TOPSOIL MANAGEMENT PLAN

Document No:	ARMS-0000-H-PLN-N-0005 Rev 2
Project Name:	Nolans Rare Earths

REVISION HISTORY

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TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1.0 REFERENCES

1.1 Arafura Resources Limited Documents

Title	Document Number
Biodiversity Management Plan	ARMS-000-H-PLN-N-0002
Nolans Project Weed Management Plan	ARMS-000-H-PLN-N-0009

1.2 Australian References

Title
Australian Government. (2016). Mine Rehabilitation: Leading Practice Sustainable Development Program for the Mining Industry. Canberra: Australian Government.
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Title
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2.0 ABBREVIATIONS AND DEFINITIONS

2.1 Abbreviations

Abbreviation	Meaning
Arafura / ARU	Arafura Resources Limited
Nolans Project	Nolans Rare Earths Project
SPCs	Soil Profile Classes
PAWC	Plant Available Water Contents

2.2 Definitions

Term	Definition
Shall / Must	A requirement is mandatory

3.0 INTRODUCTION

3.1 Background

The Nolans Rare Earths Project (the Project) is located approximately 135 km northwest of Alice Springs, Northern Territory. The Project targets the Nolans Bore mineral deposit for rare earth elements. The combined disturbance footprint of the proposed development is approximately 1300 ha and encompasses an open pit area, several waste rock dumps, a residue storage facility, Run of Mine pad, stockpiles, and the workshop/facilities/administration areas.

A Topsoil Management Plan is required for the construction and operational stage phases. The purpose of the Plan is to provide guidance on the recovery of soil materials that may be used as primary and/or secondary growth media in the rehabilitation of post construction activities and to support the post mining land uses.

3.2 Purpose

The Topsoil Management Plan (TMP) has been developed to provide a framework for topsoil management across the Project as well as providing information which is to be used in decision making and project management, detail planning and methods of work, and provide for a record of performance.

This document is an integral part of the Project's Mining Management Plan (MMP). It is a dynamic document which is to be reviewed and updated regularly (or as determined by the MMP), enabling an accurate reflection of the current operational requirements and practices whilst allowing for responsiveness to conditions, input from stakeholders, and enabling flexibility in planning and prioritisation where required.

All referenced company policies, standards, registers, operational procedures, activity specific documents, forms and templates are stored and will be accessed from within the Arafura Resources Integrated Management System (ARMS).

3.3 Objectives

The purpose of this Plan is to provide guidance on soil recovery and management to ensure the post construction and post mining land use and rehabilitation commitments can be achieved. The Plan includes:

- Reference to post-mining land use and vegetation cover requirements
- An inventory of soils that may be recovered, including the volume, quality, and location
- Volume estimates of soil required for closure of each domain
- (Proposed) stockpile location plan
- Consideration of soil recovery, stockpiling, and amendments (if necessary)
- Consideration of woody vegetation clearance and management
- Consideration of weed, exotic species, and native vegetation seed banks in topsoil.

3.4 Relevant Legislation and Guidelines

The Plan was developed in reference to the following guidelines:

- Australian Soil Classification (Isbell, 2002);
- Australian Soil Survey and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009);
- Mine Rehabilitation: Leading Practice Sustainable Development Program for the Mining Industry (Australian Government, 2016);
- Erosion Sediment Management Plan (ARMS-0000-H-PLN-N-0012);
- Biodiversity Management Plan (ARMS-0000-H-PLN-N-0002), including the vegetation management plan, and the ground disturbance permit for land clearing;
- Weed Management Plan (ARMS-0000-H-PLN-N-0009); and
- Land Clearing Guidelines (NT DENR 2020).

4.0 SOILS

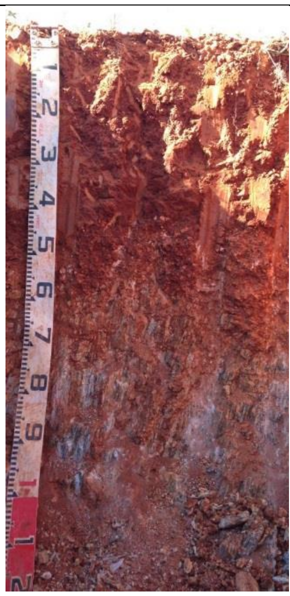
Soil mapping of the Study Area was undertaken in February 2021. Preliminary survey design and determination of soil unit boundaries used the following GIS datasets as reference materials:

- Aerial imagery from Google Earth (2021);
- Digital elevation model (DEM) (Gallant, et al., 2011);
- Previously assessed soil mapping data (CSIRO, 2020);
- Radiometric data from Geoscience Australia (Geoscience Australia, 2015); and
- Climate data downloaded from SILO (Qld Government, 2021).

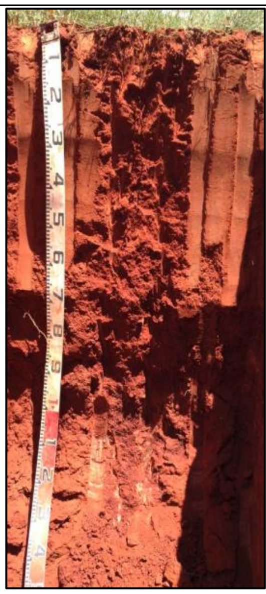
Details of these datasets, as they relate to the project area, are discussed in *Baseline soil assessment: Nolans Project* (Landloch, 2021).

The soil survey of 24 soil profile points, plus in-field observations of the landscape, resulted in the description of four Soil Profile Classes (SPCs) using methods outlined by McKenzie et al. (2008). Images of the four SPCs (A, AS, B and C) are provided in Photographs 1 to 4.

Photograph 1: SPC A



Photograph 2: SPC AS



Photograph 3: SPC B

Photograph 4: SPC C

Figure 4-1 Photographs 1-4 -Description of soil profile cases

The SPCs were all very similar, sharing the following attributes:

- Intermediate textures, mainly loam grading to light clay;
- Non-texture contrast soils;
- Rapidly and uniformly draining;
- Whole coloured and red, apart from SPC C, which was whole coloured and brown;

- Non-saline;
- Non-sodic;
- Free from chemical constraints;
- Weak surface structure; and
- Very low surface organic matter.

