# Appendix M – Weed Management Plan

# Arafura Resources Limited

## Nolans Project

## Weed Management Plan

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# Document Status

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# 1. Introduction

## 1.1 Background

Arafura Resources Limited proposes to develop the Nolans Rare Earths Project (the Project), located approximately 135 km north west of Alice Springs, Northern Territory. The Project would target the Nolans Bore mineral deposit for rare earth elements. Project activities include construction, mining, processing, rehabilitation and decommissioning of an open-cut, rare earth mine, and associated infrastructure.

For the purposes of this plan a weed is defined as:

- a declared weed (i.e. weeds are declared under the NT Weeds Management Act) or
- a Weed of National significance or WONS (these species are agreed by Australian governments based on an assessment process that prioritises these weeds based on their invasiveness, potential for spread and environmental, social and economic impacts) or
- an environmental weed (weeds that are not declared under the Act, but represent a key threatening process for conservation values).

See section 3.2 below for more information about the different categories of weeds.

## 1.2 Purpose

The Nolans Project involves several key activities during construction and operations which will disturb soils and vegetation, and have potential to introduce or transfer weeds into or across the Project area. This Weed Management Plan (WeedMP) will be implemented during Project construction and operations to reduce the risk of spreading existing weeds and introducing new weed species.

The purpose of the WeedMP is to:

- Address the weed management planning requirement described in the Environmental Impact Statement (EIS) guidelines for the Project;
- List all weeds present at the Project site;
- Provide an appraisal of weed status including current legislative status in the NT;
- Identify key threats / hot spot areas within the management area, including declared and/or environmental weed species;
- Identify measures to control and/or eradicate declared weeds and Weeds of National Significance (WONS) before, during and after construction;
- Identify measures to minimize or avoid the spread of environmental weeds:
- Identify key responsibilities for construction and operational personnel; and
- Detail a schedule for monitoring and evaluation, including review and update of the document and procedures.

## 1.3 Objective

The objective of the WeedMP is to guide the management of weeds throughout the Project by:

- Educating site personnel and providing management measures for known weeds;
- Preventing the spread of declared weeds, Weeds of National Significance (WoNS) and/or environmental weeds;

- Preventing the introduction of new weed species across the Project;
- Controlling or eradicating existing weed populations (where appropriate); and
- Enhancing rehabilitation and landscaping success through weed management.

## 1.4 Other documents

The following documents have been prepared and should be read in conjunction with this WeedMP:

- Fire Management Plan – GHD (2015a);
- Environment Management Plan – GHD (2015b); and
- Biodiversity Management Plan – GHD (2015d).

## 1.5 Relevant environmental legislation and guidelines

Arafura and their contactors are obliged to comply with all relevant environmental legislation. There is a range of legislation that relates to weed management in the Northern Territory although weeds are primarily covered by the *Weeds Management Act 2001* (WM Act).

Legislation and guidelines associated with the management of weeds is listed below:

- Environment Protection and Biodiversity Conservation Act 1999;
- Territory Parks and Wildlife Conservation Act 2006;
- Weed Management Act 2001;
- Australian Weeds Committee – Weeds of National Significance 2012;
- Australian Weeds Committee – The Australian Weeds Strategy;
- Northern Territory Government – Northern Territory Weed Management Handbook 2012;
- Department of Natural Resources, Environment, The Arts and Sport – Guidelines for Weed Data Collection in the Northern Territory; and
- Department of Land Resource Management – Buffel Grass Management Guide for Central Australia.

# 2. Existing Conditions

## 2.1 Site Surveys

A number of flora and vegetation assessments have been completed for the Project as part of the EIS process. A summary of these assessments are provided in Table 2-1.

Table 2-1 Flora and Vegetation Surveys completed for Project

| Report Title | Author | Survey period | Summary |
|---|---|---|---|
| Landscape Flora and Fauna Surveys of the Proposed Rare Earths Mine at Nolans Bore near Aileron, NT | Low Ecological Services | 4 - 7 May 2006<br>21 - 24 November 2006 | These surveys recorded a total of 185 flora species within four broad land units (riparian, rocky granite hills, shallow sand plains and rocky undulating plains). None of the flora species recorded is listed as having conservation significance under the EPBC or TPWC Acts.<br>Two exotic flora species were recorded during this survey. |
| Nolans Rare Earth Project – Flora and Vegetation Survey | GHD | 16 - 25 August 2010<br>6 - 7 December 2011<br>27 April - 3 May 2015 | Flora survey techniques used were consistent with the Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping (Brocklehurst et al. 2007) and included:<br>• 78 quadrats;<br>• 99 check sites;<br>• Opportunistic collections; and<br>• Vegetation mapping.<br>A combined total of 326 flora species were recorded within the Study area during the 2010, 2011 and 2015 survey periods.<br>Based on the fine-scale vegetation mapping and flora sampling performed by GHD a total of 14 vegetation communities were identified within the Study area.<br>A total of fourteen exotic species were recorded during the field survey. With the exception of Buffel Grass (Cenchrus ciliaris) these species generally occurred in low abundance across the Study area. |

## 2.2 Bioregion

The Project is located with the Burt Plain Bioregion which is characterised by plains and low rocky ranges with extensive areas of mulga and other acacia woodlands. The bioregion covers an area of 73,605 square kilometres which represents approximately 5% of the Northern Territory (NRETAS 2005).

Potential and existing threats to biodiversity in the bioregion include the introduction and proliferation of exotic flora, introduced animals, fire , erosion, land clearing, pastoralism and mining (Neave *et al.* 2006). There are fifteen declared weed species currently listed under the WM Act known to occur in the bioregion. Other exotic plants species, most notably Buffel and Couch grass, also pose significant threats to some habitats (Neave et al. 2006).

## 2.3 Values

Ecological values known to occur within the Project area are described in detail within the Flora and Vegetation Assessment Report (GHD 2015c). In summary, the key ecological values include:

- Extensive areas of native vegetation, including 14 native vegetation communities;
- Diversity of native flora species; and

- Habitat for mammals, birds, reptiles and invertebrates, including known and potential habitat for threatened fauna species.

### 2.3.1 Native Vegetation

The native vegetation communities recorded within Project area include:

- Riparian woodland along water courses and drainage channels;
- Mulga shrubland on sandy red earths over spinifex;
- Mulga shrubland on sandy red earths over tussock grasses;
- Mulga shrubland on sandy red earths over chenopods;
- Mixed woodland over tussock grasses on alluvial plains;
- Mixed Woodland over spinifex on alluvial plains;
- Mixed Woodland over a highly disturbed understorey dominated by Buffel Grass (*Cenchrus ciliaris);*
- *Triodia schinzii* hummock grassland on red clayey sands;
- Hakea/Senna shrubland on calcareous alluvial plains and low rises;
- Eucalyptus (mallee)/*Acacia kempeana* shrubland with Triodia on rocky slopes;
- Acacia/Triodia shrubland on rocky outcrops;
- Acacia/Senna shrubland on rocky gneiss or schist outcrops with no spinifex;
- *Acacia kempeana* and/or Mulga shrubland on gravel;
- Claypans with chenopods and herbs;
- Cottonbush chenopod shrubland on highly erodible duplex soils;
- *Triodia basedowii* hummock grassland on sand plains;
- Senna shrubland on quartz; and
- Coolabah swamp associated with claypans.

