MINERAL RESOURCES

J5 and Bungalbin East Iron Ore Proposal
Response to Submissions – Appendix C
Conservation Significant Species & Communities Mgmt. Plan

CONSERVATION SIGNIFICANT SPECIES AND COMMUNITIES MANAGEMENT PLAN

J5 AND BUNGALBIN EAST IRON ORE PROPOSAL

246-EN-PLN-0002

1st March 2017

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Version	Date	Description	Authorisation	Signature
A	10/8/2016	Initial Draft Plan for insertion as PER Section – Appendix 5H	James Hesford	
B	1/3/2017	Updated Draft Plan for Response to Submissions	Sean Gregory	Sean Gregory

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1. SUMMARY

This Conservation Significant Species and Communities Management Plan (CSSCMP) is submitted in accordance with the Environmental Scoping Document (ESD) dated 27 August 2015 for the J5 and Bungalbin East Iron Ore Project (the Proposal) by Mineral Resources Ltd (MRL).

Table 1-1 presents the environmental criteria to measure achievement of the condition environmental outcome that must be met through implementation of this this CSSCMP.

TABLE 1-1: KEY ELEMENTS OF THE EMP

Title of proposal	Jackson 5 and Bungalbin East Iron Ore Project
Proponent	Mineral Resources Ltd
Ministerial Statement number	TBA
Purpose of this Condition EMP	The Conservation Significant Species and Communities Management Plan is submitted to fulfil the requirement of Condition 6b of the Environmental Scoping Document.
EPA's environmental objective for the key environmental factor/s	To protect flora and vegetation so that biological diversity and ecological integrity are maintained
Condition environmental outcome or proposed measurable outcome	The management objectives for flora and vegetation are: • to minimise impacts on flora and vegetation of conservation significance; and • to meet statutory requirements.
Environmental Criteria	
Trigger criterion 1	For Conservation Significant Vegetation (J5 and Bungalbin East): • An observable reduction in plant vigour as measured using MSA over an area of 10,000 m^2 or greater associated with the mining operation; and/or • A recorded decline in vegetation health ranking score of 1 level over one or more quadrats relative to control sites. • A recorded decline in total foliar cover over one or more quadrats that is statistically significantly greater than recorded in control quadrats.
Trigger criterion 2	For any species of conservation significant flora (J5 and Bungalbin East): • An overall average change in health score of -1 of plants in impact susceptible sites associated with the mining operations with no corresponding reduction in health score recorded for plants at associated control sites.

Trigger criterion 3	For any species of conservation significant flora (J5 and Bungalbin East): • A statistically significant increase in mortality rate (95% confidence level) associated with the mining operation in comparison with associated control sites • A statistically significant decline in recruitment rate (95% confidence level) associated with the mining operation in comparison with associated control sites
Threshold criterion 1	For Conservation Significant Vegetation (J5 and Bungalbin East): • An increase in intensity and/or spatial extent of vegetation stress when compared to previous measurements associated with the mining operation; and/or • A recorded decline in vegetation health ranking score of more than 2 levels relative to a control site.
Threshold criterion 2	For each species of conservation significant flora for J5 and Bungalbin East: • An overall average change in health score of -1.5 of plants of any monitored taxa, associated with the mining operations, with no corresponding reduction in health score recorded for plants at control sites.
Threshold criterion 3	For any species of conservation significant flora (J5 and Bungalbin East): • A continued statistically significant increase in mortality rate (95% confidence level) associated with mining operations in comparison with associated control sites • A continued statistically significant decline in recruitment rate (95% confidence level) associated with mining operations in comparison with associated control sites

Corporate endorsement

I hereby certify that to the best of my knowledge, the EMP provisions within this Conservation Significant Species and Communities Management Plan are true and correct.

Designation: Project Manager

Signed: Sean Gregory

Date: 1 March 2017

2. CONTEXT, SCOPE AND RATIONALE

2.1 Description of Proposal

The proposed J5 and Bungalbin East Iron Ore Project will involve the mining of iron ore at the Helena-Aurora Range (HAR), about 100 kilometres (km) north of Southern Cross in the Shire of Yilgarn, Western Australia. The establishment of the project will require the clearing of vegetation and flora of significant conservation values. There is also potential for indirect impacts on adjoining flora and vegetation.

2.2 Key Environmental Factor/s addressed in this EMP

This EMP addresses the EPA's objective for flora and vegetation (as per EPA 2016):

- To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Flora and vegetation is a key environmental factor for the J5 and Bungalbin East Iron Ore Project because the J5 and Bungalbin East mines and infrastructure will be established in areas that feature conservation significant flora (CS flora) and vegetation (CS vegetation). While direct removal of some conservation significant flora and vegetation will occur through land clearing in order to establish and operate the project, further conservation significant flora and vegetation will remain, some in immediate proximity to operations, and may be indirectly impacted by operations.

The primary aim of the CSSCMP is to protect conservation significant flora and vegetation that remains after land clearing for construction of the project. The Public Environmental Review (PER) identified four CS flora taxa with a combination of the highest conservation significance ranking (T; P1) and greatest direct impact due to clearing:

- *Tetratheca aphylla subsp aphylla* (T)
- *Leucopogon spectabilis* (T)
- *Acacia adinophylla* (P1)
- *Lepidosperma bungalbin* (P1)

These taxa have been selected for monitoring because they have the highest conservation significance of taxa in the local vegetation, and they are also locally common, with enough individual plants to form a comprehensive monitoring program.

This plan also addresses the protection and management of conservation significant vegetation (CS vegetation), in the form of the Helena and Aurora Range vegetation complexes (banded ironstone formation) Priority Ecological Community (PEC) (P1) (HAR PEC). This CS vegetation incorporates several floristic communities associated with the range, mapped as the supergroup PSRN by ecologia (2016)), which is associated with BIF slopes, and comprises the majority of native vegetation surrounding operational areas.

Vegetation and flora not directly affected by initial land clearing may be indirectly affected by related activities including:

- dust deposition arising from blasting, earthmoving operations and vehicle movements
- rill of broken rock downslope from blasting and mining
- altered hydrological regimes as a result of removal or diversion of surface flows, drying of soil profiles adjacent to excavations or increased soil moisture or inundation from discharge of liquids from structures (e.g. waste rock landforms) or ponding caused by damming of surface flows by roads or other infrastructure
- fragmentation and changes in microclimate due to changed environmental conditions resulting from the establishment of the mine
- weed incursion.

The specific flora and vegetation values this EMP aims to protect are the condition and extent of:

- The HAR vegetation complexes (banded ironstone formation) Priority Ecological Community (PEC) (P1) (PSRN vegetation types) identified through biological survey (Figures 2-1 and 2-2).
- Threatened species - *Leucopogon spectabilis* (Figure 2-3) and *Tetratheca aphylla* subsp. *aphylla* (Figure 2-4).
- Priority 1 (P1) species - *Acacia adinophylla* (Figure 2-5) and *Lepidosperma bungalbin* (Figure 2-6).

P3 and P4 taxa also occur in the vicinity of the proposed operations but will not be specifically addressed within this Plan.

FIGURE 2-1: BUNGALBIN EAST– IMPACT ON HAR PEC (PRIORITY 1)

