Metro Mining
Appendix A3 - Conceptual Erosion and Sediment Control Plan
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Section 1  Introduction

1.1  Background

Aldoga Minerals Pty Ltd, a wholly owned subsidiary of Metro Mining Limited (herein referred as Metro Mining) is proposing to develop an open cut bauxite mine and barging/transhipment operation on the western coastline of Cape York (the Project) (refer Figure 1-1). The Project is expected to have a life span of 12 years at the maximum production rate of 5 million tonnes per annum (Mtpa). It is characterised by several shallow open cut pits that will be connected via internal haul roads, which in turn, will be connected to a main north-south haul road linking the Mine Infrastructure Area (MIA) and barge loading facility (BLF) located on the Skardon River.

Key components of the Project include:

- Shallow open cut pits (Bauxite Hills 1 (BH1), Bauxite Hill 6 (BH6) east and west pits) (refer Figure 1-2);
- Internal haul roads, access roads and associated borrow pits (located within haul road corridors);
- BLF and roll on/roll off (RoRo) facility on the Skardon River;
- MIA including the run-of-mine (ROM) stockpile, bauxite stockpiles, barge loading conveyor load point, earthmoving equipment hard park, administration offices, workshops and fuelling facilities;
- Accommodation camp;
- Bulk fuel storage;
- Raw and potable water supply; and
- Sewage treatment plant.

An Erosion and Sediment Control Plan (ESCP) to minimise the risk of harm to the environment and impacts to environmental values (EV) as a result of the construction and operation of the mine and associated infrastructure.

CDM Smith has been engaged by Metro Mining to develop the ESCP for the Project. This ESCP will form part of the supporting information for subsequent environmental and statutory applications made as part of the Project approval process and informs the Environmental Impact Statement (EIS).
1.2 Scope of ESCP

This ESCP considers the findings of the early planning phase of the Project, including a desktop study and preliminary site investigation. It also takes into account expected construction methodology, nominating erosion and sediment control (ESC) management measures based on a risk management approach.

A conceptual planning phase was completed to assist in minimising the potential for erosion and sediment to impact on the surrounding EVs in the Project area by considering actual site conditions as well as allowing for Project environmental obligations and ensuring they are suitably managed throughout the works.

As the Project is located in an area that experiences tropical monsoonal climates with wetter and drier seasons, proposed soil erosion management will be considered in a two-season approach. The Project is located in the Australian tropics which experiences a wet period from December to March and a dry period. Metro Mining has nominated that construction and mining activities will take place in the drier months of April to November, which account for only 11.4% of the yearly rainfall total.

The purpose of this ESCP is to:

- Consider site specific soils data collected for the Project;
- Ensure that ESC requirements, site constraints and key environmental issues are introduced in the planning phase of the Project;
- Develop a site based erosion risk assessment to ensure suitable levels of ESCs are nominated;
- Minimise the potential impacts on water quality, water courses and aquatic flora and fauna;
- Allow regulatory authorities to identify any areas of concern before the Project commences;
- Demonstrate to the regulatory body that the Project is able to go ahead while protecting key EVs;
- Comply with legal and other requirements related to ESC and acid sulfate soils (ASS);
- Develop technical notes relating to site preparation and temporary ESC devices to be installed;
- Nominate management strategies to mitigate seasonal risks; and
- Ensure ESC measures are considered and nominated for the total mine life including planning, construction, operation through to mine closure.

A preliminary soils investigation was undertaken to inform Chapter 4 – Land of the EIS. Information from this survey has been used in developing this ESCP, providing localised background soils data. Previously identified environmental features and sensitive receptors on or adjacent to the Project have also been considered in reference to environmental risk and associated management.
1.3 Objectives

The overall objectives of this ESCP are to ensure ESC measures across the Project align with the requirements of Best Practice in Erosion and Sediment Control, International Erosion Control Association (IECA 2008) for the Project’s full lifecycle.

The specific objectives, targets and indicators for erosion and sediment management across the Project site are nominated in Table 1-1 below.

Table 1-1 Objectives, targets and indicators for erosion and sediment management

<table>
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<tr>
<th>Objectives</th>
<th>Targets</th>
<th>Indicators</th>
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<td>Minimise erosion onsite and in immediate surroundings.</td>
<td>Zero incident reports for soil erosion onsite and immediate surroundings.</td>
<td>Incident reports for soil erosion.</td>
</tr>
<tr>
<td>Minimise transport of sediment across and offsite.</td>
<td>Zero incident reports and/or complaints regarding dirty water exiting the site.</td>
<td>Incident reports for dirty water going offsite. Dewatering of ponded water off site, if required, must meet discharge criteria required under relevant project approval conditions.</td>
</tr>
<tr>
<td>Ensure onsite sediment controls are effectively maintained.</td>
<td>Accumulated sediment to be removed from sediment control devices regularly.</td>
<td>Maximum allowable sediment volume caught in filter and sediment fences.</td>
</tr>
<tr>
<td>Ensure the final project site is left in an acceptable condition.</td>
<td>Final land form returned to a state that is consistent with the surrounding topography, non-erodible and stable conditions and revegetated to a level which is consistent with its final intended land use.</td>
<td>Temporary structures removed from site including mine infrastructure, temporary access and haul roads that are not approved to remain. Project site topography and gradients returned to between 0.1 and 2.4 %. Minimal surface erosion evident. Revegetation type consistent with the surrounding environment including tidal areas, buffer zones and plateaus.</td>
</tr>
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Section 2  Regulatory Requirements

2.1  Legislation

Nominated below are key legislative requirements that Metro Mining will meet throughout the life of the Project.