The condition of native vegetation varies from large tracts of intact and high quality vegetation which contain very few isolated environmental weeds, through to large areas that have dense infestations of invasive species, in particular Buffel Grass (*Cenchrus ciliaris*).

### 2.3.2 Native Flora

A combined total of 326 flora species, comprising 319 native species and 14 exotic species were recorded within the Study area during the 2010, 2011 and 2015 survey periods. This represents approximately 28 percent of all flora species know to occur in the Burt Plain Bioregion.

The Poaceae (grass family, 73 species, 67 native; 6 exotic), Fabaceae (pea family, 40 species, 39 native, one exotic), Chenopodiaceae (32 native species) and Malvaceae (25 native species) were the most species-rich families recorded.

Flora species recorded within the Study area and their associated vegetation communities are relatively common in the region with the exception of a few species. No threatened plants were recorded within the Study area. Three species recorded within the Study area are listed as near threatened (NT) and three species are listed as data deficient (DD) under the TPWC Act. An additional 11 species are noted to have bioregional significance.

The dominant vegetation types within the Study area are Mulga shrublands, which occur on alluvial fans and plains containing clayey red earths; and Triodia hummock grasslands which grow on sandy

plains. Vegetation across the Study area is generally in good condition with little anthropologic disturbance and high species richness. In more fertile riparian areas and associated floodplains there is clear evidence of impacts associated with cattle grazing including weed invasion, reduction in ground cover species richness and soil erosion. In particular there is a high abundance of the invasive Buffel Grass (*Cenchrus ciliaris*). There are also several areas that have been cleared within the mine site and borefields area during geotechnical and hydrological investigations at the site.

One of the exotic species recorded within the Project area Caltrop (*Tribulus terrestris*) is listed as a Class B (spread must be controlled) and Class C (not to be introduced to the NT) noxious weed under the WM Act. Caltrop (*Tribulus terrestris*) is a spreading annual or bi-annual herb. Its fruit is a woody burr with sharp ridged spines. The species is known to cause photosensitisation and nitrate poisoning in livestock and its fruit can cause injury to the feet of cattle and horses (Smith 2002). This species was found in low abundance throughout all vegetation types within the study area. It is likely that this species is spread by both cattle and vehicle movement.

Overall there is a low to moderate level of infestation of weeds within the Study area with the most prevalent species being Buffel Grass (*Cenchrus ciliaris*).

This species was recorded predominantly within floodplain and riparian vegetation types and in areas that have been disturbed by cattle and/or by exploration activities.

# 3. Weeds Overview

Weeds are able to successfully establish and spread due to the absence of natural plant pests and/or plant diseases, an induced disturbance to the natural environment (such as clearing) and movement of machinery, vehicles and equipment creates ideal conditions for weed germination, growth and/or spread.

## 3.1 Potential Environmental Impacts

The potential environmental impacts arising from the introduction and spread of weeds within the Project area include:

- Modification of vegetation communities: weeds can prevent seed recruitment and out-compete native species for available resources. Changes to the floristics of communities can subsequently modify habitats for threatened fauna species and/or render the habitat less valuable to indigenous fauna.
- Alteration of fire regime: weeds can create additional fuel loads which can lead to hotter and/or more frequent fire which can in turn impact vegetation communities and threatened species habitat.
- Change in hydrology: weeds can be prolific in watercourses which can alter stream flow and cause erosion.
- Revegetation and landscaping success: if weeds become established and prolific in areas subject to revegetation they can out-compete other planted species and prevent the regrowth of native plants.

## 3.2 Categories

Weeds can be categorised according to the areas they colonise and the types of threat they pose. Several categories of weeds (noxious weeds, environmental weeds and WONS) are recognised at a National, Territory and Local level. The weed category levels and a description of significance are provided in Table 3-1.

Table 3-1 Weed Categories

| Category | Description |
|---|---|
| **Northern Territory** | |
| **Class A** | **To be eradicated**<br>These plants either do not occur in Northern Territory but pose a significant threat if they invade, or are present and pose a serious threat. Under the WM Act reasonable effort must be made to eradicate these weeds. |
| **Class B** | **Growth and spread to be controlled**<br>These weeds often occur widely in the Northern Territory. They are capable of spreading further and should be prevented from doing so. To prevent their spread, continuing control measures are required. Under NT legislation reasonable attempts must be made to contain the growth and prevent the movement of these plants. |
| **Class C** | **Introduction into the Territory is to be prevented**<br>This category includes plants that pose an unacceptable risk of spreading into the Territory or to other parts of Australia if they were to be sold or traded in the Northern Territory and are a serious threat to another State or Territory of Australia. All schedule Class A and B weeds are considered to be Class C weeds. |
| **National Significance** | |
| **Weeds of National Significance** | **To be eradicated**<br>Weeds of national significance are recognised as having potential to significantly impact on natural values including: threats to human health and safety; threats to pastoral and agricultural industries; threats to water quality and supply; threats to indigenous flora; and threats to biodiversity and cultural values. |

| Non-indigenous | |
|---|---|
| **Environmental Weed** | Environmental weeds are defined as non-indigenous plant species that have invaded (or have the potential to invade) natural ecosystems and threaten (or have the potential to threaten) environmental and/or conservation assets. They can also be Australian native species that are not local (indigenous) to an area but have potential to damage the local plant community. |

## 3.3 Weed Status

### 3.3.1 On site

A Flora and Vegetation Assessment was completed at the Nolans Project over three survey periods (2010, 2011 and 2015) (GHD 2015c), summarised in Table 2-1. A total of 14 exotic species were recorded during the field surveys, one of these species Caltrop (*Tribulus terrestris*) is listed as a Class B/C Noxious weed under the NT WM Act and seven species are identified as environmental weeds. A summary of the weeds are provided in Table 3-2.

Overall there is a low to moderate level of infestation of weeds within the Project site. The most common introduced species is Buffel Grass (*Cenchrus ciliaris)*. This species was recorded predominantly within floodplain and riparian vegetation types and in areas that have been disturbed by cattle and/or by mining exploration.

Buffel Grass (*Cenchrus ciliaris)* is an environmental weed that has spread rapidly in arid and semi-arid regions of Australia (Miller *et al* 2010). Buffel Grass (*Cenchrus ciliaris)* invasion represents a key threatening process for biodiversity in the region due to its rapid spread and potential to increase fire severity.

