithopus pinnatus</i>	Slender seradella	Low		
<i>Trifolium hirtum</i>	Rose clover	Low		

Sourced: Bennett Consulting (2004).

4.3 POTENTIAL ENVIRONMENTAL IMPACTS

The following issues could potentially arise from mining and processing operations in the absence of mitigation and management measures:

- Introduction of new weed species to the project area.
- Spread of weeds via heavy plant, vehicles and equipment within and between properties.
- Increase in existing weed infestations through disturbance caused by clearing of native vegetation and soil disturbance.
- Compromised resilience of natural revegetation processes after mining due to weed infestation.
- Limiting of topsoil resources due to proliferation of weed species in topsoil seed banks.

4.4 MANAGEMENT MITIGATION MEASURES

During the life of the project all plant, heavy machinery and vehicles arriving on site will be required to be certified clean and free of soil and vegetative matter (Appendix 1). The Environmental Officer is responsible for ensuring all plant, heavy machinery and vehicles arriving on site are inspected and issued with a sticker to certify the item is clean. The sticker

is to have the date of inspection written on it, be signed by the Environmental Officer and placed in a prominent position on the item.

4.4.1 Prior to Topsoil Stripping Activities

Weed management will be required ahead of mining. The purpose of weed management in the pre-mining phase is to limit the volume of weed seeds present in topsoil. The Environmental Officer will liaise with the Site Manager during spring (in conjunction with requirements in the Rehabilitation Management Plan) to determine areas that will be mined in the coming 12 month period. It is then the responsibility of the Environmental Officer to schedule weed surveys of these areas at least three months prior to ground disturbing activities commencing.

In areas where weeds have been identified, the Environmental Officer will ensure the following is undertaken:

- Pre-clearing treatment with “knockdown” herbicide 6 to 12 weeks prior to clearing. The Environmental Officer is responsible for determining whether large scale application of herbicides is appropriate or targeted treatment should be undertaken.
- Post treatment visual inspections to evaluate results and ensure success of herbicide treatment(s).
- Follow up treatments where initial treatment has not been at least 90% successful.
- Completing records detailing the area treated, date of treatment, type of treatment and results.

4.4.2 During Topsoil Stripping

During topsoil stripping activities, plant, machinery and vehicles travelling from weed infested areas will be required to clean down before entering weed free areas. The Environmental Officer will ensure Clean on Entry (CoE) points are established as required and are equipped with log books and the appropriate cleaning equipment. Detailed information on CoE points is provided in Section 4.5.

Where topsoil stockpiles are created, the Site Manager will ensure their height is limited to two metres. The Environmental Officer will inspect topsoil stockpiles as part of regular site inspections to determine if weeds are germinating from the soil seed bank. Where weeds are growing, the Environmental Officer will ensure spot treatment of the topsoil stockpiles is undertaken with an appropriate herbicide.

4.4.3 During Mining

Weed management during mining will focus on weed hygiene procedures and the localised treatment of weeds in operational areas as required.

The Environmental Officer will undertake inspections if the Primary Processing site, production and monitoring bore locations on a monthly basis. Topsoil stockpiles will be inspected on a quarterly basis.

Clean on Entry points will be inspected on a weekly basis when they are in operation to ensure:

- Employees and contractors are using these facilities correctly.
- Adequate numbers of log sheets are available to be completed and collect completed log sheets.
- Assess the effectiveness of CoE points.

If weeds are evident in any inspected areas, the Environmental Officer is responsible for ensuring that these areas are treated with an appropriate herbicide and follow-up monitoring is implemented.

4.4.4 Rehabilitation

Monitoring of weeds in rehabilitation areas is incorporated into the general rehabilitation monitoring program conducted according to the rehabilitation monitoring procedure. Where weeds are identified, the Environmental Officer is responsible for ensuring occurrences are treated with an appropriate herbicide and implementing follow up monitoring.

Weed management post mining will continue until rehabilitated areas are resilient to weed infestation. This is expected to occur with 18 to 24 months after rehabilitation.

4.5 CLEAN ON ENTRY POINTS

CoE points will be established where vehicles and equipment moves from areas known to contain weeds to weed free areas. Where CoE points are required for weed management and hygiene only these points can be removed once topsoil removal activities have been completed. As discussed in Section 5.3.2, CoE points for dieback management and hygiene are required to be in operation for all phases of mining.

The Environmental Officer is responsible for establishing CoE points and ensuring the appropriate equipment is provided. Clean down will involve one of the three following methods depending upon site conditions:

- Washdown – during wet soil conditions only. Inspection of each vehicle/machine traversing the CoE point. Wash to ensure vehicles are free of vegetative matter and mud.
- Blowdown – during dry soil conditions. Inspection of each vehicle/machine traversing the CoE point. Blow off dust, soil and vegetative matter.
- Manual removal – during dry soil conditions. Brushes and buckets for manual removal of dust on vehicles machinery at CoE point.

The Environmental Officer will ensure CoE points are established such that washdown water, mud, soil and vegetative mater is not allowed to travel into weed free areas. Criteria necessary for effective CoE points include:

- A well drained surface to enable effluent / waste material from the clean down process to remain separate from the object being cleaned.

- Easy disposal of water or waste to prevent spread of the disease. This may include construction of bunds and/or a sump and placement of bins to contain vegetative material and soil/mud for later disposal into suitable landfill facility.
- Clear signage to identify the purpose of the CoE point:
 - CoE – WEEDS.
 - CoE – DIEBACK.
 - CoE – WEEDS & DIEBACK.

4.6 HERBICIDES

Weed eradication and control procedures can be obtained from the Department of Agriculture and Food (DAFWA), Western Australia. Contact details are available in Appendix 2.

Where herbicide application is undertaken by contractors, the Environmental Officer will ensure contractors are appropriately licensed and accredited.

A general guide to weed management for weed species rated as High has been included in Appendix 2. Management trends and herbicide use change over time and require continual updating. The Environmental Officer is responsible for remaining up to date with current best practice herbicide applications methods.

In areas where run-off from rain events is likely to enter watercourses or wetlands, the Environmental Officer will ensure that the appropriate herbicides are used to avoid adverse impacts on these areas.

The Environmental Officer will ensure appropriate safety measures are undertaken when handling herbicides including:

- Read and adhere to instructions on the product label.
- Wear appropriate personal protective equipment as detailed on the product label.
- Ensure rates of application and rates of concentration are applied. Do not dilute or over concentrate.
- Avoid spraying with herbicides during conditions of extreme heat, high winds, before or immediately after rainfall.
- Adhere to the recommended methods of application for herbicides. A guide to techniques used for different methods of application of herbicides is provided in Appendix 3.
- Limit any drifting of herbicides onto adjacent areas.

4.7 WEED MONITORING

Table 3 outlines the monitoring schedule and actions required in relation to weed management within the project area.

