APPENDIX A: DARDANUP MINE ACID SULPHATE SOILS MANAGEMENT PLAN

ACID SULFATE SOILS MANAGEMENT PLAN BUREKUP MINERAL SANDS DEPOSIT

DMS-EMP-10.2

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Doral Mineral Sands Pty Ltd ABN 18 096 342 451 ACN 096 342 451 Lot 7 Harris Road, **Picton** WA 6229 **Tel:** +61 8 9725 5444 **Fax:** +61 8 9725 4757
Email: admin@doral.com.au **Website:** www.doral.com.au

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1 INTRODUCTION

1.1 Purpose and Scope

This Environmental Management Plan has been prepared to address the Objectives and Commitments in relation to the management and monitoring of acid sulfate soils as outlined in the *Proposal for a Western Extension to the Dardanup Mineral Sands Project to Include the Burekup Mineral Sands Deposit* (Doral, 2008), any associated Ministerial Conditions of Approval for this Project (Section 1.2) and any subsequent approvals related to the Project.

This Acid Sulfate Soils Management Plan outlines the following:

- Commitments and Conditions;
- Doral Objectives;
- Relevant Standards and Legislation;
- Potential Impacts;
- Management and Monitoring Measures;
- Reporting Requirements; and
- Relevant Environmental Operating Procedures.

1.2 Commitments and Conditions

Table 1 outlines the commitments and conditions as outlined in ministerial statements and proponent environmental assessment documentation.

Table 1-1: Commitments and Conditions

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
Environmental Management Commitments as outlined in *Proposal for a Western Extension to the Dardanup Mineral Sands Project to Include the Burkekup Mineral Sands Deposit* * (Table 6-5 Proposed Environmental Management Commitments)	Commitments as outlined in the EPS in relation to Acid Sulfate Soils are as follows: • Doral will implement an approved ASSMP (789:P2); and • Doral will prepare an ASSMP Closure Report (789:P28).
Acid Sulfate Soils	Commitments as outlined in the EPS in relation to Acid Sulfate Soils are as

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
Management Plan (Version 2) (Coffey Environments, 2008)	follows: • As a precautionary measure, soil testing will occur of overburden material for the first three months of mine operation. Based on the volume guidelines presented in Table 1, approximately 1320 soil samples of overburden will be collected from overburden in the first three months of mine operation. • A fixed pH monitoring point will be located at the feed preparation plant to monitor the pH of the incoming ore/process water slurry. The purpose of this monitoring point is for the early detection of any acidification in order to assess the need for, and potentially trigger, management strategies at the source of mining. • Soil samples will be field tested for pH_F and pH_{FOX}. Samples with a pH_{FOX} >4 will be considered non-ASS and no further analysis will be required. • Data from the first three months will be reviewed and the ASSMP updated (where necessary) to reflect the findings of the first three months of monitoring. • Soil sample results tables shall be reported in the Annual Environmental Report (AER) and in the ASSMP Closure Report. • Groundwater sampling and analysis will occur monthly in bores listed in Table 4 and quarterly in bores listed in Table 5, or weekly if pH_F<4, for the analytes listed in Table 3. • Groundwater results shall be compared to background data with any anomalies discussed in the AER and the ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of groundwater level, pH, EC, total acidity, total alkalinity, iron, aluminium, and manganese should be included in the report as a minimum. • One sample point will be established to collect dewatering effluent at a location prior to the water reaching the process water pond. As a default, a sample of water from this point shall be collected daily, and subject to field analysis of electrical conductivity, pH, temperature and total titratable acidity (TTA), which will be recorded in a field log. • Field and laboratory dewatering effluent data shall be compared to the trigger values in Table 4 and results discussed in the AER and ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of pH, total acidity, EC, total alkalinity, iron, aluminium, and manganese should be included in the

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
	report as a minimum. • Doral commit to reporting on the ASS Management in an Annual Environmental Report to be provided to the DEC each year as part of licence conditions for the site. An ASSMP Closure Report will be prepared as part of the mine closure and rehabilitation plan for the Dardanup Mine. The purpose of the Closure Report is to show implementation and compliance with the ASSMP.

Conditions of Ministerial Statement 789
(Minister for the Environment; Youth, 2009)
	Conditions in relation to Acid Sulfate Soils as outlined in Ministerial Statement 789 are as follows:
	• At all times the proponent shall ensure the limit of groundwater drawdown in the proposal area and in the vicinity of the proposal area does not approach the underlying potentially acid-forming substrate to the extent that acidic waters are generated, by monitoring:
	  • Dissolved oxygen; and
	  • Other oxidising agents including nitrate, sulphate and ferric ions;
	• On a daily basis for a period of three months after the groundwater level is within three metres of the potentially acid forming substrate and thereafter to the requirements of the CEO of the Department of Environment and Conservation (789:M7.1); and
	• As mining progresses, the proponent shall commence rehabilitation of the mined area in accordance with the following:
	  • Remediation of acid sulphate soil and contaminated groundwater generated by mining operations (789:M8-2 (3)).

Licence to Take Water (GWL168577(1)) Department of Water, 2009)	The following conditions contained in Schedule 1 of the Licence to Take Water relate to Acid Sulfate Soils: *Dewatering Effluent* • The licencee shall collect a sample of the dewatering effluent on a daily basis and have the sample tested for Electrical Conductivity (EC), temperature, field pH (pHf) and Total Titrateable Acidity (TTA). Dewatering effluent pumped from different sumps on M70/720 and/or M70/652 must be sampled separately, that is, before the waters mix. Depending on the pH and TTA values, the actions specified in Table 5 of the Acid Sulfate Soil Management Plan dated 12 November 2008 (ASSMP) shall be effected (Condition 3); • Collect a sample of the dewatering effluent on a monthly basis OR

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
	weekly if the daily pHf<4 and submit the sample for laboratory analysis for the following parameters: • *pH, EC, temperature, Total Dissolved Salts (TDS), Total Acidity, Total Alkalinity, Chloride, sulphate, A1, Fe and Mn • *if A1> 1mg/1 then additional analyses required for Zn, Cr, Cu, Mg, Ni, Cd, Se, As, Pb & Hg Dewatering effluent pumped from different sumps on M71/720 and M70/652 must be sampled separately, that is, before the waters mix. Depending on the pH and TTA values, the contingency actions specified in the "Action" column in Table 1 of the Department of Environment and Conservation's (DEC) Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulphate Soil Areas (June 2006) shall be effected (Condition 4); *Adjacent Groundwater Monitoring Bores* • Measure the water level in the groundwater monitoring bores listed in Table 1 of this schedule on a monthly basis (Condition 5); • Collect a sample from the groundwater monitoring bores listed in Table 1 of this Schedule on a monthly basis. The sample shall be tested for Electrical Conductivity (EC), temperature, field pH (pHf) and Total Titrateable Acidity (TTA) (Condition 6); • Collect a sample from the groundwater monitoring bores listed in Table 1 of the schedule on a monthly basis or weekly if the pHf<4, and submit the sample for laboratory analysis for the following parameters: *pH, EC, temperature, Total Dissolved Salts (TDS), Total Acidity, Total Alkalinity, chloride, sulphate, A1, Fe and Mn. *If A1>1mg/1 then additional analyses required for Zn, Cr, Cu, MG, Ni, Cd, Se, As, Pb & Hg. If any of the trigger values listed on Table 2 of this schedule are reached, the contingency actions specified in Section 5.2.2.2 of the *Acid Sulfate Soil Management Plan* dated 12 November 2008 and/or the "Action" column in Table 1 of the Department of Environment and Conservation's (DEC) *Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulphate Soil Areas (June 2006)* shall be effected (Condition 7); *Distant Groundwater Monitoring Bores* • Measure the water level in the groundwater monitoring bores listed in Table 3 of the schedule on a monthly basis (Condition 8).

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
	• Collect a sample from the groundwater monitoring bores listed in Table 3 of this Schedule on a quarterly basis (Sept/Dec/Mar/June). The sample shall be tested for electrical conductivity (EC), temperature, field pH and Total Titrateable Acidity (TTA) (Condition 9); • Collect a sample from the groundwater monitoring bores listed in Table 3 of the Schedule on a quarterly basis (Sept/Dec/Mar/June) OR weekly if the pHf<4 and submit the sample for laboratory analysis for the following parameters: *pH, EC, temperature, Total Dissolved Salts (TDS), Total Acidity, Total Alkalinity, chloride, sulphate A1, Fe and Mn *If A1>1mg/1 then additional analyses required for Zn, Cr, Cu, Mg, Ni, Cd, Se, As, Pb & Hg If any of the chemistry trigger values listed on Table 2 of this schedule are reached, the contingency actions specified in Section 5.2.2.2 of the *Acid Sulfate Soil Management Plan* dated 12 November 2008 and/or the "Action" column in Table 1 of the Department of Environment and Conservation's (DEC) *Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulphate Soil Areas (June) 2006* shall be effected (Condition 10).
Submission for Assessment under Section 45C of the *Environmental Protection Act 1986* – Proposed Amendment to Ministerial Statement 789 (Doral, December 2010); and Submission Review Letter (Doral, June 9 2010)	The following commitments have been made in relation to the management of potential ASS: • Dewatering will be managed to avoid the cone of depression from dewatering of mine pits extending to greater than 10m BGL in the amendment areas. This will minimise the potential for oxidising any PASS which may occur in the underlying Leederville sediments. To achieve this ensure a saturated pit floor is maintained at the deepest depth of the mine pit at all times; • Laboratory data (soil and groundwater results) in the vicinity of drill hole 41 (BU007M), known to contain PASS, will be monitored closely to detect any changes in groundwater quality when dewatering occurs in this area. • Daily monitoring of adjacent bore BU007 for depth, pH, EC, dissolved oxygen, ferric, sulphate and nitric ions; • Continue the monthly monitoring (monthly or quarterly) of bores BU009, BU008, BU007M, BU007D, MB15, MB16, MB17 and MB18 whilst dewatering the amendment areas and post mining. Parameters to be analysed should include pH, total acidity, total alkalinity, chloride, sulphate, aluminium, manganese and iron. Monitoring of bore BU007 will also include depth, EC, temp and total dissolved salts;

Commitments as Outlined in Ministerial Statements and Proponent Environmental Assessment Documentation	
Burekup West	
	• Precautionary soil testing for PASS from pit areas to the east of Dowdells Line and north of St Helena Rd; • Conduct regular dewatering effluent monitoring in accordance with current practices required by the ASSMP, when mining the new mine pits for the amendment areas; • Daily pit dewatering effluent for pH, TTA, temp and EC.

*Note: These commitments may be refined in consultation with relevant authorities during the implementation of the proposal

1.3 Doral Objectives

Doral Objectives for the Acid Sulfate Soils Management Plan are as follows:

- Address all Commitments and Conditions as outlined in Table 1.

1.4 Relevant Guidelines and Legislation

The following Guidelines and Legislation are relevant to the Implementation of this EMP:

- *Identification and investigation of acid sulfate soils and acidic landscapes* (Department of Environment and Conservation, 2009a);
- *Draft Treatment and management of soils and water in acid sulfate soil landscapes* (Department of Environment and Conservation, 2009b); and
- *Contaminated Sites Act 2003.*

1.5 Responsibilities

All Management and Monitoring actions outlined in this Acid Sulfate Soils Management Plan are the responsibility of the Doral Mineral Sands Pty Ltd Environmental Representative or their delegate unless otherwise specified.

1.6 Review Date

This Plan is considered a “live document” and will be subject to an internal review on an annual basis. The next review is scheduled for **March 2012.**

1.7 History of Acid Sulfate Soils Management for Burekup West

2006 - 2008

Background groundwater quality data for the Burekup Mineral Sands Deposit had been collected by Iluka for approximately two years (2006 – 2008) on 11 bores (BU001 to BU011) (Figure 2), and Doral collected background data on the same bores since October 2008, with an extensive suite of analytes

assessed in the March 2009 pre-dewatering analysis round. This data has been used to determine trigger levels with a 20% change in water quality monitoring from background levels being the trigger level for ASS disturbance.

March to April 2009

Additional groundwater bores BU012 to BU018 were installed to monitor the broader study area, particularly downgradient of identified PASS areas illustrated in Figure 1. Only one background round of data was collected of these bores due to the tight timeframes of the project (i.e. start date of 27 March 2009).

Department of Water issued a Licence to Take Water (GWL168577) in March and subsequently the groundwater program in this ASSMP was updated to incorporate the licence conditions. Previously the following regulator comments were taken into account when designing the groundwater monitoring program:

- The DEC comments on the Iluka (2007) Draft EPS recommends specific monitoring of oxygen and other oxidising agents (nitrate, sulfate and ferric ions) in groundwater beneath the pits, together with the use of trigger values for actions to reduce the possible severity of acidification.
- DEC comments on the Cloverdale deposit near Capel, which experienced acid mine drainage issues (Appleyard, 2007) recommend radionuclide analysis on groundwater: *„Key parameters that are currently omitted from the analysis suite include elements that are likely to be leached from the heavy minerals monazite and xenotime under acidic conditions. These include the radionuclides thorium and uranium (U is also a significant chemical toxicant) and the decay daughter product radon. Radon emissions from pumped groundwater are a potential occupational safety and health issue for mine workers who manage dewatering operations for long periods of time at the site."*

24 April 2009 to 12 July 2009

Soil Monitoring was conducted for the first three months of mine operation which coincided with the construction phase of the project. Overburden was the primary material tested due to the large volumes stripped during the construction phase for use as noise bunds. Doral conducted random sampling per bench of overburden material that had been dewatered to allow dry mining to occur. Field testing for ph_F and pH_{FOX} was conducted onsite in the Doral laboratory. The GPS coordinates for each sample location was recorded, along with the block number the sample came from. Of the 262 samples collected, 38 samples had a pH_{FOX} less than four.

Thirty two (32) samples were sent to the SGS Laboratory for further analysis. Chromium Reducible Sulfur (S_{CR}) suite analysis was performed on the samples and one sample returned a net acidity result of 0.03%S, which is equal to DEC (2009a) ASS management criterion. All other samples returned net acidity results less than 0.03%S.

October 2009

An ASS Discussion Paper (Coffey Environments, 2009) was produced for the assessment of the existence of ASS in the amendment area to Burekup West. The Paper determined that ASS was present in the amendment area but would not be disturbed by mining (see Section 2.4).

10 December 2009

Version 2 of the ASSMP (dated 10 December 2009) was created to include the Amendment Area to Burekup West. The document was restructured to conform to the layout of other Doral EMPs for ease of use.

20 August 2010

A revised version (Version 3) of the ASSMP was prepared to incorporate commitments made during consultation with the Office of the Environmental Protection Authority regarding ASS and to update the figures with a revised project area, as approved under Section 45C of the *Environmental Protection Act 1986* (letter dated 7 July 2010).

2 ACID SULFATE SOIL INVESTIGATIONS

The following documentation on acid sulfate soils for the Burekup Western Extension was used as the basis for the preparation of the Acid Sulfate Soils Management Plan (see Section 3):

- *Final Report: Acid Sulfate Soil Survey for the Proposed Burekup Minesite* (SWC, 2007a);
- *Preliminary Pre-Mine Soil Assessment for the Proposed Burekup Minesite* (SWC, 2007b); and
- *Burekup Mineral Sands Project Environmental Protection Statement Draft for Government Review* (Iluka, 2007).

An *Acid Sulfate Soil Survey for the Proposed Burekup Minesite* was conducted by Soil Water Consultants (2007a). The survey included; a Desktop Assessment and Site Inspection, Soil Sampling, Laboratory Analysis and Results.

2.1 Desktop Assessment and Site Inspection (June 2007)

The desktop assessment found that mining of the Burekup Mineral Sands Deposit could lead to the disturbance of areas likely to contain ASS. This is supported by the ASS Risk Map for the Greater Bunbury region (WAPC, 2003) which shows Moderate to Low Risk that ASS are likely to occur at depths within 3m of natural soil surface. Therefore a detailed ASS Survey was required to confirm the presence or absence of ASS in the area.

The site inspection found no iron staining, scalding or jarosite formation on the surfaces of the drains. The pH of surface water in the area was 5.5–6.5 and vegetation on the site comprised of jarrah and marri trees along sandy rises and paperbarks and sedges along the low-lying areas.

The desktop assessment and site inspection indicated that no Actual Acid Sulfate Soils (AASS) or PASS occurs within the surface 3m in the area. However if ASS was present it was likely to occur at depths >3m and be associated with previous estuarine conditions which formed the heavy mineral deposit at the site (SWC, 2007a).

2.2 ASS Survey (June 2007)

2.2.1 Soil Sampling

Exploration drilling of the Burekup deposit was to a drilling density of 27 holes per ha. Soil samples were collected at 1m vertical intervals along the entire length of the drill hole. A total of 25,184 soil samples were collected and analysed for: soil texture, lithology/stratigraphy, soil colour and heavy mineral content. In addition to these parameters, metallurgical properties including percentage total sulfur, mineralogy and elemental composition, were also analysed on selected samples from each stratigraphic zone. Using this data SWC identified areas that exhibited conditions that would favour the formation and stability of pyrite, and hence may potentially contain ASS.

After a review of the exploration drilling data, an ASS drilling and soil sampling program was developed to confirm the presence or absence of ASS in the proposed mine area. Drilling was conducted between 13 March 2006 and 23 March 2006. A total of 146 holes were drilled across the western extension area (45.7ha) resulting in a density of 3.2 holes/ha. The depth of drilling varied from 7m-20m (with an average hole depth of 15m), and all drill holes extended at least 2m below the base of the proposed floor.

Soil samples were collected at 1m intervals; SWC considered this sufficient to identify ASS given the depths to which sampling occurred (21m) and the geological and soil distributions at the site. Further information on soil sampling methodology can be found in the SWC (2007a) report.

2.2.2 Laboratory Analysis

Laboratory analysis of collected soil samples included:

- Field pH (pH_F) and field peroxide pH (pH_{FOX}) measurements on all samples;
- Chromium Reducible Sulfur (S_{CR}) analysis on selected samples; and
- Leaching of non-pyritic soils (S_{CR} <0.03%) to determine potential hydrolysis and metals release characteristics of selected samples.

Field pH measurements were conducted within 24–48 hours of collection, as due to the large amount (2,054) of samples it was not possible to conduct measurements in the field.

SWC did not conduct TAA analysis on any samples collected from the Burekup Mineral Sands Deposit as they believed samples that had pH_F values >4 would not contain actual acidity.

A total of 100 samples were selected for S_{CR} analysis, with samples selected from each geological unit and covering a wide range of pH_{FOX} values.

The metals leaching investigation was conducted to determine the potential of non-pyritic soils (i.e. S_{CR} <0.03%) releasing heavy metals into the soil solution if they hydrolysed and became acidic. For the metals leaching investigation a total of 16 soils were tested from the Deposit. These soil samples were collected from various depths in the profile, ranging from surface gravely sands to mottled pale grey sands collected at 15m depth. Leachates were analysed for: arsenic, lead, cadmium, chromium, copper, nickel, zinc and mercury. SPOCAS analysis was conducted on all samples to determine their existing acidity in response to previous hydrolysis and their potential to hydrolyse further and release acidity into the soil solution (SWC, 2007a). Based on the quantities of metals leached from the soils and their initial low metals content, it is expected that minimal release of metals will occur if these soils hydrolysed or oxidised following disturbance (SWC, 2007a).

2.2.3 Results

2.2.3.1 Field pH Measurements

The pH_F values ranged from 4.13-8.83 with 94% of all soils sampled having field pH values between 5.0 and 7.0. Approximately 6% of the samples had pH_F values between 4 and 5 with the majority of these samples being associated with surface soils. No soil samples had pH_F values <4.0; consequently SWC consider no AASS are likely to occur at the site.

The pH_{FOX} values for the soils analysed varied from 1.62-8.22. The majority of these soils (75%) had pH_{FOX} values >4.0; consequently SWC consider that they are not PASS. Approximately 25% of soils tested had pH_{FOX} values <4.0, indicating the possible presence of PASS in these soils. The presence of samples with pH_{FOX} values <3.0 (11% of samples) indicates that PASS are present in the study area.

2.2.3.2 Chromium Reducible Sulfur (S_{CR}) Analysis

The S_{CR} results varied from <0.01–2.98%S. These results indicate that there is considerable pyrite present in the some of the soils at the Burekup Mineral Sands Deposit. SWC (2007c) have developed

a relationship between field peroxide (pH_{FOX}) and Chromium Reducible Sulfur (S_{CR}) in order to model the distribution of PASS. In the original model a pH_{FOX} value of 2.31 was used to determine the distribution of PASS. This pH_{FOX} corresponds to an equivalent S_{CR} level of 0.03%S. However feedback from a Third Party Review by Professor Leigh Sullivan from Southern Cross University resulted in a pH_{FOX} value of 2.66 being used to determine the distribution of PASS.

2.2.3.3 Distribution of PASS

SWC concur that PASS distribution is confined to the Leederville Formation sediments that occur beneath the deposit. SWC (2007a) state that mining of the Burekup deposit will not involve excavation of the Leederville sediments, therefore there will be no disturbance of PASS.

The distance between the base of the proposed mine pit and the upper surface of the PASS material in the Leederville Formation varies considerably across the site. Typically this distance is >3m, however in areas where the orebody dips downward or the PASS sediments rise upwards the base of the mine pit may come within 1m of the pyritic material.

2.3 Review of ASS Survey by Third Party and DoE

2.3.1 Third Party Review (July 2007)

Acid Sulfate Soil Survey for the Proposed Burekup Minesite (SWC, 2007) has been third party reviewed by Professor Leigh Sullivan from Southern Cross University. Whilst he is in agreement with the majority of findings and recommendations in this ASS Survey, he has reservations on some aspects and approaches used. His main comments in relation to ASS management are:

> "*However, I would suggest that a monitoring and management section be added to the ASSMP* (ASS Survey SWC, 2007a) *for this site to address the possible acidification of waters and soil materials resulting from dewatering in the base of the minepit and should any underlying pyritic sediments be exposed to oxidation, a possibility outlined in this report."*

2.3.2 DoE Land and Water Quality Branch (December 2007 & January 2008)

The following comments are from the Department of Environment Land and Water Quality Branch with regards to the Iluka Draft Environmental Protection Statement (Correspondence provided to Iluka from the EPASU in emails dated 14 December 2007 and 3 January 2008).

> *"I refer to your memo of 4 December 2007 requesting advice on the draft EPS for the proposed mine site. I offer the following comments:*
>
> The most significant environmental risk posed by the proposed mining activities is the risk that groundwater will be acidified and contaminated with metals and radionuclides as a result of excessive dewatering to enable the mine to be operated by "dry mining" techniques. This risk is particularly high at Burekup as it is proposed to lower the water table in a sandy aquifer to about 1m above known pyritic materials. Groundwater monitoring data from the Cloverdale/Yoganup mine sites suggest that the same *management strategy in a similar geological setting at these mine sites did not prevent groundwater acidification and metal contamination taking place. Additionally, information from similar mine sites in other parts of the world suggests that it may take many decades to centuries for groundwater quality to recover from mining-induced acidification caused by pyrite oxidation.*

Given this risk, the EPA will need to carefully weigh up the short- to medium-term social and economic benefits of the proposed mine against the risk of long-term degradation of groundwater quality beneath and down-gradient of the site.

However, if the EPA were to decide that the mine should proceed, specific monitoring of oxygen, and other oxidising agents (nitrate, sulphate and ferric ions) in groundwater beneath the pit is recommended together with trigger values for actions to reduce the severity of acidification (NOTE:- it may not be possible to prevent dewatering-induced acidification). An EPA condition requiring this could be jointly managed by the Department of Water and DEC using the groundwater abstraction licensing system as a management tool together with measures in the Environmental Protection and Contaminated Sites Acts."

2.4 ASS Discussion Paper (October 2009)

Coffey Environments prepared an ASS Discussion Paper titled "*Acid Sulfate Soils Discussion Paper – Assessment of the Existence of Acid Sulfate Soils in the Proposed Amendment Area*" for inclusion as supporting documentation to the Section 45C submission.

2.4.1 Determination of the Presence/Absence of ASS

Coffey Environments (2009) have examined all relevant soil and water data to determine the presence or absence of ASS in the amendment areas.

Based on soil data derived from the *ASS Survey* (SWC, 2007a) and from field and laboratory analysis of samples taken from the southern portion of Burekup West (Figure 2) it is evident that no PASS will be directly disturbed by excavation of mine pits in the proposed amendment areas. However PASS has been confirmed in drill hole 41 to the west of Dowdells Line and may be impacted by groundwater drawdown. The *ASS Survey* (SWC, 2007a) confirmed PASS is likely from depths greater than approximately 10m below ground level, which is mostly likely associated with Leederville sediments. However Doral will not be mining the Leederville Formation and the deepest mine pit will be at least 1m to 2m above the Leederville Formation. If a saturated pit floor can be maintained, then the PASS in the Leederville Formation should not be exposed to oxidation.

Current groundwater monitoring of the Dardanup bores and Burekup bores closest to the proposed amendment areas are not conclusively indicating that sulfides are oxidising. The dewatering effluent data from mining of the southern portion of the Burekup Mineral Sands Deposit (Section 3.5) is also not indicating that sulfides have been oxidised. Therefore Coffey Environments (2009) conclude that dewatering of new mine pits to shallow depths, is not likely to oxidise sulfides in the proposed amendment areas.

Based on the information provided by Doral and relevant data discussed above, Coffey Environments (2009) were of the opinion that ASS is present in the amendment area, but will not be directly disturbed by mining the four mine pits. Indirect disturbance (i.e. groundwater drawdown) should be avoided by implementing the existing ASSMP, with modifications, to the amendment area.

3 POTENTIAL IMPACTS OF DISTURBING ASS

Acid sulfate soils are soils which release acidity, generally in response to oxidation of iron sulfides. The sulfuric acid produced affects both soil and water, and can damage the environment severely. As the sulfuric acid moves through the soil, it strips metals such as iron, arsenic, aluminium, and selenium from the soil. In the soil this mixture can make the soil so acidic and toxic that few plants can survive. There may be so much acidity that nothing will grow, giving the soil surface a bare, scalded appearance.

Sulfuric acid produced by acid sulfate soils corrodes concrete, iron, steel and certain aluminium alloys. It has caused the weakening of concrete structures and corrosion of concrete slabs, steel fence posts, foundations of buildings and underground concrete water and sewerage pipes.

Where it is not feasible to avoid the disturbance of ASS, the primary management strategy is to neutralise affected soils with lime as they are disturbed. Ongoing soil and groundwater monitoring is required to ensure that soil is being effectively managed.

The presence of acid sulfate soils has been a recognised issue of concern in Western Australia since 2003. The Department of Environment and Conservation (DEC, then the Department of Environment, DoE) and the Western Australian Planning Commission have released guidance notes on acid sulfate soils, covering the requirement for assessing sites and the management of sites where ASS is identified. ASS investigations are commonly required as part of the conditions of development for a site or as a requirement for a dewatering licence application.

3.1 Potential Impacts on Water

The oxidation of pyrite produces sulfuric acid, which can increase the amount of hydrogen ions in the water, thereby reducing its pH. The reduction in pH promotes an increase in the solubility of some metals in groundwater. Metal contamination of the site can occur, and potential off-site impacts could eventuate.

Aluminium can be released into groundwater and has the potential to be toxic at a pH range of 4.7–5.5. Fish can be killed by aluminium as it accumulates on their gills causing clogging, preventing them from breathing and their blood can become acidic. Fish have been identified in wetlands in the Burekup study area (see EPS for details).

Soluble iron has the ability to migrate several kilometres offsite in acid solution before precipitating as ochre in a more oxidising environment. It can precipitate as scum on banks, watercourses and vegetation. Iron can contaminate water sources and cause damage to crops.

Mosquito populations may increase as they are acid tolerant and can breed in water bodies of 15cm or less. This may lead to an increase in mosquito-borne viruses such as Ross River, which can impact on human health.

3.2 Potential Human Health Impacts

There are potential human health impacts on Doral employees, subcontractors and local groundwater users. If acidic groundwater plumes occur, they can produce metal contamination at the site and plumes could flow off site, causing contamination for other groundwater users. In extreme cases, possible human health impacts may include:

- Ingestion of acidic water/soil (usually by children) causing irritation of internal organs, and/or heavy metal poisoning;

- Skin irritation from direct dermal contact; and
- Direct inhalation of hydrogen sulfide gas is likely to result in irritation of the respiratory tract. In extreme cases exposure to high concentrations of hydrogen sulphide may result in collapse, coma and death from respiratory failure. This may occur within a few seconds after one or two inspirations, at high levels (concentrations of 1,000 to 2,000 parts per million). Concentrations of 100 to 200 parts per million for one to eight hours may cause sleeplessness, blurred vision, hemorrhage and death. Lower concentrations may irritate the eyes, nose and throat (5 to 50 parts per million). Following an exposure there may be headaches, dizziness, and nausea. Repeated exposures may cause headaches, anorexia, insomnia, paralysis, meningitis, psychic troubles, slowed heart rate, bronchitis and a grey-green line on the gums (Australian Government DEWHA, 2008).

3.3 Potential Soil Impacts

Soil is crucial for vegetation survival as it provides support, water, and a variety of elements essential for growth. In acidic soils, aluminium is more soluble, and when taken up by plant roots it inhibits growth. Aluminium has a direct effect on phosphate availability, can inhibit the absorption of iron, and have a toxic effect on plant metabolism (Raven *et al*, 2003).

Under ASS conditions, the soil pH is lowered by the creation of sulfuric acid, generally from iron sulfides. Therefore any vegetation present will be dependent on the soil being a particular pH. Death of vegetation and preferential selection of acid tolerant species could result from the pH being lowered. This would lead to a loss of biodiversity and impact on the ecosystem.

Acid scalds are a potential impact on soil. These are the areas of bare or nearly bare soil where high soluble aluminium concentrations and depletion of base cations, organic carbon and nutrients limit the ability of soil to support plant growth (including soil fauna, and fauna that depend on native vegetation) (Appleyard, 2007).

4 ACID SULFATE SOILS MANAGEMENT PLAN

Burekup West (Figure 1) is mapped as having Moderate to Low risk that ASS are likely to occur at depths within 3m of natural soil surface. Based on the results of desktop and field studies, SWC (2007a) identify that potential ASS material is largely confined to pyritic sediments associated with the upper Leederville Formation, which occur beneath the Burekup Mineral Sands Deposit. Accordingly, the requirements of this ASSMP will be to provide strategies to minimise the disturbance of identified ASS by direct excavation or dewatering (where possible); to ensure that ASS material is appropriately neutralised if exposed; and to monitor groundwater and dewatering effluent to assess quality against background data.

SWC (2007a) state that mining of the Burekup Mineral Sands Deposit will not involve excavation of the Leederville sediments, therefore there will be no disturbance of the identified ASS material. Doral have overlayed SWC (2007a) data onto their mine plan (illustrated in Figure 1) and identified that some interpreted ASS material is located in the vicinity of the mine pits (i.e. 520 BCM, shown on Figure 1). However, the majority of ASS material is confined below the mine pits as illustrated in Figure 1, consistent with the interpretation that it is primarily associated with sediments of the Leederville Formation. Doral will need to ensure the ASS material located in the mine pits is avoided or appropriately neutralised if disturbed, as discussed below.

Groundwater monitoring will be conducted during mining of all pits to ensure groundwater drawdown does not expose ASS material beneath the pits directly to oxidation. Dewatering in areas were ASS material is present within 2m of the pit floor will need to utilise appropriate strategies (discussed below) to minimise the potential exposure of ASS material to oxygen.

4.1 Soil Management Strategy

Table 4-1: Conditions/Commitments to be Satisfied by the Soil Management Strategy

Condition/Commitment	Status	Timing
As a precautionary measure, soil testing will occur of overburden material for the first three months of mine operation. Based on the volume guidelines presented in Table 1, approximately 1320 soil samples of overburden will be collected from overburden in the first three months of mine operation.	**Completed 24 April 2009 – 12 July 2009** During the first three months a smaller volume of overburden was moved than originally estimated. Therefore 262 samples were collected for field testing.	Construction Phase
Soil samples will be field tested for pH_F and pH_{FOX}. Samples with a pH_{FOX} >4 will be considered non-ASS and no further analysis will be required.	**Completed 24 April 2009 – 12 July 2009** The overburden (262 samples) were field tested and 38 samples had a pH_{FOX}>4. 36 of 38 samples were subject to further analysis.	Construction Phase
Data from the first three months will be reviewed and the ASSMP updated (where necessary) to reflect the findings of the first three months of monitoring.	Version 2 incorporates the recommendations made by the ASS Discussion Paper, which reviewed soil and water data from the first three	Operations Phase

Condition/Commitment	Status	Timing
	months of monitoring.	
Soil sample results tables shall be reported in the Annual Environmental Report (AER) and in the ASSMP Closure Report.	In progress	Overall
Precautionary soil testing for PASS from pit areas to the east of Dowdells Line and north of St Helena	Field testing to be conducted as per **DMS-EP-10.1**.	Refer to mine schedule

4.1.1 Orebody Method of Extraction

Once the overburden has been removed, the orebody is accessible. The orebody comprises heavy mineral concentrate (HMC), sand (referred to as tails) and clay (referred to as fines). Approximately 10 million tonnes of ore will be extracted from the Burekup Mineral Sands Deposit to recover 0.9 million tonnes of HMC. Dry mining techniques will be utilised to excavate the orebody.

Ore will enter a hopper to screen the larger rocks out. It will then be transported from the Burekup deposit to the Dardanup mine feed preparation plant via conveyor. From there, the screened ore will be pumped as slurry to the wet concentrator plant. At the wet concentrator plant the clay fines are separated and sent through the thickener, while the remainder of the material is sent through gravity separation spirals, which separates the HMC from the sand tails. The HMC is then stockpiled, and the fines are deposited at solar evaporation ponds. The sand tails are hydraulically placed back in the previously mined mining voids.

Coffey Environments note that the sands and clays deposited with the heavy minerals over depositional time may contain pyritic ASS material. Although the previous investigations have not identified significant ASS within the orebody, ore processing may concentrate heavy non-ore minerals such as pyrite, which should be segregated for management and disposal, and not co-disposed of with fines or tails.

4.1.2 ASS Material to be Avoided within the Mine Pits

Over three years, approximately 10 million tonnes of ore will be mined from the Burekup Mineral Sands Deposit (including the amendment area), of which approximately 500 tonnes comprises ASS material.

ASS material requiring management were identified at two locations:

- Drillhole 102 (0.04%S) at a depth interval of 1-2m BGL;
- Drillhole 41 (0.14%S) at a depth of 3-4m BG; and.

The location of the ASS material is shown in Figure 1. The identified ASS material must be avoided or managed in accordance with strategies outlined in Section 4.1.3. The Mine Manager has indicated this volume can be avoided (pers comm., Barry Thomas, 30 September 2008).

4.1.3 Management if ASS Cannot be Avoided

If identified ASS material cannot be avoided, it must be segregated for neutralisation following excavation. In order to appropriately neutralise the material, it must be analysed (via SPOCAS or S_{CR} suite analyses) to determine its net acidity.

The excavated ASS material will be stockpiled on a bunded pad constructed from alkaline material of not less than 300mm thickness. The pad will be graded to ensure good drainage and the sides will be bunded with limestone or a similar alkaline material to a minimum height of approximately 300mm to prevent lateral migration of any acid drainage and to divert storm water.

The minimum number of samples to be tested will be determined by the total volume of the ore material in the batch as per Table 4-2.

Table 4-2: Minimum Number of Samples to be Collected*

Volume (m^3)	Number of Samples
<250	2
251–500	3
501–1000	4
>1000	1 per 500m^3

*Based on DEC (2009a) guidelines

Initially, samples will be analysed for pH_F and pH_{FOX}. Refer to **DMS-EP-10.1** Acid Sulfate Soils Field Testing Procedure – Burekup West. Samples with a pH_{FOX} >4 will be considered non-ASS and no further analysis will be required.

If any sample from the batch has a pH_{FOX} <4 then 25% of the samples from the batch will require further analysis to quantify their net acidity via the S_{CR} suite method. Samples will be despatched to a NATA-accredited laboratory for the analyses. Acid-Base Accounting will be performed on the results to determine if net acidity in any samples exceed the DEC's texture-based Action Criteria (DEC, 2009a) (Table 4-3). If the Action Criteria are exceeded, neutralisation and verification of the material will be undertaken, as described below. If the net acidity Action Criteria are not exceeded, the material may continue to the feed preparation plant.

Table 4-3: Net Acidity Action Criteria

Type of material		<1000 tonnes of material is disturbed		>1000 tonnes of material is disturbed	
Texture range McDonald et al (1990)	Approx. clay content (%)	Equivalent sulphur (%S) (oven-dry basis)	Equivalent Acidity (mol H+/tonne) (oven-dry basis)	Equivalent sulphur 9%S) (oven-dry basis)	Equivalent Acidity (mol H+/tonne) (oven-dry basis)
Coarse texture Sands to Loamy sands	<5	0.03	18.7	0.03	18.7
Medium Texture sandy Loams to Light Clays	5-40	0.06	37.4	0.03	18.7
Fine texture medium to heavy Clays and Silty Clays	>40	0.1	64.8	0.03	18.7

4.1.4 Neutralisation and Verification

If the Action Criteria are exceeded, the stockpile will be treated with lime to neutralise the acidity present.

Liming Rates

The liming rate will be calculated by determining the mean, standard deviation, and standard deviation plus one of the laboratory-calculated liming rates (excluding any ANC) which will be given with the SPOCAS or S_{CR} Suite methods. Refer to DMS-EP-10.2 Calculation of Net Acidity and Liming rate – Burekup West.

The liming rate then needs to be multiplied by 2 (safety factor), plus corrected for the $CaCO_3$ content and particle size distribution of the neutralising agent chosen. A suitable blending method should be implemented to ensure efficient mixing of the neutralising agent with the ASS material.

The liming rate calculations should be reviewed by a qualified environmental scientist before the rates are exercised on ASS material.

Verification Testing

Following neutralisation, the material requires re-sampling to ascertain if the stockpile has been adequately neutralised. Refer to **DMS-EP-10.5** Verification Testing of Neutralised ASS – Burekup West. The criteria for determine adequate neutralisations are:

- A mean pH_{KCL} of 6.5 or greater for the batch; and
- No detectable net acidity (including acid neutralising capacity, divided by an appropriate fineness factor).

Once the stockpile has been verified and net acidity meets the verification criteria the ore may be transported to the feed preparation plant.

4.1.4.1 Reporting

All field and laboratory results of any testing conducted shall be compiled in separate tables for with each sampling event. The table shall include the date of testing, sample labels, and volume sampled. The table shall include results of pH_F and pH_{FOX} and any additional laboratory analysis conducted (i.e. SPOCAS or S_{CR} results). Comment shall be made if the batch passed or failed to meet net acidity action criteria. Batches which fail to meet net acidity action criteria should include information about the calculated liming rate, the amount of neutralising material applied. Verification sample results tables should indicate if analytical data indicates if the material passes the neutralisation criteria listed above. Soil sample results tables shall be reported in the Annual Environmental Report (AER) and in the ASSMP Closure Report.

4.2 Groundwater Management Strategy

The disturbance of ASS material can lead to release of acid and mobilisation of metals, causing contamination of groundwater which may cause offsite impacts to groundwater and groundwater-dependent ecosystems. Indirect disturbance, via dewatering, is a primary concern at the site, as most of the identified ASS material lies below the base of the proposed pit, where it will not be excavated, but may be exposed to oxidation via dewatering. In order to try to avoid groundwater impacts, management strategies will employ monitoring of groundwater and dewatering effluent.

Table 4-4: Conditions/Commitments to be Satisfied by the Groundwater Management Strategy

Condition/Commitment	Status	Timing
Groundwater sampling and analysis will occur monthly in bores listed in Table 4 (now 4-6) and quarterly in bores listed in Table 5 (now 4-7), or weekly if pH_F<4, for the analytes listed in Table 3 (now 4-5).	In progress	Overall
Groundwater results shall be compared to background data with any anomalies discussed in the AER and the ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of groundwater level, pH, EC, total acidity, total alkalinity, iron, aluminium, and manganese should be included in the report as a minimum.	In progress	Overall
At all times the proponent shall ensure the limit of groundwater drawdown in the proposal area and in the vicinity of the proposal area does not approach the underlying potentially acid-forming substrate to the extent that acidic waters are generated, by monitoring: • Dissolved oxygen; and • Other oxidising agents including nitrate, sulphate and ferric ions; On a daily basis for a period of three months after the groundwater level is within 3 metres of the potentially acid forming substrate and thereafter to the requirements of the CEO of the Department of Environment and Conservation (789:M7.1).	In progress	Overall
Adjacent Groundwater Monitoring Bores Measure the water level in the groundwater monitoring bores listed in Table 1 of this schedule on a monthly basis (Condition 5).	In progress	Overall
Collect a sample from the groundwater monitoring bores listed in Table 1 of this Schedule on a monthly basis. The sample shall be tested for Electrical Conductivity (EC), temperature, field pH (pHf) and Total Titrateable Acidity (TTA) (Condition 6).	In progress	Overall
Collect a sample from the groundwater monitoring bores listed in Table 1 of the schedule on a monthly basis or weekly if the pHf<4, and submit the sample for laboratory analysis for the following parameters: *pH, EC, temperature, Total Dissolved Salts (TDS), Total Acidity, Total Alkalinity, chloride, sulphate, A1, Fe and Mn. *If A1>1mg/1 then additional analyses required for Zn, Cr, Cu, MG, Ni, Cd, Se, As, Pb & Hg. If any of the trigger values listed on Table 2 of this schedule are reached, the contingency actions specified in Section 5.2.2.2 of the *Acid Sulfate Soil Management Plan* dated 12 November 2008 and/or the "Action" column in Table 1 of the Department of Environment and Conservation's (DEC) *Dewatering Effluent and Groundwater Monitoring Guidance for Acid*	In progress	Overall

Condition/Commitment	Status	Timing
Sulphate Soil Areas (June 2006) shall be effected (Condition 7).		
Distant Groundwater Monitoring Bores Measure the water level in the groundwater monitoring bores listed in Table 3 of the schedule on a monthly basis (Condition 8).	In progress	Overall
Collect a sample from the groundwater monitoring bores listed in Table 3 of this Schedule on a quarterly basis (Sept/Dec/Mar/June). The sample shall be tested for electrical conductivity (EC), temperature, field pH and Total Titrateable Acidity (TTA) (Condition 9).	In progress	Overall
Collect a sample from the groundwater monitoring bores listed in Table 3 of the Schedule on a quarterly basis (Sept/Dec/Mar/June) OR weekly if the pHf<4 and submit the sample for laboratory analysis for the following parameters: *pH, EC, temperature, Total Dissolved Salts (TDS), Total Acidity, Total Alkalinity, chloride, sulphate A1, Fe and Mn *If A1>1mg/1 then additional analyses required for Zn, Cr, Cu, Mg, Ni, Cd, Se, As, Pb & Hg If any of the chemistry trigger values listed on Table 2 of this schedule are reached, the contingency actions specified in Section 5.2.2.2 of the *Acid Sulfate Soil Management Plan* dated 12 November 2008 and/or the "Action" column in Table 1 of the Department of Environment and Conservation's (DEC) *Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulphate Soil Areas (June) 2006* shall be effected (Condition 10).	In progress	Overall
Laboratory data (soil and groundwater results) in the vicinity of drill hole 41 (BU007M), known to contain PASS, will be monitored closely to detect any changes in groundwater quality when dewatering occurs in this area.	In progress	Whilst dewatering is occurring within the vicinity of drillhole 41
Continue the monthly monitoring (monthly or quarterly) of bores BU009, BU008, BU007M, BU007D, MB15, MB16, MB17 and MB18 whilst dewatering the amendment areas and post mining. Parameters to be analysed should include pH, total acidity, total alkalinity, chloride, sulphate, aluminium, manganese and iron.	In progress	Monthly or quarterly overall and post mining.

Condition/Commitment	Status	Timing
Daily monitoring of adjacent bore BU007 for depth, pH, EC, dissolved oxygen, ferric, sulfate and nitric ions.	In progress	Whilst dewatering is in the vicinity of Dowdells Line and St Helena Rd.
Monthly monitoring of adjacent bore BU007 for depth, pH, EC, temp, total dissolved salts, total acidity, total alkalinity, chloride, sulfate, Al, Fe and Mn.	In progress	Whilst dewatering is in the vicinity of Dowdells Line and St Helena Rd.

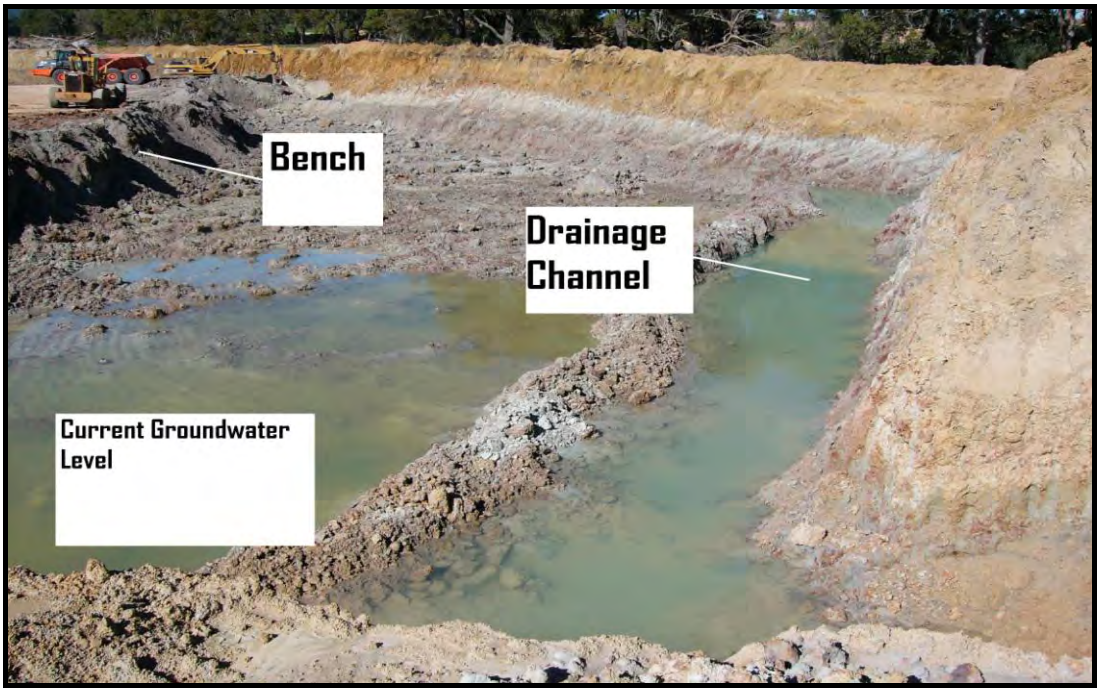
4.2.1 Groundwater Management

As the orebody is mined using dry mining methods, where the ore is below the natural groundwater table, groundwater is managed via limited open pump dewatering. Within individual excavation areas, the deepest area is mined first, following the geological basement up-slope, allowing groundwater to pool in the excavated area (Plate 1), thereby reducing dewatering requirements.

Drainage channels will be established around the perimeter of each pit allowing the dry mining techniques to be employed and diverted groundwater to re-infiltrate the superficial aquifer (Plate 2). These drainage channels will aid in reducing the effective radius of influence, defined as an air exchange distance from the geological window (i.e. the pit) that a given percentage of the atmospheric oxygen content reaches during a certain period with high atmospheric pressure (Elberling *et al.*, 1998).

Plate 1: Control of Groundwater by Mining the Deepest Horizon first, then Moving up Slope

Plate 2: Water will re-infiltrate the Aquifer through Drainage Channels Constructed around the Perimeter of the Pits



4.2.2 Groundwater Quality Monitoring

The groundwater monitoring analytes in Table 4-5 (on the following page) have been designed after consideration of the Licence to Take Water (GWLL168577) issued by the DoW, DEC guidelines (2009a), and previous DEC comments (Section 1.7) in order to assess major indicators of ASS impacts on groundwater.

