

# Appendix 14 Diversion Management Plan (GHD, August 2017)



Arafura Resources Ltd  
Nolans Project environmental services  
Diversion management plan

August 2017

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# 1. Background

This plan is part of a series of Environmental Management Plans that together form the Environmental Management System for the Nolans Project.

# 2. Objectives of this Plan

The objectives of this Plan are to satisfy regulatory requirements and approval conditions for the clean water diversions that are will be constructed as part of future operations.

# 3. Consultation

## 3.1.1 Consultation with Internal Stakeholders

This Plan has been reviewed by Arafura and endorsed at the meeting of [date]. Details of training and communication arrangements are outlined in Section 5.4.

## 3.1.2 Consultation with External Stakeholders

This plan has been prepared in consultation with the [regulator]. A copy of the consultation records are in Appendix A.

The final draft of the current revision of this Plan was submitted to the [regulator] on [date TBC]. A copy of the EPA approval of the Plan is in Appendix B.

# 4. Planning

## 4.1 Vision Statement

The diversion (Figure 4-1) is intended to prevent inundation of the open cut mining areas in the event of a major flood event by diverting flows from the upstream reaches of Kerosene Camp Creek to an adjacent tributary of Kerosene Camp Creek, while minimising the downstream impacts on Kerosene Camp Creek and the surrounding environment.

## 4.2 Environment Baseline

### 4.2.1 Water Quality

Baseline water quality of Kerosene Camp Kerosene Camp Creek as per the Water Management Plan.

### 4.2.2 Ecology

The Nolans Project is located within the Burt Plain Bioregion, on the Aileron and Napperby pastoral stations which have been used for grazing since the early 1880s.

There are five broad vegetation types that have been mapped within the bioregion (Wilson *et al.* 1990):

- Acacia woodland;
- Eucalyptus low woodland with tussock grass understory;
- Eucalyptus woodland with hummock grass understory;

- Hummock grassland; and
- Tussock grassland

There are 16 sites of botanical significance within the Burt Plain Bioregion, none of which occur within or near the Nolans Project (Neave *et al.* 2006). There are six sites in the bioregion that are listed in the directory of important wetlands. None of these are within or near the Nolans Project.

There are no sites of conservation significance in or near the study area. Lake Lewis site of conservation significance is 30 kilometres to the west.

Potential and existing threats to biodiversity that have been identified within the bioregion include exotic flora, introduced animals, fire, erosion, land clearing, grazing and mining (Neave *et al.* 2006). Much of the bioregion has been impacted by a range of broadscale processes such as grazing by livestock and/or feral animals, feral predators and weed infestations.

#### 4.2.3 Hydrology

The Kerosene Camp Creek diversion is intended to divert flow around the open cut mining operations. The results of a preliminary hydrological assessment for the Kerosene Camp Creek diversion are summarised in Table 4-1.

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Table 4-1 Modelled flows

Reach		100 year ARI	20 year ARI	2 year ARI
<b>Velocity (m/s)</b>				
Upstream	Existing	< 1.8	< 1.4	< 0.7
	Diversion	< 0.5	< 0.5	< 0.5
Within diversion	Existing	-	-	-
	Diversion	< 4.2	< 3.3	< 1.4
Downstream	Existing	< 3.0	< 2.0	< 1.2
	Diversion	< 3.4	< 2.3	< 1.3
<b>Shear stress (N/m<sup>2</sup>)</b>				
Upstream	Existing	< 40	< 35	< 12
	Diversion	< 1	< 1	< 1
Within diversion	Existing	-	-	-
	Diversion	< 100	< 95	< 21
Downstream	Existing	< 87	< 72	< 42
	Diversion	< 100	< 78	< 39

#### 4.2.4 Geomorphology

Creeks flowing through the mine site are characterised by low sinuosity channels (i.e. generally straight with gentle bends) with a grade of approximately 1 in 400 (0.25%).