During the field survey the percentage of Buffel Grass (*Cenchrus ciliaris)* cover was assessed for each vegetation polygon and a score of 1-4 assigned as follows:

- Score of 1 – very low densities (< 5 percent cover);
- Score of 2 – low – moderate density (6-40 percent cover);
- Score of 3 – moderate to high densities (41-70 percent cover); and
- Score of 4 – high densities (71-100 percent cover).

### 3.3.2 Regional

In addition to those weeds identified during the 2010, 2011 and 2015 survey, the Department of Natural Resources, Environment and the Arts (now Department of Land Resource Management) assessed the Burt Plain Bioregion (Neave et al. 2006). The assessment identified a total of 14 weeds within this Bioregion. Two of these species are listed Weeds of National Significance including Mesquite *(Prosopis pallida)* and Parkinsonia *(Parkinsonia aculeate)*.

A summary of weeds identified onsite and within the bioregion is provided in Table 3-2.

Table 3-2 Weeds Summary at the Project and within the Bioregion

| Name | | Classification | | | | | Presence | |
|---|---|---|---|---|---|---|---|---|
| **Common** | **Scientific** | **WONS** | **Class A** | **Class B** | **Class C** | **Env** | **Bioregion[A]** | **Project[B]** |
| Caltrop | *Tribulus terrestris* s.lat. | | | ✓ | ✓ | | | ✓ |
| Khaki Weed | *Alternanthera pungens* | | | ✓ | ✓ | | ✓ | |
| Cobblers Pegs | *Bidens bipinnata* | | | | | ✓ | | ✓ |
| Rubber Bush | *Calotropis procera* | | | ✓ | ✓ | | ✓ | |
| Saffron Thistle | *Carthamus lanatus* | | | ✓ | ✓ | | ✓ | |

| Name | | Classification | | | | | Presence | |
|---|---|---|---|---|---|---|---|---|
| Common | Scientific | WONS | Class A | Class B | Class C | Env | Bioregion[A] | Project[B] |
| Buffel Grass | *Cenchrus ciliaris* | | | | | ✓ | | ✓ |
| Mossman River Grass | *Cenchrus echinatus* | | | ✓ | ✓ | | ✓ | |
| Purple-top Chloris | *Chloris barbata* | | | | | | | ✓ |
| | *Chloris virgata* | | | | | | | ✓ |
| Paddy Melon | *Citrullus lanatus* | | | | | ✓ | | ✓ |
| Couch Grass | *Cynodon dactylon* var. *dactylon* | | | | | ✓ | | ✓ |
| Thornapples – Native Thornapple | *Datura* spp – *Datura leichhardtii* | | | ✓ | ✓ | | ✓ | |
| Summer Grass | *Digitaria ciliaris* | | | | | | | ✓ |
| Patterson's Curse | *Echium plantagineum* | | ✓ | | ✓ | | ✓ | |
| Pitted Lovegrass | *Eragrostis barrelieri* | | | | | | | ✓ |
| Hairyflower Lovegrass | *Eragrostis trichophora* | | | | | ✓ | | ✓ |
| Lovegrass | *Eragrostis minor* | | | | | | | ✓ |
| Malvastrum | *Malvastrum americanum* | | | | | ✓ | | ✓ |
| Prickly Pears – Devil's Rope Pear | *Opuntia* spp. – *Opuntia imbricata* | | | ✓ | ✓ | | ✓ | |
| Parkinsonia | *Parkinsonia aculeata* | ✓ | | ✓ | ✓ | | ✓ | |
| Mesquite | *Prosopis pallida* | ✓ | ✓ | | ✓ | | ✓ | |
| Castor Oil Plant | *Ricinus communis* | | | ✓ | ✓ | | ✓ | |
| Athel Pine | *Tamarix aphylla* | | | ✓ | ✓ | | ✓ | |
| Mimosa Bush | *Vachellia farnesiana var. farnesiana* | | | | | ✓ | | ✓ |
| Coffee Senna | *Senna occidentalis* | | | ✓ | ✓ | | ✓ | |
| Milk Thistle | *Sonchus oleraceus* | | | | | | | ✓ |
| Bathurst Burr | *Xanthium spinosum* | | | ✓ | ✓ | | ✓ | |
| Noogoora Burr | *Xanthium strumarium* | | | ✓ | ✓ | | ✓ | |
| | **Total** | **2** | **2** | **13** | **15** | **7** | **14** | **14** |

**Notes:** [A] Sourced form Neave et al 2006.
[B] Sourced from GHD survey data.
WONS: Weed of National Significance

## 3.4 Weeds for Control

The following weeds have been identified as requiring management (i.e. surveillance monitoring and/or active control methods such as physical, land management, chemical and biological) within the Project area based on distribution and potential environmental impacts.

### 3.4.1 Caltrop (*Tribulus terrestris*)

Caltrop (*Tribulus terrestris*) is native to southern Europe, eastern Africa, southern Asia and the USA. In northern Australia it has become naturalised and is commonly found in disturbed areas, roadsides and agricultural land.

Caltrop (*Tribulus terrestris*) has seeds which can remain dormant in the soil profile for several years. The seeds generally germinate following periods of rainfall. Plants are known to grow rapidly, flowering and forming new burrs within three to five weeks.

Caltrop (*Tribulus terrestris*) is considered a noxious weed due to its potential to poison animals. It can also cause discomfort to livestock and humans with its sharp spiny fruit impacting the feet/hooves of animals and/or humans. It is unlikely that this species would rapidly proliferate throughout the Project site if left uncontrolled.

#### *Distribution*

This species occurs in low abundance scattered throughout the Project area.

#### *Potential Environmental Impacts*

Caltrop (*Tribulus terrestris*) is considered a noxious weed due to its potential to poison animals. It can also cause discomfort to livestock and humans with its sharp spiny fruit impacting the feet/hooves of animals and/or humans. It is unlikely that this species would rapidly proliferate throughout the Project site if left uncontrolled.

### 3.4.2 Mimosa Bush (*Vachellia farnesiana* var. *farnesiana*)

Mimosa Bush (*Vachellia farnesiana var. farnesiana*) is a shrub or small tree to 3-5 metres tall.

#### *Distribution*

Mimosa Bush (*Vachellia farnesiana var. farnesiana*) occurs in low abundance along creeks and drainage lines in the Project area.

#### *Potential Environmental Impacts*

Mimosa Bush (*Vachellia farnesiana var. farnesiana*) has the potential to spread and form thickets in waterways out-competing native vegetation.

### 3.4.3 Hairyflower Lovegrass (Eragrostis trichophora)

Hairyflower Lovegrass *(Eragrostis trichophora)* is a tussock grass growing up to 0.7 metres which has the potential to rapidly proliferate and invade native vegetation.