Table 4-5: Groundwater Monitoring Analytes

Water Analytes	
Analytes	**Field or Laboratory Testing**
pH	Field
EC	Field
Temperature	Field
Total Titratable Acidity (TTA)	Field
Total Dissolved Salts (TDS)	Laboratory
Total Acidity	Laboratory
Total Alkalinity	Laboratory
Chloride	Laboratory
Sulfate	Laboratory
Aluminium (dissolved and filtered)	Laboratory
Iron (dissolved and filtered)	Laboratory
Manganese (dissolved and filtered)	Laboratory
If Al is >1mg/l then additional analysis required for metals (dissolved and field filtered):	
Zinc	Laboratory
Chromium	Laboratory
Cadmium	Laboratory
Copper	Laboratory
Magnesium	Laboratory
Nickel	Laboratory
Selenium	Laboratory
Arsenic	Laboratory
Lead	Laboratory
Mercury	Laboratory

Groundwater sampling and analysis will occur monthly in bores listed in Table 4-6 and quarterly in bores listed in Table 4-7, or weekly if pH_F<4, for the analytes listed in Table 4-5. Bore BU007 will be monitored daily whist dewatering is occurring in the vicinity of Dowdells Line and St Helena Rd (Table 4-8).

For radiation monitoring see Doral's *Radiation Management Plan*.

Table 4-6: Groundwater Bores to be Monitored Monthly

Lease No.	Bore ID	Easting	Northing
M70/720	BU003	388253	6309453
M70/652	BU004D	387656	6309555
M70/653	BU004M	387657	6309554
M70/720	BU005D	386540	6307975
M70/720	BU005M	386541	6307975
M70/720	BU007D	387560	6308731
M70/720	BU007M	387561	6308732
M70/720	BU011D	386854	6308796
M70/721	BU011M	386853	6308797
M70/720	BU012D	386927	6307556
M70/720	BU013S	386763	6308392
M70/720	BU013M	386764	6308392
M70/652	BU015	387976	6309945
M70/652	BU018	388880	6310790
M70/720	BU019M	TBC	TBC
M70/720	BU019D	TBC	TBC

Table 4-7: Groundwater Bores to be Monitored Quarterly

Lease No.	Bore ID	Easting	Northing
M70/652	BU001	388764	6311593
M70/652	BU002	389183	6310669
M70/720	BU006D	387572	6307624
M70/720	BU006M	387571	6307623
M70/720	BU008	388385	6308913
M70/652	BU009	389193	6310096
M70/652	BU010	387607	6310987
M70/720	BU014S	387596	6308304
M70/721	BU014M	387596	6308303
M70/652	BU016M	387941	6310309
M70/652	BU017	388608	6311230

Lease No.	Bore ID	Easting	Northing
M70/652	BU016D (Leederville No. 1)	387959	6310294
M70/720	BU013D (Leederville No. 2)	386786	6308414

Table 4-8: Groundwater bores to be monitored daily whilst in the vicinity of drillhole 41

Lease No.	Bore ID	Easting	Northing
M70/720	BU007D	387560	6308731
M70/720	BU007M	387561	6308732

As per Ministerial Statement 789 Condition 7-1, to ensure that the limit of groundwater drawdown in the proposal area and vicinity of the western extension does not approach the underlying potentially acid-forming substrate to the extent that acidic waters are generated, monitoring of dissolved oxygen, nitrate, sulfate and ferric ions will be conducted on a daily basis for a period of three months after the groundwater level is within 3m of the potentially acid forming substrate and thereafter to the requirements of the DEC.

Cross sections through PASS material within 2m of the mine pit floors are presented in Appendix A. When groundwater levels are within 3m of PASS, monitoring of the above analytes will commence.

4.2.3 Groundwater Level Monitoring

Water levels in the groundwater bores listed in Table 4-6 shall be measured monthly and those listed in Table 4-7 shall be measured quarterly.

BU020M, BU020D, BU021M and BU021D installed as recommended by PB (2009) for the amendment area, will be monitored for groundwater levels on a monthly basis.

4.2.4 Trigger Values for Groundwater Monitoring

A summary of the site ranges per bore is shown on the following page. A trigger value has been set by calculating the mean of the background data and adding or subtracting two standard deviations of the background data. The right hand column illustrates the trigger values for a reduction in pH, reduction in total alkalinity, an increase in total acidity, and increase in iron, aluminium and manganese for each bore. If these trigger values are exceeded, the Groundwater Contingency Plan (Section 4.2.5) will be implemented. Bores BU012–BU018 which were installed in March/April 2009, do not have trigger levels set as only one round of background data was collected before dewatering began. For these bores, sustained increasing trends in total acidity and metals data and sustained decreasing trends in pH and total alkalinity will enact the contingency plan (Section 4.2.5).

Table 4-9:Site Summary Data Western Extension Bores

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU001	pH	4.49-5.26	4.85	4.51
	Acidity	20-100	70	118
	Alkalinity	7-15	11.4	18.6
	Al	0-1.3	0.16	0
	Fe	0.1-5.6	3	5.6
	Mn	0.54-0.67	0.60	0.68
	Sulfate	0-729	615	923
	Chloride	2660-5400	4632	5680
	EC	12500-14000	13327	14191
	TDS	8730-9100	8882.5	9204.5

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU002	pH	5.17-5.69	5.4	5.08
	Acidity	12-158	75.2	149.2
	Alkalinity	6-37	28.75	8.75
	Al	0-0.014	0.002	0.007
	Fe	0.37-8.8	6.34	11.14
	Mn	0-0.059	0.04	0.07
	Sulfate	18.9-29	24.1	29.62
	Chloride	250-330	302	338
	EC	1110-1290	1197	1299
	TDS	570-740	622.5	782.50

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU003	pH	4.59-5.40	4.9	4.5
	Acidity	24-134	71	141
	Alkalinity	2-15	7.7	0
	Al	0-0.045	0.025	0.06
	Fe	0-3.1	1.63	4.29
	Mn	0-0.045	0.02	0.06
	Sulfate	36.7-67.2	46.5	61.5
	Chloride	350-543	429	521
	EC	1383-2160	1598	1978
	TDS	650-950	768	988

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU004D	pH	3.87-6.31	5.7	4.7
	Acidity	14-200	85	193
	Alkalinity	32-112	89	33
	Al	0-1.7	0.16	0.66
	Fe	0-21	17.2	30.2
	Mn	0.14-0.27	0.23	0.29
	Sulfate	47-65	53	61
	Chloride	360-490	443	493
	EC	1620-1960	1802	1964
	TDS	880-1100	952	1158

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU004M	pH	5.46-5.98	5.7	5.55
	Acidity	14-200	83.4	142
	Alkalinity	24-87	66	45
	Al	0-0.025	0.003	0.01
	Fe	0-18	11.4	15.8
	Mn	0.13-0.23	0.19	0.25
	Sulfate	46.7-80	54	61
	Chloride	360-510	453	483
	EC	1708-2000	1796	1862
	TDS	890-1100	952	1150

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU005D	pH	4.59-5.21	4.84	4.68
	Acidity	18-160	96	144
	Alkalinity	4-15	11	2.4
	Al	0-0.034	0.009	0.03
	Fe	1.5-2.2	1.76	2.56
	Mn	0.086-0.11	0.087	0.11
	Sulfate	27.1-90	65	95
	Chloride	770-1000	889	1013
	EC	2860-3150	2986	3136
	TDS	1540-1800	1660	1888

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU005M	pH	5.02-5.75	5.6	5.2
	Acidity	24-100	56.8	106.8
	Alkalinity	24-57	50	37
	Al	0-0.14	0.03	0.13
	Fe	0.08-0.37	0.11	0.24
	Mn	0.023-0.04	0.02	0.06
	Sulfate	100-140	115	137
	Chloride	1500-1900	1668	1902
	EC	5070-5490	5333	5567
	TDS	2760-3200	3014	3366

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU006D	pH	4.45-4.86	4.63	4.35
	Acidity	22-130	79	153
	Alkalinity	2-25	9.2	0
	Al	0-0.015	0.0044	0.02
	Fe	1.3-2.7	2.3	3.46
	Mn	0-0.03	0.02	0.04
	Sulfate	16-63	25.8	51.80
	Chloride	210-810	330	714
	EC	840-1128	932	1084
	TDS	360-1300	650	1524

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU006M	pH	4.99-5.69	5.22	4.78
	Acidity	54-150	83	147
	Alkalinity	10-32	22	2
	Al	0-0.019	0.007	0.027
	Fe	3.9-7.3	5.46	8.46
	Mn	0-0.035	0.02	0.04
	Sulfate	20-104	60.7	110.7
	Chloride	260-690	533	783
	EC	1677-2502	2038	2494
	TDS	540-1300	942.5	1602.5

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU007D	pH	3.54-5.63	4.85	3.85
	Acidity	26-140	73	145
	Alkalinity	4-22	12.6	0
	Al	0-0.017	0.003	0.02
	Fe	7.4-9.9	8.4	11
	Mn	0.06-0.096	0.08	0.11
	Sulfate	17-22.3	18.8	22.40
	Chloride	209-310	246	306
	EC	857-1024	931	1063
	TDS	390-620	475	675

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU007M	pH	4.32-5.63	4.88	4.20
	Acidity	30-150	67	149
	Alkalinity	0-210	49.6	0
	Al	0-0.033	0.006	0.03
	Fe	7.6-11	9.8	13.2
	Mn	0.077-0.11	0.09	0.11
	Sulfate	16-24	19.7	24.90
	Chloride	240-310	274	324
	EC	850-1053	1008	1126
	TDS	490-680	555	729

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU008	pH	3.38-4.43	4	3.46
	Acidity	32-130	83	139
	Alkalinity	0-2	0.4	0
	Al	0-0.25	0.14	0.4
	Fe	0.26-0.51	0.34	0.54
	Mn	0.02-0.54	0.12	0.58
	Sulfate	22-28	24.84	28.64
	Chloride	260-360	318	376
	EC	1079-1342	1177	1321
	TDS	540-740	626	830

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU009	pH	4.73-5.28	4.92	4.62
	Acidity	18-140	81	159
	Alkalinity	2-15	7.56	0
	Al	0-0.066	0.009	0.049
	Fe	0.49-6.3	4.56	7.70
	Mn	0.03-0.05	0.035	0.06
	Sulfate	11-20.1	14.8	18.8
	Chloride	180-284	204	254
	EC	707-1150	814.7	1019
	TDS	340-480	380	514

Bore	Analyte	Baseline Range	Baseline mean	Trigger Mean +/- 2SD
BU010	pH	5.57-6.28	5.76	5.40
	Acidity	16-88	43.4	91.40
	Alkalinity	22-53	47	25
	Al	0-1.3	0.13	0.93
	Fe	0-9.3	3.34	12.64
	Mn	0.31-0.42	0.36	0.43
	Sulfate	53.8-101	83	105
	Chloride	1200-1900	1381	1681
	EC	3610-4590	4260	4652
	TDS	2400-2500	2447.5	2557.5

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU011D	pH	4.01-5.94	5	5.8
	Acidity	20-155	72	160
	Alkalinity	4-20	13	23
	Al	0-0.017	0.002	0.012
	Fe	0-4.8	4	6.66
	Mn	0.05-0.06	0.05	0.056
	Sulfate	16.3-24	19.4	23.20
	Chloride	193-250	207	239
	EC	703-1000	808	968
	TDS	380-690	460	766

Bore	Analyte	Baseline Range	Baseline Mean	Trigger Mean +/- 2SD
BU011M	pH	4.70-5.71	5	4.4
	Acidity	27-160	80	166
	Alkalinity	3-21	14.5	0
	Al	0-0.02	0.004	0.02
	Fe	0-7.1	4.64	8.12
	Mn	0.05-0.09	0.068	0.09
	Sulfate	9.4-30	23	33
	Chloride	195-517	304	474
	EC	824-1688	1129	1613
	TDS	440-1370	762	1492

DEC guidelines indicate that chemical indicators of groundwater at the water table being affected by the oxidation of sulfides include:

- A sulfate/chloride mg/L ratio greater than 0.5;
- An alkalinity/sulfate mg/L ratio of less than 5;
- A pH of less than 5; and
- A soluble aluminium concentration greater than 1mg/L.

4.2.5 Contingency Plan

Should groundwater quality trigger values be breached, the initial response will be to increase the frequency of groundwater monitoring from monthly/quarterly to weekly. The results will be assessed against the trigger values in the site summary tables.

If groundwater does not show an improvement (i.e. a return to background levels), the DEC will be notified (in accordance with the timeframes outlined in Part 2, Division 1, Section 11 of the *Contaminated Sites Act 2003*) and possible causes of the change in quality will be considered. Mining may need to cease until groundwater quality returns to background/acceptable levels, either naturally or through implementation of remedial measures.

The details of downstream bore locations utilised by other land users are shown in Table 4-10 and their locations shown in Figure 2. Should groundwater become acidic and contaminated with heavy metals, downstream users will be supplied with an alternative water source provided by Doral to ensure they have an adequate uncontaminated supply of water.

Table 4-10: Landowner Bore Locations and Details

Bore	Easting (m) MGA94	Northing (m) MGA94	Utilisation	Equipped
L2B1	386,116	6,309,204	Stock and backup for the house. Rainwater supplies house	Pump to dam at dairy
L10B1	387,513	6,312,315	NA	NA
L13B1	385,522	6,308,275	Troughs/dairy	Pump
L11B1	384,605	6,308,560	At houses, stock	Submersible pump
L500B1	386,641	6,310,367	Irrigation/stock	To be equipped with sub pump
L31B1	386,746	6,311,493	Stock, domestic, dairy	Surface pump
L303B1	386,784	6,310,306	Troughs/stock	Submersible pump
L20B1	385,850	6,307,841	House, gardens, cattle, troughs	Submersible pump
L14B1	385,841	6,308,358	Hay (sprinklers) stock, houses (not drinking)	NA

(PB, 2007) NA = Information not available

4.2.1 Reporting

Groundwater results shall be compared to background data with any anomalies discussed in the AER and the ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of groundwater level, pH, EC, total acidity, total alkalinity, iron, aluminium, and manganese should be included in the report as a minimum.

4.3 Dewatering Effluent Management Strategies

Table 4-11: Conditions / Commitments to be Satisfied by the Dewatering Effluent Management Strategy

Condition/Commitment	Status	Timing
One sample point will be established to collect dewatering effluent at a location prior to the water reaching the process water pond. As a default, a sample of water from this point shall be collected daily, and subject to field analysis of electrical conductivity, pH, temperature and total titratable acidity (TTA), which will be recorded in a field log.	In progress	Overall
Field and laboratory dewatering effluent data shall be compared to the trigger values in Table 4 (now 4-10) and results discussed in the AER and ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of pH, total acidity, EC, total alkalinity, iron, aluminium, and manganese should be included in the report as a minimum.	In progress	Overall
Dewatering will be managed to avoid the cone of depression from dewatering of mine pits extending to greater than 10m BGL in the amendment areas. This will minimise the potential for oxidising any PASS which may occur in the underlying Leederville sediments. To achieve this ensure a saturated pit floor is maintained at the deepest depth of the mine pit at all times.	In progress	Overall
Conduct regular dewatering effluent monitoring in accordance with current practices required by the ASSMP, when mining the new mine pits for the amendment areas.	In progress	Overall
Routing monitoring of daily pit dewatering effluent for pH, TTA, temp and EC	In progress	Overall

4.3.1 Method of Dewatering

Dewatering will occur to remove water from the base of the mine pits or to lower the water table. The water will be pumped out by a suction pump and sent through to a sump and then to an unlined process water pond where it mixes with other water from other mine processes. Water from this pond is used in mining processes, and also infiltrates to groundwater at the site.

Only suction pumps (no submersible pumps) are used for dewatering and the suction pumps are set up at a level to maintain a 0.5m saturated pit floor. This is constantly inspected visually during the mining operation.

4.3.2 Indirect Disturbance to ASS by Dewatering

Groundwater modelling (PB, 2009) indicates when the Burekup West pits are dewatered simultaneously with the amendment area pits, the maximum drawdown adjacent to active mine pits will be 7m (Figure 1). The cone of depression within the superficial aquifer will extend up to 1.5km to the west from the mine pits, up to 1km to the north and 1.5km to the south by April 2013.

The majority of PASS is generally located at depths greater than 9-10m BGL in the Leederville sediments and should not be distubed. SWC (2007a) state that mining of the Burekup deposit will not involve excavation of the Leederville sediments, therefore there will be no disturbance of PASS.

The distance between the base of the proposed mine pit and the upper surface of the PASS material in the Leederville Formation varies considerably across the site. Typically this distance is >3m, however in areas where the orebody dips downward or the PASS sediments rise upwards the base of the mine pit may come within 1m of the pyritic material (SWC, 2007a).

Indirect disturbance to the small volume of ASS identified in Section 4.1.2 may occur, however any resulting change to water quality will be monitored via the extensive network of groundwater bores and in the dewatering effluent monitoring described in Section 4.3.3. By maintaining a saturated pit floor, the ASS identified below the base of the pits in the Leederville sediments will stay waterlogged.

4.3.3 Dewatering Effluent ASS Monitoring and Management

One sample point will be established to collect dewatering effluent at a location prior to the water reaching the process water pond. As a default, a sample of water from this point shall be collected daily, and subject to field analysis of electrical conductivity, pH, temperature and total titratable acidity (TTA), which will be recorded in a field log. Depending on the pH and TTA results, neutralisation of the effluent and/or additional monitoring and management may be required, as indicated in Table 4-12.

Table 4-12: Response Actions Depending on Daily Readings of pH and TTA

Trigger Criteria		Action
pH	TTA	
>6	<40mg/L	Continue daily field measurements of pH and TTA.
<6	<40mg/L	Undertake neutralisation treatment (liming).
>6	>40mg/L	Undertake neutralisation treatment (liming).
<6	<60mg/L	Undertake neutralisation treatment (liming) and aeration to precipitate iron followed by settling/flocculation treatment to settle out precipitates.
<4	>60mg/L	Increase monitoring frequency to twice daily. Increase neutralisation treatment (liming) rate and aeration to precipitate iron followed by settling/flocculation treatment to settle out precipitates. Advise the DEC Acid Sulfate Soil Section (Contaminated Sites Branch) immediately.

On a monthly basis, samples of dewatering effluent will be collected and analysed for the analytes listed in Table 4-5. If pH_F <4 the sampling shall be conducted weekly.

4.3.4 Contingency Plan

Table 4-12 on the previous page provides trigger criteria and recommended actions for managing dewatering effluent. Generally, a reduction in dewatering effluent quality (as a decrease in pH and increase in TTA) lead to changes in the frequency of monitoring and the parameters required for analysis, and undertaking neutralisation treatment (liming). Contingency measures for managing poor-quality dewatering effluent may also require redirecting the dewatering effluent away from the process water pond into a series of sediment basins or trenches or other treatment system to allow precipitation of iron and other metals. Refer to DEC (2009b) for guidance in this instance.

If dewatering effluent with TTA >40mg/L has entered the dropout pond, it is possible metals will settle out and contaminate the existing sediment. If this occurs, the sediments from the pond will need to be removed and sampled in accordance with DoE landfill disposal guidelines (2005). Sediment results will be assessed against Ecological Investigation Limits (EIL) criteria for soil (DoE, 2003). If the material meets EIL criteria it can stay on site or be disposed of as clean fill. If the material does not meet EIL guidelines and requires disposal at landfill then DoE (2005) guidelines apply. This will also apply if sediment basins/trenches are used, in order to decommission the basin/trenches after use to assess sediments for contamination.

4.3.5 Reporting

Field and laboratory dewatering effluent data shall be compared to the trigger values in Table 4 and results discussed in the AER and ASSMP Closure Report. Appropriate field and laboratory quality control data shall also be reported. Trend graphs of pH, total acidity, EC, total alkalinity, iron, aluminium, and manganese should be included in the report as a minimum.

If the sediments from ponds or trenches are sampled and analysed as described above, these results will need to be reported. Comment should be made as to the fate of these sediments (i.e. disposed of to landfill, or reused onsite).

4.4 Final Reporting

Doral commit to reporting on the ASS Management in an Annual Environmental Report to be provided to the DEC each year as part of licence conditions for the site. An ASSMP Closure Report will be prepared as part of the mine closure and rehabilitation plan for the Dardanup Mine. The purpose of the Closure Report is to show implementation and compliance with the ASSMP. Table 4-13 outlines the reporting requirements for Burekup West (including the amendment area).

Table 4-13: Reporting Requirements

Item	Reported In	Timing	Reported To
Soil sample results tables	• Annual Environmental Review • ASSMP Closure Report	• Annually • At mine closure	DEC Contaminated Sites Branch, Acid Sulfate Soil Section
Groundwater data and trends graphs	• Annual Environmental Review • ASSMP Closure Report	• Annually • At mine closure	DEC Contaminated Sites Branch, Acid Sulfate Soil Section
Dewatering effluent data	• Annual Environmental Review • ASSMP Closure Report	• Annually • At mine closure	DEC Contaminated Sites Branch, Acid Sulfate Soil Section

5 RELEVANT ENVIRONMENTAL OPERATING PROCEDURES

The following Environmental Operating Procedures are relevant to the implementation of this Acid Sulfate Soils Management Plan:

- **DMS-EP-2.3** Groundwater Monitoring Procedure – Burekup West;
- **DMS-EP-2.5** Interpretation of Groundwater and Dewatering Effluent Results – Burekup West;
- **DMS-EP-2.7** Monitoring of Dewatering Effluent – Burekup West;
- **DMS-EP-2.9** Preparation of Samples for the Laboratory – Burekup West;
- **DMS-EP-2.10** Decontamination of Groundwater Sampling Equipment Procedure;
- **DMS-EP-2.12** pH Measurement at the Thickener – Dardanup Mine;
- **DMS-EP-10.1** Acid Sulfate Soils Field Testing Procedure – Burekup West;
- **DMS-EP-10.2** Calculation of Net Acidity and Liming Rate – Burekup West;
- **DMS-EP-10.3** Preparation of Hydrogen Peroxide Solution – Burekup West;
- **DMS-EP-10.5** Verification Testing of Neutralised ASS – Burekup West;

These Environmental Operating Procedures are provided in **Section 3** in the EMS.

6 REFERENCES

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Figures

Acid Sulfate Soils Management Plan Burekup Mineral Sands Deposit
Doral Mineral Sands Pty Ltd

386000 m | 386500 m | 387000 m | 387500 m | 388000 m | 388500 m | 389000 m | 389500 m

6311500 m | 6311000 m | 6310500 m | 6310000 m | 6309500 m | 6309000 m | 6308500 m | 6308000 m | 6307500 m | 6307000 m

Predicted Groundwater Drawdown at Jan 2011
PASS Above Pit Floor
PASS Within 2m of Pit Floor
PASS Drillholes
PASS above pit floor
PASS within 2m of pit floor
Proposed Mine Layout
Pit Crest
Burekup West
Amendment Area
Aerial Photo 2009
Dardanup Regional 2006

N

0.25 | 0.5 | 1 | 3 | 5 | 7

6 bcm
513 bcm
1 bcm

A2
B2
A1
B1

DOWDELLS LINE
WILD ROSE RD
O'CONNOR RD
OFFER RD
EDWARDS RD
ST HELENA RD
HARRIS RD
SIMPSON RD

0 500 m

Doral

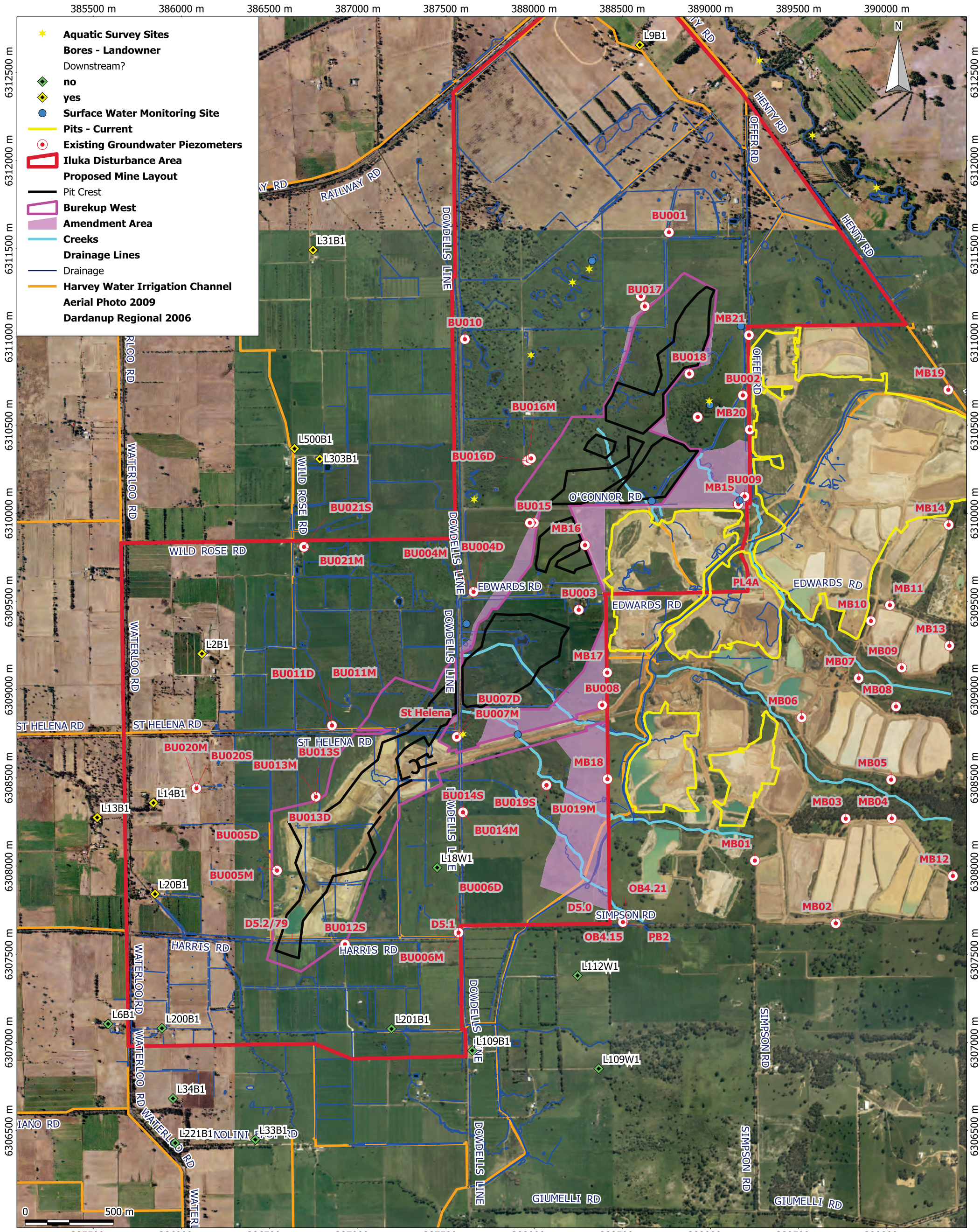
PASS Distribution

Scale:	Projection:	Sheet Size:
1:15000	Australia MGA94 (50)	A3

Acid Sulfate Soils Management Plan
Burekup Mineral Sands Deposit

Figure 1

Date:25/08/2010



Doral

Bore Locations

Scale: 1:20000	Projection: Australia MGA94 (50)	Sheet Size: A3

Acid Sulfate Soils Management Plan
Burekup Mineral Sands Deposit

Figure 2

Date:25/08/2010

APPENDIX B: DARDANUP MINE PRE-MINING AGRICULTIRAL ASSESSMENT

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 12, EDWARDS ROAD, BUREKUP.
OWNER, ILUKA RESOURCES LIMITED.
ADDRESS, GPO BOX U1988, PERTH WA 6845.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 12, Edwards Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 4 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessintial Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

The Lot.

Lot 12 Edwards Road Burekup is rural block of approximately 58 hectares accessed by Edwards Road. This lot is owned by Iluka Resources Limited and is leased by Mr Bill Olsthorne and managed in association with other land in the area to support a beef grazing enterprise.

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.
Approximately 30% of the lot comprising an area in the south and west adjoining lot 102 will be disturbed by the proposed mining activity.
This part of the lot is park land cleared to a level suitable for grazing only.
The remnant vegetation being principally flooded gum (E rudis) with some paperbark (Melaleuca sp.).

Weeds.

No weeds were observed during the course of the inspection nor were any reported by the lessee.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C. The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The improvements on the lot consisted of :-

- Boundary and subdivisional fencing which while still stock proof was approaching the end of its useful life.
- Several excavated waterholes providing stock water.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy

loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

	Annual horticulture.	Perennial horticulture.
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

	Vines.	Cropping.
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

- Grazing.

P1a	>70% class 1, 2 or 3.
P1b	>70% class 1, 2 or 3.
P6b	>70% class 1, 2 or 3.

P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection of the area of proposed mining activity on this lot revealed it to be gently undulating with low rises interspersed with shallow winter wet/inundated depressions (crab holes) and incised drains in the south east and south west. The soils had loamy surface profiles over mottled clay at depths ranging 60 to 100 centimetres representative of the P1b land unit. In all instances the soils showed evidence of being winter wet and in some instances winter inundated. There was evidence of pugging as a result of winter grazing on some areas and winter trafficability by vehicle would be extremely difficult over most of the area.

Soil Analysis Results.

Analysis of the bulk sample from the lot revealed :-

- pH. Satisfactory.
- Salt (EC). Satisfactory.
- Phosphorus. Very high.
- Potassium. High.
- PRI. Very high.

Agricultural Productivity.

At the time of the inspection the area of proposed mining activity on this lot supported a well grown pasture of lotus and grasses, principally rye grass. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in the area reported reduced pasture growth and hay cuts.*

In my opinion a lot such as this requires specific management practices to optimise its productivity which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging, periodic inundation and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

With measures including those listed lots such as this can be very productive producing high yielding quality fodder crops and quality summer grazing.

Conclusions.

This is a relatively large lot for this district and one that requires some specific management tools if productivity is to be maximised.

while the area of proposed mining activity is only a portion of this lot it is an

area of land that will not be without its problems during the post mining rehabilitation due to soil characteristics.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

John Wise Consultancy Pty Ltd is directed and managed by John Wise (B.Sc. Agric) and specialises in land use planning, property appraisals and agricultural advice.

Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, semi protected, relatively well drained.
0 - 10 cm. organic stained sandy loam.
10 - 100 cm. brown sandy clay loam.

Site 2.

Flat, semi protected, subsoil winter wet.
0 - 10 cm. organic stained loamy sand.
10 - 100 cm. grey-brown loamy sand mottled at depth.

Site 3.

Flat, semi protected, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 60 cm. brown sandy loam.
60 - 100 cm. mottled orange-brown clay.

Site 4.

Flat, open, exposed, evidence of subsoil winter waterlogging.
0 - 10 cm. organic stained sandy loam.
10 - 80 cm. grey sandy loam.
80 cm. mottled grey clay.

Appendix 2, Soil Analysis Results.

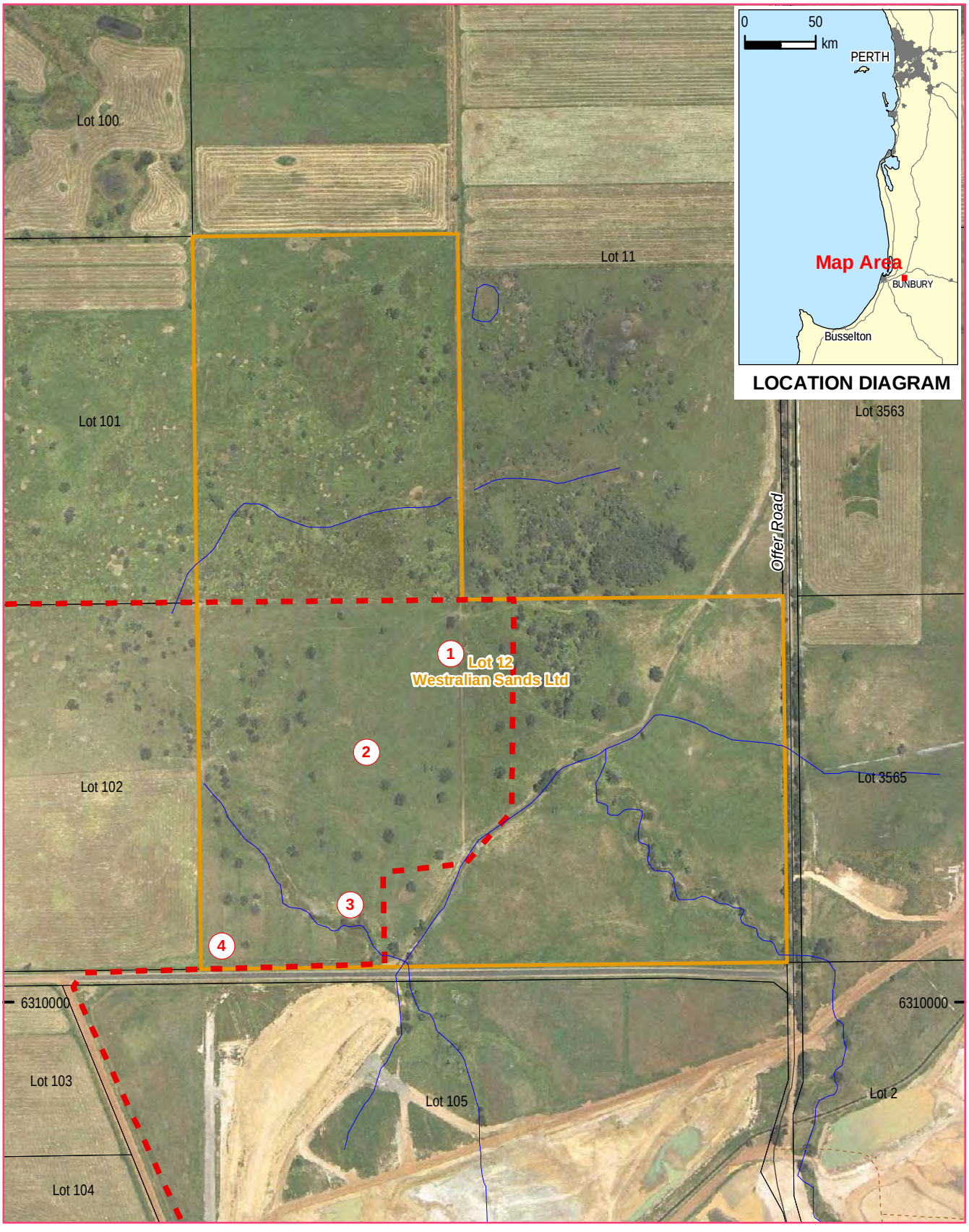
	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.5	15.4	50	179	71.

Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	0	30	0	60	5	5	0	0	0	8-10 t/ha.
Site 2.	0	20	0	30	5	30	5	10	0	7-8 t/ha.
Site 3.	0	20	0	30	5	30	5	10	0	6-7 t/ha.
Site 4.	0	40	0	40	5	5	0	10	0	7-8 t/ha.

Good pasture lot 12, 30/10/2006.

Drainage line & remnant vegetation lot12, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 400 Meters

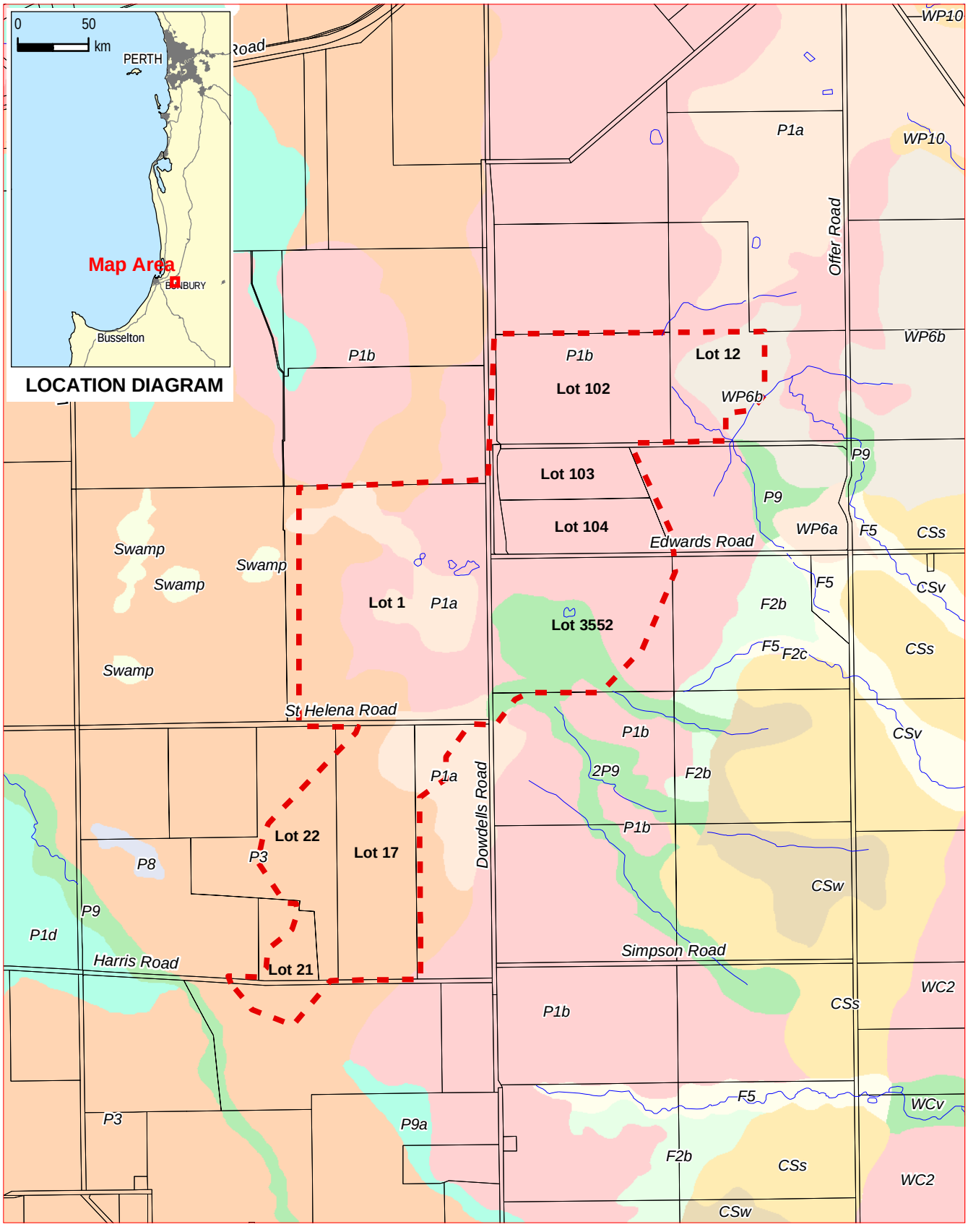
ILUKA

BUREKUP

Lot 12 - Westralian Sands

SITE MAP SOIL EXAMINATION

ORIG: J.Wise				
DRAWN: T.L.G				
SCALE: 1:7,500				
DATE: 5 Dec 2006	DWG No: 170057 ver.00	A4	FIGURE: 1	


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 17, ST. HELENA ROAD, BUREKUP.
OWNER, ILUKA RESOURCES LIMITED.
ADDRESS, GPO BOX U1988, PERTH WA 6845.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 17, St. Helena Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including the pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 3 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessential Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

As part of the investigation discussions were held with the lessee Mr Ken Tyrrell.

The Lot.

Lot 17 St. Helena Road Burekup is a rural block of approximately 42 hectares situated between St. Helena and Harris Roads. The lot is owned by Iluka Resources Limited and is leased by Mr Ken Tyrrell and managed in

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

association with other land in the area to support a dairy operation.
The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.
The lot which was historically used in association with other land in the area as dairy property is fully cleared, sown to improved pastures, and subdivided into a number of paddocks to facilitate controlled grazing.

Weeds.

No noxious weeds were observed during the course of the inspection.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C. The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The lot which was historically part of a larger dairy property is fully cleared improvements include :-

- Sown to improved pastures.
- Subdivided into small paddocks to facilitate controlled grazing.
- the bulk of the lot suitable for hay cutting.
- Boundary and subdivisional fencing which while old is still stock proof.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy

loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

	• Annual horticulture.	Perennial horticulture.
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

	• Vines.	Cropping.
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

• Grazing.

P1a	>70% class 1, 2 or 3.
P1b	>70% class 1, 2 or 3.

P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection revealed the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate hay cutting. The soils had loamy surface profiles over mottled clay at depths of 30 to 50 centimetres and while mottled were better drained than some soils in the area but were still representative of the P3 land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Marginal.
- Salt (EC). Satisfactory.
- Phosphorus. High.
- Potassium. Extremely high.
- PRI. Very high.

Agricultural Productivity.

At the time of the inspection parts of the lot had been recently cut for hay with the residues showing this to be a good mix of lotus and rye grass elsewhere on the lot the pastures were a well grown mix of clovers, lotus and grasses. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.*

However, to maintain this productivity certain management practices are required which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

Conclusions.

This is a productive lot however, at 42 hectares it is too small to be considered a viable agricultural unit on its own particularly as its agricultural capability and suitability is in the area of livestock grazing and pasture production.

In the post mining restoration of this lot attention should be paid to subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

John Wise Consultancy Pty Ltd is directed and managed by John Wise (B.Sc. Agric) and specialises in land use planning, property appraisals and agricultural advice.

Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. brown sandy loam.
30 cm, mottled orange-brown clay loam.

Site 2.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. brown sandy loam.
30 cm, mottled orange-brown clay loam.

Site 3.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. brown sandy loam.
30 cm, mottled orange-brown clay loam.

Appendix 2, Soil Analysis Results.

	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.4	18.2	59	466	107.

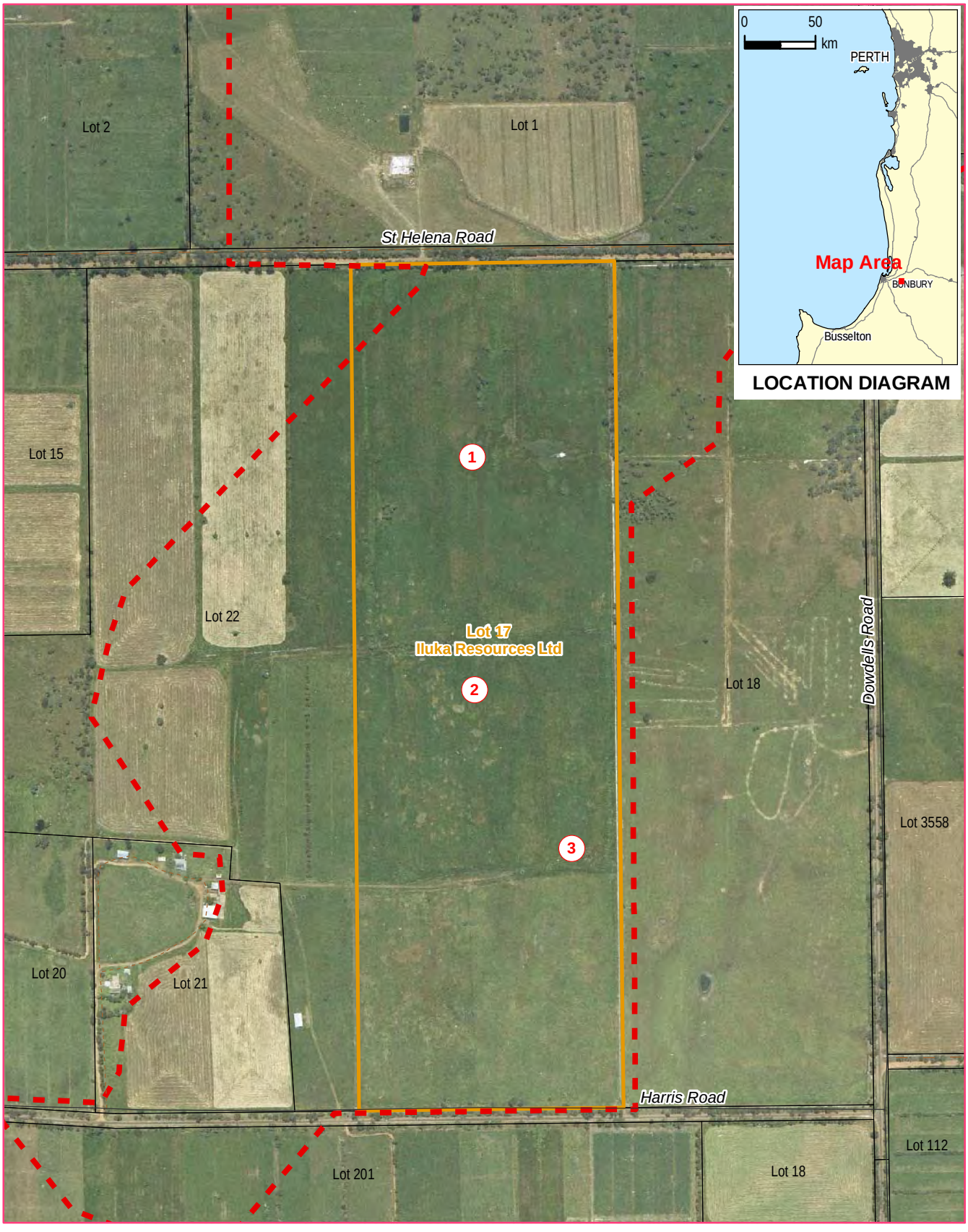
Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	0	20	0	60	5	5	0	10	0	7-8 t/ha.
Site 2.	0	0	0	60	0	0	20	20	0	6-7 t/ha.
Site 3.	0	0	0	100	0	0	0	0	0	8-10 t/ha.

The predominant other grass was kikuyu.

Flatweed dominant pasture lot 17, 30/10/2006.

View south over lot 17, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

0 100 200 300 Meters

N

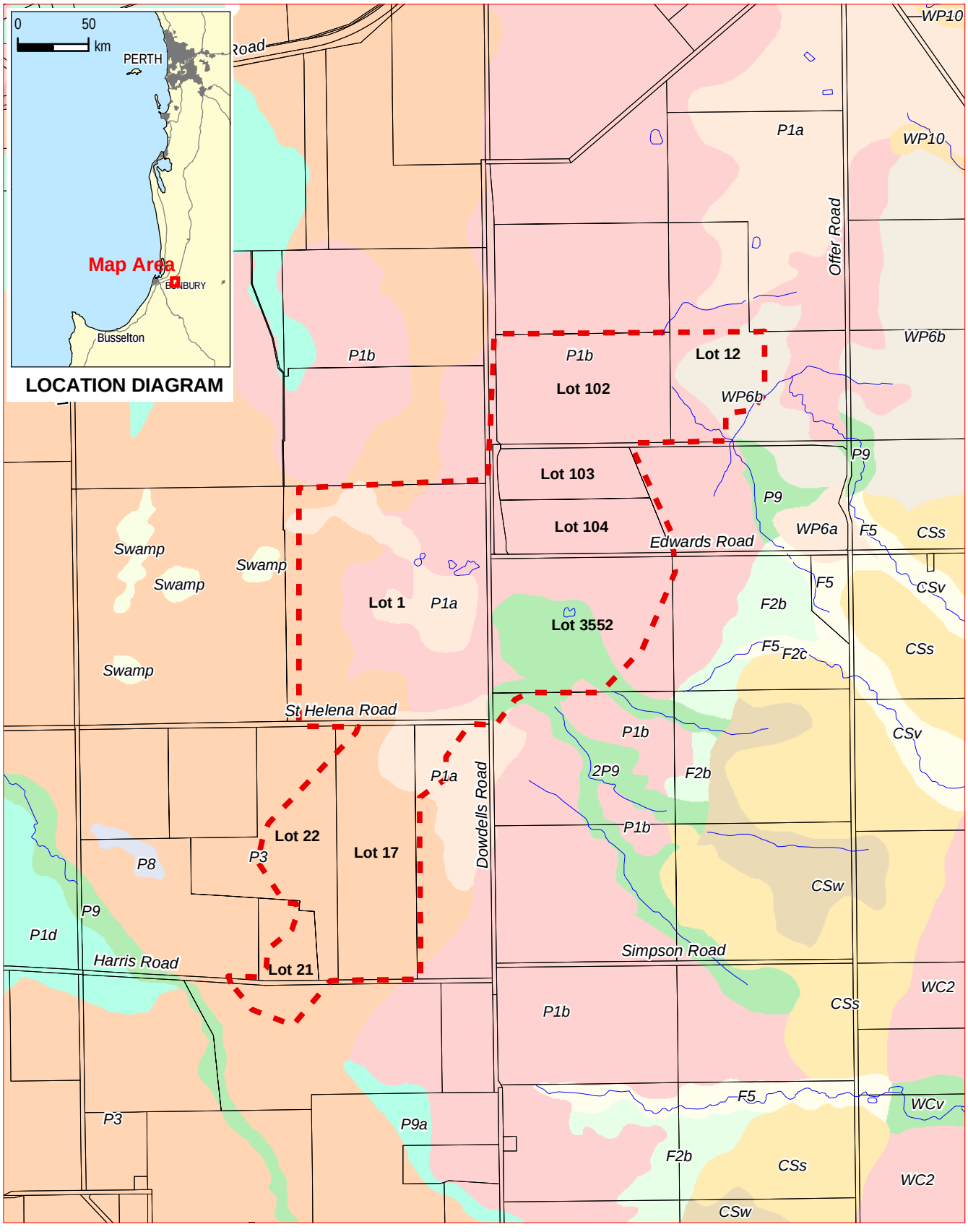
ILUKA

BUREKUP

Lot 17 - Iluka Resources

SITE MAP SOIL EXAMINATION

ORIG: J.Wise			
DRAWN: T.L.G			
SCALE: 1:7,500			
DATE: 5 Dec 2006	DWG No: 170058 ver.00	A4	FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 18, DOWDELLS ROAD, BUREKUP.
OWNER, T. J. DEPIAZZI & SONS.
ADDRESS, "SILVERSPRINGS" FERGUSON ROAD DARDANUP WA 6236.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Figures, Appendices & Attachments.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 18, Dowdells Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 2 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 2.

