## ANNUAL REVIEW DETAILS

<table>
<thead>
<tr>
<th>Name of operation</th>
<th>Balranald Mineral Sands Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of operator</td>
<td>Iluka Resources Limited</td>
</tr>
<tr>
<td>Development consent / project approval #</td>
<td>SSD – 5285</td>
</tr>
<tr>
<td>Mining Lease #</td>
<td>ML 1736</td>
</tr>
<tr>
<td>Name of holder of mining lease</td>
<td>Iluka Resources Limited</td>
</tr>
<tr>
<td>Water licence #</td>
<td>WAL31101 and WAL31102</td>
</tr>
<tr>
<td>Name of holder of water licence</td>
<td>Iluka Resources Limited</td>
</tr>
<tr>
<td>MOP / RMP start date</td>
<td>18 May 2016 (OUT16/19802)</td>
</tr>
<tr>
<td>MOP / RMP end date</td>
<td>31 May 2021</td>
</tr>
<tr>
<td>Annual Review start date</td>
<td>5&lt;sup&gt;th&lt;/sup&gt; April 2016</td>
</tr>
<tr>
<td>Annual Review end date</td>
<td>31&lt;sup&gt;st&lt;/sup&gt; December 2016</td>
</tr>
</tbody>
</table>

I, Julieanne Goode, certify that this audit report is a true and accurate record of the compliance status of the Balranald Mineral Sands Project for the period 5<sup>th</sup> April 2016 – 31<sup>st</sup> December 2016 and that I am authorised to make this statement on behalf of Iluka Resources.

<table>
<thead>
<tr>
<th>Name of authorised reporting officer</th>
<th>Julieanne Goode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of authorised reporting officer</td>
<td>Senior Environment and Community Specialist</td>
</tr>
<tr>
<td>Signature of authorised reporting officer</td>
<td>[Signature]</td>
</tr>
<tr>
<td>Date</td>
<td>03 July 2017</td>
</tr>
</tbody>
</table>
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1 INTRODUCTION

1.1 Background

On 5\textsuperscript{th} April 2016 Iluka Resources Limited (Iluka) were granted Development consent for the Balranald Mineral Sands Project (the Balranald Project) under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Balranald Project includes construction, mining, primary processing and rehabilitation of two linear mineral sand deposits, known as the West Balranald and Nepean deposits located approximately 12 kilometres (km) and 66 km north-west of the town of Balranald, respectively.

In addition, the Balranald Project includes undertaking a bulk sampling activity (the activity) at the West Balranald deposit involving the removal of up to 100,000 tonnes (t) of mineral ore.

In 2016 the bulk sampling activity was commenced for the Balranald Project. This bulk sampling activity is a continuation of smaller bulk sampling activities completed in Q1-2015 and Q1-2016 in accordance with approval under Part 5 of the EP&A Act from NSW Trade & Investment, Resources & Energy (Reference OUT13/28341 and OUT15/27702).

1.2 Operations overview

The Balranald Project is currently only completing activities associated with the completion of a bulk sampling activity.

This activity has been be undertaken ahead of commencement of construction and operation of the West Balranald mine with the objective to test the selective in-situ removal of up to 100,000 t of mineral ore to determine whether it can be:

- undertaken on a commercial scale; and
- removed in an environmentally sensitive manner.

The first stage of the bulk sampling activity commenced in June 2016 and was completed in September 2016.

The location of the activity is shown in Figures 1.1 and 1.2.
Figure 1.1: 2016 Annual Review - Activity Location
Figure 1.2: 2016 Annual Review - Activity Site Location
1.3 Current consents, authorisations, licences and management plans

The Balranald Project is a Level 1 mine and was assessed as a State Significant development under Part 4 of the EP&A Act. The following table lists the relevant consents, authorisations and licences regulating the activities on site.

**Table 1: Current consents, authorisations and licences**

<table>
<thead>
<tr>
<th>Type</th>
<th>Identification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Consent</td>
<td>SSD-5285</td>
<td>Granted: April 2016 Duration: 16 years</td>
</tr>
<tr>
<td>Mining Lease</td>
<td>ML1736</td>
<td>Granted: May 2016 Duration: 21 years</td>
</tr>
<tr>
<td>Environment Projection Licence</td>
<td>EPL20795</td>
<td>Granted: June 2016 Duration: 5 years</td>
</tr>
<tr>
<td>Water Access Licence(s)</td>
<td>WAL31101 WAL31102</td>
<td>Total allocation volume – 2500ML</td>
</tr>
</tbody>
</table>

In addition to the above consents, authorisations and licence the following management plans have been approved.

**Table 2: Approved management plans for the bulk sampling activity**

<table>
<thead>
<tr>
<th>Management Plan</th>
<th>Date of approval and approving agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Management Plan (EMP)</td>
<td>3 May 2016; NSW Planning and Environment; Reference: 11/22089-2</td>
</tr>
<tr>
<td>Bulk Sampling Activity</td>
<td></td>
</tr>
<tr>
<td>Mine Operations Plan (MOP)</td>
<td>18 May 2016; NSW Department of Industry, Resources and Energy; Reference OUT16/19802</td>
</tr>
<tr>
<td>Aboriginal Cultural Heritage Management Plan (ACHMP)</td>
<td>14 April 2016; NSW Office of Environment and Heritage; Reference: DOC16/184303</td>
</tr>
<tr>
<td></td>
<td>29 April 2016; NSW Planning and Environment; Reference: 11/22089-2</td>
</tr>
</tbody>
</table>

1.4 Purpose of this document

Condition 4 (Annual Review), Schedule 5 of the project development consent (SSD-5285) requires that:

*By the end of March each year, the Applicant shall review the environmental performance of the development for the previous calendar year to the satisfaction of the Secretary. This review must:*

(a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;

(b) include a comprehensive review of the monitoring results and complaints records of the development over the past year, which includes a comparison of these results against the:
(c) relevant statutory requirements, limits or performance measures/criteria;
(d) monitoring results of previous years; and
(e) relevant predictions in the EIS;
(f) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
(g) identify any trends in the monitoring data over the life of the development;
(h) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
(i) describe what measures will be implemented over the next year to improve the environmental performance of the development.

This report is the 2016 Annual Review for the Balranald Project as required by Condition 4, Schedule 5 of the development consent.

2 DETAILS OF PROJECT ACTIVITIES 2016

2.1 Vegetation and topsoil stripping

An area of approximately 1.41 hectares (ha) of native vegetation was cleared as part of the site preparation works for the bulk sampling activities.

To prevent excessive soil deterioration the low lying vegetation was stripped at the same time as the topsoil material in order to capture the existing native seed bank for future rehabilitation.

As per requirements in the approved EMP, vegetation/topsoil was stripped to the following depths (depending on soil availability):

- topsoil: down to 0.1 m; and
- subsoil: from 0.1 m to 0.5 m.

Stockpiles were limited to 3 m in height with stockpile material added to or placed adjacent to stockpiles that existed from previous clearing activities. All stockpiles on site are stable, partly vegetated and protected by erosion control measures.

The Iluka procedure (PRC) 7931: Site Disturbance Clearance Procedure was implemented for all site disturbance activities associated with the activity. This procedure outlines that site disturbance may only proceed once a Site Disturbance Clearance Form has been completed and signed by the relevant Iluka personnel.
2.2 Infrastructure establishment

Figure 2.1: 2016 Annual Review – Site Infrastructure – January 2016
The bulk sampling activity was a continuation of smaller bulk sampling activities completed in Q1-2015 and Q1-2016. As a result, the following infrastructure existed on site at the commencement of the bulk sampling activities approved by SSD-5285 (refer Figure 2.1):

- process water dams filled with groundwater drawn from a production well and stored for use in the bulk sampling process;
- access tracks and internal roadways; and
- site compound.

The following activities were completed to upgrade the existing infrastructure:

- upgrade of access tracks and internal roadways;
- new access track and pipe trace from site compound to monitoring infrastructure;
- installation of new monitoring infrastructure; and
- upgrades (as were required) to water storage infrastructure such as the installation of a sump(s), spoon drains and/or increasing the capacity of the existing detention basin.

The construction of a new ore pad, to be located adjacent to the existing site compound (to the west) was allowed under the consent, but not constructed due to the results of the bulk sampling activities.

2.3 Bulk sampling activities

The following table summarises the volumes of material extracted and backfilled during the bulk sampling activities completed during 2016.
Table 3: Summary of 2016 bulk sampling activities

<table>
<thead>
<tr>
<th>Bulk sampling activity</th>
<th>Stope Number</th>
<th>Approximate Tonnes</th>
<th>Approximate Litres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining system testing</td>
<td>1B</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2900</td>
<td></td>
</tr>
<tr>
<td><strong>Total tonnes mined</strong></td>
<td><strong>6400</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backfill - process water</td>
<td>1</td>
<td>-</td>
<td>3,175,750</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>-</td>
<td>954,849</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-</td>
<td>1,504,333</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-</strong></td>
<td></td>
<td><strong>5,634,933</strong></td>
</tr>
<tr>
<td>Backfill - Slurry</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>418</td>
<td>278,734</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>446</td>
<td>297,333</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>864</strong></td>
<td></td>
<td><strong>576,068</strong></td>
</tr>
<tr>
<td><strong>Total volume backfilled (slurry + process water)</strong></td>
<td>~ 6,211,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Through testing the mining system, ore material was brought to the surface and the following activities were completed:

- ore was screened for removal of coarse material (stockpiled for later backfilling) into the stopes;
- screen underflow was pumped to cyclones for removal of the fines material from the sand (containing the heavy mineral);
- cyclone underflow was stacked on the ore pad;
- cyclone overflow was sent to a thickener, where flocculent was added to create thickener underflow;
- the thickener underflow was stored in the thickener pond for backfilling into the stopes;
- the clean water from the thickener was contained in the process water storage dam for reuse in the mining operation.

The ore extracted from the activity was stockpiled and has been retained onsite, the ore stockpiled was sprayed with a proprietary based product to minimise dust generation. This continue to be periodically inspected.

Backfilling of the stopes involved combining the fines material from the thickener underflow pond with process water and sand fraction of ore and re-injecting the combined material into the area where the mining system was trialed (stopes) which had lower density.

### 2.4 Water use

Water use for the reporting period is summarised in Table 4.
### Table 4: Summary of water use

<table>
<thead>
<tr>
<th>Water Licence #</th>
<th>Water Source and Water Sharing Plan</th>
<th>Allocation*</th>
<th>Volume extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>31101</td>
<td>Western Murray Porous Rock Groundwater Source</td>
<td>150ML</td>
<td>0.56ML</td>
</tr>
<tr>
<td>31102</td>
<td>NSW Murray Darling Basin Porous Rock Groundwater Sources</td>
<td>2350ML</td>
<td>18.8ML</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>19.36M:</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Temporary allocation leased from permanent allocation holder for the water licensing period 2016-2018.

### 2.5 Decommissioning and rehabilitation

The activity was undertaken for a 12 week period between June and September 2016.

Following completion of the activity all mining plant and equipment was decommissioned and removed from site. Basic surface equipment remains on site – screen, cyclones, thickener, pumps plus associated pipes and spares. In addition, a stabilised stockpile of extracted material also remains on site. The material was sprayed with a proprietary binding material to minimise dust generation.

All site decommissioning activities were complete by October 2016.

The site is currently in a “care and maintenance” mode while Iluka completes the next design phase of the project prior to construction.

No rehabilitation activities were completed in 2016.

### 3 MONITORING RESULTS

As detailed in the EMP (and associated plans) a range of environmental monitoring was proposed to be undertaken during the completion of the activity.

The following sections provide a review of the monitoring completed during the activity.

It should be noted that the results from the monitoring completed during the course of the bulk sampling activity have not been compared to the predicted impacts as contained in the EIS.

The impacts predicted in the EIS relate to an open cut truck and shovel mining method. The activities undertaken in 2016 were an extension of bulk sampling activities completed in 2015 using an in-situ mining method. The predicted impacts in the EIS are therefore not related to the completed activities in 2016.

The 2016 monitoring results however have been assessed to determine compliance with the project’s development consent (where applicable).

### 3.1 Subsidence

A Subsidence Management Plan (SMP) was prepared to manage and mitigate impacts from activity and was contained within the EMP.

The (theoretical) maximum predicted subsidence was conservatively estimated to be up to 600 mm, this was adopted for the purpose of developing management measures. However a
lower maximum predicted subsidence of 20 mm was considered more likely to occur with the contour line ranging from 100-200 m from the extracted void (based on the 2015).

The following monitoring was completed during the activity in accordance with the SMP:

- subsidence monitoring by a specialist surveyor (with extensive experience in mining induced subsidence monitoring), as follows:
  - addition of approximately six remote (far-field) monitoring points. These points were added in accessible locations >1 km from the trial mining site to aid in understanding what (if any) level of ‘background’ ground movements may have been occurring naturally as a function of ground water levels or other environmental factors;
  - addition of a local global navigation satellite system (GNSS) base station control point. The addition of a local GNSS base station nominally within 2 km of the site will increased survey accuracy;
  - capture of a high density digital terrain model (DTM) of the entire site and surrounds. Data was be captured using drone based aerial photography and associated photogrammetric processing. The high density DTM complemented the high accuracy 3D discrete point monitoring surveys;
- landform surveys were undertaken across the entire activity site before and after the trial program to validate predictions made, while survey beacons were installed across the site and at nominated regional control points to monitor ground surface levels;

The location of the subsidence survey area (as identified in the SMP) is illustrated in Figure 3.1.
Figure 3.1: Subsidence survey extent

Results

The results of the subsidence monitoring are provided in Appendix A.

The results indicate that measured subsidence during the activity was considerably less than the conservative subsidence prediction values.

In addition, Section 4.1 below details the outcomes of one subsidence event reported to the NSW Department of Resources and Energy (DRE) and Environment Protection Authority (EPA) in August 2016. Although the vent was not a regulatory noncompliance, it was reported to the respective agencies.

In addition, an area of minor up-sidence (upswell) was identified adjacent the stope 3 extraction zone in the post mining survey completed in November 2016. It is unknown at this stage whether this is short or long term occurrence. Further post mining survey of this area is proposed in 2017.
3.2 Groundwater

A Groundwater Operating and Management Strategy (GOMS) was prepared to manage and mitigate impacts from activity and was contained within the approved EMP. The GOMS was prepared to manage potential groundwater risks associated with the activity. Operating objectives for the management of groundwater are defined in the GOMS:

- meet dewatering, water supply and disposal requirements;
- do not adversely impact neighbours water availability;
- do not adversely impact native groundwater quality off the mining lease or in the underlying Lower Renmark Group; and
- use water efficiently.

Hydraulic and water quality site specific trigger levels (SSTLs) were developed for the Shepparton, Loxton Parilla Sands and Lower Renmark aquifers as detailed in the GOMS. The management responses triggered by SSTLs were based around a three-tiered management framework which provided for early and rapid intervention of possible groundwater and geological stability issues.

The GOMS classifies groundwater monitoring sites into five broad categories:

- near-mining (within 1 km) monitoring well;
- near-mining (within 1 km) vibrating wire piezometer (VWP);
- near-mining (within 1 km) extensiometer (EXTO);
- third party water users (within 3 km); and
- regional monitoring wells (within 3 km).

Results

The results of the groundwater monitoring have been reported in a Groundwater Operating and Management Strategy Compliance report and are provided in Appendix B.

The results indicate no groundwater noncompliance with SSTLs during 2016.

One groundwater monitoring anomaly was noted during the review of the 2016 data and reported to NSW regulatory agencies even though the event did not constitute a non-compliance with the GOMS or result in significant environmental impact. Further detail on this event is provided in 4.1 below.

3.3 Noise

During completion of the activity, attended noise monitoring was undertaken on six dates in accordance with the EMP and the requirements of Schedule 3, Condition 4 of the development consent.

Noise generated by the activity (including traffic noise) was managed to meet the construction noise management levels in Table 5 at any assessment location.
Table 5: Construction noise management levels for the Balranald Project

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Management level</th>
<th>Management level $L_{eq,15min}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard hours: Monday to Friday 7:00 am to 6:00 pm, Saturday 8:00 am to 1:00 pm, No work on Sundays or NSW public holidays</td>
<td>Noise affected</td>
<td>40 dB(A)</td>
</tr>
<tr>
<td></td>
<td>Highly noise affected</td>
<td>75 dB(A)</td>
</tr>
<tr>
<td>Outside standard hours</td>
<td>Noise affected</td>
<td>35 dB(A)</td>
</tr>
</tbody>
</table>

Noise was also managed to meet the noise criteria specified in Schedule 3, Condition 3 of the development consent, as detailed in Table 6.

Table 6: Schedule 3, Condition 3 – Operational noise criteria

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq}$ (15min)</th>
<th>Evening $L_{Aeq}$ (15min)</th>
<th>Night $L_{Aeq}$ (15min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results

Table 7 provides a summary of the noise monitoring activities completed during 2016. No noncompliance with operational noise criteria occurred during the 2016 activities on site.

Appendix C contains the associated acoustic consultant’s report for the June-September monitoring events.

Table 7: Summary of noise monitoring activities and results

<table>
<thead>
<tr>
<th>Date</th>
<th>Details</th>
<th>Summary of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 April 2016</td>
<td>Iluka attended monitoring at Karra homestead (R5)</td>
<td>Site noise levels below the relevant noise limits during all measurements at the nearest residential location (R5).</td>
</tr>
<tr>
<td>15 June 2016 (day and night)</td>
<td>Attended compliance monitoring (acoustic consultants) day time and night time periods.</td>
<td>Site noise levels below the relevant noise limits during all measurements at the nearest residential location (R5) and all privately-owned residences during the monitoring period.</td>
</tr>
<tr>
<td>28 July 2016 (day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 July 2016 (night)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 August 2016 (day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 September 2016 (day and night)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Air Quality

Dust generation during the activity was managed to meet the air quality criteria specified in Schedule 3, Condition 7 of the development consent as detailed in Table 8.

Table 8: Schedule 3, Condition 7 – Air quality criteria

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended particulate (TSP) matter</td>
<td>Annual</td>
<td>90 µg/m3</td>
</tr>
<tr>
<td>Particulate matter &lt; 10 µm (PM10)</td>
<td>Annual</td>
<td>30 µg/m3</td>
</tr>
<tr>
<td>Particulate matter &lt; 10 µm (PM10)</td>
<td>24 hour</td>
<td>50 µg/m3</td>
</tr>
<tr>
<td>Deposited dust</td>
<td>Annual</td>
<td>Maximum increase in deposited dust level - 2 g/m2/month</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum total deposited dust level - 4 g/m2/month</td>
</tr>
</tbody>
</table>

Monthly dust deposition sampling was completed prior to, during and after completion of the activity. Five monitoring locations were established – comprising four around the perimeter of the activity site and one adjacent to the R5 shearing shed. Samples were analysed monthly for soluble and insoluble solids.

Results

A summary of the dust deposition results is provided in Appendix D. The results indicate that no exceedance of the above criteria occurred during the 2016 activities.

3.5 Cultural heritage

As outlined in Table 2, an ACHMP was approved for the Balranald Project in April 2016.

In accordance with the ACHMP, the following measures were implemented prior to the commencement of the activity:

- bunting off (i.e. flagging) of subsurface salvage areas adjacent the activity site (including a 10-15m buffer) to avoid unauthorised access to the areas;
- surface artefact collection within and surrounding the activity site;
- provision of a safe storage area (on Country) for artefacts collected during the salvage activities; and
- all personnel working on the site were inducted prior to commencing work.

Figure 3.2 shows surface collection area and bunted off “no go” subsurface salvage areas in relation to the activity areas.
Figure 3.2: 2016 Annual Review – Surface Collection Locations within the Activity Site
They aims and objectives of the surface collection were to:

- Mitigate impacts by collecting a representative sample of Aboriginal objects in a controlled way;
- Provide a representative sample of Aboriginal objects which may be used for educational purposes or for additional lithic analysis;
- Provide a representative sample of dateable material which may be dated to provide additional chronological information regarding Aboriginal occupation of the project area; and
- Improve survey coverage in areas of moderate to high archaeological risk to be disturbed and mitigating future operational risk of unexpected high value heritage finds.

Plate 1 and 2 below provide two typical examples of the activity area where surface collection activities were completed.

Plate 1 and 2: General view of the activity area showing salt bush and residual soils

The salvage collection area was defined based on the disturbance footprint for the activity, and the boundaries of previously identified sites (Figure 3.2).

A systematic collection of a representative sample of surface Aboriginal heritage evidence was undertaken in accordance with the ACHMP.

The surface collection was completed over 4 days between 30 April 2016 and 3 May 2016. The collection was Clare Anderson (Niche), Kerrie Grant, Dr. Nicolas Grguric and Georgia Roberts who were accompanied by four representatives from the Registered Aboriginal Parities (RAPs) associated with the project (as outlined in the ACHMP). The field team was assisted by Iluka personnel Stephanie Mitchell and Andrew Tress.

The team walked the length and width of recorded Aboriginal sites spaced between 1 and 2 m apart and flagged any Aboriginal objects. Additional time was also provided for individuals to look and flag artefacts in and near the recorded boundary of a site.

Each Aboriginal object was flagged and then point-provenienced using a Trimble Differential GPS R8 Rover linked to a Base Station over Iluka’s survey mark ST4A, providing for the accurate provenience of artefacts within 5 cm on the x and y co-ordinate and 10 cm in the z co-ordinate. Each artefact was given a Unique Reference Number, and catalogued.

The catalogue of recovered Aboriginal heritage evidence, including cultural finds (such as stone artefacts, heat retainers, shell) and environmental samples (charcoal, soils, OSL) was incorporated into the Cultural Finds Register and Environmental Samples Register in the Balranald Project Aboriginal Heritage Database.
The catalogue identifies the Unique Reference Number for each piece of Aboriginal heritage evidence, where the Aboriginal heritage evidence was originally identified, its attributes and its current Box identification and storage location, who currently has custody of the Aboriginal heritage evidence and expected return dates.

The surface collection recovered stone artefacts, heat retainers and some non-artefact materials (pebbles). Thirty recorded Aboriginal sites were subject to surface collection with all but four isolated stone artefacts being relocated after a reasonable search.

A total of 576 items were collected. Of the 499 stone artefacts collected, 440 stone artefacts from 13 sites were subject to attribute recording. All items collected are currently stored On Country in a secure location.

The majority (approximately 70%) of artefacts subject to attribute recording were recovered from two main sites, with a further substantial portion (approximately 24%) coming from smaller two sites. The remaining nine sites all had less than 10 artefacts respectively, and account for only a small portion of the total collected.

Plate 3: Typical quartzite material from the activity area  
Plate 4: Typical granular silcrete material from the activity area

Results

Attributes of the artefacts collected from the area were examined macroscopically (i.e. visible to the naked eye without magnification) and under low-power (up to 20X) magnification. While macroscopic usewear was visible on some artefacts, there was no indication of well-preserved usewear or artefact edge-residues. Given the context of recovery from open sites, the presence of residues was unlikely. There were no obvious refitting artefacts noted during the collection or attribute recording and in such a small assemblage from a dispersed area it was considered that they are unlikely to occur.

In addition to the salvage, six hearths and burnt sediment features were sampled by archaeological excavation. Four of the six excavated features had indicators of cultural origins while two were concluded to be natural features. Only one of these features was conclusively cultural in origin and contained a charcoal sample.

A relatively small number of artefacts made up the collected sample however it is considered that the collection does provide some interesting results and characteristics for further consideration in future collection and sampling activities on site.

No suggested amendments to the ACHMP were recommended based on the results of the collection activities.
Aboriginal Cultural Heritage Working Group (ACHWG)

Schedule 3 Condition 19 of the consent for the project requires Iluka to “establish and maintain an ACHWG…to the satisfaction of the Secretary. The group must (a) be established….. prior to the construction of the West Balranald mine;

The activities undertaken during 2016 were an extension of bulk sampling activities commenced in 2015 and were not associated with the commencement of the construction of the West Balranald mine as approved by the SSD approval. As a result, the ACHWG for the project has not been established at this point time. Iluka will establish the ACHWG in accordance with the conditions of consent following internal confirmation of the timing for the commencement of the project.

3.6 Radiation

The development consent does not include specific performance criteria for radiation however environmental performance goals were established for the project (and activity) as described in the Radiation Management Plan (contained within the approved EMP). Table 9 details the environmental performance goals.

Table 9: Environmental radiation performance goals

<table>
<thead>
<tr>
<th>Radiation parameter</th>
<th>Radiation measured/method/equipment</th>
<th>Performance goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental gamma</td>
<td>Absorbed gamma dose rate in air - site boundary</td>
<td>&gt;0.10uSv/h above background</td>
</tr>
<tr>
<td></td>
<td>Absorbed gamma dose rate in air stockpile areas</td>
<td>&gt;0.50uSv/h above background</td>
</tr>
<tr>
<td>Environmental dust</td>
<td>Long-lived alpha emitters at dust deposition gauges</td>
<td>Two times background concentrations</td>
</tr>
<tr>
<td>Environmental Radon /</td>
<td>Passive radon monitors</td>
<td>Two times background concentrations</td>
</tr>
<tr>
<td>Thoron gas</td>
<td>Analysis of Ra-226, Ra-228 by scintillation counting by external laboratory</td>
<td>Two times background concentrations</td>
</tr>
</tbody>
</table>

In addition to environmental performance goals, the environmental radiation monitoring for the activity is also detailed in the RMP.

As per the RMP, the following environmental monitoring was to be completed during the 2016 operations:

- bi-annual measurements of gamma radiation levels at the site boundary;
- monthly analysis of dust samples collected for alpha activity analysis;
- quarterly analysis of groundwater samples collected for selected bores for activity concentration of selected radionuclides;
- Quarterly analysis of the radioactivity of surface water samples collected from the PWD for activity concentration of selected radionuclides;
- quarterly analysis of environmental radon concentration in air; and
- analysis of the thorium and uranium concentrations in ore and tailings.
Results

The purpose of the monitoring program is to ensure that radiological impact to the local environment and to members of the public is minimised.

Results show that reported groundwater radionuclide results for December 2016 are within historical baseline concentrations previously obtained for the wider project area, the results are also below the SSTL criteria in the approved GOMS.

PWD monitoring results for August and December 2016 indicate that radium-226 and radium-288 results are lower than that observed in groundwater from the Loxton Parilla Sands aquifer unit sampled prior to and also post mining trial activities. The results are also below the SSTLs criteria in the approved GOMS.

Table 10 provides a summary of the environmental radiation monitoring results. Table 11 provides a summary of the radionuclide sampling results in comparison to historical baseline data and guidelines.

Table 10: Summary of environmental radiation monitoring activities and results

<table>
<thead>
<tr>
<th>Radiation monitoring requirement</th>
<th>Summary of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bi-annual measurements of gamma radiation levels at the site boundary.</td>
<td>Surface gamma surveys were completed on a monthly basis during the course of the bulk sampling activity with all results less than performance goals. The final surface gamma survey was completed in December 2016.</td>
</tr>
<tr>
<td>Monthly analysis of dust samples collected for alpha activity analysis.</td>
<td>Samples have been collected and currently being analysed.</td>
</tr>
<tr>
<td></td>
<td>Based on the surface gamma results, considered highly unlikely that performance goals will not be met.</td>
</tr>
<tr>
<td>Quarterly analysis of groundwater samples collected for selected bores for activity concentration of selected radionuclides.</td>
<td>Groundwater radionuclide sampling was completed in December 2016. See Table 11 for results and comparison to baseline data.</td>
</tr>
<tr>
<td>Quarterly analysis of the radioactivity of surface water samples collected from the Process Water Dam (PWD) for activity concentration of selected radionuclides.</td>
<td>Radionuclide sampling of the PWD was completed in August and December 2016. See Table 11 for results.</td>
</tr>
<tr>
<td>Quarterly analysis of environmental radon concentration in air.</td>
<td>Radon track etch monitoring was completed for the three periods over the course of the bulk sampling activities. All results were recorded to be below regulation limits.</td>
</tr>
<tr>
<td>Analysis of the thorium and uranium concentrations in ore and tailings.</td>
<td>An X-ray fluorescence (XRF) on-stream analyser collected radiation data for materials just prior to the stacker (and then stockpile). Results were collated by the site process operating system software (CITECT) that monitors both the plant and mining systems.</td>
</tr>
</tbody>
</table>
Table 11: Summary of radionuclide sampling results in comparison to historical baseline data and guidelines

<table>
<thead>
<tr>
<th>Target Area</th>
<th>Reported Analysis Concentration Range</th>
<th>Baseline Concentration Range (obtained in 2014 and 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radium-226 (Bq/L)</td>
<td>Radium-228 (Bq/L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radium-226 (Bq/L)</td>
</tr>
<tr>
<td>Near-Mining Monitoring Wells – December 2016</td>
<td>0.021 to 0.118</td>
<td>0.057 to 0.351</td>
</tr>
</tbody>
</table>

Discussion: Results were below guidelines for Radium-226 however above guidelines for all locations for Radium-228 with the exception of UGM-M2D and UGM-M8D. Results were below SSTL criteria for all locations as per the GOMS.

<table>
<thead>
<tr>
<th>Target Area</th>
<th>Reported Analysis Concentration Range</th>
<th>Guideline comparison*</th>
<th>Comparison to SSTL**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radium-226 (Bq/L)</td>
<td>Radium-228 (Bq/L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWD – December 2016</td>
<td>Below detection &lt;0.034</td>
<td>Below detection &lt;0.093 Bq/L</td>
<td>Below guideline</td>
</tr>
<tr>
<td>PWD – August 2016 (filtered)</td>
<td>Below detection &lt;0.034</td>
<td>Below detection &lt;0.063 Bq/L</td>
<td>Below guideline</td>
</tr>
<tr>
<td>PWD – August 2016 (unfiltered)</td>
<td>0.027 ± 0.014</td>
<td>0.048 ± 0.025</td>
<td>Below guideline</td>
</tr>
</tbody>
</table>

Notes: * Screening criteria for Radium-226 is World Health Organisation (2011) guideline of 1 Bq/L and for Radium-228 is World Health Organisation (2011) guideline of 0.1 Bq/L.
** Site Specific Trigger Level (GOMS, 2016) criteria was 5 Bq/L for Radium-226 and 2 Bq/L for Radium-228 based on ANZECC (2000) Irrigation Water Guideline.