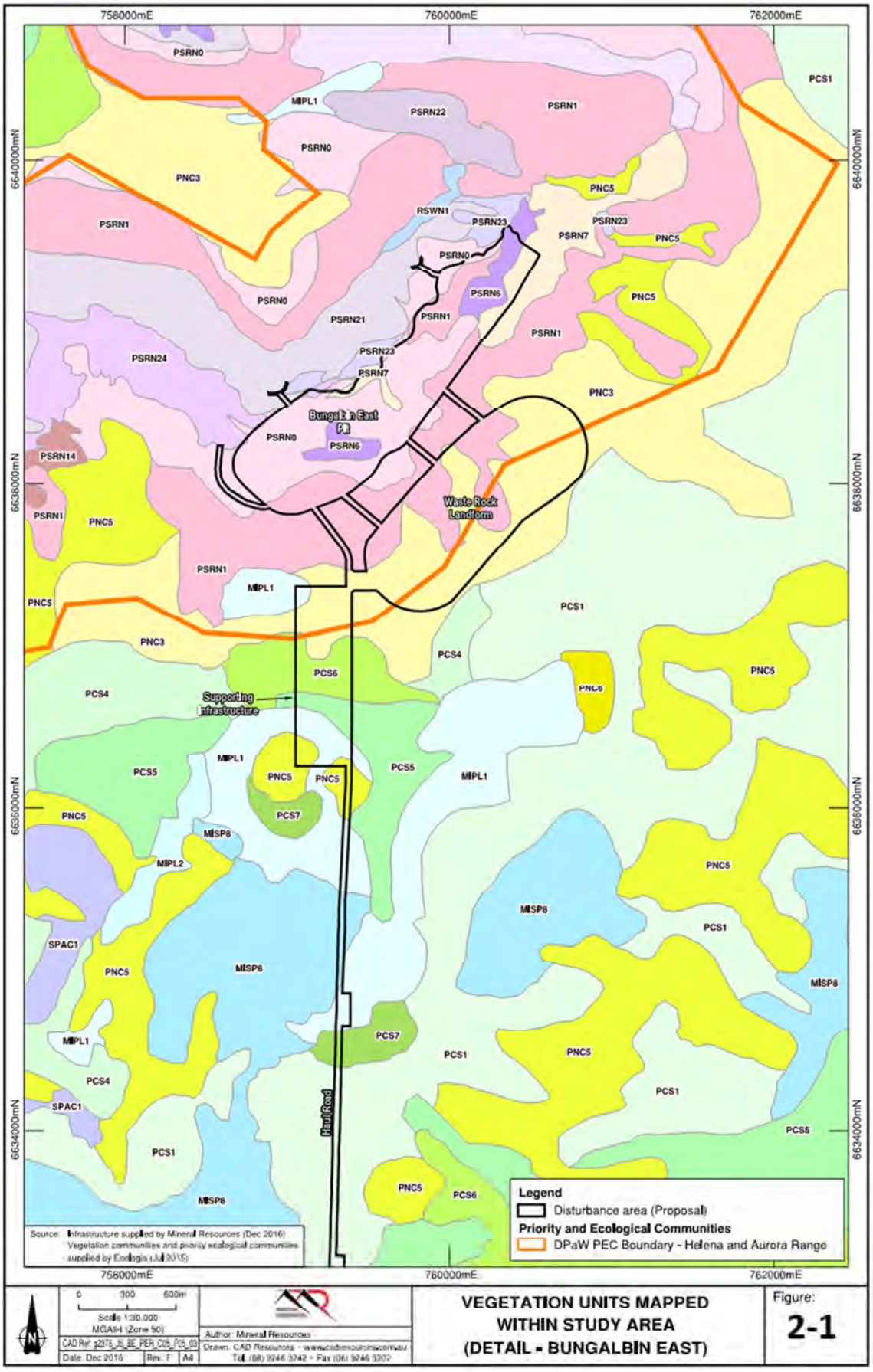


FIGURE 2-2: J5 – IMPACT ON PEC

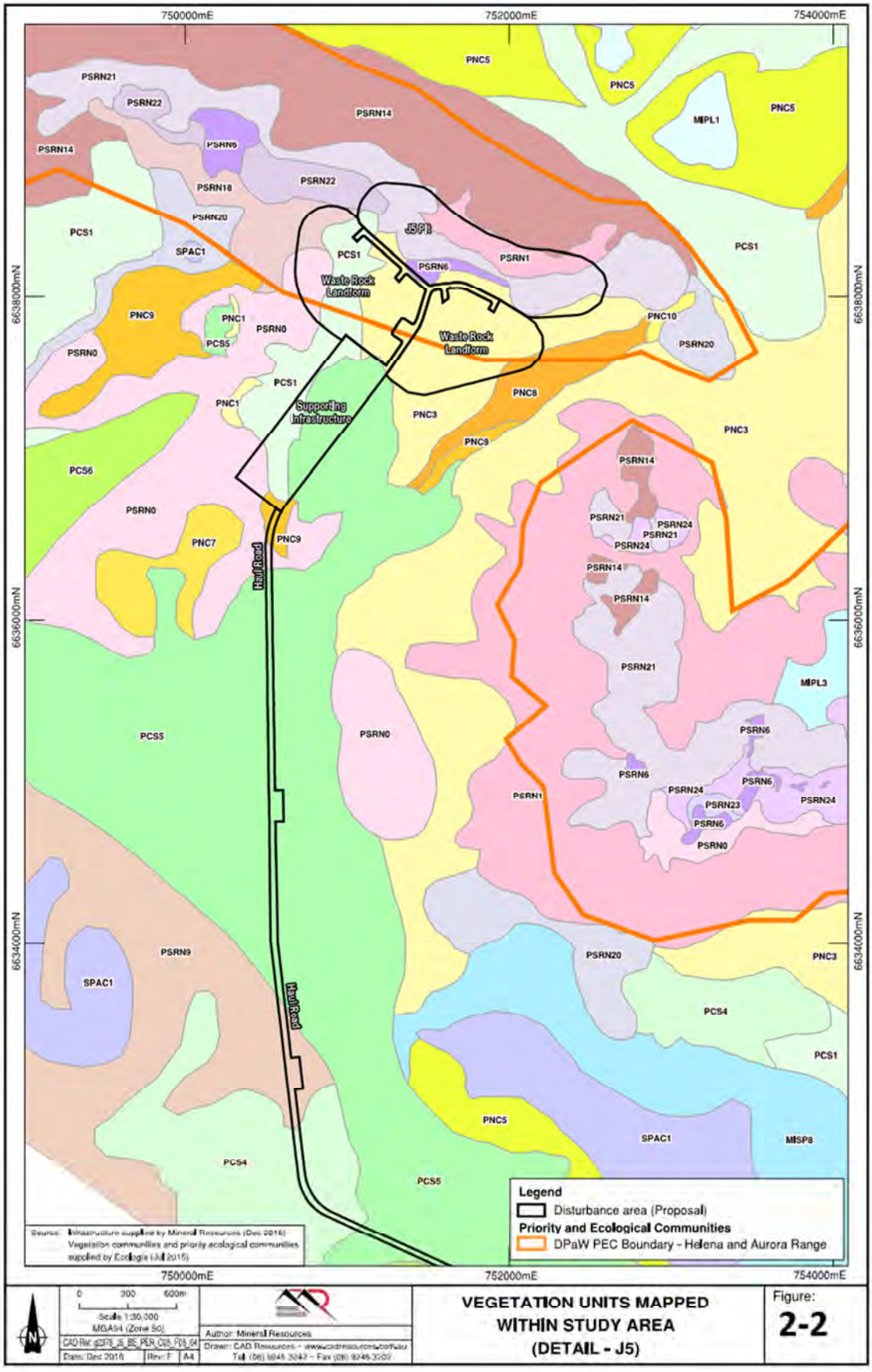


FIGURE 2-3: IMPACT ON *LEUCOPOGON SPECTABILIS* (THREATENED)

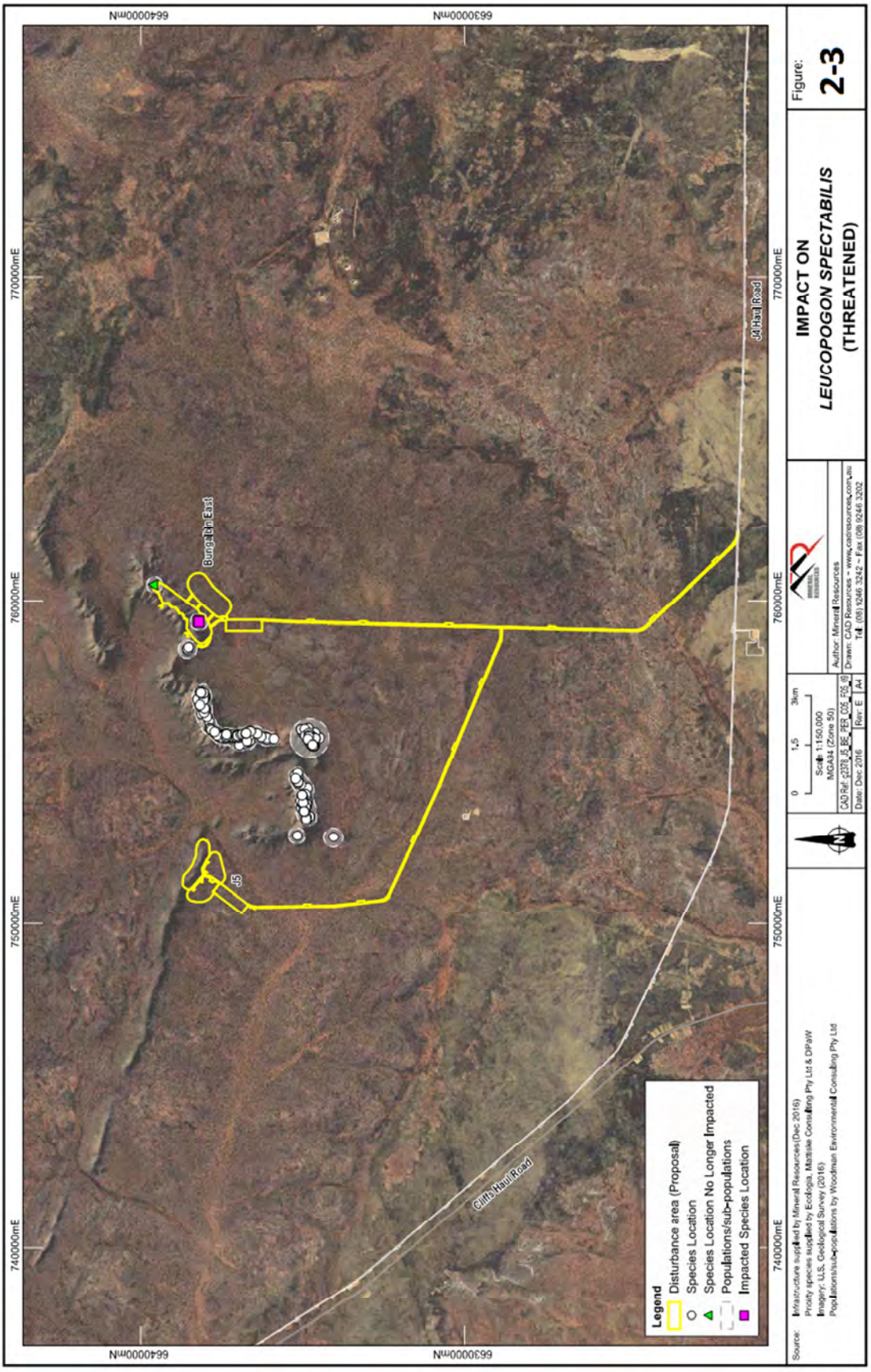


FIGURE 2-4: IMPACT ON *TETRATHECA APHYLLA SUBSP. APHYLLA* (THREATENED)