Table 3: Weed Monitoring Requirements

Description	Responsibility
Pre-mining	
Pre-mining site assessment, three months ahead of mining to identify target weeds species present and the extent of these.	Environmental Officer
Post treatment follow-up within 6-12 weeks of initial treatment during the pre-mining phase.	Environmental Officer
Records of treatment in weed management register, photographic records.	Environmental Officer
Hygiene	
Weekly inspections of all CoE points.	Environmental Officer
Monthly inspections of operational areas, bores, roads, wash down bays.	Environmental Officer
All vehicles, heavy machinery and equipment entering site must be inspected and issued with a Hygiene Certification Sticker.	Environmental Officer
Rehabilitation	
Quarterly inspection of topsoil stockpiles.	Environmental Officer
Assessment of weed presence in line with the Rehabilitation Monitoring Procedure.	Environmental Officer
Treatment of weed occurrences.	Environmental Officer
Post-treatment follow up inspections 6 weeks after herbicide treatment.	Environmental Officer

Monitoring will focus on the general area and the end land use objectives.

General monitoring criteria for weed management will include:

- Absence of Declared Plants and environmental weeds on rehabilitated sites or within operational areas.
- Species present in pre-mining phase.
- Species in rehabilitation areas.
- Weeds around CoE points and mining area.

Where weeds are present, the Weed Management Register (Appendix 4) will be completed by the Environmental Officer. A copy of the form to be completed during site inspections for weeds can be found in Appendix 5.

Monitoring and review of weed management strategies will be ongoing to ensure the Weed Management Plan is effective and progressively developed through the pre-mining, operational and post mining phases.

5. DIEBACK MANAGEMENT

Dieback is a plant pathogen that attacks the root system causing root rot. Spread of the pathogen occurs through movement of the pathogen along root systems and in water via microscopic fungal spores in surface and subsurface flows, by animals and any activity that transfers soil or plant material from one location is also a potential vector. Humans are the most effective vectors, responsible for the fastest and most widespread infestations (Commonwealth, 2009).

The presence of Dieback is deduced from the death of susceptible plants. Commonly used indicator plants include Jarrah, *Banksia*, Grasstrees (*Xanthorrhoea*), *Zamia Palm*, *Hibbertia*, and *Hakea*. Other factors that could have caused plant death (e.g. fire, insects, flooding, drought, chemicals, other pathogens etc) must also be discounted.

5.1 CURRENT STATUS OF DIEBACK IN THE PROJECT AREA

A preliminary survey and sampling program was undertaken on 30 January 2006 investigating native remnant vegetation fragments that exhibited symptoms of Dieback. Soil and root samples were taken in the vicinity of the root zone of deceased *Banksia*. The samples were analysed for the presence of Dieback by DEC's Vegetation Health Services. Results confirmed that Dieback is present in some upland sites. Locations of the sample sites confirming the presence of Dieback in the Project area is presented in Figure 3.

Dieback risk areas are:

- Areas around sampling sites on Lots 57 and 59 identified during preliminary investigations (Section 5.1) as Dieback infected (Figure 3).
- Seventy-five hectares of remnant vegetation identified for conservation in perpetuity.
- Defined buffer areas along watercourses and adjacent wetlands.
- Drainages associated with roads and surface water runoff from mine site infrastructure.
- Un-interpretable areas. Those areas that are sufficiently disturbed so that Dieback mapping can not be undertaken due to the lack of indicator species. Pasture areas, which occur across most of the project area, are un-interpretable. Presence of Dieback in these areas is possible and as such, these areas should be treated as if they are Dieback infected.

5.2 POTENTIAL ENVIRONMENTAL IMPACTS

Mining of mineral sands at Keysbrook has the potential to spread Dieback via:

- Clearing of vegetation and subsequent movement of soil and vegetation.
- Transplanting of vegetation for rehabilitation.
- Movement of soil on equipment and vehicles.
- Movement of infected soils via water erosion to Dieback Free areas.

5.3 MANAGEMENT MITIGATION MEASURES

5.3.1 Site Assessment and Area Categories for Dieback Management

Due to natural processes the extent of Dieback across the project area will have increased since samples were taken in 2006. Further investigation is required for each mining cell prior to ground disturbing activities.

The presence and extent of Dieback requires assessment of the mining area and influencing adjacent areas by an Accredited Dieback Assessor. The Environmental Officer is responsible for ensuring an Accredited Dieback Assessor is engaged to survey mining cells prior to ground disturbing activities occurring. Areas will be mapped according to the following categories:

- Dieback Infected Areas – areas that have been determined to have Dieback.
- Dieback Free Areas – areas that have been confirmed not to have Dieback.
- Un-interpretable Areas – degraded areas where a lack of indicator species presence makes it impossible to determine presence or absence of the disease.

Areas will be signposted by the Environmental Officer using Western Australian Standard Dieback Signage System. A copy of the Standard Dieback Signage Protocol is provided in Appendix 6. Maps of the project area will be maintained by the Environmental Officer to show the results of Dieback assessments, locations and categories of topsoil and vegetation and the Dieback status of each mining cell.

5.3.2 Access Management

Only mining equipment and authorised vehicles will be permitted to travel beyond the primary processing area. All other vehicles including delivery trucks and private vehicles will be required to report directly to the site office at the primary processing area. A single access road will link this area with the South Western Highway.

All vehicles and equipment that are authorised to proceed beyond the primary processing area are required to be inspected by the Environmental Officer and issued with a sticker to certify the item is clean of soil and vegetative matter. The sticker is to have the date of inspection written on it, be signed by the Environmental Officer and placed in a prominent position on the item.

Access roads in Dieback infected or uninterpretable areas will include a layer of limestone to limit the risk of spread of Dieback along these roads. The Site Manager will liaise with the Environmental Officer to determine where limestone is required. All materials for road construction will be sourced from Dieback free areas.

Outside of the site access roads, mining equipment and vehicles will be required pass through Clean on Entry (CoE) points and be free of vegetative matter and soil when leaving areas identified as being Dieback infected or uninterpretable. CoE points will be required during all phases of mining. The Environmental Officer is responsible for ensuring CoE points are established and stocked with the appropriate cleaning equipment and log books. The Environmental Officer will also ensure all Dieback CoE points are sign posted correctly (e.g. CoE – DIEBACK).

The Environmental Officer will prepare materials for and attend Toolbox and pre-start meetings to ensure employees and contractors are aware of CoE requirements and the need for Dieback hygiene.

5.3.3 Topsoil Management

Topsoil salvage requires planning ahead of mining to ensure that the spread of Dieback in topsoil is limited. The Site Manager will ensure:

- Topsoil from Dieback Infected areas is stockpiled separately, away from topsoil from Dieback Free areas.
- Topsoil from Dieback Free areas will not come into contact with surface water runoff from Dieback Infected materials.
- Topsoil is respread during rehabilitation according to its Dieback status. Topsoil potentially infected with the disease will not be used in Dieback Free areas.
- Where practicable, topsoil is respread at the same location from which it was removed.