The Lot.

Lot 18 Dowdells Road Burekup is a rural block of approximately 40 hectares situated between St. Helena and Harris Roads. The lot is owned by T. J. Depiazzi and managed in association with other land in the area to support a beef grazing enterprise.

The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup. The lot which was historically used in association with other land in the area as dairy property is essentially fully cleared, sown to improved pastures, and subdivided into a number of paddocks to facilitate controlled grazing.

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

The location of the proposed mining activity on this lot is in the north west corner and will impact on approximately 5 hectares.

Owner Comments.

Mr Rob Depiazzi pointed out that the soils of the area of proposed mining activity on lot 18 is extremely heavy and that in the rehabilitation process attention should be paid to :-

- Minimising the amount of clay in the surface soil.
- Land shaping to facilitate drainage.

Weeds.

No weeds were observed during the course of the inspection.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.

Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C.

The frequency of frosts is low; the annual average is less than 7.

The growing season breaks on average during the second week of April and lasts for approximately seven months.

This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The area of the lot on which mining is proposed is fully cleared and pastured although the pasture gives the appearance of being somewhat neglected.

There are boundary and subdivisional fences which though old are stock proof.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.

The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.

They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

- Annual horticulture.

P1a	50-70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.
P6b	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.
P9	>70% class4 or 5.

Perennial horticulture.

>70% class 4 or 5.
>70% class 4 or 5.
>70% class 1, 2 or 3.
>70% class 4 or 5.
>70% class 4 or 5.

- Vines.

P1a	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.
P6b	>70% class 1 or 2.
P3	>70% class 4 or 5.
P9	>70% class 4 or 5.

Cropping.

50-70% class 4 or 5.
>70% class1, 2 or 3.
>70% class 1, 2 or 3.
>70% class 4 or 5.
>70% class 4 or 5.

- Grazing.

P1a >70% class 1, 2 or 3.

P1b >70% class 1, 2 or 3.
P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection of the area of proposed mining activity on this lot revealed it to be gently undulating with low rises and shallow depressions. The soils were heavy, hard setting mottled clays with a tendency to pug if grazed when wet. they are representative of the P1a land unit.

Soil Analysis Results.

No bulk sample was collected as the area to be impacted by mining on this lot was so small however, the visual observations would suggest :-

- pH. Marginal.
- Salt (EC). Potentially a problem.
- Phosphorus. Low to marginal.
- Potassium. High (as a function of heavy clay soils).
- PRI. High (as a function of heavy clay soils).

Agricultural Productivity.

The area of proposed mining activity on lot 18 currently gives the impression of being somewhat neglected, the pastures were of poor composition with significant quantities of “soldiers button”, indicative of surface salt and were generally poorly grown. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.*

In the post mining rehabilitation of this area it should be possible to significantly improve the agricultural productivity by :-

- Excluding of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging and suited to heavy hard setting soils.
- Selection of appropriate fertilisers, appreciating that the time of application is constrained by by trafficability.
- A system of land shaping and drainage.

Conclusions.

The area of proposed mining activity on this lot has very heavy hard setting clay soils prone to pugging when grazed in winter. There is also a potential salt problem in this area of the lot.

In the post mining restoration of this lot attention should be paid to

subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

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J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Sites 1 & 2.

Flat, open, exposed, winter wet.

Mottled orange-brown clay at surface.

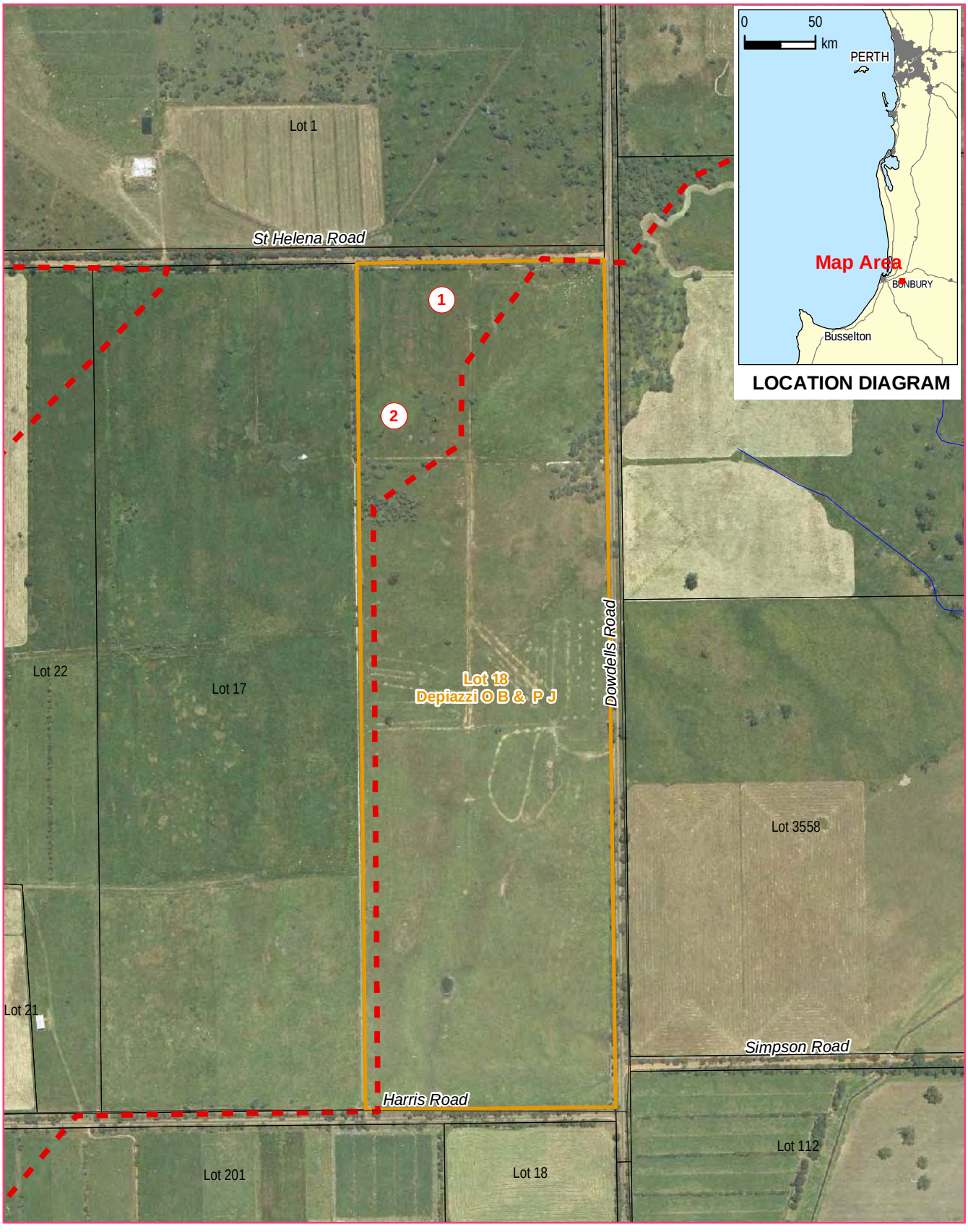
Appendix 2, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.-	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.

Sites 1 & 2. Neglected, pugged and consisting principally of soldiers button and rye grass. 3-5 t/ha.

Pugged pasture dominated by Soldiers Button & rye grass lot 18, 30/10/2006.

View SW across northern part of lot 18, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 Meters

ILUKA

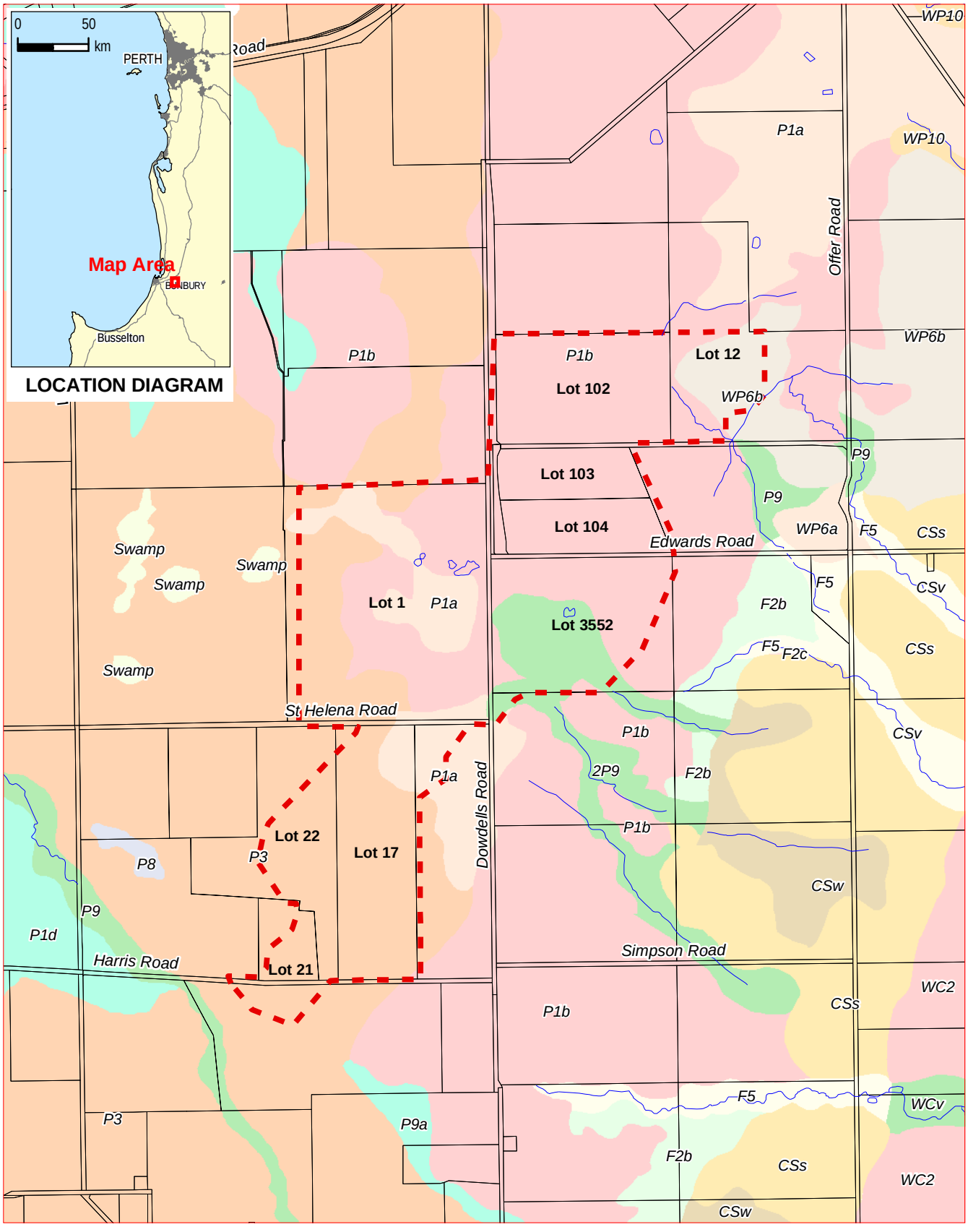
ORIG:	J.Wise
DRAWN:	T.L.G
SCALE:	1:7,500
DATE:	5 Dec 2006

BUREKUP

Lot 18 - Depiazzi O B & P J

SITE MAP SOIL EXAMINATION

DWG No: 170059 ver.00 | A4 | FIGURE: 1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km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
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Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
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ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
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SCALE: 1:25,000
DATE: 23 Mar 2007
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FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 201, HARRIS ROAD, BUREKUP.
OWNER, T. R. BUSHER.
ADDRESS, C/- POST OFFICE DARDANUP, WA 6236.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Figures, Appendices & Attachments.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 201, Harris Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 2 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessintial Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

The Lot.

Lot 201 Harris Road Burekup is a large rural block of approximately 57 hectares situated on Harris Road. The lot is owned by T R Busher and managed in association with other land in the area to support a beef grazing enterprise.

The lot lies on the Swan Coastal Plain some 15 kilometres east of the City

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

of Bunbury and within the Shire of Dardanup.
The lot which was historically used in association with other land in the area as dairy property is fully cleared, sown to improved pastures, and subdivided into a number of paddocks to facilitate controlled grazing.
The area on this lot to be impacted by the proposed mining activity is a small section of about 4 hectares abutting Harris Road.

Weeds.

No weeds were observed during the course of the inspection.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C.
The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The improvements on that part of this lot which will be impacted by mining include :-

- Boundary and subdivisional fencing well maintained and in good condition.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units present on this lot as follows-:

	• Annual horticulture.	Perennial horticulture.
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

	• Vines.	Cropping.
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

• Grazing.

P1a	>70% class 1, 2 or 3.
P1b	>70% class 1, 2 or 3.

P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection revealed the area of proposed mining on the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate irrigation. The soils of this area ranged from loamy surface profiles over mottled clay to soils with surface clay they were representative of the P3 land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Satisfactory.
- Salt (EC). At the higher end of optimum.
- Phosphorus. High.
- Potassium. High.
- PRI. Very high.

Agricultural Productivity.

The pastures on that part of lot 201 to be mined appear neglected and unproductive. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported hay cuts significantly below average.*

I believe that the productivity of this part of lot 201 could be improved significantly by applying the following management practices :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

Conclusions.

The area of proposed mining on lot 201 is currently not being managed to its full potential however, in the post mining restoration of this lot if attention is paid to subsurface and surface drainage, minimising the amount of clay in the surface profile and the selection of appropriate pasture cultivars it should be possible to significantly improve productivity.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during

the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

John Wise Consultancy Pty Ltd is directed and managed by John Wise (B.Sc. Agric) and specialises in land use planning, property appraisals and agricultural advice.

Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 40 cm. pale brown sandy loam.
40 cm. mottled orange-brown clay.

Site 2.

Flat, open, exposed, winter wet.
Pugged mottled clay to surface.

Appendix 2, Soil Analysis Results.

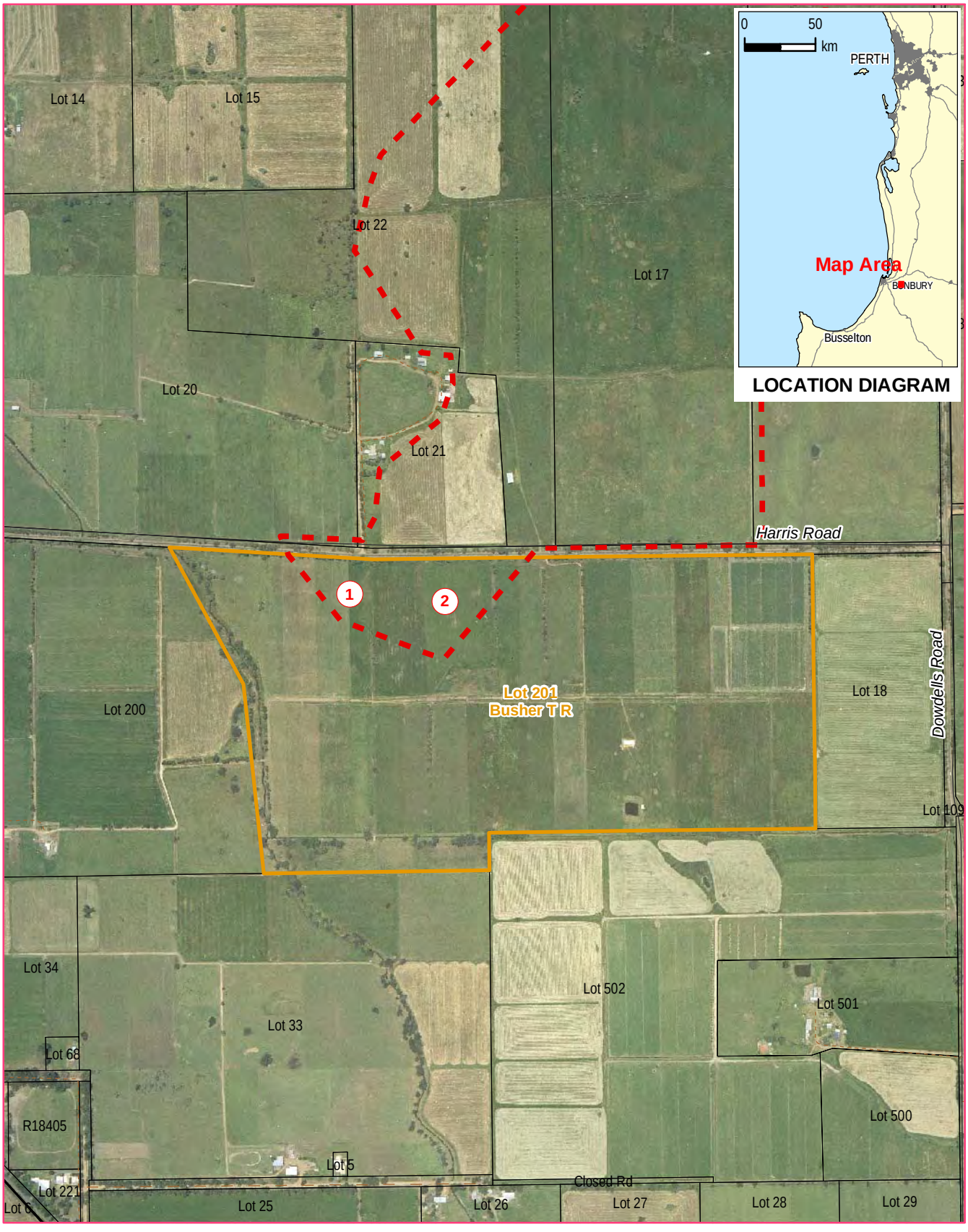
	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.9	19.6	59	394	63.

Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	0	10	0	60	0	0	20	10	0	5-6 t/ha.
Site 2.	Very patchy, some lotus, wire weed rye and soldiers button.									3-4 t/ha.

Pugged & neglected pasture lot 201, 30/10/2006.

Average pasture lot 201, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 400 Meters

ILUKA

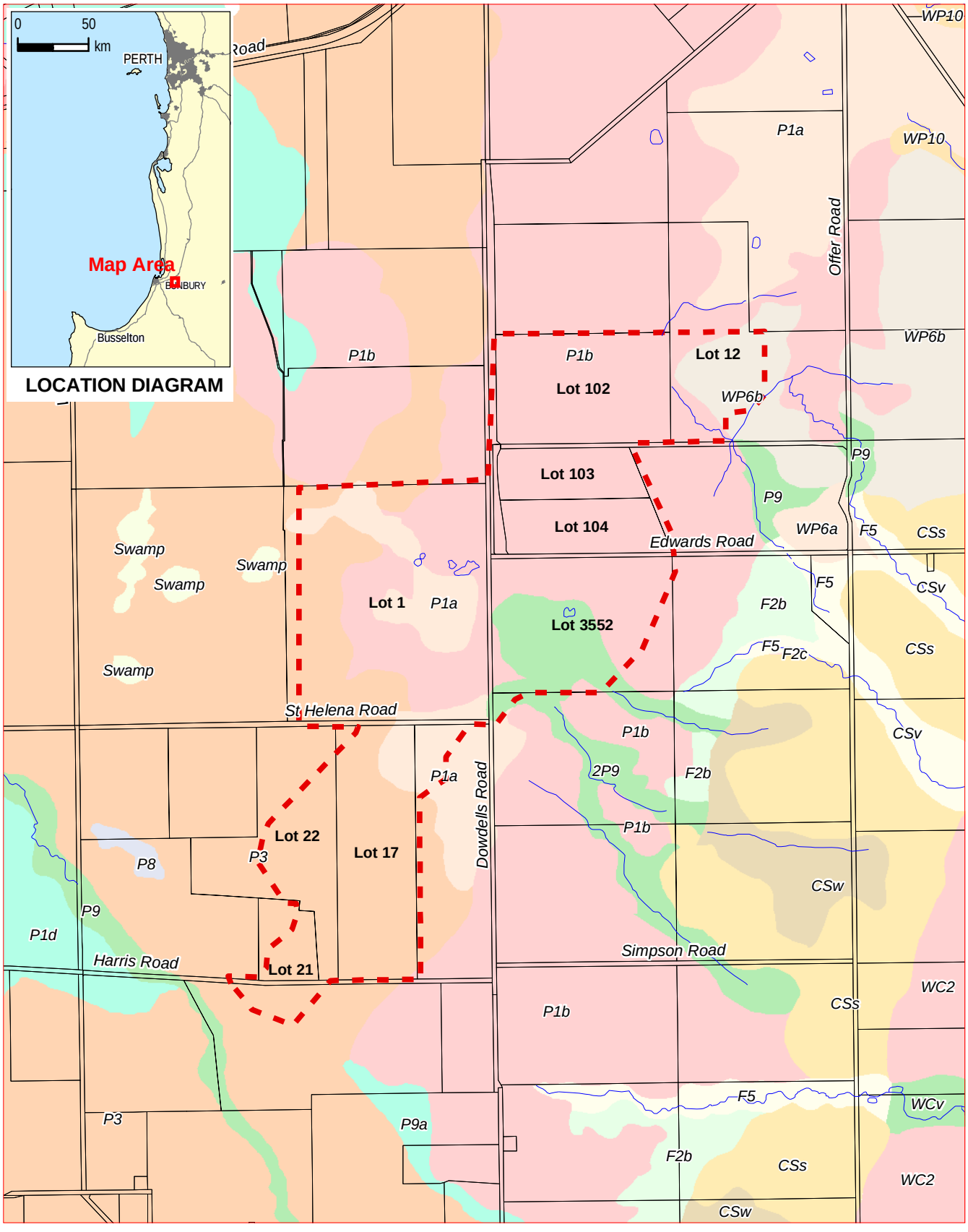
ORIG:	J.Wise
DRAWN:	T.L.G
SCALE:	1:10,000
DATE:	5 Dec 2006

BUREKUP

Lot 201- Busher T R

SITE MAP SOIL EXAMINATION

DWG No: 170065 ver.00 | A4 | FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 21, HARRIS ROAD, BUREKUP.
OWNER, ILUKA RESOURCES LIMITED.
ADDRESS, GPO BOX U1988, PERTH WA 6845.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 21, Harris Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 2 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessintial Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

As part of the investigation discussions were held with the lessee Mr Adrian Tyrrell.

The Lot.

Lot 21 Harris Road Burekup is a small rural block of approximately 9.5 hectares situated on Harris Road. The lot is owned by Iluka Resources Limited and is leased by Mr Adrian Tyrrell and managed in association with

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

other land in the area to support a beef grazing enterprise.
The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.
The lot which was historically used in association with other land in the area as dairy property is fully cleared, sown to improved pastures, and subdivided into a number of paddocks to facilitate controlled grazing.

Weeds.

No noxious weeds were observed during the course of the inspection.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C.
The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The lot which was historically part of a larger dairy property is fully cleared improvements include :-

- Sown to improved pastures.
- Subdivided into small paddocks to facilitate controlled grazing.
- The bulk of the lot suitable for hay cutting.
- Boundary and subdivisional fencing which while old is still stock proof.
- A brick and tile residence, associated outbuildings and an old disused dairy.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for these land units are as follows-:

• <u>Annual horticulture.</u>		<u>Perennial horticulture.</u>
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

• <u>Vines.</u>		<u>Cropping.</u>
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

- Grazing.

P1a >70% class 1, 2 or 3.
P1b >70% class 1, 2 or 3.
P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection revealed the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate hay cutting. The soils had loamy surface profiles over mottled clay at depths of 30 to 50 centimetres and while mottled were better drained than some soils in the area but were still representative of the P3 land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Low.
- Salt (EC). Satisfactory.
- Phosphorus. High.
- Potassium. High.
- PRI. Very high.

Agricultural Productivity.

At the time of the inspection much of the lot had been recently cut for hay with the residues showing this to be a good mix of lotus and rye grass. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.*

However, to maintain productivity certain management practices are required which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

Conclusions.

This is a productive lot however, at 9.5 hectares it is too small to be considered a viable agricultural unit on its own particularly as its agricultural capability and suitability is in the area of livestock grazing and

pasture production, it is essentially a rural lifestyle lot.
In the post mining restoration of this lot attention should be paid to subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

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Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. brown sandy loam.
30 cm. mottled orange-brown clay.

Site 2.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. brown sandy loam.
30 cm. mottled orange-brown clay.

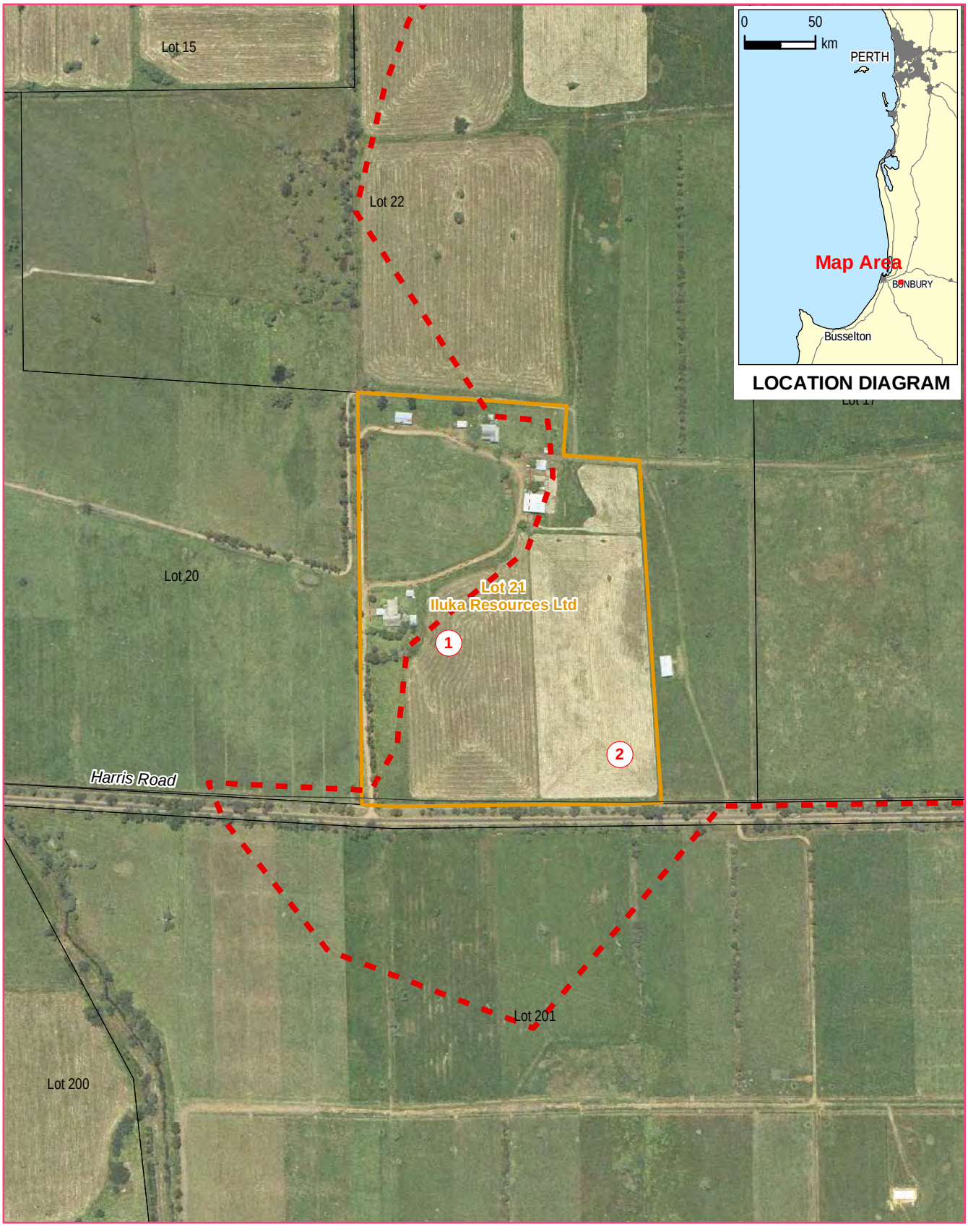
Appendix 2, Soil Analysis Results.

	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.2	7.5	59	163	>500.

Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	0	40	0	60	0	0	0	0	0	10+ t/ha.
Site 2.	0	40	0	60	0	0	0	0	0	10+ t/ha.

Cut and uncut pasture lot 21, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 Meters

ILUKA

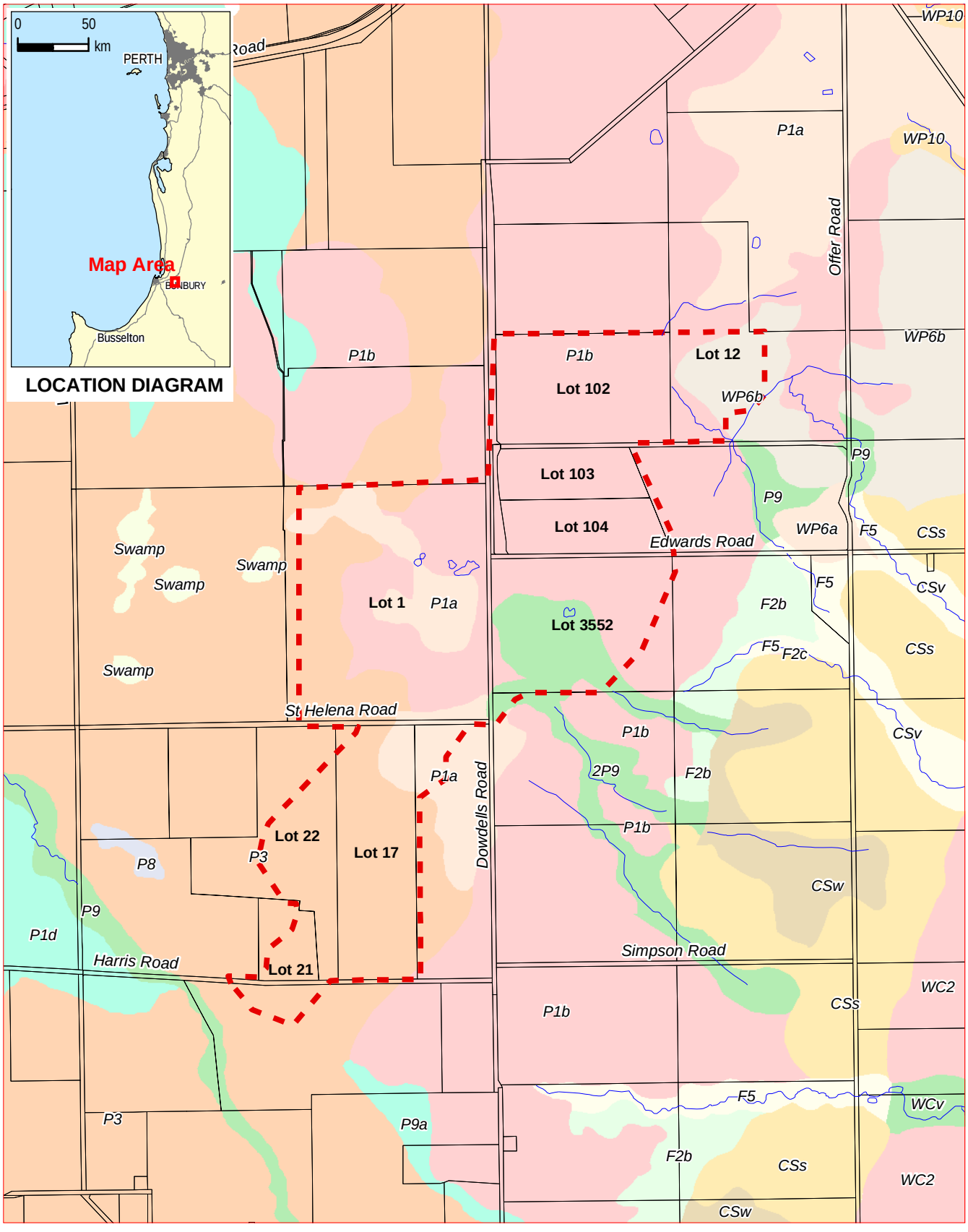
ORIG:	J.Wise
DRAWN:	T.L.G
SCALE:	1:5,000
DATE:	5 Dec 2006

BUREKUP

Lot 21- Iluka Resources

SITE MAP SOIL EXAMINATION

DWG No: 170060 ver.00 | A4 | FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 22, ST. HELENA ROAD, BUREKUP.
OWNERS, A. L. & J. A. TYRRELL.
ADDRESS, 418 WATERLOO ROAD WATERLOO WA 6228.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 22, St. Helena Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 4 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessential Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

As part of the investigation discussions were held with the owner Mr Adrian Tyrrell.

The Lot.

Lot 22 St. Helena Road Burekup is a rural block of approximately 41 hectares situated between St. Helena and Harris Roads. The lot is owned by A. L. & J. A. Tyrrell and managed in association with other land in the area to

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

support a beef grazing enterprise.
The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.
The lot which was historically used in association with other land in the area as dairy property is fully cleared, sown to improved pastures, and subdivided into a number of paddocks to facilitate controlled grazing.
Much of the lot is suitable for hay cutting.

Owner Comments.

Concerns expressed by Mr Tyrrell in respect of the proposed mining operation on lot 22 were directed towards the rehabilitation of the land post mining and included :-

- A desire to see the top soil stripped from lot 22 returned to lot 22 because of its nutrient status.
- That adequate land shaping be employed to facilitate drainage.
- That efforts be made to minimise the amount of clay in the surface soil.

Weeds.

No weeds were observed during the course of the inspection nor were any reported by the lessee.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are “Mediterranean” with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C. The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The lot which was historically part of a larger dairy property is fully cleared improvements include :-

- Sown to improved pastures.
- Subdivided into small paddocks to facilitate controlled grazing.
- the bulk of the lot suitable for hay cutting.
- Boundary and subdivisional fencing which while old is still stock proof.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In

The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

•	<u>Annual horticulture.</u>	<u>Perennial horticulture.</u>
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.

P9	>70% class4 or 5.	>70% class 4 or 5.

- Vines.

		Cropping.
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

- Grazing.

P1a	>70% class 1, 2 or 3.
P1b	>70% class 1, 2 or 3.
P6b	>70% class 1, 2 or 3.
P3	>70% class 1, 2 or 3.
P9.	>70% class 4 or 5.

The detailed inspection revealed the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate hay cutting and/or irrigation. The soils had loamy surface profiles over mottled clay at depths of 30 centimetres and while mottled were better drained than some soils in the area but were still representative of the P3 land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Satisfactory.
- Salt (EC). At the high end of optimal.
- Phosphorus. Very high.
- Potassium. Extremely high.
- PRI. Very high.

Agricultural Productivity.

Lot 22 under its current management gives the appearance of being very productive considering the season. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.*

To maintain this productivity certain management practices are required which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of

application is limited by trafficability constraints.

- A system of land shaping and drainage.

Conclusions.

This is a productive lot however, at 41 hectares it is too small to be considered a viable agricultural unit on its own particularly as its agricultural capability and suitability is in the area of livestock grazing and pasture production.

In the post mining restoration of this lot attention should be paid to subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

John Wise Consultancy Pty Ltd is directed and managed by John Wise (B.Sc. Agric) and specialises in land use planning, property appraisals and agricultural advice.

Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. pale brown sandy loam.
30 cm, mottled orange-brown clay loam.

Site 2.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. pale brown sandy loam.
30 cm, mottled orange-brown clay loam.

Site 3.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. pale brown sandy loam.
30 cm, mottled orange-brown clay loam.

Site 4

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 30 cm. pale brown sandy loam.
30 cm, mottled orange-brown clay loam.

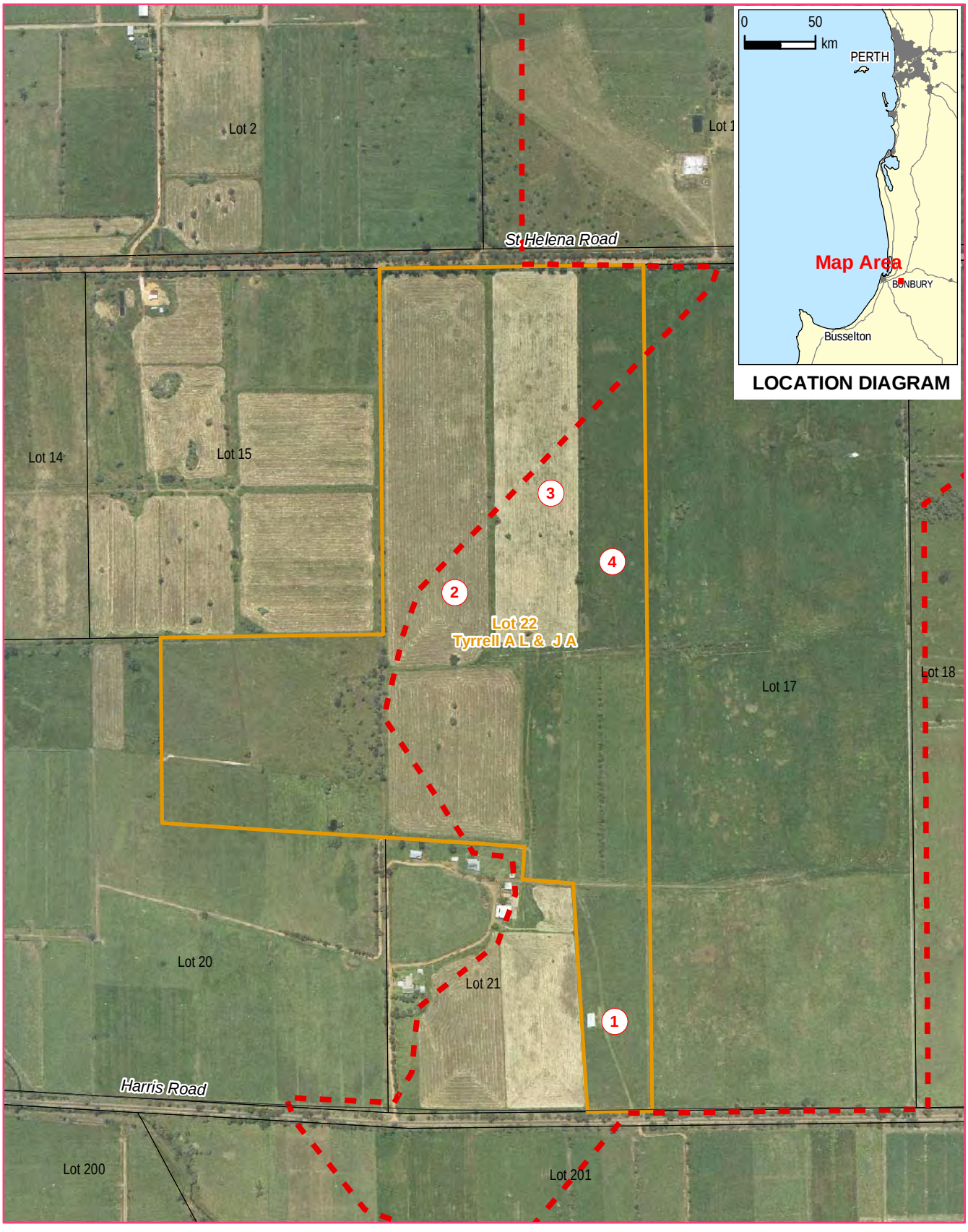
Appendix 2, Soil Analysis Results.

	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.9	24.4	115	322	192.

Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	very variable dominated by cape weed and dock.									
Site 2.	0	0	0	100	0	0	0	0		10+ t/ha.
Site 3.	0	0	0	100	0	0	0	0	0	10+ t/ha.
Site 4.	0	20	0	80	0	0	0	0	0	8-10 t/ha.

View east across cut pasture awaiting baling lot 22, 30/11/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 Meters

ILUKA

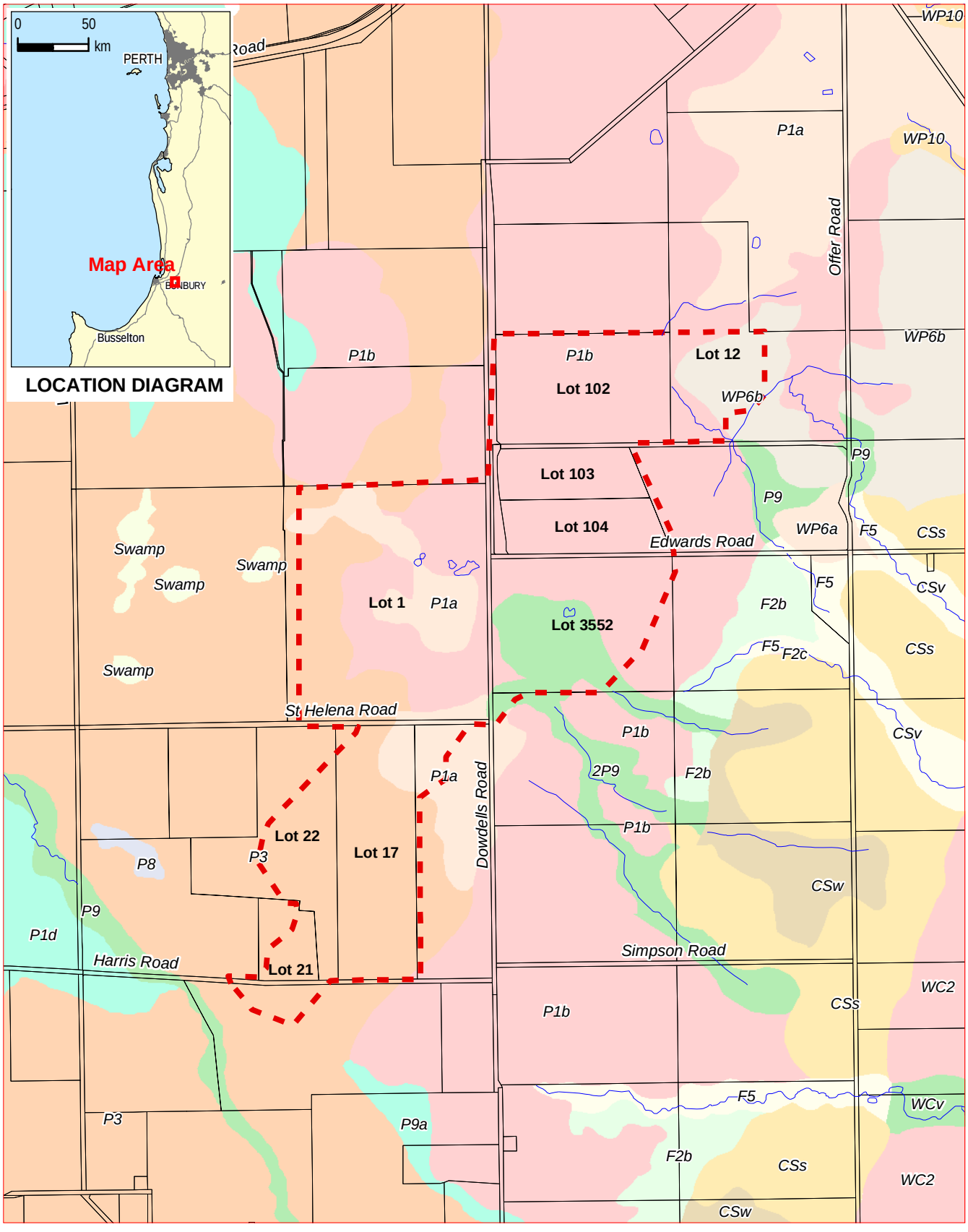
ORIG:	J.Wise
DRAWN:	T.L.G
SCALE:	1:7,500
DATE:	5 Dec 2006

BUREKUP

Lot 22 - Tyrrell A L & J A

SITE MAP SOIL EXAMINATION

DWG No: 170061 ver.00 | A4 | FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 103, DOWDELLS ROAD, BUREKUP.
OWNER, ILUKA RESOURCES LIMITED.
ADDRESS, GPO BOX U1988, PERTH WA 6845.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 103, Dowdells Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 3 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (see figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessintial Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

As part of the investigation discussions were held with the lessee Mr Phil Depiazzi.

The Lot.

Lot 103 Dowdells Road Burekup is a small rural block of approximately 15 hectares accessed by Dowdell Road. The lot is owned by Iluka Resources

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

Limited and is leased by Mr Phil Depiazzi and managed in association with other land in the area to support a beef grazing enterprise.
The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.
The lot which was historically part of a larger dairy property is fully cleared, sown to improved pastures, laser levelled to allow flood irrigation and subdivided into small paddocks to facilitate controlled grazing.

Weeds.

No noxious weeds were observed during the course of the inspection.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.
Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C. The frequency of frosts is low; the annual average is less than 7.
The growing season breaks on average during the second week of April and lasts for approximately seven months.
This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The lot which was historically part of a larger dairy property is fully cleared improvements include :-

- Sown to improved pastures.
- Laser levelled to allow flood irrigation.
- Subdivided into small paddocks to facilitate controlled grazing.
- All paddocks suitable for hay cutting.
- Boundary and subdivisional fencing which while old is still stock proof.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.
The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.
They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

	Annual horticulture.	Perennial horticulture.
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

	Vines.	Cropping.
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

- Grazing.

P1a >70% class 1, 2 or 3.

P1b >70% class 1, 2 or 3.
P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection revealed the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate irrigation.. The soils had loamy surface profiles over mottled clay at depths of about 60 centimetres and while mottled were better drained than some soils in the area. While the soils of the lot show some evidence of modification (levelling) I believe they are still representative of the P1b land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Satisfactory.
- Salt (EC). Satisfactory.
- Phosphorus. High.
- Potassium. Extremely high.
- PRI. Satisfactory.

Agricultural Productivity.

At the time of the inspection the lot had been recently cut for hay with the residues showing this to be a good mix of perennial clover and rye grass elsewhere on the lot the pastures were a well grown mix of clovers, lotus and grasses. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.*
However, to maintain this productivity certain management practices are required which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging, periodic inundation and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

Conclusions.

This is a productive small lot however, at 15 hectares it is too small to be considered a viable agricultural unit on its own particularly as its agricultural capability and suitability is in the area of livestock grazing and pasture production.

In the post mining restoration of this lot attention should be paid to subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

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Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 80 cm. grey sandy loam.
80 cm, mottled grey-brown clay loam.

Site 2.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained loamy sand.
10 - 60 cm. grey sandy loam.
60 cm, mottled brown clay.

Site 3.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained loamy sand.
10 - 60 cm. grey sandy loam.
60 cm, mottled brown clay.

Appendix 2, Soil Analysis Results.

	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	5.1	19.4	39	336	14.