The existing channel of Kerosene Camp Creek has bankfull widths in the order of 10 to 15 metres and depths in the range of 1 to 2 metres. The channel invert typically consists of a relatively featureless bed of sand with some gravel. In cross-section, the channel is symmetrical and relatively simplistic in form with limited evidence of features such as pools, bars or benches. Banks are composed of alluvially deposited sand and silt and are vegetated with low grasses and scattered shrubs and trees. Bedrock occasionally outcrops in the banks and bed providing some control on channel form and bed levels.

The sands and gravels are likely to be mobilised during relatively frequent storm events (Table 4-1 and Table 4-2). The proposed diversion would need to maintain a similar pattern of sediment transport.

Table 4-2 Watercourse lining stability thresholds

Bed material	Velocity (m/s)	Shear stress (N/m <sup>2</sup> )
Fine colloidal sand	0.5	1.5
Fine gravels	0.8	3.7
25 mm gravel	1.5	16
50 mm gravel	1.8	33
150 mm cobble	2.3	99
300 mm cobble	3.7	199
Short native grasses	1.2	47

Source: adapted from Fischenich (2001)

### 4.3 Design of Diversions

The design criteria for the Kerosene Camp Creek diversion included:

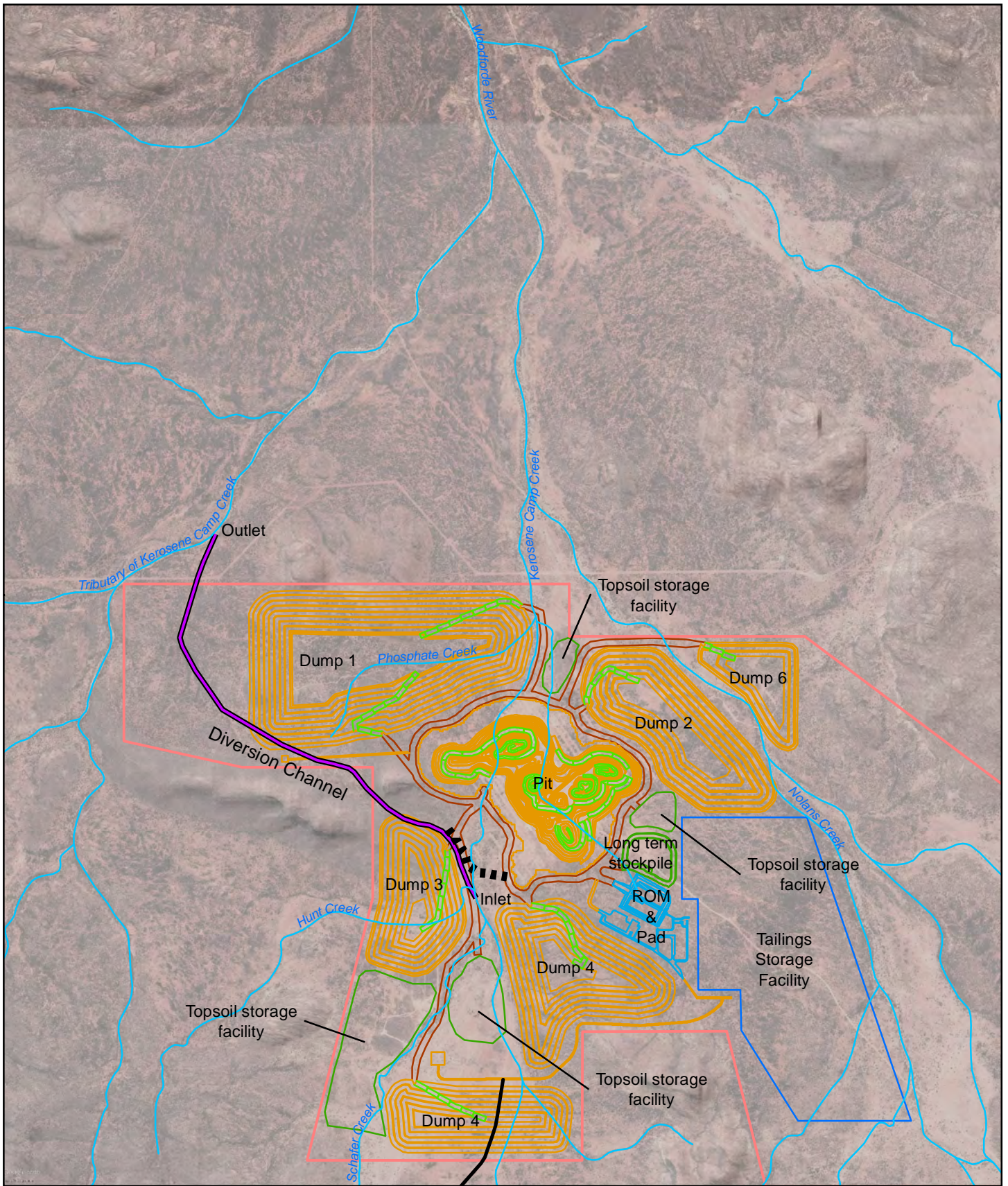
- produce stable channel, which is unlikely to undergo significant geomorphic change over time;