The Environmental Officer shall ensure topsoil stockpiles are signposted as described in Section 5.3.1.

5.4 DIEBACK ASSESSMENT

The Environmental Officer will ensure that annual assessments are undertaken to confirm the Dieback status of each mining and rehabilitation each area.

Areas requiring annual assessment outside of staged mining areas include:

- Seventy-five hectares of remnant vegetation identified for conservation in perpetuity.
- Defined buffer areas along watercourses and adjacent to wetlands.
- The edges of known or suspected Dieback infected areas to determine the extent of spread (if any).

6. RESPONSIBILITIES

6.1 GENERAL MANAGER

The General Manager is responsible for ensuring any non-compliance are reported to the CEO of the Office of the Environmental Protection Authority (OEPA) within two business days of the non-compliance being known.

6.2 SITE MANAGER

The Site Manager is responsible for:

- Liaising with the Environmental Officer every Spring to determine areas to be mined in the coming 12 month period such that weed and Dieback assessments can be completed.
- Limiting the height of topsoil stockpiles to two metres or less.
- Liaising with the Environmental Officer to determine where limestone is required in road construction to limit the risk of Dieback spread along site access roads.
- Ensuring topsoil from Dieback infected areas is stockpiled separately, away from topsoil from Dieback Free areas.
- Topsoil is respread during rehabilitation according to its Dieback status. Topsoil potentially infected with the disease will not be used in Dieback Free areas.
- Where practicable, topsoil is respread at the same location from which it was removed.

6.3 ENVIRONMENTAL OFFICER

The Environmental Officer is responsible for:

- Ensure all plant, heavy machinery and vehicles arriving on site are inspected and issued with a sticker to certify the item is clean. The sticker is to have the date of inspection written on it, be signed by the Environmental Officer and placed in a prominent position on the item.
- Liaising with the Site Manager during Spring (in conjunction with requirements in the Rehabilitation Management Plan) to determine areas that will be mined in the coming 12 month period such that weed and Dieback assessments can be completed.
- Scheduling weed surveys of areas at least three months prior to ground disturbing activities commencing.
- Scheduling Dieback Assessments prior to ground disturbing activities.
- Establish CoE points and ensure they are appropriately equipped and maintained.
- Conducting quarterly assessments of topsoil stockpiles to assess/treat weed growth.
- Conduct monthly weed inspections of operational areas and treat any identified problem areas.
- Remaining up to date with current herbicide regulations and best practice.

- Identifying appropriate herbicides for use dependant upon specific conditions at each treatment location.
- Ensuring appropriate safety measures are undertaken when handling herbicides including:
 - Read and adhere to instructions on the product label.
 - Wear appropriate personal protective equipment as detailed on the product label.
 - Ensure rates of application and rates of concentration are applied. Do not dilute or over concentrate.
 - Avoid spraying with herbicides during conditions of extreme heat, high winds, before or immediately after rainfall.
 - Limit any drifting of herbicides onto adjacent areas.
- Ensuring topsoil stockpiles, CoE points and Dieback areas are appropriately signed.
- Ensuring accurate maps are maintained of Dieback occurrence across the project area.
- Liaising with the Site Manager to advise where limestone is required in road construction to limit the risk of Dieback spread along site access roads
- Attend Toolbox and pre-start meetings to ensure employees and contractors are aware of CoE requirements and the need for dieback hygiene.

7. AUDITING, REPORTING AND REVIEW

This WDMP will undergo an internal audit to ensure compliance with this plan and assess the effectiveness of management measures contained within the plan. The Environmental Officer is responsible for ensuring this audit is undertaken on an annual basis.

The Environmental Officer is responsible for internal monthly reporting of results of all monitoring and assessments under this Plan. This information will also be included in the Annual Environmental Report submitted to DEC.

The Environmental Officer is responsible for reporting any non-compliance with this Plan to the General Manager. The General Manager is responsible for ensuring any non-compliance are reported to the CEO of the Office of the Environmental Protection Authority (OEPA) within two business days of the non-compliance being known.

This WDMP will be reviewed on an annual basis and as directed by the CEO of OEPA to ensure it remains current. Results of monitoring and internal audits will be taken into account during the review process.

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 KEYSBROOK MINERAL SANDS PROJECT
 KEYSBROOK, WESTERN AUSTRALIA
 JANUARY 2011

PROJECT CODE: MATWEE

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APPENDICES

**APPENDIX 1:
KEYSBROOK MINERAL SANDS PROJECT MACHINERY AND
VEHICLE INSPECTION HYGIENE CERTIFICATE**

**MATILDA ZIRCON MACHINERY AND VEHICLE HYGIENE
CERTIFICATE CHECKLIST**

It is important that all earthmoving machinery, vehicles and equipment are in an acceptable condition before entering the Keysbrook Mineral Sands Project area in relation to weeds and Dieback..

This inspection must be completed upon entry to the site and submitted to the Environmental Officer. A sticker confirming this inspection has been passed will be issued.

Date of inspection:

Company requesting equipment import to Frances Creek:

Name of person conducting inspection:

What kind of vehicle / machine /equipment is it?

Serial or registration No of equipment/machine:

Was the vehicle / machine cleaned before it left the last site? Yes No

Are buckets, tracks, blades, grills, utility tray-back free of soil and vegetation? Yes No

Are the tyres free of vegetation and soil? Yes No

Work required/comments:

If you have answered **NO** to any of these questions, please carry out the required cleaning and/or maintenance before the machine is transported onto Keysbrook Mineral Sand Project. Entry of the machinery will not be permitted until evidence of cleaning can be provided. No machines may enter site until authorised by the Environmental Officer.

Based on inspection of the specified equipment/machinery, I confirm the item is free of vegetative and soil material and is suitable for entry into the Keysbrook Project area.

Signed:

Name:

Position:

Date:

KEYSBROOK MINERAL SANDS PROJECT USE ONLY

Evidence of cleaning provided is satisfactory and the equipment is suitable for entry to Frances Creek.