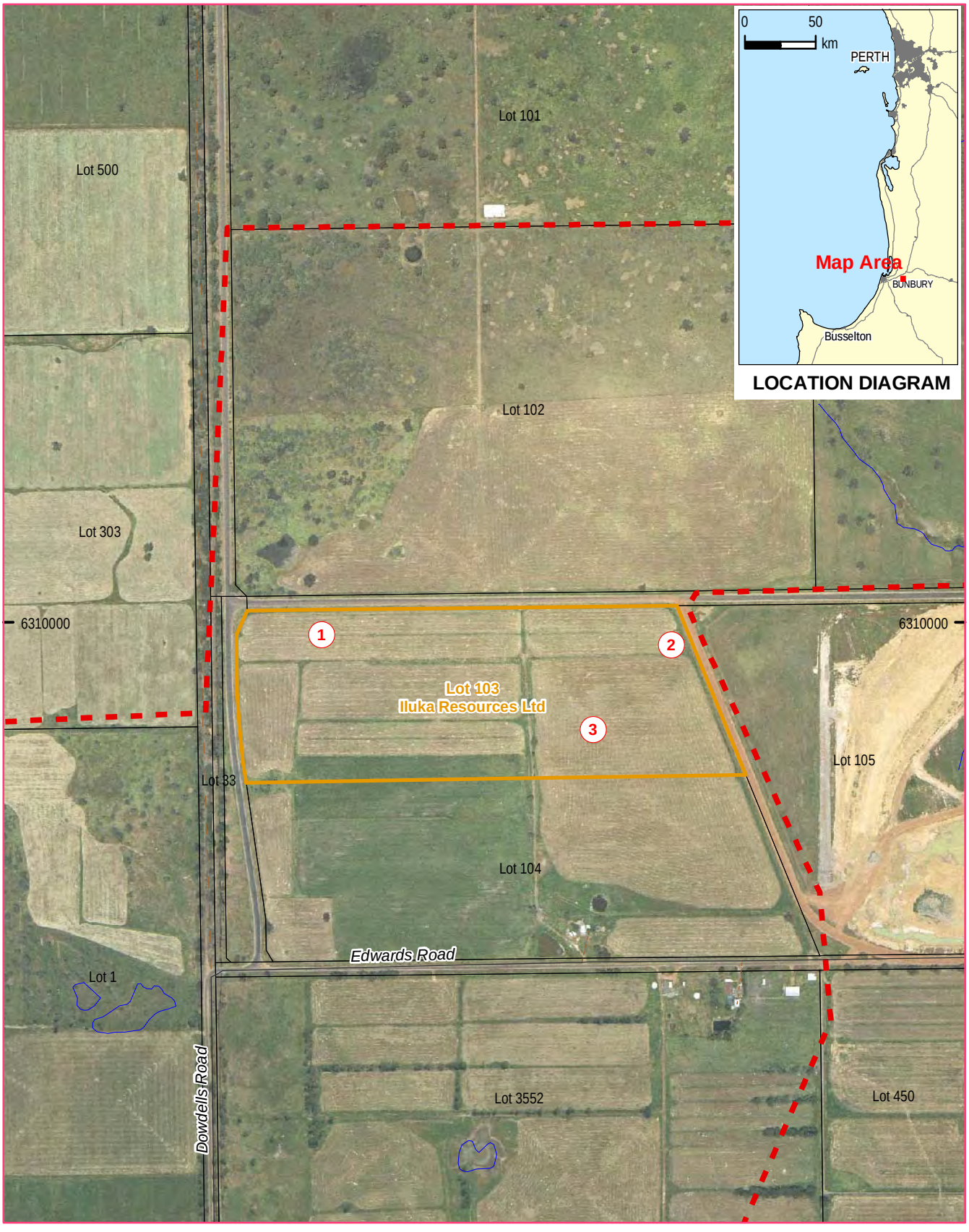
Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	20*	0	0	60	15	5	0	0	0	8-10 t/ha.
Site 2.	0	0	0	100	0	0	0	0	0	8-10 t/ha.
Site 3.	10*	0	0	60	15	5	0	10	0	8-10 t/ha.

* Denotes strawberry clover.
Wireweed and kikuyu at site 3.

Dense pasture lot 103, 30/10/2006.

Thin ryegrass lot 103, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 400 Meters

ILUKA

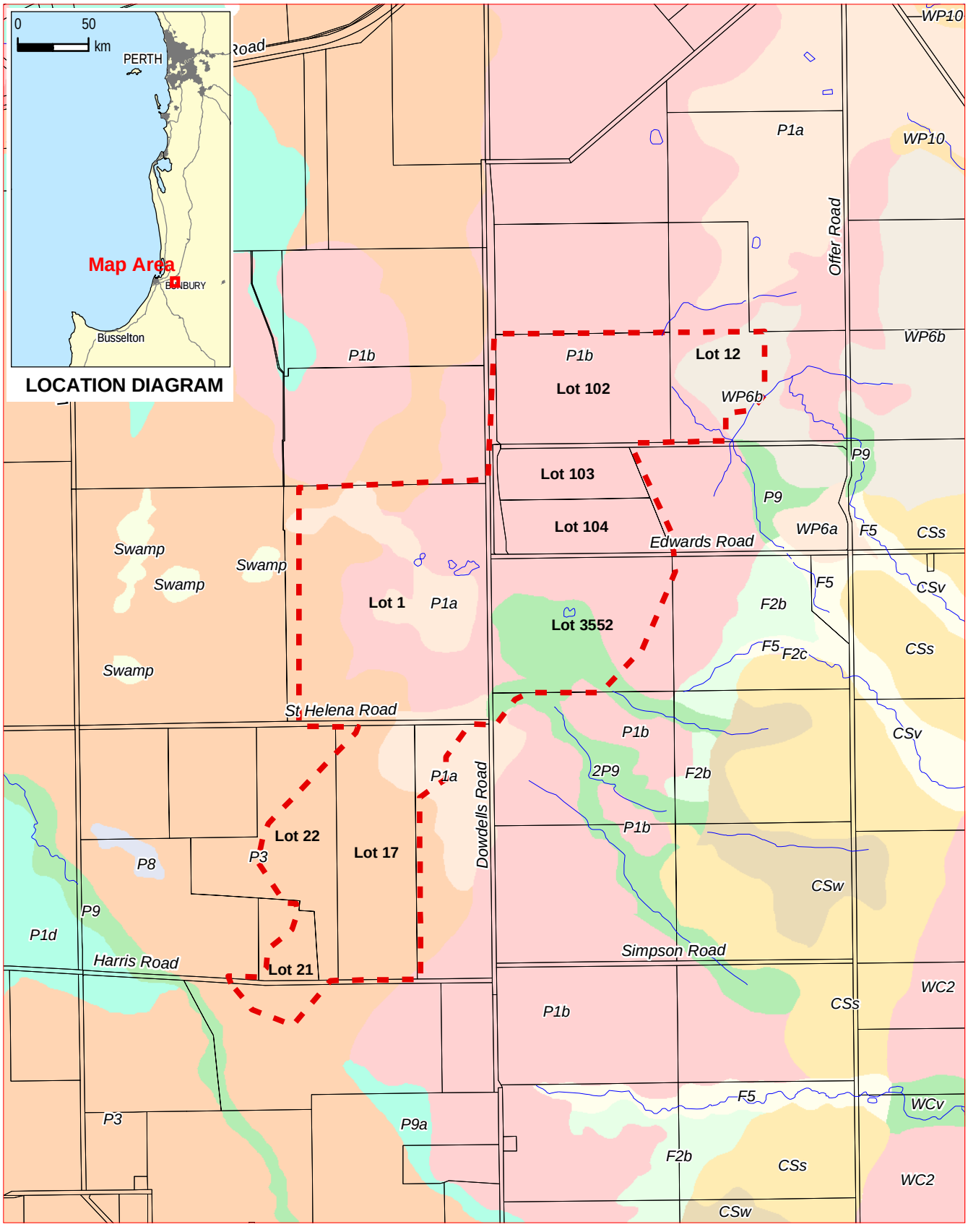
ORIG:	J.Wise		
DRAWN:	T.L.G		
SCALE:	1:7,500		
DATE:	5 Dec 2006	DWG No: 170063 ver.00	A4

BUREKUP

Lot 103 - Iluka Resources

SITE MAP SOIL EXAMINATION

FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

John Wise Consultancy
Pty Ltd.
Landuse Consultants
A.C.N. 072 614 307
ABN: 22 072 614 307

Lot 50 Fern Road
Eagle Bay
PO Box 198
Dunsborough WA 6381
Phone/Fax (08) 9755 3917
email: wisecon@wn.com.au

PRE MINING AGRICULTURAL ASSESSMENT.
LOT 104, DOWDELLS ROAD, BUREKUP.
OWNER, ILUKA RESOURCES LIMITED.
ADDRESS, GPO BOX U1988, PERTH WA 6845.

Prepared By

JOHN WISE CONSULTANCY PTY LTD.

For

ILUKA RESOURCES LIMITED.

November 2006.

CONTENTS.

Introduction.

In anticipation of a future mining operation Mr Neil McMulkin, Rehabilitation Superintendent for Iluka Resources Limited requested that John Wise Consultancy Pty Ltd carry out an independent agricultural assessment of Lot 104, Dowdells Road Burekup.

Assessment Objectives.

The objectives of the assessment are to: -

1) Describe the lot including its pastures and soils including their composition and characteristics.

2) Note and describe any improvements and their condition in the areas where mining is to occur.

3) assess the agricultural potential of the proposed mining areas.

4) Provide criteria that will enable a comparison to be made of post mining productivity versus pre mining productivity.

Method.

On October 30, 2006 a detailed inspection of the areas of proposed mining activity on this lot was carried out, as part of this inspection 2 auger examinations# of the soil profiles were made to one metre (conditions permitting), the sites of these examinations are shown on the attached aerial photograph (figure 1) while the detailed profile descriptions together with comments on slope, aspect and drainage are listed in appendix 1.

In the vicinity of each soil examination site samples were also collected using a standard 100 millimetre soil sampling tool as a representative bulk soil sample, these samples were analysed for a range of nutrients and properties by Vintessintial Laboratories, Unit 1/222 Naturaliste Terrace Dunsborough, see appendix 2.

At the same time at each site a subjective assessment of the pasture yield was made while the composition was assessed using a randomly placed metre rule recording species and their occurrence at 10 centimetre intervals, see appendix 3.

As part of the investigation discussions were held with the lessee Mr Phil Depiazzi.

The Lot.

Lot 104 Dowdells Road Burekup is a small rural block of approximately 17 hectares accessed by Dowdell Road. The lot is owned by Iluka

#The use of specialised soil augers to examine soil profiles is accepted practice and was the method employed by Tille and Lantzke in their regional soil survey of the Busselton and Augusta Margaret River Shires.

Resources Limited and is leased by Mr Phil Depiazzi and managed in association with other land in the area to support a beef grazing enterprise. The lot lies on the Swan Coastal Plain some 15 kilometres east of the City of Bunbury and within the Shire of Dardanup.

The lot which was historically part of a larger dairy property is fully cleared, sown to improved pastures, laser levelled to allow flood irrigation and subdivided into small paddocks to facilitate controlled grazing.

Weeds.

No weeds were observed during the course of the inspection nor were any reported by the lessee.

Prevailing Climatic Conditions.

The climatic conditions experienced by this lot are "Mediterranean" with a distinct cool wet winter and a warm dry summer. Annual average rainfall is in the order of 1000 millimetres.

Mean temperatures range from 12°C in winter to 21°C in summer; the range between daily minimum and daily maximum rarely exceeds 15°C. The frequency of frosts is low; the annual average is less than 7.

The growing season breaks on average during the second week of April and lasts for approximately seven months.

This part of the State frequently experiences strong to gale force winds during winter and spring.

Improvements.

The lot which was historically part of a larger dairy property is fully cleared improvements include :-

- Sown to improved pastures.
- Laser levelled to allow flood irrigation.
- Subdivided into small paddocks to facilitate controlled grazing.
- All paddocks suitable for hay cutting.
- Boundary and subdivisional fencing which while old is still stock proof.
- A water hole and pump is in the south of the lot.
- An old milking shed is in the south of the lot.

Land Forms, Soils and Land Capability (figure 2).

van Gool and Kipling (Department of Agriculture, 1992, Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia) describe the land form of this lot as belonging to Pinjarra Land System.

The Pinjarra Land System occurs on the Swan Coastal Plain between Perth and Capel and is described as a flat to gently undulating poorly drained coastal plain.

They describe this land system as consisting of a number of sub-units, those which occur on the area of mining interest in the Burekup area are :-

- P1a a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging.

- P1b a flat to gently undulating plain imperfectly or poorly drained. The soils are deep acidic mottled duplex soils and shallow pale sandy loams over clay. The principal limitation on this sub-unit is waterlogging with minor limitations considered to be wind erosion and phosphorus export.

- P6b a gently undulating flood plain including gentle slopes with well drained deep loamy duplex soils and coloured and earthy sands associated with prior stream deposits. The principal limitation on this sub-unit is wind erosion which is considered to be of minor significance.

- P3 a flat to very gently undulating plain imperfectly or poorly drained. The soils are acidic yellow or grey-brown earths and mottled yellow soils with a surface horizon of varying from loam to clay. The principal limitation on this sub-unit is waterlogging with phosphorus export considered moderate to low and water erosion low.

- P9 waterways with deep acidic mottled duplex soils. The principal limitations on this sub-unit are waterlogging, water erosion and phosphorus export which are all considered major.

They describe the land capability for the land units as follows-:

• <u>Annual horticulture.</u>		<u>Perennial horticulture.</u>
P1a	50-70% class 4 or 5.	>70% class 4 or 5.
P1b	50-70% class 1, 2 or 3.	>70% class 4 or 5.
P6b	>70% class 1, 2 or 3.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class4 or 5.	>70% class 4 or 5.

• <u>Vines.</u>		<u>Cropping.</u>
P1a	50-70% class 4 or 5.	50-70% class 4 or 5.
P1b	50-70% class1, 2 or 3.	>70% class1, 2 or 3.
P6b	>70% class 1 or 2.	>70% class 1, 2 or 3.
P3	>70% class 4 or 5.	>70% class 4 or 5.
P9	>70% class 4 or 5.	>70% class 4 or 5.

- Grazing.

P1a >70% class 1, 2 or 3.
P1b >70% class 1, 2 or 3.
P6b >70% class 1, 2 or 3.
P3 >70% class 1, 2 or 3.
P9. >70% class 4 or 5.

The detailed inspection revealed the lot to be generally level probably reflecting some prior land-grading/shaping to facilitate irrigation.. The soils had loamy surface profiles over mottled clay at depths of about 60 centimetres and while mottled were better drained than some soils in the area. While the soils of the lot show some evidence of modification (levelling) I believe they are still representative of the P1b land unit.

Soil Analysis Results.

Analysis of a bulk sample from the lot revealed :-

- pH. Satisfactory.
- Salt (EC). Satisfactory.
- Phosphorus. High.
- Potassium. High.
- PRI. Satisfactory.

Agricultural Productivity.

At the time of the inspection parts of the lot had been recently cut for hay with the residues showing this to be a good mix of perennial clover and rye grass elsewhere on the lot the pastures were a well grown mix of clovers, lotus and grasses. *Note, the 2006 growing season has been particularly hard with a late start and below average rainfall. Most growers in this area have reported pasture growth and hay cuts significantly below average.* However, to maintain this productivity certain management practices are required which include :-

- The exclusion of winter grazing from those areas those areas prone to surface pugging.
- Selection of pasture species adapted to winter waterlogging, periodic inundation and suited to heavy hard setting soils.
- Appropriate fertiliser selection appreciating that the time of application is limited by trafficability constraints.
- A system of land shaping and drainage.

Conclusions.

This is a productive small lot however, at 17 hectares it is too small to be considered a viable agricultural unit on its own particularly as its agricultural capability and suitability is in the area of livestock grazing and pasture

production.

In the post mining restoration of this lot attention should be paid to subsurface and surface drainage and minimising the amount of clay in the surface profile.

Acknowledgments.

I would like to acknowledge the assistance provided by Iluka staff during the field work and compilation of the final report and especially Mr Neil McMulkin, Rehabilitation Superintendent, Capel and the Cartographic Section, Capel particularly Duncan Scott, Dan Smith and Todd Griffin.

Notes.

John Wise Consultancy Pty Ltd is directed and managed by John Wise (B.Sc. Agric) and specialises in land use planning, property appraisals and agricultural advice.

Its principal Mr John Wise was prior to setting up the consultancy in 1996 an agricultural extension officer with the Western Australian Department of Agriculture serving 27 years with that organization in various parts of the South West Land Division, he is familiar with most aspects of high and low rainfall agriculture in south-western Australia.

J L Wise.
November 2006.

Appendix 1, Soil Profile Descriptions.

Site 1.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained sandy loam.
10 - 80 cm. grey sandy loam.
80 cm, mottled grey-brown clay loam.

Site 2.

Flat, open, exposed, subsoil winter wet.
0 - 10 cm. organic stained loamy sand.
10 - 100 cm. pale grey sandy loam.
100 cm, evidence of a ferruginous layer.

Appendix 2, Soil Analysis Results.

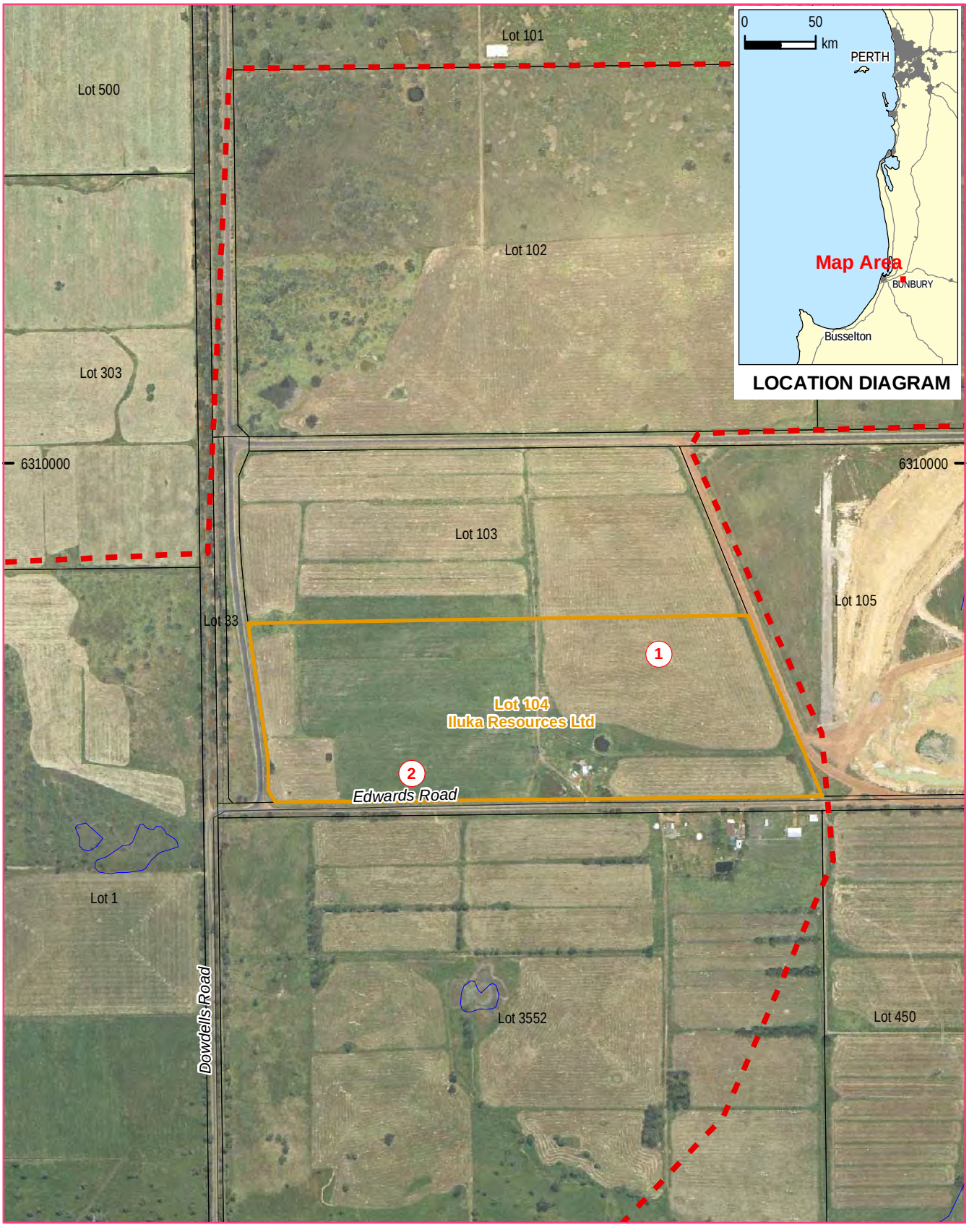
	pH (CaCl)	EC mS/m	Phosphorus mg/Kg	Potassium mg/Kg	PRI
Optimum	>4.3	<30	24-30	>100	>6
Sample.	4.9	11.7	57	62	20.

Appendix 3, Pasture Composition 30/10/06 (expressed on a % basis).

Species.	Clover.	Lotus.	Serr della.	Rye grass.	Cape weed.	Dock	Flat weed	Other grass.	Bare.	Aprox-yield.
Site 1.	10*	0	0	60	15	5	0	10	0	8-10 t/ha.
Site 2.	10*	0	0	60	15	5	0	10	0	8-10 t/ha.

* Denotes strawberry clover.
Wireweed at site and kikuyu at both sites.

Recently cut pasture awaiting rolling lot 104, 30/10/2006.



Aerial Photo : November 2005

Legend

1 Soil Examination Site

Surveyed Property

Prop. Disturbance Area

N

0 100 200 300 400 Meters

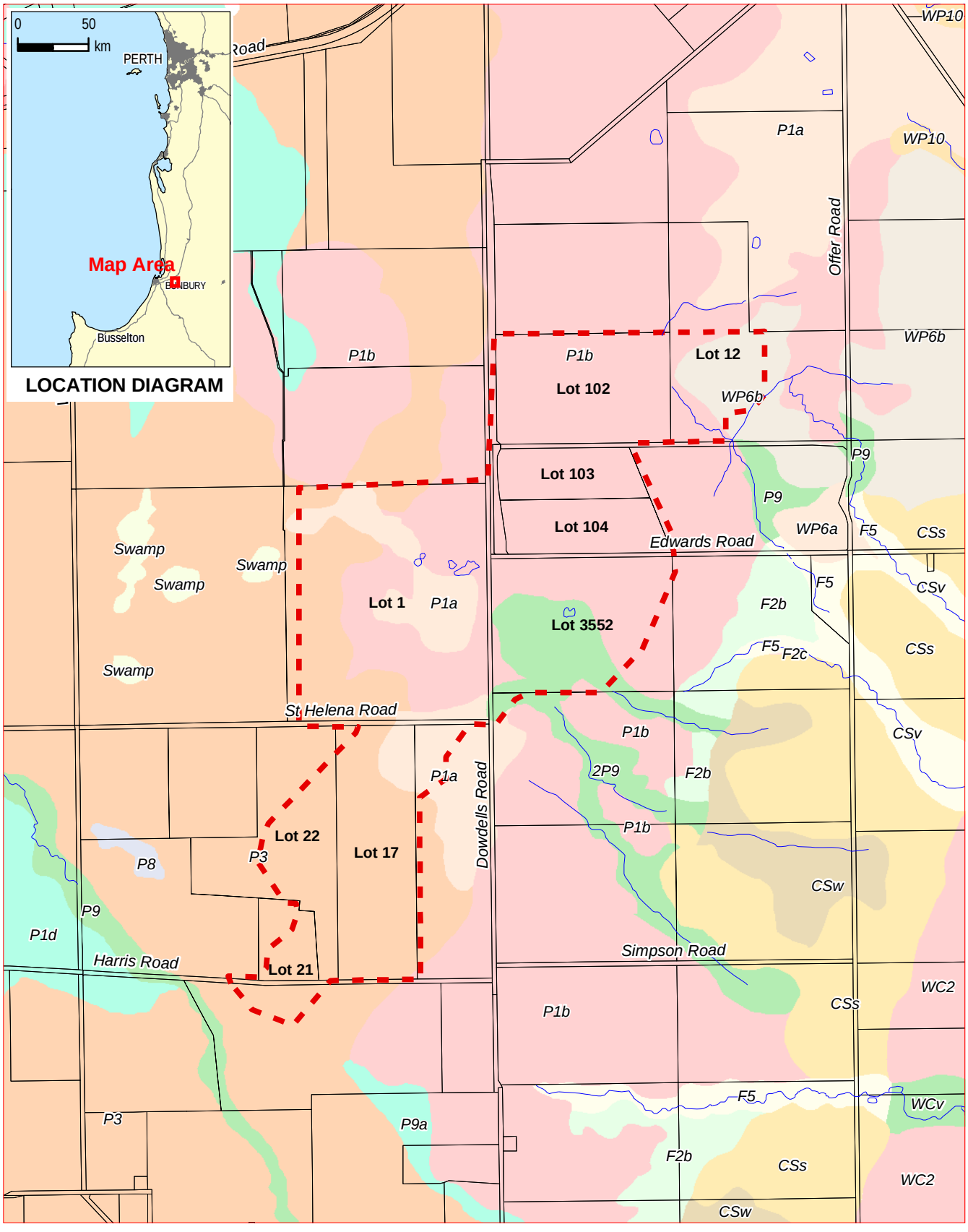
ILUKA

BUREKUP

Lot 104 - Iluka Resources

SITE MAP SOIL EXAMINATION

ORIG: J.Wise			
DRAWN: T.L.G			
SCALE: 1:7,500			
DATE: 5 Dec 2006	DWG No: 170064 ver.00	A4	FIGURE: 1


0
50
km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
F5
CSv
Lot 1
P1a
F2b
Lot 3552
F5
F2c
CSs
Swamp
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Simpson Road
Harris Road
Lot 21
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0
500
1,000
1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

APPENDIX C: DARDANUP MINE EVALUATION OF POST MINING AREAS

Primary Consulting Services Pty Ltd ABN 30 016 690 242

Location: Lot 1044 Goodwood Road Capel
Postal: PO Box 472 Capel WA 6271
Phone: +618 9731 7000 Facsimile: +618 9731 7011
Email: bosustow@bordernet.com.au

Agricultural & Financial Consultants

Colin Bosustow
B.Sc.(Agric.) Hons
Assoc. Dip. Val.
Member AAAC (WA) Inc

Helen Bosustow
B.Bus. (Agric.)

30th January 2012

Chris Howe
Environmental Officer
Doral Mineral Sands

Via email: chris.howe@doral.com.au

Dear Chris

Re - Dardanup/Waterloo Farms Benchmarking

Soil test results are appended for your records.

I have maintained all sites GPS coordinates so that later resampling can be aligned with benchmarking sites.

Comments on individual measurements show general trends -

- Soil ph values are generally well below recommended levels and liming would be recommended for 95% of sites
- Sandy soil types to south show low PBI & lower nutrient ranges
- Clay soils to north show higher nutrient holding capacity but variable nutrient levels
- N & S not commented upon given highly mobile nature of these elements.

One group of Adrian Tyrrell's sites don't make any sense and I will resample these in the near future - only 2 samples.

A good benchmark for the various sites has been established and can be followed up with pasture samples in the winter & spring as discussed.

An account for the agreed amount is attached for payment - thank you

Please call if there are any queries or comments.

Yours faithfully
Colin Bosustow
CJ Bosustow

John Giumelli

North of Creek	Sample 1		Sample 2		Control 1		Comment
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte							
Soil Texture (Northcote)	1.500000	1.500000	1.500000	1.500000	2.000000	2.000000	grazed paddocks, sandy
pH (1:5 CaCl2)	4.46	4.43	4.5	4.55	4.42	4.5	very low
pH (1:5 H2O)	5.33	5.37	5.5	5.41	5.33	5.22	
EC (1:5 H2O) dS/m	0.152	0.025	0.043	0.023	0.112	0.132	Ok
Organic carbon (Walkley Black) %	1.423	0.263	1.597	0.641	3.977	1.904	low except C 1
Nitrate nitrogen (KCl) mg/kg	46.349	4.603	8.706	3.442	3.609	1	
Ammonium nitrogen (KCl) mg/kg	9.579	2.334	5.091	2.082	14.742	4.801	
Phosphorus (Colwell) mg/kg	35.736	27.098	42.891	35.08	174.26	226.664	good P levels versus PBI
Phosphorus Buffer Index (PBI)	15.152	9.192	38.666	48.169	273.705	231.445	v low in samples, control is heavier soil
Potassium (Colwell) mg/kg	132.692	26.53	81.543	23.841	253.597	175.899	Ggood in topsoil
Sulfur (KCl-40) (mg/kg)	10.817	2.854	4.458	2.013	24.154	32.49	low in S 2

South of Creek	Sample 1		Sample 2		Sample 3		Sample 4		Control 1		Control 2		Comment
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte													
Soil Texture (Northcote)	3.000000	3.000000	3.000000	3.000000	2.500000	2.500000	3.000000	3.000000	2.500000	2.000000	3.000000	3.000000	
pH (1:5 CaCl2)	4.73	4.34	4.68	4.21	4.57	4.4	5.7	4.8	4.49	4.1	4.34	4.21	all low-very low except S 4
pH (1:5 H2O)	5.27	5.2	5.21	4.92	5.44	5.18	6.63	5.77	5.18	4.69	5.1	4.95	
EC (1:5 H2O) dS/m	0.304	0.079	0.204	0.089	0.048	0.037	0.06	0.033	0.758	0.413	0.111	0.072	
Organic carbon (Walkley Black) %	3.38	0.842	3.171	1.429	1.891	0.726	2.156	1.131	4.999	1.889	3.181	1.372	generally good
Nitrate nitrogen (KCl) mg/kg	81.627	7.73	54.117	10.75	9.606	7.986	7.05	1.561	1.836	1	29.628	3.464	
Ammonium nitrogen (KCl) mg/kg	10.598	5.881	11.096	4.482	4.763	3.651	9.8	7.053	24.035	8.45	8.168	3.252	
Phosphorus (Colwell) mg/kg	47.989	23.056	55.103	38.953	63.499	41.999	48.39	37.91	15.856	7.922	85.189	20.643	c 1 is the only low P site
Phosphorus Buffer Index (PBI)	164.192	114.708	222.367	177.171	63.957	51.408	72.65	82.542	94.485	51.341	268.71	230.56	low to moderate
Potassium (Colwell) mg/kg	103.767	51.398	80.851	37.5	71.691	41.25	131.756	190.49	117.931	45.323	252.857	57.042	S 2 & 3 low, others adequate to high
Sulfur (KCl-40) (mg/kg)	30.25	16.02	46.329	32.711	7.068	3.742	6.936	3.994	23.068	33.718	21.857	33.89	S 3 & 4 low

Ken Tyrrell

E of Dowdells Line - Irrigation Area	Control 1		Control 2		Comment
	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte					
Soil Texture (Northcote)	2.000000	1.500000	2.000000	1.500000	
pH (1:5 CaCl2)	4.61	4.3	4.79	4.4	Low
pH (1:5 H2O)	5.47	5.3	5.62	5.4	
EC (1:5 H2O) dS/m	0.136	0.025	0.307	0.102	
Organic carbon (Walkley Black) %	5.075	0.999	4.23	0.441	good
Nitrate nitrogen (KCl) mg/kg	2.038	1	13.06	1.089	
Ammonium nitrogen (KCl) mg/kg	31.548	2.716	15.05	1.497	
Phosphorus (Colwell) mg/kg	70.02	11.771	77.235	4.146	P very high
Phosphorus Buffer Index (PBI)	28.638	10.325	141.417	16.707	C 1 very very low, C 2 moderate
Potassium (Colwell) mg/kg	463.138	50.335	73.566	15	C 1 excessive, C 2 low
Sulfur (KCl-40) (mg/kg)	28.77	3.566	59.476	22.69	

E of Dowdells Line - Adj to road	Control 1		
	Topsoil	Subsoil	
Analyte			
Soil Texture (Northcote)	1.500000	1.500000	
pH (1:5 CaCl2)	4.4	4.33	Low
pH (1:5 H2O)	5.4	5.09	
EC (1:5 H2O) dS/m	0.114	0.175	
Organic carbon (Walkley Black) %	2.534	0.414	OK
Nitrate nitrogen (KCl) mg/kg	8.873	3.669	
Ammonium nitrogen (KCl) mg/kg	7.67	2.98	
Phosphorus (Colwell) mg/kg	3.185	4.505	very low
Phosphorus Buffer Index (PBI)	9.739	7.963	exceedingly low
Potassium (Colwell) mg/kg	34.931	22.147	low
Sulfur (KCl-40) (mg/kg)	13.941	35.292	

Adrian Tyrrell

W of Dowdells Line - 2010 & 2011 R	2010 Rehab 1		2010 Rehab 2		2011 Rehab 1		2011 Rehab 2		Irrigation		Comment
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Site 2 needs resampling as results
Analyte											are inconsistent with soil type
Soil Texture (Northcote)	3.500000	3.500000	1.500000	1.500000	3.000000	3.000000	3.000000	3.000000	3.000000	3.000000	
pH (1:5 CaCl2)	4.4	5.41	6.2	5.77	4.37	4.75	4.69	4.9	4.55	4.2	all low except 2010 rehab site 2
pH (1:5 H2O)	5.24	6.43	6.68	6.28	5.15	5.65	5.66	5.73	5.35	5.09	
EC (1:5 H2O) dS/m	0.188	0.066	0.092	0.063	0.12	0.12	0.174	0.12	0.106	0.046	
Organic carbon (Walkley Black) %	2.66	0.343	0.068	0.05	2.428	1.719	2.488	0.567	3.77	1.242	OK
Nitrate nitrogen (KCl) mg/kg	14.091	2.648	1	1	34.989	9.626	12.747	1.284	19.904	1.869	
Ammonium nitrogen (KCl) mg/kg	6.916	2.717	1.588	2.497	9.955	7.365	8.016	2.867	11.417	4.957	
Phosphorus (Colwell) mg/kg	57.39	6.808	2	2	76.943	48.107	51.417	13.232	45.869	12.519	
Phosphorus Buffer Index (PBI)	237.582	230.811	10.94	12.898	263.146	285.443	167.832	301.48	300.62	279.384	all moderate
Potassium (Colwell) mg/kg	117.218	75.46	16.887	15	93.75	56.622	109.459	79.225	63.043	28.125	generally adequate, irrigation low.
Sulfur (KCl-40) (mg/kg)	17.202	30.575	7.793	7.576	15.6	36.769	27.706	54.964	23.47	23.079	

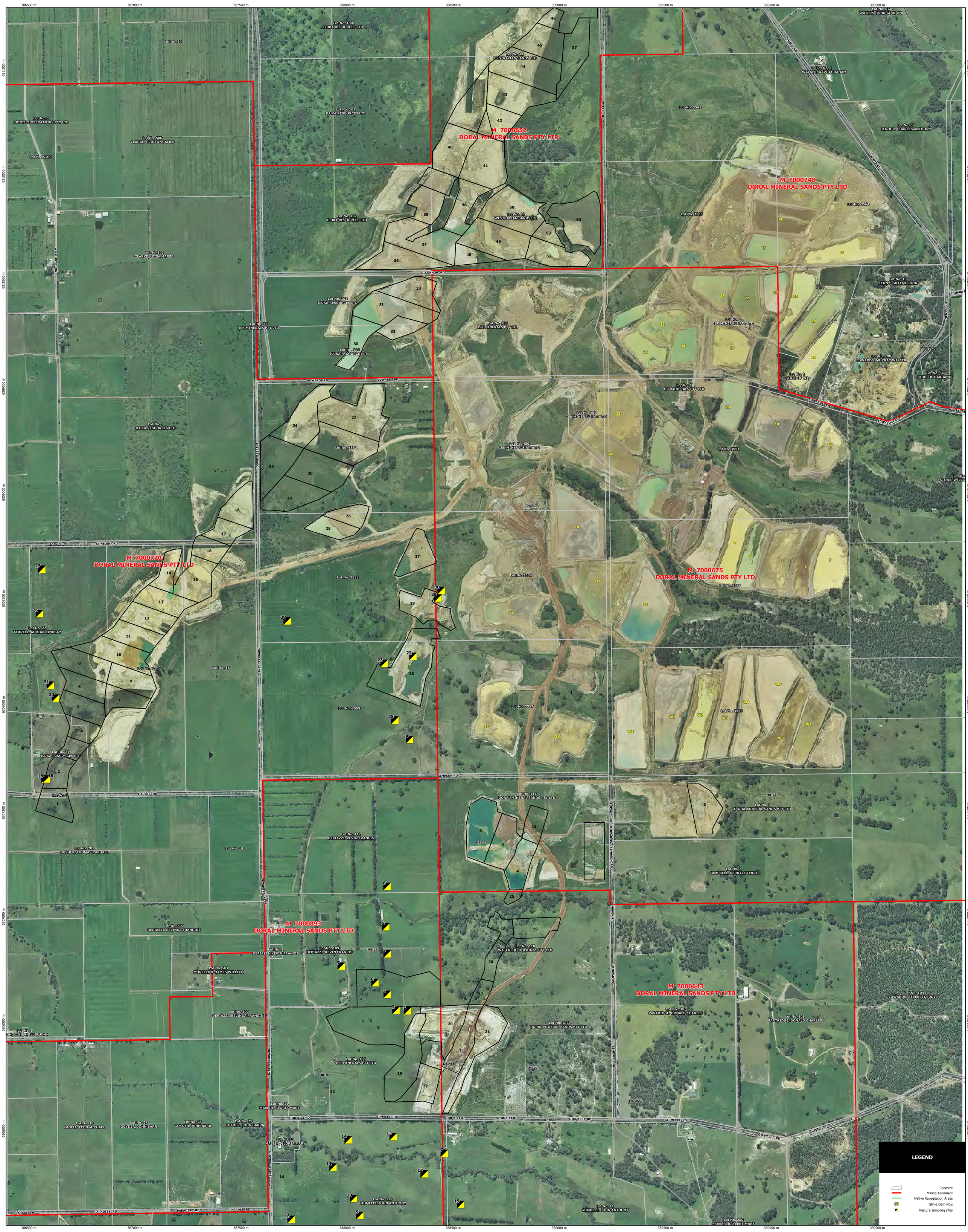
E of Dowdells Line	Control 1		Control 2		Irrigation 1		Irrigation 2		
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte									
Soil Texture (Northcote)	1.500000	1.500000	2.000000	1.500000	1.500000	1.500000	1.500000	1.500000	
pH (1:5 CaCl2)	3.9	3.9	4.2	4.33	4.2	4.47	4	4.1	very low, liming a priority
pH (1:5 H2O)	4.53	4.4	4.58	4.72	4.99	5.3	4.85	5.1	
EC (1:5 H2O) dS/m	0.411	0.237	0.848	0.31	0.074	0.048	0.028	0.045	
Organic carbon (Walkley Black) %	1.17	0.405	1.112	0.219	2.62	0.409	0.486	2.513	low - very low
Nitrate nitrogen (KCl) mg/kg	1	1.031	1	1	34.25	11.439	1	6.957	
Ammonium nitrogen (KCl) mg/kg	5.423	2.226	6.919	1.872	6.44	2.043	1.852	6.551	
Phosphorus (Colwell) mg/kg	8.981	7.374	14.594	23.767	21.261	49.575	29.161	28.38	C 1 & 2 low, others OK
Phosphorus Buffer Index (PBI)	12.885	6.215	25.575	19.804	13.798	15.186	14.782	19.339	extremely low >> sandy soils
Potassium (Colwell) mg/kg	31.521	24.295	25.51	20	44.117	19.387	30	104.629	all very low in K
Sulfur (KCl-40) (mg/kg)	15.107	8.367	53.257	13.35	7.96	12.966	1.864	5.342	

Depiazzi

Giumelli Lease	Primary Site 1		Primary Site 2		Control 1		Control 2		Comments
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte									
Soil Texture (Northcote)	1.500000	1.500000	1.500000	1.500000	1.500000	1.500000	1.500000	1.500000	sandy soil type
pH (1:5 CaCl2)	5.13	5.08	4.7	4.73	4.9	4.8	4.86	5	district average but still require liming
pH (1:5 H2O)	5.69	5.88	5.67	5.7	5.9	5.8	5.88	6	
EC (1:5 H2O) dS/m	0.119	0.044	0.066	0.033	0.044	0.035	0.143	0.044	
Organic carbon (Walkley Black) %	2.703	0.72	2.468	0.774	0.924	0.999	2.71	0.77	OK but low in C 1
Nitrate nitrogen (KCl) mg/kg	35.127	9.444	4.75	3.611	2.82	3.817	14.465	2.262	
Ammonium nitrogen (KCl) mg/kg	7.138	1.98	5.199	1.956	1.789	3.832	14.342	2.118	
Phosphorus (Colwell) mg/kg	38.643	88.683	8.144	6.654	47.346	6.715	14.559	4.552	PS 1 & C 1 OK, other low
Phosphorus Buffer Index (PBI)	29.523	40.065	15.858	13.976	26.054	22.926	36.766	18.116	very very low
Potassium (Colwell) mg/kg	58	30.555	34.687	17.812	59.589	21.897	60.638	33.841	very low
Sulfur (KCl-40) (mg/kg)	17.195	4.491	17.248	5.26	8.465	3.884	25.63	4.485	

Secondary Site	Secondary Site 1		Secondary Site 2		Control 1		Control 2		
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	
Analyte									
Soil Texture (Northcote)			3.000000	3.000000	3.000000	3.000000	3.000000	3.000000	
pH (1:5 CaCl2)			4.57	5	5.18	4.7	5.44	5.18	marginally low
pH (1:5 H2O)			5.01	5.8	5.99	5.72	6.24	6.15	
EC (1:5 H2O) dS/m			1.007	0.25	0.266	0.113	0.387	0.156	
Organic carbon (Walkley Black) %			3.982	1.281	4.362	4.077	4.252	2.4	good
Nitrate nitrogen (KCl) mg/kg			17.201	4.846	63.453	5.957	44.231	11.826	
Ammonium nitrogen (KCl) mg/kg			11.06	13.188	8.723	6.587	11.008	4.401	
Phosphorus (Colwell) mg/kg			32.616	10.028	246.03	178	121	107.815	generally good, SS 2 is low
Phosphorus Buffer Index (PBI)			166.104	93.768	276.919	377.128	231.276	228.789	moderate
Potassium (Colwell) mg/kg			65.073	83.544	622.549	559.574	596.938	391.216	generally v high, SS 2 is low
Sulfur (KCl-40) (mg/kg)			228.84	49.07	40.649	29.179	37.57	18.91	

No Samples



Doral

PASTURE MONITORING LOCATIONS

DARDANUP MINERAL SANDS PROJECT

Scale 1:5500 @ A0	MGA94 Zone 50	Drawn By: ARM
File Name: Enviro monitoring layout.map		Date:21/03/2014

Primary Business Services Pty Ltd

ABN 38 230 152 391
Agricultural & Financial Consultants

Location: 1135 Goodwood Road Capel
Postal: PO Box 472 Capel WA 6271
Phone: +618 9731 7000 Facsimile: +618 9731 7011
Email: bosustow@bordernet.com.au

Colin Bosustow
B.Sc.(Agric.) Hons
Assoc. Dip. Val.
Helen Bosustow
B.Bus. (Agric.)

7th November 2014

Julie Edwards
Environmental Advisor
Doral Pty Ltd

Via email: julie.edwards@doral.com.au

Dear Julie

Pasture and soil samples collected in late September have been analysed and our report is detailed below.

1. Burekup North

   This area was previously rehabilitated after mining with topsoil and subsoil stockpiled for a number of years. It has grown a very impressive hay crop of annual ryegrass and Balansa clover, as the attached photographs show. The crop was self seeded. No fertilizer or soil ameliorants were applied.

   Samples were collected just before the crop was cut for hay.

   Soil Analysis

Item	Result (ave)	Desired Level	Comments
General			
Soil Balance	28%	50%	Overall soil balance is below average
pH	4.7	5.5	Soil is acidic and requires liming
TSS	295	<990	Non saline
Organic Carbon	2.35%	2-3%	SW site low but SE site OK
Structure	% Adjusted CEC		
Ca	23%	65-70%	Too low for good plant growth in 2015
Mg	22%	12-15%	High and will cause poor soil flocculation
Na	4.8%	0.5-5%	Slightly high in SE quadrant
K	1.2%	3-5%	Level too low for good plant growth in 2015
Hydrogen	49%	<20%	Very high Hydrogen, acidic soil

Item	Result (ave)	Desired Level	Comments
Nutrients			
N	6ppm	24ppm	Insufficient nitrogen for good pasture growth in 2015
P	10.5	22	Slightly low as an end of year value
K	53	220	Low value limited clover growth in spring 2014
S	10.5	7-15	Adequate
Micro-nutrients			
Copper	3.5	2ppm	Adequate
Zinc	1.8	5	Low, will limit grasses
Iron	570	>30	High due to anaerobic conditions
Manganese	25	>20	Adequate
Cobalt	1.6	0.7	Adequate
Molybdenum	0.6	0.3	Adequate
Boron	0.55	0.6	Adequate
C/N Ratio	13.4	<10	Too high to support good nutrient extraction by plants next year.

Pasture analysis showed good levels of energy and crude protein with the feed being suitable for all classes of cattle. Low Calcium and high Sodium levels were evident in the pastures reflecting levels found in the soil. The SW area showed higher nutritional value that the SE area.

The period of stockpiling allowed the soil biology to consume most of the usable organic matter and in doing so make nutrients within the soil highly available − hence the excellent crop in the first year.

The resulting soil is now very acidic, pH 4.7, low in Calcium and the other main nutrients needed to support production. The low Calcium combined with high Magnesium and Sodium result in poor soil structure evidenced by the sticky hard setting nature of the soil.

It is highly doubtful that these paddocks will repeat the excellent production levels of 2014 and will continue to decline if the base issues are not addressed.

It would also be highly beneficial if the paddocks were grazed, to recycle nutrients, rather than cropped and nutrients removed, but this may not be practical. Growing a crop and plowing back into the soil (green manure) would be another good alternative.

The 2015 program for these paddocks should ideally include −

Reseeding with annual ryegrass and clover at say 30-40kg/ha, cost = $230/ha
Apply 1t/ha blend of compost, burnt lime & Zinc, cost = $200/ha
Apply 200kg/ha Super Potash 3:1, cost = $120/ha

Total cost excluding contract operations = $550/ha or $22,000 for 40 ha

2. Green 17 & 18

Soil Analysis

Item	Result (ave)	Desired Level	Comments
General			
pH	4.5	5.5	Soil is acidic and requires liming
TSS	280	<990	Non saline
Organic Carbon	2.2%	2-3%	Slightly low
Structure	% Adjusted CEC		
Ca	15%	65-70%	Too low for good plant growth in 2015
Mg	26%	12-15%	High and will cause poor soil flocculation
Na	6.0%	0.5-5%	As above
K	1.25%	3-5%	Level too low for good plant growth in 2015
Hydrogen	51%	<20%	Very high Hydrogen, acidic soil

Item	Result (ave)	Desired Level	Comments
Nutrients			
N	10ppm	27ppm	Insufficient nitrogen for good pasture growth in 2015
P	13	25	Slightly low as an end of year value
K	60	235	Low value limited clover growth in spring 2014
S	12	11-15	Adequate
Micro-nutrients			
Copper	2.9	2ppm	Adequate
Zinc	1.0	5	Very low
Iron	650	>30	High due to anaerobic conditions
Manganese	17-25	>20	Just adequate
Cobalt	1.2	0.7	Adequate
Molybdenum	0.47	0.3	Adequate
Boron	0.43	0.6	Slightly low

Pasture analysis showed good levels of energy and crude protein with the feed being suitable for all classes of cattle. Low Calcium and high Sodium levels were evident in the pastures reflecting levels found in the soil.

Soil profile is similar to Burekup North. Very acidic, pH 4.5, low in Calcium and the other main nutrients needed to support good production levels. The low Calcium combined with high Magnesium and Sodium results in poor soil structure and hard setting soils.