- reduce the need for ongoing maintenance where possible; and
- ensure sufficient capacity to convey the estimated peakflow from the 1 % AEP storm event;

Where practical the diversions have been designed to incorporate maintain sediment transport comparable to adjacent watercourses.

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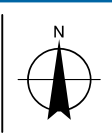




**LEGEND**

- Waterways
- Proposed Mine Site Boundary
- Diversion
- Levee

1:40,000 @ A4  
 0 250 500 750 1,000  
 Metres  
 Map Projection: Universal Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 53



Arafura Resources Limited  
 Nollans Project

Job Number | 43-22301  
 Revision | 0  
 Date | 23 Mar 2016

**Kerosene Camp Creek  
 Diversion Channel - Option D Alignment** Figure 4.1

G:\43\22301\GIS\Maps\4322301\_572\_DiversionOptionD.mxd Level 5, 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com  
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 Data source: GA - Roads, Waterways, Placenames, Placenames, Lakes (2015). ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 05/11/2015). ARL - Project Areas (2015). Created by: CM

# 5. Implementation

## 5.1 Construction Program

The management of upstream runoff is an important component for the construction of the diversion works.

Prior to constructing a diversion, temporary diversions will be constructed upslope of the diversion to redirect flows around active work areas. Temporary diversions will be constructed and stabilised in a manner so as to minimise erosion. A temporary dam will be constructed at the downstream end of the diversion to prevent the discharge of sediment laden water from the works area into the downstream environment.

Once construction of the creek diversion has been completed the temporary diversion will be backfilled and the downstream dam removed.

Erosion and sediment controls that are to be implemented throughout the construction period include:

- check dams within the temporary diversions and permanent creek diversion to slow flow velocities and encourage sediment accretion; and
- clean water diversion drains to divert runoff around the works area.

## 5.2 Revegetation Program

Revegetation of the land disturbed by diversion works will be undertaken in three stages:

- Stage one will include:
  - spreading of topsoil and the establishment of a cover crop (grasses) to stabilise exposed surfaces and minimise sediment generation during rainfall events;
  - direct seeding and planting of native vegetation within defined vegetation zones;
- Stage two will include:
  - ongoing removal of weeds and supplemental seeding and planting where necessary;
  - identification and undertaking of remedial actions (if any); and
- Stage three will include:
  - an evaluation of the revegetation, with stage two repeated as necessary.

Where practical, diversions will be revegetated with suitable native species, with a preference for:

- locally endemic species; and
- fast growing species that allow for rapid soil cover and erosion protection.