Signed:

Position:

Date: _____



**APPENDIX 2:
WEED INFORMATION AND ERADICATION PROCEDURES**

Weed information and eradication procedures can be gained from consultation with:

Department of Food and Agriculture (DAFWA), Western Australia

Senior Research Officer: John Moore

Phone: (08) 989 28 444 or E mail: jmoore@agric.wa.gov.au

Weed Control Procedures for Targeted Environmental Weeds

Weed Species	Description	Eradication
<i>Bromus diandrus</i>	Not a Declared Weed A tufted annual grass to 90 cm tall with soft, hairy, flat, loosely folded. The inflorescence is an erect or drooping panicle to 15 to 25 cm long. Flowers in spring leaves with branched inflorescences that are 2-12 centimetres long and usually prominently long awned spikelets.	500 ml glyphosate (450g/l) applied when grass in very young or flowering is fairly selective amongst native vegetation, cheap and effective (DAFWA Bulletin 4744)
<i>Ehrharta calycina</i> Perennial Veldt Grass	Not a Declared Weed Serpentine – Jarrahdale Pest Plant Check periodically with shires for changes to weeds declared under the Local Government Act. A tufted annual grass up to 80 cm high. Inflorescence is an erect panicle of drooping reddish purple flowers 7 – 22 cm long. Flowers in spring.	Spray topping with 1200 ml/ha glyphosate (1350g/l) when flowering. Contact DAFWA for suitable control methods for use during rehabilitation.
<i>Romulea rosea</i> Guilford Grass/Onion Grass	Not a Declared Weed A small herb with long slender, very tough, cylindrical basal leaves produced annually from a small corm. Star flowers pink to purple. Flowers winter and spring.	20g/ha chlorsulfuron (750g/kg) plus 25 ml Pulse® suitable for use in bushland (DAFWA Bulletin 4744).
<i>Leptospermum laevigatum</i> Victorian teatree	Not a Declared Weed Serpentine – Jarrahdale Declared Pest Plant Check periodically with shires for changes to weeds declared under the Local Government Act. Large shrub to 5 m high with greyish green foliage, leathery leaves, 15-30 mm long and 4-9mm wide. Single white flowers have 5 small but broad petals spreading above cup-shaped leathery base. Domed woody fruit opens by 7 – 10 valves to release tiny seeds.	Slash, burn, bulldoze or mulch thickets then burn dry. Spray re-growth until just wet with 100ml Grazon® plus 25ml Pulse® n 10l water. Seedlings can be manually removed the first year or two seedlings (DAFWA Bulletin 4744).

Weed Species	Description	Eradication
<p><i>Rumex crispus</i> Curled Dock</p>	<p>Not a Declared Weed Serpentine – Jarrahdale Pest Plant Check periodically with shires for changes to weeds declared under the Local Government Act.</p> <p>A robust, tap-rooted perennial 50-150 cm high, with numerous stiff branches held more or less upright. Basal rosette of big leaves at ground-level. The leaf blade is puckered or wavy especially near the margins (crisped), narrowly egg-shaped (ovate) to more or less oblong, to 30 cm long and to 6 cm wide, with a pointed tip and a tapered to blunt base. The numerous flowers are in dense clusters close together along the branches. Flowers have 6 greenish to white perianth segments (commonly called 'valves' in the docks). The fruiting heads become rusty-brown and conspicuous.</p>	<p>5ml per litre Asulox® (Asulam) Apply in spring when leaves fully expanded but before the flowering shoot begins elongation. May also be applied by wiper applicator.</p>

Pictures of each weed species are provided to assist with identification (see Plates 1 to 5).



Plate 1: Flowers of *Bromus diandrus* (Great Brome) (Florabase 2010)



Plate 2: *Ehrharta calycina* (Perennial Veldt Grass) (Florabase 2010)



Plate 3: *Romulea rosea* (Guilford Grass/Onion Grass) (Florabase 2010)



Plate 4: *Leptospermum laevigatum* (Victorian teatree) (Florabase 2010)



Plate 5: *Rumex crispus* (Curled Dock) (Florabase 2010)

**APPENDIX 3:
WEED CONTROL TECHNIQUES FOR EFFECTIVE USE OF
HERBICIDES**

Weed Control Techniques for Effective Use of Herbicides

Different techniques for the application of herbicides include:

- **Foliar Sprays** – usually most effective during phases of active plant growth. Concentration and rates of application vary between products and manufacturers (read product label), consider use of dyes to identify sprayed areas, use of wetters/surfactants to improve results.
- **Cut Stump/Cut and Paint** – suitable for woody species. Involves cutting the plant off close to the ground and immediately applying herbicide to the cut surface whilst the stem is still wet to maximise uptake by translocation of sap. Large trees can be ring barked and treated via the same method.
- **Scrape and Paint** – Useful on scrambling vines and shrubs with a woody stem. Scrape a section of stem with a knife to expose sapwood just below the bark, apply herbicide with a paint brush immediately to the exposed stem. Avoid scraping the width of the whole stem, consider scraping thicker stems on two sides, and follow directions on the product label.
- **Stem Injection** – useful to kill trees in situ without chopping. Apply concentrated herbicide to an angled cut or drill hole made into the xylem/ woody part of the stem.
- **Basal Bark Treatment** – useful on young woody species and suckers. Spray herbicide onto bark at the base of the plant from ground level to about 30 centimetres above the ground.

**APPENDIX 4:
WEED MANAGEMENT REGISTER**

APPENDIX 4: WEED MANAGEMENT REGISTER	
Details of Personnel	
Name	
Position	
Date	
Specifics	Details
Weed species	
Common name	
Cause of weed occurrence (e.g. vehicle)	
Photo of weed attached	
Approximate area for control (m2)	
GPS location	
Before photo date and number at GPS location	
After photo date and number at GPS location	
Fixed Point Photography site:	YES/NO
Site description	
Aspect.	
Control method including herbicide name with/without wetter/surfactant	
Post Treatment	Follow up Actions
No further treatment required:	YES/NO
Date:	
Description of growth, e.g. seedlings and height, coppicing, length of shoots, , flowers, seeds, fruit, coloration, etc	
Herbicide	
Date of treatment	
Concentration and rate	
Surfactant/wetter	

**APPENDIX 5:
WEED MONITORING FORM**

KEYSBROOK MINERAL SAND PROJECT WEED MONITORING FORM

Name of Inspector (Print): _____ Date: _____

Weather Conditions Prior to Inspection: _____

Weed Inspection Areas	Date Completed	Weeds Present (Yes/No)	Actions to be Taken
Primary Processing Area			
Wash down bay			
Office and Car Park area			
Access Roads			
Monitoring/Production Bores			
CoE Points			
Other			



**APPENDIX 6:
STANDARD DIEBACK SIGNAGE PROTOCOL**

Standard Dieback Signage Protocol

For the use of Standard Phytophthora Dieback Signage on all land tenures in Western Australia.

10 March 2009



Project Dieback is delivered by South Coast Region NRM Inc., funded by the Australian Government and Government of Western Australia.

Australian Government



Department of Environment and Conservation
Our environment, our future



DIEBACK
CONSULTATIVE
COUNCIL
WESTERN AUSTRALIA



Dieback
GOVERNMENT OF WESTERN AUSTRALIA

Summary

Any person or organisation responsible for the management of lands either with or neighbouring native vegetation in the South West of Western Australia should consider the threat that *Phytophthora Dieback* presents to the maintenance of biodiversity. This is important particularly for areas receiving more than an average annual rainfall of 400mm.

A professional assessment should first be made to determine the disease status of an area. Standard signage is then available which can be used to insure protection of disease free areas.

A range of signs are available depending on the management objectives for an area or works and activities planned.