#### *Distribution*

This species was recorded at three locations within the Project area including two areas at the mine site and one along the access road.

#### *Potential Environmental Impacts*

Hairyflower Lovegrass *(Eragrostis trichophora)* has the potential to invade areas of native vegetation, outcompeting native species and altering community floristics.

# 4. Weed Management Measures

## 4.1 Weed Management

In instances where there is a low likelihood that weeds can be eradicated from the site, weed management actions will focus on protecting areas of native vegetation by preventing the spread of weeds into these areas. This would be most successfully achieved through containment, and land protection measures.

Other longer-term objectives for dealing with well-established weed species will be to undertake measures to reduce the extent of the infestation of weed species (i.e aiming for a slow reduction in the extent of these infestations overtime through a staged assault on these areas). Tackling large areas starting from the outside and working inwards would be the best approach for achieving this objective.

In areas where weed infestations are at their early stages and there are currently only a few isolated weeds, there is a high likelihood that this plan could result in the eradication of the weeds from these areas. In addition, if appropriate mitigation and monitoring measures are implemented, these areas could be successfully protected from future reinfestation.

## 4.2 Surveillance Monitoring

Surveillance monitoring is an essential component of any weed management program as it provides a means of identifying how well control measures are working, the rate of spread of weeds and/or the detection of new weeds established in disturbed areas. Weed management plans can be adapted as needed to improve results and accommodate changing circumstances or changes in the local environment.

Ongoing surveillance monitoring and management of weeds, particularly in disturbed areas is a high priority. Follow up control is vital as many weed species have a large number of long-lived seeds that have the potential to remain viable in the soil for many years. It is recommended that ongoing surveillance monitoring of sites be undertaken throughout the year, especially after rain periods. Surveillance monitoring programs will involve mapping Project area for presence of weeds, taking photos at marked photo points and revisiting information to evaluate if the weed management plan requires updating.

Weeds identified will be logged within a weed register including the following:

- Changes in the extent of weed populations;
- Changes in the cover density of weed populations;
- Any new weed species that may become established;
- Documentation of any unexpected impacts of weed control activities (i.e. damage to native vegetation);
- Changes in the extent and condition of native vegetation; and
- Changes in any conditions that have the potential to impact on site restoration works.

## 4.3 General Weed Control Techniques

Different weed control techniques have specific advantages and disadvantages, with the optimum method of control dependent on the type of weed, level of infestation and where it is located (e.g. disturbed areas verses native vegetation).

Treatment methods available include Physical, Land Management, Chemical or Biological and are detailed within Table 4-1.

## Table 4-1 Weed Control Techniques

| Type | Description |
|---|---|
| **Physical** | |
| Hand Pulling | Labour intensive method that should be carried out systematically before seed set to ensure effectiveness of the treatment. It is important to ensure that all root material is removed and plants or plant parts are not left on the ground to re-shoot or release seed. It is most effective for isolated small outbreaks and is particularly suitable for easy to remove shallow-rooted grasses and herbaceous plants (Smith 2002). |
| Grubbing | This treatment uses implements such as shovels, spades and mattocks to manually remove weeds. This means of control is best suited to the removal of deep-rooted woody species (Smith 2002). |
| Slashing | This mechanism of control involves the use of machinery to slash weeds before they are able to set seed. The advantage of this form of control is that it maintains some ground cover to prevent erosion and re-colonisation of weeds, it is relatively inexpensive and can be used for relatively large infestations. It is not usually effective for controlling perennial weeds but may eradicate some annuals if carried out before seed is mature. A disadvantage is that some plants may regrow close to the ground and set seed out of reach of machinery (Smith 2002). |
| Cultivation | Cultivation of weeds aims to expose the roots and bury the plant to a depth where it cannot re-grow. This is a very effective method of controlling annual or herbaceous plants and seedlings. Deep cultivation or ripping technique can be utilised for perennial species (Smith 2002). This method of control is relatively cheap and can be used for controlling large weed infestations (Muyt 1991). |
| Mowing | This provides a similar effect to slashing but is usually used on smaller infestations. It is recommended that mowing or slashing occurs from the outside patch of weeds and moving inwards as this has been shown to be more effective in containing an outbreak (Smith 2002). |
| Mulching | Mulching around plants can be effective for small areas. This control technique prevents weeds from germinating by removing the light and increasing the temperature of the soil's surface. Materials that can be utilised include cardboard, sawdust, rocks, black plastic, straw, woodchip, etc. Mulching also has the additional benefit of helping reduce erosion and conserving soil moisture (Smith 2002). |
| **Land Management** | |
| Revegetation | Revegetation may help to control weed infestations by encouraging the growth of native species, which are then able to out-compete and reduce the numbers of exotics. In cleared or disturbed areas revegetation can be utilised to prevent weeds from colonising. As a component of long-term weed management, revegetation can follow other control methods to prevent weeds from re-establishing. It is recommended that indigenous species are planted (i.e plant of local provenance) as these species are more likely to be better adapted to the local soil and climatic conditions (Smith 2002). |
| Quarantine | Isolating infestations can be an effective way of preventing dispersal or disturbance factors and therefore prevent a weed from spreading further. This technique is most effective for eradicating small outbreaks or may be used to help reduce the proliferation or spread of larger infestations (Smith 2002). |
| Fire | In some instances burning areas can work to eliminate weeds from an area. This means of weed control is particularly effective for woody weeds and fire-sensitive species. However, one disadvantage in using fire to control weeds is that it can have the reverse effect and encourage some weed species. As fire may trigger the germination of some weed seeds it is recommended that some form of follow-up control such as cultivation or spraying is undertaken (Smith 2002). |
| **Chemical** | |
| Foliar Spray | Using a chemical based foliar spray may be a suitable method for the control of herbaceous weeds or young re-growth (Smith 2002). Disadvantages with this kind of control is the potential for damage to surrounding native flora species or other non–target plants. The use of chemical sprays is best suited to large infestations of herbaceous weeds that are some distance from areas of native vegetation. |
| Soil Application | This method of weed control involves application of a granular, pellet or liquid herbicide directly onto the soil around a weed or infestation. The herbicide is absorbed through the plant roots (Smith 2002). The disadvantage of this technique is that rain is required for the treatment to be effective and this may not occur within the desired time for best treatment. |
| **Biological** | |

| Type | Description |
|---|---|
| Biological | Biological control is an attempt to restore balance to systems that go out of kilter when exotic species invade or take over. It is rarely an attempt at eradication. The most common strategy is to import host-specific natural enemies of the invader from its native home, and to encourage them to establish and multiply in their new home. Once established, the populations are self-sustaining and a long-term balance is reached with the target pest.<br>A number of biological control projects have involved Northern Territory weeds: Noogoora Burr, Salvinia, Parkinsonia, Spinyhead Sida, Mimosa and Bellyache Bush have all been targeted.<br>Biological control is often the only relatively inexpensive, specific, permanent and environmentally safe option for the management of introduced weeds. There have been over 1000 releases of insects or diseases worldwide. Stringent testing in quarantine has generally prevented significant damage to non-target plants. Although only about one-third of the projects result in successful control, economic benefits far outweigh all the costs, and benefits continue to accrue each year.<br>None of the weeds present within the Project has a reliable biological control that can be used for management. This method of treatment is not considered a viable option for weed management at the site. |

## 4.4 Chemical Weed Control

Weed control will be undertaken prior to disturbances in accordance with the Ground Disturbance Permit System, located within the Biodiversity Management Plan. This will limit the potential for machinery or vehicles to spread weeds across the Project.