The four SPCs are listed in Table 4-1. Further details on each SPC can be found in Baseline soil assessment: Nolans Project (Landloch, 2021).

Table 4-1 Soil profile classes (Landloch 2021)

Soil Profile Class	Description	Area (ha)	Proportion of Study Area
A	Red earth over rock	841*	59 %
AS	Red earth over rock, shallow version		
B	Red earth - deep	565	39%
C	Calcareous brown earth	30	2 %

*SPC AS is a shallower version of SPC A. These two soil forms are associated over short distances, and have been combined in one Soil Map Unit.

4.1 Disturbance areas

A map of the key areas that are proposed to be affected by the mine disturbance is provided in Figure 4-2 not including the borefield, pipeline corridor, and some roads. Disturbance from mine activities relate to the following domains:

- Open pit;
- Residue Storage Facility (RSF);
- Run of Mine (ROM) pad;
- Waste rock dumps;
- Long term stockpiles;
- Water management infrastructure;
- Mine offices, Operations Administration Complex, workshops and associated buildings;
- Explosives Storage Area;
- Process Plant;
- Borefield and pipelines;
- Accommodation village; and
- Roads.

These domains will require soil stripping. Disturbed sub-surface soils that remain *in situ* during the life of the mine will require amendment such as deep ripping, potential application of fertiliser and seeding.

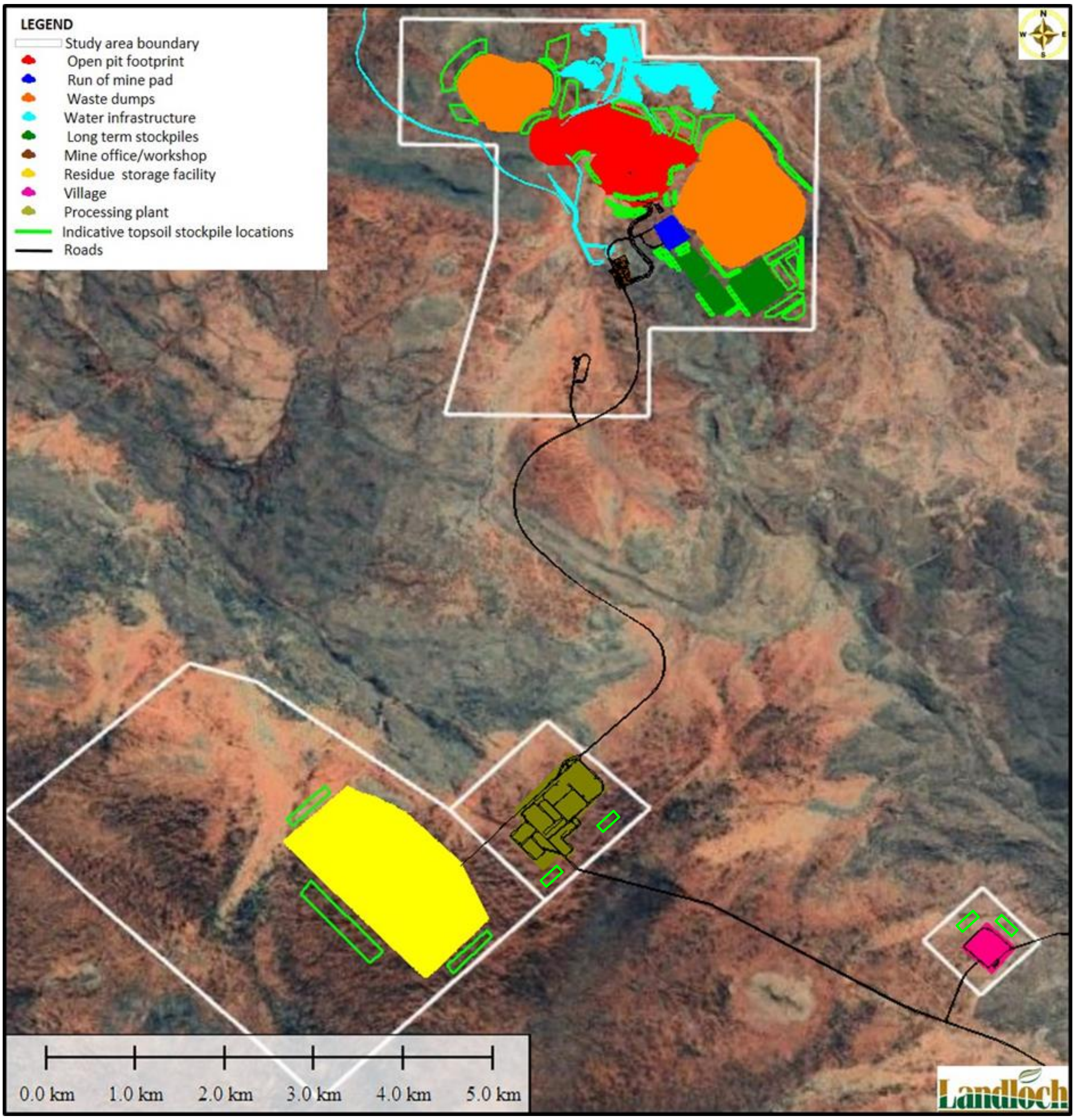


Figure 4-2 Proposed development disturbance footprints requiring soil stripping

5.0 REHABILITATION COMMITMENTS

5.1 Rehabilitation Objectives

The rehabilitation objectives listed in the *Nolans Environmental Impact Statement* (GHD, 2016) are:

- To establish a safe and stable post-mining land surface that supports vegetation growth over the long-term;
- To return the land, as close is reasonably practical, to its pre-disturbance land use; and
- To make the site suitable for future leaseholders likely uses for the site.

5.2 Post Mine Land Uses

The post mine land uses are to be cattle grazing and/or native vegetation. Native vegetation is to be selected with erosion control and site stability as a success criterion.

6.0 GROWTH MEDIA

6.1 Primary Growth Media

Primary growth media infers the ability of materials to be used as a surface soil (surrogate topsoil).

