POLARIS
METALS PTY LTD

Carina Iron Ore Project

Ministerial Statement 852 - 957 Compliance Assessment Report

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DECLARATION

I, **Joshua Thurlow (Executive General Manager – Project Development)** declare that I am authorised to submit this form and that the information contained in this form is true and not misleading.

Signature:____________________ Date: 30/04/2021

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1. INTRODUCTION

This document has been written to satisfy the reporting conditions of Ministerial Statement 852 (MS852) and MS957, approved under Section 45(5) of the *Environmental Protection Act 1986* (EP Act) for the Carina Iron Ore Project (the Project). The Compliance Assessment Report (CAR) covers the period between 29 April 2020 and 28 April 2021 (the reporting period).

The Carina Iron Ore Project (The Project) is owned and operated by Polaris Metals Pty Ltd (Polaris), a wholly owned subsidiary of Mineral Resources Limited (MRL). Carina is located in the south-west of the Goldfields region in Western Australia, approximately 100 kilometres (km) north-east from the town of Southern Cross (Figure 1). Carina is a direct ship ore project with two open cut pits on the Yendilberin Hills (which forms a part of the Finnerty Range) and associated mine infrastructure.

Carina is divided into two operational areas. A mine infrastructure area and a crushing and rail siding, connected by a bitumised haul road (Figure 2). The mine is located 48 km north of the rail siding. An accommodation village is located approximately 3 km north of the rail siding area and is connected with a power line corridor.

In 2006, Polaris acquired iron ore tenements in the Yilgarn area of Western Australia. Exploration drilling identified the Carina deposits as being suitable for iron ore mining. During the environmental approvals process the Project was referred to the Environmental Protection Authority (EPA) for assessment under Part IV of the *Environmental Protection Act 1986* (WA) (EP Act). The level of assessment was set as public environmental review, and the report Public Environmental Review Carina Iron Ore Mine: Yilgarn Region WA was submitted to EPA in March 2010. Approval was granted for the project with issuing of Ministerial Statement 852 on 28 January 2011. A subsequent amendment removing condition 5-2 was approved in the form of MS957 on 11 December 2013.

A mining proposal for the project was submitted to the Department of Mines, Industry Regulation and Safety (DMIRS) for assessment (Mining Proposal: Carina Iron Ore Project M77/1244, L15/305, L15/303, L15/306, L15/310, L15/311, G15/21 Yilgarn Region WA, dated January 2011, Reg ID 28616). The mining proposal was approved on 21 February 2011.

Four amendments have been made (via the S45C and S46 process) to MS852. Amendments were made in June 2012, October 2013 and December 2013 which have since been superseded. The fourth S45C was submitted to the OEPA and approved in September 2016.

Ministerial Statement 988 was approved 24 October 2014 for the Jackson 4 (J4) Iron Ore Project. The J4 project utilises infrastructure approved under MS852 (transport and crushing infrastructure).

A further mining proposal was submitted and approved in October 2013 (Reg ID 41730) for the development of a second iron ore deposit, Carina Extended.

Additionally, the following submissions have been approved by the DMIRS for changes to MP Reg ID 28616:

- Mining Proposal Amendment Reg ID 36609 – Changes to Site Layout (Mine) dated 2 July 2013.
- Mining Proposal Amendment Reg ID 39874 – Haul Road and Accommodation Villages dated 1 August 2013.
- Mining Proposal Amendment Reg ID 41955 - Changes to Mining Operations dated 22 October 2013
- Mining Proposal Amendment Reg ID 45594 - Change to Disturbance Locations under MP Reg ID 41955 on M77/1244 dated 9 January 2014.
- Mining Proposal Amendment Reg ID 45952 - Carina Iron Ore Project - Rail Siding Area, Access Road and Powerline Corridor on G15/21 dated 12 February 2014.
- Mining Proposal Amendment Reg ID 50795 - In-Pit Disposal of Waste Rock in the Carina Pit on M77/1244 under MP Reg ID 41955 dated 8 July 2014.

- Mining Proposal Amendment Reg ID 51085 - Construction of a Crib, Ablution and Supervisor Facility on M77/1244 dated 6 August 2014.
- Mining Proposal Amendment Reg ID 52261 - Additional In-Pit Disposal of Waste Rock in the Carina Pit under MP Reg ID 41955, Tenement M77/1244 dated 21 August 2014.
- Mining Proposal Amendment Reg ID 53420 – Changes to Power Generation on G15/21 dated 16 February 2015.
- Mining Proposal Amendment Reg ID 54393 – Additional Changes to Power Generation on G15/21 dated 13 May 2015.
- Mining Proposal Amendment Reg ID 69968 – Carina Extended Abandonment Bund Amendment on M77/1261-I

A revised consolidated Mine Closure Plan was submitted to DMIRS which includes the Carina, Carina Extended and the Jackson 4 projects and is still currently under assessment by DMIRS.

1.1. Project Implementation Status

The Project was placed into care and maintenance in July 2018, which continued throughout the reporting period until November 2020. At this time the processing plant was recommissioned to support mining activities at MRL's nearby Yilgarn Operations.

No mining activities occurred at the Project during the reporting period.

The 2020-21 reporting period is the ninth year of operation for the Project. Activities conducted during this reporting period include:

- Continued used of the Carina haul road to transport personnel to and from the East Jaurdi Aerodrome.
- Dewatering of the Carina pit for dust suppression using operational pipeline.
- Processing plant and crusher receiving ore from Windarling, Deception and Mt Jackson pits.
- Crushing and train load out started in November 2020, with continued use of the train loop.
- Infrastructure re-commissioned:
    - Camp (up to 50 people).
    - Accommodation Village Wastewater Treatment Plant (WWTP) with a design capacity of 100 cubic meters per day and irrigation field.
    - Dewatering pipeline (not for mining below water table).
- No rehabilitation or demobilisation was conducted during the reporting period.
- Aerial survey (LiDAR and DTM capture) (Carina and Kooly operations).
- Annual rehabilitation monitoring completed on the Carina WRL.

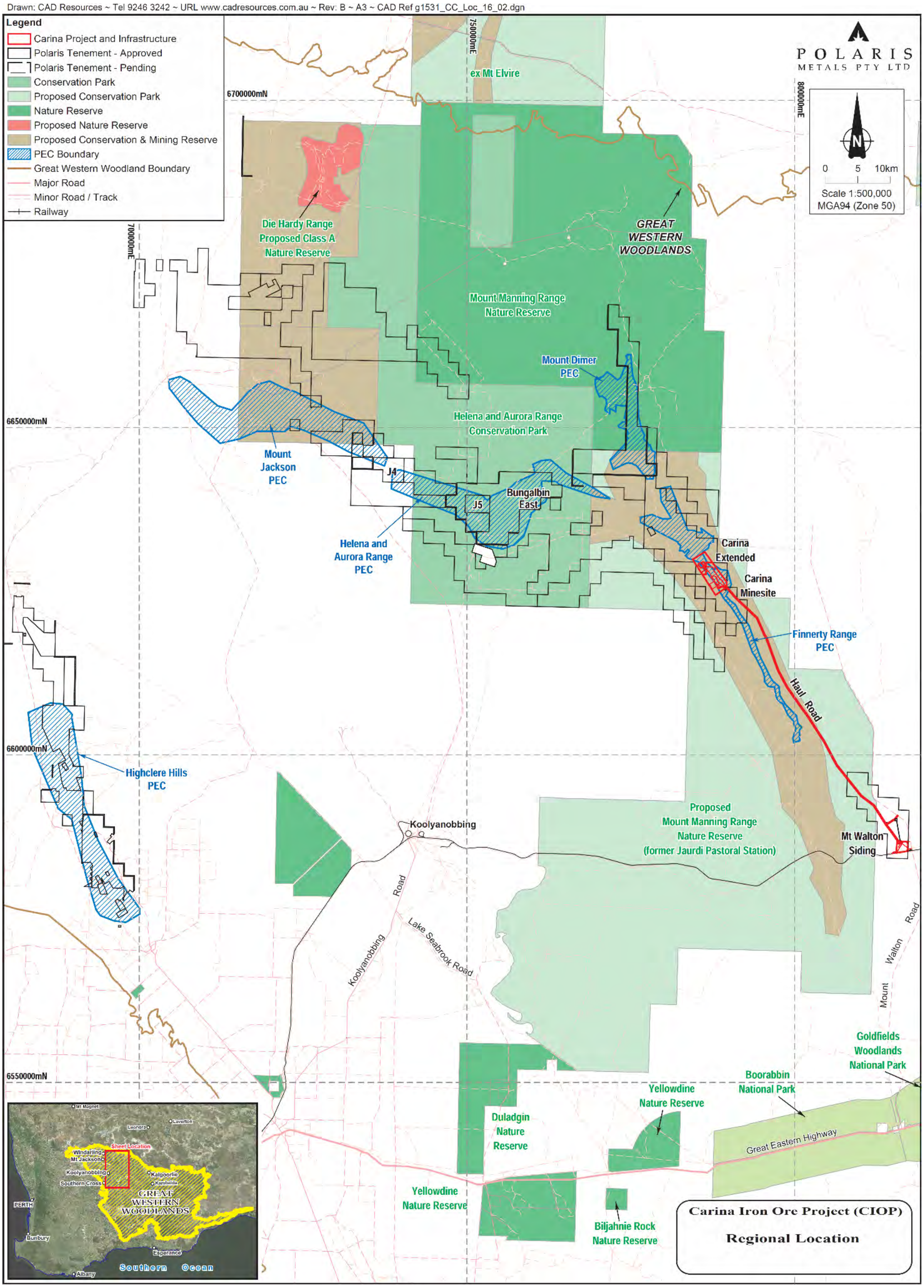

FIGURE 1 SITE LOCATION

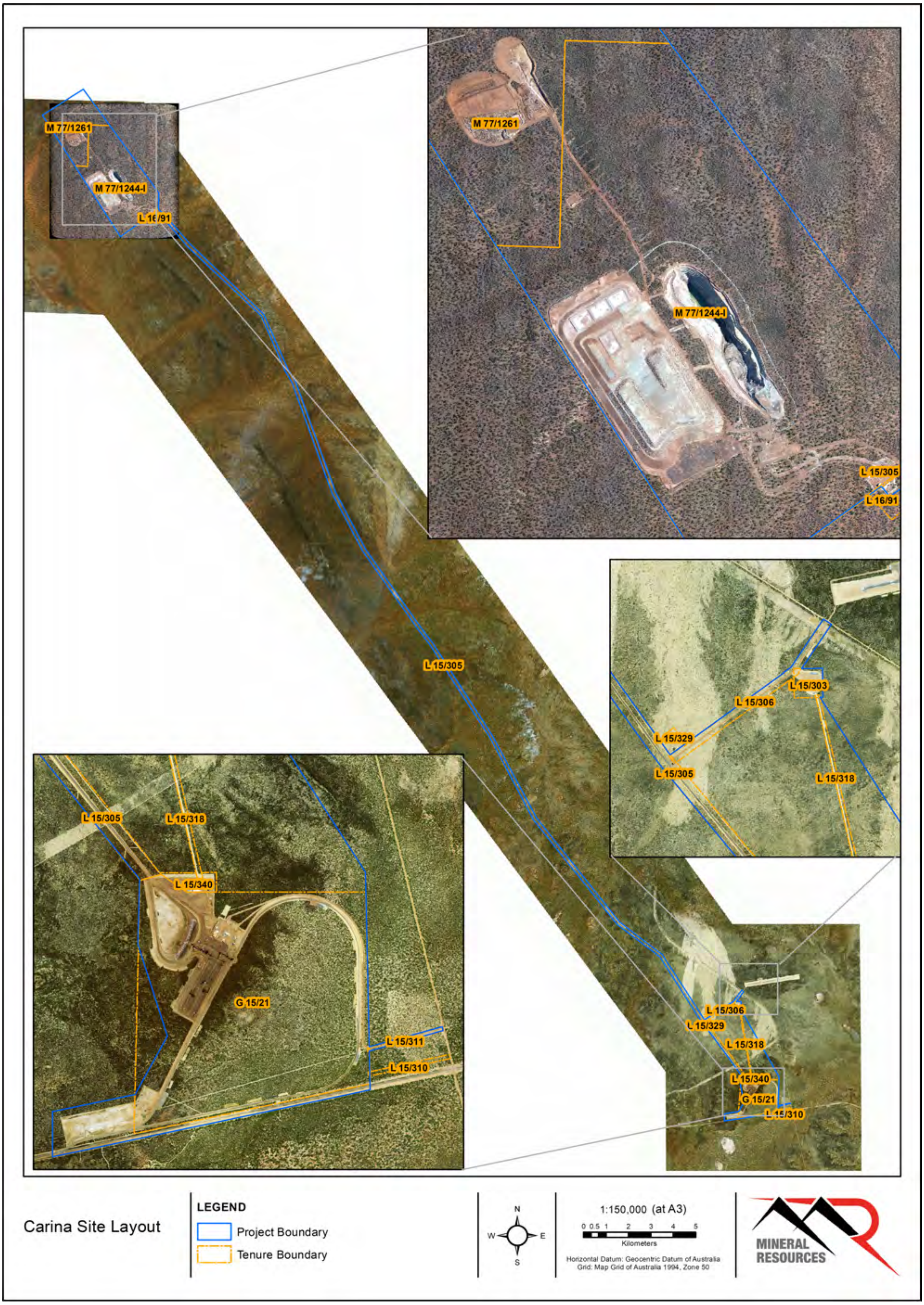

FIGURE 2: SITE LAYOUT

2. STATEMENT OF COMPLIANCE

2.1. Compliance Assessment

Annual compliance auditing and reporting, Conditions 4-3 and 4-6 of MS 852 specify:

> *4-3 The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 4-1.*
>
> *4-6 The proponent shall submit to the CEO the first compliance assessment report fifteen months from the date of issue of this statement addressing the twelve month period from the date of issue of this statement and then annually from the date of submission of the first compliance assessment report.*
>
> *The compliance assessment report shall:*
>
> *1 be endorsed by the proponent's Chief Executive Officer or a person delegated to sign on the Chief Executive Officer's behalf;*
>
> *2 include a statement as to whether the proponent has complied with the conditions;*
>
> *3 identify all potential non-compliances and describe corrective and preventative actions taken;*
>
> *4 be made publicly available in accordance with the approved compliance assessment plan; and*
>
> *5 indicate any proposed changes to the compliance assessment plan required by condition 4-1.*

A Compliance Audit Table for the reporting period is included as Table 1

TABLE 1: COMPLIANCE AUDIT TABLE

Section	Condition Description	Status	Supporting Documents
1 Proposal Implementation			
1-1	The proponent shall implement the proposal as documented and described in schedule 1 of this statement subject to the conditions and procedures of this statement.	**Compliant** Changes to the proposal have been approved under S45C on four occasions (June 2012, October 2013, December 2014 and September 2016).	This document.
2 Proponent Nomination and Contact Details			
2-1	The proponent for the time being nominated by the Minister for Environment under sections 38(6) or 38(7) of the Environmental Protection Act 1986 is responsible for the implementation of the proposal.	**Compliant**	
2-2	The proponent shall notify the CEO of any change of the name and address of the proponent for the serving of notices or other correspondence within 30 days of such change.	**Compliant** No change to nominated proponent	
3 Time Limit of Authorisation			
3-1	The authorisation to implement the proposal provided for in this statement shall lapse and be void five years after the date of this statement if the proposal to which this statement relates is not substantially commenced.	**Compliant**	Reported activities in previous Compliance Assessment reports.
3-2	The proponent shall provide the CEO with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of five years from the date of this statement.	**Compliant**	Reported activities in previous Compliance Assessment reports.
4 Compliance Reporting			
4-1	The proponent shall prepare and maintain a compliance assessment plan to the satisfaction of the CEO.	**Compliant** The Compliance Assessment Plan was prepared and approved by the EPA on 15 April 2011.	MS852 Compliance Assessment Plan 2011 and OEPA approval letter (2013-0000072098) were submitted in a previous Compliance Assessment Report.
4-2	The proponent shall submit to the CEO the compliance assessment plan required by condition 4-1 at least six months prior to the first compliance report required by condition 4-6, or prior to implementation, whichever is sooner. The compliance assessment plan shall indicate: 1. the frequency of compliance reporting; 2. the approach and timing of compliance assessments; 3. the retention of compliance assessments; 4. the method of reporting of potential non-compliances and corrective actions taken; 5. the table of contents of compliance assessment reports; and 6. public availability of all compliance assessment reports.	**Complete**	MS852 Compliance Assessment Plan 2011 and OEPA approval letter (2013-0000072098) were submitted in a previous Compliance Assessment Report.
4-3	The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 4-1.	**Compliant**	This document.
4-4	The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by condition 4-1 and shall make those reports available when requested by the CEO.	**Compliant** All records and reports are maintained in accordance with Polaris's document management system. Documents are available upon request.	

4-5	The proponent shall advise the CEO of any potential non-compliance within seven days of that non-compliance being known.	**Compliant**	
4-6	The proponent shall submit to the CEO the first compliance assessment report fifteen months from the date of issue of this statement addressing the twelve month period from the date of issue of this statement and then annually from the date of submission of the first compliance assessment report. The compliance assessment report shall: 1. be endorsed by the proponent's Chief Executive Officer or a person delegated to sign on the Chief Executive Officer's behalf; 2. include a statement as to whether the proponent has complied with the conditions; 3. identify all potential non-compliances and describe corrective and preventative actions taken; 4. be made publicly available in accordance with the approved compliance assessment plan; and 5. indicate any proposed changes to the compliance assessment plan required by condition 4-1.	**Completed** The first compliance assessment was submitted to the OEPA on 30 April 2012. This is the ninth CAR submitted for the Project.	
5 Protection of vegetation			
5-1	The proponent shall implement the proposal so that it does not adversely affect vegetation, in particular S2 and W22 vegetation communities, outside the proposal boundary as shown in Figure 2 and delineated by MGA co-ordinates listed in Schedule 2.	**Compliant** The proposal has had no adverse effect on vegetation outside the proposal boundary.	Flora and Vegetation Condition Monitoring Report 2020 (Astron 2020) (Appendix 1).
~~5-2~~	~~The proponent shall ensure that the implementation of the proposal does not result in (through either direct or indirect impacts) a loss of more than 8.6 ha of the S2 vegetation community and 66 ha of the W22 vegetation community.~~	**Condition deleted by MS957**	Ministerial Statements 852 and 957.
5-3	The proponent shall monitor prior to disturbance and every 12 months the health and condition of vegetation located within 1 kilometre of the proposal boundary as shown in Figure 2 and delineated by MGA coordinates listed in Schedule 2. This monitoring is to be carried out to the satisfaction of the CEO on advice of the DEC.	**Compliant** Vegetation monitoring was conducted in October 2020 and mining operations continue to not significantly impact vegetation.	Flora and Vegetation Condition Monitoring Report 2020 (Appendix 1).
5-4	Should the potential impact sites show a 25 per cent (or greater) decline in cover or productivity, the proponent shall provide a report to the CEO within 21 days of the decline being identified which: 1. describes the decline; 2. provides information which allows determination of the likely root cause of the decline; and 3. if likely to be caused by activities undertaken in implementing 4. the proposal, states the actions and associated timelines 5. proposed to remediate the decline.	**Compliant** The monitoring report identified that there has not been a significant decline (>25%) in vegetation cover or productivity.	Flora and Vegetation Condition Monitoring Report 2020 (Appendix 1).
5-5	The proponent shall, on approval of the CEO, implement the actions identified in 5-4 (3) and continue to implement such actions until the CEO determines that the remedial actions may cease.	**Compliant** Not required.	
6 Fauna mortality			
6-1	Prior to ground disturbing activities the proponent shall prepare and submit strategies to avoid fauna deaths in areas of mining, the haul road, the rail siding and other areas associated with the proposal on advice of DEC and to the satisfaction of the CEO.	**Compliant** A Fauna Management Procedure was prepared in conjunction with the PEMP and agreed to by the Department of Biodiversity, Conservation and Attractions (DBCA) in January 2011.	
6-2	The proponent shall implement the strategies as required by condition 6-1.	**Compliant**	

		During the reporting period the Project continued under care and maintenance until November 2020, after cessation of mining, haulage and processing of ore in 2018. No mining activities were undertaken. Risk to fauna is considered minor.	
6-3	Prior to ground disturbing activities the proponent shall prepare and implement a Fauna Mortality Register for conservation significant species in the proposal area on advice of DEC and to the satisfaction of the CEO.	**Compliant** No conservation significant species were injured or killed during the reporting period.	N/A
6-4	The proponent shall produce a report with details of fauna mortalities including the cause, location, number and type of species to the CEO as part of the compliance assessment report required by condition 4-6 and provide a report to the DEC.	**Compliant**	Carina Fauna Interaction Register 2020-2021 (Appendix 3).
6-5	The proponent shall review and revise the strategies required by condition 6-1 as required by the CEO.	**Compliant** The Fauna Management Procedure is being developed into a Fauna Management Plan for Carina, Carina Extended and J4. Previously this was to be submitted in 2020 but care and maintenance at Carina halted a new revision.	
7 Flora Survey			
7-1	Within 18 months of ground disturbance the proponent shall undertake a flora survey within the areas delineated by MGA coordinates provided in Schedule 3 that are located within the yellow sandplain vegetation type to determine the presence and abundance of priority flora species present.	**Compliant** A flora survey within delineated areas located within the yellow sandplain vegetation type was implemented and completed. The report was submitted with the first CAR (30 April 2012).	Threatened and Priority Flora Survey Report submitted in a previous Compliance Assessment Report.
7-2	The survey will be conducted in accordance with Environmental Protection Authority Guidance Statement 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (June 2004) or its revisions and to the satisfaction of the CEO.	**Compliant** The flora survey within delineated areas located within the yellow sandplain vegetation type was conducted in accordance with EPA Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Assessment in Western Australia (June 2004).	Threatened and Priority Flora Survey Report submitted in a previous Compliance Assessment Report.
7-3	Within 24 months of ground disturbing activities the proponent shall submit the results of the survey required by condition 7-1 to the requirements of the CEO on advice of the DEC.	**Compliant** Document was submitted with the first CAR (30 April 2012).	The 2012 Compliance Assessment Report.
7-4	The proponent shall make the results of the survey required by condition 7-3 publicly available in a manner approved by the CEO.	**Compliant** This report was included as an attachment to a previous CAR which was made publicly available via the MRL website.	
8 Troglofauna			
8-1	The proponent shall undertake a baseline troglofauna survey within 15 kilometres of the Project Boundary (as shown in Figure 2 and delineated by MGA co-ordinates listed in Schedule 2) in similar geological formations to validate	**Completed**	The Yilgarn Iron Ore Project Troglofauna Surveys 2011 and OEPA approval letter

	predictions of habitat connectivity and improve knowledge of troglofauna populations in the region to inform future management of mining and associated operations.	Baseline troglofauna surveys were carried out and approved by OEPA in consultation with DEC on 1 March 2012.	(2013-0000090478) were submitted in a previous Compliance Assessment Report.
8-2	The baseline troglofauna survey shall be undertaken in accordance with the draft Environmental Protection Authority Guidance Statement 54a Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australian (August 2007) or its revisions and to the satisfaction of the CEO.	**Completed** Baseline troglofauna surveys were carried out with methodology consistent with Guidance Statement 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (August 2007).	The Yilgarn Iron Ore Project Troglofauna Surveys 2011 and OEPA approval letter (2013-0000090478) were submitted in a previous Compliance Assessment Report.
8-3	Within 30 months of ground disturbing activities the proponent shall prepare and submit a technical report based on the results of the survey required by condition 8-1 to the requirements of the CEO on advice of the DEC.	**Completed** A technical report based on the results of the baseline troglofauna surveys required by Condition 8-1 was submitted and accepted by the OEPA in consultation with DEC.	The Yilgarn Iron Ore Project Troglofauna Surveys 2011 and OEPA approval letter (2013-0000090478) were submitted in a previous Compliance Assessment Report.
8-4	The proponent shall make the report required by condition 8-3 publicly available in a manner approved by the CEO.	**Compliant** This report was included as an attachment to a previous CAR which was made publicly available via the MRL website.	
9 Project Environmental Management Plan			
9-1	Prior to ground disturbing activities the proponent shall prepare a Project Environmental Management Plan to the satisfaction of the DEC. The objectives of the plan are to ensure that the adverse impacts from mining and associated activities do not unnecessarily threaten conservation values within the mining lease and prevent impacts outside of the mining lease. The project environmental management plan will address: 1. Hygiene management measures to prevent the introduction of weeds and dieback disease. 2. Management of feral animals. 3. Company protocols to authorise disturbance and clearance of vegetation. 4. Limiting and authorising access to areas within the mining lease. 5. Fire prevention and response. 6. Management and monitoring of saline water used for dust suppression.	**Compliant** The Project Environmental Management Plan was prepared, and agreed with DEC on 28 January 2011. A revised Carina and J4 Project Environmental Management Plan was submitted in December 2020 and approved in January 2021.	DEC approval correspondence (2013-0000078393). Carina and Jackson 4 Iron Ore Project Environmental Management Plan- Rev 4 (Polaris Metals Pty Ltd 2020) (Appendix 4) Approval Letter dated 8 January 2021 (Reference DWERT5201) (Appendix 5).
9-2	The proponent shall implement the Project Environmental Management Plan required by condition 9-1.	**Compliant** The PEMP was implemented following its preparation and agreement with DBCA. It was available to site personnel and its content used in the induction process.	Carina and Jackson 4 Iron Ore Project Environmental Management Plan- Rev 4 (Polaris Metals Pty Ltd 2020) (Appendix 4)
9-3	The proponent shall review and revise the Project Environmental Management Plan required by condition 9-1 at intervals not exceeding three years.	**Compliant** A revised Carina and J4 Project Environmental Management Plan was submitted in December 2020 and approved in January 2021.	Carina and Jackson 4 Iron Ore Project Environmental Management Plan- Rev 4 (Polaris Metals Pty Ltd 2020) (Appendix 4) Approval Letter dated 8 January 2021 (Reference DWERT5201) (Appendix 5)..
9-4	The proponent shall report to the CEO on implementation of the Project Environmental Management Plan every two years from the date of commencing ground disturbing activities.	**Compliant.** Last report was submitted in 2019.	

9-5	The proponent shall make the Project Environmental Management Plan required by condition 9-1 publicly available in a manner approved by the CEO.	**Compliant** The Project Environmental Management Plan is included as Appendix 4 and this CAR will be made publicly available via the MRL website.	
10 Weeds			
10-1	The proponent shall ensure that: 1. No new species of weeds (including both declared weeds and environmental weeds) are introduced into the proposal area as a result of the implementation of the proposal. 2. Prior to ground disturbing activities the proponent shall undertake a baseline weed survey to determine the species and extent of weeds (including both declared weeds and environmental weeds) present within the proposal area to the requirements of the CEO on advice of the DEC. 3. Within 12 months of the date of publication of this statement the proponent shall establish at least three reference sites on undisturbed land (not impacted by the proposal) at each of the mine, haul road, rail siding and accommodation facilities. Reference sites are to be chosen in consultation with the DEC. The reference sites are to be monitored every 2 years to determine whether changes in weed cover and type within and up to 1 kilometre from the Project Boundary (as shown in Figure 2 and delineated by MGA co-ordinates listed in Schedule 2) are as a result of project implementation or broader regional changes. 4. The species and extent of weed cover within the proposal area shall not exceed that identified in the baseline survey identified in 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.	**10-1 (1) Compliant** No new weed species were detected during the 2020 Carina Flora and Vegetation Condition Monitoring Report. **10-1 (2) Compliant** Prior to ground disturbing activities baseline weed surveys were undertaken in conjunction with the PER botanical surveys determining the species and extent of weeds in the proposal area. **10-1 (3) Compliant** The period 12 months from the publication of the statement expired 28 January 2012. Within this 12 month period, on 19 October 2011 at least three reference sites on undisturbed land at each of the mine, haul road, rail siding and accommodation facilities were established and monitored for the changes in weed cover and type. Works were undertaken by Mattiskee Consulting. **10-1 (4) Compliant** No weed incursions were recorded for the second consecutive year and there were no significant differences between analogue and buffer transects in the 2020 Carina Flora and Vegetation Condition Monitoring Report	Carina Flora and Vegetation Condition Monitoring Report 2020 (Appendix 2). Ongoing weed management is undertaken in accordance with the Carina and J4 Weed Assessment document, dated 6 December 2019 (Appendix 6).
11 Rehabilitation			
11-1	The proponent shall undertake progressive rehabilitation over the life of the proposal to achieve the following outcomes: 1. The waste material landforms shall be non-polluting and shall be constructed so that their stability, surface drainage, resistance to erosion and ability to support local native vegetation are similar to undisturbed natural analogue landforms as demonstrated by Ecosystem Function Analysis or other methodology acceptable to the CEO. 2. The waste material landforms and other areas disturbed through implementation of the proposal (excluding mine pits), shall be progressively rehabilitated with vegetation composed of native plant species of local provenance. 3. Within 12 months of the date of publication of this statement the proponent shall conduct surveys of each of the vegetation communities that will be impacted by the proposal to collect adequate information in	**11-1 (1) Compliant** Rehabilitation monitoring was undertaken during the reporting period by Astron between October - November 2020 including analogue sites (Appendix 2). The Compliance of Borrow Pits, Road Infrastructure, the Carina Waste Rock Landform (WRL) and Carina Extended WRL are progressing with additional UAV survey recommended for the WRLs to assess landform areas as a whole.	Mine Plan and Preliminary Closure Strategy (2013-0000154701). Carina Flora and Vegetation Condition Monitoring Report 2020 (Appendix 1). Carina Rehabilitation Monitoring Report 2020 (Appendix 2). Ongoing weed management is undertaken in accordance with the Carina and J4 Weed Assessment document, dated 6 December 2019 (Appendix 6).

	preparation for setting completion criteria for rehabilitation to the requirements of the CEO on advice of the DEC. 4. The methodology of the survey required in condition 11-1(3) shall be prepared in consultation and to the satisfaction of the DEC. 5. Within 18 months of mining commencing the proponent will develop completion criteria for rehabilitation to the requirements of the CEO on advice from the DEC. 6. The percentage cover 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 and species diversity as demonstrated by other methodology acceptable to the CEO. 7. 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. 8. The 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.	**11-1 (2) Compliant** Refer to Condition 11-1 (1) and the Rehabilitation Plan, appended to the PEMP, which was prepared and agreed with DBCA on 28 January 2011. **11-1 (3) Compliant** A baseline vegetation survey was conducted on 19 October 2011 in communities identified to be impacted by the Proposal to collect information for the setting of completion criteria for rehabilitation. This report was completed by Mattiskee Consulting Pty Ltd and appended to the 2013 CAR. **11-1 (4) Compliant** The Rehabilitation Plan, appended to the PEMP, was prepared and agreed with DBCA on 28 January 2011. **11-1 (5) Compliant** The Rehabilitation Plan, appended to the PEMP, was prepared and agreed with DBCA on 28 January 2011 and addressed completion criteria for rehabilitation. **11-1 (6) Compliant** Rehabilitation monitoring including the calculation of percentage cover of living self-sustaining native vegetation in all rehabilitation areas as per Condition 11-1.6 was completed by Astron between October - November 2020. Generally, and in light of the second year of dry conditions, the percentage foliar cover at rehabilitation sites are progressing towards analogue sites. Three sites continue to perform poorly within the Road Infrastructure domain and the contingency measures advised in the Carina and J4 Weed Assessment document (December 2019) are required to be continued. **11-1 (7) Compliant** Polaris is committed to the ongoing monitoring and control of weed populations through the annual Rehabilitation Monitoring and no new weed species were detected in this monitoring period. *Sonchus asper* was the only weed species to be recorded at the WRL rehabilitation sites	

		in both 2019 and 2020. This species was also recorded in 2018 and has been recorded at Carina previously; therefore, condition 11-1.7 of MS 852 has been met. **11-1 (8) Compliant** There was no change in weed cover between 2019 and 2020, but weed abundance increased, although not significantly. Therefore, compliance with condition 11-1.8 of MS 852 has been met. Weed control activities should continue in an effort to reduce weed populations that may impact on successful vegetation establishment.	
11-2	The proponent shall monitor progressively the rehabilitation for a range of sites against the criteria developed pursuant to condition 11-1(5) with appropriately timed surveys as agreed with the DEC, until the completion criteria are met. The surveys shall be conducted annually unless otherwise agreed by the CEO, on advice from the DEC.	**Compliant** The rehabilitation plan was prepared and agreed with DEC on 28 January 2011 and it addressed completion criteria for rehabilitation. A revised Carina / J4 MCP was submitted to DMIRS on 03 May 2019. The document is not yet approved. Since the 2016 reporting period, Rehabilitation monitoring has been completed annually at the Project.	Mine Plan and Preliminary Closure Strategy (2013-0000154701). Carina Rehabilitation Monitoring Report 2020 (Appendix 2).
11-3	The proponent shall include the results of the rehabilitation monitoring required pursuant to condition 11-2 in the compliance assessment report referred to in condition 4-6 commencing from the date rehabilitation was commenced. The report shall address the following: 1. The progress made towards meeting the completion criteria developed pursuant to condition 11-1(5); and 2. Contingency management measures in the event that the completion criteria required by condition 11-1(5) are unlikely to be met.	**Compliant** Rehabilitation sites are generally progressing towards achieving the compliance criteria. The continuation of contingency measures from the Carina and J4 Weed Assessment document (December 2019) are required for three under-performing Road Infrastructure sites.	Carina Rehabilitation Monitoring Report 2020 (Appendix 2). Ongoing weed management is undertaken in accordance with the Carina and J4 Weed Assessment document, dated 6 December 2019 (Appendix 6).
11-4	The proponent shall make the monitoring reports required by condition 11-2 publicly available in a manner approved by the CEO.	**Compliant** Carina Rehabiliation Monitoring Report is provided as (Appendix 2) and this CAR will be made publicly available via the MRL website.	
12 Conceptual Closure Strategy			
12-1	Prior to construction of the waste dump, the proponent shall submit a detailed and project-specific Mine Plan and Preliminary Closure Strategy to the requirements of the CEO on advice of the DMP and DEC.	**Compliant** A MCP was submitted to the DMIRS in June 2013 prior to construction of the waste dump and it was subsequently approved in September 2013.	Mine Plan and Preliminary Closure Strategy (2013-0000154701) submitted in 2011. Mine Closure Plan submitted in 2013. OEPA approval letter (2014-0000885791).

		The 2013 MCP superseded the Mine Plan and Preliminary Closure Strategy (MPPCS) report that was submitted to CEO on 22 February 2011.	
12-2	The Mine Plan and Preliminary Closure Strategy shall include detailed results of geochemical and geophysical characterisation of materials, in particular the potential for acid drainage, metalliferous drainage, and of the occurrence of dispersive materials and asbestiform minerals. Testing for materials with potential to cause acid and/or metalliferous drainage shall include static and kinetic testing carried out using techniques and timeframes consistent with national and international standards (Leading Practice Sustainable Development Program for the Mining Industry – Managing Acid and Metalliferous Drainage 2009 – Department of Industry, Tourism and Resources; The Global Acid Rock Drainage Guide 2009 – International Network for Acid Prevention).	**Compliant** Refer to Condition 12-1. Additional waste characterisation was undertaken in the 2017 reporting period and attached as an Appendix to the 2017 CAR.	Mine Closure Plan submitted in 2013. OEPA approval letter (2014-0000885791).
12-3	The Mine Plan and Preliminary Closure Strategy shall provide detailed technical information on proposed management measures to prevent pollution, environmental harm or human health impacts during implementation of the proposal and after mine completion and closure.	**Compliant** Refer to Condition 12-1.	
12-4	The Mine Plan and Preliminary Closure Strategy shall include maps and diagrams showing the proposed placement, dimensions, design and proposed methods of construction and closure of waste disposal facilities, mine pits and evaporation pond.	**Compliant** Refer to Condition 12-1.	
12-5	The Mine Plan and Preliminary Closure Strategy shall demonstrate that waste disposal facilities will be located, designed and constructed to ensure that they are non-polluting and so that their final shape, height, stability and ability to support native vegetation are comparable to natural landforms in the area.	**Compliant** Refer to Condition 12-1.	
12-6	The proponent shall implement the Mine Plan and Preliminary Closure Strategy referred to in conditions 12-1 to 12-5.	**Compliant**	
12-7	The proponent shall make the Mine Plan and Preliminary Closure Strategy referred to in conditions 12-1 to 12-5 publicly available in a manner approved by the CEO.	**Compliant** Documents are available upon request.	
13 Final Closure and Decommissioning Plan			
13-1	At least 3 years prior to mine completion, the proponent shall prepare and submit a Final Closure and Decommissioning Plan to the requirements of the CEO, on advice of the DEC and DMP.	**Compliant** Refer to Condition 12-1. A Final Closure and Decommissioning Plan was approved by DMIRS in 2018. A revised Carina / J4 MCP was submitted to DMIRS on 03 May 2019. The document is not yet approved.	Mine Closure Plan (2019) still under review
13-2	The Final Closure and Decommissioning Plan shall be prepared consistent with: 1. 1 ANZMEC/MCA 2000, Strategic Framework for Mine Closure Planning; and 2. Department of Industry Tourism and Resources 2006 Mine Closure and Completion (Leading Practice Sustainable Development Program for the Mining Industry), Commonwealth Government, Canberra;	**Compliant** Refer to Condition 13-1.	
13-3	The Final Closure and Decommissioning Plan shall provide detailed technical information on the following: 1. Final closure of all areas disturbed through implementation of the proposal so that they are safe, stable and non-polluting. 2. Details of a monitoring program to be carried out to inform final closure procedures for the pit void such that the standing water body does not cause environmental harm by: o attracting native fauna which may be subsequently harmed; or o attracting fauna which may harm native fauna populations and/or surrounding native vegetation.	**Compliant** Refer to Condition 13-1.	

	3. Management actions to be undertaken based on the findings under condition 13-3(2). 4. Decommissioning of all plant and equipment. 5. Disposal of waste materials. 6. Final rehabilitation of: o the minesite including waste material landforms and other areas outside the mine pit; and o the haul road and accommodation facilities. 7. Management and monitoring following mine completion. 8. Inventory of all contaminated sites and proposed management.		
13-4	The proponent shall make the Final Closure and Decommissioning Plan required by conditions 13-1 to 13-3 publicly available in a manner approved by the CEO.	**Compliant** Available on request and through DMIRS online systems.	
13-5	The proponent shall close, decommission and rehabilitate the proposal in accordance with the Final Closure and Decommissioning Plan required by conditions 13-1 to 13-3.	**Compliant** A revised Carina / J4 MCP was submitted to DMIRS on 03 May 2019. The document is not yet approved.	Carina Rehabilitation Monitoring Report 2020 (Appendix 2).

3. NOTIFICATION OF NON-COMPLIANCES AND POTENTIAL NON-COMPLIANCES

No non-compliances or potential non-compliances were identified in this reporting period.

4. CORRECTIVE AND PREVENTATIVE ACTIONS TAKEN

No corrective or preventative actions are required subsequent to no non-compliance or potential non-compliances in this period.

5. PROPOSED CHANGES TO THE COMPLIANCE ASSESSMENT PLAN

No changes to the Compliance Assessment Plan are currently proposed.

6. REFERENCES

EPA (2011) Ministerial Statement 852: Carina Iron Ore Mine. Statement published 28 January 2011, amended 13 December 2013.

EPA (2013) Ministerial Statement 957: Carina Iron Ore Mine. Statement published 11 December 2013.

Polaris Metals Pty Ltd (2010). Public Environmental Review Carina Iron Ore Mine: Yilgarn Region WA. Internal report prepared by Polaris Metals Pty Ltd.

Polaris Metals Pty Ltd (2016). Mining Proposal: Carina Iron Ore Project M77/1244, M77/1261 L15/305, L15/303, L15/306, L15/310, L15/311, G15/21 Yilgarn Region WA. Internal report prepared by Polaris Metals Pty Ltd.

APPENDICES

APPENDIX 1: CARINA FLORA AND VEGETATION MONITORING REPORT 2020

APPENDIX 2: CARINA REHABILITATION MONITORING REPORT 2020

APPENDIX 3 CARINA FAUNA INTERACTION REGISTER 2019-2020

APPENDIX 4: CARINA AND J4 PROJECT ENVIRONMENTAL MANAGEMENT PLAN 2020

APPENDIX 5: CARINA AND J4 PEMP APPROVAL LETTER 2021

APPENDIX 6: CARINA AND JACKSON 4 WEEDS ASSESSMENT 2019

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APPENDIX 1: CARINA FLORA AND VEGETATION MONITORING REPORT 2020

Carina Iron Ore Project
Flora and Vegetation Condition Monitoring
October 2020

Prepared for
Polaris Metals Pty Ltd

Report Reference: 13029-20-BISR-1Rev0_201221

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Carina Iron Ore Project
Flora and Vegetation Condition Monitoring

Prepared for
Polaris Metals Pty Ltd

Job Number: 13029-20

Reference: 13029-20-BISR-1Rev0_201221

Revision Status

Rev	Date	Description	Author(s)	Reviewer
A	03/12/2020	Draft Issued for Client Review	H. Poole S. Moore	A. Gove
0	21/12/2020	Final Issued for Information	H. Poole S. Moore	J. Rouw

Approval

Rev	Date	Issued to	Authorised by	
			Name	**Signature**
A	03/12/2020	T. Netto	B. Lucas	
0	21/12/2020	T. Netto	B. Lucas	

Abbreviations

Abbreviation	Definition
Astron	Astron Environmental Services
Carina	Carina Iron Ore Project
DBCA	Department Biodiversity, Conservation and Attractions
F	Value of F statistic
km	Kilometre
m	Metre
mm	Millimetre
MS	Ministerial Statement
Polaris	Polaris Metals Pty Ltd
P	Priority flora species
p	Probability of rejecting null hypothesis unnecessarily
PERMANOVA	Permutation-based multivariate analysis of variance
ROM	Run of mine (pad)
t	Value of t statistic
'The project'	Carina Iron Ore project

Executive Summary

Polaris Metals Pty Ltd operates the Carina Iron Ore Project, located 100 km north-east of Southern Cross. The mining project is split into two operational areas: the mine infrastructure area ('Northern Operations') and the rail siding area ('Southern Operations'). These areas are connected by a 48 km bituminised haul road. The mining project was approved under Ministerial Statement 852, with condition 5-3 requiring annual vegetation health and condition monitoring.

In 2013 Astron developed a revised monitoring design and program in consultation with Department of Parks and Wildlife (now Department of Biodiversity Conservation and Attractions) to comply with condition 5-3 of Ministerial Statement 852. The project was divided into four areas, with monitoring transects positioned in the 'buffer' zones (potential areas of impact) and in 'analogue' zones (no potential impact). Designated monitoring trees ('marked trees') were also selected at each transect. Monitoring commenced in September 2013 with subsequent monitoring in September 2014, December 2015, December 2016, December 2017, October/November 2018, October 2019 and the current survey in October 2020.

Understorey floristic composition and species richness did not differ significantly between analogue and buffer zones in 2020 for all areas combined. As observed in previous years, the mine area buffer zone had significantly higher species richness than the analogue zone in 2020. No statistically significant decreases in understorey species cover, dust loading, or health were recorded between 2013 and 2020.

No Threatened flora species have been detected in any of the monitoring surveys since 2013. Four Priority flora species, *Melichrus* sp. Coolgardie (K.R. Newbey 8698) Priority 1, *Lepidosperma lyonsii* Priority 1, *Calytrix creswellii* Priority 3 and *Phebalium appressum* Priority 1 were recorded in 2020. No introduced flora (weed) species were recorded during the monitoring survey in 2020, demonstrating compliance with condition 10 of Ministerial Statement 852.

Tree health scores in the buffer zone were significantly lower in 2020 to those in 2013, however no significant difference was detected between analogue and buffer zones in 2020. Tree dust loads in the buffer zone were not significantly different in 2020 to that in 2013, nor was there a significant difference between analogue and buffer zones in 2020.

Compliance with condition 5-3 of Ministerial Statement 852 continues to be maintained, as no impacts to vegetation from mining operations have been detected.

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1 Introduction

The Carina Iron Ore project (the project) is operated by Polaris Metals Pty Ltd (Polaris) and is located approximately 100 km north-east of Southern Cross, in the Goldfields region of Western Australia (Figure 1). Key components of the project are:

- a mine infrastructure area ('Northern Operations'), consisting of a single open-cut pit, waste dump, magazine, two run of mine (ROM) pads, two workshops, office administration complex and associated ancillary infrastructure
- a rail siding area ('Southern Operations'), consisting of a ROM pad, dry crushing and screening plant, a reclaimer, two stackers, train load out facility, workshop, administration complex, haulage workshop and yard, and associated ancillary infrastructure
- a 48 km bituminised haul road, connecting the Northern and Southern Operations
- an accommodation village located approximately 3 km north of the Southern Operations, with a powerline corridor and access road directly between the rail siding area and the accommodation village (Figure 1).

The project was assessed by Report 1368 (Environmental Protection Authority 2010) and approved under Ministerial Statement (MS) 852 on 27 January 2011. Conditions related to vegetation condition are summarised in Table 1.

Table 1: Ministerial statement 852 conditions relevant to vegetation condition.

Condition	
5 – Protection of vegetation	
5-1	The proponent shall implement the proposal so that it does not adversely affect vegetation, in particular S2 and W22 vegetation communities, outside the proposal boundary.
5-3	The proponent shall monitor prior to disturbance and every 12 months the health and condition of vegetation located within 1 kilometre of the proposal boundary.
5-4	Should the potential impact sites show a 25 per cent (or greater) decline in cover or productivity, the proponent shall provide a report to the CEO within 21 days of the decline being identified.
10 – Weeds	
10-1(1)	No new species of weeds (including both declared weeds and environmental weeds) are introduced into the proposal area as a result of the implementation of the proposal.
10-1(3)	Within 12 months of the date of the publication of this statement the proponent shall establish at least three reference sites on undisturbed land (not impacted by the proposal) at each of the mine, haul road, rail siding and accommodation facilities. Reference sites are to be chosen in consultation with the DEC. The reference sites are to be monitored every 2 years to determine whether changes in weed cover and type within and up to 1 kilometre from the Project Boundary are as a result of project implementation or broader regional changes.
10-1(4)	The species and extent of weed cover within the proposal area shall not exceed that identified in the baseline survey identified in 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.

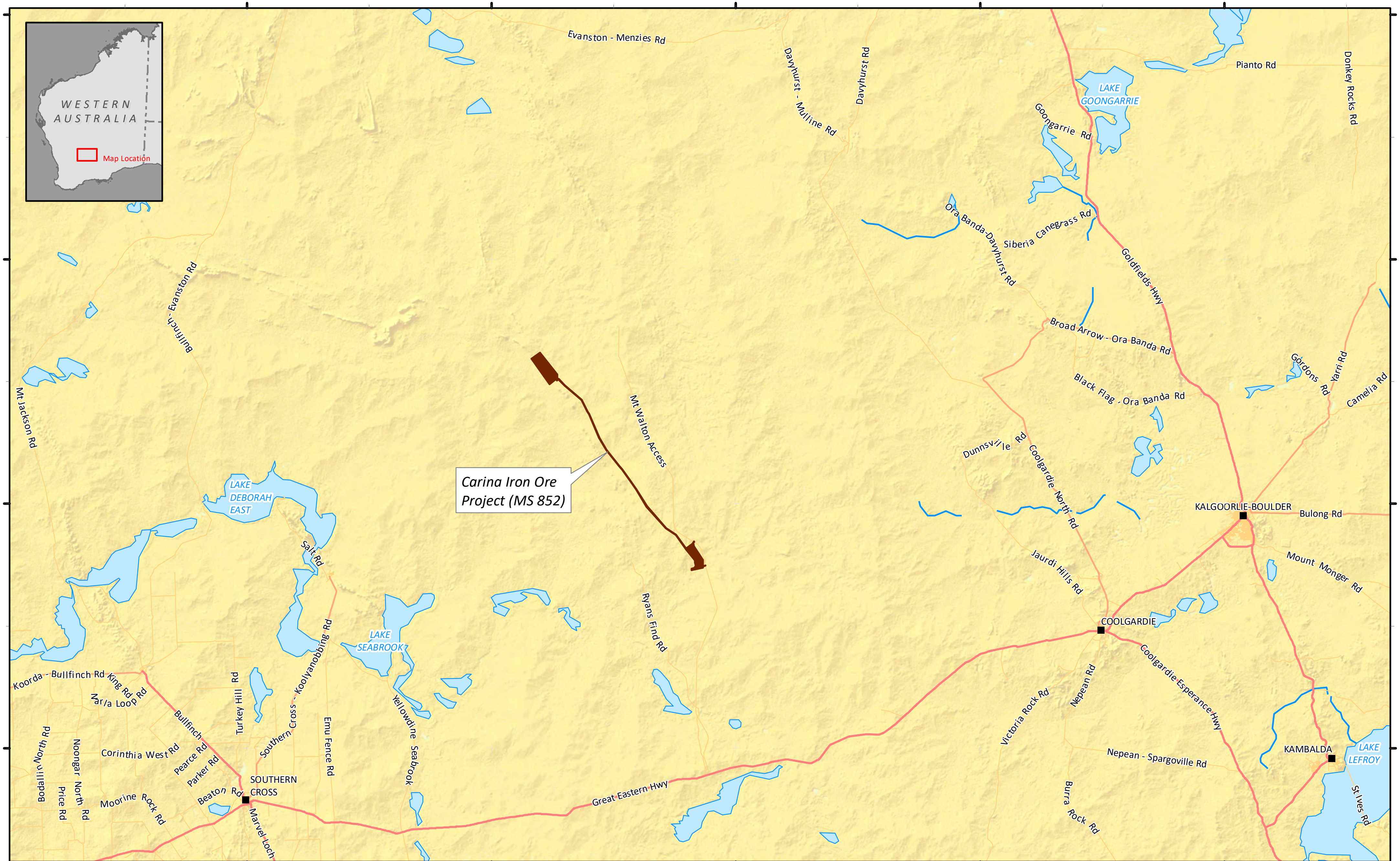
1.1 Background

In 2013, Astron Environmental Services (Astron) developed the *Carina Iron Ore Project Flora and Vegetation Condition Monitoring Plan* in consultation with the Department of Parks and Wildlife (now the Department Biodiversity, Conservation and Attractions (DBCA)) to address the conditions of MS 852 (Astron Environmental Services 2013). The monitoring plan was approved by DBCA and monitoring commenced in September 2013. Annual monitoring was continued by Astron in September 2014, then December 2015, 2016 and 2017, October/November 2018, October 2019 and the current survey in October 2020.

1.2 Scope of Work

Astron was commissioned by Polaris to complete the 2020 Flora and Vegetation Condition Monitoring Program, which includes:

- monitoring 38 monitoring sites located within four areas with different operational activities: accommodation village, haul road, mine and railway siding
- monitor permanently marked trees and tall shrubs adjacent to each site (approximately 10 to 15 species per site)
- preparation of a monitoring report to determine any potential impact to vegetation within the four different areas.



Polaris Metals Pty Ltd

Carina Iron Ore Project – Flora and Vegetation Condition Monitoring, October 2020

Figure 1: Regional location of the Carina Iron Ore project

Coordinate System: GDA 1994 MGA Zone 51

0 10 20 30 40 50 Kilometres

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Author: S. Moore | Drawn: T. Pedersen | Date: 03-12-2020 | Figure Ref: 13029-20-BIDR-1RevA_201203_Carina_Fig01

1.3 Environmental Context

The Carina Iron Ore project is situated within the Southern Cross subregion of the Coolgardie Bioregion (Department of the Environment and Energy 2016). The Southern Cross subregion is described as having a subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills and chains of saline playa-lakes (Cowan 2001).

Vegetation in the Southern Cross subregion is described as diverse eucalypt woodlands (*Eucalyptus salmonophloia, E. salubris, E. transcontinentalis* and *E. longicornis*), rich in endemic eucalypts, which occur around the salt lakes, on the low greenstone hills, valley alluvials and broad plains of calcareous earths. The salt lakes support dwarf shrublands of samphire. The granite basement outcrops at mid-levels in the landscape and supports swards of *Borya constricta*, with stands of *Acacia acuminata* and *E. loxophleba*. Upper parts of the landscape are the eroded remnants of a lateritic duricrust yielding sandplains and breakaways. Mallee (*E. leptopoda, E. platycorys* and *E. scyphocalyx*) and scrub-heath (*Allocasuarina corniculata, Callitris preissii, Melaleuca uncinata* and *A. beauverdiana*) occur on these uplands, as well as on sand lunettes associated with playas along the broad valley floors and sand sheets around the granite outcrops. The scrubs are rich in endemic acacias and Myrtaceae (Cowan 2001).

Vegetation mapping by Mattiske (2008a, 2008b, 2009, 2010) describes 68 vegetation units across the project area and exploration tenements. Of these, nine vegetation units were associated with the vegetation monitoring program (Table 2).

Table 2: Vegetation unit mapping (Mattiske Consulting 2008b, 2008a, 2009, 2010) associated with the vegetation monitoring program.

Vegetation code	Vegetation community description	Landform description
S12	Scrub (fire disturbed) of *Allocasuarina corniculata* and occasional mixed Eucalypt species over *Melaleuca cordata, Euryomyrtus maidenii* and mixed shrubs over *Triodia desertorum*	Yellow sandy soils on gently undulating plains
S30	Open low woodland to low woodland of *Eucalyptus horistes* and *E. leptopoda* subsp. *subluta* over occasional *Callitris preissii* and *Allocasuarina spinosissima* over *Beyeria brevifolia, B. sulcata, Leucopogon* sp. Coolgardie (M. Hislop & F. Hort MH 3197) and mixed shrubs over *Triodia scariosa*	Yellow sandy soils on flats
S31	Mosaic of open scrub to scrub of *Acacia resinimarginea, Callitris preissii* and occasional *Allocasuarina spinosissima* with occasional emergent *Eucalyptus horistes* and *E. leptopoda* subsp. *subluta* over *Leptospermum fastigiatum* and *Melaleuca hamata* over *Phebalium canaliculatum, P. filifolium, Micromyrtus monotaxis* and mixed shrubs over *Triodia scariosa*	Lateritic yellow sandy soils on lower to mid-slopes
S32	Scrub of *Acacia resinimarginea* with occasional *Callitris preissii* and occasional emergent *Eucalyptus leptopoda* subsp. *subluta* over *Leptospermum fastigiatum, Melaleuca hamata, Phebalium canaliculatum, P. filifolium* and mixed shrubs	Lateritic yellow sandy soils on flats and lower slopes

Vegetation code	Vegetation community description	Landform description
W1	Woodland of *Eucalyptus salmonophloia, E. salubris, E. sheathiana, E. corrugata, E. yilgarnensis, E. transcontinentalis, E. longicornis* and *E. ravida* over *Acacia jennerae, A. prainii, A. colletioides, Santalum acuminatum, Exocarpos aphyllus, Eremophila scoparia, E. granitica, E. ionantha, Senna artemisioides* subsp. *filifolia* and *Atriplex nummularia* over *A. vesicaria, Grevillea acuaria, Olearia muelleri, O. pimelioides and Austrostipa elegantissima*	Red-brown clay on flats
W2	Woodland of *Eucalyptus salmonophloia* with *E. ravida* and mixed Eucalypts over *Eremophila ionantha, Exocarpos aphyllus, Atriplex nummularia* and *Acacia colletioides* over *A. vesicaria*	Flat red clay soils
W12	Open Woodland of *Eucalyptus sheathiana, E. salubris, E. loxophleba* subsp. *lissophloia, E. ravida* and *E. salmonophloia* over *Acacia burkittii, Eremophila ionantha, Senna artemisioides* subsp. *filifolia* and *A. colletioides* over *Grevillea acuaria*	Red-brown clay to sandy-clay on flats with scattered ironstone pebbles
W22	Open Low Woodland of *Eucalyptus corrugata* with mixed *Eucalyptus* spp. over *Allocasuarina campestris* and *Acacia burkittii* over *Alyxia buxifolia, Philotheca brucei* subsp. *brucei* and *Isopogon gardneri* over *Scaevola spinescens* and *Olearia muelleri*	Red-brown clay soils on mid and lower slopes
W45	Low woodland of *Eucalyptus horistes* and *Eucalyptus oleosa* subsp. *oleosa* with occasional *Callitris preissii* over mixed shrubs over *Triodia scariosa*	Yellow sandy soils on flats

2 Methods

2.1 Monitoring Design

The design and execution of this monitoring program follows the approved *Carina Iron Ore Project Flora and Vegetation Condition Monitoring Plan* (Astron Environmental Services 2013). The project area was divided into four areas with different operational activities: accommodation village, haul road, mine and railway siding. In each of the four areas, two or more pairs of monitoring transects ('blocks') were established.

In 2013, 18 blocks were established, forming the framework of the monitoring program. Each block includes one monitoring transect in the 'buffer' zone (potential area of impact) and another in the 'analogue' zone (no potential impact). Each transect within a block lies within the same vegetation unit (according to mapping completed by Mattiske Consulting (2008b, 2009, 2010)) and was located to maximise similarity in total cover and relative abundance of species within the block. Each transect is 20 m long and 2 m wide and consists of 10 contiguous 2 m by 2 m quadrats. To monitor overstorey species, permanently marked trees and tall shrubs adjacent to transects ('marked trees') were photographed.

In 2014, a new block (block 19) was established in the mine area to identify any potentially significant trends in flora and/or vegetation condition that could be attributed to altered surface water flow due to the construction of a bund around the office building at the Northern Operations. In addition, one of the transects in the mine area (M-7-B (W2) was re-established in 2014 due to operational activities. However in 2018, this transect was disturbed as a result of mining operational activities and as such transects M-7-B (W2) and its respective analogue site M-7-A (W2) (block 7) are no longer monitored. One other transect, RS-14-B (S31), was not assessed for the fourth consecutive year due to fire related impacts from 2017 (Plate 1). There were signs of re-growth in 2020, however this primarily consisted of annual species and short lived perennial species (Plate 2).

Plate 1: Transect RS-14-B in 2017 showing fire damage (Astron Environmental Services 2017).

Plate 2: Transect RS-14-B in 2020 showing signs of regrowth from the fire in 2017.

Table 3: Location of vegetation monitoring transects. UTM coordinates set in GDA94 Zone 50.

Area	Vegetation unit	Block	Transect	Zone	Easting	Northing
Accommodation Village	S12	1	AV-1-B (S12)	Buffer	815677	6590247
			AV-1-A (S12)	Analogue	815758	6590171
		2	AV-2-B (S12)	Buffer	815728	6589894
			AV-2-A (S12)	Analogue	815885	6589833
Haul Road	W1	3	HR-3-B (W1)	Buffer	802053	6605677
			HR-3-A (W1)	Analogue	801978	6605627
		4	HR-4-B (W1)	Buffer	802175	6605945
			HR-4-A (W1)	Analogue	802287	6606065
Mine	W2	5	M-5-B (W2)	Buffer	789640	6625675
			M-5-A (W2)	Analogue	789770	6625690
		6	M-6-B (W2)	Buffer	788866	6626175
			M-6-A (W2)	Analogue	788966	6626284
		7	^M-7-B (W2)	Buffer	786576	6626718
			^M-7-A (W2)	Analogue	786221	6626720
		8	M-8-B (W2)	Buffer	787845	6627643
			M-8-A (W2)	Analogue	787867	6627761
	W22	9	M-9-B (W22)	Buffer	788188	6627139
			M-9-A (W22)	Analogue	788374	6627288
		10	M-10-B (W22)	Buffer	787491	6627500
			M-10-A (W22)	Analogue	787542	6627788
Railway Siding	S30	11	RS-11-B (S30)	Buffer	817377	6586518
			RS-11-A (S30)	Analogue	817486	6586522
		12	RS-12-B (S30)	Buffer	817385	6586364
			RS-12-A (S30)	Analogue	817486	6586407
	S31	13	RS-13-B (S31)	Buffer	815623	6586376
			RS-13-A (S31)	Analogue	815515	6586349
		14	^RS-14-B (S31)	Buffer	815666	6586156
			RS-14-A (S31)	Analogue	815537	6586128
	S32	15	RS-15-B (S32)	Buffer	814876	6585017
			RS-15-A (S32)	Analogue	814753	6584998
		16	RS-16-B (S32)	Buffer	814889	6585123
			RS-16-A (S32)	Analogue	814802	6585094
	W45	17	RS-17-B (W45)	Buffer	817318	6585730
			RS-17-A (W45)	Analogue	817410	6585715
		18	RS-18-B (W45)	Buffer	817394	6586155
			RS-18-A (W45)	Analogue	817471	6586125
Mine	W12	19	M-19-B (W12)	Buffer	789247	6625428
			M-19-A (W12)	Analogue	789427	6625136

^ Transects not assessed in 2020.