3.7 Weeds

During activities on site in 2016 the following weed management measures were implemented:

- implementation of the PLN1587060: Iluka Mining Trial Weed Management Plan;
- inspection and cleaning of vehicles, plant and equipment before entry to the site; and
- inspections of project work areas to identify potential weed infestations.

In addition, in January, April and September 2016 specialist services were engaged to survey and assess the distribution of noxious and environmental weeds at a number of sites within the project area.

The method implemented for each survey was as follows:

- visually survey and assess access tracks and work areas to create an inventory of weed species present;
- for each weed species identified, note its distribution within the project area; and
• treat identified weed incursions by either physical removal (chipping) or herbicide (spraying).

Results
Records of the weed survey and treatments completed in 2016 are maintained on Iluka’s internal document management system (TRIM).

4 ENVIRONMENTAL COMPLAINTS, INCIDENTS AND NONCOMPLIANCE

As per Iluka’s EHS Group Standard 12 – Incident Reporting and Investigation any incident, hazard, activity or near miss with the potential to effect the environment, community or health and safety of personnel is to be reported using the Iluka internal Loss Control Card (LCC).

Incidents include any unplanned event where control is lost such as dangerous occurrences, negative impacts to the environment, cultural heritage, property or equipment, and accidents or impairments to employees and contractors.

Incidents are classified according to the Iluka risk matrix and incident classification system; the level of which will determine corrective actions and whether contact with relevant regulatory authorities and/or an internal ICAM investigation (Incident Cause Analysis Method) is required.

Iluka also maintains a grievance mechanism, which allows external stakeholders to formally raise concerns with the company. All complaints are recorded, investigated and responded to in line the Iluka’s Stakeholder Complaint Reporting and Resolution Procedure. Those grievances of a specific risk classification are reported through to the executive and Iluka Board as part of monthly sustainability reports.

4.1 Environmental Incidents

Activities approved by the SSD-5285 development consent commenced in June 2016. In the period May – December 2016, a total of 25 environmental incidents were reported using Iluka’s LCCs. Table 11 provides a summary of the environmental incidents and their ranking. Appendix E contains further detail of the incidents including date, location and follow up actions.

Table 12: Summary of environmental incidents June – December 2016

<table>
<thead>
<tr>
<th>Incident type (and number)</th>
<th>Risk ranking</th>
<th>Incident type (and number)</th>
<th>Risk ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeds (potential) x 2</td>
<td>Low</td>
<td>Rubbish x 3</td>
<td>Low</td>
</tr>
<tr>
<td>Pests x 1</td>
<td>Low</td>
<td>Soil contamination x 1</td>
<td>Low</td>
</tr>
<tr>
<td>Resource wastage x 2</td>
<td>Low</td>
<td>Subsidence* x 1</td>
<td>Low</td>
</tr>
<tr>
<td>Vegetation damage x 1</td>
<td>Low</td>
<td>Spills** x 14</td>
<td>Low</td>
</tr>
</tbody>
</table>

* Discussed in further detail in section 4.3.1 below. ** Includes all spills e.g. drill muds, saline water, hydrocarbons < 100L.

4.2 Third Party Complaints

In the period June – December 2016 one third party complaint was received (September 2016) from a landholder who identified that an Iluka survey team had become bogged in their cropping area.

4.3 Regulatory Non compliance

No incidents relating in regulatory non-compliance occurred during 2016 on the Balranald Project.
4.4 Internal Non compliance

Two incidents occurred during the 2016 activities and were reported to NSW Government agencies. Neither incident was a non-compliance with approval conditions or approved management plan requirements however the incidents were reported. Further details on the two events are provided in section 4.4.1 and 4.4.2 below.

In addition, during the preparation of the 2016 Annual Review it was highlighted that collection of radionuclide data was not completed as identified in Table 9. Further discussion is provided in section 4.4.3.

4.4.1 Subsidence

The incident was first communicated (by phone) with NSW DRE and EPA on 26th July 2016. Following an internal review of activities and monitoring, further information was provided to both agencies (by written correspondence Iluka Trim reference 187750 and 187748) on 4th and 5th August 2016.

The incident involved isolated slumping adjacent to an installed injection well located above Stope 3. The event occurred post the mining of Stope 3 and affected an isolated area (approximately 2.0 metres in radius and 1.25m in depth) immediately surrounding the injection well.

A risk assessment followed the event and identified that the adopted control measures and identified actions would not result in any significant risk to the environment, public health, safety of employees or any other persons and that any risks both now and in the future will cause no acceptable detriment to the environment. The adopted control measures and actions included:

- Isolation away from site infrastructure and sensitive receivers;
- Establishment of exclusion zone around the affected area; and
- Continued aerial and groundwater monitoring.

Post mining survey activities proposed for 2017 (refer 5.2) will include the area of the isolated slumping event.

4.4.2 Groundwater pressure data

Whilst completing a review of 2016 groundwater monitoring data for the purposes of internal reporting and compliance reporting to government, Iluka became aware of a data anomaly between autonomous real time data (collected via vibrating wire piezometers) and recorded logger data (collected via monitoring bore data loggers) during activities of backfilling previously mined material underground.

Notification of the anomalous data was provided to NSW EPA, DRE and NSW Department of Planning and Environment (DP&E) via phone and email on 24th February 2017.

Iluka is currently reviewing the data associated with the event however it is not considered that the event was a significant incident or one that has resulted in material harm to the environment due to the limited duration and extent of the event.

Once the outcomes of the review are collated, Iluka proposes to provide further details to the respective agencies. It is anticipated that this information will be made available in June 2017.

Note: this incident is not included in the summary provided in section 4.1 as the reporting (using Iluka’s LCC) occurred in February 2017 as a result of data review.
4.4.3 Radionuclide monitoring

Groundwater

The approved EMP and RMP for the bulk sampling activities identified that the following groundwater monitoring would be undertaken:

- Quarterly analysis of groundwater samples collected for selected bores for activity concentration of selected radionuclides.

Upon review of all environmental monitoring data in preparation for the Annual Review it has been identified that during the course period between June – December 2016, only one groundwater radionuclide monitoring event (December 2016) was completed.

Although data from the July 2016 monitoring event is missing from the radionuclide data set, comparison of the December 2016 results with the baseline results (Iluka's pre mining, 2014 and 2015 data collections and analysis) indicate that the completion of the bulk sampling activities did not result in any elevated levels of radionuclides in the groundwater (as reported in this Annual Review). With no elevation in radionuclide levels, no impact to groundwater (associated with radionuclides) has been evident as a result of the 2016 activities.

5 PROPOSED ACTIVITIES 2017

5.1 Operations

During 2017 Iluka will continue to complete feasibility studies for the Balranald Project and as at the preparation of this Annual Report foresees limited site based activities, the site will remain in care and maintenance mode for most of 2017.

Details of the planned (as at 30 June 2017) site activities for 2017 are summarised in Table 12.

Table 13: Proposed 2017 care and maintenance activities

<table>
<thead>
<tr>
<th>Month</th>
<th>Site Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>Removal of water pipeline – 85% completed.</td>
</tr>
<tr>
<td>May</td>
<td>Site re-establishment activities.</td>
</tr>
<tr>
<td>June</td>
<td>Equipment testing (2 - 4 weeks only) – using the existing site infrastructure. No additional clearing or extraction activities proposed.</td>
</tr>
<tr>
<td>September / October</td>
<td>Commencement of pre clearance surveys – Corbens Long Eared Bat and Malleefowl. Cultural heritage collection and salvage (as may be required – based on risk and scope of clearing activities proposed for November / December).</td>
</tr>
<tr>
<td>November / December</td>
<td>Commencement of site clearing and preparation works.</td>
</tr>
</tbody>
</table>

5.2 Environmental monitoring

The approved EMP (and associated plans) was specific in their intent in that they were to be implemented during the completion of the bulk sampling activity.

As the site is currently in care and maintenance with no bulk sampling activities to be completed in 2017, it is proposed that limited environmental monitoring will be undertaken i.e. the monitoring outlined in the approved EMP (and associated plans) will not be implemented during 2017.

Table 14 details the proposed limited environmental monitoring for 2017. At this point, it is not proposed to revise the respective management plans to reflect the proposed monitoring for 2017.
Preparation of new and updated management plans (and submission for approval) will be undertaken to facilitate site activities as may be required for 2018.

Table 14: Proposed 2017 environmental monitoring

<table>
<thead>
<tr>
<th>Month</th>
<th>Proposed care and maintenance environmental monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>Weed inspection and treatment (as required).</td>
</tr>
<tr>
<td>May</td>
<td>Post mining subsidence survey.</td>
</tr>
<tr>
<td>June / July</td>
<td>Groundwater quality and depth (including selected radionuclide sampling at selected bores for activity).</td>
</tr>
<tr>
<td>September</td>
<td>Weed inspection and treatment (as required).</td>
</tr>
<tr>
<td>November</td>
<td>Post mining subsidence survey.</td>
</tr>
<tr>
<td>December</td>
<td>Groundwater quality and depth (including selected radionuclide sampling at selected bores for activity concentration).</td>
</tr>
</tbody>
</table>

6 IMPROVING ENVIRONMENTAL PERFORMANCE

Iluka strives to contribute positively to the communities in which it operates, maintenance of our Social Licence to Operate is imperative to the success of individual operations and the entire company. Iluka will continue to monitor the Balranald Project for potential issues or matters of local concern to ensure compliance with statutory approvals and approved management plans to improve the operations.

As an outcome of this Annual Review Iluka has identified the following opportunities to improve environmental performance:

- Consideration of more frequent review of monitoring data (during operations) particularly groundwater; and
- Development of an annual environmental monitoring schedule (for inclusion in revised future EMP) succinctly summarising all monitoring requirements.
APPENDICES

Appendix A: Subsidence Monitoring Results and Discussion
Appendix B: Groundwater Operating and Management Strategy Compliance Report
Appendix C: Noise Monitoring Reports
Appendix D: 2016 Dust Deposition Monitoring Results – Summary
Appendix E: Environmental Incident Summary (2016)
WEST BALRANALD TRIAL 2 - SURVEY AND SUBSIDENCE MONITORING REPORT

BACKGROUND

In late 2014 early 2015 Iluka Resources commenced the first phase of trial mining on a small portion of their West Balranald lease. This initial mining trial is now referred to as Trial 1 (T1). Both Mine Subsidence Engineering Consultants (MSEC) and Michael Nicholson Consulting (MNC) were part of the T1 team.

Background information on T1 was presented in the T1 Survey and Subsidence Monitoring Report that was prepared by MSEC and MNC in. This Trial 2 (T2) report is best reviewed in combination with the previously distributed T1 Survey and Subsidence Monitoring Report along with additional supporting documentation that is also included in the attached Appendices.

The project site is located approximately 30km NNW of the NSW township of Balranald. The landform is very flat, desert-like country with a generally sparse covering of low (<1m) saltbush as shown below in Figure 1 which is an aerial photograph looking directly across both the T1 / T2 project site. Apart from a sparse network of dirt tracks, prior to the commencement of Trial mining there was no infrastructure or improvements on the land (Project Site and immediate surrounds) that forms part of Karra Station.

Figure 1 – West Balranald Trial 1 / Trial 2 Project Site
REVIEWS OF TRIAL 1 SURVEY AND SUBSIDENCE MONITORING REPORT

The key findings from the Trial 1 report can be summarised as:

- It was difficult to make accurate subsidence predictions due to the proposed new mining method and the uncertain / variable properties of the alluvial overburden (predominantly Shepparton Formation). Existing underground coal mining empirical subsidence data was regarded to be of little use given vastly different geological properties involved.
- Assuming the Shepparton formation did not span over the mined voids, the original maximum subsidence prediction of 600mm for the extraction of four adjacent cavities was considered to be a ‘conservative upper bound’ estimate.
- It was suggested that the prediction could be lower because of presence of stiff overlaying clay layers within the Shepparton Formation that could be capable of arching over small extracted voids.
- MSEC suggested that a range of geological and mining / backfilling variables would contribute to the observed subsidence result and ongoing subsidence monitoring and research was required as the extent of mining developed before more accurate predictions could be developed.
- T1 mined volumes and the “as mined” void widths were considerably less than those initially planned and predicted for.
- The pre mining T1 assumed mined voids were four adjacent cavities or voids of 30 metres by 12 metres separated by unmined sand pillars that were to be only 10 metres wide. The initial report suggested that the extraction of one of these voids may result in a maximum subsidence of 200 mm, but, to date not one of the mined voids in T1 or T2 has been mined to this extent.
- The backfilling (re-injection) process has also proved to be successful in reducing the magnitude of subsidence on the surface.
- Maximum observed subsidence after T1 was 57mm. This significantly reduced observed subsidence is likely to be a function of; the less than planned extraction with partial backfill and significantly reduced void width sizes and the presence of stiff clays that appear to be arching over the mined voids.
- The observed 20mm subsidence contour(s) over the Stope 1 to 3 area extended beyond a 45° angle of draw (AOD). However, due to the achieved survey accuracy for T1, the plotting of very small magnitude subsidence values becomes increasingly unreliable (refer to T1 recommendations below).
- T1 extracted ~1700 tonnes with ~300 tonnes backfilled. The net volume extracted of ~1400 tonnes represents ~700 m³ (after adopting a mean specific gravity of extracted material of 2).
- Notwithstanding the accuracy issues (noted above) associated with measuring very small subsidence values, the indicative total volume of observed subsidence bowl was ~900 m³. Hence, the extracted mineral ore volume approximately equalled the subsided volume on the surface and the difference can be attributed to the reduced density of the overburden strata layers.
- The low levels of observed subsidence had little to no impact on the farming land and topography of the Karra Station.

In addition to the key findings summarised above there were also some recommendations that were agreed upon to improve the survey monitoring of future trials:

- Future subsidence surveys should aim at providing greater accuracy in order to better detect the significantly lower levels of subsidence that can now be expected.
- Survey monitoring should also aim at understanding the background environmental ground movements at both the project site and locations remote from site (1 – 4km).
These two improvements to the survey monitoring were proposed to:

1. Increase the ability for monitoring surveys to accurately define the magnitude and extents of subsided ground, particularly where only small movements are involved.
2. Determine what the ‘normal’ seasonal range of non-mining, environmental ground movements are and, perhaps more importantly, what are the ground movements associated with significant rain events.

TRIAL 2 SUBSIDENCE SURVEY SCOPE

Proposed Trial 2 Mining Extents

T2 mining was planned to take place in two separate locations:

1. Within the original T1 footprint referred to as Stope 1 – 3 (T2 mined Stopes 1B and 3).
2. Stope 4 - new area approximately 470m Southeast of Stope 1 – 3 location.

Figure 2 below shows Iluka Plan **WBAL-G01 229602 rev3**, which details the ‘as-mined’ layouts for T1 and the T2 Stopes 1,1B, 2 and 3, plus the proposed maximum extraction extent for Stope 4.
Figure 2 – Trial 2 Mining Layouts including plan of geotechnical monitoring instrumentation locations.
Survey Monitoring Point Layout

As the Stope 1 – 3 area was essentially unchanged from T1, the same survey points were used for the T2 monitoring. As discussed in the T1 Survey and Subsidence Monitoring Report, the survey monitoring network was originally optimised to provide:

- very high density monitoring points (10m X 10m grid as shown in yellow in Figure 3 below) over an area 200m x 200m centred directly above the Stope 1 – 3 cavity site, and
- a 20m x 20m grid extending a further 100m in all directions around the very high density monitoring points and these 20m x 20m points are shown in cyan in Figure 3 below), and
- a 40m x 40m grid extending a further 200m in all directions around the 20m x 20m grid points, as shown in cyan in Figure 3 below.

The only real changes to the Stope 1 – 3 monitoring network used for T2 was that approximately 100 of the 10m X 10m grid points directly over the cavity site were destroyed during preparatory works for T2 and hence these had to be replaced. The other slight change was that the Stope 4 access road, new perimeter fencing and other minor surface works destroyed a small number of points, many of which were not replaced because of risk of further disturbance (i.e. points that fell on access roads or high traffic areas were not re-instated).

The new monitoring network installed for Stope 4 was optimised based on the data captured on the Stope 1-3 network during T1.

The key refinement was that the very high density 10m x 10m grid of monitoring points directly over the proposed Stope 4 cavity site was reduced to a 20m x 20m grid of ground points supplemented by a higher density of ‘fixed prism’ monitoring points located along the centreline of proposed Stope 4 extraction. Beyond the 20m grid of points was a 40m x 40m grid which merged seamlessly with the existing 40m grid that formed part of the original (and T2) Stope 1 – 3 network (refer to Figure 4 below for plan of Stope 4 monitoring point layout).
The total monitoring network for the combined Stopes 1 – 3 and Stope 4 areas had nominal extents of 1150m x 800m and consisted of approximately 1250 discrete monitoring points (refer to Figure 5 below for overview of entire T2 survey monitoring network).
Far Field Survey Monitoring

As per the recommendations from the T1 report, as detailed above, a network of well distributed remote (‘far field’) points were established. This far field monitoring point network comprised a total of seven points:

- STN4A, which was located within 250m of Stope 1-3 cavity site;
- 4 points located 1.3km to 2 km from cavity site, 2 of which were located over the ore body and the other 2 were approximately perpendicular from the alignment of the mineral ore body; and
- 2 points ~4km from the cavity site, 1 over the ore body and 1 nominally square off the ore body

The aim of the far field monitoring network was to get a better understanding of any ambient (natural) environmental ground movement fluctuations that may be occurring seasonally or due to extreme rain events and also to confirm that the mining activities themselves did not contributed to any far field ground movements. Figure 6 below shows the nominal layout of far field monitoring network.

Continuous GNSS Based Monitoring

In addition to the conventional survey monitoring outlined above, the opportunity was also taken to benchmark the performance and reliability of some new technology - continuous GNSS based ground measurement units.
The Continuous GNSS monitoring network comprised:

- 3 X GNSS monitoring units deployed to log continuous ground movement data for a 3-month period between late August (pre-mining) and late November 2016 (~3 months post mining);
- 1 Unit (known as GNSS00) located at local site base station - STN4A (refer to Figure 7 below); and
- 2 X Units (GNSS01 and GNSS02) located directly over Stope 4 centreline, nominally 25-30m apart

Approximate MGA / AHD coordinates are provided for each of the 3 units however the measured/reported parameters are: ‘change’ in 3D position (i.e. ∆E, ∆N, ∆Ht) with a relative accuracy of ±3mm 3D @ SD1.

Primary aim of continuous units was to determine rate and duration of any ground movements.

UAV Based Monitoring

Another key piece of new technology adopted for T2 was the use of UAV based ground mapping.

An extensive baseline dataset of ground positions was captured in May 2016 prior to the commencement of T2 extraction. This baseline dataset was survey controlled and thus suitable to be used to generate a spatially correct Digital Terrain Model (DTM) of the entire project site along with a fully rectified high resolution orthophoto (5cm GSD).

The post-mining DTM surface(s) were compared directly to the pre-mining ‘base’ DTM surface to accurately quantify the ground deformations and immediate surrounds.

Control

To increase the overall survey accuracy (refer T1 recommendations above) the key refinement adopted was to increase the accuracy of the survey control framework (the largest survey error component in T1 was the derivation of site control from the Balranald CORS Station). For T2 essentially the same survey infrastructure was carried over from T1, however, the key difference was that a local site base station was established (STN4A) and this base station operated continuously for the entire duration of T2 survey monitoring. The control values for this local site base station were independently verified daily using Geosciences Australia’s AusPos facility. As a result of these refinements the accuracy of the survey control went from:
< ± 20mm 3D @SD1 achieved on T1
< ± 10mm 3D @SD2 for T2

As per T1 all survey work was performed on:
- Map Grid Australia (MGA) Zone54, Geodetic Datum of Australia 1994 (GDA94);
- Australian Height Datum (AHD), utilising the latest Ausgeoid09 gravity model; and
- → MGA54 / AHD09

Note: During the course of the T2 survey works it came to light that the coordinate system originally set up for the then named Balranald BHM Project (prior to MNC Pty Ltd involvement) and used by Iluka for both T1 and T2 is only an approximation of true MGA54 / AHD. Preliminary check surveys by MNC indicated that this ‘Site Coordinate System’ differed from true MGA54 / AHD by approximately:

ΔE -1.7m  ΔN +1.6m  ΔHt -0.07m

This small difference in coordinate systems is not ideal, however, the issue was identified, communicated to the Iluka Management team, documented and successfully managed for the duration of the Trials.

TIMELINE OF TRIAL 2 MINING / MONITORING

Key Survey Dates
- 20/05/16 – Baseline UAV data capture of entire T2 project site (including Stope 4)
- 27/05/16 – Baseline monitoring survey over original Stope 1 – 3 area
- 28/05/16 – Baseline survey of Far Field monitoring network
- 05/06/16 – Mining commenced Stope 1B
- 17/06/16 – Mining complete Stope 1B (including initial water based backfill trials)
- 07/07/16 – Mining commenced Stope 3
- 18/07/16 – Mining complete Stope 3
- 23/07/16 – Interim (Scaled down) post-mining monitoring survey of subset of points in Stope 1-3 area
- 24/07/16 – First post-mining survey of Far Field monitoring points
- 18/08/16 – Baseline monitoring survey over Stope 4 network
- 21/08/16 – Installation and commencement of logging of Continuous GNSS units
- 22/08/16 – Mining commenced Stope 4
- 29/08/16 – Mining complete Stope 4
- 01/09/16 – Commence further backfill operations
- 05/09/16 – Interim post-mining monitoring survey of subset of points in Stope 4 area (fixed prisms only)
- 15/09/16 – Completion of backfill operations
- 19/09/16 – Follow-up UAV Survey of Stope 1 – 3
- 20/09/16 – Follow-up interim post-mining monitoring survey of subset of points in Stope 4 area
- 22/11/16 – 3 months post-mining Far Field network survey
- 23/11/16 – 3 months post mining Stope 4 network survey (full survey / all points)
- 24/11/16 – 3 months post mining Stope 1 – 3 network survey (full survey / all points)
- 25/11/16 – Finalise post mining surveys and recovery of Continuous GNSS units
Mined / Backfilled Volumes

UAV based Volumetric Surveys were performed on the mineral ore stockpile at three epochs: following T2 mining of Stopes 1B & 3, following T2 mining of Stope 4, following completion of backfill operations. The accuracy of the measured volumes referenced below could be even further enhanced if stockpile ‘base’ surface information was available.

1. Ore Stockpile Volume after mining Stope 1B & 3
   ~1900 m$^3$ → 3800 tonnes (assuming specific gravity of 2.0)

![Figure 9 – Plan and Isometric views of Ore Stockpile after Stopes 1B & 3](image)

2. Ore Stockpile Volume after mining Stope 4 (including existing Stope 1B & 3 material)
   ~3600 m$^3$ → 7200 tonnes (i.e. additional ~1700 m$^3$ / 3400 tonnes from Stope 4)
3. Ore Stockpile Volume after completion of post-mining backfill operations
   ~3250 m³ → 6500 tonnes (i.e. approximately 350 m³ / 700 tonnes ore material backfilled)

SURVEY MONITORING RESULTS

This summary of survey monitoring results primarily focuses on the comparison of pre-mining baseline survey data with the (nominally) 3 months post-mining datasets.

For both the Stope 1 – 3 and Stope 4 areas a number of small ‘interim’ post-mining surveys were also conducted at various timings starting from immediately after mining. In all cases these interim post-mining surveys involved the survey of a relatively small number of survey points (subset) within the broader survey network. The aim of these scaled interim surveys was twofold:

1. To provide information on the rate at which ground deformations developed over time; and
2. To understand indicative magnitude and extent of ground deformations such that Site Management could manage the access risks to cavity areas whilst the project proceeded.
Survey Results Data

Comprehensive survey monitoring results were distributed in Excel Spreadsheet format, and typically included; tabular coordinate listings, layout plans, subsidence contour plans, and summary comments. For T2 there were a total of 5 separate finalised results spreadsheets issued:

- West Balranald_Trial2_Stope1-3_FinalSurvey Results_v01.xlsx
- West Balranald_Trial2_Stope4_FinalSurvey Results_v01.xlsx
- West Balranald_Trial2_Stope1-3_UAVSurvey Results_v01.xlsx
- West Balranald_Trial2_FarField_FinalSurvey Results_v01.xlsx
- West Balranald_Trial2_Stope4_ContinuousResults_v00.xlsx

In addition to the 5 finalised results spreadsheets there were a number of Interim Results issued at various stages during T2.

The Table 1 below summarises the key subsidence parameters derived from the survey results. For full details on monitoring surveys refer to results spreadsheets referenced above. Note that a column has been included which indicates the cumulative subsidence observed over the original Stope 1-3 area (i.e. the addition of the subsidence measured after T1, plus, the additional subsidence measured over the same area after T2.

<table>
<thead>
<tr>
<th>Subsidence Parameter</th>
<th>Trial 2 (T2) Only</th>
<th>Cumulative of T1 + T2</th>
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<tr>
<td></td>
<td>Stope 1-3 Area</td>
<td>Stope 4 Area</td>
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<tr>
<td>Maximum Subsidence</td>
<td>-100mm *</td>
<td>-23mm</td>
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<td>Maximum Tilt</td>
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<tr>
<td>Subsided Volume</td>
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<tr>
<td>Upsidence Area</td>
<td>~3000 m²</td>
<td>–</td>
</tr>
</tbody>
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The sub sections below include comments taken directly from the ‘Summary’ tab of the applicable results spreadsheet along with associated Figures depicted subsidence contours.

Stope 1-3 Area

Ground Survey - 23/07/2016 (Scaled down Interim Survey - Nominally 1 month post-mining)
Ground survey was performed over 121 point Interim (Scaled) point network.
Relatively low level ground movement observed between pre-mining (May 2016) and initial post-mining survey (23 July 2016 - immediately after mining).
Ground movements that were detected were generally very localised to a zone immediately above Cavity 1B and Cavity 3.
Maximum observed vertical subsidence was 107mm.
Maximum observed horizontal ground movement was 57mm.

UAV Survey - 6/09/2016
UAV survey was performed over both the broader Stopes 1-3 exclusion zone
The full site (pre-mining) UAV survey performed in May 2016 was used as the baseline surface for ground deformation comparisons.
Little to no additional (to the ground survey of 23/07/16) subsidence was detected across the broader Stope 1-3 exclusion zone.

**UAV Survey - 19/09/2016**
Additional UAV survey was performed over both the broader Stopes 1-3 exclusion
The full site (pre-mining) UAV survey performed in May 2016 was used as the baseline surface for ground deformation comparisons.

**Ground Survey - 24/11/2016 (Full Post-Mining Survey)**
Ground survey was performed over the entire ~990 point network (full survey).
As per the Interim post-mining survey, relatively low level ground movements were observed between pre-mining (May 2016) and the full post-mining survey (24/11/16).
Two relatively localised areas of ground movement (deformation) were clearly identified:
- an area of subsidence directly above the Cavity 1, 1B, 2 and 3 extraction zones (maximum subsidence observed ~100mm)
- an area of upsidence (upswell) most notable SSE of Cavity 3 extraction zone (maximum upsidence observed ~60mm)

The deformation areas noted above are highly accurate and were both defined by a large number of points which are all indicating very consistent trends.
Using the point information, deformation contours have been produced using a 10mm contour interval. These contours are very effective at illustrating the magnitude and extent of the ground deformations.

Note: No measurable movement (i.e. movement above stated survey tolerances) was observed beyond the extent of the deformation contours plotted.
Figure 11 – Trial 2 Deformation Contours over Stope 1 – 3 Area
Ground survey performed of all 12 points in fixed prism ground survey network. Relatively low level ground movement observed between pre-mining (August 2016) and initial post-mining survey (5th September 2016 - immediately after mining). Ground movements that were detected were highest immediately above Stope 4 cavity (as expected) and reduced progressively as a function of distance from cavity. Maximum observed vertical subsidence was 26mm. Maximum observed horizontal ground movement was 15mm. There were little to no measurable horizontal ground movements observed.

UAV Survey – 6/09/2016
UAV did an aerial surveillance flight over Stope 4 on 6th of Sept and noted ponded water on much of site indicating ground surface in tact

Fixed Prism Survey - 19/09/2016
Ground survey performed of all 12 points in fixed prism ground survey network. Relatively low level ground movement observed between pre-mining (August 2016) and second post mining survey performed 19/09/2016. Essentially no additional ground movement observed between initial post-mining survey of 5/09/2016 and most recent survey of 19/09/2016. Ground movements that were detected were highest immediately above Stope 4 cavity (as expected) and reduced progressively as a function of distance from cavity. Maximum observed vertical subsidence was 19mm. Maximum observed horizontal ground movement was 15mm.
There were little to no measurable horizontal ground movements observed.

**Interim Ground Point Survey (scaled survey only) - 20/09/2016**
In addition to the 12 point fixed prism survey a further ~40 ground survey points within the exclusion zone were also measured.
Results of this survey were consistent with prism survey and indicated low levels of subsidence reducing rapidly as a function of distance from Stope 4 centreline.
One point (5061) was clearly disturbed and results for this point disregarded.
Note: temporary 5000 series labels used for ground points. Their full labels will be used for the full post-mining survey.
Maximum observed vertical subsidence was 19mm.
Maximum observed horizontal ground movement was 15mm.
There were little to no measurable horizontal ground movements observed.