2.1.1 Environmental Protection Act 1994

The Environmental Protection Act 1994 (EP Act) is the primary legislation for environmental management and protection in Queensland. It forms the main framework for protecting and managing Queensland’s environment, particularly in relation to regulating activities which have potential to release contaminants into the environment (defined as Environmentally Relevant Activities (ERAs)).

The EP Act also governs the management, investigations and remediation of any contaminated land. If land becomes contaminated there is a duty to notify the Department of Environment and Heritage Protection (EHP).

2.1.1.1 Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP (Water)) seeks to achieve the objectives set out within the EP Act in relation to Queensland waterways. That is, it seeks to: “Protect Queensland’s waters while allowing for development that is ecologically sustainable” (s3 EP Act).

The purpose of this policy is achieved by:

- Identifying EVs and management goals for Queensland waters;
- Stating water quality guidelines and water quality objectives (WQO) to enhance or protect the EVs;
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

2.1.2 Water Act 2000

The Water Act 2000 (the Water Act) provides a structured system for the planning, protection, allocation and use of Queensland’s surface waters and groundwater. Under section 808 of the Water Act, a person must not take, supply or interfere with water unless authorised. Authorisation under the Water Act for the taking of water from overland flow, a watercourse, lake or spring comes via a water entitlement.

The Water Act provides for the protection of natural ecosystems and security of supply to water users through the development of water resource plans (WRPs), and other activities. Each managed catchment in Queensland has a separate WRP and associated Resource Operations Plan (ROP) to provide a framework to apply (under the Water Act, chapter 2 part 6) and regulate water extractions to ensure that they are maintained as a sustainable resource. The Project is not covered by any ROP and the only applicable WRP is the Water Resources (Great Artesian Basin) Plan 2006 (GAB WRP).
2.1.3 Land Act 1994

The *Land Act 1994* addresses the management of land for the benefit of the people of Queensland with respect to the following principles:

- Sustainable resource use and development;
- Land evaluation based on the appraisal of land capability and the balancing of different economic, environmental, cultural and social opportunities;
- Values of the land, development, community purpose, protection of environmentally and culturally valuable and sensitive areas and features; and
- Consultation with community groups, industry associations and authorities and administration.

2.2 Environmental Guidelines

This ESCP has been developed with reference to the *Best Practice Guidelines for Erosion and Sediment Control*, published by the International Erosion Control Association (IECA) in November 2008. These guidelines are accepted in Queensland and nationally as industry best practice with respect to erosion control and the management of sediment.

Other documents that have been referenced while developing this ESCP are:

- Appendix P: Land-Based Pipeline Construction, Best Practice Guidelines for Erosion and Sediment Control, IECA 2015;
- Erosion and Sediment Control – A Field Guide for Construction Site Managers (Catchments and Creeks);
- Queensland Acid Sulphate Soil Technical Manual Legislation and Policy Guide (DERM);
- Soil Conservation Measures – A design manual for Queensland (DERM); and
- STATE PLANNING POLICY 2/02 - Planning and Managing Development Involving Acid Sulphate Soils.
Section 3  Site Analysis

In order to adequately assess potential Project impacts on the surrounding environment through increased erosion and sediment loss caused by modifying the local geology, topography, soils and landscape, the following assessments have been undertaken:

- Desktop assessment, including review of publicly available literature, maps and resources relevant to the geology, soils and landforms in the Project area;
- Review of existing Metro Mining Resource Statements and Gulf Alumina Skardon River Bauxite Project EIS; and
- Field surveys and laboratory analysis focusing on site characterisation to improve the understanding of soils within the Project area. Results from the following surveys conducted in the Project area have been used in the development of the ESCP:
  - The most recent detailed field soil survey of the Project area which was conducted over a five day period from 12 to 16 October 2015 and consisted of nine full soil samples and 10 topsoil and visual assessments;
  - A smaller scale survey undertaken in March 2015 which included the construction of and laboratory sample analysis from three boreholes; and
  - An investigation undertaken by Cape Alumina in September 2014 to investigate ASS which included constructing two boreholes to depth.

3.1 Site Description

The Project area is remote from any township with the nearest town Mapoon, located approximately 35 kilometres (km) to the southwest of the proposed MIA. There are no reserves, stock routes, easements or public road reserves within the Project area.

The Project is located on bauxite plateaus that surround the Skardon River. The plateaus are non-undulating and exhibit moderate slopes with steeper slopes along the fringes of the Skardon River. The BH1 boundary is surrounded to the north and south by tidal zones of the Skardon River and main tributary, respectively. To the east, a ridge rises between these major drainage lines and is characterised by tributary gully formations that feed the main channels.

The BH6 West is divided by a ridgeline running parallel to the main tributary of the Skardon River. The western boundary is characterised by a series of swamps, coastal dunes and low lying coastal zones that are tidally influenced. The eastern boundary rises up a ridge that forms the divide between the Skardon River and Namaleta Creek catchments.