A summary of five exotic weed species' chemical treatment methodologies are provided in Table 4-2. In general, chemical control will be utilised and supplemented by alterative treatment methods as required.

### 4.4.1 Herbicide Application

The application of herbicides can be grouped into two discrete methods; application by foliar spraying; or direct application with a wiper or paintbrush (usually the cut stump method). The method of application should be chosen with consideration to the weed being managed and surrounding vegetation, as spraying of herbicides presents a risk to non-target species through spray drift which can potentially result in the mortality of native plant species.

Where possible plants should be treated when actively growing, according to the prescriptions and notes in Table 4-2. This is generally from early spring to late summer. However, herbicides are less effective if the plants are under environmental stress (e.g. drought), and this should be considered before application. In situations where environmental stress seems likely, herbicides should be applied at an alternative time of the year, when the effect of the stress is minimised; this will generally require a follow-up treatment.

#### *Riparian Zones*

Weed control in or near riparian areas, must also consider the presence of frogs and/or other aquatic species, with manual removal preferable. Otherwise low-toxicity non-residual herbicides registered as suitable in watercourses may be appropriate for use in a targeted manner such as spot spraying.

#### *Native Vegetation*

Care also needs to be taken in order to avoid impacting any native species during weed control works; make sure that such works are undertaken by an appropriately qualified person with the ability to accurately distinguish the relevant weed species from indigenous flora.

Table 4-2 Treatment Options for Weeds within the Project Area

| Priority Weed | Treatment Options | Active Ingredient / Example Commercial Product (content of active ingredient) | Application Rate of Commercial Product / L of Water | Optimal Treatment Season | Notes |
|---|---|---|---|---|---|
| *Caltrop (Tribulus terrestris)* | Foliar Spray | Glyphosate / (360 g/L) | 10 mL/ 1 L | Apply when actively growing (following rain) | Glyphosate is a non-selective herbicide, and care should be taken not to allow spray to drift onto non-target species. With regards to the cut stump method, the mixture must be applied immediately after the cut is made.<br><br>When applying metsulfuron –methyl a wetting agent is required. |
| | | 2,4-D amine 635 g/L | 10 mL/1L | Apply when actively growing (following rain) | |
| | | Metsulfuron-methyl 600g/kg | 10 g/ 100 L | Apply when actively growing (following rain) | |
| Mimosa Bush *(Vachellia farnesiana)* | Basal bark spray | Triclopyr / Garlon 600 ® (600 g/L) | 1 L per 50 L of diesel distillate or kerosene | Actively growing prior to seed set (following rain) | Ensure all stems on multi-stemmed plants are treated. |
| | | Cut Stump Method | Triclopyr / Garlon 600 ® (600 g/L) | 1 L per 50 L of diesel distillate or kerosene | All season |
| Hairyflower Lovegrass *Eragrostis trichophora* | Foliar Spray | Fluazifop-p-butyle | 250ml/100L | Actively growing prior to seed set (following rain) | Safe to use in riparian areas.<br>Should be applied when leaves are at least 5 cm long. |
| | | Glyphosate / RoundUp Biactive ® (360 g/L) | 75-100 ml/15L | Actively growing prior to seed set (following rain) | Non-selective and will damage or kill trees and grasses that come into contact with spray drift. |
| | | | | | |
| | | | | | |

### 4.4.2 Documentation of Control Actions

It is important that accurate records are kept, these will be recorded within the Weed Monitoring / Control Form situated in Appendix A. The form collects the following data:

- Assessor name;
- Time and date of control;
- Species targeted;
- Methods of control used;
- Herbicide dosages applied;
- Area applied; and
- Purpose of control.

## 4.5 General Mitigation Measures

### 4.5.1 Personnel, Vehicle and Equipment Hygiene

One of the major concerns associated with construction activities is the further spread of existing weeds or the introduction of new weed species into the area. Weed species can potentially spread between sites by a number of different vectors including, but not limited to, contaminated machinery, vehicles, equipment, clothing and footwear. The implementation of weed hygiene procedures are critical to minimising the spread and/or introduction of weeds.

Appropriate weed hygiene measures will be implemented to minimise further spread and introduction of weed species. Weed hygiene measures must be followed by all site personnel, vehicles and equipment entering the Project area. Specific measures to be implemented may include the following:

- Establishing vehicle access points across the Project;
- Washdown bays established at vehicle access points where vehicles and equipment are to be cleaned of mud, dirt and organic matter from underneath vehicle, in the cabin and/or load trays, followed by removal of excess material by high pressure air or water spray jets;
- Establishing contract conditions directing contractors and/or suppliers to ensure earthmoving equipment, vehicles and other stationary equipment coming onto site is cleaned and clear of any free dirt prior to arriving onsite; and
- The movement of vehicles, equipment and personnel between disturbed areas will be minimised as much as possible, to reduce the risk of spreading/introducing weeds.

### 4.5.2 Ground Disturbance Permit

All ground disturbance will be undertaken through a permitting system with sign-off required prior to ground disturbance occurring. If the area contains weeds they will be removed prior to vegetation clearance so that vegetative material would be clean and able to be mulched and reused directly on site.

The Ground Disturbance Permit (GDP) will have photo graphic evidence of before and after impacts. The area of disturbance will be kept to a minimum and no protected areas or buffer zones will be disturbed. The GDP will include:

- Disturbance Requirements (contractor, dates, works and dimensions);
- Area Assessment (restricted work areas, EIS approved area, within lease boundary, services, weeds controlled); and

- Clearing Details (surveyed and demarked by flagging, supervisor of clearing, post clearing survey data).

The GDP will be issued by the respective officers from HSEC Team.

# 5. Weed Management

Weed management refers to weeds which are known to be present or have potential to be present across the Project. Management of weeds is structured below as follows:

- **Key Activities, Risks and Impacts:** 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.

## 5.1 Key Activities, Risks and Impacts

The key activities associated with the project and potential environmental impacts associated with weed management at the site are listed in Table 5-1. The risk matrix is provided in Appendix C.