The signage system is based on the following status symbols:



Soil, gravel, sand and plant material should never be moved from areas that are known to be infested to areas known to be disease free. It is important to get the message across “Be Clean in the Green” and “Don’t Spread the Red”.

Interpreting the disease status of areas can be difficult especially as many areas of the South West have been affected for many decades. Signage should only be used if qualified environmental consultants have sampled and verified the disease situation in an area.

There are many reasons for the cause of plant deaths so it is important to confirm presence of *Phytophthora cinnamomi* in any candidate areas for signage. However, if field interpretation is not available in the short term for a potentially threatened area, non-mapped “Dieback Protection Area” signs are available until a *Phytophthora Dieback* assessment can be made.

Project Dieback NRM, in conjunction with the State Dieback Consultative Council (DCC), Dieback Working Group (DWG) and Department of Environment & Conservation (DEC), have developed this standard dieback signage system to assist in the management of *Phytophthora Dieback*. Project Dieback is a Natural Resource Management (NRM) initiative to protect environmental, social and economic values from the dieback threat in Western Australia. The Australian Government and Western Australian Government fund the project through the joint National Action Plan for Salinity and Water Quality programme and the Natural Heritage Trust.

Introduction

The south west of Australia is extensively invaded by the introduced soil borne water mould *Phytophthora cinnamomi* known as Phytophthora Dieback. The pathogen is recognised as one of the key threatening processes to Australian biodiversity.

Humans are the greatest vectors in spreading Phytophthora Dieback. People can carry the plant pathogen from infested areas in many ways. Often by mud on footwear or vehicles, shifting infested soil or gravel, grading roads or moving infected plant material.

The aim of the signage is to raise dieback awareness and to assist land managers, operations staff and contractors involved in any earthworks to minimise the risk of spreading existing infestations and protecting areas still free from this invasive species.

The Western Australian Standard Dieback Signage System has been developed for use across all land tenures, including areas managed by local and state government, private property and mining areas. Land managers, government agencies, extractive industries and developers should use the signage system as part of an overall disease risk management plan to minimise the risks of establishing new infestations as a result of human activity.

The signage system is designed particularly to protect valued areas threatened by dieback following the field interpretation and mapping of *Phytophthora cinnamomi*. These areas may be identified as Dieback Protection Areas and dieback infestations can be delineated from dieback free areas using the signs.

The signage has a standardised series of designs to ensure consistency across land tenures and therefore higher recognition and understanding of the threat. Consequently, the signage will be the same format in national parks and reserves, mine sites, along road sides and in local government parks.

To be effective, signs must be considered an integral part of an area's overall management. Use of signage to guide public staff and contractors should be one component of management. Managers, government agencies and developers are advised to also adopt best practise disease management to minimise the risks of establishing new infestations as a result of soil movements.

This protocol describes the signage system, sets out a flow chart to graphically represent the sequencing of steps required to use the signs and provides information required for signage application, installation and management.

Standard Dieback Signage System

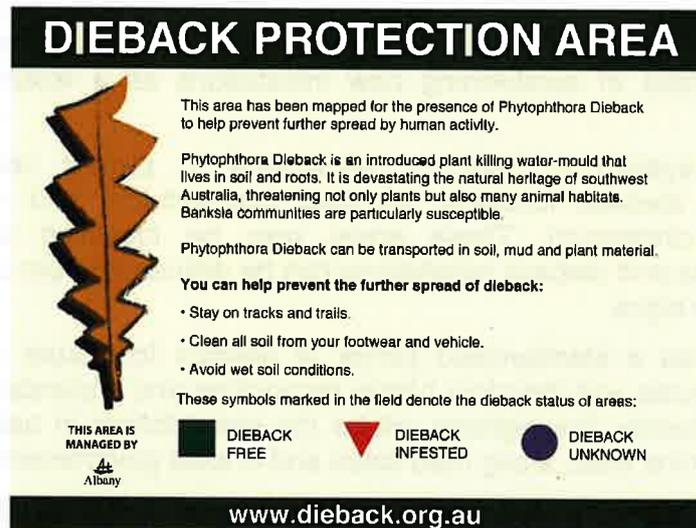
The signage system was designed as part of a state communication plan that aims to have consistent relevant themes and messages for stakeholder groups to use in Western Australia in regard to Phytophthora Dieback management.

The signs aim to enable people to gain the right message, do the right actions and be aware of Phytophthora Dieback in the environment.

The signage system is based on the following status symbols:



A range of signs and markers are available depending on an area's requirements including for roadsides, walk tracks and Dieback Protection Areas. (Section 1: Dieback Signs and markers.)



Picture 1: Example of Dieback Protection Area sign.

There is an option to have management logos integrated into Dieback Protection Area signs and changes to wording for specific area requirements. These wording changes however still need to be approved to ensure messages and themes are accurate and consistent with Phytophthora Dieback management.

The Dieback Signage flow chart sets of the procedure to follow in regard to using the signs.

Protocol Flowchart

The following flowchart provides guidance for incorporating the Standard Dieback Signage System into an area.



Section 1: Values Threatened by Dieback

Phytophthora Dieback impacts over 40% of the plant species in Southwest Australia, which consequently threatens many environmental values including changes to ecosystems and destruction of habitats. Dieback threatens social and economic values impacting natural resources and horticultural industry.

When assessing the risks from Phytophthora Dieback, values should to be prioritised to ensure management resources are designated effectively.

Area may have access roads, tracks or drainage lines into other areas with values that are threatened by Phytophthora dieback and therefore neighbouring areas should to be taken into consideration in surveying values and Dieback Management planning. Hygiene control is advised during any ground survey.

An overall strategic risk assessment has been carried out for the south west of WA and is also a resource that can assist in value assessment. Details can be accessed through the www.dieback.net.au website as well as a list of the most susceptible species threatened by Phytophthora Dieback. The following lists some of the values that may be impacted.

Environmental Values

Environmental Values may include:

- healthy bushlands with susceptible plant communities,
- endangered plants,
- rare animal habitats.

A susceptible plant species list is available on www.dieback.net.au. Technical advice is available through your NRM Dieback officer, DEC or local environmental officer.

Social Values

Social Values may include:

- wildflower viewing areas,
- cultural places,
- bush products.
-

Economic Values

Economic Values may include:

- tourist areas,
- timber resources,
- nurseries,
- susceptible horticultural plantations
- honey production.

Section 2: Dieback Interpretation and Mapping

Dieback Interpreters carry out a detailed procedure to determine the presence of Phytophthora Dieback (*Phytophthora cinnamomi*) in bushland and forest areas.

The presence of this soil borne pathogen is typically undertaken using a combination of aerial photography interpretation (API), assessment of existing vegetation using certain susceptible species as indicators and sampling soil and plants to confirm infestation through laboratory testing.

The determination of the presence of Phytophthora dieback requires significant technical knowledge and it is recommended that suitably qualified and experienced professionals undertake this assessment.