**Ground Survey - 22/11/2016 (Full Post-Mining Survey)**
Ground survey performed over the entire ~300 point network (full survey - fixed prisms and entire ground point network).
5000 series point labels have been retained for consistency rather than moving to the previously (Stope 1- 3 Area) adopted 20.* series labels.
As per the Interim post-mining survey, only very low level ground movements were observed between pre-mining (Aug 2016) and the full post-mining survey (Nov 2016).
The only measurable ground deformation detected was an area of very low subsidence (~20mm) along the centreline of the Stope 4 extraction zone.
The subsidence zone reduced quickly as a function of distance from the extraction zone. The 10mm subsidence contour is approx. 25m - 30m from edge of Stope 4 cavity.
There were little to no measurable horizontal ground movements observed.

Note: No measurable movement (i.e. movement above stated survey tolerances) was observed beyond the extent of the deformation contours plotted.

It should also be noted that the observed ground movements occurred immediately after mining with no additional deformation observed over the ensuing 3 months.
(Refer to West Balranald_Trial2_Stope4_ContinuousResults_v00 spreadsheet for further details on timing of observed movements over Stope 4).
Far Field Survey

Ground Survey - 28/05/2016 (Pre-mining Base Survey)

Ground Survey - 24/07/2016 (Post-Mining Survey Stopes 1-3)
No measurable movement observed at any point within the Far Field survey network.

Ground Survey - 22/11/2016 (Post-Mining Survey - ~3 months after completion of all mining (inc Stope 4))
No measurable movement observed at any points within the Far Field survey network.

REVIEW OF OBSERVED vs PREDICTED SUBSIDENCE

The T1 Survey and Subsidence Report referenced above included an extensive discussion on the significantly reduced magnitude of subsidence observed (57mm) relative to the 'conservative upper bound' subsidence prediction of up to 600mm. The report noted that there are likely to be a range of factors influencing subsidence effects measured; geology over overburden, particularly the presence of stiff clay layers within the Shepparton Formation, the size and geometry of the extraction cavities, quantity and distribution of backfill material re-injected into cavities, size and geometry of resultant / remnant voids, interplay between any adjacent voids, aquifer pressures (both during mining and after return to natural state), and time.
For T2 these same factors were all pertinent and in many cases considerable effort was made to gain a better understanding of each of the factors e.g. review of core samples to better map lithology, 2D / 3D seismic surveys to help identify / quantify remnant voids and extent of strata disturbance (refer to separate T2 Seismic Reports prepared by HiSeis), accurate volume measurement of extracted and backfilled ore, addition of many more geotechnical monitoring instruments (piezometers, extensometers, inclinometers, etc..), significant increase in survey monitoring sensitivity (accuracy), addition of Far Field survey network to better understand background environmental effects.

Despite only low levels of observed subsidence for T1 it was considered prudent to maintain the same conservative subsidence prediction value(s) for T2.

The T2 mining within the Stope 1 – 3 Area provided an excellent opportunity to gain significant understanding on how blocks of adjacent cavities / voids may influence the magnitude and extent of resultant subsidence. In addition, there was also the influence of remnant voids from T1 mining in the same area 12 months prior.

The mining of the isolated Stope 4 area (no previous mining) provided an ideal comparison to the multiple adjacent cavity / void scenario of Stope 1- 3 area. It should be noted that during T2 similar (total) volume of ore was extracted from both areas; 3800 tonnes (1900m³) from Stopes 1B and 3, 3400 (1700m³) tonnes from Stope 4. Also note that approximately 1700 tonnes (850m³) of ore was extracted from Stopes 1 and 2 during T1 (early 2015).

The T2 monitoring data showed clear evidence that the proximity of neighbouring voids did have a significant impact on some subsidence effects but made little difference on others:

- Maximum subsidence Stope 1- 3 Area >100mm  vs  23mm for Stope 4
- ‘Footprint’ of subsided area only slightly larger for Stope 1- 3 area 4650m² vs 4250m² for Stope 4
- Angle of Draw (AOD) essentially the same for both areas - 20°
- Maximum Tilt Stope 1- 3 Area 0.5° vs < 0.1° (both very small)
- Nominal subsided volume Stope 1- 3 Area 200m³ vs 60m³ for Stope 4

Based on the comparative data above it can be reasoned that the likely interaction of the adjacent cavities / voids at Stope 1 – 3 area has led to joining of at least some of the adjacent voids resulting in a steeper and deeper subsidence trough. These combined void space(s) have potentially reached a size where stiffer overlaying clay layers in the strata above are less able to ‘arch’ over the larger voids below.

At Stope 4, where there were no remnant or adjacent cavities, the area subsided (and therefore AOD) was almost exactly the same as observed at Stope 1 – 3, however, the subsidence trough was relatively very shallow. This tends to indicate that the stiff overlaying clays are (currently) capable of arching across (spanning) the singular Stope 4 cavities.

It seems reasonable to presume that the ability of the overburden at the Trial sites to arch across cavities / voids is a function of the size of the combined void and the stiffness of overlaying clay layers. Interestingly the seismic survey identified that the height of overburden disturbance over the NW portion Stope 4 was significantly lower than determined over the SE portion of Stope 4. This increased height of disturbance above otherwise relatively similar cavities may suggest localised variability in overlaying clay stiffness (i.e. weaker clay layers above SE portion). Interestingly surface subsidence was also higher over the SE extent of Stope 4.
# It is noted that as with all previously mined stopes, the extraction of each stope involves a series of smaller extractions along the same longitudinal alignment – Refer Figure 2 above for as-mined plan for Stope 1 – 3 area and Figure 13 above for indication of as-mined Stope 4.

The cumulative subsidence effect over the Stope 1 – 3 area was also analysed (i.e. combined subsidence from T1 and T2). The concept of the combined effect of adjacent, co-joined voids is perhaps further evidenced by looking at the cumulative data which compares the October 2014 pre-mining (T1) surface with the November 2016 - 3 months post-mining (T2) data.

The analysis reveals that there has been a total of 190mm of subsidence, an AOD of 30°, Maximum tilts 1.0°, a subsided area of >10,000m² and a subsided volume of 600m³. These parameters are all around two times larger than those measured over the same area for T2 only.

Given the relatively small extraction achieved during T1, it appears that relatively small increases in cumulative void spaces can have a very significant impact on the ability of overlaying clays to arch over these voids. This proposition is consistent with the general properties associated clays and other alluvial materials. Time may also be an important factor in the cumulative scenario as well.

At both the Stope 1 – 3 area and the subsequent Stope 4 area, scaled back interim subsidence surveys were performed within days of completion of extraction. These interim surveys directly after mining definitively showed that surface ground deformation (subsidence) occurred immediately. In all cases there was no additional subsidence measured between the interim surveys undertaken directly after mining and the full surveys performed >3 months after mining. If anything, small ‘recoveries’ in surface deformations were observed in the ensuing 3 months.

The Continuous GNSS monitoring units installed over Stope 4 concur with these findings. They indicated subsidence started within ~24 hours of commencement of extraction and likewise ceased within ~24 hours completion of mining. These units also showed evidence of a small recovery / reduction in subsidence over the week following the completion of mining. These relatively small upward ground movements may be associated with backfill operations and aquifer pressure variations.

An area of up-swell (upsidence) was very clearly identified immediately SE of the Stope 1-3 cavity area. A considerable number of survey points all showed a consistent upward trend. This area of up-swell falls along the ore body down dip from the Stope 1 – 3 cavity site. This area is also a low point within its immediate surrounds. It is presumed this area has swelled in response to aquifer pressurisation and / or backfill operations. It should be noted however that a number of very significant rain events occurred during T2 and the months after resulting in an unseasonally wet Winter / Spring. It’s difficult to determine what if any contribution these conditions may have made to the observed up-swell.

The far field network of points was installed and monitored to gain an understanding of what the level background, environmental ground movement might be. The network was designed to monitor points at various distances (1 km – 4 km) from the project site, both along the alignment of the ore body and square off the ore body. At the ±10mm level no ground movements were detected at any stage for any of the 7 points within the far field network.

T2 survey monitoring data has clearly shown that ground deformations are restricted to a very localised area almost directly above the extraction zones (20° - 30° AOD) so it was not expected to observe any mining related movements at these far field points. It was however, somewhat surprising not to show at least some environmental movement, especially considering the numerous rain events that occurred during the almost 6 month monitoring period.
Groundwater Operating Strategy Compliance Report

2016 Balranald Mining Trials, Murray Basin, New South Wales

Prepared for
Iluka Resources Limited
11 Dequetteville Terrace
Kent Town, SA, 5067

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1 INTRODUCTION

Land & Water Consulting (LWC) was engaged by Iluka Resources Limited (Iluka) to review groundwater data collected during Iluka’s 2016 mining trial at the West Balranald mineral sands project, in New South Wales (NSW) (the Site).

The approved Groundwater Operating and Management Strategy (GOMS) for the Site (Iluka 2016a), states that as part of the administrative arrangements, a compliance report will be prepared by 15 March each year, with the reporting period being 1st January to 31st December of the previous year. The compliance report requires the groundwater data to be assessed against the Site Specific Trigger Levels (SSTLs), including a summary of the water usage. An aquifer trend assessment has also been undertaken.

1.1 PROJECT BACKGROUND

An extensive field program involving the installation and monitoring of groundwater infrastructure was undertaken to assess the impacts on groundwater systems at the Site, as a response to Iluka’s second phase of the mining trials. A location map of the monitoring wells that form part of this compliance report is shown in Figure 1.

The mining trial, from a hydrogeological-perspective, involved the simultaneous abstraction of groundwater from the Loxton Parilla Sand-hosted aquifer (LPS Aquifer) and high-pressure reinjection into the same groundwater system. Mining trials began in April 2016, with backfilling trials being completed by mid-September 2016.

1.2 COMPLIANCE REPORT OBJECTIVES

The objectives of the compliance report is to:

- Tabulate water usage throughout the trials;
- Collate all data during the reporting period;
- Compare both groundwater pressure and chemistry data against the Site Specific Trigger Levels (SSTLs); and
- Conduct an aquifer trend assessment.

1.3 COMPLIANCE REPORT SCOPE

To meet the above objectives, the scope involves:

- Collate and present groundwater pressure data collected both in the field and derived from data-loggers and highlight any SSTL breaches using Microsoft Excel;
- Tabulating all chemical field and laboratory data collected during the trial phase, and highlight any SSTL breaches using Microsoft Excel; and
- Build a trial specific database and use the WISH software to produce aquifer plots to facilitate an aquifer trend assessment.

**Figure 1: Site layout and well location map**
2   WATER USAGE

The GOMS requires that all water usage throughout the reporting period (2016 calendar year) be recorded and documented within a compliance report. A summary of the water usage is shown in Table 1 for the two main production wells utilised.

The Karra Homestead well, which was completed in the Olney Formation in 2014, supported dust suppression and track maintenance during the reporting period. A total volume of 566 kL (~0.6 ML) was extracted from this well.

The UGM-P2 production well, which is completed in the LPS, was used to support the mining trials during the second half of 2016. This well was constructed in early 2016, and is located adjacent to the south-west corner of the PWD. A total volume of 18,818 kL (~19 ML) was extracted from UGM-P2.

Prior to the installation of UGM-P2, an existing production well (termed UGM-P1) was used to support the mining trials, and is also screened across the LPS. UGM-P1 was constructed as part of the historical groundwater trials at Balranald during the early 2010s', and is also known as LPSPB04 within Iluka’s database. The well is located directly east of Stope 4 (refer to Figure 1). Although no extraction data exists for this well, it was only used to top-up the PWD prior to the mining trials commencing (per comms. Principal Mining Engineer- Mrs Rathy Brandes de Roos, 9 March 2017) and thus it is expected that less than 3 ML had been used.

* A total groundwater usage of around 23 ML was used during the reporting year to support the mining trials at Balranald.

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<td>21-May-16</td>
<td>24,233</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Jul-16</td>
<td>24,520</td>
<td>287</td>
<td></td>
</tr>
<tr>
<td>17-Jul-16</td>
<td>24,644</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>12-Aug-16</td>
<td>24,686</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>25-Aug-16</td>
<td>24,726</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>22-Sep-16</td>
<td>24,799</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td>566</td>
</tr>
<tr>
<td>UGM-P2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Jul-16</td>
<td>87,853</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13-Jul-16</td>
<td>88,714</td>
<td>861</td>
<td></td>
</tr>
<tr>
<td>12-Aug-16</td>
<td>97,996</td>
<td>9,282</td>
<td></td>
</tr>
<tr>
<td>25-Aug-16</td>
<td>101,160</td>
<td>3,164</td>
<td></td>
</tr>
<tr>
<td>8-Sep-16</td>
<td>106,671</td>
<td>5,511</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td>18,818</td>
</tr>
</tbody>
</table>
3 SSTL & TREND ASSESSMENT

3.1 SSTL FRAMEWORK

The GOMS (Iluka, 2016a) outlines a set of hydraulic (Table 2) and water quality (Table 3) SSTLs for each aquifer unit, applicable to both field and laboratory data. Derivation of the SSTL’s are based on baseline groundwater chemistry, the beneficial users of each aquifer, and a factor that acknowledges temporary variations are expected during the mining trials. Further information on SSTL derivation is provided in the GOMS companion report (Iluka, 2016a).

The type and urgency of management responses, triggered by a SSTL breach, corresponded to a three-tiered management framework, further defined in the GOMS (Iluka, 2016a). This approach allowed for early and rapid intervention of possible groundwater contamination and geological instability (i.e. hydraulic fracturing).

The review as documented in this report, compares the data sampled from the monitoring well network throughout the 2016 calendar year, and compares to the SSTLs documented in Table 2 and Table 3. Assessments of both field derived and laboratory data have been completed.

Table 2: Hydraulic SSTL

<table>
<thead>
<tr>
<th>SSTL Parameter</th>
<th>Shepparton Aquifer</th>
<th>Loxton Parilla Sands Aquifer</th>
<th>Lower Renmark Group Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Depth to Groundwater (Mounding Impacts)</td>
<td>&gt; 8 mBGL</td>
<td>≤ 8 to &gt; 6 mBGL</td>
<td>≤ 6 mBGL</td>
</tr>
<tr>
<td>Depth to Groundwater (Dewatering Impacts)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### Table 3: Water Quality SSTL

<table>
<thead>
<tr>
<th>Water Quality Parameter</th>
<th>Adverse risk to Beneficial Users</th>
<th>ANZECC Irrigation Water Guideline</th>
<th>Shepparton Aquifer</th>
<th>Loxton Parilla Sands Aquifer</th>
<th>Lower Renmark Group Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LTV</td>
<td>STV</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>Upper pH bounds</td>
<td>Direct</td>
<td>9</td>
<td>N/A</td>
<td>&lt; 8.78</td>
<td>≥ 8.78</td>
</tr>
<tr>
<td>Lower pH bounds</td>
<td>Direct</td>
<td>4</td>
<td>N/A</td>
<td>&gt; 5.60</td>
<td>≤ 5.60</td>
</tr>
<tr>
<td>Total Alkalinity (mg/L CaCO₃)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 628</td>
<td>≥ 628</td>
</tr>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 64474</td>
<td>≥ 64474</td>
</tr>
<tr>
<td>Ca (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 1112</td>
<td>≥ 1112</td>
</tr>
<tr>
<td>Mg (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 3219</td>
<td>≥ 3219</td>
</tr>
<tr>
<td>Na (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 23586</td>
<td>≥ 23586</td>
</tr>
<tr>
<td>K (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 141</td>
<td>≥ 141</td>
</tr>
<tr>
<td>SO₄ (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 8254</td>
<td>≥ 8254</td>
</tr>
<tr>
<td>Cl (mg/L)</td>
<td>Indirect</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 42672</td>
<td>≥ 42672</td>
</tr>
<tr>
<td>Al (mg/L)</td>
<td>Direct</td>
<td>5</td>
<td>20</td>
<td>&lt; 0.129</td>
<td>≥ 0.129</td>
</tr>
<tr>
<td>Ag (mg/L)(^+)</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 0.01</td>
<td>≥ 0.01</td>
</tr>
<tr>
<td>As (mg/L)</td>
<td>Direct</td>
<td>0.1</td>
<td>2</td>
<td>&lt; 0.026</td>
<td>≥ 0.026</td>
</tr>
<tr>
<td>B (mg/L)</td>
<td>Direct</td>
<td>0.5</td>
<td>1.0</td>
<td>&lt; 0.5</td>
<td>≥ 0.5</td>
</tr>
<tr>
<td>Water Quality Parameter</td>
<td>Adverse risk to Beneficial Users</td>
<td>ANZEC Irrigation Water Guideline</td>
<td>Shepparton Aquifer</td>
<td>Loxton Parilla Sands Aquifer</td>
<td>Lower Renmark Group Aquifer</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------</td>
<td>---------------------------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LTV</td>
<td>STV</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>Be (mg/L)</td>
<td>Direct</td>
<td>0.1</td>
<td>0.5</td>
<td>&lt; 0.1</td>
<td>≥ 0.1</td>
</tr>
<tr>
<td>Bi (mg/L)*</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 0.01</td>
<td>≥ 0.01</td>
</tr>
<tr>
<td>Cd (mg/L)</td>
<td>Direct</td>
<td>0.01</td>
<td>0.05</td>
<td>&lt; 0.01</td>
<td>≥ 0.01</td>
</tr>
<tr>
<td>Co (mg/L)</td>
<td>Direct</td>
<td>0.05</td>
<td>0.1</td>
<td>&lt; 0.05</td>
<td>≥ 0.05</td>
</tr>
<tr>
<td>Cr (mg/L)</td>
<td>Direct</td>
<td>0.1</td>
<td>1.0</td>
<td>&lt;0.1</td>
<td>≥ 0.1</td>
</tr>
<tr>
<td>Cu (mg/L)</td>
<td>Direct</td>
<td>0.2</td>
<td>5</td>
<td>&lt; 0.042</td>
<td>≥ 0.042</td>
</tr>
<tr>
<td>F (mg/L)</td>
<td>Direct</td>
<td>1.0</td>
<td>2.0</td>
<td>&lt; 1.0</td>
<td>≥ 1.0</td>
</tr>
<tr>
<td>Fe (mg/L)</td>
<td>Direct</td>
<td>0.2</td>
<td>10</td>
<td>&lt; 9.422</td>
<td>≥ 9.422</td>
</tr>
<tr>
<td>Li (mg/L)</td>
<td>Direct</td>
<td>2.5</td>
<td>2.5</td>
<td>&lt; 0.233</td>
<td>≥ 0.233</td>
</tr>
<tr>
<td>Mn (mg/L)</td>
<td>Direct</td>
<td>0.2</td>
<td>10</td>
<td>&lt; 1.472</td>
<td>≥ 1.472</td>
</tr>
<tr>
<td>Mo (mg/L)</td>
<td>Direct</td>
<td>0.01</td>
<td>0.05</td>
<td>&lt; 0.024</td>
<td>≥ 0.024</td>
</tr>
<tr>
<td>Ni (mg/L)</td>
<td>Direct</td>
<td>0.2</td>
<td>2.0</td>
<td>&lt; 0.038</td>
<td>≥ 0.038</td>
</tr>
<tr>
<td>Pb (mg/L)</td>
<td>Direct</td>
<td>2.0</td>
<td>5.0</td>
<td>&lt; 2.0</td>
<td>≥ 2.0</td>
</tr>
<tr>
<td>Sb (mg/L)*</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 0.01</td>
<td>≥ 0.01</td>
</tr>
<tr>
<td>Se (mg/L)</td>
<td>Direct</td>
<td>0.02</td>
<td>0.05</td>
<td>&lt; 0.02</td>
<td>≥ 0.02</td>
</tr>
<tr>
<td>Water Quality Parameter</td>
<td>Adverse risk to Beneficial Users</td>
<td>ANZECC Irrigation Water Guideline</td>
<td>Shepparton Aquifer</td>
<td>Loxton Parilla Sands Aquifer</td>
<td>Lower Renmark Group Aquifer</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LTV</td>
<td>STV</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>Sr (mg/L)</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 26.964</td>
<td>≥ 26.964</td>
</tr>
<tr>
<td>Th (mg/L)^*</td>
<td>Direct</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 0.01</td>
<td>≥ 0.01</td>
</tr>
<tr>
<td>U (mg/L)</td>
<td>Direct</td>
<td>0.01</td>
<td>0.1</td>
<td>&lt; 0.065</td>
<td>≥ 0.065</td>
</tr>
<tr>
<td>V (mg/L)</td>
<td>Direct</td>
<td>0.1</td>
<td>0.5</td>
<td>&lt; 0.1</td>
<td>≥ 0.1</td>
</tr>
<tr>
<td>Zn (mg/L)</td>
<td>Direct</td>
<td>2</td>
<td>5</td>
<td>&lt; 0.166</td>
<td>≥ 0.166</td>
</tr>
<tr>
<td>Ra-226 (Bq/L)^*</td>
<td>Direct</td>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
<td>≥ 5</td>
</tr>
<tr>
<td>Ra-228 (Bq/L)^*</td>
<td>Direct</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
<td>≥ 2</td>
</tr>
<tr>
<td>N-species</td>
<td>Direct</td>
<td>5.0</td>
<td>25.0</td>
<td>&lt; 5.0</td>
<td>≥ 5.0</td>
</tr>
<tr>
<td>Total Recoverable Hydrocarbons (TPH)</td>
<td>Direct</td>
<td>&lt;0.3</td>
<td>N/A</td>
<td>≥ 0.3</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Notes:

* In the absence of baseline information and ANZECC guidelines, the LTV and STV for Cadmium was applied.

^ In the absence of baseline information and ANZECC guidelines, the LTV and STV for Uranium was applied.

^ Tiered approach not applied to Radionuclide or Total Recoverable Hydrocarbon (TRH) data.
3.2 2016 REVISION OF SSTL

Iluka (2016b) reviewed operations within the May/June interim reporting period of the mining trial. Hydraulic conditions in all groundwater systems, recorded at all multi-nested and VWP monitoring locations remained within the respective Green SSTLs. Thus, there was no requirement for a management response.

Iluka (2016b) reported several water quality SSTL exceedances throughout the May/June 2016 internal reporting period. While there were a number of exceedances recorded at near mining groundwater monitoring wells, a review of datasets used to derive each aquifer’s average water chemistry (the basis of SSTL derivation) indicated that the concentrations were generally consistent with the individual well’s historical variation.

Subsequently, certain SSTLs were redefined for individual wells (Table 4), on the statistical basis consistent with the approach outlined in the GOMS (Iluka, 2016a) and the maximum observable concentration at each location.

As per the procedure for infringement confirmation, no SSTL breaches were thus recorded for the May/June 2016 interim reporting period, and the groundwater systems remained in the Green operating threshold.

Table 4: 2016 Revised SSTL for Water Quality

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Well ID</th>
<th>Analyte</th>
<th>Current SSTL</th>
<th>Redefined SSTL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>SFM</td>
<td>UGM-M9S</td>
<td>TDS</td>
<td>&lt; 64,474</td>
<td>≥ 64,474</td>
</tr>
<tr>
<td></td>
<td>UGM-M1S</td>
<td>Mo</td>
<td>&lt; 0.024</td>
<td>≥ 0.024</td>
</tr>
<tr>
<td></td>
<td>UGM-M1S</td>
<td>Total Al</td>
<td>&lt; 0.129</td>
<td>≥ 0.129</td>
</tr>
<tr>
<td></td>
<td>UGM-M6S</td>
<td>Total Al</td>
<td>&lt; 0.129</td>
<td>≥ 0.129</td>
</tr>
<tr>
<td>LPS</td>
<td>UGM-M2D</td>
<td>Total Al</td>
<td>&lt; 0.129</td>
<td>≥ 0.129</td>
</tr>
<tr>
<td></td>
<td>UGM-M4D</td>
<td>Total Al</td>
<td>&lt; 0.129</td>
<td>≥ 0.129</td>
</tr>
<tr>
<td>LRG</td>
<td>Karra Well</td>
<td>Zn</td>
<td>LOR</td>
<td>&gt; LOR</td>
</tr>
</tbody>
</table>

3.3 SUMMARY OF JULY 2016 INTERIM ASSESSMENT

Iluka (2016b) produced a summary interim assessment in July 2016 and reported notable variations between dissolved Al and Total Al concentrations, recorded in both the Shepparton and Loxton Parilla Sands aquifers, and concluded that such distribution indicates a high percentage of suspended clay (mined-slimes and drilling mud i.e. bentonite). Iluka (2016b) theorized that the high turbidities are likely related to significant volumes of poly-anionic cellulose-based drill polymer, used during horizontal directional drilling operations, which is designed to ensure sediments remain in suspension.

LWC would agree with this consideration on the basis of aluminium solubility characteristics. An Eh-pH diagram for LPS groundwater was constructed using the Act2 application of the GWB (Figure 2) based on the averaged reported composition of groundwater as sampled. Note that consistent with almost all waters, Al is present in solution only where pH <~4.4, and above this pH, Al is predicted to be present as
the mineral phase Gibbsite. Subsequently at the given pH of the LPS water (circum-neutral), aluminium will be partitioned as insoluble mineral phase and therefore turbidity/ colloids are more likely to be a primary influence on variation between dissolved and total aluminium.

It is noted that Iluka (2016b) reported some variation between dissolved Fe and Total Fe concentrations, recorded in the Loxton Parilla Sands Aquifer, and considered that significant volumes of ferricydrate sludge may be formed as groundwater is oxidised upon abstraction and circulation through the process water circuit. As reported in Iluka (2016b), ferricydrate sludge can lead to pipeline encrustation and corrosion, and may over time impact on the performance of the process water circuit. Similarly, the sludge has a high adsorption rate of heavy metals present in low concentrations in groundwater (i.e. As, Cr, Mn).

In general, Iluka (2016b) reported that the comparison of hydraulic and hydrogeochemical groundwater data, against SSTLs derived in the GOMS (Iluka, 2016a), indicated that no permanent alteration of the groundwater system can be delineated as a result of the mining trials during the May/June interim reporting period.

---

**Figure 2: Eh-pH diagram for aluminium**

![Eh-pH diagram for aluminium](image-url)
3.4 GROUNDWATER PRESSURE ASSESSMENT AND SSTL REVIEW

Groundwater pressure responses have been assessed between May and September 2016, which covers the period of Stope 1 mining, Stope 3 mining, Stope 4 mining, Stope 1 backfilling and Stope 3 backfilling. The groundwater pressure assessment includes the data manually and automatically collected from the shallow (SFM) and deep (LPS) monitoring wells.

The following figures have been produced to facilitate this review:

- Figure 3 to Figure 7 shows the hydrographs for all the ‘deep’ wells which monitor the LPS. Both manual and data-logger pressures are shown; and
- Figure 8 to Figure 12 shows the hydrographs for all the ‘shallow’ wells which monitor the SFM. Both manual and data-logger pressures are shown.

The hydrograph plots also show periods of active mining and backfilling, along with the Red and Yellow SSTLs.

The trial pressure impact results suggest:

- Drawdown impacts of up to 4 m are generally observed at wells M1D, M2D, M3D and M4D due to pumping from the P2 production well, which is used to supply process demand water. The P2 well is located at the south-western corner of the Process Water Dam (PWD). No drawdown impacts within the SFM are observed. Please note that SSTLs related to drawdown within the SFM and LPS are not applicable;
- Both the mining and backfilling activities result in mounding impacts, where groundwater pressures increase above their static level, as detailed below;
- Groundwater pressures rapidly increase and recover as a response to both the mining and backfilling activities, a function of the confining and semi-confining nature of the LPS and SFM respectively;
- Generally, pressure impacts are larger within the LPS compared to the SFM, however there are a few exceptions which are discussed in further detail below;
- Mining impacts associated with Stope 1 showed the largest pressure impacts at M5D and M7D within the LPS on 15 June 2016, with maximum mounding of ~9 and 6 m being recorded. During this time, mounding impacts within the SFM are more subdued, with a maximum impact of ~ 2.9 m being recorded at M5S. At this time, mounding responses within the LPS and SFM fall within the normal operating levels (i.e. the Green zone) as defined by the GOMS.
- Mining impacts associated with Stope 3 showed the largest pressure impact at M9D within the LPS on the 16 July 2016, with maximum mounding of ~11.5 m being recorded. However, mounding impacts within the SFM are negligible as indicated by M9S, suggesting that a sufficient and intact aquitard exists between the LPS and SFM at this location. Pressure impacts are also recorded at M5S during Stope 3 mining. At this time, mounding responses within the LPS and SFM fall within the normal operating levels (i.e. the Green zone) as defined by the GOMS;
Mining impacts associated with Stope 4 showed the largest pressure impacts at M13D and M14D within the LPS on 24 August 2016, with maximum mounding of ~9.3 m and ~10 m being recorded respectively. Mounding impacts within the SFM above Stope 4 are negligible, suggesting that a sufficient and intact aquitard exists between the LPS and SFM at this location. Pressure impacts of up to 1.2 m were also recorded at M10S, located in close proximity to the Stope 4 HDD line. At this time, mounding responses within the LPS and SFM fall within the normal operating levels (i.e. the Green zone) as defined by the GOMS;

In summary, during the mining periods, no breaches to either the SFM or LPS hydraulic SSTLs were observed;

Maximum backfilling impacts associated with injecting water only into Stope 1, were recorded on 2 September 2016 (Backfill test 3C). Unlike the mining impacts, peak mounding was observed within the SFM wells as opposed to the LPS wells. M5S and M7S recorded a peak mounding impact of ~6.7 m and ~11.7 m respectively, noting that a similar mound response was also noted at M5S a day earlier (1 September 2016, Backfill test 3B);

Maximum mounding impacts within the LPS were around 4.5 m on the 2 September 2016;

Backfill test 4 consisted on injecting slurry into Stope 1 on the 8 September 2016, followed by a second test on the 10 September 2016. Maximum pressure impacts where again measured within the SFM at wells M5S and M7S, with recorded peak mounding impacts of ~5.9 m and ~11.2 m respectively;

Backfill test 5 was trialled on Stope 3 between the 14 and 15 September 2016. Again, maximum impacts where recorded within the SFM, with M6S recording a maximum mound impact of up to ~3.2 m. M6S is in close proximity to M10S, which also showed an impact during Stope 4;

Backfill test 5 resulted in no hydraulic SSTL breaches; and

No hydraulic SSTL breaches within the LPS were observed during the backfill periods.