Table 5-1 Key Activities, Risks and Impacts

| Activity | Potential Environmental Impact | Residual Risk Level | | |
|---|---|---|---|---|
| | | Consequence | Likelihood | Risk |
| Construction of linear infrastructure (e.g. access tracks, water supply pipelines, powerlines etc) results in reduction in native vegetation and disturbance of habitat. | Loss of native vegetation allowing for weed establishment, along exposed edges and in cleared areas. | Minor | Unlikely | Low |
| | Habitat fragmentation, particularly for small ground-dwelling fauna, and the introduction and/or spread of exotic plants (weeds) adversely affecting habitat values and capacity of individuals and/ or population to persist. | | | |
| Diversion of Kerosene Camp Creek and alteration of waterway form. | Diversion of the old channel resulting in loss of riparian vegetation in the diversion area, and impact on riparian vegetation downstream in the floodplain associated with the old channel of Kerosene Camp Creek (approx. 3 km length). | | | |
| Transport of materials, machinery and vehicle movements and inappropriate waste management allows for introduction of new weeds and spread of existing weeds into new areas during construction and operation phases. | Increased presence of weed species resulting in decline or modification of existing vegetation communities, including habitat quality. | Minor | Possible | Medium |
| | An increase in the incidence / spread of weed species leading to reduction in food plant availability and habitat of listed threatened species such that the population declines. | Moderate | Unlikely | Medium |
| | Cause a long term reduction of habitat for rare or threatened fauna species. | Minor | Possible | Medium |

## 5.2 Objectives

The weed management objectives have been established and are detailed in Table 5-2.

### Table 5-2 Weed Management Plan Objectives

| Objective | Target | KPI |
|---|---|---|
| No spread of existing Declared weeds within the Project area. | No significant change to the extent and distribution of Declared weeds within one year of completion of construction activities compared to the extent and distribution of weeds prior to construction. | Weed surveillance monitoring to show that existing Declared weeds have not proliferated through Project area or into adjoining vegetation. |
| Prevent the introduction of new Declared weed species across the Project. | Zero occurrences of new weeds. | No new species of weeds recorded in the Project area. |

## 5.1 Mitigation Measures

Mitigation measures have been developed to minimise potential impacts associated with weeds within the Project area. The mitigation measures, timing and responsibilities are provided in Table 5-3.

### Table 5-3 Mitigation Measures

| ID | Mitigation Measure | Timing | Responsibility |
|---|---|---|---|
| **Site Induction** | | | |
| WD01 | Site inductions will include the following components for weed management:<br>• Summary of known weed infestations at the site;<br>• Requirement to enter and exit site through recognised vehicle access points;<br>• Requirement to jet wash vehicles/equipment entering and exiting the Project;<br>• Weed removal required prior to vegetation clearing;<br>• Areas to be cleared are to be flagged and approved through a Ground Disturbance Permit Procedure; and<br>• All onsite personnel are to utilise existing/approved roads and tracks only. | Site Induction | All personnel |
| **General** | | | |
| WD02 | Imported fill will be certified weed-free prior to being utilised at the Project. | Construction and operation | Construction and Site Manager |
| WD03 | All vehicles entering and exiting the Project area are to be jet washed to remove potential seeds. | On site entry. | All personnel |
| WD04 | Quarterly weed surveillance monitoring and control of weeds across the Project. The survey is to determine if weed controls have been effective and if additional measures are required. | Quarterly and after rain events. | Environmental Technician |
| WD05 | If works are being undertaken in an area known to contain WONS or Class A, B or C weeds, plant/equipment and vehicles are to be washed prior to vacating the areas. | At all times. | All personnel |
| **Vegetation Clearing** | | | |
| WD06 | Prior to clearing a Ground Disturbance Permit is required to be issued by the representative from HSEC Team. | At all times | HSEC Team |
| WD07 | Minimise ground disturbance within sensitive areas such as riparian zones. | | |
| WD08 | Weed removal as required prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site. | | |
| WD09 | Areas to be cleared outside of existing disturbance will be flagged to prevent over clearing. | | |
| WD10 | Vegetation and soil stockpiled from clearing activities will be monitored and chemical control undertaken should weeds be identified. | | |
| **Inspection and Monitoring** | | | |

| ID | Mitigation Measure | Timing | Responsibility |
|---|---|---|---|
| WD11 | Daily assessment of compliance with Ground Disturbance Permits. | Daily | HSEC Team |
| WD12 | Quarterly (or following rain events) weed surveillance monitoring and application of chemical control as required. Monitoring and applications will be recorded in the Weed Register (Appendix B). | Quarterly and after rain events. | Environmental Technician |
| WD13 | Annual Weed surveillance monitoring and control to be completed by an appropriately experienced and qualified person. The annual weed surveillance monitoring will establish potential requirements for additional control measures. | Annually | HSEC Manager |
| **Management Plan Review** | | | |
| WD14 | Annual Weed Management Plan performance review (Section 6). | Annually | HSEC Manager |

## 5.2 Trigger, Action and Response Plan

The Trigger, Action and Response Plan (TARP) outlines remedial actions and responses to the situation. The levels of incidents and TARP are provided in Table 5-4.

Table 5-4 Trigger, Action and Response Plan

| Responsibility | Situation | | |
|---|---|---|---|
| | Standard | Level 1 | Level 2 |
| | No introduction of weeds at the Project or spread of weeds from current locations. | **Triger:** Spread of environmental weeds to areas previously weed free. | **Trigger:** Introduction of Class A, B and C weeds and WoNS to areas previous weed free |
| Site Personnel | Comply with:<br>• Site Induction requirements.<br>• Personnel, Vehicle and Equipment Hygiene Procedures.<br>• Ground Disturbance Permit Procedures. | | |
| Environmental Officer | • Ensure all employees and contractors are aware of all required procedures and systems to erosion and sediment management and are provided with all required resources to implement the requirements effectively.<br>• Assessment of compliance with Ground Disturbance Permits.<br>• Weed surveillance monitoring and application of chemical control.<br>• Ensure all employees and contractors are provided with appropriate clearance approvals and on-ground guidance prior to giving any ground disturbance instructions.<br>• Complete weed surveillance monitoring and control by an appropriately experienced and qualified person as required and following Wet Season rains. | • Undertake additional chemical control as required and increase frequency of surveillance monitoring.<br>• Record monitoring and application of chemical control in the Weed Register. | • Undertake additional chemical control as required and increase frequency to monthly surveillance monitoring.<br>• Record monitoring and application of chemical control in the Weed Register.<br>• Commission an appropriately experienced and qualified person to undertake weed surveillance survey and control across the Project. The subcontractor is to establish additional weed mitigation measures as required.<br>• Revise the Environmental Management Plan and Weed Management Plan following HSEC Manager approval of additional mitigation measures. |
| Environmental Officer and Subcontractor | Annual weed surveillance monitoring by an appropriately experienced and qualified person.<br>Weed surveillance to be summarised within a report detailing controls, spread and additional management measures (if any). | | Undertake weed surveillance monitoring, assessment of Project activities and existing weed mitigation measures. Determine additional mitigation measures and provide a summary report. |