It is the uppermost layer of soil/material placed over the area to be rehabilitated. In most situations, it will be 0.15–0.3 m deep and consist of surface soil materials recovered during stripping, prior to mining.

Compared to some overburden and tailings materials, primary growth media have low to negligible limitations to plant growth. Both the surface soil and subsoil from SPC A, AS, B, and C have been identified as primary growth media. Further detail is provided in Section 7.0

6.2 Secondary Growth Media

Secondary growth media infers the ability of materials to be used as a rootzone layer below the primary growth media. Its prime purpose is to provide soil water storage, and/or to meet the soil depth requirements for vegetation associated with the planned post-mining land uses.

In some circumstances, it may be improved by the addition of amendments (e.g. gypsum, lime, organic matter) such that it is converted into a primary growth media. However, the cost and practicability of such amendments are often prohibitive.

Waste rock and substrate materials are likely candidates for secondary growth media. However, their suitability for use as a secondary growth media is yet to be determined and will be further explored throughout the mine closure process. As mining progresses, recovered waste rock and substrate materials will be tested to assess their suitability to be secondary growth media.

Waste rock from the site was assessed in the report: *Strategic guidance for rehabilitated waste landforms: Nolans rare earths project* (Howard, 2021). The materials included igneous and metamorphic rock and were found to be hard and durable. They contained fines that were non-saline, infertile, and strongly alkaline. The strong alkalinity is most likely treatable using gypsum. Water holding capacity was not determined but is likely to be very low. It is likely that the waste rock could be used as secondary growth media, however, thicknesses of the rootzone may need to be two to three times that of rootzones comprising soil.

6.3 Soil Water Storage

To achieve the post mining land uses of cattle grazing and/or native vegetation, it is crucial the growth media profile has adequate plant available soil water storage capacity to support vegetation between rainfall events. The soil survey of the study area showed that plant roots were active to the full depth of the soil profile, which ranged from 0.5 m in SPC AS to 1.5 m in the other SPCs. The mulga (Acacia aneura) dominated vegetation includes deep rooted, perennial species with requirements for soils with plant available water contents (PAWC) over approximately 80 mm. Based on these soil data, the target plant available water capacity (PAWC) values nominated are:

- a minimum of 40 mm (based on the lower PAWC range estimated for SPC AS); and
- an average of at least 80 mm.

For perspective, the natural soils exhibited PAWC ranging from 40 mm to over 170 mm.

Achieving the target PAWC will depend on the texture of the growth media and the depth to a restricting sublayer.

For this report, PAWC has been estimated based on soil morphology (texture, consistence, and structure), with a PAWC of approximately 115 mm/m used for all the recoverable surface soil and subsoil materials described (Hazelton & Murphy, 2016). That is, in every 100 mm of soil available to plant roots, the soil is able to store 11.5 mm of water. This is based on the water held between field capacity and wilt point Figure 6-1 Plant available soil water holding is based on the water held between field capacity and wilt point. Nolans soils - 115mm of stored water per metre of soil depthFigure 6-1

As an oversimplified example, a dry soil that is 700 mm thick can potentially store all the rainfall from an 80 mm rainfall event. Any further rain will be lost, either as runoff or as deep drainage. The plant can then draw down on this stored moisture until it is either used up or replenished through further rain. For gravelly and stony materials, these PAWC values need to be reduced by adjusting proportionally to the rock content.

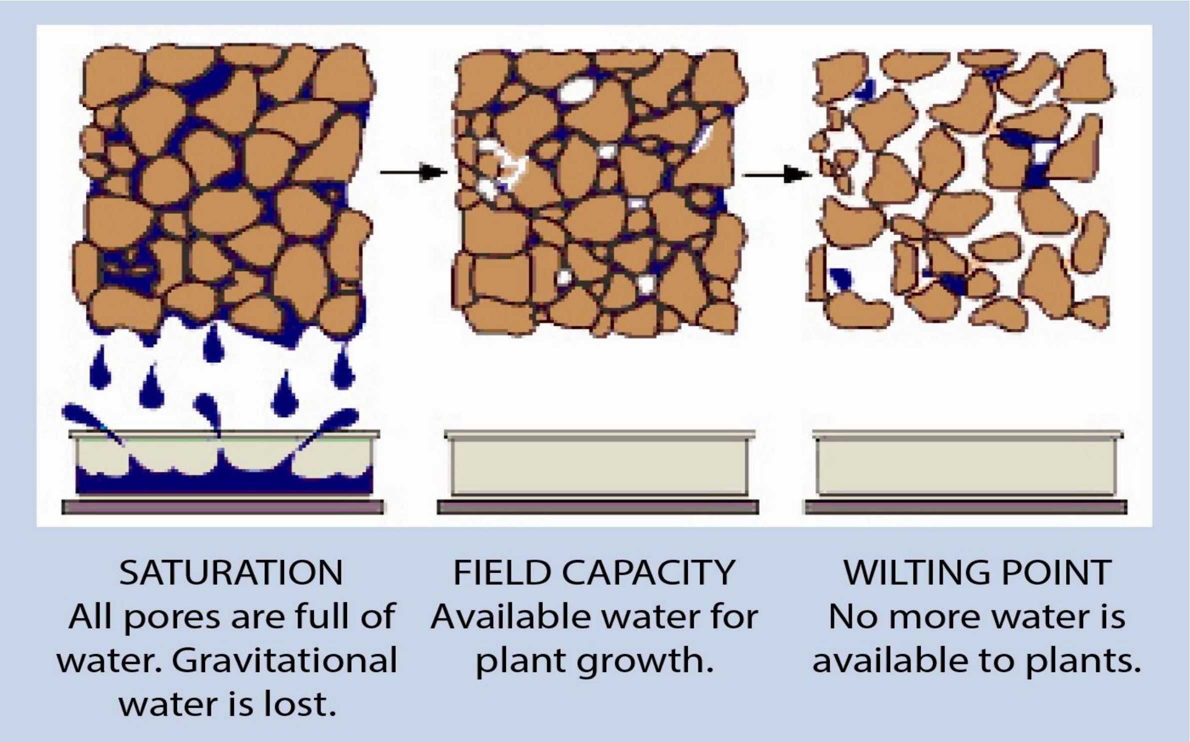


Figure 6-1 Plant available soil water holding is based on the water held between field capacity and wilt point. Nolans soils - 115mm of stored water per metre of soil depth

