A review of mine rehabilitation condition setting in Western Australia

The Western Australian Biodiversity Science Institute

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Executive Summary

Rehabilitating land following mining is a major and growing issue for Western Australia, with around 2.5 million hectares of land currently under an active mining lease. About 85% of mining proposals assessed by the Western Australia Environmental Protection Authority (EPA) have had rehabilitation and/or closure requirements recommended and subsequently applied by the Minister for Environment through a Ministerial Statement. This is in addition to the conditions for rehabilitation and/or closure specified under the *Mining Act 1978*.

This project collected and analysed publically available information on the conditions for mine site rehabilitation in Western Australia. Information was collated about mine rehabilitation and/or closure conditions recommended by the EPA under Part IV of the *Environmental Protection Act 1986*, to provide baseline information of the requirements for rehabilitation in the state. A total of 277 Ministerial Statements were assessed, dating back to 1987. Until the 1990s, requirements related to rehabilitation have primarily been assigned to the decommissioning phase, with progressive rehabilitation requirements starting to appear from 1992 onwards. Despite the importance for assessing completion, about 35% of the Statements specified rehabilitation targets to be met. These rehabilitation targets focussed most often on the percentage of vegetation cover and species diversity.

We further aimed to quantify the costs of rehabilitation works as part of assessing the 'achievability' of recommended rehabilitation and/or closure conditions. However, obtaining cost data, evidence of rehabilitation progress, or evidence on rehabilitation success in publicly available documents proved challenging, with very limited information available. The post-mining land use proposed at a site was not always specified, and could often not be found for projects pre-2013. Current lack of transparency points at the need for knowledge sharing and/or a data repository where proponents, regulators, and researchers can jointly work towards achievable and acceptable mine rehabilitation.

Consultation with mine closure experts from mining companies, consultants, and researchers indicated that rehabilitation conditions are often seen as aspirational objectives or performance management tools rather than achievable targets. Experts agreed that rehabilitation requirements should be interpreted as the minimum standards that define the overall outcome of rehabilitation, but should be broadly defined to allow the specification of more detailed targets in Mine Closure Plans. At the same time, experts raised concerns that conditions and targets in Ministerial Statements were frequently unachievable because they failed to account for particularities across mine sites, such as their geographic and climatic locations, the type of mine, and timeframe of rehabilitation. Experts recommended that conditions should consider more reasonable reference targets (not 'undisturbed sites'), that terminology is better defined, and that an agency-specific 'conditions libraries' be developed.

CONTENTS

ABBREVIATIONS

AER	Annual Environmental Reports
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EP Act	Environmental Protection Act 1986 (Western Australia)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
MCA	Minerals Council of Australia
MCP	Mine Closure Plans
MINEDEX	Mines and Mineral Deposits System
MRF	Mine Rehabilitation Fund
MS	Ministerial Statements
PMLU	Post Mining Land Use
SMT	Specific, Measurable, Time-Bound

1 Introduction

Western Australia's mineral and petroleum industry is one of the State's dominant economic sectors. In 2018, output from mining and mineral projects accounted for 72%, or AU$92 billion, of total sales value from the Western Australian (WA) resources sector (DMIRS 2018b). Almost AU$18 billion were invested in WA's mining industry in 2018, representing 52% of national Australian mining investment (DMIRS 2018a). There are currently 127 principal higher-value and export-oriented mining projects, hundreds of quarries and smaller mines, as well as major mineral processing projects operating in all regions across the state. The vast majority of value is produced in the Pilbara region, where AU$62.7 billion worth of iron ore sales were recorded in 2018 (DMIRS 2018a).

In 2017-18, 44.2 million hectares of land were under mining tenements, which accounts for about 17% of WA's total land area. Approximately 2.5 million hectares of land are under an active mining lease (DMIRS 2018b). With vast areas of land being affected by mining and exploration, it is important that disturbed land is ultimately returned to a state that supports agreed post-mining land use(s). To achieve successful rehabilitation, objectives, closure criteria, or rehabilitation conditions need to be established by the proponent or the regulator. Such conditions[1] have to be achieved before relinquishment can occur.

It is currently, however, not known what rehabilitation outcomes are envisaged for the many mining projects in Western Australia. The Department of Mines, Industry Regulation and Safety (DMIRS) defines rehabilitation objectives as (i) safe to humans and animals, (ii) geotechnically stable, (ii) non-polluting/ non-contaminating, and (iv) capable of sustaining a proposed post-mining land use without unacceptable liability to the State. The Environmental Protection Authority (EPA) further aims for rehabilitation to be undertaken in an ecologically sustainable manner that supports agreed outcomes and land uses (DMP & EPA 2015). In this project, we investigate what rehabilitation conditions are required of mining projects in WA, evaluate what rehabilitation targets are set by the regulator, and assess whether these conditions vary over time, across regions, or between resources.

1.1 Regulatory context in Western Australia

The key Western Australian regulators involved with mine rehabilitation are the Department of Mines, Industry Regulation and Safety (DMIRS)[2] and the Department for Water and Environmental Regulation (DWER). Rehabilitation has historically been assessed by the Environmental Protection Authority (EPA) when a proposal has significant environmental impact. The EPA's role is to provide advice and recommendations for the Minister for Environment (including rehabilitation requirements), while the DMIRS and the DWER assess compliance. Rehabilitation may also be conditioned under other parts of the EP Act (Pt V), *Mining Act 1978, or the Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act).

DMIRS is the lead decision maker for mining projects that fall under the *Mining Act 1978* (the Mining Act). Amendments to the Mining Act which came into effect on 1 July 2011 require proponents to submit a Mine Closure Plan to DMIRS for assessment and approval as part of Mining Proposal applications. The joint DMIRS/EPA Guidelines for Preparing Mine Closure Plans published in 2011 (revised in 2015 and under review at the time of writing) stipulate how such plans are to be prepared (DMP & EPA 2015). An approved Mine Closure Plan must be reviewed and resubmitted for assessment every three years after its initial approval. Mining operations and projects approved prior to 2011 and before the release of the Guidelines for Preparing Mine Closure Plans are now required to also prepare Mine Closure Plans.

[1] In this document, mine rehabilitation 'requirements' and 'conditions' are used to imply the recommendations from the EPA or the legally binding conditions imposed on the operator. An effort has been made to be specific. However, whether a recommendation or condition is legally binding will depend on each specific context.

[2] Previously the Department of Mines and Petroleum (DMP).

The EPA conducts Environmental Impact Assessments (EIAs) for any proposals resulting in significant impacts in accordance with Part IV of the *Environmental Protection Act 1986* (the EP Act). DMIRS is required to refer any Mining Proposals that appear to be significant to the EPA for assessment. Proponents may also choose to refer a proposal directly to the EPA (DMP & EPA 2015). The EPA further assesses mine closure under Part IV of the EP Act for projects that are not subject to the Mining Act, or when the EPA considers rehabilitation outcomes as part of its EIA (EPA 2018a). For any projects where rehabilitation and closure is regulated under Part IV of the EP Act, the EPA can recommend that proponents are required to meet the rehabilitation and closure conditions specified in the Ministerial Statement.

Operators are expected to liaise with relevant regulators, such as the Department of Jobs, Tourism, Science and Innovation, which manages State Agreements, about their requirements for mine closure planning.

1.2 Study objectives

The project described in this paper assesses what rehabilitation conditions are required of mining projects in WA. Rehabilitation conditions and subsequent targets provide the basis for evaluating successful rehabilitation and, ultimately, mine closure. There exists currently no overview of rehabilitation conditions for WA mining and related projects, making it difficult to assess what rehabilitation targets may be pursued by different proponents across the state. This research focusses on rehabilitation and closure requirements that are recommended by the EPA as captured in Ministerial Statements (Section 1.1). In particular, we consider recommendations that target flora and vegetation, fauna, and terrestrial environmental quality ('Land' factors of the EPA 2018b).

The overall objectives of this project are to:

1. Collect publicly available information about rehabilitation conditions and/or targets recommended by the EPA.
2. Assess whether recommended rehabilitation conditions and/or targets vary between regions or have changed over time.
3. Document to what extend the industry is working towards meeting set mine rehabilitation conditions and targets.
4. Assess the achievability of current mine rehabilitation conditions and/or targets.

This project originally set out to assess the *feasibility* of mine rehabilitation conditions or targets. However, feasibility pertains to what can reasonably be expected of a mining company given financial, labour, as well as biophysical and knowledge constraints. To avoid discussions about company-specific constraints, this project instead focusses on the *achievability* of rehabilitation (i.e. what is possible given our current level of knowledge).

2 Methods

2.1 Review of Ministerial Statements

In the first stage of this project, a database was constructed that collates the publically available information about rehabilitation and/or closure conditions. This review documents a long term history of key rehabilitation and/or closure conditions recommended by the EPA.

Note that the data sources for this research were the Ministerial Statements (MSs) on the EPA's website (http://www.epa.wa.gov.au/all-ministerial-statements) and—in some cases—EPA Assessment Reports. A full analysis of how proponents operationalise rehabilitation conditions would require a separate study into each company's Mine Closure Plan to evaluate how completion criteria specified in the closure plans align with rehabilitation conditions imposed in the Ministerial Statement, so this information is excluded from the report.

These MSs were read to see what rehabilitation conditions have been imposed on each project. The focus of this study was on conditions specifically related to rehabilitation of flora and fauna. Other data that was extracted is summarised in Table 1. All data were entered into an Excel database. Due to the variability in rehabilitation conditions, any condition(s) recommended by the EPA were manually entered *ad verbatim* into the database.

TABLE 1 Data collected from resource projects' Ministerial Statements

Variable	Description
Number	Number of the Ministerial Statement (MS)
Date	Date the MS was approved
Project title	Description of project on the MS
Proponent name	Proponent's name on the MS
Project type	Type of development approved (gas production, infrastructure, mining, oilfield, etc.)
Resource type	Type of resource proposed to be mined at the project (bauxite, iron ore, gas, limestone, sand, etc.)
Region	Region in which the project is located (based on the regions used by the WA Department of Primary Industries and Regional Development)
Rehabilitation condition text	Rehabilitation conditions imposed on the project (if specified)
Terrestrial footprint cleared (ha)	Maximum clearing proposed in the MS (if specified)
Post-mine land use	Post-mine land use proposed in the MS (if specified)
Completion criteria	Measurable condition targets specified in the conditions (if applicable)
Offsets	Offset conditions specified in the MS (if applicable)

Each rehabilitation condition was classified independently by two members of the research team into one of 17 categories (Table 3). These categories were then reviewed to ensure that they capture the primary intent of each condition. The data were then examined via pivot tables in Excel to assess:

- What rehabilitation and/or closure conditions are recommended in the Ministerial Statement?
- Have recommendations changed over time?
- Are there differences in recommendations across regions?
- What condition targets or objectives are specified?
- Has the definition of targets changed over time?
- What post-mine land uses are proposed in the Ministerial Statements?
- What offsets are required?

2.2 Expert consultation

In the second stage, the achievability of rehabilitation conditions and/or closure targets was assessed through a combination of literature review and expert consultation. The scientific literature on ecological restoration provides some case studies of rehabilitation trials in specific areas. However, much rehabilitation research is undertaken by proponents or consultants, with knowledge remaining either intellectual property of the company or difficult to find in the grey literature. It proved difficult to draw general conclusions regarding the achievability of rehabilitation targets based on ecological trials. It is recommended that a future project is dedicated specifically to collating the restoration data available in different WA biomes.

Given the limited available evidence about rehabilitation 'achievability', a workshop with rehabilitation experts was convened on the 30th of April 2019. The workshop was attended by experts from mining companies (2), consulting firms (3), and researchers (5). A further two interviews with closure consultants supplemented the data. Questions discussed during the workshop and interviews included:

- Do the rehabilitation conditions give sufficient information to enable definition of rehabilitation targets (which may ultimately be used to define completion criteria)?
- Are rehabilitation targets sufficiently (or too) SMART (Specific, Measurable, Achievable, Realistic, Time-Bound)? Do they need to be?
- Which rehabilitation targets do you deem achievable and which are not achievable, and why?
- How should targets be (re-)defined to enhance achievability?
- Should conditions / targets be changed to be more ambitious?
- Are conditions and targets aligned with safe, stable, non-polluting and self-sustaining aim of rehabilitation?

2.3 Evidence of rehabilitation success in WA

The third and final stage of the data collection aimed to use publically available information to:

- Quantify the extent of on-ground rehabilitation works that have been undertaken at sites
- Provide evidence of rehabilitation success or quality
- Detail rehabilitation progress against targets
- Quantify the costs of rehabilitation works
- Evaluate proposed post-mine land use

It was expected that this information could be sourced from company annual reports, reports to the Mine Rehabilitation Fund, and updates to mine closure plans. However, over the course of the project, it became clear that detailed information is not typically available to the public. It has been challenging to retrieve mine closure plans and link these to projects' Ministerial Statements because:

a) Mine closure plans are not typically publically available on company websites, particularly for projects that started in the 1980s–1990s. Where company reports are available, very little details could be found for individual sites (typically overall global or national business results are reported).

b) Mine closure plans are sometimes available via DMIRS' online Mines and mineral deposits (MINEDEX) system. However, the information needed to link the Ministerial Statement to the MINEDEX data base is not always easily accessible (registration title, tenement name, project name, or site name not matching MS). Furthermore, where mine closure plans are submitted to the DMIRS, they are not typically publically available in full.

c) Rehabilitation progress is reported in Annual Environmental Reports (AERs), which are available in the DMIRS' online EARS2 database for all AERs required under the *Mining Act 1978*. However, finding the relevant project AER is not straightforward in the database, because the information does not necessarily link directly to the information on the MS. This, combined with the slow processing speed of the online interface, can make evaluating AERs a time-consuming task.