3.2 Topography

The topography and landscape of the Project area was reviewed with reference to:

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Soil Resource Information System (ASRIS) 2011 datasets;
- Resource and tenure maps and records from EHP;
- Local government mapping;
• Cadastral data;
• EHP 10 m contour data; and
• Queensland Globe (Department of Natural Resources and Mines (DNRM) 2015a)) feature of Google Earth.

The proposed Project mining is located on bauxite plateaus that surround the Skardon River. Mine pit areas are proposed across an elevation range of approximately 6 metres Australian Height Datum (mAHD) to 16 mAHD. The plateaus are non-undulating and exhibit moderate slopes of approximately 0.6% (BH1) and 0.3% (BH6 West). Steeper slopes are encountered along the fringes of the Skardon River (refer Figure 3-1).

The proposed final rehabilitated topography, developed by MEC Mining, has been used in developing sub-catchments for the final landforms, particularly the mine pits, where majority of the changes will occur. This Lidar data has been used in conjunction with existing topographical data for areas outside of the mine pits where little to no changes are expected.

3.3 Vegetation

The vegetation of the Project area is a complex mosaic of open forest, woodland, extensive swamplands, gallery forests on perennial streams and rivers, closed forest and mangroves. The lateritic surface of the Weipa Plateau is characterized by *Eucalyptus* and *Corymbia* woodlands with the deep aluminous laterites of the Weipa area supporting the best development of Darwin Stringybark (*E. tetrodonta*), Melville Island Bloodwood (*C. nesophila*) and Cooktown Ironwood (*Erythrophloeum chlorostachys*) dominant tall woodland and open forest on Cape York Peninsula. Areas of shallow silty soils with impeded drainage characteristics are scattered across the lateritic surface, supporting low woodland communities with dominant eucalypt and *Melaleuca* species. Shallow drainage depressions provide a seasonal wetland habitat and are dominated by woodlands and open forests with characteristic *Melaleuca*, *Lophostemon*, *Xanthostemon* and *Asteromyrtus* species. These swamp forests display a complex variety of vegetation communities on their margins, compositionally zoned in response to local variations in the persistence of water through the dry season.

The majority of the Project area was found to support remnant Darwin Stringybark and Melville Island Bloodwood tall woodland. Darwin Stringybark predominates forming a distinct but discontinuous canopy with Melville Island Bloodwood present as a sub-dominant canopy species. The very sparse to sparse sub canopy and shrub layers are dominated by *Eucalyptus* and *Acacia* spp., and Bushman's Clothes Peg (*Grevillea glauca*). The ground layer is typically sparse to medium density native grasses.

Lower areas including a number of haul road crossings are predominantly located in areas of *Melaleuca*.

Further descriptions of vegetation characteristics are presented in Chapter 6 – Terrestrial and Freshwater Ecology of the EIS.
3.4 Soils

3.4.1 Soils Assessment Methodology

Desktop Assessment

A preliminary desktop soils and landform assessment was undertaken to inform the nominated soils fieldwork program. The desktop study also included a review of the potential presence of and the likelihood of disturbing ASS or potential ASS (PASS) across the Project site. ASRIS, developed by CSIRO, provides predictive ASS mapping across Australia (refer Figure 3-2). From the ASRIS mapping it was identified the adjacent mangrove and riparian habitats were areas with the greatest potential to generate ASS. The potential to generate ASS decreases away from the Skardon River and associated tributaries, with low potential within the woodlands and grasslands.

No mining pits are located on areas with a high or low probability of ASS or PASS. Construction of the BLF, RoRo facility and haul roads has a high potential to coincide with areas of ASS and PASS as some of these activities take place below 5.0 mAHDA.

Field Assessment

A soils field assessment was undertaken in accordance with the following:

- Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (Department of Mines and Energy ((DME), 1995)) (including the collection of soil samples in line with the Land Suitability Assessment Techniques within DME, 1995);
- State Planning Policy – state interest guideline - Agriculture;
- Planning Guideline: The Identification of Good Quality Agricultural Land (Department of Primary Industries (DPI) and Department of Housing and Local Government Planning (DHLGP), 1993);
- The Australian Soil Classification (Isbell, 2002);
- Guidelines for Surveying Soil and Land Resources (McKenzie et al., 2008); and
- Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009).

As a result of the three soil surveys undertaken across the Project site, soils information was collected from a total of 14 full soil samples (boreholes) and 10 topsoil / visual assessments of the soil and landscape characteristics (herein termed ‘observations’). Detailed assessment of soil characteristics (comprising soil sampling and in-field analysis of the profile) were also supplemented by laboratory analysis.
Atlas of Australian Acid Sulfate Soils (CSIRO Lands and Water 2014)

Probability of Occurrence / Confidence

- High Probability (>7% chance) / No necessary analytical data are available but confidence is fair, based on a knowledge of similar soils in similar environments
- High Probability (>7% chance) / No necessary analytical data are available and classifier has little knowledge or experience with ASS, hence classification is provisional
- Low Probability (6-70%) / No necessary analytical data are available and classifier has little knowledge or experience with ASS, hence classification is provisional
- Extremely Low Probability (1-5%) (with occurrence in small localised areas) / No necessary analytical data are available and classifier has little knowledge or experience with ASS, hence classification is provisional

Legend

- Mine Infrastructure Area
- Watercourse
- Haul Road
- Pit Extents
- Mine Lease Area
- Accommodation Camp

Figure 3-2
Probability of Australian acid sulfate soils occurring
Detailed Sites

Detailed soil profile information was gathered from 11 constructed boreholes in the Project area. The detailed sites were augered to a depth of 1.2 m or until refusal was reached. A selection of 23 soil samples were issued for laboratory analysis (refer Figure 3-3).