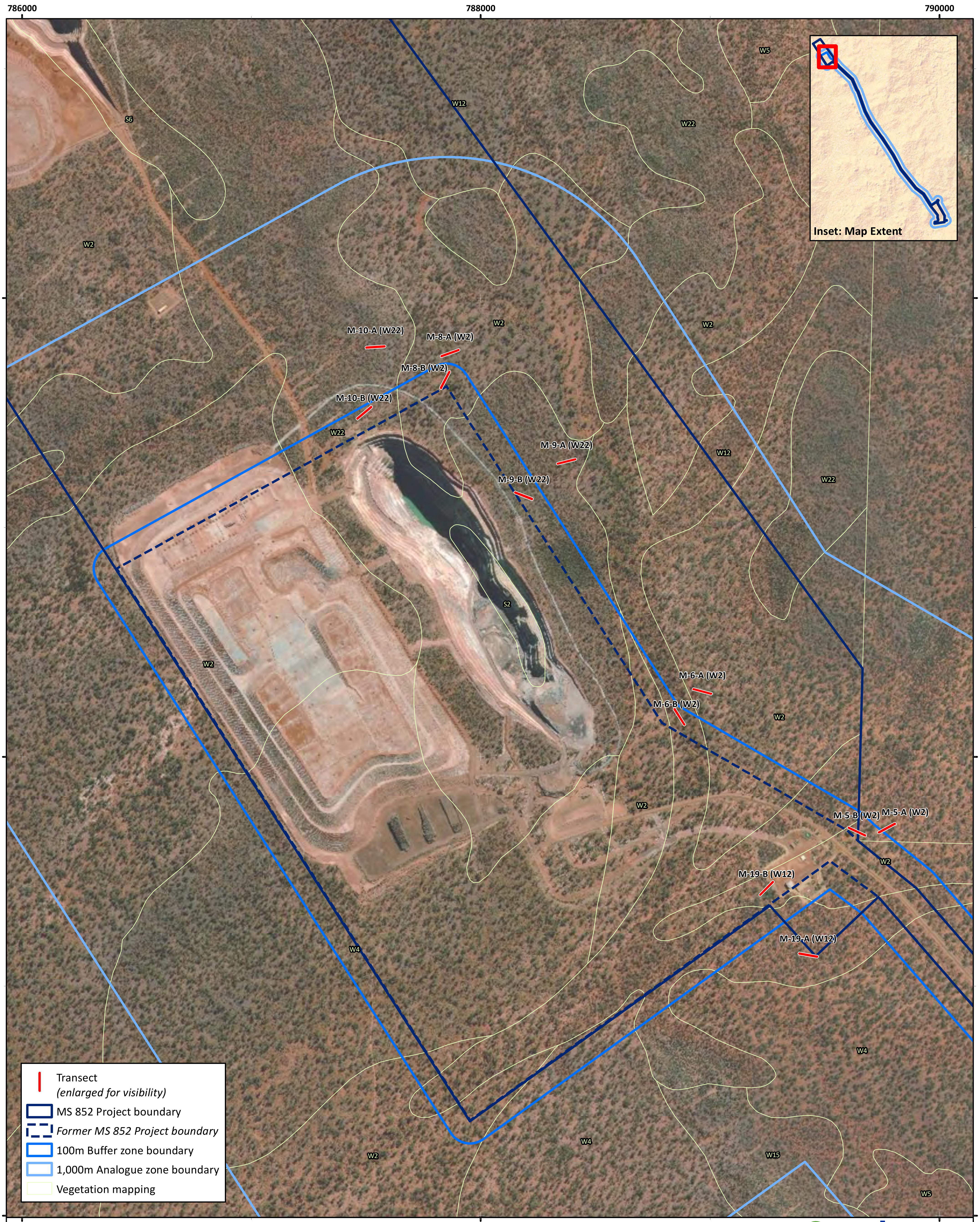

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Figure 2: Transect locations within the project boundary and Ministerial Condition reference areas (Northern Operations)

Author: S. Moore	Date: 25-11-2020	Coordinate System: GDA 1994 MGA Zone 50
Drawn: T. Pedersen	Figure Ref: 13029-20-BIDR-1RevA_201125_Carina_Fig02	0 200 400 600 800 1,000 Metres N

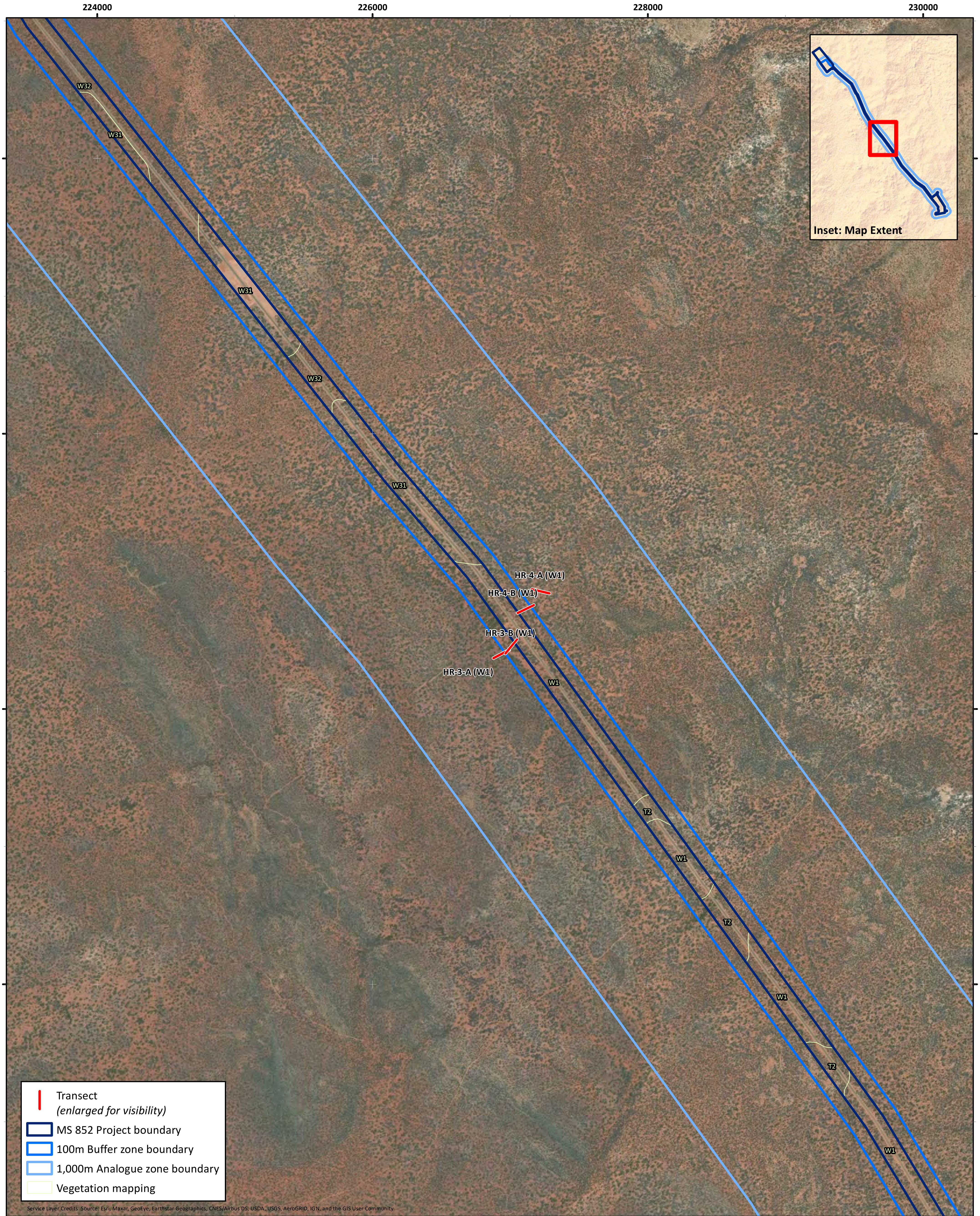

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Figure 3: Transect locations within the project boundary and Ministerial Condition reference areas (Haul Road)

Author: S. Moore	Date: 25-11-2020	Coordinate System: GDA 1994 MGA Zone 51
Drawn: T. Pedersen	Figure Ref: 13029-20-BIDR-1RevA_201125_Carina_Fig03	Metres 0 500 1,000 1,500 2,000

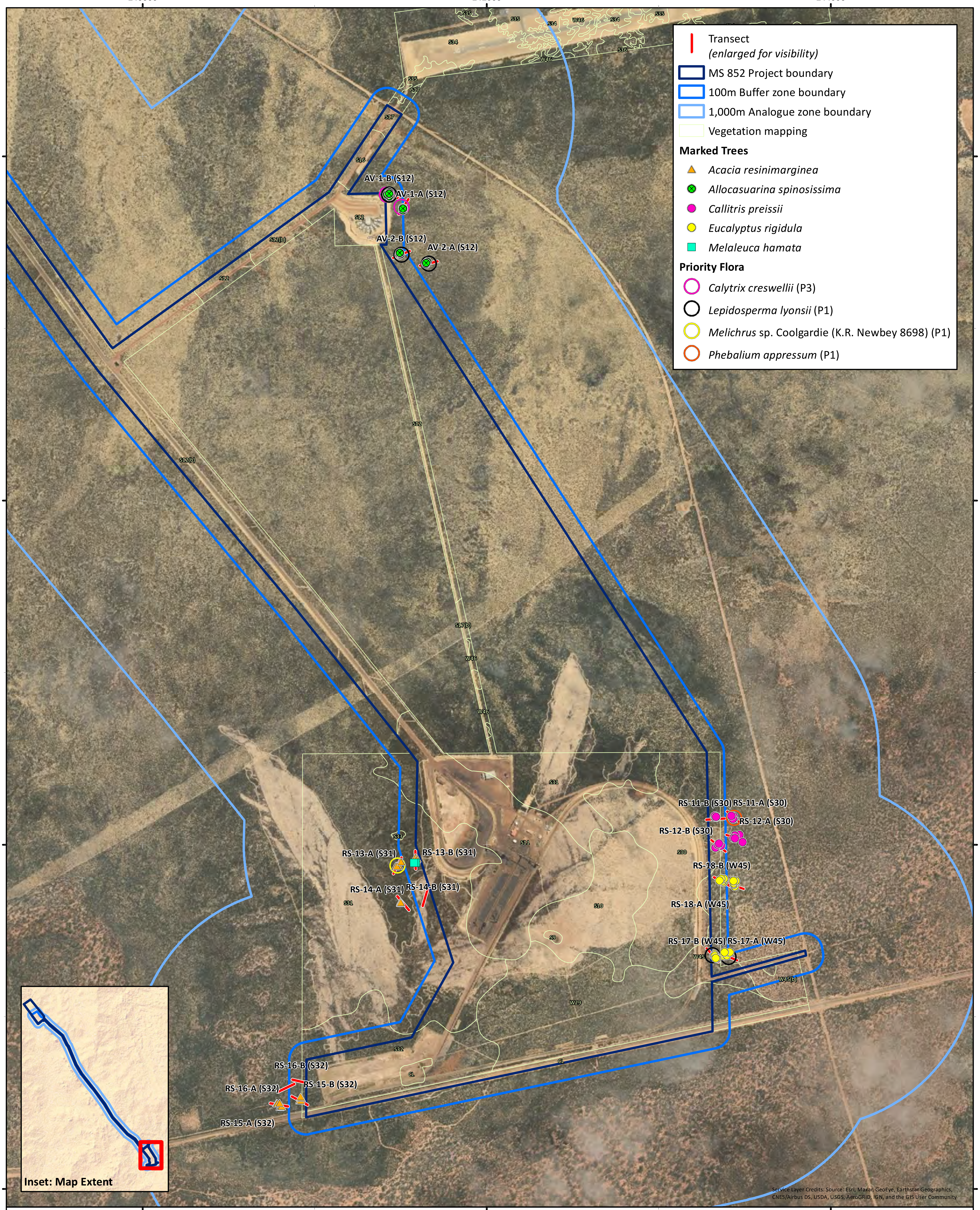

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Figure 4: **Transect locations, marked trees and priority flora locations within the project boundary and Ministerial Condition reference areas (Southern Operations)**

Author: S. Moore	Date: 25-11-2020	Coordinate System: GDA 1994 MGA Zone 51
Drawn: T. Pedersen	Figure Ref: 13029-20-BIDR-1RevA_201125_Carina_Fig04	0 250 500 750 1,000 Metres

2.2 Field Assessment

The 2020 monitoring was conducted between 13 to 22 October by Astron Environmental Scientists Holly Poole and Josh Collard.

Monitoring was undertaken according to the approved Carina Iron Ore Project Flora and Vegetation Condition Monitoring Plan (Astron Environmental Services 2013). All perennial plants in a 2 m by 2 m quadrat, excluding overstorey species that would generally grow to more than 1.5 m in height, were identified to species or subspecies (taxa) level. For each taxon in a quadrat, percentage cover was visually estimated to the nearest 1%, and dust and plant health scores were recorded (Appendix A). The presence of any conservation significant flora or weed species in transects was recorded.

To monitor overstorey species, permanently marked trees and tall shrubs adjacent to transects ('marked trees') were photographed. These marked trees belong to five common species: *Allocasuarina spinosissima*, *Callitris preissii*, *Acacia resinimarginea*, *Eucalyptus rigidula*, and *Melaleuca hamata*. There were 10 to 15 plants per species in both the buffer and analogue zones. To ensure that photographs amongst years were comparable, photographs were taken at a fixed peg associated with each marked tree. For each marked tree, the dust and health scores were also recorded (Appendix A). The protocol for taking photographs of the marked trees is detailed in Appendix B.

2.3 Data Management and Analysis

Data was recorded electronically using smart phones operating the Fulcrum database. A standardised process of quality control was then applied to the data upon return from the field.

Using permutation-based multivariate analysis of variance (PERMANOVA), differences between the analogue and buffer zones, between 2013 (pre-impact baseline) and 2020 were compared using the following factors: time (year) and treatment (analogue, buffer). Data for each of the four areas (accommodation village, haul road, mine and railway siding) were also analysed separately. Variables tested were:

- floristic composition (species and cover) of understorey species
- native species richness of understorey species
- mean native cover of understorey species
- the mean dust score of understorey species and marked trees
- the mean health score of understorey species and marked trees.

Prior to analysis of floristic composition, the percentage foliar cover of each species in each quadrat was square-root transformed and similarity between each pair of transects was calculated using Bray-Curtis similarity index. For all other variables, Euclidian distance was calculated. Data from the entire project area was analysed first. To test for differences in site level species compositional changes between 2013 and 2020, a dendrogram was produced, based upon the Bray Curtis similarity index. The Simprof test was then used to detect significant clusters of sites based on their species composition. All data analysis was performed in Primer (Anderson et al. 2008).

The accommodation village and haul road consist of a very small sample size (only two blocks in each area). Therefore, analyses focused on these zones would only detect quite large effect sizes.

3 Results and Discussion

3.1 Seasonal Conditions

Due to inconsistencies with data collected at many of the weather stations situated around the Carina area, daily rainfall observations were taken from Koolyanobbing weather station (number 12227) to quantify local rainfall preceding the monitoring (Figure 5). Seasonal conditions at the time of the field survey were average with 72.6 mm of rain recorded in the three months prior to the survey (Bureau of Meteorology 2020). This is slightly above the long-term mean of 72.2 mm for the same period. In the 12 months preceding the field survey, rainfall was slightly below average at 243 mm compared to the long-term mean of 285 mm. February had the highest rainfall for the year with 95.6 mm of rain recorded, 60.2 mm higher than the long-term mean.

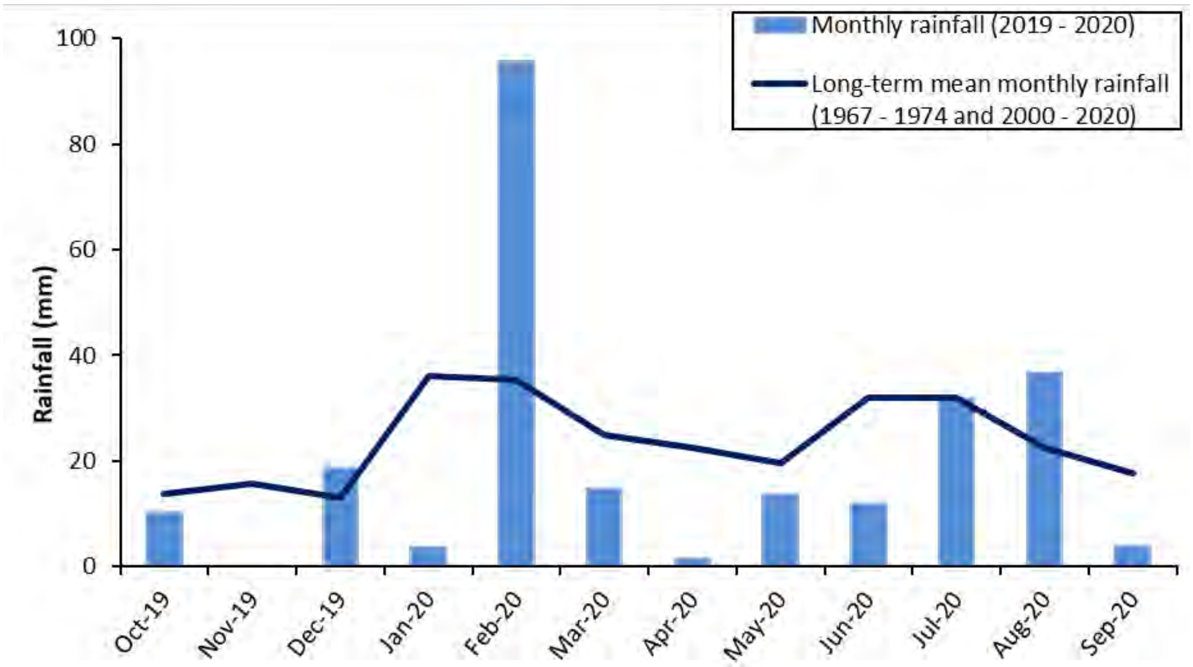


Figure 5: Monthly rainfall recorded 12 months preceding the field survey (from October 2019 to September 2020) and the long-term mean monthly rainfall (1967 to 1974, and 2000 to 2020). Data obtained from Bureau of Meteorology (2020) Koolyanobbing weather station (number 12227).

3.2 Floristic Composition

A total of 85 confirmed taxa were recorded during the 2020 monitoring survey, compared to 81 in 2019 and 103 in 2018. There were no significant differences in floristic composition between analogue and buffer zones in 2020 (Table 4). Additionally, floristic composition within all transects did not differ significantly between 2013 and 2020 (Pseudo $F_{1,70} = 0.21$, $P = 0.99$, Figure 6). In Figure 6 transects connected by red lines are not significantly different, while groups of transects that are connected by black lines are significantly different ($P < 0.05$). Generally, the paired transects of different years are grouped together by red lines, indicating similar floristic composition between 2013 and 2020.

Table 4: Statistical significance of differences between transects in analogue and buffer zones in 2020. NB: p-values in parentheses and significant results in bold.

Area	F-value (P-value)				
	Floristic composition	Species richness	Cover	Dust score	Health score
All	$F_{1,34}$ = 0.44 (0.94)	$F_{1,29}$ = 0.50 (0.53)	$F_{1,29}$ = 0.07 (0.79)	$F_{1,34}$ = 0.02 (1.00)	$F_{1,34}$ = 0.01 (0.92)
Accommodation Village	$F_{1,3}$ = 0.69 (0.66)	$F_{1,3}$ = 0.20 (1.00)	$F_{1,3}$ = 0.25 (0.67)	$F_{1,3}$ = 0.00 (NA)	$F_{1,3}$ = 0.74 (0.67)
Haul Road	$F_{1,3}$ = 0.95 (0.65)	$F_{1,3}$ = 18 (0.34)	$F_{1,3}$ = 2.59 (0.34)	$F_{1,3}$ = 0.00 (NA)	$F_{1,3}$ = 0.01 (1.00)
Mine	$F_{1,11}$ = 1.05 (0.36)	**$F_{1,11}$ = 6.74 (0.03); buffer higher than analogue**	$F_{1,11}$ = 0.02 (0.85)	$F_{1,11}$ = 0.00 (NA)	$F_{1,11}$ = 0.12 (0.74)
Railway Siding	$F_{1,14}$ = 0.41 (0.77)	$F_{1,9}$ = 0.18 (0.77)	$F_{1,9}$ = 0.43 (0.54)	$F_{1,14}$ = < 0.01 (1.00)	$F_{1,14}$ = 0.27 (0.62)

^ NA Indicates that a P value could not be obtained due to the analogue and buffer zones having identical scores.

3.3 Species Richness and Cover

Native species richness in 2020 was not significantly different between analogue and buffer transects (P = 0.53; Table 4) and was similar or equal in the majority of transects compared to 2019 (Figure 7). Compared to 2013, species richness in 2020 was significantly higher (Pseudo $F_{1,61}$ = 5.72, P = 0.02), however, there was no significant difference between analogue and buffer transects (Pseudo $F_{1,61}$ = 0.34, P = 0.58). Species richness in 2020 within the mine area buffer transects was significantly higher than analogue transects (P = 0.03; Table 4), a trend observed since 2016 (Astron Environmental Services 2016, 2017, 2018, 2019). Average species richness at the buffer transects in 2020 was not significantly different to that of 2013 (t = 0.48, P = 0.84).

Overall, no statistically significant differences in plant cover were recorded between analogue and buffer transects in 2020 (P = 0.79; Table 4) or between 2013 and 2020 (Pseudo $F_{1,61}$ = 0.43, P = 0.51). In previous years it was noted that there had been a general tendency for lower cover values over time, believed to have been influenced by seasonal conditions associated with changes in survey timing (Astron Environmental Services 2019). However, cover values appear to have stabilised between 2019 and 2020 with similar mean vegetation cover recorded (Figure 8).

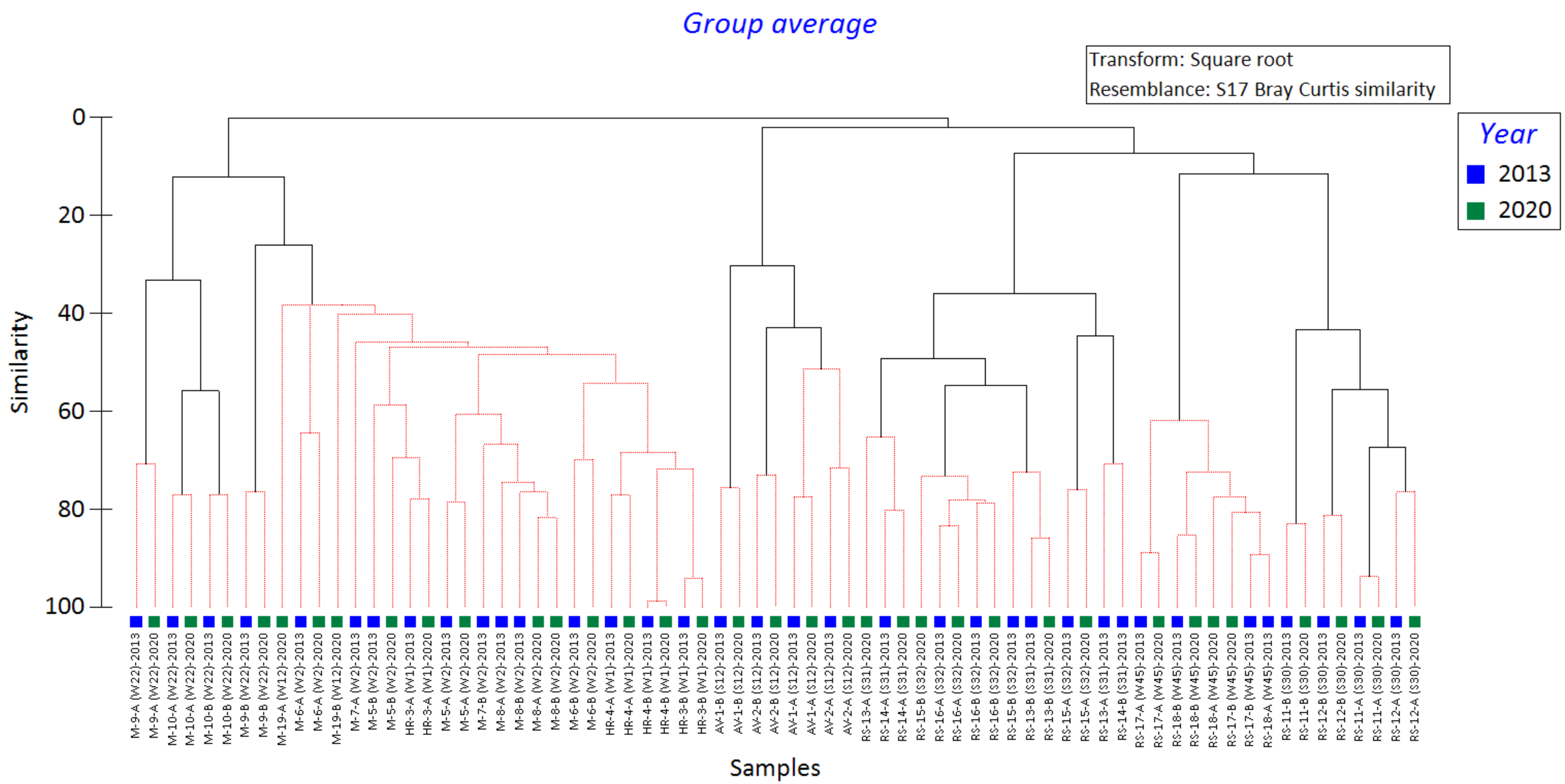
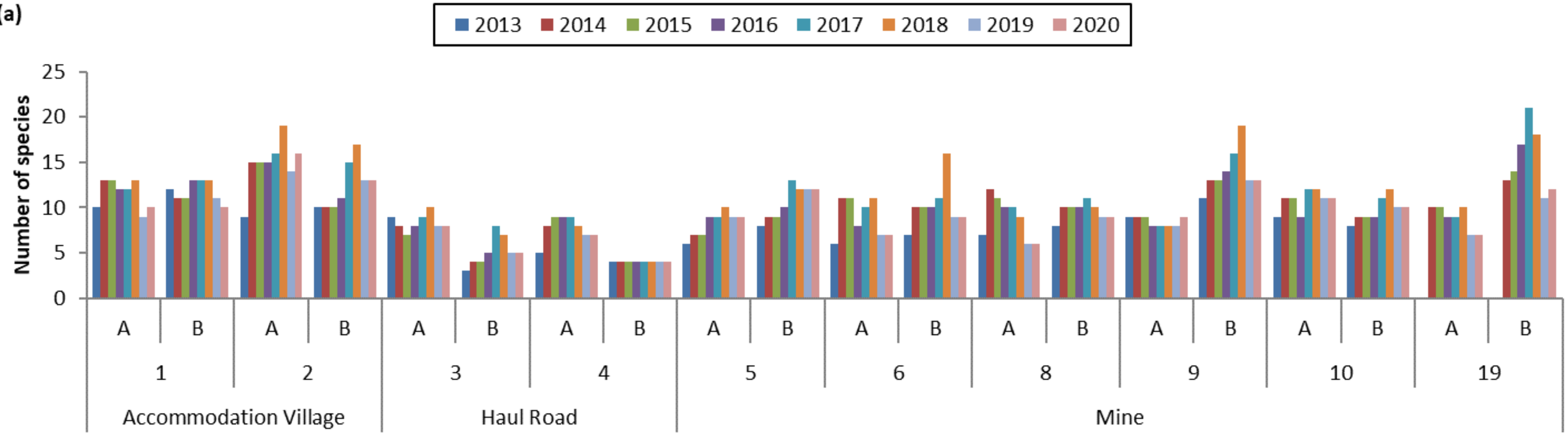


Figure 6: Floristic similarity between 2013 and 2020 at the accommodation village (AV), haul road (HR), mine (M) and railway siding (RS) analogue (A) and buffer (B) zones. Numbers indicate blocks. Pairs of samples connected by a solid black line have significantly different species compositions.

(a)



(b)

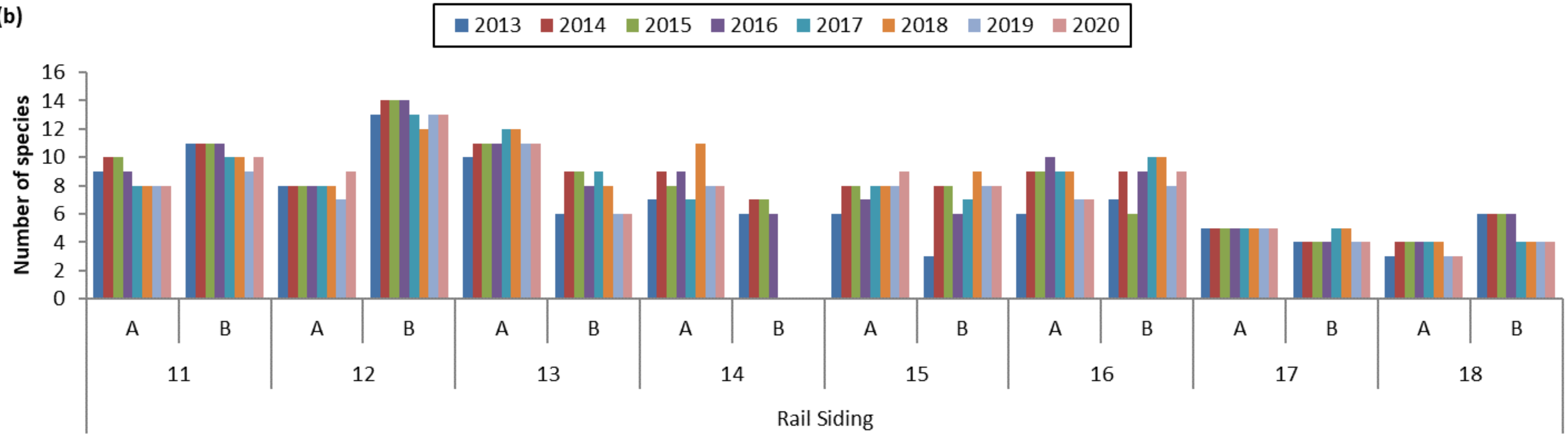


Figure 7: Species richness of understory species between 2013 and 2020 at the (a) accommodation village, haul road and mine area, and (b) rail siding area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

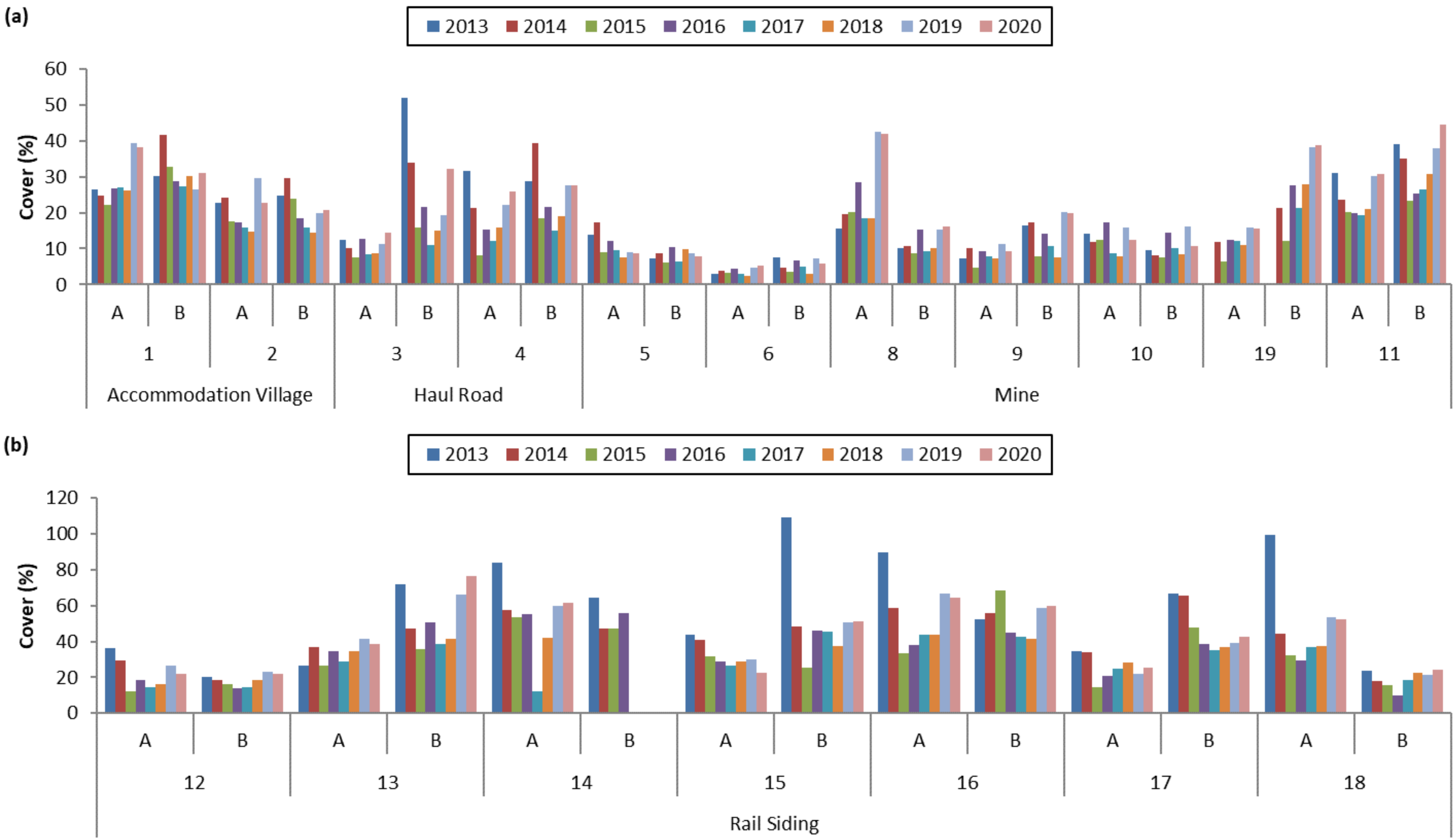


Figure 8: Cover (%) of understorey species between 2013 and 2020 at the (a) accommodation village, haul road and mine area and (b) rail siding area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

3.4 Conservation Significant Flora

No Threatened flora has been recorded since monitoring began in 2013.

Four Priority flora species were recorded in 2020: *Melichrus* sp. Coolgardie (K.R. Newbey 8698) Priority (P) 1, *Calytrix creswellii* P3, *Lepidosperma lyonsii* P1 and *Phebalium appressum* P1. The locations of all Priority flora are presented in Figure 2, Figure 3 and Figure 4. Priority flora species *Phebalium appressum* P1 was misidentified in 2019 as *Micromyrtus erichsenii* which was corrected during the 2020 survey. This species was recorded in 2020 at the same transect in the Rail Siding area RS-11-A (S30) as in all other previous surveys.

Melichrus sp. Coolgardie (K.R. Newbey 8698) P1 represents the northern-most known location of the species (Western Australian Herbarium 2020) and as per 2019 monitoring it was recorded in the railway siding area at transect RS-13-A (S31). *Lepidosperma lyonsii* P1 was recorded in four transects: AV-1-B (S12) and AV-2-B (S12) from block 1 and 2 in the accommodation village area, RS-17-A (W45) and RS-17-B (W45) from block 17 in the railway siding area similar to previous years.

As per 2019 monitoring *C. creswellii* P3 was recorded in both analogue and buffer transects from block 1 in the accommodation village area: AV-1-A (S12) and AV-1-B (S12).

3.5 Weeds

Consistent with the 2019 survey, no weed species were recorded in the 2020 survey. In 2018 one weed species, **Sonchus oleraceus* (common sowthistle), was recorded at two transects: M-9-B (W22) and M-19-B (W12) within the buffer zone of the mine area (Astron Environmental Services 2018). **Sonchus oleraceus* was also recorded at one transect in the buffer zone of the mine area M-9-B (W22) in 2016 and 2017 (Astron Environmental Services 2016, 2017).

3.6 Dust Load and Plant Health

3.6.1 Transects

There was no significant difference in dust load between analogue and buffer transects in 2020 (Table 4). There was negligible or low dust cover on understory vegetation at the majority of transects (Figure 9 to Figure 11). Consistent with 2019, moderate dust loads were again recorded on plants at three transects within the rail siding area: RS-13-A (S31), RS-13-B (S31) and RS-14-A (S31). The two rail siding transects are in close proximity to a fire affected area from 2017 and the higher dust loading may be attributed to the open areas caused by the fire. Higher dust loadings at these transects have been observed since 2017, but diminishing over time (Figure 11). The moderate dust loading did not correspond with declines in plant health at any of the three sites (Figure 12 and Figure 14).

Mean plant health in the buffer transects were not significantly different between 2013 and 2020 ($t = 0.09$, $P = 0.92$; Figure 12 to Figure 14). There was also no significant difference in plant health between analogue and buffer transects in 2020 (Table 4). However in 2020, plants were generally in poorer health than previous years and were mostly recorded in fair and good health at both the buffer and analogue zones (Figure 12 to Figure 14). A larger number of species were observed to be in poor health during the 2020 survey than in 2019. The poorer plant health conditions in 2020 is likely due to long-term impacts from previous poor seasonal conditions (Bureau of Meteorology 2020).

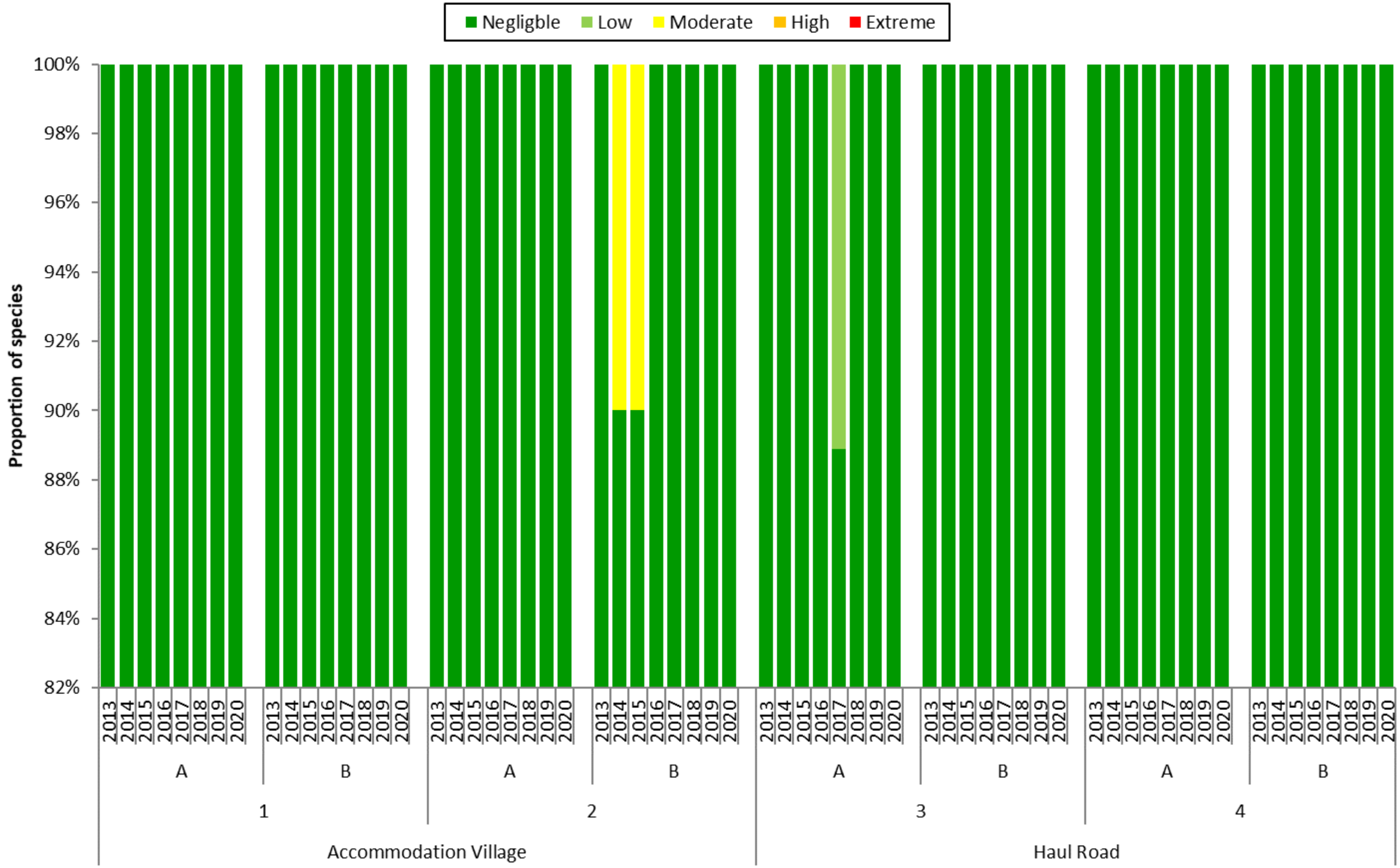


Figure 9: Dust load of understorey species between 2013 and 2020 at the accommodation village and haul road areas analogue (A) and buffer (B) zones. Numbers indicate the blocks.

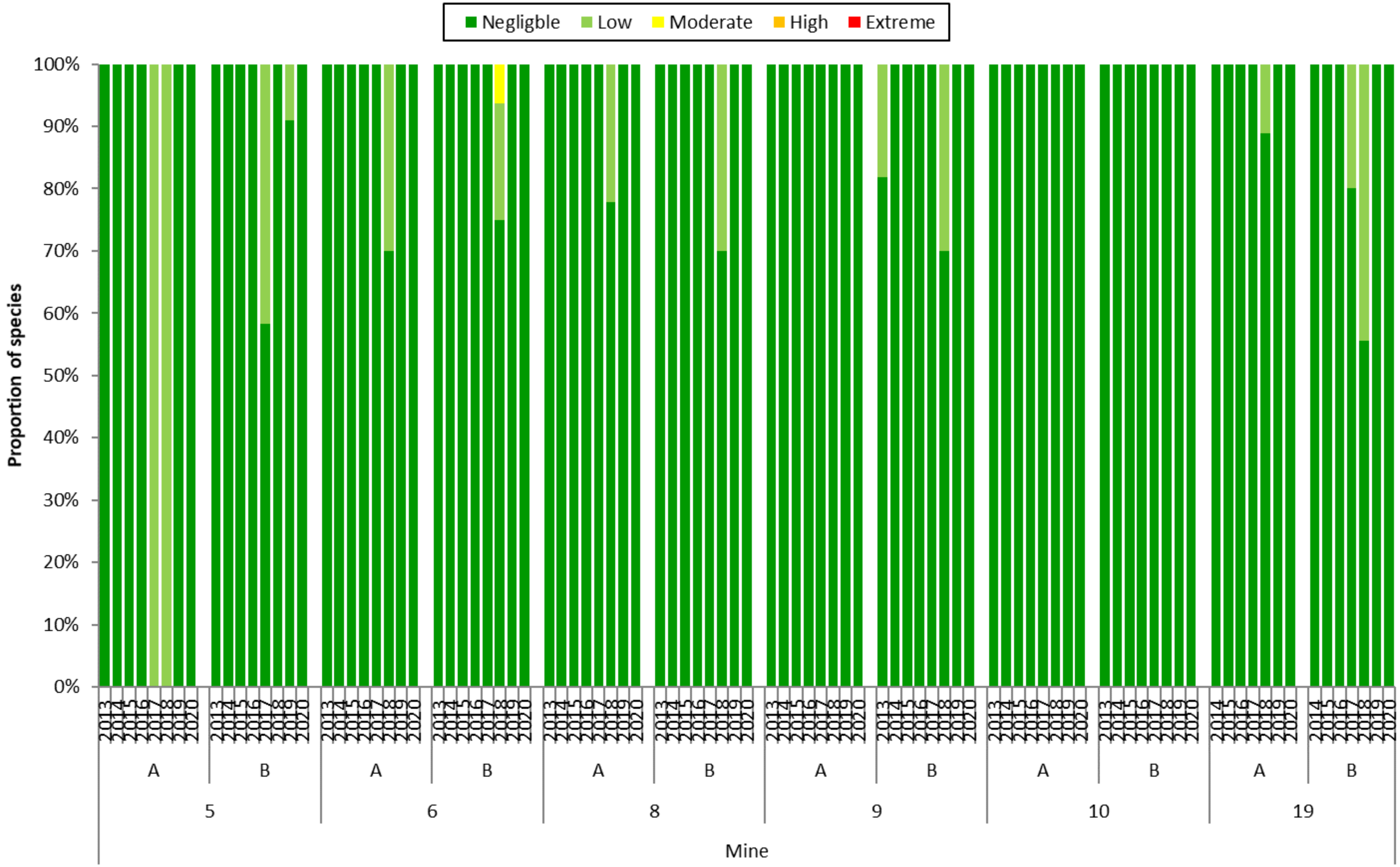


Figure 10: Dust load of understorey species between 2013 and 2020 at the mine area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

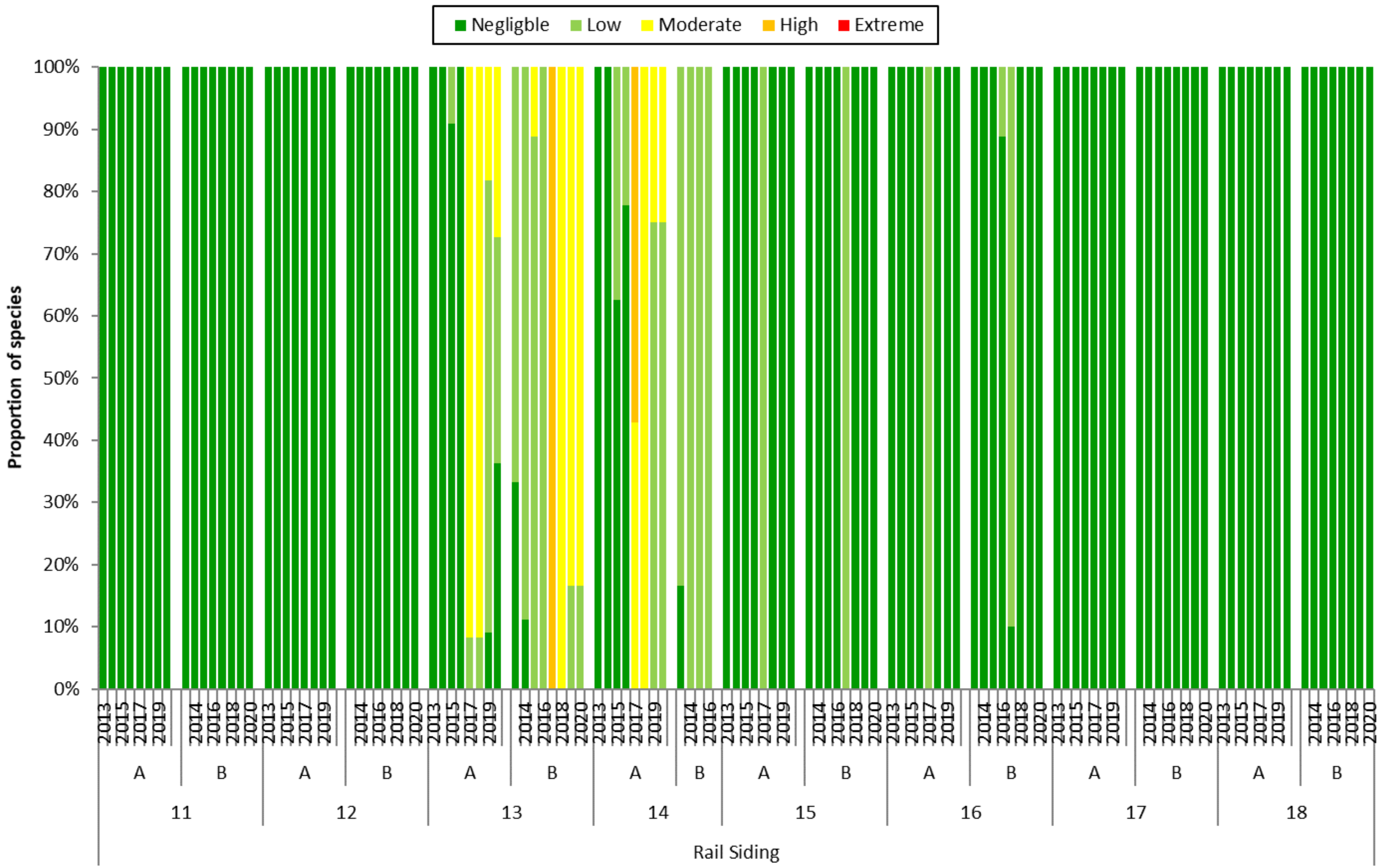


Figure 11: Dust load of understorey species between 2013 and 2020 at the rail siding area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

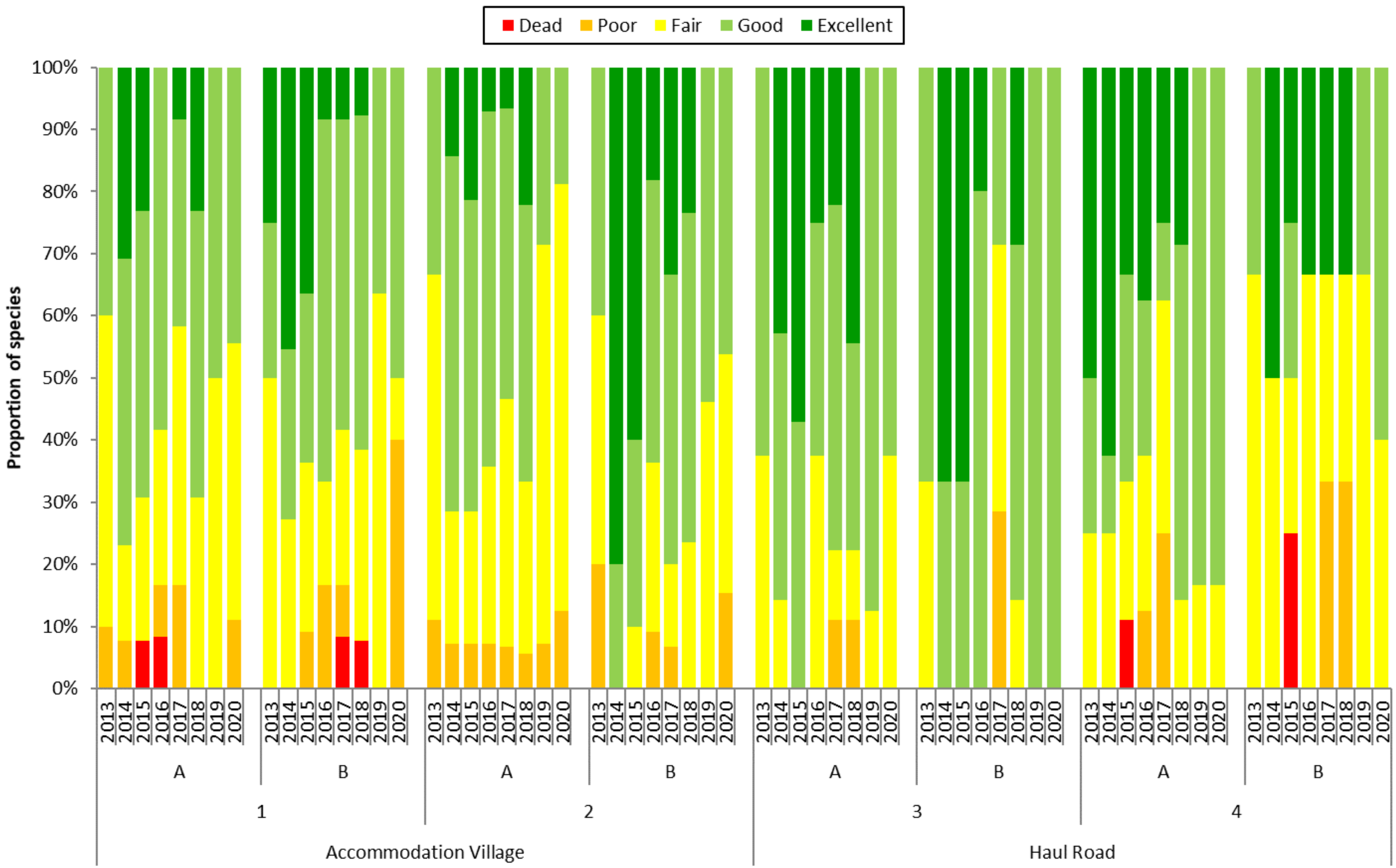


Figure 12: Plant health scores of understorey species between 2013 and 2020 at the accommodation village and haul road areas analogue (A) and buffer (B) zones. Numbers indicate the blocks.

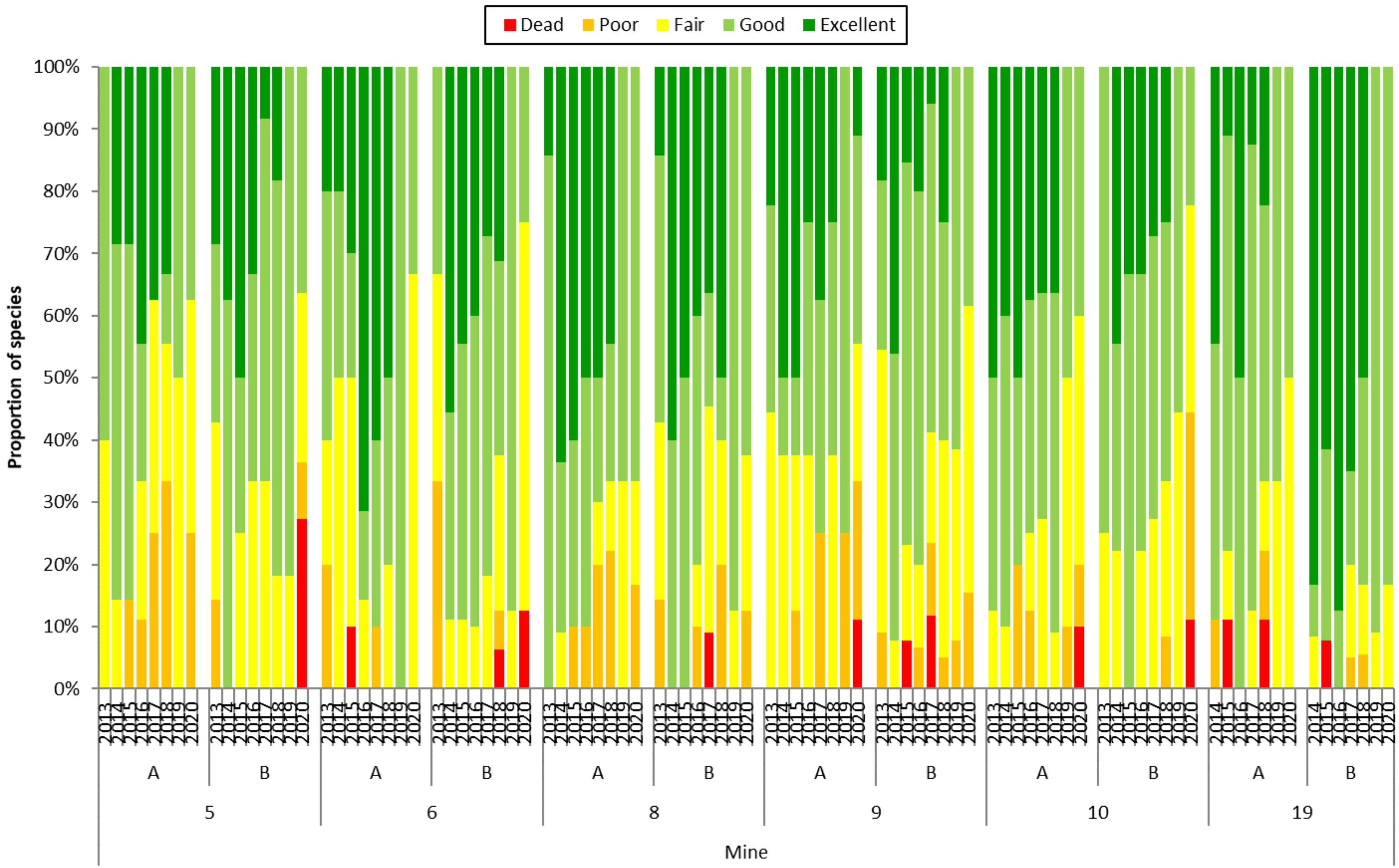


Figure 13: Plant health scores of understorey species between 2013 and 2020 at the mine area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

Figure 14: Plant health scores of understorey species between 2013 and 2020 at the rail siding area analogue (A) and buffer (B) zones. Numbers indicate the blocks.

3.6.2 Trees

For the marked trees, dust loads for 2020 were negligible, low or moderate and no scores higher than moderate were observed (Figure 15). In 2013, negligible to low dust loads were observed for some *Acacia resinimarginea* trees in analogue and buffer zones, however between 2017 and 2020 surveys, loads have been negligible to moderate for both analogue and buffer zones (Figure 15). Dust loads on *Melaleuca hamata* trees in the buffer zone remained low in 2020 after an increase to moderate loads was recorded between 2017 and 2018 (Figure 15). Overall, tree dust loads in the buffer zone did not differ significantly in 2020 compared to 2013 (t = 0.02, P = 1.00, Figure 15). Additionally, dust loads did not differ between buffer and analogue zones in 2020 (Pseudo $F_{1,84} = 2.89$, P = 0.09).

Tree health scores in the buffer zone were significantly lower in 2020 compared to 2013 (t = 2.26, P = 0.03). However, in 2020 health scores did not differ between buffer and analogue zones (t = 0.03, P = 1.00). *Acacia resinimarginea* health in the buffer zone has stabilised since the 2017 survey with an increase in the number of trees in fair health rather than poor (Figure 16). However, in analogue zones *A. resinimarginea* health has decreased slightly since 2019.

Transect and monitoring photographs for marked trees are presented in Appendix C.

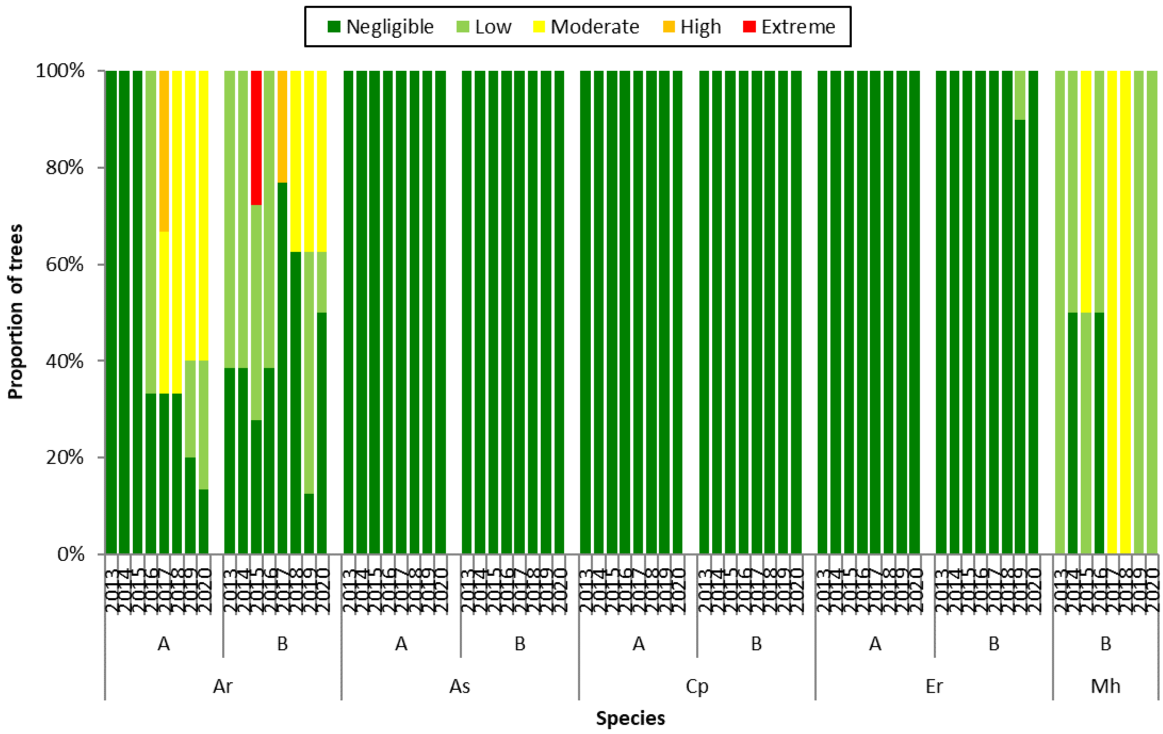


Figure 15: Dust load of marked trees between 2013 and 2020 at the analogue (A) and buffer (B) zones. Ar = *Acacia resinimarginea*, As = *Allocasuarina spinosissima*, Cp = *Callitris preissii,* Er = *Eucalyptus rigidula*, Mh = *Melaleuca hamata.*

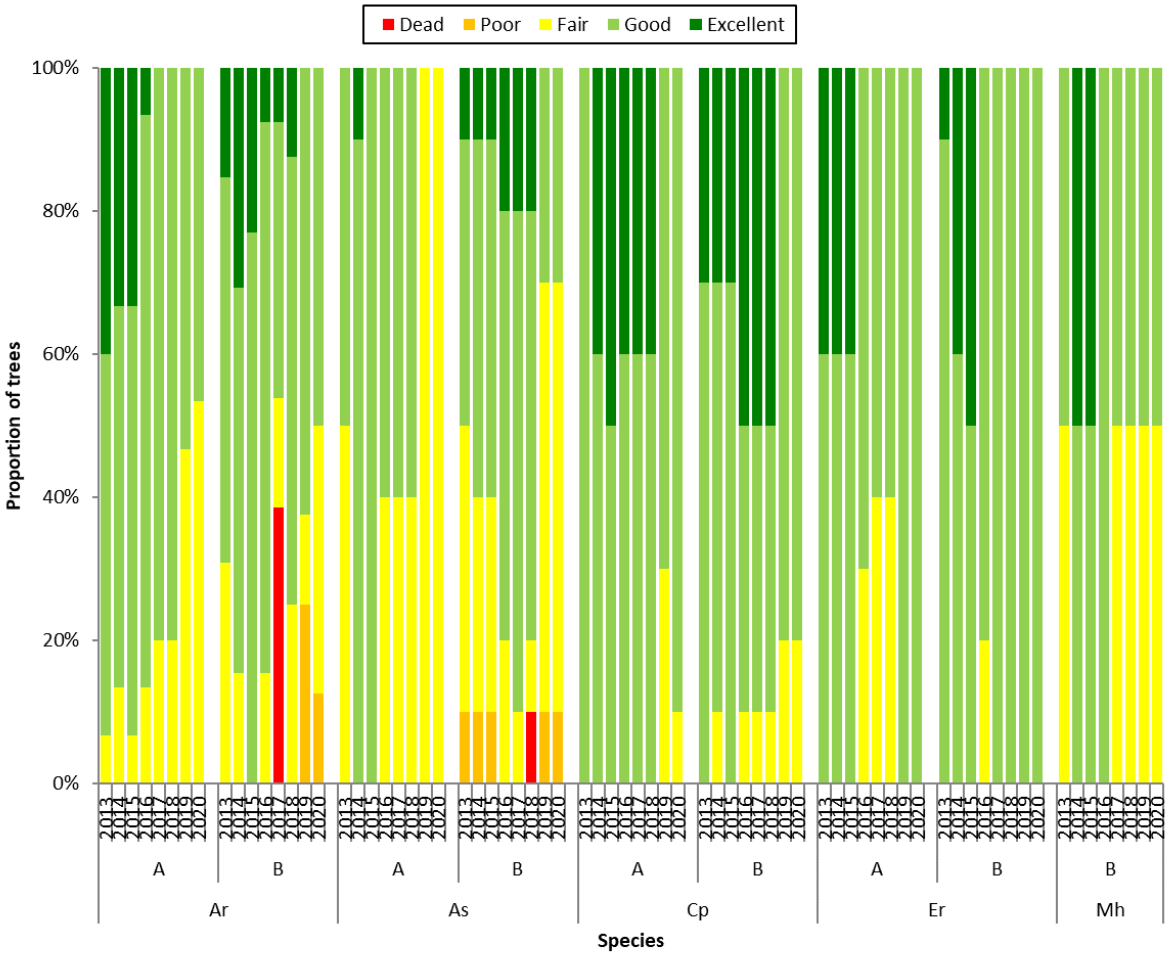


Figure 16: Health scores of marked trees between 2013 and 2020 at the analogue (A) and buffer (B) zones. Ar = *Acacia resinimarginea*. As = *Allocasuarina spinosissima*, Cp = *Callitris preissii,* Er = *Eucalyptus rigidula*, Mh =*Melaleuca hamata.*

4 Conclusion

There was no evidence to indicate that operational activities at Carina had a negative impact on flora and/or vegetation between September 2013 and October 2020. Changes in floristic composition over time are considered to be the result of natural fluctuations, and there is no trend to indicate buffer zone transects are different to those in the analogue zones. There was no significant difference in species richness between the analogue and buffer transects, except in the mine area, with a significant difference recorded each year since 2016. Plant cover, dust loading and health were not significantly different between 2013 and 2020.

No Threatened flora species have been detected in any of the monitoring surveys since 2013. Four Priority flora species were recorded in 2020. No weed incursions were recorded for a second consecutive year. Therefore conditions 10-1(1), 10-1(3) and 10-1(4) of MS 852 have been met in 2020.

A significant decline in tree health for the buffer zone has occurred since monitoring commenced in 2013. However, in 2020 there was no significant difference in tree health between the buffer and analogue zones, indicating that the decline in tree health is most likely a consequence of broad-scale natural processes.

Across the project, the level of dust being recorded is not having an impact on plant health. Therefore, compliance with conditions 5-2, 5-3 and 5-4 of MS 852 continue to be maintained.

5 References

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Appendix A: Plant Health and Vegetation Dust Load Scales

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Table A. 1: Plant health rating scale used to score the health of native vegetation.

Health score	Short description	Detailed description
1	Dead	• Plants beyond regenerative ability (0-5% projected foliar cover) (fire impact excluded) • Mostly dead branches • Occasional epicormic shoots, mostly dead • Cambium under bark no longer green
2	Poor	• Plants with (very) sparse canopy (5-40% projected foliar cover) • Dead branchlets and branches • Senescence of older and recent leaves • Dying of epicormic shoots • Cambium under bark green, indicating potential to regenerate
3	Fair	• Tips of branchlets dying or dead (40-60% projected foliar cover) • Leaves more susceptible to insect damage • Noticeable leaf senescence of older leaves • Epicormic shoots (stress related)
4	Good	• Plants not as densely green (60-80% projected foliar cover) • Some yellowing and drying of old leaves • Young leaves green to yellow-green • Occasional leaf insect damage
5	Excellent	• Plants appearing vigorous and green (>80% projected foliar cover). • Very little leaf senescence • Very little insect damage on leaves

Table A. 2: Dust rating scale used to score the dust load on native vegetation.

Dust load score	Short description	Detailed description
1	Negligible	• No dust obviously visible on plant • Virtually no cloud of dust when plant is shaken • No trace of dust when rubbing plant
2	Low	• Thin layer of dust apparent on leaves/stems • Dust may or may not come off when plant is shaken • Only very small amount of dust can be rubbed off • Amount of dust too little to be noticeable between fingers
3	Moderate	• Plant obviously covered in dust but leaf colour plainly visible • Dust falls off in a thin cloud when plant is shaken • Dust can be rubbed off plant • Grit/powder noticeable between fingers, smear thin when wet
4	High	• Plant covered in dust, but leaf colour is faintly visible through dust layer • Dust falls off in a cloud when plant is shaken • Dust can be rubbed off plant • Grit/powder noticeable between fingers, smear opaque when wet
5	Extreme	• Dust is caking the plant thickly, leaf/stems take on colour of dust • Dust falls off in a thick cloud when plant is shaken • Dust can be rubbed off leaves or stems • Dust feels powdery/gritty between fingers, smear clayey when wet

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Appendix B: Photographic Monitoring Protocol for Marked Trees

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Photographic tree monitoring protocol

1. A permanently marked stake (the photo-point) is established approximately north from the tree, and coordinates are recorded using a handheld GPS device.
2. The photo-point is chosen so that the entire canopy and base of the tree can be photographed, and ideally facing away from the sun in the morning and/or evening as much as practicably possible. In addition, the photo of the tree should have uninterrupted obstruction from any of the surrounding vegetation.
3. For each tree, take one photo as a close-up shot of the tag of the tree to ensure correct identification.
4. At the photo-point, take two photos of the tree from the same point (i.e. two identical photos to ensure adequate quality of the photo). Photos of the trees should be taken in a portrait position to capture the entire canopy and base of the tree.

Plate 1: Photo-point for an individual tree.

Plate 2: Tree labelling.

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Appendix C: Transect and Marked Tree Photographs

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Table C. 1: Transect photographs, October 2020.

Transect: AV-1-A (S12)

0 m

20 m

Transect: AV-1-B (S12)

0 m

20 m

Transect: AV-2-A (S12)

0 m

20 m

Transect: AV-2-B (S12)

0 m

20 m

Transcect: RS-11-A (S30)

0 m

20 m

Transect: RS-11-B (S30)

0 m

20 m

Transect: RS-12-A (S30)

0 m

20 m

Transect: RS-12-B (S30)

0 m

20 m

Transect: RS-13-A (S31)

0 m

20 m

Transect: RS-13-B (S31)

0 m

20 m

Transect: RS-14-A (S31)

0 m

20 m

Transect: RS-14-B (S31)

0 m

20 m

Transect: RS-15-A (S32)

0 m

20 m

Transect: RS-15-B (S32)

0 m

20 m

Transect: RS-16-A (S32)

0 m

20 m

Transect: RS-16-B (S32)

0 m

20 m

Transect: HR-3-A (W1)

0 m

20 m

Transect: HR-3-B (W1)

0 m

20 m

Transect: HR-4-A (W1)

0 m

20 m

Transect: HR-4-B (W1)

0 m

20 m

Transect: M-19-A (W12)

0 m

20 m

Transect: M-19-B (W12)

0 m

20 m

Transect: M-5-A (W2)

0 m

20 m

Transect: M-5-B (W2)

0 m

20 m

Transect: M-6-A (W2)

0 m

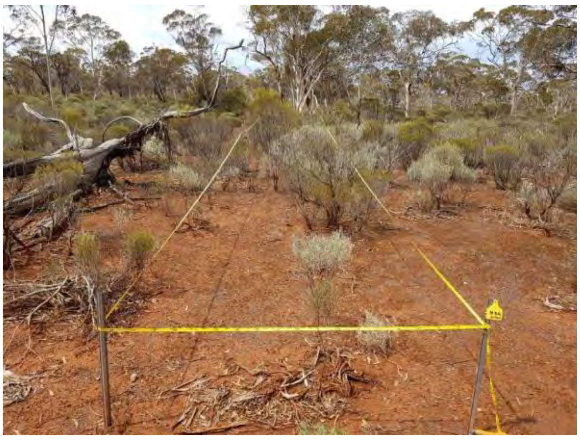
20 m

Transect: M-6-B (W2)

0 m

20 m

Transect: M-8-A (W2)



0 m

20 m

Transect: M-8-B (W2)

0 m

20 m

Transect: M-9-A (W22)

0 m

20 m

Transect: M-9-B (W22)

0 m

20 m

Transect: M-10-A (W22)

0 m

20 m

Transect: M-10-B (W22)

0 m

20 m

Transect: RS-17-A (W45)

0 m

20 m

Transect: RS-17-B (W45)

0 m

20 m

Transect: RS-18-A (W45)

0 m

20 m

Transect: RS-18-B (W45)

0 m

20 m

Table C. 2: Tree assessment photographs, October 2020.