Given the limited time frame of this project, an alternative approach was used to address Stage 3 questions. A case study data set was constructed, consisting of the first MS per year for the period 1987–2010, and the first January MS and the first June MS for the period 2011–2018. This yielded 40 case study projects for which the following data was collected from the Ministerial Statement, EPA reports, and/or (where available) Annual Environmental Reports, Annual Compliance Reports, or Mine Closure Plans (Table 2).

TABLE 2 Data collected for 40 case study projects (1987–2018)

Variable	Description
MS / Project	Number of the Ministerial Statement (MS) and project title
Year	Year the MS was approved
Rehabilitation targets	Target (qualitative or numerical) objectives for rehabilitation
Terrestrial footprint	Area in hectares approved or disturbed to date
Area rehabilitated	Area in hectares that have been rehabilitated to date
Reporting against objectives	To what extend is rehabilitation progress reported against the targets that were set?
Post-mine land use	Expected post-mine land use
Rehabilitation costs	Reported costs of rehabilitation, where possible reported against activities or domains

3 Results

In total, 277 Ministerial Statements (MSs) related to resource development projects were analysed, with approvals dating from October 1987 to December 2018 (i.e. spanning more than 31 years). These MSs covered all regions in Western Australia and 24 different resource types (Appendix 1).

3.1 Mine site rehabilitation conditions in Ministerial Statements

Of the 277 mining and resource sector projects that were assessed by the EPA, 236 (85%) have had rehabilitation conditions recommended and subsequently applied by the Minister for Environment through a Ministerial Statement. With one exception in 1987, MSs before 2006 all applied a rehabilitation or closure condition(s). In recent years, especially since changes to the Mining Act requiring Mine Closure Plans to be completed, the proportion of MSs with rehabilitation conditions has decreased considerably.

Every project has its unique set of rehabilitation conditions, which makes it difficult to quantitatively compare the conditions imposed. There is no standard terminology to define rehabilitation conditions. As such, conditions are worded differently across projects. To provide consistency in the results, descriptive data were grouped into common themes using thematic analysis—a common method in qualitative research. The 17 identified themes (Table 3) cover the main aspects of each rehabilitation condition. One MS can have multiple associated rehabilitation conditions addressing different categories.

By far the most used conditions were associated with preparing a decommissioning, closure, and/or rehabilitation plan. Typical conditions imposed included:

> *"Prepare and implement rehabilitation plan"* (used 28 times);
>
> *"Prepare and implement a decommissioning and rehabilitation plan"* (34); or
>
> *"Prepare and implement an Environmental Management Programme covering rehabilitation"* (25)

Conditions like these did not specify any condition targets or rehabilitation outcomes. The use of the 'planning' conditions showed no trend visible over time, regions, or resources until about 2013 when the planning requirement was used less often. This is probably due to the change in regulations under the Mining Act in 2011 that made Mine Closure Plans a condition on the tenement. Mining operations not subject to the Mining Act (e.g. pre-1899 title or *State Agreement Act*) could be required to prepare a Mine Closure Plan as a condition of the Ministerial Statement.

TABLE 3 Classification of rehabilitation conditions and the number of times each condition appeared in the dataset of Ministerial Statements

Category of rehabilitation condition	Number of MS	Percentage of MS
Planning	169	28.5%
Decommissioning and rehabilitation	69	11.6%
Decommissioning	18	3.0%
Rehabilitation (generic)	63	10.6%
Progressive rehabilitation	55	9.3%
Species selection	23	3.9%
Progressive rehabilitation and species selection	14	2.4%
Topsoil procedures	33	5.6%
Research and development	26	4.4%
Waste dumps, tailings, pits	15	2.5%
Weed management	15	2.5%
Rare and priority flora	12	2.0%
Seeding procedures	12	2.0%
Procedures and techniques (generic)	12	2.0%
Landforms	12	2.0%
Refers to DMP regulation	5	0.8%
Dieback protocols	3	0.5%
None specified	38	6.4%
Total	**594**	**100%**

From 1987 to approximately 1998, conditions related to rehabilitation were primarily assigned to the decommissioning phase. In the first five years (1987–1991), conditions were purely focussed on decommissioning, such as *"The proponent shall be responsible for decommissioning and removal of plant and installations"*. From 1991–1998, rehabilitation was added as a generic requirement. *"The proponent will be responsible for decommissioning and rehabilitating the site and its environs"* is a common condition during this period. Any conditions related to rehabilitation used in this period are typically quite generic without specifying objectives or targets for rehabilitation. For example:

"Commence rehabilitation (of the mined area/site)" (7 times); or

"Rehabilitate disturbed land" (7 times).

In earlier years (1987–1994), generic reference would sometimes be made to rehabilitation techniques and seed collection procedures (e.g. *"Use the most successful vegetation techniques available"*, *"Preserve seed and plant material for rehabilitation"*, or *"Develop seed collection protocols for rehabilitation"*). A total of 26 Ministerial Statements in that period also specified procedures specific to the handling of topsoil. These typically required topsoil to be stripped and stockpiled or salvaged for future rehabilitation. References to topsoil handling were no longer made in the 2000s, possibly indicating that topsoil stockpiling had become common practice.

Specific requirements for 'progressive rehabilitation' were employed intermittently from 1988, but more often since about 2001 in the form of *"Address/carry out/commence/ensure/implement progressive rehabilitation"*. From 2005 onwards, proponents were often also required to undertake (progressive) rehabilitation *"with species of local provenance"* (categorised as 'species selection' in Table 3).

Conditions specifying the need for rehabilitation research and trials were included more often from 2001 onwards. Such conditions were typically in the form of *"Rehabilitation trials will be undertaken"* or *"Conduct research on methods of rehabilitation"*.

There are few substantial differences between regions, other than those caused by evolutions of rehabilitation conditions imposed over time. Development applications in the Peel and Perth regions peaked in the 1980s and early 1990s, and due to the common conditions at that time those applications had a significantly larger number of associated 'decommissioning' conditions.

Development applications in the Pilbara region peaked during the 2005–2013 mining boom. The only difference standing out for the Pilbara is the significantly lower requirement for research & development, or rehabilitation trials, compared to other regions (1% of MSs for the Pilbara region, compared to a 6% average).

Conditions related to rare and priority flora were predominantly imposed on MSs for projects in the Peel and Wheatbelt regions, while dieback requirements only appeared in the Peel and South-West regions. Finally, weed management conditions were imposed more on projects in the Great Southern or South-West, reflecting the context of mining in those regions.

There were 205 MSs that specified the terrestrial footprint cleared under the project and that also had rehabilitation conditions applied. These were used to assess differences in conditions between projects of different sized footprints. The only difference between projects of different sizes were that conditions around rare and priority flora were imposed only on projects with >500 hectares of clearing. Larger projects are more likely to cover sensitive areas than smaller projects. However, given that not all projects defined their clearing limit in the MS, it is impossible to draw conclusive inferences about the relationship between imposed conditions and the size of a mining project.

3.2 Condition targets (completion criteria)

All 277 MSs were inspected for the specification of condition targets. Targets were found in the rehabilitation conditions and specified a measurable (quantifiable or qualitative) outcome for rehabilitation. Such targets serve as guides to develop completion criteria, which must be met if rehabilitation is to be demonstrated as being successful. Off all projects, only 98 were found to specify condition targets (see Appendix 2 for list of projects). Examples of condition targets include:

- Projected foliage cover values of local provenance native species is greater than 20% of the foliage cover values of reference sites;
- Average species diversity is greater than 20% of the average species diversity value of analogue sites (excluding weeds);
- Species diversity is not less than 60% of the known original species diversity;
- Priority flora are re-established with not less than 50% success after three years and 65% success after five years; or
- Weed coverage is less than 10%.

Although the targets varied considerably across projects, a series of common themes were identified (Table 4). Some projects have multiple targets, and some condition targets were articulated in ways that covered more than one theme. The total number of observations is therefore more than 98.

Specifying the percentage of vegetation cover and target species diversity/composition was by far the most common target, appearing 44 times. Weed species or weed cover, is the second most recurrent target, although this was only used from 2006 onwards. Likewise, percentage cover and species diversity targets appear for the first time in 2006, prior to which vegetation targets used less concise language. In fact, targets set in the 1990s employ the terms 'vegetation' or 'native vegetation', without specifying which aspects (cover, diversity, or other) are targeted.

Before 2009, two widely used targets were based on the loosely-defined concepts of 'area' and 'rehabilitation'. 'Area' would refer to the mine footprint and the associated target will typically indicate the need to rehabilitate this footprint. For example, one statement from the year 2000 reads as follows:

> *"Render mine site areas safe and stable and encourage re-establishment of self-sustaining ecosystems"*

Before 2006, 'rehabilitation' also appears frequently as an umbrella term, e.g.:

> *"The objective (of the Rehabilitation Plan) is to ensure that closure planning and rehabilitation are carried out in a coordinated, progressive manner and are integrated with development planning"*

Landforms were mentioned in 14 out of 97 projects with targets, ranging from 1991 to 2012. Other targets mentioned only three times or less include waste rock dumps, pastures, priority fauna, ponds, tailing storage facilities, soil profiles, ecosystems, and ecological functions.

TABLE 4 Classification of rehabilitation conditions targets and the number of times each target appeared in the dataset of Ministerial Statements

Category of condition target	Number of times specified (% of total)
Percentage vegetation cover and/or Species diversity or composition	44 (27%)
Weeds	28 (17%)
Vegetation	25 (16%)
Landforms	17 (11%)
Rehabilitation	16 (10%)
Area targets (for mined/rehabilitated/disturbed land)	16 (10%)
Ecosystems	6 (4%)
Other	9 (6%)
Total	**161**

Interestingly, most condition targets provided an indication of the reference to be used in defining the target levels. In some cases, two or up to three references were noted. Table 5 provides a summary of the references mentioned, by frequency of appearance.

Baseline conditions (also referred to as 'pre-mining' conditions) was the most common reference, followed by 'surrounding' areas , which encompasses terms as 'nearby', 'adjacent' and 'local'. It is worth noting that 'surrounding' areas was widely used in the 1990s and 2000s. However, in 2010 the term 'undisturbed natural analogue' is introduced, which is subsequently adopted by most condition targets. Out of 14 references to 'undisturbed natural analogue', 10 are in the Pilbara region.

TABLE 5 Classification of references for conditions targets and the number of times each reference appeared in the dataset of Ministerial Statements

Reference statement	Number of times specified (% of total)
Baseline	37 (25%)
Surrounding areas	36 (24%)
Post-mine land use	26 (17%)
Best-practice	17 (11%)
Undisturbed natural analogue	14 (9%)
Consultation with regulator	10 (7%)
ANZMEC/MCA	8 (5%)
Designated area within the mine site	2 (1%)
Total	**150**

References to land use, such as 'post-mining land use' or 'designated end land use', were referenced in 26 cases, often without specifying the actual land use. Only in a few cases PMLU, e.g. 'Tuart forest' or 'woodland', are mentioned. The fourth most common reference is 'best-practice', although this is often undefined. A number of condition targets also make mention to setting conditions in consultation with regulators or following regulatory documents. Between 2005 and 2006, eight condition targets were found specifically referring to the Australian and New Zealand Minerals and Energy Council (ANZMEC) / Minerals Council of Australia (MCA) Strategic Framework for Mine Closure (ANZMEC & MCA 2000).

Specific, Measurable and Time-bound targets

Conditions targets were assessed against S.M.A.R.T. (Specific, Measurable, Achievable, Realistic, Time-Bound) characteristics (DMP & EPA 2015). Without knowledge of particular site conditions and rehabilitation practices, it is not possible to determine whether condition targets are 'achievable' or 'realistic' (this was also noted during the expert workshop-Section 4). Hence, in this section, condition targets are assessed on the grounds of being 'Specific', 'Measurable' and 'Time-Bound' (S.M.T.).

The database included 98 projects with condition targets, some of which covered multiple themes, thus resulting in a total of 119 targets. Out of this total, only six (Table 6) were found to be 'Specific enough to reflect a unique set of environmental, social and economic circumstances' (DMP 2016 p. 30). The six appear only after 2003. In these cases, targets made mention to the particular context of the mine site or to sections of the Ministerial Statements where details were specified. For example, one of the goals set in a 2007 target for a mine in the Pilbara stated the following:

> *"Objective for Mine Closure and Rehabilitation Plan (MCRP): To ensure that an intact Mining Exclusion Zone (MEZ) is retained as indicated in Figure 2; To ensure that waste rock is carefully placed after mining both to protect and support any projecting 'fingers' of rock and to maximise survival of, and possible re-colonisation by, troglobitic fauna."*

In contrast to a few 'Specific' targets, in the vast majority of cases, targets were generic, lacking the ability to guide closure development and design, and without clear indication of what the proponent commits to achieve at closure.