Several samples were taken from down the soil profile at each location to allow for representative information to be gathered from the A horizons ‘topsoils’ and B horizons ‘subsoils’. Texture was assessed in-field where changes in the profile were evident.

Observation Sites

In addition to the full soil profile samples, 10 observations were conducted in the Project area (refer Figure 3-3). The observations consisted of a visual assessment of soil conditions and the surrounding environment taking into account the general terrain of the area, and landform and vegetative characteristics across the site.

Laboratory Analysis

Those samples collected from detailed sites that were considered most representative of the mapped soil units were submitted to a National Association of Testing Authorities (NATA) accredited laboratory for soil testing, providing information that directly informed the overall soils characterisation and determination of agricultural suitability of the soils. It was also used in determining soil suitability for future rehabilitation based on physical and chemical parameters.
Figure 3.3
Soil sample locations

Legend
- Soil Sampling Location
- Watercourse
- Barge Loading Area
- Pit Extents
- Haul Road
- Accommodation Camp
- Metro Mining Mine Lease Area

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
- MEC Mining
- QLD Government Open Source Data
- Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

DESIGNER
CDM Smith

CLIENT
Metro Mining Limited

DRG Ref: BE150115-006-R1_SOIL

For Information Updated Pit Extents

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Note: Updated Pit Extents

15/07/15 Camp Access Road

18/03/16 Details

1 For Information
19/03/16
2 Updated Pit Extents
20/03/16

DESIGNED
MD
CHECKED

DRAWN
MD
CHECKED

APPROVED
DATE
18/03/16

1:58,491 Scale @ A3 - 1:58,491

South Australia

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### 3.4.2 Soil Survey Results

Information presented in Section 3.4.2 is from Chapter 4 – Land of the EIS.

#### 3.4.2.1 Soil Types

The soil types mapped for the Project area are outlined in Table 3-1 (refer Figure 3-4).

**Table 3-1 Soil types mapped in the Project area**

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<th>Landform</th>
<th>Assoc. Soils³</th>
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<tr>
<td>Wp</td>
<td>Weipa</td>
<td>Deep gradational or uniform red massive soils with aluminous concretions</td>
<td>Red Earth</td>
<td>Red Kandosol</td>
<td>Plains</td>
<td>Ad Mp</td>
</tr>
<tr>
<td>Bv</td>
<td>Batavia</td>
<td>Deep Gradational mottled yellow soils with nodules (F,N,M)</td>
<td>Yellow Podzolic</td>
<td>Yellow Dermosol</td>
<td>Hillslopes, plains</td>
<td>MI Ld Pn Sp Br Hk</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sd</td>
<td>Skardon</td>
<td>Recent estuarine deposits under mangrove</td>
<td>No suitable group</td>
<td>Intertidal Hydrosol</td>
<td>Tidal flats, estuarine</td>
<td>Go Mn</td>
</tr>
<tr>
<td><strong>Soils on the Coastal Margin – Beach ridge and dune deposits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cv</td>
<td>Caravan</td>
<td>Deep to very deep coloured uniform sands formed in beach ridges on chenier and beach ridge plains</td>
<td>Siliceous sands</td>
<td>Othic Tenosol</td>
<td>Coastal margin associated with younger sand dune deposits and beach ridges. Very minor distribution</td>
<td>Mn</td>
</tr>
<tr>
<td><strong>Soils the Drainage Lines and Swamps</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mp</td>
<td>Mapoon</td>
<td>Deep duplex or Gradational soils with dark loamy surface over mottled grey clay</td>
<td>Humic gley</td>
<td>Redoxic Hydrosol</td>
<td>Swamps, drainage depressions</td>
<td>Wp Ad Kd Ab</td>
</tr>
</tbody>
</table>

1. Australian Soil Classification (Isbell, 2002).
2. Great Soil Group (Stace et al., 1968).
3. Ad = Andoom, Mp = Mapoon, MI = Myall, Ld = Lydia, Pn = Picanniny, Sp = Scorpion, Br = Burn, Hk = Hesket, Kd = Kennedy, Ab = Antbed, Mn = Marina, Go = George.
Figure 3-4
Soil types and sample locations

Legend
- Soil Sampling Location
- Watercourse
- Barge Loading Area
- Pit Extents
- Haul Road
- Accommodation Camp
- Metro Mining Mine Lease Area

Mapped soils of the Cape York Peninsula (1995)
- Bt-Deep Gradational or Uniform red massive soil with ferruginous nodules formed on remnant surfaces.
- Bv-Deep Gradational mottled yellow soil formed on siltstone, mudstone or claystone
- Cv-Deep to very deep coloured Uniform sands formed in beach ridges on chernier and beach ridge plains.
- Cu-Deep Uniform or Gradational red massive soils on alluvial plains within the Rolling Downs Group.
- Cv-Deep uniform bleached sand over coffee rock formed on drainage depressions and footslopes on northern sandstone
- Hm-Deep gradational bleached yellow massive soils formed on sandstones
- Mn-Very deep uniform frequently cracking saline grey clays formed on marine plains
- Mp-Deep duplex or gradational soils with a dark loamy surface over a mottled grey clay formed in swamps
- Sa-Recent estuarine deposits under mangroves
- Ss-Very deep uniform coastal sands deposited on latere and other surfaces
- Wp-Deep gradational or uniform red massive soil with aluminous concretions

Acknowledgements
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
MEC Mining;
QLD Government Open Source Data;
Australian Hydrological Geospatial Fabric (Geofabric) PRODUCT SUITE V2.1.1

Notes:
For Information
Updated Pit Extents

Disclaimer
This drawing is confidential and shall only be used for the purpose of this project.