| Responsibility | Situation<br>Standard | Level 1 | Level 2 |
|---|---|---|---|
| HSEC Manger | Ensure that the Weed Management Plan is implemented by all Site Personnel. | | • Assess and implement Quarterly Surveillance Report mitigation measures.<br>• Facilitate the revision of the Environmental Management Plan and Weed Management Plan. |
| | Clearing undertaken in accordance with Ground Disturbance Permit. | **Trigger:** Clearing undertaken outside of established Ground Disturbance Permit approval but outside of sensitive areas (i.e restricted works areas). | **Trigger:** Clearing undertaken outside of established Ground Disturbance Permit approval and within sensitive areas (i.e restricted works areas). |
| Environmental Officer and HSEC Manager | • Daily assessment of compliance with Ground Disturbance Permits. | • Commence investigation into the clearing works to determine root cause of over clearing.<br>• Establish the significance of over clearing and determine rehabilitation measures.<br>• Produce summary report within 1 week of the incident occurring. | • Commence investigation into the clearing works to determine root cause of over clearing.<br>• Establish the level/area of impact within the sensitive area.<br>• Produce summary report within 24 hours of the incident occurring. |
| HSEC Manager and General Manager | Ensure that the Weed Management Plan is implemented by all Site Personnel. | Review summary report and undertake debriefing with site personnel. | Review summary report and inform relevant stakeholders regarding over clearance.<br>Review contractor / personnel performance and implement management measures. |

# 6. Performance Review

No previous period data is available for review.

# 7. References


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GHD (2015c) Nolans Rare Earths Project – Flora and Vegetation Assessment, unpublished report prepared for Arafura Resources Limited

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# Appendices

# Appendix A – Weed Monitoring/Control Form

# Weed Control Form

| | | | |
|---|---|---|---|
| **Assessor** | | **Date** | |
| **Site Location(s)** | | **Purpose of Visit** | |
| **Weed Control Equipment** | | **Weather** | |

| **Weed Species** | | **Grid Reference (GDA94Z53)** | | **Cover Abundance / Number Species** | **Flowering / Seeding** | **Control Method (include dilution ratios)** | **Previous Treatment Summary** |
|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Easting** | **Northing** | | | | |
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# Appendix B – Weed Register

| your reference | eg. 2/11/2006 | 52 or 53 | Set the Datum on your GPS receiver to WGS84 or GDA94 using easting and northings in metres | | Common name | 20, 50, 100 | 2,3,4,5 | 0, 25, 50, 75, 100 (3 columns add up to 100%) | | | Today, Previous, No Treatment | use list | use list | Use List | Yes No | Yes No | Yes No | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WAYPOINT | DATE_REC | UTM_ZONE | EAST | NORTH | WEED_NAME | SIZE_DIA_M | DENS_CAT | SEEDLINGS | JUVENILES | ADULTS | TREATED | TREAT_TYPE | TREAT_CHEM | TREAT_MON | SEEDED | SOIL_DIST | VEG_DIST | COMMENTS |
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# Appendix C – Risk Matrix

An environmental risk assessment was undertaken for the Nolans Project and associated construction, operation and closure. The risk assessment identified the risk source (hazard and event), receptors and potential impact. The consequence and likelihood were determined using the descriptions identified in Table C1 and Table C2 respectively. The risk matrix is provided in Table C3.

## Table C1 Consequence Description

| Category of Impact | Aspect | Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|---|
| Air | Air quality | No measurable air quality impacts or exceedance of air quality standards. | Local short term and approaching exceedance of air quality standards. | Local minor long term, or widespread minor short term or exceedance of air quality standards. | Widespread (regional) major short term exceedance of air quality standards. | Regional long term change in air quality or exceedance of air quality standards. |
| Air | Noise | Applicable standards / guidelines met at all sensitive receptors at all times. | Isolated and temporary increase in noise levels exceeding relevant noise standards / guidelines at a sensitive receptor. | Short term, local increase in noise levels exceeding relevant noise standards / guidelines at a sensitive receptor. | Long term, local increase in noise levels exceeding relevant noise standards / guidelines at a sensitive receptor. | Long term, regional increase in noise levels exceeding relevant noise standards / guidelines at a sensitive receptor. |
| Biodiversity | Listed Flora Species | Minor local habitat modification and/or lifecycle disruption for a listed species. | Moderate local habitat modification and/or lifecycle disruption for a listed species. | Substantial local habitat modification and/or lifecycle disruption for a listed species. | Moderate regional habitat modification and/or lifecycle disruption for a listed species. | Substantial regional habitat modification and/or lifecycle disruption for a listed species. |
| Biodiversity | Listed Threatened Fauna Species | No loss of individuals of listed fauna species. | Minor local decrease in size of population(s) of listed fauna species. | Moderate local decrease in size of population(s) of listed fauna species. | Substantial local decrease in size of population(s) of listed fauna species. | Moderate or substantial regional decrease in size of population(s) of listed fauna species. |
| Biodiversity | General flora and fauna | Insignificant or imperceptible effects. | Local short term decrease in abundance of some species with no lasting effects on local population. | Local long term decrease in abundance of some species resulting in some change to community structure. | Regional decrease in abundance of some species resulting in some changes to community structure. | Regional loss of numerous species resulting in the dominance of only a few species. |
| Historic and cultural heritage | Aboriginal and cultural heritage | Minor repairable damage to more common structures or sites. No disturbance of historic and / or cultural heritage sites. | Moderate or repairable damage or infringement to sensitive structures or sites of cultural significance or sacred value. | Considerable damage or infringement to sensitive structures or sites of cultural significance or sacred value. | Major damage or infringement to sensitive structures or sites of cultural significance or sacred value. | Irreparable and permanent damage to sensitive structures or sites of cultural significance or sacred value. |