> *"The percentage cover and species diversity of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites as demonstrated by Ecosystem Function Analysis, or other methodology acceptable to the CEO";*

In some cases, targets provided a high level of detail of the objectives to be achieved, yet there was no indication that these had been set specifically for the site in question, but rather applied as generic 'off-the-shelf' statements, often repeated across sites. While these targets may be considered 'measurable', they cannot be considered specific to the unique circumstances of the sites. For instance, two projects in distinctly different areas, extracting different commodities, required similar targets:

> *"Species diversity not less than 70% of the known original species diversity. Weed coverage not to exceed the recorded baseline weed cover levels"* Mineral Sands in the Wheatbelt, 2009;
>
> *"Species diversity is not less than 60 percent of the known original species diversity. Weed coverage is equal to or less than that of pre-cleared levels"* Gas Production in the Pilbara, 2010.

Over a third of the condition targets (46 out of 119) were found to be 'Measurable', meaning they included at least one element that could be quantitated to demonstrate rehabilitation trends. 'Measurable attributes' were only found from 2006 onwards, whereas before targets were often based on broad terms such as 'safety' or 'self-sustainability'. However, only 29 out of 46 'measurable' targets had a numeric criterion attached to them (e.g. 60% species diversity, as above) or a defined threshold (e.g. "abundance of weeds *no greater* than in undisturbed site"). Instead one-in-three 'measurable'' targets employed qualitative references such as:

> *"The vegetation shall have comparable densities and abundances of plant species to those which occurred prior to clearing and excavation"* Mineral Sands, South West, 2008.

Only one-in-six targets (18 out of 119) could be classified as 'Time-Bound' by indicating when rehabilitation goals should be achieved. The first 'Time-Bound' target appears in 2003, although the majority (13 out of 18) were used in 2008 and 2009. An example is as follows:

> *"Within five years of mine closure, the percentage cover of native vegetation shall be comparable with that of natural landforms in the area"* Iron Ore, Pilbara, 2009.

TABLE 6 Frequency of Specific, Measurable, Time-Bound target characteristics

Target characteristics	Number of occurrences (% of total)
Is the target 'Specific'?	6 (5%)
Is the target 'Measurable'?	46 (39%)
Does the target include a numeric criterion?	29 (24%)
Is the target 'Time-Bound'?	18 (15%)

Target characteristics by region

Assessing target characteristics by region, it becomes evident that some differences exist across WA. The proportion of projects with and without targets varies by region (Figure 1). In the Goldfields-Esperance, Mid-West and Perth, only one-in-five projects had targets specified. By contrast, the proportion was much higher in the Pilbara (40%), South-West (49%) and Wheatbelt (50%). The fact that regions with particularly sensitive environments such as the Pilbara and the South-West have targets specified more often than other regions is, perhaps, a reflection of the need to achieve high levels of ecological restoration, as part of the mine rehabilitation process.

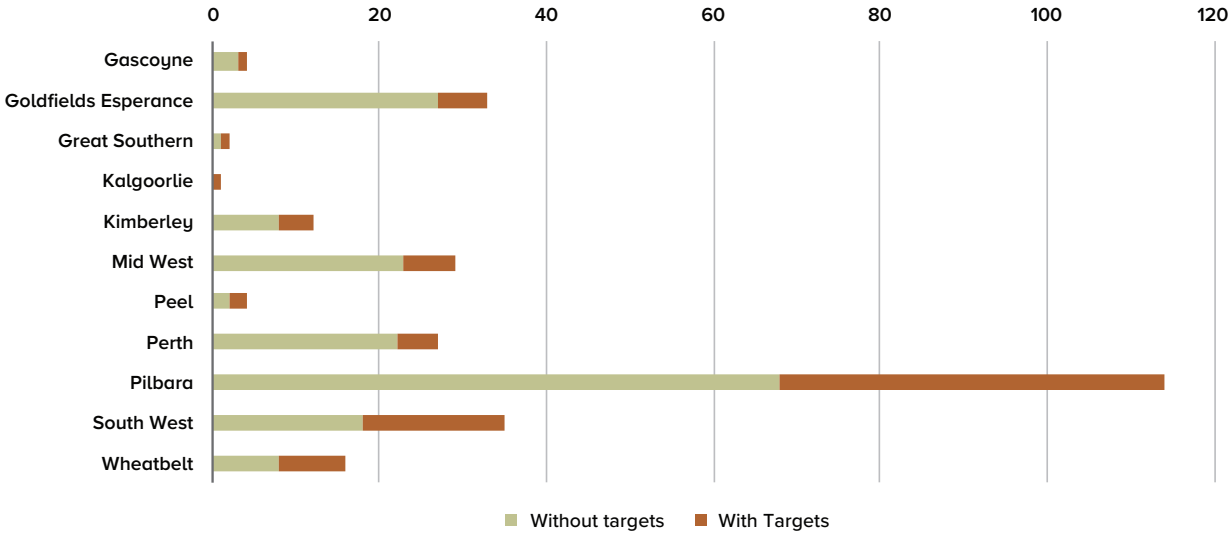

FIGURE 1 Number of projects with and without specified rehabilitation targets

About half of the targets in the Mid-West, Peel and Pilbara were 'Measurable', and in most cases, with a numeric criterion (Table 7). By contrast, in the South-West, only one-in-five targets were 'Measurable', with only one-in-ten having a numeric criterion. In the Pilbara and the South-West, approximately 15% of targets were time-bound, in-line with the WA average. In the Mid-West, the proportion was 50%. These comparisons provide insights into geographic differences, although these comparisons are hindered the very small number of targets found in some regions.

TABLE 7 Frequency of S.M.T. characteristics in rehabilitation targets by region

Regions	Number of targets	Target is 'Specific'	Target is 'Measurable'	Target includes numeric criterion	Target is 'Time-Bound'
Gascoyne	1	-	1 (100%)	1 (100%)	-
Goldfields Esperance	8	-	2 (25%)	2 (25%)	-
Great Southern	1	-	-	-	-
Kalgoorlie	1	-	-	-	-
Kimberley	7	-	-	-	-
Mid-West	6	-	3 (50%)	3 (50%)	3 (50%)
Peel	2	-	1 (50%)	1 (50%)	-
Perth	5	1 (20%)	1 (20%)	1 (20%)	1 (20%)
Pilbara	55	3 (5%)	29 (53%)	16 (29%)	8 (15%)
South-West	21	1 (5%)	5 (24%)	2 (10%)	3 (14%)
Wheatbelt	12	1 (8%)	4 (33%)	3 (25%)	3 (25%)
Total	**119**	**6 (5%)**	**46 (39%)**	**29 (24%)**	**18 (15%)**

Note: Blanks (-) indicate the characteristic does not appear in any target for the nominated region

3.3 Post mine land use

Despite 16 MSs specifying that rehabilitation should be *"consistent with agreed post-mining outcomes and land uses"* or *"to a standard suitable for the new land use(s)"*, none of those actually stated the proposed post-mine land use in the MS.

Only 18 MS in our dataset of Ministerial Statements identified the anticipated post-mine land use for the site. These land uses were: Agriculture and native vegetation (9 times); Pastoral use (4); National Park or State Forest (3); Conservation and recreation (1); and Water production (1).

To obtain information about proposed post-mine land uses for each project, one would need to find each project's mine closure plan. This proved to be a challenging exercise because mine closure plans are not typically publicly available on company websites, particularly for projects that started before 2011. Since 2015, some approved mine closure plans are available for viewing through the DMIRS' MINEDEX (Mines and Mineral Deposits Database) query system (**http://www.dmp.wa.gov.au/Mines-and-mineral-deposits-1502.aspx**). However, this database is not easily searchable and not all approved mine closure plans are publicly accessible.

Instead, the project team tried to ascertain proposed PMLU for a subset of 40 case study projects (see Section 2.3). Of the 40 projects assessed in detail, information about proposed PMLU was found for 21 of them. Information about PMLU was difficult to find and often hidden in the text of a proposed Mine Closure Plan, EPA assessment reports, or Public Environmental Review documents for a project. The PMLUs specified included: Agriculture/pastoral use (13 times), native vegetation/conservation (12), restricted access/safety exclusion zone (2), other uses (4: recreation, residential development, plantation forestry, future mining). Nine projects proposed returning the land to multiple land uses, consistent with the pre-mining land use. As expected, projects in the Pilbara (or Goldfields) largely proposed low-intensity grazing and pastoral use, while projects in the South-West, Peel and Perth areas focussed more on native vegetation. There was no pattern in changing definitions of PMLU over time; expectations that more information would be available for 'newer' projects were not confirmed by the data. The full text of proposed PMLU and data sources are available in Appendix 3.

3.4 Reporting of progress on rehabilitation

As part of assessing the status of rehabilitation in WA, this project also attempted to quantify the extent to which mined land has been rehabilitated. Some information on the level of disturbance can be found in reports that proponents have to submit annually to the Mining Rehabilitation Fund (MRF). The DMIRS publishes annual reports that shows the ground disturbances as reported by each tenement holder under the MRF (DMIRS, 2018c). In the period ending 30 June 2018, a total of 126,197 hectares of disturbed land was reported (DMIRS 2018c). Of this, 38,627 hectares of land (30.6%) were under rehabilitation. Unfortunately, the land disturbance categories used in the MRF are broad categories that do not distinguish between rehabilitation activities, land types, bioregions, or completion targets (Appendix 4). The lack of specificity with regard to these disclosures (in terms of rehabilitation timing, extent, and activities) makes them largely unusable to analyse to what extend proponents are working towards meeting closure objectives or rehabilitation targets.

To assess progress towards meeting rehabilitation conditions or targets, we conducted an in-depth analysis for 40 randomly selected case study projects (Appendix 3). Of these 40 cases, nearly half (18 cases) had defined rehabilitation targets or completion criteria. However, only three projects reported on their rehabilitation progress beyond the area (hectares) rehabilitated. None of the projects provided a clear report of progress towards meeting individual completion criteria in the public domain.

Finally, we attempted to document the cost of meeting rehabilitation conditions. A review was conducted of public documents submitted to the DMIRS or published on proponents' websites. This review found mine rehabilitation costs to be particularly elusive in public reports.

Prior to 2012, under the Mining Act, tenement holders were required to provide bonds to secure their rehabilitation obligations. These bonds were published annually as part of the tenement holder's AER. These bonds alone, however, typically don't provide adequate resources and incentives for rehabilitation (Lechner *et al.* 2016; Pepper *et al.* 2014; White 2015; White *et al.* 2012).

Since the passage of the *Mining Rehabilitation Fund Act 2012*, this system of bonds was replaced by contributions to the MRF. Under the *Mining Rehabilitation Fund Act 2012*, tenement holders are required to provide assessment information annually to DMIRS in order to calculate the mining rehabilitation levy that is payable for that given year. The amount of levy payable in respect to a mining tenement in a year is calculated using the formula under Regulation 4 of the *Mining Rehabilitation Fund Regulation 2013* that includes a rehabilitation liability estimate (RLE). The RLE itself severs only as a basis for calculating the levy and is not intended to represent an estimate of the real cost of rehabilitating any particular site.

Tenement holders are required under the *Mining Rehabilitation Fund Act 2012* to estimate their rehabilitation and closure costs to be able to submit these to the DMIRS or DWER upon request. Mine Closure Plans must contain a summary of the mine closure costing methodology, assumptions and financial processes in order to demonstrate that adequate provision has been made for closure. While these summaries are publically available in the Mine Closure Plans on the DMIRS website, tenement holders may request (with sufficient justification) that certain information is not publically released.

In our analysis of the 40 case study projects, reference to mine rehabilitation costs was made in 13 projects. Three projects reported on their rehabilitation bonds. However, bond amounts provide no indication of rehabilitation costs for activities associated with the bond. Similarly, where mine rehabilitation costs are provided in company financial statements, either in annual financial reports or Global Reporting Initiative reports, costs are listed as an annual lump sum without any detail or breakdown of costs by rehabilitation activities. For some tenement holders with multiple sites, these costs are not even delineated by site, but are given as an overall cost for the company, thus providing little information of value for the current project. Although the Mine Closure Plans (MCPs) prepared for tenement holders' sites uniformly include language stating that a cost estimation for mine rehabilitation has been performed (e.g. through external reclamation cost estimators), dollar amounts were available in only a couple of the MCPs reviewed. Only one case provided detail of costs relative to rehabilitation activities and domains, but none referenced rehabilitation conditions/targets.