As mentioned above, the CTD data-logger series at two SFM monitoring wells M7S and M5S, both showed numerous pressure spikes and subsequently, breached the hydraulic SSTL for the ‘red’ and ‘yellow’ zones respectively. This occurred on the 1, 2, 8, and 10 of September 2016, which was associated with Backfill tests 3B, 3C and 4. A summary of the breaches are shown in Table 5. Although the groundwater pressures breached the absolute trigger levels, the GOMS states that infringement confirmation is defined by “24 hours of continuously recorded infringement in autonomous and telemetry collected data”. A review of the autonomous data showed that any one infringement, did not last longer than 4.3 hours, and thus does not constitute a breach of the operating rules nor the requirement to submit a notification report to DPI Water and the NSW EPA.
Table 5: Summary of hydraulic SSTL breaches

<table>
<thead>
<tr>
<th>Date</th>
<th>Back-fill Test</th>
<th>UGM well</th>
<th>SSTL Breach</th>
<th>Breach period (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sept 2016</td>
<td>3B</td>
<td>M5S</td>
<td>Yellow</td>
<td>1.2</td>
</tr>
<tr>
<td>2 Sept 2016</td>
<td>3C</td>
<td>M5S</td>
<td>Yellow</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M7S</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M7S</td>
<td>Red</td>
<td>2.5</td>
</tr>
<tr>
<td>8 Sept 2016</td>
<td>4</td>
<td>M5S</td>
<td>Yellow</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M7S</td>
<td>Yellow</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M7S</td>
<td>Red</td>
<td>1.3</td>
</tr>
<tr>
<td>10 Sept 2016</td>
<td></td>
<td>M7S</td>
<td>Yellow</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M7S</td>
<td>Red</td>
<td>1.7</td>
</tr>
</tbody>
</table>

In summary, LPS pressure impacts are larger than the corresponding SFM impacts during the mining periods, as expected. However, backfilling results indicate that pressure impacts are generally larger within the SFM, at some locations. Although hydraulic SSTL breaches were observed within the SFM, these periods were not long enough to constitute a violation of the operating rules nor the requirement to submit a notification report to DPI Water and the NSW EPA.
Figure 3: LPS hydrographs (M1D, M2D and M4D)
Figure 4: LPS hydrographs (M5D, M6D and M7D)
Figure 5: LPS hydrographs (M8D, M9D and M10D)
Figure 6: LPS hydrographs (M13D, M14D and M15D)
Figure 7: LPS hydrographs (LPSPB04)
Figure 8: SFM hydrographs (M1S, M2S and M5S)
Figure 9: SFM hydrographs (M6S, M7S and M8S)
Figure 10: SFM hydrographs (M9S, M10S and M11S)
Figure 11: SFM hydrographs (M12S, M13S and M14S)
Figure 12: SFM hydrographs (M15S and SHOB04)
3.5 FIELD PARAMETER REVIEW

3.5.1 Loxton Parilla Sands

Water in the LPS monitoring wells was monitored with respect to pH, electrical conductivity (EC), total dissolved solids (TDS), redox, temperature, ferrous iron and total iron. A summary of field data for the LPS water is presented as Table 6, with absolute values reported in Appendix A.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>pH</th>
<th>EC (mS/cm)</th>
<th>TDS (mg/L)</th>
<th>Redox (mV)</th>
<th>Temperature (°C)</th>
<th>Ferrous Fe (mg/L)</th>
<th>Total Fe (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>6.59</td>
<td>40.0</td>
<td>25,997</td>
<td>-257</td>
<td>6.71</td>
<td>0.21</td>
<td>1.18</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.67</td>
<td>57.6</td>
<td>37,435</td>
<td>33</td>
<td>22.6</td>
<td>6.83</td>
<td>9</td>
</tr>
<tr>
<td>Mean</td>
<td>6.87</td>
<td>52.4</td>
<td>34,059</td>
<td>-173</td>
<td>19.91</td>
<td>2.25</td>
<td>3.20</td>
</tr>
</tbody>
</table>

The ranges of field parameters appear reasonably small noting in particular that no significant change in the geochemical leading indicator of pH was recorded.

3.5.2 Shepparton Formation

The SFM water was monitored for the same parameters as the LPS. A summary of the parameters is presented as Table 7 with absolute values as Appendix A.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>pH</th>
<th>EC (mS/cm)</th>
<th>TDS (mg/L)</th>
<th>Redox (mV)</th>
<th>Temperature (°C)</th>
<th>Ferrous Fe (mg/L)</th>
<th>Total Fe (mg/L)</th>
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<tr>
<td>Minimum</td>
<td>6.72</td>
<td>56.6</td>
<td>36,829</td>
<td>-205.10</td>
<td>20.50</td>
<td>0.34</td>
<td>0.25</td>
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<tr>
<td>Maximum</td>
<td>7.47</td>
<td>64.49</td>
<td>41,917</td>
<td>-49.90</td>
<td>21.10</td>
<td>1.79</td>
<td>1.79</td>
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<tr>
<td>Mean</td>
<td>7.09</td>
<td>57.12</td>
<td>37,127</td>
<td>-107.74</td>
<td>19.64</td>
<td>0.67</td>
<td>0.95</td>
</tr>
</tbody>
</table>

3.5.3 Time series plots

Field monitored pH and EC have been plotted as time series and against the SSTLs in Appendix B. In summary, the field based values do not exceed the SSTLs, except for pH at wells UGM-M13S and UGM-M15S from August 2016. The high pH values here are most likely due to residual drilling muds occurring within the wells, noting that wells constructed within the less transmissive SFM are more challenging to develop.
As observed at UGM-M15S, the pH values are dropping over time, indicating that native water is progressively ingressing the well. Further discussion is provided in Section 3.6 below.

3.6 COMPLETE CHEMICAL DATASET ASSESSMENT AGAINST SSTL

3.6.1 Loxton Parilla Sands

The entire chemical substance dataset was reviewed against the SSTLs for all groundwater monitoring events (i.e. 1 – 10) undertaken during the trial. The tabulated data is presented as Appendix C. Key leading indicators from the dataset have been isolated and are presented in terms of concentration over time (trends) as Appendix F (see Section 3.7).

A summary of SSTL exceedances per swing is presented as Table 8. Note in addition, dissolved and total iron and manganese generally are reported above the respective ANZECC (2000) criteria in all waters at all time points and such reported concentrations are considered to be representative of background groundwater composition.

In general, and in accordance with the internal assessment (Iluka, 2016b), there does not appear to be any significant identifiable exceedance of SSTL (at the time of monitoring) or trend in chemical substance data in both the LPS and SFM during either the mining or backfilling trial periods.
Table 8: Summary of LPS groundwater criterion (SSTL) exceedances per swing

<table>
<thead>
<tr>
<th>Assessment Criterion</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPS Yellow Trigger</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>LPS Red Trigger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

1. Dissolved bismuth was reported at 0.011 mg/L where the trigger is 0.01 mg/L in water sampled from UGM-M6D in June 2016. This occurred prior to any mining trial and only marginally exceeds trigger. Not considered to be significant.

   Ionic balance of water was reported at 7.54%, which exceeds the trigger (yellow) of 7% in water sampled from UGM-M8D in June 2016.

2. Ionic balance of water was reported at 9.58%, which exceeds the trigger (yellow) of 7% in water sampled from UGM-M2D in August 2016. This well is located to the north of the stopes at a distance greater than 200 m and is considered to be representative of background groundwater conditions rather than operations. A similar balance was reported in water sampled from UGM-M8D.

   Arsenic was reported at a concentration greater than the yellow trigger level of 0.02 mg/L in water sampled from Stope 4 monitoring wells UGM-M11D and UGM-M12D (0.061 and 0.056 mg/L respectively). These concentrations were reported prior to mining trials and thus are considered to be representative of background groundwater.

3. Nickel exceeded the 0.009 mg/L trigger (yellow) in water sampled from UGM-M6D in July 2016 (0.011 mg/L) after mining trials at Stope 1B and 3. The exceedance is relatively minor and is not considered to be significant noting the remainder of the dataset at such location both in terms of this event and other events.

   Aluminium exceeded the yellow trigger level of 0.129 mg/L in water sampled from UGM-M8D (0.29 mg/L).

   Ionic balance of water was reported at 7.32%, which exceeds the trigger (yellow) of 7% in water sampled from UGM-M9D in June 2016.

4. Ionic balance of water was reported at 7.20%, which exceeds the trigger (yellow) of 7% in water sampled from UGM-M8D in June 2016.

5. Iron was reported at a concentration greater than the red trigger level of 12 mg/L in water sampled from Stope 4 monitoring wells UGM-M11D and UGM-M12D (29.8 and 31.9 mg/L respectively). These concentrations were reported prior to mining trials and thus are considered to be representative of background groundwater.

   Uranium was reported at a concentration greater than the red trigger level of 0.015 mg/L in water sampled from Stope 4 monitoring wells UGM-M11D and UGM-M12D (0.017 and 0.016 mg/L respectively). These concentrations were reported prior to mining trials and thus are considered to be representative of background groundwater.
Ionic balance of water was reported >7% in water sampled from LPSB03, LPSB04, UGM-M4D and UGM-M8D which exceeds the trigger (yellow) of 7%.

Dissolved bismuth was reported at 0.022 mg/L where the trigger is 0.01 mg/L in water sampled from UGM-M4D in June 2016. Not considered to be significant. This well is located to the north of the stopes at a distance greater than 200 m and is considered to be representative of background groundwater conditions.

Total aluminium was reported at a concentration of 0.14 mg/L which exceeds the yellow trigger level of 0.129 mg/L in water sampled from UGM-M8D. However, dissolved aluminium was below the laboratory limit of detection.

Similar elevated concentrations of total aluminium were reported in water sampled from WBGT4, UGM-M5D, UGM-M11D, and UGM-M12D. Noting the geochemistry of aluminium as discussed above, the reported result is likely associated with colloidal entrainment during field filtration. Dissolved aluminium was below the laboratory limit of detection.

3.6.2 Shepparton Formation

As per the LPS review, a review of the chemical substance trends and concentrations relative to the SFM SSTLs was undertaken. The SFM data is presented as Appendix D.

In general, the reported chemical substance concentrations do not exceed either the yellow or red SSTL with exception of water sampled from the monitoring wells newly installed to monitor Stope 4 in August 2016 (Stope 4). The evidence of high pH at the Stope 4 suggests these wells have not been sufficiently developed and contain residual drilling fluids. Therefore, water sampled from these wells do not represent true native groundwater, and thus exceedances observed here should be treated with caution. A summary of the SFM exceedances include:

- Exceedances of the ANZECC 2000 irrigation Long-term trigger level are common throughout the trial period for:
  - filtered iron at wells M1S, M2S, M5S, M6S, M7S, M8S and M10S
  - filtered manganese at wells M5S, M6S, M7S and M10S
  - filtered uranium at wells M1S, M2S, M6S, M8S, M9S and M10S
  - total iron at wells M1S, M2S, M5S, M6S, M7S, M8S and M10S
  - Total uranium at wells M1S, M2S, M5S, M6S, M7S, M8S, M9S and M10S

- During monitoring swing 6 and prior to Stope 4 mining, the following exceedances were observed:
  - Red breach of filtered molybdenum, red breach of total iron, and yellow breach of total arsenic at well M11S
  - Red breach of filtered molybdenum, red breach of filtered strontium, yellow breach for and yellow breach of filtered and total chromium (3 and 4) at well M12S
- Red breach for pH, yellow breaches filtered calcium, chromium (3 and 4) and filtered molybdenum at well M13S
- Red breaches for filtered and total uranium at well M14S
- Red breaches for pH, filtered and total chromium (3 and 4), and yellow breach for filtered calcium at well M15S
- Yellow breaches for ionic balance and fluoride at well SHOB04

During monitoring swing 7 which occurred during mining of Stope 4, the following exceedances were observed:

- Red breaches for filtered and total chromium (3 and 4) at well M15S
- Yellow breach of fluoride at well SHOB04

During monitoring swing 8 which occurred during backfilling trials of Stope 1B, the following exceedances were observed:

- Yellow breaches for filtered and total chromium (3 and 4) at well M15S
- Yellow breaches for fluoride and total uranium at well SHOB04

### 3.6.3 Olney Formation

The Karra Homestead well, which accessed fresher Olney Formation water (typically around 5,000 mg/L) for dust suppression during the trials, formed part of the monitoring program. The Olney Formation data and the corresponding SSTLs are presented in Appendix E. Key observations include:

- ANZECC 2000 irrigation Long-term trigger level breaches for filtered and total ion during the entire 2016 trial period;
- Yellow breach for the ionic balance during swing 2 (June 2016), swing 5 (July 2016), swing 6 (mid-August 2016) and swing 7 (late-August 2016);
- Yellow breach for filtered Nickel during swing 2 (June 2016) and swing 9 (late-September 2016); and
- Yellow breach for filtered Zinc during swing 5 (July 2016), swing 6 (mid-August 2016), swing 7 (late-August 2016) and swing 8 (early-September 2016).

### 3.7 AQUIFER TREND ASSESSMENT

An aquifer trend assessment has been completed using the WISH software with the full suite of plots shown in Appendix F. The leading indicators are based on consideration of potential reportable magnitude of geochemical reactivity that may occur during change to the system during extraction of ore and the following backfill periods.

Of interest, noting the presence of sulfides in ore and mining by-products, leading indicators are considered to be:
These parameters are considered to have the most notable effect on groundwater metal composition with respect to pH sensitive species and general dissolution of ferric hydroxide phases (which may release sorbed species). Note that in most instances, the field parameter pH as reported in Appendix A, is lower than the corresponding laboratory reported pH as tabulated in Appendices C and D. This is a common phenomenon caused by precipitation of calcite or dolomite in laboratory bottles thereby decreasing the HCO₃⁻ concentration and causing pH adjustment.

Referring to the aquifer plots shown in Appendix F, the following main observations are:

- The Durov diagrams for both the SFM and LPS show that the water is Na-Cl dominant, pH range of approximately 7 to 8.4 and a TDS generally above 50,000 mS/m;
- The similarities of the Durov diagram pre- and post-trials support the notion that no permanent changes to the groundwater chemical composition has occurred due to mining;
- The highest salinity most recently measured was at well M9 (July 2016), with the SFM and LPS being measured at 59,600 mg/L and 47,000 mg/L respectively;
- The groundwater salinities are generally showing a downward trend, a consequence of the PWD (being the source water), progressively becoming more fresh over the mining period. This freshening effect, is most likely caused by higher winter rainfalls recharging the PWD;
- pH is generally neutral to slightly basic;
- The overall trend of pH remained relatively constant between pre- and post-mining, although some variance has been measured at individual monitoring locations;
- The most recent monitoring event (December 2016) showed a pH ranging from 7.2 at M6S to 8.5 at the PWD;
- Alkalinity is generally higher within the LPS (387 mg/L to 445 mg/L as at December 2016), compared to the SFM (26 mg/L to 419 mg/L as at December 2016);
- Overall alkalinity trend through the trial period remained stable, suggesting buffering capacity of the aquifer has not diminished due to mining and backfilling activities. However, there is a distinct decrease in alkalinity measure in the PWD between August and September 2016;
- Total acidity was calculated from dissolved aluminium, iron and manganese, which also considers the mineral or latent acidity (in addition to free hydrogen ions) that could be generated through hydrogeochemical processes. The biggest source of acidity is measured at wells M10S, M5S, M11D, M12D, M13D and M15D;
- Total acidity is larger in the LPS compared to the SFM; and
Total acidity trend shows mixed results; however the rates of change are small. The largest increase in total acidity was observed at well M11D, which rose from 5.7 mg/L in August 2016 to 14.1 mg/L in December 2016.

In addition to the leading indicators above, aluminum, chloride-sulfate ratio, magnesium, ferrous iron and sulphide data was also assessed, as these species can assist in determining whether in-situ acidification of the aquifer is occurring. The data suggests:

- Aluminium showed no significant trends, with the highest concentration being recorded within the PWD. The concentrations fell below the ANZECC 2000 guidelines for irrigation and the Red SSTL over the entire reporting period;

- The Cl:SO₄ is generally used to assess the trend of the sulphate ion against the more stable and conservative chloride ion. When acidification occurs, especially through the process of sulphide mineral oxidation, this ratio will start to trend downwards. Generally speaking, a ratio of less than 2 suggests that this process is occurring. Referring to the time series plots, trends and absolute value bubble plots, the Site ratios remain above 2 at all locations over the reporting period, with the majority of the ratios remaining above 4;

- Absolute values for magnesium stayed within the Green SSTL at all locations during the reporting period;

- Magnesium for both the SFM and LPS wells generally showed a neutral to downward trend throughout the reporting period, with the exception of M4D which showed a rising trend since September 2016; and

- Not enough data was collected for ferrous iron and sulphide to support trend assessments. Absolute values of both these species are no cause of concern at this stage.

**In summary, the trend assessment indicates that no long term or permanent acidification or other impacts are occurring within the aquifer as a result of the mining trial.**
4 SUMMARY

The reporting period defined by the GOMS (Iluka, 2016a) is from the 1 January 2016 to 31 December 2016. During this time, a total water volume of 566 kL (or ~ 0.6 ML) was extracted from the Karra Homestead well to support dust suppression and track maintenance works. To support the mining trial, groundwater was extracted from two production wells, UGM-P1 and UGM-P2, with a total water usage of around 22 ML being recorded.

An internal report conducted by Iluka (2016b) in July 2016, compared hydraulic and hydrogeochemical groundwater data, against SSTLs derived in the GOMS. The study indicated that no permanent alteration of the groundwater system can be delineated as a result of mining trials during the May/June 2016 interim reporting period.

This compliance report builds upon the previous assessment conducted by Iluka (2016b) and compares all the hydraulic and hydrogeochemical groundwater data, against the defined SSTLs. The review suggests that as expected, the LPS pressure impacts are larger than the corresponding SFM impacts during the mining periods. However, backfilling results indicate that pressure impacts are generally larger within the SFM, at some locations. Although hydraulic SSTL breaches were observed within the SFM, these periods were not long enough to constitute a violation of the operating rules nor the requirement to submit a notification report to DPI Water and the NSW EPA.

A full review of the chemical substance trends and concentrations relative to the LPS and SFM SSTLs was undertaken. In general, the reported chemical substance concentrations do not exceed either the yellow or red SSTL with exception of water sampled from the SFM monitoring wells newly installed to monitor Stope 4 in August 2016. Such exceedances occur prior to Stope 4 mining (or backfilling trials elsewhere) and thus are not associated with any impacts from the mining/ backfilling operations. The evidence of high pH at the Stope 4 wells suggest they have not been sufficiently developed and contain residual drilling fluids. Therefore, water sampled from these wells do not represent true native groundwater, and thus exceedances observed here should be treated with caution.

In addition to a comprehensive assessment against the SSTLs, a groundwater trend assessment was undertaken using the WISH software. In summary, the trend assessment indicates that no permanent acidification or other impacts are occurring within the aquifer as a result of the mining trials.

1 LWC notes that Iluka has notified DPI Water and NSW EPA (via email on 24th February 2017) of the occurrences and has committed to providing further information to both departments once the outcome of an internal review is completed.
5 REFERENCES


Appendix A

Field measured parameters
<table>
<thead>
<tr>
<th>Wellbore Well</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
<th>WL (mbTOC)</th>
<th>Date</th>
</tr>
</thead>
</table>

Notes:
* Water levels have been corrected for height changes post head works installation (1/2016)
### Appendix 2: Table 2. Summary of Field Parameters, Shepparton Aquifer Formation (Swing 1 to 10)

<table>
<thead>
<tr>
<th>Monitoring Well</th>
<th>Swing No.*</th>
<th>Date</th>
<th>pH</th>
<th>EC (mS/cm)</th>
<th>TDS (mg/L)**</th>
<th>Redox (mV)</th>
<th>Temperature (°C)</th>
<th>Ferric Iron (mg/L)</th>
<th>Total Iron (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GUM-M15</td>
<td>1</td>
<td>3-Jun-16</td>
<td>7.82</td>
<td>66.46</td>
<td>43,199</td>
<td>-206.9</td>
<td>19.4</td>
<td>0.73</td>
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<tr>
<td></td>
<td></td>
<td>29-Jun-16</td>
<td>7.78</td>
<td>67.33</td>
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<td>19.4</td>
<td>0.43</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7-Jul-16</td>
<td>7.36</td>
<td>61.68</td>
<td>40,093</td>
<td>-186.1</td>
<td>19.4</td>
<td>0.72</td>
<td>0.86</td>
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<tr>
<td></td>
<td></td>
<td>13-Jul-16</td>
<td>7.23</td>
<td>54.83</td>
<td>35,641</td>
<td>-190.9</td>
<td>14.9**</td>
<td>1.00</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>24-Aug-16</td>
<td>7.68</td>
<td>61.33</td>
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<td>20.3</td>
<td>0.39</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-Sep-16</td>
<td>7.7</td>
<td>64.51</td>
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<td>20.9</td>
<td>0.1</td>
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<td>7.64</td>
<td>64.48</td>
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<td>-192.7</td>
<td>21.1</td>
<td>0.34</td>
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<td>27-Nov-16</td>
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<td>61.83</td>
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<td>7.20</td>
<td>54.91</td>
<td>35,692</td>
<td>-213.1</td>
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<tr>
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<td>19-May-16</td>
<td>6.50</td>
<td>35.99</td>
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<td>6.55</td>
<td>35.11</td>
<td>35,932</td>
<td>-176.1</td>
<td>19.3</td>
<td>0.04</td>
<td>0.04</td>
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<td></td>
<td></td>
<td>14-Aug-16</td>
<td>8.64</td>
<td>36.16</td>
<td>36,397</td>
<td>-396</td>
<td>19.8</td>
<td>Below Detection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13-Jul-16</td>
<td>6.85</td>
<td>58.39</td>
<td>30,644</td>
<td>-23.3</td>
<td>20.4</td>
<td>Below Detection</td>
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<tr>
<td></td>
<td></td>
<td>2-Sep-16</td>
<td>7.36</td>
<td>65.39</td>
<td>32,624</td>
<td>-11.8</td>
<td>20.7</td>
<td>Below Detection</td>
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<tr>
<td></td>
<td></td>
<td>9-Sep-16</td>
<td>7.59</td>
<td>66.86</td>
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<td>-205.1</td>
<td>20.5</td>
<td>1.79</td>
<td>1.79</td>
</tr>
</tbody>
</table>

**Notes:**
- Swing 1 was undertaken between the 16 and 22 May 2016, Swing 2 occurred between 30 May and 5 June 2016, Swing 3 occurred between 15 and 20 June 2016, Swing 4 occurred between the 29 June and 3 July 2016, Swing 5 occurred between 12 and 20 July 2016, Swing 6 occurred between 23 and 25 August 2016, Swing 7 occurred between 6 and 8 September 2016 and Swing 8 occurred between 22 September 2016 and 26 November 2016 and 6 December 2016.
- TDS calculated by multiplying the observed electrical conductivity value by 650 consistent with industry standards.
- Field staff used lateral tubing as such the temperature is lower than usually observed.
### Appendix 2: Table 3. Summary of Field Parameters, Loxton Parilla Sands Formation (Swing 1 to 10)

<table>
<thead>
<tr>
<th>Monitoring Well</th>
<th>Swing No.*</th>
<th>Date</th>
<th>pH</th>
<th>EC (mS/cm)</th>
<th>TDS (mg/L)**</th>
<th>Redox (mV)</th>
<th>Temperature (°C)</th>
<th>Ferrous Iron (mg/L)</th>
<th>Total Iron (mg/L)</th>
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<tr>
<td>UGM-M10</td>
<td>1</td>
<td>20-May-16</td>
<td>6.79</td>
<td>53.945</td>
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<td>21.6</td>
<td>1.50</td>
<td>2.09</td>
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<td></td>
<td>2</td>
<td>03-Jun-16</td>
<td>6.70</td>
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<td>53.945</td>
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<th>Monitoring Well</th>
<th>Swing No.*</th>
<th>Date</th>
<th>pH</th>
<th>EC (mS/cm)</th>
<th>TDS (mg/L)**</th>
<th>Redox (mV)</th>
<th>Temperature (°C)</th>
<th>Ferrous Iron (mg/L)</th>
<th>Total Iron (mg/L)</th>
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<td>1.50</td>
<td>2.09</td>
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<td>1.50</td>
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<td>54.850</td>
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<td>54.850</td>
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<td>-234.90</td>
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<td>-241.10</td>
<td>21.6</td>
<td>1.50</td>
<td>2.09</td>
</tr>
</tbody>
</table>

### Notes:
- EC: Electrical Conductivity
- TDS: Total Dissolved Solids
- Redox: Redox Potential
- Temperature: Water Temperature
- Ferrous Iron: Ferrous Iron Concentration
- Total Iron: Total Iron Concentration
Notes

* Swing 1 was undertaken between the 16 and 22 May 2016, Swing 2 occurred between 30 May and 5 June 2016, Swing 3 occurred between 15 and 20 June 2016, Swing 4 occurred between the 29 June and 8 July 2016, Swing 5 occurred between 12 and 20 July 2016, Swing 6 occurred between 8 and 13 August 2016, Swing 7 occurred between 23 and 25 August 2016, Swing 8 occurred between 6 and 8 September 2016 and Swing 9 occurred on 22 September 2016, swing 10 occurred between 26 November 2016 and 6 December 2016.