Site: AV-1-A (S12)

Tree 1: ***Allocasuarina spinosissima***

Tree 2: ***Allocasuarina spinosissima***

Tree 3: ***Allocasuarina spinosissima***

Tree 4: ***Allocasuarina spinosissima***

Site: AV-1-A (S12)

Tree 5: ***Allocasuarina spinosissima***

Site: AV-1-B (S12)

Tree 1: ***Allocasuarina spinosissima***

Tree 2: ***Allocasuarina spinosissima***

Site: AV-1-B (S12)

Tree 3: ***Allocasuarina spinosissima***

Tree 4: ***Allocasuarina spinosissima***

Tree 5: ***Allocasuarina spinosissima***

Site: AV-2-A (S12)

Tree 1: ***Allocasuarina spinosissima***

Tree 2: ***Allocasuarina spinosissima***

Tree 3: ***Allocasuarina spinosissima***

Tree 4: ***Allocasuarina spinosissima***

Site: AV-2-A (S12)

Tree 5: ***Allocasuarina spinosissima***

Site: AV-2-B (S12)

Tree 1: ***Allocasuarina spinosissima***

Tree 2: ***Allocasuarina spinosissima***

Site: AV-2-B (S12)

Tree 3: ***Allocasuarina spinosissima***

Tree 4: ***Allocasuarina spinosissima***

Tree 5: ***Allocasuarina spinosissima***

Site: RS-11-A (S30)

Tree 1: ***Callitris preissii***

Tree 2: ***Callitris preissii***

Tree 3: ***Callitris preissii***

Tree 4: ***Callitris preissii***

Site: RS-11-A (S30)

Tree 5: ***Callitris preissii***

Site: RS-11-B (S30)

Tree 1: ***Callitris preissii***

Tree 2: ***Callitris preissii***

Site: RS-11-B (S30)

Tree 3: ***Callitris preissii***

Tree 4: ***Callitris preissii***

Tree 5: ***Callitris preissii***

Site: RS-12-A (S30)

Tree 1: ***Callitris preissii***

Tree 2: ***Callitris preissii***

Tree 3: ***Callitris preissii***

Tree 4: ***Callitris preissii***

Site: RS-12-A (S30)

Tree 5: ***Callitris preissii***

Site: RS-12-B (S30)

Tree 1: ***Callitris preissii***

Tree 2: ***Callitris preissii***

Site: RS-12-B (S30)

Tree 3: ***Callitris preissii***

Tree 4: ***Callitris preissii***

Tree 5: ***Callitris preissii***

Site: RS-13-A (S31)

Tree 1: ***Acacia resinomarginea***

Tree 2: ***Acacia resinomarginea***

Tree 3: ***Acacia resinomarginea***

Tree 4: ***Acacia resinomarginea***

Site: RS-13-A (S31)

Tree 5: ***Acacia resinomarginea***

Site: RS-13-B (S31)

Tree 1: ***Melaleuca hamata***

Tree 2: ***Melaleuca hamata***

Site: RS-13-B (S31)

Tree 3: ***Acacia resinimarginea***

Tree 4: ***Acacia resinimarginea***

Tree 5: ***Acacia resinimarginea***

Site: RS-14-A (S31)

Tree 1: ***Acacia resinimarginea***

Tree 2: ***Acacia resinimarginea***

Tree 3: ***Acacia resinimarginea***

Tree 4: ***Acacia resinimarginea***

Site: RS-14-A (S31)

Tree 5: ***Acacia resinimarginea***

Site: RS-15-A (S32)

Tree 1: ***Acacia resinimarginea***

Tree 2: ***Acacia resinimarginea***

Site: RS-15-A (S32)

Tree 3: ***Acacia resinimarginea***

Tree 4: ***Acacia resinimarginea***

Tree 5: ***Acacia resinimarginea***

Site: RS-15-B (S32)

Tree 1: ***Acacia resinimarginea***

Tree 2: ***Acacia resinimarginea***

Tree 3: ***Acacia resinimarginea***

Tree 4: ***Acacia resinimarginea***

Site: RS-15-B (S32)

Tree 5: ***Acacia resinimarginea***

Site: RS-17-A (W45)

Tree 1: ***Eucalyptus rigidula***

Tree 2: ***Eucalyptus rigidula***

Site: RS-17-A (W45)

Tree 3: ***Eucalyptus rigidula***

Tree 4: ***Eucalyptus rigidula***

Tree 5: ***Eucalyptus rigidula***

Site: RS-17-B (W45)

Tree 1: ***Eucalyptus rigidula***

Tree 2: ***Eucalyptus rigidula***

Tree 3: ***Eucalyptus rigidula***

Tree 4: ***Eucalyptus rigidula***

Site: RS-17-B (W45)

Tree 5: ***Eucalyptus rigidula***

Site: RS-18-A (W45)

Tree 1: ***Eucalyptus rigidula***

Tree 2: ***Eucalyptus rigidula***

Site: RS-17-B (W45)

Tree 3: ***Eucalyptus rigidula***

Tree 4: ***Eucalyptus rigidula***

Tree 5: ***Eucalyptus rigidula***

Site: RS-18-B (W45)

Tree 1: ***Eucalyptus rigidula***

Tree 2: ***Eucalyptus rigidula***

Tree 3: ***Eucalyptus rigidula***

Tree 4: ***Eucalyptus rigidula***

Site: RS-18-B (W45)

Tree 5: ***Eucalyptus rigidula***

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APPENDIX 2: CARINA REHABILITATION MONITORING REPORT 2020

Carina Iron Ore Project
2020 Rehabilitation Monitoring
December 2020

Prepared for

Polaris Metals Pty Ltd

Report Reference: 13029-20-RESR-3Rev0_210419

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Carina Iron Ore Project
2020 Rehabilitation Monitoring

Prepared for
Polaris Metals Pty Ltd

Job Number: 13029-20

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Abbreviations

Abbreviation	Definition
Astron	Astron Environmental Services
Carina	Carina Iron Ore Project
CI	Confidence interval
GDA94	Geocentric Datum of Australia 1994
GPS	Global Positioning System
ha	Hectares
km	Kilometres
m	Metres
mm	Millimetres
MS	Ministerial Statement
P	Priority
Polaris	Polaris Metals Pty Ltd
sp.	Species
spp.	Species (plural)
subsp.	Subspecies
UAV	Unmanned aerial vehicle
UTM	Universal Transverse Mercator
WRL	Waste rock landform

Executive Summary

Polaris Metals Pty Ltd operates the Carina Iron Ore Project, 100 km north-east of Southern Cross in the Goldfields region of Western Australia. Under condition 11 of Ministerial Statement 852, Polaris Metals Pty Ltd is required to monitor progressive rehabilitation. A monitoring program was first established in 2015, with subsequent annual monitoring and additional sites installed as areas are progressively rehabilitated. The rehabilitation monitoring program design and methods are documented in the *Carina and J4 Vegetation and Rehabilitation Monitoring Plan.* In 2020, the rehabilitation monitoring program consisted of 42 sites: 23 rehabilitation sites and 19 analogue sites. On-ground monitoring was undertaken to assess the performance of the rehabilitation at borrow pits, road infrastructure and the waste rock landform at Carina and Carina Extended.

Borrow pit rehabilitation sites are trending towards meeting condition 11 of Ministerial Statement 852: The surface is stable and resistant to erosion, native species richness is higher than the analogue sites, native cover and species dominance is similar to the analogue sites, and the structure is progressing towards a stable vegetation community similar to that of undisturbed nearby vegetation. Weed levels have declined over time with no weeds recorded in 2020; although weeds were observed outside of monitoring sites.

The data collected at road infrastructure sites indicates that the rehabilitation is progressing towards meeting some aspects of Ministerial Statement 852. No major erosion or disturbance is present at any of the monitoring sites, species richness and dominance are similar to undisturbed analogue sites. Foliar cover and vegetation structure remain different to the analogue sites but are progressing towards a similar state. However, poor performance is still apparent for three sites which have shown no improvement since monitoring began in 2015. No weeds were recorded at any site in 2020 which meets the weed related conditions of Ministerial Statement 852.

The erosion features at the rehabilitated Carina waste rock landform sites have not worsened since 2019, indicating the surface may have begun to stabilise. Although below average rainfall for the past two years may be a contributing factor, with unstable surfaces more susceptible to heavy rainfall events. Further monitoring is required to draw broad assessments on the stability of the waste rock landform as a whole. Species richness at the rehabilitation sites were similar to 2019, with a decline in native cover; a reflection of dry seasonal conditions. Species dominance and vegetation structure improved from 2019, however this may be influenced by the reduction of herbaceous species under dry conditions. The vegetation monitoring data obtained during two years of dry seasonal conditions indicate that the Carina waste rock landform can support vegetation with the ability to sustain prolonged dry conditions. Further monitoring is required to assess vegetation progress towards a similar state to the analogue vegetation. Weed abundance continues to be increasing, although was not significantly higher than previous years, demonstrating compliance with weed related conditions of Ministerial Statement 852. Weed management should be maintained with the aim of reducing weed populations across the Carina waste rock landform.

The surface of the Carina Extended waste rock landform has further eroded since 2019, with significant erosion features recorded at two sites. Remote sensing across the entire waste rock landform is required to assess the area as a whole and to identify problem areas that may impact on successful vegetation establishment. Vegetation aspects have continually improved since 2018, a positive result considering the dry seasonal conditions that have followed rehabilitation completion. Further monitoring is required to determine if these trends continue and if the vegetation of the waste rock landform is progressing towards a similar state to the analogue vegetation. **Sonchus asper* was the only weed species recorded in 2020; present at all rehabilitation sites, but cover and abundance was not significantly higher than baseline (2019). Therefore, the weed related conditions of Ministerial Statement 852 have been met.

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1 Introduction

The Carina Iron Ore Project (Carina) is operated by Polaris Metals Pty Ltd (Polaris) and is located approximately 100 km north-east of Southern Cross, in the Goldfields region of Western Australia (Figure 1). The mine site comprises a rail siding area, a haul road, accommodation village, and a mine infrastructure area which includes 'Carina Extended', approximately 2 km north-west of the Carina northern operations. The area is accessed via a haul road from the northern operations and consists of an open pit, waste rock landform (WRL) and access tracks.

Polaris is required to monitor progressive rehabilitation at Carina (including Carina Extended) under condition 11 of Ministerial Statement 852 (MS 852) (Table 1). Areas rehabilitated to date include:

- 11 ha of borrow pits along the Carina haul road
- approximately 47 ha of the 140 ha WRL at Carina
- 10 ha of road infrastructure at Carina
- approximately 32 ha of the Carina Extended WRL.

The collection of on-ground monitoring data enables the evaluation of progress against the requirements of MS 852. Criteria used to assess rehabilitation success are documented in the *Carina and J4 Vegetation and Rehabilitation Monitoring Plan* (Astron Environmental Services 2020a) and presented in Table 1.

Table 1: Rehabilitation monitoring conditions in Ministerial Statement 852 and criteria for evaluation.

Condition number	Condition requirement	Monitoring method/ attributes	Evaluation
11-1.1	The waste dumps shall be constructed in a way that their stability, surface drainage and resistance to erosion can support local native vegetation	Unmanned aerial vehicle (UAV) captured orthophotography and digital terrain model of the waste dumps	Spatial analysis of geometry, stability and vegetation characteristics to assess: • Batter height and angle, and berm width and angle are compliant to landform design. • Any crest bunds or drains compliant to design. • Frequency and dimensions of erosion gullies. • Native vegetation density, cover and height.
11-1.6	Self-sustaining native vegetation at the rehabilitation areas is comparable to analogue sites	On-ground monitoring of native species richness and cover	Comparison between rehabilitation site and corresponding analogue site for: • Species inventory and richness. • Berger Parker index of species evenness. • Mean native cover (using linear model analysis or similar). • Mean native cover contribution by each vegetation stratum.

Condition number	Condition requirement	Monitoring method/ attributes	Evaluation
11.-1.7	No new declared or environmental weed species have been introduced into the rehabilitation areas as a result of project activities.	On-ground monitoring of weed species inventory	• Review of current databases to determine status of weed species: Western Australian Organism List (Department of Primary Industries and Regional Development 2020), Weeds of National Significance (Australian Weeds Committee 2012), FloraBase (Western Australian Herbarium 2020). • Comparison of weed species inventory between rehabilitation and analogue sites, and to previous flora, vegetation and weed surveys.
11-1.8	The cover of declared or environmental weed species is comparable to the baseline survey or that recorded at the analogue sites	On-ground monitoring of weed cover	• Linear model or 95% Confidence Interval comparison of mean weed cover between rehabilitation and corresponding analogue sites, and to baseline (2015) data. NB: where cover values are low (<0.01%), abundance can be used as a surrogate.

1.1 Background

The methods used for establishing and monitoring rehabilitation and analogue sites is documented in the *Carina and J4 Vegetation and Rehabilitation Monitoring Plan* (Astron Environmental Services 2020a). The monitoring design was based on the previous rehabilitation monitoring surveys conducted annually since November 2015 (Ecologia Environment and Soilwater Group 2015, Astron Environmental Services 2017, 2018, 2019, 2020b).

In 2015, rehabilitation and corresponding analogue monitoring sites were established and monitored at borrow pits along the haul road, road infrastructure areas, and the western rehabilitation trial area on the WRL at Carina. On-ground monitoring included the assessment of site characteristics, and flora and vegetation measurements. Landform stability was assessed using light detection and ranging technologies.

In 2016, the previously installed sites were re-monitored and additional rehabilitation sites were established and monitored in areas of new road infrastructure rehabilitation. A comprehensive unmanned aerial vehicle (UAV) survey was conducted at the Carina WRL to assess landform stability and conformance with design.

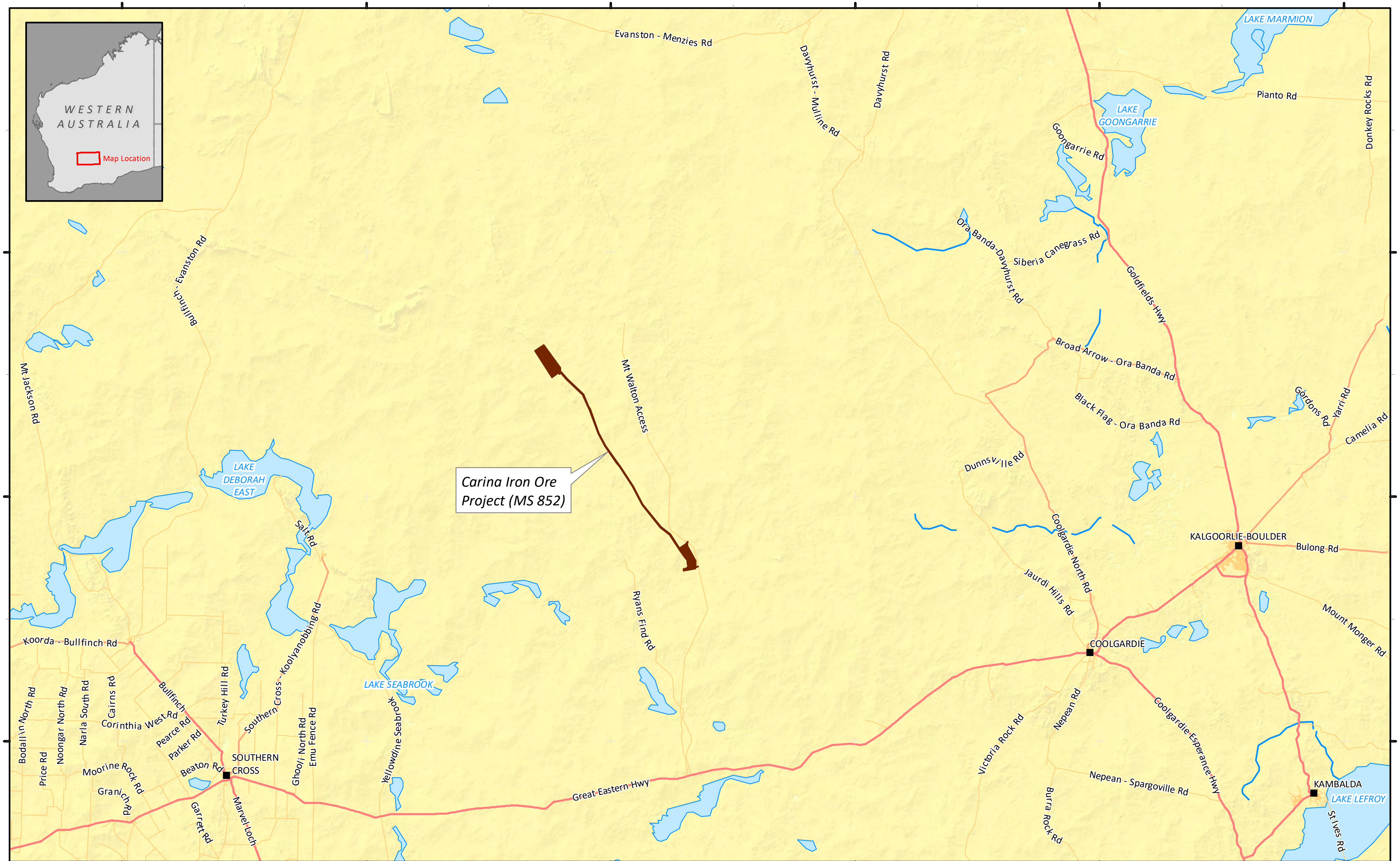
In 2017, the previously installed sites were re-monitored and a UAV survey completed. Additional rehabilitation sites were installed and monitored at Carina WRL eastern rehabilitation trial, and additional analogue sites installed and monitored adjacent to the Carina and Carina Extended WRL.

In 2018, the previously installed sites were re-monitored, except for the rehabilitation trial areas at Carina WRL. Additional sites were installed at Carina WRL and Carina Extended WRL, including additional analogue sites. A UAV survey was completed for Carina WRL and Carina Extended WRL. The same sites were re-monitored in 2019, but no UAV survey was completed.

1.2 Scope of Work

Astron Environmental Services (Astron) was commissioned by Polaris to undertake the 2020 monitoring of rehabilitation and analogue sites. The purpose of the monitoring survey is to assess progress towards achieving self-sustaining native vegetation comparable to that of undisturbed analogue sites and assess weed presence and cover compared to previous surveys and analogue sites. The scope of works included the following:

- field assessment of previously installed rehabilitation sites at borrow pits along the Carina haul road and road infrastructure areas, and at Carina and Carina Extended WRLs (excluding rehabilitation trial areas)
- preparation of a rehabilitation monitoring report to assess progress towards achieving self-sustaining native vegetation comparable to that of undisturbed analogue sites at Carina and Carina Extended.



Polaris Metals Pty Ltd

Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure 1: Regional location

Coordinate System: GDA 1994 MGA Zone 50

0 10 20 30 40 50 Kilometres

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1.3 Environmental Context

The Carina Iron Ore Project is situated within the Southern Cross sub region (COO02) of the Coolgardie Bioregion (Department of the Environment and Energy 2019). The Southern Cross sub region is described as having a subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills and chains of saline playa-lakes (Cowan et al. 2001).

Vegetation in the Southern Cross subregion is described as diverse eucalypt woodlands (*Eucalyptus salmonophloia, E. salubris, E. transcontinentalis* and *E. longicornis*) rich in endemic eucalypts, which occur around the salt lakes, on the low greenstone hills, valley alluvials and broad plains of calcareous earths. The Salt Lake surfaces support dwarf shrublands of samphire. The granite basement outcrops at mid-levels in the landscape and support swards of *Borya constricta,* with stands of *Acacia acuminata* and *E. loxophleba*. Upper levels in the landscape are the eroded remnants of a lateritic duricrust yielding sandplains and breakaways. Mallee (*E. leptopoda, E. platycorys* and *E. scyphocalyx*) and scrub-heath (*Allocasuarina corniculata, Callitris preissii, Melaleuca uncinata* and *A. beauverdiana*) occur on these uplands, as well as on sand lunettes associated with playas along the broad valley floors, and sand sheets around the granite outcrops. The scrubs are rich in endemic acacias and Myrtaceae (Cowan et al. 2001).

Vegetation mapping by Mattiske Consulting (2008a, 2008b, 2009) identified 68 vegetation communities across the Carina Project area and exploration tenements. Of these, fourteen vegetation communities were associated with the rehabilitation areas (Table 2).

Table 2: Vegetation communities associated with the rehabilitation areas (Mattiske Consulting 2008a, 2008b, 2009).

Vegetation code	Vegetation community description	Landform description
S11	Scrub of *Acacia resinimarginea, Callitris preissii, Eucalyptus pileata* and mixed *Allocasuarina* species over *Melaleuca hamata* and *Leptospermum fastigiatum* over *Baeckea* sp. Mt. Clara and mixed shrubs.	Lateritic yellow sandy soils on mid to upper slopes
S12(b)	Scrub (fire disturbed) of *Allocasuarina corniculata* and occasional mixed Eucalypt species over *Melaleuca cordata*, *Euryomyrtus maidenii* and mixed shrubs over *Triodia desertorum*	Yellow sandy soils on gently undulating plains
S13	Scrub of *Allocasuarina corniculata* and *Acacia yorkrakinensis* subsp. *acrita* with emergent mixed Eucalypt species over *Thryptomene kochii, Baeckea* sp. Mt. Clara, *Euryomyrtus maidenii, Leptospermum fastigiatum* and *Melaleuca cordata* over *Triodia ?desertorum*	Lateritic yellow to orange-yellow sandy soils
S14	Scrub of *Acacia burkittii, Allocasuarina corniculata* and *Allocasuarina campestris* with emergent *Eucalyptus loxophleba* subsp. *supralaevis* over *Dodonaea microzyga* and mixed shrubs	Red-brown clay soils on flats
S15	Scrub of *Allocasuarina campestris* with emergent *Eucalyptus loxophleba* subsp. *lissophloia* and *E. eremophila* subsp. *eremophila* over mixed shrubs over *Triodia irritans*	Lateritic orange-brown sandy clay soils
W1	Woodland of *Eucalyptus salmonophloia, E. salubris, E. sheathiana, E. corrugata, E. yilgarnensis, E. transcontinentalis, E. longicornis* and *E. ravida* over *Acacia jennerae, A. prainii, A. colletioides, Santalum acuminatum, Exocarpos aphyllus, Eremophila scoparia, E. granitica, E ionantha, Senna artemisioides* subsp. *filifolia* and *Atriplex nummularia* over *A. vesicaria, Grevillea acuaria, Olearia muelleri, O. pimelioides* and *Austrostipa elegantissima*	Red-brown clay on flats

Vegetation code	Vegetation community description	Landform description
W2	Woodland of *Eucalyptus salmonophloia* with *E. ravida* and mixed *Eucalypts* over *Eremophila ionantha, Exocarpos aphyllus*, *Atriplex nummularia* and *Acacia colletioides* over *Atriplex vesicaria*.	Flat red clay soils
W4	Woodland of *Eucalyptus longicornis, E. salubris, E. corrugata* and *E. moderata* over *Eremophila ionantha, E. scoparia, Senna artemisioides* subsp. *filifolia, Exocarpos aphyllus, Atriplex nummularia* and *Santalum acuminatum* over *Acacia colletioides* and *A. vesicaria*	Red-brown sandy-clay flats with scattered ironstone and quartz pebbles
W12	Open Woodland of *Eucalyptus sheathiana, E. salubris, E. loxophleba* subsp. *lissophloia, E. ravida* and *E. salmonophloia* over *Acacia burkittii, Eremophila ionantha, Senna artemisioides* subsp. *filifolia* and *A. colletioides* over *Grevillea acuaria*	Red-brown clay to sandy-clay on flats with scattered ironstone pebbles
W15	Low Woodland of *Eucalyptus corrugata, E. loxophleba* subsp. *lissophloia* and *E. longicornis* over *Acacia burkittii, Allocasuarina campestris* and *Exocarpos aphyllus* over *Senna artemisioides* subsp. *filifolia, Philotheca tomentella, Prostanthera grylloana, Templetonia sulcata* and *P. brucei* subsp. *brucei* over *Grevillea acuaria* and *Scaevola spinescens*	Red-brown clay soils on flats
W22	Open Low Woodland of *Eucalyptus corrugata* with mixed *Eucalyptus* spp. over *Allocasuarina campestris* and *Acacia burkittii* over *Alyxia buxifolia, Philotheca brucei* subsp. *brucei* and *Isopogon gardneri* over *Scaevola spinescens* and *Olearia muelleri*	Red-brown clay soils on mid and lower slopes
W30	Low woodland of *Eucalyptus corrugata* over *Acacia resinimarginea* over *Beyeria brevifolia, A. hemiteles*, and mixed shrubs over *Triodia scariosa* and *T. ?desertorum*	Yellow to orange sandy clay soils on flats
W31	Woodland of *Eucalyptus longicornis, E. sheathiana* and *E. loxophleba* subsp. *lissophloia* over *Eremophila scoparia, Atriplex nummularia, Exocarpos aphyllus* over *A. vesicaria, Olearia muelleri* and mixed shrubs	Orange- brown clay soils on flats
W33	Low woodland of *Eucalyptus corrugata* and mixed Eucalypt species over mixed *Allocasuarina* species and *Acacia burkittii* over *Alyxia buxifolia, Grevillea obliquistigma* subsp. *obliquistigma* over *Prostanthera grylloana* and *Leucopogon* sp. Clyde Hill	Orange to red-brown clay soils on flats and lower slopes

2 Methods

The rehabilitation monitoring design and methods follow those documented in the *Carina and J4 Vegetation and Rehabilitation Monitoring Plan* (Astron Environmental Services 2020a). The 2020 rehabilitation monitoring survey consisted of on-ground monitoring at:

- rehabilitation sites at borrow pits along the Carina haul road and road infrastructure areas
- analogue sites in undisturbed vegetation that are comparable to pre-disturbance vegetation of the WRL rehabilitation areas at Carina and Carina Extended
- rehabilitation sites at the Carina and Carina Extended rehabilitated WRLs.

The 2020 monitoring survey was conducted between 2 and 12 December by Beth Loudon (Senior Environmental Scientist) and Holly Poole (Environmental Scientist). Follow-up erosion monitoring at the Carina and Carina Extended waste rock landform rehabilitation sites was undertaken on 8 and 9 April 2021, due to this component of the scope being mistakenly omitted from the monitoring survey. The erosion monitoring was undertaken by Sharyn Moore (Senior Environmental Scientist) and Roxanne de Vos (Environmental Technician).

Previous monitoring surveys were conducted in November 2015, December 2016, December 2017, October and December 2018, and November 2019.

2.1 Monitoring Design

Representative rehabilitation sites are installed and monitored as areas are progressively rehabilitated. In 2015, Ecologia Environment and Soilwater Group (2015) installed 32 monitoring sites at Carina in rehabilitated areas (rehabilitation sites) and in surrounding undisturbed vegetation considered appropriate for corresponding analogue monitoring sites (analogue sites) based on vegetation community, soil, topography and terrain.

Three additional sites were installed at rehabilitation road infrastructure in 2016 (Astron Environmental Services 2017). In 2017, an additional 13 sites were installed: eight rehabilitation sites and four analogue sites at Carina, and one analogue site at Carina Extended (Astron Environmental Services 2018). The 2018 monitoring survey installed an additional five rehabilitation sites and one analogue site at Carina, and five rehabilitation sites and two analogue sites at Carina Extended (Astron Environmental Services 2019).

In 2019 and 2020, the monitoring program consisted of 42 sites, comprised of 23 rehabilitation sites and 19 analogues sites (Table 3, Figure 2 and Appendix A). Monitoring site setup is documented in detail in the *Carina and J4 Vegetation and Rehabilitation Monitoring Plan* (Astron Environmental Services 2020a). Sites are classified as either transect sites or quadrat sites, depending on the size of the rehabilitation area:

1. Transect sites:

   A single transect 50 m in length with ten 2 m by 2 m quadrats set up at 5 m intervals. Where the site is too small for a 50 m transect, two 25 m transects run parallel to each other and are 50 m apart.

   Transects are used to monitor understorey vegetation and surface characteristics while one 50 m by 50 m quadrat is installed to monitor overstorey vegetation and weed species. The overstorey quadrat spans 25 m either side of the transect. Where the site contains two 25 m transects, the overstorey quadrat is 100 m by 25 m.

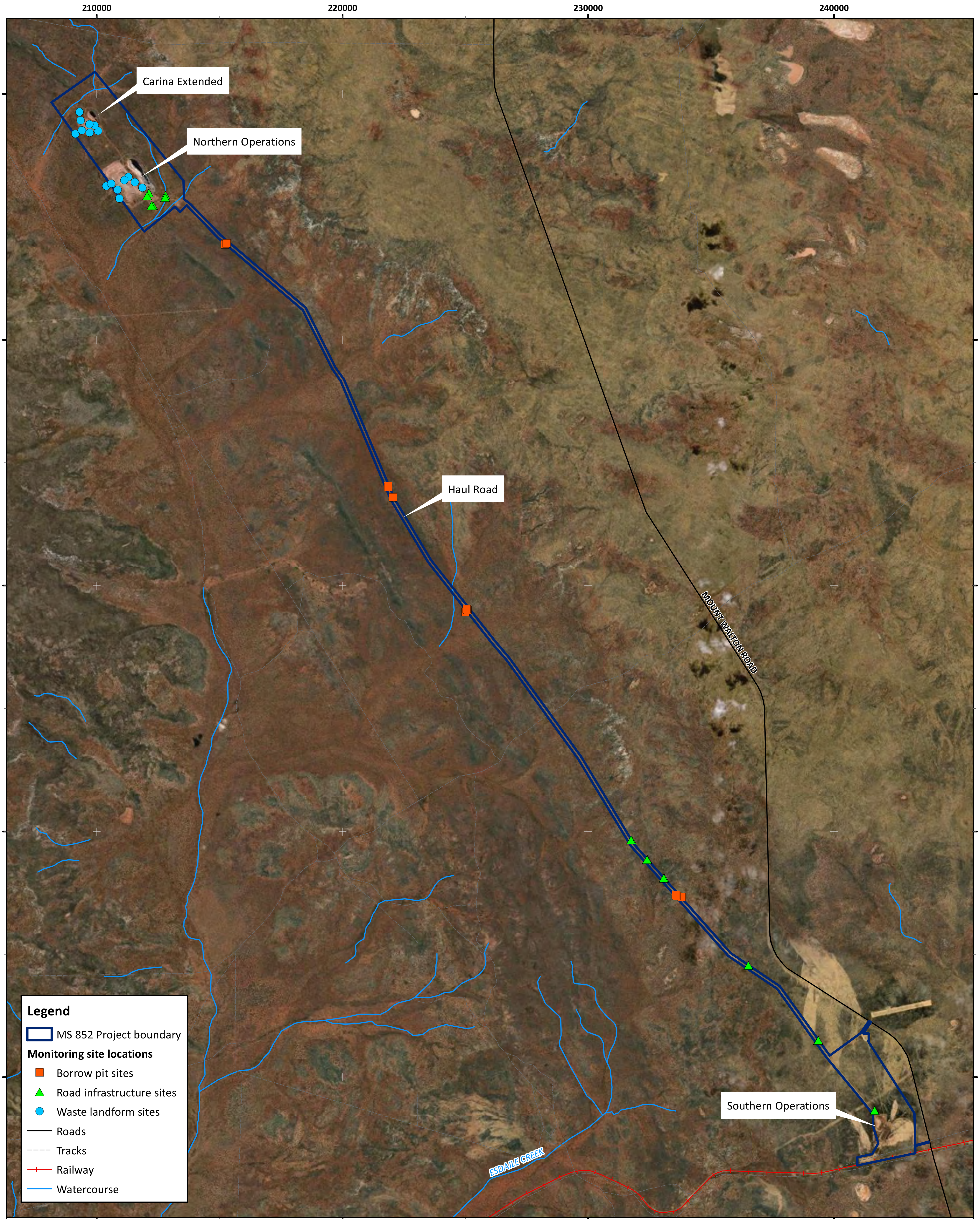
2. Quadrat sites:

   A single 5 m by 5 m quadrat is established where the rehabilitation area is too small for a transect.

Table 3: Location, type and corresponding vegetation community of monitoring sites assessed in 2020.

Site setup	Location	Vegetation community code	Site type	Site name	Zone	Easting	Northing	Year rehabilitation completed	Year monitoring established	No. transects (length (m))	No. quadrats within transect	No. overstorey quadrats
Transect	Haul road borrow pit (Carina)	W31	Rehabilitation	SR01	51	225060	6609045	2014	2015	2 (25)	10	1
			Analogue	SC01	50	741039	6588076	n/a		1 (50)	10	1
		W30	Rehabilitation	SR02	51	233609	6597388	2015		2 (25)	10	1
			Analogue	SC02	51	233843	6597360	n/a		1 (50)	10	1
		W15	Rehabilitation	SR03	51	215278	6623924	2014		1 (50)	10	1
			Analogue	SC03	51	215216	6623872	n/a		1 (50)	10	1
		W33	Rehabilitation	SR04	51	221806	6614149	2012		2 (25)	10	1
			Analogue	SC04	51	222094	6613619	n/a		1 (50)	10	1
	WRL (Carina)	W2	Rehabilitation	SR21	50	786757	6626468	2018	2018	1 (50)	10	1
				SR22	50	787006	6626191	2015		1 (50)	10	1
				SR23	50	787658	6626475	2015		2 (25)	10	1
				SR24	50	787484	6626679	2015		1 (50)	10	1
				SR25	50	787290	6626492	2015		2 (25)	10	1
		W4	Analogue	SC05	50	787024	6625806	n/a	2015	1 (50)	10	1
		W22	Analogue	SC06	50	787944	6626239		2017	1 (50)	10	1
		W2	Analogue	SC10	50	786461	6626351		2018	1 (50)	10	1
	WRL (Carina Extended)	W2	Rehabilitation	SR26	50	785612	6629058	2018	2018	1 (50)	10	1
				SR27	50	785634	6628656			1 (50)	10	1
				SR28	50	786163	6628823			2 (25)	10	1
				SR29	50	785955	6628889			2 (25)	10	1
				SR30	50	785948	6628556			2 (25)	10	1
			Analogue	SC07	50	786300	6628604	n/a	2017	1 (50)	10	1

Site setup	Location	Vegetation community code	Site type	Site name	Zone	Easting	Northing	Year rehabilitation completed	Year monitoring established	No. transects (length (m))	No. quadrats within transect	No. overstorey quadrats
			Analogue	SC11	50	785585	6629395		2018	1 (50)	10	1
			Analogue	SC12	50	785314	6628500		2018	1 (50)	10	1
Quadrat	Road infrastructure (Carina)	S15	Rehabilitation	PR01	51	231750	6599665	2015	2015	N/A	1	0
			Analogue	PC01	50	769188	6621354	n/a			1	0
		S14	Rehabilitation	PR02	51	232374	6598878	2015			1	0
			Analogue	PC02	51	232411	6598881	n/a			1	0
		W1	Rehabilitation	PR03	51	233067	6598107	2015			1	0
			Analogue	PC03	51	233079	6598119	n/a			1	0
		S13	Rehabilitation	PR04	51	236525	6594560	2015			1	0
			Analogue	PC04	51	236516	6594538	n/a			1	0
		S12(b)	Rehabilitation	PR05	51	239361	6591519	2015			1	0
			Analogue	PC05	51	239348	6591523	n/a			1	0
		S11	Rehabilitation	PR06	51	241647	6588660	2015			1	0
			Analogue	PC06	51	241666	6588666	n/a			1	0
		W22	Rehabilitation	PR07	51	212050	6625871	2015	2016		1	0
			Analogue	PC07	51	212132	6625991	n/a	2017		1	0
		W4	Rehabilitation	PR08	51	212234	6625477	2015	2016		1	0
			Analogue	PC08	51	212282	6625481	n/a	2017		1	0
		W12	Rehabilitation	PR09	51	212796	6625800	2015	2016		1	0
			Analogue	PC09	50	212804	6625895	n/a	2017		1	0



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Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure 2: Monitoring site locations

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Author: S. Moore	Date: 18-01-2021
Drawn: T. Pedersen	Figure Ref: 13029-20-REDR-3RevA_210118_Fig02

Coordinate System: GDA 1994 MGA Zone 51

0 2 4 6 8 10 km

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2.2 Monitoring Variables

Variables recorded at each 50 m transect, 2 m by 2 m quadrat, overstorey quadrat and 5 m by 5 m quadrats are presented in Table 4. Transect attributes are assessed for the entire length of the transect, extending 2 m either side, aligning with the width of the quadrats.

Descriptions of the categories for vegetation classification, vegetation condition, erosion, disturbance, plant health and dust are provided in Appendix B.

Table 4: Attributes recorded at each monitoring site.

Site component	Variable	Description
Transect and 5 m by 5 m quadrats	Site code	Site – S = transect site, P = quadrat site; Treatment – R = rehabilitation, C = analogue; Number – consecutively labelled. Fence droppers are labelled with A = start or B = end.
	Treatment	Rehabilitation or analogue.
	Location	UTM coordinates of the sites recorded on a GPS unit (GDA94, Zone 50 or 51).
	Photograph	Two digital photographs taken from the start (A) and end (B) of the transect, orientated on the right-hand side of the transect to capture the 2 m by 2 m quadrats.
	Habitat description	Landform broadly described for rehabilitation areas.
	Vegetation community	Vegetation described according to level 5 of the National Vegetation Information System guidelines (Department of the Environment and Energy) and classified according to the Aplin (1979) modification of the vegetation classification system of Specht (1970; Table B.1, Appendix B).
	Vegetation condition	Described based on Trudgen (1988) categories; excellent, very good, good, poor, very poor, completely degraded (Table B.2, Appendix B). For analogue sites only.
	Fire	Describe evidence.
2 m by 2 m quadrat and 5 m by 5 m quadrat	Quadrat number	Labelled based on distance along transect (i.e. Q00 = quadrat starting at 0 m, Q05 = quadrat starting at 5 m).
	Plant cover	Percent of total vegetation cover.
	Ground cover	Percent cover of boulders, rocks, logs, litter, bare ground.
	Cryptogams	Percent of cryptogam cover.
	Surface crust	Presence of a surface crust.
	Water pooling	Presence of current water pooling or evidence of previous pooling.
	Fauna evidence	Record fauna species or group, identify type (e.g., sighting, scats, nest).
	Disturbance	Disturbance scored; extensive (4), moderate (3), low/scattered (2), none (1).
	Erosion	Erosion scored; extensive (4), moderate (3), low/scattered (2), none (1). Where erosion rill is observed, record the number, maximum depth and width. Erosion monitoring included the GPS coordinates of each rill/gully and a photograph with soil profile and depth marker where possible.

Site component	Variable	Description
	Foliar cover	Projected live foliar cover (%) for each species (stems inside or outside quadrat). Trees not included in any measurements for the 2 m by 2 m quadrats as these are captured in the overstorey quadrat.
	Abundance	Number of individuals of each perennial native species with stems inside the quadrat.
	Stratum	Stratum expected to be occupied by each species, determined by taxon, not height at time of survey (consistent with Florabase (Western Australian Herbarium 2020); herb, tussock grass, hummock grass, sedge, low shrub < 1 m, mid shrub 1 – 2 m, tall shrub > 2 m.
	Reproductive state	Record the most common reproductive state: flowering, fruiting, flowering and fruiting, or sterile.
	Health	Record the most common plant health: 1 – dead, 2 – poor, 3 – fair, 4 – good, 5 – excellent.
	Dust	Record the most common dust loading: 1 – negligible, 2 – low, 3 – moderate, 4 – high, 5 – extreme.
Overstorey quadrat	Tree species cover	Projected live foliar cover (%) of each tree species within each stratum; seedling < 1 m, juvenile 1 - 2 m, mature > 2 m.
	Tree species abundance	Abundance of all tree species within each stratum (seedling, juvenile, mature): 0 – absent, 1 – sparse, 2 – common, 3 – abundant. Dead trees to be scored separately.
	Weed species cover	Projected live foliar cover (%) of each weed species.
	Weed species abundance	Abundance of each weed species.

2.3 Data Management and Analysis

During on-ground monitoring, data was recorded electronically on pre-designed field forms using a smart phone operating the Fulcrum database. A standardised process of quality control was then applied to the data upon return from the field.

Data from each of the different locations were summarised and analysed separately: road infrastructure, borrow pits, Carina WRL and Carina Extended WRL. As the rehabilitation sites at Carina WRL and Carina Extended WRL were newly installed in 2018, only data from 2018 onwards are presented for the corresponding analogue sites to allow for a direct comparison between treatments.

For all sites, differences in native species richness and cover between site types and years were assessed statistically using a linear mixed model, which included a site type by year interaction term which would indicate whether the two site types were converging or diverging over time.

Native species richness for transect sites was calculated as a count of the number of species for each site and analysed between analogue and rehabilitation sites, and to previous years' data. Differences in native species diversity between rehabilitation and analogue sites, and to previous years' data, was analysed using the Berger-Parker index of species evenness, based on species cover (excluding weed species) (Magurran 1988). The Berger-Parker index quantifies the level of species dominance, and is the proportional cover of the most dominant species, as a ratio of total vegetation cover. Therefore, low values of the index indicate a more even representation of species.

For borrow pit sites and WRL sites, the sum of native species cover was calculated for each quadrat, with the mean then calculated for each transect. These were graphed (with standard error) to show trends over time for each analogue and rehabilitation site, and the mean (and standard error) for all analogue and rehabilitation sites combined. The proportion of cover attributed to each stratum was graphed to show differences in composition between analogue and rehabilitation sites over time. Total cover and mean cover (with standard error) of overstorey species was graphed for each site and all analogue and rehabilitation sites combined, to compare differences between sites and over time. Total weed cover for each site and mean weed cover (with 95% confidence intervals (CI)) for all analogue and rehabilitation sites were calculated to show any significant difference in weed cover between sites, treatment and time.

For road infrastructure sites, the sum of native species cover (%) was graphed for each analogue and rehabilitation site from 2018 onwards: data from 2015 to 2017 was recorded as total native perennial cover. To compare differences between analogue and rehabilitation sites combined, mean cover (with standard error) were graphed. The proportion of cover attributed to each stratum was graphed to show differences in composition between analogue and rehabilitation sites from 2018 onwards, as individual species data was not recorded in previous years.

2.4 Specimen Identification, Taxonomy and Nomenclature

Plant specimens that were not identified in the field were brought to Perth and identified by Astron Botanists. The assigned nomenclature is consistent with the current listing of scientific names recognised by FloraBase (Western Australian Herbarium 2020) and was used for the species list and associated species information collected. Where there were germinants or plants with insufficient reproductive material to identify specimens to species level, best estimates of family and/or genus were used to differentiate the taxon. The nomenclature of some species recorded in previous years was updated following 2020 confirmed specimen identifications. Changes made to previous years' data are documented in the master data provided as an Excel spreadsheet separate to this report.

3 Results and Discussion

3.1 Seasonal Conditions

Due to inconsistencies with data collected at many of the weather stations situated around the Carina area, daily rainfall observations were obtained from Kalgoorlie-Boulder Airport weather station (number 012038) to quantify local rainfall preceding the monitoring survey (Bureau of Meteorology 2020). Seasonal conditions at the time of the field survey were slightly below average with 37.8 mm of rain recorded in the three months leading up to the field survey, compared to the long-term average of 48.0 mm for the same period (Figure 3). The majority of this rain was received in early November 2020 with a total of 32.6 mm. Prior to this, below average rainfall was recorded, except for February 2020 when 62.2 mm was recorded; double the long-term mean monthly rainfall. In the 12 months prior to the field survey a total of 179.4 mm rain was recorded, 86.7 mm below the long-term mean annual rainfall. This is similar to conditions experienced in 2019, whilst 2016 to 2018 each had above average annual rainfall (Figure 4). Annual rainfall recorded during the baseline survey in 2015 was below average, yet higher than both 2019 and 2020.

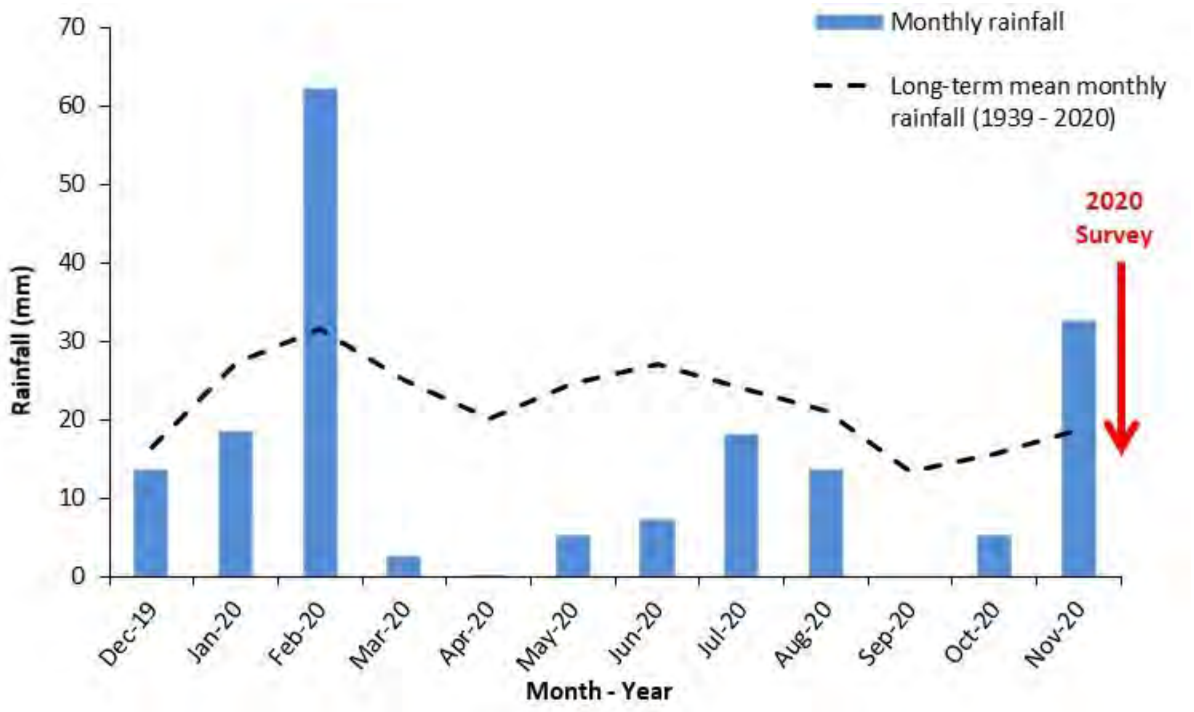

Figure 3: Monthly rainfall (mm) and long-term mean monthly rainfall (1939 to 2020) 12 months preceding the December 2020 survey. Data sourced from Kalgoorlie-Boulder Airport weather station number 012038 (Bureau of Meteorology 2020).

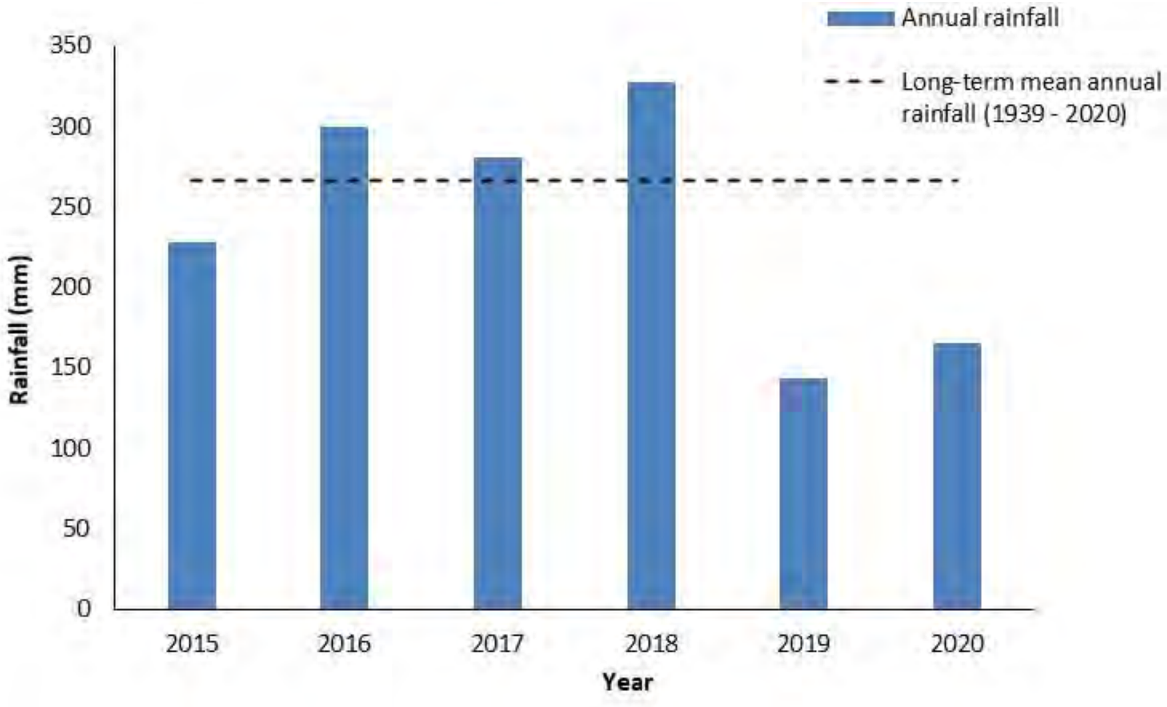

Figure 4: Total rainfall (mm) between 2015 and 2020, and long-term mean annual rainfall (1939 to 2020). Data sourced from Kalgoorlie-Boulder Airport weather station number 012038 (Bureau of Meteorology 2019).

3.2 Borrow Pits

No erosion, disturbance or evidence of fire were recorded at any of the analogue or rehabilitation sites between 2019 and 2020 (Table 5; Appendix C, Table C.1 (Rehabilitation) and Table C.4: SC01 to SC04 (Analogue)). Evidence of water pooling increased at all rehabilitation sites in 2020 and was evident at one of the analogue sites. A physical surface crust was present at almost all analogue and rehabilitation sites in 2020 but decreased overall since 2019. The average cover of cryptogams decreased in analogue sites compared to 2019 and have all but ceased to occur in rehabilitation sites in 2020 (cover < 0.1%).

Evidence of fauna was observed at all analogue and rehabilitation sites in both years. The most common fauna evidence observed in 2019 was invertebrate activity, with some kangaroo, emu, and rabbit activity.

The rehabilitation sites are dominated by rock cover, with low litter cover. However, the ground cover of the analogue sites is comprised primarily of litter, with moderate levels of bare ground and rock cover. The average cover of litter and bare ground has increased slightly at rehabilitation sites between 2019 and 2020 whilst rock cover decreased. Physical attributes at analogue sites have stayed relatively similar between 2019 and 2020.

Table 5: Borrow pit rehabilitation sites and corresponding analogue sites, physical characteristics summary in 2019 and 2020.

Site type	Year	Average plant cover (%)	Average boulder cover (%)	Average rock cover (%)	Average log cover (%)	Average litter cover (%)	Average bare ground (%)	Average cryptogam cover (%)	Surface crust presence	Evidence of water pooling	Erosion	Disturbance	Fauna evidence
Analogue	2019	11.8	Nil	22.4	0.1	38.9	28.5	10.2	4 of 4 sites	Absent	None	None	4 of 4 sites
	2020	11.3	Nil	23.9	0.1	38.9	25.0	9.5	4 of 4 sites	1 of 4 sites	None	None	4 of 4 sites
Rehabilitation	2019	10.8	Nil	55.8	0.3	14.9	28.7	0.3	4 of 4 sites	4 of 4 sites	None	None	4 of 4 sites
	2020	10.9	Nil	49.3	0.3	17.0	32.9	< 0.1	4 of 4 sites	4 of 4 sites	None	None	3 of 4 sites

3.2.1 Species Composition

Mean native species richness at the borrow pit rehabilitation sites remains significantly higher than the analogue sites ($F_{1,41} = 15.09$, $p < 0.001$; Figure 5 and Figure 6). A minor declining trend in mean native species richness has continued in 2020 as colonising species senesce and the vegetation community reaches a more stable state similar to the analogue sites. Three of the four rehabilitation sites have increased in species richness since 2015, with substantial increases at SR02 and SR03. Between 2019 and 2020, species richness remained the same at two rehabilitation sites and decreased slightly at SR02 and SR03. This decline was predominantly due to an absence of annual species and some perennial species loss as a result of dry seasonal conditions. In comparison, all analogue sites recorded the same species richness in 2019 and 2020. Species richness remains higher at all rehabilitation sites compared to their corresponding analogue sites, except for SR04. Overall species richness at the rehabilitation sites has remained relatively stable since 2016, which indicates a positive trend towards a permanent, self-sustaining vegetation community (Figure 5).

Two conservation significant flora species were recorded within the monitoring sites. *Grevillea georgeana* Priority (P) 3 has been recorded at SC03 in all monitoring years. This species was recorded within the rehabilitation for the first time in 2016, at SR03, where it has been recorded each year since. However, one *G. georgeana* P3 individual was recorded as dead in one of the two quadrats it occurs. *Lepidosperma lyonsii* P1 (previously P4) has been recorded at SC04 each year. This species was first recorded within the rehabilitation in 2017 at SR02 and remains present in 2020, though it was misidentified previously between 2018 and 2019.

Species dominance was significantly higher at rehabilitation sites compared to analogue sites ($F_{1,41} = 4.67$, $p = 0.037$; Figure 7 and Figure 8). Species dominance was similar at all rehabilitation sites compared to their corresponding analogue sites, except for SR03 which was dominated by *Acacia burkittii.* There has been an increasing trend for the dominance of this species each year since 2016, however it does not appear to be inhibiting the establishment of other native species: SR03 has had one of the highest species richness of all the rehabilitation sites since 2016. Species dominance for each rehabilitation site was similar between 2019 and 2020 indicating a stabilising vegetation community at the borrow pits (Figure 8).

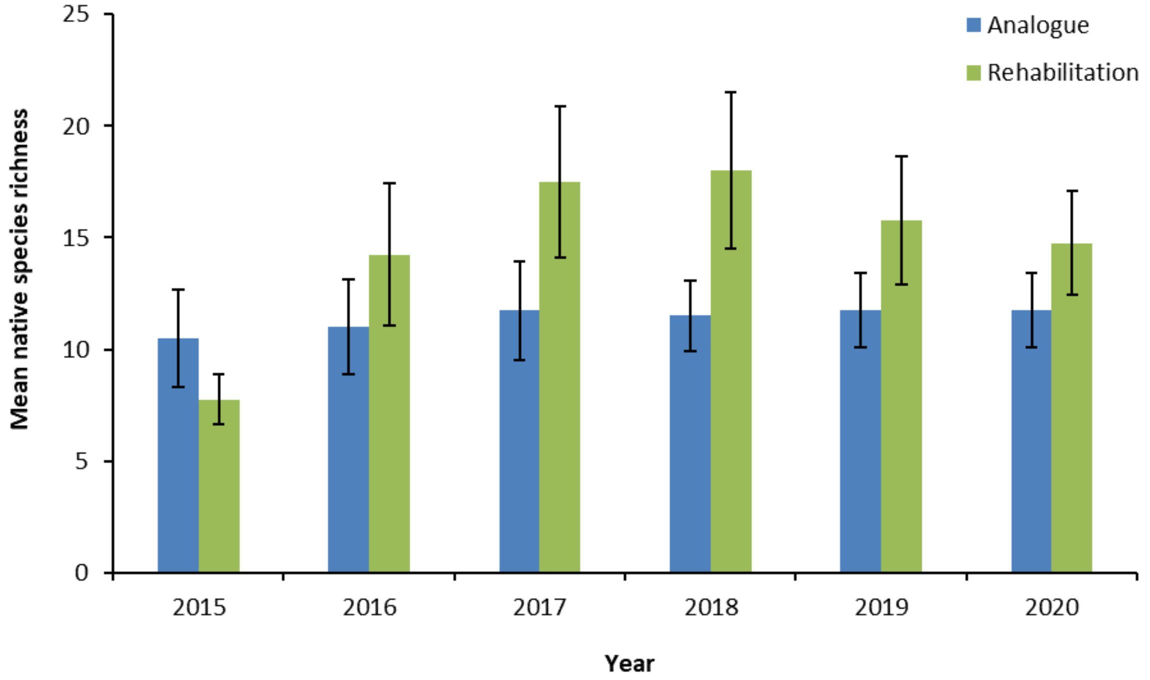

Figure 5: Mean native species richness for the borrow pit analogue and rehabilitation sites from 2015 to 2020. Error bars denote standard error.

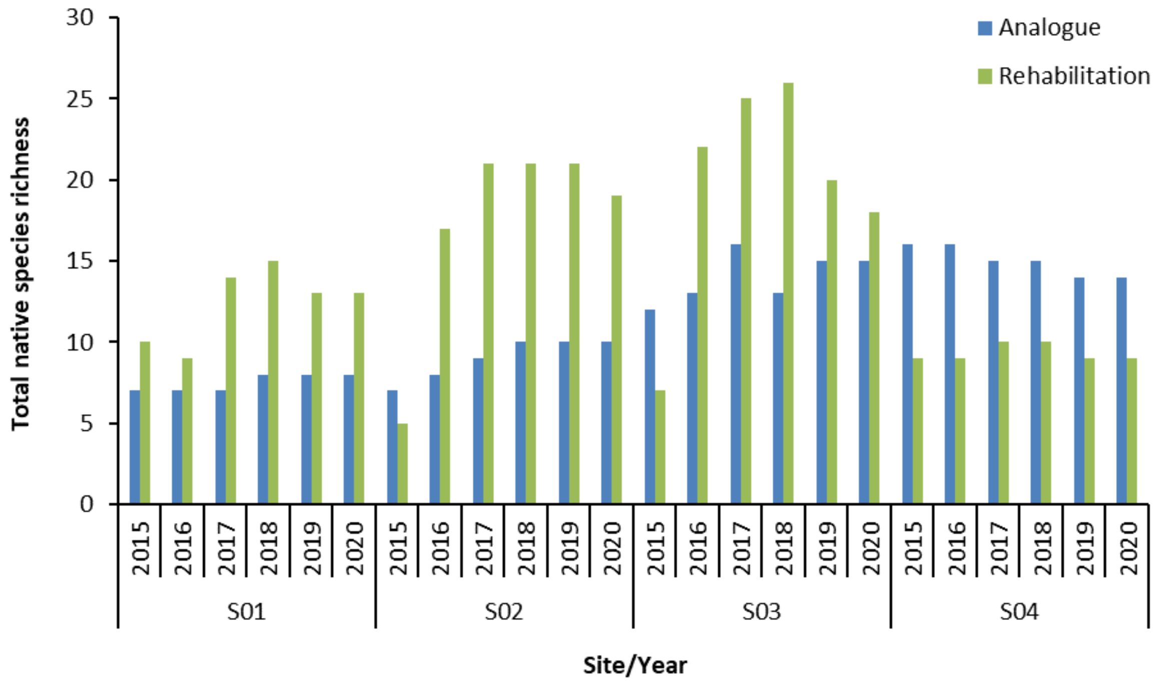

Figure 6: Total native species richness for each borrow pit analogue and rehabilitation site from 2015 to 2020.

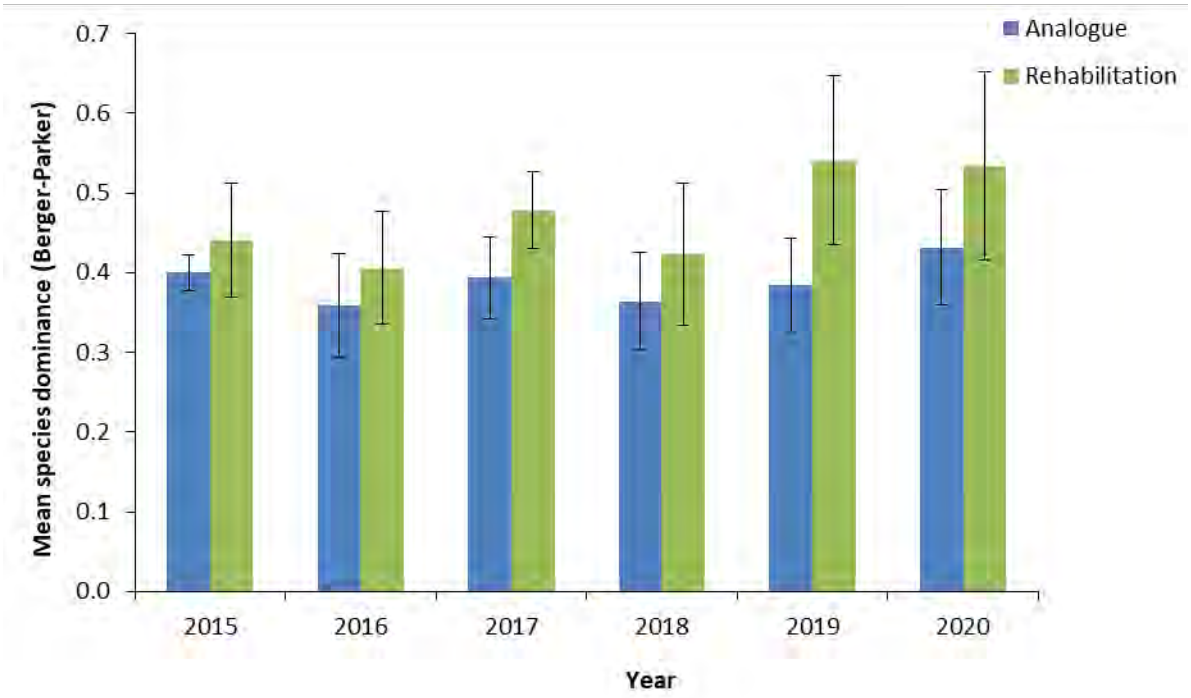

Figure 7: Mean species dominance as quantified by the Berger-Parker index for borrow pit analogue and rehabilitation site from 2015 to 2020. Error bars denote standard error.

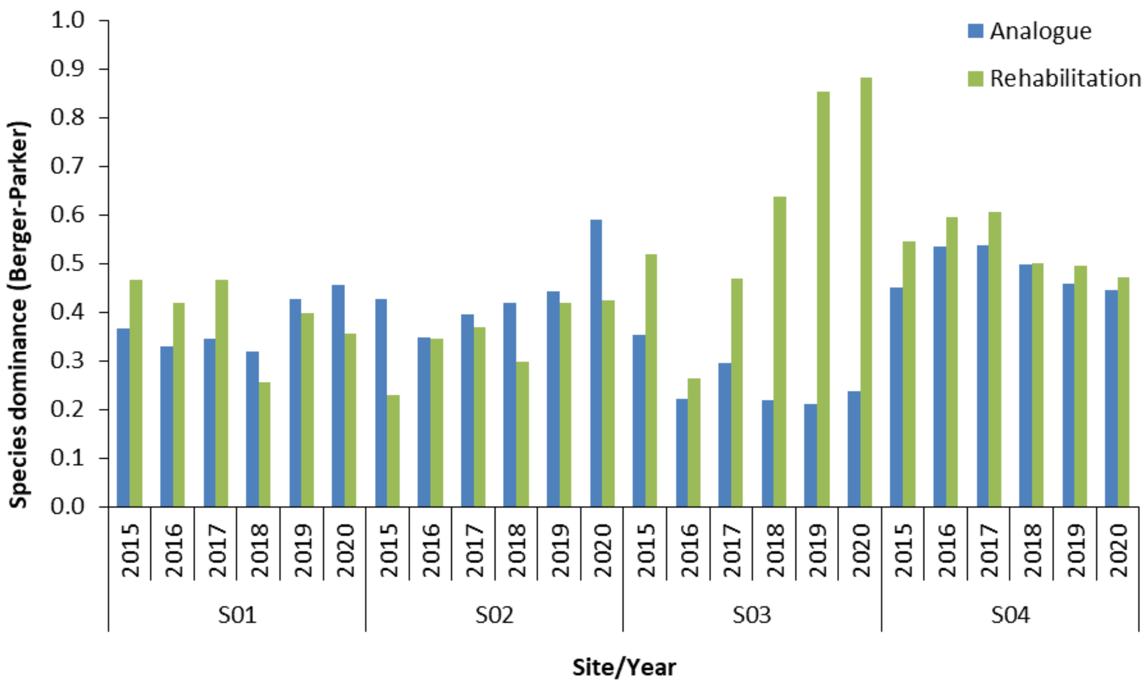

Figure 8: Species dominance as quantified by the Berger-Parker index for each borrow pit analogue and rehabilitation site from 2015 to 2020.

3.2.2 Native Cover

There was a significant year by site type interaction for mean native cover between the analogue and rehabilitation sites from 2015 to 2020 ($F_{1,41}$ = 23.25, p = < 0.01). However, this is most likely due to cover at analogue sites in 2015, which was significantly higher than rehabilitation sites. In 2020, cover at all rehabilitation sites was similar to analogue sites (Figure 9 and Figure 10). The rehabilitation sites as a whole remained similar in cover scores between 2019 and 2020, whilst the gradual trend of decline has remained evident at analogue sites ever since 2015.