The 2015 program for these paddocks should ideally include −

Apply 1t/ha blend of compost, burnt lime & Zinc, cost = $200/ha
Apply 200kg/ha Super Potash 3:1, cost = $120/ha

Total cost excluding contract operations = $320/ha or $12,800 for 40 ha

3. Depiazzi - South side of Harris Road

Soil Analysis

Item	Result (ave)	Desired Level	Comments
General			
pH	4.7	5.5	Soil is acidic and requires liming
TSS	141	<990	Non saline
Organic Carbon	1.65%	2-3%	Slightly low
Structure	% Adjusted CEC		
Ca	17%	65-70%	Too low for good plant growth in 2015
Mg	22%	12-15%	High reflecting heavy clay soils
Na	2.9%	0.5-5%	OK
K	0.9%	3-5%	Level too low for good plant growth in 2015
Hydrogen	56%	<20%	Very high Hydrogen, acidic soil

Item	Result (ave)	Desired Level	Comments
Nutrients			
N	1 ppm	22ppm	Insufficient nitrogen for good pasture growth in 2015
P	8	20	Very low as an end of year value
K	29	166	Low value limited clover growth in spring 2014
S	6	7-10	Low
Micro-nutrients			
Copper	2.6	2ppm	Adequate
Zinc	0.8	3-5	Very low
Iron	644	>30	High due to anaerobic conditions
Manganese	26	>20	Adequate
Cobalt	0.8	0.7	Adequate
Molybdenum	0.43	0.2	Adequate
Boron	0.44	0.6	Slightly low

Pasture analysis showed good levels of energy and crude protein with the feed being suitable for all classes of cattle. Low Calcium and high Sodium levels were evident in the pastures reflecting levels found in the soil.

Again, soil profile is similar to Burekup North. Very acidic, pH 4.7, low in Calcium and the other main nutrients needed to support good production levels. The low Calcium level combined with high magnesium adversely affects soil structure but lower sodium levels suggest it is better than the other 2 areas.

The 2015 program for these paddocks should ideally include –

Apply 1t/ha blend of compost, burnt lime & Zinc, cost = $200/ha
Apply 200kg/ha Super Potash 3:1, cost = $120/ha

Total cost excluding contract operations = $320/ha or $12,800 for 40 ha

4. Depiazzi – Poor Pasture

Soil analysis showed this to be land that had previously been limed and productive but that had, probably more recently, been allowed to run down with major nutrients ie NPKS all low and also low in trace elements.

With a pH of 5.7, very good for SW soils, and good structure, this soil could be quickly returned to productivity with normal farm inputs.

The photograph below shows the poor state of pasture on the paddock. Pasture composition is dominated by capeweed with significant bare patches and a low level of productive species.

5. Dead Trees

   Inspection of the site showed that only Jarrah trees had succumbed and that Marri trees were quite healthy.

   This indicates that changes in groundwater levels may responsible as Jarrah's are highly susceptible to any change in groundwater levels whereas Marri's are known to be relatively unaffected.

   The soil analysis shows fairly infertile soil with poor sandy structure but no factors that could be directly linked to tree deaths.

   This assessment relating to groundwater fits with mining activities at the site ie excavating below the natural water table, dewatering then pumping slurry to pits adjacent to the site.

   Given the proximity of the trees to mining activities, I don't believe that Doral could have changed practices to have saved the trees.

There are common trends in all of the rehabilitated sites that affect soil health and will limit pasture production going into the future. However, these limitations can be overcome in a cost effective manner to return the soil to its pre-mining productive potential.

We would be happy to assist in improving the pastured sites, including sourcing the compost blends as indicated.

Yours faithfully

CJ Bosustow

APPENDICES

1. **ILS Pasture analyses**
2. **SWEP Soil Tests**
    a. **Burekup N – SW**
    b. **Burekup N – SE**
    c. **Green 17**
    d. **Green 18**
    e. **Depiazzi – Harris Rd**
    f. **Depiazzi – Poor pasture**
    g. **Dead Trees**

Evaluation of post mining areas

Lot 1 St Helena Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
Fax. 9731 7011
Email: bosustow@bordernet.com.au

CONTENTS

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1. Describe the lot including its pastures and soils including their composition and characteristics
2. Describe any improvements and compare to Pre mining Assessment
3. Compare pre and post mining agricultural productivity by objective measurement. Where pre mining data is unavailable, eg micro-nutrients, post mining data will be compared to typical farm levels. Soil analysis of both topsoil and subsoils to include −
    a. Soil Balance − pH, TSS, organic carbon
    b. Cation exchange capacity − Ca Mg Na K Hydrogen
    c. Nutrients − N P K S
    d. Micro-nutrients − Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected in November 2015 and October 2016 with composite top & sub soil samples were collected from each site. In 2015, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup West	Lot 1	1		
Total				1 sites
Top & sub soil samples				2 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lot

Lot 1 St Helena Road is a rural block of approximately 96 hectares accessed by St Helena Road and bounded to the east by Dowdells Line.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.
Approximately 5% of the lot comprising an area across the SE corner has been mined and rehabilitated.

The subject area has been cleared suitable for grazing and hay production. Drainage is poor being flat heavy soils similar to surrounding lots.

Prevailing Conditions

No direct pre-mining report but considered comparable with Pre Mining Report by Wise for Lot 18 situated to the south of Lot 1 encompassing similar beef grazing land on similar soil types.

Improvements

Stock proof boundary fence and internal fences.
Several excavated water holes providing stockwater.

Land Forms, Soils and Land Capability

Refer Pre Mining Report by Wise for Lot 18 for general outline.

The lot comprises a gently undulating grazing land with some paperbark swamps and water courses. All depressions would be waterlogged in winter. Nevertheless, the block provides productive grazing land especially in the spring. Paddocks to the west of the mined area have been developed for flood irrigation and intensive grazing but were dry in the 2016 season. The mined area soils had brown clay at the surface and as deep as an auger could penetrate.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined*	Desired Level	Comments
General					
pH CaCl	5	4.86	5.24	5.5	Soil is acidic and acidifying further
TSS	415	910	325	<990	Non saline but TSS increased markedly in 2016
Organic Carbon	2.1%	1.6%	6.45%	2%	Now marginal
Structure		% Adjusted CEC			% Adjusted CEC
Ca	30%	25%	57%	65-70%	Too low for good plant growth
Mg	25%	25%	20%	12-15%	High and will cause poor soil flocculation
Na	7%	8%	3%	0.5-5%	High, sodic type soils, pugging & waterlogging
K	2.3%	0.9%	0.6%	3-5%	Level too low for good pasture production
Hydrogen	34%	41%	20%	<20%	High Hydrogen%, acidic soil

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	6ppm	3	9	22ppm	N utilized in 2015 and again in 2016
P	14	4	26	20	Low
K	99	54	38	160	Low
S	21	77	16	7-10	Adequate, high % in 2016??
Micro-nutrients					
Copper	2.63	3.01	2.83	2ppm	Adequate
Zinc	0.92	0.67	2.80	3-5	Low and falling, will limit grasses
Iron	631	509	518	>30	High due to anaerobic conditions
Manganese	17	21	4	>20	Adequate
Cobalt	1.22	1.18	0.42	0.5-0.7	Adequate
Molybdenum	0.38	0.38	0.30	0.1-0.2	Adequate
Boron	0.44	0.52	0.09	0.4-0.6	Adequate

* Non-mined data from Lot 104 which had a comparable soil type

The long growing season in 2016 further depleted fertility levels which are now very low. CEC confirms poor soil structure. Trace element levels were adequate except for zinc. Sub soils were similar.
Pasture production was generally good but is limited by low fertility together with winter waterlogging due to less than optimum soil structure.

Pasture Composition and Production

Pasture composition was estimated as 7% Lotus, 90% annual ryegrass, 0% kikuyu and 3% weeds.
Current pasture production estimated at 5tDM/ha with average quality due to lack of legume species.
Potential pasture production estimated at 8-9tDM/ha with good quality if potash levels are lifted, soil balance and pH corrected and productive legumes are reseeded.

Conclusions

The mined soils of Lot 1 are trending towards being more acidic, less fertile and poorer structured than the non-mined soils of Lot 104. Comparative productivity is falling. Higher inputs are now required to correct.
To optimize pasture production, the 2017 program for the mined area of Lot 1 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 2.66t/ha (1.54t/ha)gypsum to improve soil structure
Apply 1.04/ha (1.04t/ha) lime to boost Calcium levels and address acidity
Apply 0t/ha (0t/ha) dolomite to boost Ca & Mg levels and address acidity

Nutrient input to optimize pasture production

N	24 (7) kg/ha
P	26(21) kg/ha
K	80 (0) kg/ha
S	0 (0) kg/ha
Copper	0 (0) kg/ha
Zinc	3.75 (0) kg/ha
Cobalt	0 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	2.0 (0) kg/ha
Boron	0.75 (0) kg/ha

Once soil pH and structure improves, reseeding with suitable clovers would improve pasture quality which is currently grass dominant.

Acknowledgements

We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Rob Oliver for his assistance in the field.

Disclaimer

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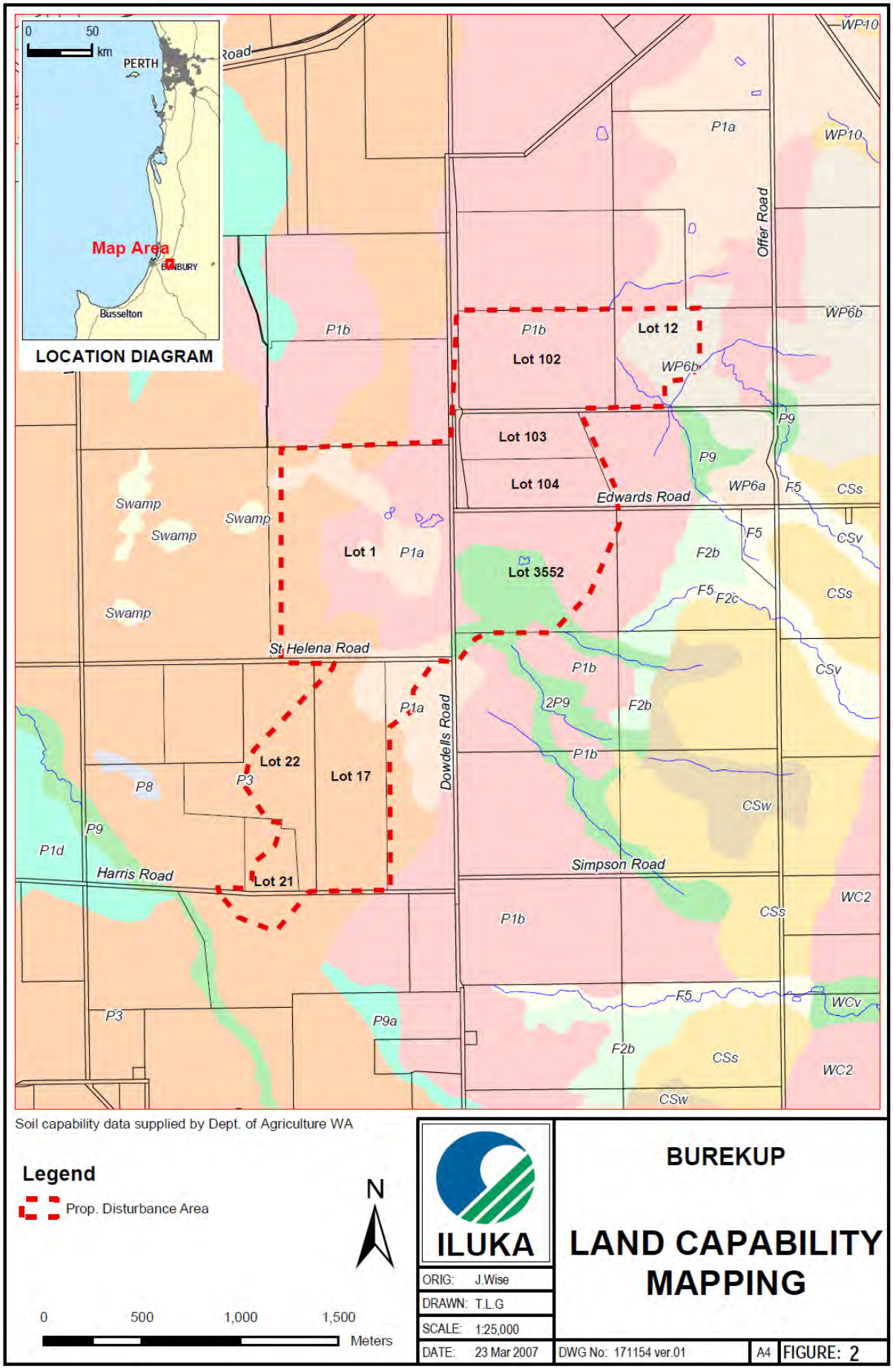
CJ Bosustow

Appendix 1

Aerial photo March 2015 showing Wise (nil) and PBS sites on Lot 1

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
F5
CSv
F2b
Lot 3552
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 102 O'Connor Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
Fax. 9731 7011
Email: bosustow@bordernet.com.au

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    b. Cation exchange capacity − Ca Mg Na K Hydrogen
    c. Nutrients − N P K S
    d. Micro-nutrients − Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected on 16 November 2015 and composite top & sub soil samples were collected from each site. At same time, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup North	Lot 102	1	1	
Total				2 sites
Top & sub soil samples				4 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lot

Lot 102 O'Connor Road is a rural block of approximately 40 hectares accessed by O'Connor Road and bounded to the west by Dowdells Line.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.
Approximately 35% of the lot comprising an area through the eastern section has been disturbed by mining then rehabilitated.

The lot has been parkland cleared suitable for grazing but retains a significant number of paperbark trees to the west on the non-mined area. Drainage is poor.

Prevailing Conditions

As per Pre Mining Report by Wise for Lot 103 immediately south of Lot 102.

Improvements

Stock proof boundary fence.
Several excavated water holes providing stockwater.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being −

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance − low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 103.

The lot comprises a paperbark swamp area, shallow undulations and areas of subsidence following mining. All depressions would be waterlogged in winter, as noted by Wise. Nevertheless, the block provides productive grazing land especially in the spring. The non-mined soils had brown clay loam topsoil to 20cm, grey clay loam to 40cm thereafter light fawn clay loam subsoil to 100cm. The mined area showed similar topsoil characteristics to 50cm thereafter tailing sands to 100cm.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
General					
pH CaCl	4.5	4.78	4.89	5.5	Soil is acidic
TSS	191	491	223	<990	Non saline but TSS is increasing
Organic Carbon	0.75%	1.15%	4.9%	2%	Low with some improvement
Structure	% Adjusted CEC				
Ca	25%	22%	26%	65-70%	Too low for good plant growth
Mg	8.5%	12%	8%	12-15%	High and will cause poor soil flocculation
Na	2.8%	5%	3.5%	0.5-5%	High, sodic type soils, pugging & waterlogging
K	0.7%	1%	4.1%	3-5%	Level too low for good pasture production
Hydrogen	63%	61%	59%	<20%	Very high Hydrogen, acidic soil

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	0.1ppm	1.54	10	22ppm	N reserves fully utilized in 2016
P	12	10	40	20	Fair as an end of year value
K	13	36	186	91	Low value limiting total production & clover growth
S	5	38	7	7-10	Adequate
Micro-nutrients					
Copper	1.06	1.02	1.94	2ppm	Low, will limit grasses
Zinc	1.58	1.9	4.85	3-5	Low, will limit grasses
Iron	202	266	571	>30	High due to anaerobic conditions
Manganese	5	10	9	>20	Low
Cobalt	0.23	0.27	0.53	0.5-0.7	Low
Molybdenum	0.17	0.27	0.3	0.1-0.2	Adequate
Boron	0.16	0.01	0.04	0.4-0.6	Low

Soil analysis for 2016 is very similar to previous year reflecting a typical low input Burekup "beef block".
Soils are acidic, limiting nutrient uptake, and poorly structured causing waterlogging in winter and hard cracking soils in summer. Spring fodder production can be quite high but is limited by fertility in the mined area. The non mined area is similar but has a far higher level of NPK and trace elements.
The mined area had been cropped for hay with the non mined area utilized for grazing.

Pasture Composition and Production

Pasture composition was estimated as 10-20% Lotus, 40-60% annual ryegrass, 0-30% sub clover, 0% kikuyu and 10-20% weeds. The better quality pastures were on the non mined area.
Hay production on the mined area was estimated at 2-4tDM/ha with approximately 80% at the higher figure. Pasture production on non mined land was 3tDM/ha.
Potential pasture production estimated at 7-8tDM/ha with good quality if soil fertility is lifted, soil balance corrected and productive legumes are reseeded.

Conclusions

No significant differences appear between non-mined and mined topsoils with respect to structure and pH. Subsidence in the mined area can create wet hollows in the winter and some mine tailings were visible at the surface.
Fertility was far higher on the non mined land but this could easily be corrected across the Lot through the application of a compound fertilizer.
Application of dolomite and lime will improve soil structure and pH in future years.

To optimize pasture production, the 2017 program for the mined area of Lot 102 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 0t/ha (0t/ha) gypsum to improve soil structure
Apply 1.6t/ha (nil) lime to boost Calcium levels and reduce acidity
Apply 0.32t/ha (nil) dolomite to boost Ca & Mg levels and reduce acidity

Nutrient input to optimize pasture production

N	20 (4) kg/ha
P	10 (10) kg/ha
K	80 (63) kg/ha
S	0 (0) kg/ha
Copper	0.75 (0) kg/ha
Zinc	3.0 (0) kg/ha
Cobalt	0.03 (0.01) kg/ha
Molybdenum	-
Iron	-
Manganese	2.5 (0) kg/ha
Boron	0.3 (0) kg/ha

Once soil pH and structure improves, reseeding with suitable clovers would improve pasture quality which is currently grass dominant.

Acknowledgements

We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Bruce Trepp for his assistance in the field.

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CJ Bosustow

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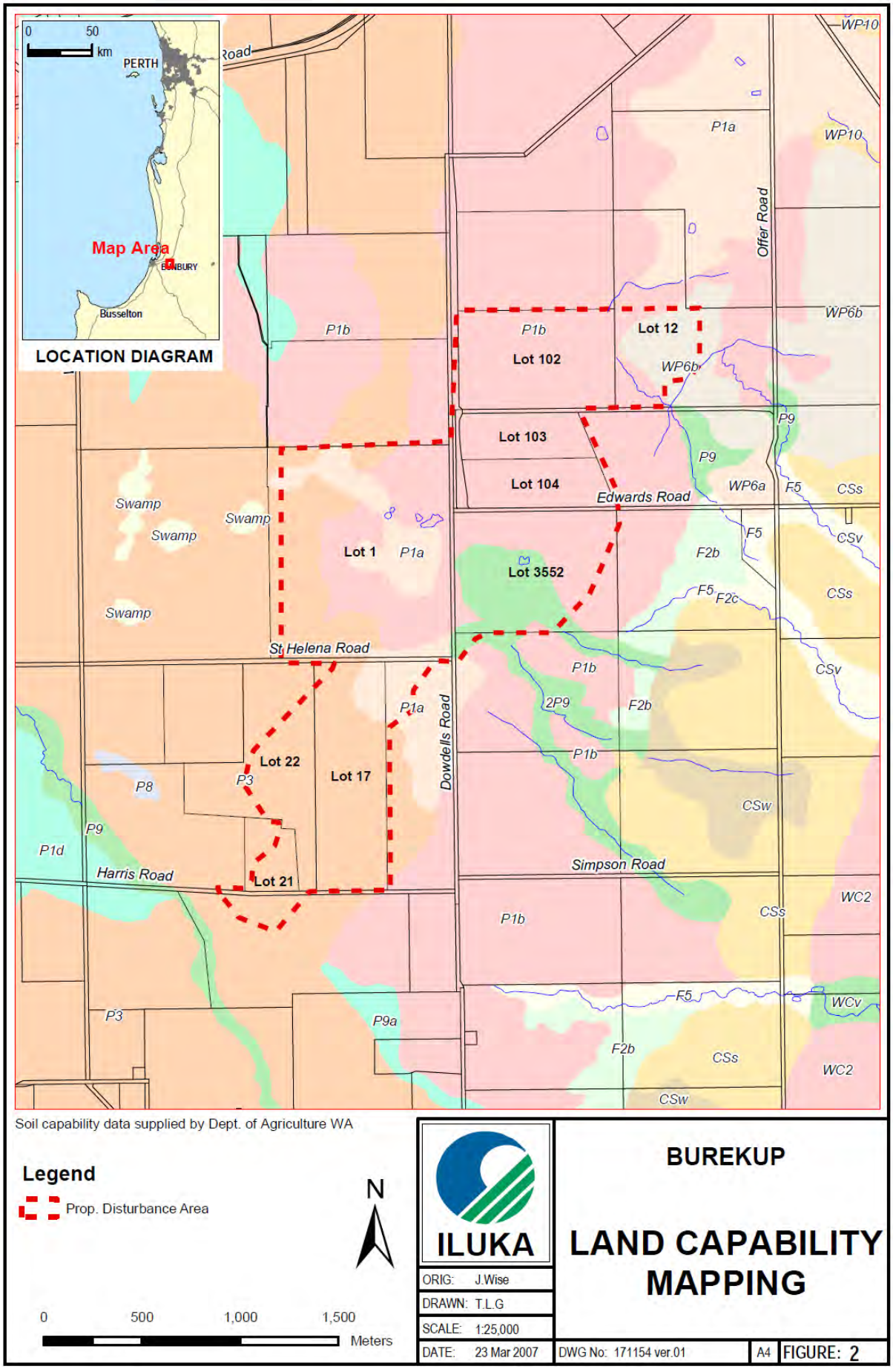
Aerial photo March 2015 showing Wise (nil) and PBS sites on Lot 102

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
F5
CSv
F2b
Lot 3552
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lots 103 & 104 O'Connor Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
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The lot was inspected on 16 November 2015 and composite top & sub soil samples were collected from each site. At same time, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup Central	Lot 103	1 (Wise)		
	Lot 104	1 (Wise)	1 (Wise)	
Total				3 sites
Top & sub soil samples				6 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lots

Lot 103 O'Connor Road is a rural block of approximately 15 hectares accessed by O'Connor Road and bounded to the west by Dowdells Line.
Lot 104 Edwards Road is a rural block of approximately 18 hectares accessed by Edwards Road and bounded to the west by Dowdells Line.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.

The Lots adjoin and were historically part of the Edwards family dairy farm being fully cleared and developed with fencing, water, laser levelled for flood irrigation and sown to improved pastures.
Approximately 50% of lot 103 and 30% of Lot 104 has been disturbed by mining then rehabilitated.

Prevailing Conditions

As per Pre Mining Report by Wise for Lots 103 & 104.

Improvements

Stock proof boundary fence.
Good internal fencing for dairy.
Reticulated stockwater.
Laser levelled paddocks for flood irrigation, currently used for hay production.
Old dairy & yards on Lot 104.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being –

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance – low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lots 103 & 104.

The lots comprise heavy clay loam soils well suited to flood irrigation of perennial pastures in the summer but require destocking in the winter to prevent excessive pugging. Currently well suited to dryland hay production.
The non-mined soils had brown clay loam topsoil to 20cm, grey clay loam to 40cm thereafter light fawn clay loam subsoil to 100cm. The mined area showed similar topsoil characteristics to 60cm thereafter tailing sands to 100cm.

Soil Analysis Results

Item	Mined 103		Mined 104		Non Mined 104	Desired Level	Comments
	2015	2016	2015	2016	2016		
General							
pH CaCl	4.6	5.0	4.6	5.08	5.24	5.5	pH improved on all sites
TSS	320	211	313	180	325	<990	Non saline
Organic Carbon	1.6%	3%	2.8%	3.3%	6.45%	2-3%	Average/improved
Structure	% Adjusted CEC						
Ca	45%	49%	43%	47%	57%	65-70%	Low but marginal improvement in all sites
Mg	12%	11.5 %	11%	13%	20%	12-15%	Adequate
Na	4.3%	3.7%	5.9%	2.2%	3.0%	0.5-5%	Mined area improved with higher rainfall
K	2.1%	0.8%	1.2%	1.1%	0.6%	3-5%	Low levels reflect high rainfall in 2016
Hydrogen	35%	35%	38%	36%	20%	<20%	Mined areas remain high

Item	Mined 103		Mined 104		Non Mined 104	Desired Level	Comments
	2015	2016	2015	2016	2016		
Nutrients							
N	14ppm	1.6	6.3	8.4	9	22	N fully utilized in 2016
P	27	20	34	24	26	20	Good as end of year values
K	49	23	20	30	38	150	Low value limiting total production & clover growth, leached by heavy rains
S	10	11	15	7	16	7-10	Adequate
Micro-nutrients							
Copper	0.97	1.06	1.38	1.29	2.83	2ppm	Low will limit spring production
Zinc	2.08	2.22	2.17	2.19	2.8	3-5	Low, will limit grasses
Iron	305	352	392	487	518	>30	High due to anaerobic (waterlogging)conditions
Manganese	4	6	6	6	4	>20	Low
Cobalt	0.25	0.29	0.29	0.31	0.42	0.5-0.7	Low
Molybdenum	0.19	0.13	0.27	0.17	0.30	0.1-0.2	Adequate
Boron	0.45	0.01	0.41	0.01	0.09	0.4-0.6	Low

The results continue to reflect the sites history of irrigated dairy pastures.
Again, analysis reveals reasonable levels of P, Ca, Mg & S from past fertilizer programs and hay cropping in 2016. Low levels of K reflect leaching with heavy winter/spring rains in 2016 and the continuous cutting and removal of hay from the site. Trace elements have been similarly removed.
High P & S levels throughout suggest application of superphosphate without added Potash in the spring.
Soil structure is now similar within mined and non mined areas. The mined area is marginally more acidic.
Sub soils were poorer to topsoils in the mined area of Lot 103 and the non mined area but better structured in the mined area of Lot 104.

Pasture Composition and Production

Pasture composition was estimated as 0% Lotus, 99% annual ryegrass, 0% kikuyu and 1% weeds. A good ryegrass based hay crop.
Current pasture production estimated at 5 and 6tDM/ha respectively for Lots 103 and 104 with average quality due to lack of legume species. The non-mined areas was pasture rather than hay.
Potential pasture production estimated at 8-9tDM/ha with good quality if soil fertility is lifted, soil balance corrected and productive legumes are reseeded.

Conclusions

Soil pH and CEC (structure) have marginally improved on the mined areas of both lots. Heavy winter rains may have flushed some sodium from the topsoil improving structure.
At the same time these heavy rains have leached already low levels of potassium (K) and levels are now very low.
Trace element levels have also fallen presumably with another year's hay production and are also critically low.
Application of both dolomite and lime is required to improve soil structure and further improve pH on mined soils whereas non-mined soils require gypsum only to improve structure only.
Again, all soils require high rates of K and a mix of trace elements to lift production. P is not required on mined soils but a modest application of P on the non-mined area would be beneficial, as detailed below.

To optimize pasture production, the 2017 program for the mined area of Lots 103 & 104 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 0t/ha (0t/ha)gypsum to improve soil structure
Apply 0.4t/ha (0.4) lime to boost Calcium levels and address acidity
Apply 0.23t/ha (nil) dolomite to boost Ca & Mg levels and address acidity

Nutrient input to optimize pasture production

N	13-20 (0) kg/ha
P	0-5 (0) kg/ha
K	80 (0) kg/ha
S	0 (0) kg/ha
Copper	0.75 (0.25) kg/ha
Zinc	3.0 (0) kg/ha
Cobalt	0.03 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	2.5 (0) kg/ha
Boron	0.3 (0) kg/ha

Once soil pH and structure improves, reseeding with suitable clovers would improve pasture quality which is currently grass dominant.

Acknowledgements

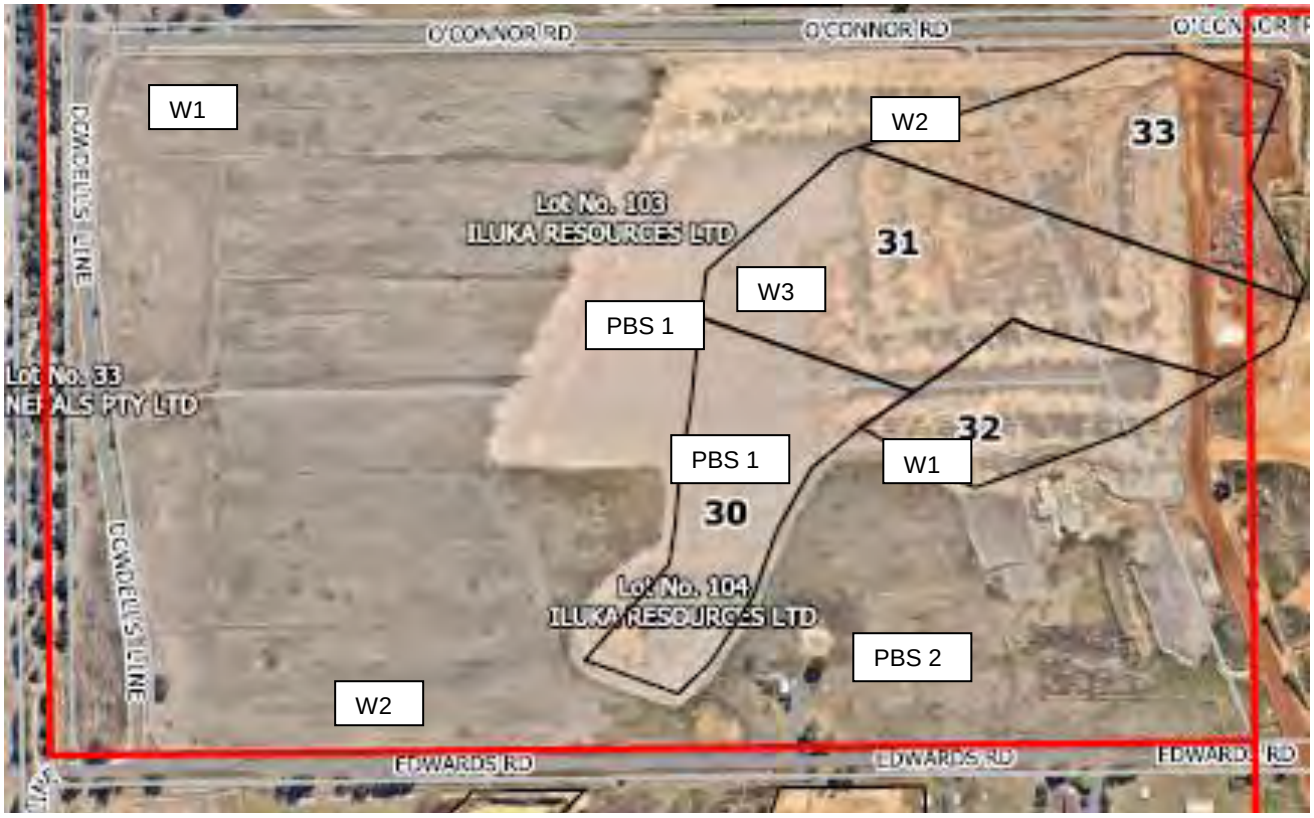
We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Bruce Trepp for his assistance on site.

Disclaimer

Primary Business Services Pty Ltd (PBS) has prepared this report for the use of the Client in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. It is prepared in accordance with the above assessment objectives.
Information supplied by the client and third parties has been used within the report without independent audit and PBS has relied upon the accuracy of this information.
This report was prepared in November 2016 and is based on the conditions and information reviewed at the time of preparation.
This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. The client should make their own enquiries through their professional advisers taking into account their whole business structure before committing to any action including capital expenses.

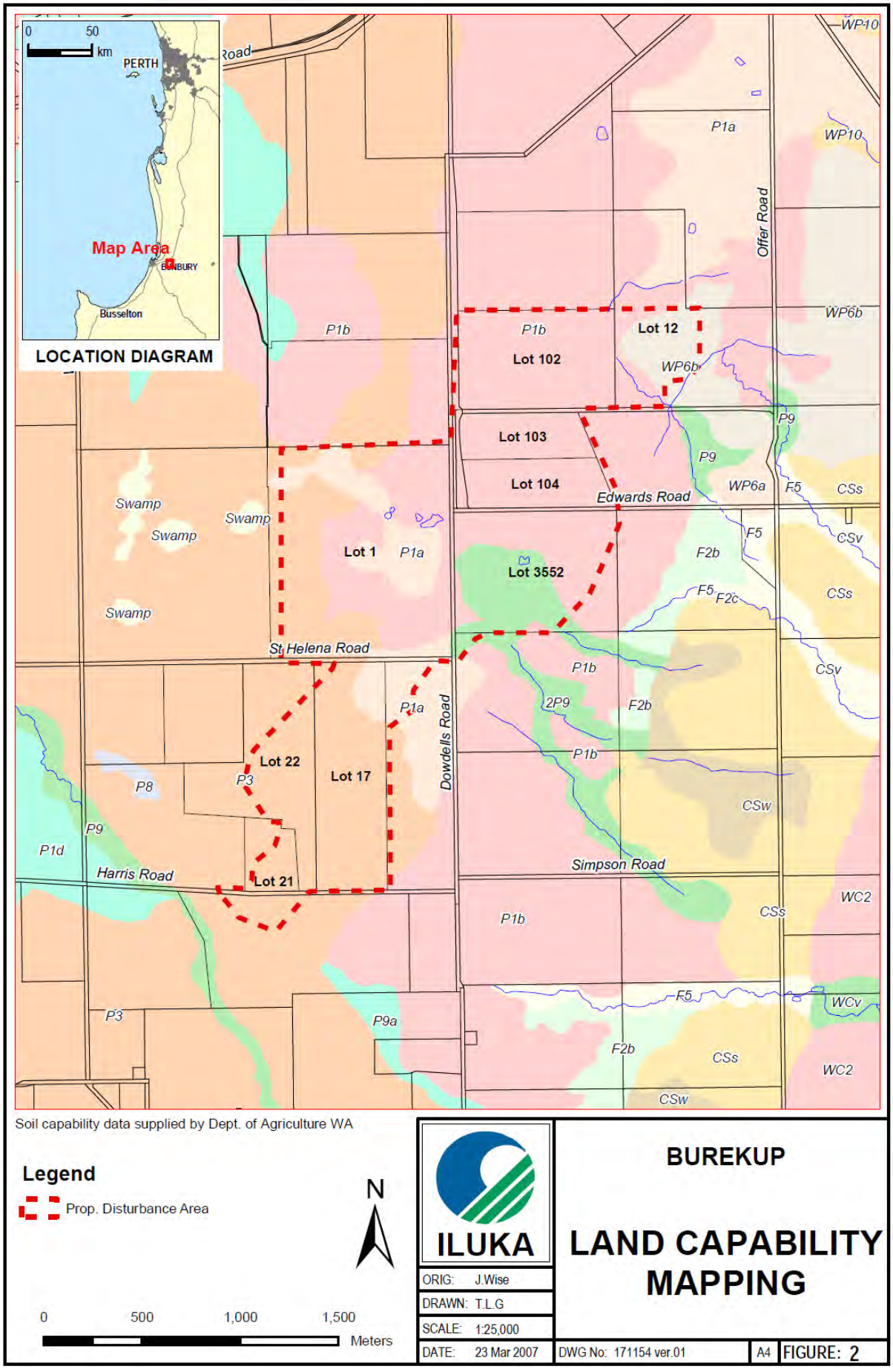
CJ Bosustow

Appendix 1



Aerial photo March 2015 showing Wise and PBS sites on Lots 103 & 104

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
F5
CSv
F2b
Lot 3552
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 11 Offer Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
Fax. 9731 7011
Email: bosustow@bordernet.com.au

CONTENTS

Introduction

Doral Mineral Sands Pty Ltd requested Primary Business Services Pty Ltd to carry out an independent agricultural assessment of the subject lot, post mining in 2015 and again in 2016. Pre mining assessment of much of the area was completed by John Wise Consultancy Pty Ltd. Sampling numbers and approximate locations were determined by Doral.

Assessment Objectives

1. Describe the lot including its pastures and soils including their composition and characteristics
2. Describe any improvements and compare to Pre mining Assessment
3. Compare pre and post mining agricultural productivity by objective measurement. Where pre mining data is unavailable, eg micro-nutrients, post mining data will be compared to typical farm levels. Soil analysis of both topsoil and subsoils to include –
    a. Soil Balance – pH, TSS, organic carbon
    b. Cation exchange capacity – Ca Mg Na K Hydrogen
    c. Nutrients – N P K S
    d. Micro-nutrients – Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected in November 2015 and October 2016 with composite top & sub soil samples collected from each site. At same time, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup North	Lot 11	~~2~~ 1	~~1~~	
Total				~~3~~ 1 sites
Top & sub soil samples				~~6~~ 2 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.
Sites shown on Doral map indicated 3 sites for Lot11 but reference to cadastral survey showed only one of these sites on Lot 11 with the other 2 on Lot 12.

The Lot

Lot 11 Offer Road is a rural block of approximately 56 hectares accessed by Offer Road.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.

Approximately 40% of the lot comprising an area through the mid section has been disturbed by mining then rehabilitated.
The lot has been parkland cleared suitable for grazing and was supporting a herd of rising 2 year old Friesian steers at inspection.

Prevailing Conditions

Refer Pre Mining Report by Wise for Lot 12

Improvements

Stock proof boundary fence.
Several excavated water holes providing stockwater.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being −

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance − low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 12 .

Inspection of the mined area showed undulating topography with low rises and shallow depressions which would be waterlogged in winter. Wise warns of vulnerability to winter pugging and loss of production and we concur. Nevertheless, the block provides productive grazing land especially in the spring. The soil had a brown clay loam topsoil to 40cm thereafter mottled yellow clay subsoil to 100cm. The 0-10cm brown stained organic topsoil noted by Wise was yet to fully redevelop.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined*	Desired Level	Comments
General					
pH CaCl	5.0	5.49	4.65	5.5	Soil is marginally acidic but improving
TSS	323	521	154	<990	Non saline but increasing TSS
Organic Carbon	3.7%	4.6%	3.4%	2-3%	High
Structure		% Adjusted CEC			
Ca	23%	30%	23%	65-70%	Too low for good plant growth
Mg	25%	26%	9%	12-15%	High and will cause poor soil flocculation
Na	5%	5%	1.5%	0.5-5%	High, sodic type soils, pugging & waterlogging
K	1.3%	1.2%	1.1%	3-5%	Level too low for good pasture production
Hydrogen	46%	38%	66%	<20%	High Hydrogen, acidic soil, reducing as Ca increases

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	0.1	1.3	6.07	27ppm	N reserves fully utilized in spring 2016
P	20	15	0.4	25	Adequate as an end of year value
K	61	69	50	196	Low value limiting total production & clover growth
S	16	29	5	11-15	Adequate/surplus
Micro-nutrients					
Copper	2.82	5.33	5.68	2ppm	Adequate
Zinc	2.86	3.51	1.65	5-7	Low, will limit grasses
Iron	619	600	509	>30	High due to anaerobic conditions
Manganese	7	46	16	>20	Adequate
Cobalt	0.7	1.23	1.2	0.7-0.8	Adequate
Molybdenum	0.56	0.79	0.57	0.3-0.4	Adequate
Boron	0.4	0.27	0.06	0.6-0.7	Low

* Non mined results for Lot 12 used. No non mined sites sampled on Lot 11.

The rehabilitated soil is showing signs of improvement due to good farming practices modestly boosting soil pH, fertility and soil structure.
Soil structure remains a limitation on pastures.
Subsoil results were similar to topsoil with poor structure and low nutrient levels.
In comparison, the non-mined soils of Lot 12 appear to be managed will limited or no inputs and are continuing to acidify with structure and fertility remaining poor. Ie these are not improving from their native state.
Nutrient levels are generally lower in the non-mined area presumably due to low input levels in a season with an extended growing period.

Pasture Composition and Production

Pasture composition was estimated as 4% Lotus, 65% annual ryegrass, 0% kikuyu, 25% clover and 6% weeds. Pastures show an improvement on 2015.
Current pasture production estimated at 5tDM/ha with fair/good quality due to improved pasture species including clovers.
Potential pasture production estimated at 8-9tDM/ha with good quality if soil balance is corrected and fertility improved.

Conclusions

Topsoil within the rehabilitated area shows similar general characteristics to that in the adjoining non-mined areas, however fertility and soil pH is improving with

higher inputs associated with hay production. Poor soil structure remains a major limitation. Cation exchange capacity is affected by higher levels of Mg & Na than non-mined land.
Poor soil structure is a general weakness throughout this area, limiting trafficability and production throughout winter.
Application of gypsum and lime will improve soil structure in future years.
Specific nutrient deficiencies can be resolved with application of P,K and trace elements, as detailed below.

To optimize pasture production, the 2017 program for the mined area of Lot 11 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 2.37t/ha (2.37t/ha)gypsum to improve soil structure
Apply 1.03t/ha (0.83)lime to boost Calcium levels and address acidity

Nutrient input to optimize pasture production

N	25 (5) kg/ha
P	15 (15) kg/ha
K	80 (0) kg/ha
S	0 (0) kg/ha

Copper	-
Zinc	3.0 (0) kg/ha
Cobalt	0 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	0 (0) kg/ha
Boron	0.75 (0) kg/ha

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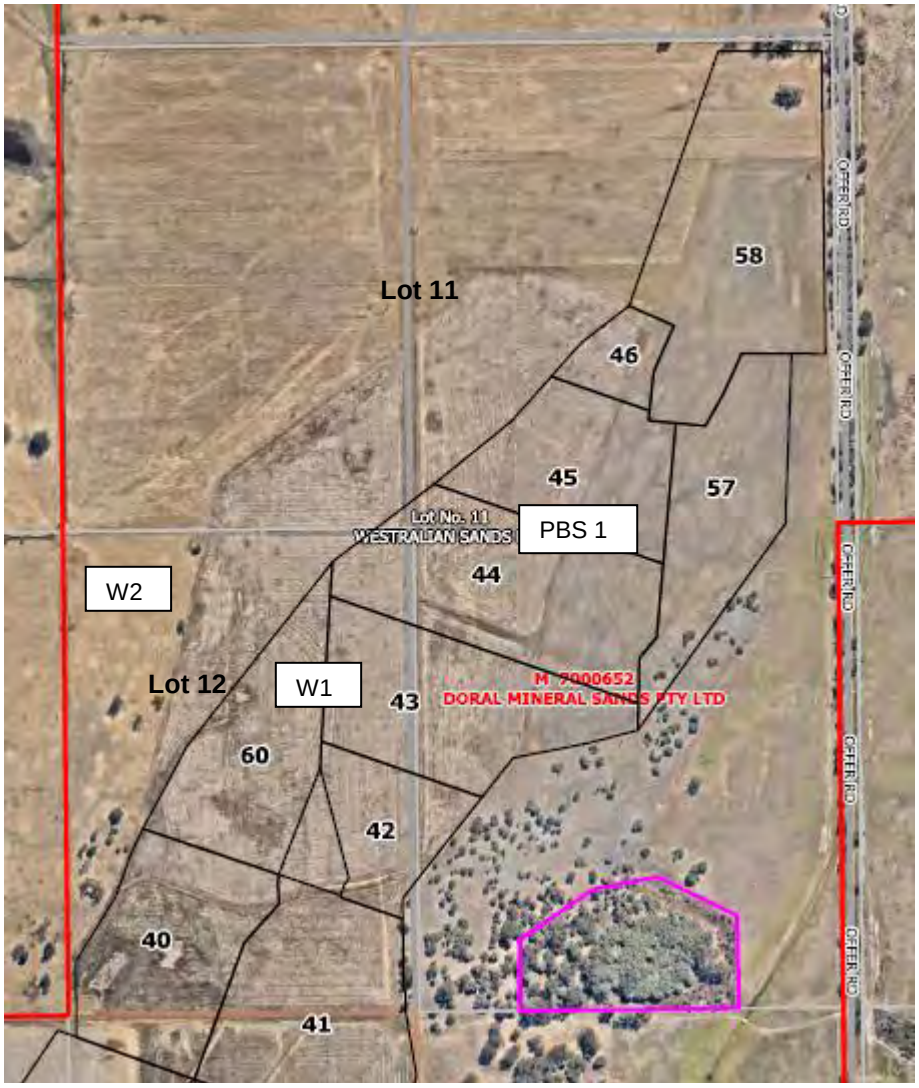
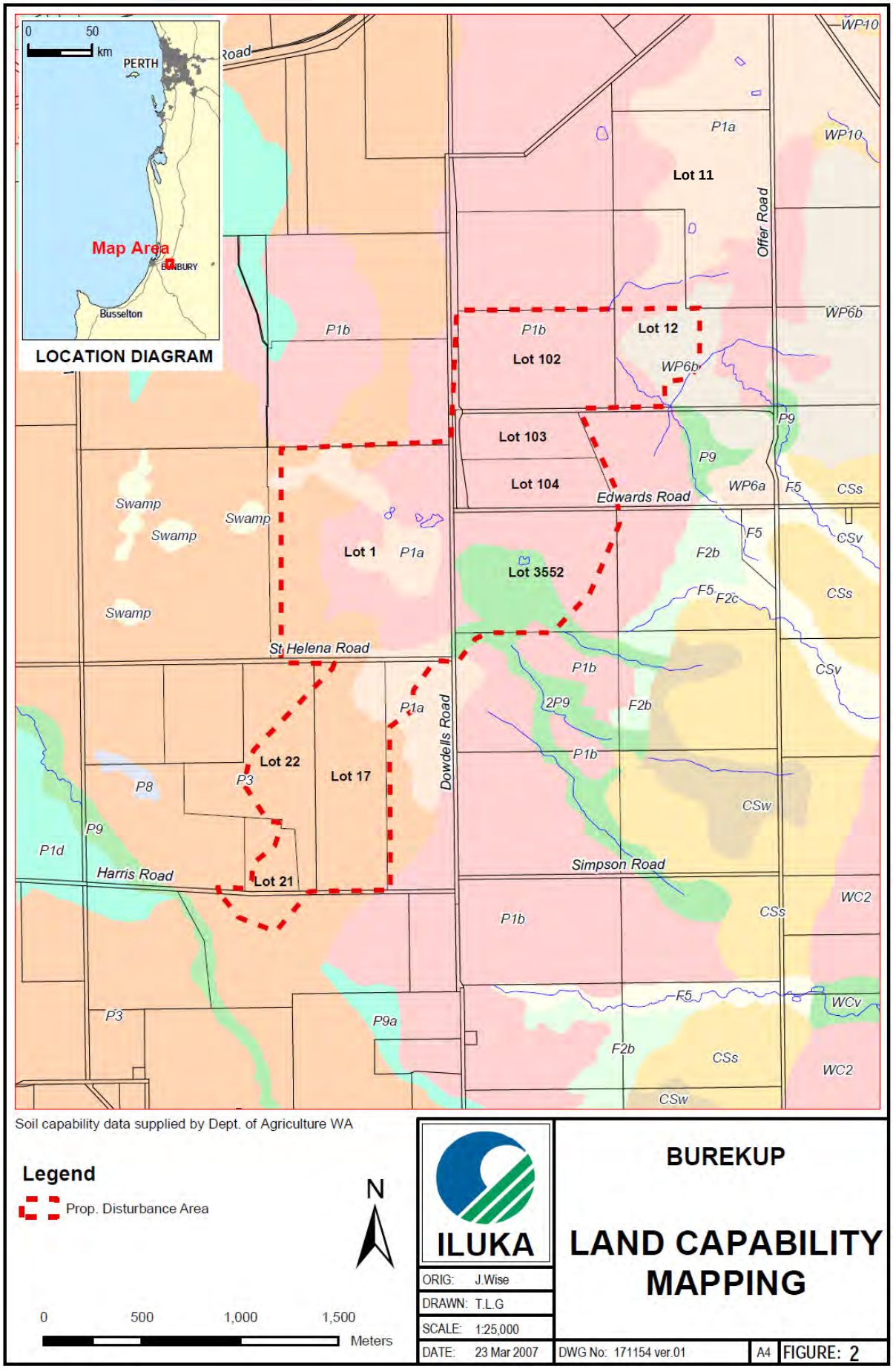
CJ Bosustow

Appendix 1



Aerial photo March 2015 showing Wise sites on lot 12 and PBS site on Lot 11

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
Lot 11
Offer Road
P1b
Lot 102
Lot 12
WP6b
Lot 103
P9
Lot 104
Edwards Road
WP6a
F5
CSs
CSv
Swamp
Lot 1
Lot 3552
F2b
F2c
St Helena Road
2P9
Lot 22
Lot 17
Dowdells Road
P8
P3
CSw
P1d
Harris Road
Lot 21
Simpson Road
WC2
P9a
WCv
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
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ILUKA
BUREKUP
LAND CAPABILITY MAPPING
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SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 12 O'Connor Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271

Ph. 9731 7000

Fax. 9731 7012

Email: bosustow@bordernet.com.au

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Assessment Objectives

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2. Describe any improvements and compare to Pre mining Assessment
3. Compare pre and post mining agricultural productivity by objective measurement. Where pre mining data is unavailable, eg micro-nutrients, post mining data will be compared to typical farm levels. Soil analysis of both topsoil and subsoils to include –
    a. Soil Balance – pH, TSS, organic carbon
    b. Cation exchange capacity – Ca Mg Na K Hydrogen
    c. Nutrients – N P K S
    d. Micro-nutrients – Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected in November 2015and October 2016 with composite top & sub soil samples collected from each site. In 2015, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup North	Lot 12	~~1~~ 2	~~0~~ 1	
Total				~~1~~ 3 sites
Top & sub soil samples				~~2~~ 6 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.
Sites shown on Doral map indicated 1 site for Lot12 but reference to cadastral survey showed 3 sites on Lot 12, gaining 2 sites thought to be on Lot11.