CDM Smith
METRO MINING LIMITED

Scale @ A3 - 1:85,000
GCS GDA 1994 MGA Zone 54
3.4.2.2 Emerson Aggregate Test

The Emerson aggregate test measures the dispersion potential of soils and has a direct effect on the erosion susceptibility of a soil. The various Emerson classes (AS1289.3.8.1 – 2006) are identified and defined in Table 3-2.

### Table 3-2 Emerson class descriptions

<table>
<thead>
<tr>
<th>Emerson Class</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Air-dried crumbs of soil show a strong dispersing reaction, i.e. a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10 min. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.</td>
</tr>
<tr>
<td>Class 2</td>
<td>Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.</td>
</tr>
<tr>
<td>Class 3</td>
<td>The soil remoulded at the plastic limit disperses in water.</td>
</tr>
<tr>
<td>Class 4</td>
<td>The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present.</td>
</tr>
<tr>
<td>Class 5</td>
<td>The remoulded soil does not disperse in water and the 1:5 soil / water suspension remains dispersed after 5 min.</td>
</tr>
<tr>
<td>Class 6</td>
<td>The remoulded soil does not disperse in water and the 1:5 soil / water suspension begins to flocculate within 5 min.</td>
</tr>
<tr>
<td>Class 7</td>
<td>The air-dried crumbs of soil remain coherent (do not disperse) in water and swell.</td>
</tr>
<tr>
<td>Class 8</td>
<td>The air-dried crumbs of soil remain coherent (do not disperse) in water and do not swell.</td>
</tr>
</tbody>
</table>

All of the soil samples from the Project area were rated as a Class 4 with the exception of one Class 6 sample and one Class 5 sample. The soils are therefore considered to only have moderate dispersive tendencies. Soils can be remoulded and will not readily disperse in water.

3.4.2.3 Sodicity

Exchangeable Sodium Percentage (ESP) measures the sodicity of a soil which, along with the Emerson aggregate test, is directly related to a soil’s erosion potential. The sodicity ratings for soils (Northcore and Skene, 1972) are shown at Table 3-3.

### Table 3-3 Soil sodicity/ESP ratings

<table>
<thead>
<tr>
<th>Sodicity Rating</th>
<th>ESPs proposed for Australia Soils (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-sodic</td>
<td>0 – 6</td>
</tr>
<tr>
<td>Sodic</td>
<td>6 – 15</td>
</tr>
<tr>
<td>Strongly sodic</td>
<td>&gt; 15</td>
</tr>
</tbody>
</table>

Sample sites within the Project area varied between non-sodic and strongly sodic with <0.1% to 36.4% ESP as identified by analytical test results. The variation in sodicity across the site is generally reflective of the topography across the site as historical wetting and periodic inundation will increase sodicity levels. Samples close to water bodies and of lower topography are generally sodic to strongly sodic, whereas those samples displaying non-sodic characteristics are located at higher elevations and often on bauxite plateaus.

Despite some boreholes returning ESPs of greater than 15% and therefore strongly sodic ratings, the exchangeable calcium results outlined below provide an ionic balance, therefore these soils are likely to be non-dispersive. This is also supported by the results of the Emerson aggregate test.
3.4.2.4 Soil Erosion Susceptibility

The susceptibility of an area of land to erosion is a function of the soil type, soil cover, topography and slope, rainfall intensity and land use. Soil erosion susceptibility has been considered in this detailed ESCP, prepared by a Certified Professional in Erosion and Sediment Control (CPESC), developed for the full life cycle of the Project. The plan considers and addresses the aforementioned variables in a seasonal context to measure (using the Revised Universal Soil Loss Equation (RUSLE)) and manages the risk of soil erosion from all activities associated with the mine. Soil conservation and general site rehabilitation measures have also been integrated into the detailed ESCP.

The soil erosion hazard for soil families identified across the Project site is generally high as outlined in Table 3-4. However, despite the sodic nature of a large portion of the soils, the classification of Emerson Class 4 for those sites within the Project area lowers the risk of dispersion to low to moderate.