The cover contributed by each stratum was different between all rehabilitation sites and their respective analogue site in 2020 (Figure 11). In general, the main difference was the presence of herb species, such as *Sclerolaena diacantha*, a higher proportion of low shrubs, such as *Maireana trichopteran* and *Seringia cacaobrunnea*, and a lower proportion of hummock grasses (i.e., *Triodia tomentosa*) at the rehabilitation sites compared to the analogue sites (Figure 12). The cover of herbs at the rehabilitation sites appear to have stabilised in 2020 from its declining trend over time, which is considered to be a natural succession as rehabilitation progresses. With the herb species dying off, it makes way for more permanent shrub and grass species that will be more effective at ensuring vegetation is self-sustaining in the long-term. In 2020, tall shrub cover was slightly higher at the rehabilitation sites, whilst the cover of low shrub and mid shrub species decreased from 2019. This trend indicates that the rehabilitation sites are moving towards a stable, self-sustaining vegetation structure similar to the analogue sites.

Rehabilitation site SR04 continues to display a similar vegetation structure to its respective analogue site (Figure 11). This is the oldest of all the rehabilitation sites, at eight years old, and has displayed similar vegetation structure to the analogue site since monitoring began in 2015; three years after rehabilitation was completed. The site is dominated by tall and mid shrub species, such as *Grevillea zygoloba*, *A. burkittii* and *A. sibina.* In contrast, cover at the analogue site is dominated by *Allocasuarina eriochlamys* subsp. *eriochlamys*, *Allocasuarina acutivalvis* subsp. *acutivalvis* and to a lesser extent *A. burkittii;* but like the rehabilitation site the dominant mid shrub species is *G. zygoloba*.

The remaining rehabilitation sites are now five and six years old, and whilst they are progressing towards a similar structure to their corresponding analogue sites, none of the sites are displaying similarities to the extent of SR04 with the respective analogue site (Figure 11). At SR01, there is still a large dominance of herb species, mainly *S. diacantha* and low cover of mid shrub species such as *Atriplex nummularia* and *Eremophila scoparia*, which dominate the analogue site. However, the slight decline in low shrub cover is trending towards the structure of the analogue site. At SR02, tall to low shrub species are dominant, such as *Melaleuca hamata, G. haplantha subsp. haplantha* and *Seringia cacaobrunnea*, compared to a dominance of the hummock grass species *T. tomentosa* at the analogue site. There was a slight increase in the proportion of *T. tomentosa* cover at the rehabilitation site since 2019, which is a promising sign after a minor reduction was recorded in 2018. *Triodia* spp. commonly have a low seed fill rate and can therefore take a long time to establish in rehabilitation sites (Erickson et al. 2016). SR03 continues to be dominated by the tall shrub species *A. burkittii*, which has increased in dominance every year since 2015. While the corresponding analogue site has a relatively even distribution of tussock grasses, mid shrubs and tall shrub species.

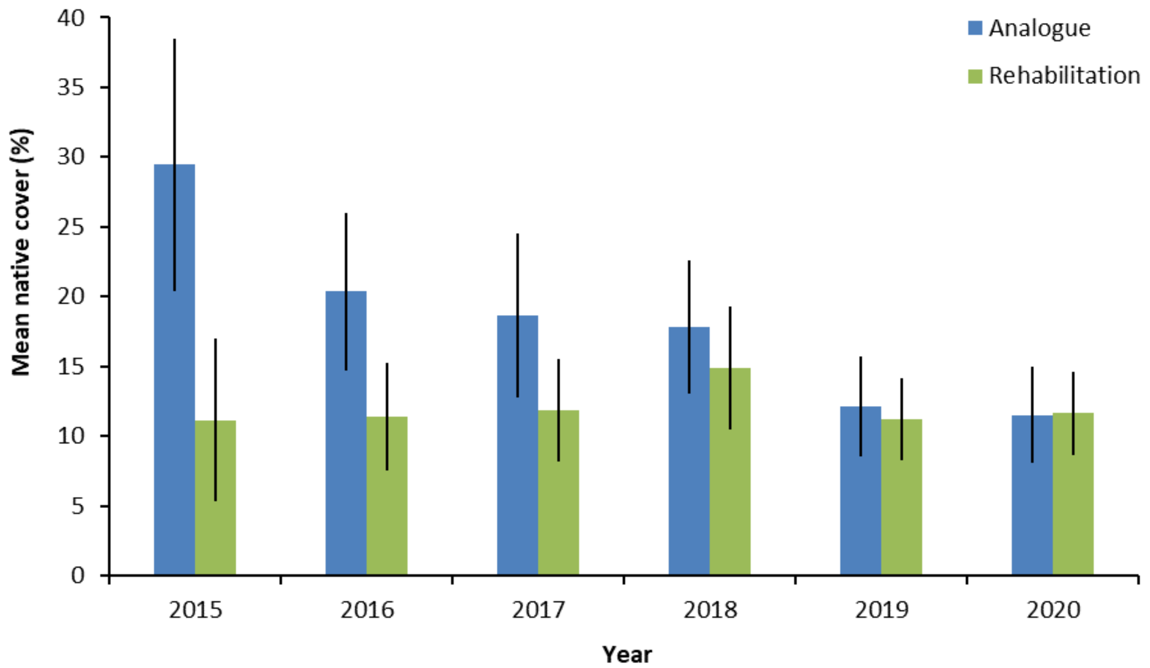

Figure 9: Mean native cover (%) at the borrow pit analogue and rehabilitation sites from 2015 to 2020.Error bars denote standard error.

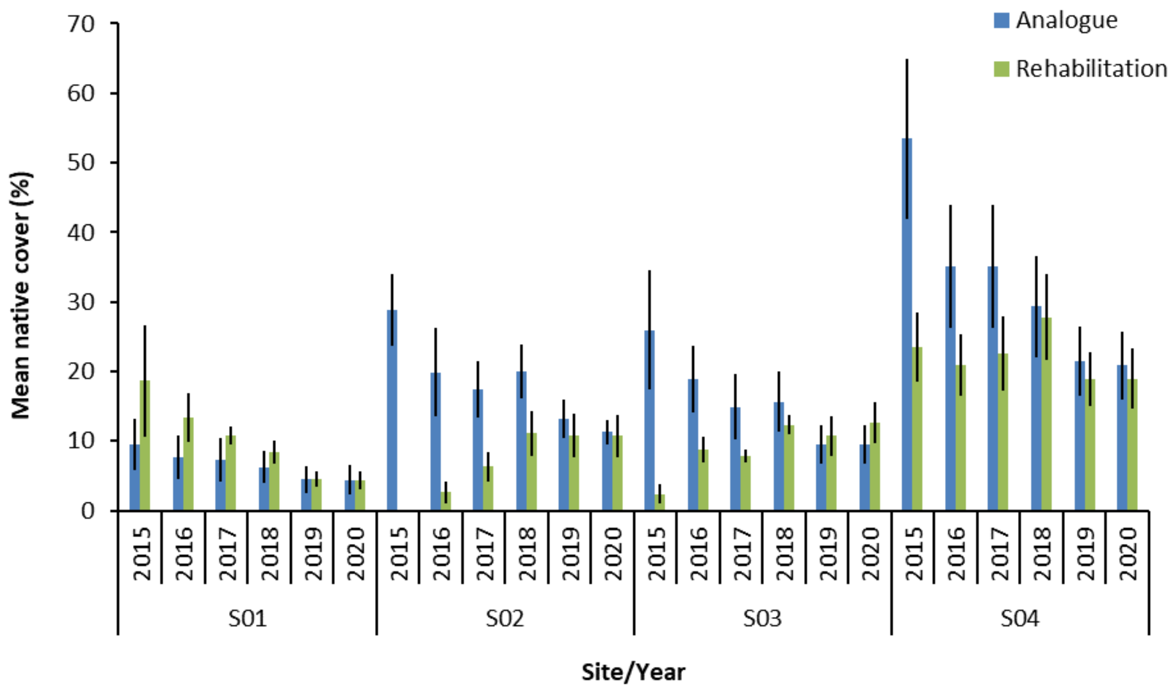

Figure 10: Mean native cover (%) at each of the borrow pit analogue and rehabilitation sites from 2015 to 2020. Error bars denote standard error.

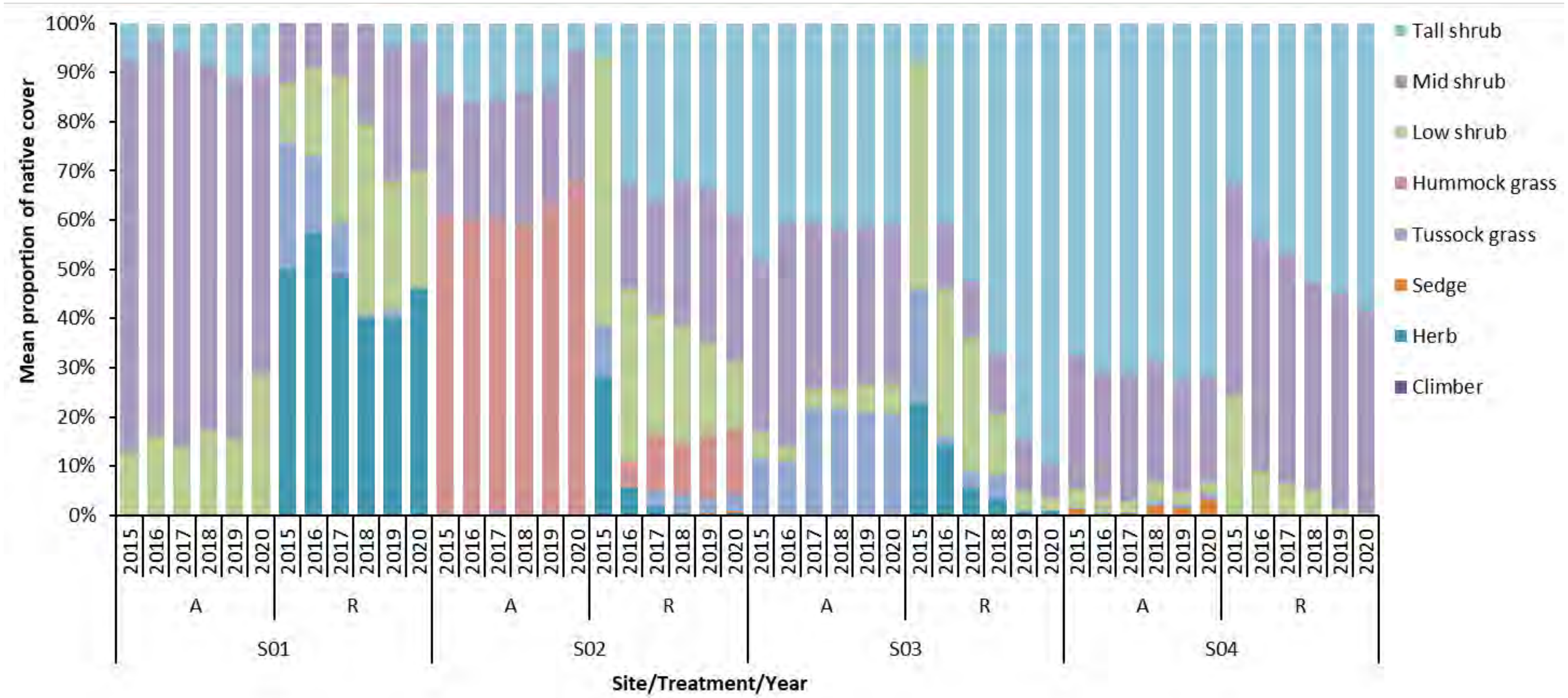

Figure 11: Mean proportion of native foliar cover (%) by stratum for each of the borrow pit analogue and rehabilitation sites from 2015 to 2020. A = analogue, R = rehabilitation.

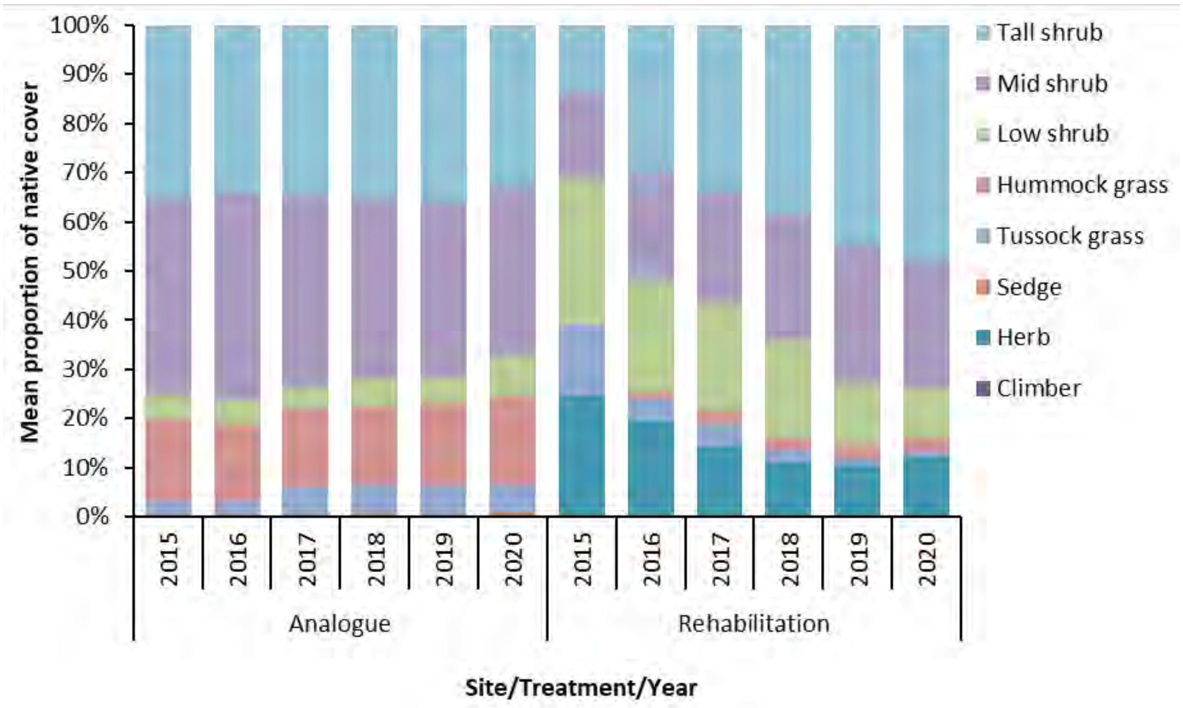

Figure 12: Mean proportion of native foliar cover (%) by stratum for the borrow pit analogue and rehabilitation sites from 2015 to 2020.

3.2.3 Plant Health and Dust Loading

Plant health recorded at the rehabilitation and analogue sites in 2019 was mostly in good to excellent condition (Figure 13). An overall increase in plant health was recorded across all rehabilitation and analogue sites between 2019 and 2020, likely attributable to November rain events. At SR03, the proportion of dead plants increased between 2019 and 2020, which were predominantly comprised of tussock grasses that are strongly affected by seasonal conditions. However, one individual of *G. georgeana* P3 was dead at SR03. Dead plants were recorded at three rehabilitation sites and one analogue site in 2020, compared to all two rehabilitation sites and two analogue sites in 2019. Dead plants at the rehabilitation sites were comprised of herbs, tussock grasses and low shrub species, which are most susceptible to dry seasonal conditions. Whereas, at the analogue sites, the dead plant consisted of a climber which was also dead in 2019.

Dust loading at rehabilitation and analogue sites was negligible in 2020, consistent with 2019 results (Figure 14). The extreme dust loads from 2017 have not re-occurred, indicating that the Carina Iron Ore Project is not having an impact on plant dust loads at the borrow pit rehabilitation sites.

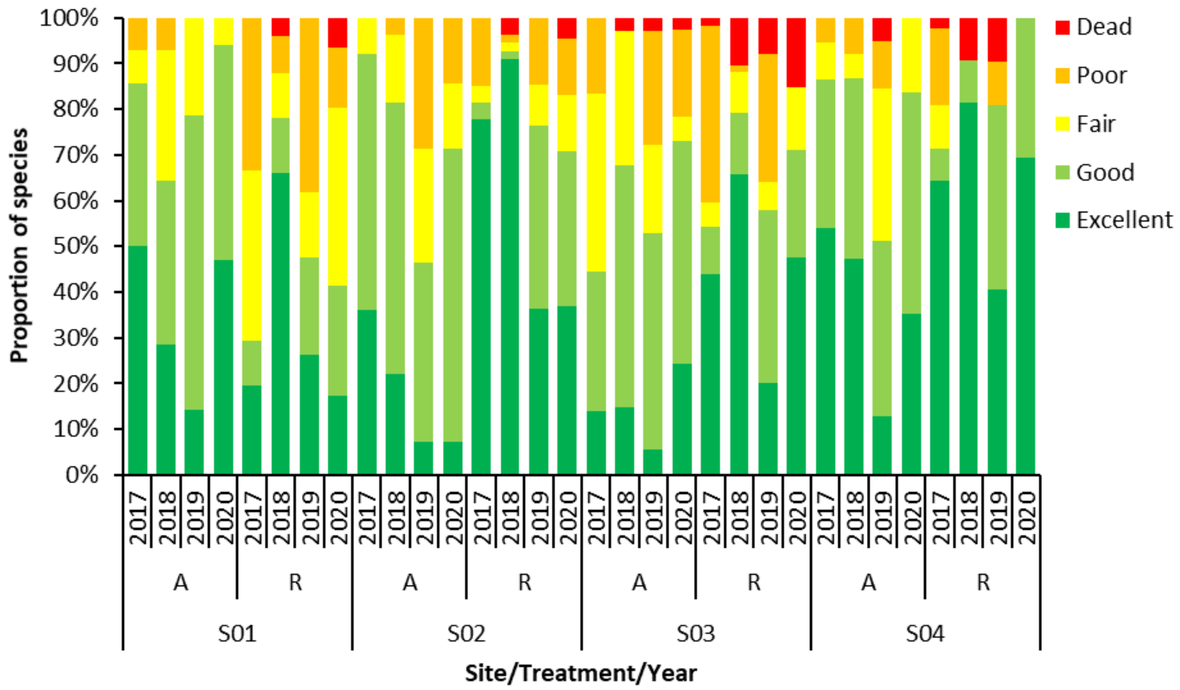

Figure 13: Plant health of understorey species at each of the borrow pit analogue and rehabilitation sites from 2017 to 2020. A = analogue, R = rehabilitation.

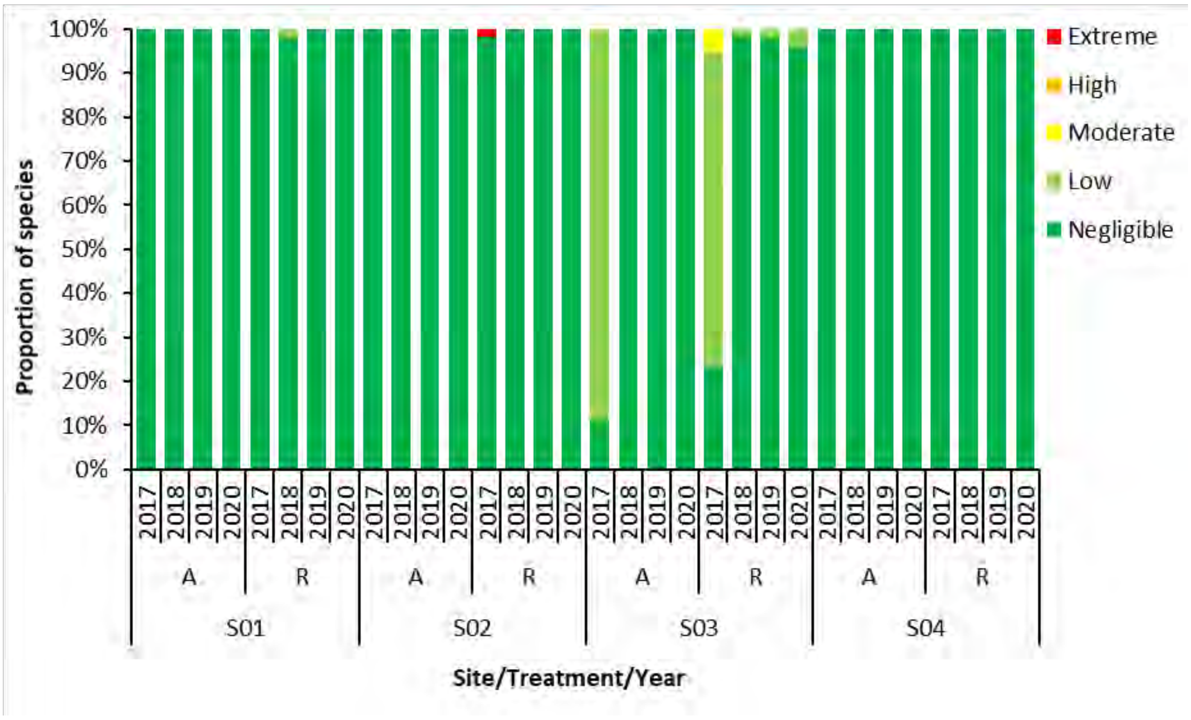

Figure 14: Dust loading of understorey species at each of the borrow pit analogue and rehabilitation sites from 2017 to 2020. A = analogue, R = rehabilitation.

3.2.4 Overstorey Species

In 2020, seven confirmed overstorey species were recorded across the rehabilitation and analogues sites (Table 6). Four confirmed *Eucalyptus* species were recorded at the rehabilitation sites, three of which were also recorded at the analogue sites. *Eucalyptus vittata* is present at the rehabilitation sites, but not at any analogue sites, whilst *Eucalyptus comitae-vallis, Santalum acuminatum* and *Callitris preissii* were recorded at the analogue sites but not at the rehabilitation sites.

Rehabilitation sites continue to be dominated by seedlings and juveniles, with only one site recording mature trees (SR01; Table 7). Site SR01 continues to show good establishment and succession of overstorey species, with seedlings, juveniles and mature trees recorded for the last four years and no dead trees recorded to date. This is a successful result given mature trees were first recorded in 2017, only three years after rehabilitation was completed; a good indication that SR01 supports self-sustaining vegetation. In contrast, vegetation at SR03 is the same age and dead mature trees were recorded in 2018 and 2020, with no juveniles having reached maturity in 2020. Sparse seedlings and juveniles are continually recorded at SR04 but none have reached maturity after six years of monitoring and eight years after rehabilitation was completed. Site SR02 has not recorded any overstorey species for the last three years: the last record was *Codonocarpus cotinifolius* juveniles in 2017.

The rehabilitation sites continue to have much lower overstorey cover compared to the analogue sites (Figure 15 and Figure 16). This is to be expected given the relatively young age of the rehabilitation and the dominance of seedlings and juveniles, compared to the mature trees at the analogue sites. In 2020, mean overstorey cover for all rehabilitation sites combined was slightly lower than 2019, predominantly due to lower cover of juvenile trees at SR01 and seedlings at SR03 (Figure 15, Figure 16 and Figure 17). The combined mean cover estimates for analogue sites were also slightly lower than 2019, which is likely influenced both by seasonal conditions and variation in observers.

Table 6: Overstorey species composition at the borrow pit analogue and rehabilitation sites from 2015 to 2020. Dashes indicate species not recorded.

Taxon	Number of analogue sites						Number of rehabilitation sites					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Callitris preissii	1	1	1	1	1	1	-	-	-	-	-	-
Codonocarpus cotinifolius	-	-	-	-	-	-	1	2	2	0	0	0
Eucalyptus comitae-vallis	1	1	1	1	1	1	-	-	-	-	-	-
Eucalyptus corrugata	2	2	2	2	3	3	0	1	1	1	1	1
Eucalyptus horistes	2	3	3	3	3	3	0	1	1	0	1	1
Eucalyptus oleosa subsp. *oleosa*	1	1	1	1	1	1	1	1	1	1	1	1
Eucalyptus vittata	-	-	-	-	-	-	2	2	2	2	2	2
Santalum acuminatum	1	2	2	2	2		-	-	-	-	-	-
Eucalyptus sp.	-	1	0	0	0		-	-	-	-	1	0

Table 7: Borrow pit analogue and rehabilitation sites overstorey species abundance scores for each stratum from 2015 to 2020.

Site	Site type	2015	2016	2017	2018	2019	2020
Seedling							
S01	Analogue	-	-	-	-	-	
	Rehabilitation	Sparse	Common	Sparse	Sparse	Sparse	Sparse
S02	Analogue	Sparse	Sparse	Sparse	Common	Common	Common
	Rehabilitation	-	Sparse	Sparse	-	-	-
S03	Analogue	-	-	-	-	-	-
	Rehabilitation	-	Sparse	Sparse	Sparse	Sparse	Sparse
S04	Analogue	-	-	-	-	-	-
	Rehabilitation	-	Sparse	Sparse	Sparse	Sparse	-
Juvenile							
S01	Analogue	-	Sparse	Sparse	Sparse	-	-
	Rehabilitation	Common	Common	Abundant	Common	Common	Sparse
S02	Analogue	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse
	Rehabilitation	-	Sparse	Sparse	-	-	-
S03	Analogue	-	-	-	Sparse	Sparse	Sparse
	Rehabilitation	Sparse	-	-	Sparse	Sparse	Sparse
S04	Analogue	-	-	-	-	-	-
	Rehabilitation	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse
Mature							
S01	Analogue	Abundant	Abundant	Abundant	Abundant	Common	Abundant
	Rehabilitation	-	-	Sparse	Sparse	Sparse	Common
S02	Analogue	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant
	Rehabilitation	-	-	-	-	-	-
S03	Analogue	Sparse	Sparse	Sparse	Common	Sparse	Sparse
	Rehabilitation	-	Sparse	Sparse	-	-	-
S04	Analogue	Sparse	Sparse	Common	Common	Sparse	Sparse
	Rehabilitation	-	-	-	-	-	-
Dead							
S01	Analogue	-	-	-	-	Sparse	-
	Rehabilitation	-	-	-	-	-	-
S02	Analogue	-	-	-	-	-	-
	Rehabilitation	-	-	-	-	-	-
S03	Analogue	-	-	-	-	-	-
	Rehabilitation	-	-	-	Sparse	-	Sparse
S04	Analogue	-	-	-	-	-	-
	Rehabilitation	-	-	-	-	Sparse	-

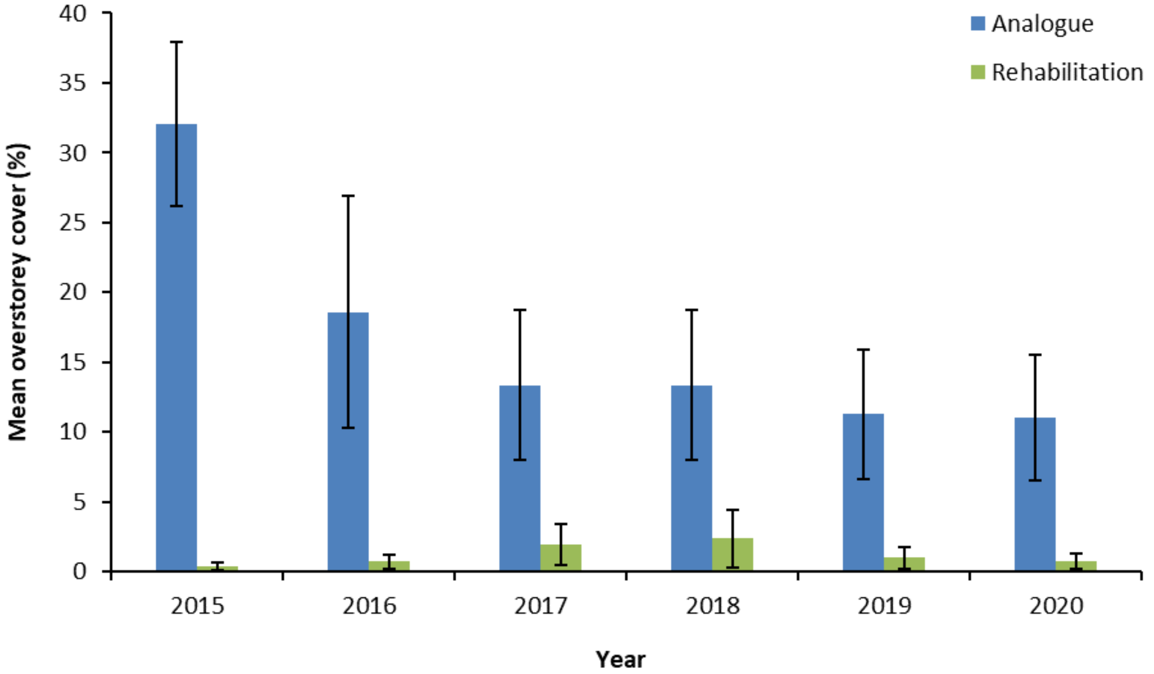

Figure 15: Mean cover (%) of overstorey species at the borrow pit analogue and rehabilitation sites from 2015 to 2020. Error bars denote standard error.

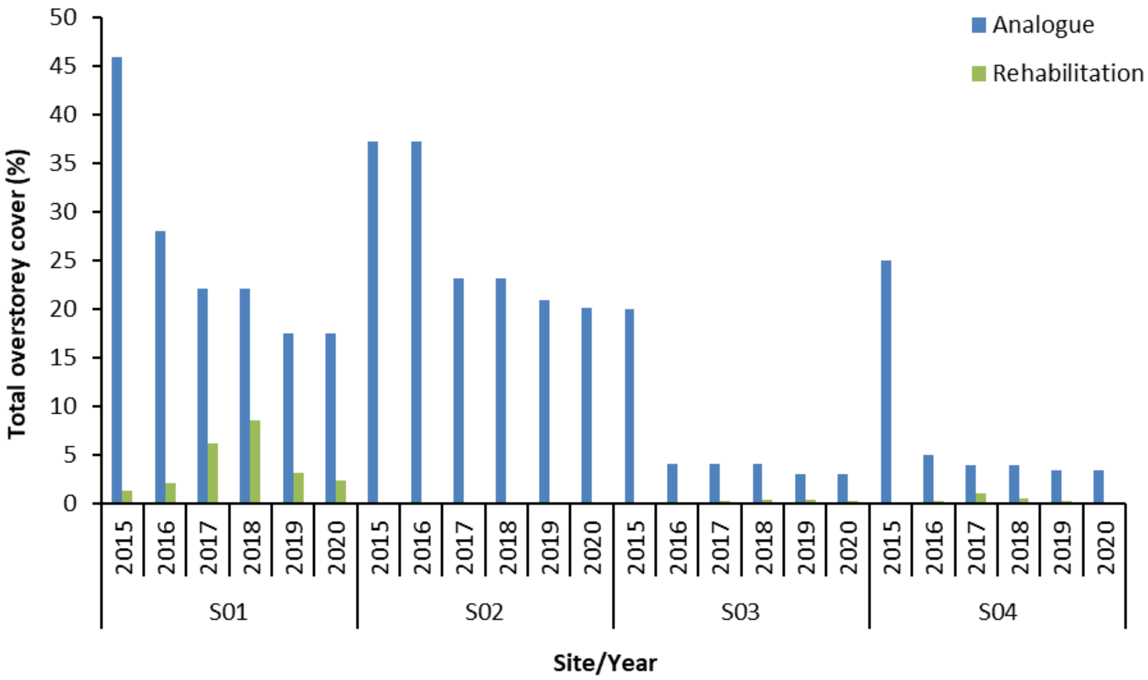

Figure 16: Total cover (%) of overstorey species at each of the borrow pit analogue and rehabilitation sites from 2015 to 2020.

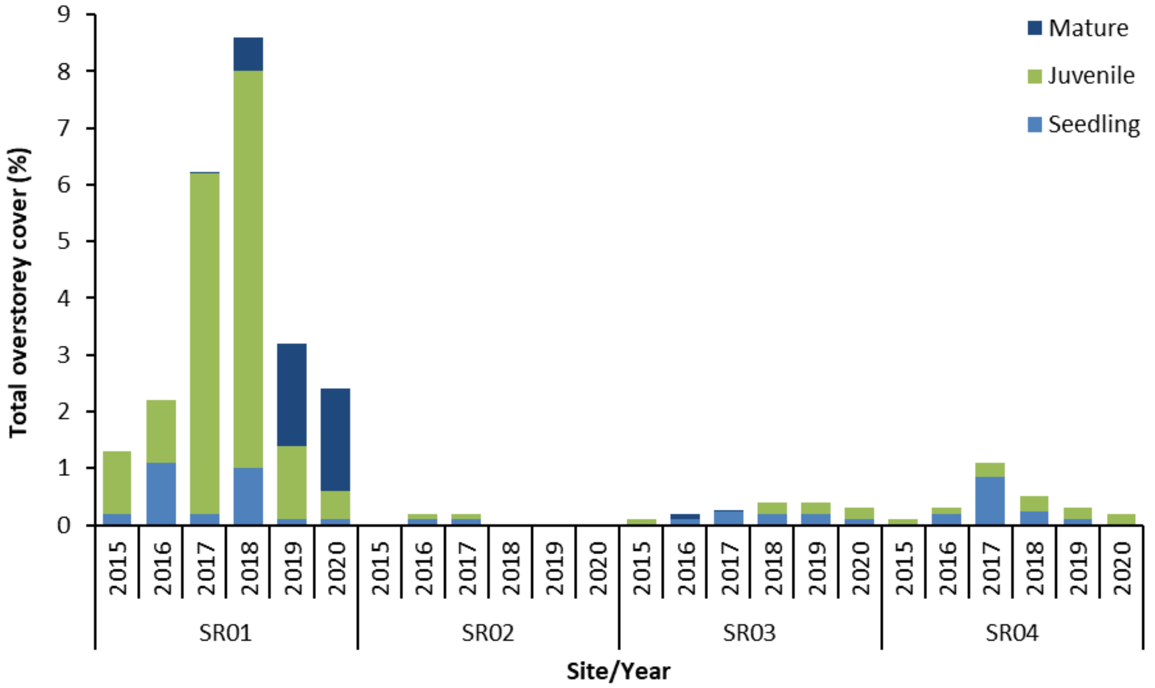

Figure 17: Total cover (%) of overstorey species in each life stage at each of the borrow pit rehabilitation sites from 2015 to 2020.

3.2.5 Weed Presence

Since the baseline survey in 2015, weed species have been recorded or observed at all rehabilitation sites except SR04 (Astron Environmental Services 2020b), however, in 2020 no weed species were recorded within the Borrow pit rehabilitation monitoring sites. No weeds have been recorded at any of the analogue sites since monitoring began in 2015. Both dead and live individuals were opportunistically observed just outside of rehabilitation monitoring site SR01, with evidence of recent chemical control observed. Weed management activities at the borrow pit rehabilitation sites appears to have been effective in reducing weed populations at the rehabilitated borrow pits.

3.3 Road Infrastructure

No disturbance was recorded at any of the analogue or rehabilitation sites between 2019 and 2020 (Table 8). Evidence of fire has been noted at PC01 during all monitoring years with one tree which is long burnt (>10 years) and dead. Evidence of water pooling was found at half of the rehabilitation sites and three of the analogue sites in 2020, with low level erosion continuing to occur, in the form of a minor rill, in one rehabilitation site. A physical surface crust was present at all but one analogue and one rehabilitation site for 2020.

Evidence of fauna was observed at nearly all analogue and rehabilitation sites in both years. The most common fauna evidence observed in 2020 was invertebrate activity, with some kangaroo, canine, reptile and emu activity observed from scats and tracks.

The rehabilitation sites are dominated by rock cover and bare ground, with low litter cover. However, the ground cover of the analogue sites is comprised primarily of bare ground and moderate levels of litter and rock cover. The most noticeable variation between 2019 and 2020 was the presence of cryptogams in rehabilitation sites.

Table 8: Road infrastructure rehabilitation sites and corresponding analogue sites physical characteristics summary in 2019 and 2020.

Site type	Year	Average plant cover (%)	Average boulder cover (%)	Average rock cover (%)	Average log cover (%)	Average litter cover (%)	Average bare ground (%)	Average cryptogam cover (%)	Surface crust presence	Evidence of water pooling	Erosion	Disturbance	Fauna evidence
Analogue	2019	18.1	Nil	7.1	0.3	24.0	50.4	18.1	9 of 9 sites	Nil	None	None	8 of 9 sites
	2020	16.5	Nil	4.9	0.3	25.4	51.3	17.8	8 of 9 sites	3 of 9 sites	None	None	6 of 9 sites
Rehabilitation	2019	5.0	Nil	16.1	Nil	4.4	79.4	Nil	9 of 9 sites	5 of 9 sites	None to Low	None	9 of 9 sites
	2020	6.8	Nil	16.1	Nil	5.0	78.8	0.2	8 of 9 sites	5 of 9 sites	None to Low	None	8 of 9 sites

3.3.1 Species Composition

Mean native species richness at the road infrastructure rehabilitation sites continues to be lower at the rehabilitation sites compared to the analogue sites, however the difference was not significant (Figure 18; $F_{1,42}$ = 3.74, p = 0.053). Species richness was lower at five of the nine rehabilitation sites compared to their respective analogue sites, whilst two sites were equal (P02 and P03), and two sites had higher species richness than their analogue site counterparts (P04 and P08; Figure 19). Four rehabilitation sites recorded a decline in species richness between 2019 and 2020, predominantly due to a reduction in herb and low shrub species as a result of dry seasonal conditions.

Species dominance was overall higher at the rehabilitation sites compared to analogue sites, however the difference was not significant (Figure 20; $F_{1,42}$ = 3.93, p = 0.054). An increase in species dominance was recorded at five of the nine rehabilitation sites between 2019 and 2020, however this was due to the absence of some species and/or declines in species cover rather than an increase in the proportional cover of dominant species (Figure 21). At a site level, species dominance in 2020 was notably higher at rehabilitation sites compared to their corresponding analogue sites for PR02, PR03 and PR09 (Figure 21): PR02 was dominated by *A. burkittii*; PR03 was dominated by *Acacia heteroneura* var. *heteroneura* and PR09 was dominated by *Eucalyptus* ?*salubris* (confirmed identification to species level not possible due to juvenile life stage and lack of reproductive features).Species dominance was lower at PR01 and PR08 compared to their corresponding analogue sites in 2020, due to the dominance of *Alyxia buxifolia* and *Atriplex vesicaria*, respectively.

One conservation significant species was recorded at one rehabilitation site in both 2019 and 2020: *Calytrix creswellii* P3 was recorded at PR06. The individual was not growing in the rehabilitation site, rather foliage was overhanging from adjacent undisturbed vegetation. There is the potential that, over time, reproductive material may be dispersed in the rehabilitation site and germination may occur in the future.

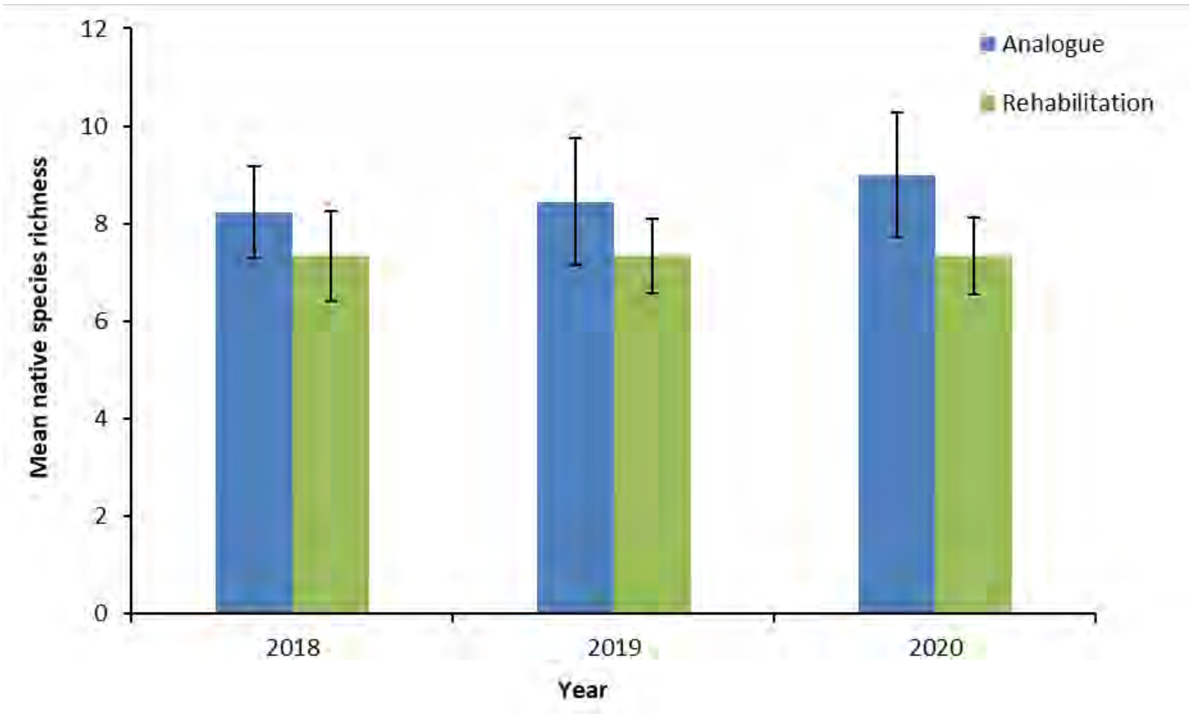

Figure 18: Mean native species richness at the road infrastructure analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

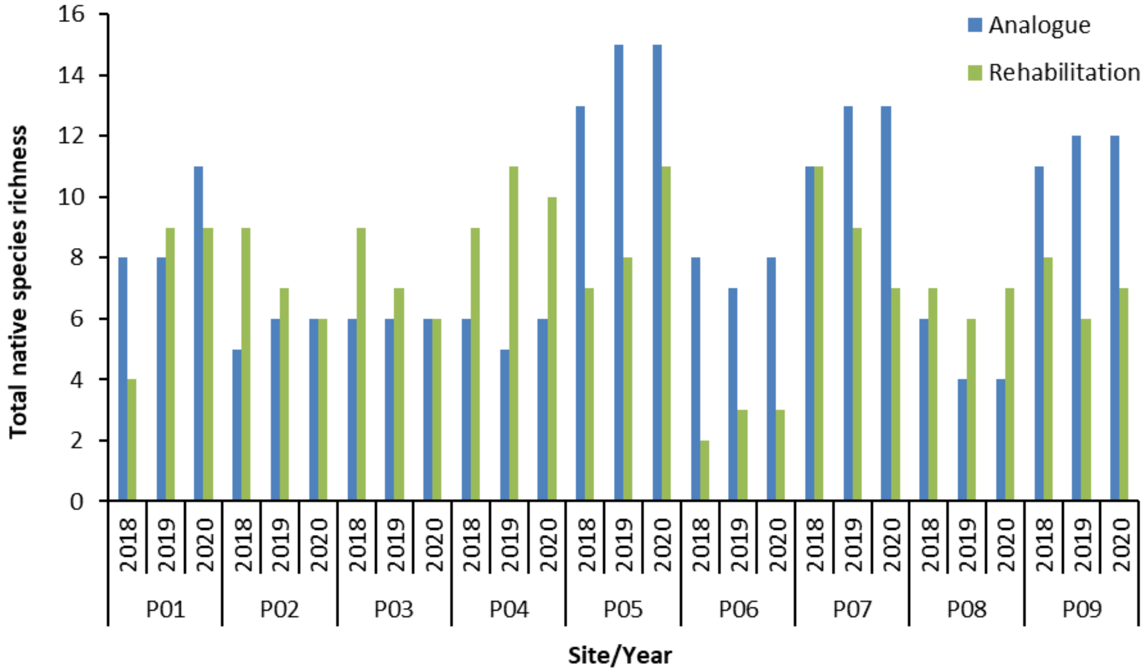

Figure 19: Total native species richness for each of the road infrastructure analogue and rehabilitation sites from 2018 to 2020.

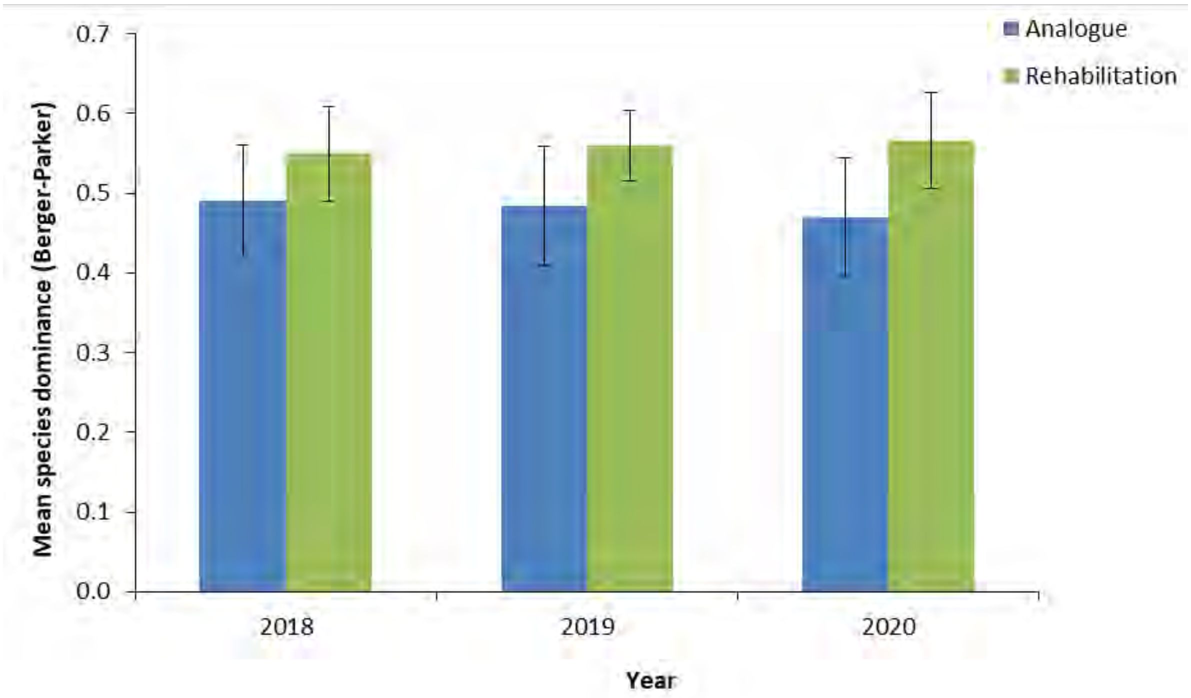

Figure 20: Species dominance as quantified by the Berger-Parker index for road infrastructure analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

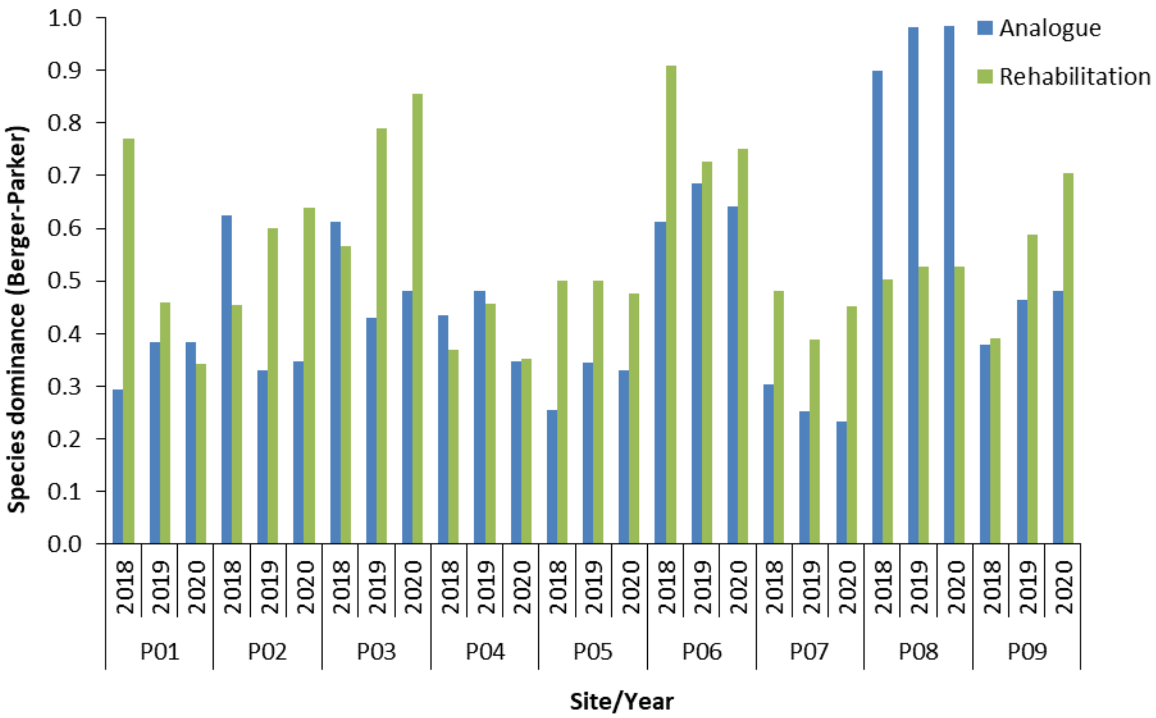

Figure 21: Species dominance as quantified by the Berger-Parker index for each road infrastructure analogue and rehabilitation site from 2018 to 2020.

3.3.2 Native Cover

Mean native cover at the rehabilitation sites remains significantly lower than the analogue sites, (Figure 22; $F_{1,50} = 24.46$, $p < 0.001$). There was a slight increase in native cover at the rehabilitation sites between 2019 and 2020, after a decline was recorded between 2018 and 2019. Conversely, there was a slight decrease in cover at the analogue sites. The difference in cover is likely to be attributable to the ability of each site to tolerate changing seasonal conditions and the resulting growth or decline of annual and herbaceous species.

In 2020, total native cover at all except one rehabilitation site (PR07) was lower than their corresponding analogue sites (Figure 23). Between 2019 and 2020, cover increased slightly at six of the nine rehabilitation sites, decreased at two and equalled at one. There were no notable reductions in cover at either analogue or rehabilitation sites and most can be attributed to lower cover of herb and low shrub species which are more susceptible to dry seasonal conditions. Native cover remains low (1.2% to 3.8%) at PR01, PR05 and PR06 with a small improvement since rehabilitation was completed in 2015. This is a concerning result after five years of rehabilitation and suggests that these three sites have not yet begun to establish a self-sustaining vegetation community.

The cover contributed by each stratum remains different between the rehabilitation and analogue sites in 2020 (Figure 24). The main difference continues to be the higher proportion of herb species, such as *S. diacantha,* and tree species such as *Eucalyptus comitae-vallis*, *E. transcontinentalis* and *E. ?salubris* (confirmed identification to species level not possible due to juvenile state and lack of reproductive features)*,* at the rehabilitation sites compared to the analogue sites. Although a continued declining trend in herb species is trending towards a similar structure to the analogue sites. None of the rehabilitation sites are displaying substantial similarities in vegetation structure to their corresponding analogue sites in 2020, except for PR01 which had no herbs in 2020, declined in mid shrub species and increased in tall shrub species cover towards that of the analogue site PC01.

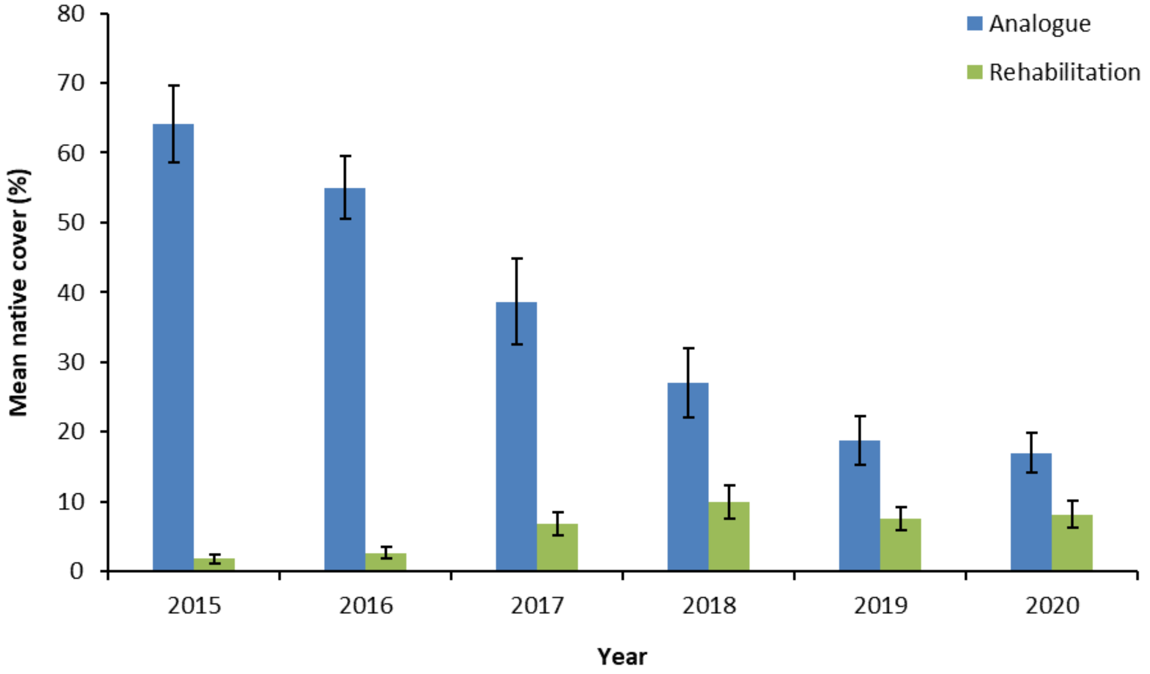

Figure 22: Mean native cover (%) at the road infrastructure analogue and rehabilitation sites from 2015 to 2020. Error bars denote standard error.

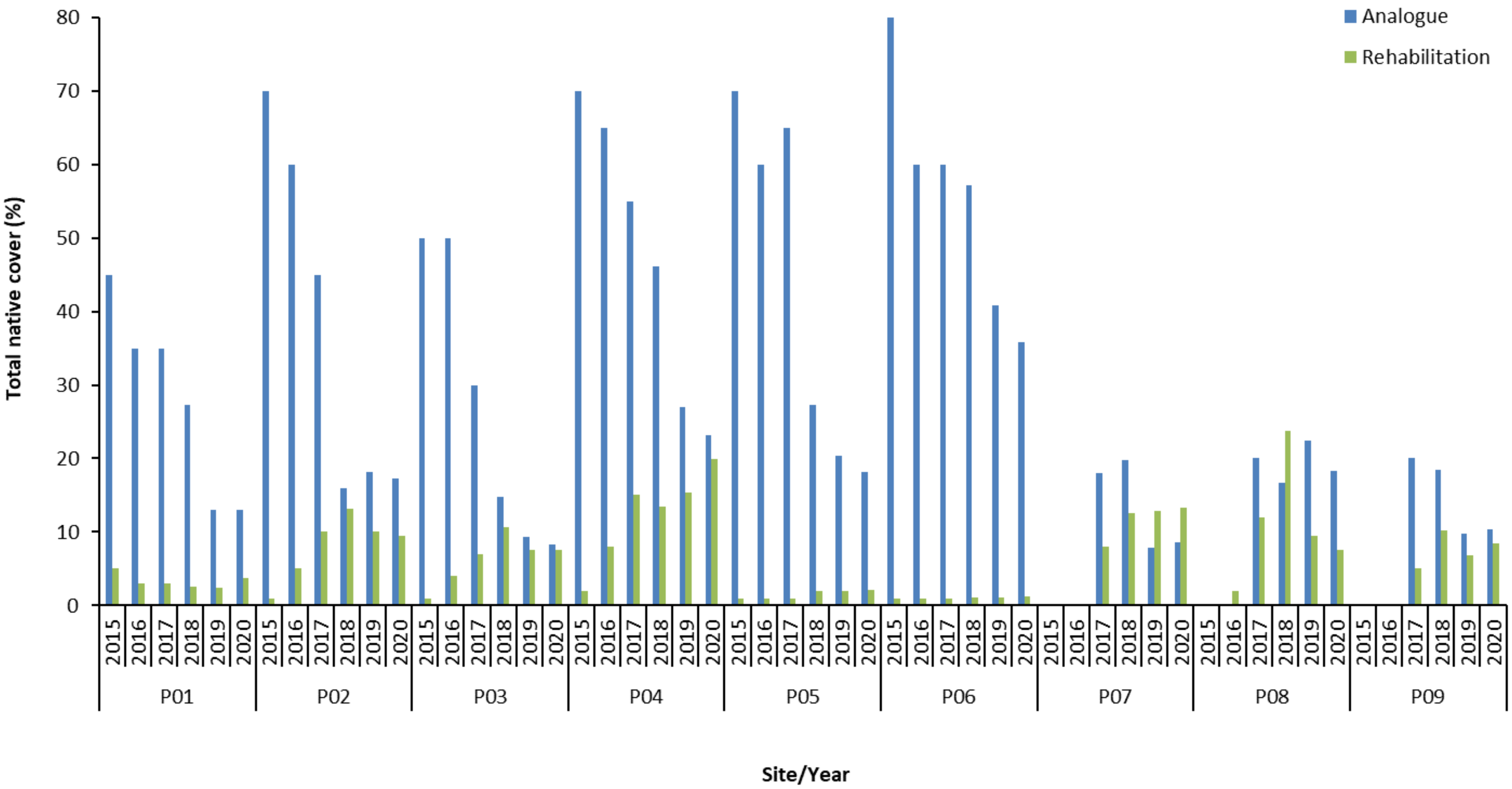

Figure 23: Total native cover (%) for each of the road infrastructure analogue and rehabilitation sites from 2015 to 2020. NB: Rehabilitation sites P07, P08 and P09 installed in 2016. Analogue sites P07, P08 and P09 installed in 2017.

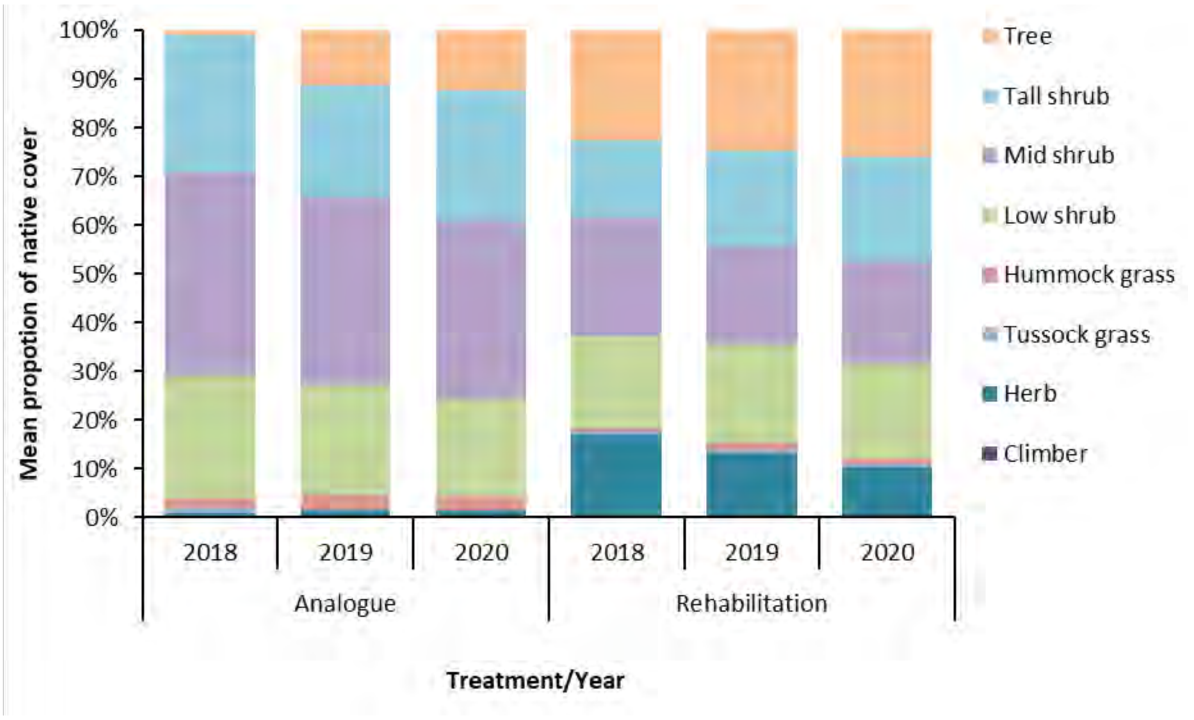

Figure 24: Mean proportion of native foliar cover (%) by stratum for the road infrastructure analogue and rehabilitation sites from 2018 to 2020.

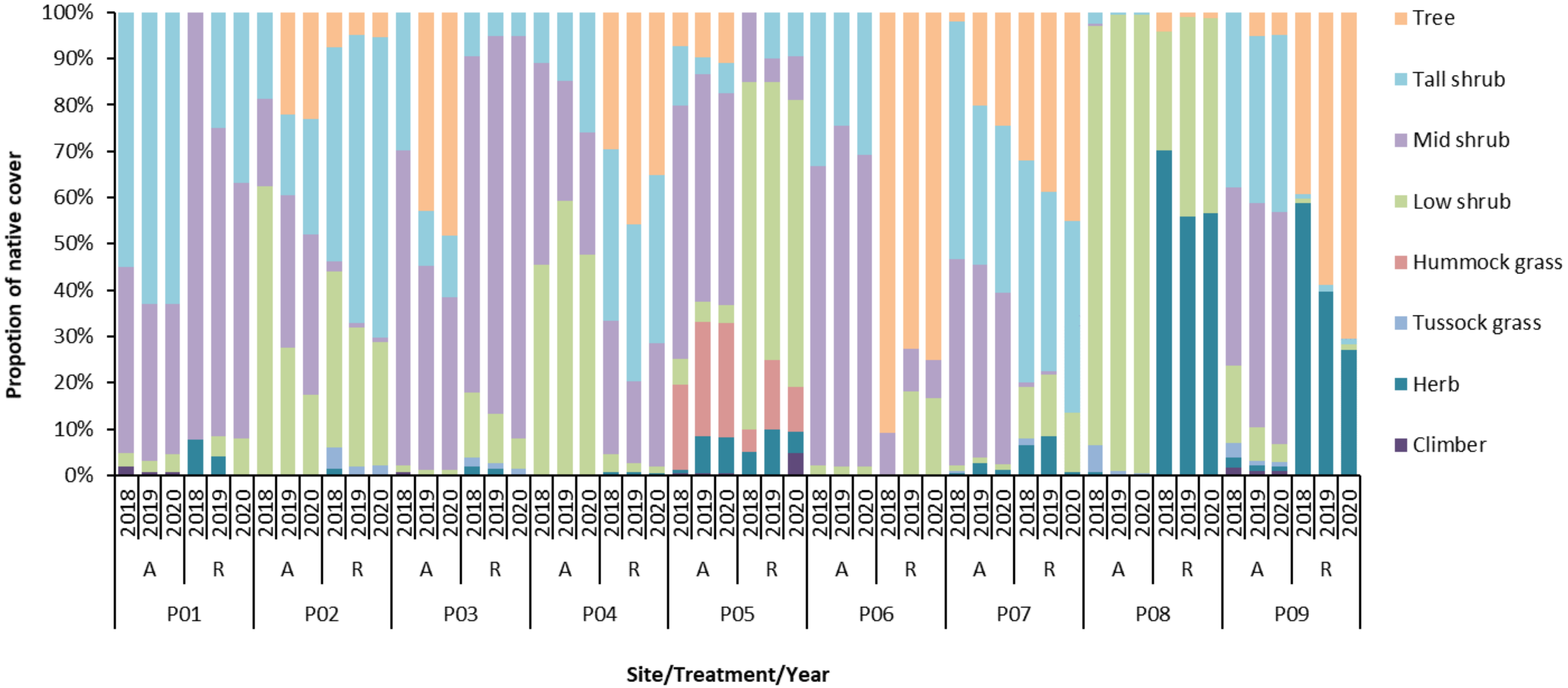

Figure 25: Proportion of native foliar cover (%) by stratum for each of the road infrastructure analogue and rehabilitation sites from 2018 to 2020. A = analogue, R = rehabilitation.

3.3.3 Plant Health and Dust

The majority of plants in 2020 were in excellent to good condition at the rehabilitation sites and fair to good condition at the analogue sites (Figure 26a). Overall, the analogue sites had a higher proportion of plants in poor to fair condition compared to the rehabilitation sites. There was a general increase in plant health between 2019 and 2020 for the rehabilitation and analogue sites, which can be attributed to the late November rain events. Dead plants were recorded at two rehabilitation sites and two analogue sites. Plant deaths comprised predominantly herbs and annual species which are susceptible to dry conditions.

Similar to 2019, overall dust loading was negligible in 2020 at the rehabilitation and analogue sites (Figure 26b). The two rehabilitation sites that recorded low dust loads in 2018 had negligible dust loads in 2019 and 2020. The one analogue site containing low dust scores increased slightly in 2020. The similarities in plant health and dust loading between analogue and rehabilitation sites indicate that the Carina Iron Ore Project is not having a negative impact on plant health, nor is it increasing plant dust loading at the road infrastructure rehabilitation sites.