Consultants provide a dieback report, management recommendations, detailed maps of dieback status/protectable areas and ground demarcation usually with coloured tape. Old mapping and demarcation may need to be refreshed as dieback has been known to move downhill over ten metres a year and even uphill one metre a year though root to root contact. Dieback status signage should only be used in areas where the dieback has been recently verified.

Phytophthora Dieback indicator plants include members of the Proteaceae, (*Banksia, Grevillea, Hakea etc*), Myrtaceae (*Eucalyptus, Verticordia, Calothamnus etc*), as well as species such as grasstrees (*Xanthorrhoea sp.*), and zamia palms (*Macrozamia sp.*). More details of susceptible can be found at www.dieback.org.au.

Consultants that can provide assessment of lands and arrange analysis of soil samples for dieback can be found in Section 9: Contacts.

Section 3: Dieback Signs and Markers

1. Dieback Protection Area (DPA) Signs

DPA Signs are digitally printed on 600 x 450 aluminium panels.

1.1 DPA Boundary Entry Signs for dieback mapped areas:

DIEBACK PROTECTION AREA

THIS AREA IS MANAGED BY

The presence of Phytophthora Dieback is being mapped to help prevent further spread of dieback by human activity.

Phytophthora Dieback is an introduced plant killing water mould that lives in soil and plant material. It is devastating the natural heritage of southwest Australia, threatening not only plants but also many unique animal habitats. Banksia communities are particularly susceptible.

Phytophthora Dieback can be transported by human activity, carried on boots and tyres and moved in plant material.

You can help to prevent the further spread of Dieback:

- Stay on tracks and trails.
- Clean all soil from your shoes and vehicle.
- Avoid wet soil conditions.

These symbols marked in the field denote areas that are:

	DIEBACK FREE		DIEBACK INFESTED		DIEBACK UNKNOWN
--	---------------------	--	-------------------------	--	------------------------

www.dieback.org.au

Item Code: DPA07-1

1.2 DPA Boundary Entry sign for non-mapped areas

DIEBACK PROTECTION AREA

THIS AREA IS MANAGED BY

This is an area being protected against the threat of Phytophthora Dieback. Please help prevent further spread of Dieback by human-activity.

Phytophthora Dieback is an introduced plant killing water mould that lives in soil and plant material. It is devastating the natural heritage of southwest Australia, threatening not only plants but also many unique animal habitats. Banksia communities are particularly susceptible.

Phytophthora Dieback can be transported by human activity, carried on boots and tyres and moved in plant material.

You can help prevent the further spread of dieback:

- Stay on tracks and trails.
- Clean all soil from your footwear and vehicle.
- Avoid wet soil conditions.

www.dieback.org.au

Item Code: DPA07-2

1.3 DPA Boundary Entry Signs for Access By Permit Only Areas:



DIEBACK PROTECTION AREA



Access By Permit Only

This is an area being protected against the threat of Phytophthora Dieback.

A permit system is in place to help prevent further spread of dieback by human activity.

Phytophthora Dieback can be transported in soil, mud and plant material.

Spreading dieback threatens not only plants but also many animal habitats.

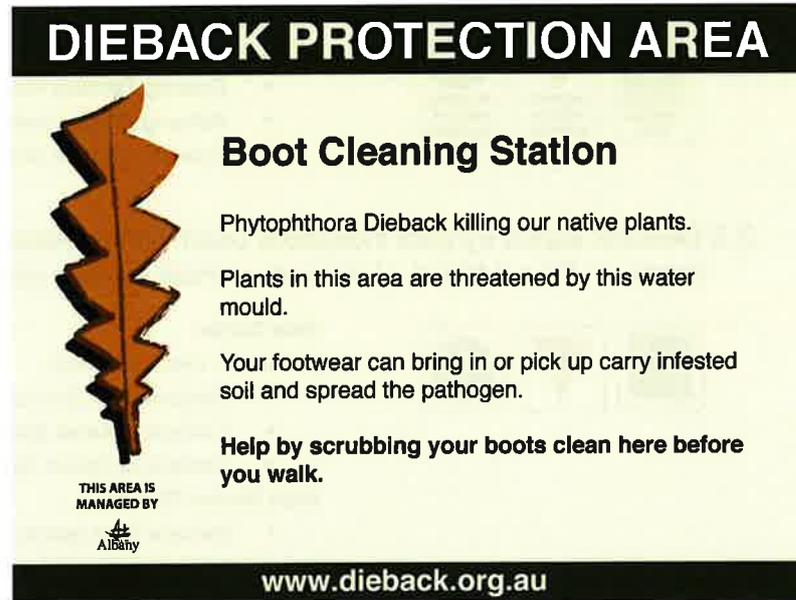
Contact management for more information and permits.

THIS AREA IS MANAGED BY

www.dieback.org.au

Item Code: DPA07-3

1.4 DPA Boundary Entry Signs for Hygiene Stations - Footwear:



DIEBACK PROTECTION AREA



Boot Cleaning Station

Phytophthora Dieback killing our native plants.

Plants in this area are threatened by this water mould.

Your footwear can bring in or pick up carry infested soil and spread the pathogen.

Help by scrubbing your boots clean here before you walk.

THIS AREA IS MANAGED BY

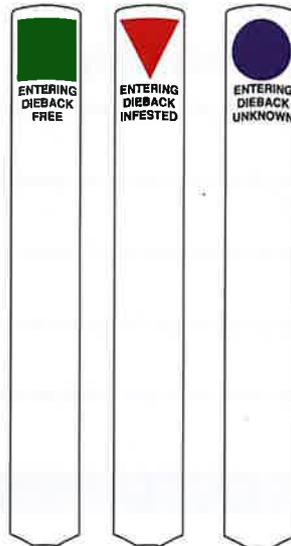


www.dieback.org.au

Item Code: BCS-1

2. Dieback Status Markers and Symbols

2.1 Dieback status boundary markers for roads and walk tracks are indicated using status stickers on white steelflex guideposts.



Item Codes:

Steelflex Posts - EDSF1300-WHT

Vinyl Stickers -

- Entering Dieback Free – EDF-TV
- Entering Dieback Infested – EDI-TV
- Entering Dieback Unknown – EDU-TV

2.2 Dieback status symbol alternative for roads and walktracks are on 95 x 140mm aluminium panels.



Item Codes:

Aluminium Panels -

- Entering Dieback Free – EDF-TA
- Entering Dieback Infested – EDI-TA
- Entering Dieback Unknown – EDU-TA

2.3 Dieback status symbol indicators used within dieback status areas on 95 x 140mm aluminium panels or vinyl stickers.



Item Codes:

Aluminium Symbol Panels -

- Dieback Free Symbol – DF-SA
- Dieback Infested Symbol – DI-SA
- Dieback Unknown Symbol – DU-SA

Vinyl Symbol Stickers

- Dieback Free Symbol – DF-SV
- Dieback Infested Symbol – DI-SV
- Dieback Unknown Symbol – DU-SV

See Appendix 1 for current Signs ordering form.