Table 3-4 Risk of dispersion

<table>
<thead>
<tr>
<th>Soil Family</th>
<th>Erosion Hazard</th>
<th>Sodicity</th>
<th>Emerson Class</th>
<th>Risk of Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrosol</td>
<td>High erosion hazard due to concentrated surface water channel flow for two to three months of the year and exchangeable sodium, however these soils are characterised by elevated exchangeable calcium levels providing ionic balance on a minimal slope landscape.</td>
<td>Sodic</td>
<td>Class 4</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Ferrosol</td>
<td>High erosion hazard due to the lack of soil structure and exchangeable sodium, however these soils are characterised by elevated exchangeable calcium levels providing ionic balance on a minimal slope landscape.</td>
<td>Sodic</td>
<td>Class 4</td>
<td>Low to moderate</td>
</tr>
</tbody>
</table>

3.4.2.5 Electrical Conductivity

Electrical conductivity (EC) relates to the degree of salinity in the soil. The higher the EC value, the more soluble salt is present in the soil. Very high to extreme soil salinity is generally a sign of areas that are prone to poor root development except for areas where mangroves are the prime vegetative species.

Samples that were close to water sources were generally rated with soil salinity of very high and extreme, whereas samples that were terrestrial were rated very low. This is to be expected with samples close to water sources predominantly being mangroves.

The mining and majority of the soil impact will take place in areas with soils of low salinity, while the high salinity soils are located primarily in estuarine areas with minimal construction activities and consequent impact proposed, with the exception of construction of the BLF, LBF and some sections of haul roads.

3.4.2.6 Calcium/Magnesium Ratio

A higher portion of calcium will result in ‘loose’ soils with more available oxygen and ability to drain freely. A high portion of magnesium will result in ‘tight’ soils with less available oxygen, poor draining characteristics and will limit the ability of organic matter to break down effectively. Each
A borehole located within the Project area was rated as either very low, low or medium, indicating unfavourable levels of oxygen and soils that are lacking in free draining properties.

### 3.4.2.7 Soil pH Characteristics

Soil pH has a strong influence on the solubility and form of chemical compounds, the availability of ions in the soil solution as well as microbial activity. Plants are fairly tolerant of pH range and it is only if pH is less than 4.5 or greater than 9.0 that pH is likely to have direct effects on plant growth.

Soil pH measured from samples collected across the Project area were generally within the optimum pH range for plant growth (between 5.5 and 7.0) with only a few exceptions. These exceptions were samples S01, S010 and S07 that were within a range of 4.6 to 7.2. This small variance outside the optimal range is not considered significant for plant growth in the area.

### 3.4.2.8 Cation Exchange Capacity and Exchangeable Cations

Cation Exchange Capacity (CEC) is a useful indicator of soil fertility as it demonstrates the soil’s ability to supply the important plant nutrients Ca, Mg, K, and Na. A low CEC indicates low fertility.

The soil laboratory results indicate that the majority of soil samples across the Project area contain CEC levels that are considered to be very low (<6) and low (6 to 12), while a small number of the samples had CEC levels in the moderate range. The following cations were recorded in laboratory results from detailed soil samples:

- Exchangeable calcium results were very low to low;
- Exchangeable magnesium results ranged from very low to high with high variability across the site;
- Exchangeable potassium rating levels vary across the site with samples having exchangeable potassium levels between very low and high; and
- Exchangeable sodium levels also varied across the site, with samples recording levels from very low to very high.

Lower lying clayey soils taken from sample sites located near water bodies typically exhibited higher CECs, whereas tertiary soils with higher silt and sand contents exhibited lower CECs as expected.

### 3.4.2.9 Other Soil Characteristics

The results indicate that the soils in the Project area are generally low in nitrogen, phosphorus and total organic carbon which may lead to impeded growth of vegetation during rehabilitation. Total iron concentrations are high which was evident on site due to the rich red soil colour. Exchangeable Aluminium (Al) has been analysed in the context of plant availability. Desirable Exchangeable Al concentration for plant growth is <0.1 milliequivalent of hydrogen per 100 g of dry soil (meq/100g). Results from the sampling program undertaken in November 2015 in the Weipa Sands topsoil indicate Exchangeable Al range from <0.1 meq/100g to 0.4 meq/100g. These levels of exchangeable Al indicate the potential for alum toxicity within the root zone if the pH decreases below 5.5.
3.4.2.1 Acid Sulfate Soils

The sediments of Skardon River have not been subject to extensive anthropogenic processes or development, with the exception of small levels of disturbance from the previous kaolin mine and other mining operations, recreational fishing and camping.

External to the most recent soil sampling program, sediment investigations were completed in 2014 and 2015 in the Skardon River area including the mouth of the river. However, limited ASS screening was completed with only two core samples taken approximately upstream of the existing Gulf Alumina port facility location. Based on this screening exercise it was determined that any marine sediments that need to be excavated and disposed to land would present a risk of PASS. For this reason, during construction, any marine sediments that need to be excavated will undergo specific ASS testing prior to disturbance to determine an appropriate management and treatment plan, with all material contained within the nominated Project area. Disturbance of marine sediments will be avoided as much as practical and not undertaken without a detailed ASS Management Plan in place.

A review of preliminary historical ASS laboratory results and bore logs constructed to a maximum depth of 6 m indicated the presence of Actual ASS (Chromium Suite Net Acidity ≥ 0.03% sulfur) in a number of samples from surface level to 0.5 m below surface level within the area of investigation. However, the samples with results indicative of ASS are not located in areas that will be mined, so potential impacts are predominantly limited to the initial Project construction period. The risk of disturbing ASS and PASS as a result of direct mining activities is therefore negligible, as these soils are only present in Skardon River channels and banks and its tributaries.