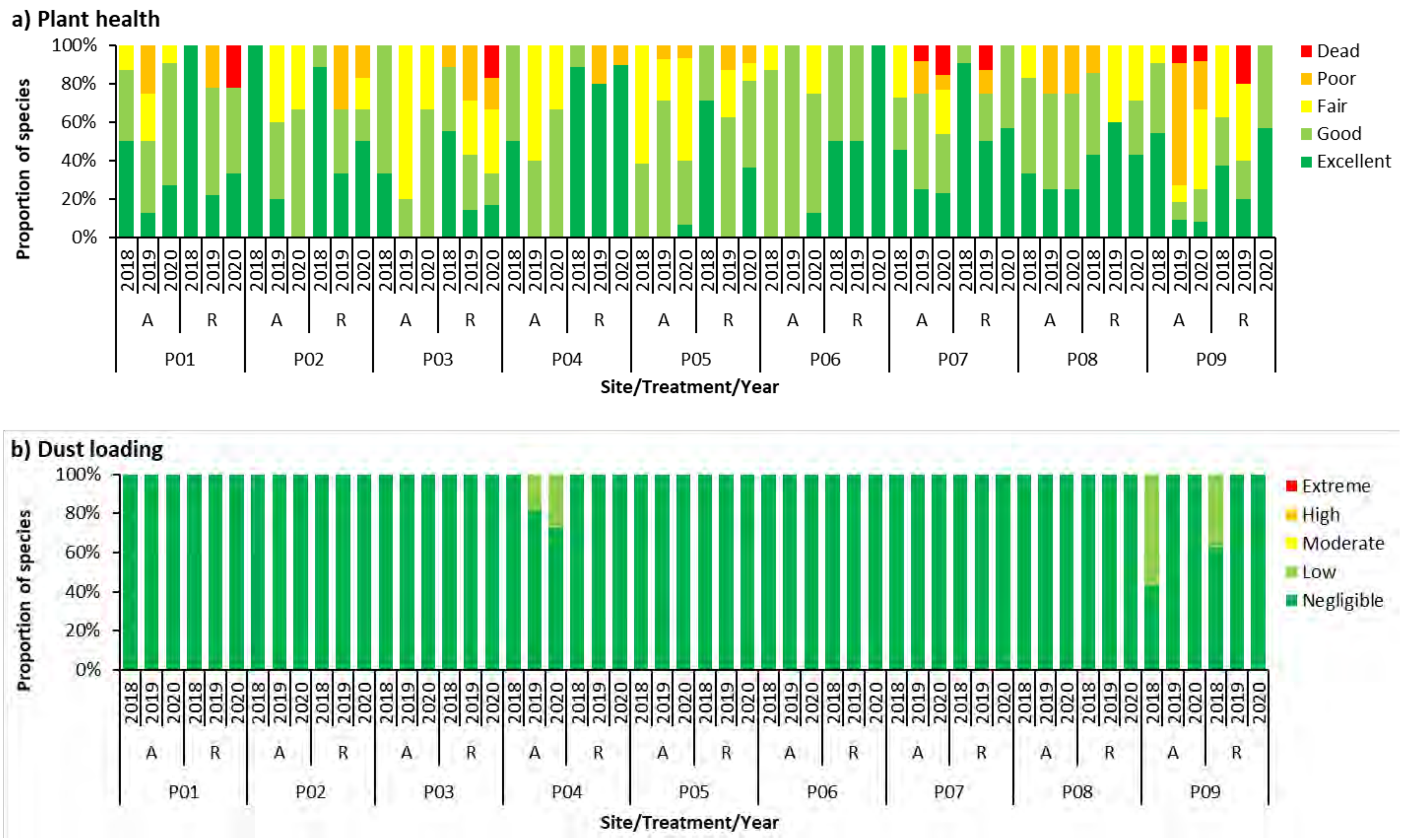

Figure 26: Plant health (a) and dust loading (b) of species at each of the road infrastructure analogue and rehabilitation sites from 2018 to 2020. A = analogue, R = rehabilitation.

3.3.4 Weed Presence

No weeds were recorded at any of the rehabilitation and analogue sites in 2019 or 2020.

3.4 Carina Waste Rock Landform

No disturbance was recorded at any of the analogue or rehabilitation sites in 2019 and 2020 (Table 9; Appendix C, Table C.2 (Rehabilitation) and Table C.4, SC05, SC06 and SC10 (Analogue)). Evidence of previous water pooling was found at two out of three analogue sites in 2020, the same as in 2019. All rehabilitation sites continued to show signs of water pooling in 2020. A physical surface crust was present at all analogue and rehabilitation sites for both years.

Evidence of fauna was observed at two analogue sites and three rehabilitation sites, a slight decrease from 2019. The most common fauna evidence observed in 2020 was invertebrate activity, with some kangaroo and rabbit activity observed as scats and grazing.

Rehabilitation sites are dominated by rock cover, a moderate amount of bare ground and low levels of litter and plant cover. Analogue sites are also comprised primarily of rock cover, with moderate cover of litter and bare ground, and low plant cover.

Erosion was still absent at all analogue sites in 2020, however it is present at all rehabilitation sites with levels ranging from low to extensive. Two of five sites exhibited a slight increase in the average number of rills, with the maximum number of rills recorded at SR23 (four rills recorded within a single quadrat in both 2019 and 2020; Table 10). Average maximum rill width and depth altered slightly between 2019 and 2020 but remained relatively similar at all sites. Maximum rill width and depth recorded within a single quadrat was largest at SR21, with 1.70 m and 0.80 m, respectively. This is only a slight change from 2019 which indicates stable rills/gullies at the monitoring sites. Photographs and GPS coordinates for each rill/gully at the rehabilitation sites are provided in Appendix D.

Table 9: Carina waste rock landform rehabilitation sites and corresponding analogue sites physical characteristics summary in 2019 and 2020.

Site type	Year	Average plant cover (%)	Average boulder cover (%)	Average rock cover (%)	Average log cover (%)	Average litter cover (%)	Average bare ground (%)	Average cryptogam cover (%)	Surface crust presence	Evidence of water pooling	Erosion	Disturbance	Fauna evidence
Analogue	2019	3.4	Nil	54.0	0.1	23.8	16.1	6.1	3 of 3 sites	2 of 3 sites	None	None	3 of 3 sites
	2020	3.4	Nil	53.5	0.1	23.2	15.4	7.7	3 of 3 sites	2 of 3 sites	None	None	2 of 3 sites
Rehabilitation	2019	5.5	0.9	66.2	0.1	3.7	29.3	Nil	5 of 5 sites	5 of 5 sites	None to Extensive	None	4 of 5 sites
	2020	4.8	0.9	64.8	0.1	2.9	28.8	Nil	5 of 5 sites	5 of 5 sites	None to Extensive	None	3 of 5 sites

Table 10: Erosion monitoring at each of the Carina waste rock landform rehabilitation sites in 2019 and 2020. NB: parenthesis denotes maximum recorded within a single quadrat.

Site	Year	Average no. rills	Average maximum rill width (m)	Average maximum rill depth (m)
SR21	2019	0.90 (2)	0.43 (1.65)	0.34 (0.80)
	2020	1.10 (2)	0.49 (1.70)	0.29 (0.80)
SR22	2019	0.50 (2)	0.07 (0.50)	0.02 (0.15)
	2020	0.40 (2)	0.10 (0.72)	0.03 (0.15)
SR23	2019	1.60 (4)	0.19 (0.50)	0.07 (0.20)
	2020	1.80 (4)	0.22 (0.53)	0.07 (0.22)
SR24	2019	0.70 (3)	0.12 (0.62)	0.05 (0.20)
	2020	0.40 (2)	0.09 (0.40)	0.02 (0.10)
SR25	2019	1.00 (3)	0.15 (0.46)	0.04 (0.15)
	2020	1.00 (2)	0.20 (0.60)	0.04 (0.08)

3.4.1 Species Composition

Mean native species richness at the Carina WRL continues to be significantly lower at the rehabilitation sites compared to the analogue sites (Figure 27; $F_{1,20} = 6.23$, $p = 0.02$). This is not unexpected given that most of the rehabilitation is only five years old. A slight increase in mean species richness was recorded at the rehabilitation sites between 2019 and 2020. Total species richness was similar for each of the rehabilitation sites between 2019 and 2020 (Figure 28).

Mean species dominance was significantly higher at the rehabilitation sites than the analogue sites (Figure 29; $F_{1,19} = 6.74$, $p = 0.02$). A decline in species dominance at the rehabilitation sites has been recorded in both 2019 and 2020, indicating that the vegetation is progressing to be similar to the analogue sites. At a site level, SR21, SR24 and SR25 all declined in species dominance from 2019 to be lower than the mean of the analogue sites (Figure 30). This is a positive trend that demonstrates a diversity of species contributing to vegetation cover. Site SR23 continues to be highly dominated by *Maireana triptera,* with an increase in the dominance of this species also recorded at SR22. Five years post rehabilitation it is expected that the dominance of short-lived Chenopods would be declining at this stage making way for a more permanent vegetation structure of long-lived species as the rehabilitation progresses.

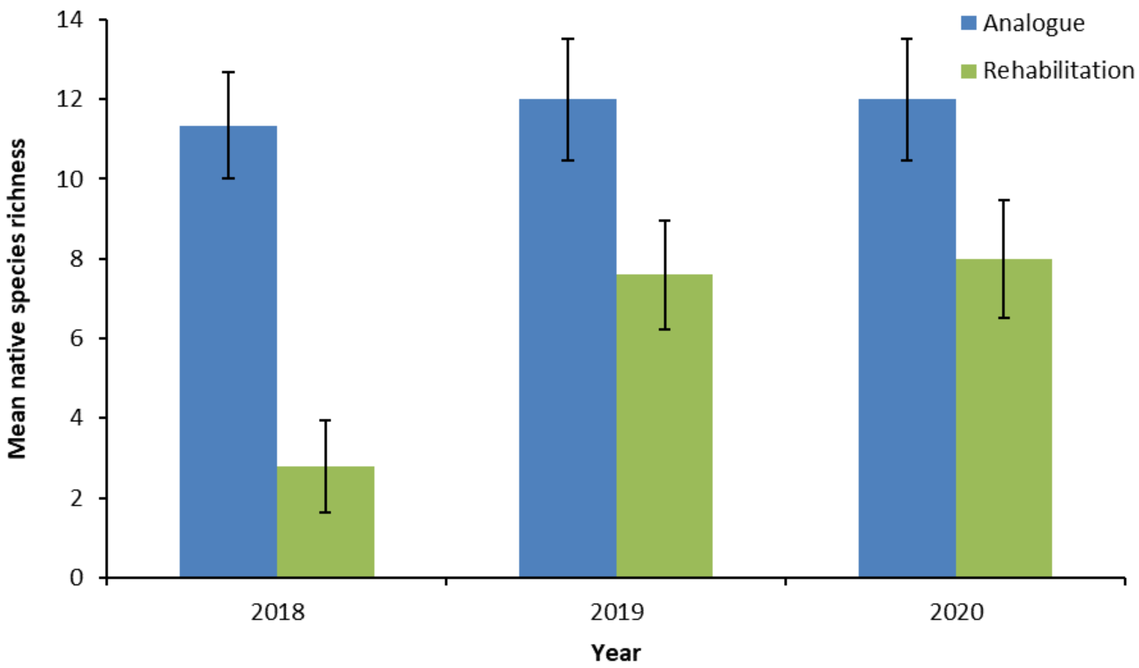

Figure 27: Mean native species richness for the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

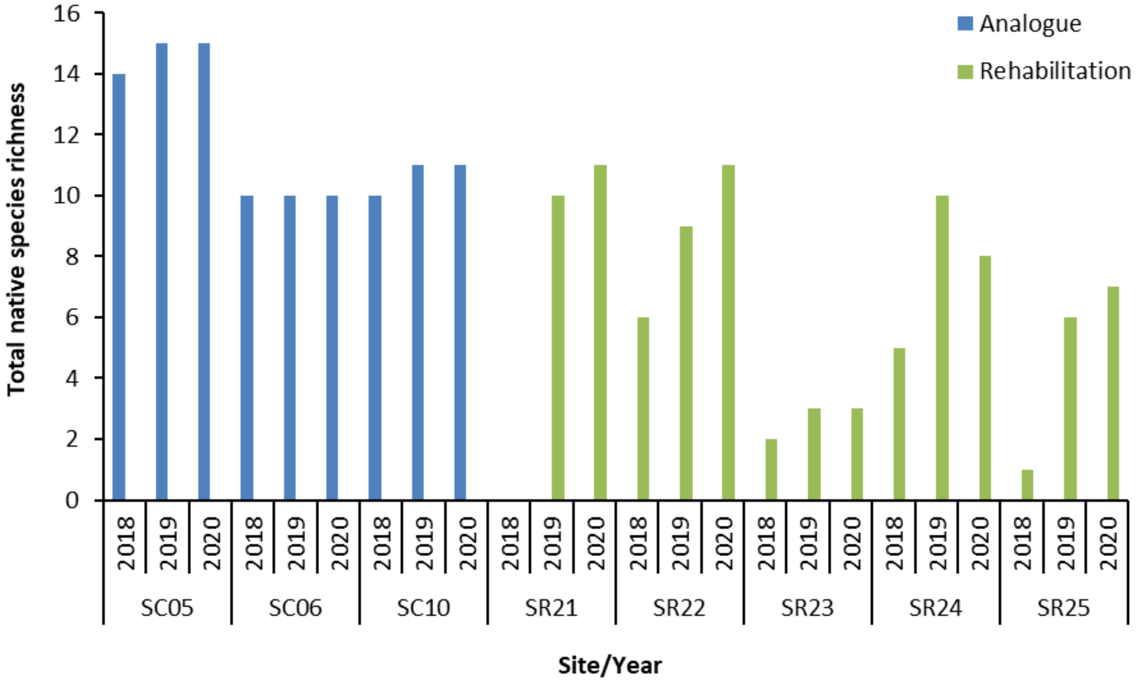

Figure 28: Total native species richness for each Carina waste rock landform analogue and rehabilitation site from 2018 to 2019.

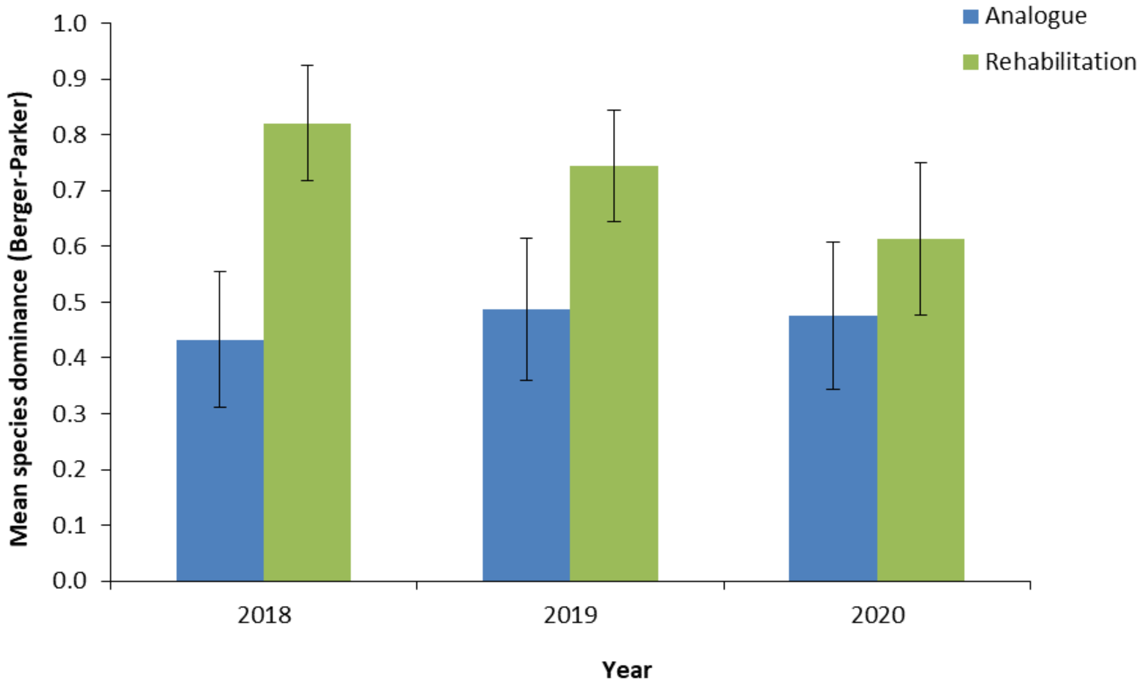

Figure 29: Mean species dominance as quantified by the Berger-Parker index for Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

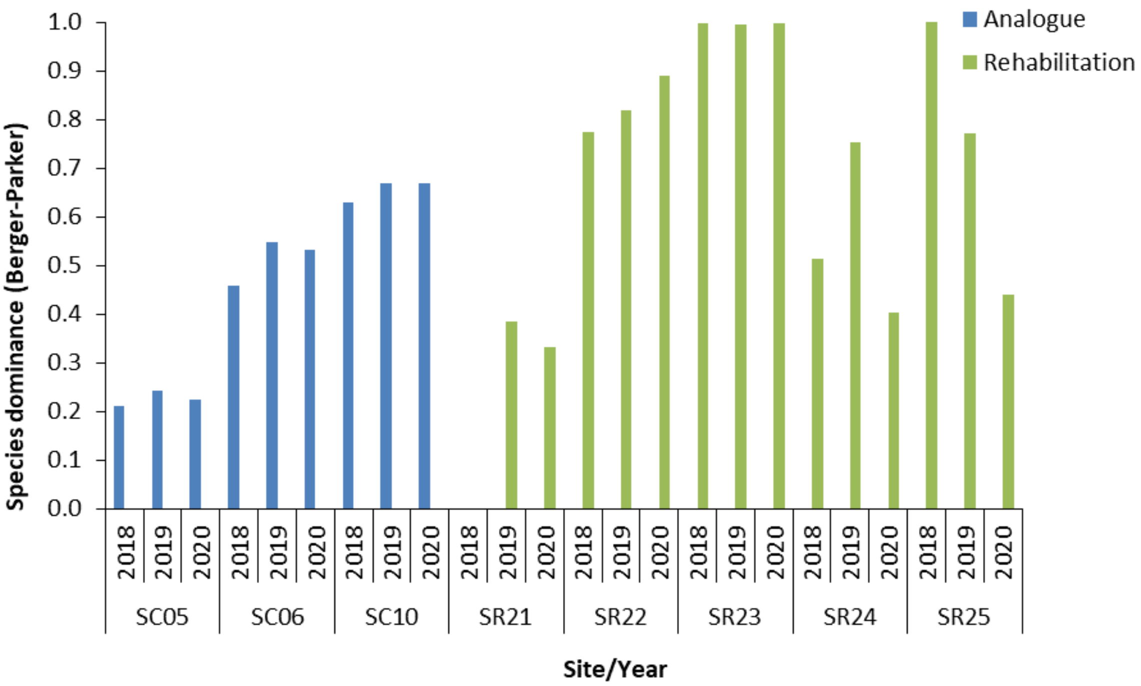

Figure 30: Species dominance as quantified by the Berger-Parker index for each Carina waste rock landform analogue and rehabilitation site from 2018 to 2020.

3.4.2 Native Cover

Mean native cover at the rehabilitation sites exceeded the analogue sites in 2019 and 2020, however the exceedance is not significant (Figure 31; $F_{1,20} = 0.27$, $p = 0.61$). This trend is primarily due to a decline in cover at the analogue sites, with only minor variation in cover recorded at the rehabilitation sites between 2018 and 2020 (Figure 31). At a site level, mean cover increased at three rehabilitation sites and decreased at two sites between 2019 and 2020 (Figure 32). Mean cover decreased at SR22 and SR23; a result of a reduction in herbs, annuals and short-lived shrubs that are susceptible to dry seasonal conditions. Mean cover at both rehabilitation sites remain higher than the mean of the analogue sites.

Vegetation structure at the rehabilitation sites remains different to the analogue sites, with the rehabilitation sites dominated by herbaceous species, such as *S. diacantha* and low shrub species, such as *M. triptera* (Figure 33). While the vegetation structure at the analogue sites consists of low to tall shrub species such as *A. vesicaria*, *Eremophila ionantha* and *A. burkittii*. However, the rehabilitation sites are trending towards the analogue sites with an overall reduction in the cover of herbs and an increase in tall shrubs. None of the rehabilitation sites are displaying similar vegetation structure to any of the analogue sites with a distinct lack of mid shrub species (Figure 34). A reduction of herbaceous cover and an increase in tall shrubs at SR22, SR23 and SR24 is trending in the right direction, however this is likely to be influenced by seasonal conditions, especially for herb species. Further to this, herbaceous cover at SC10 has declined since 2018, adding to the effect of dry seasonal conditions on the presence of herb species. Continued monitoring is required to determine if vegetation at the rehabilitated Carina WRL is progressing towards a state similar to that of undisturbed analogue vegetation.

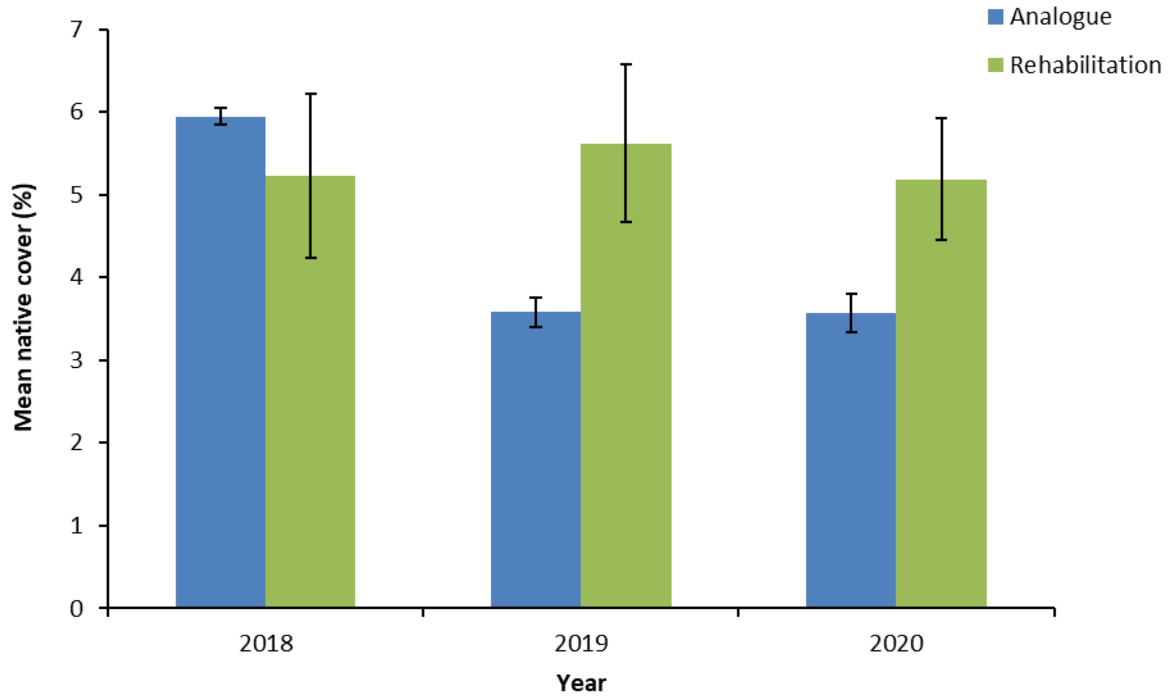

Figure 31: Mean native foliar cover (%) at the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

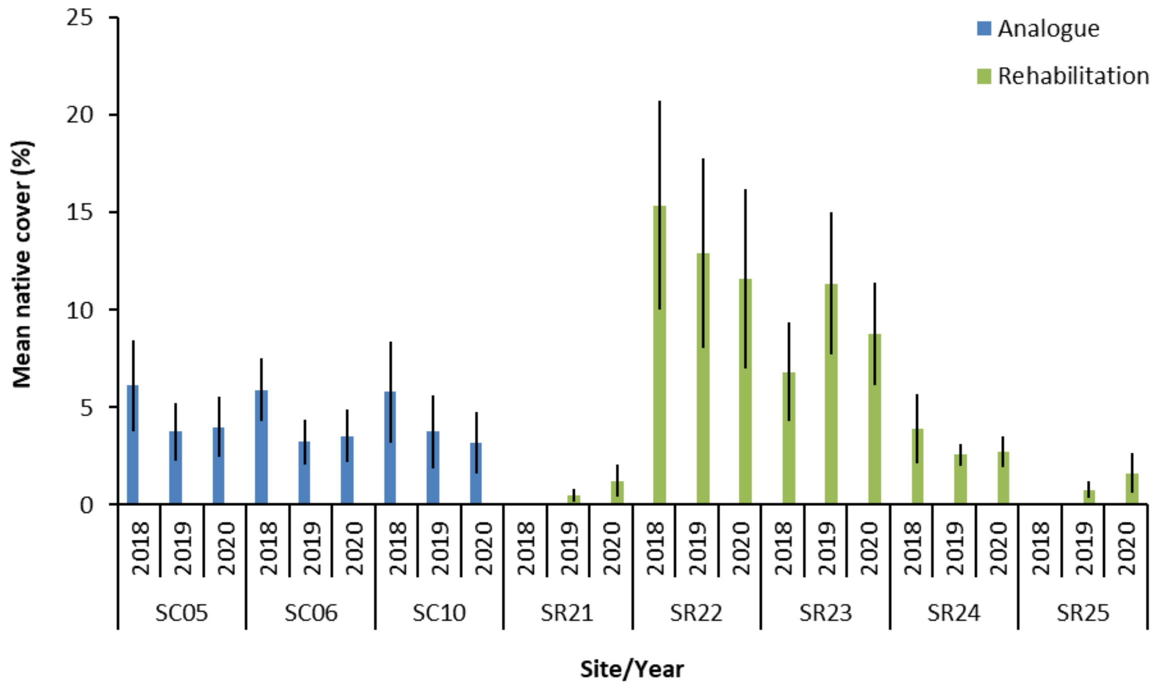

Figure 32: Mean native foliar cover (%) at each of the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

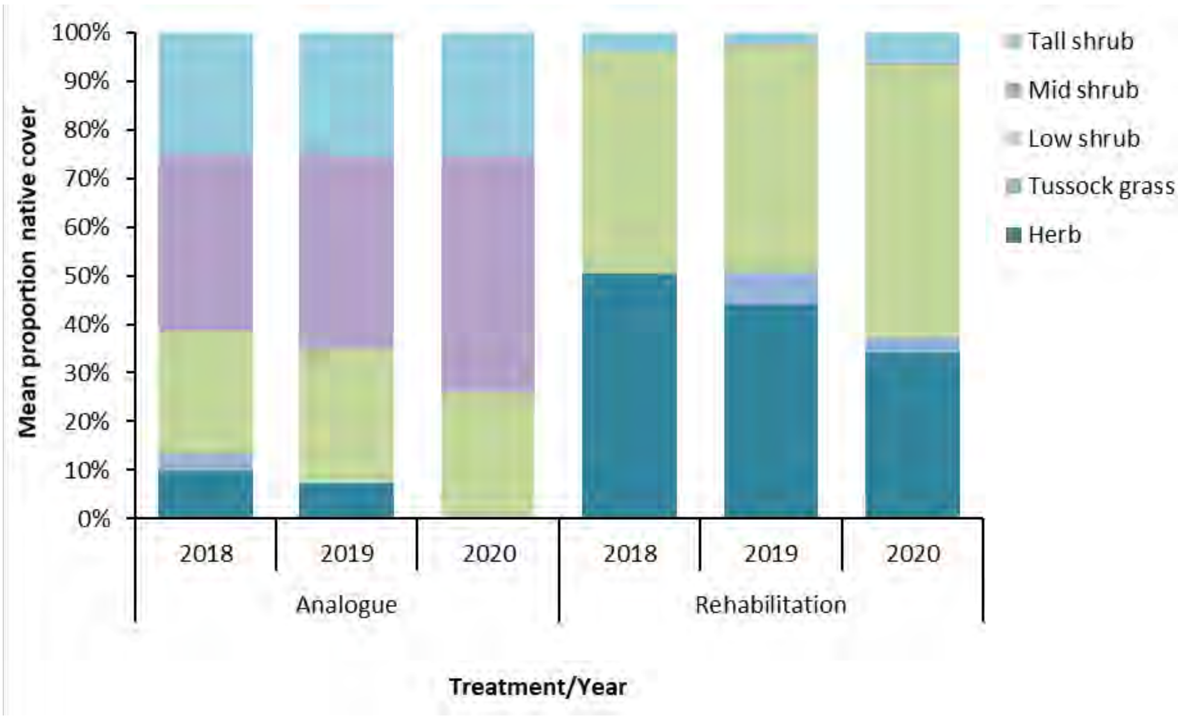

Figure 33: Mean proportion of native foliar cover (%) by stratum for the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

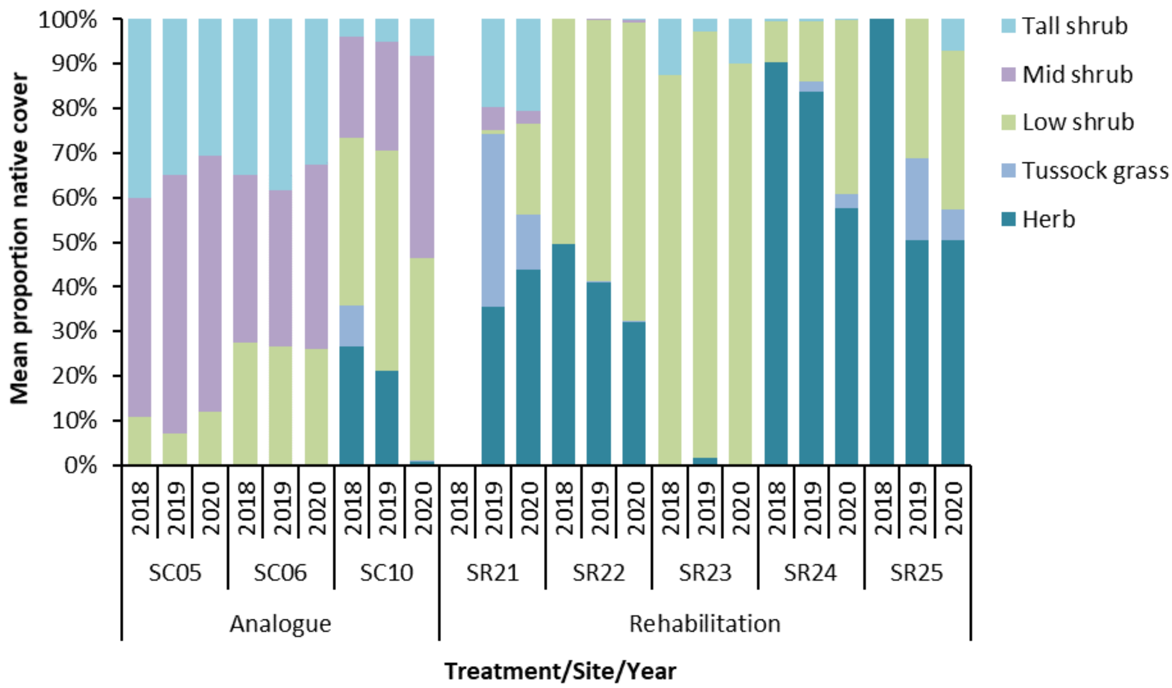

Figure 34: Mean proportion of native foliar cover (%) by stratum for each of the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

3.4.3 Plant Health and Dust Loading

Plant health in 2020 was good to excellent and was similar between rehabilitation and analogue sites (Figure 35). However, there was a general decline in plant health between 2019 and 2020 at each of the rehabilitation sites, with a lower proportion of plants in excellent health in 2020. Furthermore, there were more dead plants recorded in 2020 compared to 2019 at both the rehabilitation and analogue sites; these were mostly herb species that are susceptible to dry seasonal conditions.

Dust loading overall was negligible in 2020 at the rehabilitation and analogue sites (Figure 36). Low dust loads were recorded at three sites in 2020 and moderate loads at two sites. Field observations noted that some low to moderate dust loading was residual dirt from previous water pooling. The overall excellent to good plant health and negligible dust loads demonstrates that the Carina Iron Ore Project is not impacting on the health and dust of vegetation at and surrounding the Carina WRL.

Figure 35: Plant health of understorey species at each of the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

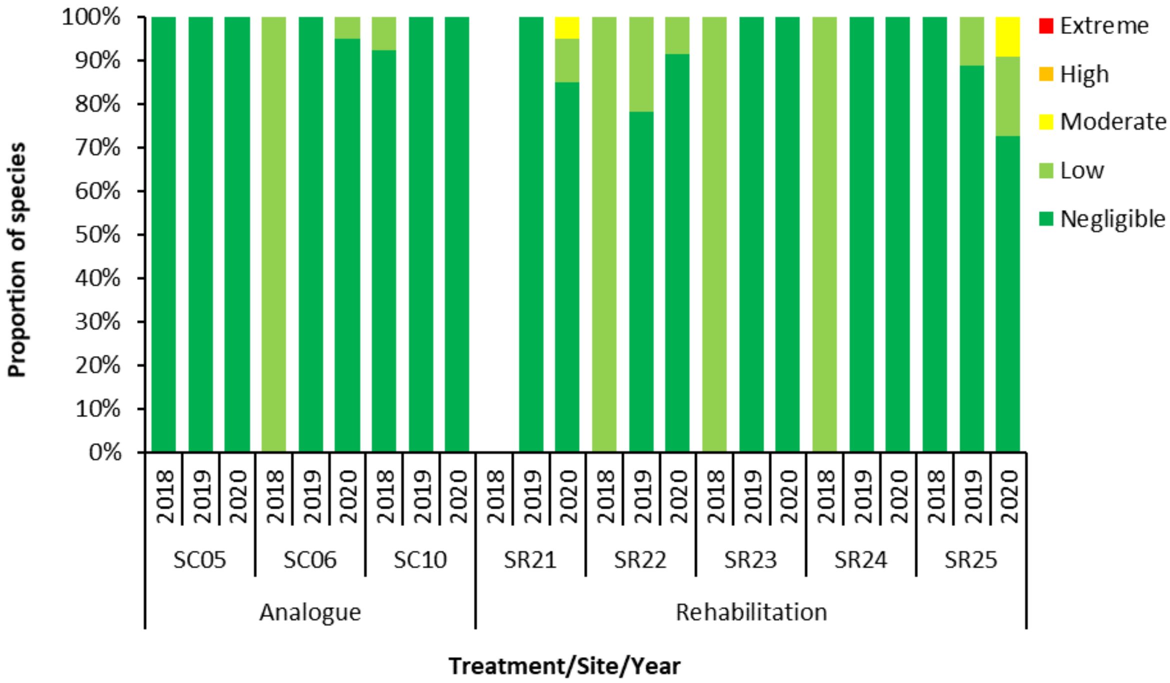

Figure 36: Dust loading of understorey species at each of the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

3.4.4 Overstorey Species

A total of three confirmed overstorey species were recorded at the rehabilitation sites in 2020, compared to six species at the analogue sites (Table 11). Two species were shared between the rehabilitation and analogue sites: *Eucalyptus corrugata* and *Eucalyptus salubris*. No overstorey species have been recorded at SR21 and SR25 to date (Table 12). This is to be expected at SR21 which is only two years old, however SR25, situated on top of the Carina WRL, is now five years old and has had adequate time for overstorey species to establish. SR22 and SR23 are displaying recruitment and succession of overstorey species, with seedlings, juveniles and mature trees recorded since 2018. This is a good indication that the sites (located on the east and west side batter slopes) are stable and have the ability to support mature vegetation. However, dead trees were recorded at SR22 which may indicate some inhibitions to long-term self-sustaining vegetation. No recruitment has been observed at SR24 since 2018 and the juveniles recorded in 2019 have not progressed to mature trees.

Mean overstorey cover at the rehabilitation sites continues to increase but remains lower than the analogue sites, as expected with young (< 5 years) rehabilitation dominated by seedlings and juveniles (Figure 37 and Figure 38). Of the three sites with overstorey species present, SR22 was the only site to record an increase in total overstorey, owing predominantly to the growth of juveniles (Figure 38 and Figure 39). SR23 and SR24 recorded no change in total overstorey cover.

Table 11: Overstorey species composition at the waste rock landform analogue and rehabilitation sites from 2018 to 2020.

Species	Number of analogue sites			Number of rehabilitation sites		
	2018	2019	2020	2018	2019	2020
Casuarina pauper	1	2	2	-	-	
Eucalyptus celastroides subsp. *celastroides*	1	1	1	-	-	

Species	Number of analogue sites			Number of rehabilitation sites		
	2018	2019	2020	2018	2019	2020
Eucalyptus corrugata	1	1	1	1	2	3
Eucalyptus griffithsii	1	1	1	-	-	-
Eucalyptus salmonophloia	1	1	1	-	-	-
Eucalyptus salubris	0	1	1	1	2	1
Eucalyptus transcontinentalis	-	-	-	1	1	1
Eucalyptus sp.	-	-	-	1	1	0

Table 12: Overstorey species abundance scores for each stratum at the waste rock landform analogue and rehabilitation sites from 2018 to 2020.

Site type	Site	2018	2019	2020
Seedling				
Analogue	SC05	-	-	-
	SC06	-	Sparse	Sparse
	SC10	-	-	-
Rehabilitation	SR21	-	-	-
	SR22	Abundant	Abundant	Abundant
	SR23	Sparse	Sparse	Sparse
	SR24	Sparse	-	-
	SR25	-	-	-
Juvenile				
Analogue	SC05	Sparse	-	-
	SC06	-	Sparse	Sparse
	SC10	-	-	-
Rehabilitation	SR21	-	-	-
	SR22	-	Common	Abundant
	SR23	-	Sparse	Common
	SR24	-	Sparse	Sparse
	SR25	-	-	-
Mature				
Analogue	SC05	Common	Common	Common
	SC06	Sparse	Sparse	Common
	SC10	Common	Sparse	Sparse
Rehabilitation	SR21	-	-	-
	SR22	-	Sparse	Sparse
	SR23	-	Sparse	Sparse
	SR24	-	-	-
	SR25	-	-	-
Dead				
Analogue	SC05	-	Sparse	Sparse

Site type	Site	2018	2019	2020
	SC06	-	-	-
	SC10	-	-	-
Rehabilitation	SR21	-	-	-
	SR22	-	Sparse	Sparse
	SR23	-	-	-
	SR24	-	-	-
	SR25	-	-	-

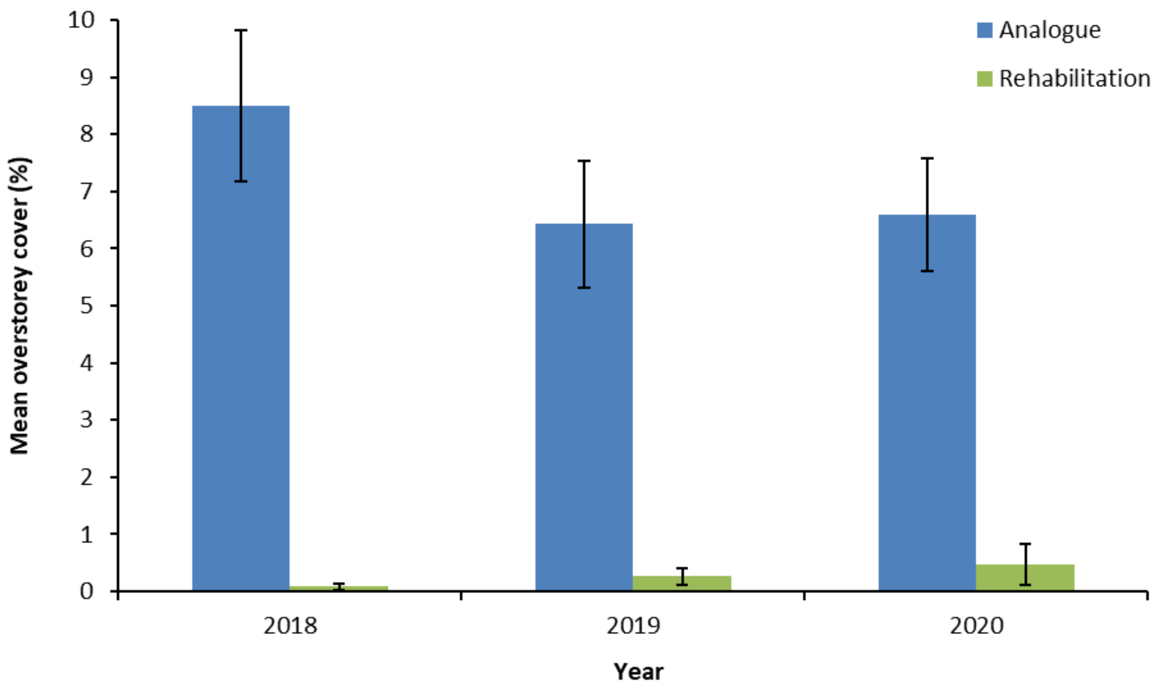

Figure 37: Mean cover (%) of overstorey species at the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

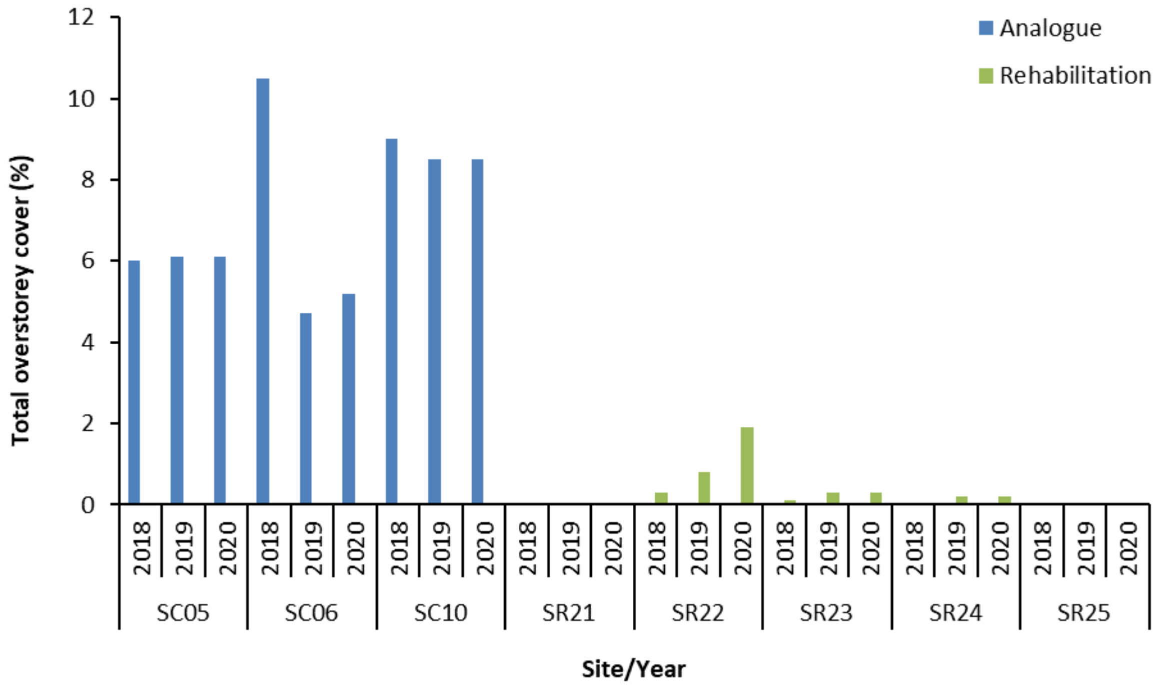

Figure 38: Total cover (%) of overstorey species at each of the Carina waste rock landform analogue and rehabilitation sites from 2018 to 2020.

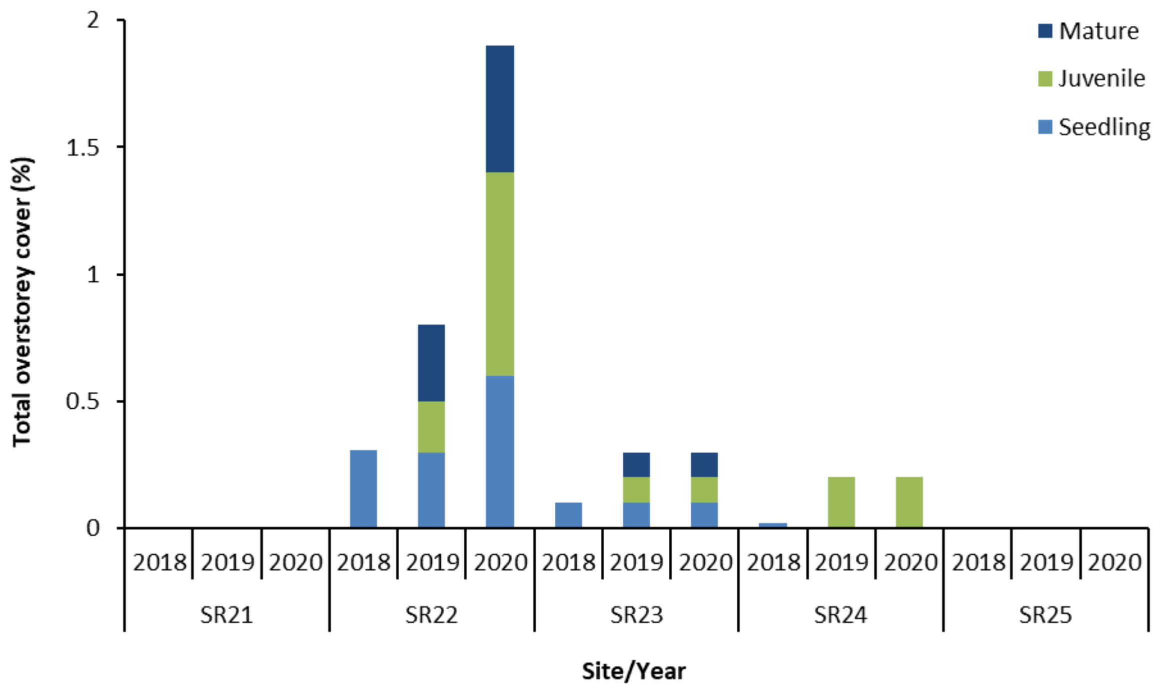

Figure 39: Total cover (%) of overstorey species in each life stage at each of the Carina waste rock landform rehabilitation sites from 2018 to 2020.

3.4.5 Weed Presence

One weed species (**Sonchus asper*) was recorded at four Carina WRL rehabilitation sites in 2020, and no weeds were recorded at any of the analogue sites (Table 13). No change was recorded in mean weed cover across the rehabilitation sites. However, mean weed abundance across all sites has increased since 2018, although the increase was not significant (Table 13). Three of the four sites with weeds present recorded an increase in abundance between 2019 and 2020, with the most substantial increases at SR21 and SR24, increasing by 500 and 404 individuals, respectively. Continued weed control activities are required to minimise the impact of weed populations on the successful established of native vegetation.

Table 13: Weed species cover (%) and abundance at the Carina waste rock landform rehabilitation sites from 2018 to 2020. Dashes indicate species not recorded.

Site	Weed species	Cover (%)			Abundance		
		2018	2019	2020	2018	2019	2020
SR21	**Sonchus asper*	-	0.1	0.1	-	64	564
SR22	**Sonchus asper*	0.01	0.1	0.1	3	24	28
SR23	-	-	-		-	-	
SR24	**Sonchus asper*	0.1	0.1	0.1	3	2	406
SR25	**Sonchus asper*	-	0.1	0.1	-	800	244
	**Sonchus oleraceus*	0.1	-	-	61	-	-
Mean weed occurrence (±95% CI)		**0.04 (±0.07)**	**0.08 (±0.06)**	**0.08 (±0.06)**	**13.40 (±33.09)**	**178.00 (±432.92)**	**248.40 (±300.79)**

3.5 Carina Extended Waste Rock Landform

In 2020, there continued to be no disturbance evident at any analogue or rehabilitation site from 2019 (Table 14; Appendix C, Table C.3 (Rehabilitation) and Table C.4: SC07, SC11 and SC12 (Analogue)).Evidence of previous water pooling was found at all analogue and rehabilitation sites in 2020, whilst previously being recorded at only one analogue site in 2019 and all rehabilitation sites. A physical surface crust was present at all analogue and rehabilitation sites for both years.

Evidence of fauna decreased from all three sites in 2019 to two sites in 2020. Conversely fauna evidence increased from four to five rehabilitation sites between 2019 and 2020. The most common fauna evidence observed in 2020 was invertebrate activity, with some kangaroo evidence observed from scats at two rehabilitation sites. Old camel scats were observed at one analogue site.

The rehabilitation sites are dominated by rock cover and a moderate amount of bare ground with very little plant cover. Analogue sites also have low plant cover, and are comprised of moderate levels of litter, rock and bare ground.

Erosion remained absent at analogue sites in 2020, whilst at the rehabilitation sites, increased from low to extensive as the maximum erosion level recorded. The average number of rills increased between 2019 and 2020 at four sites, whilst remaining the same at SR29 (Table 15). Average maximum rill width also increased at four sites, with a decrease recorded at SR26. However, the maximum rill width recorded within a single quadrat increased at all sites between 2019 and 2020. Average maximum rill depth decreased at three sites, but the maximum rill depth recorded at a single quadrat increased at all sites. This indicates that the Carina Extended WRL surface is actively eroding with significant erosion features recorded at SR27 and SR28; average rill depths were 0.45 m and 0.44 m, respectively. Photographs and GPS coordinates for each rill/gully at the rehabilitation sites are provided in Appendix D.

Table 14: Carina Extended waste rock landform rehabilitation sites and corresponding analogue sites physical characteristics summary in 2019 and 2020.

Site type	Year	Average plant cover (%)	Average boulder cover (%)	Average rock cover (%)	Average log cover (%)	Average litter cover (%)	Average bare ground (%)	Average cryptogam cover (%)	Surface crust presence	Evidence of water pooling	Erosion	Disturbance	Fauna evidence
Analogue	2019	5.0	Nil	24.0	2.0	39.0	25.1	10.1	3 of 3 sites	1 of 3 sites	None	None	3 of 3 sites
	2020	4.7	Nil	22.4	2.0	38.8	20.1	15.6	3 of 3 sites	3 of 3 sites	None	None	2 of 3 sites
Rehabilitation	2019	0.2	0.9	60.7	0.3	1.5	36.6	Nil	5 of 5 sites	5 of 5 sites	None to Low	None	4 of 5 sites
	2020	1.3	0.9	60.4	0.3	1.2	36.0	Nil	5 of 5 sites	5 of 5 sites	None to Extensive	None	5 of 5 sites

Table 15: Erosion monitoring at each of the Carina Extended waste rock landform rehabilitation sites in 2019 and 2020. NB: parenthesis denotes maximum recorded within a single quadrat.

Site	Year	Average no. rills	Average maximum rill width (m)	Average maximum rill depth (m)
SR26	2019	0.10 (1)	0.14 (0.14)	0.05 (0.05)
	2020	0.60 (1)	0.10 (0.22)	0.04 (0.12)
SR27	2019	0.40 (1)	0.14 (0.20)	0.06 (0.10)
	2020	1.00 (2)	0.27 (0.62)	0.13 (0.45)
SR28	2019	0.50 (1)	0.19 (0.36)	0.09 (0.17)
	2020	0.60 (2)	0.28 (1.12)	0.11 (0.44)
SR29	2019	0.40 (1)	0.14 (0.30)	0.04 (0.08)
	2020	0.40 (1)	0.19 (0.96)	0.03 (0.17)
SR30	2019	0.20 (1)	0.11 (0.12)	0.07 (0.08)
	2020	0.60 (2)	0.15 (0.45)	0.05 (0.13)

3.5.1 Species Composition

Mean native species richness at Carina Extended WRL rehabilitation sites was significantly lower than the analogue sites (Figure 40; $F_{1,15} = 47.97$, $p < 0.001$); an expected result with two year old rehabilitation. Native species richness at rehabilitation sites increased between 2019 and 2020 while analogue sites have remained relatively constant since 2018. Native species richness increased from 2019 at four rehabilitation sites, with SR29 remaining at two species (Figure 41). The largest increase in species richness was recorded at SR26, with an increase from three species in 2019 to 11 species in 2020. This site is now equal to the species richness of one analogue site (SC12) but remains lower than the mean for the analogue sites (14 species).

Mean species dominance at the rehabilitation sites decreased slightly between 2019 and 2020, although remains higher than the analogue sites, however the difference is not significant (Figure 42; $F_{1,11} = 3.71$, $p = 0.10$). High species dominance in young rehabilitation is not unexpected given the young age of the rehabilitation when vegetation is often dominated by a few early colonizing species. At an individual site level species dominance decreased at three sites, a positive trend that demonstrates vegetation progressing towards a more permanent structure with vegetation cover beginning to be contributed by a range of species (Figure 43). Site SR27 increased in species dominance due to an increase in the dominance of *S. diacantha*. Site SR29 remains completely dominated by *S. diacantha*. In comparison, mean species dominance at the analogue sites increased slightly between 2019 and 2020 (Figure 42). Three rehabilitation sites (SR26, SR27 and SR30) had lower species dominance than one of the analogue sites; SC07, which is highly dominated by *Eremophila oppositifolia* subsp. *angustifolia* (Figure 43).

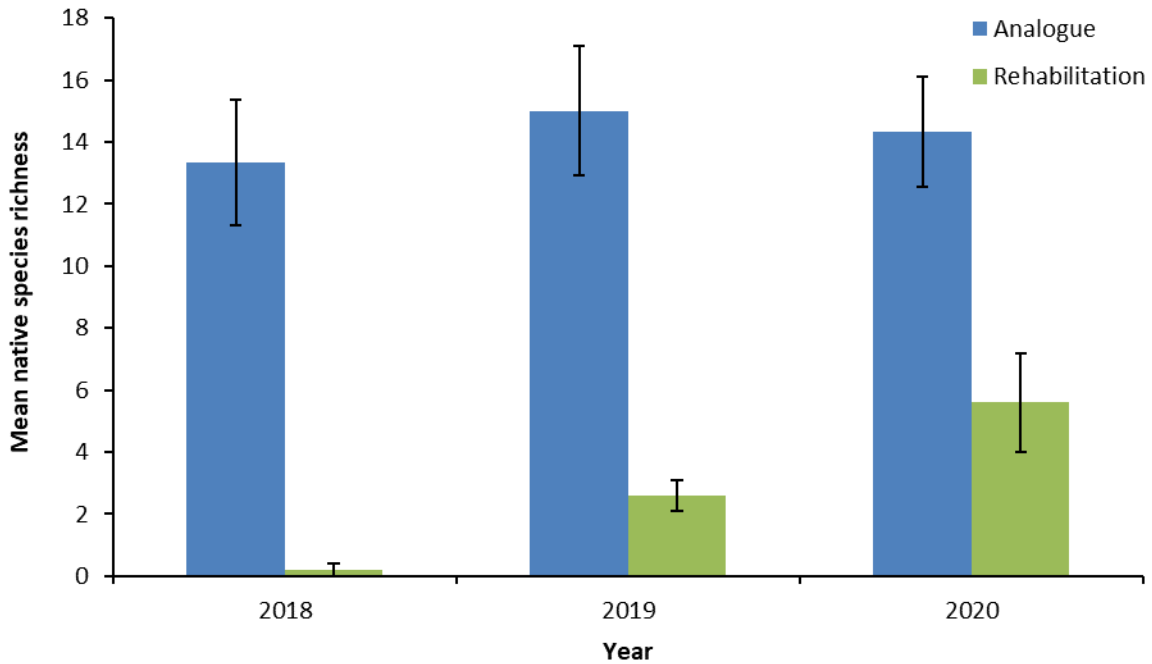

Figure 40: Mean native species richness for the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

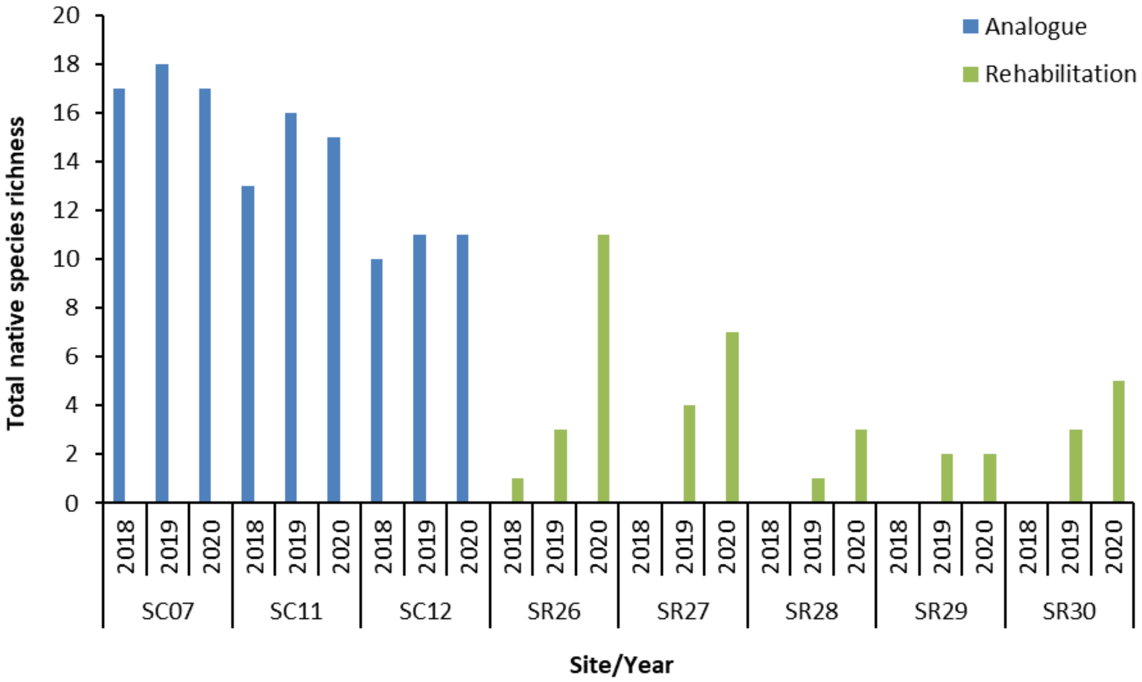

Figure 41: Total native species richness for each Carina Extended waste rock landform analogue and rehabilitation site from 2018 to 2020.

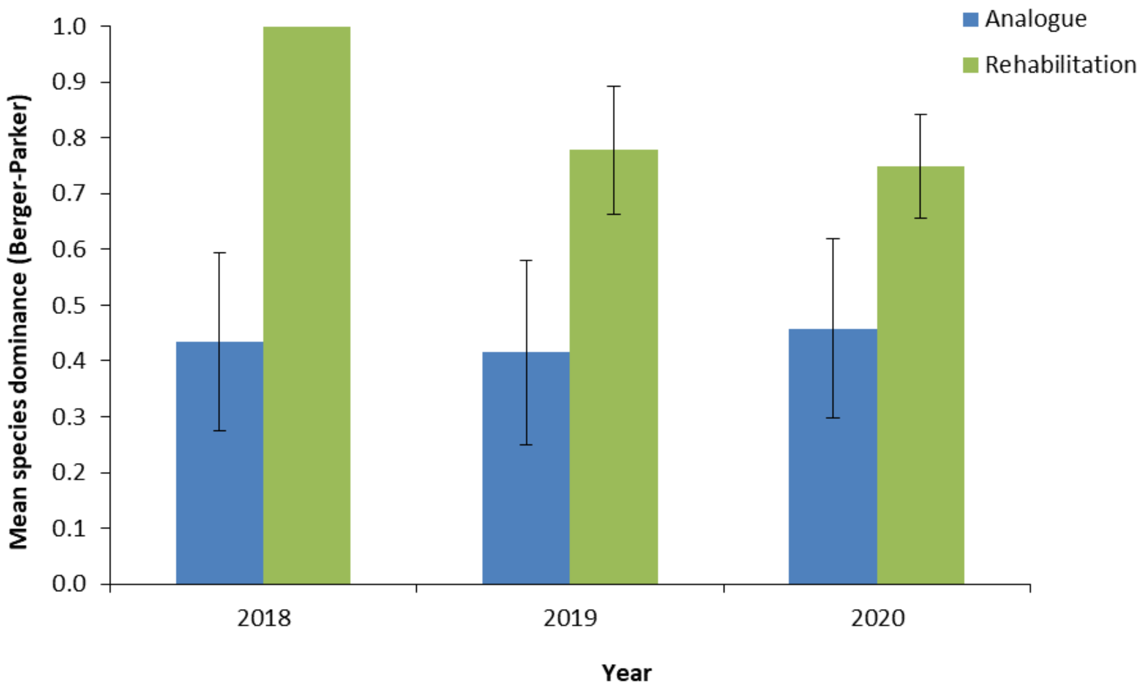

Figure 42: Mean species dominance as quantified by the Berger-Parker index for Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

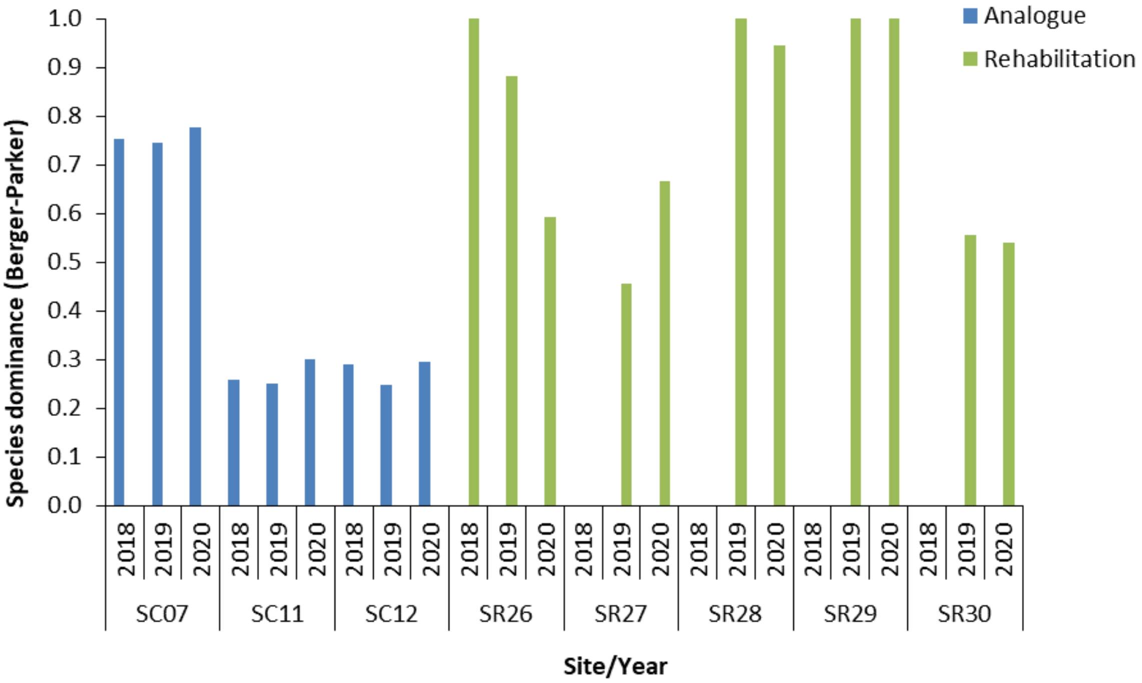

Figure 43: Species dominance as quantified by the Berger-Parker index for each Carina Extended waste rock landform analogue and rehabilitation site from 2018 to 2020.

3.5.2 Native Cover

Mean native cover at the rehabilitation sites was significantly lower than the analogue sites (Figure 44; $F_{1,6}$ = 8.59, p = 0.02). Mean native cover at the rehabilitation sites increased between 2019 and 2020, while the analogue sites remained stable, which is to be expected with two year old rehabilitation (Figure 44;). All rehabilitation sites recorded an increase in mean native cover from 2019, a positive trend that demonstrates vegetation progression. The largest increase in mean native cover was recorded at SR27, increasing from 0.11% in 2019 to 1.59% in 2020, which has surpassed one of the analogue sites (SC12; Figure 45).

The vegetation at the WRL is still young with and a simple structure of herbaceous species and tall shrub species, such as *S. diacantha* and *A. burkittii* remains from 2019 (Figure 46). An increase in tussock grasses, low shrubs and mid shrubs from 2019 shows that the vegetation is progressing, however none of the rehabilitation sites are yet to display similar structure to the analogue sites, which are a mix of low to tall shrub species (Figure 47). As for species richness and dominance, no change from 2019 was recorded in vegetation structure at SR29, which continues to be comprised of two herbaceous species: *S. diacantha* and *Eriochiton sclerolaenoides.* The most improvement in vegetation structure from 2019 was observed at SR27, where herb and tall shrub cover declined and a new presence of tussock grasses and mid shrubs was recorded (Figure 47). Further monitoring is required to assess if vegetation structure continues to diversify at the rehabilitation sites and progress towards a similar structure to the analogue sites.