3.5 Offset conditions

Environmental offsets are actions that provide environmental benefits which counterbalance the significant residual environmental impacts or risks of a project or activity (Government of Western Australia 2014). While rehabilitation occurs on-site, offsets are undertaken outside of the project area and counterbalance significant residual impacts. Offsets are considered only after the mitigation hierarchy (avoidance, minimisation, mitigation) has been applied. In a project application, proponents must first apply this hierarchy to reduce potential impacts on the environment. Thus, setting rehabilitation targets may reduce the likelihood that offsets are required, and also the magnitude of any offset that is required (Government of Western Australia 2014).

The WA Environmental Offset Policy specifies that offsets are appropriate to compensate for significant residual impacts (Government of Western Australia 2014), such as those that affect endangered plants and animals, areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements, and areas that are being critically impacted in a cumulative context. Thus, the use of offsets could either indicate that a project is unlikely to achieve sufficient rehabilitation outcomes, or that a project is located in an environmentally sensitive region where additional compensation is preferable.

There are 83 projects out of the 277 Ministerial Statements that have offset conditions specified (Table 8). Projects in the Wheatbelt, Mid-West, South-West and Pilbara have the highest proportion of offset requirements (36-44% of all MS in those regions), while only 8% of projects in the Kimberley have offset requirements imposed in the MS. Note that the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) also includes an environmental offsets policy (Commonwealth of Australia 2012). However, projects that fall under the EPBC Act are not reviewed here.

It might be tempting to draw parallels with the Wheatbelt, South-West, and Pilbara also having the highest proportion of rehabilitation targets specified. This could indicate that, in addition to strict targets, projects in these regions are required to counter-balance any residual impact on rare and sensitive environments through offsets. However, an analysis at the individual project level demonstrated this to not be the case. There was no indication that projects with specified targets were also more likely to also have offset requirements: 30 projects with targets also had offset requirements, while 67 projects with targets did not include offsets. There was no observable difference in the 'levels' of targets between these two groups. A further 53 projects did not specify any targets but did require offsets. A chi-square test showed that there were no significant differences in the proportions of MS with offsets across the sample as a whole (χ^2-test 9.00 against χ^2-critical of 16.92).

TABLE 8 Number of times offset conditions are specified in the dataset of Ministerial Statements, by region (% of total in parentheses)

Regions	MS in dataset (% of all MS)		MS with offsets (% of all MS)		% MS with offsets in that region
Gascoyne	4	(1%)	1	(1%)	25%
Goldfields Esperance	33	(12%)	4	(5%)	12%
Great Southern	5	(2%)	1	(1%)	20%
Kimberley	12	(4%)	1	(1%)	8%
Mid-West	29	(10%)	11	(13%)	38%
Peel	13	(5%)	4	(5%)	31%
Perth	26	(9%)	4	(5%)	15%
Pilbara	114	(41%)	41	(49%)	36%
South West	25	(9%)	9	(11%)	36%
Wheatbelt	16	(6%)	7	(8%)	44%
Total	**277**		**83**		

Two categories of environmental offsets are observed in the database (Table 9):

1. **Direct offsets** designed to improve vegetation conditions, or protect habitat or rare species. These direct offsets include: land acquisition and placing land under conservation covenants (23 times), rehabilitation of natural areas outside the project area (7 times), and translocation of rare flora (4 times).
2. **Indirect offsets** are designed to improving scientific understanding of the environmental values affected the mining development. These indirect offsets include: provide funding for research projects (11 times), contribute funds specifically to the regional conservation initiative for the Pilbara (6 times), or general contribution of funds to State Government or general strategic conservation activities (37 times).

Some projects are required to provide multiple offsets (e.g. indirect funding as well as land acquisition).

TABLE 9 Types of offset conditions specified in the dataset of Ministerial Statements (as % of total)

Type of offset	% MS with offset requirement
Direct	
Land acquisition and conservation covenants	23%
Land rehabilitation	7%
Rare flora translocation	4%
Indirect	
Contribute funds (general)	37%
Contribute funds for research	11%
Funding for the regional Pilbara conservation initiative	6%
Other (e.g. greenhouse gas offset package)	2%
Total	**90%**

4 Achievability of mine rehabilitation conditions and targets: A summary

While there is a plethora of scientific studies available on ecological restoration of mine sites, such studies are typically small-scale or site-specific trials that may not be relevant to most mine tenement holders. Results from ecological research and rehabilitation trials will be conditional on the context of the trial, and thus not generally applicable. It was found that much rehabilitation data is privately owned by proponents or consultants and thus not accessible for the project team. Conducting a full review of the scientific literature was beyond the scope of the current project, and it is highly recommended that a future project collates the available knowledge (including company specific trials) to enable a transparent analysis of what rehabilitation outcomes can be achieved across the state.

Mine site rehabilitation conditions and the achievability of targets were discussed with experts on mine closure in Western Australia. The expert consultation phase involved three rehabilitation experts from mining companies, four consultants, and five researchers from three WA universities and Kings Park Science. The consultation process used an open-ended question format, following a semi-structured interview guide. Example conditions and targets that were discussed are available in Appendix 5.

Experts' responses covered a range of topics that were grouped into five themes as described below. It is understood that the feasibility / achievability of mine rehabilitation will vary considerably with the type of resource being exploited (e.g. shallow bauxite or sand mining versus gold or iron-ore pits); the bioregion and climate in which exploitation takes place (e.g. Pilbara versus South West); the domain that is being rehabilitated (e.g. pitlakes, tailings, waste dumps, roads etc.); and the money and labour available (company constraints).

4.1 Policy context

Rehabilitation conditions and targets are now largely negotiated directly between regulators and mining companies when developing the Mine Closure Plans. Ministerial Statements have perhaps become less relevant. It was noted that individual negotiations between the regulator and proponent limits the opportunity for independent scientific assessment or public scrutiny, in particular when MCPs are not available for public review. The negotiations around the MCP provide some flexibility to proponents, which may lead to variations across rehabilitation standards since companies have different levels of expertise and resources available for the negotiation process.

Expert discussions considered the achievability of rehabilitation conditions in Ministerial Statements. The EPA has its policy mandate provided in the EP Act, and EPA objectives of protecting environmental values may lead to recommendations that require the development of new knowledge and technical innovation to achieve the recommended rehabilitation conditions. Experts stated that rehabilitation conditions could be a useful 'performance management tool'. The EPA could also recommend ambitious or strict conditions to effectively advise the Minister to reject the development application. However, it was noted that, in the end, approval is at the discretion of the Minister and may not necessarily follow EPA advice.

The EPA is in a position to recommend ministerial conditions to manage cumulative environmental impacts at a landscape scale. The EPA can consider regional data on landscape features, sensitive environments, and ongoing and proposed mining projects, to evaluate whether individual site conditions meet landscape scale environmental management objectives.

4.2 Differentiation between conditions and targets

Rehabilitation conditions and targets should be defined on different levels of detail, although this distinction is often not clearly reflected in the Ministerial Statements (MS). Currently, rehabilitation conditions may sometimes contain too much detail, while, in some other cases, targets are too broad. Experts agreed that conditions should be interpreted as the minimum standards that define the overall outcome of rehabilitation. These Ministerial Conditions give the legal context for rehabilitation (including what guidance documents and references should be used, and what type of information companies should report on). Conditions should be sufficiently broad to allow further definition of specific targets (e.g. numerical completion criteria) in the Mine Closure Plans. Conditions are better without a time-bound element, as they should apply to the whole life of mine, across all domains.

It was noted that detailed conditions could be appropriate in situations where there are high risks involved (e.g. environmentally sensitive areas), or in cases where a mine does not have a MCP (e.g. sites not subject to the Mining Act). However, the consulted experts believed that, if the EPA wanted to recommend specific conditions, they should involve knowledge leaders in the field. It was recognised that the EPA may not have sufficient capacity or technical knowledge to define specific targets for each project. Therefore, defining broader conditions in a MS was considered appropriate.

BOX 1. Example conditions that experts considered well-defined

"*Remove all infrastructure*" → Not open to interpretation and clearly achievable.

"*Reflecting the surrounding natural ecosystem*" → Implies that ecosystems need to be consistent with the surrounding landscape, but don't necessarily need to be the same. A contrasting example that would not be achievable is *"restoration as closely as practicable (to) the pre-disturbance biodiversity and ecosystem functional values"*.

"*The dominant species, species composition, percentage cover and community structure in rehabilitated areas*" → Ticks off on variety of relevant richness aspects instead of just a percentage cover and diversity.

"*Undertake trials*" or "*Conduct laboratory and field scale research*" → Such targets are clearly achievable. However, they should be linked to delivering an outcome. Doing research for the sake of research is not necessarily useful.

4.3 Specificity of rehabilitation targets and conditions

Experts raised several concerns about how conditions and targets were formulated in MSs. First, conditions are typically formulated in a 'generic' manner, without accounting for particularities of the mine site, such as climatic zone or type of commodity and extractive process. Post mine land uses are often not mentioned in rehabilitation conditions or, when they are, the conditions are not aligned to envisaged future land uses.

Second, rehabilitation targets typically fail to recognise the variation in rehabilitation capacity across geographies and mine types, partly because targets are directly based on EPA's guidelines (EPA 2006). For example, the same level of species diversity cannot be expected from two different sites (e.g. bauxite vs. mineral sands), even though these would apply the exact same rehabilitation practices. Whether 'natural vegetation', species diversity and cover targets are achievable depend largely on the region or system.

Finally, rehabilitation timeframes will vary widely, yet in many cases, the timeframes set in the MS do not take such variation into account, thus applying time-bound conditions for mines that may operate over much longer periods. Experts noted that safety, stability, and non-polluting outcomes can be assessed relatively well over comparatively short time frames, while ecosystem conditions are notoriously difficult to evaluate over longer time frames. Experts agreed that we have insufficient knowledge about how ecosystems develop over time and insufficient data about how WA ecosystems respond to disturbances.

4.4 Potential improvements in the definition of rehabilitation conditions and targets

In response the concerns raised about current practices in the definition of rehabilitation conditions and targets, experts provided a series of recommendations.

Many targets define references to which outcomes should be compared. However, references to "suitable undisturbed reference sites", "undisturbed native vegetation", or "natural undisturbed analogue" are inappropriate because such sites have not been disturbed to the same extent as the mine. Comparisons to "pre-mining vegetation" are also inappropriate because the benchmark may have changed. Instead of requiring reference to original or previous conditions, references should consider (a) the anticipated post-mining land use, and (b) the significant disturbances at a mine site. Use of reference trajectories that take into account disturbances that have occurred naturally in the region (e.g. bushfires or droughts), and/or reference based on post-mining land use may be more suitable.

Most recommendations were related to the conditions and targets specified for ecosystem restoration. Experts commented that ecosystem targets using generic, ill-defined terms such as "ecologically sustainable manner", "achieve a self-sustaining and functioning ecosystem"; or "resilient vegetation" are impossible to evaluate (e.g. there is currently no agreed definitions of 'self-sustaining' or 'resilient').[3] Terms that are insufficiently defined are left open to interpretation. It was recommended that terminology is tightened up and used properly. Conditions could also avoid using generic terms entirely, and instead make mention to references or guidelines to follow.

Vegetation cover and diversity are easy indicators that are used widely to define rehabilitation targets. However, these do not capture ecosystem complexity, ecosystem function, and key species that are important to the function of the system. Ecosystem structure and/or composition were considered more relevant than cover and diversity.

Targets for weeds should avoid the use of baseline conditions as a reference and, instead, use analogue sites that are being monitored and for which up-to-date data is available. Baseline conditions are limited by the information available at that time, which are likely to change over the life-of-mine, in many cases due to processes outside the control of the proponent. Conditions and targets for weeds could be set here around the management of weeds, rather than outcomes.

The idea of an agency-specific 'conditions library' was discussed, whereby each relevant regulatory body would develop a portfolio of potential conditions that are broadly applicable across regions and types of mines. Such conditions would then need to be further detailed according to the specifics of the project including a) climatic region; b) commodity/mining method; c) timeframe and site age/maturity. It is possible that such 'library' would provide greater consistency in conditions definition, while at the same time allowing for variations across areas and types of mines.

[3] The EPA's Guidance Note 6 (2006) *Rehabilitation of Terrestrial Ecosystems* defines 'Resilience' as the ability of an ecosystem to maintain structural and functional attributes in the face of severe impacts by external factors. No definition is provided for 'Self-sustaining' in the Guidance Note.

Some, but not all, Ministerial Statements describe 'self-sustaining vegetation' as *"permanent vegetation which grows and persists without human management or intervention beyond that which would be required to maintain comparable undisturbed native vegetation"* (MS 916)

5 Discussion and conclusion

This project collected publicly available information about rehabilitation and/or closure conditions recommended by the EPA, aiming to document a long-term history of rehabilitation and/or closure conditions for mining projects in Western Australia. The focus of this work has been on rehabilitation conditions related to ecological restoration and the 'land' factors recommended by the EPA and subsequently applied by the Minister for Environment through a Ministerial Statement. Conditions related to safety, stability, and contamination were not covered in this project.