The key activities that have the potential to disturb ASS are vegetation clearing, earthworks (e.g. for borrow pits, haul roads and haul road culverts) and construction of the BLF and RoRo facility. These construction activities will take place in areas closer to water sources where ASS are likely to be present. For construction purposes, soils that occur on the lower-lying Melaleuca and mangrove ecosystems along the Skardon River and tributaries should be treated as PASS. Further, any infrastructure being constructed at or below 5.0 mAHD should be designed with the likelihood of finding ASS and PASS taken into account.

Once final design and construction plans have been approved, and prior to disturbance by construction activities, Metro Mining shall delineate ASS within the proposed disturbance area in accordance with the QASSIT Manual Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland (1998). Once the quantity and quality of ASS have been delineated, identified ASS shall be managed in accordance with Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines (Dear et al., 2014).

3.5 Local Geology

Various publicly available data sources consulted to determine the geomorphology and geology underlying the Project were:

- Surface geological mapping from the Geological Survey of Queensland (1:250,000 Series) (Geoscience Australia (GA) 2008);
- Queensland Globe (Department of Natural Resources and Mines (DNRM) 2015a)) feature of Google Earth; and
- Mines Online Maps (DNRM 2015b).

The Project bauxite deposits are located within the Carpentaria Basin, a sub-basin of the Great Artesian Basin (GAB). The bauxite occurs on plateaus as the upper part of a Quaternary / Tertiary
loose, pisolitic, laterite profile that is up to about 15 m thick. Quaternary alluvial deposits of silt, clay and minor sand occur in the valleys associated with the rivers. The alluvial deposits are derived from Palaeozoic basement rocks that sub crop in the Eastern Highlands.

The bauxite is formed from weathering and leaching of shales and siltstones of the underlying Tertiary / Cretaceous Bulimba Formation and Lower Cretaceous Rolling Downs Group. This has resulted in a “classic” lateritic profile; an upper bauxite layer which is up to 5 m thick, grades over a narrow interval into ferricretes which in turn grade into mottled and silty clays, including kaolinite, with some sandy clay layers. The clays in turn grade into the parent rock at depth, being generally dark grey Cretaceous shales and siltstones.

The Carpentaria Basin, in which the Skardon River Project is located, has been identified as a Jurassic to Cretaceous age (200 to 66 million years before present) basin, covering majority of the Western Cape York Peninsula. The geology that sub-crops across the majority of the Skardon River Project area is the Tertiary age (66 to 2 million years before present) Bulimba Formation.

The underlying geological sequence consists of about 800 m of shales, siltstones and sandstones overlying granite and metamorphic basement rocks which form the ancient, stable rock platform of the continent. Refer Figure 3-5 for the Project’s geology.

Further information about the local geology can be found in Chapter 4 – Land of the EIS.
3.6 Local Climate

The Project lies within the Australian Monsoon Zone and has a Climate Classification of Equatorial – Tropical Savannah using the BoM modified Koppen classification system (BoM, 2014).

The area typically experiences warm wet summers and warm dry winters. The summer wet period is relatively short, lasting from approximately November to March, and occurs with the change in the prevailing south-east trade winds to the north-west monsoons.

A significant influence on the year-to-year weather variability is exerted by the El Nino Southern Oscillation phenomenon, an eastern Pacific system of atmospheric and oceanic interactions which affects the weather worldwide and can result in large variations in the timing and amount of wet season rainfall on Cape York.

The local monthly mean minimum and maximum temperatures indicate that the hottest months of the year for the Project are typically October, November and December, ranging from 34 to 36.1 degrees Celsius (°C). The coolest months of the year across all weather stations are July and August, with monthly mean minimum temperatures ranging from 17.5°C to 18.9°C.

The mean annual rainfall at the broader Project area ranges between 1,640 mm at Old Mapoon to 1,768.8 mm at Weipa.

Further information about Local Climate can be found in Chapter 3 – Climate of the EIS.

3.6.1 Local Temperature

Temperature data for Old Mapoon, Weipa and the Pisolite Hills Project area are presented in Table 3-5 below. The local monthly mean, minimum and maximum temperatures indicate that the hottest months of the year for the Project are typically October, November and December, ranging from 34 to 36.1°C. The coolest month of the year across all weather stations are July and August, with monthly mean minimum temperatures ranging from 17.5°C to 18.9°C.

<table>
<thead>
<tr>
<th>Month</th>
<th>Old Mapoon</th>
<th>Weipa Eastern Ave</th>
<th>Pisolite Hills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Minimum Temperature (°C)</td>
<td>Mean Maximum Temperature (°C)</td>
<td>Mean Minimum Temperature (°C)</td>
</tr>
<tr>
<td>January</td>
<td>22.5</td>
<td>32.7</td>
<td>24</td>
</tr>
<tr>
<td>February</td>
<td>22.5</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>March</td>
<td>22.2</td>
<td>33</td>
<td>23.6</td>
</tr>
<tr>
<td>April</td>
<td>21.9</td>
<td>32.8</td>
<td>22.5</td>
</tr>
<tr>
<td>May</td>
<td>20.5</td>
<td>31.4</td>
<td>21.3</td>
</tr>
<tr>
<td>June</td>
<td>18.8</td>
<td>30.4</td>
<td>19.5</td>
</tr>
<tr>
<td>July</td>
<td>18.1</td>
<td>30.3</td>
<td>18.9</td>
</tr>
<tr>
<td>August</td>
<td>18.1</td>
<td>30.6</td>
<td>18.8</td>
</tr>
<tr>
<td>September</td>
<td>19.2</td>
<td>32.4</td>
<td>20</td>
</tr>
<tr>
<td>October</td>
<td>20.7</td>
<td>34</td>
<td>21.4</td>
</tr>
<tr>
<td>November</td>
<td>21.7</td>
<td>35</td>
<td>23.2</td>
</tr>
<tr>
<td>December</td>
<td>22.5</td>
<td>34.7</td>
<td>23.9</td>
</tr>
</tbody>
</table>
3.6.2 Wind Roses