** TDS calculated by multiplying the observed electrical conductivity value by 650 consistent with industry standards.

*** Field staff used lateral tubing as such the temperature is lower than usually observed.
Appendix B

Field monitored pH and EC time series
Lower Renmark Formation: Karra Homestead

Discrete Sampling Location: Process Water Dam (PWD)

Discrete Sampling Location: Pre-Trommel

Discrete Sampling Location: Process Water Dam

Discrete Sampling Location: Pre-Trommel

Discrete Sampling Location: Process Water Dam
Appendix C

Entire chemical substance dataset and SSTLs for LPS
## Table 1: Summary of Groundwater Analytical Results - Loxton Parilla Sands Formation (Sampling 1 to Sampling 4)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Units</th>
<th>Loxton</th>
<th>Parilla</th>
<th>sands</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
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<tbody>
<tr>
<td><strong>Reactive Silica</strong></td>
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<td>0.05</td>
<td>6.54</td>
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<td>6.23</td>
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<td>7.53</td>
<td>7.82</td>
<td>7.95</td>
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<tr>
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<td>mg/L</td>
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<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
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<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td><strong>Alkalinity (Bicarbonate as CaCO3)</strong></td>
<td>mg/L</td>
<td>1 394</td>
<td>388</td>
<td>390</td>
<td>397</td>
<td>409</td>
<td>411</td>
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<td>403</td>
<td>401</td>
<td>403</td>
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<tr>
<td><strong>Acidity</strong></td>
<td>mg/L</td>
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<td>94</td>
<td>96</td>
<td>92</td>
<td>88</td>
<td>99</td>
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<tr>
<td><strong>Total Carbon</strong></td>
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**Notes:**
- The value is at the site-specific contaminant level (SDL) but an acceptable change balance error (CCBE) threshold for high-level strength groundwater
- This is at the location profile sand formation
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<th>Sample</th>
<th>Lab 1</th>
<th>Lab 2</th>
<th>Lab 3</th>
<th>Lab 4</th>
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<th>Lab 7</th>
<th>Lab 8</th>
<th>Lab 9</th>
<th>Lab 10</th>
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<th>Lab 15</th>
<th>Lab 16</th>
<th>Lab 17</th>
<th>Lab 18</th>
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</tbody>
</table>

*Note: This value is a site-specific trigger level (STL), but an acceptable change should occur (STL) threshold for high level strength. G"
Appendix B: Table 1. Summary of Geochemistry Analytical Results - Section Profile Sands Formation (S1 to S9)  

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<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
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<td>0.015</td>
<td>0.015</td>
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<td>pH Units</td>
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<td>2.5</td>
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<td>2.5</td>
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</tr>
</tbody>
</table>

**Notes:**
- *This value is to be site-specific (trigger level) but no acceptable change balance error (CBE) threshold for high level strength.**
- From the section profile Sands Formation
<table>
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<tr>
<th>Sample</th>
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<th>UGR</th>
<th>ANZECC 2000 Yellow/Black</th>
<th>Threshold</th>
<th>Nutrients</th>
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<tbody>
<tr>
<td>Hardness as CaCO3</td>
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<td>8.02</td>
<td>7.92</td>
<td>7.12</td>
</tr>
<tr>
<td>Alkalinity (Bicarbonate as CaCO3)</td>
<td>mg/L</td>
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<td>4.36</td>
<td>4.66</td>
<td>5.18</td>
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<tr>
<td>TOC</td>
<td>g/L</td>
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<td>4.66</td>
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</tr>
<tr>
<td>Lead</td>
<td>g/L</td>
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<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Arsenic</td>
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* The value is in Site Specific Nitrogen Level (SBNL) but an acceptable change has been made (SBNL) threshold for high level strength gas from the target profile sand formation.
### Table 1: Summary of Groundwater Analytical Results - Section Profile Sedile Formation (Sewing 3 to Sewing 11)

| Sample | Units | Limit | ANZECC 2000 
Irrigation Short Term Trigger Values | ANZECC 2000 
Irrigation Long Term Trigger Values | ANZECC 2000 

g | 
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**Notes:**
- *This value to the site specific trigger level (SST) but an acceptable change balance entered (CIB) threshold for high levels of strength was not met.*
## Table 1: Summary of Sample Analytical Results - Section Profile Sediment Formation (Swing 1 to Swing 2)

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Notes:
1. This value is at the site specific trigger level (SW) but an acceptable change balance error (SW) threshold for high level strength gas
2. From the section profile sediment formation
### Appendix B: Table 1. Summary of Groundwater Analytical Results - Loxton Parilla Sands Formation

#### Field ID
- EM1606645, 503612
- EM1607177, 505085
- EM1607836
- EM1608389/508136
- EM1609598/511974
- EM1610093/513470
- EM1610711/515434

#### Project
- Extended Bulk Sampling, Balranald Mineral Sands Project

**ANZECC 2000**
- Balranald - LPS
- Irrigation Short
- Irrigation Long

#### Analyte Units
- **LOR**: Lower Organisational Requirement
- **NDS**: New Daily Standard
- **LOR & NDS**: Lower Organisational Requirement and New Daily Standard

#### Analytes

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| *The value is a site specific trigger level (SST) but an acceptable change if balance is > SST of +100% threshold for high level strength gas from the Loxton Parilla Sands Formation.*
Appendix D

Entire chemical substance dataset and SSTLs for SFM
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Note:
1. This value is not the Site Specific Trigger Level (SSL) but an acceptable charge balance error (CBE) threshold for high ionic strength groundwater from the Shepparton Formation.
2. *RQLs for UQnRnS, UQnRn6, and Site specific have been revised as follows:
   - 0.0583 mg/L (UQnRnS, UQnRn6, and Site specific).
   - 0.02 mg/L (UQnRnS, UQnRn6, and Site specific).
   - 1.0 mg/L (UQnRnS, UQnRn6, and Site specific).
3. The pH threshold for high ionic strength groundwater from the Shepparton Formation is 5.6-8.7.
### Analyte

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<th>GND C. 2002 Initial Value</th>
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<tr>
<td><strong>Silver</strong></td>
<td><strong>mg/L</strong></td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>Vanadium</strong></td>
<td><strong>mg/L</strong></td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Note:
- **µS/cm**: The value is not at the Specific Trigger Level (STL), but on acceptable charge balance error (CBE) threshold for high ionic strength groundwater from the Shepparton Formation.
- **µS/cm**: The values for GDL (µS/cm) and GND C. 2002 Initial Value have been revised as follows: (µS/cm) (GDL): Green >7,270 mg/L, Yellow > 7,270 mg/L, Red >12,150 mg/L (GDL: 0.45).
Appendix C: Table 1. Summary of Groundwater Analytical Results -Shepparton Formation (Swing 1 to Swing 9)
Field ID

Job Number: CP-01-13
Client: Iluka Resources Limited
Project: Extended Bulk Sampling, Balranald Mineral Sands Project

Analyte

Inorganics
Electrical conductivity *(lab)
pH (Lab)
TDS**
Hardness as CaCO3 (filtered)
Reactive Silica
Silicon (filtered)
Unionized Hydrogen Sulfide
Alkalinity
Carbonate Alkalinity as CaCO3
Alkalinity (Bicarbonate as CaCO3)
Alkalinity (Hydroxide) as CaCO3
Alkalinity (total) as CaCO3
Acidity as CaCO3
Organic Carbon
Total Carbon
Dissolved Organic Carbon
TOC
Major Cations and Anions
Anions Total
Cations Total
Ionic Balance
Calcium (filtered)
Chloride
Fluoride
Magnesium (filtered)
Potassium (filtered)
Sodium (filtered)
Sulfate as SO4 - Turbidimetric
(filtered)
Sulphide
Sulphur

Unit

EQL

uS/cm
mg/L
mg/L
mg/L
mg/L
mg/L

1
0.01
10
1
0.05
0.05
0.1

mg/L

-

mg/L

1

mg/L
mg/L
mg/L

1
1
1

mg/L
mg/L
mg/L

1
1
1

meq/L
meq/L
%
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L

0.01
0.01
0.01
1
1
0.1
1
1
1

mg/L

1

mg/L
mg/L

0.1
1.0

Dissolved Metals
Aluminium (filtered)
Antimony (filtered)
Arsenic (filtered)
Beryllium (filtered)
Bismuth (filtered)
Cadmium (filtered)
Chromium (III+VI) (filtered)
Cobalt (filtered)
Copper (filtered)
Iron (filtered)
Lead (filtered)
Lithium (filtered)
Manganese (filtered)
Molybdenum (filtered)**
Nickel (filtered)
Selenium (filtered)
Silver (filtered)
Strontium (filtered)
Thorium (filtered)
Titanium (filtered)
Uranium (filtered)
Vanadium (filtered)
Zinc (filtered)
Zirconium (filtered)

mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L
mg/L

0.01
0.001
0.001
0.001
0.001
0.0001
0.001
0.001
0.001
0.05
0.001
0.001
0.001
0.001
0.001
0.01
0.001
0.001
0.001
0.01
0.001
0.01
0.005
0.005

Total Metals
Aluminium**
Arsenic
Chromium (III+VI)
Iron
Manganese
Uranium

mg/L
mg/L
mg/L
mg/L
mg/L
mg/L

0.01
0.001
0.0010
0.05
0.001
0.001

Nutrients
Nitrite + Nitrate as N
Ammonia as N
Kjeldahl Nitrogen Total
Nitrate (as N)
Nitrite (as N)
Nitrogen (Total)

mg/L
mg/L
mg/L
mg/L
mg/L
mg/L

0.01
0.01
0.1
0.01
0.01
0.1

Lab Report
Lab Name
Program
Date
ANZECC 2000
Irrigation Long
Term Trigger
Values

ANZECC 2000
Irrigation Short
Term Trigger
Values

Balranald Shepparton
Yellow Trigger
Level

Balranald Shepparton Red
Trigger Level

5.6-8.78
64474

4-9
73266

628

1

2

7*
1112
42672
1
3219
141
23586

754

1335
51206
2
3863
169
28303

DUP1

DUP1

UGM-M7S

UGM - M7S

UGM-M7S

UGM-M7S

UGM-M8S

UGM - M8S

UGM - M8S

UGM - M8S

UGM-M8S

EM1608694/ 508864
ALS/ MGT
Swing 5
19/07/2016

508864/ EM1608694
ALS/ MGT
Swing 5
19/07/2016

EM1606066
ALSE-Melbourne
Swing 1
19/05/2016

EM1607177/ 505085
ALS/ Eurofins MGT
Swing 3
18/06/2016

EM1607836
ALSE-Melbourne
Swing 4
1/07/2016

EM1608694/ 508864
ALS/ MGT
Swing 5
18/07/2016

EM1606066
ALSE-Melbourne
Swing 1
19/05/2016

EM1606512, 503157
ALS-Melbourne
Swing 2
1/06/2016

503612
ALS-Melbourne
Swing 2
1/06/2016

EM1607177/ 505085
ALS/ Eurofins MGT
Swing 3
17/06/2016

EM1607836
ALSE-Melbourne
Swing 4
30/06/2016

62,800
7.13
39,300
7,970
31.7
17
<0.1

67,000
7.5
41,000
7,500
27
14.93

60,200
7.62
48,600
8,350
20.1
9,910

59,800
7.82
42,200
8,080
24.3
11.8

67,500
7.65
38,300
8,070
34.7
11.7

62,700
7.61
42,600
8,710
22.8
12.2
<0.1

64,500
6.95
51,800
9,350
38.3
19.2

62,100
7.12
48,300
8,400
37.0
18.4

-

63,300
7.60
47,200
8,250
34.9
14.4

72,500
6.94
42,200
8,730
49.5
19.8

<1

<10

<1

<1

<1

<1

<1

<1

-

<1

<1

400
<1
400

400
<10
400

345
<1
345

362
<1
362

338
<1
338

365
<1
365

252
<1
252

253
<1
253

-

282
<1
282

260
<1
260

86
4
2

110
11
18

-

88
7
6

76
7
8

-

58
<1
13

-

70
4
3

795
839
2.67
585
24,600
<0.1
1,580
42
15,600

744
674
4.9
560
23,000
<0.5
1,500
38
12,000

745
685
4.19
688
22,900
0.3
1,610
29
11,900

795
723
4.77
662
24,600
0.3
1,560
27
12,900

802
745
3.70
743
25,000
0.4
1,510
29
13,400

795
779
1.01
784
24,600
0.3
1,640
30
13,900

798
762
2.35
742
24,600
0.2
1,820
21
13,200

816
716
6.53
675
25,000
0.2
1,630
25
12,600

-

837
744
5.92
648
26,000
0.3
1,610
27
13,300

860
810
3.01
708
26,800
0.3
1,690
29
14,600

4,470
<0.1
1,340

4200
<0.05

4,420
0.1
-

4,530
<0.1
-

4,320
<0.1
1,500

4,510
<0.1
1,410

4,750
<0.1
-

5,100
<0.1
-

-

4,720
<0.1
-

4,760
<0.1
1,700

0.03
<0.002
<0.002
<0.002
<0.002
<0.0002
0.003
<0.002
<0.002
<0.10
<0.002
0.076
0.164
0.003
0.006
<0.02
<0.002
15.8
<0.002
<0.02
0.020
<0.02
0.039
<0.005

<0.25
<0.005
0.001
<0.001
<0.005
<0.0002
0.001
<0.001
<0.001
<0.05
<0.001
0.10
0.17
<0.005
0.005
0.002
<0.005
17
<0.05
<0.005
<0.005
<0.005
0.033

-

<0.01
<0.001
0.013
<0.001
<0.001
<1E-4
<0.001
<0.001
<0.001
0.71
<0.001
0.061
0.248
0.004
0.002
<0.01
<0.001
12.1
<0.001
<0.01
0.008
<0.01
0.006
<0.005

-

0.04
0.002
0.013
<0.002
0.002
<0.0002
<0.002
<0.002
<0.002
0.77
<0.002
0.049
0.248
0.004
<0.002
<0.02
<0.002
16.8
<0.002
<0.02
0.008
<0.02
<0.010
<0.005

-

<0.01
<0.001
0.003
<0.001
0.002
<0.0001
<0.001
0.001
<0.001
0.16
<0.001
0.033
0.096
0.002
0.006
<0.01
<0.001
15.5
<0.001
<0.01
0.009
<0.01
0.084
<0.005

-

<0.01
<0.001
0.005
<0.001
<0.001
<1E-4
<0.001
0.001
<0.001
0.21
<0.001
0.042
0.113
0.003
0.005
<0.01
<0.001
12.7
<0.001
<0.01
0.011
<0.01
0.040
<0.005

-

-

-

0.129
0.01
0.026
0.1
0.01
0.01
0.1
0.05
0.042
9.42
2
0.233
1.47
0.024
0.038
0.02
0.01
27
0.01

5
0.05
0.1
0.5
0.05
0.05
1
0.1
0.2
10.7
5
2.5
1.67
0.028
0.2
0.05
0.05
30.6
0.1

0.1
0.5
5

0.065
0.1
0.166

0.076
0.5
2

5
0.1
0.1
0.2
0.2
0.01

2
1
10
10
0.1

0.026
0.1
9.422
1.472
0.065

0.1
1
10.706
1.673
0.073

0.05
<0.002
0.004
<0.10
0.172
0.024

<0.25
0.001
0.003
0.05
0.17
0.018

-

0.23
0.013
<0.001
0.90
0.241
0.008

-

0.18
0.014
<0.002
0.94
0.265
0.015

-

0.02
0.003
<0.001
0.19
0.096
0.011

-

0.10
0.005
<0.001
0.32
0.125
0.014

-

5

5
5
5
5
5
5

5
5
5
5
5
5

25
25
25
25
25
25

< 0.05
0.18
< 0.2
0.05
< 0.02
< 0.2

0.05
0.26
0.3
0.4

-

< 0.05
0.13
< 0.2
0.03
< 0.02
< 0.2

-

< 0.05
0.17
< 0.2
< 0.02
< 0.02
< 0.2

-

< 0.05
< 0.01
< 0.2
< 0.02
< 0.02
< 0.2

< 0.05
0.03
< 0.2
0.04
< 0.02
< 0.2

< 0.05
0.06
< 0.2
0.02
< 0.02
< 0.2

-

5

20

0.1
0.1

2
0.5

0.01
0.1
0.05
0.2
0.2
2
2.5
0.2
0.01
0.2
0.02

0.05
1
0.1
5
10
5
2.5
10
0.05
2
0.05

0.01
0.1
2

Note:
* This value is not a Site Specific Trigger Level (SSTL) but an acceptable charge balance error (CBE) threshold for high ionic strength
groundwater from the Shepparton Formation
** SSTLs for UGM-M9S, UGM-M1S and UGM-M6S have been revised as follows:
UGM-M9S - TDS: Green (<72,270 mg/L), Yellow (≥ 72,270 mg/L), Red (>81,125 mg/L)
UGM-M1S - Molybdenum: Green (<0.0583 mg/L), Yellow (≥ 0.0583 mg/L), Red (>0.662 mg/L)

Page 3 of 6


### Appendix C: Table 1. Summary of Groundwater Analytical Results - Shepparton Formation (Swing 1 to Swing 9)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>EQL</th>
<th>Groundwater from Shepparton Formation</th>
<th>Groundwater from Shepparton Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Cations and Anions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>2.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfate as SO4</td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iron</td>
<td>mg/L</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organic Carbon</strong></td>
<td>mg/L</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Organic Carbon</strong></td>
<td>mg/L</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Balance Error</strong></td>
<td>mg/L</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. This value is not a Site Specific trigger level (EQL) but can be acceptable change balance error (CBE) threshold for high ionic strength groundwater from the Shepparton Formation.
### Appendix C: Table 1. Summary of Groundwater Analytical Results - Shepparton Formation (Swing 1 to Swing 9)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
<th>Sample 6</th>
<th>Sample 7</th>
<th>Sample 8</th>
<th>Sample 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Cations and Anions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>mg/L</td>
<td>56,900</td>
<td>32,300</td>
<td>51,200</td>
<td>39,300</td>
<td>36,100</td>
<td>40,300</td>
<td>34,000</td>
<td>44,300</td>
<td>40,100</td>
</tr>
<tr>
<td><strong>Dissolved Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony (Sb)</td>
<td>mg/L</td>
<td>0.004</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>-</td>
<td>0.001</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Bismuth (Bi)</td>
<td>mg/L</td>
<td>&lt;0.002</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>-</td>
<td>0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>mg/L</td>
<td>0.016</td>
<td>0.010</td>
<td>0.002</td>
<td>0.036</td>
<td>0.005</td>
<td>&lt;0.002</td>
<td>0.003</td>
<td>0.008</td>
<td>0.002</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>mg/L</td>
<td>1.480</td>
<td>1.150</td>
<td>0.480</td>
<td>0.670</td>
<td>0.450</td>
<td>0.210</td>
<td>0.280</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>mg/L</td>
<td>1.567</td>
<td>1.335</td>
<td>0.674</td>
<td>0.968</td>
<td>0.630</td>
<td>0.350</td>
<td>0.438</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>mg/L</td>
<td>2.627</td>
<td>2.227</td>
<td>1.074</td>
<td>1.567</td>
<td>1.227</td>
<td>0.534</td>
<td>0.638</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>mg/L</td>
<td>1.040</td>
<td>0.840</td>
<td>0.390</td>
<td>0.580</td>
<td>0.450</td>
<td>0.210</td>
<td>0.280</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>mg/L</td>
<td>3.970</td>
<td>3.270</td>
<td>1.530</td>
<td>2.080</td>
<td>1.730</td>
<td>0.810</td>
<td>0.990</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>mg/L</td>
<td>0.084</td>
<td>0.074</td>
<td>0.034</td>
<td>0.054</td>
<td>0.044</td>
<td>0.024</td>
<td>0.034</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td>Tin (Sn)</td>
<td>mg/L</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.005</td>
<td>0.010</td>
</tr>
<tr>
<td><strong>Total Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium (Al)</td>
<td>mg/L</td>
<td>1.760</td>
<td>1.380</td>
<td>1.300</td>
<td>1.320</td>
<td>1.730</td>
<td>933</td>
<td>2,070</td>
<td>1,430</td>
<td></td>
</tr>
<tr>
<td><strong>Organic Carbon</strong></td>
<td>mg/L</td>
<td>0.004</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>-</td>
<td>0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
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Appendix C: Table 1. Summary of Groundwater Analytical Results - Shepparton Formation (Swing 1 to Swing 9)

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<td>Organic Carbon</td>
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Note: The values are not in Site Specific Trigger Levels (SSTLs) but on acceptable charge balance error (CBE) threshold for high ionic strength groundwater from the Shepparton Formation.

*100% for UGM-M9S, UGM-M1S and UGM-M6S have been revised as follows:
*100% for UGM-M9S, UGM-M1S and UGM-M6S have been revised as follows:
*100% for UGM-M9S, UGM-M1S and UGM-M6S have been revised as follows:
*100% for UGM-M9S, UGM-M1S and UGM-M6S have been revised as follows:
Appendix E

Entire chemical substance dataset and SSTLs for Olney Fm
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<td>10.1</td>
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| **SSTLs for dissolved zinc for Karra Homestead have been revised and are as follows:**
|                    |      |          |             |                  |                      |                |                 |                 |
|                    |      |          |             |                  |                      |                |                 |                 |
|                    |      |          |             |                  |                      |                |                 |                 |

Notes:
- *Note:* this value is not a Site Specific Trigger Level (SSTL) but an acceptable charge balance error (CBE) threshold for the Lower Kenrick Formation
- *SSTLs for dissolved zinc for Karra Homestead have been revised and are as follows:*
- Green 2.0 (11.5 mg/l), Yellow 0.5 (0.5 mg/l), Red 0.5 (0.5 mg/l)
Appendix F

WISH groundwater plots and trend assessment
TDS (mg/L) - LPS time series

Total dissolved solids

TDS [mg/L]

Time

TDS (mg/L) - SFM bubble plot for Stope 4 - Dec 2016
TDS (mg/L) - LPS bubble plot for Hard-stand and Stope 1b & 3 - Dec 2016
TDS- SFM slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
TDS- SFM slope trend (mg/L/day) for Stope 4
TDS- LPS slope trend (mg/L/day) for Stope 1b & 3
TDS- LPS slope trend (mg/L/day) for Stope 4
pH - SFM time series
pH - LPS time series
pH- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016
pH- LPS bubble plot for Hard-stand and Stope 1b & 3- Dec 2016
pH- LPS bubble plot for Stope 4- Dec 2016
pH- SFM slope trend (mg/L/day) for Stope 4
pH- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
pH- LPS slope trend (mg/L/day) for Stope 4
Alk- SFM time series

Methyl orange alkalinity

T.Alk [mg/l]

Time

Alk- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016
Alk- SFM bubble plot for Stope 4- Dec 2016
Alk- LPS bubble plot for Hard-stand and Stope 1b & 3- Dec 2016
Alk- LPS bubble plot for Stope 4- Dec 2016
Alk- SFM slope trend (mg/L/day) for Stope 1b & 3
Alk- SFM slope trend (mg/L/day) for Stope 4
Alk- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
Alk- LPS slope trend (mg/L/day) for Stope 4
Total Acidity (mg/L) - SFM time series
Total Acidity (mg/L) - SFM bubble plot for Hard-stand and Stopes 1b & 3 - Dec 2016
Total Acidity (mg/L) - SFM bubble plot for Stope 4 - Dec 2016
Total Acidity (mg/L) - LPS bubble plot for Hard-stand and Stope 1b & 3 - Dec 2016
Total Acidity (mg/L) - LPS bubble plot for Stope 4 - Dec 2016
Total Acidity - SFM slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
Total Acidity - SFM slope trend (mg/L/day) for Stope 4
Total Acidity - LPS slope trend (mg/L/day) for Stope 1b & 3
Total Acidity - LPS slope trend (mg/L/day) for Stope 4
Al- SFM time series
Al - LPS time series

Time series graph showing Al levels over time from May 2016 to December 2016. The graph includes various markers and colors representing different data points and trends.
Al- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016
N/A since AL is LOD
Al- LPS bubble plot for Hard-stand and Stope 1b & 3- Dec 2016
N/A since AL is LOD
Al-SFM slope trend (mg/L/day) for Stope 1b & 3
Al- SFM slope trend (mg/L/day) for Stope 4

N/A since AL is LOD
Al- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
Al- LPS slope trend (mg/L/day) for Stope 4

N/A since AL is LOD
Cl:SO4- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016
Cl:SO\textsubscript{4} - SFM bubble plot for Stope 4 - Dec 2016
Cl:SO4- SFM slope trend (mg/L/day) for Stope 4
Cl:SO4- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
Cl\textsubscript{4}SO- LPS slope trend (mg/L/day) for Stope 4
Mg - SFM time series
Mg- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016
Mg - SFM bubble plot for Stope 4 - Dec 2016
Mg- LPS bubble plot for Hard-stand and Stope 1b & 3- Dec 2016
Mg- SFM slope trend (mg/L/day) for Stope 1b & 3
Mg- SFM slope trend (mg/L/day) for Stope 4
Mg- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
Mg- LPS slope trend (mg/L/day) for Stope 4
Fe2 (mg/L) - SFM B&W
Fe2 (mg/L) - SFM bubble plot for Hard-stand and Stopes 1b & 3 - Dec 2016
Fe₂ (mg/L) - SFM bubble plot for Stope 4 - Dec 2016
Fe2 (mg/L) - LPS bubble plot for Hard-stand and Stope 1b & 3 - Dec 2016
Fe2 (mg/L) - LPS bubble plot for Stope 4 - Dec 2016
S2 (mg/L) - LPS time series
S2- SFM bubble plot for Hard-stand and Stopes 1b & 3- Dec 2016

N/A all below LOD
S2- SFM bubble plot for Stope 4- Dec 2016

N/A all below LOD
S2- LPS bubble plot (mg/L) for Hard-stand and Stope 1b & 3- Dec 2016
S2- LPS bubble plot (mg/L) for Stope 4 - Dec 2016
S2- SFM slope trend (mg/L/day) for Stope 1b & 3

N/A all below LOD
S2- SFM slope trend (mg/L/day) for Stope 4

N/A all below LOD
S2- LPS slope trend (mg/L/day) for Hard-stand and Stope 1b & 3
S2- LPS slope trend (mg/L/day) for Stope 4
Appendix G

Statement of Limitations
INTRODUCTION

This report has been prepared by Land & Water Consulting for you, as Land & Water Consulting’s client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice.

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Land & Water Consulting may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Land & Water Consulting has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

No warranty or guarantee of the site conditions is intended.

This report was prepared for the sole use of you, the Client and may not contain sufficient information for purposes of other parties or for other uses. Any reliance on this report by third parties shall be at such parties sole risk. This report shall only be presented in full and may not be used to support any other objectives than those set out in the report, except where written approval with comments are provided by Land & Water Consulting.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

LIMITATIONS OF THE REPORT

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- When the size or configuration of the proposed development is altered;
- When the location or orientation of the proposed structures are modified;
- When there is a change in ownership;
- For application to an adjacent site.
In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

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Balranald Mineral Sands Project

Compliance noise monitoring June 2016

Prepared for Iluka Resources Limited | 5 July 2016
Balranald Mineral Sands Project

Final

Report J16090RP1 | Prepared for Iluka Resources Limited | 5 July 2016

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<th>Teanuanua Villerre</th>
<th>Approved by</th>
<th>Najah Ishac</th>
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</thead>
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<td>Acoustic Consultant</td>
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<td>Director</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Date</td>
<td>5/7/16</td>
<td>Date</td>
<td>5/7/16</td>
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</tbody>
</table>

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<td>Draft</td>
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1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged to complete attended noise monitoring on behalf of Iluka Resources Limited (Iluka Resources) during pre-mining bulk sampling work associated with the Balranald Mineral Sands Project (the project).

The purpose of the noise monitoring was to address requirements of the project’s Development Consent (application number SSD-5285) by establishing a definitive noise contribution during the bulk sampling activity to inform the project team of expected worst case noise levels and assessing compliance against the noise criteria (refer Section 3).

This report presents the methodology, results and findings of attended noise monitoring conducted during the day-time and night-time periods on 15 June 2016.

The following material was referenced as part of this assessment:

- Department of Planning and Environment (DP&E), Development Consent SSD-5285 (development consent), 2016; and
- Environment Protection Authority (EPA), Industrial Noise Policy (INP), 2000.

Monitoring results showed that site noise levels were below the relevant noise limits during all measurements at the nearest residential location R5 and all privately-owned residences during this June 2016 monitoring period.
2 Glossary of acoustic terms

Several technical terms are discussed in this report. These are explained in Table 2.1.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB</td>
<td>Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.</td>
</tr>
<tr>
<td>$L_{A1}$</td>
<td>The 'A-weighted' noise level which is exceeded 1% of the time.</td>
</tr>
<tr>
<td>$L_{A1(1-min)}$</td>
<td>The 'A-weighted' noise level exceeded for 1% of the specified time period of 1 minute.</td>
</tr>
<tr>
<td>$L_{A10}$</td>
<td>The 'A-weighted' noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise level.</td>
</tr>
<tr>
<td>$L_{A90}$</td>
<td>Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.</td>
</tr>
<tr>
<td>$L_{Aeq}$</td>
<td>The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The $L_{Aeq(15-min)}$ descriptor refers to an $L_{Aeq}$ noise level measured over a 15 minute period.</td>
</tr>
<tr>
<td>$L_{Amin}$</td>
<td>The minimum 'A-weighted' noise level received during a measuring interval.</td>
</tr>
<tr>
<td>$L_{Amax}$</td>
<td>The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.</td>
</tr>
<tr>
<td>$L_{Ceq}$</td>
<td>The energy average noise from a source. This is the equivalent continuous 'C-weighted' sound pressure level over a given period. The $L_{Ceq(15-min)}$ descriptor refers to an $L_{Ceq}$ noise level measured over a 15 minute period.</td>
</tr>
<tr>
<td>Day period</td>
<td>Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.</td>
</tr>
<tr>
<td>Evening period</td>
<td>Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.</td>
</tr>
<tr>
<td>Night period</td>
<td>Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.</td>
</tr>
<tr>
<td>Temperature Inversion</td>
<td>A meteorological condition where the atmospheric temperature increases with altitude.</td>
</tr>
</tbody>
</table>

It is useful to have an appreciation of decibels (dB), the unit of noise measurement. Table 2.2 gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels are provided in Figure 2.1.

<table>
<thead>
<tr>
<th>Change in sound level (dB)</th>
<th>Perceived change in noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>just perceptible</td>
</tr>
<tr>
<td>5</td>
<td>noticeable difference</td>
</tr>
<tr>
<td>10</td>
<td>twice (or half) as loud</td>
</tr>
<tr>
<td>15</td>
<td>large change</td>
</tr>
<tr>
<td>20</td>
<td>four times (or quarter) as loud</td>
</tr>
</tbody>
</table>
Figure 2.1  Common noise levels

Source: Road Noise Policy (Department of Environment, Climate Change and Water 2011)
3 Noise criteria

3.1 Acquisition

The project’s development consent (Table 1, Schedule 3) states that due to noise, one property namely ‘R5’, has acquisition rights upon request. Its location can be seen in Figure 3.1.

3.2 Operational noise

With regard to operational noise, the project’s development consent states (Section 4, Schedule 3):

4. Except for the noise affected land in Table 1 (R5), the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2 at any residence on privately-owned land of the other specified locations.

The project’s operational noise criteria are provided in Table 2, Schedule 3 of the development consent. They are reproduced in Table 3.1 and an extract of the relevant sections of the development consent pertaining to noise is provided in Appendix A.

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq(15 \text{ min})}$</th>
<th>Evening $L_{Aeq(15 \text{ min})}$</th>
<th>Night $L_{Aeq(15 \text{ min})}$</th>
<th>$L_{A1(1 \text{ min})}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

Property R5 is entitled to acquisition upon request and therefore the noise criteria for privately-owned land do not apply, however, has been adopted as the residential location to the bulk sampling activity (being approximately 3.1 km away) for the purpose of compliance noise monitoring. Compliance at this location will confirm compliance at all other privately-owned residences, with the nearest residences located more than 8.6 km from the bulk sampling activity.
Attended noise monitoring locations
Balranald Mineral Sands Project
Compliance noise monitoring June 2016
Figure 3.1
3.3 Meteorology

The noise criteria listed in Table 3.1 and Table 3.2 do not apply under the following meteorological conditions, as defined in the project’s development consent (Appendix 5 Section 1):

- wind speeds greater than 3 m/s at 10 m above ground level; or
- stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
- temperature inversion conditions greater than 8°C/100 m.

For the purpose of this assessment, the recorded $L_{A_{max}}$ has been used as a conservative estimate of the $L_{A_{1(1min)}}$. The INP application notes state that the EPA accepts sleep disturbance analysis based on either the $L_{A_{1(1min)}}$ or $L_{A_{max}}$ metrics (EPA 2013).

The project’s development consent states that modification factors in Section 4 of the INP (EPA 2000) shall be applied to the measured mine noise levels where applicable.

Section 11.1.3 of the INP identifies that a development is deemed to be in non-compliance if the monitored noise levels from the mine are more than 2 dB above the statutory limit. This approach is in recognition of field measurement tolerances and human perceptions to changes in noise levels and was adopted for this assessment.

3.4 Low frequency noise criteria

Section 4, Schedule 3 of the project’s development consent states that noise generated by the project is to be measured in accordance with the relevant requirements of the INP. Section 4 of the INP (EPA 2000) states that modification factors shall be applied to the measured noise levels where applicable.