Of the 277 mining and resource sector projects that were assessed by the EPA between 1987 and 2018, 236 (85%) have had rehabilitation or closure conditions recommended in their Ministerial Statement. Since 2013 (following changes in the Mining Act), the proportion of MS with rehabilitation conditions has decreased, most likely transferring definitions of rehabilitation targets from MSs to Mine Closure Plans instead. Most rehabilitation conditions were associated with preparing a decommissioning, closure, and/or rehabilitation plan, without specifying any condition targets or rehabilitation outcomes. Limited trends were observed in recommended rehabilitation conditions over time, between regions, or between projects of different sizes.

A clear time trend is, however, visible when assessing rehabilitation targets (where specified in the MS). During the 1990s and early 2000s, rehabilitation targets were general in nature, and based on broad terms such as 'vegetation' or 'rehabilitation'. Over the last 10 years, condition targets have become more specific, with a few incorporating numeric thresholds. Post 2013, rehabilitation targets were no longer specified in MSs. Targets should now be defined as part of Completion Criteria in companies' Mine Closure Plans. The current project did not evaluate whether rehabilitation targets specified in MSs or Mine Closure Plans meet ministerial conditions. Given that rehabilitation targets are often identified (as rehabilitation objectives or completion criteria) through an opaque negotiation process between the regulator and proponent, an interesting project could evaluate whether completion criteria correspond to rehabilitation conditions set in Ministerial Statements.

The experts consulted as part of this project noted that further research is needed to better understand how WA ecosystems respond to natural disturbances such as droughts, floods, and fires. Yet, experts agreed that there is already much knowledge available about the structure of natural ecosystems that can be used to assess whether rehabilitation targets are achievable. A lot of this knowledge is, however, spread across companies, not publicly available in one place, and not available in a coherent way to allow in-depth analysis. There is a need to collate the information and manage the data gained from trials and on-site research to better understand the bio-physical and ecological feasibility of rehabilitation targets.

A challenge in completing this project was the lack of readily accessible data about rehabilitation. Environmental conditions may be specified in Ministerial Statements, but post-mine land uses are not typically identified, which makes it impossible to evaluate whether conditions are in line with agreed outcomes and land uses. A follow-up project is recommended to analyse what post-mine land uses are feasible in different mining environments. Such a project would then need to assess whether EPA recommended rehabilitation conditions/targets are aligned with proposed PMLU and envisaged future values.

Progress toward rehabilitation is only reported in terms of hectares rehabilitated, but rarely (if ever) with reference to meeting rehabilitation conditions or targets, nor specified by domain. The costs of meeting rehabilitation targets are hardly every reported, complicating any analysis of the feasibility of rehabilitation conditions and also adding to a lack of foresight and planning of funds needed for successful rehabilitation. There is currently no standard reporting framework for closure costs. The DMIRS could set up a harmonised accounting framework and prepare guidance notes that lay out what rehabilitation costs should be reported and how.

Progress is being made to increase the transparency of information and decision-making around mine proposals and mine closure planning, particularly with publication of data on the EPA and DMIRS websites[4]. However, the information needed to search these data bases is not always easily accessible (registration title, tenement name, project name), and combined figures for Western Australian regions are still unavailable. The current project hopes to improve the information availability by creating a database of rehabilitation conditions and targets for projects assessed by the EPA.

[3] http://www.dmp.wa.gov.au/Environmental-Assessment-and-1471.aspx; http://www.dmp.wa.gov.au/Mines-and-mineral-deposits-1502.aspx; and http://www.epa.wa.gov.au/all-ministerial-statements

References

ANZMEC, & MCA. 2000. 'Strategic Framework for Mine Closure'. Canberra, Australia http://www.sernageomin.cl/wp-content/uploads/2017/11/Strategic-Framework-Mine-Closure.pdf

Commonwealth of Australia. 2012. *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy, October 2012. Canberra: Australian Government Department of Sustainability, Environment, Water, Population and Communities.

DMIRS. 2018a. '2018 review of mineral and petroleum industry activity'. viewed 22 March 2019. http://dmp.wa.gov.au/About-Us-Careers/Latest-Resources-Investment-4083.aspx

DMIRS. 2018b. 'Mineral and petroleum commodity review 2018'. viewed 22 March 2019. http://www.dmp.wa.gov.au/About-Us-Careers/Latest-Statistics-Release-4081.aspx

DMIRS. 2018c. 'Mining Rehabilitation Fund (MRF) 2018 Data Release'. viewed. http://www.dmp.wa.gov.au/Environment/What-is-the-MRF-19522.aspx

DMP. 2016. *Guidelines for Mining Proposals in Western Australia*. http://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-213.pdf

DMP, & EPA. 2015. *Guidelines for Preparing Mine Closure Plans. May 2015*. Perth: Government of Western Australia: Department of Mines and Petroleum (DMP) and the Environmental Protection Authority (EPA) http://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-121.pdf

EPA. 2006. *Guidance Statement No. 6: Guidance for the assessment of environmental factors: rehabilitation of terrestrial ecosystems*. Perth, Western Australia: Department of Water and Environmental Regulation, Environmental Protection Authority. http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/GS6-Rehab-Terrestrial-Ecosystems-260606.pdf

http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/WAEnvOffsetsPolicy-270911.pdfEPA (2011). WA Environmental Offsets Policy. Perth, Western Australia: Department of Water and Environmental Regulation, Environmental Protection Authority.

EPA. 2014. *WA Environmental Offsets Guidelines*. Perth, Western Australia: Department of Water and Environmental Regulation, Environmental Protection Authority. https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/WA%20Environmental%20Offsets%20Guideline%20August%202014.pdf

EPA. 2018a. *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual*. Perth, Western Australia: Environmental Protection Authority.

EPA. 2018b. 'Statement of Environmental Principles, Factors and Objectives'. Perth, Western Australia: http://epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Statement%20of%20Environmental%20Principles%2C%20factors%20and%20objectives_29062018_0.pdf

Government of Western Australia (2011) WA Environmental Offsets Policy. Perth, Western Australia. http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/WAEnvOffsetsPolicy-270911.pdf

Government of Western Australia (2013). Mining Rehabilitation Fund Regulations 2013. Perth, Western Australia.

Government of Western Australia (2014). *WA Environmental Offsets Guidelines*. Perth, Western Australia. https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/WA%20Environmental%20Offsets%20Guideline%20August%202014.pdf

Lechner, A. M., Kassulke, O., & Unger, C. 2016. 'Spatial assessment of open cut coal mining progressive rehabilitation to support the monitoring of rehabilitation liabilities'. *Resources Policy*, 50, 234-243.

Pepper, M., Roche, C. P., & Mudd, G. M. 2014. 'Mining legacies—Understanding life-of-mine across time and space'. Proceedings of the Life-of-Mine Conference.

White, B. 2015. 'Do control rights determine the optimal extension of liability to investors? The case of environmental policy for mines'. *Journal of Regulatory Economics*, 48(1), 26-52.

White, B., Doole, G. J., Pannell, D. J., & Florec, V. 2012. 'Optimal environmental policy design for mine rehabilitation and pollution with a risk of non-compliance owing to firm insolvency'. *Australian Journal Of Agricultural and Resource Economics*, 56(2), 280-301.

Appendix 1

Descriptive statistics for the database of Ministerial Statements (MSs) used in this study

Variable	Sample characteristics
Number of MSs assessed	**277**
Date range	**15/10/1987–28/12/2018**
Project types	
Gas production – Construction	5
Gas production – Infrastructure	6
Mining – Construction	223
Mining – Infrastructure	18
Infrastructure development (general)	22
Oilfield development	3
Resource types	
Aggregates (gravel, hard rock and clay)	8
Bauxite	5
Clay	8
Diamonds	7
Gas	14
Gold	24
Iron ore	114
Mineral sands	43
Nickel	12
Oil	3
Rare earth minerals	5
Salt	5
Uranium	5
Others (coal, copper, granite, gypsum, lead, limestone, molybdenum, silica, titanium, vanadium)	20

Variable	Sample characteristics
Region	
Gascoyne	4
Goldfields-Esperance	33
Great Southern	5
Kimberley	12
Mid-West	29
Peel	13
Perth	26
Pilbara	114
South-West	25
Wheatbelt	16
Terrestrial footprint cleared (range in ha)	**4–26,925**
Number of MS with post-mine land use specified in MS	**18**
Number of MS with condition targets specified	**98**
Number of MS with offset conditions specified	**83**

Appendix 2

List of projects with rehabilitation targets specified in their Ministerial Statement

Source: EPA Ministerial Statements

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
923	1883	Brockman Railway Infrastructure Project	Brockman Iron Pty Ltd	Pilbara
918	1937	Cape Lambert to Emu Siding Rail Duplication and Borrow Pits in Milstream Chichester NP	Robe River Mining Co Pty Ltd	Pilbara
916	1494	Extension of Kemerton Silica Sand Dredge Mining	Kemerton Silica Sand Pty Ltd	South West
915	1908	Ferraus Pilbara Project	FerrAus Pty Ltd	Pilbara
912	1669	Red Hill Quarry Development	Hanson Construction Materials Pty Ltd	Perth
899	1848	Cloudbreak Life of Mine, Pilbara	Fortescue Metals Group Ltd	Pilbara
880	1892	Cape Lambert to Emu Siding Rail Duplication	Rio Tinto Pty Ltd	Pilbara
873	1754	Wheatstone Development – Gas Processing, Export Facilities and Infrastructure. Shire of Ashburton and Roebourne	Chevron Australia Pty Ltd	Pilbara
867	1865	Brockman 2 Detrital Iron Ore Mine Extension Phase 2B	Hamersley Iron Pty Ltd	Pilbara
862	1841	Solomon Iron Ore Project	Fortescue Metals Group Ltd	Pilbara
857	1847	Jimblebar Iron Ore Project, 40 kilometres East of Newman, Shire of East Pilbara	BHP Billiton Iron Ore Pty Ltd	Pilbara
855	1781	Marillana Iron Ore Project, Shire of East Pilbara	Brockman Resources Ltd	Pilbara
854	1738	Hope Downs 4 Iron Ore Mine Shire of East Pilbara	Hamersley HMS Pty Ltd	Pilbara
852	1756	Carina Iron Ore Mine, approximately 60 kilometres north east of Koolyanobbing, Shire of Yilgarn	Polaris Metals Pty Ltd	Goldfields Esperance

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
847	1849	Roy Hill Infrastructure Railway, Shire of Ashburton, Shire of East Pilbara, Town of Port Hedland	Roy Hill Infrastructure Pty Ltd	Pilbara
844	1838	Macedon Gas Development Shire of Ashburton	BHP Billiton Petroleum Pty Ltd	Pilbara
843	1753	Koolyanobbing Iron Ore Project – Mt Jackson J1 Deposit, Shire of Yilgarn.	Cliffs Asia Pacific Iron Ore Pty Ltd	Wheatbelt
840	1717	Cape Lambert Port B Development – Shire of Roebourne	Pilbara Iron Ore Pty Ltd	Pilbara
839	1745	Tropicana Gold Project, Shire of Menzies, Shire of Laverton and the City of Kalgoorlie – Boulder	Tropicana Joint Venture (AngloGold Ashanti Australia and Independence Group)	Goldfields Esperance
834	1833	Orebody 24/25 Upgrade Project	BHP Billiton Iron Ore Pty Ltd	Pilbara
833	1686	Marandoo Mine Phase 2, Shire of Ashburton	Hamersley Iron Pty Ltd	Pilbara
829	1822	Roy Hill 1 Iron Ore Mining Project Stage 2, 110 kilometres North of Newman, Shire of East Pilbara	Roy Hill Iron Ore Pty Ltd	Pilbara
824	1589	Roy Hill 1 Iron Ore Mining Project Stage 1, 110 kilometres North of Newman, Shire of East Pilbara	Roy Hill Iron Ore Pty Ltd	Pilbara
823	1677	Balmoral South Iron Ore Project, Cape Preston, Shire of Roebourne	Mineralogy Pty Ltd	Pilbara
818	1801	Chichester Rail deviation, Shire of Ashburton	BHP Billiton Iron Ore Pty Ltd	Pilbara
816	1596	Albany Iron Ore Project – Southdown Magnetite proposal mine	Grange Resources Ltd	South West
814	1812	Cundaline and Callawa Mining Operations	BHP Billiton Iron Ore Pty Ltd	Pilbara
813	1783	Silicon Project, Kemerton and Mine at Moora	Simcoa Operations Pty. Ltd.	Wheatbelt
812	1803	Dredging at Nelson Point, BHP Billiton RGP6 Project, Port Hedland	BHP Billiton Iron Ore Pty Ltd	Pilbara
811	1653	Koolanooka/Blue Hills direct shipping ore mining project	Sinosteel Midwest Corp Ltd	Mid West