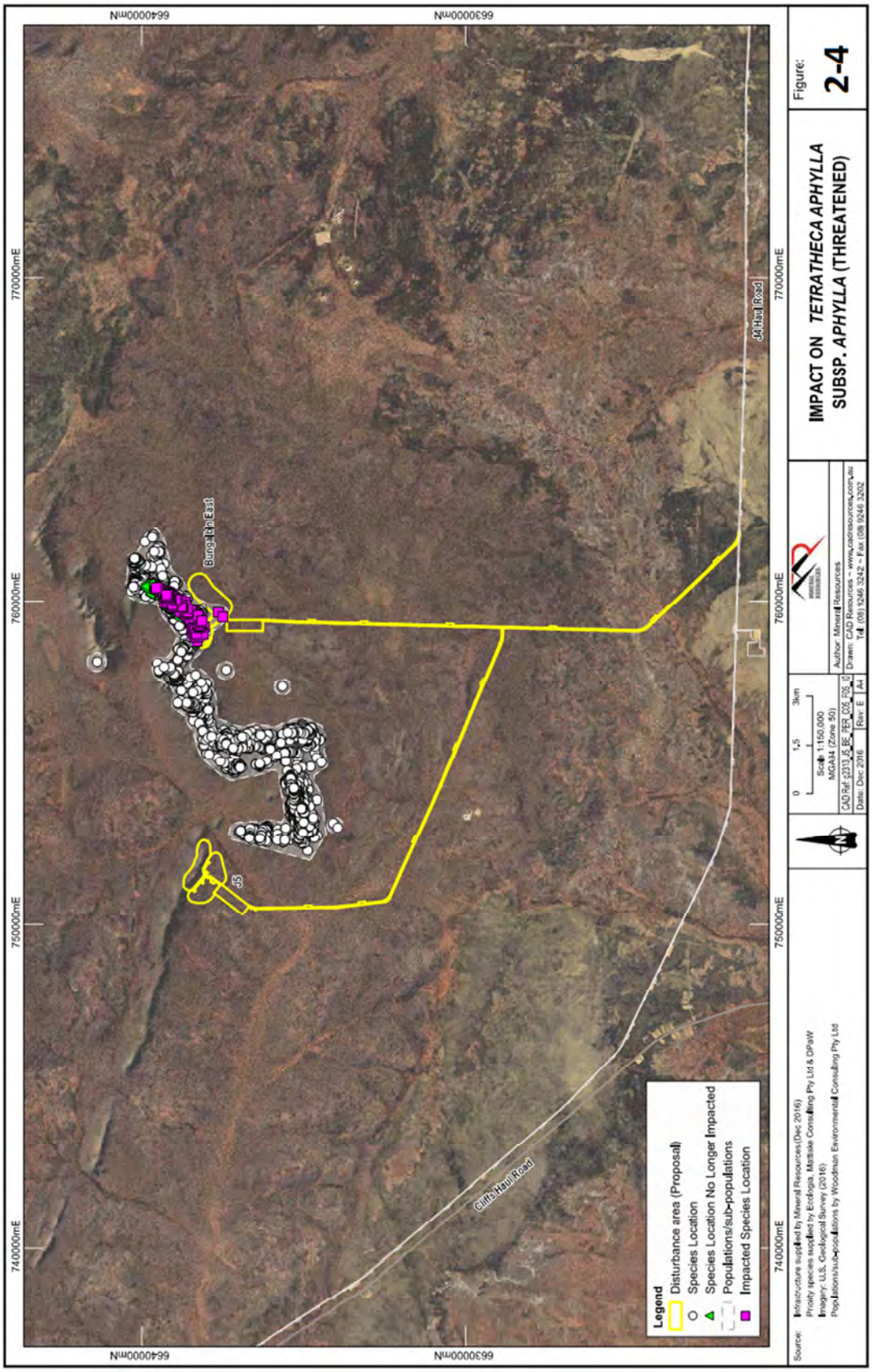


FIGURE 2-5: IMPACT ON *ACACIA ADINOPHYLLA* (P1)

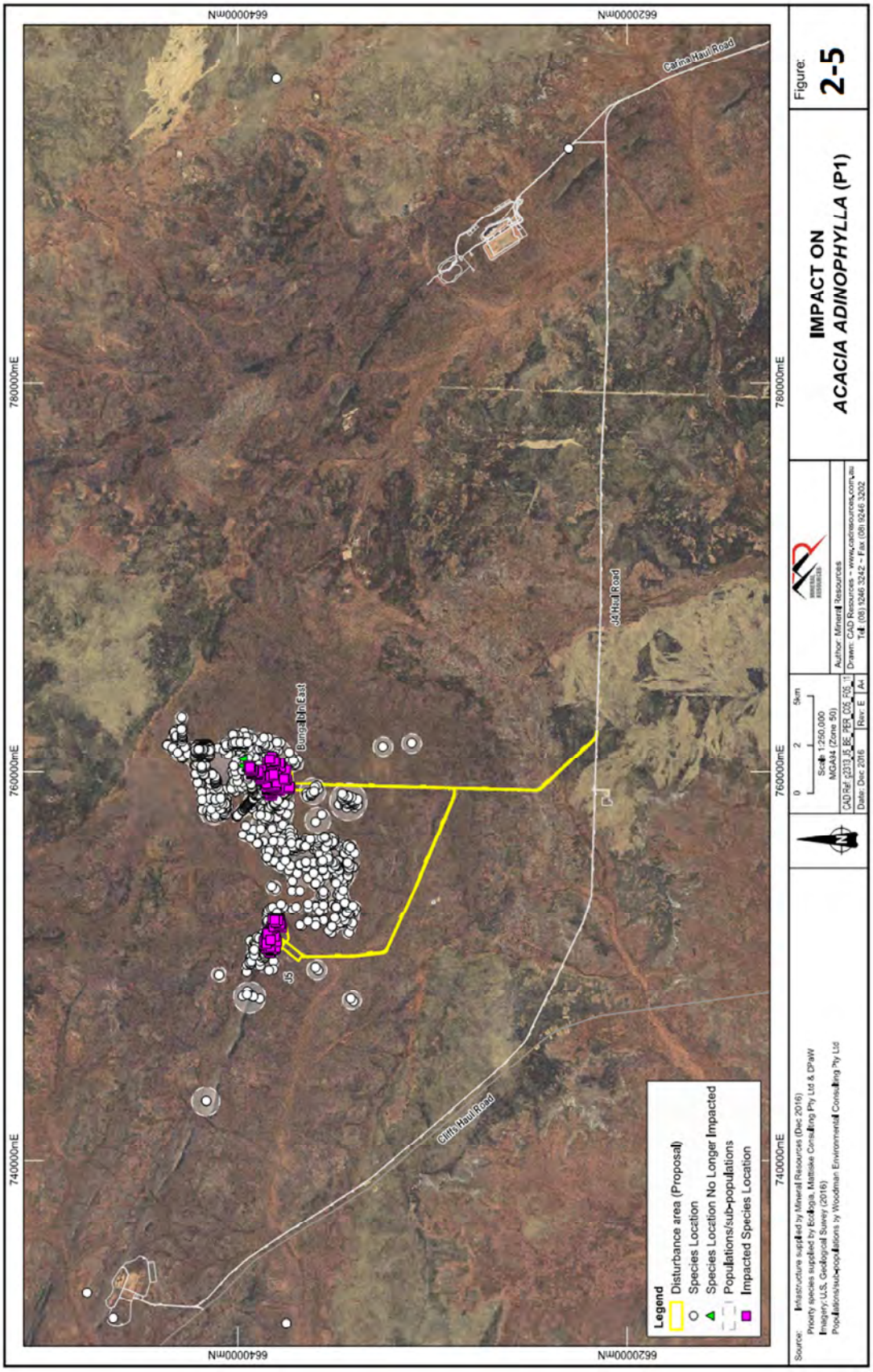
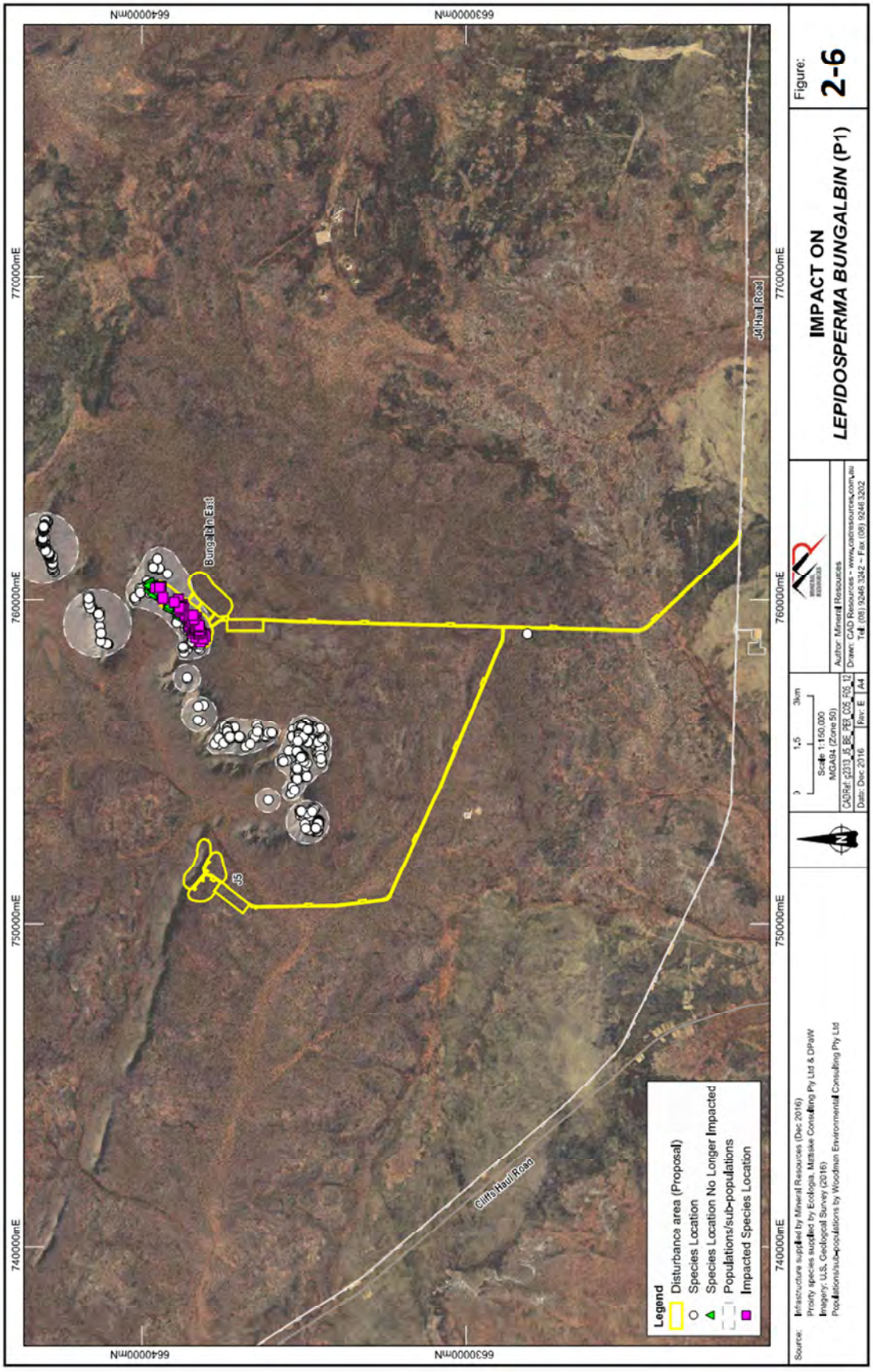