Restricting layers can act as physical and/or chemical barriers to root growth. Physical barriers include bedrock, hardpans, dispersive materials with high bulk density, and continuous rock or gravel layers. Chemical barriers include extremes of pH, salinity, and sodicity. Restrictions in root depth restrict PAWC. At rehabilitation, any shortfall in substrate, waste rock, or undisturbed subsoil available to provide rootzone needs to be made up for by increasing the depth of topsoil. The rootzone depth requirements required to supply adequate PAWC have been estimated on this basis and are provided in Table 6-1

6.4 Generalised Growth Media Profiles

The growth media profiles required to achieve the target PAWC will generally vary across domains, and be dependent upon the substrate being rehabilitated. Generalised profiles are provided in Table 6-1. The depth to a restricting layer will need to be revised based on the texture and rock content of secondary growth media in each domain.

Table 6-1 Generalised growth media profiles to achieve the target PAWC

Domain	Growth media profile	Details
Infrastructure, Roads, Temporary Stockpiles, and Processing Plant	0.15 m of primary growth media capping over natural ground (secondary growth media); and At least 0.5 m to a restricting layer.	Reduce compaction in natural ground by ripping to 0.5 m.
Residue Storage Facility	0.3 m of primary growth media capping over secondary growth media (if available); and At least 0.7 m* to restricting layer.	Depending on the tailings disposal method employed, reworking the surface may be necessary to make it a more uniform texture by blending sand, loam, and clay lenses.
Waste Emplacement Areas	0.3 m of primary growth media capping over secondary growth media: Non-rocky wastes - at least 0.7 m* to restricting layer; or in Rocky wastes - at least 1.2 m* to restricting layer	The fines content of rocky wastes will greatly influence the PAWC of the materials and depth required to support plant growth.
Open Pit	May be left open. Growth media profile not required.	Rehabilitation requirements will depend on post mining objectives for the pit.

* Depths are estimates only and are to be confirmed based on the soil water characteristics of waste and substrate materials. Shortfalls in suitable secondary growth media will need to be made up using primary growth media (topsoil). Total rootzone depth, where materials have an estimated PAWC of 115mm/m, should average >0.7 m.

It is noted that 100 mm is a difficult thickness to remove consistently using earthmoving equipment, and an even more difficult thickness to replace evenly (Australian Government, 2016). Consequently, in order to ensure adequate topsoil recovery, 150 mm has been nominated where subsoil material is not being stripped. Where subsoil is being stripped, should topsoil replacement be somewhat patchy, this is of no consequence, due to the very similar physical and chemical attributes of the subsoil soil materials.

7.0 PRIMARY GROWTH MEDIA MANAGEMENT

7.1 Recoverable Inventory

All soils described within the Study Area were assessed as suitable for use as primary growth media. They include all pedogenic materials (A and B horizons) found above parent material (C horizon) layers. The stripping plan should be developed with this in mind, with depths given in Table 6-1 being indicative only, and not limited by the quality of the subsoil. Economic and logistical objectives may have a greater bearing on stripping depths than the depth of suitable growth media materials.

Primary growth media stripping depths for each soil profile class (SPC) are provided in Table 7-1. Surface soil (surface 100 mm) and subsoils are identical from a management perspective, apart from the following:

- The surface 100 mm of soil contains the great majority of the soil's reserves of seed (both weeds and desirable plants), organic matter and microbial activity.
- Subsoils of SPCs A, AS and C all contain fractured rock. In arid environments, surface rock fragments can provide valuable surface cover that can act to reduce erosion potential.

Table 7-1 Inventory of primary growth media potentially available from within the domain disturbance footprints (if depth of stripping were only limited by soil quality)

Soil Profile Class	Area (ha)	Recoverable Depths (mm)		Recoverable Volumes (m^3)	
		Surface Soil	Subsoil*	Surface Soil	Subsoil
A	352	100	100 - 1,000	351,500	3,163,500
AS	352	100	100 - 500	351,500	1,406,000
B	563	100	100 - 1,500	563,300	7,886,500
C	50	100	100 - 900	50,000	400,000
Totals	1316	-	-	1,316,300	12,856,000

*Subsoil material depths indicate suitability as primary growth media. Shallower depths may be stripped, based on economic and/or logistical criteria (Table 7-2)

7.2 Stripping

For all soil profile classes, surface soils can be stripped to a thickness of approximately 100 mm where subsoils are also to be stripped i.e. Open Pit, Waste Rock Dumps and RSF (Table 7-2). However, depth of stripping of surface soils is to be 150 mm in the Infrastructure, Roads, Temporary Stockpiles, and Processing Plant areas because subsoil stripping is not required. The intent is to provide adequate volume of materials to reinstate to a depth of 150 mm (± 50 mm).

Refer to *Biodiversity Management Plan (ARMS-000-H-PLN-N-0002)* for details on the Ground Disturbance Permit.

Subsoils can potentially be stripped down to parent rock without changing suitability as primary growth media (Table 7-1). However, the material stripping depth required to source the volume required for rehabilitation is generally shallower than the depth to parent rock. Nominally, a subsoil depth of 300 mm (measured from the surface) has been used to calculate the depth of soil required (Table 7-2). Note that Table 7-1 can be used to determine if more soil is available for any given domain, should the volumes given inTable 7-2 be deemed inadequate when stripping commences.

Timing of stripping should avoid periods when the soil is either very moist or very dry (Australian Government, 2016). Overly moist soil, that is, close to or above field capacity, is susceptible to compaction. This reduces the soils PAWC, as well as its suitability to support plant roots. Very dry soil, due to its loamy texture and lack of structure, is prone to become powdery and bull-dusty. This will result in the soil being more prone to erosion.