| Category of Impact | Aspect | Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|---|
| Human health and safety | Safety | Low level short term subjective inconvenience or symptoms. Typically a first aid and no medical treatment. | Reversible / minor injuries requiring medical treatment, but does not lead to restricted duties. Typically a medical treatment. | Reversible injury or moderate irreversible damage or impairment to one or more persons. Typically a lost time injury. | Single fatality and/or severe irreversible damage or severe impairment to one or more persons. | Multiple fatalities or permanent damage to multiple people. |
| Human health and safety | Health | Reversible health effects of little concern, requiring first aid treatment at most. | Reversible health effects of concern that would typically result in medical treatment. | Severe, reversible health effects of concern that would typically result in a lost time illness. | Single fatality or irreversible health effects or disabling illness. | Multiple fatalities or serious disabling illness to multiple people. |
| Radiation | Occupational exposure | <1 mSv/y<br><br>Measurable increase in radiation dose with outcomes below public dose limit. | <5 mSv/y<br><br>Measurable increase in radiation dose with outcomes remaining below dose constraints. | >5 mSv/y and <20 mSv/y<br><br>Measurable increase in radiation dose with outcomes between dose constraint and dose limit (averaged over five years). | >20 mSv/y and <50 mSv/y<br><br>Measurable increase in radiation dose with outcomes between dose limit (averaged over five years) and maximum annual dose. | >50 mSv/y<br><br>Measurable increase in radiation dose with outcomes greater than the maximum annual dose. |
| Radiation | Public exposure | No change from background.<br><br>Dose not discernible above natural background. | <0.3 mSv/y<br><br>Measurable increase in radiation dose with outcomes below public dose constraint. | >0.3 mSv/y and <1 mSv/y<br><br>Measurable increase in radiation dose with outcomes between dose constraint and dose limit (averaged over five years) for public. | >1 mSv/y and <5 mSv/y<br><br>Measurable increase in radiation dose with outcomes between dose limit (averaged over five years) and maximum annual dose for public. | >5 mSv/y<br><br>Measurable increase in radiation dose with outcomes greater than the maximum annual dose for public. |
| Radiation | Environmental impact | ERICA RQ < 0.1 | ERICA RQ >0.1 and <1.0 | ERICA RQ >1.0 plus justification | ERICA RQ >1.0 and no justification | ERICA RQ > 10.0 |

| Category of Impact | Aspect | Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|---|
| Socio-economic | Community | Local, small-scale, easily reversible change on social characteristics or values of the communities of interest or communities can easily adapt or cope with change. | Short-term recoverable changes to social characteristics and values of the communities of interest or community has substantial capacity to adapt and cope with change. | Medium-term recoverable changes to social characteristics and values of the communities of interest or community has some capacity to adapt and cope with change. | Long-term recoverable changes to social characteristics and values of the communities of interest or community has limited capacity to adapt and cope with change. | Irreversible changes to social characteristics and values of the communities of interest or community has no capacity to adapt and cope with change. |
| Socio-economic | Visual and landscape | Almost imperceptible or no visual change from sensitive receptors or places of cultural and natural value. No loss of / or change to features or characteristics of the landscape. | Minor visual change from sensitive receptors or places of cultural and natural value. Minor loss or alteration to key landscape characteristics, or introduction of elements that may be visible but not uncharacteristic. | Moderate visual change from sensitive receptors and places of cultural and natural value. Discernible changes in the landscape due to partial loss or change to characteristics of the landscape. | Significant visual change from sensitive receptors and places of cultural and natural value. Discernible change which is out of scale with the landscape, at odds with landform and will leave an adverse impact. | Catastrophic visual change from sensitive receptors and places of cultural and natural value. A substantial change to the landscape due to total loss of elements or characteristics, causing the landscape to be permanently changed and its quality diminished. |
| Transport | Traffic and transport operations and conditions | Negligible adverse impact on traffic and transport conditions. No perceptible deterioration of road integrity. | Detectable adverse changes in traffic and transport condition (decrease in Level of Service) at one or two locations at any one point in time during the construction period or at a single location during operations. Seasonal, local deterioration of road integrity. | Detectable adverse change in traffic and transport conditions (decrease in Level of Service) at multiple locations. Short term, local deterioration of road integrity. | Traffic and transport congestion and delays exceed acceptable levels at multiple locations. Short term, regional deterioration of road integrity. | Traffic and transport congestion and delays severely restrict the safe operation and efficiency of the transport network. Long term, regional deterioration of road integrity. |

| Category of Impact | Aspect | Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|---|
| Transport | Road safety | No increase in vehicle incidents along relevant haulage routes above historical baseline trend. | An increase in vehicle incidents along relevant haulage routes of five per cent above historical baseline trend. | An increase in vehicle incidents along relevant haulage routes of ten per cent above historical baseline trend. | An increase in vehicle incidents along relevant haulage routes of twenty per cent above historical baseline trend. | An increase in vehicle incidents along relevant haulage routes of greater than twenty per cent above historical baseline trend. |
| Water | Surface water | Minimal contamination or change with no significant loss of quality. | Local minor short term reduction or change in water quality. Local contamination or change that can be immediately remediated. | Local minor long term or widespread minor short term or local major short term reduction or change in water quality. Local contamination or change that can be remediated in long term. | Widespread (regional) major short term reduction or change in water quality. Local contamination or change that cannot be remediated in long term. Widespread contamination or change that can be remediated. | Regional long term reduction or change in water quality. Widespread contamination or change that cannot be immediately remediated. |
| Water | Groundwater | Negligible change to groundwater regime, quality and availability. | Changes to groundwater regime, quality and availability but no significant implications. | Changes to groundwater regime, quality and availability with minor groundwater implications for a localised area. | Groundwater regime, quality or availability significantly compromised. | Widespread groundwater resource depletion, contamination or subsidence. |

## Table C2 Likelihood Description

| Likelihood | Rare | Unlikely | Moderate | Likely | Almost Certain |
|---|---|---|---|---|---|
| **Description** | The event may occur only in exceptional circumstances.<br>This event is not expected to occur except under exceptional circumstances (up to once every 100 projects of this nature). | The event could occur but is improbable.<br>This event could occur up to once every 10-100 projects of this nature. | The event could occur but not expected.<br>This event could occur up to once every 10 projects of this nature. | The event will probably occur in most circumstances.<br>This event could occur up to once during a project of this nature. | The event is expected to occur in most circumstances.<br>This event could occur at least once during a project of this nature. |
| **Chance of Occurring (%)** | 0 - 1% | 2 - 10% | 11 - 50% | 51 - 90% | > 91% |

## Table C3 Risk Matrix

| | | Consequence | | | | |
|---|---|---|---|---|---|---|
| | | **Insignificant** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
| **Likelihood** | **Almost Certain** | Medium | High | High | Extreme | Extreme |
| | **Likely** | Medium | Medium | High | High | Extreme |
| | **Possible** | Low | Medium | Medium | High | High |
| | **Unlikely** | Low | Low | Medium | Medium | High |
| | **Rare** | Low | Low | Low | Medium | Medium |

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| Revision | Author | Reviewer | | Approved for Issue | | |
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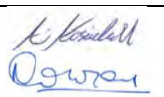
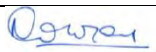
| Rev.0 | A Quinn | A Koscielski<br>N Conroy |  | N Conroy |  | 30/03/16 |

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