FIGURE 2-6: IMPACT ON *LEPIDOSPERMA BUNGALBIN* (P1)



Specific objectives include:

- Prevent further impacts (over and above the initial approved clearing) to the extent, health and productivity of the HAR PEC as a result of the project.
- Prevent further impacts (over and above the initial approved clearing) to the extent, health and productivity of the CS flora taxa *Leucopogon spectabilis*, *Tetratheca aphylla* subsp. *aphylla*, *Acacia adinophylla* and *Lepidosperma bungalbin*.

Other aspects of CS flora and vegetation management, such as improvement of survivorship/increase in wild populations or introduction of species into areas of mine restoration, will be addressed in plans to be developed in consultation with the Department of Parks and Wildlife and other relevant stakeholders prior to commencement of mining operations.

Other relevant documents include:

- MRL's Land Clearing Procedure (MRL-EN-PRO-0004)
- MRL's Weed Hygiene and Control Procedure (MRL-EN-PRO-0007).

2.3 Requirements of the condition

This EMP is provided as part of the assessment of the J5 and Bungalbin East Iron Ore Project under Part IV of the *Environmental Protection Act 1986* to fulfil the requirement of Condition 6b of the ESD. As such, it does not relate to any existing condition within a Ministerial Statement.

This document is consistent with EPA Instruction on how to prepare *Environmental Protection Act 1986 Part IV Environmental Management Plans.*

2.4 Rationale and approach in meeting the Environmental Objective

Previous Surveys

The following surveys and investigations are relevant to this EMP:

TABLE 2-1: RELEVANT SURVEYS AND INVESTIGATIONS

ecologia (2016)	Biological surveys of project area including: Vegetation mapping based on quadrat data from a range of local and regional surveys Targeted searches and mapping of individual species with significant conservation values Vegetation health (at the population level) Records of weeds.
Pacific Environment Ltd (2016)	Air quality assessment. Modelled expected dust deposition values around mining operations.

Key Assumptions and Uncertainties

Vegetation and flora has been mapped and recorded as presented on Figure 2-1 to Figure 2-6 with a high degree of certainty. As such, the direct impacts to these factors have been quantified.

Some residual uncertainty exists around the following factors, and the potential indirect impacts they could have on CS flora and vegetation:

- Differences, if any, between modelled dust generation and actual dust generation.
- Uncertainty regarding physical and chemical properties of generated dust.
- Susceptibility of the CS flora taxa and vegetation to local mine-produced dust impacts.
- Likelihood of impact due to dust on CS flora taxa and vegetation given the environmental setting (e.g. rainfall, prevailing winds, etc.).
- The effect of fragmentation, altered topography due to mining and subsequent changes in microclimate on plant health and survivorship.

Management approach

The management approach to ensure the environmental objectives (Section 2.2) are achieved includes:

- Retention of CS flora and vegetation in the vicinity of the proposed footprint as much as practical through careful planning of disturbances associated with infrastructure, roads and stockpiles.
- Protection of CS flora and vegetation adjacent to operations from inadvertent clearing through the implementation of rigorous controls (MRL-EN-PRO-0004).
- Protection of CS flora and vegetation from indirect impacts associated with the operations, including; dust, altered hydrology and degradation through weed infestation. These potential impacts will be managed through:
    - careful planning of site infrastructure, roads and stockpiles to minimise exposure of conservation significant flora and vegetation to dust and also any associated impacts from altered site hydrology
    - minimisation of dust generation through dust suppression of dust generating activities (blasting; digging, loading and haulage of waste rock and ore)
    - Implementation of weed hygiene procedures and weed control where necessary.
- Monitoring of CS flora and vegetation to identify potential residual impacts (after management) and inform adaptive management actions to prevent ongoing impacts where required.

Rationale for choice of environmental criteria

Options for environmental criteria include environmental variables (e.g. dust deposition levels and meteorological conditions), and the health of CS vegetation and individual CS taxa plants.

PEC Condition

Monitoring will be undertaken using traditional field vegetation assessment methods, including area-based vegetation health scale assessment and photographic assessment, as well as using remote sensing technology. Multi-Spectral Analysis (MSA) provides monitoring that is both spatial (location of stress and spatial extent) and is highly sensitive to changes between monitoring events. This monitoring will provide a focus for investigation of impacts and causal agents as well as an accurate function for reporting of both extent of impacts and subsequent recovery following mitigation. MSA also allows for assessment of large areas of vegetation that may not be easily accessible by vehicle or foot, and can provide data on possible changes in vegetation health in areas which not otherwise be monitored.

This method has been used to assess changes in vegetation health on the Gnangara Groundwater Mound (Canci *et al.* unknown date; Woodman Environmental 2014) and also in relation to Tuart decline (Evans *et al.* 2012) at Yalgorup. The Gnangara studies correlated the imagery with

traditional vegetation monitoring transects and some limited ground truthing while the Yalgorup study was ground truthed using vegetation health indexes coupled with traditional photographs to monitor changes in individual tree condition. Other studies including monitoring of tree and vegetation health in riverine communities in the Pilbara (SpecTerra Services pers. comm.) have also proved highly effective.

Conservation Significant Flora Health

Individual plants may suffer impacts from operations that are not necessarily apparent at the community level or scale, and therefore will be monitored using a field assessment method.

Environmental Variables

Environmental variables (dust deposition, rainfall, wind direction and strength) will be monitored to potentially provide correlation with any observed impacts, and also to potentially identify triggers for management. The relationship between environmental variables (e.g. dust) and plant health for the conservation significant flora in question is currently unknown. To address this, a risk-based approach is being taken, whereby plant/vegetation health is being monitored alongside the variable in question where possible. Each monitoring location where dust has been identified as posing a potential risk to plant health will have dust deposition measuring to allow correlation between ambient dust levels and health. Results of monitoring and impact related studies will inform modification of the monitoring programme over time.

Rationale for choice of trigger level actions and threshold contingency actions

There is a lack of documented evidence regarding impacts of dust and other factors on flora and vegetation known from the project area. A risk-based approach to monitoring of species and vegetation response to such variables, based upon recent works such as that by Turner (2013), will be utilised to determine potential real-time indirect impacts on these factors.

Formal trigger levels in relation to these environmental variables that identify a requirement for an immediate management response to prevent impacts on flora and vegetation occurring cannot be proposed at this time. A management response will be initiated by MRL in the event that impacts on conservation significant flora or vegetation as a result of operations are identified, either through formal monitoring or through routine site inspections. This will allow MRL to mitigate observed impacts and prevent the extent or severity of impact from escalating. It will also provide data for the revision of environmental variable trigger levels, and documenting of impacts and actions reported to the Office of the Office of the Environmental Protection Authority (OEPA) and the Department of Parks and Wildlife (DPaW), outlining:

- the extent of the impact
- the likely reasons why it has occurred and why preventative measures to date were ineffective
- an outline of how MRL will prevent further impacts.

Interim trigger levels and actions are proposed on the understanding that revision will occur once additional data is collected to refine these. The triggered response actions will be specific to the identified causal agent of the observed stress (e.g. increased dust suppression where deposition levels are implicated, installation of culverts where ponding is implicated or potentially provision of water where loss of catchment is implicated).

Threshold criteria will be set at a level which indicates that a clear adverse impact to the health of conservation significant flora or vegetation is occurring, and that any steps taken when the trigger criteria were reached have been unsuccessful in preventing a further decline in condition. If a circumstance arises where a threshold criterion is reached, the cause of the decline will be investigated immediately and reported to the OEPA and DPaW, outlining:

- the extent of the impact
- the likely reasons why it has occurred and why preventative measures to date were ineffective
- an outline of how MRL will prevent further impacts.

3. CONDITION EMP PROVISIONS

The provisions in this EMP are outcome-based and are presented below in detail. Objective measuring of factors such as health ranking and recruitment/death rate of individuals of specific CS flora taxa, and health of CS vegetation, in comparison to control sites, will be measured and reported, against the objectives as specified in Section 2.2:

- Prevent further impacts (over and above the initial approved clearing) to the extent, health and productivity of the HAR vegetation complexes (banded ironstone formation) PEC (P1) as a result of the project.
- Prevent further impacts (over and above the initial approved clearing) to the extent, health and productivity of the conservation significant species *Leucopogon spectabilis*, *Tetratheca aphylla* subsp. *aphylla*, *Acacia adinophylla* and *Lepidosperma bungalbin*.

In conjunction with this, management strategies will also be designed to minimise impacts as far as practicable. For example, dust will be created as part of clearing and mining operations; the potential impact of dust creation on significant flora and vegetation is difficult to quantify, and therefore management measures will reduce as far as possible dust creation and therefore impacts of this variable on the environment. Likewise, impacts to flora and vegetation may occur as a result of surface water drainage shadow or ponding; mine planning and design of mine features will be undertaken to avoid or minimise these scenarios, with monitoring to determine any residual impacts.