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
810	1580	Keysbrook Mineral Sands Mine	Matilda Zircon Ltd	Peel
809	1796	Wheelarra Hill Mine Modification Shire of East Pilbara	BHP Billiton Iron Ore Pty Ltd	Pilbara
808	1795	Spotted Quoll open pit nickel mine, Shire of Kondinin	Western Areas NL	Wheatbelt
807	1786	Western Turner Syncline, Section 10 Iron Ore Project, Shire of Ashburton	Rio Tinto Pty Ltd	Pilbara
806	1633	Mungada Iron Ore project, 220km east-southeast of Geraldton	Karara Mining Ltd	Mid West
800	1221, 1323	Gorgon Gas Development Revised and Expanded Proposal: Barrow Island Nature Reserve	Chevron Australia Pty Ltd	Pilbara
799	1660	Tutunup South Mineral Sands Project	Iluka Resources Limited	South West
795	1710	Devil Creek Development Project, Gnoorea Point, Shire of Roebourne	Apache Northwest Pty Ltd	Pilbara
794	1770	Balla Balla magnetite mining project, 10 kilometres north-west of Whim Creek, Shire of Roebourne	Ferro Metals Australia Pty Ltd	Pilbara
790	1749	Cooljarloo Mine – Falcon extension approx 10km north-west of Cataby shire of Dandaragan	Tiwest Pty Ltd	Wheatbelt
789	1768	Western extension to the Dardanup Mineral Sands Project to include the Burekup Mineral Sands Deposit	Doral Mineral Sands Pty Ltd	Perth
781	1759	Dredging at Finucane Island, BHP Billiton RGP5 Project, Port Hedland	BHP Billiton Iron Ore Pty Ltd	Pilbara
775	1685	Pardoo iron ore mine and direct shipping from Port Hedland, Shire of East Pilbara and Town of Port Hedland	Atlas Iron Ltd	Pilbara
773	1743	Windimurra Vanadium Project: Land clearing and mining below the base of weathering Shire of Mount Magnet	Windimurra Vanadium Ltd	Mid West

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
772	1657	Spinifex Ridge Molybdenum project, 50 kilometres North-East of Marble Bar, Shire of East Pilbara.	Moly Metals Australia Pty Ltd	Pilbara
769	1716	Jansz Feed Gas Pipeline	Mobil Australia Resources Company Pty Ltd	Pilbara
767	1301	Southern Extension of Sand Pit, Lot 2 Calinup Road Gelorup, Shire of Capel	Cotton Holdings Pty Ltd t/as APH Contractors (ACN 009 198 887)	South West
756	1574	Mesa A/Warramboo Iron Ore Project 43km west of Pannawonica, Shire of Ashburton	Robe River Mining Co Pty Ltd	Pilbara
753	1538	Mt Gibson Iron Ore Mine and Infrastructure Project, Shire of Yalgoo	Mount Gibson Mining Ltd	Mid West
748	1496	Gorgon Gas Development: Barrow Island Nature Reserve	Chevron Australia Pty Ltd	Pilbara
736	1658	Cloverdale Minerals Sands, mining and processing; Shires of Capel and Busselton	Iluka Resources Ltd	South West
730	1619	Expansion of Jurien Gypsum mining operation ML70/1161, Shire of Dandaragan	CSR Gyprock Fibre Cement	Wheatbelt
723	1491	Coburn Mineral Sand Project, 84 kilometres south-east of Denham, Shire of Shark Bay	Gunson Resources Ltd	Gascoyne
721	1577	Pilbara Iron Ore and Infrastructure Project: Cloud Break (no beneficiation)	Fortescue Metals Group Ltd	Pilbara
720	1612	Cataby Mineral Sands Project, Cataby, Shire of Dandaragan	Iluka Resources Ltd	Wheatbelt
719	984.1526	Worsley Alumina – Production to maximum capacity of 4.4MTPA alumina and associated mining	Worsley Alumina Pty Ltd	South West
718	1259	Gwindinup Mineral Sands Mine, Shire of Capel	Cable Sands (WA) Pty Ltd	South West
717	1543	Brockman Syncline 4 Iron Ore Project	Hamersley Iron Pty Ltd	Pilbara
715	1605	Koolan Island Iron Ore Mine and Port Facility, Shire of Derby-West Kimberley	Aztec Resources Ltd	Kimberley

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
712	1609	Orebody 25 extension project 8 kilometres north-east of Newman, Shire of East Pilbara	BHP Billiton Iron Ore Pty Ltd	Pilbara
711	1606	Argyle Diamond Mine, Underground Project, 110km south of Kununurra, Shire of Wyndham – East Kimberley	Argyle Diamond Mines Pty Ltd	Kimberley
708	1607	Dampier to Bunbury Natural Gas Pipeline, Southern Looping Project, Loop 10, South of Kwinana	DBNGP Pty Ltd	Peel
707	1520	Pilbara Iron Ore and Infrastructure Project: East-West Railway and mine sites (Stage B)	Fortescue Metals Group Ltd	Pilbara
706	1413	Voyager Quarry, Lots 11 & 14 Horton Road, The Lakes, Avon Location 1881, Shire of Northam	BGC (Australia) Pty Ltd	Perth
704	1604	Dampier to Bunbury Natural Gas Pipeline, Kemerton Lateral Gas Pipeline, Kemerton, Shire of Harvey	DBNGP Pty Ltd	South West
703	1573	Kemerton Silica Sand Mining Proposal, Additional Mining Areas and Transfer of Land for Conservation	Kemerton Silica Sand Pty Ltd	South West
695	1590	Yandicoogina Junction South-East Mine, Mining Lease 274SA, Shire of East Pilbara	Hamersley Iron Pty Ltd	Pilbara
684	1571	Ellendale 4 Diamond Project, West Kimberley, Shire of Derby – West Kimberley	Kimberley Diamond Company NL	Kimberley
683	1558	Wheelarra Hill Iron Ore Extension Life-of-mine Proposal Mining Lease 266SA, 40km east of Newman, Shire of East Pilbara	BHP Billiton Iron Ore Pty Ltd	Pilbara
682	1568	Goldsworthy Iron Ore Mines extension project 100-170 kilometres east of Port Hedland	BHP Billiton Iron Ore Pty Ltd	Pilbara
679	1555	Marillana Creek (Yandi) Life-of-Mine proposal mining leases 270SA% 47/292, 90km North-West of Newman Shire of East Pilbara	BHP Billiton Iron Ore Pty Ltd	Pilbara

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
670	1506	Cliff Head OilField Development, 20km south of Dongara, Shire of Irwin	Roc Oil (WA) Pty Ltd	Mid West
639	1385	Ludlow Titanium Minerals Mine 34km South of Bunbury Shire of Capel	Cable Sands (WA) Pty Ltd	South West
627	1374	Koolyanobbing Iron Ore Expansion Windarling Range and Mt Jackson Shire of Yilgarn	Portman Iron Ore Limited	Wheatbelt
606	1445	Telfer Project, Expansion of Telfer Gold Mine, Great Sandy Desert	Newcrest Mining Ltd	Pilbara
571	1317	Mt Margaret Nickel-Cobalt Project, Shire of Leonora	Anaconda Nickel NL	Goldfields Esperance
559	1262	Magellan Lead Carbonate Project, Wiluna	Magellan Metals Pty Ltd	Mid West
557	1272	Cooljarloo Mineral Sands Project	Tiwest Pty Ltd	Wheatbelt
551	1348	Wallaby Gold Mine, Lake Carey, Shire of Laverton	Placer (Granny Smith) Pty Limited	Goldfields Esperance
548	1250	Gold Mine Developments On Lake Lefroy, 7 kilometres South-East of Kambalda	WMC Resources (St Ives Gold)	Goldfields Esperance
521	1049	Continuation of Limesand Mining, Ocean Beach Quarry, Portion of Reserve A24913, Oceon Road, Denmark	Shire of Denmark	South West
514	1144	West Angelas Iron Ore Project Shires of East Pilbara, Ashburton and Roebourne	Robe River Mining Co	Pilbara
509	1199	Ravensthorpe Nickel Project, Bandalup Hill Shire of Ravensthorpe	Comet Resources NL	Great Southern
453	1033	Boddington Gold Mine, Extended Basement Operation, Shire of Boddington	Worsley Alumina Pty Ltd	South West
442	1032	Mining of Titanium Minerals, 2km south of Yarloop	Cable Sands (WA) Pty Ltd	South West
426	954	Rare earth project 4km south of Alcoa Alumina Refinery and next to Gallium Plant Pinjarra	Rhone-Poulenc Chimie Australia Pty Ltd	South West

Ministerial Statement No.	EPA Assessment No.	Project Title	Proponent	Region
423	984	Expansion of Alumina Production from 2.0 to 3.5 million tonnes per annum at Worsley Refinery, and associated bauxite mining activities, Boddington	Worsley Alumina Pty Ltd	South West
415	995	Mt Keith Nickel Project Tailings Storage Upgrade	Western Mining Corporation Ltd	Kalgoorlie
405	969	Duplication of iron ore mining operation, Yandi Mine mining lease	BHP Iron Ore Pty Ltd	Pilbara
335	787	Gold Mine in 'C' Class Nature Reserve 18584 Rutherfords Reward Mine, Westonia	Rutherford Resources Pty Ltd	Wheatbelt
326	794	Extension of Diamond Mining into Beefwood Creek, Lissadell Station East Kimberley	Poseidon Bow River Diamond Mine Pty Ltd	Kimberley
303	753	Goldsworthy Extension Project Phase 2 – Yarrie Project Area, East Pilbara	BHP Iron Ore Pty Ltd	Pilbara
286	599	Marandoo Iron Ore Mine and Central Pilbara Railway	Hamersley Iron Pty Ltd	Pilbara
282	501	Ewington Open Cut Mine, Collie	The Griffin Coal Mining Company Pty Ltd	South West
239	624	Mineral Sands Mine, Dardanup	Doral Mineral Sands Pty Ltd	South West
227	563	Extension of Existing Quarry South West Highway, Byford	Pioneer (WA) Pty Ltd	Perth
199	354	Relocation of Herne Hill Quarry Operation	Hanson Construction Materials (previously Pioneer Concrete (WA) Pty Ltd)	Perth
117	352	Yakabindie Nickel Project at Leonora	Dominion Mining Limited	Goldfields Esperance

Appendix 3

Case study projects for detailed assessment

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
7/Limesand Extraction, Lancelin	1987	Not defined	Not mentioned	Not found	Not found	Not specified	Not mentioned	EPA report (Bulletin 294, Aug 1987). No AER[6] found
16/Channar Mining Project, Hamersley Range (J00481)[7]	1988	Not defined	2,500ha approved (2011)	Not found	Not found	Not specified	Not mentioned	EPA report 310 (Dec 1987). No AER found
75/Three Mile Hill Gold Project, Coolgardie (J00340)	1989	Not defined	Not mentioned	Not found	Not found	Not specified	Not mentioned	EPA report 394 (Jul 1989). No AER found
95/ Wagerup Alumina refinery expansion (J00779) **(Amended by MS 728 and MS 1069)**	1990	Not defined	183ha approved (2006) 183ha disturbed (2018)	Not found	Not found	Not specified	Not mentioned	EPA report 423 (Dec 1989). Wagerup Refinery Annual Compliance Report (Mar 2019). No AER found
130/Heavy Mineral Sands, Bremer Bay	1991	Not defined	Not mentioned	Not found	Not found	Unvested reserves with native vegetation (Maintenance of existing conservation and landscape values to retain the maximum range of options for future use)	Not mentioned	EPA report 494 (Jan 1991). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
208/Mesa J Iron Ore Development, Pannawonica	1992	1) Seed used in rehabilitation works is of local provenance. 2) Native plants within rehabilitated areas are observed to flower and/or fruit. 3) Recruitment of native perennial plants is observed. 4) Species richness of native perennial plants within rehabilitated areas is not less than reference sites. 5) Any weed species recorded within rehabilitation areas are present within the local area. 6) Erosion from landforms does not threaten surrounding significant natural ecosystems (Robe River Pools).	1,927ha approved (2007)	Not found	Not found	The final land use will be determined prior to closure during final planning phases and in consultation with relevant stakeholders	Not mentioned	EPA report 574 (Aug 1991). Mesa J Hub Closure Plan (Jul 2018). No AER found
299/ Boddington Gold Mine (J00026)	1993	Refer to Table 8-1: 'Completion Criteria Framework for mine operations' in 2012 MCP	4,132ha approved (2018) 3,634ha disturbed (2018)	399ha (2018)	Table 1: 'Summary of Compliance against Conditions' in 2018 ACR reports clearing area, and Management Plans for Black Cockatoo and Terrestrial Fauna	Combination of potential PMLUs identified: • Nature conservation • Recreation • Forestry • Water catchment • Future mining Livestock grazing at village site	Not mentioned	EPA report 766 (Dec 1994). Newmont Boddington Gold Closure Plan (Dec 2012). Newmont Boddington Gold Annual Compliance Report (Jun 2018). AER 2018