7.3 Stockpiling

The topsoil and subsoil stockpile footprints do not themselves require topsoil stripping prior to material being placed. Surface soils and subsoils reserved for use as primary growth media in rehabilitation will need to be stockpiled separately. This is because the highest concentration of organic matter, soil biota, and seed banks are found in the surface soils, and stockpiling them separately will help to preserve its biological advantages.

Surface soil (topsoil) stockpiles should be kept to a maximum of 2 m in height (Australian Government, 2016).

Subsoils can be treated as if it is uniform in its properties and stockpiled as one unit. The height of the subsoil stockpiles may need to be restricted to 3 m, which is reflective of the *Standard Specifications for Environmental Management v2* (NT Government, 2019). However, this specification is directed at civil and buildings works projects, and may not apply to mining.

As the subsoil materials have lower biological activity and negligible seed bank or organic matter content, stockpiling subsoil materials to greater height will have negligible impact on their quality. Hence, provided regulatory compliance is achieved subsoil stockpiles with a greater height and smaller footprint may be more desirable to minimise disturbance areas.

7.4 Rehabilitation Volume Estimates

Estimates of the volume of primary growth media that will be required for rehabilitation of each domain are provided in Table 7-2. They assume placement of a capping layer of primary growth media that is 0.15 m to 0.3 m in thickness over a secondary growth media layer (e.g. recovered substrates, waste rock, natural ground). If a suitable secondary growth media is not available, then the required rootzone depth will need to be made up of primary growth media of a minimum of 0.35 m and an average of 0.7 m thick. The below ground level (BGL) stripping depths provided inTable 7-2 reflect the average soil materials required should secondary growth media be available.

Table 7-2 Rehabilitation volume estimates

Domain	Area (ha)	Soil Profile Class	Required Primary Growth Media Volume (m3)	Recoverable Soil within Disturbance (m3)	
				Surface Soil	Subsoil (0.1-0.3m bgl)
Open pit	119	A/AS	357,000*	119,000 (0-0.1m bgl)	238,000
ROM pad	17	A/AS	25,500	25,500 (0-0.15m bgl)	-
RSF	361	15% A 85% B	1,083,000	361,000 (0-0.1m bgl)	722,000
Waste rock dumps	313	A/AS	939,000	313,000 (0-0.1m bgl)	626,000
Mine infrastructure	50	50% A/AS, 50% B	75,000	75,000 (0-0.15m bgl)	-
Long term stockpiles	50	A/AS	150,000	50,000 (0-0.1m bgl)	150,000
Mine water management infrastructure	128	50% A/AS 50% C	192,000	192,000 (0-0.15m bgl)	-
Roads	150	-	225,000	225,000 (0-0.15m bgl)	-
Village	25	B	37,500	37,500 (0-0.15m bgl)	-
Processing plant	99	B	148,500	148,500 (0-0.15m bgl)	
Bores	4	-	6,000	6,000 (0-0.15m bgl)	-
TOTALS	1316	-	3,238,500	1,552,500	1,686,000

*Open pit may not require any soil materials for rehabilitation, depending on post mine use objectives. However, it would be beneficial to recover soil material (particularly surface soil) for use as a primary growth media in other rehabilitation domains.

7.5 Stockpile Inventory

A set of records and maps of the various stockpiled primary growth media are to be kept for each disturbed area. Table 7-3 provides the estimated area and volume of each of stockpile. *Indicative* areas for the stockpiles are illustrated in Figure 7-1 and Figure 7-2.

Table 7-3 Primary growth media stockpile and footprint estimates

Domain	Surface Soil		Subsoil	
	Area (ha) [A]	Volume (m^3)	Area (ha) [B]	Volume (m^3)
Open pit	6	119,000	8	238,000
ROM pad	1.3	25,500	-	-
RSF	18	361,000	24	722,000
Waste rock dumps	16	313,000	21	626,000
Mine infrastructure	4	75,000	-	-
Long term stockpiles	3	50,000	3	100,000
Mine water management infrastructure	10	192,000	-	-
Roads	11	225,000	-	-
Village	2	37500	-	-
Processing plant	7	148500	-	-
Bores	0.3	6000	-	-
TOTAL	78	1,552,500	56	1,686,000

[A] Assumed surface soil stockpile height of 2 m. [B] Assumed subsoil stockpile height of 3 m.