3.1 Environmental criteria

Two levels of criteria have been included in this EMP, being trigger criteria and threshold criteria. The trigger criteria were set at a conservative level to ensure trigger level actions are implemented well in advance of the environmental outcome being compromised. The threshold criteria were framed to measure achievement of the environmental outcome. A failure to meet threshold criteria signals the environmental outcome is not being met and implies non-compliance. Trigger and Threshold criteria are presented in Table 3-1.

Dust deposition levels (including type of dust) have not been included at this stage as either trigger or threshold criteria. This is due to the lack of site-specific and species-specific information in relation to levels at which dust will cause negative impacts to CS flora taxa, or vegetation associated with the PEC.

TABLE 3-1: CONSERVATION SIGNIFICANT SPECIES AND COMMUNITIES – TRIGGER AND THRESHOLD CRITERIA

Trigger criterion 1	For Conservation Significant Vegetation (J5 and Bungalbin East): • An observable reduction in plant vigour as measured using MSA over an area of 10,000 m^2 or greater associated with the mining operation; and/or • A recorded decline in vegetation health ranking score of 1 level over one or more quadrats relative to a control site. • A recorded decline in total foliar cover over one or more quadrats that is statistically significantly greater than recorded in control quadrats.

Trigger criterion 2	For any species of conservation significant flora (J5 and Bungalbin East): • An overall average change in health score of -1 of plants in impact susceptible sites associated with the mining operations with no corresponding reduction in health score recorded for plants at associated control sites.
Trigger criterion 3	For any species of conservation significant flora (J5 and Bungalbin East): • A statistically significant increase in mortality rate (95% confidence level) associated with the mining operation in comparison with associated control sites • A statistically significant decline in recruitment rate (95% confidence level) associated with the mining operation in comparison with associated control sites
Threshold criterion 1	For Conservation Significant Vegetation (J5 and Bungalbin East): • An increase in intensity and/or spatial extent of vegetation stress when compared to previous measurements associated with the mining operation; and/or • A recorded decline in vegetation health ranking score of more than 2 levels relative to a control site.
Threshold criterion 2	For each species of conservation significant flora for J5 and Bungalbin East: • An overall average change in health score of -1.5 of plants associated with the mining operations with no corresponding reduction in health score recorded for plants at control sites.
Threshold criterion 3	For any species of conservation significant flora (J5 and Bungalbin East): • A continued statistically significant increase in mortality rate (95% confidence level) associated with mining operations in comparison with associated control sites • A continued statistically significant decline in recruitment rate (95% confidence level) associated with mining operations in comparison with associated control sites

3.2 Response Actions and Timing

Implementation of Trigger Level Actions

MRL has developed trigger level actions that would be implemented if the associated trigger criterion signals the need for increased mitigation or protection (Table 3-2). These trigger level actions will be implemented by MRL to mitigate and manage impacts so they once again will meet trigger criteria and safeguard threshold criteria.

TABLE 3-2: TRIGGER LEVEL ACTIONS

Environmental Criteria and Monitoring Method	Trigger Level	Action
Trigger Criterion 1: Conservation Significant Vegetation Health	Multispectral imagery – an observable reduction in density of foliage chlorophyll associated with the mining operation.	• Field investigation to identify cause/s and propose mitigation actions to regulators (see below). • Review trigger levels and criteria based on investigation findings. • Increase monitoring frequency to until vegetation health responds positively to mitigation efforts.
	Field Monitoring - a recorded decline in vegetation health ranking score associated with the mining operation.	
	Site Inspections - an observed decline in vegetation health reported on site.	
Trigger Criterion 2: Conservation Significant Flora Health	A change in health score of -1 of plants in impact susceptible sites with no corresponding reduction in health score recorded for plants at control sites.	• Field investigation to identify cause/s and proposed mitigation actions to regulators (see below). • Review trigger levels and criteria based on investigation findings • Increase monitoring frequency to until flora health responds positively to mitigation efforts.

Monitoring of significant flora and vegetation factors will determine if the above trigger and/or threshold criteria are breached. Actions upon breaching trigger levels (trigger criteria 1 – 3) during monitoring will involve:

- Detailed analysis of the reasons behind the breach. Investigations to the cause of the breach must be undertaken to conclude as to the involvement of mining operations in the breach, as opposed to other sources (e.g. drought, fire, etc.).
- If it is concluded that mining operations have caused or attributed to the breach, the environmental variable at cause must also be identified (i.e. dust issues, drainage shadows, increase in weeds). The response actions will depend upon the environmental variable, and will be addressed as below:

Dust impacts on flora/vegetation: investigations into the amount and type of dust within the impact and control monitoring sites will be undertaken, in conjunction with investigation into the operational aspect (e.g. haulage; crushing; blasting) that may be causing the issue. The amount and type of dust will be investigated both in terms of air quality dust monitoring, and samples on leaves of potentially affected plant taxa. If dust is causing the decline in vegetation/plant health, actions to control the operational aspect will be investigated in order to halt the decline, for example increased wetting of haulage routes, reinforcement of dust covers on crushers, etc. The

monitoring regime will be altered (see Section 3.3) to determine the effectiveness of the trigger action.

Surface water drainage shadow/ponding: Action to restore natural surface water flows to affected areas will be investigated, to fine-tune the existing placement of culverts, bunding, and other attempts to re-direct water flow around mining structures. This may also include investigation into sedimentation run-off from bunds and haulage roads if this is impacting flora and/or vegetation. The monitoring regime will be altered (see Section 3.3) to determine the effectiveness of the trigger action.

Implementation of Threshold Level Actions

MRL has developed a number of threshold contingency actions that would be implemented if the associated threshold criterion signals that the environmental outcome is exceeded. The threshold contingency actions will be implemented to manage aspects of the proposal and achieve the condition environmental outcome and manage the impact to below threshold and trigger criteria again and hence bring MRL back into compliance.

Threshold contingency actions for all criteria include:

- Suspend or modify all activities identified in trigger contingency investigations.
- If trigger level criteria breaches were not previously identified, the detailed analysis of the reasons of the breach must first be undertaken (see trigger level criteria breach above).
- Report breach of threshold to OEPA and DPaW.
- Investigate and implement additional mitigation/amelioration actions in consultation with appropriate stakeholders.
- Identify and implement additional protection measures to ensure that impacts do not continue.
- The identified operational cause of the breach must be halted until such time that appropriate responses to halt the identified decline are determined and approved by the relevant stakeholders.
- Increase monitoring frequency until vegetation/flora health responds positively to mitigation efforts.

3.3 Monitoring

This monitoring program comprises a 'Before – After – Control – Impact (BACI) design that allows comparison of potential impact data with both the pre-impact conditions and also a set of control conditions. The monitoring approach is presented below.

Conservation Significant Vegetation

Multispectral imagery

Multispectral imagery (MSI) will be collected and analysed over the project area and adjacent range to provide a quantitative measure of change in overall vegetation health. Monitoring will commence prior to initial project clearing to provide a baseline of vegetation health (in terms of plant vigour) against which potential impacts associated with operations can be measured. As a minimum, the imagery shall capture the area encompassing Bungalbin East extending westward to

J5, all associated haulage routes and all identified monitoring transects (both impact and control). Data collected during this phase will include:

- Narrow-band multispectral data acquisition (blue (450nm); green (550 nm); red (675nm) and near infra-red (780 nm) (critical spectra for vegetation vigour and health monitoring), through use of fixed wing aircraft;
- Standard baseline data analysis to include plant cell density index to assess relative health and vigour of vegetation;
- Initial baseline field investigation of representative areas of non-stressed and stressed vegetation. This will involve on-ground visual inspection of vegetation, including determination of dominant species, health of overall canopy and canopy of dominant species, including yellowing or death of leaves/phyllodes, to determine background levels of stress and on-ground visual interpretation of the data;
- Repeat acquisition of multispectral data to allow for change detection over time. This is best undertaken as close as possible to the anniversary of the baseline data collection, with the solar angle difference to be less than 5º to ensure that ground features are lit at the same angle. The data can be calibrated in such a way to remove other environmental variables to allow for direct comparison over time.

Subsequent image collection and analysis will generate a 'change detection image' that identifies areas of foliage that has experienced either an increase or loss of plant vigour. Areas of reduced plant vigour can be correlated with ground conditions, operational areas and potential vectors for stress to determine whether the change is potentially related to the mining operation. Ground based monitoring (transects) will be adjusted where necessary to encompass areas of stress identified using multispectral imagery.

Semi-quantitative monitoring of vegetation health along transects

Monitoring transects will be positioned within the PEC in locations identified as potentially susceptible to mining related impacts. These locations are particularly relevant in terms of the prevailing wind direction, for monitoring of impacts by dust over time; however, transects will also be positioned in other directions to determine impacts of other vectors, such as changes in microclimate. Transects will be positioned perpendicular from the edges of mining pits/waste dumps/haulage routes, to ascertain impacts from vectors such as dust at a variety of different distances from the areas of dust generation. Turner (2013) determined that mining at Jack Hills generated dust above natural levels up to 2000 m (2 km) from the operational areas. Monitoring will be undertaken to determine the extent of impacts specifically at J5 and Bungalbin over a comparable distance.

The data collected from these transects will be used to provide context for the multispectral imagery. However, further transects may need to be monitored if change detection arising from the multispectral imagery uncovers a fall in plant vigour in CS vegetation that cannot be effectively assessed using results from nominated transects.

Vegetation health and photographic monitoring will be undertaken along transects between 500 metres (m) – 1000 m in length, with a series of repeated paired 10m x 10m quadrats located at a spacing of 50m along each transect (Figure 3-1). End points of each transect, corners of the paired quadrats and the 10 m intervals between the paired quadrats will be marked using fence droppers, labelled using metal tags, and the GPS location recorded. Photographs across each

quadrat will be taken at the fence dropper with the direction to be measured using a compass and recorded. During subsequent monitoring events copies of previous photographs are to be taken in the field for reference and to aid in replicating the image for ease of comparison.