The Lot

Lot 12 is bounded by Offer and O'Connor Roads and is a rural block of approximately 58 hectares accessed by O'Connor Road.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.
Approximately 75% of the lot comprising an area north from O'Connor Road has been disturbed by mining then rehabilitated.
The lot has been cleared suitable for grazing and hay production and had been cut for hay just prior to inspection.

Prevailing Conditions

As per Pre Mining Report by Wise for Lot 12

Improvements

Stock proof boundary and internal fences.
Several excavated water holes provide stockwater.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previous-ly supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being –

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance – low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 12 .

Inspection of the mined area showed undulating topography with low rises and shallow depressions which would be waterlogged in winter. Subsidence within the mined area is prevalent and has a negative impact. Wise warns of vulnerability to winter pugging and loss of production and we concur. Nevertheless, the block provides productive grazing land and good potential for hay production in the

spring. The soil had a brown loam topsoil to 10cm, mottled clay mixed in loam at 10-20cm thereafter mine waste being a pink gritty clay loam to 100cm. The 0-10cm brown stained organic topsoil noted by Wise had largely redeveloped and showed improved production over Lot 11.

Soil Analysis Results

Item	Mined North		Mined South		Non Mined	Desired Level	Comments
Year	2015	2016	2015	2016	2016		
General							
pH CaCl	5.0	5.46	4.7	4.87	4.65	5.5	Soils are marginally acidic, improving
TSS	356	432	217	415	154	<990	Non saline
Organic Carbon	2.8%	2.7%	0.9%	1.4%	3.4%	2-3%	Higher in north
Structure	% Adjusted CEC						
Ca	24%	33%	32%	27%	23%	65-70%	Too low for good plant growth
Mg	25%	25%	9.7%	13%	9%	12-15%	Excessive Mg in north, poor structure
Na	4.9%	6%	3.5%	6%	1.5%	0.5-5%	Excessive levels on both sites now
K	0.8%	1.1%	1.2%	1.2%	1.1%	3-5%	Level too low for good pasture production
Hydrogen	45%	36%	53.5%	53%	66%	<20%	Very high Hydrogen, acidic soil

Item	Mined North		Mined South		Non Mined	Desired Level	Comments
Year	2015	2016	2015	2016	2016		
Nutrients							
N	5.2	1.5	0.1	4.1	6.1ppm	22-27	Low
P	11	2.6	10	7.7	0.5	20-25	Low
K	44	56	24	34	50	103-250	Low
S	30	18	13	12	5	7-15	Adequate
Micro-nutrients							
Copper	4.34	4.41	1.39	1.77	5.68	2ppm	Adequate in north, low in south
Zinc	1.82	1.37	1.1	1.51	1.65	5-7	Low, will limit grasses
Iron	402	434	413	480	509	>30	High due to anaerobic conditions
Manganese	27	31	13	22	16	>20	Adequate
Cobalt	2.34	1.81	0.47	0.59	1.21	0.7-0.8	Adequate in north, low in south
Molybdenum	0.58	0.47	0.2	0.28	0.57	0.3-0.4	Adequate in north, low in south
Boron	0.55	0.1	0.29	0.01	0.06	0.6-0.7	Low

The rehabilitated soils appear better structured at the southern end of the Lot and more poorly structured to the north due to excessive Mg levels in the north. Both had inferior structure (CEC) to the un-mined area. Soil pH in both areas showed marginal improvement since 2015.

The soils lack Ca & K and are high in Na & Mg making them poorly flocculated, waterlogging soils which are susceptible to pugging and cracking. Soils are also highly acidic at 36-66% H.

Subsoil results were similar to topsoil showing poor soil structure and low nutrient levels.

In comparison to both mined areas, the non-mined soils of Lot 12 continue to show improved soil structure with lower Na & Mg, providing better drainage and less likely to pug and waterlog than the northern mined area. This is also reflected in the sub soil.

It is important to recognize however that the non-mined soils have generally poor structure and specific limiting factors similar to the mined area, just not as detrimental.

Macro nutrients – N P K & S generally reduced across all sites in 2016, presumably from the longer growing season. End of season values are now well below generally accepted target levels in both mined and non-mined areas.

Zinc deficiency is a major limitation on all sites with copper, cobalt, molybdenum and boron deficient in the south site.

Pasture Composition and Production

Pasture composition was estimated as - North 39% Lotus, 40% annual ryegrass, 0% kikuyu and 1% weeds. Ryegrass had reduced and lotus increased from last year. South 18% Lotus, 70% annual ryegrass, 10% clover, 0% kikuyu and 2% weeds.
Current pasture production estimated at 2-3tDM/ha in the north and 5 tDM/ha in the south with improved quality in south due to emergence of clover species.
Potential pasture production estimated at 8-9tDM/ha with good quality if soil balance is corrected and productive legumes are reseeded.

Conclusions

Topsoil within the rehabilitated area shows similar general characteristics to that in the adjoining non-mined areas, but with reduced productivity due to poorer soil structure ie higher Na & Mg levels.
Poor soil structure is a general weakness throughout this area, limiting trafficability and production throughout winter.
Application of gypsum and lime will improve soil structure in future years. We also support the current application of compost and poultry manure to boost usable organic matter in the soil.
Specific nutrient deficiencies can be resolved with application of N,P,K and trace elements, as detailed below.

To optimize pasture production, the 2017 program for the mined area of Lot 12 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 1.91t/ha (1.91t/ha)gypsum to improve soil structure in north (nil to south)
Apply 1.0t/ha (nil)lime to boost Calcium levels and address acidity across all.

Nutrient input to optimize pasture production

N	22 (0) kg/ha
P	20 (0) kg/ha
K	80 (0) kg/ha
S	-

Copper	0.75 (0) kg/ha on south
Zinc	3.75 (0) kg/ha on all
Cobalt	-
Molybdenum	-
Iron	-
Manganese	0 (0) kg/ha
Boron	0.75 (0) kg/ha on all

Acknowledgements

We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Rob Oliver for his assistance in the field.

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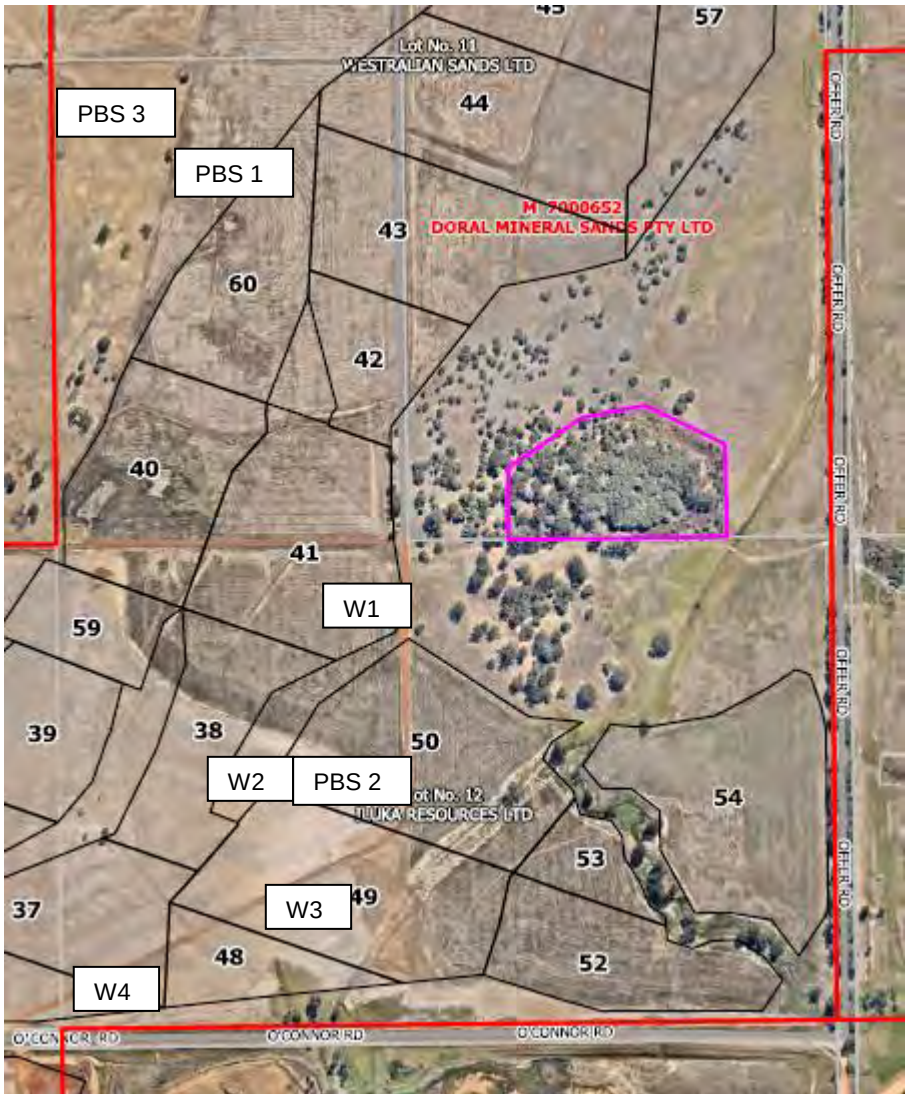
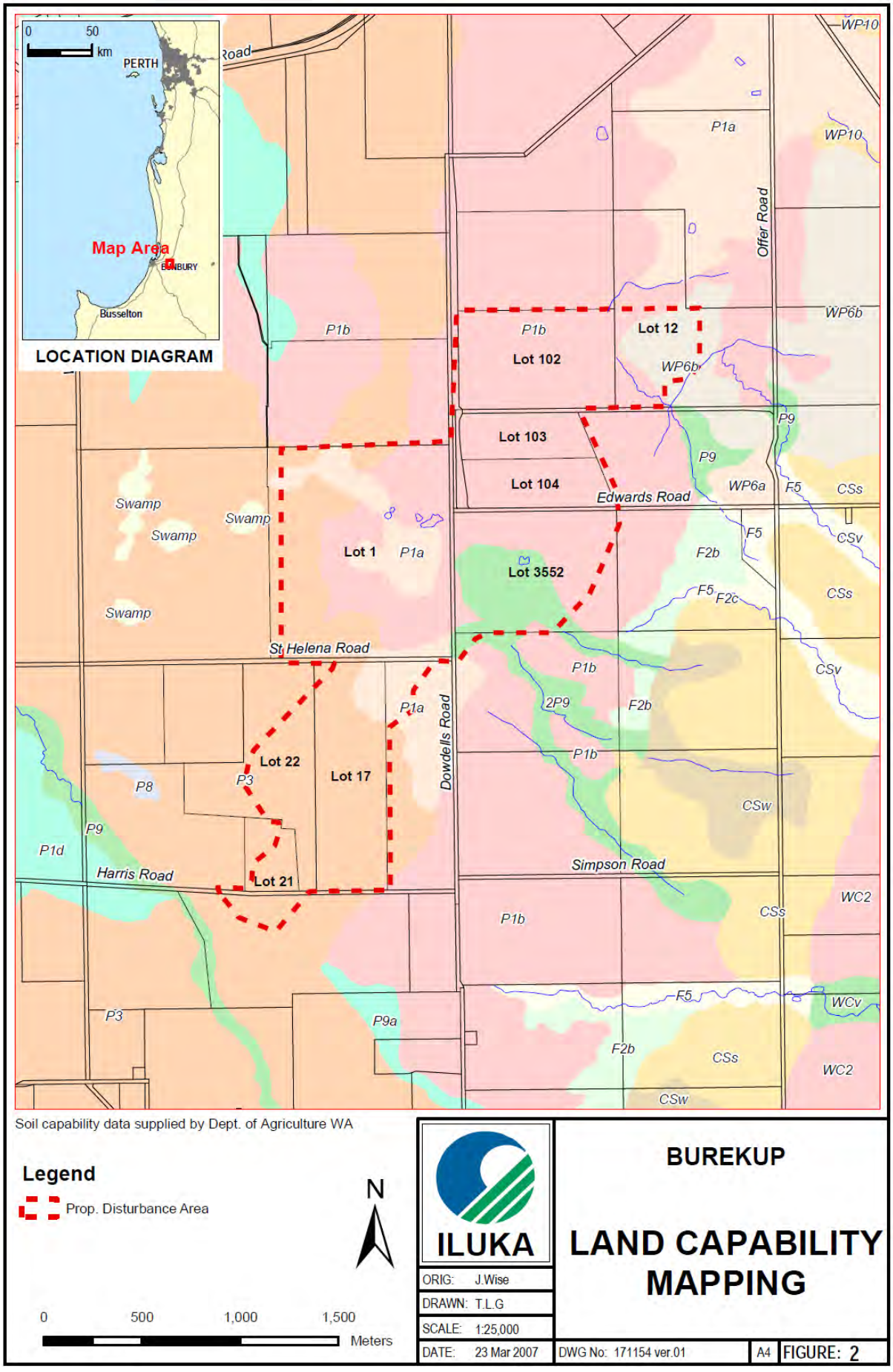
CJ Bosustow

Appendix 1



Aerial photo March 2015 showing Wise and PBS sites on Lot 12

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
Lot 3552
F5
CSv
F2b
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 17 St Helena Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
Fax. 9731 7011
Email: bosustow@bordernet.com.au

CONTENTS

Introduction

Doral Mineral Sands Pty Ltd requested Primary Business Services Pty Ltd to carry out an independent agricultural assessment of the subject lot, post mining in 2015 and again in 2016. Pre mining assessment of much of the area was completed by John Wise Consultancy Pty Ltd. Sampling numbers and approximate locations were determined by Doral.

Assessment Objectives

1. Describe the lot including its pastures and soils including their composition and characteristics
2. Describe any improvements and compare to Pre mining Assessment
3. Compare pre and post mining agricultural productivity by objective measurement. Where pre mining data is unavailable, eg micro-nutrients, post mining data will be compared to typical farm levels. Soil analysis of both topsoil and subsoils to include –
    a. Soil Balance – pH, TSS, organic carbon
    b. Cation exchange capacity – Ca Mg Na K Hydrogen
    c. Nutrients – N P K S
    d. Micro-nutrients – Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected on 16 November 2015 and composite top & sub soil samples were collected from each site. At same time, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup West	Lot 17	1(Wise)	1(Wise)	
Total				2 sites
Top & sub soil samples				4 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lot

Lot 17 St Helena Road is a rural block of approximately 42 hectares accessed by St Helena Road and running south to Harris Road.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.
Approximately 65% of the lot, comprising an area running NE to SW across the Lot, has been mined and rehabilitated.

The subject area has been cleared suitable for intensive grazing and hay production, previously used as support land for milk production. Drainage is poor being flat heavy soils similar to surrounding lots.

Prevailing Conditions

Refer Pre Mining Report by Wise for Lot 17.

Improvements

Stock proof boundary fence and internal fences.
Several excavated water holes providing stockwater.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being –

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance – low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 17.

The lot comprises flat grazing land. Drainage is an issue but we note that Wise reported soils being "better drained than some soils in the area". The block provides productive grazing land and hay production in the spring. The mined area soils had brown clay topsoil to 20cm thereafter mottled orange clay subsoil. Non-mined soils showed brown sandy loams to 40cm then yellow-orange mottled clays to the limit of the auger.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined*	Desired Level	Comments
General					
pH CaCl	4.5	4.15	5.82	5.5	Soil is highly acidic and worsening. Non mined improved
TSS	584	370	495	<990	Non saline
Organic Carbon	3.1%	1.35%	3.45%	2%	Marginal in 2016
Structure	% Adjusted CEC				% Adjusted CEC
Ca	16%	22%	62%	65-70%	Too low for good plant growth. Non mined greatly improved
Mg	21%	2.7%	7.5%	12-15%	Large fall in 2016??
Na	6.5%	0.9%	1.4%	0.5-5%	Large fall in 2016??
K	1.6%	2.7%	1.2%	3-5%	Level too low for good pasture production
Hydrogen	54%	72%	28%	<20%	High Hydrogen%, acidic soil

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	11ppm	1.5	2	27ppm	N depleted in 2016
P	32	22	19	25	Adequate
K	94	84	70	210	Low but higher than most other samples
S	29	40	20	11-15	Adequate
Micro-nutrients					
Copper	3.45	2.3	2.26	2ppm	Adequate
Zinc	2.0	0.35	0.67	5-7	Low, will limit grasses
Iron	570	311	558	>30	High due to anaerobic conditions
Manganese	31	7	5	>20	Low
Cobalt	1.24	0.31	0.45	0.7-0.8	Low
Molybdenum	0.55	0.33	0.65	0.3-0.4	Adequate
Boron	0.49	0.01	0.01	0.6-0.7	Low

* Non-mined data from same Lot

Note that Warwick Tyrrell had spread spring fertilizer just before sampling, hence higher P,K&S values than surrounding lots.

The mined area is becoming very acidic and this would limit uptake of macro nutrients by pastures. Calcium values are very low and the need for liming is strongly indicated.

In contrast, the non mined area has improved in both soil pH (acidity) and structure. Ongoing Zn deficiency will limit ryegrass production with low manganese, cobalt and boron across the site.

Pasture production was visibly better on the non mined area and poorer where mined being limited by soil acidity and winter waterlogging due to less than optimum soil structure.

Pasture Composition and Production

Pasture composition in the mined area was estimated as 10% Lotus, 30% annual ryegrass, 20% kikuyu, 30% clover and 30% weeds. Regeneration of clover was a positive seasonal result but clover scorch and red clover virus reduced production. Mined area pasture production estimated at 1-2 tDM/ha versus 4-5tDM/ha on the non mined area.

Potential pasture production estimated at 8-9tDM/ha with good quality if potash levels are lifted, soil balance and pH corrected and productive legumes are reseeded.

Conclusions

The mined soils of Lot 17 have become more acidic and less productive than the non-mined soils in 2016.
Both are also limited by waterlogging/hard setting (structure), K & Zn deficiency.
To optimize pasture production, the 2017 program for the mined area of Lot 17 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.
The mined soils require lime in addition to gypsum to assist in lowering pH and addressing structural issues in comparison to non-mined soils. Both sites showed similar levels of fertility.

Apply 0/ha (0t/ha)gypsum to improve soil structure
Apply 0.88/ha (0.88t/ha) lime to boost Calcium levels and address acidity
Apply 0.88t/ha (0t/ha) dolomite to boost Ca & Mg levels and address acidity

Nutrient input to optimize pasture production

N	20 (0) kg/ha
P	0(0) kg/ha
K	58 (0) kg/ha
S	0 (0) kg/ha
Copper	0 (0) kg/ha
Zinc	3 (0) kg/ha
Cobalt	0.03 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	2.5 (0) kg/ha
Boron	0.3 (0) kg/ha

Improving soil pH, potash levels and soil structure, will be the key to supporting pasture improvement in the longer term.

Acknowledgements

We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Bruce Trepp for his assistance in the field.

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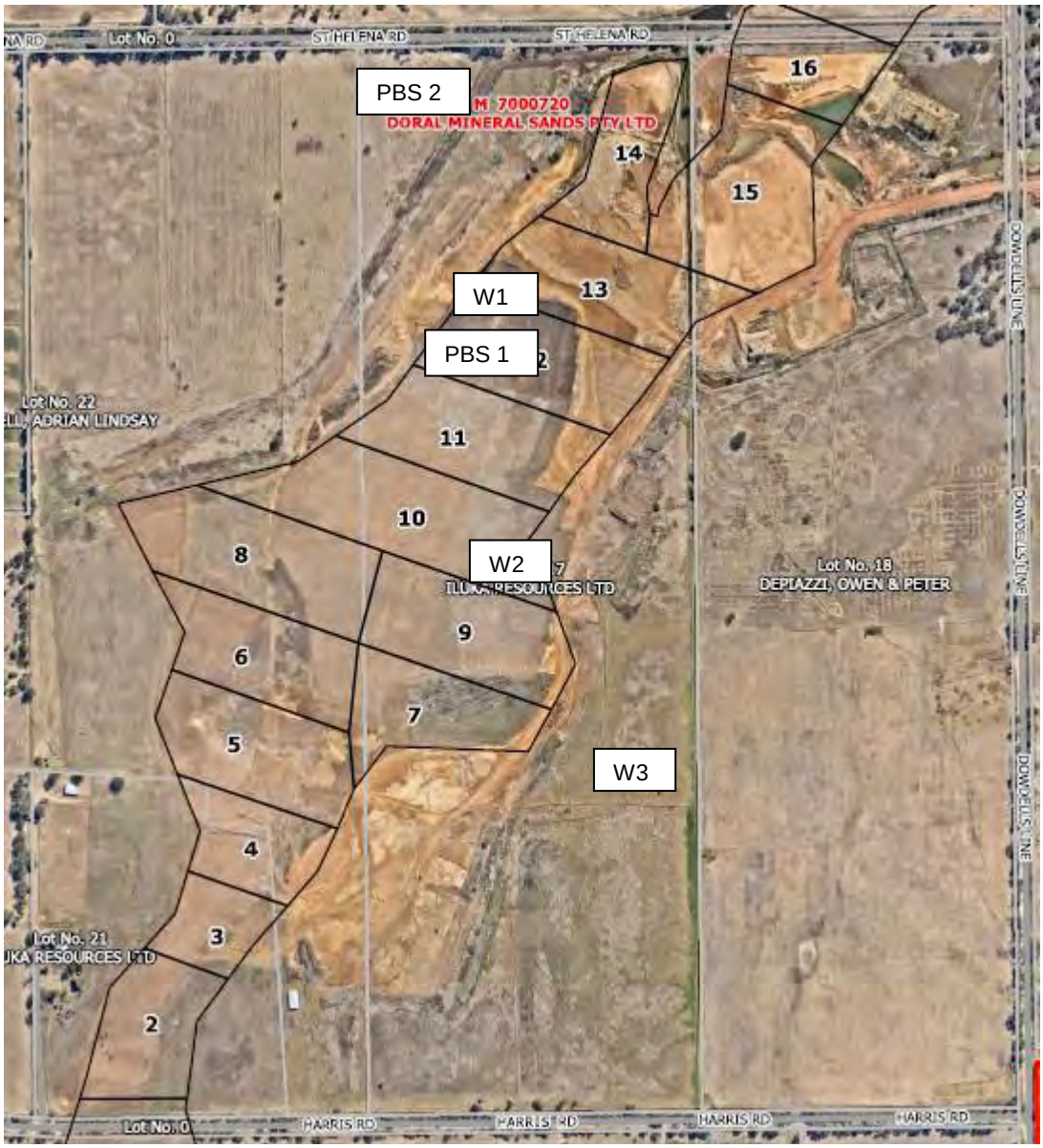
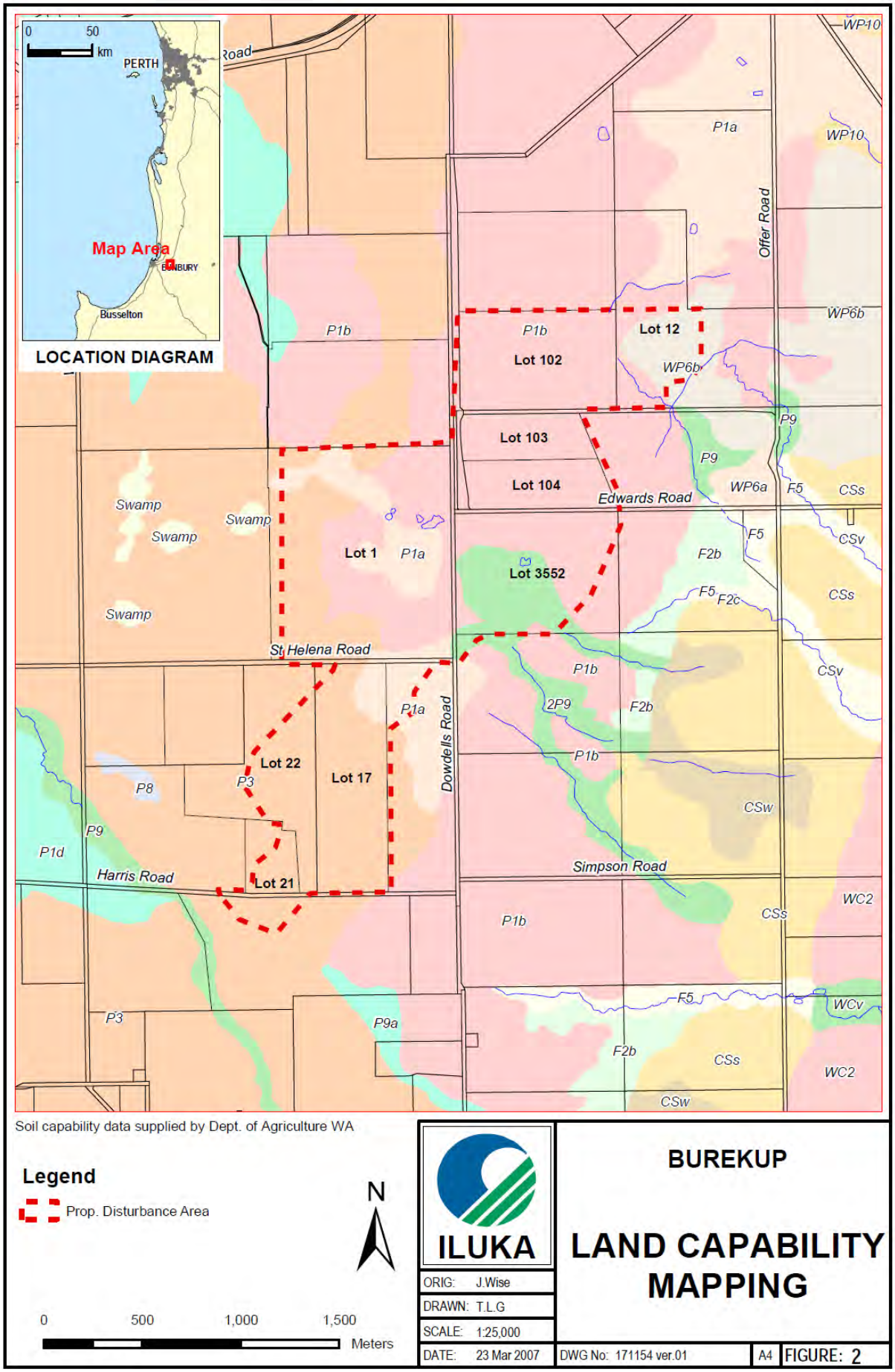
CJ Bosustow
Agricultural Consultant

Appendix 1



Aerial photo March 2015 showing Wise and PBS sites on Lot 17

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
Edwards Road
WP6a
F5
CSs
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
Lot 3552
F5
CSv
F2b
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 21 Harris Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271

Ph. 9731 7000

Fax. 9731 7011

Email: bosustow@bordernet.com.au

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    a. Soil Balance − pH, TSS, organic carbon
    b. Cation exchange capacity − Ca Mg Na K Hydrogen
    c. Nutrients − N P K S
    d. Micro-nutrients − Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected on 16 November 2015 and composite top & sub soil samples were collected from each site. At same time, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup West	Lot 21	1(Wise)		
Total				1 sites
Top & sub soil samples				2 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lot

Lot 21 Harris Road is a rural block of approximately 9.5 hectares accessed from Harris Road.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.
Approximately 40% of the lot, comprising an area running NE to SW across the Lot, has been mined and rehabilitated.

The subject area has been cleared suitable for intensive grazing and hay production, previously used as support land for milk production. During the 1960's or 70's, it appears that paddocks were roughly levelled for flood irrigation. Drainage is poor being flat heavy soils similar to surrounding lots. Current use is beef grazing and hay production.

Prevailing Conditions

Refer Pre Mining Report by Wise for Lot 21.

Improvements

Stock proof boundary fence and internal fences which are old but stock proof.
Several excavated water holes providing stockwater.
Improved pastures.
Older house, sheds and disused dairy.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being –

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance – low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 21.

The lot comprises flat grazing land previously levelled for flood irrigation. Paddock levelling in the 1960's & 70's did not involve removal, stockpiling and replacement of topsoil as is the practice today. Topsoil and subsoils were often mixed in the process. This has resulted in poorly structured subsoil being brought to the surface in many places across the site. Doral advises that an additional 80mm of topsoil was spread on the site post rehabilitation to improve productivity. Poor soil drainage remains an issue and this is compounded by

subsidence throughout the lot where mine tailings have been returned. Pasture production was highly variable across the lot from drier rises to wet depressions. Wise noted the lot as being highly productive pre-mining but current data from the non-mined area does not support this, suggesting the site to be highly variable from the start.
The block provides grazing land and hay production in the spring.
The mined area soils had brown clay topsoil and subsoil with a thin layer of organic material in the top 3cm. Wise noted soils pre-mining to have 0-10cm organic stained sandy loam, 10-30 brown sandy loam and 30cm on mottled orange clay.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined*	Desired Level	Comments
General					
pH $CaCl_2$	4.8	5.46	5.8	5.5	Soil has improved markedly. Liming??
TSS	293	232	495	<990	Non saline
Organic Carbon	1.8%	1.65%	3.45%	2%	Marginal
Structure	% Adjusted CEC				% Adjusted CEC
Ca	15%	27%	62%	65-70%	Too low for good plant growth
Mg	21%	25%	7.5%	12-15%	High and will cause poor soil flocculation
Na	4.9%	5.3%	1.4%	0.5-5%	High, sodic type soils, pugging & waterlogging
K	2%	1.4%	1.2%	3-5%	Level too low for good pasture production
Hydrogen	56%	41%	28%	<20%	Reduced Hydrogen%,

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	0.1ppm	1.7	2	22ppm	Low
P	8.5	3.9	19	20	Low
K	70	48	70	177	Low
S	12	13	20	7-10	Adequate
Micro-nutrients					
Copper	2.39	2.57	2.26	2ppm	Adequate
Zinc	1.17	0.78	0.67	3-5	Low, will limit grasses
Iron	464	499	558	>30	High due to anaerobic conditions
Manganese	14	15	5	>20	Marginal
Cobalt	1.01	0.83	0.45	0.5-0.7	Adequate
Molybdenum	0.28	0.28	0.65	0.1-0.2	Adequate
Boron	0.29	0.01	0.01	0.4-0.6	Low

* Non-mined data from Lot 17

Soil pH has improved markedly in both mined and non mined (Lot 17). Calcium levels also improved suggesting that lime has been applied.
Soil structure (CEC) has improved in the non mined soils but continues as poor in the mined area. Fertility of both areas is very low however the non mined P level is now reasonable suggesting applied superphosphate.
Trace element levels are low across both sites with the exception of copper.
Poor soil structure leading to winter waterlogging on the mined site continues as the main limitation to production.

Pasture Composition and Production

Pasture composition was estimated as 40% Lotus, 50% annual ryegrass,5% clover, 2% kikuyu and 3% weeds.
Current pasture production estimated at 2-4tDM/ha with marginal improvement in quality due to increased presence of legume species.
Potential pasture production estimated at 8-9tDM/ha with good quality if potash levels are lifted, soil balance improved and productive legumes are reseeded.

Conclusions

The mined soils of Lot 21 have been improved in 2016 through correction of soil pH (liming) and boosting Calcium levels.
However, Pasture production continues to be limited by soil CEC balance (structure), K and trace element deficiencies and the physical deformity of the soil surface due to subsidence creating wet hollows and dry ridges.
To optimize pasture production, the 2016 program for the mined area of Lot 21 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.
Relevelling of the soil surface with a land plane or similar to overcome wet depressions. The addition of organic matter would also be highly beneficial.
The addition of gypsum and lime to assist soil structure are essential. Fertility also requires improvement to achieve pre-mining levels.

Apply 1.29t/ha (1.29t/ha)gypsum to improve soil structure
Apply 0.83/ha (0t/ha) lime to boost Calcium levels and address acidity
Apply 0t/ha (0t/ha) dolomite to boost Ca & Mg levels and address acidity

Nutrient input to optimize pasture production

N	21 (0) kg/ha
P	16(0) kg/ha
K	80 (0) kg/ha
S	0 (0) kg/ha
Copper	0 (0) kg/ha
Zinc	3.0 (0) kg/ha
Cobalt	0 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	2.5 (0) kg/ha
Boron	0.3 (0) kg/ha

Once potassium levels rise and structure improves, reseeding with suitable clovers would improve pasture quality which is currently grass dominant. Note that while Lotus is a legume it is far less productive than improved clover varieties.

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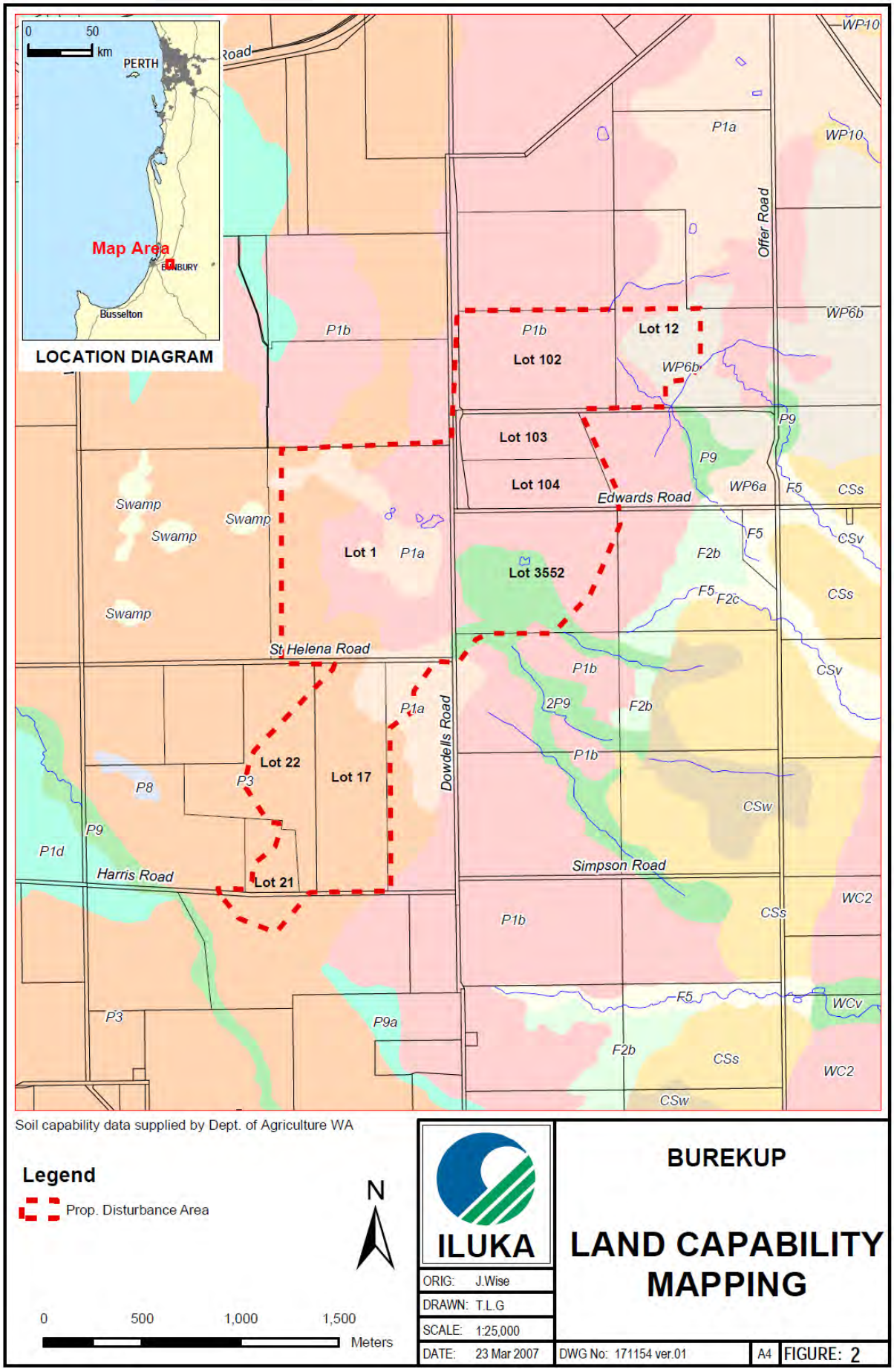
CJ Bosustow

Appendix 1

Aerial photo March 2015 showing Wise and PBS sites on Lot 21

Appendix 2


0 50 km
PERTH
Map Area
BUNBURY
Busselton
LOCATION DIAGRAM
Road
WP10
P1a
WP10
Offer Road
P1b
P1b
Lot 12
Lot 102
WP6b
WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
Lot 3552
F5
CSv
F2b
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
P1d
Harris Road
Lot 21
Simpson Road
WC2
P1b
CSs
F5
WCv
P3
P9a
F2b
CSs
WC2
CSw
Soil capability data supplied by Dept. of Agriculture WA
Legend
Prop. Disturbance Area
N
0 500 1,000 1,500
Meters
ILUKA
BUREKUP
LAND CAPABILITY MAPPING
ORIG: J.Wise
DRAWN: T.L.G
SCALE: 1:25,000
DATE: 23 Mar 2007
DWG No: 171154 ver.01
A4
FIGURE: 2

Evaluation of post mining areas

Lot 3552 O'Connor Road, Burekup

November 2016

Prepared for

Bruce Trepp

Doral Mineral Sands Pty Ltd

Prepared by: **Primary Business Services Pty Ltd**

PO Box 472 CAPEL 6271
Ph. 9731 7000
Fax. 9731 7011
Email: bosustow@bordernet.com.au

CONTENTS

Introduction

Doral Mineral Sands Pty Ltd requested Primary Business Services Pty Ltd to carry out an independent agricultural assessment of the subject lot, post mining in 2015 and again in 2016. Pre mining assessment of much of the area was completed by John Wise Consultancy Pty Ltd. Sampling numbers and approximate locations were determined by Doral.

Assessment Objectives

1. Describe the lot including its pastures and soils including their composition and characteristics
2. Describe any improvements and compare to Pre mining Assessment
3. Compare pre and post mining agricultural productivity by objective measurement. Where pre mining data is unavailable, eg micro-nutrients, post mining data will be compared to typical farm levels. Soil analysis of both topsoil and subsoils to include −
    a. Soil Balance − pH, TSS, organic carbon
    b. Cation exchange capacity − Ca Mg Na K Hydrogen
    c. Nutrients − N P K S
    d. Micro-nutrients − Cu Zn Fe Mn Co Mo B
    e. C/N Ratio
4. Pasture production estimate as TDM/ha/yr

Method

The lot was inspected in November 2015 and October 2016 with composite top & sub soil samples collected from each site. In 2015, using a suitable auger, soil profiles were documented to one metre, site conditions permitting. All aspects of site including drainage, slope and pastures were noted.
A subjective assessment of pasture production capacity was made at each site.
Soil samples were forwarded for analysis to SWEP Laboratories in Victoria.
Results were compared to pre mining data (where available) contained within the Wise reports.

No. Samples				
Area	Lot	Mine area	Non mined	Total
Burekup Central	Lot 3552	1		
Total				1 sites
Top & sub soil samples				2 samples

(Wise) denotes pre mining sampling by John Wise Consultancy.

The Lot

Lot 3552 Edwards Road is a rural block of approximately 47 hectares accessed by Edwards Road and bounded to the west by Dowdells Line.
The lot is situated on the Swan Coastal Plain some 15 km east of the City of Bunbury and within the Shire of Dardanup.

Approximately 25% of the lot comprising an area through the northern section has been disturbed by mining then rehabilitated. A haul road enters from the east and exits to the south.
The lot has been parkland cleared suitable for grazing with isolated stands of paperbark trees remaining. Drainage is poor.

Prevailing Conditions

No direct pre-mining report but considered comparable with Pre Mining Report by Wise for Lot 102 situated to the north of Lot 3552 encompassing similar beef grazing land.

Improvements

Stock proof boundary fence.
Several excavated water holes providing stockwater.

Land Forms, Soils and Land Capability

Land in the locality of the subject lot has previously supported milk and beef production from both dryland and irrigated pastures. Current use is limited to dryland beef production or hay cropping.
Soils in the Burekup area are described by the Department of Agriculture in the 1992 publication, *Land Resources In The Southern Section Of The Peel Harvey Catchment, Swan Coastal Plain, Western Australia*, as flat to gently undulating poorly drained coastal plain belonging to the Pinjarra System. Soils are typically acidic duplex soils with sandy loams overlaying clay subsoils. The principle limitation is waterlogging.
More recent soil testing in the region has identified several common limitations to fertility and soil structure, being –

- Low pH indicating acidic soils, limiting nutrient uptake and rooting depth
- Poor exchangeable cation balance – low Calcium & Potassium %'s, high Sodium and Magnesium %'s and high Hydrogen % producing acidic, poorly structured soils susceptible to waterlogging & pugging
- Low Potassium levels limiting overall pasture production capacity and specifically limiting legumes eg clovers
- Low Zinc levels limiting overall pasture production, specifically oats grown for hay
- Low Manganese levels and high iron levels usually associated with waterlogging

In general terms, across all lots reported, similar limitations to production were found across both mined and non-mined soils reflecting and dominated by the properties of the original soil.

Refer Pre Mining Report by Wise for Lot 102.

The lot comprises a gently undulating grazing land with some paperbark swamps and water courses. All depressions would be waterlogged in winter. Nevertheless, the block provides productive grazing land especially in the spring. The mined area soils had brown sandy loam topsoil to 10cm, brown clay loam to 30cm thereafter grey clay with iron oxide staining subsoil to 100cm.

Soil Analysis Results

Item	Mined 2015	Mined 2016	Non Mined*	Desired Level	Comments
General					
pH CaCl	4.0	5.87	5.24	5.5	Soil pH has improved
TSS	212	205	325	<990	Non saline
Organic Carbon	2.1%	0.6%	6.45%	2%	Low
Structure		% Adjusted CEC			% Adjusted CEC
Ca	18%	26%	57%	65-70%	Too low for good plant growth
Mg	17%	29%	20%	12-15%	High and will cause poor soil flocculation
Na	8.3%	5.1%	3%	0.5-5%	High, sodic type soils, pugging & waterlogging
K	1%	2%	0.6%	3-5%	Level too low for good pasture production
Hydrogen	55%	38%	20%	<20%	Very high Hydrogen, acidic soil

Item	Mined 2015	Mined 2016	Non Mined	Desired Level	Comments
Nutrients					
N	19ppm	1	9	22ppm	Very low, fallen
P	26	2	26	20	Very low, fallen
K	31	40	38	160	Low value limiting total production & clover growth
S	26	5	16	7-10	Marginal, fallen
Micro-nutrients					
Copper	1.03	0.78	2.83	2ppm	Low, will limit grasses
Zinc	1.23	0.43	2.8	3-5	Low, will limit grasses
Iron	375	326	518	>30	High due to anaerobic conditions
Manganese	4	9	4	>20	Low
Cobalt	0.33	0.66	0.42	0.5-0.7	Adequate
Molybdenum	0.33	0.10	0.30	0.1-0.2	Adequate
Boron	0.32	0.01	0.09	0.4-0.6	Low

* Non-mined data from Lot 104 for 2016

The long growing season in 2016 has depleted fertility levels. Poor soil structure continues to limit production in the mined area. Trace element levels also low.
Sub soil was less acidic but less fertile overall as would be expected.
Pasture production was generally poor at time of inspection limited by winter waterlogging due to poor soil structure and low fertility.

Pasture Composition and Production

Pasture composition was estimated as 0% Lotus, 25% annual ryegrass, 75% kikuyu and minimal weeds.
Current pasture production estimated at 1-2tDM/ha (4-5tDM last year) with poor quality due to lack of legume species.
Potential pasture production estimated at 7-8tDM/ha with good quality if potash levels are lifted, soil balance and pH corrected and productive legumes are reseeded.

Conclusions

The mined soils of Lot 3552 appear less productive than the non-mined soils of Lot 104 being more limited by general fertility, CEC balance (structure) and Potassium and trace element deficiencies.

To optimize pasture production, the 2017 program for the mined area of Lot 3552 should include the following inputs.
Bracketed figures show inputs required to lift the mined area to the standard of the non-mined area before starting a normal fertilizer program.

Apply 1.1t/ha (0t/ha)gypsum to improve soil structure
Apply 0.3/ha (0t/ha) lime to boost Calcium levels and address acidity
Apply 0t/ha (0t/ha) dolomite to boost Ca & Mg levels and address acidity

Nutrient input to optimize pasture production

N	21 (4) kg/ha
P	18 (13) kg/ha
K	58 (0) kg/ha
S	0 (0) kg/ha
Copper	0.75 (0.25) kg/ha
Zinc	3.0 (0) kg/ha
Cobalt	0 (0) kg/ha
Molybdenum	-
Iron	-
Manganese	2.5 (0) kg/ha
Boron	0.3 (0) kg/ha

Once soil pH and structure improves, reseeding with suitable clovers would improve pasture quality which is currently grass dominant.

Acknowledgements

We acknowledge the assistance provided by Doral staff, specifically Craig Bovell in sourcing much of the background information and Bruce Trepp for his assistance on site.

Disclaimer

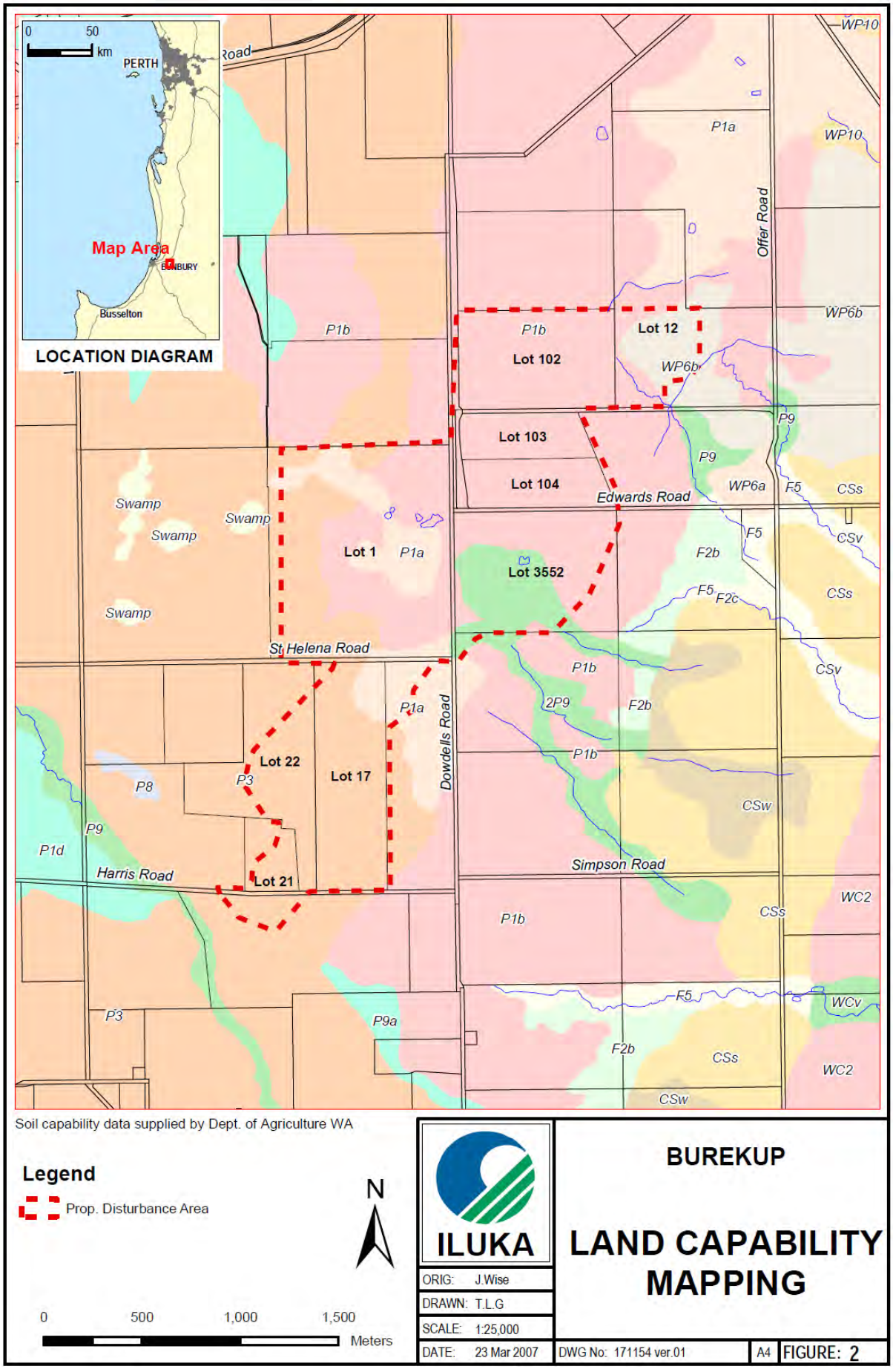
Primary Business Services Pty Ltd (PBS) has prepared this report for the use of the Client in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. It is prepared in accordance with the above assessment objectives.
Information supplied by the client and third parties has been used within the report without independent audit and PBS has relied upon the accuracy of this information.
This report was prepared in November 2016 and is based on the conditions and information reviewed at the time of preparation.
This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. The client should make their own enquiries through their professional advisers taking into account their whole business structure before committing to any action including capital expenses.