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
335/Gold Mine Rutherfords Reward Mine, Westonia (J03294)	1994	Not defined	Not mentioned	Not found	Not found	Self-sustaining native vegetation	Not mentioned	EPA report 712 (Oct 1993). No AER found
393/Hot Briquetted Iron Project, Port Hedland	1995	1) There should be no net loss of mangroves from the area and accordingly the 3ha of mangroves lost be replaced. Recognising that there is a largescale mangrove re-establishment program in the East Creek area, the proponent should apply the techniques and methods of this programme to recolonising the causeway area and the area should be as far as practical equal to or greater than the 3ha lost during construction. 2) Monitoring changes to nearby mangroves. 3) Rectification measures should monitoring indicate that adverse impacts have occurred or are occurring.	500ha approved (1995)	Not found	Not found	Not specified	Not mentioned	EPA report 784 (Jun 1995). No AER found
405/Duplication of iron ore mining operation, Yandi Mine mining lease (J00571)	1996	Not defined	510ha approved (1995)	Not found	Not found	Not specified	Not mentioned	EPA report 802 (Dec 1995). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
439/Orebody 18 Iron Ore Mine, Newman (J00623) **(Amended by MS 1012 — offsets added)**	1997	Not defined	793ha approved (2015)	Not found	Not found	Not specified	Not mentioned	EPA report 840 (Dec 1996). No AER found
476/Rare Earths Mining and Beneficiation at Mt Weld, Laverton & Secondary Processing at Meenaar, near Northam (J00772) **(Amendment to MS 290)**	1998	Not defined	380ha approved. 352ha disturbed (2019)	1.11ha (2019)	Not found	Not specified	Not mentioned	EPA report 884 (Mar 1998). AER 2019. MCP 2019 not publically accessible
505/Mt Charlotte Gold Mine, Kalgoorlie	1999	1) Be propagated with native species of local provenance. 2) Satisfactory vegetation community structures are attained when compared to surrounding vegetation communities. 3) Show a statistically favourable comparison of key dominant species with surrounding vegetation communities.	18ha disturbed (2015)	0ha (2015)	Not found	Restricted access	Financial provisions in the MCP do not provide costings. Instead, the MCP refers to the Barrick Reclamation Cost Estimator for calculating the costs for mine site rehabilitation.	EPA report 919 (Dec 1998). KCGM Mine Closure Plan (Mar 2015). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
		4) Revegetation is self-sustaining and where appropriate consist of mature, juvenile and emergent vegetation and in some cases be producing seed. 5) Weed species abundance of weed species is comparable to local analogue vegetation communities. 6) Rehabilitation vegetation communities demonstrate evidence of fauna utilisation or fauna visitation.						
536/North West Shelf Gas Project additional Liquefied Natural Gas Facilities (J02379)	2000	Not defined	276ha approved (1999)	Not found	Not found	Not specified	Not mentioned	EPA report 962 (Dec 1999). No AER found
571/Mt Margaret Nickel-Cobalt, Leonora (J02263)	2001	1) Waste dumps are stable and support a self-sustaining vegetation 2) Optimise rehabilitation of the TSF	11,100ha approved (2001)	Not found	Not found	Conservation and pastoral use	Not mentioned	EPA report 1025 (Aug 2001). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
584/Hope Downs Iron Ore Mine, 75km NW of Newman (J00685) **(Amended by MS 893 and MS 1025)**	2002	Not defined	3,750ha approved (2002)	2,990ha (2002)	Not found	Land use options under consideration include a change to pastoralism or return to a native ecosystem	$190,000,000 and $500,000/ year (estimated costs of backfilling and maintenance of water to Weeli Wolli Spring)	EPA report 1024 (Aug 2001). EPA report 1424 (Dec 2011). EPA report 1562 (Nov 2015). No AER found
621/Tutunup Titanium, Busselton (J02258)	2003	Not defined	174ha approved (2003)	Not found	Not found	Agriculture	EPA report estimates costs for some rehabilitation measures and monitoring of $400,000 (page 69)	EPA report 1085 (Dec 2002). No AER found
666/Mineral Sands Mine, 2.5km NW of Gingin (J00460)	2004	Not defined	370ha approved (2006)	Not found	Not found	Pastoral and native vegetation	$2,400,000 (Rehabilitation performance bond)	EPA report 1146 (Sep 2004). No AER found
679/Marillana Creek, Newman (J00571) **(Amended by MS 855, MS 1039, and MS 1055)**	2005	C10. Impacted areas will be returned to self-sustaining vegetation communities and fauna habitats that reflect pre-disturbed state. C11. Noxious weeds will be managed in line with mining best practice in the Pilbara. C12. Topsoil remains viable and has the capacity to support a safe, stable and functioning ecosystem that meets the requirements of the post-mining land use.	4,558ha approved (2016)	Not found	Not found	The post-mining land use is dependent on the State Government's intention to either continue leasing the land for pastoralism or allow the land to become de-stocked and revert to its pre-pastoral wilderness status	$204,600,000 (estimated caretaker, maintenance, and relinquishment costs for Years 26-38)	EPA report 1166 (Apr 2005). Brockman Mine Closure Plan and Costs (Jul 2010). EPA report 1577 (Aug 2016). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
712/Orebody 25 extension, Newman (J00623) **(Amended by MS)**	2006	Refer to Table 7: 'Eastern Ridge mining operations Completion Criteria' in 2016 MCP	800ha approved (2006)	38ha (2005)	Not found	The most likely final land use for the area is either water reserve (mining operations are located within Water Reserve 6), low intensity cattle grazing (the current land use for areas not directly affected by mining activities), or inclusion in some form of natural conservation area	MCP checklist states that the MCP includes a costing methodology in Section 11, but the 2016 publicly available document only includes up to Section 6	EPA report 1210 (Nov 2005). BHP Billiton Iron Ore Eastern Ridge mining operations, MCP (Jan 2016). No AER found
736/Cloverdale Mineral Sands, Capel (J00456)	2007	Not defined	350ha approved (2007)	Not found	Not found	Native vegetation	Not mentioned	EPA report 1233 (Nov 2006). EPA report 1507 (Apr 2014). No AER found
767/Southern Extension of Sand Pit, Capel	2008	Not defined	19ha approved (2008)	Not found	Not found	The restored landform will be suitable for future residential development	Not mentioned	EPA report 1194 (Aug 2005). No AER found
782/Fimiston Gold Mine, Kalgoorlie (J00027)	2009	As per MS505: 505/Mt Charlotte Gold Mine	2,955ha approved 2,450ha disturbed (2015)	505ha (2015)	Not found	Safety exclusion zone, open pit mining activities, 'modified natural ecosystems'	MCP only describes costing using the Barrick Reclamation Cost Estimator	EPA report 1273 (Dec 2007). KCGM Mine Closure Plan (Mar 2015). No AER found

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
829/Roy Hill 1 Iron Ore Mining Project Stage 2 (J02889)	2010	1) Percentage cover of living vegetation in all rehabilitation areas shall be comparable with that of nearby land which has not been disturbed during implementation of the proposal. 2) No new species of weeds (including both declared weeds and environmental weeds) shall be introduced into the area as a result of the implementation of the proposal. 3) Coverage of weeds (including both declared weeds and environmental weeds) within the rehabilitation areas shall not exceed that identified in baseline monitoring undertaken prior to commencement of operations, or exceed that existent on comparable, nearby land which has not been disturbed during implementation of the proposal, whichever is less.	10,342ha approved 6,389ha disturbed (2019)	325ha (2019)	The 2018 Parkinsonia program controlled approximately 30,000 plants covering 5,000ha of Roy Hill tenure and covered all priority areas, with the majority of these being juvenile plants. Based upon the comparison of photo point monitoring over the years, the current Parkinsonia control method and resources allocated (both in time, manning and equipment) appears to be a very effective method of control.	Low intensity cattle grazing and pastoral activities	The RHIO closure costing methodology was based on the total area of disturbance for the proposed project and estimated volumes of material requiring placement, hours of equipment usage or man-hours required. Rates were based on figures from third party reviews. Roy Hill has engaged a third party consultant to develop a cost model based on the Standardised Reclamation Cost Estimator (SRCE).	EPA report 1345 (Dec 2009). Roy Hill Project MCP (Mar 2015). AER 2019

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
852/Carina Iron Ore, Koolyanobbing (J03423)	2011	1) The percentage cover of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites. 2) No new species of weeds (including both declared weeds and environmental weeds) are introduced into the rehabilitated areas as a result of the implementation of the proposal. 3) Cover of weeds (including both declared weeds and environmental weeds) in rehabilitated areas shall not exceed that identified in the baseline survey condition 10–1(2) or exceed that existing on comparable, nearby land, determined by condition 10–1(3) which has not been disturbed during implementation of the proposal, whichever is less.	1,675ha approved 952ha disturbed (2019)	182ha (2019)	Not found	Yet to be developed	Current total bond of AU$6.115 million, but no listing of rehabilitation costs	EPA report 1368 (Oct 2010). Polaris Metals Pty Ltd Mining Proposal, Carina Extended Iron Ore Project (Nov 2012). AER 2019. MCP 2018 not publically accessible.

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
867/Brockman 2 Detrital Iron Ore Mine Extension, Phase 2B (J03932) **(Extension of MS 131)**	2011	1) Percentage cover and species diversity of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites as demonstrated by Ecosystem Function Analysis or other methodology acceptable to the CEO. 2) No new species of weeds (including both declared weeds and environmental weeds) shall establish in the area as a result of the implementation of the proposal. 3) Coverage of weeds (including both declared weeds and environmental weeds) within rehabilitated areas shall be no greater than the average of three reference sites on nearby land, with the reference sites to be chosen in consultation with the DEC and the DMP.	1,029ha approved 571ha disturbed (2019)	87ha (2019)	Not found	The post-mining land use is dependent on the State Government's intention to either continue leasing the land for pastoralism or allow the land to become de-stocked and revert to its pre-pastoral wilderness status (MCP 2010)	Reported $204,600,000 for closure costs of MS 131 (Refer to pages 23–24 of 2010 MCP)	Brockman Mine Closure Plan and Costs 2010 (for MS 131). EPA report 1393 (Apr 2011). AER 2019.

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
886/Jack Hills Expansion project, Meekatharra (J03040)	2012	Not defined	192ha approved 144ha disturbed (2019)	26ha (2019)	Not found	Not specified	Not specified	EPA report 1413 (Aug 2011). AER 2019. MCP 2017 not publically accessible.
899/ Cloudbreak Life of Mine, Pilbara **(Amended by MS 962 and MS 1010)**	2012	Not defined	13,633ha approved (2012)	Not found	Not found	Pastoral grazing	Not specified	EPA report 1429 (Feb 2012). No AER found.
923/Brockman Railway project	2013	Percentage cover and species diversity of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites as demonstrated by Ecosystem Function Analysis, or other methodology acceptable to the CEO.	1,588ha (approved 2012)	Not found	Not found	Not specified	Not specified	Brockman Iron Pty Ltd, Rail Infra-structure Project Offset Plan (Jul 2012). EPA report 1455 (Nov 2012). No AER found.
940/Shine Iron Ore project (J04475)	2013	1) Revegetation comprised of local provenance species in a self-sustaining and resilient community (i.e. meets structural and diversity targets). 2) Target species maintaining equivalent function to analogue flora site.	131ha approved 114ha disturbed (2019)	4ha (2019)	Not found	Conservational purposes	Estimated using Standardised Reclamation Costs Estimator. Estimated closure costs of $4,249,995 specified by domain.	EPA report 1472 (Dec 2012). AER 2019. Shine Iron Ore Project: MCP 2013

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
		3) Response of target revegetated community / species to controlled disturbance equivalent to analogue flora sites. 4) Weed coverage and disease spread no greater than pre-mine extent. 5) Revegetated habitat supports pre-mine fauna and guilds						
958/Tronox Chandala Synthetic Rutile Plant (J02458)	2014	Refer to Table 7: 'Completion Criteria' in 2017 MCP	53ha approved (2014)	Not found	Not found	Unallocated Crown Land will be rehabilitated back to a stated that is broadly representative of native vegetation communities. Freehold land will be rehabilitated to mixed agriculture land use (that may include grazing, cropping or more intensive forms of agricultural production.)	Costing methodology included in page 103–104 of the MCP, but no specific cost given. Overall expenditure on rehabilitation is provided in Tronox Global Reporting Initative report 2017, but not specific to activities.	EPA report 1490 (Oct 2013). Tronox Cooljarloo Mine, MCP (Nov 2015). Cooljarloo West Titanium Minerals Project, Public Environmental Review, EPA Assessment 1974 (May 2017). No AER found.
968/Hinge Iron Ore Project (J02815)	2014	Not defined	312ha approved 165ha disturbed (2018)	134ha (2018)	Not found	Not specified	Not specified	EPA report 1505 (Mar 2014). AER 2018 (one of three mines reported in Karara – Blue Hills/ Gindalbie AER). MCP 2016 not publically accessible.

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
993/North Star Magnetite Project (J04193)	2015	Not defined	5,251ha approved (2019)	Not found	Not found	Return to pre-mining land use: Unallocated Crown Land will be returned to UCL – native vegetation. Areas within Pastoral Lease boundaries will be returned to a pastoral land use (livestock grazing)	Not specified	Public Environmental Review (Aug 2013). EPA report 1514 (Jun 2014). No AER found.
1007/Heavy Mineral Sands Mine, Beenup (J05349) **(Amendment to MS 140 and MS 434)**	2015	Total rehabilitation area of no less than 336.2ha within a 697ha project envelope, comprising: • Former dredge ponds (now permanent wetlands) – 71.50ha • Mine Development Storage Area – 42.60ha • Trial Mining Areas – 25.46ha • Disturbed but un-mined areas (decommissioned dams, stockpile areas, general project related disturbance) rehabilitated to pasture, native vegetation and ephemeral wetlands – 196.62ha	336ha approved 1ha still disturbed (2014)	335ha (2014)	AER indicates 335ha of 336ha have been rehabilitated	Not specified	Not specified	AER 2014. EPA report 1545 (Apr 2015).