The following information will be recorded at each quadrat:

- Vegetation health monitoring will be undertaken for each quadrat, with the health of the vegetation as a whole within the quadrat scored as per the scale presented in Table 3-3.
- The overall alive percentage foliage cover for each perennial taxon within the quadrat will be recorded, to assist in determination of impacts to specific components of the PEC vegetation, as dust impacts may affect different taxa to different levels.
- General notes on the health of the vegetation, including individual component taxa which may be exhibiting signs of stress will also be taken. This will include the shedding of leaves/phyllodes, and identification of extent of dead individuals of perennial taxa within each quadrat.
- Presence and extent (foliage cover) of weed species to be recorded within each quadrat.

The indicative locations of impact monitoring transects are presented on Figures 3.2 – 3.3. The final locations will need to be verified both by mine planning (i.e. when the areas of disturbance are finalised), and will be further refined during the in-field establishment programme, dependant on site conditions.

A summary of information including the location, indicative length, indicative numbers of quadrats, and factors to be monitored at each transect is summarised in Table 3-5.

Control transects will also be established in similar vegetation types in locations identified as unlikely to experience impacts from mining (>2km from mining or haulage routes). The methods of establishment and monitoring parameters of the control transects are presented in detail below.

TABLE 3-3: VEGETATION HEALTH SCALE

Health Score	Description
0	Vegetation healthy; no dead or stressed leaves
1	Vegetation showing signs of yellowing foliage; no dead leaves
2	Vegetation < half of foliage yellowing or dead
3	Vegetation > than half of foliage yellowing or dead
4	Majority to entire vegetation in quadrat dead

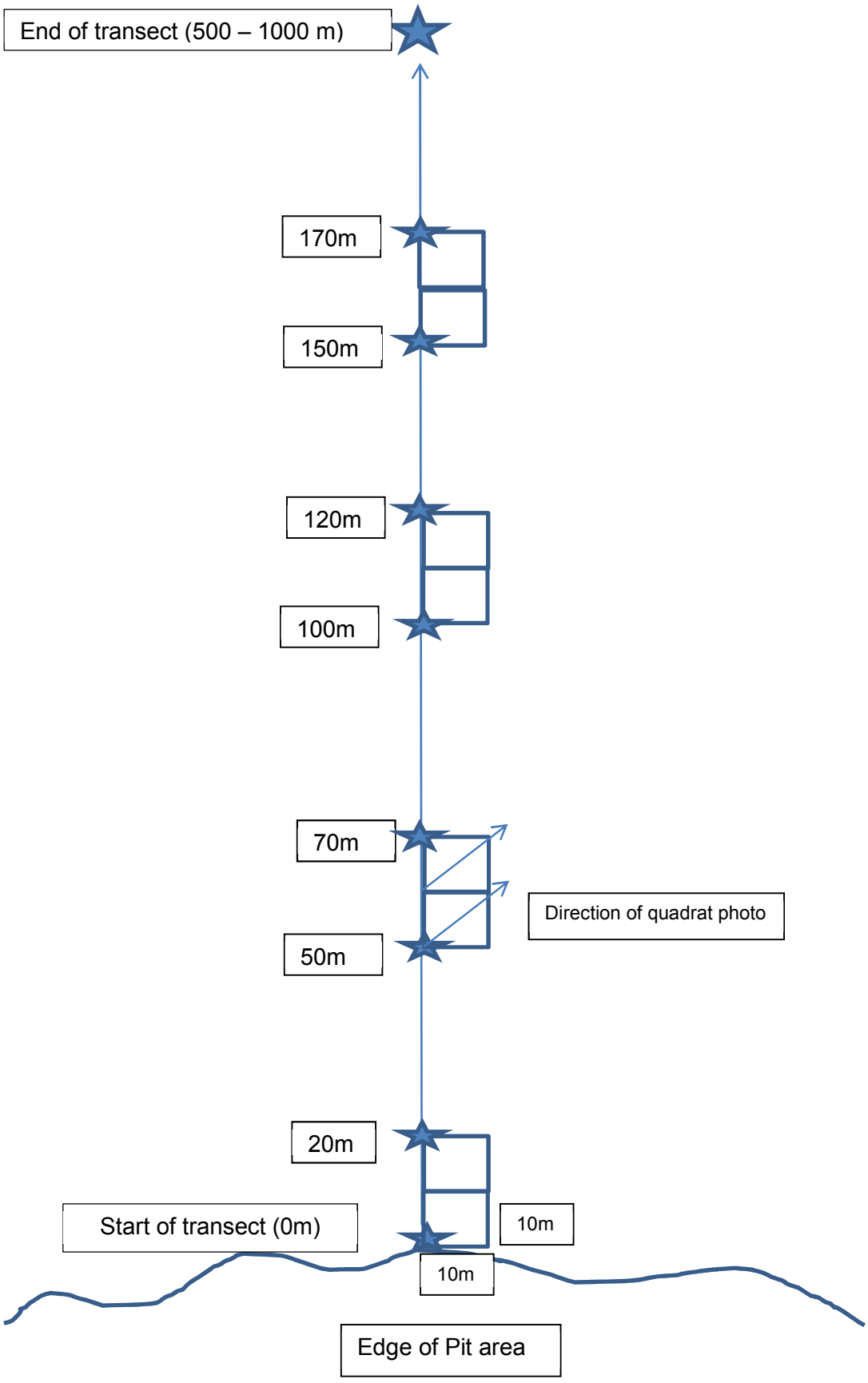


FIGURE 3-1: MONITORING TRANSECT LAYOUT

FIGURE 3-2: IMPACT MONITORING TRANSECTS FOR J5

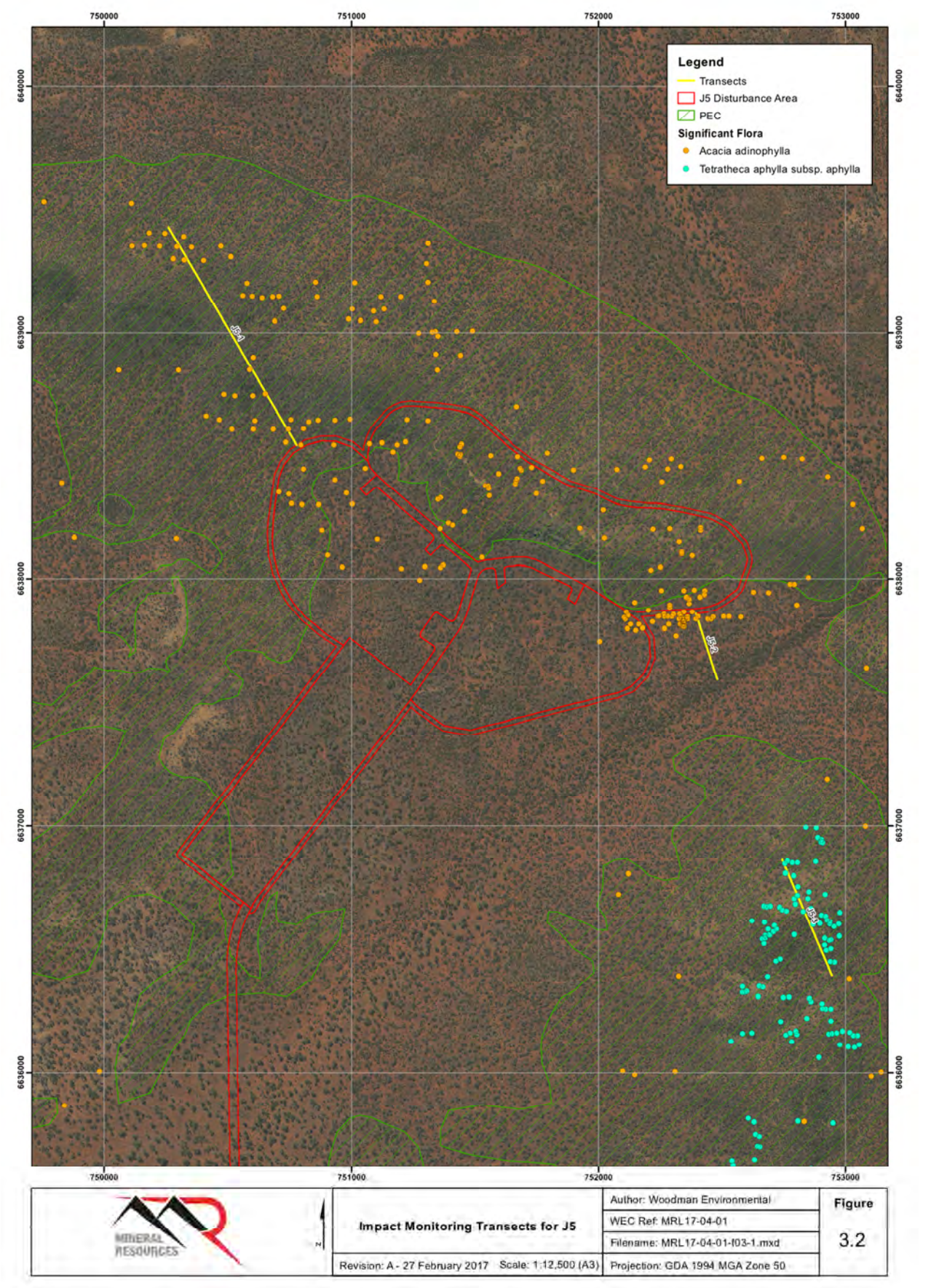
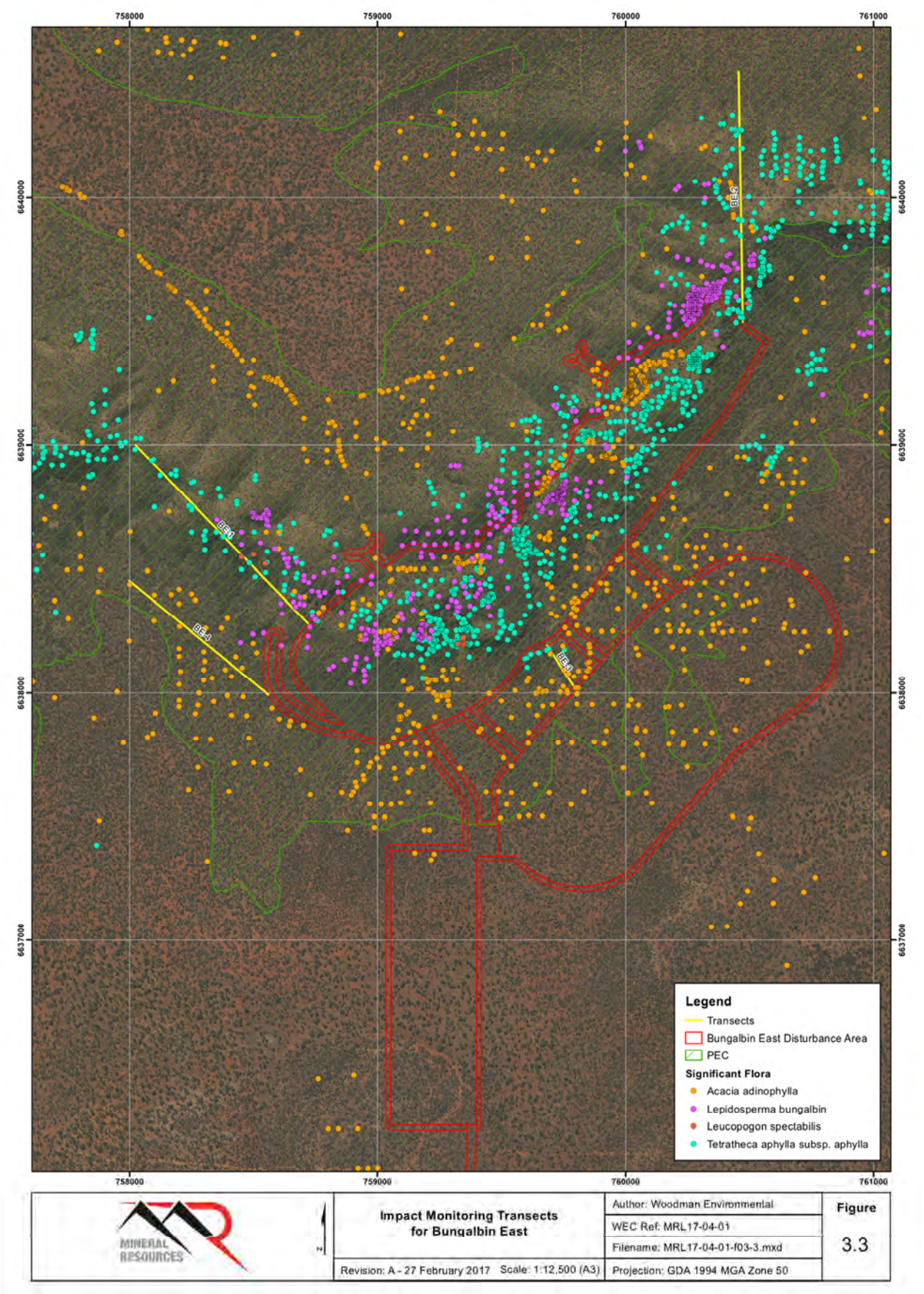