It is noted that the NSW DP&E and the NSW EPA are currently completing a comprehensive study of low frequency noise (LFN) as part of the INP review. Additionally, it is acknowledged that assessment of LFN in rural areas is difficult and that current assessment processes make it difficult to enforce LFN criteria as part of consent conditions.

Section 4 of the INP (EPA 2000) provides guidelines for applying ‘modifying factor’ adjustments to account for low frequency noise emissions. The INP requires that where there is a difference of 15 dB or more between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels, a correction factor of 5 dB is added to the measured site noise level (at residences only) before comparison to the relevant noise criterion. Hence, where possible throughout each survey the operator has estimated the difference between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels by matching audible sounds with the response of the analyser ($L_{Ceq}-L_{Aeq}$ noise metric). Monitoring identified that the correction factor of 5 dB for low frequency noise was identified to be applicable during two of the three night-time measurements at residential location R5. This is discussed further in Section 5.
4 Assessment methodology

4.1 Attended noise monitoring locations

The purpose of the attended noise monitoring was to assess the project’s compliance with noise criteria (refer to Section 3.2) and capture a definitive noise contribution from the bulk sampling activity. Therefore, noise monitoring was conducted at the nearest residential location, R5, and at intermediate locations nearer to the project’s activities (being NM1 and NM2) when noise from the project was barely audible or a noise contribution was not determinable at location R5. It is noted that noise limits only apply at privately-owned residences and therefore do not also apply at the two intermediate locations NM1 and NM2. The noise monitoring was conducted during peak bulk sampling activity to assess noise levels during worst case operations.

The attended noise monitoring locations and their coordinates are listed in Table 4.1 and are shown in Figure 3.1.

Table 4.1 Attended noise monitoring locations

<table>
<thead>
<tr>
<th>Monitoring location</th>
<th>Description</th>
<th>Distance to current bulk sampling location</th>
<th>MGA54</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5¹</td>
<td>Nearest residential location</td>
<td>Approximately 3.1 km to the south-west</td>
<td>0720405 6188313</td>
</tr>
<tr>
<td>NM1</td>
<td>Intermediate monitoring location</td>
<td>Approximately 1.7 km to the south-west</td>
<td>0721547 6189159</td>
</tr>
<tr>
<td>NM2</td>
<td>Intermediate monitoring location</td>
<td>Approximately 0.8 km to the south-west</td>
<td>0722391 6189660</td>
</tr>
</tbody>
</table>

Notes: ¹ Has acquisition rights upon request.

4.2 Instrumentation

A Brüel & Kjær 2250 Type 1 sound analyser (s/n 2759405) was used to conduct 15-minute measurements and record 1/3 octave frequency and statistical noise indices. The sound analyser was calibrated before and on completion of the survey using a Brüel & Kjær Type 4230 calibrator (s/n 1276091). The instruments were within their NATA laboratory calibration period during the time of these readings and certificates are provided in Appendix B.

Where possible throughout each survey the operator has quantified the contribution of each significant noise source. This is done by matching audible sounds with the response of the analyser (where applicable) and/or via post-analysis of data (eg low pass filtering).

4.3 Meteorology

There is currently no weather station installed at the project site and the closest publically available weather station is at Mildura, approximately 160 km from the project site. Therefore, wind speed measurements (at microphone height) were taken and weather observations noted by the operator during each survey.
4.3.1 Stability category

The stability category throughout the attended monitoring program was quantified using the Pasquill-Gilford scheme as per Appendix E of the INP (EPA 2000). This analysis was required to determine, in accordance with the project’s development consent, whether noise limits were applicable during the attended noise monitoring period.

Table E3 of the INP (EPA 2000) is reproduced in Table 4.2 and presents the stability categories based on night-time cloud cover.

Table 4.2 Key to Pasquill stability categories

<table>
<thead>
<tr>
<th>Hourly average wind speed at 10 m (m/s)</th>
<th>Daytime stability categories</th>
<th>Stability categories based on night cloud cover² (night = 6 pm to 7 am)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Thinly overcast or ≥ 4/8 low cloud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 3/8 cloud</td>
</tr>
<tr>
<td>&lt;2</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>2-3</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>3-5</td>
<td>A-D¹</td>
<td>D</td>
</tr>
<tr>
<td>5-6</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>&gt;6</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

Source: Table E3 Appendix E of the INP (2000) (Adapted from Pasquill 1961)

Notes:
1. In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gilford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. Class F relates to stable conditions, such as those that occur when the sky is clear, the winds are light and an inversion is present. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. A seventh class, G, has also been defined to accommodate extremely stable conditions such as might be found in arid rural areas.
2. The neutral category D should be used for overcast conditions regardless of wind speed.

Table 4.3 provides the stability categories calculated using the Pasquill-Gilford scheme for each measurement during the monitoring period.

Table 4.3 Calculated stability category Pasquill

<table>
<thead>
<tr>
<th>Date</th>
<th>Start time</th>
<th>Average wind speed during measurement at 10 m (m/s)³</th>
<th>Cloud cover (eighths)</th>
<th>Calculated stability category</th>
<th>Noise limits apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/6/16</td>
<td>15:33</td>
<td>&lt;2</td>
<td>0</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>15/6/16</td>
<td>16:00</td>
<td>≤2</td>
<td>0</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>15/6/16</td>
<td>16:21</td>
<td>≤4-6</td>
<td>0</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>15/6/16</td>
<td>23:05</td>
<td>&lt;2</td>
<td>0</td>
<td>G</td>
<td>Yes</td>
</tr>
<tr>
<td>15/6/16</td>
<td>23:30</td>
<td>2-3</td>
<td>0</td>
<td>F</td>
<td>No</td>
</tr>
<tr>
<td>15/6/16</td>
<td>23:57</td>
<td>&lt;2</td>
<td>0</td>
<td>G</td>
<td>Yes</td>
</tr>
<tr>
<td>16/6/16</td>
<td>00:15</td>
<td>2-3</td>
<td>0</td>
<td>F</td>
<td>No</td>
</tr>
</tbody>
</table>

Notes:
1. Wind speed values were measured at microphone height (1.5 m above ground level) during each measurement and were extrapolated to 10 m values using the method outlined in the technical paper "Converting bureau of meteorology wind speed data to local wind speeds at 1.5 m above ground level" (Gowen et. al 2004).
5 Review of data and discussion

5.1 Summary

The results of the attended noise monitoring are summarised in Table 5.1. The project’s contribution was determined using in field observations and post-analysis of data as required (eg removing higher frequencies that are not mine related, ie above 630 Hz). Attended noise monitoring was completed during the day-time and night-time period of 15 June 2016, and the night-time period of 16 June 2016.

The results demonstrate that the project’s \( L_{Aeq(15\text{ min})} \) noise contribution was below the development consent limits. This is based on all measurements at location R5, where limits do not apply, and privately-owned residences being further removed.

The total measured \( L_{Aeq(15\text{ min})} \) noise level (ie all noise sources) was below the relevant development consent noise limits for all the night-time measurements at location R5, as well as the day-time and night-time measurement at NM1. Hence, this reaffirms that the project’s noise emissions were below the development consent noise limits at all privately-owned residences.

Low frequency noise was assessed by estimating site 'C-weighted' minus 'A-weighted' levels. The project’s 'C-weighted' emission values were not determinable for the day-time measurements, and the first night-time measurement at location R5. This was due to the relatively low site noise emissions (intermittently audible) compared to ambient noise during these measurements. Low frequency noise, as defined in the INP, was identified during two of the three night-time measurements at residential location R5. Therefore, a 5 dB modifying factor has been added to site noise \( L_{Aeq(15\text{-min})} \) contribution for these two measurements.
## Table 5.1  Project attended noise monitoring results - June 2016

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Start time</th>
<th>Total noise levels, dB</th>
<th>Site contribution, dB</th>
<th>Noise limits(^4) (\text{dB})</th>
<th>Meteorological condition(^1)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(L_{A_{min}})</td>
<td>(L_{A_{20}})</td>
<td>(L_{A_{eq}})</td>
<td>(L_{A_{10}})</td>
<td>(L_{A_{1}})</td>
</tr>
<tr>
<td>R5</td>
<td>15/6</td>
<td>15:33</td>
<td>22</td>
<td>24</td>
<td>36</td>
<td>29</td>
<td>49</td>
</tr>
<tr>
<td>NM1 (1.7 km from site activities)</td>
<td>15/6</td>
<td>16:00</td>
<td>21</td>
<td>23</td>
<td>27</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td>NM2 (0.8 km from site activities)</td>
<td>15/6</td>
<td>16:21</td>
<td>30</td>
<td>33</td>
<td>36</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>R5</td>
<td>15/6</td>
<td>23:05</td>
<td>22</td>
<td>24</td>
<td>26</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>NM1 (1.7 km from site activities)</td>
<td>15/6</td>
<td>23:30</td>
<td>28</td>
<td>32</td>
<td>34</td>
<td>36</td>
<td>37</td>
</tr>
<tr>
<td>R5</td>
<td>15/6</td>
<td>23:57</td>
<td>23</td>
<td>26</td>
<td>28</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>R5</td>
<td>16/6</td>
<td>00:15</td>
<td>25</td>
<td>27</td>
<td>30</td>
<td>32</td>
<td>36</td>
</tr>
</tbody>
</table>

**Notes:**
1. Wind data was taken (at microphone height) during measurement. Refer to Section 4.3 for stability class.
2. Modifying factor of 5 dB for low frequency noise applicable in accordance with section 4 of the INP (difference of 15 dB or more between site 'C-weighted' and site 'A-weighted' noise levels).
3. For assessment purposes the \(L_{A_{eq}}\) and the \(L_{A_{eq}}\) are interchangeable.
4. '-' indicates that development consent limits do not apply at this location.
5.2 Residential location R5

Noise emissions from the project were audible at location R5. Noise from the project was characterised by general mine ‘hum’. No individual noise sources (ie certain types of plant) were identified at location R5.

During the day-time and first night-time measurement (started at 23:05) at location R5 the general mine ‘hum’ of the project was intermittently audible over the background ambient noise. During the other night-time measurements at location R5 the mine ‘hum’ was audible and more present as well as some intermittent noise from mobile plant.

Due to meteorological conditions, noise limits were applicable for three of the four measurements at location R5.

The project’s L_{Aeq(15\text{ min})} contribution at location R5 was estimated to be below 20 dB during the day-time period measurement. During the night-time period measurement, the project’s L_{Aeq(15\text{ min})} contribution ranged between 22 and 35 dB, including where applicable a low frequency noise penalty of 5 dB.

The total measured L_{Aeq(15\text{ min})} noise level (ie all noise sources) was below the development consent noise limits for all the night-time measurements at location R5, and hence this provides further indication of compliance with the project’s development consent.

5.3 Intermediate monitoring location NM1

Due to noise from site not being clearly audible at location R5, monitoring was completed at intermediate location NM1 (approximately 1.7 km from bulk sampling activities). Noise from the project was audible at NM1 and site L_{Aeq(15\text{ min})} contributions were estimated to be 24 dB and 34 dB during the daytime and night-time measurements, respectively. It is noted that the site 'C-weighted' minus site 'A-weighted' level was estimated to be on or above the 15 dB low frequency noise threshold during the night-time measurement at location NM1, however the INP’s 5 dB modification factor does not apply at this location. Development consent noise limits do not apply at location NM1, however it is estimated that site L_{Aeq(15\text{ min})} noise levels at location R5 during these measurements would be below the relevant noise limits.

5.4 Intermediate monitoring location NM2

Due to noise from site not being clearly audible at locations R5 and NM1 during the daytime noise monitoring, attended measurement was completed at intermediate location NM2 (approximately 0.8 km from bulk sampling activities). Noise from the project was clearly audible at location NM2 and site L_{Aeq(15\text{ min})} contribution was estimated to be 36 dB during the daytime period. Development consent noise limits do not apply at location NM2, however it is estimated that site L_{Aeq(15\text{ min})} noise levels at location R5 during this measurement would be below the relevant noise limits.
6 Conclusion

EMM has completed a review of noise emissions from pre-mining bulk sampling work associated with the Balranald Mineral Sands Project based on attended noise monitoring conducted during the day-time and night-time periods on 15 June 2016 and the night-time period on 16 June 2016.

Based on monitoring results at monitoring location R5, the site $L_{Aeq(15\text{ min})}$ noise satisfied the noise limits during all measurements at privately-owned residential properties. Meteorological observations and measurements during the attended noise monitoring period were assessed and noise limits were deemed to be applicable as per the development consent as relevant.

Further, monitoring completed at intermediate locations NM1 and NM2 indicated that site $L_{Aeq(15\text{ min})}$ noise level would satisfy the noise limits at privately-owned residences.

Therefore attended noise monitoring demonstrated that site noise complied with the relevant noise limits for this June monitoring period.
Appendix A

Development consent
SCHEDULE 3
ENVIRONMENTAL PERFORMANCE CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from an owner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 3 and 4 of Schedule 4.

<table>
<thead>
<tr>
<th>Acquisition Basis</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>R5</td>
</tr>
</tbody>
</table>

Note: To interpret the land referred to in Table 1, see the figure in Appendix 4.

ADDITIONAL NOISE MITIGATION UPON REQUEST

2. Upon receiving a written request from an owner of the land listed in Table 1 (unless the landowner has requested acquisition), the Applicant shall implement additional noise mitigation measures (such as double glazing, insulation and/or air conditioning) at the residence in consultation with the landowner. These measures must be reasonable and feasible, and directed towards reducing the noise impacts of the development on the residence commensurate with the level of impact in accordance with the Voluntary Land Acquisition and Mitigation Policy (November 2014).

If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or if there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

NOISE

Operational Noise Criteria

3. Except for the noise-affected land in Table 1, the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq(15min)}$</th>
<th>Evening $L_{Aeq(15min)}$</th>
<th>Night $L_{Aeq(15min)}$</th>
<th>$L_{A1(1min)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any residence on privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

Noise generated by the development is to be measured in accordance with the relevant requirements of the NSW Industrial Noise Policy (as may be updated or replaced from time to time). Appendix 5 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.

However, these noise criteria do not apply if the Applicant has an agreement with the owner/s or leaseholders of the residence to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.

Operating Conditions

4. The Applicant shall:
   (a) implement all reasonable and feasible measures to minimise the construction, operational and road noise of the development;
   (b) minimise the noise impacts of the development during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 5); and
   (c) undertake regular attended monitoring of the noise of the development, to ensure compliance with the relevant conditions of this consent.

Noise Management Plan

5. Prior to carrying any development under this consent, the Applicant shall prepare a Noise Management Plan for the development to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA;
(b) describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions of this consent;
(c) include a noise monitoring program for evaluating and reporting on:
   • compliance against the noise criteria in this consent; and
   • compliance against the noise operating conditions; and
(d) defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

Following approval, the Applicant must carry out the development in accordance with this plan.

AIR QUALITY

Odour
6. The Applicant shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

Air Quality Criteria
7. The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 3, 4 and 5 at any residence on privately owned land.

<table>
<thead>
<tr>
<th>Table 3: Long term impact assessment criteria for particulate matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Total suspended particulate (TSP) matter</td>
</tr>
<tr>
<td>Particulate matter &lt; 10 µm (PM10)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4: Short term impact assessment criterion for particulate matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Particulate matter &lt; 10 µm (PM10)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5: Long term impact assessment criteria for deposited dust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>c Deposited dust</td>
</tr>
</tbody>
</table>

Notes to Tables 3-5
- a Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).
- b Incremental impact (i.e. incremental increase in concentrations due to the development on its own).
- c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
- d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

Operating Conditions
8. The Applicant shall:
(a) implement all reasonable and feasible measures to minimise the:
   • off-site odour and dust emissions of the development; and
   • release of greenhouse gas emissions from the development;
(b) minimise any visible off-site air pollution generated by the development;
(c) minimise the surface disturbance of the site;
(d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d to Tables 3-5); and
(e) assess air quality monitoring data to determine whether the development is complying with the relevant conditions of this consent and, if necessary, adjust the scale of operations on site to meet the criteria in this consent.
APPENDIX 5
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions
1. The noise criteria in condition 3 of Schedule 3 apply under all meteorological conditions except the following:
   (a) wind speeds greater than 3 m/s at 10 metres above ground level; or
   (b) stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
   (c) temperature inversion conditions greater than 8°C/100m.

Determination of Meteorological Conditions
2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station on or in the vicinity of the site.

Compliance Monitoring
3. Unless directed otherwise by the Secretary, attended monitoring is to be used to evaluate compliance with the relevant conditions of consent.

   Note: The Noise Management Plan (see condition 5 of Schedule 3) is required to include a noise monitoring program for the development, which will include details of the frequency of monitoring. The Secretary may direct that the frequency of monitoring increase or decrease at any time during the life of the development.

4. Unless otherwise agreed with the Secretary, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended or replaced from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.
Appendix B

Calibration certificates
CERTIFICATE OF CALIBRATION

Calibration of:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Brand</th>
<th>Model</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound Level Meter</td>
<td>Brüel &amp; Kjær</td>
<td>2250</td>
<td>2759405</td>
</tr>
<tr>
<td>Microphone</td>
<td>Brüel &amp; Kjær</td>
<td>4189</td>
<td>2888134</td>
</tr>
<tr>
<td>Preamplifier</td>
<td>Brüel &amp; Kjær</td>
<td>ZC-0032</td>
<td>16037</td>
</tr>
<tr>
<td>Supplied Calibrator</td>
<td>Brüel &amp; Kjær</td>
<td>4230</td>
<td>1276091</td>
</tr>
<tr>
<td>Software version</td>
<td>BZ7222 Version 3.5.3</td>
<td>Pattern Approval:</td>
<td>Pending</td>
</tr>
<tr>
<td>Instruction manual</td>
<td>BE1712-18</td>
<td>Identification:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Customer:
EMM Consulting
Level 5, 21 Bolton Street
Newcastle NSW 2300

Calibration Conditions:
Preconditioning: 4 hours at 23 °C
Environment conditions: see actual values in Environmental conditions sections

Specifications:
The Sound Level Meter has been calibrated in accordance with the requirements as specified in IEC61672-3:2006 class 1. Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Procedure:
The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System B&K 3630 with application software type 7763 (version 5.1 - DB: 5.10) and test procedure 2250-4189.

Results:

<table>
<thead>
<tr>
<th></th>
<th>Calibration prior to repair/adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial calibration</td>
<td>Calibration without repair/adjustment</td>
</tr>
<tr>
<td>X Calibration without repair/adjustment</td>
<td>Calibration after repair/adjustment</td>
</tr>
</tbody>
</table>

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor k = 2 providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 03/02/2016
Certificate issued: 03/02/2016

Sajeeb Tharayil
Calibration Technician

Jan Rasmussen
Approved signatory

Reproduction of the complete certificate is allowed. Part of the certificate may only be reproduced after written permission.
CERTIFICATE OF CALIBRATION No.: CAU1600071

CALIBRATION OF:

| Calibrator: | Brüel & Kjær 4230 | No: 1276091 |
| Identification: | Sound Level Calibrator |
| IEC Class: | 2 |

CUSTOMER:

| EMM Consulting |
| Level 5 |
| 21 Bolton Street |
| Newcastle NSW 2300 |

CALIBRATION CONDITIONS:

| Preconditioning: | 4 hours at 23 °C |
| Environment conditions: | Air temperature: 24.3 °C |
| | Air pressure: 100.1 kPa |
| | Relative Humidity: 56.3 %RH |

SPECIFICATIONS:
The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:
The measurements have been performed with the assistance of Brüel & Kjær acoustic calibrator calibration application software Type 7794 using calibration procedure 4230 Complete

RESULTS:

- Initial Calibration
- Recalibration without repair/adjustment
- Calibration before repair/adjustment
- Calibration after repair/adjustment

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: 03/02/2016
Certificate issued: 03/02/2016

Jan Rasmussen
Approved Signatory

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Balranald Mineral Sands Project

Compliance noise monitoring July 2016

Prepared for Iluka Resources Limited | 27 September 2016
Balranald Mineral Sands Project

Compliance noise monitoring July 2016

Prepared for Iluka Resources Limited | 27 September 2016
Balranald Mineral Sands Project

Final


Prepared by  Teanuanua Villierme  
Position  Senior Acoustic Consultant  
Signature

Approved by  Najah Ishac  
Position  Director  
Signature

Date  27/9/16  

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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Document Control

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<th>Date</th>
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<th>Reviewed by</th>
</tr>
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<td>15/8/16</td>
<td>Teanuanua Villierme</td>
<td>Najah Ishac</td>
</tr>
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<td>Final</td>
<td>27/9/16</td>
<td>Teanuanua Villierme</td>
<td>Najah Ishac</td>
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EMM

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1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged to complete attended noise monitoring on behalf of Iluka Resources Limited (Iluka Resources) during pre-mining bulk sampling work associated with the Balranald Mineral Sands Project (the project).

The purpose of the noise monitoring was to address requirements of the project’s Development Consent (application number SSD-5285) by determining a noise contribution during project operations to inform the project team of expected noise levels and assessing compliance against the noise criteria (refer Section 3). It is noted that site operations at the time of the attended noise monitoring did not include all typical activities such as drilling and sand extraction activities. Furthermore, the project was not operating between the hours of 5 pm and 6 am and therefore attended noise monitoring was not possible within those times.

This report presents the methodology, results and findings of attended noise monitoring conducted during the daytime period on 28 July 2016, as well as during the night-time and daytime periods on 29 July 2016.

The following material was referenced as part of this assessment:

- Department of Planning and Environment (DP&E), Development Consent SSD-5285 (development consent), 2016; and
- Environment Protection Authority (EPA), Industrial Noise Policy (INP), 2000.

Monitoring results showed that the project noise levels were below the relevant noise limits during all measurements at the nearest residential location R5 and all privately-owned residences during this July 2016 monitoring period.
2 Glossary of acoustic terms

Several technical terms are discussed in this report. These are explained in Table 2.1.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB</td>
<td>Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.</td>
</tr>
<tr>
<td>LA1</td>
<td>The 'A-weighted' noise level which is exceeded 1% of the time.</td>
</tr>
<tr>
<td>LA1(1-min)</td>
<td>The 'A-weighted' noise level exceeded for 1% of the specified time period of 1 minute.</td>
</tr>
<tr>
<td>LA10</td>
<td>The 'A-weighted' noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise level.</td>
</tr>
<tr>
<td>LA90</td>
<td>Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.</td>
</tr>
<tr>
<td>LAna</td>
<td>The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The LAeq(15-min) descriptor refers to an LAna noise level measured over a 15 minute period.</td>
</tr>
<tr>
<td>Lamin</td>
<td>The minimum 'A-weighted' noise level received during a measuring interval.</td>
</tr>
<tr>
<td>Lamax</td>
<td>The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.</td>
</tr>
<tr>
<td>LCeq</td>
<td>The energy average noise from a source. This is the equivalent continuous 'C-weighted' sound pressure level over a given period. The LCeq(15-min) descriptor refers to an LCeq noise level measured over a 15 minute period.</td>
</tr>
<tr>
<td>Day period</td>
<td>Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.</td>
</tr>
<tr>
<td>Evening period</td>
<td>Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.</td>
</tr>
<tr>
<td>Night period</td>
<td>Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.</td>
</tr>
<tr>
<td>Temperature Inversion</td>
<td>A meteorological condition where the atmospheric temperature increases with altitude.</td>
</tr>
</tbody>
</table>

It is useful to have an appreciation of decibels (dB), the unit of noise measurement. Table 2.2 gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels are provided in Figure 2.1.

<table>
<thead>
<tr>
<th>Change in sound pressure level (dB)</th>
<th>Perceived change in noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>just perceptible</td>
</tr>
<tr>
<td>5</td>
<td>noticeable difference</td>
</tr>
<tr>
<td>10</td>
<td>twice (or half) as loud</td>
</tr>
<tr>
<td>15</td>
<td>large change</td>
</tr>
<tr>
<td>20</td>
<td>four times (or quarter) as loud</td>
</tr>
</tbody>
</table>
Figure 2.1  Common noise levels

Source: Road Noise Policy (Department of Environment, Climate Change and Water 2011)
3 Noise criteria

3.1 Acquisition

The project’s development consent (Table 1, Schedule 3) states that due to noise, one property namely ‘R5’, has acquisition rights upon request. Its location can be seen in Figure 3.1.

3.2 Operational noise

With regard to operational noise, the project’s development consent states (Section 4, Schedule 3):

4. Except for the noise affected land in Table 1 (R5), the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2 at any residence on privately-owned land of the other specified locations.

The project’s operational noise criteria are provided in Table 2, Schedule 3 of the development consent. They are reproduced in Table 3.1 and an extract of the relevant sections of the development consent pertaining to noise is provided in Appendix A.

Table 3.1 Noise criteria from the Development Consent

<table>
<thead>
<tr>
<th>Location</th>
<th>Day</th>
<th>Evening</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{Aeq}(15 \text{ min})$</td>
<td>$L_{Aeq}(15 \text{ min})$</td>
<td>$L_{Aeq}(15 \text{ min})$</td>
</tr>
<tr>
<td>All privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Property R5 is entitled to acquisition upon request and therefore the noise criteria for privately-owned land do not apply to this location. However, this location has been adopted as the nearest residential location to the bulk sampling activity (being approximately 3.1 km away) for the purpose of compliance noise monitoring. Compliance at this location will confirm compliance at all privately-owned residences, with the nearest of these located more than 8.6 km from the bulk sampling activity.
Attended noise monitoring locations
Balranald Mineral Sands Project
Compliance noise monitoring July 2016
Figure 3.1
3.3 Meteorology

The noise criteria listed in Table 3.1 and Table 3.2 do not apply under the following meteorological conditions, as defined in the development consent (Appendix 5 Section 1):

- wind speeds greater than 3 m/s at 10 m above ground level; or
- stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
- temperature inversion conditions greater than 8°C/100 m.

For the purpose of this assessment, the recorded LAmax has been used as a conservative estimate of the LAeq(1-min). The INP application notes state that the EPA accepts sleep disturbance analysis based on either the LAeq(1-min) or LAmax metrics (EPA 2013).

The project’s development consent states that modification factors in Section 4 of the INP (EPA 2000) shall be applied to the measured mine noise levels where applicable.

Section 11.1.3 of the INP identifies that a development is deemed to be in non-compliance if the monitored noise levels from the mine are more than 2 dB above the statutory limit. This approach is in recognition of field measurement tolerances and human perceptions to changes in noise levels and was adopted for this assessment.

3.4 Low frequency noise criteria

Section 4 of Schedule 3 of the development consent states that noise generated by the project is to be measured in accordance with the relevant requirements of the INP. Section 4 of the INP (EPA 2000) states that modification factors shall be applied to the measured noise levels where applicable.

It is noted that the NSW DP&E and the NSW EPA are currently completing a comprehensive study of low frequency noise (LFN) as part of the INP review. Additionally, it is acknowledged that assessment of LFN in rural areas is difficult and that current assessment processes make it difficult to enforce LFN criteria as part of consent conditions. The draft Industrial Noise Guideline (ING) will replace the INP and is the first official publication that clearly indicates a change from the current INP approach.

Section 4 of the INP (EPA 2000) provides guidelines for applying ‘modifying factor’ adjustments to account for low frequency noise emissions. The INP requires that where there is a difference of 15 dB or more between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels, a correction factor of 5 dB is added to the measured site noise level (at residences only) before comparison to the relevant noise criterion. Hence, where possible throughout each survey the operator has estimated the difference between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels by matching audible sounds with the response of the analyser (L\text{eq}-L\text{eq} noise metric). Monitoring identified that the correction factor of 5 dB for low frequency noise was identified to be not applicable during the measurements at residential location R5. This is discussed further in Section 5.
4 Assessment methodology

4.1 Attended noise monitoring locations

The purpose of the attended noise monitoring was to assess the project’s compliance with noise criteria (refer to Section 3.2) and capture a noise contribution from the bulk sampling activity. Project operations at the time of the attended noise monitoring did not include drilling and sand extraction activities. Noise monitoring was conducted at the nearest residential location, R5, and at intermediate locations nearer and downwind from the project’s activities (being NM3 and NM4) when noise from the project was inaudible and a noise contribution was not determinable at location R5. It is noted that noise limits only apply at privately-owned residences and therefore do not apply at R5 or the two intermediate locations NM3 and NM4.

The attended noise monitoring locations and their coordinates are listed in Table 4.1 and are shown in Figure 3.1.

<table>
<thead>
<tr>
<th>Monitoring location</th>
<th>Description</th>
<th>Distance to current bulk sampling location</th>
<th>MGA54</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5</td>
<td>Nearest residential location</td>
<td>Approximately 3.1 km to the south-west</td>
<td>0720405 6188313</td>
</tr>
<tr>
<td>NM3</td>
<td>Intermediate monitoring location</td>
<td>Approximately 0.9 km to the south-south-east</td>
<td>0723660 6188883</td>
</tr>
<tr>
<td>NM4</td>
<td>Intermediate monitoring location</td>
<td>Approximately 0.9 km to the south-south-east</td>
<td>0723721 6188937</td>
</tr>
</tbody>
</table>

Notes: 1. Has acquisition rights upon request.

4.2 Instrumentation

A Brüel & Kjær 2250 Type 1 sound analyser (s/n 2759405) was used to conduct 15-minute measurements and record 1/3 octave frequency and statistical noise indices. The sound analyser was calibrated before and on completion of the survey using a Brüel & Kjær Type 4230 calibrator (s/n 1276091). The instruments were within their NATA laboratory calibration period during the time of these readings and certificates are provided in Appendix B.

Where possible throughout each survey the operator has quantified the contribution of each significant noise source. This is done by matching audible sounds with the response of the analyser (where applicable) and/or via post-analysis of data (eg low pass filtering).