## 5.3 Maintenance and Rehabilitation

Arafura will undertake works necessary and maintain all diversions. Arafura will undertake works necessary to repair and rehabilitate any diversion that fails to meet the performance criteria described in Section 6.1.

## 5.4 Training and Communication

Generic training is provided to all employees and contractors during the site induction.



From time to time, workforce communication days and toolbox talks allow for discussion of the objectives and requirements of this and any other relevant plans.

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## 6. Measurement and evaluation

### 6.1 Performance and Completion Criteria

#### 6.1.1 Water Quality

Performance and completion criteria of the diversions are described in the Water Management Plan.

#### 6.1.2 Ecology

Performance and completion criteria of the diversions are described the Biodiversity Management Plan.

#### 6.1.3 Hydrology

The diversion will be constructed and maintained such that it meets the design criteria described in Section 4.3 and is hydraulically stable.

#### 6.1.4 Geomorphology

The performance of the diversion will be assessed against the following the performance criteria:

- condition of channel bank: no evidence of rill erosion or slumping;
- condition of channel invert: no evidence of geomorphically unstable erosion and sediment deposition;
- condition of vegetation: no evidence of weed growth or death of vegetation;
- deposition of sediment and debris: no evidence of accumulation or reduced waterway access; and
- general conditions: no evidence of hazards presented to the public, poor aesthetics or feral animals, or geomorphical instability.

### 6.2 Monitoring Program

#### 6.2.1 Water Quality

The monitoring of water quality of the diversion forms part of the monitoring program described in the Water Management Plan.

#### 6.2.2 Ecology

The monitoring of ecology of the diversion forms part of the monitoring program described in the Biodiversity Management Plan.

#### 6.2.3 Hydrology

Due to the difficulty in accurately estimating the AEP of flood events due to timing, safety and accurate measurement, the hydrology of the diversion will not be directly monitored. Rather the water quality, ecological and geomorphological monitoring data will be used as proxy measures of the hydrological performance of the diversion.

#### 6.2.4 Geomorphology

The diversions will be inspected on a quarterly basis to assess the components of the diversion are performing satisfactorily against the performance criteria. A record of monitoring observations will include:

- condition of channel bank;
- condition of channel invert;
- condition of vegetation;
- deposition of sediment and debris; and
- general conditions.

If any unsatisfactory performance is identified, the actions and follow up required will be recorded as part of the monitoring observations.

#### 6.2.5 Trigger-Action-Response plans

Trigger-Action-Response plans (TARPs) are included in Appendix C.

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## 7. Review and improvement

### 7.1 Reporting

#### 7.1.1 Annual Review

The Mine Manager will be responsible for reporting any significant findings regarding the implementation of this Plan in the Annual Review. The Annual Review will be provided to [regulator].

### 7.2 Plan Review

This Plan will be reviewed:

- every three years;
- following an independent environmental audit, with findings relevant to this Plan;
- following an environmental incident or community complaint relevant to the control measures outlined in this Plan; or
- following relevant outcomes from a risk assessment or change management process.

If any significant modifications to the Plan are required as an outcome of the review, relevant government agencies will be consulted regarding the changes and the revised Plan will be submitted to [regulator] for approval.

## 8. Commitments

All commitments outlined within this management plan are detailed in Table 8-1. Management commitments requiring actioning will be entered into a Compliance Management system (CMO) and actioned. Records of documentation associated with the management commitments will also be maintained within CMO.