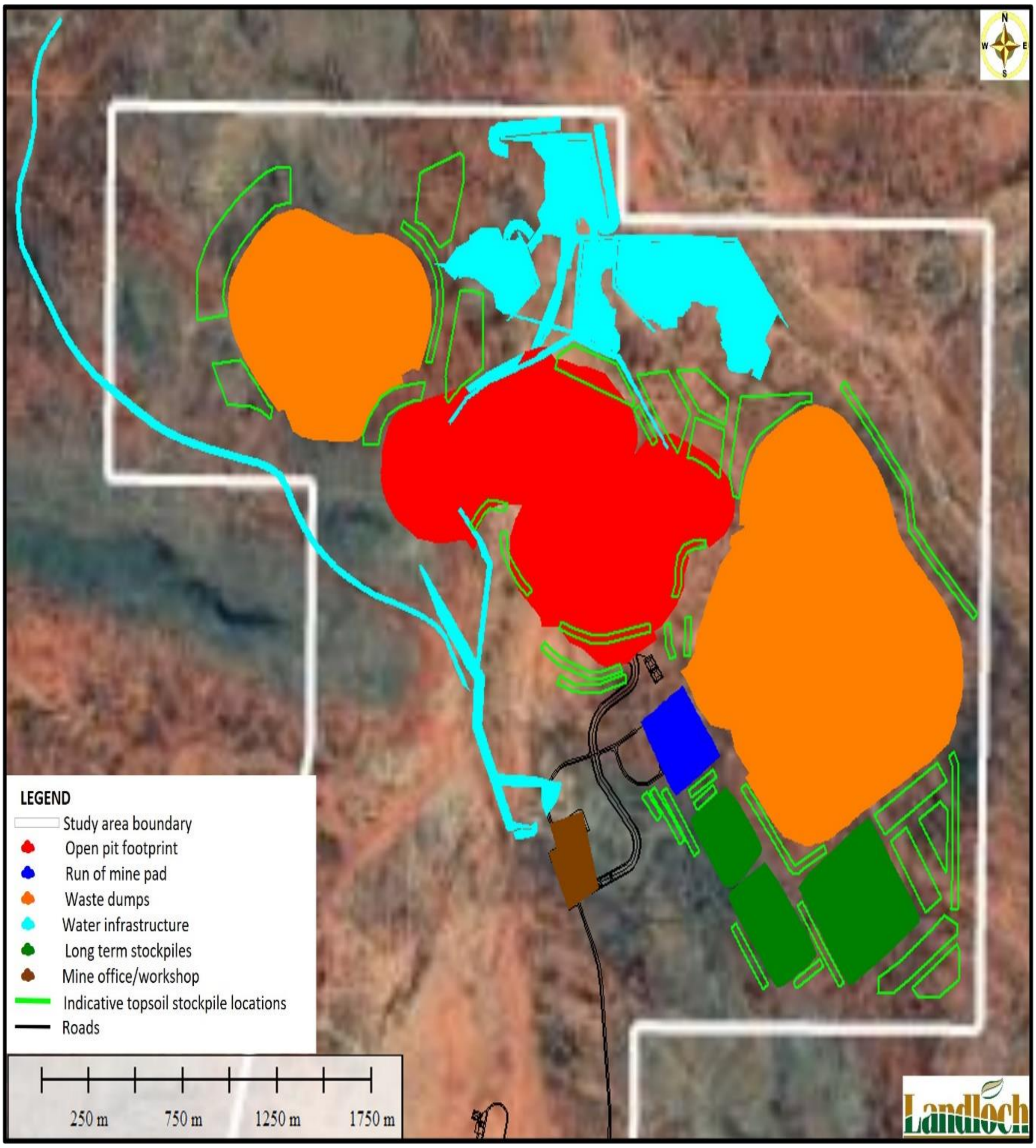


Figure 7-1 Indicative mine infrastructure locations and indicative stockpile locations (based on GIS data supplied by Arafura 2021)

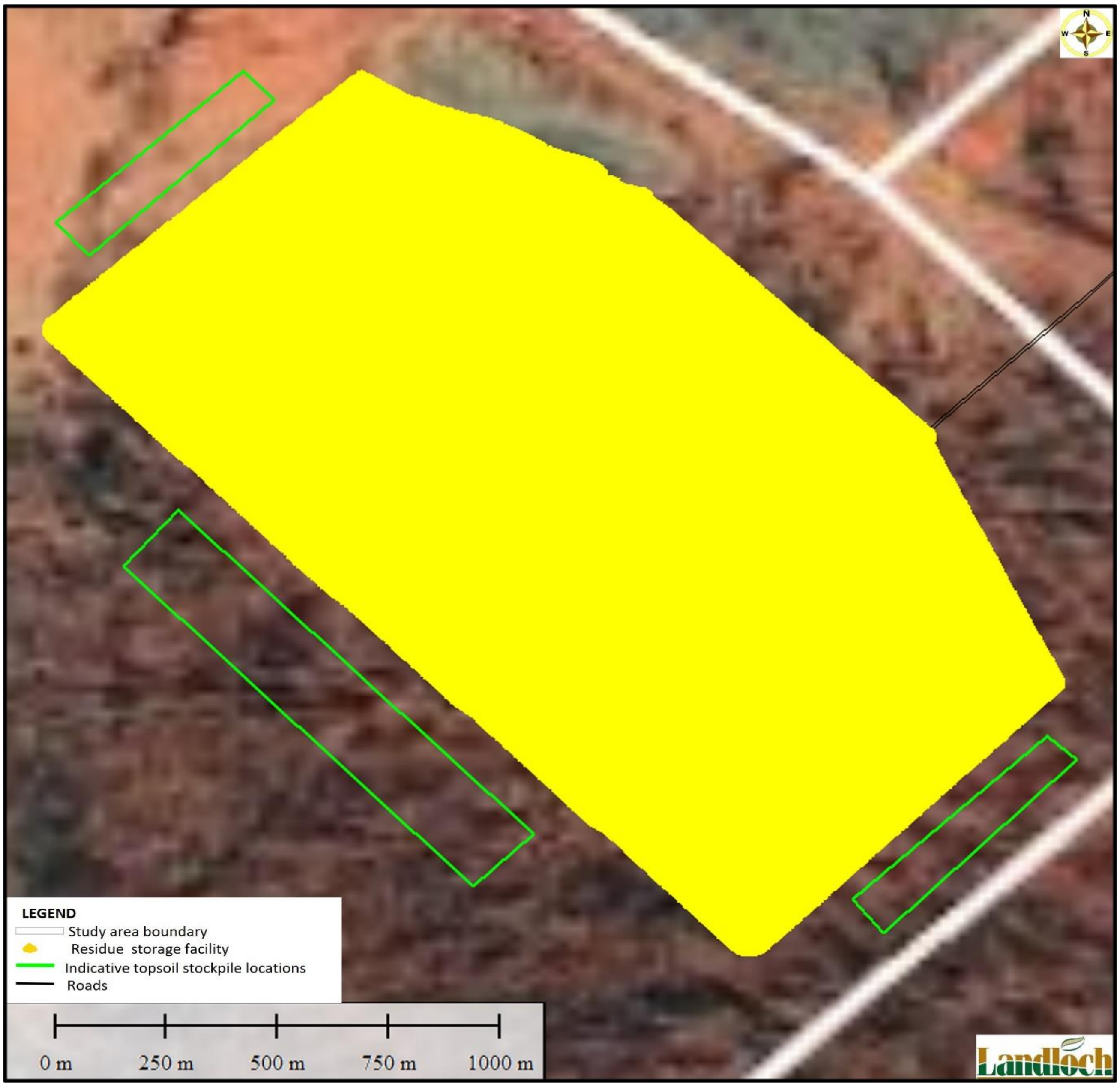


Figure 7-2 Indicative reside storage facility location and indicative stockpile locations

For each stockpile, records should include details of the following (Australian Government, 2016):

- Domain title.
- Georeferenced outline (polygon) of location that was stripped;
- Surface area size (hectares) and soil volumes and depths stripped;
- Georeferenced outline (polygon) of stockpile locations;
- Whether material is categorised as surface soil or subsoil; and
- Date of stockpile construction.