FIGURE 3-3: IMPACT MONITORING TRANSECTS FOR BUNGALBIN EAST



Conservation Significant Flora

Monitoring of CS flora health, mortality and recruitment will be undertaken using a semi-quantitative assessment, both in areas where impacts may occur and associated control areas. Seasonal differences in plant health may be expected within and between monitoring years, however monitoring should highlight changes in plant health associated with mine impacts, regardless of seasonal effects. If such seasonal changes occur they should be apparent across the monitoring zones (including control areas) so will not in themselves cause a trigger and threshold criterion to be reached. .

Monitoring of impacts will be conducted for each CS flora taxon within paired quadrats spaced every 50m associated with the transects established to monitor the health of the PEC, with the layout as presented on Figure 3-1 and indicative locations presented Figures 3-2 (J5) and Figure 3-3 (Bungalbin East). The individual plants to be monitored will be located within each quadrat, to a maximum of 20 plants per taxon present in each quadrat. If less than 10 individuals are present within a quadrat, individuals may be chosen from the immediate vicinity. A minimum of 150 individual plants of each of the four CS flora taxa will be monitored within the impact transects (where available).

Within each quadrat, the following will be monitored:

- Assessment of the total number of alive individuals of each CS flora taxon present within each quadrat (survival/mortality and recruitment data collection)
- Assessment of the number of dead individuals of each CS flora taxon present within each quadrat (mortality data collection)
- Qualitative assessment of factors such as trampling, unauthorised clearing, insect damage to each CS flora taxon within the quadrat as a whole

The following information will be recorded for each CS flora individual selected for monitoring:

- Monitored individuals to be tagged, provided with unique number and photographed
- Plant health score for each tagged individual (Table 3-4)
- Visual assessment of foliar dust load (no dust present on individual; dust present but light and patchy; dust present, heavy and contiguous).

TABLE 3-4: HEALTH SCORES FOR PLANT MONITORING

Health Score	Description
0	Plant is dead.
1	Plant is heavily senescent with most leaves yellowing or senescent. Only parts of the plant remain alive.
2	Plant is in fair health, mostly healthy but with parts of the plant (> 25 %) yellowing or senescent.
3	Plant is neither healthy nor unhealthy. No active growth but leaves otherwise healthy, < 25 % yellowing or senescent leaves.
4	Plant is healthy. No active growth. < 5 % yellowing or senescent leaves.
5	Plant is healthy with at least some new growth evident.

The same health score ranking system (Table 3-4) will be used for each CS flora taxon monitored. This is to assist in the implementation of the monitoring in the field. Representative photographs of each individual are to be taken during the baseline monitoring (prior to mining impacts), and taken in the field during monitoring, to assist field personnel in the identification of decline of health of individuals. The visual assessment of dust loading will assist identification of potential environmental variables which may be causing impact to individual monitored CS flora taxa.

The flowering/fruiting of individuals will not be recorded during the field monitoring. This is because the level of existing knowledge with regards to natural variation of flowering (amount and timing) and fruiting (viability; germination rates) are unknown. Reproductive success of these taxa will be monitored through assessment of recruitment (new seedlings) and mortality (death of individuals) using the quadrat-based system as presented above.

Impact monitoring for CS flora taxa will be undertaken within quadrats along transects (as described above) extending up to 1km from the operational areas. This is in line with findings by Turner (2013) where impacts through dust deposition were monitored up to 600m from operational areas. Monitoring conducted at interval distances extending away from operational areas will enable determination of the extent of indirect impacts through both clearing and operational aspects of the works, and allow results to be correlated against monitoring of environmental variables such as dust deposition monitoring (dust gauges), which are also to be established at repeated distances from mining operations (detail presented below).

Table 3-5 presents a summary of each monitoring transect, including the location, indicative length of each transect, numbers of quadrats to be monitored and factors to be monitored at each transect (i.e. CS flora target taxa). As mentioned above, the final locations and extent of transects will need to be determined using a combination of final impact area design and in-field examination of CS vegetation, locations of CS flora taxa and safety aspects of monitoring such as navigating around steep topography.

Control monitoring transects to enable data comparison with potential impact monitoring will also be established.