Section 4: Dieback Management and Signs Plan

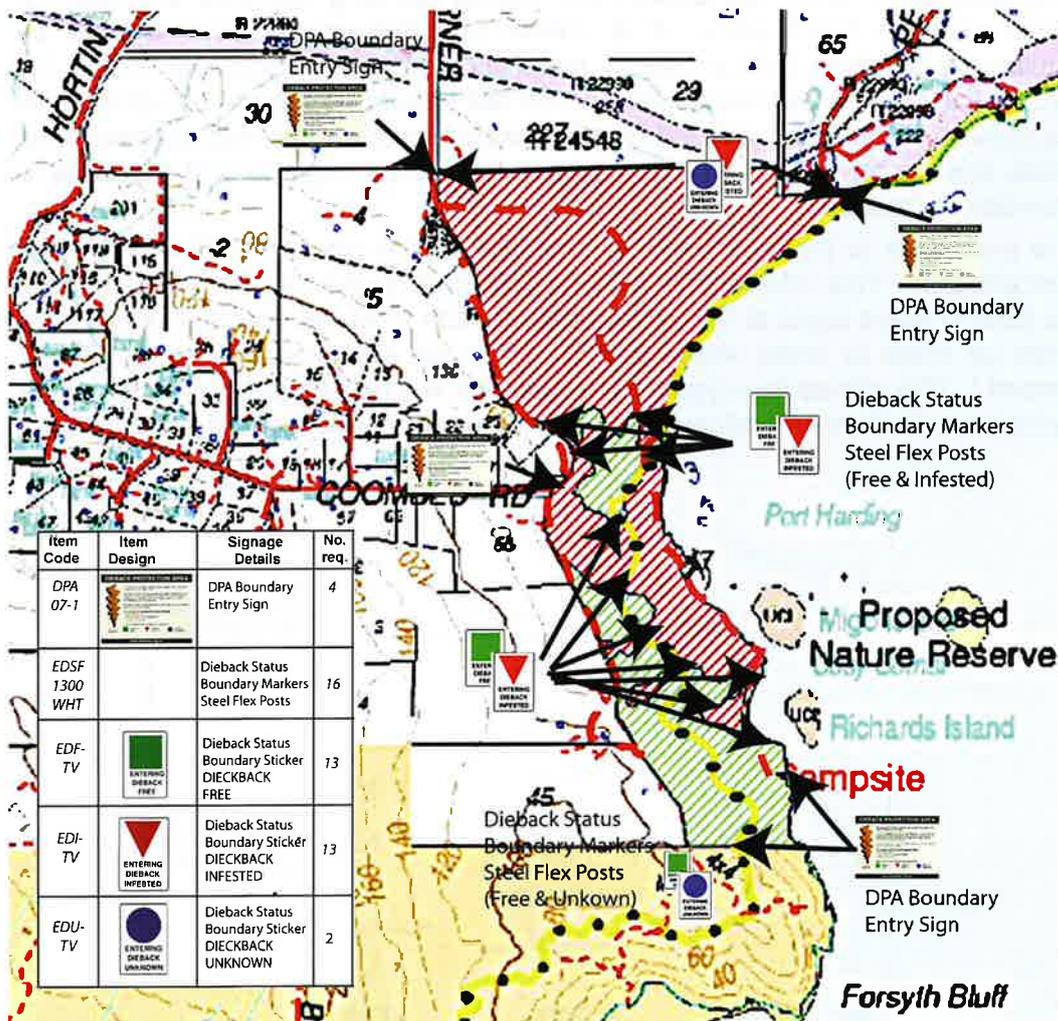
A signs plan is done in conjunction with the area’s overall management plan. The Signs plan records required signs in regard to access points, awareness objectives, restrictions, hygiene stations and future predicted autonomous spread.

The Area Signage Plan should also designate hygiene requirements for installation and future dieback monitoring and signs review. It is essential that signs are maintained in good condition and a register of installations be made.

All Dieback Signage used in any area is to be documented as part of the signs plan and a summary is requested to be sent to the DCC State Register (Appendix 1).

Example of a Signs Plan Map

Phytophthora Dieback Signs Plan Map Cosy Corner Reserve, Albany



Section 5: Signage Installation Guidelines

The correct placement of signs along the dieback boundary and at entrances to areas affected by Dieback is important assist in reducing the spread of Phytophthora Dieback.

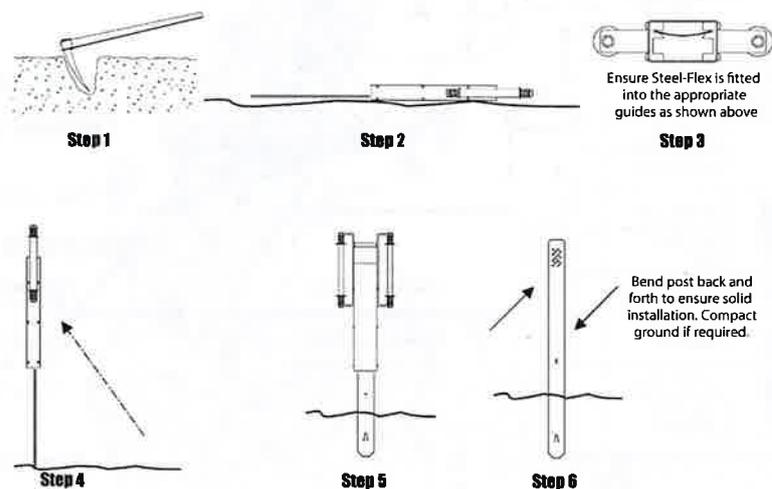
Dieback Protection Area Entry signs (DPA-071, DPA-072;) should be placed at road and walking trail entrances. This should be at a location where vehicle speeds are at a minimum such as a gate, or walking trail entrance. These signs should be installed on posts of sufficient length to enable them to be visible over any vegetation. 4x4 wooden posts are acceptable or the 2250 mm steel posts (code Calm2250-csa) which can be driven directly into the ground.

Posts for the delineation of the dieback front are to be Ezydrive Steel Flex posts. (Code EDSF1300-WHT) with self adhesive symbols (code DF-SA, DI-SA, and DU-SA) to be applied to the posts. These should be installed so that the posts are aligned with the axis of the dieback front as demarcated by the Dieback Interpreters.

Installation of the Posts

The easy drive steel flex posts from Rondo Building services are easy to install using a hand driver. It is critical that care is taken to ensure all equipment is clean before use in installation of posts. Signage should be installed under dry soil conditions and no soil should be moved on vehicles or equipment away from infested areas. Always install signs into disease free areas prior to any with in infested areas. Advice on hygiene and sterilants is provided in Section 7.