4.3 Meteorology

There is currently no weather station installed at the project site and the closest publically available weather station is at Mildura, approximately 160 km from the project site. Therefore, wind speed measurements (at microphone height) were recorded and weather observations noted by the operator during each survey.
4.3.1 Stability category

The stability category throughout the attended monitoring program was quantified using the Pasquill-Gilford scheme as per Appendix E of the INP (EPA 2000). This analysis was required to determine, in accordance with the project’s development consent, whether noise limits were applicable during the attended noise monitoring period.

Table E3 of the INP (EPA 2000) is reproduced in Table 4.2 and presents the stability categories based on night-time cloud cover.

Table 4.2 Key to Pasquill stability categories

<table>
<thead>
<tr>
<th>Hourly average wind speed at 10 m (m/s)</th>
<th>Daytime stability categories</th>
<th>Stability categories based on night cloud cover (night = 6 pm to 7 am)</th>
<th>Thinly overcast or ≥ 4/8 low cloud</th>
<th>≤ 3/8 cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td></td>
<td>G</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td>E</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>3-5</td>
<td>A-D¹</td>
<td>D</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>5-6</td>
<td></td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>&gt;6</td>
<td></td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

Source: Table E3 Appendix E of the INP (2000) (Adapted from Pasquill 1961)

Notes: 1. In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gilford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. Class F relates to stable conditions, such as those that occur when the sky is clear, the winds are light and an inversion is present. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. A seventh class, G, has also been defined to accommodate extremely stable conditions such as might be found in arid rural areas.

2. The neutral category D should be used for overcast conditions regardless of wind speed.

Table 4.3 provides the stability categories calculated using the Pasquill-Gilford scheme for each measurement during the monitoring period.

Table 4.3 Calculated stability category Pasquill

<table>
<thead>
<tr>
<th>Date</th>
<th>Start time</th>
<th>Average wind speed during measurement at 10 m (m/s)</th>
<th>Cloud cover (eighths)</th>
<th>Calculated stability category</th>
<th>Noise limits apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/7/16</td>
<td>15:01</td>
<td>2.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>28/7/16</td>
<td>15:45</td>
<td>3.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>28/7/16</td>
<td>16:08</td>
<td>3.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>29/7/16</td>
<td>6:40</td>
<td>2.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>29/7/16</td>
<td>7:09</td>
<td>1.2</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>29/7/16</td>
<td>7:26</td>
<td>3.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: 1. Wind speed values were measured at microphone height (1.5 m above ground level) during each measurement and were extrapolated to 10 m values using the method outlined in the technical paper “Converting bureau of meteorology wind speed data to local wind speeds at 1.5 m above ground level” (Gowen et. al 2004).
5 Review of data and discussion

5.1 Summary

The results of the attended noise monitoring are summarised in Table 5.1. The project’s noise contribution was determined using in field observations and post-analysis of data as required (e.g., removing higher frequencies that are not mine related, i.e., above 630 Hz). Attended noise monitoring was completed during the daytime and night-time period of 28 July 2016, and the daytime period of 29 July 2016.

The results demonstrate that the project’s $L_{Aeq(15\ min)}$ noise contribution satisfies the development consent limits. This is based on all measurements at location R5, NM3 and NM4, where limits do not apply, and privately-owned residences being further removed.

The total measured $L_{Aeq(15\ min)}$ noise level (i.e., all noise sources) was below the relevant development consent noise limits for all the measurements at location R5, as well as most measurements at NM3 and NM4. The exception to this was during the last measurement at location NM4, although the project’s $L_{Aeq(15\ min)}$ noise contribution at the time was estimated at 32 dB. Hence, this reaffirms that the project’s noise emissions were below the development consent noise limits at all privately-owned residences.

Low frequency noise was assessed by estimating site ‘C-weighted’ minus site ‘A-weighted’ levels. The project’s ‘C-weighted’ emission values were not determinable for all measurements at location R5. This was due to the relatively low site noise emissions (inaudible) compared to ambient noise during these measurements.
<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Start</th>
<th>Total noise levels, dB</th>
<th>Site contribution, dB</th>
<th>Noise limits</th>
<th>Meteorological condition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>time</td>
<td>$L_{A_{min}}$ $L_{A_{90}}$ $L_{A_{eq}}$ $L_{A_{10}}$ $L_{A_{1}}$ $L_{A_{max}}$ $L_{C_{eq}}$</td>
<td>$L_{A_{eq}}$ $L_{A_{max}}^2$</td>
<td>$L_{A_{eq}}$ $L_{A_{max}}^2$</td>
<td>Noise limits apply (Y/N)</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>28/7/16</td>
<td>15:01</td>
<td>24 27 33 33 39 67 47</td>
<td>n/a IA IA</td>
<td>-</td>
<td>-</td>
<td>Project noise inaudible. Birds and wind in trees and shrubs very frequent. Livestock occasionally audible.</td>
</tr>
<tr>
<td>NM4</td>
<td>28/7/16</td>
<td>16:08</td>
<td>24 26 30 31 41 49 56</td>
<td>≥15 23 24</td>
<td>-</td>
<td>-</td>
<td>Project noise just audible including generators and engine noise. Birds frequently audible. Livestock occasionally audible.</td>
</tr>
<tr>
<td>R5</td>
<td>29/7/16</td>
<td>6:40</td>
<td>28 29 34 37 45 53 40</td>
<td>n/a IA IA</td>
<td>-</td>
<td>-</td>
<td>Project noise inaudible. Birds very frequent. Livestock occasionally audible.</td>
</tr>
<tr>
<td>NM4</td>
<td>29/7/16</td>
<td>7:09</td>
<td>30 32 34 36 39 54 57</td>
<td>≥15 32 41</td>
<td>-</td>
<td>-</td>
<td>Project noise audible including generators and engine revs from on-site vehicle movements. Project related personnel nearby audible. Birds frequent.</td>
</tr>
<tr>
<td>NM4</td>
<td>29/7/16</td>
<td>7:26</td>
<td>30 33 41 43 48 68 59</td>
<td>≥15 32 34</td>
<td>-</td>
<td>-</td>
<td>Project noise audible including generators and engine revs from on-site vehicle movements. Project related personnel nearby audible. Birds frequent.</td>
</tr>
</tbody>
</table>

**Notes:**
1. Wind data was taken (at microphone height) during measurement. Refer to Section 4.3 for stability class.
2. For assessment purposes the $L_{A_{eq}}$ and the $L_{A_{10}, A_{eq}}$ are interchangeable.
3. ‘-’ indicates that development consent limits do not apply at this location. Noise limits do not apply at property R5, and therefore are indicative only.
5.2 Residential location R5

Noise from the project was inaudible at location R5. The project’s $L_{Aeq(15\,\text{min})}$ contribution at location R5 was estimated to be below 20 dB during all measurements. Based on meteorological conditions at the time, noise limits were applicable for the two measurements at location R5. The total measured $L_{Aeq(15\,\text{min})}$ noise level (ie all noise sources) was below the development consent noise limits for all the measurements at location R5, and hence this provides further indication of compliance with the project’s development consent, applicable at residences further away.

5.3 Intermediate monitoring location NM3

Due to noise from the project not being audible at location R5, monitoring was also completed at intermediate location NM3 (approximately 0.9 km from the project activities). Noise from the project was audible at NM3 and site $L_{Aeq(15\,\text{min})}$ contribution was estimated to be 22 dB during the daytime measurement. It is noted that the site 'C-weighted' minus site 'A-weighted' level was estimated to be above the 15 dB low frequency noise threshold during the measurement at location NM3, however the INP’s 5 dB modification factor does not apply at this location. Development consent noise limits do not apply at location NM3, however it is estimated that site $L_{Aeq(15\,\text{min})}$ noise levels at privately owned residences during these measurements would be below the relevant noise limits.

5.4 Intermediate monitoring location NM4

Due to noise from site not being audible at locations R5 during the noise monitoring, attended measurement was also completed at intermediate location NM4 (approximately 0.9 km from the project activities). Noise from the project was audible at location NM4 and site $L_{Aeq(15\,\text{min})}$ contribution was estimated to be 23 dB during the daytime period on 28 July 2016. During the two daytime measurements on 29 July 2016, site $L_{Aeq(15\,\text{min})}$ contribution was estimated to be 32 dB. It is noted that the site 'C-weighted' minus site 'A-weighted' level was estimated to be above the 15 dB low frequency noise threshold during these measurements at location NM4, however the INP’s 5 dB modification factor does not apply at this location. Development consent noise limits do not apply at location NM4, however given the proximity of this monitoring location to the project activities, it is estimated that site $L_{Aeq(15\,\text{min})}$ noise levels at privately owned residences during these measurements would be below the relevant noise limits.
6 Conclusion

EMM has completed a review of noise emissions from pre-mining bulk sampling work associated with the Balranald Mineral Sands Project based on attended noise monitoring conducted during the daytime period on 28 July 2016 and the night-time and daytime periods on 29 July 2016.

Based on monitoring results at monitoring location R5, the site $L_{Aeq(15\text{ min})}$ noise satisfied the noise limits during all measurements at privately-owned residential properties. Meteorological observations and measurements during the attended noise monitoring period were assessed and noise limits were deemed to be applicable as per the development consent as relevant.

Further, attended noise monitoring completed at intermediate locations NM3 and NM4 indicated that site $L_{Aeq(15\text{ min})}$ noise contributions would satisfy the noise limits at privately-owned residences.

Therefore attended noise monitoring demonstrated that site noise complied with the relevant noise limits for this July monitoring period.
Appendix A

Development consent
SCHEDULE 3
ENVIRONMENTAL PERFORMANCE CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from an owner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 3 and 4 of Schedule 4.

<table>
<thead>
<tr>
<th>Acquisition Basis</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>R5</td>
</tr>
</tbody>
</table>

Note: To interpret the land referred to in Table 1, see the figure in Appendix 4.

ADDITIONAL NOISE MITIGATION UPON REQUEST

2. Upon receiving a written request from an owner of the land listed in Table 1 (unless the landowner has requested acquisition), the Applicant shall implement additional noise mitigation measures (such as double glazing, insulation and/or air conditioning) at the residence in consultation with the landowner. These measures must be reasonable and feasible, and directed towards reducing the noise impacts of the development on the residence commensurate with the level of impact in accordance with the Voluntary Land Acquisition and Mitigation Policy (November 2014).

If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or if there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

NOISE

Operational Noise Criteria

3. Except for the noise-affected land in Table 1, the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq}(15\text{min})$</th>
<th>Evening $L_{Aeq}(15\text{min})$</th>
<th>Night $L_{Aeq}(15\text{min})$</th>
<th>$L_{A1}(1\text{min})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any residence on privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

Noise generated by the development is to be measured in accordance with the relevant requirements of the NSW Industrial Noise Policy (as may be updated or replaced from time to time). Appendix 5 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.

However, these noise criteria do not apply if the Applicant has an agreement with the owner/s or leaseholders of the residence to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.

Operating Conditions

4. The Applicant shall:
   (a) implement all reasonable and feasible measures to minimise the construction, operational and road noise of the development;
   (b) minimise the noise impacts of the development during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 5); and
   (c) undertake regular attended monitoring of the noise of the development, to ensure compliance with the relevant conditions of this consent.

Noise Management Plan

5. Prior to carrying any development under this consent, the Applicant shall prepare a Noise Management Plan for the development to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA;
(b) describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions of this consent;
(c) include a noise monitoring program for evaluating and reporting on:
   • compliance against the noise criteria in this consent; and
   • compliance against the noise operating conditions; and
(d) defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

Following approval, the Applicant must carry out the development in accordance with this plan.

AIR QUALITY

Odour

6. The Applicant shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

Air Quality Criteria

7. The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 3, 4 and 5 at any residence on privately owned land.

| Table 3: Long term impact assessment criteria for particulate matter |
|------------------------|------------------|----------------|
| Pollutant              | Averaging period | Criterion      |
| Total suspended particulate (TSP) matter | Annual | \(^a\) 90 µg/m\(^3\) |
| Particulate matter < 10 µm (PM\(_{10}\)) | Annual | \(^a\) 30 µg/m\(^3\) |

| Table 4: Short term impact assessment criterion for particulate matter |
|------------------------|------------------|----------------|
| Pollutant              | Averaging period | Criterion      |
| Particulate matter < 10 µm (PM\(_{10}\)) | 24 hour | \(^a\) 50 µg/m\(^3\) |

| Table 5: Long term impact assessment criteria for deposited dust |
|------------------------|------------------|-----------------|
| Pollutant              | Averaging period | Maximum increase\(^c\) in deposited dust level | Maximum total\(^d\) deposited dust level |
| Deposited dust         | Annual           | \(^b\) 2 g/m\(^2\)/month | \(^a\) 4 g/m\(^2\)/month |

Notes to Tables 3-5
- \(^a\) Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).
- \(^b\) Incremental impact (i.e. incremental increase in concentrations due to the development on its own).
- \(^c\) Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
- \(^d\) Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

Operating Conditions

8. The Applicant shall:
   (a) implement all reasonable and feasible measures to minimise the:
       • off-site odour and dust emissions of the development; and
       • release of greenhouse gas emissions from the development;
   (b) minimise any visible off-site air pollution generated by the development;
   (c) minimise the surface disturbance of the site;
   (d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note \(d\) to Tables 3-5); and
   (e) assess air quality monitoring data to determine whether the development is complying with the relevant conditions of this consent and, if necessary, adjust the scale of operations on site to meet the criteria in this consent.
APPENDIX 5
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in condition 3 of Schedule 3 apply under all meteorological conditions except the following:
   (a) wind speeds greater than 3 m/s at 10 metres above ground level; or
   (b) stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
   (c) temperature inversion conditions greater than 8°C/100m.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station on or in the vicinity of the site.

Compliance Monitoring

3. Unless directed otherwise by the Secretary, attended monitoring is to be used to evaluate compliance with the relevant conditions of consent.

   Note: The Noise Management Plan (see condition 5 of Schedule 3) is required to include a noise monitoring program for the development, which will include details of the frequency of monitoring. The Secretary may direct that the frequency of monitoring increase or decrease at any time during the life of the development.

4. Unless otherwise agreed with the Secretary, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended or replaced from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.
Appendix B

Calibration certificates
CERTIFICATE OF CALIBRATION

Certificate No: CAU1600070

CALIBRATION OF:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacturer</th>
<th>Model</th>
<th>No.</th>
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</thead>
<tbody>
<tr>
<td>Sound Level Meter</td>
<td>Brüel &amp; Kjær</td>
<td>2250</td>
<td></td>
</tr>
<tr>
<td>Microphone</td>
<td>Brüel &amp; Kjær</td>
<td>4189</td>
<td></td>
</tr>
<tr>
<td>Preampifier</td>
<td>Brüel &amp; Kjær</td>
<td>ZC-0032</td>
<td>No: 2888134</td>
</tr>
<tr>
<td>Supplied Calibrator</td>
<td>Brüel &amp; Kjær</td>
<td>4230</td>
<td></td>
</tr>
<tr>
<td>Software version</td>
<td>BZ7222 Version 3.5.3</td>
<td>Pattern Approval: Pending</td>
<td></td>
</tr>
<tr>
<td>Instruction manual</td>
<td>BE1712-18</td>
<td>Identification: N/A</td>
<td></td>
</tr>
</tbody>
</table>

CUSTOMER:
EMM Consulting
Level 5, 21 Bolton Street
Newcastle NSW 2300

CALIBRATION CONDITIONS:
Preconditioning: 4 hours at 23 °C
Environement conditions: see actual values in Environmental conditions sections

SPECIFICATIONS:
The Sound Level Meter has been calibrated in accordance with the requirements as specified in IEC61672-3:2006 class 1. Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

PROCEDURE:
The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System B&K 3630 with application software type 7763 (version 5.1 - DB: 5.10) and test procedure 2250-4189.

RESULTS:

<table>
<thead>
<tr>
<th>Initial calibration</th>
<th>Calibration prior to repair/adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Calibration without repair/adjustment</td>
<td>Calibration after repair/adjustment</td>
</tr>
</tbody>
</table>

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor k = 2 providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 03/02/2016
Certificate issued: 03/02/2016

Sajeeb Tharayil
Calibration Technician

Jan Rasmussen
Approved signatory

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CERTIFICATE OF CALIBRATION  No.: CAU1600071

CALIBRATION OF:

Calibrator: Brüel & Kjær
Identification: Sound Level Calibrator
IEC Class: 2

No: 1276091

CUSTOMER:
EMM Consulting
Level 5
21 Bolton Street
Newcastle NSW 2300

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions:
Air temperature: 24.3 °C
Air pressure: 100.1 kPa
Relative Humidity: 56.3 %RH

SPECIFICATIONS:
The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:
The measurements have been performed with the assistance of Brüel & Kjær acoustic calibrator calibration application software Type 7794 using calibration procedure 4230 Complete

RESULTS:

☐ Initial Calibration  ☐ Calibration before repair/adjustment
☒ Recalibration without repair/adjustment  ☐ Calibration after repair/adjustment

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: 03/02/2016  Certificate issued: 03/02/2016

Jan Rasmussen
Approved Signatory

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Balranald Mineral Sands Project

Compliance noise monitoring | August and September 2016

Prepared for Iluka Resources Limited | 27 September 2016
Balranald Mineral Sands Project

Final


Prepared by  Teanuanua Villierme  
Position  Senior Acoustic Consultant
Signature

Approved by  Najah Ishac  
Position  Director
Signature

Date  27/9/16  

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Document Control

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<th>Date</th>
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<th>Reviewed by</th>
</tr>
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<tr>
<td>Draft</td>
<td>20/9/16</td>
<td>Teanuanua Villierme</td>
<td>Daniel Weston</td>
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<td>Final</td>
<td>27/9/16</td>
<td>Teanuanua Villierme</td>
<td>Daniel Weston</td>
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EMM

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1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged to complete attended noise monitoring on behalf of Iluka Resources Limited (Iluka Resources) during pre-mining bulk sampling work associated with the Balranald Mineral Sands Project (the project).

The purpose of the noise monitoring was to address requirements of the project’s Development Consent (application number SSD-5285) by determining a noise contribution during project operations to inform the project team of expected noise levels and assessing compliance against the noise criteria (refer Section 3).

This report presents the methodology, results and findings of attended noise monitoring conducted during the daytime period on 31 August 2016. It is noted that site operations at the time of the attended noise monitoring did not include all activities such as drilling and sand extraction. Further, the project was not operating between the hours of 5 pm and 6 am at the time. Supplementary noise monitoring during the daytime and night-time periods on 1 September 2016 when the site was operating was therefore conducted.

The following material was referenced as part of this assessment:

- Department of Planning and Environment (DP&E), Development Consent SSD-5285 (development consent), 2016; and
- Environment Protection Authority (EPA), Industrial Noise Policy (INP), 2000.

Monitoring results showed that site noise levels were below the relevant noise limits during all measurements at the nearest residential location R5 and all other privately-owned residences during this August and September 2016 monitoring period.
2 Glossary of acoustic terms

Several technical terms are discussed in this report. These are explained in Table 2.1.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB</td>
<td>Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.</td>
</tr>
<tr>
<td>( L_{A1} )</td>
<td>The 'A-weighted' noise level which is exceeded 1% of the time.</td>
</tr>
<tr>
<td>( L_{A(1\text{-}min)} )</td>
<td>The 'A-weighted' noise level exceeded for 1% of the specified time period of 1 minute.</td>
</tr>
<tr>
<td>( L_{A10} )</td>
<td>The 'A-weighted' noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise level.</td>
</tr>
<tr>
<td>( L_{A90} )</td>
<td>Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.</td>
</tr>
<tr>
<td>( L_{Aeq} )</td>
<td>The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The ( L_{Aeq(15\text{-}min)} ) descriptor refers to an ( L_{Aeq} ) noise level measured over a 15 minute period.</td>
</tr>
<tr>
<td>( L_{Amin} )</td>
<td>The minimum 'A-weighted' noise level received during a measuring interval.</td>
</tr>
<tr>
<td>( L_{Amax} )</td>
<td>The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.</td>
</tr>
<tr>
<td>( L_{Ceq} )</td>
<td>The energy average noise from a source. This is the equivalent continuous 'C-weighted' sound pressure level over a given period. The ( L_{Ceq(15\text{-}min)} ) descriptor refers to an ( L_{Ceq} ) noise level measured over a 15 minute period.</td>
</tr>
</tbody>
</table>

Day period: Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.

Evening period: Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.

Night period: Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.

Temperature inversion: A meteorological condition where the atmospheric temperature increases with altitude.

It is useful to have an appreciation of decibel (dB), the unit of noise measurement. Table 2.2 gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels are provided in Figure 2.1.

<table>
<thead>
<tr>
<th>Change in sound pressure level (dB)</th>
<th>Perceived change in noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>just perceptible</td>
</tr>
<tr>
<td>5</td>
<td>noticeable difference</td>
</tr>
<tr>
<td>10</td>
<td>twice (or half) as loud</td>
</tr>
<tr>
<td>15</td>
<td>large change</td>
</tr>
<tr>
<td>20</td>
<td>four times (or quarter) as loud</td>
</tr>
</tbody>
</table>
Indicative A-weighted decibel (dBA) noise levels in typical situations

Threshold of pain
Jet takeoff at 100m
Rock concert
Jackhammer near operator
Busy city street at kerbside
Busy office
Quiet suburban area
Quiet countryside
Inside bedroom - windows closed
Threshold of hearing

Source: Road Noise Policy (Department of Environment, Climate Change and Water 2011)

Figure 2.1 Common noise levels
3 Noise criteria

3.1 Acquisition

The project’s development consent (Table 1, Schedule 3) states that due to noise, one property (R5) has acquisition rights upon request. Its location can be seen in Figure 3.1.

3.2 Operational noise

With regard to operational noise, the project’s development consent (Section 4, Schedule 3) states:

4. Except for the noise affected land in Table 1 (R5), the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2 at any residence on privately-owned land of the other specified locations.

The project’s operational noise criteria are provided in Table 2, Schedule 3 of the development consent. They are reproduced in Table 3.1 and an extract of the relevant sections of the development consent pertaining to noise is provided in Appendix A.

<table>
<thead>
<tr>
<th>Location</th>
<th>Day</th>
<th>Evening</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>All privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Property R5 is entitled to acquisition upon request and therefore the noise criteria for privately-owned land do not apply to this location. However, this location has been adopted as the nearest residential location to the bulk sampling activity (being approximately 3.1 km away) for the purpose of compliance noise monitoring. Compliance at this location will confirm compliance at all privately-owned residences, with the nearest of these located more than 8.6 km from the bulk sampling activity.
KEY

- Attended noise monitoring location
- Assessment location
- Current bulk sampling location

- Project area
- Main road
- Local road
- Major watercourses
- Cadastre
- Relict and ephemeral lakes
- Perennial lakes
- National parks and conservation areas

GDA 1994 MGA Zone 54

Figure 3.1 attended noise monitoring locations
Balranald Mineral Sands Project
Compliance noise monitoring August 2016
Figure 3.1
3.3 Meteorology

The noise criteria listed in Table 3.1 and Table 3.2 do not apply under the following meteorological conditions, as defined in the development consent (Appendix 5 Section 1):

- wind speeds greater than 3 m/s at 10 m above ground level; or
- stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
- temperature inversion conditions greater than 8°C/100 m.

For the purpose of this assessment, the recorded $L_{A_{max}}$ has been used as a conservative estimate of the $L_{A_{eq;1min}}$. The INP application notes state that the EPA accepts sleep disturbance analysis based on either the $L_{A_{eq;1min}}$ or $L_{A_{max}}$ metrics (EPA 2013).

The project’s development consent states that modification factors in Section 4 of the INP (EPA 2000) shall be applied to the measured mine noise levels where applicable.

Section 11.1.3 of the INP (EPA 2000) identifies that a development is deemed to be in non-compliance if the monitored noise levels from the site are more than 2 dB above the statutory limit. This approach is in recognition of field measurement tolerances and human perceptions to changes in noise levels and has been adopted for this assessment.

3.4 Low frequency noise criteria

Section 4, Schedule 3 of the development consent states that noise generated by the project is to be measured in accordance with the relevant requirements of the INP. Section 4 of the INP (EPA 2000) states that modification factors shall be applied to the measured noise levels where applicable.

It is noted that the NSW DP&E and the NSW EPA are currently completing a comprehensive study of low frequency noise (LFN) as part of the INP review. Additionally, it is acknowledged that assessment of LFN in rural areas is difficult and that current assessment processes make it difficult to enforce LFN criteria as part of consent conditions. The draft Industrial Noise Guideline (ING) will replace the INP and is the first official publication that clearly indicates a change from the current INP approach.

Section 4 of the INP (EPA 2000) provides guidelines for applying ‘modifying factor’ adjustments to account for low frequency noise emissions. The INP requires that where there is a difference of 15 dB or more between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels, a correction factor of 5 dB is added to the measured site noise level (at residences only) before comparison to the relevant noise criterion. Hence, where possible throughout each survey the operator has estimated the difference between site ‘C-weighted’ and site ‘A-weighted’ noise emission levels by matching audible sounds with the response of the analyser ($L_{C_{eq}}$-$L_{A_{eq}}$ noise metric). Monitoring identified that the correction factor of 5 dB for low frequency noise was identified to be applicable during two measurements at residential location NM5. This is discussed further in Section 5.
4  Assessment methodology

4.1 Attended noise monitoring locations

The purpose of the attended noise monitoring was to assess the project’s compliance with noise criteria (refer to Section 3.2) and capture a noise contribution from the bulk sampling activity. Project operations at the time of the attended noise monitoring did not include drilling and sand extraction activities. Noise monitoring was conducted at the nearest residential location, R5, and at intermediate locations nearer and downwind from the project’s activities (being NM1 and NM5) when noise from the project was inaudible and a noise contribution was not determinable at location R5. It is noted that noise limits do not apply at R5 or the two intermediate locations NM1 and NM5.

The attended noise monitoring locations and their coordinates are listed in Table 4.1 and are shown in Figure 3.1.

<table>
<thead>
<tr>
<th>Monitoring location</th>
<th>Description</th>
<th>Distance to current bulk sampling location</th>
<th>MGA54 Easting</th>
<th>MGA54 Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5</td>
<td>Nearest residential location</td>
<td>Approximately 3.1 km to the south-west</td>
<td>0720405</td>
<td>6188313</td>
</tr>
<tr>
<td>NM1</td>
<td>Intermediate monitoring location</td>
<td>Approximately 1.7 km to the south-west</td>
<td>0721547</td>
<td>6189159</td>
</tr>
<tr>
<td>NM5</td>
<td>Intermediate monitoring location</td>
<td>Approximately 0.7 km to the south-east</td>
<td>0723830</td>
<td>6189456</td>
</tr>
</tbody>
</table>

Notes: 1. Has acquisition rights upon request.

4.2 Instrumentation

A Brüel & Kjær 2250 Type 1 sound analyser (s/n 2759405) was used to conduct 15-minute measurements and record 1/3 octave frequency and statistical noise indices. The sound analyser was calibrated before and on completion of the survey using a Brüel & Kjær Type 4230 calibrator (s/n 1276091). The instruments were within their NATA laboratory calibration period during the time of these readings and certificates are provided in Appendix B.

Where possible throughout each survey the operator has quantified the contribution of each significant noise source. This is done by matching audible sounds with the response of the analyser (where applicable) and/or via post-analysis of data (eg low pass filtering).

4.3 Meteorology

There is currently no weather station installed at the project site and the closest publically available weather station is at Mildura (VIC), approximately 160 km from the project site. Therefore, wind speed measurements (at microphone height) were taken and weather observations noted by the operator during each survey.
4.3.1 Stability category

The stability category throughout the attended monitoring program was quantified using the Pasquill-Gilford scheme as per Appendix E of the INP (EPA 2000). This analysis was required to determine, in accordance with the project’s development consent, whether noise limits were applicable during the attended noise monitoring period.

Table E3 of the INP (EPA 2000) is reproduced in Table 4.2 and presents the stability categories based on night-time cloud cover.

### Table 4.2 Key to Pasquill stability categories

<table>
<thead>
<tr>
<th>Hourly average wind speed at 10 m (m/s)</th>
<th>Daytime stability categories</th>
<th>Stability categories based on night cloud cover² (night = 6 pm to 7 am)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Thinly overcast or ≥ 4/8 low cloud</td>
</tr>
<tr>
<td>&lt;2</td>
<td></td>
<td>G</td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>3-5</td>
<td>A-D¹</td>
<td>D</td>
</tr>
<tr>
<td>5-6</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>&gt;6</td>
<td></td>
<td>D</td>
</tr>
</tbody>
</table>

Source: Table E3 Appendix E of the INP (2000) (Adapted from Pasquill 1961)

Notes:
1. In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. Class F relates to stable conditions, such as those that occur when the sky is clear, the winds are light and an inversion is present. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. A seventh class, G, has also been defined to accommodate extremely stable conditions such as might be found in arid rural areas.
2. The neutral category D should be used for overcast conditions regardless of wind speed.

Table 4.3 provides the stability categories calculated using the Pasquill-Gilford scheme for each measurement during the monitoring period.