The Nolans Project Environmental department will maintain the register of all soil related records.

7.6 Stockpile Erosion Management

Stockpile designs are to have a 1:3 (V:H) batter gradient.

Stockpiled material is to be clear of surface water drainage lines and vegetated areas (Australian Government, 2016).

Freshly harvested topsoil is likely to develop vegetation cover without supplementary seeding (Golos 2016). However, where natural regeneration of vegetation is inadequate in topsoil stockpiles or subsoil stockpiles, then stockpiles will be sown with a seed mix representing the original vegetation community. Irrigation may be desirable to get rapid protection from cover. Sowing desirable vegetation will also assist with outcompeting weed species.

While stockpiles are in a bare condition, they are to be sprayed with an erosion control product with a cover rating C-factor of 0.05 or less.

8.0 CLEARED VEGETATION

Woody vegetation, dominated by mulga, is present across the site. The standing volume of vegetation has not been measured. Based on informal visual assessments made during the soil field survey, the standing volume has been estimated to range from 5 to 50 m^3 per hectare. This is useful for providing a coarse ballpark volume relating to vegetation stockpile footprints.

Preferably trees and shrubs are to remain whole (ie: not chipped), as they can then be placed across the landscape at rehabilitation. This is valuable in providing initial surface cover prior to the germination of seed. At rehabilitation, place the debris across batters and slopes, then track roll the dry timber and branches to break into sizable chunks. This will improve surface roughness and reduce erosion rates during the vegetation establishment phase of rehabilitation.

Stockpiled whole plants are estimated to require up to 0.2 to 0.4 hectares per 100 hectares of cleared land, based on stockpiles 3 m high. That is, for the 1300 ha of land potentially requiring clearing, only in the order of two or four hectares of stockpiles is required to accommodate the residues. Plant residue stockpiles are likely to be placed in a series of windrows beside topsoil and subsoil stockpiles. Leave trafficable laneways between rows/piles. Trafficable laneways will allow access for a water cart in the case of fire management.

The stockpile footprint required for cleared vegetation is estimated to be one to two orders of magnitude less than that required for soil. The areas allocated for stockpiled material are more than sufficient to accommodate the materials likely to be produced.

Refer to the *Biodiversity Management Plan (ARMS-000-H-PLN-N-0002)* for details on vegetation clearance.

Figure 8-1 Photograph 5 Native woody vegetation

9.0 REHABILITATION

9.1 Weeds and Native Vegetation Seed Bank

Fourteen exotic weed species, including *Tribulus terrestris*, have been identified at the site (GHD, 2016). Most of the weed seed bank will be contained within the stripped surface soil layer. Treatment of weeds, and exclusion of soil materials that contain weeds, may be required prior to stripping (Australian Government, 2016). Soil materials with high weed densities are to be stockpiled separately. Refer to *Weed Management Plan (ARMS-000-H-PLN-N-0009)* for details on weed management. The surface soil stockpiles will require greater management for weeds than the subsoil stockpiles.

9.2 Fertilisers and Amendments

9.2.1 Gypsum

Most of the soil materials assessed in the soil had an electrochemical stability index (ESI) of less than 0.05. This measurement is derived by dividing the salinity ($EC_{1:5}$) by the exchangeable sodium percentage (ESP) (McKenzie, 1998). An ESI less than 0.05 indicates that a soil is at high risk of being dispersive, often despite having a low ESP.

Field assessments indicated that numerous samples of the soil exhibited dispersive behaviour. As a result, it is recommended that the ground surface be spread with gypsum prior to stripping the surface soil layer and subsoil layer. Gypsum is to be broadcast at a low rate of 1 t/ha is prior to the stripping of each layer. The stripping and stockpiling process will facilitate incorporation of the gypsum, allowing the soil to respond to the gypsum during its period of storage (Australian Government, 2016). Soil Profile Class C soils do not require gypsum treatment (refer to Section 4.3 in *Baseline soil assessment: Nolans Project* (Landloch, 2021)).

Figure 9-1 An example of gypsum spreading equipment

9.2.2 Fertiliser

Soils presented very low levels of nitrogen and organic carbon. Nitrogen in the form of sulphate of ammonia and 270-day coated urea are recommended to address the deficiency of nitrogen. Rates are presented in Figure 9-1. Fertiliser should be spread around the time of seed sowing, after the soil has been respread across the site. Further studies on the need for fertiliser applications and potential application rates will be conducted throughout the mine closure planning process.

Table 9-1 Amendment / fertiliser rates

Product	Rate (kg/ha)	Total required (tonnes)	Notes
Gypsum	1,000	1,340	Broadcast gypsum prior to stripping each layer prior to stripping. Applies to all SPCs except C.
Sulphate of ammonia	200	140	Apply at rehabilitation post placement of primary growth media.
270-day coated urea	150	100	

10.0 SOIL SUMMARY

The soil profile classes found at the Nolans Project were all very similar in their properties. All surveyed soils (observed to their full depth of profile) could be classed as primary growth media. As the surface contains the majority of the seedbank and organic components of the soils, the upper 100 mm to 150 mm layer should be stockpiled separately from the underlying materials.

Stripping depths are governed more by the volumes required for rehabilitation and the depth that is economic/logistically suitable for stripping, than by any inherent limitation of the soils themselves. The surface soil and the subsoil (to full depth of the profile) are chemically and physically very similar. The rock in the subsoil of SPCs A, AS and C may be useful as surface cover to reduce erosion risk.

Records of type (surface soil or subsoil) and locations for each stockpile need to be kept for each stockpile, in particular defining and distinguishing between the surface and subsoil materials.

Both surface soils and subsoils are suitable for use as a primary growth media; Although the surface soils should be used preferentially as they are the better of the two materials due to its marginally higher organic matter content and local native seed content.

Amendment of the soil layers with gypsum, spread prior to stripping, will raise the ESI of the soil, and make it less prone to water erosion. Successful rehabilitation, after respreading of the soil at rehabilitation and post, may require the addition of nitrogen fertilisers to address the soils' deficiency in this nutrient. Other nutrients are generally not deficient.