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
1030/ Yoongarillup Mineral Sands (J04330)	2016	Not defined	97ha approved (2016)	Not found	Not found	Three land uses on the site overall: Dryland pasture; State Forest; and Native vegetation in road reserves	$6,200,000 in rehabilitation bonds	Yoongarillup Mineral Sands Project, Preliminary MCP (Sep 2014). EPA report 1552 (Jul 2015). No AER found.
1032/ Gidji Gold Processing Plant, near Kalgoorlie (J00116, J01140) **(Amendment to MS 28 and MS 77)**	2016	As per MS505: 505/Mt Charlotte Gold Mine	73ha approved 68ha disturbed (2015)	0ha (2015)	Not found	Not specified	MCP only describes costing using the Barrick Reclamation Cost Estimator	KCGM Mine Closure Plan (Mar 2015). EPA report 1566 (May 2016).
1052/Cyclone Mineral Sands (J03442)	2017	Not defined	1,272ha approved (2017)	Not found	Not found	Not specified	Not specified	EPA report 1575 (Aug 2016). No AER found.
1062/Solomon Iron Ore project – Sustaining Production (J01646) **(Amendment to MS 862)**	2017	Table 6: 'Closure Objectives and Provisional Completion Criteria' in 2015 MCP only states that "Rehabilitation activities are carried out in accordance with Fortescue's Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)"	10,309ha approved 4,676ha disturbed (2019)	193ha (2019)	Not found	UCL is proposed to be returned to UCL: Hamersley Station and Mt Florence pastoral leases proposed to be returned to pastoral use (low-intensity grazing)	Not specified	Solomon Project Mine Closure Plan (Oct 2015). EPA report 1588 (Nov 2016). AER 2019.

MS/project	MS Year	Rehabilitation targets[1]	Terrestrial footprint[2]	Area rehabilitated[3]	Reporting against objectives[4]	Proposed PMLU[5]	Rehabilitation costs	Information source
1072/Mining Area C (J00576) **(Amendment to MS 491)**	2018	Refer to Table 10: 'Mining Area C Completion Criteria' in 2017 MCP	21,824ha approved (2018)	Not found	Not found	Native pastoral ecosystem, capable of supporting low intensity grazing	Not specified	BHP Billiton, Mining Area C, MCP (Oct 2017). EPA report 1610 (Dec 2017). No AER found.
1078/Sandy Ridge Project (J04723)	2018	Not defined	276ha approved (2018)	Not found	Not found	Not specified	Not specified	EPA report 1611 (Dec 2017). No AER found.

[1] Numerical targets or completion criteria defined in MS or MCP

[2] Extend of disturbance in hectares approved by the EPA (*potential footprint*), area disturbed as reported in AER in year defined

[3] Hectares rehabilitated as reported in AER in year defined

[4] To what extend is rehabilitation progress reported against targets/mine closure objectives?

[5] PMLU = Post-Mine Land Use

[6] AER = Annual Environmental Report

[7] J-numbers are DMIRS project identification codes. Note that the absence of data does not necessarily mean that the company has no Mine Closure Plan or Completion Criteria, but that such information was not available in the public domain.

Appendix 4

Rehabilitation Liability Categories and Unit Rates

The following table has been reproduced from Schedule 1 of the MRF Regulations (Government of Western Australia 2013)

Description of infrastructure or land	Category	Unit rate (per ha)
• Tailings or residue storage facility (Class 1) • Waste dump or overburden stockpile (Class 1) • Heap or vat leach facility • Evaporation pond • Dam – saline water or process liquor	A	$50,000
• Tailings or residue storage facility (Class 2) • Waste dump or overburden stockpile (Class 2) • Low-grade ore stockpile (Class 1) • Plant site • Fuel storage facility • Workshop • Mining void (with a depth of at least 5 meters) — below ground water level • Landfill site • Diversion channel or drain • Dam — fresh water	B	$30,000
• Low-grade ore stockpile (Class 2) • Sewage pond • Run-of-mine pad • Building (other than workshop) or camp site • Transport or service infrastructure corridor • Airstrip • Mining void (with a depth of at least 5 meters) — above ground water level • Laydown or hardstand area • Core yard • Borrow pit or shallow surface excavation (with a depth of less than 5 meters) • Borefield • Processing equipment or stockpile associated with Basic Raw Material extraction • Land (other than land under rehabilitation or rehabilitated land) that is cleared of vegetation and is not otherwise described in this Table	C	$18,000
• Land (other than land under rehabilitation or rehabilitated land) that has been disturbed by exploration operations	D	$2,000
• Land under rehabilitation (other than land that has been disturbed by exploration operations) • Topsoil stockpile	E	$2,000
• Exploration operations: – Land under rehabilitation, – Rehabilitated land	No rate applicable	

Appendix 5

Example rehabilitation conditions and targets discussed during expert consultation phase

Source: EPA Ministerial Statements

	CONDITIONS
2018	*Progressive rehabilitation* for the proposal will be undertaken in a manner that will result in habitat suitable for use, including foraging and burrowing
2018	Ensure that the proposal is *decommissioned and rehabilitated* in an ecologically sustainable manner
2013	Prepare Mine Closure Plan and ensure that the mine is closed, *decommissioned and rehabilitated* in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State of Western Australia
2017	Ensure that the flora and vegetation of rehabilitated areas *reflects the environmental values of the surrounding natural ecosystem* and provides appropriate habitat for fauna
2008	The proponent shall implement the proposal to achieve stable, self-sustaining and functioning ecosystem(s) that is/are c*onsistent with the surrounding landscape* and maintain(s) key environmental values over the long-term
2017	Ensure that the proposal is rehabilitated and contoured in a manner which *minimises impacts to visual amenity* consistent with the end land use for conservation and recreation
2010	Within five years of the cessation of operations, remove all infrastructure and r*ehabilitate all areas* disturbed by the development
2017	*Conduct laboratory and field scale research* on the rate at which revegetation cover can be established, the effect of vegetation cover on the erosion rate and the need for alternative surface treatments to prevent erosion on the cover system to inform condition
2009	*Undertake trials* to determine criteria for successful re-growth, using local native flora species, including Priority and Declared Rare flora species
2017	Provisions required for the environmental management plan shall include *maximising the potential for rehabilitation success* (including topsoil collection and appropriate storage, seed collection, management and remediation (if required) of the soil profile, and rehabilitation trials)
2006	*Rehabilitation will be undertaken* on waste rock dumps and TSF
2015	The proponent shall ensure that *progressive rehabilitation* of areas not required for permanent infrastructure is undertaken *using native species of local provenance* and that the condition and *composition of vegetation is comparable to natural vegetation surrounding the proposal*
2011	Areas disturbed through implementation of the proposal, shall be *progressively rehabilitated* with vegetation composed of *native plant species of local provenance*
2011	Proponent shall undertake *progressive rehabilitation with species of local provenance*

	CONDITIONS
2014	The proponent shall *prepare and implement Mine Closure Plan* and ensure that the mining operations are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses
2012	At least six months prior to the anticipated date of closure, the proponent shall submit a *decommissioning and rehabilitation management plan*
2010	*Prepare and implement Final Decommissioning Plan* that provides detail on final rehabilitation
2009	*Prepare and implement Rehabilitation and Mine Closure Plan*
2013	Where the results of monitoring indicate adverse changes in the presence, extent, species diversity and invasive characteristics of weeds and weed cover, the proponent shall: • immediately implement, and/or propose appropriately timed weed control measures in affected areas to the satisfaction of the CEO; • submit details of weed control measures that have or will be implemented and any proposed rehabilitation measures to be implemented to the CEO, within 21 days of becoming aware of adverse changes; and, • implement weed control and rehabilitation measures until such time as the CEO agrees implementation may cease.
1999	Address *topsoil management*
1991	Wherever practicable *topsoil* will be removed from larger building sites, borrow areas and other disturbed areas *for use in rehabilitation works*
1989	The proponent shall prepare a report annually as required on the rehabilitation programme and shall undertake decommissioning of the plant and rehabilitation of the mine site to the *satisfaction of the Department of Mines*.
1988	Should monitoring indicate that rehabilitation as required under condition 2 is not being successfully met, the proponent shall undertake r*emedial or additional works to the satisfaction of the Environmental Protection Authority and the Department of Mines*

	TARGETS
	References
2012	The percentage cover and species diversity of living self-sustaining native vegetation in all rehabilitation areas shall be comparable to that of undisturbed natural analogue sites as determined by botanical surveys carried out in accordance with Environmental Protection Authority Guidance Statement Number 51 (or subsequent updates) or other methodology acceptable to the CEO.
2011	After five years of the completion of rehabilitation of those areas temporarily disturbed, the percentage cover and species diversity of living self-sustaining native vegetation in rehabilitation areas shall be comparable to the completion criteria.
2010	The dominant species, general species composition, percentage cover and community structure in rehabilitated areas are to be comparable with suitable reference sites on nearby land which has not been disturbed by industrial development.
2009	Within five years of mine closure, the percentage cover of native vegetation shall be comparable with that of natural landforms in the area.
	Weeds
2011	• No new species of declared weeds and environmental weeds shall be introduced into the rehabilitated areas which are likely to be attributable to the Proposal. • Cover of declared weeds and environmental weeds in rehabilitated areas shall not exceed the lesser of: (i) that identified in the baseline weed survey; and (ii) that existing on comparable nearby land which has not been disturbed during implementation of the Proposal.
2011	• No new species of weeds (including both declared weeds and environmental weeds) shall establish in the area as a result of the implementation of the proposal. • The coverage of weeds (including both declared weeds and environmental weeds) within rehabilitated areas shall be no greater than the average of three reference sites on nearby land, with the reference sites to be chosen in consultation with the Department of Environment and Conservation and the Department of Mines and Petroleum.
2011	Weed coverage is equal to or less than that of pre-cleared levels.
2009	Within five years of mine closure the distribution and abundance of weeds shall be no greater than the distribution and abundance of weeds prior to the implementation of the proposal.
	Species diversity and cover
2009	Rehabilitation completion criteria to provide a self-sustaining, functional ecosystem comprising native vegetation of local provenance species and to meet the following criteria: • flora and vegetation are re-established at a ratio of 1:1 with not less than 70% cover (not including weed species); and • flora species diversity not less than 70% that of pre-mining vegetation.
2011	Species diversity is not less than 60 percent of the known original species diversity
2009	Within five years of mine closure, the percentage cover of native vegetation shall be comparable with that of natural landforms in the area.

	TARGETS
	Objectives
2012	The proponent shall ensure that the rehabilitation and closure of the proposal addresses the following objectives: • resilient and self-sustaining vegetation comprised of local provenance species; • reaching agreed numeric targets for vegetation recovery; and • comprising habitats capable of supporting all types of biodiversity.
2009	The objectives of the Plan are to: • ensure that the rehabilitation of terrestrial areas following construction is properly planned in a manner which promotes self-sustaining ecosystems able to be managed as part of their surroundings consistent with the conservation objectives of a class 'A' Nature Reserve; • design rehabilitation of native vegetation to ultimately develop into viable ecological systems which are comparable and compatible with surrounding native vegetation and its land uses, and restores as closely as practicable the pre-disturbance biodiversity and ecosystem functional values; • ensure planning, implementation, monitoring and reporting on rehabilitation is carried out consistent with industry best practice; • ensure management of rehabilitation continues until affected areas are self-sustaining; and, • better inform any on-going rehabilitation and post-closure rehabilitation.
2008	Objectives of rehab plan: • ensure disturbed areas are rehabilitated using local provenance species as soon as possible following cessation of mining of those areas; • design rehabilitation of native vegetation to ultimately develop into viable ecological systems which are comparable and compatible with surrounding native vegetation and its land uses, and restores as closely as practicable the pre-disturbance biodiversity and functional values; • ensure planning, implementation, monitoring and reporting on rehabilitation is carried out in a manner consistent with industry best practice; and • ensure management of rehabilitation continues until affected areas are self-sustaining.
2006	Objective proponent commitments: • to ensure that rehabilitation of mined areas on private property leaves the land in an environmentally stable and sustainable conditions and meets the requirements of the private property owner.
2006	Objective of rehab on tailings: ensure resulting landforms safe, stable, minimal eroding, non-polluting and will conform with surrounding landscape.
1993	Objective is to ensure that all disturbed surfaces (with the exception of mine pits) are returned to a stable condition with a flora and fauna which approaches the natural condition of the site.
	Other
2003	Optimise soil profile reconstruction methods to re-create soil profiles suitable for establishment of Tuart forest.
1996	Revegetation activities will continue until stable communities are established.
1992	Rehabilitation to an acceptable land use.

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