### Table 4.3 Calculated Pasquill stability category

<table>
<thead>
<tr>
<th>Date</th>
<th>Start time</th>
<th>Average wind speed during measurement at 10 m (m/s)³</th>
<th>Cloud cover (eighths)</th>
<th>Calculated stability category</th>
<th>Noise limits apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>31/8/16</td>
<td>15:31</td>
<td>3.0</td>
<td>3</td>
<td>B</td>
<td>Yes</td>
</tr>
<tr>
<td>31/8/16</td>
<td>16:23</td>
<td>4.2</td>
<td>3</td>
<td>B</td>
<td>n/a</td>
</tr>
<tr>
<td>31/8/16</td>
<td>16:46</td>
<td>3.6</td>
<td>3</td>
<td>B</td>
<td>n/a</td>
</tr>
<tr>
<td>1/9/16</td>
<td>6:45</td>
<td>1.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>1/9/16</td>
<td>7:01</td>
<td>1.0</td>
<td>8</td>
<td>D</td>
<td>Yes</td>
</tr>
<tr>
<td>1/9/16</td>
<td>7:20</td>
<td>1.0</td>
<td>8</td>
<td>D</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Notes: 1. Wind speed values were measured at microphone height (1.5 m above ground level) during each measurement and were extrapolated to 10 m values using the method outlined in the technical paper "Converting bureau of meteorology wind speed data to local wind speeds at 1.5 m above ground level" (Gowen et. al 2004).
5 Review of data and discussion

5.1 Summary

The results of the attended noise monitoring are summarised in Table 5.1. The project’s noise contribution was determined using in field observations and post-analysis of data as required (eg removing higher frequencies that are not mine related). Attended noise monitoring was completed during the daytime period on 31 August 2016, as well as during the daytime and night-time periods on 1 September 2016.

The results demonstrate that the project’s $L_{Aeq(15\,\text{min})}$ noise contribution satisfied the development consent limits. This is based on all measurements at location R5, where limits do not apply, and privately-owned residences being distanced further from bulk sampling activity.

Low frequency noise was assessed by estimating site 'C-weighted' minus site 'A-weighted' levels. The project’s 'C-weighted' emission values were not determinable for the first measurement at location R5 due to relatively low site noise emissions (inaudible) compared to ambient noise during the measurement. Low frequency noise, as defined in the INP, was identified during two measurements at location NM5. Therefore, a 5 dB modifying factor has been added to site noise $L_{Aeq(15\,\text{min})}$ contribution for these two measurements at location R5.
<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Start time (hours)</th>
<th>Date</th>
<th>Start time (hours)</th>
<th>Total noise levels, dB</th>
<th>Site contribution, dB</th>
<th>Noise limits, dB</th>
<th>Meteorological condition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5</td>
<td>31/8</td>
<td>15:31 Day</td>
<td></td>
<td></td>
<td>25 29 46 49 57 70 50</td>
<td>n/a IA IA</td>
<td>- (35)</td>
<td>- (45)</td>
<td>Noise from the project was Inaudible. Bird noise consistently audible. Wind in trees and shrubs frequently audible.</td>
</tr>
<tr>
<td>NM5</td>
<td>31/8</td>
<td>16:23 Day</td>
<td></td>
<td></td>
<td>36 40 45 48 54 65 69</td>
<td>n/a 44 52</td>
<td>-</td>
<td>-</td>
<td>Noise from the project was consistently audible including power packs and crane revs on occasion. Wind in trees/shrubs frequently audible.</td>
</tr>
<tr>
<td>NM5</td>
<td>31/8</td>
<td>16:45 Day</td>
<td></td>
<td></td>
<td>32 37 44 46 53 61 63</td>
<td>n/a 43 59</td>
<td>-</td>
<td>-</td>
<td>Noise from the project was consistently audible including power packs and occasional crane revs. Wind gusts occasionally audible.</td>
</tr>
<tr>
<td>R5</td>
<td>1/9</td>
<td>06:45 Night</td>
<td></td>
<td></td>
<td>20 22 48 52 60 71 48</td>
<td>n/a &lt;20 22</td>
<td>- (35)</td>
<td>- (45)</td>
<td>Noise from the project was occasionally audible including noise from power packs. Bird noise consistently audible.</td>
</tr>
<tr>
<td>R5</td>
<td>1/9</td>
<td>07:01 Day</td>
<td></td>
<td></td>
<td>21 25 45 48 57 70 47</td>
<td>≥15 27 27 (22+5)</td>
<td>- (35)</td>
<td>- (45)</td>
<td>Noise from the project was audible including consistent noise from power packs. Bird noise consistently audible.</td>
</tr>
<tr>
<td>R5</td>
<td>1/9</td>
<td>07:20 Day</td>
<td></td>
<td></td>
<td>21 25 48 52 60 66 49</td>
<td>≥15 27 27 (22+5)</td>
<td>- (35)</td>
<td>- (45)</td>
<td>Noise from the project was audible including consistent noise from power packs and engine revs. Bird noise consistently audible.</td>
</tr>
<tr>
<td>NM1</td>
<td>1/9</td>
<td>07:43 Day</td>
<td></td>
<td></td>
<td>25 27 31 33 36 45 49</td>
<td>n/a 29 34</td>
<td>-</td>
<td>-</td>
<td>Noise from the project was audible including frequent noise from power packs and an excavator. Bird noise consistently audible.</td>
</tr>
</tbody>
</table>

Notes: 1. Wind data was taken (at microphone height) during measurement. Refer to Section 4.3 for stability class.
2. Modifying factor of 5 dB for low frequency noise applicable in accordance with section 4 of the INP (difference of 15 dB or more between site ‘C-weighted’ and site ‘A-weighted’ noise levels).
3. For assessment purposes the $L_{max}$ and the $L_{A10}$ are interchangeable.
4. ‘-’ indicates that development consent limits do not apply at this location.
5.2 Residential location R5

Noise from the project was inaudible during the daytime measurement on 31 August 2016 at location R5. During the night-time and daytime measurements on 1 September 2016, the project’s $L_{Aeq(15\text{ min})}$ contribution at location R5 was estimated to be 27 dB (including the 5 dB low frequency noise penalty where applicable) or below during all measurements. Based on meteorological conditions at the time, noise limits were applicable for all measurements at location R5. Based on these results the project’s $L_{Aeq(15\text{ min})}$ noise contribution satisfied the development consent noise limits for all the measurements at location R5, and hence this provides further indication of compliance with the project’s development consent, applicable at residences further away.

5.3 Intermediate monitoring location NM5

Due to noise from site not being audible at locations R5 during the noise monitoring, attended measurement was also completed at intermediate location NM5 (approximately 0.7 km south-east of the project activities). Noise from the project was audible at location NM5 and site $L_{Aeq(15\text{ min})}$ Contribution was estimated to be 44 dB and 43 dB during the first and second daytime period measurement on 31 August 2016, respectively. It is noted that the site 'C-weighted' minus site 'A-weighted' level was estimated to be below the 15 dB low frequency noise threshold during these measurements at location NM5. Although, the INP’s 5 dB modification factor does not apply at this location (non-residential), it would have not applied for these measurements. Development consent noise limits do not apply at location NM5, however given the proximity of this monitoring location to the project activities, it is estimated that site $L_{Aeq(15\text{ min})}$ noise levels at privately owned residences during these measurements would be below the relevant noise limits.

5.4 Intermediate monitoring location NM1

To compliment the monitoring data recorded at location R5 on 1 September 2016, monitoring was also completed at intermediate location NM1 (approximately 1.7 km west of the project activities). Noise from the project was audible at NM1 and the site $L_{Aeq(15\text{ min})}$ contribution was estimated to be 29 dB. It is noted that the site 'C-weighted' minus site 'A-weighted' level was estimated to be above the 15 dB low frequency noise threshold during the measurement at location NM1, however the INP’s 5 dB modification factor does not apply at this location (non-residential). Development consent noise limits do not apply at location NM1, however it is estimated that site $L_{Aeq(15\text{ min})}$ noise levels at privately owned residences during this measurement would be below the relevant noise limits.
6 Conclusion

EMM has completed a review of noise emissions from pre-mining bulk sampling work associated with the Balranald Mineral Sands Project based on attended noise monitoring conducted during the daytime period on 31 August 2016, as well as during the daytime and night-time periods on 1 September 2016.

Based on monitoring results at monitoring location R5, the site $L_{Aeq(15-min)}$ noise satisfied the noise limits during all measurements at privately-owned residential properties. Meteorological observations and measurements during the attended noise monitoring period were assessed and noise limits were deemed to be applicable during these measurements as per the development consent as relevant.

Further, attended noise monitoring completed at intermediate locations NM1 and NM5 indicated that site $L_{Aeq(15-min)}$ noise contributions would satisfy the noise limits at privately-owned residences.

Therefore attended noise monitoring demonstrated that site noise complied with the relevant noise limits for the August and September 2016 monitoring period.
Appendix A

Development consent
SCHEDULE 3
ENVIRONMENTAL PERFORMANCE CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from an owner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 3 and 4 of Schedule 4.

Table 1: Land subject to acquisition upon request

<table>
<thead>
<tr>
<th>Acquisition Basis</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>R5</td>
</tr>
</tbody>
</table>

Note: To interpret the land referred to in Table 1, see the figure in Appendix 4.

ADDITIONAL NOISE MITIGATION UPON REQUEST

2. Upon receiving a written request from an owner of the land listed in Table 1 (unless the landowner has requested acquisition), the Applicant shall implement additional noise mitigation measures (such as double glazing, insulation and/or air conditioning) at the residence in consultation with the landowner. These measures must be reasonable and feasible, and directed towards reducing the noise impacts of the development on the residence commensurate with the level of impact in accordance with the Voluntary Land Acquisition and Mitigation Policy (November 2014).

If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or if there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

NOISE

Operational Noise Criteria

3. Except for the noise-affected land in Table 1, the Applicant shall ensure that the noise generated by the development does not exceed the noise criteria in Table 2.

Table 2: Noise criteria dB(A)

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq(15min)}$</th>
<th>Evening $L_{Aeq(15min)}$</th>
<th>Night $L_{Aeq(15min)}$</th>
<th>$L_{A1(1min)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any residence on privately-owned land</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Mungo National Park and Mungo State Conservation Area (when in use)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

Noise generated by the development is to be measured in accordance with the relevant requirements of the NSW Industrial Noise Policy (as may be updated or replaced from time to time). Appendix 5 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.

However, these noise criteria do not apply if the Applicant has an agreement with the owner/s or leaseholders of the residence to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.

Operating Conditions

4. The Applicant shall:
   (a) implement all reasonable and feasible measures to minimise the construction, operational and road noise of the development;
   (b) minimise the noise impacts of the development during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 5); and
   (c) undertake regular attended monitoring of the noise of the development, to ensure compliance with the relevant conditions of this consent.

Noise Management Plan

5. Prior to carrying any development under this consent, the Applicant shall prepare a Noise Management Plan for the development to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA;
(b) describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions of this consent;
(c) include a noise monitoring program for evaluating and reporting on:
   - compliance against the noise criteria in this consent; and
   - compliance against the noise operating conditions; and
(d) defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

Following approval, the Applicant must carry out the development in accordance with this plan.

AIR QUALITY

Odour

6. The Applicant shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

Air Quality Criteria

7. The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 3, 4 and 5 at any residence on privately owned land.

| Table 3: Long term impact assessment criteria for particulate matter |
|-----------------|-----------------|-----------------|
| Pollutant         | Averaging period | d Criterion |
| Total suspended particulate (TSP) matter | Annual | \(^a\) 90 µg/m\(^3\) |
| Particulate matter < 10 µm (PM\(_{10}\)) | Annual | \(^a\) 30 µg/m\(^3\) |

| Table 4: Short term impact assessment criterion for particulate matter |
|-----------------|-----------------|-----------------|
| Pollutant         | Averaging period | d Criterion |
| Particulate matter < 10 µm (PM\(_{10}\)) | 24 hour | \(^a\) 50 µg/m\(^3\) |

| Table 5: Long term impact assessment criteria for deposited dust |
|-----------------|-----------------|-----------------|
| Pollutant         | Averaging period | Maximum increase\(^b\) in deposited dust level | Maximum total\(^c\) deposited dust level |
| \(^c\) Deposited dust | Annual | \(^b\) 2 g/m\(^2\)/month | \(^a\) 4 g/m\(^2\)/month |

Notes to Tables 3-5
- \(^a\) Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).
- \(^b\) Incremental impact (i.e. incremental increase in concentrations due to the development on its own).
- \(^c\) Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
- \(^d\) Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

Operating Conditions

8. The Applicant shall:
   (a) implement all reasonable and feasible measures to minimise the:
      - off-site odour and dust emissions of the development; and
      - release of greenhouse gas emissions from the development;
   (b) minimise any visible off-site air pollution generated by the development;
   (c) minimise the surface disturbance of the site;
   (d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d to Tables 3-5); and
   (e) assess air quality monitoring data to determine whether the development is complying with the relevant conditions of this consent and, if necessary, adjust the scale of operations on site to meet the criteria in this consent.
APPENDIX 5
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in condition 3 of Schedule 3 apply under all meteorological conditions except the following:
   (a) wind speeds greater than 3 m/s at 10 metres above ground level; or
   (b) stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
   (c) temperature inversion conditions greater than 8°C/100m.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station on or in the vicinity of the site.

Compliance Monitoring

3. Unless directed otherwise by the Secretary, attended monitoring is to be used to evaluate compliance with the relevant conditions of consent.

   Note: The Noise Management Plan (see condition 5 of Schedule 3) is required to include a noise monitoring program for the development, which will include details of the frequency of monitoring. The Secretary may direct that the frequency of monitoring increase or decrease at any time during the life of the development.

4. Unless otherwise agreed with the Secretary, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended or replaced from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.
Appendix B

Calibration certificates
CERTIFICATE OF CALIBRATION

CALIBRATION OF:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Certificate No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound Level Meter</td>
<td>Brüel &amp; Kjær</td>
<td>2250</td>
<td>No: 2759405</td>
</tr>
<tr>
<td>Microphone</td>
<td>Brüel &amp; Kjær</td>
<td>4189</td>
<td>No: 2888134</td>
</tr>
<tr>
<td>Preamplifier</td>
<td>Brüel &amp; Kjær</td>
<td>ZC-0032</td>
<td>No: 16037</td>
</tr>
<tr>
<td>Supplied Calibrator</td>
<td>Brüel &amp; Kjær</td>
<td>4230</td>
<td>No: 1276091</td>
</tr>
<tr>
<td>Software version</td>
<td>BZ7222 Version 3.5.3</td>
<td>Pattern Approval:</td>
<td>Pending</td>
</tr>
<tr>
<td>Instruction manual</td>
<td>BE1712-18</td>
<td>Identification:</td>
<td>N/A</td>
</tr>
</tbody>
</table>

CUSTOMER:

EMM Consulting
Level 5, 21 Bolton Street
Newcastle NSW 2300

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions: see actual values in Environmental conditions sections

SPECIFICATIONS:
The Sound Level Meter has been calibrated in accordance with the requirements as specified in IEC61672-3:2006 class 1.
Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

PROCEDURE:
The measurements have been performed with the assistance of Brüel & Kjær Sound Level Meter Calibration System B&K 3630 with application software type 7763 (version 5.1 - DB: 5.10) and test procedure 2250-4189.

RESULTS:

<table>
<thead>
<tr>
<th>Calibration Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial calibration</td>
</tr>
<tr>
<td>Calibration prior to repair/adjustment</td>
</tr>
<tr>
<td>X Calibration without repair/adjustment</td>
</tr>
<tr>
<td>Calibration after repair/adjustment</td>
</tr>
</tbody>
</table>

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor k = 2 providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the device under calibration.

Date of Calibration: 03/02/2016
Certificate issued: 03/02/2016

Sajeeb Tharayil
Calibration Technician

Jan Rasmussen
Approved signatory

Reproduction of the complete certificate is allowed. Part of the certificate may only be reproduced after written permission.
CERTIFICATE OF CALIBRATION
No.: CAU1600071

CALIBRATION OF:

Calibrator: Brüel & Kjær
Identification: Sound Level Calibrator
IEC Class: 2

No: 1276091

CUSTOMER:

EMM Consulting
Level 5
21 Bolton Street
Newcastle NSW 2300

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 °C
Environment conditions: Air temperature: 24.3 °C
Air pressure: 100.1 kPa
Relative Humidity: 56.3 %RH

SPECIFICATIONS:
The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:
The measurements have been performed with the assistance of Brüel & Kjær acoustic calibrator calibration application software Type 7794 using calibration procedure 4230 Complete.

RESULTS:

☐ Initial Calibration   ☐ Calibration before repair/adjustment
☒ Recalibration without repair/adjustment ☐ Calibration after repair/adjustment

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: 03/02/2016
Certificate issued: 03/02/2016

Jan Rasmussen
Approved Signatory

Reproduction of the complete certificate is allowed. Part of the certificate may only be reproduced after written permission.
1. RESULTS

Results of the dust deposition sampling are summarised below.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>IL Bal 1</th>
<th>IL Bal 2</th>
<th>IL Bal 3</th>
<th>IL Bal 4</th>
<th>IL Bal 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sampling Period</strong></td>
<td><strong>Total Solids (g/m²/month)</strong></td>
<td><strong>Insoluble Solids (g/m²/month)</strong></td>
<td><strong>Combustible Matter (g/m²/month)</strong></td>
<td><strong>Ash (g/m²/month)</strong></td>
<td><strong>Soluble Matter (g/m²/month)</strong></td>
</tr>
<tr>
<td><strong>10 April – 10 May 2016</strong></td>
<td>4</td>
<td>1.8</td>
<td>2.1</td>
<td>-</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Approximate Rainfall (mm)</strong></td>
<td>51</td>
<td>48</td>
<td>48</td>
<td>-</td>
<td>52</td>
</tr>
<tr>
<td><strong>Sampling Period</strong></td>
<td><strong>Total Solids (g/m²/month)</strong></td>
<td><strong>Insoluble Solids (g/m²/month)</strong></td>
<td><strong>Combustible Matter (g/m²/month)</strong></td>
<td><strong>Ash (g/m²/month)</strong></td>
<td><strong>Soluble Matter (g/m²/month)</strong></td>
</tr>
<tr>
<td><strong>10 May – 10 June 2016</strong></td>
<td>0.62</td>
<td>0.25</td>
<td>0.32</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Approximate Rainfall (mm)</strong></td>
<td>26</td>
<td>1.1</td>
<td>1.2</td>
<td>-</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Sampling Period</strong></td>
<td><strong>Total Solids (g/m²/month)</strong></td>
<td><strong>Insoluble Solids (g/m²/month)</strong></td>
<td><strong>Combustible Matter (g/m²/month)</strong></td>
<td><strong>Ash (g/m²/month)</strong></td>
<td><strong>Soluble Matter (g/m²/month)</strong></td>
</tr>
<tr>
<td><strong>10 June – 15 July 2016</strong></td>
<td>1.1</td>
<td>0.26</td>
<td>0.28</td>
<td>-</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Approximate Rainfall (mm)</strong></td>
<td>0.26</td>
<td>0.088</td>
<td>0.096</td>
<td>-</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Sampling Period</strong></td>
<td><strong>Total Solids (g/m²/month)</strong></td>
<td><strong>Insoluble Solids (g/m²/month)</strong></td>
<td><strong>Combustible Matter (g/m²/month)</strong></td>
<td><strong>Ash (g/m²/month)</strong></td>
<td><strong>Soluble Matter (g/m²/month)</strong></td>
</tr>
<tr>
<td><strong>15 July – 12 August 2016</strong></td>
<td>0.079</td>
<td>0.17</td>
<td>2</td>
<td>-</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Approximate Rainfall (mm)</strong></td>
<td>0.48</td>
<td>0.31</td>
<td>0.96</td>
<td>-</td>
<td>0.97</td>
</tr>
<tr>
<td><strong>Sampling Period</strong></td>
<td><strong>Total Solids (g/m²/month)</strong></td>
<td><strong>Insoluble Solids (g/m²/month)</strong></td>
<td><strong>Combustible Matter (g/m²/month)</strong></td>
<td><strong>Ash (g/m²/month)</strong></td>
<td><strong>Soluble Matter (g/m²/month)</strong></td>
</tr>
<tr>
<td><strong>12 August – 13 September 2016</strong></td>
<td>0.19</td>
<td>0.12</td>
<td>0.47</td>
<td>-</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Approximate Rainfall (mm)</strong></td>
<td>0.75</td>
<td>0.68</td>
<td>0.72</td>
<td>-</td>
<td>68</td>
</tr>
</tbody>
</table>
(a) Approximate rainfall = total volume of accumulated rainwater over the sampling period ÷ cross sectional area of the funnel opening. Small evaporative losses from the sampling bottle cannot be accounted for in the approximation of rainfall.

(b) Total solids are expressed as soluble matter plus insoluble solids.

(c) Combustible matter is expressed as soluble plus insoluble solids minus ash.

(d) IL Bal4 sample left in field for extended period for radionuclide analysis.

(e) IL Bal 1 – deposition gauge adjacent to R5 shearing shed

All analysis of samples was completed by Ektimo (Nata Accredited) in accordance with AS3580: Methods for sampling an analysis of ambient air.

2. REFERENCES

The data above was collated from the following Ektimo reports:


### APPENDIX E

#### BALRANALD MINERAL SANDS PROJECT - ENVIRONMENTAL INCIDENT SUMMARY (2016)

<table>
<thead>
<tr>
<th>Incident Date</th>
<th>Incident #</th>
<th>Risk</th>
<th>Location</th>
<th>Category</th>
<th>Details</th>
<th>Action taken / mitigation measure / prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/05/2016</td>
<td>INC257055</td>
<td>LOW</td>
<td>General site area</td>
<td>Weeds</td>
<td>The 3 vehicles that come from JA (other operations) not cleaned. Inside had sand on the floor. Underneath still had mud all over.</td>
<td>Operators reminded of procedure to be followed and requirement to clean vehicles at Council depot prior to accessing Balranald site. Vehicles cleaned and then allowed to access site. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>9/06/2016</td>
<td>INC257685</td>
<td>LOW</td>
<td>Plant area - hard stand</td>
<td>Spill - saline water</td>
<td>Airlock in pump 79 causing a large water spill from tank 60. Spill contained in operational footprint.</td>
<td>Plant shut down and air line bled. Pump tested prior to works recommencing. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>14/06/2016</td>
<td>INC257803</td>
<td>LOW</td>
<td>Plant area - hard stand</td>
<td>Spill - hydrocarbon</td>
<td>Oil all over rig walkway (oil for seals)</td>
<td>Seals checked and rig wash-down in designated area. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>15/06/2016</td>
<td>INC257869</td>
<td>LOW</td>
<td>Mud system - hard stand drill area</td>
<td>Spill - drilling muds</td>
<td>Mud spill (Drill muds) on project area.</td>
<td>Muds contained and area cleaned up. Muds placed on stockpile. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>29/06/2016</td>
<td>INC258193</td>
<td>LOW</td>
<td>HDD drill area</td>
<td>Spill - drilling fluids</td>
<td>Layflat hose leaking drilling fluid (biodegradable) at coupling joint (approx. 20L) into area of vegetation behind monitoring well and HDD area.</td>
<td>Leak immediately stopped by raising joint connection. Joint connection fixed. Layflat hose flushed with freshwater. Issue discussed at following day pre-start. Rainfall flushed vegetation. No permanent damage to vegetation noted.</td>
</tr>
<tr>
<td>30/06/2016</td>
<td>INC258192</td>
<td>LOW</td>
<td>Met office - hard stand</td>
<td>Resource wastage</td>
<td>HM samples spill outside MET site office within work area (2 buckets full)</td>
<td>Metallurgist advised. HM cleaned up and placed on ore stockpile. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>30/06/2016</td>
<td>INC258199</td>
<td>LOW</td>
<td>Balranald</td>
<td>Soil contamination</td>
<td>Waterwell drilling for New VWP (V15) using unlined sump for muds.</td>
<td>Supervisor notified. Sump material excavated at completion of drilling. Material placed on muds stockpile. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>1/07/2016</td>
<td>INC258314</td>
<td>LOW</td>
<td>General site area - hard stand</td>
<td>Spill - water</td>
<td>Water leaked from camlock of water truck over night.</td>
<td>Tap turned off and hose removed. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>2/07/2016</td>
<td>INC258297</td>
<td>LOW</td>
<td>HDD drill area - hard stand</td>
<td>Spill - drilling muds</td>
<td>Blockage in gpu had to discharge 20lt of drilling grout on ground in set work area.</td>
<td>Vehicles cleaned at Hamilton MSP. Issue discussed at following day pre-start. Operators reminded of procedure to be followed and requirement to clean vehicles at Council depot prior to leaving Balranald for other operations.</td>
</tr>
<tr>
<td>7/07/2016</td>
<td>INC258320</td>
<td>LOW</td>
<td>General site area</td>
<td>Weeds</td>
<td>Hilux ute driven from Balranald arrived at Hamilton MSP covered in mud.</td>
<td>Vehicles had sand on the floor. Underneath still had mud all over.</td>
</tr>
<tr>
<td>13/07/2016</td>
<td>INC258459</td>
<td>LOW</td>
<td>Drill pad (V15)</td>
<td>Spill - drilling muds</td>
<td>COE drilling mud spill on drill pad (V15), after transfer pump disconnected. Uncontained but spill only present in cleared area.</td>
<td>Drilling muds cleaned up and muds placed on stockpile. Issue discussed at following day pre-start. Area was tidied up part of drillers demob from site.</td>
</tr>
<tr>
<td>14/07/2016</td>
<td>INC258454</td>
<td>LOW</td>
<td>Balranald</td>
<td>Spill - muds</td>
<td>Reducer had been removed from mud line causing mud to flow under thickener tank.</td>
<td>Muds cleaned up (placed on stockpile). Reducer replaced on mud line prior to restart. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>19/07/2016</td>
<td>INC258587</td>
<td>LOW</td>
<td>Balranald</td>
<td>Pests</td>
<td>An abundance of caterpillars on site and around site on the vegetation.</td>
<td>Photos taken. Issue reported to site environmental advisor. No further identification of issue.</td>
</tr>
<tr>
<td>19/07/2016</td>
<td>INC258589</td>
<td>LOW</td>
<td>Balranald</td>
<td>Rubbish</td>
<td>Rubbish around site including on the track in.</td>
<td>Rubbish cleaned up. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>19/07/2016</td>
<td>INC258588</td>
<td>LOW</td>
<td>Balranald</td>
<td>Rubbish</td>
<td>There is mud and ore been placed in the general skip bin.</td>
<td>Mud and ore removed from bin (and placed on stockpiles) prior to bins being removed from site. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>19/07/2016</td>
<td>INC258586</td>
<td>LOW</td>
<td>Balranald</td>
<td>Spill - ore</td>
<td>Ore has leaked off the ore pad on the north side.</td>
<td>Ore cleaned up and area reinstated - spill within approved site disturbance area. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>22/07/2016</td>
<td>INC258693</td>
<td>LOW</td>
<td>General site area - hard stand</td>
<td>Spill - hydrocarbon</td>
<td>Diesel spill on ground at end of IOR container. Approximately 10L.</td>
<td>Hydrocarbon pads used to clean up. Cause investigated (vehicle). Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>22/07/2016</td>
<td>INC258702</td>
<td>LOW</td>
<td>Balranald</td>
<td>Subsidence</td>
<td>Noted cracking in cavity area around stope 3 HBF well.</td>
<td>Investigated area. Danger tape erected around the area. Site safety notice prepared. Issue discussed at following day pre-start. Crack size noted. Survey undertaken. NSW government agencies notified and follow up reporting completed. Ongoing monitoring during activities and post mining (including 2017).</td>
</tr>
<tr>
<td>26/07/2016</td>
<td>INC258803</td>
<td>LOW</td>
<td>Balranald</td>
<td>Rubbish</td>
<td>General rubbish in scrap steel bins.</td>
<td>General rubbish cleared out of scrap metal bin and placed in correct bin prior to removal from site. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>9/08/2016</td>
<td>INC259063</td>
<td>LOW</td>
<td>Wash plant - hard stand</td>
<td>Spill - hydrocarbon</td>
<td>Nozzle on fuel truck did not click off and over flowed. Operator had to run and turn off valve on working plant hardstand.</td>
<td>Spill cleaned with soak pads from spill kit. Equipment tagged with ‘out of service’ and fixed prior to use. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>Incident Date</td>
<td>Incident #</td>
<td>Risk</td>
<td>Location</td>
<td>Category</td>
<td>Details</td>
<td>Action taken / mitigation measure / prevention</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>------</td>
<td>------------------</td>
<td>------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>17/08/2016</td>
<td>INC259244</td>
<td>LOW</td>
<td>Track 6</td>
<td>Vegetation - damage</td>
<td>Vehicle driving, slightly veered off road, minimal damage to vegetation.</td>
<td>Issue discussed at following day pre-start. Site vehicle speeds and behaviours reiterated. Track maintenance. No permanent damage to vegetation evident.</td>
</tr>
<tr>
<td>22/08/2016</td>
<td>INC259388</td>
<td>LOW</td>
<td>Balranald</td>
<td>Resource wastage</td>
<td>Ore pad liner damaged while cleaning up pad with excavator.</td>
<td>Ore pad liner reinstated following clean up. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>25/08/2016</td>
<td>INC259404</td>
<td>LOW</td>
<td>Balranald</td>
<td>Spill - muds</td>
<td>Slurry feed valve (FV2601) was left open. While tripping out mining pipe and pumping muds, tank (TK013) filled with muds and overflowed into swale drain.</td>
<td>Valve immediately closed. Muds removed from tank and placed on muds stockpile. Swale drain cleaned and reinstated. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>31/08/2016</td>
<td>INC259558</td>
<td>LOW</td>
<td>Balranald town office</td>
<td>Spill - hydrocarbon</td>
<td>Diesel observed dripping from contractor HV Parked outside town office.</td>
<td>Supervisor and contractor notified. HV relocated to flat surface and tank inspected. Spilt diesel cleaned up with hydrocarbon matting and sand. Issue discussed at following day pre-start.</td>
</tr>
<tr>
<td>6/09/2016</td>
<td>INC259670</td>
<td>LOW</td>
<td>Balranald</td>
<td>Spill - ore</td>
<td>Mineral in scrap metal bin.</td>
<td>Mineral cleaned out of scrap metal bin and placed in stockpile area. Issue discussed at following day pre-start.</td>
</tr>
</tbody>
</table>