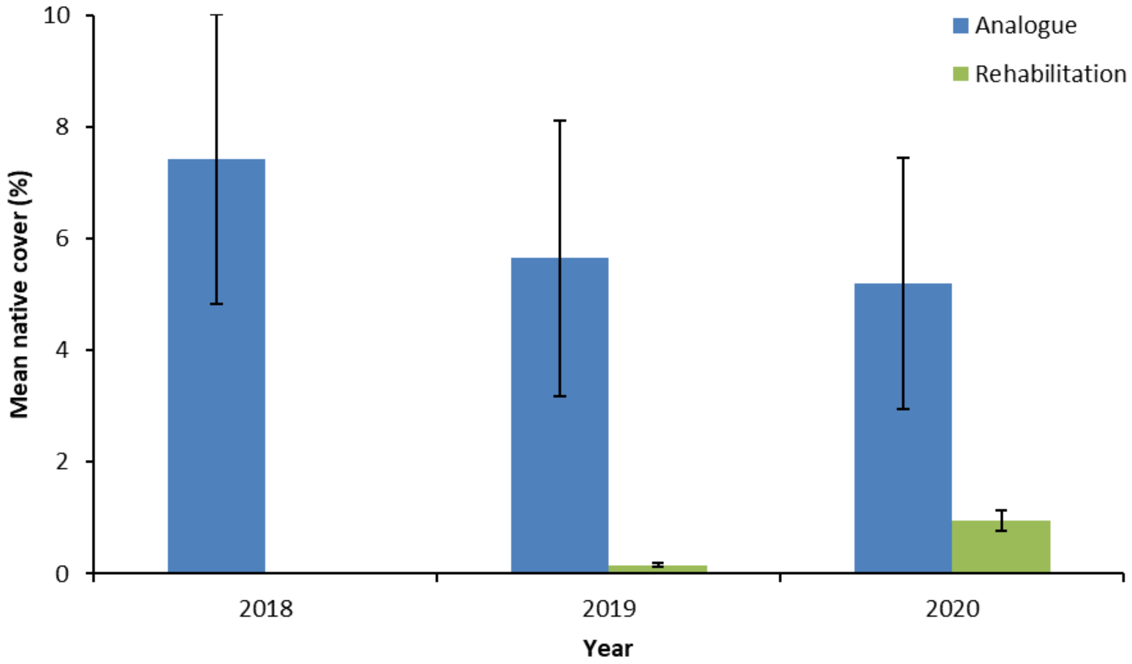

Figure 44: Mean native foliar cover (%) at the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

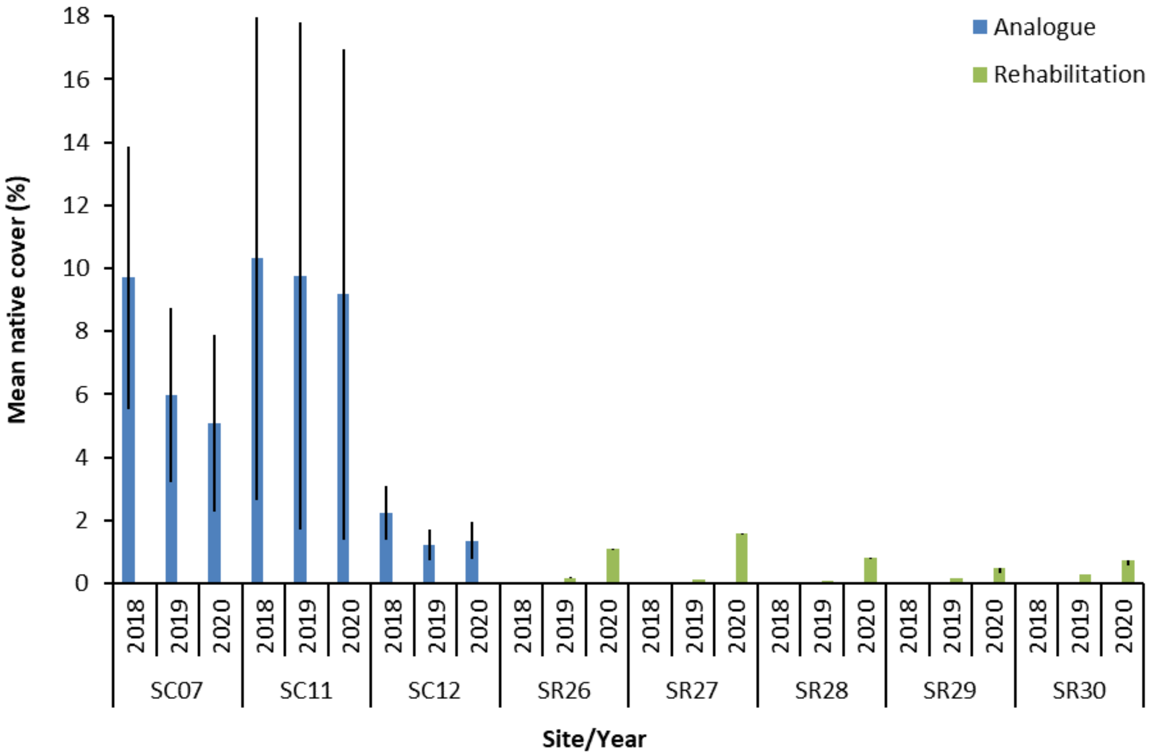

Figure 45: Mean native foliar cover (%) at each of the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

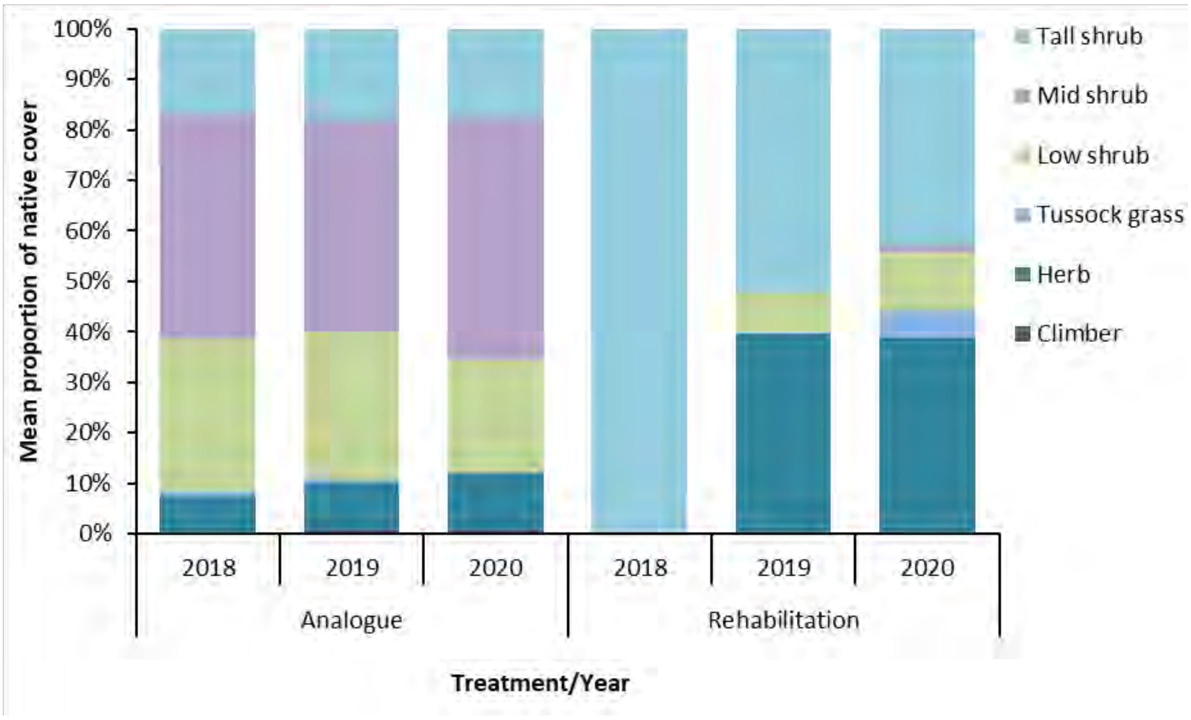

Figure 46: Mean proportion of native foliar cover (%) by stratum for the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

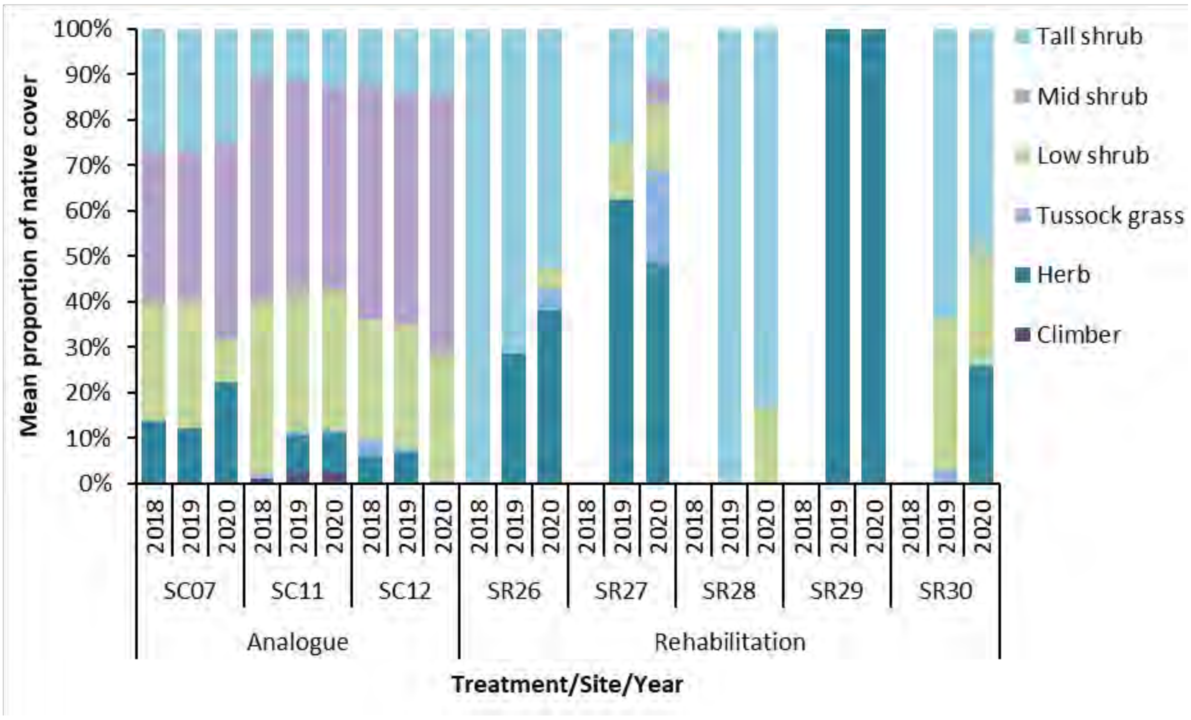

Figure 47: Mean proportion of native foliar cover (%) by stratum for each of the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

3.5.3 Plant Health and Dust Loading

Overall plant health at the rehabilitation sites in 2020 was excellent, consistent with 2019 (Figure 48). More plants were recorded in poor to good health compared to 2019, with no dead plants observed to date. A decline in plant health was observed at the analogue sites between 2019 and 2020, declining from good condition in 2019 to dead to good condition in 2020. Dead plants were recorded at all analogue sites and was the dominant plant health score at SC07. The dead plants at the analogue sites were predominantly comprised of short-lived Chenopods and do not necessarily indicate a decline in overall vegetation health.

Similar to previous years, dust loading overall was negligible at rehabilitation and analogue sites in 2020 (Figure 49). Low dust loading was recorded at three of the rehabilitation sites for the first time in 2020, after consistent records of negligible. However, this is likely to be influenced by the increase in vegetation presence rather than an indication of a potential impact due to project activities. Low dust loading was also recorded at one analogue site in 2020. Whilst vegetation is still young at the rehabilitation sites, the monitoring results from 2020 indicate the Carina Iron Ore Project is not negatively impacting plant health or increasing plant dust load at Carina Extended WRL.

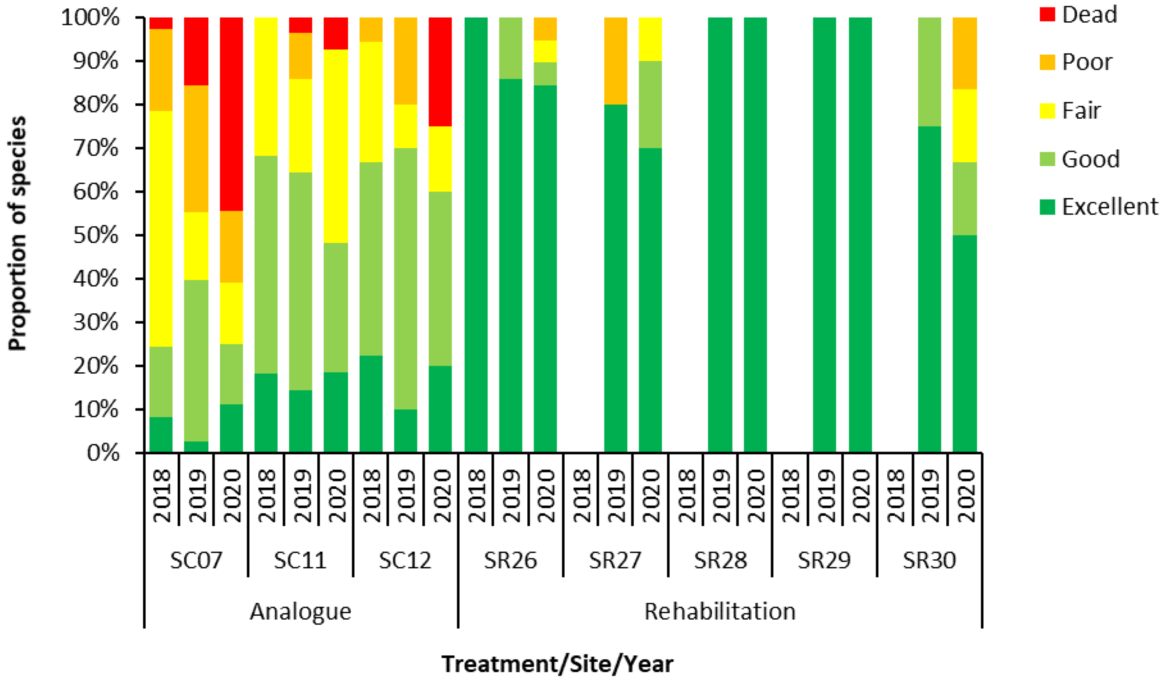

Figure 48: Plant health of understorey species at each of the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

Figure 49: Dust loading of understorey species at each of the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

3.5.4 Overstorey Species

Four confirmed overstorey species were present across four rehabilitation sites in 2020; an increase from one unconfirmed *Eucalyptus* sp. at two sites in 2019 (Table 16 and Table 17). This is a positive trend in overstorey species recruitment. One unconfirmed *Eucalyptus* sp. was present at one site in 2020 and could not be identified to species level due to the immature life stage and lack of reproductive material. Future monitoring should be able to confirm the species name once the trees have matured. In comparison, nine confirmed overstorey species were recorded at the analogue sites, three of which were also recorded at the rehabilitation sites. This is a promising result, representing 75% of overstorey species similarity between the rehabilitation and analogue sites.

Overstorey species succession has occurred at one rehabilitation site, with seedlings and juveniles recorded at SR27 (Table 17). However, in 2019 seedlings were recorded at SR29 and SR30, but no juveniles were recorded at these sites in 2020. This indicates that overstorey succession has been inhibited at these two rehabilitation sites.

Cover of overstorey species at the rehabilitation sites is naturally low with a dominance of seedlings compared to the mature trees at the analogue sites (Figure 50). Total overstorey cover did not exceed 0.2% at the rehabilitation sites in 2020 (Figure 51).

Table 16: Overstorey species composition at the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Dashes denote species not recorded.

Species	Number of analogue sites			Number of rehabilitation sites		
	2018	2019	2020	2018	2019	2020
Codonocarpus cotinifolius	-	-	-	0	0	1
Eucalyptus celastroides subsp. *celastroides*	1	2	2	-	-	-

Species	Number of analogue sites			Number of rehabilitation sites		
	2018	2019	2020	2018	2019	2020
Eucalyptus celastroides subsp. *virella*	1	1	1	-	-	-
Eucalyptus loxophleba subsp. *supralaevis*	1	1	1	-	-	-
Eucalyptus oleosa subsp. *oleosa*	1	1	1	0	0	1
Eucalyptus salubris	1	1	1	-	-	-
Eucalyptus sheathiana	1	0	0	-	-	-
Eucalyptus transcontinentalis	1	2	2	0	0	2
Eucalyptus vittata	1	2	2	0	0	2
Eucalyptus sp.	-	-	-	0	2	1
Santalum acuminatum	3	3	3	-	-	-

Table 17: Overstorey species abundance scores for each stratum at the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

Site type	Site	2018	2019	2020
Seedling				
Analogue	SC07	Sparse	-	-
	SC11	Sparse	-	-
	SC12	Sparse	-	-
Rehabilitation	SR26	-	-	Sparse
	SR27	-	-	Sparse
	SR28	-	-	Sparse
	SR29	-	Sparse	Sparse
	SR30	-	Sparse	Sparse
Juvenile				
Analogue	SC07	Sparse	-	-
	SC11	Sparse	Common	Common
	SC12	Sparse	Sparse	Sparse
Rehabilitation	SR26	-	-	-
	SR27	-	-	Sparse
	SR28	-	-	-
	SR29	-	-	-
	SR30	-	-	-
Mature				
Analogue	SC07	Sparse	Sparse	Common
	SC11	Sparse	Sparse	Sparse
	SC12	Abundant	Common	Common
Rehabilitation	SR26	-	-	-
	SR27	-	-	-
	SR28	-	-	-
	SR29	-	-	-

Site type	Site	2018	2019	2020
	SR30	-	-	-

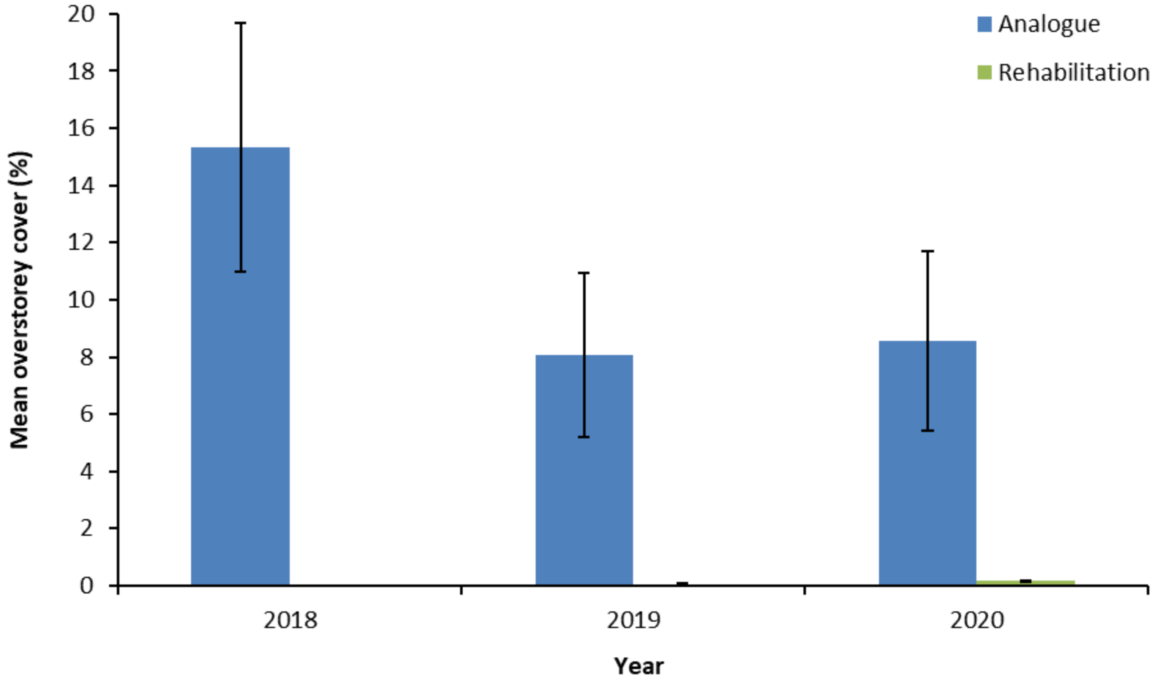

Figure 50: Mean cover (%) of overstorey species at the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020. Error bars denote standard error.

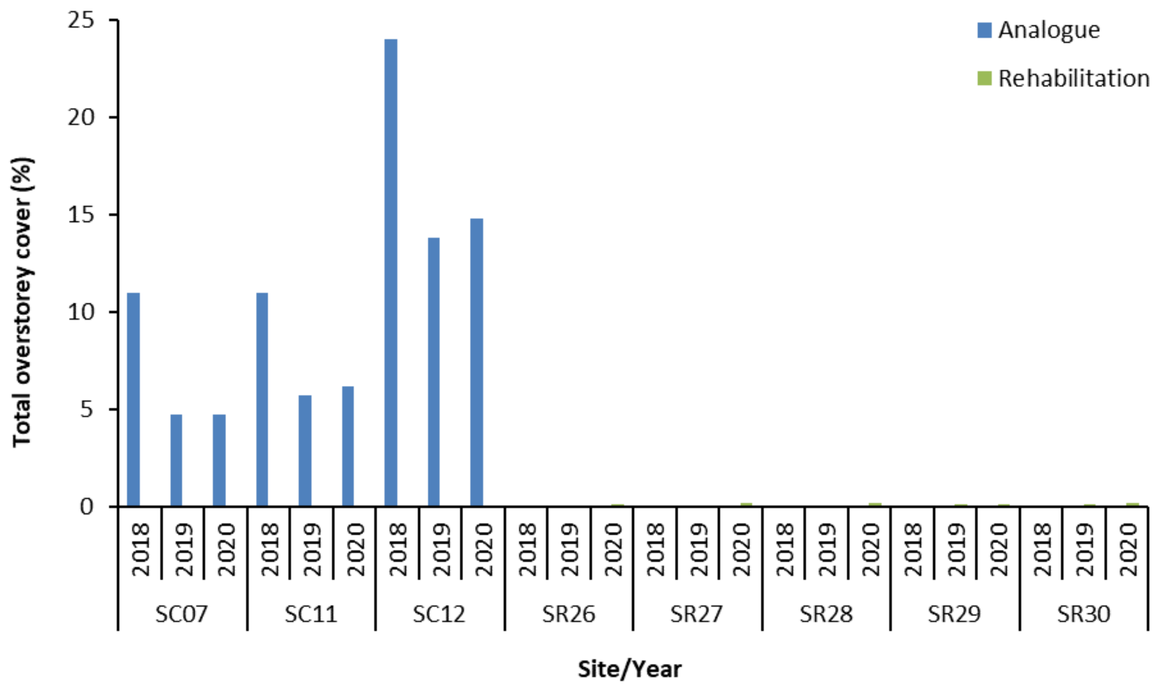

Figure 51: Total cover (%) of overstorey species at each of the Carina Extended waste rock landform analogue and rehabilitation sites from 2018 to 2020.

3.5.5 Weed Presence

No weeds have been recorded at the analogue sites to date. One weed species was recorded across all five rehabilitation sites in 2020; **S. asper* (Table 18). **Erodium botrys* which was recorded for the first time in 2019 at SR28 was not found again. Mean weed cover decreased marginally from 2019 due to the absence of **E. botrys*. However, mean weed cover has increased significantly since 2018. Additionally, weed abundance increased for the second consecutive year and was only lower at SR28 between 2019 and 2020. Continued weed management is required at the Carina Extended WRL to reduce weed populations from impacting on the successful establishment of vegetation.

Table 18: Weed species cover (%) and abundance at the Carina Extended waste rock landform rehabilitation sites from 2018 to 2020. Dashes indicate species not recorded.

Site	Weed species	Cover (%)			Abundance		
		2018	2019	2020	2018	2019	2020
SR26	**Sonchus asper*	-	0.1	0.1	-	4	6
SR27	**Sonchus asper*	-	0.1	0.1	-	10	56
SR28	**Erodium botrys*	-	0.1	-	-	10	-
	**Sonchus asper*	-	0.1	0.1	-	38	18
SR29	**Sonchus asper*	-	0.1	0.1	-	6	25
	**Sonchus oleraceus*	0.1	-	-	2	-	-
SR30	**Sonchus asper*	-	0.1	0.1	-	3	8
Mean weed occurrence (±95% CI)		**0.02 (±0.06)**	**0.12 (±0.06)**	**0.10 (±0)**	**0.40 (±1.11)**	**14.20 (±23.70)**	**22.60 (±25.07)**

4 Conclusions

4.1 Borrow Pits

Monitoring at the rehabilitated borrow pits has determined that the surface is stable and resistant to erosion, with the ability to support native vegetation. Therefore, condition 11-1.1 of MS 852 has been met.

Native species richness at the rehabilitated borrow pits has remained relatively stable since 2016, with only a slight decline recorded between 2019 and 2020. Species richness remains higher at the rehabilitation sites compared to the analogue sites, with this trend observed for the past five years. The rehabilitation sites have a similar species dominance compared to the analogue sites, indicating comparable representation of species. One site (SR03) continues to be dominated by *Acacia burkittii*. With the rehabilitation at SR03 now six years old, a more even representation of species is expected, especially considering the high species richness at this site.

Mean native cover at the rehabilitation sites was similar to the analogue sites in 2020 for all sites combined and each individual site and was also similar to 2019. Whilst the vegetation community structure remains different between rehabilitation and analogue sites, the rehabilitation sites as a whole are displaying a positive trend towards a similar structure to the analogue sites. One site (SR04) has consistently been similar to the corresponding analogue site since monitoring began in 2015. Furthermore, overstorey species were present at three rehabilitation sites with seedlings, juveniles and mature trees continually recorded, indicating good succession and continued recruitment of overstorey species. These results, along with the relatively high species richness and similar species dominance, demonstrate that the rehabilitated borrow pits support self-sustaining vegetation which is progressing towards being similar to the analogue sites. Therefore, condition 11-1.6 of MS 852 is on track to being achieved.

No weed species were recorded at the rehabilitation borrow pit sites in 2020, demonstrating compliance with condition 11-1.7 and 11-1.8 of MS 852. However, weeds were observed outside of monitoring sites, with evidence of recent chemical control.

4.2 Road Infrastructure

Monitoring at the rehabilitated road infrastructure sites has determined that the surface is stable and resistant to erosion, with the ability to support native vegetation. Therefore, condition 11-1.1 of MS 852 has been met.

Native species richness and species dominance at the rehabilitation sites remains similar to the analogue sites. A reduction in species richness was recorded at four of nine rehabilitation sites, attributable to a decline in herb and low shrub species due to the dry seasonal conditions. Five sites had lower species richness than their corresponding analogue sites, and three sites had notably higher species dominance than the analogue sites. Overall mean native cover remains lower at the rehabilitation sites compared to the analogue sites and has shown minimal improvement since 2017. Total native cover at sites PR01, PR05 and PR06 have shown no improvement since monitoring began in 2015. At this stage of rehabilitation, cover should be approaching similar levels to the analogue sites, as observed for the remaining six sites. Differences in vegetation structure are still apparent between the rehabilitation and analogue sites, with PR01 the only site to be trending towards a similar structure to the analogue sites. Whilst species richness and dominance at the rehabilitated road infrastructure sites is similar to the analogue sites, the differences in cover and vegetation structure, and the continued poor performance at three sites, has not yet demonstrated that the rehabilitation as a whole supports self-sustaining native vegetation that is progressing towards analogue sites. Continued monitoring and contingency measures are required to address condition 11-1.6 of MS 852.

No weed species were recorded at the rehabilitated road infrastructure sites for the second consecutive year, which demonstrates compliance with condition 11-1.7 and 11-1.8 of MS 852.

4.3 Carina Waste Rock Landform

Monitoring at the Carina WRL recorded erosion features at all rehabilitation sites. The degree of erosion has remained relatively stable between 2019 and 2020 with no major variation in rill numbers, width and depth. However dry seasonal conditions are limiting the ability to accurately assess condition 11-1.1 of MS 852, with the risk of soil movement highest under heavy rainfall events which were absent in both 2019 and 2020. A repeat of the UAV survey is recommended after heavy rainfall to quantify the change in erosion features over time across the whole of the Carina WRL.

Native species richness at the Carina WRL rehabilitation sites was similar between 2019 and 2020, however was still lower than the analogue sites. This is an expected result given the relatively young age of the rehabilitation. There was a slight decline in species dominance for the rehabilitation sites as a whole, and in 2020 was similar to the analogue sites, although there is a continued dominance of *M. triptera* at two sites that are now five years post rehabilitation. At this stage, it is expected that some improvements in species dominance would be recorded.

Cover remains higher at the rehabilitation sites compared to the analogue sites with two sites having higher cover than the mean of the analogue sites. Vegetation structure at the rehabilitation sites remains different to the analogue sites, with a dominance of herb and low shrub species. Although a slight reduction in herb cover and an increase in tall shrubs at the rehabilitation sites as a whole and at sites SR22, SR23 and SR24 is a positive trend towards the analogue sites. Succession and recruitment of overstorey species was recorded at two sites on the batter slopes; a good indication that the WRL can support self-sustaining vegetation. However, no overstorey species have been recorded to date at SR25 on top of the WRL, or at SR21 where rehabilitation is only two years old. The positive trends in species dominance and cover are good results, however the rehabilitation as a whole is yet to display consistent trends across all attributes to determine if vegetation is progressing towards a similar structure to the analogue sites.

**Sonchus asper* was the only weed species to be recorded at the WRL rehabilitation sites in both 2019 and 2020. This species was also recorded in 2018 and has been recorded at Carina previously; therefore, condition 11-1.7 of MS 852 has been met. There was no change in weed cover between 2019 and 2020, but weed abundance increased, although not significantly. Therefore, compliance with condition 11-1.8 of MS 852 has been met. Weed control activities should continue in an effort to reduce weed populations that may impact on successful vegetation establishment.

4.4 Carina Extended Waste Rock Landform

The third year of monitoring at the rehabilitated Carina Extended WRL has recorded active erosion at all sites, with significant erosion features recorded at SR27 and SR28. Despite below average annual rainfall over the past two years, erosion has increased in frequency and severity at the rehabilitation sites, indicating a potentially unstable surface. It is recommended that the UAV survey be repeated in 2021 to identify any areas of concern across the entire WRL that may require remediation. The limited erosion data available from on-ground monitoring indicates that condition 11-1.1 of MS 852 is not being achieved. The UAV survey will allow for a more comprehensive assessment of the stability of the WRL and condition 11-1.1.

A further increase in native species richness and cover was recorded in 2020 across the rehabilitation sites. All sites except SR29 increased in total native species richness. Species dominance declined slightly from 2019, although this was mostly due to decreased dominance at one site: SR26. Species richness and cover remains lower at the rehabilitation sites compared to the analogue sites, with species dominance higher; this is expected with two-year-old rehabilitation. The vegetation structure remains different to the analogue sites, with a dominance of herbaceous and tall shrub species. However, the increase in low and mid shrub cover is an early indication that the vegetation is progressing towards a structure similar to the analogue sites.

The presence of overstorey species at the rehabilitation sites has increased from one species in 2019 to five in 2020, three of which are shared with the analogue sites. Recruitment was observed at all rehabilitation sites, with succession recorded at one site. Mature trees are yet to be recorded, which is not unexpected at this early stage of rehabilitation. The positive trends in native vegetation recorded between 2019 and 2020 indicates that the rehabilitated Carina Extended WRL can support self-sustaining vegetation, however continued monitoring is required to assess if rehabilitation is trending towards a similar state to the analogue vegetation.

One weed species was recorded in 2020 at all five sites: **S. asper*. This species was also recorded in 2019 at all sites and does not represent a new introduction to the Carina Iron Ore Project. Therefore, condition 11-1.7 of MS 852 has been met. **Erodium botrys* which was recorded for the first time in 2019 was not found to re-occur. Overall weed cover did not vary from 2019, however was significantly higher than 2018. Weed abundance also increased for the second consecutive year. Condition 11-1.8 of MS 852 requires an assessment against baseline data; in this instance 2019 data is regarded as baseline data due to the absence of vegetation in the first year of monitoring in 2018. Therefore, with no significant increase in weed cover (or abundance) from 2019, condition 11-1.8 of MS 852 has been achieved. Continued weed control effort should be maintained to decrease weed populations and provide the best opportunity for native vegetation to establish.

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Appendix A: Monitoring site location maps

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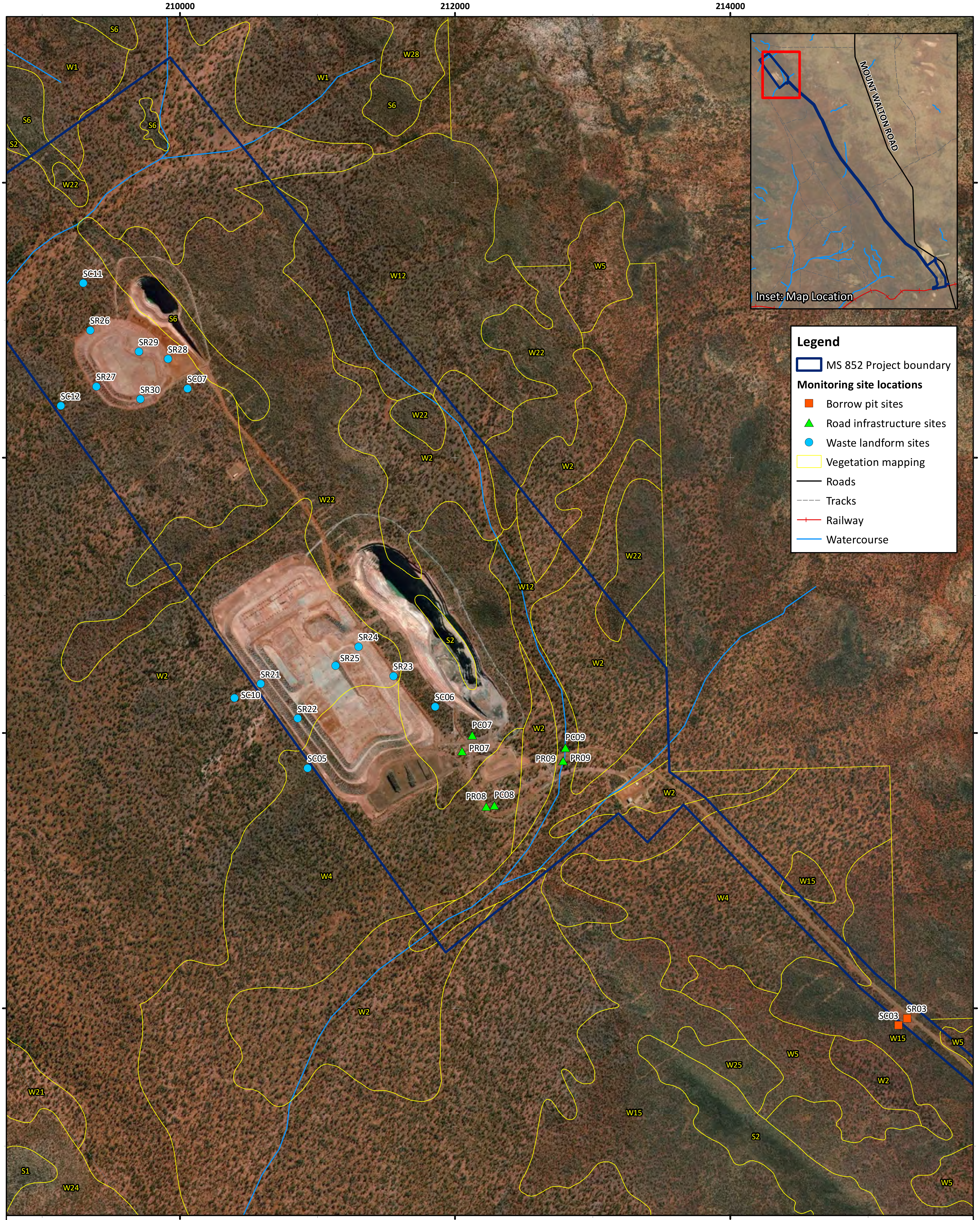

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Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure A.1: Monitoring site locations (northern operations)

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Author: S. Moore	Date: 18-01-2021
Drawn: T. Pedersen	Figure Ref: 13029-20-REDR-3RevA_210118_FigA1

Coordinate System: GDA 1994 MGA Zone 51

0 500 1,000 1,500 2,000 Metres

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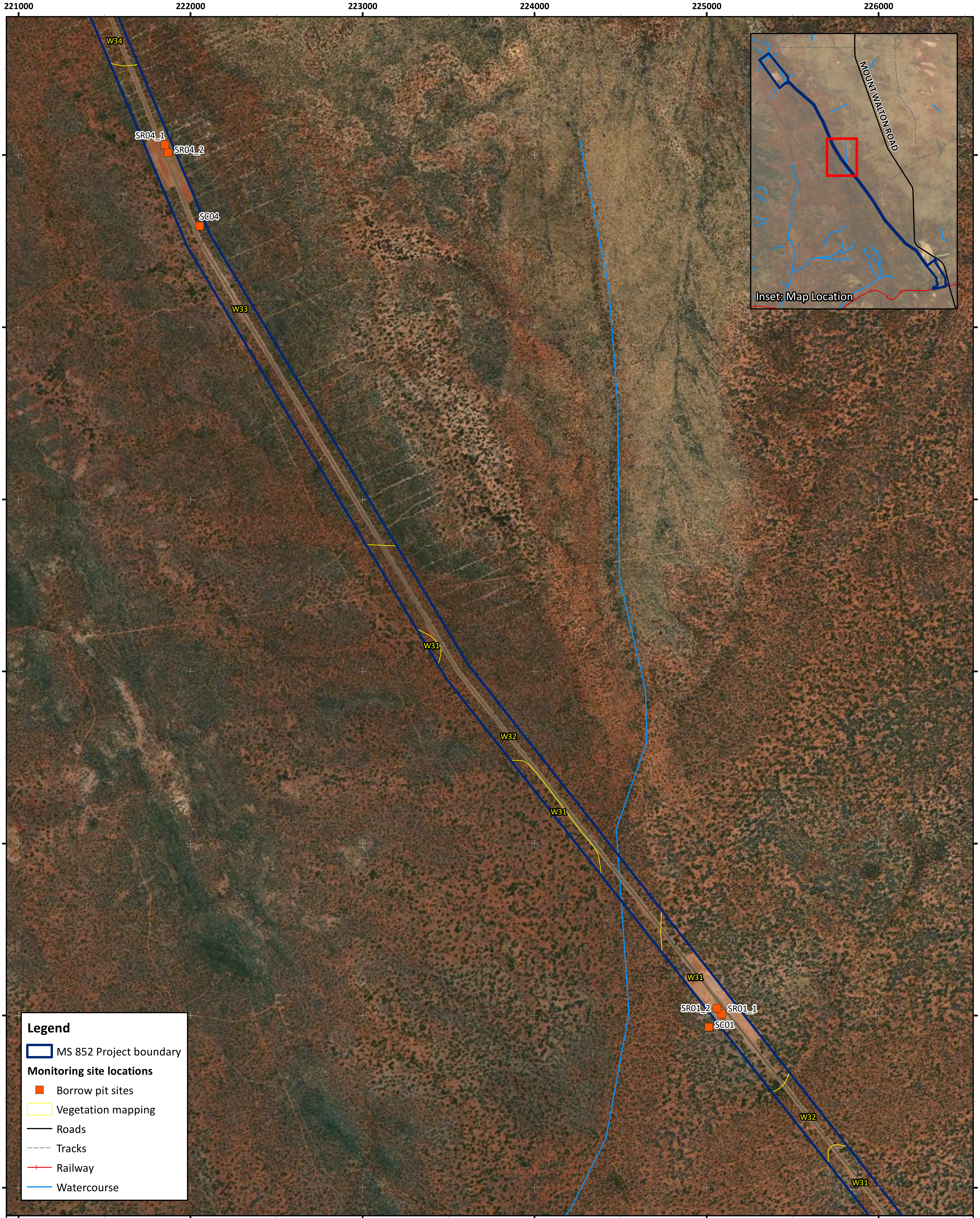

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Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure A.2: Monitoring site locations (haul road)

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Author: S. Moore	Date: 18-01-2021	Coordinate System: GDA 1994 MGA Zone 51
Drawn: T. Pedersen	Figure Ref: 13029-20-REDR-3RevA_210118_FigA2	0 200 400 600 800 1,000 Metres

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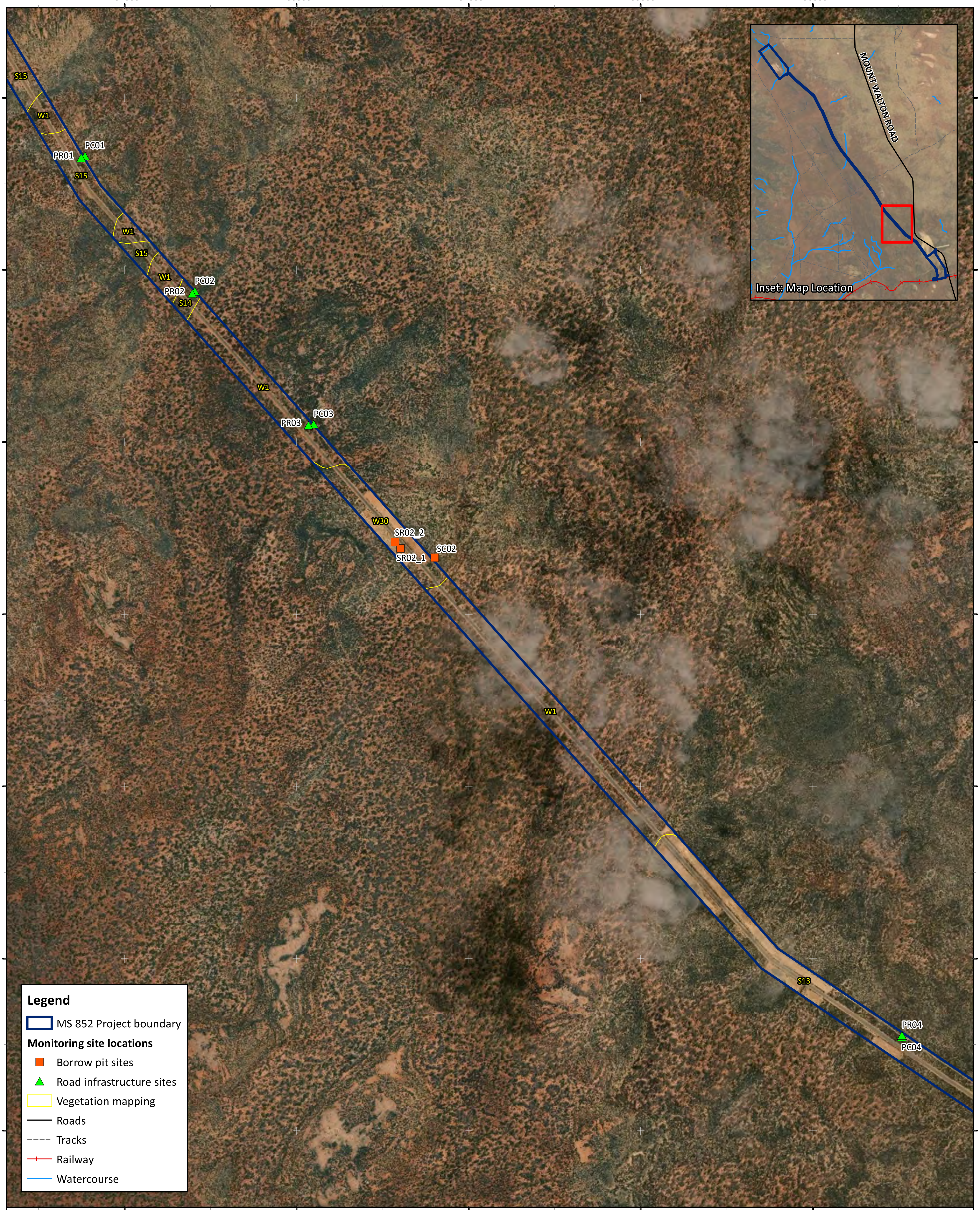

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Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure A.3: Monitoring site locations (haul road)

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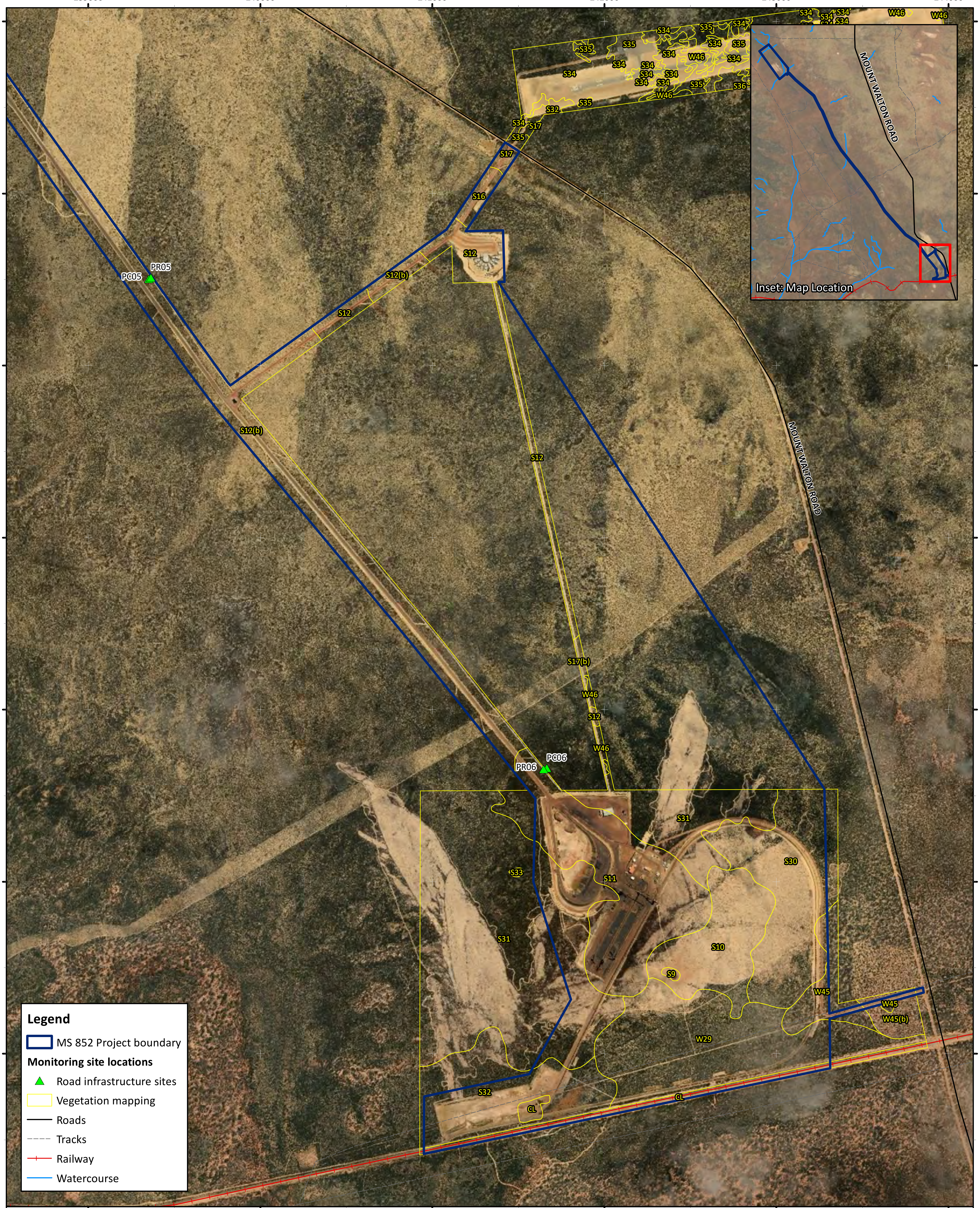
Drawn: T. Pedersen	Figure Ref: 13029-20-REDR-3RevA_210118_FigA3	0 200 400 600 800 1,000 Metres

N



Polaris Metals Pty Ltd

Carina Iron Ore Project – 2020 Rehabilitation Monitoring, December 2020

Figure A.4: Monitoring site locations (southern operations)

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Author: S. Moore	Date: 18-01-2021	Coordinate System: GDA 1994 MGA Zone 51
Drawn: T. Pedersen	Figure Ref: 13029-20-REDR-3RevA_210118_FigA4	0 200 400 600 800 1,000 Metres

N

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Appendix B: Vegetation classification and condition scales, rehabilitation condition rating, and plant health and dust rating scales

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Table B.1: Vegetation Classification System (Specht 1970) as modified by Aplin (1979).

Stratum	70-100% cover	30-70% cover	10-30% cover	2-10% cover	<2% cover
Trees > 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees < 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs > 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs < 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, sedges, herbs	Closed tussock grassland/ sedgeland/ herbland	Tussock grassland/ sedgeland/ herbland	Open tussock grassland/ sedgeland/ herbland	Very open tussock grassland/ sedgeland/ herbland	Scattered tussock grasses/ sedges/ herbs

Table B.2: Summary of vegetation condition scale, as adapted by Trudgen (1988).

Vegetation condition	Condition description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Table B.3: Rehabilitation condition rating.

Attribute	Rating			
Erosion	Extensive rills or gullies	Moderate rills or gullies	Scattered rills or gullies	No erosion
	4	3	2	1
Disturbance	Extensive disturbance (> 40% of site affected)	Moderate disturbance (10 – 40% of site affected)	Scattered disturbance (<10% of site affected)	No disturbance
	4	3	2	1

Table B.4: Plant health condition rating.

Health score	Short description	Detailed description
1	Dead	Plants beyond regenerative ability (0 – 5% projected foliar cover) (fire impact excluded) Mostly dead branches Occasional epicormic shoots, mostly dead Cambium under bark no longer green
2	Poor	Plants with (very) sparse canopy (5 – 40% projected foliar cover) Dead branchlets and branches Senescence of older and recent leaves Dying of epicormic shoots Cambium under bark green, indicating potential to regenerate
3	Fair	Tips of branchlets dying or dead (40 – 60% projected foliar cover) Leaves more susceptible to insect damage Noticeable leaf senescence of older leaves Epicormic shoots (stress related)
4	Good	Plants not as densely green (60 – 80% projected foliar cover) Some yellowing and drying of old leaves Young leaves green to yellow-green Occasional leaf insect damage
5	Excellent	Plants appearing vigorous and green (> 80% projected foliar cover) Very little leaf senescence Very little insect damage on leaves

Table B.5: Dust rating scale.

Dust load score	Short description	Detailed description
1	Negligible	No dust obviously visible on plant Virtually no cloud of dust when plant is shaken No trace of dust when rubbing plant
2	Low	Thin layer of dust apparent on leaves / stems Dust may or may not come off when plant is shaken Only very small amount of dust can be rubbed off Amount of dust too little to be noticeable between fingers
3	Moderate	Plant obviously covered in dust but leaf colour plainly visible Dust falls off in a thin cloud when plant is shaken Dust can be rubbed off plant Grit/powder noticeable between fingers, smear thin when wet
4	High	Plant covered in dust, but leaf colour is faintly visible through dust layer Dust falls off in a cloud when plant is shaken Dust can be rubbed off plant Grit/powder noticeable between fingers, smear opaque when wet
5	Extreme	Dust is caking the plant thickly, leaf/stems take on colour of dust Dust falls off in a thick cloud when plant is shaken Dust can be rubbed off leaves or stems Dust feels powdery/gritty between fingers, smear clayey when wet

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Appendix C: Monitoring site photographs

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Table C.1: Rehabilitation site photographs at borrow pits. Photographs taken at the start of each transect.

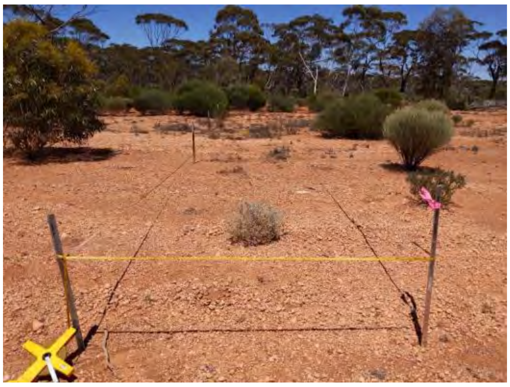
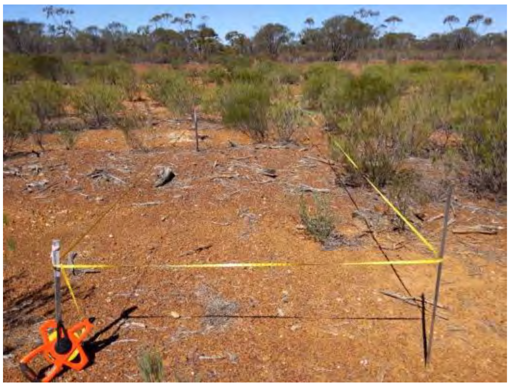
SR01 – Transect 1	SR01 – Transect 2
	
SR02 – Transect 1	**SR02 – Transect 2**
	
SR03	
	N/A
SR04 – Transect 1	**SR04 – Transect 2**
	

Table C.2: Rehabilitation site photographs at Carina waste rock landform. Photographs taken from the start of each transect.

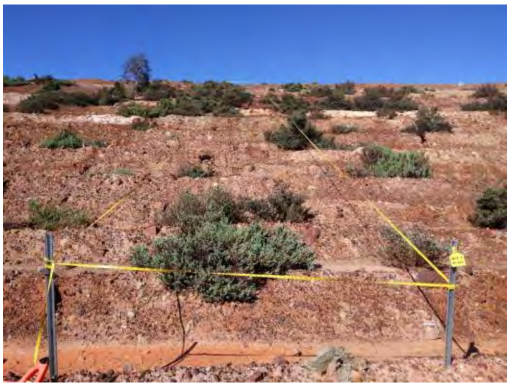
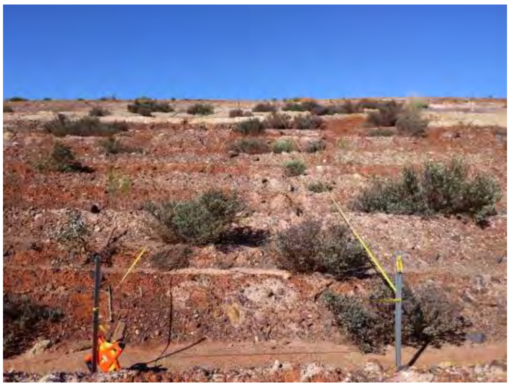
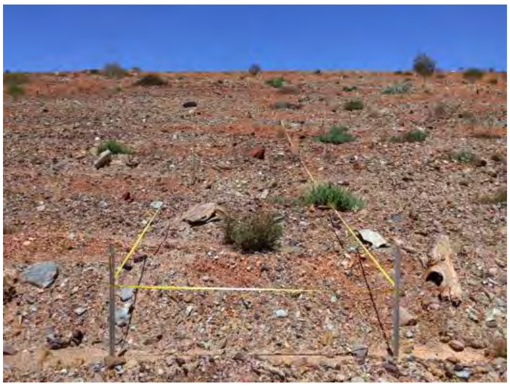
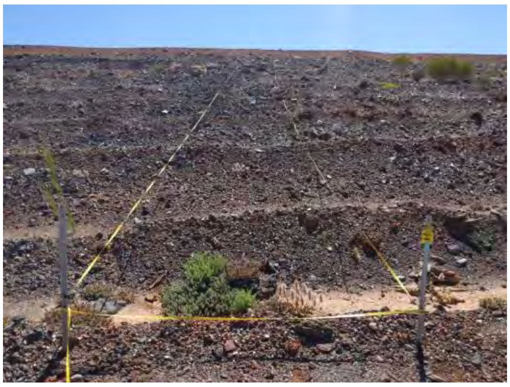
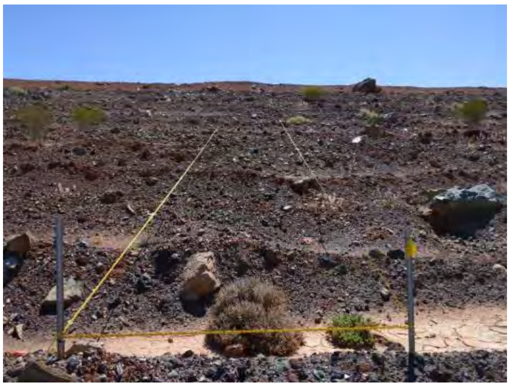
SR21	SR22
	
SR23 – Transect 1	**SR23 – Transect 2**
	
SR24	
	N/A
SR25 – Transect 1	**SR25 – Transect 2**
	

Table C.3: Rehabilitation site photographs at Carina Extended waste rock landform. Photographs taken from the start of each transect.

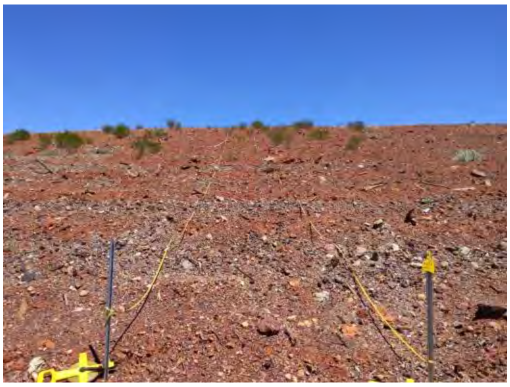
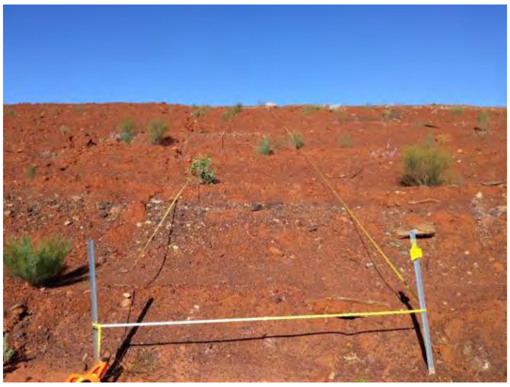
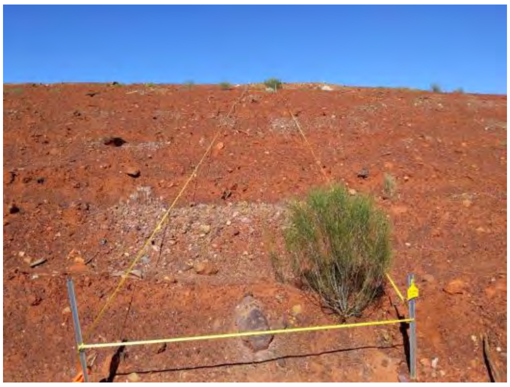
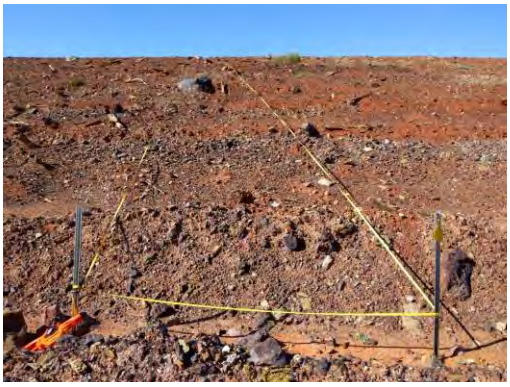
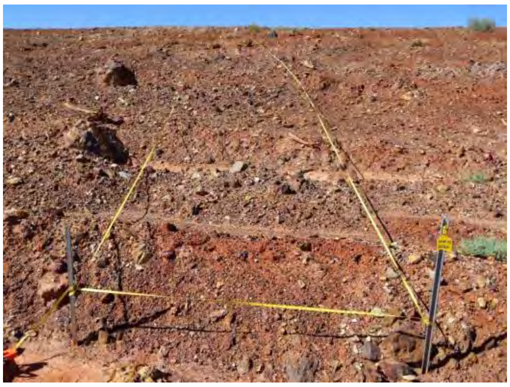
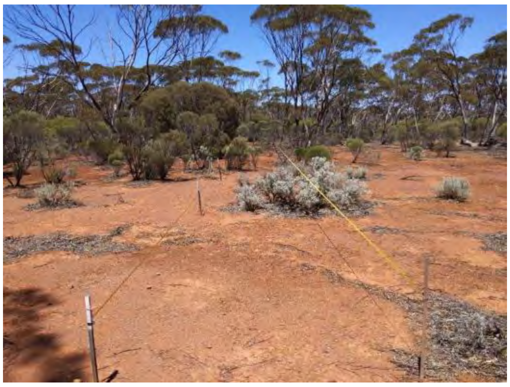
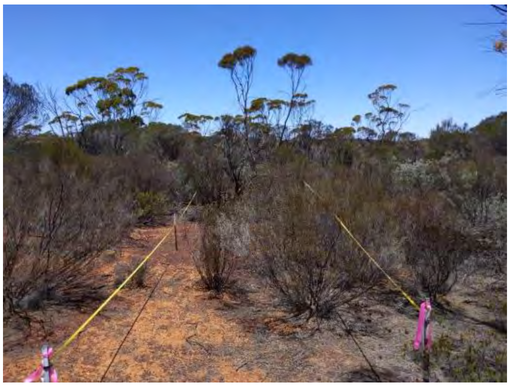
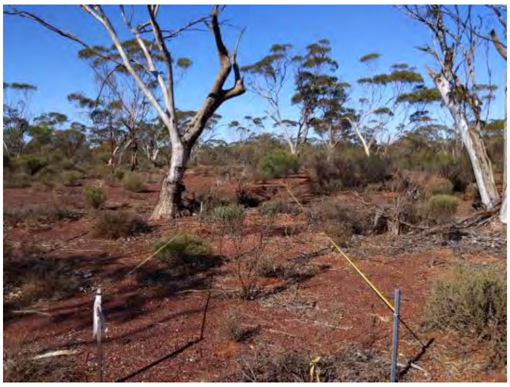
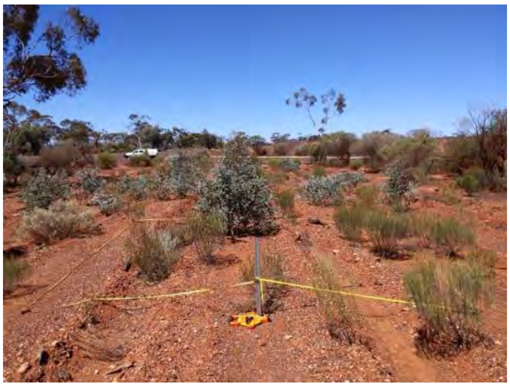
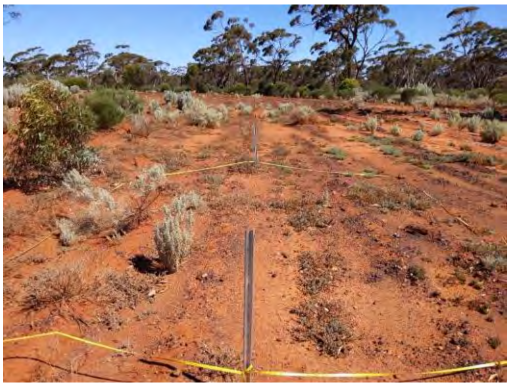
SR26	SR27
	
SR28 – Transect 1	**SR28 – Transect 2**
	
SR29 – Transect 1	**SR29 – Transect 2**
	
SR30 – Transect 1	**SR30 – Transect 2**
	

Table C.4: Analogue site photographs taken from the start of each transect.

SC01	SC02
	
SC03	**SC04**
	
SC05	**SC06**
	
SC07	**SC10**
	

SC11	SC12
	

Table C.5: Rehabilitation and analogue site photographs at rehabilitated road infrastructure.

PR01	PR02
	
PR03	**PR04**
	
PR05	**PR06**
	
PR07	**PR08**
	

PR09	PC01
	
PC02	**PC03**
	
PC04	**PC05**
	
PC06	**PC07**
	

PC08	PC09
	

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Appendix D: Erosion monitoring photographs and coordinates

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Plate D.1: SR21-Q00-R1 (786711mE, 6626435mN).

Plate D.2: SR21-Q00-R1 (786711mE, 6626435mN)_a.

Plate D.3: SR21-Q05-R1 (786715mE, 6626432mN).

Plate D.1: SR21-Q05-R1 (786715mE, 6626432mN)_a.

Plate D.5: SR21-Q10-R1 (786719mE, 6626435mN).

Plate D.6: SR21-Q10-R1 (786719mE, 6626435mN)_a.

Plate D.7: SR21-Q15-R1 (786724mE, 6626437mN).

Plate D.8: SR21-Q15-R1 (786724mE, 6626437mN)_a.

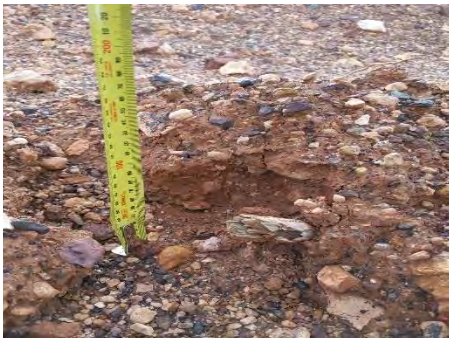

Plate D.9: SR21-Q15-R2 (786726mE, 6626439mN).

Plate D.10: SR21-Q15-R2 (786726mE, 6626439mN)_a.

Plate D.11: SR21-Q20-R1 (786731mE, 6626441mN).

Plate D.12: SR21-Q20-R1 (786731mE, 6626441mN)_a.

Plate D.13: SR21-Q20-R2 (786730mE, 6626438mN).

Plate D.14: SR21-Q20-R2 (786730mE, 6626438mN)_a.

Plate D.15: SR21-Q25-R1 (786734mE, 6626447mN).

Plate D.16: SR21-Q25-R1 (786734mE, 6626447mN)_a.

Plate D.17: SR21-Q25-R2 (786736mE, 6626449mN).

Plate D.18: SR21-Q25-R2 (786736mE, 6626449mN)_a.

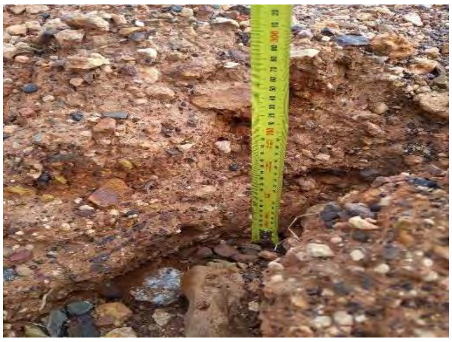

Plate D.19: SR21-Q35-R1 (786743mE, 6626451mN).

Plate D.20: SR21-Q35-R1 (786743mE, 6626451mN)_a.

Plate D.21: SR22-Q05-R1 (786971mE, 6626170mN).

Plate D.22: SR22-Q05-R1 (786971mE, 6626170mN)_a.

Plate D.23: SR22-Q25-R1 (786989mE, 6626181mN).

Plate D.24: SR22-Q25-R1 (786989mE, 6626181mN)_a.

Plate D.25: SR22-Q25-R2 (786987mE, 6626183mN).

Plate D.26: SR22-Q25-R2 (786987mE, 6626183mN)_a.

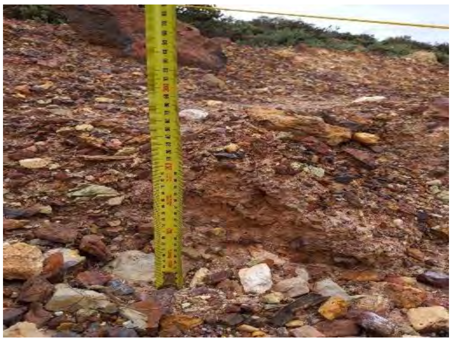

Plate D.27: SR23-Q05-R1 (787677mE, 6626435mN).