CJ Bosustow

Appendix 1

Aerial photo March 2015 showing Wise (NIL) and PBS sites on Lot 3552

Appendix 2


0 50 km
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Map Area
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WP6b
P9
Lot 103
P9
Lot 104
WP6a
F5
CSs
Edwards Road
Swamp
Swamp
Swamp
Swamp
Lot 1
P1a
Lot 3552
F5
CSv
F2b
F5
F2c
CSs
St Helena Road
P1b
CSv
P1a
2P9
F2b
Dowdells Road
P1b
Lot 22
Lot 17
P3
P8
CSw
P9
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DWG No: 171154 ver.01
A4
FIGURE: 2

APPENDIX D: ASSESSMENT OF THE SUSTAINABILITY OF THE T5 IN-PIT LAKE

CyMod Systems
Applied Numerical Modelling

PO Box 917
Armadale, WA, 6992
Tel: 08 9399 2600
Fax: 08 9399 2700

25 November 2015

Doral Mineral Sands Pty Ltd
PO Box 9155
Picton Western Australia 6229

Attn: Mr. C. Bovell, OSH&E Superintendent

Re: Assessment of the Sustainability of the T5 In-pit Lake - Dardanup mine

Dear Craig,

Please find below a report on the results of the water balance modelling of the T5 pit void at the above referenced location. As discussed the objectives of the work were to:

1. Determine if the proposed T5 lake geometry supports a design water level of 46 mAHD;
2. Evaluate the possible impacts on lake levels under prevailing hydrological conditions and for dry and wet climate sequences; and
3. Provide a report detailing a quantitative assessment suitable for submission to regulatory agencies.

The construction of the model and the results of the forward scenarios are described below.

Yours sincerely

Neil Milligan
CyMod Systems

1. Model Construction

A water balance model of the proposed pit lake was constructed using Goldsim 11.1. Goldsim is an algebraic modelling platform widely used for constructing stochastic water balance models of lakes and reservoirs. The conceptual model of the pit lake was based on available information on the hydrogeology and hydrology of the mining area, as supplied by Doral Mineral Sands (Doral). The conceptual model of the pit lake consists of the following flow components.

1.1 Water Storage

Water storage will be provided by the T5 pit void that extends below the water table and that was created as a result of mining. The location and extent of the pit void, as configured as a pit lake, is shown in Figure 1. The hydrological characteristics of the pit lake can be described by a volume versus depth/elevation curve (fill), and a volume versus area curve, both of which were developed from a digital terrain model (DTM) of the pit lake geometry provided by Doral. The fill and area curves are shown in Figure 2. Note that the fill curve is for water, and assumes a flat upper surface.

1.2 Surface Water Flow

The pit lake has a catchment upstream of the eastern edge of the pit of about 32 Ha, as determined from available topography, and as shown in Figure 3. This catchment will result in flow into the pit during rainfall (i.e. rainfall runoff). Parsons Brinckerhoff (PB) estimated the catchment yield from winter rain is between 0.15 and 0.30 (PB 2013). Consequently, given average rainfall during winter (May through September) of 685 mm, the average runoff into the pit lake will be between 33,000 and 66,000 kL/annum. In the absence of the pit lake this water would runoff into the irrigation channel to the west of the pit lake (Figure 1).

1.2.1 Pit Lake Spillway Discharge

Based on the pit geometry as defined by the DTM of the proposed pit lake, a spillway extends from the northwest side to the irrigation channel. The invert level of this spillway is approximately 46 mAHD, which will act to limit the maximum volume of water in the pit lake under normal conditions to 320,000 m^3. Pit lake water levels above this elevation will result in the discharge of water to the irrigation channel.

1.2.2 Pit Lake Evaporation

The excavation of the pit lake to an invert level of 36 mAHD intersects the local water table, and results in a permanent body of water. The free surface of the lake will be subject to evaporation all year, with evaporative losses a function of the season and the area of the lake's free surface. Based on annual evaporation of 1600 mm/annum (BoM), a pan correction factor of 0.80 and an average surface area of 49,000 m^2 indicate average daily evaporation loss of 170 m^3/day.

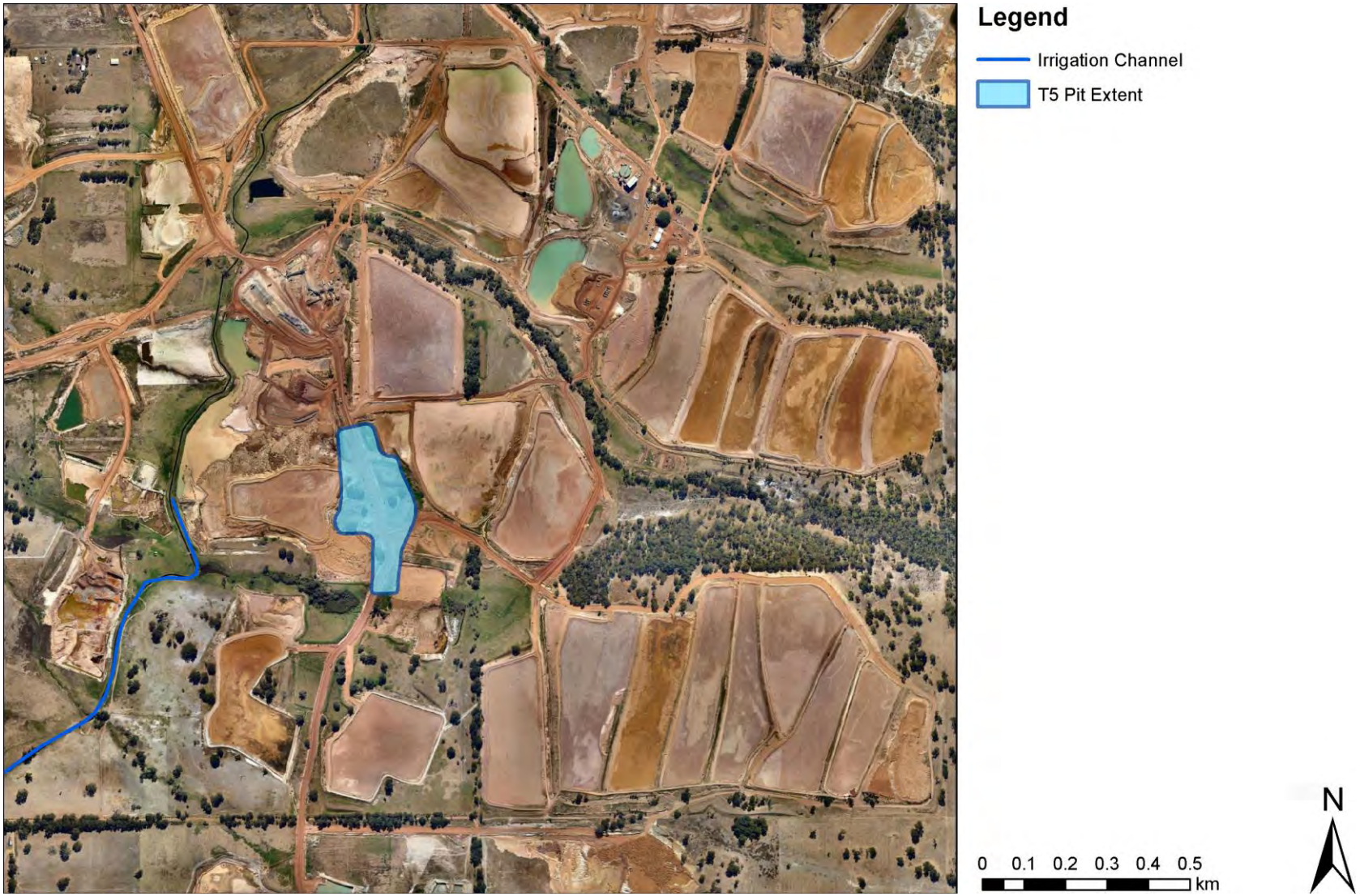
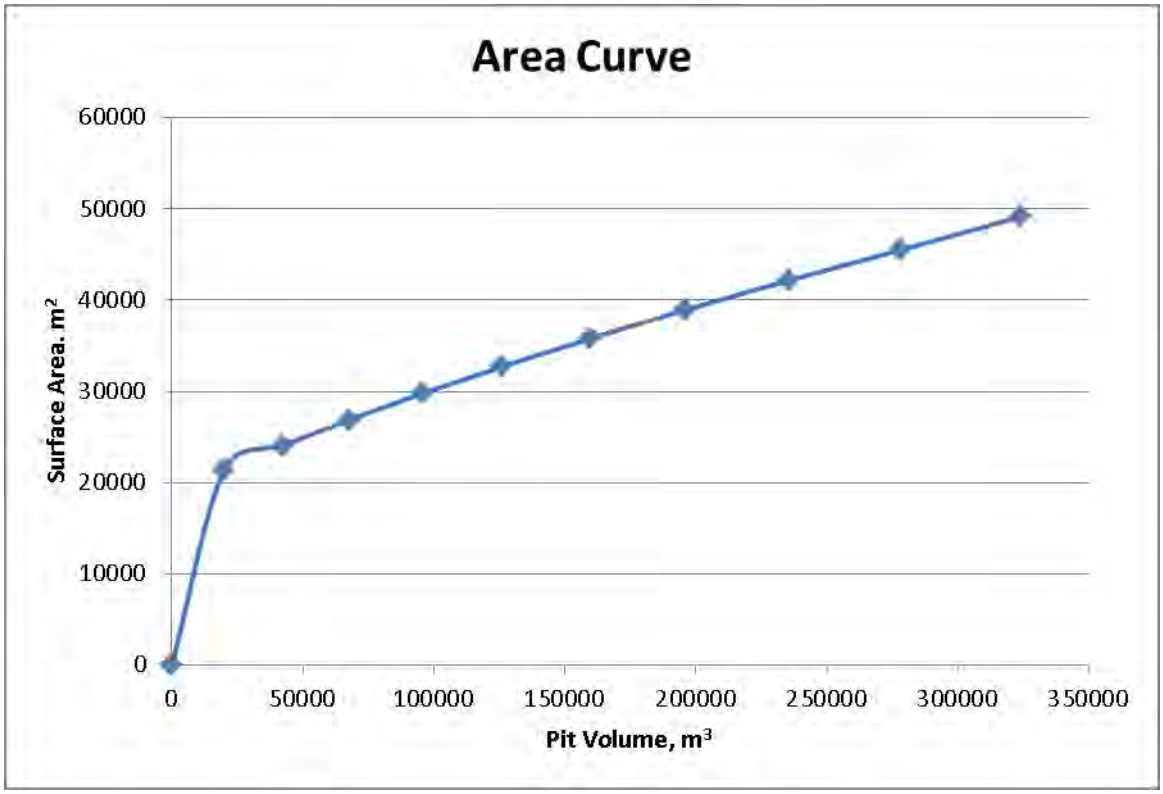


Figure 1: Proposed T5 Pit Lake



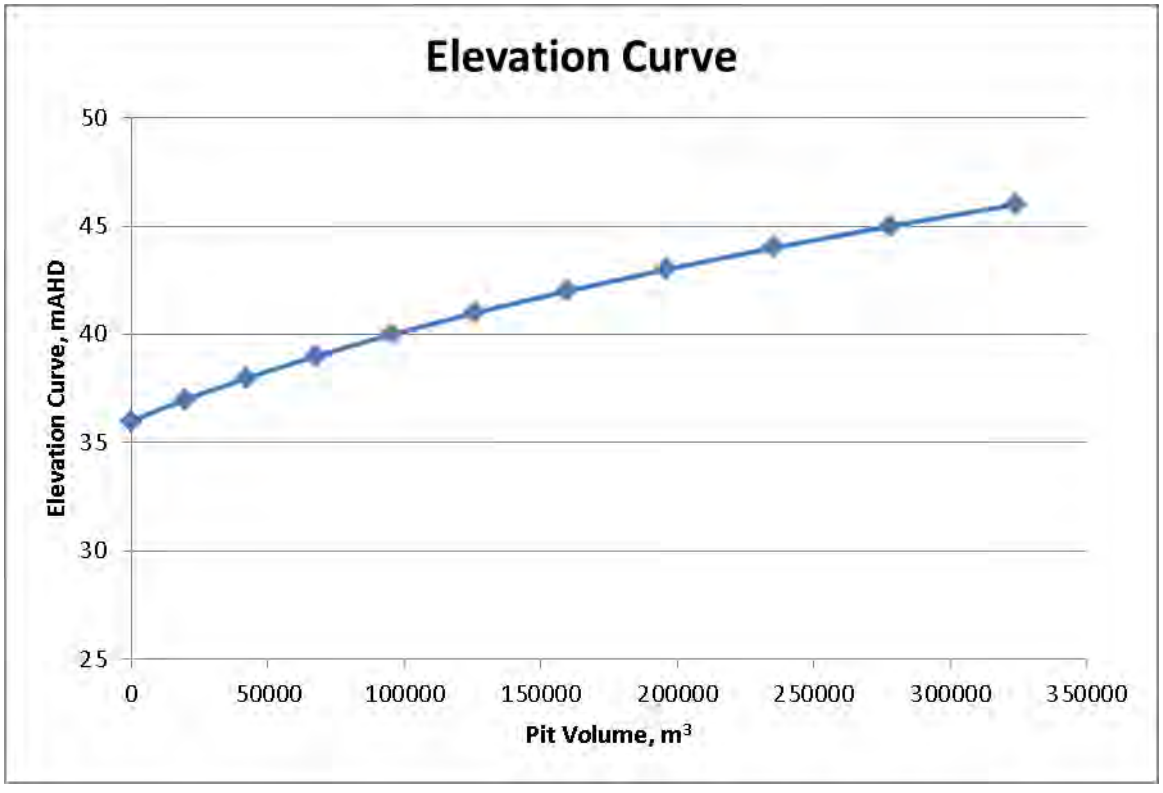


Figure 2: Pit Void Area and Fill Curve

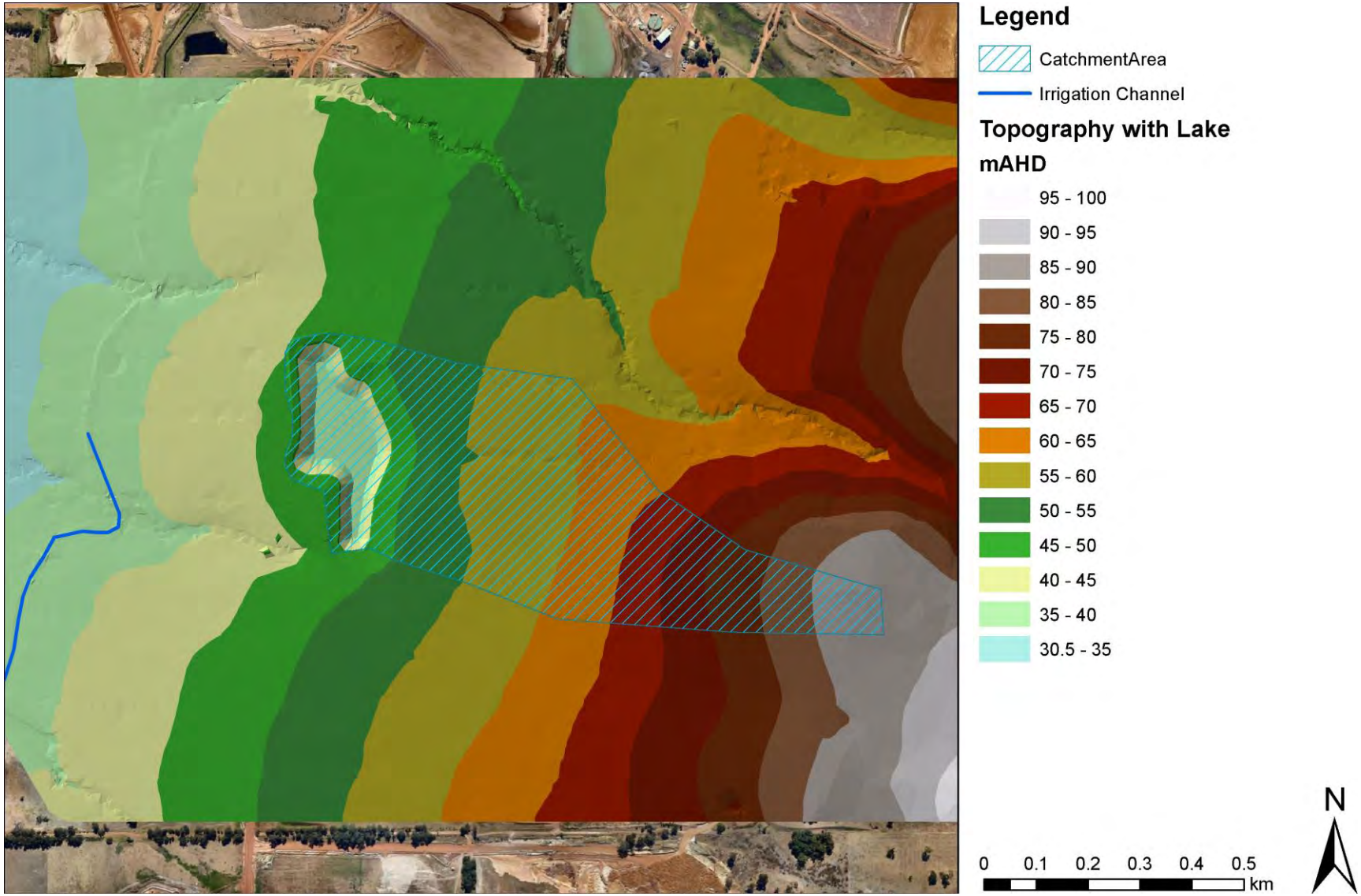


Figure 3: T5 Lake Topography

1.2.3 Groundwater Inflow and outflow

Groundwater will flow into the T5 pit void from upstream due to the prevailing hydraulic gradients, which indicate groundwater flow predominantly to the west, where it discharges to irrigation channel or the ocean. Groundwater flow into the pit lake from upstream is controlled by the hydraulic gradient, length of the pit lake perpendicular to the direction of groundwater flow, aquifer hydraulic conductivity and aquifer flow area. Based on work done by PB (2011), and the available topography and water levels, the following values are used for estimating groundwater flow into the T5 lake:

- Upstream head – 68 mAHD;
- Flow length to pit lake – 800 m;
- Flow area - 8000 m^2;
- Pit lake water levels 36-46 mAHD; and
- Hydraulic conductivity – 2 m/day.

Figure 4 shows the monitoring bores in the area of the T5 pit lake and the inferred water table as measured at six monitoring bore. Based on these parameters, the average flow from upstream of the lake ranges from 440 to 640 m^3/day. These estimates of inflow are consistent with observed pumping rates during dewatering of the pit, while mining, which suggests a hydraulic conductivity of 2 m/day.

Groundwater will flow out of the pit lake due to the prevailing hydraulic gradients, which indicate groundwater flow predominantly to the west, where it discharges to the irrigation channel or the ocean. Groundwater flow out of the pit lake is controlled by the hydraulic gradient, length of the pit lake perpendicular to the direction of groundwater flow, aquifer hydraulic conductivity and aquifer flow area. Based on work done by PB (2013), the following values are for estimating groundwater flow into the T5 lake:

- Downstream head – 33 mAHD
- Flow length – 600 m;
- Flow area - 8000 m^2
- Pit lake water level 36-46 mAHD; and
- Hydraulic conductivity – 2 m/day.

Figure 4 shows the monitoring bores in the area of the T5 pit lake and the inferred water table as measured at six monitoring bore. Based on these parameters, the average flow downstream from the lake ranges is 80-360 m^3/day.

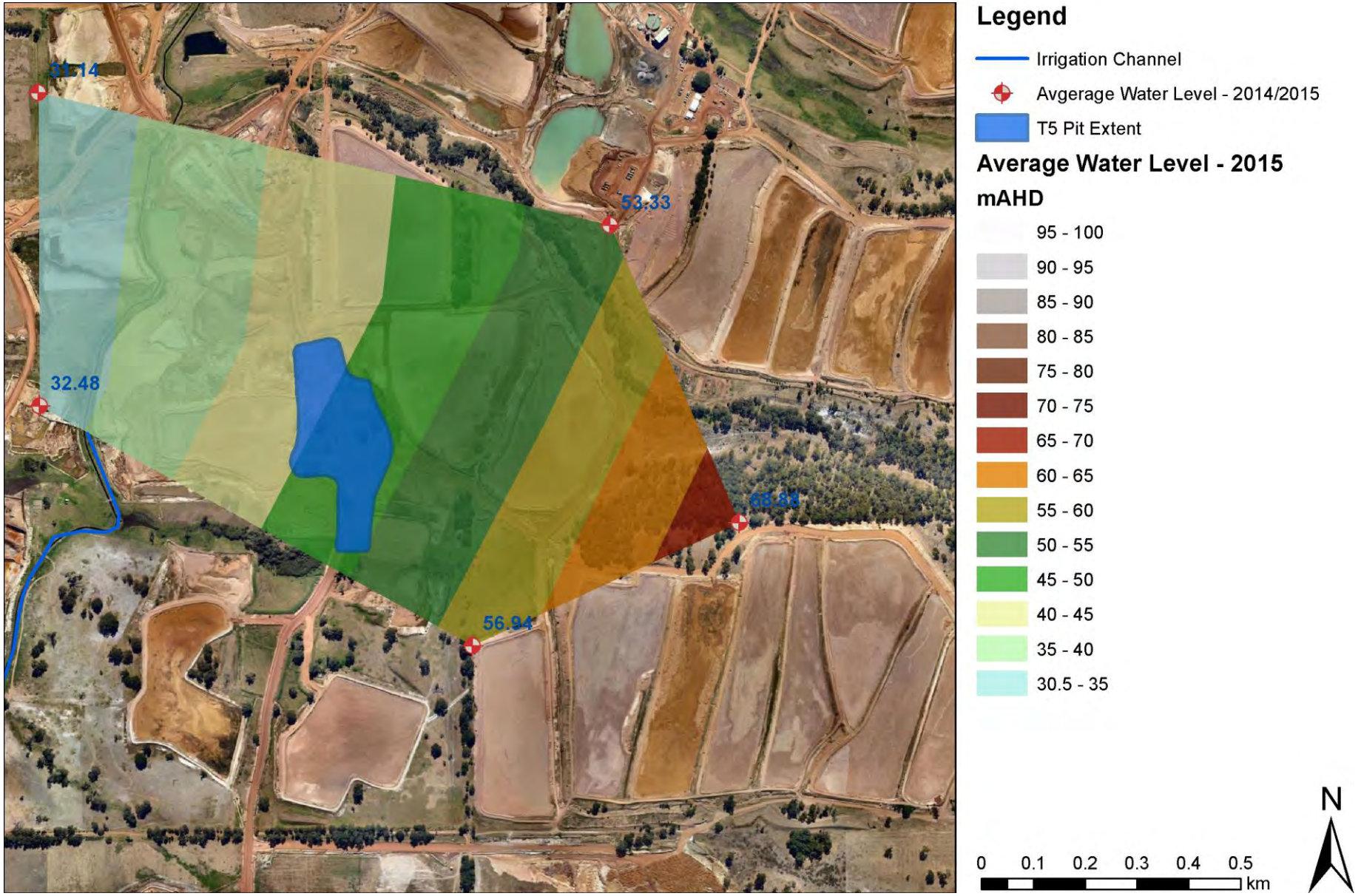


Figure 4: Water Table in the Vicinity of T5 Lake

2. Model Simulations

A Goldsim algebraic water balance model was constructed based on the conceptual model as presented above. The model was calibrated against measured flows and pit water level elevation in 2015. The calibrated model was then used to simulate a dry climate scenario, to assess the sustainability of the pit lake as a viable year-round open body of water.

2.2 Dry Rainfall Sequence

The calibrated model was modified to allow the stochastic simulation of pit lake discharge and water level under dry rainfall conditions. In this case, a 1977-2015 rainfall time series from 5 Km east of the T5 pit lake was scaled randomly, using a normal distribution with a mean of 0.8. Effectively, over a large number of simulations, in this case 100 replicants, the mean rainfall used in the model will be 0.8 of the historical data. Since the historical sequence is getting drier, the scaled rainfall sequence will also have that characteristic. In addition, to stochastically assess the impact of reduced mean rainfall on runoff, the catchment yield of the pit lake catchment was scaled by the square of the rainfall mean, to reflect the non-linear nature of runoff as a function of rainfall.

Figures 5 and 6 show the results of the simulation for pit lake water level and pit discharge model variables. The pit lake water level is consistently between 45 and 46 mAHD indicating the reduced rainfall will not in itself cause the lake to become dry. The apparent stability in pit lake water level reflects that groundwater inflow can sustain the design water level of the lake (as defined by the spillway elevation) under reduce rainfall scenarios.

In the case of pit lake discharge, there is a much higher sensitivity to changes in rainfall than is the case for pit lake water level, due to the variation in rainfall runoff. The median and 95% percentile discharge show that in all cases the pit lake is likely to have seasonal varying discharge due to groundwater flow and rainfall runoff. The lake only fails to discharge continuously for rainfall less than the 10% percentile or when rainfall is 0.47 of the mean. This suggests that even under reduced rainfall conditions the pit lake will be regularly flushed and is unlikely to become brackish in the medium term.

In the case of minimum discharge, the discharge from the pit lake becomes intermittent with flows periods related to rainfall runoff, rather than groundwater flow. The minimum discharge occurred when rainfall for the years from 1977 to 2015 was reduced below 0.5 of the mean.

2.3 Wet Rainfall Sequence

The calibrated model was modified to allow the stochastic simulation of pit lake discharge and water level under wet rainfall conditions. In this case the 1977-2015 rainfall time series was scaled randomly, using a normal distribution with a mean of 1.2. While it is unlikely that rainfall will increase in the near to medium time frame (5-30 years), this simulation demonstrates whether the pit lake is stable under a variety of conditions.

Effectively, over a large number of simulations, in this case 100 replicants, the mean rainfall used in the model will be 1.2 of the historical data. Since the historical sequence is getting drier, the scaled rainfall sequence will also have that characteristic. In addition, to stochastically assess the impact of reduced mean rainfall on runoff, the catchment yield of the pit lake catchment was scaled by the square of the rainfall mean, to reflect the non-linear nature of runoff as a function of rainfall.

The results for the wet rainfall sequence are consistent with the model, with the pit lake water level being stable at approximately 46 mAHD, while pit lake discharge increases to reflect increased rainfall.

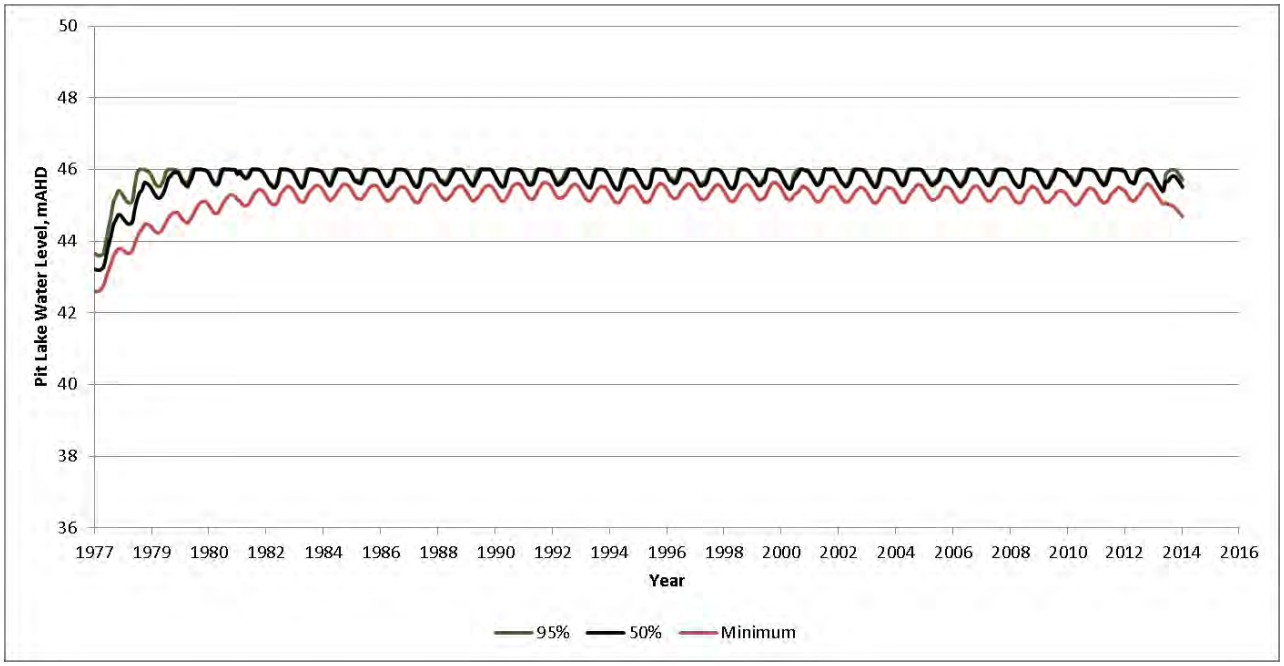


Figure 5: Pit Lake Water Level - Dry Rainfall Conditions

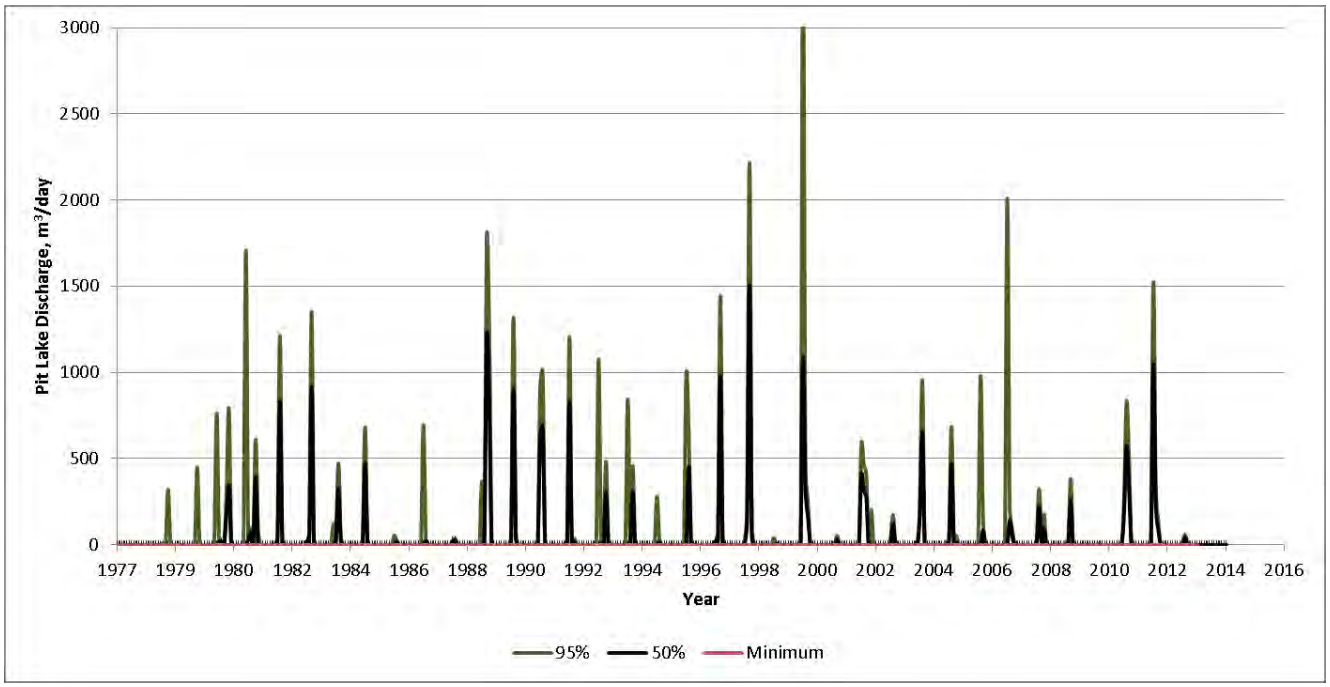


Figure 6: Pit Lake Discharge - Dry Rainfall Conditions

3.0 Conclusions

The water balance model accounts for surface water and groundwater flows into the pit, as well as evaporation and is consider a reasonable analogy of the hydrogeological system.

Stochastic simulations of a dry climate sequence using 0.8 of mean rainfall for a rainfall time series from 1977 to 2015 showed that the pit lake water level was controlled by the spillway elevation of 46 mAHD, and the lake would likely discharge in winter months of the year under most conditions.

Most lake discharge is due to winter rainfall runoff. The pit lake only fails to discharge for rainfall less than the 10 percentile or when rainfall is 0.47 of the mean annual rainfall as measured from 1977 to 2015.

Based on these results it is likely the pit lake flows are sustainable and there is a low risk that lake water quality will be degraded by declining rainfall in the area. The flow of groundwater through the pit will result in pit lake water quality similar to the groundwater quality from upstream flow. However, there is some risk that under dry winter conditions, the lake may not have any significant discharge for more than a year.

Reducing the design pit level to less than 46 mAHD will increase inflow and decrease outflow, while increasing seasonal discharges. The increase flows will act to provide increased certainty that the T5 lake will be sustainable with respect to water quality and through flows, under dry climatic conditions.

4.0 References

Parsons Brinckerhoff Australia Pty Ltd, *Prediction of groundwater impacts associated with mining at the Dardanup mine*, 2012.

Parsons Brinckerhoff Australia Pty Ltd, *Surface water assessment for the proposed mine pits.* 2011.

Parsons Brinckerhoff Australia Pty Ltd, *Surface water assessment for the proposed Central (Waterloo) Block*, 2013.

APPENDIX E: DARDANUP MINE CLOSURE RISK ASSESSMENT

DARDANUP MINE CLOSURE RISK ASSESSMENT

						Risk Analysis				Control Analysis					
							Inherent				Residual				
Item No.	Risk	Hazard	Possible Causes	Potential Impacts	Worst Case Scenario	Likelihood	Consequence	Risk Rating	Control	Likelihood	Consequence	Risk Rating	Responsible Person	Control Status
1	Compliance	Legal Obligations and commitments	1. Failure to plan to meet legal obligations. 2. Failure to implement / undertake legal obligations. 3. Failure to understand, or difference in interpretation, of obligations.	1. Prosecution with associated penalties. 2. Delay to relinquishing land tenure, involving management time and cost. 3. Cost of rework. 4. Deterioration of public reputation. 5. Failure to get bonds released.	Earthworks are required to rework final landform(s) to meet an obligation.	Possible	Catastrophic	High	1. Legal obligations and commitments identified and included within MCP. 2. MCP includes tracking of how obligations and commitments are being met. 3. 'Decision making stakeholder' review and acceptance of how obligations are being met, prior to closure. 4. AER includes discussion on closure and rehabilitation 5. Update and maintain Legal Compliance Register	Rare	Major	Medium		
2	Completion Criteria	Geotechnical stability (subsidence)	1. Backfill in mine pits consolidation pattern is unknown or not as expected. 2. Post-mining land owners build structures on backfilled mining voids.	1. Cost of rework to correct (e.g. maintenance backfilling of shallow slumps). 2. Compensation (cost) to future land users if structures fail. 3. Changes to surface water drainage if not corrected. 4. Restrictions to post-mining agricultural management (e.g. hazards to livestock or restriction to vehicle and equipment movement). 5. Structural failure of road (built over mine pit). 6. Reduced land value at time of sale.	Cost to correct or remedy structure (i.e. road, house or shed) built on backfilled mine pit which fails due to ground subsidence.	Possible	Major	High	1. Mined out road tenure (i.e. areas where post-mining landuse is road reserve) is backfilled with materials that meet compaction specifications. 2. Subsidence monitoring and rework to correct. 3. Land is retained by Doral for at least 3 years prior to resale. 4. Map rehabilitated mine pit backfill types and depth.	Rare	Moderate	Low		
3	Completion Criteria	Landuse	1. Landuse not agreed with landowners and/or DMP. 2. Change in landuse post-closure to a landuse incompatible with land capability. 3. Post-mining land capability is not able to support agreed landuse.	1. Delay in handover / relinquishment of land as it is not fit for new purpose. 2. Cost to rework to meet required landuse.	Cost of rework to meet landuse standards	Possible	Major	High	1. Landowner agreements include broad post-mining landuse. 2. MCP submitted and approved by DMP.	Unlikely	Major	High		
4	Completion Criteria	Weeds (agricultural, environmental and declared)	1. Failure to identify, monitor and control weeds	1. Cost of control. 2. Compliance (declared weeds, revegetation composition). 3. Deterioration of public relations. 4. Competition from weeds results in failure of revegetation.	Competition from weeds results in revegetation failure (either native or agricultural revegetation).	Almost certain	Moderate	Extreme	1. Pre-disturbance surveys 2. Inspections 3. Removal and spraying of weeds in native vegetation areas and declared weeds. 4. Implement weed control in other agricultural areas.	Unlikely	Minor	Low		
5	Completion Criteria	Agricultural Productivity (is not as good as or better than pre-mining levels)	1. Post-mining soil profiles do not support productive pastures 2. Saline ground water contaminates surface soils 3. Poor pasture management practices (e.g. fertiliser use, weed control, stock management)	1. Post-mining land fails to be as productive as pre-mining land. 2. Loss of access to future deposits. 3. Inability to realise commercial value of land held by Doral upon sale of land.	Landowners refuse to provide access to southern extension and other future mining areas	Possible	Catastrophic	Extreme	1. Design soils profiles for each rehab block with at least 1m of soil materials on top of sand tails. 2. Keep topsoil and subsoil for use in rehab. 3. Keep no less than 100mm of subsoil when ore is to surface. 4. Measure soil properties and agricultural productivity (pre and post mining). 5. Control of brackish and saline groundwater during operations, such that rehab surface soils are not contaminated. 6. Implement good practice pasture management practices. 7. Develop and obtain landholder agreement to detailed landform designs.	Unlikely	Moderate	Medium		

					Risk Analysis				Control Analysis					
						Inherent				Residual				
Item No.	Risk	Hazard	Possible Causes	Potential Impacts	Worst Case Scenario	Likelihood	Consequence	Risk Rating	Control	Likelihood	Consequence	Risk Rating	Responsible Person	Control Status
6	Completion Criteria	Erosion	1. Unstable and unvegetated surface soils (i.e. sands) and creeklines. 2. Landform design does not accommodate surface water flows of site.	1. Unacceptable turbidity in waterways. 2. Meandering creek beds kill revegetation by eroding and/or sedimentation of vegetation. 3. Increase siltation within creeklines and drainage channels . 4. Cost of rework. 5. Deterioration of public reputation. 6. Impacts on neighbours (e.g. road reserves, adjoining landowners)	Unstable drainage line meanders annually killing vegetation, modifying topography and deteriorating downstream water quality.	Unlikely	Moderate	Medium	1. When economics are marginal avoid mining 10m either side of creek bankfull level. 2. Post-mining a 10 metre corridor of native vegetation established both sides of creek bankfull levels. 3. Soil profiles are modified within creek beds so there is no sand on the surface. 4. Generally creekbed slopes are less than 1:130. Where they are at a steeper slope than this rock armouring is utilised to prevent scouring. 5. Each creek created in rehabilitation areas is subject to site specific design. 6. Inspection and rework to correct smaller issues before esculation to significant damage.	Rare	Minor	Low		
7	Completion Criteria	Contaminated Sites	1. Dry plant tails not adequately covered with low radiation soils. 2. Diesel (or other hydrocarbon) spill or leak. 3. Acid Sulphate Soils are oxidised creating acidity.	1. Elevated radiation levels at the final landform surface. 2. Hydrocarbon contaminated soil and/or water. 3. Acidified soil and/or water.	Contaminated site prevents relinquishment of land and incurs significant costs for ongoing treatment	Possible	Major	High	1. Undertake hydrocarbon site contamination assessment. 2. Decontaminate any hydrocarbon contamination identified. 3. Pre- and post-mining radiation surveys. 4. Dry plant tailings is capped with 5 metres of sand, clay, overburden and/or soil. 5. Water and soil monitoring to detect acidification resulting from ASS. 6. Implementation of the ASS Managment Plan.	Rare	Moderate	Low		
8	Completion Criteria	Native Revegetation (fails to establish where planted)	1. Planted in areas with too little soil water available (e.g. mine voids backfilled with sand tails). 2. Stock or vermin (e.g. rabbits) eat seedlings 3. Area is unexpectedly waterlogged and seedlings die due to waterlogging. 4. Vegetation succumbs to disease (i.e.. dieback). 5. Erosion 6. Weed competition. 7. Low rainfall seasonal conditions.	1. Conservation offset not able to be achieved (resulting in compliance issue, loss of licence to operate and/or difficulty getting access to new areas). 2. Cost of rework (where rework solution is possible). 3. Change to post-mining landuse.	Conservation offset revegetation fails to establish.	Likely	Major	Extreme	1. Deep rooted vegetation is not planted in rehabilitated mine pits that have been backfilled with sand tails. 2. Seedlings area planted and tree guards installed. 3. Dieback management measures as defined in Rehilitation Management Plans for offset areas. 4. Vegetation species are selected based on the expected conditions of the site (e.g. wetland species to be planted in areas where waterlogging could be expected). 5. Kangaroo fencing and managed culling. 6. Rabbit control baiting. 7. Site preparation activities, including weed control for 2 years prior to planting, ripping and scalping. 8. Inspection and adaptive management (response to weeds, grazing pressure, erosion)	Unlikely	Moderate	Medium		
9	Completion Criteria	Mining Infrastructure removal (failure to completely remove)	1. Not enough money available at closure to remove all infrastructure. 2. Not all infrastructure identified and costed. 3. Recovery/Sale value assumed in cost estimate overly optimistic.	1. Delay in handover / relinquishment of land until infrastructure removed. 2. Ongoing liability to public safety for any infrastructure left on site. 3. Deterioration of public reputation.	Delay in handover / relinquish of land resulting in ongoing cost incursion.	Possible	Major	High	1. Closure cost estimates and provisioning includes removal of infrastructure. 2. Closure cost estimates and provisioning is reviewed and updated on annual basis.	Unlikely	Major	High		
10	Completion Criteria	Infrastructure reinstatement (failure to reinstate to required standard)	1. Failure to plan to reinstate all required infrastructure. 2. Reinstated instructure not build to required standard.	1. Unplanned rework cost. 2. Delay in handover / relinquishment of land.	Cost of rework / remediation.	Possible	Major	High	1. Infrastructure to be reinstated is clearly identified and costed for within MRCP. 2. Utilisation of Dardanup Shires road standards, Harvey Water standards and Telstra standards as relevant to road, irrigation channel and telecommunications infrastructure. 3. Define irrigation and access infrastructure in consultation with landholders and include within MRCP.	Rare	Moderate	Low		
11	Completion Criteria	Groundwater (does not return similar to pre-mining functioning)	1. Groundwater patterns and flows on site not understood. 2. Groundwater flows and quality not considered in rehabilitation planning. 3. Backfill of mine pits with sand or overburden/tails locally changes the groundwater behaviour (i.e. localised waterlogging / flooding occurs, or soil suffers springtime 'drought').	1. Amenity / use of land is compromised. 2. Agricultural productivity is reduced. 3. Land not able to sustain target native vegetation growth. 4. Neighbours water bores dry up at or post-closure.	Neighbours water bores dry up at or post-closure.	Possible	Moderate	High	1. Groundwater investigation, modelling and assessment undertaken, including post-mining groundwater recovery. 2. Groundwater monitoring includes neighbouring landowners bores. 3. Post-mining soil profiles on coastal plain include 'duplex' soils within top 1 metre, which recreates perched watertable which supplies water for agricultural species.	Unlikely	Moderate	Medium		

					Risk Analysis				Control Analysis					
						Inherent				Residual				
Item No.	Risk	Hazard	Possible Causes	Potential Impacts	Worst Case Scenario	Likelihood	Consequence	Risk Rating	Control	Likelihood	Consequence	Risk Rating	Responsible Person	Control Status
12	Completion Criteria	Conservation Offsets (are not sustained)	1. Dieback kills established vegetation 2. Altered water regime (ie local drought or waterlogging resulting from removal of SEPs)	1. Loss of access to future deposits. 2. Deterioration of public reputation.	Conservation offset vegetation dies shortly after closure and acccess to future mineral deposits is denied by Government.	Unlikely	Catastrophic	High	1. Legal mechanisms for implementing management controls of Offset areas are established by Doral prior to land transfer.	Rare	Catastrophic	High		
13	Completion Criteria	Landforms (do not support agreed landuses)	1. Design landforms and soil profiles do not support agreed landuse. 2. Performance of landforms and soil profiles not well understood and assumptions prove incorrect. 3. Landforms and soil profiles are not created (implemented) as designed.	1. Delay in handover / relinquishment of land as it is not fit for new landuse 2. Cost to rework to meet agreed landuse.	Cost of rework / remediation.	Possible	Major	High	1. Landform and soil profile design based on industry experience, good science and site specific information. 2. Adequate supervision of rehabilitation activities so that landforms and soil profiles are created as designed. 3. Monitor/measure performance of landforms and soil profiles in rehabilitated areas, and incorporate any learnings/lessons into future rehabilitation design.	Unlikely	Major	Medium		
14	Cost	Inadequate Provision	1. Underestimate of costs 2. Specific items required at and post-closure are not costed. 3. Assumptions used prove to be inaccurate. 4. Schedule blows out.	1. State government pursues Doral owners for costs. 2. Deterioration of public reputation.	State government pursues Doral owners for costs	Likely	Catastrophic	Extreme	1. Annual review of MRCP and cost estimates, with continual improvement in the level of detail contained. 2. Feedback from actual rehabilitation expenditure is utilised in updates to rehabilitation cost estimates and provisioning. 3. Assumptions used in cost estimates to be included within the MCRP and reviewed annually.	Unlikely	Catastrophic	High		
15	Closure Plan	Schedules	1. Closure implementation not planned for. 2. Closure implementation schedule not based on learnings from progressive rehabilitation. 3. Schedule is not location specific.	1. Cost overrun due to increased duration of activities. 2. Deterioration of public reputation. 3. Contractual dispute with Iluka over requirement to handback land within 2 years of mining. 4. Impact on neighbouring landowners and community due ongoing delays (e.g. ongoing road closures, noise impacts, irrigation channel control)	Cost overrun due to increased duration of activities	Likely	Catastrophic	Extreme	1. MRCP and rehabilitation schedule annually updated. 2. Consultation with Iluka regarding handback of land and contractual obligations. 3. Ongoing consultation with neighbours, community and other stakeholders regarding planned implementation of closure.	Unlikely	Major	High		

APPENDIX F: DARDANUP MINE DECOMMISSIONING MANAGEMENT PLAN

Government of **Western Australia**
Office of the **Environmental Protection Authority**

Mr Andrew Templeman
General Manager
Doral Mineral Sands Pty Ltd
PO Box 9155
Picton WA 6229

Our Ref: AC05-2015-0023
Enquiries: Mark Jefferies, 6145 0847
Email: mark.jefferies@epa.wa.gov.au

Dear Mr Templeman

MINERAL SANDS MINE, DARDANUP – MINISTERIAL STATEMENT 484 – CONDITION 7-1 DECOMMISSIONING MANAGEMENT PLAN

Thank you for your letter of 6 October 2016 submitting the Dardanup Mine Site Decommissioning Plan V2, October 2016, (the Plan) to the Office of the Environmental Protection Authority (OEPA) for review.