It is preferable to locate the correct location for the sign by GPS and ground demarcation. This information is to be provided by the mapping consultants. Be sure to place signs at the correct buffer width from the visible disease front (15m up slope or cross slope, and 25m + down slope depending on rate of spread.) This allows for cryptic disease which will be present but not showing symptoms. Buffers also allow for some movement of the disease as it grows.



Section 6: Standard Hygiene and Management

To manage Phytophthora Dieback in any area, there is a need to plan ahead. The introduction or human-assisted spread of the pathogen can be avoided if activities are well planned and management procedures are in place. Phytophthora Dieback management procedures must be integrated into all land management activities if the spread and impact of this organism is to be minimised.

Organisations such as the Department of Environment and Conservation (DEC), Alcoa World Alumina Australia and Main Roads WA follow procedures to minimise the risk of their activities spreading the pathogen. Many local governments are also adopting Phytophthora Dieback management policies and implementing management procedures. Anyone who owns, manages or uses a bushland area can also take steps to ensure that their activities don't introduce or spread the pathogen. Any operations which involve soil movement can put disease free areas at risk.

Standard hygiene and management may vary for each status area.

DIEBACK FREE	DIEBACK INFESTED	DIEBACK UNKNOWN
<p>Cleandown stations should be used to remove or sterilize mud and soil from footwear, equipment and vehicles when entering Dieback Free.</p> <p>Avoid moist soil conditions. Access may be restricted.</p>	<p>An effective hygiene cleandown must be carried out when leaving a Dieback Infested area into Dieback Free.</p> <p>Ensure no infested soil, gravel or plant material crosses the dieback boundary.</p>	<p>Areas are unknown if they have not been mapped or do not have indicators that identify the presence of Phytophthora Dieback.</p> <p>Areas may still have hygiene and access restrictions.</p>

Hygiene is essential to any operation or activity aiming to minimise the spread of Phytophthora Dieback. Next section details some guidelines applicable to the cleaning of vehicles, equipment and footwear. Also included are some points about sterilisation of water, equipment and footwear. Where practical it is preferable to use the dry cleaning methods (air compressor, brushes) rather than cleaning with water as it has a significantly lower chance of accidentally spreading the pathogen.

It should be noted that dust and grime on vehicles or equipment is not a threat in terms of spreading Phytophthora Dieback.

Section 7: Guidelines for cleaning vehicles/equipment

- Cleaning will be easier and more effective if completed at a depot or designated cleaning area.
- Field-based cleaning requires:
 - A hard, well-drained surface (e.g. road) that is well away from native vegetation. Any washdown effluent should be collected on-site and must not be allowed to drain bushland.
 - Minimise water use to remove soil and mud from equipment/vehicles. This can be achieved by preferentially dry cleaning techniques e.g. stiff brushes.
 - Washdown on ramps if possible.
 - Prevention of mud and slurry from entering into uninfested or uninterpretable bushland. Soil and waster can be collected for sterilisation (see guidelines for sterilising below).
 - Pay particular attention to mudflaps and tyres.
 - Do not drive through effluent generated from cleaning when exiting the washdown facility.

Guidelines for cleaning footwear

- Try to remove mud and soil when it is dry. Remove as much mud and soil as possible with a stiff brush or stick and minimise the amount of water used.
- Collect all mud and soil removed and place in a bucket or bag for later disposal at a site that is infested with *P. cinnamomi* or that contains no native vegetation.

Guidelines for sterilising

- Sterilisation of equipment, footwear and vehicle tyres can be used to take an extra precaution. Sterilisation of nursery equipment using steam is common practice, however the use of steam is not practical in the field. The following sterilisation methods can be used in the field.
- Spray methylated spirits on small hand tools and footwear covering all surfaces and allowing a few minutes for it to soak into all soil material.
- Spray diluted bleach (sodium hypochlorite) onto equipment and footwear allowing a few minutes before rinsing the bleach off using water. Dilute bleach so that solution contains 1% active ingredient sodium hypochlorite. Be sure to follow any of the manufacturer's safety instructions provided on the bleach container.
- Spray Phytoclean® can be used in footbaths, washdown facilities and during the cleaning of equipment. See the manufacturer's details for directions.

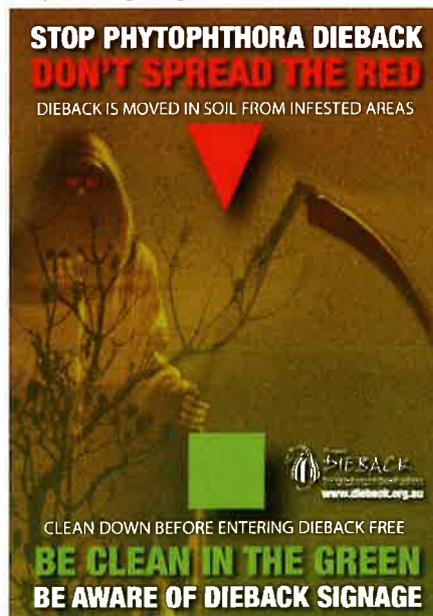
Section 8: Publications and resources

- “Signage For All” DL Pamphlet



Produced by Project Dieback April 2008

- “Botanical Grim Reaper Signage Awareness” A3 Posters



- Project dieback website www.dieback.net.au

Pamphlets and posters are free on request from South Coast NRM Inc. on Mercer Rd., Albany or Cranmill Environmental Services.

Section 9: Contacts

Dieback Consultants

Coffey Environments

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Woodman Environmental Consulting Pty Ltd

Greg Woodman

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Ordering Signs

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Mob: 0409 290 944
Email: cranmill@iinet.net.au

Jason Signs

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WELSHPOOL WA 6106
Ph: 08 9458 7033
Fax: 08 9458 8552
Web: jsm.net.au

State Dieback Signs Register

The following Signage Summary Sheet should be completed and copied for each area where signage is installed. A copy should be sent to Cranmill Environmental Services (PO Box 500 Mundijong WA 6123 or cranmill@inet.net.au;) who are coordinating the state register funded by Project Dieback on behalf of the Dieback Consultative Council.

Reserve or Location:	
Central GPS Reading:	
Closest road name:	
Contact person/position:	
Organisation:	
Phone:	
Email:	
Values at risk:	
 DPA Entry with Status Symbols	Total Number Used: <input type="text"/>
 DPA Entry without Status symbols	Total Number Used: <input type="text"/>
 Boot Cleaning Station	Total Number Used: <input type="text"/>
 Road/Track Posts	Total Number Used: <input type="text"/>
 Track Markers Panels 95 x 140 (Aluminium)	Total Number used: <input type="text"/>
 Track Markers 95 x 95 (Aluminium)	Total Number Used: <input type="text"/>
Dieback interpretation done by:	
Date of installation:	
Monitoring of disease fronts in vicinity of signs.	Dates to be visited by officer responsible.
Comments/Requests:	

Acknowledgements



Great Southern TAFE

Students assisted in developing this system and have also developed icons representing values and threats which could be made available if any land managers felt they would assist them in communicating with the public.