Plate D.28: SR23-Q05-R1 (787677mE, 6626435mN)_a.

Plate D.29: SR23-Q05-R2 (787677mE, 6626435mN).

Plate D.30: SR23-Q05-R2 (787677mE, 6626435mN)_a.

Plate D.31: SR23-Q10-R1 (787674mE, 6626433mN).

Plate D.32: SR23-Q10-R1 (787674mE, 6626433mN)_a.

Plate D.33: SR23-Q10-R2 (787674mE, 6626433mN).

Plate D.34: SR23-Q10-R2 (787674mE, 6626433mN)_a.

Plate D.35: SR23-Q10-R3 (787674mE, 6626433mN).

Plate D.36: SR23-Q10-R3 (787674mE, 6626433mN)_a.

Plate D.37: SR23-Q10-R4 (787674mE, 6626433mN).

Plate D.38: SR23-Q10-R4 (787674mE, 6626433mN)_a.

Plate D.39: SR23-Q20-R1 (787666mE, 6626430mN).

Plate D.40: SR23-Q20-R1 (787666mE, 6626430mN)_a.

Plate D.41: SR23-Q25-R1 (787655mE, 6626479mN).

Plate D.42: SR23-Q25-R1 (787655mE, 6626479mN)_a.

Plate D.43: SR23-Q25-R2 (787655mE, 6626479mN).

Plate D.44: SR23-Q25-R2 (787655mE, 6626479mN)_a.

Plate D.45: SR23-Q25-R3 (787655mE, 6626481mN).

Plate D.46: SR23-Q25-R3 (787655mE, 6626481mN)_a.

Plate D.47: SR23-Q30-R1 (787653mE, 6626481mN).

Plate D.48: SR23-Q30-R1 (787653mE, 6626481mN)_a.

Plate D.49: SR23-Q30-R2 (787653mE, 6626480mN).

Plate D.50: SR23-Q30-R2 (787653mE, 6626480mN)_a.

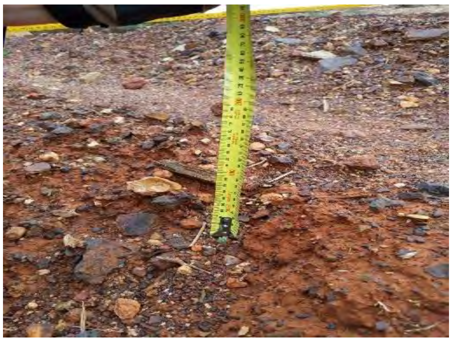

Plate D.51: SR23-Q35-R1 (787649mE, 6626477mN).

Plate D.52: SR23-Q35-R1 (787649mE, 6626477mN)_a.

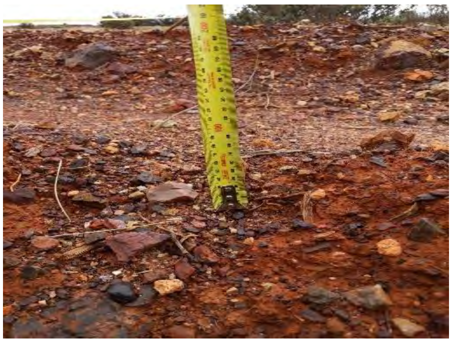

Plate D.53: SR23-Q35-R2 (787649mE, 6626477mN).

Plate D.54: SR23-Q35-R2 (787649mE, 6626477mN)_a.

Plate D.55: SR23-Q40-R1 (787645mE, 6626475mN).

Plate D.56: SR23-Q40-R1 (787645mE, 6626475mN)_a.

Plate D.57: SR23-Q40-R2 (787645mE, 6626474mN).

Plate D.58: SR23-Q40-R2 (787645mE, 6626474mN)_a.

Plate D.59: SR23-Q45-R1 (787642mE, 6626472mN).

Plate D.60: SR23-Q45-R1 (787642mE, 6626472mN)_a.

Plate D.61: SR23-Q45-R2 (787642mE, 6626472mN).

Plate D.62: SR23-Q45-R2 (787642mE, 6626472mN)_a.

Plate D.63: SR23-Q45-R3 (787641mE, 6626474mN).

Plate D.64: SR23-Q45-R3 (787641mE, 6626474mN)_a.

Plate D.65: SR23-Q45-R4 (787640mE, 6626474mN).

Plate D.66: SR23-Q45-R4 (787640mE, 6626474mN)_a.

Plate D.67: SR24-Q15-R1 (787467mE, 6626683mN).

Plate D.68: SR24-Q15-R1 (787467mE, 6626683mN)_a.

Plate D.69: SR24-Q35-R1 (787450mE, 6626672mN).

Plate D.70: SR24-Q35-R1 (787450mE, 6626672mN)_a.

Plate D.71: SR24-Q35-R2 (787450mE, 6626671mN).

Plate D.72: SR24-Q35-R2 (787450mE, 6626671mN)_a.

Plate D.73: SR24-Q40-R1 (787446mE, 6626668mN).

Plate D.74: SR24-Q40-R1 (787446mE, 6626668mN)_a.

Plate D.75: SR25-Q05-R1 (787273mE, 6626539mN).

Plate D.76: SR25-Q05-R1 (787273mE, 6626539mN)_a.

Plate D.77: SR25-Q10-R1 (787276mE, 6626542mN).

Plate D.78: SR25-Q10-R1 (787276mE, 6626542mN)_a.

Plate D.79: SR25-Q15-R1 (787283mE, 6626544mN).

Plate D.80: SR25-Q15-R1 (787283mE, 6626544mN)_a.

Plate D.81: SR25-Q15-R2 (787282mE, 6626544mN).

Plate D.82: SR25-Q15-R2 (787282mE, 6626544mN)_a.

Plate D.83: SR25-Q20-R1 (787283mE, 6626544mN).

Plate D.84: SR25-Q20-R1 (787283mE, 6626544mN)_a.

Plate D.85: SR25-Q30-R1 (787299mE, 6626498mN).

Plate D.86: SR25-Q30-R1 (787299mE, 6626498mN)_a.

Plate D.87: SR25-Q40-R1 (787307mE, 6626503mN).

Plate D.88: SR25-Q40-R1 (787307mE, 6626503mN)_a.

Plate D.89: SR25-Q40-R2 (787308mE, 6626503mN).

Plate D.90: SR25-Q40-R2 (787308mE, 6626503mN)_a.

Plate D.91: SR26-Q15-R1 (785623mE, 6629049mN).

Plate D.92: SR26-Q15-R1 (785623mE, 6629049mN)_a.

Plate D.93: SR26-Q20-R1 (785624mE, 6629045mN).

Plate D.94: SR26-Q20-R1 (785624mE, 6629045mN)_a.

Plate D.95: SR26-Q25-R1 (785629mE, 6629042mN).

Plate D.96: SR26-Q25-R1 (785629mE, 6629042mN)_a.

Plate D.97: SR26-Q30-R1 (785631mE, 6629038mN).

Plate D.98: SR26-Q30-R1 (785631mE, 6629038mN)_a.

Plate D.99: SR26-Q35-R1 (785633mE, 6629034mN).

Plate D.100: SR26-Q35-R1 (785633mE, 6629034mN)_a.

Plate D.101: SR26-Q40-R1 (785636mE, 6629032mN).

Plate D.102: SR26-Q40-R1 (785636mE, 6629032mN)_a.

Plate D.103: SR27-Q00-R1 (785636mE, 6628656mN).

Plate D.104: SR27-Q00-R1 (785636mE, 6628656mN)_a.

Plate D.105: SR27-Q00-R2 (785636mE, 6628655mN).

Plate D.106: SR27-Q00-R2 (785636mE, 6628655mN)_a.

Plate D.107: SR27-Q05-R1 (785641mE, 6628659mN).

Plate D.108: SR27-Q05-R1 (785641mE, 6628659mN)_a.

Plate D.109: SR27-Q05-R2 (785640mE, 6628658mN).

Plate D.110: SR27-Q05-R2 (785640mE, 6628658mN)_a.

Plate D.111: SR27-Q10-R1 (785645mE, 6628662mN).

Plate D.112: SR27-Q10-R1 (785645mE, 6628662mN)_a.

Plate D.113: SR27-Q15-R1 (785649mE, 6628665mN).

Plate D.114: SR27-Q15-R1 (785649mE, 6628665mN)_a.

Plate D.115: SR27-Q20-R1 (785654mE, 6628666mN).

Plate D.116: SR27-Q20-R1 (785654mE, 6628666mN)_a.

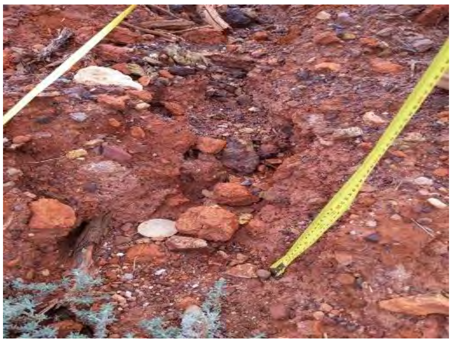

Plate D.117: SR27-Q45-R1 (785674mE, 6628679mN).

Plate D.118: SR27-Q45-R1 (785674mE, 6628679mN)_a.

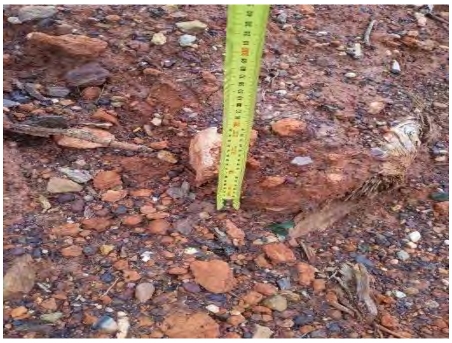

Plate D.119: SR27-Q45-R2 (785674mE, 6628679mN).

Plate D.120: SR27-Q45-R2 (785674mE, 6628679mN)_a.

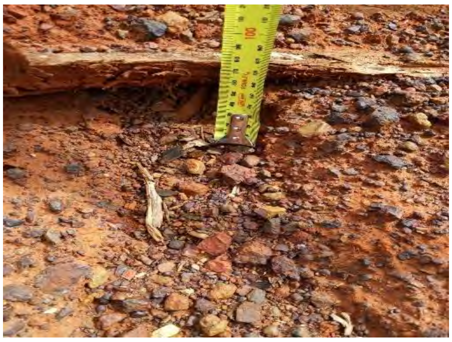

Plate D.121: SR28-Q00-R1 (786166mE, 6628824mN).

Plate D.122: SR28-Q00-R1 (786166mE, 6628824mN)_a.

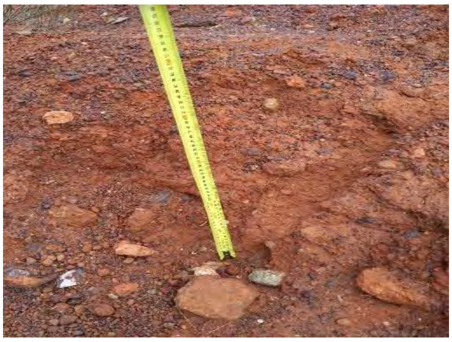

Plate D.123: SR28-Q15-R1 (786151mE, 6628822mN).

Plate D.124: SR28-Q15-R1 (786151mE, 6628822mN)_a.

Plate D.125: SR28-Q20-R1 (786147mE, 6628823mN).

Plate D.126: SR28-Q20-R1 (786147mE, 6628823mN)_a.

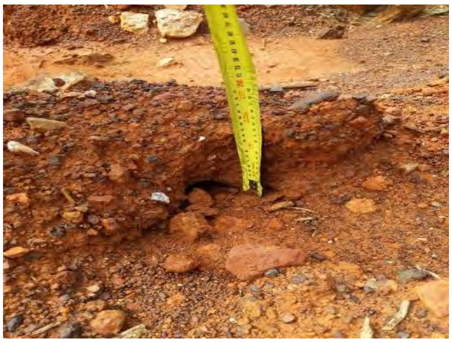

Plate D.127: SR28-Q20-R2 (786146mE, 6628822mN).

Plate D.128: SR28-Q20-R2 (786146mE, 6628822mN)_a.

Plate D.129: SR28-Q25-R1 (786155mE, 6628873mN).

Plate D.130: SR28-Q25-R1 (786155mE, 6628873mN)_a.

Plate D.131: SR28-Q45-R1 (786139mE, 6628868mN).

Plate D.132: SR28-Q45-R1 (786139mE, 6628868mN)_a.

Plate D.133: SR29-Q35-R1 (785911mE, 6628903mN).

Plate D.134: SR29-Q35-R1 (785911mE, 6628903mN)_a.

Plate D.135: SR29-Q40-R1 (785912mE, 6628897mN).

Plate D.136: SR29-Q40-R1 (785912mE, 6628897mN)_a.

Plate D.137 SR30-Q00-R1 (785954mE, 6628546mN).

Plate D.138: SR30-Q00-R1 (785954mE, 6628546mN)_a.

Plate D.139: SR30-Q10-R1 (785950mE, 6628555mN).

Plate D.140: SR30-Q10-R1 (785950mE, 6628555mN)_a.

Plate D.141: SR30-Q15-R1 (785951mE, 6628560mN).

Plate D.142: SR30-Q15-R1 (785951mE, 6628560mN)_a.

Plate D.143: SR30-Q20-R1 (785950mE, 6628564mN).

Plate D.144: SR30-Q20-R1 (785950mE, 6628564mN)_a.

Plate D.145: SR30-Q25-R1 (786002mE, 6628557mN).

Plate D.146: SR30-Q25-R1 (786002mE, 6628557mN)_a.

Plate D.147: SR30-Q25-R2 (786003mE, 6628557mN).

Plate D.148: SR30-Q25-R2 (786003mE, 6628557mN)_a.

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APPENDIX 3: CARINA FAUNA INTERACTION REGISTER 2020-2021

Carina Iron Ore Fauna Interaction Register

DATE	Time	ANIMAL	*GENUS/SPECIES*	NUMBER	ESCRIPTION OF INTERACTIO	CONDITION	REPORTED BY	Easting	Northing	LOCATION
7/01/21	8:00:00 AM	Malleefowl	*Leipoa ocellata*	1	Sighting	Alive	Gavin Bell	739,568.00	6,500,749.00	Sighted a malleefowl on the corner of the parker access and emu fence rd approx. 8am today… about 10m from the malleefowl sign on the road
8/01/21	6:00:00 AM	Malleefowl	*Leipoa ocellata*	1	Sighting	Alive	Gavin Bell	739,568.00	6,500,749.00	Another sighting same intersection different corner at 6am this morning too

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APPENDIX 4: CARINA AND J4 PROJECT ENVIRONMENTAL MANAGEMENT PLAN 2020

POLARIS
METALS PTY LTD

Carina and Jackson 4 Iron Ore Project

PROJECT ENVIRONMENTAL MANAGEMENT PLAN – Rev4

Proponent:	Polaris Metals Pty Ltd
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3 December 2020

Report Reference: ENV-TS-RP-0236

Revision History

Document Status	Prepared By	Authorised By	Date
Draft Report	Leo Boynton (MBS)	Elizabeth Mason (MBS)	3 April 2020
Final Report	Elizabeth Mason (MBS)	Kristy Sell (MBS)	30 April 2020
Revisoin 1	Leo Boyton (MBS)	Elizabeth Mason (MBS)	6 July 2020
Revision 2	Kyle Hodgson	Craig Holness	24 July 2020
Revision 3	Kyle Hodgson	Craig Holness	29 July 2020
Revision 4	Kyle Hodgson	Craig Holness	3 December 2020

SUMMARY

This Project Environmental Management Plan (PEMP) is submitted by Polaris Metals Pty Ltd (Polaris) for the overarching management of the Carina and Carina Extended (Carina), and Jackson 4 (J4) projects (the Project) approved under Ministerial Statements (MS), MS 852 and MS 988, respectively. The two mines operate in close proximity, in similar environments and have similar MS Conditions in relation to environmental management, therefore the administration of the two projects is appropriate under this PEMP.

Table 1 and **Table 2** present the relevant EPA Factors, condition objectives and environmental management target/s to assess compliance with and efficacy of the conditional environmental objective that must be met through implementation of this Condition PEMP.

TABLE 1: PEMP PURPOSE, ENVIRONMENTAL FACTORS AND CONDITIONS OBJECTIVES FOR MS 852

Title of Proposal	Carina Iron Ore Project
Proponent	Polaris Metals Pty Ltd
Ministerial Stamtenet	852
Purpose of this Condition EMP	The revised Carina and J4 PEMP (this document) is submitted to fulfil the requirements of Conditions 9-1 and 9-3 of MS 852.
EPA's Key Factors and Environmental Objectives	Flora and Vegetation: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. Terrestrial Fauna: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
MS 852 Conditions	**9-1:** Prepare Project Environmental Management Plan to ensure that theadverse impacts from mining and associated activities do not unnecessarilythreaten conservation values within the mining lease and prevent impactsoutside of the mining lease. **9-3:** The proponent shall review and revise the Project EnvironmentalManagement Plan required by condition 9-1 at intervals not exceeding threeyears. **9.4** The proponent shall report to the CEO on implementation of the Project Environmental Management Plan every two years from the date of commencing ground disturbing activities. **9.5** The proponent shall make the Project Environmental Management Plan required by condition 9-1 publicly available in a manner approved by the CEO.

<table>
<tr><td>Key Provisions</td><td>As there are several provisions for each of the PEMP aspects, a summary of key provisions is provided. Induction and training is a common provision across the management aspects.
Hygiene Management:
• Weed hygiene certificate for high risk operations.
• Annual Spring weed survey.
• Targeted weed survey and chemical control during March – September period.
• Annual assessment of dieback by an accredited assessor.
Feral Animal Management:
• Feral animal attractants fenced, i.e. landfill, water sources.
• Record feral animal sightings.
• Annual camera trapping program.
Disturbance and Vegetation Clearing Management:
• Implement Site Disturbance Permit procedure.
• All vehicles, plant and equipment restricted to within the clearing limits.
Limit Unauthorised Access:
• Block off minor tracks that access the project site in consultation with Department of Biodiversity Conservation and Attractions (DBCA) Kalgoorlie.
• The access road to the mine will be signposted and all visitors are to report to the mine office.
Fire Prevention and Response:
• Implement hot work permit system.
• On-site emergency response team on site and trained.
Saline Dust Suppression Water Management:
• Saline water pipelines located within bunds.
• Spray bar calibrated to road width and appropriate pressure to reduce overspray.
• Maintain 300mm freeboard in turkeys nest.
• Pre-start inspections and scheduled maintenance of water carts.
Reporting
• Report to the implementation of the Project Environmental Management Plan every two years.
• Project Environmental Management Plan to be made publicly available.</td></tr>
</table>

TABLE 2: PEMP PURPOSE, ENVIRONMENTAL FACTORS AND CONDITIONS OBJECTIVES FOR MS 988

Title of Proposal	Jackson 4 (J4) Iron Ore Project
Proponent	Polaris Metals Pty Ltd
Ministerial Stamtenet	988
Purpose of this Condition EMP	The revised Carina and J4 PEMP (this document) is submitted to fulfil the requirements of Conditions 6-2 of MS 988.
EPA's Key Factors and Environmental Objectives	**Flora and Vegetation:** To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Landforms:** To maintain the variety and integrity of significant physical landforms so that environmental values are protected.
MS 988 Conditions	**6-2:** The proponent shall ensure that the design, construction and operation of the Haul Road does not impact the surrounding environment and existing infrastructure from the effects of surface water flow impedance, dust, use of saline water, weed encroachment and fire.
Key Provisions	As there are several provisions for each of the PEMP aspects, a summary of key provisions is provided. Induction and training is a common provision across the management aspects. **Hygiene Management:** • Weed hygiene certificate for high risk operations. • Annual Spring weed survey. • Targeted weed survey and chemical control during March – September period. • Annual assessment of dieback by an accredited assessor. **Disturbance and Vegetation Clearing Management:** • Implement Site Disturbance Permit procedure. • All vehicles, plant and equipment restricted to within the clearing limits. **Fire Prevention and Response:** • Implement hot work permit system. • On-site emergency response team on site and trained. **Saline Dust Suppression Water Management:** • Saline water pipelines located within bunds. • Spray bar calibrated to road width and appropriate pressure to reduce overspray. • Maintain 300mm freeboard in turkeys nest. • Pre-start inspections and scheduled maintenance of water carts. **Surface Water Flow Management:** • Installation of culverts and flood ways • Cross-flow haul road drains will be maintained to minimise alteration and impacts on the natural surface water drainage systems.

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1. CONTEXT SCOPE AND RATIONALE

1.1. PROJECT

The two projects are owned and operated by Polaris Metals Pty Ltd (Polaris) which is a wholly owned subsidiary of Mineral Resources Limited. Carina is located approximately 60 kilometres (km) north east of Koolyanobbing and 100 km north east of Southern Cross (**Figure 1**). J4 is approximately 70 km west of the Carina northern operations and is accessed via the Carina haul road. Both projects are within the Goldfields region of Western Australia. The Project areas consist of the below.

Carina (MS 852):

- Carina Northern Operations:
  - Two depleted open cut pits (Carina and Carina Extended).
  - Two Waste Rock Landforms (Carina and Carina Extended) – Currently under rehabilitation.
  - A Run of Mine (ROM).
  - Infrastructure area.
- A bitumen haul road, approximately 50 km in length links Carina to the Mt Walton Rail Siding which is connected to the trans Australian railway.
- Carina Southern Operations:
  - Accommodation camp.
  - East Jaurdi Aerodrome (Not approved under MS 852 and MS 988).
  - A ROM
  - Dry crushing and screening plant.
  - Stockyard with associated Stacker and Reclaimers.
  - Train loader and rail loop.
  - Associated support infrastructure (Offices, Laboratory, Workshops)

J4 (MS 988):

- Two depleted open cut pits (East and West Pit's).
- Two Waste Rock Landforms (East and West WRL's) – Currently under rehabilitation.
- A ROM.
- Infrastructure area (Office, workshop, magazine area and bulk explosives area decommissioned and removed from site.)
- A bitumen haul road, approximately 70 km in length.

The projects are located in the Coolgardie 2 Bioregion (COO2 – Southern Cross subregion) as defined by the Interim Biogeographical Regionalisation for Australia (IBRA). The region is east of the wheat belt and although it has a long history of pastoral, historic woodcutting and mining land uses, it remains largely uncleared. Carina is approximately 20 km from both the existing Mt Manning Nature Reserve (to the north) and the Helena and Aurora Conservation Park (to the west), while J4 mine lies approximately 9 km south of a proposed Conservation and Mining Reserve (the ex. Mt Jackson lease) and 2.5 km south-west of the Mt Manning Helena and Aurora Conservation Park's south-west border. J4's haul road extends from the J4 ore body tracking south-east along shared infrastructure through just under 14 km of the southwest corner of the Helena and Aurora Conservation Park, into Unallocated Crown land and through approximately 8 km of the proposed extension of the Yilgarn conservation reserve system to connect to the north-south travelling Carina haul road (**Figure 1**).

The Carina project is located on the former Jaurdi Pastoral Station in the proposed extended Yilgarn conservation reserve system. The proposed Jaurdi Conservation Park is recognised for inclusion in the State's conservation reserve system based on landscape and biodiversity values which are currently poorly represented, including flora and fauna of conservation significance. The former Jaurdi pastoral station has not yet been converted into a Crown reserve, of any category nor vested in the Conservation Commission under the *Land Administration Act 1997*.

The areas are known for their biodiversity; however, the location of the project is not recognised as having the highest conservation significance (EPA Bulletin 1256) for A class reservation, and mining is considered compatible with both the existing and proposed land use.

The Carina project was referred to the West Australian Environmental Protection Authority (EPA) on 15 September 2008. On 3 November 2008, the EPA published its decision to assess the project at a Public Environmental Review (PER) level of assessment, with a four-week review period. The project was approved via the grant of Ministerial Statement 852 on 27 January 2011. A Section 46 application was made to remove Condition 5-2 of MS 852 and was approved via the grant of Ministerial Statement 957 on date 11 December 2013. The conditions of approval include several provisions for managing conservation values of the adjacent environment to be administered through a PEMP (Condition 9-1 and 9-3).

The J4 project was referred to the EPA on 23 December 2013 and was advertised for public comment from 7 to 13 January 2014. J4 was approved under Ministerial Statement 988 on 24 October 2014 which included conditions regarding the design, construction and closure of the haul road, and the management and mitigation of haul road related impacts to adjacent environmental values (Condition 6-2).

TABLE 3: KEY PROJECT CHARACTERISTICS

Aspect	Description
Project	**Carina**
Components	Two open pits, two mine waste landforms and ancillary mine infrastructure.
Mineral resource	Direct shipping ore (DSO) – hematite / goethite.
Processing type	Dry crushing and screening.
Date of commencement	January 2011.
Life of mine	5 – 10 years.
Date of completion	Drill and blast mining at Carina ceased in May 2016 followed by Carina Extended which ceased in March 2018. Haulage of remaining stockpiles is on-going. East Jaurdi Aerodrome and Carina haul road is used to transport FIFO personnel to adjacent Koolyanobbing operations. Key infrastructurture such as the Carina Village, Crusher and Train Load Out will be used to facilitate the export of ore from MRL's network of mines in the region.

Aspect	Description
Project	**Jackson 4**
Components	Two open pits, two mine waste landforms, ROM pad, ancillary mine infrastructure and haul road.
Mineral resource	Direct shipping ore (DSO) – hematite / goethite.
Processing type	Dry crushing and screening.
Date of commencement	January 2015.
Life of mine	5 years.
Date of completion	Drill and blast mining ceased in November 2017.

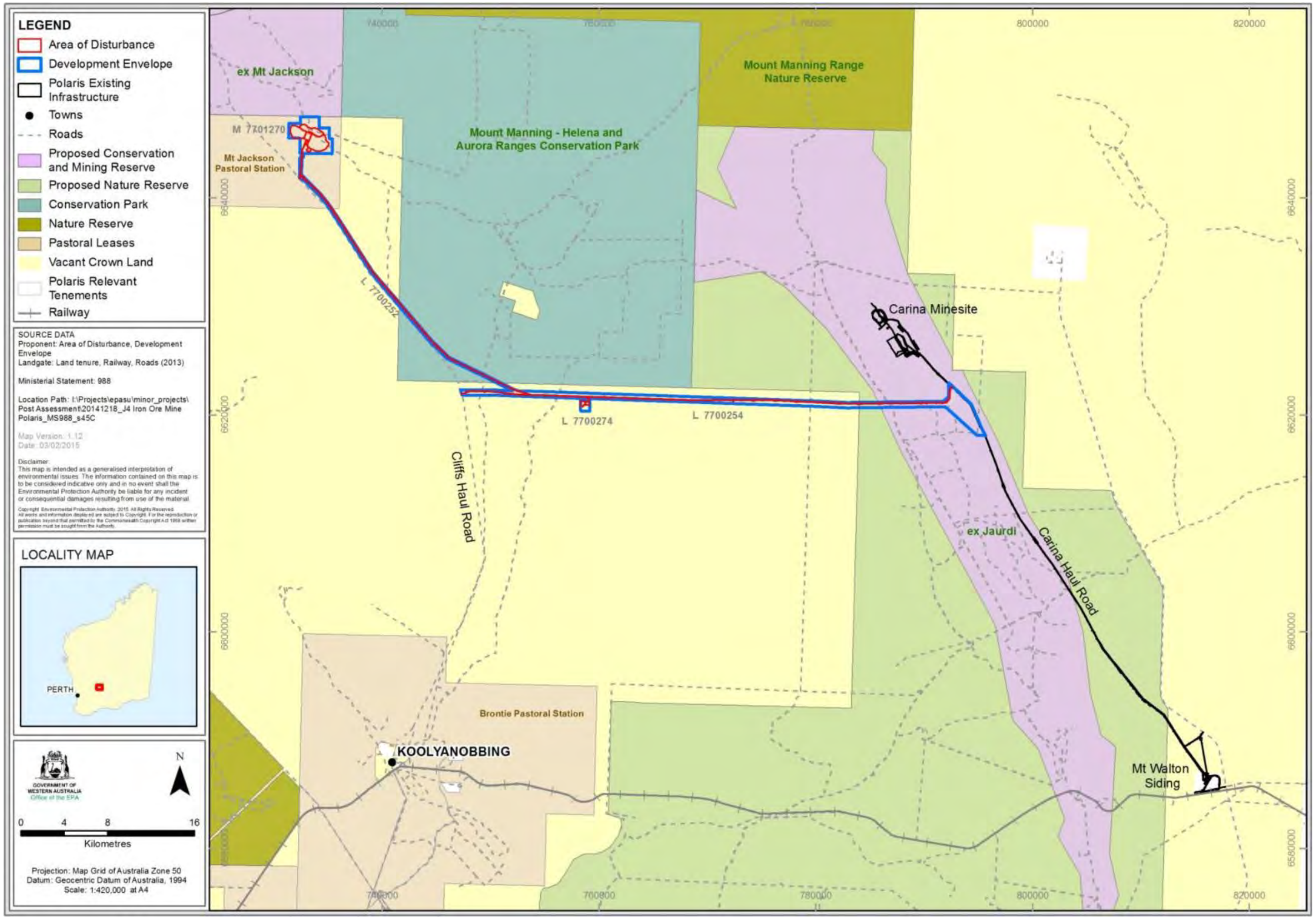

FIGURE 1: CARINA AND J4 PROJECT LOCATION

FIGURE 2: CARINA SITE COMPONENTS

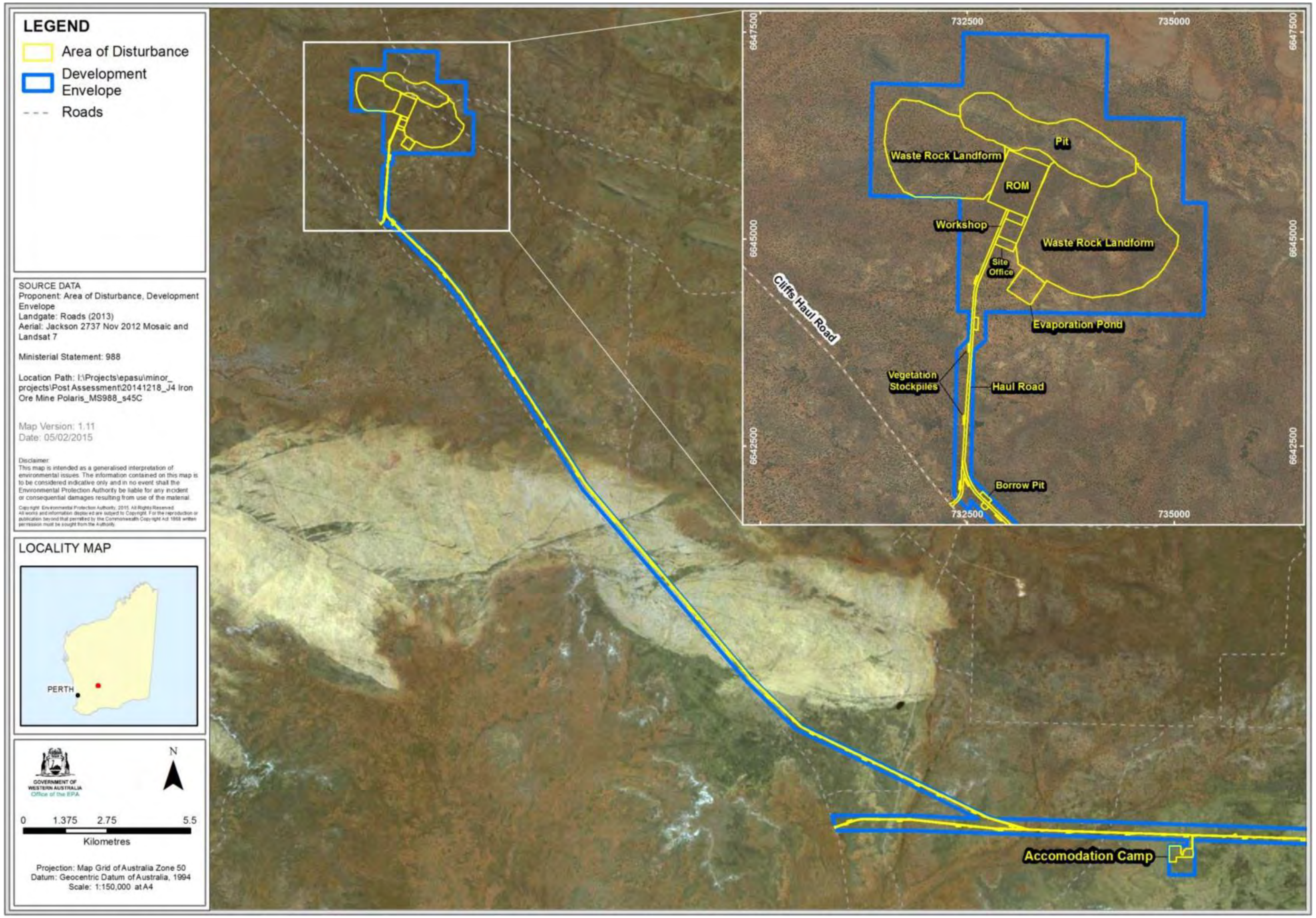

FIGURE 3: J4 SITE COMPONENTS

1.2. KEY ENVIRONMENTAL FACTORS

Key Environmental Factors have been identified by the EPA.

Carina:

- Terrestrial Fauna: EPA Objective - To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
- Flora and Vegetation: EPA Objective - To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Jackson 4:

- Flora and Vegetation: EPA Objective - To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
- Landforms EPA Objective: To maintain the variety and integrity of significant physical landforms so that environmental values are protected.

1.3. CONDITION REQUIREMENTS

This revised PEMP is submitted in accordance with Condition 9-1, Condition 9-3, Condition 9-4 and Condition 9-5 of Ministerial Statement 852 and Condition 6-2 of Ministerial Statement 988. Details of the requirements of these Conditions are provided in **Table 4**, and are addressed within this PEMP.

TABLE 4: REQUIREMENTS OF RELEVANT CONDITIONS

No	Condition	Section in PEMP
Ministerial Statement 852		
9-1	Prior to ground disturbing activities the proponent shall prepare a Project Environmental Management Plan to the satisfaction of the DEC. The objectives of the plan are to ensure that the adverse impacts from mining and associated activities do not unnecessarily threaten conservation values within the mining lease and prevent impacts outside of the mining lease. The project environmental management plan will address:	Section 1
	• Hygiene management measures to prevent the introduction of weeds and dieback disease	Section 1.4.4.1 and **Table 8.**
	• Management of feral animals.	Section 1.4.4.2 and **Table 9**
	• Company protocols to authorise disturbance and clearance of vegetation.	Section 1.4.4.3 and **Table 10**
	• Limiting and authorising access to areas within the mining lease.	Section 1.4.4.4 and **Table 11**
	• Fire prevention and response.	Section 1.4.4.5 and **Table 12**
	• Management and monitoring of saline water used for dust suppression.	Section 1.4.4.6 and **Table 13**
9-3	• The proponent shall review and revise the Project Environmental Management Plan required by Condition 9-1 at intervals not exceeding three years.	Section 5

No	Condition	Section in PEMP
9-4	• The proponent shall report to the CEO on implementation of the Project Environmental Management Plan every two years from the date of commencing ground disturbing activities.	Section 5
9-5	• The proponent shall make the Project Environmental Management Plan required by condition 9-1 publicly available in a manner approved by the CEO.	Section 5
Ministerial Statement 988		
6-2	The proponent shall ensure that the design, construction and operation of the Haul Road does not impact the surrounding environment and existing infrastructure from the effects of surface water flow impedance, dust, use of saline water, weed encroachment and fire.	Section 1.4.4
	Weed encroachment	Section 1.4.4.1 and **Table 8**
	Fire	Section 1.4.4.5 and **Table 12**
	Dust	Section 1.4.4.6
	Use of saline water	Section 1.4.4.6 and **Table 13**
	Surface water flow impedance	Section 1.4.4.7 and **Table 14**

1.4. RATIONALE AND APPROACH

Results of baseline surveys, vegetation monitoring and a number of assumptions and uncertainties inform the management approach for meeting the environmental objectives stated in **Table 1** and **Table 2**. Key data which inform the rationale and management approach for meeting the environmental objectives are:

- Baseline flora and fauna surveys (Section 1.4.1.1 and 1.4.1.3).
- Baseline surface water flow assessment (Section 1.4.1.5).
- Results and observations from annual vegetation monitoring carried out to meet the requirements of Condition 5-3 of MS 852 (Section 1.4.1.2).
- Results and observations from annual vegetation monitoring carried out to meet the requirements of Condition 6-2 of MS 988 (Section 1.4.1.2).
- Assumptions and uncertainties from baseline surveys and monitoring (Section 1.4.2).

Results from baseline flora, vegetation and fauna surveys and previous rehabilitation outcomes, as well as key assumptions and uncertainties are documented in following sections.

1.4.1. Survey and Study Findings

1.4.1.1 Baseline Flora Studies

The Carina project is situated in the proposed Jaurdi Conservation Park and the J4 project is distributed in the Mt Jackson Pastoral Station. Both are located in the Southern Cross subregion (COO02) of the Coolgardie Bioregion (Department of the Environment and Energy 2016). The Southern Cross subregion is described as having a subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills and chains of saline playa-lakes (Cowan, Graham, and McKenzie 2001).

Vegetation in the Southern Cross subregion is described as diverse eucalypt woodlands (Eucalyptus salmonophloia, E. salubris, E. transcontinentalis and E. longicornis), rich in endemic eucalypts, which occur around the salt lakes, on the low greenstone hills, valley alluvials and broad plains of calcareous earths. The salt lake surfaces support dwarf shrublands of samphire. The granite basement outcrops at mid-levels in the landscape and supports swards of *Borya constricta*, with stands of *Acacia acuminata* and *Eucalyptus loxophleba*. Upper parts of the landscape are the eroded remnants of a lateritic duricrust yielding sandplains and breakaways.

Mallee (*E. leptopoda, E. platycorys and E. scyphocalyx*) and scrub-heath (*Allocasuarina corniculata, Callitris preissii, Melaleuca uncinata and A. beauverdiana*) occur on these uplands, as well as on sand lunettes associated with playas along the broad valley floors and sand sheets around the granite outcrops. The scrubs are rich in endemic acacias and Myrtaceae (Cowan, Graham, and McKenzie 2001).

Several flora and vegetation baseline studies have been carried out over Carina and J4, these are displayed in **Table 5**. Some have been targeted surveys or for drilling programs, while others have been detailed surveys. The surveys have mapped the entire mining tenement and haul road.

TABLE 5: PREVIOUS FLORA AND VEGETATION STUDIES

Source	Published	Description
Mattiske Consulting Pty Ltd.	Oct 2007	Flora and vegetation survey of drill hole sites in exploration tenement E77.1115 Carina Prospect.
	Mar 2008	Flora and vegetation survey of proposed access route exploration tenement E77/1115 Carina Prospect.
	Mar 2008a	Flora and vegetation survey of infill drill sites in exploration tenement E77/1115 Carina Prospect.
	Jul 2008	Flora survey of the proposed gravel pit within exploration tenement E77/1115 Carina Prospect.
	Aug 2008	Flora and vegetation survey of proposed Carina transport route: Darrine siding.
	Sep 2008	Flora and vegetation survey of the Carina exploration lease area.
	Apr 2009	Declared rare and priority flora survey: Carina mine tenement M77.1244A.
	Oct 2009	Flora and vegetation survey of proposed Carina transport route: Carina mine to Mt Walton road siding.
	Oct 2012	Flora and vegetation survey of the J4 mine and haul road study area.
	Apr 2013	Flora and vegetation survey of the J4 mine and haul road study area.
Recon Environmental	Feb 2010	Carina iron ore project: Mt Walton siding vegetation. Report for Polaris Metals NL

Pre-disturbance vegetation mapping by Mattiske Consulting (2008a, 2008b, 2009) identified 35 vegetation communities at Carina, within the MS 852 project boundary. At J4, 28 vegetation communities were mapped within the MS 988 project boundary (Ecologia, 2014).

1.4.1.2 Project Flora and Vegetation Summary

Carina

Key results of the Carina vegetation and flora surveys are:

- Vegetation communities are broadly divided into two major groups:
  - A sclerophyllous Eucalypt woodland of *Eucalyptus salmonophloia and Eucalyptus salubris*, together with a range of other Eucalypt species, over an understorey composed predominantly of *Acacia* sp., *Eremophila* sp. and *Atriplex* sp.
  - Acacia dominated scrub and thicket communities.
- A total of 237 taxa from 103 genera and 45 families were recorded. These taxa are typical of the Coolgardie District.
- No Threatened Flora have been recorded in the project area.
- Eleven Priority taxa in total were identified, all of which were found in the haul road, siding and village areas. Two species were recorded in the mine area. Known Priority species in the project area are summarised in **Table 6**. The largest populations of Priority flora in the project area include:
  - 87 Daviesia purpurascens (P4) plants recorded in 22 separate locations. Regionally, approximately 850 plants are known outside the project tenements.
  - 330 *Grevillea georgeana* (P3) plants recorded in two separate populations.
- 14 weed species have been identified at the project since commencement (including baseline surveys), none of which are declared plants under the Biosecurity and Agricultural Management Act 2007 or are considered weeds of national significance.
- Surveys indicated the low relief ridge of the Carina deposit does not appear to contain the high level of diversity and endemism characterised by other surveys of some major BIF ranges in the Midwest and Yilgarn regions.

Jackson 4

Key results of the J4 vegetation and flora surveys are:

- 28 floristic community types are within the project footprint, with seven correlating to the BIF PEC.
- A total of 359 taxa from 179 genera and 57 families were recorded.
- No Threatened Flora have been recorded in the project area.
- 14 Priority taxa are known to occur within the project area. Known Priority species in the project area are summarised in **Table 6**.
- Neither floristic community types nor Priority flora are endemic to the disturbance footprint and are found outside of the project area.

- 7 weed species are known to occur in the project area, none of which are declared plants under the Biosecurity and *Agricultural Management Act 2007* or are considered Weeds of National Significance.

A list of total Priority Flora identified in the project areas are included below in **Table 6**.

Conservation values of the project and surrounding areas are shown in **Figure 1.**

TABLE 6: PRIORITY FLORA SPECIES WITHIN PROJECT AREA

Project Area	Species	Status at time of Survey
Carina		
Mine	*Grevillea georgeana*	P3
	Daviesia purpurascens	P4
Haul Road, Accommodation Village and Siding	*Acacia adinophylla*	P1
	Calytrix creswellii	P1
	Homalocalyx grandiflorus	P1
	Stylidium choreanthum	P2
	Acacia crenulata	P3
	Acacia formidabilis	P3
	Grevillea georgeana	P3
	*Mirbelia ferricola sp. (*previously *M.* sp. Helena & Aurora Range)	P3
	Lepidosperma lyonsii	P3
	Spartothamnella sp. Helena & Aurora Range	P3
	Daviesia purpurascens	P4
Jackson 4		
Inside disturbance area	*Banksia arborea*	P4
	Calytrix ?creswellii	P3
	Grevillea georgeana	P3
	Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)	P3
	Neurachne annularis	P3
	Acacia crenulata	P3
Outside the disturbance area	*Baeckea sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586)*	P3
	Beyeria rostellata	P1
	Gompholobium cinereum	P3
	Hibbertia lepidocalyx subsp. tuberculata	P3
	Leptospermum macgillivrayi	P1
	Mirbelia ferricola	P3
	Sowerbaea multicaulis	P4
	Stenanthemum newbeyi	P3

1.4.1.3 Vegetation Condition and Weed Monitoring

Carina

Monitoring of vegetation condition and weed status in unmined areas surrounding the Carina project is completed as required under Conditions 5-3 and 10-3 of MS 852 to assess the impact of the project on the surrounding vegetation. Monitoring is carried out as per the Draft Carina and J4 – Vegetation and Rehabilitation Monitoring Plan (Astron 2018).

The results of the most recent monitoring by Astron (2019b) for Carina found no difference in plant health between analogue (no impact) and buffer zone (potential impact) areas, indicating there has not been any negative impact on vegetation from operational activities. No significant decrease in plant health has been found at analogue or buffer transects since monitoring commenced in 2013, however changes in floristic composition have been noted over time and are considered to be the result of natural fluctuations, and broad-scale natural processes. Changes appear to be similar for both impact and non-impact areas (Astron 2018).

A total of 14 weed species have been identified at the project since project commencement, none of which are classified as Weeds of National Significance or Declared Pests (Astron 2019a). Six of these species were recorded during pre-disturbance flora and vegetation surveys and have not been recorded since. The remaining eight species have been recorded at the site during operations (Astron 2019a). Dense weed populations have been recorded along the Carina haul road, with the densest occurrence approximately 20 km north of the southern operations. The most abundant and widespread species are **Centaurea melitensis* and **Sonchus oleraceus*, which have been recorded at the project area since 2013.

No weed species were recorded in the 2019 vegetation condition monitoring (Astron 2019b). In previous years, (2016, 2017 and 2018) **Sonchus oleraceus* (common sowthistle) has been recorded within the buffer zone of the mine area. The absence of this annual weed species in 2019 is most likely due to dry seasonal conditions with below-average monthly rainfall recorded in the four months prior to the field survey (Astron 2019b).

Carina weed survey information (Condition 10-1(3)) is reported in the annual vegetation condition monitoring reports submitted to DWER, however, a review of data collected and reported in 2018 by Polaris, and feedback from DBCA on the 2017 draft PEMP identified that it was unclear that the requirements of condition 10-1(3) had been met. Polaris will ensure that weed monitoring and reporting is clearly reported and submitted as required by Condition 10-1(3).

Following non-compliance with conditions 9-4, 10-1(1), 10-1(4), 11-1(7) and 11-1(8) of MS 852 in July 2019, Polaris issued Astron to conduct a gap analysis of weed hygiene measures. In line with Astron's recommendations and DWER request, Polaris will ensure that weed monitoring is conducted annually in addition to at least one weed survey and chemical control conducted during March and September during conditions promoting weed germination and growth (i.e. post significant rainfall). This monitoring is to be reported to achieve weed management objectives.

Jackson 4

J4 monitoring of vegetation condition is conducted as required under Condition 6-2, and where triggered Condition 6-4. Monitoring is undertaken as per the Jackson 4 Flora and Vegetation Conditions Monitoring Plan (Astron 2019c).

A monitoring program aligned to the Carina survey methodology and frequency was established for J4. The most recent results of monitoring by Astron (2019c) for J4 found no significant difference in plant or tree health between analogue and the buffer zone areas indicating no negative impacts have occurred due to operational activities from water flow, saline water, dust, weeds and fire originating from the haul road. Dust was detected on vegetation although it was assessed as of no consequence to plant health.

1.4.1.4 Baseline Fauna Surveys

Carina

The Carina project is located on the intersection of the Eremaean and Southwest botanical provinces and as such is a diverse habitat which supports a diverse faunal assemblage, of which many species are at their extents. J4 on the other hand does not include such a fauna population whereby fauna risk are most relevant to the trenching of the haul road construction which are addressed by Condition 7 of MS 988. A terrestrial fauna survey was completed at the project area and predominantly Carina's surrounds by Ninox Wildlife Consulting in 2009. Key findings of the survey were:

- A total of 22 reptile species were recorded, of which one skink (*Cyclodomorphus melanops elongatus*) is considered to be of conservation significance as it appears to be specific to Banded Ironstone Formations (BIF) outcrop habitat which is found both within and surrounding the project area.
- A total of 59 species of bird were recorded, none of which are currently conservation significant. One disused Malleefowl (Leipoa ocellata) mound was found nearby, but outside the Carina tenement.
- Four species of non-volant native mammals were recorded, none of which are conservation significant. The remains of several Stick-nest Rat (*Leporillus apicalis*) nests were found in caves and overhangs in BIF outcropping.
- Eight species of bat were recorded, one of which may be a Priority 4 species, but could not be determined from call recordings.
- No frogs were recorded.

Jackson 4

The J4 mine and haul road (impact area) was assessed and surveyed concurrently with sites in the Helena Aurora Range adjacent to the mine and haul road to provide additional information about the distribution of species recorded from inside the impact area. Key findings of the survey were:

- Five habitat types (rocky ridge, Mallee woodland on rocky plain and foot slopes, mixed eucalypt woodland, sandy plain with shrubland and drainage line) are present within the J4 disturbance footprint.
- A total of 10 native and two introduced mammal species, 46 bird and 28 reptile species were recorded in the J4 footprint. In addition, seven native and one introduced mammal species, 44 bird species, 20 reptile species and two species of frog were recorded from the surrounding area.
- Four species of conservation significance were sighted within the footprint: Crested Bellbird, Shy Heathwren, Major Mitchells' Cockatoo and Rainbow Bee-eater. Malleefowl was also recorded through secondary evidence (fresh tracks and old mounds) within the footprint. The Fork-tailed Swift and Peregrine Falcon were recorded in the area surrounding J4 and secondary evidence of either the Australian Bustard or the Bush Stone-curlew was recorded.
- A total of 40 potential short-range endemics (SRE), four likely SREs and five confirmed SRE species are known to occur in the area.

1.4.1.5 Baseline Surface Water Assessment

The project lies within the upper reaches of two large surface water systems, one of which drains west toward Hamersley Lake while the other drains south toward Lake Deborah East and Lake Eva. These lakes are large, intermittent salt lakes that are generally dry through most years and only fill following periods of significant rainfall i.e. every 10 years or more. The mine area and part of the north-south oriented portion of the haul road are situated within the Lake Hamersley catchment. The majority of the haul road is situated in the Lake Deborah/Lake Eva catchment (**Figure 4**).

Hydrological responses to rainfall are characterised by highly ephemeral stream, creek and drainage networks with surface water runoff events occurring in response to significant storm events, or following the infrequent prolonged periods of rainfall.

Surface water flow occurs in defined channels where there are sufficient convergence of flows and increases in flow velocities sufficient to promote scour and channel formation. In smaller drainage systems surface water flows predominantly occur as sheet flow in a broad, shallow front in response to infiltration of excess rainfall prior to channel initiation.

The mine itself is located on a local high point that forms a catchment divide between a northern and southern surface water system.

1.4.2. Key Assumptions and Uncertainties

It is assumed that investigations and studies undertaken, and management plans implemented have adequately:

- Identified the flora, vegetation and faunal conservation values present within and surrounding the project.
- Mapped vegetation communities within the project area and understood local and regional scale of surroundings to ensure potential direct and indirect impacts are accurately determined for the project.
- Identified and ranked the risk of impact to the surrounding environment from the project, and
- Addressed annual vegetation health (Condition 5-3) and weed monitoring (Condition 10-1(3)) of MS 852, and provided for a determination against Condition 6-2 of MS 988, so that the assessments provide an accurate representation of impacts of the project on the vegetation immediately surrounding the project.

1.4.3. Management Approach

Polaris has prioritised management provisions using a risk based approach informed by baseline flora and fauna survey data and vegetation health monitoring data as detailed in Section 1.4.1.

Management actions detailed in this PEMP focus on the minimisation of impacts to conservation significant flora and fauna within and adjacent to the project area, through operational management actions.

Management targets have been designed around the SMART principle as detailed in DMP (2015) and are specific, measurable, achievable, relevant and time bound. The BACI principle of understanding impacts through before/after and control/impact analysis has been used through monitoring and adaptive management.

Management targets reflect the environmental objectives specified in MS 852 and MS 988, where provided and deemed appropriate as targets.

1.4.4. Rationale for Provisions

Management targets have been developed using baseline surveys, knowledge from vegetation health monitoring as detailed in Section 2.4.1, the assessed risks for the project in the Public Environmental Review (PER) for Carina and ERD for J4, and commitments made to mitigate these risks. Appropriate management will ensure that the EPA factor objectives are met and as such, provisions reflect the key risks of the project to the local area and the operational mechanisms through which they are likely to occur.

The provisions appropriately address the intensity, duration and magnitude of the project in terms of potential impacts. The rationale for provisions are detailed in the following sections.

1.4.4.1 Hygiene Management

Weeds can have a significant impact on the biodiversity of an area due to their ability to outcompete native species and eventually dominate. Hygiene management provisions have been specified to prevent any new weed species becoming established on site and prevent or minimise the spread of existing weed populations. Vehicles working in one particular area are at a lower risk of spreading weeds and have less stringent management actions. Where vehicles are moving between work areas more stringent hygiene measures are specified to reflect the risk. Where weeds are found to have established, provisions for control/management have been included to assist in restoring the ecosystem.

A gap analysis on the effectiveness of weed hygiene management measures detailed in the approved PEMP was carried out in October 2019 (Astron 2019a). Known populations of weeds in the region and transportation of weeds via native and introduced carriers were considered in the gap analysis in addition to Carina's proximity to the former Jaurdi Pastoral Station and J4's location within the Mt Jackson Pastoral Station. The gap analysis found that the historic/current weed hygiene and management measures have been effective in ensuring where practicable, that weed species distribution and occurrence within the project areas remain comparable to surrounding areas and similar land uses (Astron 2019a). Continued implementation and a recommendation of an additional weed survey and control during March to September as specified in **Table 8** should result in further positive outcomes in the project area.

The risk of dieback in the project area is considered to be low. This is based on the average rainfall (being between 200 and 300 mm), no known historic cases of dieback at Carina / J4 or MRL's adjacent Koolyanobbing operations and the mine being located in a low risk area. PEMP provisions for the management of hygiene (weeds and dieback) are provided in **Table 8**.

1.4.4.2 Management of Feral Animals

The project is located in the former Jaurdi pastoral lease (Carina) and Mt Jackson Pastoral Station (J4) which was purchased by CALM/ DPaW (DBCA) and has been destocked (Jaurdi for over 20 years). There are no active pastoral stations adjacent to the former Jaurdi station area that could be a source of migrating stock and as such, there are minimal stock in the local area. DBCA manages feral animal control in the wider area. Two feral animal species, the camel and rabbit are known to occur in the area. Rabbits are present in high numbers and may have a significant effect on ground level vegetation.

Feral cats and dogs may be present in the area and are often present where freshwater ponds and where putrescible waste is stored in landfill or in bins. Provisions for the management of this type of feral animal are focused on eliminating attractants such as water and food and to minimise human to feral animal interactions through ensuring employees and contractors do not feed feral animals. Provisions also include feral animal control as required. The regime of feral animal control is informed by the number of feral animals noted through the reporting system.

PEMP provisions for the management of feral animals are provided in **Table 9**.

1.4.4.3 Disturbance and Vegetation Clearing

Land clearing for exploration, mining and infrastructure is the most significant environmental impact Polaris is likely to have and it is required to be managed effectively and have the commitment from senior management through to site operators and the environment department (ED). Strict control of ground disturbance, inspection and reporting is achieved through the implementation of a site disturbance permit (SDP) for land clearing and vegetation disturbance as well as other provisions to ensure clearing is minimised and that topsoil and vegetation from cleared areas is stored such that it is maintained at an optimum state for use in rehabilitation. An overview of the site disturbance permit is provided below:

- Applicant to consult with the ED prior to completing form to ensure there is no obvious impediment to site disturbance proceeding.
- Once confirmed, SDP is created, and contains following information:
- All tenements affected.
- Comprehensive description of the proposed activity.
- Drawing or drawings showing the location of all proposed disturbance.
- Total area to be disturbed (ha).
- The volume of topsoil to be recovered and stockpiled (cubic metres).
- Machinery to be used for the activity.
- SDP submitted to the ED.
- ED to assess proposed clearing to ensure it is within approved area and identify any constraints to clearing and ensure sufficient buffer has been allowed. ED will apply conditions if required.
- The application is then assessed by the site manager to ensure it is consistent with project planning. If so, it can be approved and implemented.
- Once clearing has been completed, the cleared area and topsoil and vegetation stockpiles is surveyed, and spatial information forwarded to the ED for storage.
- ED will conduct an inspection of the cleared area to ensure compliance with SDP conditions.

A representative from the ED will inspect topsoil and vegetation stockpiles to ensure they are signposted to prevent inadvertent use for unapproved purposes. ED to maintain records of the areas cleared and the resources available for future rehabilitation works (topsoil, subsoil, woody debris).

PEMP provisions for disturbance and vegetation clearing are provided in **Table 10**.

1.4.4.4 Limiting and Authorising Access

The project is located approximately equidistant from the towns of Southern Cross and Coolgardie, in a wider land precinct of existing and proposed reserves. Access for the Carina mine is off the Great Eastern Highway, on an unsealed road approximately 95 km east of Southern Cross. All mine traffic uses this unsealed road from the highway to the rail siding, which is approximately 45 km from the Great Eastern Highway turnoff. For safety reasons, all active mine areas and worksites are not open to public access and appropriate signage and safety information is required under legislation, warning the public of heavy vehicle traffic and active operational areas. Designated public crossing points on haul roads will be adequately sign posted. Public tracks crossing the site's general access road to the Great Eastern Highway, (the DTF road), such as the Ryan's Find road may be inadvertently or otherwise accessed by the public which creates a significant safety issue.

Provisions target accidental access to the site by ensuring minor tracks that access the project site are blocked off, (in consultation with DBCA Kalgoorlie) and that major roads are well signposted. Additionally, the risk of unauthorised access is reduced by requiring all visitors to report to the mine office. Provisions limit employee and contractor access offsite to limit interaction with third parties and the public. Some personnel such as environmental staff undertaking monitoring and surveys in the surrounding area and exploration geology personnel undertaking exploration work will be using tracks outside the project footprint where interaction with third parties could occur and normal safe driving practices are expected from all personnel.

PEMP provisions for limiting and authorising access are provided in **Table 11**.

1.4.4.5 Fire Prevention and Response

The project is located in a remote semi-arid zone of WA. As with most areas of native vegetation within the state, the risk of natural bush fires is high due to lightning strikes from storm events. These are natural processes which have occurred throughout history and may positively impact native vegetation through increased germination of some species. The project could alter natural fire regimes through a change in the structure and composition of vegetation communities via clearing, the extinguishing of natural fires where presenting hazards to human life and project infrastructure, and fires directly caused by project activities. Bushfires present a significant safety issue to mine sites and must be protected against in addition to prevented if anthropogenic.

Provisions for fire prevention and response are two-fold as described above, preventing the spread of natural bushfire to the mine site through emergency preparedness and preventing fires occurring as a result of the project.

PEMP Provisions for fire prevention and response are detailed in **Table 12**.

1.4.4.6 Saline Dust Suppression Water Management and Monitoring

Dust generation from unsealed roads is a key environmental issue over the project areas and is common to most mining operations. In addition to dust generation through mining the haul roads present linear sources of dust generation through various environments. Road watering is used to suppress dust using local groundwater as the site is too remote to obtain alternative water supplies. As the groundwater used for the project is characterised as saline to hypersaline, there is a risk of overspray or run-off impacting adjacent land, flora and vegetation.

A rainfall study was carried out to investigate rates of mobilisation of sodium bicarbonate from compacted soil surfaces simulating an unsealed road (Loch & Squires 2010) which found that particularly for mine sites, the use of saline water in dust suppression on unsealed roads is unlikely to significantly impact the wider surrounding environment. This is primarily because the flush of salts in run-off from the roads occurs very early in the run-off event when none of the surrounding area would have commenced to run off. Consequently, the relatively small volume of run-off produced directly by the road could be expected to predominantly infiltrate in the table drain adjoining the road. The initial flush of saline water would then be leached to depth or diluted by the less saline run-off generated from the road in the latter part of the run-off event, or by non-saline run-off from the surrounding catchment (Loch & Squires 2010).

Provisions include operational measures which can be used to limit the potential for overspray and run-off from areas of dust suppression. Additional measures can also be used to reduce the likelihood of a spill or leak of saline water from water management infrastructure.

PEMP provisions for saline dust suppression water management and monitoring are provided in **Table 13**.

1.4.4.7 Surface water flow impedance

A surface water risk assessment for the project was undertaken by Golder Associates in 2013, as well hydrological modelling in proximity to the mine area.

The mine area (e.g. pits, ROM) are located on high ground between small, local surface water systems. There is little to no risk of flood inundation or flood flows from adjacent drainage systems within the extent of the mine, based on hydraulic modelling (Golder 2013a).

The mine area is located more than 1 km from the 100 year ARI flood extent and approximately 10–12 m above the associated modelled peak flood level. Surface water management for the mine primarily requires drainage from incidental rainfall falling directly on the site rather than inflows from surrounding catchments (Golder 2013b). Runoff will be captured in earth sediment ponds prior to discharge to the environment as necessary.

The haul road and road networks to support the mine has been designed to cater for a 100 year ARI peak event. The north-south aligned portion of the haul road (L77/250) does not cross any significant surface water drainage systems (Golder 2013c). Sheet-flow generated by significant storm events are managed via the strategically placed culverts that allow sheet-flow to drain to downslope areas.

The east-west aligned portion of the haul road (L77/254) crosses two major surface water drainage systems, with contributing catchment areas of approximately 187 km^2 and 197 km^2 respectively (Golder 2013a). Cross flow road drainage in the form of environment culvert crossings have been installed as required to minimise the impact of up gradient ponding and reduce the extent of any potential downslope drainage shadows. The infrastructure has been constructed to minimise alteration and impacts on the natural surface water runoff regimes in the local area.

PEMP provisions for surface water flow management and monitoring are provided in **Table 14**.

2. EMP PROVISIONS

Management-based provisions identify management actions that will be implemented to mitigate and manage potential impacts to surrounding flora, vegetation and fauna to a specific management target. Monitoring is specified to measure performance in relation to the management targets, and reporting mechanisms for each management action are also specified.

The majority of Conditions specified in the below provisions are relevant to both Carina and J4, although there are provisions relevant to Carina only, such as those relating to feral animal and unauthorised access. This is due to some of the hazards relevant to construction, such as trenching, are not applicable at this stage of the project (i.e. operational).

TABLE 7: PEMP MANAGMEENT BASED PROVISIONS TABLE

Condition	Table No.
Hygiene management measures to prevent the introduction of weeds and dieback disease.	**Table 8**
Management of feral animals.	**Table 9**
Company protocols to authorise disturbance and clearance of vegetation.	**Table 10**
Limiting and authorising access to areas within the mining lease.	**Table 11**
Fire prevention and response.	**Table 12**
Management and monitoring of saline water used for dust suppression.	**Table 13**
Management of surface water.	**Table 14**

TABLE 8: HYGIENE MANAGEMENT PROVISIONS

Purpose: To meet the legal requirements of Condition 9-1 clause 1 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora (PF) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: introduction of weeds and dieback disease.

Key Risks: Loss or reduction in species and populations of native species.

Management Action	Management Target	Monitoring	Reporting
Objective: No increase in weed species diversity, extent or abundance and/or introduction of dieback due to project activities.			
Carina and J4			
Weed Hygiene Certificate (WHC) for medium to high risk situations. WHC requires cleaning of equipment to remove seeds, plant material and soil/mud and suitable disposal of material. Equipment to be inspected on arrival prior to use.	**Carina** • Species and extent of weed cover within the proposal area shall not exceed that identified in the baseline survey identified in 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. • No introduction of dieback into the project area.	**Carina** • Annual Spring weed monitoring carried out to satisfy Condition 10-3 of MS 852 (refer to Section 3 for details). • One additional weed survey and control between March and September to satisfy Condition 10-3 of MS 852 (refer to Section 3 for details). • Annual assessment of dieback by an accredited assessor.	**Carina** • Annual vegetation condition reporting. • Annual Compliance Assessment Report (CAR) (MS 852) **J4** • Annual vegetation condition reporting. • Annual Compliance Assessment Report (CAR) (MS 988)
Employees and contractors are required to participate in the site induction, which will provide an awareness of weeds, including risk species, and an overview of the weed hygiene process.			
Employees and contractors who are involved in movement or operation of earthworks equipment, off road vehicles, and land clearing will be specifically trained in weed hygiene procedures and documentation.			

Purpose: To meet the legal requirements of Condition 9-1 clause 1 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora (PF) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: introduction of weeds and dieback disease.

Key Risks: Loss or reduction in species and populations of native species.

Management Action	Management Target	Monitoring	Reporting
Annual weed control informed by results of weed surveys (Condition 10-1(3) of MS 852 and Condition 6-2 of MS 988) with control methods comprising manual, mechanical and chemical control as required.	**J4** • Species and extent of weed cover within the Haul Road and in surrounding environment shall not exceed that identified in the baseline survey or exceed that existing on comparable, nearby land, determined by Condition 6-2. • No introduction of dieback into the project area.	**J4** • Annual Spring weed monitoring carried out to satisfy Condition 6-2 of MS 988 (refer to Section 3 for details). • One additional weed survey and control between March and September to satisfy Condition 6-2 of MS 988 (refer to Section 3 for details). • Annual assessment of dieback by an accredited assessor.	

TABLE 9: FERAL ANIMAL MANAGEMENT PROVISION

Purpose: To meet the legal requirements of Condition 9-1 clause 2 of MS 852.

EPA Factor: Terrestrial Fauna

EPA Objective: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi nature reserve).

Key Impacts: Increase in feral animal species and populations.

Key Risks: Loss or reduction of native species and populations.

Management Action	Management Target	Monitoring	Reporting
Objective: No increase in weed species diversity, extent or abundance due to project activities.			
Carina and J4			
Environmental Induction to provide information on introduced predators and pest species, discouragement of feeding of fauna and protection of native fauna.	• Feral animal attractants fenced. • No increased observation of feral animals at landfill, WWTP, water storage ponds and accommodation camp.	• Annual assessment of feral animal sighting records. • Annual camera trapping program.	• Fauna sighting and incident reporting. • Compliance Assessment Report (CAR) (MS 852).
Waste to be place in covered bins, collected regularly and transferred to the landfill.			
Fencing to be maintained around the landfill.			
Fencing to be maintained around water holding facilities containing stock quality or better within the project area.			
Implement system to record and quantify introduced species.			
Implement feral animal control program if numbers of feral animals increase significantly (currently use local pastoralist).			

TABLE 10: DISTURBANCE AND VEGETATION CLEARING MANAGEMENT PROVISION

Purpose: To meet the legal requirements of Condition 9-1 clause 3 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi nature reserve). Known PF populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Unapproved or unnecessary loss of native vegetation and biodiversity.