I note the Plan has been prepared to satisfy condition 7-1 of Ministerial Statement 484 which states:

> *At least six months prior to decommissioning, the proponent shall prepare a decommissioning Management Plan to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Department of Minerals and Energy.*
>
> *The plan shall address:*
>
> 1. *removal or, if appropriate, disposal on site of plant and infrastructure;*
> 2. *rehabilitation of all disturbed areas to agreed final land use(s); and*
> 3. *identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.*

I am satisfied with the preparation of the Dardanup Mine Site Decommissioning Plan V2, October 2016, and consider the requirements of condition 7-1 of Ministerial Statement 484 have been met.

Level 8, The Atrium, 168 St Georges Terrace, Perth, Western Australia 6000
Telephone 08 6145 0800 Facsimile 08 6145 0895 Email info@epa.wa.gov.au

Locked Bag 10, East Perth WA 6892

www.epa.wa.gov.au

Please note any changes to the management actions or targets of the Dardanup Mine Site Decommissioning Plan V2, October 2016, would require the approval of the OEPA.

Yours sincerely

Mr Kim Taylor
GENERAL MANAGER

27 October 2016

Doral Mineral Sands

Dardanup Mine Site
Decommissioning Plan V2

October 2016

Authored By: **Craig Bovell**

OSH&E Superintendent

Doral Mineral Sands Pty Ltd ABN 18 096 342 451 ACN 096 342 451 Lot 7 Harris Road, **Picton** WA 6229 **Tel:** +61 8 9725 5444 **Fax:** +61 8 9725 4757
Email: admin@doral.com.au **Website:** www.doral.com.au

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1. *INTRODUCTION*

This document describes Doral Mineral Sands Pty Ltd (Doral's) plan for the decommissioning of the Dardanup Mine plant and equipment.

This document has been prepared for the Office of the Environmental Protection Authority (OEPA) to meet Condition 7 of the Ministerial Statement 484 as follows, and shall be read with reference to the *Doral Mineral Sands Dardanup Mine Closure Plan (Ver5)* submitted to the Department of Mines and Petroleum.

This V2 2016 version of the Dardanup Mine Decommissioning plan incorporates a progress update of deconstruction to date as well as the Preliminary Site Investigation (PSI) conducted by Aurora Environmental consultants.

Condition 7 of Ministerial Statement 484 states;

> **7 Decommissioning Management Plan**
>
> 7-1 At least six months prior to decommissioning, the proponent shall prepare a Decommissioning Management Plan to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Department of Minerals and Energy.
>
> This Plan shall address:
>
> 1 removal or, if appropriate, disposal on-site of plant and infrastructure;
> 2 rehabilitation of all disturbed areas to agreed final land use(s); and
> 3 identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.
>
> 7-2 The proponent shall implement the Decommissioning Management Plan required by condition 7-1.

2. *DECOMMISSIONING PLAN OBJECTIVES;*

The Doral Decommissioning plan is committed to the following objectives;

- Removal or, if appropriate, disposal on-site of plant and infrastructure,
- Rehabilitation of all disturbed areas to agreed final land use,
- Identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.

Mining and processing infrastructure shall be removed from site following completion of mining. Some of the infrastructure may be sold on site, however all mining infrastructure shall be removed for subsequent use (most likely at another mining operation), recycling, or disposal in a licenced waste management facility.

The following mining and processing infrastructure has been removed of has been identified for removal from site:

- Disconnection and removal of poly pipe. From approximately 34km there is presently approximately 5km remaining. Removed poly pipe has either been recycled or placed on laydown pad awaiting transfer to the proposed Yoongarillup Mine.
- Dismantling and removal of aerial power lines. From 4.5km approximately 3km remains and is scheduled for removal in October 2016.
- The wet concentrator has been de-constructed and has either been relocated offsite for refurbishment of taken to laydown area awaiting relocation to the Yoongarillup mine. The thickener is in the process of being de-constructed due for completion in December 2016 and the maintenance workshops will remain until the later stages of decommissioning.
- Dismantle and removal of field pumps and motor control centres. Presently 3 field pumps remain for the management of surface water. The electric pumps will be removed by the end of October 2016 and replaced by self bunded diesel units. The pumps shall be removed following the rehabilitation of all surface water catchment areas.
- The feed preparation plant, workshops and associated infrastructure have been de-constructed and either taken offsite for refurbishment, taken offsite for recycling or taken to laydown yard awaiting relocation to the Yoongarillup mine.
- Salvage hardstand areas including Wayne's World shed will remain until the final stages of decommissioning.
- All 43 solar drying dam weir boxes have been removed and 14 dams are presently in various stages of rehabilitation. These remaining dams will be rehabilitated during the drier months of 2016/17 and prior to winter 2017.
- The following infrastructure will remain on site subject to regulatory approvals and landowner requirements:
    - Groundwater production bore
    - Three remaining Harvey Water irrigation channel bridges
    - Farm buildings and sheds (e.g. current mine administration office), and
    - Some mine roads subject to landowner requirements

Road base and concrete footings from infrastructure will be disposed of onsite and will be covered with a minimum 3 metres of soil material.

3. *INFRASTRUCTURE REINSTATEMENT*

Doral has requirements to reinstate the following infrastructure in consultation with the Shire of Dardanup at closure, all of which has been costed within the cost estimate:

- Construction and sealing of Edwards, Offer, Harris and Dowdell Roads. The length of construction totals 950 meters of double width seal.
- The re-establishment of underground Telstra communications line within the Offer, Edwards Road reserve.
- Re-establishment of all cadastral boundaries by licensed surveying consultants.
- Re-establishment of the Spray irrigation channel. This was completed in Q2 2016.

4. *REHABILITATION OF DISTURBED AREAS*

All disturbed areas shall be appropriately rehabilitated and returned to the agreed final land use. As discussed in the Mine Closure Plan, post mining land uses have been discussed and agreed with landowners prior to entering agreements to access the land for mining.

Final land use is also described and included within environmental approval documentation and commitments. The majority of the Dardanup mine shall be returned to pasture with several conservation areas placed under restrictive conservation covenants.

The Dardanup Mine Closure Plan as submitted to the DMP shall be revised and updated in March 2017.

5. *DECONSTRUCTION AND REHABILITATION PROGRESS TO DATE*

The Dardanup mine ceased production on the 23rd December 2015. Continuous rehabilitation of mining voids has always been conducted by Doral throughout operation and this has continued from this time as well as the deconstruction of plant and equipment.

The feed prep plant was de-constructed During Q1 and Q2 of 2016 with the dismantled plant either taken to a designed temporary laydown area for repairs, taken offsite for refurbishment, or recycled through scrap metal dealer. The feed prep plant and equipment shall remain at the laydown area until relocation to the proposed Yoongarillup Mine in 2017.

The wet concentrator and associated plant was under de-construction from Q2 of 2016 as shown in the photos below and as at October 2016 only the thickener remains and is presently commencing de-construction. The deconstructed plant and equipment has been relocated to a designed temporary laydown area or taken off site for refurbishment prior to being relocated to the proposed Yoongarillup Mine in 2017.

6. IDENTIFICATION OF CONTAMINATED AREAS

Doral has engaged a suitably qualified contaminated sites consultant (ABEC Consulting formerly Aurora Dunsborough) to undertake a Preliminary Site Investigation (PSI) at the Dardanup Mine in accordance with the Department of Environment Regulation (DER) guideline *Assessment and management of contaminated sites (DER, 2014)*. This guideline advocates a staged approach for investigation and assessment of contaminated sites.

The preliminary investigation (PSI) as shown in Appendix 2 of this plan, is focused on the identification of site contamination characteristics such as potentially contaminating land uses or the location of potentially contaminating substances with considerations to possible contamination and human health and/or environmental values.

Following this preliminary investigation the next stage is to develop a sampling and quality analysis plan (SAQP) based on the findings of the PSI to ensure that the data collected are representative and sufficient to address critical data gaps and uncertainties identified in the conceptual site model (CSM). The SAQP to be developed in 2017 will demonstrate the rationale for sample locations and data to be collected by linking the areas of concern identified in the CSM to the sampling program for the Detailed Site Investigation (DSI). The DSI shall then be undertaken with advice by an accredited auditor to confirm the absence or presence of contamination, and if present:

- Establish the nature of contamination;
- Consider the vertical and lateral extent of contamination;
- Determine the source and concentration of contaminants;
- Assess the potential human health and environmental risks that may result.

At conclusion of the stages of investigation, a Mandatory Auditor's Report shall be prepared for the site as required.

7. CLOSURE PROVISIONING

Doral recognises the risks to its reputation, the ability to continue operations and the ability to secure access to future deposits that may result from inadequate funding of closure activities. To ensure that sufficient financial provision is provided for closure activities Doral reviews and updates closure provision annually as part of the budget cycle. This allows for experience and learnings gained in progressive rehabilitation to be included within the provisioning process.

Doral's process for closure provisioning is described in Section 9 of the Mine Closure Plan as submitted to the DMP.

8. SCHEDULING

Doral is presently executing the plan for decommissioning and rehabilitation activities at the Dardanup Mine site. Delays in implementation of decommissioning activities are not seen as likely due to the mining plant and equipment to be transferred to the Yoongarillup project which is scheduled to commence in January 2017.

The closure implementation schedule is described within Sections 7 and 10 of the Mine Closure Plan and is reviewed and updated on an annual basis as part of the annual budgeting cycle. Appendix 1 details the planned scheduling for the decommissioning of plant and infrastructure at the Dardanup Mine.

Appendix 1 DORAL DARDANUP MINE – DECOMMISSIONING PLAN SCHEDULE

(as updated from 2015 Plan)

TENEMENT	ESTIMATED TIMEFRAME	ITEM	EXTENT OF EQUIPMENT	ACTION	FINAL USE	STATUS
M70/652	2015	Sand tail return infrastructure	Poly Pipe Field Pump and MCC Lime dosing tank Aerial Powerlines	Nil	Pasture	**Complete**
	2016	Piacentini plant	Temporary stored hopper (non-Doral) and conveyor equipment	Contractor to remove stored equipment from site	Offsite	**Complete**
	2020	Gravel stockpile	Stockpiled gravel for road construction and maintenance	Remove / dispose of gravel stockpile and hardstand area in consultation with landowner and rehabilitate	Hardstand/ Pasture	Incomplete
	2020	Haul Road	Approx 500m of haul road	Remove haul roads in consultation with landowner and rehabilitate	Pasture	Incomplete
	2018	Drainage and sump	Approx 30m of drainage and small collection sump	Rehabilitate	Pasture	Incomplete
	2018	Monitoring bores	7x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete
M70/748	2017/19	Solar Evaporation Ponds	8 SEP's, weir boxes and associated drainage channels	Dry, harvest for removal of clay to mine void, Profile dams and rehabilitate	Pasture	In process. Dams profiled and partial topsoil replacement
	2017	Poly pipes	Approx 3km of tails return poly pipe	Remove poly pipe	Recycle / Reuse	Incomplete
	2017/19	Haul Roads	Approx 3.5km of haul roads	Remove haul roads in consultation with landowner and rehabilitate	Pasture	Incomplete
	2018	Monitoring bores	4x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete

Appendix 1 DORAL DARDANUP MINE – DECOMMISSIONING PLAN SCHEDULE

(as updated from 2015 Plan)

TENEMENT	ESTIMATED TIMEFRAME	ITEM	EXTENT OF EQUIPMENT	ACTION	FINAL USE	STATUS
M70/720	2016/17	PP78	PP78 Pump and infrastructure, sump and associated drainage	Remove PP78 pump and infrastructure, rehabilitate 78 sump and associated drainage	Pasture	**Complete**
	2016/17	Dowdells Line culvert	Dowdells Line culvert	Backfill / remove road culvert and rehabilitate in consultation with Shire of Dardanup	Road / Adjacent pasture	**Complete**
	2016/17	Haul Rd	Approx 2.5km of haul road	Remove haul roads in consultation with landowner and rehabilitate	Pasture	**Complete**
	2016/17	Aerial powerlines	Approx 1.5km of aerial powerlines	Remove from site for reuse / recycle	Offsite	**Complete**
	2018	Monitoring bores	8x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete
M70/893	2016	Field pumps	Mobile diesel pumps	Remove pumps	Pasture	**Complete**
	2016	Poly pipes	Approx 2km of poly pipe	Remove poly pipe	Recycle / Reuse	**Complete**
	2016	Haul Rd	Approx 1km of haul road	Remove haul roads in consultation with landowner and rehabilitate	Pasture	**Complete**
	2018	Monitoring bores	7x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete
M70/643	2016	Haul Rd	Approx 2km of haul road	Remove haul roads in consultation with landowner and rehabilitate	Pasture	**Complete**
	2016	Poly pipes	Approx 1km of tails return poly pipe	Remove poly pipe	Recycle / Reuse	**Complete**
	2016	Field pumps	Mobile diesel pumps	Remove pumps	Off site	**Complete**
	2018	Monitoring bores	3x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete

Appendix 1 DORAL DARDANUP MINE – DECOMMISSIONING PLAN SCHEDULE

(as updated from 2015 Plan)

TENEMENT	ESTIMATED TIMEFRAME	ITEM	EXTENT OF EQUIPMENT	ACTION	FINAL USE	STATUS
M70/675	2018/20	Poly pipe	Approx 28km Poly pipe	Remove poly pipe to temporary storage area prior to disposal / recycling off site	Recycle / Reuse	In process. Approx 3-4km remaining
	2020	Field pumps and MCCs	PP62, PP38, PP35, Tails Booster, Slime booster, and associated infrastructure	Remove pumps and MCCs to temporary storage area prior to disposal / recycling off site	Offsite	Incomplete
	2020	Aerial powerlines	Approx 3km of aerial powerlines	Remove from site for reuse / recycle	Offsite	Ongoing
	2018/20	Access / haul roads	Approx 20km of haul road	Progressive removal of haul roads in consultation with landowner and rehabilitate	Pasture	Ongoing
	2018/20	Road / drainage culverts	Approx 15km of drainage channels and approx 18 drainage culverts	Progressive removal of drainage channels with rehabilitation of haul roads	Pasture	Ongoing
	2020	Sheds	Farm shed, Hay shed	Remove/retain in consultation with landowner	Recycle / Reuse	Incomplete
	2020	Offices	Office house	Remove/retain in consultation with landowner	Recycle / Reuse	Incomplete
	2020	Workshop	Doral light workshop, MSCS Heavy workshop, MSCS Office and ablutions	Remove all structures and hard stand areas in consultation with landowner and rehabilitate. Conduct contaminated sites assessment	Hard stand/ Pasture	Incomplete
	2017/18	Concentrator and associated infrastructure	Concentrator, Thickener, Tails hopper, CD Tank, Pumps, poly pipes	Remove all structures and hard stand areas in consultation with landowner and rehabilitate.	Offsite reuse / recycle	Ongoing. Feed prep and wet concentrator complete
	2018/19	Solar Evaporation Ponds	35 SEP's, weir boxes and associated drainage channels	Dry, harvest and removal of clay to mine void, Progressive profiling and rehabilitation of dams	Pasture	Ongoing 14 SEP's remaining
	2017/18	Feed Prep Plant and associated infrastructure	Control room office, ROM bin, CV02, Jacques screen, CV03, CV04, Double Deck screen, Scrubber 1&2, Trommel, MCC's, booster pumps	Remove all structures and hard stand areas in consultation with landowner and rehabilitate.	Offsite reuse / recycle	**Complete**
	2020	Production bore	Concentrator production bore	Consultation with landowner and DoW prior to potential decommissioning of bore	Reuse/Recycle	Incomplete
	2018	Monitoring bores	17x groundwater monitoring bores	Decommission monitoring bores	Dispose	Incomplete
	2018	Laydown yard	2x laydown yards	Remove all materials and hard stand areas in consultation with landowner and rehabilitate. Conduct contaminated sites assessment	Offsite reuse / recycle	Incomplete

APPENDIX G: DARDANUP MINE CLOSURE OBLIGATIONS CHECKLIST

Doral Dardanup Mine Closure Obligations Checklist

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Aboriginal Heritage Act 1978.	Part IV	Heritage sites are not to be altered, excavated, damaged, concealed or any portion of the site removed in anyway, unless granted via Section 16 or 18 under the Aboriginal Heritage Act 1978.	Heritage site south of Giumelli Rd not disturbed confirmed by notification to Dept. Aboriginal Affairs	2017	OSHE Supt
Agriculture and Related Resources Protection Act 1976	Part V, Division IV (47)	The occupier of any private land shall control declared plants and declared animals on and in relation to that land.	Declared weed management program employees and contractors Feral animal baiting and control program	Ongoing	Mine Manager OSHE Supt
Contaminated Sites Act 2003. *Contaminated Sites Regulations 2006.*	Part I, Section 11 Part II (6)	The proponent or individuals are to report known or suspected areas of contaminated sites.	Preliminary Site Investigation completed. Detailed site assessment to be conducted and reported to DER	2017	OSHE Supt
Contaminated Sites Act 2003.	Part III, (23)	Sites classified as Contaminated - Remediation Required as described under the Contaminated Sites Act 2003 are to be remediated.	Formal acceptance by DER that no contamination exists	2018	OSHE Supt
Environmental Protection (Controlled Waste) Regulations 2004		Disposal of asbestos is to be separated, wrapped and labelled and disposed in accordance with Part III,(6)(44)	Asbestos removal conducted by licenced persons	Ongoing	Mine Manager OSHE Supt
Environmental Protection (Controlled Waste) Regulations 2004		The proponent is to treat all products listed in schedule 1 of the Environmental Protection (Controlled Waste) Regulations 2004 as a controlled waste.	Site assessment and reporting to DER	2018	OSHE Supt
Environmental Protection Act 1986.	Part V, (49)	Proponent shall not cause pollution or an unreasonable emission of noise, odour or electromagnetic radiation.	DER Licence compliance as reported annually in AER	Ongoing	OSHE Supt
Environmental Protection Act 1986.	Part V, (51)	The proponent shall not clear native vegetation without the relevant approval (e.g. clearing permit) in place.	EPA/DMP Mining approvals	Ongoing	Mine Manager
Health Act 1911.	Part IV (2) (87)	The proponent shall ensure (stagnant) pools, ponds, open ditches, and drains do not become offensive to the public or allow these areas to become prejudicial to human health.	Verified upon closure by DER	2018	Mine Manager

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Health Act 1911. *Environmental Protection (Controlled Waste) Regulations 2004.*	Part IV (3) (95) Part III	Removal of sewerage systems is to be conducted in accordance with Local Government Law and by a licensed contractor in accordance with the Environmental Protection (Controlled Waste) Regulations 2004.	Licenced contractor used if house sewerage removed As inspected by Shire of Dardanup Officers	Ongoing	Mine Manager
Mines Safety and Inspection Regulations 1995.	Part III, (2)(3.11)	Notification of suspension of mining operations must be in writing and include the requirements specified in Section 3.14 of the regulations.	Notification letter to DMP	Completed in 2016	Mine Manager
Mines Safety and Inspection Regulations 1995.	Part III, (2)(3.16)	At notification of abandonment the proponent is required to notify the department how the following has been achieved: • Secure the site against inadvertent public access. • Prevent and mitigate mine subsidence. • Plant and equipment removed or secured and left in a safe condition. • Hazardous substances removed or properly disposed.	As inspected by DMP Officers	2018	Mine Manager
Mines Safety and Inspection Regulations 1995.	Part XVI, (2)(16.35)	The proponent shall submit a plan with the notification which shows: (a) the specific locations in which radioactive waste has been buried; and (b) the absorbed dose rates in air one metre above the final surface.	Radiation Management Plan; AER; MCP	2018	OSHE Supt
Mines Safety and Inspection Regulations 1995.	Part XVI, (2)(16.35)	After the mine is abandoned, rehabilitation sites are to be inspected and monitored at such intervals and in such a way as is approved by the State mining engineer.	As inspected and instructed by DMP Officers	2018	Mine Manager
Mines Safety and Inspection Regulations 1995.	Part XIII, (13.8)	The principal employer at, and the manager of, a mine must ensure that geotechnical aspects are adequately considered in relation to the design, operation and abandonment of quarry operations.	As inspected by DMP Officers	2018	Mine Manager
Mining Act 1978	Part IV (84AA)	A mine closure plan is required to be approved by the Department and reviewed every 3 years, or as specified by the Department.	MCP submitted and approved in 2016 and resubmitted in 2017	2017	Mine Manager OSHE Supt
Mining Act 1978.	Part III (1)(20)(3a)	Make safe all holes, pits, trenches and other disturbances on the surface of the land which are likely to endanger the safety of any person or animal.	Site safety audit As inspected by DMP Officers	Ongoing	Mine Manager

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Mining Act 1978.	Part III (1)(20)(3b)	Take all necessary steps to prevent fire and damage to trees or other property.	Burning dates as per Shire requirements Hot work permit procedures	Ongoing	Mine Manager
Mining Regulations 1981.	Part V, (6)(97)	Avoid activity that obstructs any public thoroughfare or undermines any road, railway, dam or building in such manner as to endanger the public safety.	Suitable signage and fencing, consultation with Dardanup Shire	Ongoing	Mine Manager
Mining Regulations 1981.	Part V, (6)(98)	The proponent shall not allow detritus, dirt, sludge, refuse, garbage, mine water or pollutant from the tenement to become an inconvenience to the holder of any other mining tenement or to the public, or in any way injure or obstruct any road or thoroughfare or any land used for agricultural purposes.	Site inspection	Ongoing	Mine Manager
Soil and Land Conservation Act 1945.	Part V (32)	The proponent shall take adequate precautions to prevent or control soil erosion, salinity or flooding; or the destruction, cutting down or injuring of any tree, shrub, grass or any other plant on land where land degradation is occurring or likely to occur.	Site inspection	Ongoing	Mine Manager
Wildlife Conservation Act 1950	(16 and 23F)	A person may not take for any purpose protected fauna or flora without a licence, or rare and endangered flora without the written consent of the Minister.	Licence issued for any taking of flora or fauna	As required	Mine Manager
M70/652	28	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.	Reported in AER	Annual	Mine Manager OSHE Supt
M70/675	18	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.	Reported in AER	Annual	Mine Manager OSHE Supt
M70/720	28	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.	Reported in AER	Annual	Mine Manager OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
M70/784	18	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.	Reported in AER	Annual	Mine Manager OSHE Supt
M70/675	19	Rehabilitated areas being levelled or gently sloped or made to a design in reasonable keeping with the natural surroundings and being replanted with suitable grass, cereals, shrubs or other suitable vegetation with measures such as fertiliser application and watering being taken to promote growth and, where considered necessary by the District Mining Engineer, brush matting or other suitable cover being provided to prevent sand drift and dust nuisance.	Reported in AER	Annual	Mine Manager OSHE Supt
M70/652	29	At completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the State Mining Engineer.	Site relinquished	2020	Mine Manager
M70/720	29	At completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the State Mining Engineer.	Site relinquished	2020	Mine Manager
M70/748	19	At completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the State Mining Engineer.	Site relinquished	2020	Mine Manager
M70/748	21	At the completion of operations or progressively where possible all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the State Mining Engineer and on freehold land, the landholder.	Site relinquished	2020	Mine Manager
M70/675	21	At the completion of operations or progressively where possible all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the State Mining Engineer.	Site relinquished	2020	Mine Manager
M70/652	31	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment	Site relinquished	2020	Mine Manager

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		Division, DMP.			
M70/720	31	At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Director, Environment Division, DMP.	Site relinquished	2020	Mine Manager
M70/652	37	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitation to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or an alternative agreed outcome to the satisfaction of an Environmental Officer, DMP.	Site relinquished	2020	Mine Manager
M70/675	23	The lessee submitting to the Executive Director, Environment Division, DMP, a brief annual report outlining the project operations, minesite environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March.	Reported in AER	Annual	OSHE Supt
M70/652	32	The lessee submitting to the Director, Environment Division, DMP, a brief annual report outlining the project operations, minesite environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March.	Reported in AER	Annual	OSHE Supt
M70/720	32	The lessee submitting to the Director, Environment Division, DMP, a brief annual report outlining the project operations, minesite environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation	Reported in AER	Annual	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		programmes for the next 12 months. This report to be submitted each year in: • March.			
M70/748	24	The lessee submitting to the Director, Environment Division, DMP, a brief annual report outlining the project operations, minesite environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March.	Reported in AER	Annual	OSHE Supt
M70/652	38	A Mine Closure Plan is to be submitted in the Annual Environmental Reporting month specified in tenement conditions in the year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • 2017.	Mine Closure Plan	2017	OSHE Supt
M70/675	25	A Mine Closure Plan is to be submitted in the Annual Environmental Reporting month specified in tenement conditions in the year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • 2017.	Mine Closure Plan	2017	OSHE Supt
M70/720	36	A Mine Closure Plan is to be submitted in the Annual Environmental Reporting month specified in tenement conditions in the year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • 2017.	Mine Closure Plan	2017	OSHE Supt
M70/784	25	A Mine Closure Plan is to be submitted in the Annual Environmental Reporting month specified in tenement conditions	Mine Closure Plan	2017	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		in the year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • 2017.			
Ministerial Statement 484	4-1	*Environmental Management Program* Prior to commencement of ground-disturbing activities, the proponent shall prepare an Environmental Management Program to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection, the Department of Minerals and Energy, Agriculture Western Australia, the Water and Rivers Commission and the owners of land on which mining takes place. The Program shall include: 1 construction of facilities and stockpiles with consideration given to visual impact on public and private locations; 2 limitation of clearing and land disturbance to that required for safe operation; and 3 consultation with Western Power and relevant landowners to determine the most acceptable means of extending the existing 22 kV agricultural supply transmission line to the mining area, and shall consist of the following environmental management plans: 1 Surface Water and Groundwater Monitoring and Management Plan (see condition 5); 2 Rehabilitation Management Plan (see condition 6); and 3 Decommissioning Management Plan (see condition 7).	Consultative Environmental Review; Doral Environmental Management Plans; Decommissioning Plan approved by OEPA	Completed 2016	OSHE Supt
Ministerial Statement 484	4-2	*Environmental Management Program* The proponent shall implement the Environmental Management Program required by condition 4-1.	Reported in AER, MCP	Annual	Mine Manager OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Ministerial Statement 484	6-1	*Rehabilitation Management Plan* Prior to the commencement of mining, the proponent shall develop a progressive rehabilitation plan, in order to rehabilitate the mine site to an environmentally stable condition, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection, the Department of Minerals and Energy, Agriculture Western Australia, the Water and Rivers Commission and the owners of land on which mining takes place.	DMS-EMP-6.1 Rehabilitation Management Plan; Performance report in AER; MCP	Annual	Mine Manager OSHE Supt
Ministerial Statement 484	6-2	*Rehabilitation Management Plan* The proponent shall implement the Rehabilitation Management Plan required by condition 6-1. Note: The final land use after mining will be determined between the land owners and the proponent.	Performance report in AER; MCP	Annual	Mine Manager OSHE Supt
Ministerial Statement 484	7-1	*Decommissioning Management Plan* At least six months prior to decommissioning, the proponent shall prepare a Decommissioning Management Plan to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection and the Department of Minerals and Energy. This Plan shall address: 1 removal or, if appropriate, disposal on-site of plant and infrastructure; 2 rehabilitation of all disturbed areas to agreed final land use(s); and 3 identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.	Decommissioning Plan approved by OEPA	Completed in 2016	OSHE Supt
Ministerial Statement 484	7-2	*Decommissioning Management Plan* The proponent shall implement the Decommissioning Management Plan required by condition 7-1	Reported in AER, MCP	Annual	Mine Manager OSHE Supt
Ministerial Statement 789	6-2	*Flora, Vegetation and Aquatic Ecosystems* *Indirect impacts on Flora, Vegetation and Aquatic Ecosystems* At all times, the proponent shall ensure that mining excavations and dewatering do not reduce water availability so as to	Reported in Biannual Flora, Vegetation and Aquatic Systems reports 2009 – 2014	Complete	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		adversely affect flora, vegetation and aquatic ecosystem health, by monitoring: 1. groundwater levels and vegetation health in the vicinity of mining operations; 2. perched water levels, soil moisture and vegetation health in Conservation Category Wetland UFI2362 and Resource Enhancement Wetland UFI2165; 3. soil moisture levels and vegetation health in the low woodland of *Casuarina obesa* near Dowdells Line; and 4. changes to the existence of permanent pools in Henty Brook over summer; This monitoring shall be carried out before, during and for at least 12 months after dewatering and mining has ceased, on a monthly basis or at a monitoring frequency that is to the satisfaction of the Department of Environment and Conservation.			
Ministerial Statement 789	6-3	*Flora, Vegetation and Aquatic Ecosystems* *Indirect impacts on Flora, Vegetation and Aquatic Ecosystems* The proponent shall submit the results of the monitoring required by condition 6-2 to the Department of Environment and Conservation every six months following the commencement of ground disturbing activities.	Reported in Biannual Flora, Vegetation and Aquatic Systems reports 2009 – 2014	Complete	OSHE Supt
Ministerial Statement 789	8-1	*Closure and Rehabilitation* Prior to commencement of ground disturbing activities, the proponent shall conduct surveys of the proposal area to collect baseline information, including photographic records, on the following: 1 Pre-mining soil profiles; 2 Groundwater levels; 3 Surface water flows; 4 Vegetation complexes; and 5 Landscape and landforms.	EPS documents for the Western Extension proposal; Reported in AER; MCP	Annual	Mine Manager OSHE Supt
Ministerial Statement 789	8-2	*Closure and Rehabilitation* As mining progresses, the proponent shall commence rehabilitation of the mined area in accordance with the following:	Quarterly and bi-annual monitoring reports Reported in AER	Annual	Mine Manager OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		1. Re-establishment of vegetation in the rehabilitation area to be comparable with that of the pre-mining vegetation such that the following criteria are met within three years following the cessation of productive mining: (1) Species diversity is not less than 70 percent of the known original species diversity; (2) Priority flora are re-established with not less than 50 percent success after three years and 65 percent success after five years; and (3) Weed coverage less than 10 percent. 2. Re-establishment of the soil profile to ensure repair of any damage to wetland perched water containment and to emulate the pre-mining hydraulic properties of the area generally. 3. Remediation of acid sulphate soil and contaminated groundwater generated by mining operations. 4. A schedule of the rate of rehabilitation acceptable to the CEO of the Department of Environment and Conservation.			
Ministerial Statement 789	8-3	*Closure and Rehabilitation* In liaison with the Department of Environment and Conservation, the proponent shall monitor progressively the performance of rehabilitation against the criteria in condition 8-2.	Reported in AER	Annual	Mine Manager OSHE Supt
Ministerial Statement 789	8-4	*Closure and Rehabilitation* The proponent shall submit annually a report of the rehabilitation performance monitoring required by condition 8-3 to the CEO of the Department of Environment and Conservation and shall address in the report the following: 1. Progress towards meeting the criteria required by condition 8-2 and milestone criteria; and 2. Contingency management measures in the event that criteria are unlikely to be met.	Reported in AER	Annual	Mine Manager OSHE Supt
EPBC Referral 2011/6087 Approval	3	Within three years of the date of this approval the person taking the action must register a legally binding conservation covenant over the Woodland Habitat Rehabilitation and Offset Area (WHROA). The conservation covenant must provide enduring protection and rehabilitation of no less than 19 ha including the	Conservation Covenants in place for Lot 107	Completed in 2016	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		establishment of 1600 black cockatoo habitat trees.			
EPBC Referral 2011/6087 Approval	4	To offset the impacts to black cockatoos, within 60 days of commencement of construction, the person taking the action must submit to the Minister for approval a Woodland Habitat Rehabilitation Plan (WHRP).This plan must be used to establish and maintain the WHROA in accordance with the Offset Management Plan (2012) provided in the Preliminary Documentation. The WHRP must include, but not be limited to the following: a) milestones and objectives of the WHROA b) a description and map to clearly define the location and boundaries of all of the offset areas. This must be accompanied by the offset attributes and a shapefile c) details of management actions to protect and enhance the extent and condition of habitat values of the offset areas including but not limited to rehabilitation, weed control and feral animal control d) details of the location and type of habitat creation (including but not limited to artificial nesting boxes and relocated logs) e) the timing, responsibilities, performance criteria and corrective actions, to be implemented if performance criteria are not met with in specified timeframes, for management actions f) a monitoring plan, including timing and methods for assessment of rehabilitation success to be undertaken by a qualified ecologist or suitably experienced environmental scientist to assess the success of the management actions against identified milestones and objectives g) a process to report to the department, the management actions undertaken in the offset areas and the outcome of those actions, including identification of any need for adapting management actions h) a description of the potential risks to successful management and rehabilitation in the offset areas, and a description of the contingency measures that would be implemented to mitigate these risks •	Approved Woodland Habitat Rehabilitation Plan (WHRP) in place. Reported in AER	Annual	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		i) details of parties responsible for management, monitoring and implementing the plan, including their position or status as a separate contractor. The approved WHRP must be implemented.			
EPBC Referral 2011/6087 Approval	6	The person taking the action must develop a Perched Groundwater and Tree Health Monitoring Program (the program) to be conducted for the life of the project, including the rehabilitation phase, to ensure mining excavations do not reduce water availability. The program, including trigger values and contingency measures, must be developed in consultation with local DEC officers. The program must be provided to the department within 60 days of establishment of the program.	Approved Monitoring program in place. Reported in AER	Annual	OSHE Supt
EPBC Referral 2011/6087 Approval	8	The Mine Closure Plan (DMS-EMP-6.3) (June 2012) and Rehabilitation Management Plan (DMS-EMP-6.1) (June 2012) must include the DSE and be submitted to the department for approval within 90 days of the commencement of construction. The approved DMS-EMP-6.3 and DMS-EMP-6.1 must be implemented.	Approved Plans in place. Reported in AER	Annual	OSHE Supt
EPBC Referral 2013/6879 Approval	2	To offset the loss of habitat for black cockatoos, within 2 years of the date of this approval, the person taking the action must provide written evidence to the Department [of Environment] that a legally binding conservation covenant has been registered over the offset areas identified as Management Areas A, B, C and D at Attachment B, at Lot 110, Simpson Road, Henty, WA. The conservation covenant must provide protection and rehabilitation of no less than 14.95 ha of black cockatoo habitat.	Conservation Covenant in place for Lot 110.	Completed in 2016	OSHE Supt
EPBC Referral 2013/6879 Approval	3	To mitigate impacts to black cockatoos, prior to the commencement of the action, the person taking the action must prepare and submit an Environmental Management and Offset Strategy (EMOS) for the Ministers approval. The EMOS must include, but not be limited to: a) Milestones and objectives of the EMOS; b) Avoidance and mitigation measures to reduce impacts to black cockatoo habitat prior to, during and post mining operations; c) A description and map to clearly define the location and	Approved Environmental Management and Offset Strategy (EMOS) in place. Reported in AER	Annual	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		boundaries of all the offset areas. This must be accomplished by the offset attributes and shapefile; d) Details of rehabilitation measures for offset areas. These details should include but not be limited to, commencement timeframes, species to be utilised, stocking rates, measures to be utilised to ensure success, success targets, contingency measures in the case of not meeting targets and monitoring requirements; e) Measures to exclude weeds and feral animals from offset areas; f) Timeframes for the implementation and completion of the above measures and strategies; g) Details of monitoring, reporting, and contingency measures if performance indicators are not met; and h) Roles and responsibilities of personnel associated with implementing each of the above measures. Methods for assessment of rehabilitation must be undertaken by a qualified ecologist or suitably experienced environmental scientist. The person taking the action must not undertake any clearing of habitat for black cockatoos within the project area unless the EMOS has been approved by the Minister. If the Minister approves the EMOS, then the approved EMOS must be implemented.			
EPBC Referral 2013/6879 Approval	5	The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the EMOS required by this approval, and make them available upon the request to the department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department website. The results of audits may also be publicised through the general media.	Reported in AER	Annual	OSHE Supt
EPBC Referral	8	If the person taking the action wishes to carry out any activity	Reported in AER	Annual	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
2013/6879 Approval		otherwise than in accordance with the EMOS as specified in the conditions, the person taking the action must submit to the Department for the Minister's written approval a revised version of that EMOS. The varied activity shall not commence until the Minister has approved the varied EMOS in writing. The Minister will not approve a varied EMOS unless the revised EMOS would result in an equivalent or improved environmental outcome over time. If the Minister approved the revised EMOS, that EMOS must be implemented in place of the EMOS originally approved.			
Willoughby South Creek – Beds and Banks Permit: PMB168635(1)	Section 5. Site Rehabilitation	The following rehabilitation works will be undertaken: • The original channel profile will be reinstated as per the survey data collected: • Banks will be stabilised; and • Bank and riparian zones will be revegetated with native tree, shrub and sedge species. Species such as Eucalyptus rudis, Melaleuca rhaphiophylla, Melaleuca preissiana and Casuarina obesa represent the original vegetation in the area and will be used wherever possible in the rehabilitation of the riparian zone. Advice on the most appropriate methods for the above rehabilitation works will be sought (at the time of implementation) from the DEC and other rehabilitation specialists. It is the intention of Doral Mineral Sands to improve the current ecological values of the creek lines that are disturbed. The re-established creek line will be fenced 20m either side of the stream invert and re-establish native trees and under storey.	Reported in AER	Annual	OSHE Supt
Burekup West Dewatering Licence: GWL168577(1)	17	The groundwater bore monitoring program *(and reporting)* shall be maintained for a period covering at least two winters' rainfall seasons after cessation of dewatering extraction	Reported in AER	Complete	OSHE Supt
CER	4	Ensure that backfilled mine areas have the capacity to transmit water from east to west in a fashion similar to that which currently occurs.	Site Inspection	2020	Mine Manager
CER	5	Rehabilitate land disturbed by mining activities to restore agricultural productivity to levels at least equal to those which currently exist.	Annual Pasture monitoring	2020	Mine Manager

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
CER	6	Consult with the Department of Agriculture, the Water Authority of Western Australia and landowners to include native vegetation in rehabilitation strategies, with the view to contributing to the management of localised and regional hydrogeological problems of high water tables and salinity.	Rehabilitation Management Plan Reported in AER	Annual	Mine Manager OSHE Supt
CER	11	Enrich and establish native vegetation along existing permanent public roads and roads developed or disturbed as a result of project activities.	Rehabilitation Management Plan Reported in AER	Annual	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	1	Update the existing Dardanup Project Rehabilitation and Decommissioning Plan to include the western extension. The Plan will include an ASSMP Closure Report. Implement the Rehabilitation and Decommissioning Plan.	Rehabilitation Management Plan Reported in AER MCP	Annual	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	4	• Progressively fill the pit void with a heterogeneous mixture of sand tailings, dried clay tailings and oversize; • Incorporate the western extension proposal into the Groundwater Management Plan and enact the Plan; and • Incorporate the western extension into the Rehabilitation and Decommissioning Plan and enact the Plan.	Groundwater Management Plan Rehabilitation Management Plan Reported in AER MCP	Annual	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	12	• Fence CCW and REW wetlands; • Maintenance of fencing prior to and post rehabilitation for approximately 3 years post mining; and • Covenant the CCW.	Fencing in place (REW yet to be determined with DPaW) Conservation Covenant in place	Complete Completed 2016	OSHE Supt
Western Extension EPS and Mining Proposal	13	Collect seed at the appropriate time of year and store to preserve seed viability.	Seedling reveg reported in AER	Annual	
Western Extension EPS and Mining Proposal	14	Monitoring of vegetation condition to be conducted every three months during mine operation; every month during dewatering activity in areas designated as Groundwater Dependant Ecosystem (GDE); and annually for 3 years post mining.	Monitoring reports Reported in AER	Annual	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Western Extension EPS and Mining Proposal	16	• Fence the Low Woodland of *C.obesa;* • The disturbance corridor for the conveyor will be rehabilitated post mining using seed of local provenance; and • Maintenance of fencing prior to and post rehabilitation for approximately 3 years post mining.	Fencing in place, Revegetation planting included in rehabilitation	2018	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	20	Rehabilitate mine disturbance areas by planting trees within strategic corridors such as adjacent to road reserves and fence lines to link, strengthen or improve corridors for native fauna. Species selection will focus on fauna habitat and be of local provenance where possible.	Rehabilitation Management Plan Reported in AER	Annual	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	26	Update the Rehabilitation and Decommissioning Plan for the Dardanup Mineral Sands Project to include the western extension proposal. Enact the Plan. Management measures will include: • The return of clay fine material and subsoil to emulate pre-mine hydraulic properties of the region. • After replacement of subsoil, the surface will be contoured to provide drainage and then harrowed in areas of pasture establishment. • Soil amendments, fertiliser application and seeding rates will be undertaken in consultation with the Department of Agriculture.	Rehabilitation Management Plan Reported in AER MCP	Annual	Mine Manager OSHE Supt
Western Extension EPS and Mining Proposal	27	• Secure and rehabilitate approximately 20ha of Guildford Vegetation Complex, referred to as the Willoughby Offset Area. Provide $250,000 over 5 years to manage the Willoughby Offset area. • Offset the (approximate) 450 trees to be cleared with the planting of 5,000 trees within the Willoughby Offset Area. • Secure and rehabilitate the CCW. A CCW Covenant Area has been agreed in principle in preliminary discussions with the owner and DEC.	Conservation Covenant in place for Willoughby Offset and CCW Annual expenditure reports for Willoughby's Offset Planting of seedlings conducted	Completed 2016 Annual	OSHE Supt
Western Extension EPS and Mining Proposal	28	Prepare an ASSMP Closure Report (prior to Mine Closure)	Contaminated Sites Assessment and report	2018	OSHE Supt

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
Mining Proposal Burekup Amendment 2010	2	Planting of additional 2000 local species in strategic rehabilitation areas to provide an improved habitat for native fauna	Planting conducted Rehabilitation Management Plan. Reported in AER	Complete	OSHE Supt
Mining Proposal Burekup Northern Amendment 2011	1	Plant an additional 200 trees within Burekup northern mining area to strengthen or improve corridors for native fauna. Plant species will focus on fauna habitat and be of local provenance wherever possible.	Planting conducted Rehabilitation Management Plan. Reported in AER	Complete	OSHE Supt
Southern Extension Section 45C	1	Update Dardanup Mine EMP's (including the Rehabilitation Management Plan Dardanup Mine and Burekup West, DMS-EMP-6.1) to reflect the scope and environmental effects of the Dardanup southern extension.	Updated Plans	Complete	OSHE Supt
Inclusion of Waterloo Block into Dardanup Southern Extension s45C	1	Update Dardanup Mine EMP's to reflect the scope and environmental effects of the inclusion of the Waterloo Block. - Rehabilitation Management Plan Dardanup Mine and Burekup West (DMS-EMP-6.1);	Updated Plans	Complete	OSHE Supt
Extractive Industries Licence	1	Extraction area is to be rehabilitated and re-vegetated in accordance with the approved plan within 12 months of the completion of the operation to the satisfaction of the Director Engineering Services.	Site Inspection, removal of Extractive Industry Licence	2017	Mine Manager OSHE Supt
Stakeholder - Adrian Tyrrell	Lot 22 On Diagram 83297	Final soil surface level must be designed and constructed with laser level for flood irrigation. Hay shed on the eastern boundary of pit to be kept or replaced to same standard at Doral's cost.	Topo survey plan Shed retained	2017	Mine Manager
Stakeholder - Adrian Tyrrell	Lot 3558 On Plan 202219	Doral committed to installing fencing so that access to cattle yards on Lot 3557 can be maintained from Lot 3558.	Fencing in place	Complete	Mine Manager
Stakeholder - Ken Tyrrell	Wellington Location 3553 On Plan 202219	Livestock access to cattle yards must be maintained, by either keeping existing yards and fencing or if required shift yards and fences with Ken's approval, at Doral cost.	Fencing in place	Complete	Mine Manager
Stakeholder - Rob Depiazzi	Lot 18 On Plan 232787	Rob has requested that subsoil needs more sand as it is very high clay at present. Doral has committed to incorporating a thin	Site Inspection	2017	Mine Manager

Source	Section Reference	Closure Obligation	Evidence of Conformance	Completion timeframe	Responsible Person
		sand tails layer into the reconstructed soil profile.			
Stakeholder - Tom Busher	Lot 201 On Diagram 12309	Lot currently leased by Phil Depiazzi. Area was rehabilitated in 2010, surface remediation work required in 2012/13 season to remedy subsidence.	Topo survey, Site Inspection	2017	Mine Manager
Stakeholder - Iluka Resources Ltd	Lot 21 On Diagram 83379	House at front with of Lot must be kept. All other buildings can be removed but Iluka must be notified to salvage for charity.	House in place	2017	Mine Manager
Stakeholder - Harvey Water	Swan Channel Spray Channel	Doral shall re-establish the Swan and Spray channels to a similar standard and at the same location as existed pre-mining.	Swan and Spray channel in place	Swan channel complete Spray channel 2017	Mine Manager

Source Documents Reference List

Short Name (Source)	Full Reference
Southern Extension Section 45C	Aurora Environmental. (2012). *Doral Mineral Sands Southern Extension Section 45C Request.* Unpublished Report for Doral Mineral Sands Pty Ltd.
Southern Extension EPBC Consolidated Preliminary Documentation	Aurora Environmental. (2012). *Consolidated Preliminary Documentation, Southern Extension to the Dardanup Mineral Sands Project (EPBC Referral Reference Number 2011:6087).* Unpublished Report for Doral Mineral Sands Pty Ltd.
EPBC Referral 2011/6087 Approval	EPBC Referral 2011/6087 Approval Decision
EPBC Referral 2013/6879 Approval	EPBC Referral 2013/6879 Approval Decision
Western Extension EPS and Mining Proposal[1]	Doral. (2008). *Environmental Protection Statement - Western Extension to the Dardanup Mineral Sands Project to include the Burekup Mineral Sands Deposit.* Bunbury: Doral Resources Pty Ltd. Doral (2009). *Mining Proposal Addendum to Notice of Intent 761: Western Extension to the Dardanup Mineral Sands Project to Include the Burekup Mineral Sands Deposit.* M70/652 and M70/720. Doral Mineral Sands Pty Ltd. February 2009
CER	ISK Minerals. (1991). *Dardanup Mineral Sands Project, Consultative Environmental Review.* Unpublished Report for ISK Minerals Pty Ltd.
Mining Proposal Burekup Northern Amendment 2011	Doral (2011) *Mining Proposal Amendment to Registration Number 21253: Mining Proposal for a Northern Amendment to Burekup West.* M70/652. Doral Mineral Sands Pty Ltd. August 2011
Mining Proposal Burekup Amendment 2010	Doral (2010) *Mining Proposal Amendment to Registration Number 21253: Mining Proposal for an Amendment to Burekup West*. M70/652 and M70/720). Doral Mineral Sands Pty Ltd. August 2010
Inclusion of Waterloo Block into Dardanup Southern Extension s45C	Inclusion of Waterloo Block into Dardanup Southern Extension s45C Request
Extractive Industries Licence	The Shire of Dardanup Extractive Industries Licence, inclusion of the Waterloo Block into the Dardanup Southern Extension

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(08) 9794 6096
0422 812 845 | 0418 329 390
admin@abecenviron.com.au
PO Box 1013, DUNSBOROUGH WA 6281