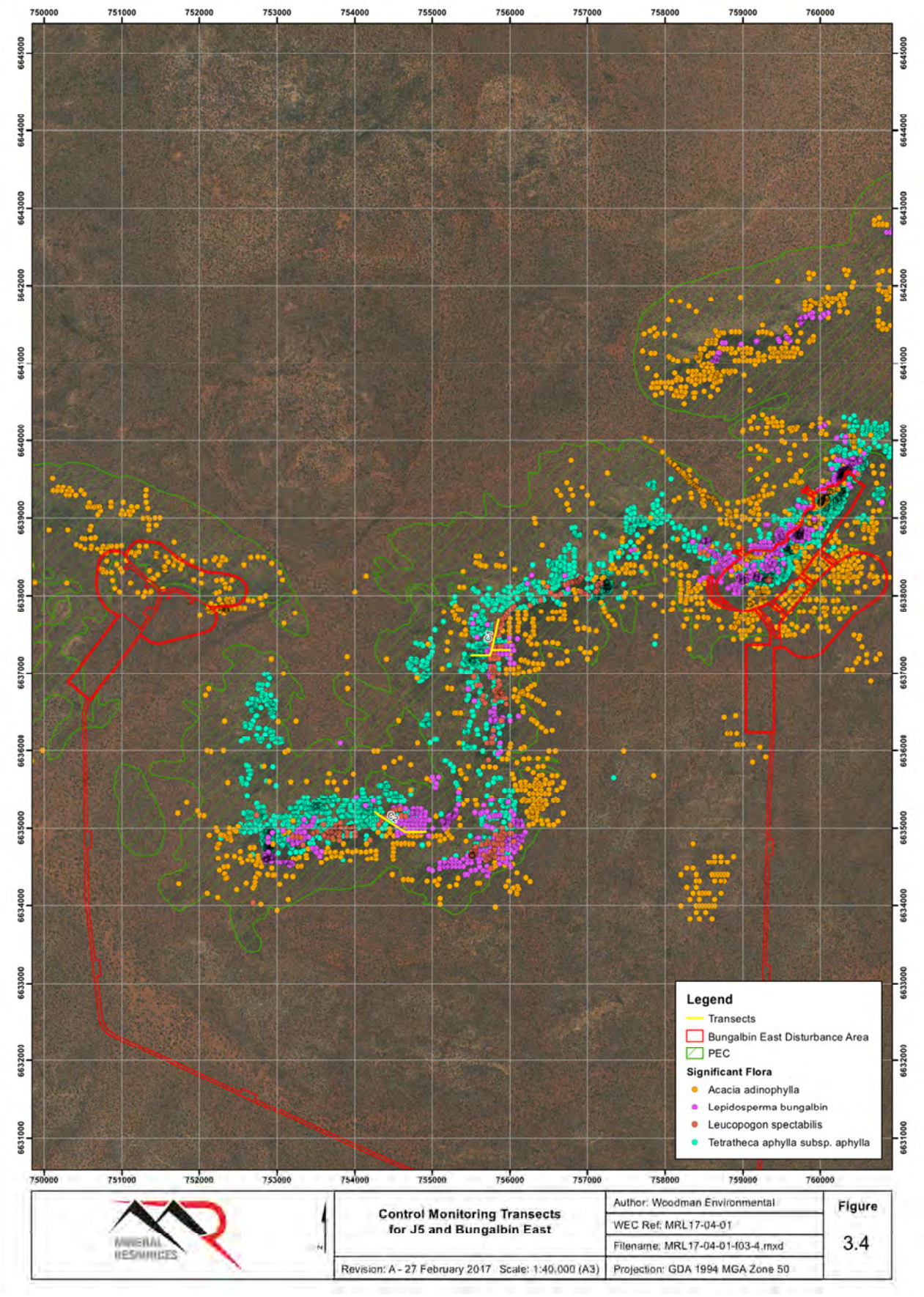
Control Monitoring

Control transects with associated paired quadrats to monitor the health of both CS vegetation and CS flora taxa will be established in relevant areas outside of indirect impact areas (>2km from operational areas or haulage routes). These areas have been identified as having both similar habitat and species composition to those areas which surround the current mine plan, including presence of CS flora taxa.

Two control transects will be established, both to encourage multiple sampling to avoid particular site characteristics from potentially skewing the control data, and also due to the differences in distribution of CS flora taxa within these control areas. Figure 3-4 presents the indicative layout of the control transects (C-1 and C-2), and positioning in relation to J5 and Bungalbin East impact areas. All four CS flora taxa being monitored for indirect impacts will also be monitored within these control transects.

The assessment of CS vegetation and CS flora taxa within the paired quadrats will replicate the methods as presented above, in order to allow for direct comparison of changes of health, mortality and recruitment over time.

FIGURE 3-4: CONTROL MONITORING TRANSECTS FOR J5 AND BUNGALBIN EAST



Summary of Monitoring Transects

Table 3-5 presents a summary of proposed impact and control monitoring transects. The actual transect locations and lengths will be refined as both the mine direct impact areas are confirmed, and through inspection during the field monitoring establishment phase. This will include review of locations of CS flora taxa individuals and the topography encountered on the proposed transects. Monitoring methods undertaken in the field will be reported in full after the initial monitoring establishment. It is expected that the number of quadrats/number of individuals of each CS flora taxon will be similar between monitoring and control sites.

TABLE 3-5: SUMMARY OF IMPACT AND CONTROL MONITORING TRANSECTS

Transect Number	Factor	Length / #of Quadrats	Direction	Figure
J5-1	PEC Flora: *A. adinophylla*	1 km / 18 paired quadrats	Extends in NW direction from northern face of waste dump	3-2
J5-2	PEC Flora: *A. adinophylla*	500 m / 9 paired quadrats	Extends in SSE direction from south-eastern face of pit area	3-2
J5-3	PEC Flora: *T. aphylla* subsp. *aphylla*	1 km / 18 paired quadrats	Extends in SE direction within *T. aphylla* subsp. *aphylla* population located 1 km SE of J5	3-2
BE-1	PEC Flora: *L. bungalbin* *L. spectabilis* *T. aphylla* subsp. *aphylla*	1 km / 18 paired quadrats	Extends in a NW direction from NW face of pit area	3-3
BE-2	PEC Flora: *L. bungalbin* *L. spectabilis* *T. aphylla* subsp. *aphylla*	1 km / 18 paired quadrats	Extends in a northerly direction from northern face of pit area	3-3
BE-3	PEC Flora: *A. adinophylla* *T. aphylla* subsp. *aphylla*	200 m / 6 paired quadrats	Extends in a southerly direction in uncleared land between pit area and waste dump	3-3
BE-4	Flora: *A. adinophylla*	500 m / 9 paired transects	Extends in a NW direction from NW face of pit area	3-3
C-1	PEC Flora: *L. bungalbin* *L. spectabilis* *T. aphylla* subsp. *aphylla*	1 km / 18 paired quadrats	Layout to reflect that shown on Figure 3-4; may be altered in the field to ensure that relevant CS flora taxa are monitored	3-4 3-4

Transect Number	Factor	Length / #of Quadrats	Direction	Figure
C-2	PEC	800 m / 16 paired quadrats	Layout to reflect that shown on Figure 3-4; may be altered in the field to ensure that relevant CS flora taxa are monitored	3-4
	Flora: *A. adinophylla* *L. bungalbin* *L. spectabilis* *T. aphylla* subsp. *aphylla*			

Site inspections

Site inspections of native vegetation surrounding the impact areas will be routinely conducted to complement the above-mentioned monitoring program. These inspections will occur on a daily basis, and in the context of this CSSCMP, will focus on areas of CS vegetation and flora locations which are at risk of impact by factors such as:

- Ponding,
- Sedimentation,
- Unauthorised clearing, and
- Areas near known weed locations or at greater risk of weed invasion (such as turn-around areas, buildings and in the vicinity of drainage features).

Any irregular occurrences with actual or potential impacts on vegetation and flora beyond that authorised will be reported internally as an incident and investigated accordingly. Unauthorised environmental impacts will also be reported to the regulatory authorities.

A comprehensive weed eradication programme will be initiated in the event that infestations of invasive weed species are recorded on site, either through vegetation monitoring or routine site inspections. These will be managed through a site specific Weed Management Procedure based on the corporate procedure (MRL-EN-PRO-0007). This circumstance would also require an investigation of the effectiveness of the weed hygiene process.

Environmental variables

To provide context for the results of the vegetation and flora monitoring, a range of environmental variables will also be routinely monitored. These include:

- Meteorological conditions, including temperature, rainfall and wind strength and direction.
- Dust deposition via dust deposition gauges located in potential impact areas and at control sites. One dust gauge will be positioned at the following distances at each monitoring transect: 10m; 20m; 50m; 100m; 500m; 1km. The results of these gauges can be correlated against plant health monitoring results to assist in determination of potential impacts due to dust creation by mining activities.

Monitoring schedule

Monitoring will be conducted in accordance with the schedule outlined in Table 3-6.

TABLE 3-6: PROPOSED MONITORING SCHEDULE

Item	Details and frequency
Conservation significant vegetation – MSA	Baseline monitoring will be conducted immediately prior to project commencement and every six months for the first two years of operations. After this period and in the absence of any documented impacts on vegetation from operations, and in the absence of further clearing operations, an annual assessment will be conducted to provide a regular assessment of vegetation health. If further clearing is required (i.e. pit expansion after the initial two years of monitoring), then multi-spectral data will continue to be collected every six months. This form of monitoring requires ground-truthing of initial monitoring parameters but can be conducted independently of ground studies once relationships are understood unless impact investigation is required.
Conservation significant vegetation – transects	Monitoring will commence prior to the commencement of construction and will be undertaken every six months for the first two years of operations. If no significant impacts have been recorded during the first two years of operations, and in the absence of further clearing operations, the monitoring frequency will be reduced to annual. If further clearing is required (i.e. pit expansion or waste dump footprint construction) after the initial two years of monitoring, then monitoring will continue to be undertaken on a every six months basis.
Conservation significant flora	Monitoring will commence prior to the commencement of construction and will be undertaken every six months for the first two years of operations. If no significant impacts are recorded two years following commencement of mining operations, and in the absence of further clearing operations, the monitoring frequency will be reduced to annual. If further clearing is required (i.e. pit expansion or waste dump footprint construction) after the initial two years of monitoring), then monitoring will continue to be undertaken on a every six months basis. A minimum of 150 plants of each taxon to be monitored will be monitored for impacts (where available)
Environmental variables	Meteorological conditions (daily commencing three months before commencement of construction).
	Dust deposition to be monitored monthly commencing three months before commencement of construction).

Studies and Investigations

Studies will be conducted to characterise the risk of impact of dust deposition from mining activities on the CS flora taxa addressed by this EMP. Studies will address both the physical and chemical characteristics of dust generated by the operations and also the physiological characteristics of each taxon that will allow an assessment of the risk of impact to be conducted (Turner 2013).

These studies will be conducted during the first year of operation of the mine and the results will be used to refine the monitoring and management approach documented in this EMP. The results of the studies will also be reported to DPaW and the OEPA in support of proposed revisions of this EMP.

3.4 Reporting provisions

Annual reporting

The environmental outcomes of the monitoring assessments will be reported against trigger and threshold criteria in annual compliance reports.

In the event that trigger criteria or trigger and threshold criteria are exceeded during the reporting period, the annual report will include a description of the effectiveness of trigger level actions, and threshold contingency actions that have been implemented to manage the impact, as well as an analysis of trends.

Reporting on exceedance of trigger criteria and threshold criteria

In the event of exceedance of any trigger or threshold criteria, MRL will consult with the OEPA and DPaW within 5 working days and notify the OEPA in writing within 14 days.

4. ADAPTIVE MANAGEMENT AND REVIEW OF THE CONDITION EMP

MRL will also implement adaptive management to learn from the implementation of mitigation measures, monitoring and evaluation against trigger and threshold criteria, to more effectively meet the condition environmental outcome.

Trigger contingency investigations will focus on causes of impacts so that more appropriate trigger levels can be set for environmental criteria (such as levels and types of dust deposition) rather than plant or vegetation health criteria. This will provide improved identification of issues and allow timely management responses at the operational level.

The proposed mine life is up to 15 years. This EMP will be reviewed every three years or whenever a trigger or threshold level exceedance event occurs.

5. STAKEHOLDER CONSULTATION

This section will be populated as the assessment of the J5 and Bungalbin East Proposal progresses.

6. REFERENCES

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