Key Risks: Unauthorised clearing or clearing excessive to project requirements.

Management Action	Management Target	Monitoring	Reporting
Objective: Minimise clearing to that essential for project activities			
Carina and J4			
Review proposed works and existing clearing to maximise utilisation of previously disturbed areas. Early stage mine planning to minimise footprint required for infrastructure and mining landforms. Implement Site Disturbance Permit procedure. Trim vegetation by hand where only a portion is affected by works. For example, if the trunk of a tree is outside the clearing boundary.	• No clearing outside of approved clearing area. • Clearing compliant with approved total areas (MS 852 and 988 respectively). • No bare unused areas indicating excessive clearing.	• Annual review of SDPs, cleared areas as surveyed and approved clearing areas.	• Annual Compliance Assessment Audit and Report (CAR) (MS 852 and 988 respectively). • Annual Environmental Report (AER) to DMIRS.
Objective: Prevent accidental clearing			
Carina and J4			
Vehicles, plant and equipment restricted to within the clearing limits.			• Annual Compliance Assessment Audit and

Purpose: To meet the legal requirements of Condition 9-1 clause 3 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi nature reserve). Known PF populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Unapproved or unnecessary loss of native vegetation and biodiversity.

Key Risks: Unauthorised clearing or clearing excessive to project requirements.

Management Action	Management Target	Monitoring	Reporting
Observers and spotters will be used when working near sensitive sites, e.g. near Priority flora, or when clearing boundaries may not be readily visible (for example due to dense vegetation).			Report (CAR) (MS 852 and 988 respectively).
Environmental Induction to provide information on Site Disturbance Permit.			
Objective: Minimise loss of topsoil or degradation of land			
Carina and J4			
Environmental Induction to provide information on Site Disturbance Permit.	• Clearing undertaken less than one month prior to proposed use.	• Annual review of topsoil and subsoil stockpiles.	• Incident reporting. • Annual Compliance Assessment Audit and Report (CAR) (MS 852 and MS 988 respectively). • Annual Environmental Report (AER) to DMIRS.
Recover topsoil and stockpile to maximum height of 2 m to preserve the soil physical/chemical properties and seed bank. Where required, recover subsoil and stockpile to a height of 4 m.	• Topsoil and subsoil is recovered and stored to maximise viability.		
Signpost stockpiled topsoil and subsoil to prevent accidental use or degradation of soil resources.			

TABLE 11: ACCESS MANAMGENENT PROVISIONS

Purpose: To meet the legal requirements of Condition 9-1 clause 4 of MS 852.

EPA Factor: Flora and Vegetation, Terrestrial Fauna.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained, and to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora (PF) populations.

Key Impacts: Degradation or loss of native vegetation, native fauna and/or biodiversity, spread of weeds and safety concerns.

Key Risks: Unauthorised access to mining operations.

Management Action	Management Target	Monitoring	Reporting
Objective: Limit unauthorised access to the mine			
Carina			
Install 'Danger Active Mine-site No Entry' signs at access points.	• All access points signposted and signs clearly visible and maintained. • All minor track access points blocked.	• Monthly checks of access points for signage/ blocked access. • Monthly inspection of signs.	• Annual Compliance Assessment Audit and Report (CAR) (MS 852).
Traffic management chicanes used on higher traffic public tracks to reduce vehicle speed leading up to active haul roads.			
Minor tracks that access the project site will be blocked off, in consultation with DBCA Kalgoorlie.			
The access road to the mine will be signposted and all visitors are to report to the mine office.			

TABLE 12: FIRE MANAGEMENT PROVISION

Purpose: To meet the legal requirements of Condition 9-1 clause 5 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation, Terrestrial Fauna

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained, and to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora (PF) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park

Key Impacts: Degradation or loss of native vegetation, native fauna and/or biodiversity and safety concerns.

Key Risks: Bushfire extending to Project area and accidental fire caused by the Project.

Management Action	Management Target	Monitoring	Reporting
Objective: No net increase in fire frequency within the project area.			
Carina and J4			
Environmental Induction to provide information on the prevention and management of fires.	• No unplanned fires attributable to project activities.	• Annual inspection of firebreaks. • Regular review of incident reports.	• Annual Compliance Assessment Audit and Report (CAR) (MS 852 and MS 988 respectively). • Incident reporting.
Firefighting equipment maintained in buildings and vehicles.			
Flammable materials appropriately stored and segregated from ignition sources.			
General mine vehicles not permitted to leave access tracks or cleared areas.			
Cigarette smoking restricted to designated smoking areas with appropriate disposal facilities.			
Fire breaks maintained around infrastructure.			
Implementation and adherence with a hot work permit system.			
Induction includes information re fire safety and is provided to all personnel.			

Purpose: To meet the legal requirements of Condition 9-1 clause 5 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation, Terrestrial Fauna

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained, and to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora (PF) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park

Key Impacts: Degradation or loss of native vegetation, native fauna and/or biodiversity and safety concerns.

Key Risks: Bushfire extending to Project area and accidental fire caused by the Project.

Management Action	Management Target	Monitoring	Reporting
Objective: Fire Response to Minimise Risk and Spread of Fire			
Carina and J4			
Emergency response team on site during operations. Up to date fire preparedness and evacuation plan and ERT regularly trained to implement plans.	• No spread of natural fires attributable to project activities or lack of response.	• Annual training exercise for ERT team.	• Annual Compliance Assessment Audit and Report (CAR) (MS 852 and MS 988 respectively). • Annual Compliance Assessment Audit and Report (CAR).

TABLE 13: SALINE DUST SUPPRESSION WATER MANAGEMENT PROVISIONS

Purpose: To meet the legal requirements of Condition 9-1 clause 6 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Degradation (poor health) or loss of native vegetation and flora**.**

Key Risks: Spill or leak of saline water from water management infrastructure, and/or overspray of saline water used for dust suppression.

Management Action	Management Target	Monitoring	Reporting
Objective: Prevent impacts on surrounding vegetation from saline dust suppression water spills			
Carina and J4			
Saline water pipelines located within bunds.	• No vegetation death due to saline water spillages from Project activities.	• Daily inspection of saline water infrastructure.	• Annual Compliance Assessment Audit and Report (CAR) (MS 852 and MS 988 respectively). • Incident reporting.
Saline water or hazardous materials pipelines incorporate isolation valves at appropriate intervals.			
Catch pits or sumps constructed along above ground saline water or hazardous materials pipeline corridors maintained to collect leaks or spillages.			
Regular inspections and maintenance of pipelines and water holding facilities.			
All pipelines, bunds and storage facilities will be designed to required engineering specifications (e.g. liners).			
Decommission saline water holding facilities when not in use.			
Spills are cleaned up appropriately if they occur.			
Implement an incident reporting system and train personnel in its use.			

Purpose: To meet the legal requirements of Condition 9-1 clause 6 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Degradation (poor health) or loss of native vegetation and flora**.**

Key Risks: Spill or leak of saline water from water management infrastructure, and/or overspray of saline water used for dust suppression.

Management Action	Management Target	Monitoring	Reporting
Objective: Prevent Overspray of Saline Water			
Carina and J4			
Calibrate water trucks spray bar to road width only.	• No decline in cover or productivity greater than 25% due run off of saline dust suppression water (Condition 5-4 of MS 852 and Condition 6-2 of MS 988).	• Annual vegetation condition survey as required by Condition 5-3 of MS 852 and Condition 6-2 of MS 988) (refer to Section 4).	• Annual Compliance Assessment and Report (CAR) (MS 852 and MS 988 respectively). • Incident Reporting.
Manage water pressure in the spray bar on tracks and narrower roads to minimise likelihood of overspray.			
Ensure water truck operators are appropriately trained and competent.			
Pre-start inspections and scheduled maintenance of water carts.			
Objective: Prevent Run off of Saline Dust Suppression Water			
Carina and J4			
Dust suppression water to be applied at the minimum rate required.	• No decline in cover or productivity greater than 25% due run off of saline dust suppression water (Condition 5-4 of MS 852	• Annual vegetation condition survey as required by Condition 5-3 of MS 852 and Condition 6-2 of MS	• Annual Compliance Assessment and Report (CAR) (MS 852 and MS 988 respectively). • Incident Reporting.
Wet areas not to be resprayed until dry.			
Water truck operators to be appropriately trained and competent.			

Purpose: To meet the legal requirements of Condition 9-1 clause 6 of MS 852 and Condition 6-2 of MS 988.

EPA Factor: Flora and Vegetation.

EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Degradation (poor health) or loss of native vegetation and flora**.**

Key Risks: Spill or leak of saline water from water management infrastructure, and/or overspray of saline water used for dust suppression.

Management Action	Management Target	Monitoring	Reporting
	and Condition 6-2 of MS 988).	988) (refer to Section 4).	
Objective: Prevent Overtopping of Saline Turkeys nest and other Saline water ponds/dams.			
Carina and J4			
Maintain minimum freeboard of 300 millimetre (mm) within turkeys nests and other saline water ponds/dams at all times. Operator to remain present during filling of turkeys nests and other saline water ponds/dams.	• No decline in cover or productivity greater than 25% due run off of saline dust suppression water (Condition 5-4 of MS 852 and Condition 6-2 of MS 988).	• Annual vegetation condition survey as required by Condition 5-3 of MS 852 and Condition 6-2 of MS 988) (refer to Section 4).	• Annual Compliance Assessment and Report (CAR) (MS 852 and MS 988 respectively). • Incident Reporting.

TABLE 14: SURFACE WATER FLOW MANAGEMENT:

Purpose: To meet the legal requirements of Condition 6-2 of MS 988.

EPA Factor: Surface water flow impedence.

EPA Objective: Protect surrounding environment and existing infrastructure from the effects of surface water flow impedance.

Key Environmental Values: Ex-pastoral station (Jaurdi) acquired by DBCA for the purposes of conservation (proposed Jaurdi Nature Reserve). Known Priority Flora) populations. BIF PEC associated floristic community types. Helena and Aurora Ranges Conservation Park.

Key Impacts: Degradation of surrounding environment and existing infrastructure.

Key Risks: Altered surface water flows.

Management Action	Management Target	Monitoring	Reporting
Objective: Prevent impacts on infrastructure and surrounding vegetation from altered surface water flows.			
Carina and J4			
Installation of culverts and flood ways.	• No significant impact on the environment and existing infrastructure from surface water flow impedence (Condition 6-2 of MS 988).	• Annual vegetation condition survey as required by Condition 6-2 of MS 988) (refer to Section 4). • Inspections to determine infrastructure integrity and maintenance as required.	• Annual Compliance Assessment and Report (CAR - MS 988). • Incident Reporting.
Cross-flow haul road drains will be maintained to minimise alteration and impacts on the natural surface water drainage systems.			

3. VEGETATION CONDITION AND WEED MONITORING

Adequately designed vegetation monitoring is required to determine whether the management actions are being undertaken and whether current mitigation measures are effective with respect to the relevant targets and objectives being achieved. The methodology for monitoring specified in the above Provisions tables, which is not self-explanatory e.g. such as visual inspection of pipelines, signage, water storages etc., is documented in the following sections. This primarily relates to vegetation condition and weed monitoring.

Vegetation condition monitoring is used to assess the state of flora and vegetation and to determine impacts of the project on surrounding vegetation primarily from saline overspray and dust, primarily as a means of chronological condition comparison. Vegetation condition is used as an indicator of the level of impact on the local vegetation and fauna habitat to satisfy Condition 5-3 of MS 852 and Condition 6-2 of MS 988. The vegetation condition monitoring program was originally approved by DWER in 2013 as documented in the Carina Iron Ore Project Flora and Vegetation Condition Monitoring Plan (Astron 2013) and this method was been adopted for J4.

A revision to the monitoring plan was developed in 2018 by Astron and submitted to DBCA in November 2018. The revised Carina and J4 Vegetation and rehabilitation Monitoring Plan includes the following changes:

- The monitoring design of the Plan is based on previous monitoring conducted in 2015, 2016 and 2017 (ecologia Environment and Soilwater Group 2015; Astron Environmental Services 2017b, 2017a).
- Monitoring of the impact on the surrounding environment of the J4 Haul Road as required under Condition 6-2 of Ministerial Statement 988 has been included, the methods align with the vegetation monitoring successfully established, monitored and analysed for potential impact associated with the Carina Mine and infrastructure (Astron Environmental Services 2013, 2014, 2016, 2017c, 2018).
- Photo points have been modified to consist of sampling quadrats, accompanied by photo points.
- The number of transects and quadrats have been increased to ensure that valid statistical tests can be performed to compare rehabilitation or potential impact sites with reference sites, and to quantify change across time. Proposed sites will be finalised during this year's monitoring activities
- The structure of the plan has been modified to facilitate better understanding and application of the methods described.

Weed monitoring is used to assess changes to weed species and populations in the project area and surrounds as a result of the direct and indirect impacts of the Project to satisfy Condition 10-1(3) of MS 852 and Condition 6-2 of MS 988. The annual spring survey is carried out concurrently with the vegetation condition monitoring at the same transect locations for Carina and J4 (along the haul road) and an additional weed monitoring and control event is undertaken between March and September in conditions optimal for weed germination and growth as per DWER request (correspondence to Polaris, dated 25 March 2020).

3.1. LOCATION

The Carina project is divided into four areas based on operational activities; accommodation village, haul road, mine and railway siding. Within these operational areas, two or more pairs of monitoring transects have been established which include one monitoring transect in the 'buffer' zone (potential area of impact) and another in the 'analogue' zone (no potential impact). A buffer and its analogue transect as referred to as a single block. There are a total of 19 blocks for Carina (including Carina Extended) totalling 28 transects, although a block 7 is no longer monitored (i.e. 26 transects are monitored). Each transect within a block lies within the same vegetation unit and is located to maximise similarity in total cover and relative abundance of species within the block.

At J4, the monitoring locations are distributed along the haul road. There are 20 transects across seven vegetation units with at least a 'buffer' or 'analogue' zone in each. The buffer transects are located within 100 metres (m) of the project disturbance boundary while the analogue are located between 100 m and 1000 m form the disturbance boundary. As per at Carina, transects are located in the same vegetation units and located to match similarities in total cover and species abundance.

Locations of vegetation condition monitoring transects, marked trees and priority flora as documented by Astron are shown in **Figure 5**, **Figure 6, Figure 7** and **Figure 8**. These transects are also used for weed monitoring as required by Condition 10-1(3) of ms 852 for Carina and Condition 6-2 of MS 988 for J4, whereby polaris are required to establish “weed reference sites on undisturbed land (not impacted by the proposal) at each of the mine, haul road, rail siding and accommodation facilities” for Carina and along the haul road for J4.

3.2. METHODOLOGY

Each transect is 20 m long and 2 m wide and consists of 10 contiguous 2 m by 2 m quadrats. To monitor overstorey species at Carina, designated monitoring trees and tall shrubs (‘marked trees’) have been selected at each transect and photo-points for each tree are pegged. At J4, five trees adjacent to each transect have been marked to monitor overstorey species. These marked trees are photographed, and dust and health scores recorded at both Carina and J4 sites. Marked trees belong to five common species: *Allocasuarina corniculata, Callitris preissii, Acacia resinimarginea, Eucalyptus oleosa subsp. oleosa*, and *Melaleuca nematophylla*.

All perennial plants in each 2 m by 2 m quadrat, excluding overstorey species that would generally grow to more than 1.5 m in height, are identified to species or subspecies (taxa) level where possible. For each taxon in a quadrat, percentage cover is visually estimated to the nearest 1%, and dust and plant health scores are recorded. Conservation significant flora and weed species and population numbers in transects are recorded; presence of these taxa outside transects are recorded opportunistically.

Vegetation condition and weed monitoring are carried out annually during spring as required for vegetation condition monitoring. This is more frequent than Condition 10-1(3) of MS 852 ‘weed monitoring’ which is only required once every 2 years. The requirement of Condition 6-2 of MS 988 is not specified but weed assessment frequency and methodology was proposed in the Carina and Jackson 4 Weeds Assessment in (Astron 2019a) in response to a non-compliance and has been accepted by DWER. No weed species have been recorded in the 2019 or 2018 vegetation condition monitoring (Astron 2019a).

3.3. DATA ASSESSMENT

Using permutation-based multivariate analysis of variance (PERMANOVA), differences between the analogue and buffer zones, between 2013 (pre-impact baseline), and each consecutive monitoring year are compared using the following factors: time (year) and treatment (analogue, buffer). Data for each of the four areas (accommodation village, haul road, mine and railway siding) are also analysed separately for Carina while this is not necessary for J4. Variables tested include:

- Floristic composition (species and cover).
- Mean dust score
- Mean health score.
- Native species richness.

- Mean native cover.
- Mean percentage weed cover (if present)

Prior to analysis of floristic composition, the percentage foliar cover of each species in each quadrat is square-root transformed and similarity between each pair of quadrats calculated using Bray-Curtis similarity index. For all other variables, Euclidian distance is calculated. To test for differences in site level species compositional changes, a dendrogram is produced, using the Bray Curtis similarity index. The Simprof test is then used to detect significant clusters of sites based on their species composition.

3.4. MANAGEMENT RESPONSE

No noticeable decline in vegetation condition has been noted to date, however if a decline of greater than 25% in cover or productivity of native vegetation is found, investigation into the cause of the degradation would be initiated in consultation with DWER and appropriate management actions implemented as per Condition 5-4 and 5-5 of MS 852 for Carina and Condition 6-4 of MS 988 for J4. This may include a review of current practices (e.g. dust monitoring) and investigations into alternatives.

As recommended in Astron (2019a) in response to non-compliances with conditions 9-4, 10-1(1), 10-1(4) 11-1(7) and 11-1(8) of Statement 852, annual weed control between March and September when seasonal conditions are optimal for weed germination and growth, is carried out additional to the spring weed survey.

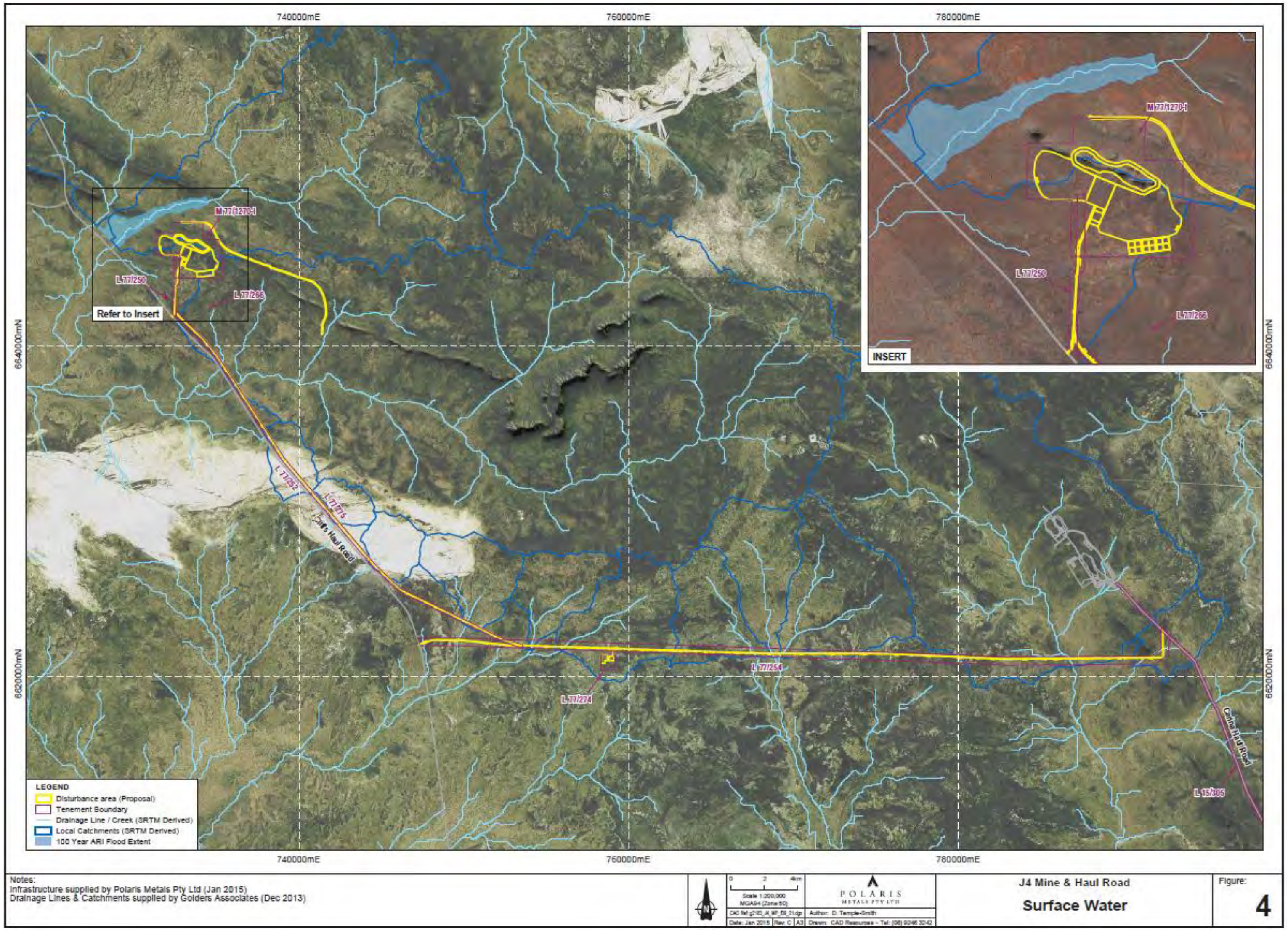

FIGURE 4: SURFACE WATER

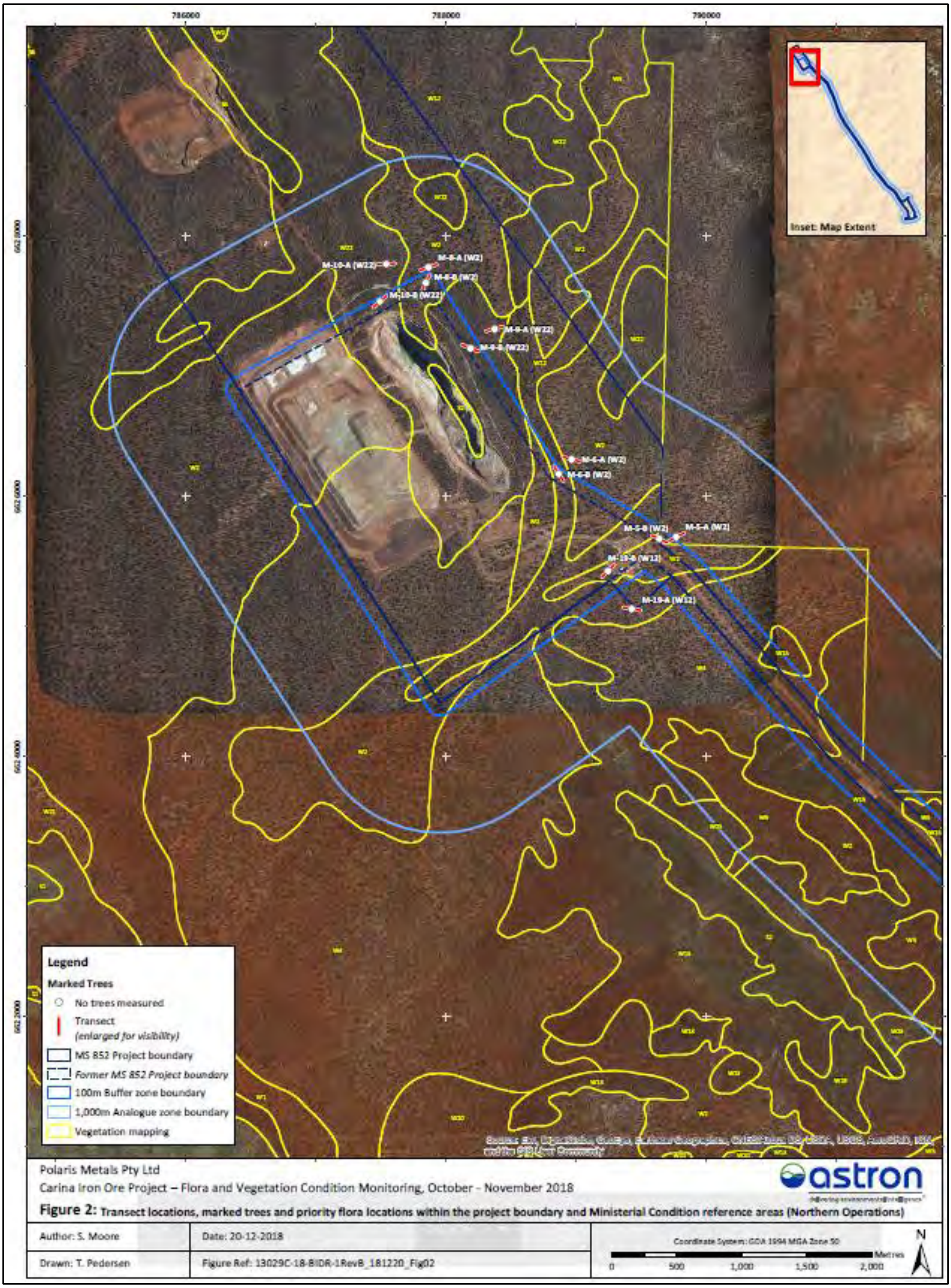

FIGURE 5: CARINA FLORA AND VEGETATION MONITORING TRANSECT LOCATIONS (NORTH)

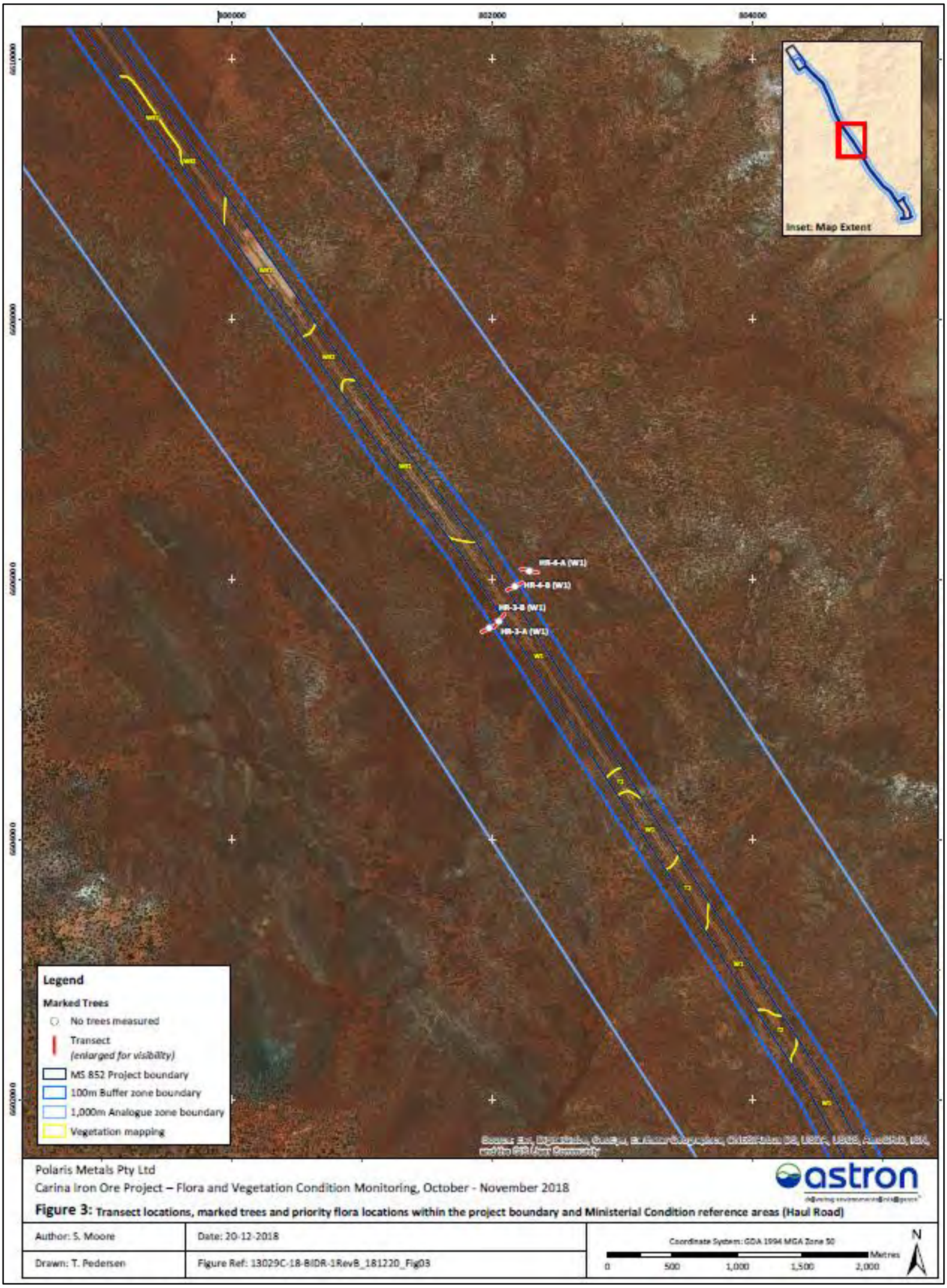

FIGURE 6: CARINA FLORA AND VEGETATION MONITORING TRANSECT LOCATION (CENTRAL)

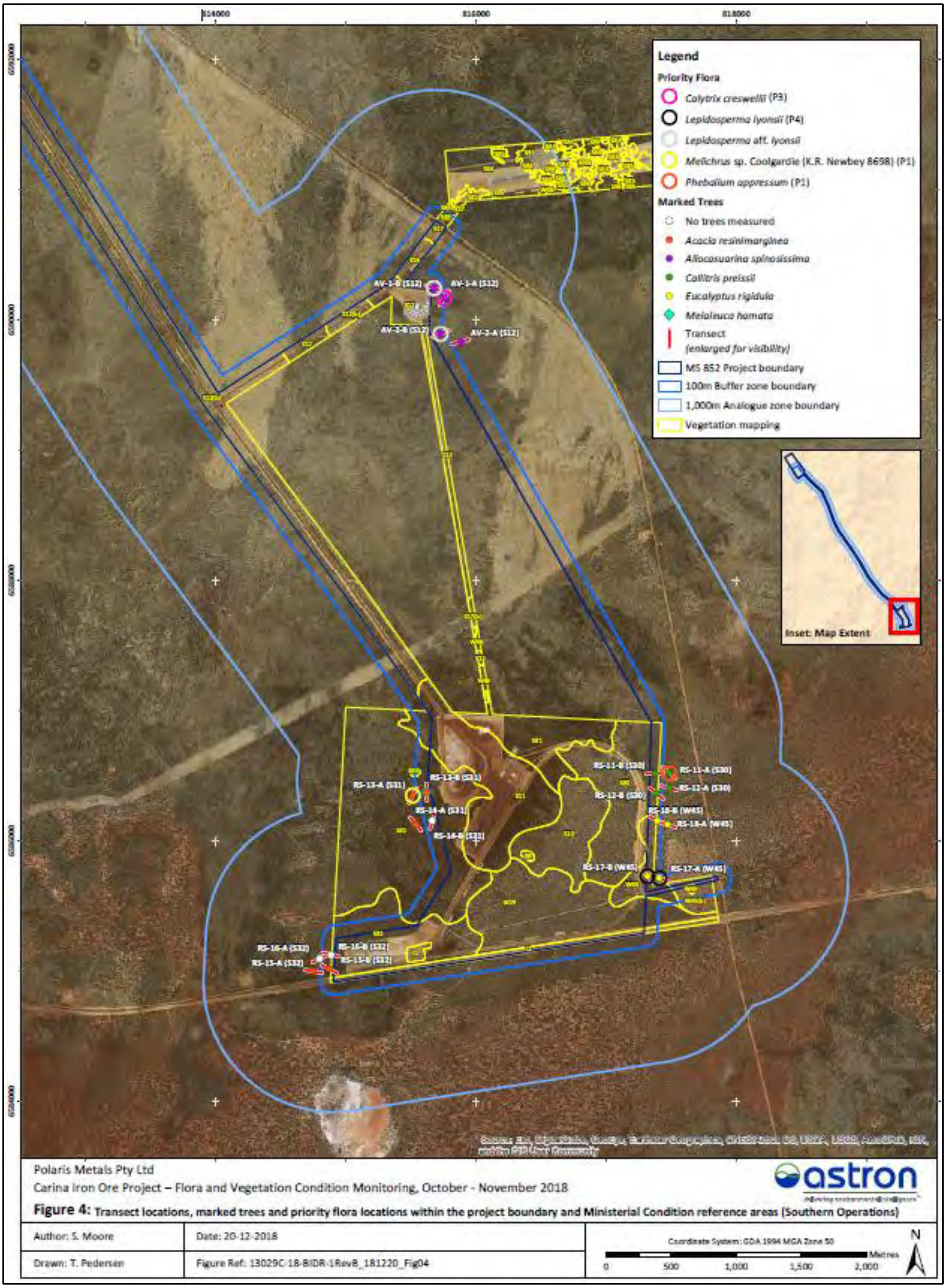

FIGURE 7: CARINA FLORA AND VEGETATION MONITORING TRANSECT LOCATION (SOUTH)

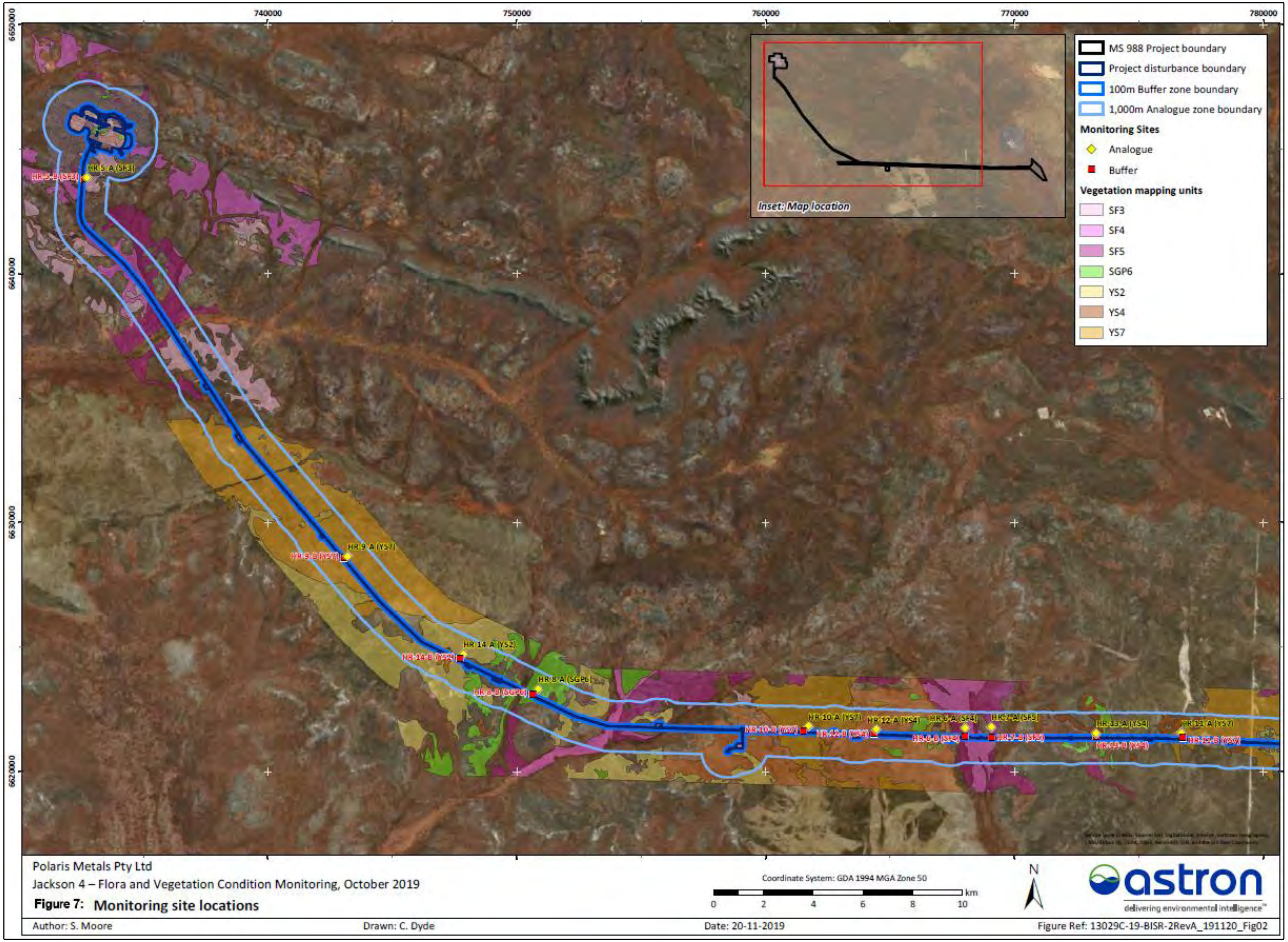

FIGURE 8: J4 FLORA AND VEGETATION MONITORING TRANSECTS

4. ADAPTIVE MANAGEMENT AND REVIEW

Polaris will assess compliance with this PEMP as part of the annual compliance review required by Condition 4-6 of MS 852 and MS 988, and submit an annual Compliance Assessment Report (CAR) to DWER separately for the Carina and J4 (as annual reporting is approval-date based) unless otherwise approved by DWER. The CAR will document any exceedances or failure to achieve management targets and amendments to or inclusion of additional management actions to management targets.

Where a management target is not met, Polaris will review and revise the management actions and identify additional management actions and implement as required to meet the management target and the condition environmental objective as per Condition 5-4 and 5-5 of MS 852 for Carina and 6-4 of MS 988 for J4. Where necessary, management targets will be reviewed and revised. This PEMP will be reviewed every three years as required by Condition 9-3 of MS 852. Updated versions of the PEMP will be forwarded to DWER for review and approval.

Review processes for the PEMP will be based on formal dates as required by MS 852 and MS 988 and triggers such as:

- Monitoring results: If vegetation condition and/or weed monitoring results indicate that management targets are not being achieved.
- Changes in knowledge: If additional information about the flora, vegetation or fauna of the region is received that would better inform management approaches.
- Significant changes to the project: The relevance and effectiveness of management measures would be considered.

If management targets for weed status, feral animals or vegetation condition as a result of impacts from saline dust suppression, inadequate hygiene, unauthorised access or excessive or accidental clearing, Polaris will implement an appropriate management response which will involve review of data to identify potential causes. If necessary, appropriate remedial actions will be developed and implemented.

5. REPORTING

To address Condition 9-3, Condition 9-4 and Condition 9-5 of Ministerial Statement 852 refer to **Table 15**.

TABLE 15: REPORTING OBLIGATIONS

Condition	Action	Time Frame
9-3	Polaris will review and revise the Project Environmental Management Plan	Intervals not exceeding three years.
9-4	Polaris will report to the CEO on implementation of the Project Environmental Management Plan	Every two years from the date of commencing ground disturbing activities
9-5	Polaris will make the Project Environmental Management Plan publicly available in a manner approved by the CEO.	Within seven days of receiving a request for information from a stakeholder.

6. STAKEHOLDER CONSULTATION

Polaris have undertaken stakeholder engagement to ensure internal and external communications are maintained to facilitate effective environmental management and ensure open and constructive dialogue with stakeholders.

This PEMP is an update to the 2017 PEMP and includes updates based on feedback. Previous versions of the PEMP were approved in 2011 and 2014. This version of the PEMP (2020) includes the J4 project environmental management and monitoring relevant to Condition 6-2 of MS 988, but it does not represent a significant change to the current management actions on site or the existing PEMP.

The key stakeholders for the update of this PEMP are DWER - EPA Services and DBCA – Environmental Management Branch (EMB). Polaris consulted with both EPA Services and DBCA EMB to create and implement the proposed overarching PEMP, and received advice 27 February 2020 approving the combination of Carina and J4 projects.

There are limited other stakeholders in relation to environmental management for the Carina and J4 Projects and as such there has been minimal stakeholder consultation in relation to this PEMP. Those consulted during this update are limited to DWER and DBCA. Other stakeholders for the mining operation itself are listed in **Table 16**.

TABLE 16: STAKEHOLDER ENGAGEMENT

Stakeholder	Engagement Method	Actions
Department of Biodiversity Conservation and Attractions: Environmental Management Branch	• Ecological reports supplied. • Draft PEMP (2017) supplied for review and advice.	• Draft PEMP (2020) updated based on written feedback
	• Submission of revised Carina and J4 Vegetation and rehabilitation Monitoring Plan – Draft to DBCA for review and comment.	• No comment was received back from DBCA on draft plan. The plan was finalise in 2019.
Department of Water and Environmental Regulation	• Compliance Inspection - L8596/2011/1 date, 22 November 2018	• Single action to remove contaminated rain water from single self-bundled pallet. Action closed out 6 February 2019.
	• Meetings to discuss requirements of 2020 PEMP • Draft 2017 PEMP supplied	• Draft PEMP updated based on feedback
	• Letter of Notice of non-compliance with Conditions 9-4, 10-1(1), 10-1(4) 11-1(7) and 11-1(8) of Statement 852 date, 15 July 2019	• Polaris letter dated, 9 August 2019 responding to actions. • Astron Consulting gap analysis on the effectiveness of weed hygiene management measures detailed in the approved Project Environmental Management Plan provided to DWER on 6 December 2019.

Stakeholder	Engagement Method	Actions
	• Consultation with DWER to discuss the integration of the J4 into the revised Carina PEMP.	• Polaris advised on 27 February 2020 to proceed and submit a revised 30 April 2020.
	• Document Review Comments from DWER review of Carina and Jackson 4 Iron Ore Project's PEMP, 30 April 2020.	• Minor amendments required • DWER request to include Astron's gap analysis of Project Environmental Management Plan provided to DWER on 6 December 2019 and their recommendation of an additional annual weed survey and control during March – September.
	• DWER review of Carina and Jackson 4 Iron Ore Project's PEMP	• DWER request on 5 July 2020 to correct spelling and clarify the management action for "limiting unauthorised access to mine".
	• DWER review of Carina and Jackson 4 Iron Ore Project's PEMP	• DWER request on 6 July 2020 to update the Document control table date of submission
	• DWER review of Carina and Jackson 4 Iron Ore Project's PEMP	• DWER request on 9 July 2020 to clarify how the PEMP addresses condition 6-2: "The proponent shall ensure that the design, construction and operation of the Haul Road does not impact the surrounding environment and existing infrastructure from the effects of: surface water flow impedance."
	• DWER review of Carina and Jackson 4 Iron Ore Project's PEMP	• DWER request on 28 July 2020 to include a section on reporting requirements.
	• DWER review of Carina and Jackson 4 Iron Ore Project's PEMP	• DWER request on 18 November 2020 to revise PEMP monitoring of dieback and feral animal to meet SMART principles and update management actions for saline water managment.
The Department of Mines, Industry Regulation and Safety	• Approval of Carina Mine Closure Plan (MCP) dated, 5 January 2018.	• Condition of approvals outlined the requirement to submit a revised combined J4 and Carina MCP in 2019. • Submission of revised Mine Closure Plan date, 5 May 2019.
	• Environmental inspection dated, 4 April 2018.	• No Actions
	• Environmental inspection dated, 29 May 2019.	• Provide evidence to close out identified general housekeeping actions. • Prepare Care and Maintenance plan (Submitted, 13 September 2019)

Stakeholder	Engagement Method	Actions
	• District Inspector of Mines inspection dated, 9-10 October 2019	• Close out actions identified in audit through DMIRS – SRS online system on-going.
	• Submission of consolidated Carina Yilgarn MCP to address DMIRS 2018 approval conditions. MCP submitted 03 May 2019.	• MCP still under assessment.

7. REFERENCES

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APPENDIX 5: CARINA AND J4 PEMP APPROVAL LETTER 2021

Government of Western Australia
Department of Water and Environmental Regulation

Your ref: ENV-TS-RP-0236
Our ref: DWERT5201
Enquiries: Aidan Walsh, Ph 6364 7369

Mr Kyle Hodgson
Senior Environmental Scientist
Mineral Resources Limited
Via email: kyle.hodgson@mrl.com.au

Dear Mr Hodgson

CARINA AND JACKSON 4 IRON ORE PROJECTS – MINISTERIAL STATEMENT 852 AND 988 – PROJECT ENVIRONMENTAL MANAGEMENT PLAN (3 DECEMBER 2020) – APPROVED

Thank you for your correspondence on 3 December 2020 submitting the *Carina and Jackson 4 Iron Ore Project's Project Environmental Management Plan* (Revision 4) to the Department of Water and Environmental Regulation (DWER) for review.

I note the plan has been prepared to satisfy condition 9 of Ministerial Statement 852 and condition 6-2 of Ministerial Statement 988 which states:

<u>Ministerial Statement 852</u>

9-1 Prepare Project Environmental Management Plan to ensure that the adverse impacts from mining and associated activities do not unnecessarily threaten conservation values within the mining lease and prevent impacts outside of the mining lease.

9-2 The proponent shall implement the Project Environmental Management Plan required by condition 9-1.

9-3 The proponent shall review and revise the Project Environmental Management Plan required by condition 9-1 at intervals not exceeding three years.

9-4 The proponent shall report to the CEO on implementation of the Project Environmental Management Plan every two years from the date of commencing ground disturbing activities.

9-5 The proponent shall make the Project Environmental Management Plan required by condition 9-1 publicly available in a manner approved by the CEO.

Ministerial Statement 988

6-2 *The proponent shall ensure that the design, construction and operation of the Haul Road does not impact the surrounding environment and existing infrastructure from the effects of surface water flow impedance, dust, use of saline water, weed encroachment and fire.*

I am satisfied with the preparation of the *Carina and Jackson 4 Iron Ore Project – Project Environmental Management Plan* (Revision 4) and consider the requirements of conditions 9 of Ministerial Statement 852 and condition 6-2 of Ministerial Statement 988 have been met.

Please note any changes to the management actions or targets of the *Carina and Jackson 4 Iron Ore Project's Project Environmental Management Plan* (Revision 4) would require the approval of DWER.

Yours sincerely

Hans Jacob
A/EXECUTIVE DIRECTOR
EPA SERVICES
for the Chief Executive Officer under Notice of Delegation dated 3 July 2017

8 January 2021

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APPENDIX 6: CARINA AND J4 WEEDS ASSESSMENT 2019

06 December 2019

Hugh Lance
Statement Compliance
Department of Water and Environment Regulation
Prime House
8 Davidson Terrace
Joondalup WA 6027

By Email: hugh.lance@dwer.wa.gov.au

Dear Hugh

RE: CARINA IRON ORE PROJECT – NOTIFICE OF NON COMPLIANCE – STATEMENT 852 – POLARIS METALS PTY LTD RESPONSE

We refer to the letter from the Department of Water and Environment Regulation (**DWER**) to Polaris Metals Pty Ltd (**Polaris**) dated 22 August 2019, reference DWERDT190161 (**Letter**).

In response to DWER's request to provide a gap analysis on the effectiveness of weed hygiene management measures detailed in the approved Project Environmental Management Plan, refer to the Astron Environmental Services letter attached.

Please contact Kyle Hodgson – Senior Environmental Advisor (08) 9323 3569 or by email kyle.hodgson@mrl.com.au should you require further information on this matter.

Yours sincerely,
Polaris Metals Pty Ltd

David Swain
Team Leader Environment - Operations
Mineral Resources Limited

astron
delivering environmental intelligence™
astron.com.au

6 December 2019

Our Reference: 13040-19-RELR-1Rev0_191206

Kyle Hodgson
Senior Environmental Advisor
Polaris Metals Pty Ltd
1 Sleat Rd
Applecross WA 6153

Dear Kyle,

Re: Carina and Jackson 4 Weeds Assessment, October 2019

1 Introduction

Polaris Metals Pty Ltd (Polaris) owns the Carina Iron Ore Project (the Project), which includes Carina Extension and Jackson 4 (J4) mines pursuant to the conditions of Ministerial Statement (MS) 852, 957 and 988. Monitoring and management of weeds at the Project is required under Condition 10 of MS 852 and at J4 under Condition 6-2 of MS 988. As required under Condition 9 of MS 952, Polaris developed a Project Environmental Management Plan (PEMP) for the Project which documents weed hygiene, management and monitoring procedures (Polaris Metals Pty Ltd 2011).

The Purpose of this assessment is to provide a gap analysis on the effectiveness of weed hygiene management measures detailed in the approved PEMP.

To facilitate this assessment, Polaris engaged Astron Environmental Services (Astron) to undertake this work due to their recognised industry leading experience in weed management practices and broad knowledge of the Project.

The Project is divided into two operational areas, which include a mine infrastructure area and crushing and rail siding facilities, all connected by a bituminised haul road. The Carina mine is located 48 kilometres (km) north of the rail siding. An accommodation village is located approximately 3 km north of the rail siding area and is connected with a power line corridor. The J4 project area is located approximately 70 km north east of Carina and is connected to Carina via a bituminised haul road.

Astron understands that there is public access to the site and transport routes, so recommendations are to be practical and achievable with Polaris having restricted control of the movement of the general public and recreational vehicles through the Project area.

Carina's proximity to the former Jaurdi Pastoral Station, known populations of weeds in the region and transportation of weeds via native and introduced carriers have all been considered in the gap analysis.

2 Methods

Quantitative and qualitative weed data available for Carina and J4, and associated contextual information, was collated from the sources outlined in **Table 1.** Information for weed species recorded within the project area was collated with nearby records of those species. The legal status for each species was checked and the invasiveness and impact ratings listed according to the Department of Biodiversity, Conservation and Attractions (2013) prioritisation process for weed management. The mechanism of proliferation for each species was summarised. The collated information was then used to assign management categories to each species (**Table 2**).

Table 1: Desktop assessment information sources.

Data/information resource	Context	Source
Weed control program	Qualitative and quantitative data from weed control surveys undertaken at Carina (2015 to 2019) and J4 (2017 to 2019)	• Polaris Metals Pty Ltd • Astron
Flora and vegetation monitoring program	Qualitative data from flora and vegetation monitoring surveys undertaken at Carina (2013 to 2018) and J4 (2018)	
Rehabilitation monitoring program	Qualitative data from rehabilitation monitoring surveys undertaken at Carina (2015 to 2018) and J4 (2017 to 2018)	• Astron • Ecologia Environment and Soil Water Group
Pre-disturbance flora and vegetation surveys	Detailed flora and vegetation surveys undertaken prior to project development at Carina (2007 to 2010) and J4 (2015)	• Mattiske Consulting • Ecologia Environment
Weeds in Australia	List of Weeds of National Significance	Australian Weeds Committee
Western Australian Organism List	List of Declared Pests under the Biosecurity and Agriculture Management Act 2007	Department of Primary Industries and Regional Development
Weed Prioritisation Process	Goldfields Impact and Invasiveness Ratings	Department of Biodiversity, Conservation and Attractions
FloraBase – the Western Australian Flora	Information and records of weed species in Western Australia	
NatureMap	Records of weed species across Western Australia	
Atlas of Living Australia	Information and records of weed species in Australia	Atlas of Living Australia
Invasive Species Compendium	Weed species information	CAB International (CABI)
Weeds of Australia		Queensland Government
PlantNET		New South Wales Flora Online

Table 2: Assigned weed management categories.

Management category	Description
Prevent	Prevent the establishment of any new weed species in the project area. A species is considered established when it is recorded in a reproductive life stage on more than one occasion. Prevention is to be achieved through strict weed hygiene measures and active control.
Monitor	Monitor weed species occurrences, including any new introductions.
Contain	Contain weed species to the current known location with no further proliferation and a reduction in cover and occurrence. Containment should be achieved through active control.
Control	Control weed species across the project area to reduce the cover and occurrence.

3 Results

Flora, vegetation and weed surveys have recorded a total of 14 weed species at Carina and J4 (**Table 3**), none of which are classified as Weeds of National Significance or Declared Pests (Australian Weeds Committee 2012, Department of Primary Industries and Regional Development 2019). Six of these species were recorded during pre-disturbance flora and vegetation surveys and have not been recorded since. The remaining seven species are considered to be currently present at Carina and J4, and were recorded during the most recent weed control survey in September 2019 (Astron Environmental Services 2019a). The survey recorded dense weed populations along the Carina haul road, with the densest occurrence approximately 20 km north of the southern operations. This was also noted during the 2017 and 2018 weed control survey (Astron Environmental Services 2017a, 2018a). Weed occurrence along the J4 haul road is densest at the drainage area near Compound Bend, close to the Koolyanobbing access track. This was consistent with observations noted during the 2018 survey (Astron Environmental Services 2018a). The most abundant and widespread species are **Centaurea melitensis* and **Sonchus oleraceus*, which have been recorded at the project area since 2013 (**Table 3**).

Four of the 14 weed species may have been introduced to the project area due to site activities (**Table 3**). To prevent any new weed species becoming established on site, strict weed hygiene and management measures must continue to be adhered to.

Table 3: Weed species recorded at Carina and Jackson 4 and associated contextual information.

Species name	Records	Site	Location	Population details	Distribution in Western Australia	Nearest record+	Ecological impact, invasiveness rating^	Vectors for proliferation	Likelihood of project related introduction
**Aira caryophyllea*	Mattiske Consulting (2013)	Carina	Haul road	Fifty individuals recorded at one location	945 records in Western Australia[3] across Avon Wheatbelt, Coolgardie, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain and Warren IBRA regions[1]	Helena and Aurora Range approximately 65 km north-west[2]	Unknown, Rapid	Small plants and seed can get caught in the fur, feather and hair of animals, or in personnel clothing[4]	Likely – recorded after commencement of project activities
**Brassica tournefortii*	Astron (2018a, 2019a)	Carina	Accommodation Village	Moderate density in a restricted area	394 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Central Ranges, Coolgardie, Esperance Plains, Geraldton Sandplains, Great Victoria Desert, Hampton, Jarrah Forest, Little Sandy Desert, Mallee, Murchison, Nullarbor, Pilbara, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Koolyanobbing approximately 70 km west[2]	Unknown, Rapid	Seeds spread by wind and water. Sticky seeds can attach to passing fauna, personnel, vehicles and equipment and can spread long distances[4]	Possible – recorded in 2018 at accommodation village, however only recorded after site was decommissioned
**Centaurea melitensis*	• Ecologia Environment (2013) • S Kinsey, Senior Environmental Advisor Polaris Metals Pty Ltd, pers. comm., 2015, 2016 • Astron (2017a, 2018a, 2018b, 2019a, 2019b)	• Carina • J4	• Carina waste landform • Carina haul road • Carina haul road borrow pits • J4 haul road • J4 mine • Outside J4 mine disturbance footprint	• High densities and widespread along both haul roads and at the Carina borrow pits; densest occurrences at J4 compound bend and Carina haul road 20km mark. • Low density and sparse occurrence at the Carina waste landform and J4 mine. • Low density at one location within 5 km east of J4 mine disturbance footprint prior to project activities.	246 records in Western Australia[2] across Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Geraldton Sandplains, Hampton, Jarrah Forest, Mallee, Murchison, Nullarbor, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Jaurdi Station approximately 3 km west[1]	High, Rapid	Spines of fruit can adhere to passing fauna, personnel, vehicles and equipment and can spread long distances[4]	Unlikely – occurs in surrounding area
**Cleretum papulosum* ssp. *papulosum*	Ecologia Environment (2013)	J4	J4 mine disturbance footprint	Low density at one location at J4 mine disturbance footprint prior to project activities	123 records in Western Australia[3] across Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Murchison and Yalgoo IBRA regions[1]	Credo station approximately 140 km north-east[1]	Not listed	Unknown	No – recorded prior to project activities
**Conyza bonariensis*	Astron (2019a)	Carina	Northern operations	Low density in a restricted area	153 records in Western Australia[2] across Avon Wheatbelt, Carnarvon, Central Kimberley, Coolgardie, Dampierland, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Murchison, Nullarbor, Pilbara, Swan Coastal Plain, Victoria Bonaparte, Warren, Yalgoo IBRA regions[1]	Coolgardie approximately 80 km east[1]	Unknown, Rapid	Produces copious amounts of light seed with a pappus that are dispersed by wind[4] and which may also attach to passing fauna, personnel, vehicle and equipment	Possible – first record in 2019 around mine infrastructure, however only recorded after project was decommissioned
**Erodium aureum*	• Mattiske Consulting (2008a) • Ecologia Environment (2013)	• Carina • J4	• Carina transport route • Outside J4 mine disturbance footprint	• Low density at five of 61 survey sites at Carina prior to project activities. • Low density at one location just north of J4 mine disturbance footprint prior to project activities.	129 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Central Ranges, Coolgardie, Esperance Plains, Geraldton Sandplains, Mallee, Murchison, Nullarbor and Yalgoo IBRA regions[1]	Black Flag station approximately 90 km east[1]	Unknown, Unknown	Unknown, but the similar physiology to **E. botrys* assumes a similar dispersal method	No – recorded prior to project activities

Species name	Records	Site	Location	Population details	Distribution in Western Australia	Nearest record+	Ecological impact, invasiveness rating^	Vectors for proliferation	Likelihood of project related introduction
**Erodium botrys*	Mattiske Consulting (2008a, 2008b)	Carina	• Transport route • Exploration tenement E77/1115	• Low density at five of 61 survey sites along Carina transport route prior to project activities. • Recorded prior to project activities in the exploration tenement.	153 records in Western Australia[3] across Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Nullarbor, Swan Coastal Plain and Warren IBRA regions[1]	Kooralwaylee Rock, Boorabbin approximately 60 km south-west[1]	Unknown, Unknown	Spiral corkscrew of the awn can attach to passing fauna and can spread long distances[4]	No – recorded prior to project activities
**Erodium cicutarium*	Mattiske Consulting (2008b)	Carina	Exploration tenement E77/1115	Recorded prior to project activities	240 records in Western Australia[2] across Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Geraldton Sandplains, Hampton, Jarrah Forest, Mallee, Murchison, Nullarbor, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Jaurdi Uplands approximately 9 km west[2]	Unknown, Unknown	Seeds can be transported by water, and the long, coiled tails and barbs can attach to passing fauna and can spread long distances. Carried and eaten by rodents and ants[4]	No – recorded prior to project activities
**Hypochaeris glabra*	Ecologia Environment (2013)	J4	Outside J4 mine disturbance footprint	Low density at one location just north of J4 mine disturbance footprint prior to project activities	2,327 records in Western Australia[2] across Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Murchison, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Helena and Aurora Range approximately 10 km east[1]	Unknown, Unknown	Unknown, but the similar species **Hypochaeris radicata* is spread by wind, birds and ants[4]	No – recorded prior to project activities
**Lactuca serriola*	Astron (2019a)	Carina	• Northern operations • One occurrence south of pit	Medium density throughout Carina northern operations infrastructure	96 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Esperance Plains, Jarrah Forest, Mallee, Murchison, Pilbara, Swan Coastal Plain and Warren IBRA regions[1]	Southern Cross approximately 105 km south-west[1]	Not listed	Unknown, but the light seed with pappus is likely to be dispersed by wind and moved through attachment to passing fauna, personnel, vehicle and equipment	Possible – first record in 2019 around mine infrastructure, however only recorded after project was decommissioned
**Lysimachia arvensis*	Astron (2019b, 2019a)	• Carina • J4	• Carina haul road • Carina haul road borrow pits • J4 haul road; one location near mine	Low densities and patchy occurrence along Carina haul road and borrow pits	1,068 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Gascoyne, Geraldton Sandplains, Hampton, Jarrah Forest, Mallee, Murchison, Nullarbor, Pilbara, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Jaurdi Station (south-west of Mount Finnerty) approximately 11 km west[1]	Unknown, Rapid	Seed is dispersed by water, and can attach to passing fauna and vehicles[5]	Unlikely – occurs in surrounding area
**Sonchus asper*	• Ecologia Environment (2013) • Astron (2019b, 2019a)	• Carina • J4	• Carina waste landform • Carina northern operations • J4 haul road • J4 mine	• Low density and sparse occurrence at J4 mine disturbance footprint prior to project activities. • High densities and widespread along J4 haul road and at the Carina waste landform; densest occurrence at J4 compound bend. • Low density and sparse occurrence at Carina northern operations and J4 mine.	177 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Coolgardie, Esperance Plains, Geraldton Sandplains, Hampton, Jarrah Forest, Mallee, Swan Coastal Plain and Warren IBRA regions[1]	Mount Jackson approximately 15 km west[1]	Not listed	Seeds copiously and spreads by wind, water and being ingested by birds and small mammals. Seeds may also attach to passing fauna, personnel, vehicles and equipment[4]	Unlikely – occurs in surrounding area, and was recorded prior to project activities at J4

Species name	Records	Site	Location	Population details	Distribution in Western Australia	Nearest record+	Ecological impact, invasiveness rating^	Vectors for proliferation	Likelihood of project related introduction
**Sonchus oleraceus*	• Ecologia Environment (2013) • S Kinsey, Senior Environmental Advisor Polaris Metals Pty Ltd, pers. comm., 2015, 2016 • Ecologia Environment and Soil Water Group (2015) • Astron (2017b, 2017a, 2017c, 2018b, 2018a, 2018c, 2018d, 2019b, 2019a)	• Carina • J4 • Aurora	• Carina waste landform • Carina northern operations • Carina haul road • Carina haul road borrow pits • Carina southern operations • Carina accommodation village • J4 haul road • J4 mine • Aurora camp	• Moderate density and occurrence at J4 haul road disturbance footprint, (near compound bend) prior to project activities. • High densities and widespread along both haul roads, the Carina borrow pits and Carina northern operations infrastructure; densest occurrences at Carina haul road 20 km mark and J4 compound bend. • Low density and sparse occurrence at Carina southern operations and accommodation village, J4 mine and Aurora camp. • Low density at two flora and vegetation monitoring transects at the Carina mine buffer zone (potential area of impact within 100 m of the project boundary).	1,425 records in Western Australia[3] across Avon Wheatbelt, Carnarvon, Central Ranges, Coolgardie, Dampierland, Esperance Plains, Gascoyne, Geraldton Sandplains, Great Victoria Desert, Hampton, Jarrah Forest, Little Sandy Desert, Mallee, Murchison, Nullarbor, Ord Victoria Plain, Pilbara, Swan Coastal Plain, Victoria Bonaparte, Warren and Yalgoo IBRA regions[1]	Helena and Aurora Range approximately 8 km east of J4 haul road[2], and at Jaurdi Station (south-west of Mt Finnerty) 10 km west of Carina haul road[1]	Unknown, Rapid	Seeds copiously and spreads by wind, water and being ingested by birds and small mammals. Seeds may also attach to passing fauna, personnel, vehicles and equipment[4]	Unlikely - occurs in surrounding area, and was recorded prior to project activities at J4
**Vulpia myuros*	Ecologia Environment (2013)	J4	• J4 mine disturbance footprint • Outside J4 mine disturbance footprint	Low density and one location within J4 mine disturbance footprint and one location within 5 km north-west of J4 mine disturbance footprint prior to project activities	636 records in Western Australia[3] across Avon Wheatbelt, Coolgardie, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren and Yalgoo IBRA regions[1]	Helena and Aurora Range approximately 10 km east[2]	Unknown, Unknown	Seed can attach to passing fauna, personnel, vehicles and equipment[4]	No – recorded prior to project activities

+ Nearest record prior to first record at Carina and/or J4.

^ Goldfields ecological impact and invasiveness ratings (Department of Biodiversity et al. 2013).

1 FloraBase (Department of Biodiversity, Conservation and Attractions et al. 2019a).

2 NatureMap (Department of Biodiversity, Conservation and Attractions et al. 2019b).

3 The Atlas of Living Australia (Atlas of Living Australia 2019).

4 Invasive Species Compendium (CAB International 2019).

5 Weeds of Australia (Queensland Government 2019).

Table 4: Weed management categories assigned to each species

Management category	Species
Prevent	Any new weed introductions
Monitor	All environmental weed species
Contain	*Brassica tournefortii* *Conyza bonariensis* *Lactuca serriola*
Control	*Centaurea melitensis* *Lysimachia arvensis* *Sonchus asper* *Sonchus oleraceus*

4 Conclusion

In terms of the Gap Analysis objective, it was concluded that the Project's current weed hygiene and management measures have been effective in ensuring where practicable, that weed species distribution and occurrence within the Project area remain comparable to surrounding areas and similar land uses. Continued implementation of the current weed hygiene and management measures coupled with an adaptable seasonal approach to weed management that incorporates ongoing data effort, should result in further positive outcomes in the Project area with regards to weed species occurrence and distribution.

On-going monitoring of weed species occurrences will help to detect any new species before they become established and proliferate and will provide the data required to assess progress towards achieving weed management objectives.

Astron recommends that Polaris undertake consecutive weed control surveys between March and September when seasonal conditions are optimal for weed germination and growth. During each survey, all weeds should be chemically controlled and data recorded to report on survey effort and outcomes. Accurate data records will allow Polaris to report on changes in weed populations across the project area and will indicate progress towards achieving weed management objectives and future survey events and duration.

For the seven (7) weed species currently occurring at the Project (Carina and J4), three (3) have been characterised as "contain management" due to their restricted distribution, with four (4) species characterised as requiring "control"(**Table 4**).

None of the weed species recorded within the Project area are a Declared Pest.

A majority of weed species are considered environmental weeds and are observable in the surrounding former pastoral lease. The Project's proximity to former pastoral leases, legacy mining projects and publicly accessible recreation areas ensure that challenges are likely to remain with regards to availability of vectors for proliferation of weed species. Human and Fauna activity (native & introduced) within and around the Project area, coupled with the physiology of weed seeds is likely to present challenges to ongoing weed management strategies with regards to containing and controlling current populations of weed species.

This letter was prepared by Sharyn Moore (Senior Scientist), and technically reviewed by Janelle Atkinson, (Principal Scientist). If you have any queries, please don't hesitate to contact myself or Sharyn on 9421 9600.

Yours sincerely
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