11.0 MANAGEMENT AND MITIGATION

Topsoil management is required to provide guidance on the recovery of soil materials that may be used in the rehabilitation of post construction activities and to support the post mining land uses. Management of topsoil is structured as follows:

- **Key Activities, Impacts and Residual Risks:** A summary of the key activities being undertaken during the management period. The potential environmental impacts and residual risk levels are identified for each environmental aspect.
- **Objective:** The guiding environmental management objective(s) and activities that apply to the element.
- **Mitigation Measures:** The procedures to be employed to ensure that the relevant objectives are met.
- **Responsibility:** Nominates the responsible position for implementing actions and monitoring.
- **Trigger, Action, Response Plan (TARP):** The actions to be implemented in the case of non-compliance. This includes strategies of remediation and the person(s) responsible for the actions.

11.1 Key Activities and Potential Environmental Impacts

The key activities and potential environmental impacts have been identified for topsoil management and are listed in Table 11—1.

Table 11—1 Key Activities and Potential Impacts

ID No	Activity	Potential Environmental Impact
1	Too little depth/volume of topsoil and/or subsoil removed	Inadequate soil volume available for rehabilitation Inadequate seed bank in topsoil for rehabilitation
2	Topsoil stockpiles greater than 2 metres in height	Degradation of seed quality and organic matter making the topsoil less effective during future rehabilitation
3	Topsoil/subsoil inventory does not properly account for the location the soil was removed, where it was taken to and doesn't properly estimate the volume removed/stockpiled	Unable to properly quantify the volumes of topsoil removed to stockpiles Unable to track where the topsoil was removed from Uncertainty of the total topsoil volume present for future rehabilitation
4	Erosion of topsoil stockpiles	Loss of topsoil

ID No	Activity	Potential Environmental Impact
5	Cleared vegetation not stored properly	Vegetation subject to burning from bushfires
6	Weed management of topsoil stockpiles	Poor outcomes in rehabilitation using weed infested topsoil stockpiles

11.2 Mitigation Objectives

The topsoil management objectives have been established and are detailed in Table 11—2.

Table 11—2 Mitigation Objectives

Objective	Target	KPI
Ensure topsoil is harvested and stored properly for future rehabilitation	Zero deviations from this Topsoil Management Procedure	Number of incidents which occur in relation to the topsoil management at Nolans

11.3 Mitigation Measures

Mitigation measures have been developed to minimise potential impacts associated with any topsoil management related incidents. The mitigation measures, timing and responsibilities are provided in Table 11—3.

Table 11—3 Mitigation Measures

Mitigation Measure	Timing	Responsibility
Induction of Topsoil Management Plan (Risk Activity 1 – 6)		
Inductions will include the following specific topsoil management components from this plan: How to record and audit topsoil recovery and storage Depts of topsoil/subsoil to remove from various domains Surveying of areas to remove topsoil from and locations of stockpiles Allowable depths of soil stockpiles	Site Induction	All personnel working with topsoil management
Height of Topsoil Stockpiles (Risk Activity 2)		
Ensure topsoil stockpile heights do not exceed 2 metres.	At all times	All personnel working with topsoil management Environmental Officer
Mapping of Topsoil (Risk Activity 3)		

Mitigation Measure	Timing	Responsibility
Ensure topsoil/subsoil clearance is marked out and removed in accordance with the Biodiversity Management Plan (ARMS-000-H-PLN-N-0002) Use the appropriate recording forms	As required	All personnel working with topsoil management Environmental Officer
Erosion (Risk Activity 4)		
Ensure topsoil stockpile heights do not exceed 2 metres.	As required	All personnel working with topsoil management Environmental Officer
Vegetation Storage (Risk Activity 5)		
Ensure crushed vegetation is stored next to or between topsoil/subsoil piles, or that a fire break is placed around any vegetation stockpiles	At all times	All personnel working with topsoil management Environmental Officer
Weed Management (Risk Activity 6)		
Manage the topsoil and subsoil stockpiles in accordance with the Biodiversity Management Plan (ARMS-000-H-PLN-N-0002) and Weed Management Plan (ARMS-000-H-PLN-N-0009)	Monthly	Environmental Officer

11.4 Trigger, Action and Response Plan

The Trigger, Action and Response Plan (TARP) outlines remedial actions and responses to a situation that is encountered that violates one of the above mitigation measures. The levels of incidents and TARP are provided in Table 11—4.

Table 11—4 Trigger, Action and Response Plan

Trigger	Action	Response
Topsoil incorrectly documented as to where it came from, and which stockpiles it ended up in	1. Complete a full audit of all stockpiles to verify the locations and volumes of all stockpiles on site 2. Complete re-induction on the Plan with the appropriate contractors	ESG Manager to reinforce topsoil stockpile management procedures and regularly update the topsoil stockpile audit throughout construction activities
Topsoils constructed to incorrect heights	Resurvey stockpile heights and have contractors move topsoil to	Environmental department to re-educate employees on the

Trigger	Action	Response
	account for the proper height requirements	contents and requirements of this Plan
Burning of stored vegetation due to local bushfire	Ensure crushed and stripped vegetation is stored in accordance to this Plan	Environmental department to review all vegetation stockpiles for the presence of appropriate fire breaks
Weed infestations present on soil stockpiles	Conduct weed survey and undertake regular weed control	Ongoing weed monitoring of the stockpiles in accordance with the Weed Management Plan (ARMS-000-H-PLN-N-0009)
Noted erosion of stockpiles	If the stockpiles are eroding from stormwater, assess the potential to move the stockpiles of construct water diversion channels around the stockpiles If stockpiles are eroding from wind, consider vegetating with native vegetation	Environmental department to assess the best methods of minimising erosion to the stockpiles

12.0 PERFORMANCE REVIEW

An annual review of performance of this management plan is to coincide with the review process of the Project's Mining Management Plan (MMP).

The review process is to assess performance against objectives of this plan and the stated actions within the MMP, with any relevant outcomes, supporting information, reports and/or data, discussed within the relevant section of the MMP, and supporting information/reports provided within the appendices.