Table 8-1 Management Plan Commitments

No.	Commitment	Where in Management Plan
1	Where practical, diversion will be designed to maintain sediment transport comparable to surrounding water-courses.	Section 2.3
2	Revegetated areas will be watered as necessary.	Section 3.2
3	Assessment will be made of the need for remedial actions and these will be undertaken as required.	Section 3.2
4	Where practical, diversions will be revegetated with suitable native species.	Section 3.2
5	Undertake works necessary to repair and rehabilitate diversion to meet the performance criteria.	Section 3.3
6	The diversion will be inspected on a quarterly basis to assess the components of the diversion are performing satisfactorily against the performance criteria.	Section 4.2.4
7	A record of monitoring observations will maintained, including are actions taken and follow up actions required.	Section 4.2.4
8	Any significant findings regarding the implementation of this Plan will be reported in the Annual Review.	Section 5.1
9	This Plan will be reviewed periodically.	Section 5.2
10	If any significant modifications to the Plan are required as an outcome of the review, relevant government agencies will be consulted regarding the changes and the revised Plan will be submitted to NT EPA for approval.	Section 5.2

## 9. Accountabilities

Table 9-1 outlines the accountabilities associated with this Plan.

Table 9-1 Accountabilities

Role	Accountabilities for this document
Operations Manager	Provide adequate resources for the implementation of this Plan.
Environment and Community Manager	<p>Implement this Plan.</p> <p>Responsible for ensuring that monitoring, periodic environmental inspections and visual assessments after high rainfall events are undertaken.</p> <p>Oversee the planning, construction, inspection, maintenance and repair of the diversions.</p> <p>Provide that the requirements of this Plan are met.</p> <p>Investigate and report all incidents involving the failure or damage to diversions.</p>
Environment and Community Coordinator / Officer	<p>Assist the E&amp;C Manager as required in implementation of this Plan.</p> <p>Investigate and report all incidents involving the failure or damage to diversions.</p>
Task Coordinators	<p>Provide that the requirements of this Plan are met through compliance with procedures.</p> <p>Report all incidents involving the failure or damage to diversions.</p>
All contractors	<p>Undertake works in accordance with the objectives and principles of this Plan.</p> <p>Report all incidents involving the failure or damage to diversions</p>
All personnel	<p>Undertake works in accordance with the objectives and principles of this Plan.</p> <p>Report all incidents involving the failure or damage to diversions.</p>



# 10. Document information

## 10.1 Relevant Legislation

The following legislation is relevant to this Plan:

- Planning Act 2017;
- Environment Assessment Act 2013;
- Environmental Offences and Penalties Act 2011;
- Water Act 2016; and
- Ti-Tree Water Allocation Plan 2009 (under review).

## 10.2 Related Documents

Related documents, listed in Table 10-1, are internal documents directly related to or referenced from this document.

Table 10-1 Related documents

Number	Title
TBC	Biodiversity Management Plan
TBC	Water Management Plan

## 10.3 Change Information

A summary of the document history is provided in Table 10-2.

Table 10-2 Change information

Ver-sion	Date	Review team (consultation)	Change Summary
A	August 2017		Draft for EIS

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## Appendices

# Appendix A – External consultation records (to be inserted)

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## Appendix B – Plan approval (to be inserted)

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# Appendix C – TARPS

## Water quality

	Normal	Stage 1	Stage 2
Trigger	Water quality measurements within normal ranges	One (1) water measurements quality outside normal ranges	Two (2) water measurements out of normal ranges
Action	Record water quality measurements	Record water quality measurements	Record water quality measurements Temporarily cease mining operations
Response	Nil	Notify EPA Inspect dirty water system and contaminated water systems for potential leaks	Notify EPA Undertake incident investigation to determine source of pollution

## Geomorphology

	Normal	Stage 1	Stage 2
Trigger	No appreciable erosion and scouring within diversion No appreciable accretion of sediments within diversion	Minor erosion (< 0.5 metres deep) observed: - within the diversion; - upstream of the diversion; or - downstream of the diversion	Scouring (> 0.5 metres deep) observed: - within the diversion; - upstream of the diversion; or - downstream of the diversion
Action	Record inspection	Record inspection Rip affected area(s), track roll and re-vegetate	Record inspection Fill affected areas and cover with protective rock layer
Response	Nil	Nil	Review hydraulic modelling of the diversion Review selection of lining material along length of diversion

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Document Status

Re- vi- sion	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	A Wyatt					24/08/17

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