The Bureau of Meteorology data and the The Air Pollution Model (TAPM) was used to determine wind direct and speed. The wind roses, for the Project, are presented in Figure 3-6. The dominant wind direction is from east and east-southeast during spring, autumn and winter, whilst in summer the wind is strongest from the northwest. It is noted that the Project does not propose to operate over the summer (wetter) period. The predominant winds will transport the pollutants away from any receptors of concern. Overall, the meteorological data generated by The TAPM is considered to be representative of the site.

A review of the annual wind speeds has determined that:

- The winds were calm for 0.38% of the year;
- The winds were 0.5 to 3 m/s for 53% of the year;
- The winds were 3 to 5 m/s for 36% of the year; and
- The winds were greater than 5 m/s for 11% of the year.

3.6.3 Rainfall

Rainfall data for Old Mapoon, Weipa and the Pisolite Hills project area are presented in Table 3-6. The mean annual rainfall at the broader Project area ranges between 1,640 mm and Old Mapoon to 1,768.8 mm at Weipa. As discussed, there are clear wetter and drier months in the area. The Project can typically experience 90 days of precipitation per annum. The driest period is between June and August where mean rainfall is less than 2 mm for these months.

<table>
<thead>
<tr>
<th>Month</th>
<th>Old Mapoon</th>
<th>Weipa Eastern Ave</th>
<th>Pisolite Hills</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>421.1</td>
<td>448.8</td>
<td>425.3</td>
</tr>
<tr>
<td>February</td>
<td>411.2</td>
<td>444.9</td>
<td>361.8</td>
</tr>
<tr>
<td>March</td>
<td>308.4</td>
<td>347.4</td>
<td>337.8</td>
</tr>
<tr>
<td>April</td>
<td>94.8</td>
<td>108.1</td>
<td>136.6</td>
</tr>
<tr>
<td>May</td>
<td>18.7</td>
<td>16.8</td>
<td>9.2</td>
</tr>
<tr>
<td>June</td>
<td>4.2</td>
<td>4.3</td>
<td>1.5</td>
</tr>
<tr>
<td>July</td>
<td>2.7</td>
<td>1.7</td>
<td>3.7</td>
</tr>
<tr>
<td>August</td>
<td>1.1</td>
<td>2.8</td>
<td>23.3</td>
</tr>
<tr>
<td>September</td>
<td>4.0</td>
<td>5.6</td>
<td>8.3</td>
</tr>
<tr>
<td>October</td>
<td>11.1</td>
<td>25.2</td>
<td>40.2</td>
</tr>
<tr>
<td>November</td>
<td>63.8</td>
<td>103.0</td>
<td>106.5</td>
</tr>
<tr>
<td>December</td>
<td>228.9</td>
<td>259.6</td>
<td>286.1</td>
</tr>
<tr>
<td>Total</td>
<td>1,640.0</td>
<td>1,768.8</td>
<td>1,740.1</td>
</tr>
</tbody>
</table>
Figure 3-6
Seasonal wind direction

Legend
- Town
- Watercourse
- Barge Loading Area
- Accommodation Camp
- Haul Road
- Pit Extents
- Mine Lease Area

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
NEC Mining, 1N37M v1 Geoscience-Australia 2011; QLD Government Open Source Data; Australian Hydrological Geospatial Fabric; Geofabric PRODUCT SUITE v2.1.1

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For Information
15/07/15
3.6.4 Intensity Frequency Duration 5 Day Rainfall Event

Table 3-7 contains Intensity Frequency Duration values for various average recurrence intervals (ARI) and durations for the area, and this information has been utilised in the design calculations.

Table 3-7 Intensity Frequency Duration values for the site

<table>
<thead>
<tr>
<th>Duration</th>
<th>1 Year</th>
<th>2 years</th>
<th>5 years</th>
<th>10 years</th>
<th>20 years</th>
<th>50 years</th>
<th>100 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mins</td>
<td>163</td>
<td>205</td>
<td>243</td>
<td>266</td>
<td>300</td>
<td>345</td>
<td>381</td>
</tr>
<tr>
<td>6 mins</td>
<td>152</td>
<td>191</td>
<td>227</td>
<td>249</td>
<td>281</td>
<td>324</td>
<td>357</td>
</tr>
<tr>
<td>10 mins</td>
<td>128</td>
<td>161</td>
<td>191</td>
<td>210</td>
<td>237</td>
<td>273</td>
<td>301</td>
</tr>
<tr>
<td>20 mins</td>
<td>100</td>
<td>126</td>
<td>150</td>
<td>164</td>
<td>185</td>
<td>214</td>
<td>236</td>
</tr>
<tr>
<td>30 mins</td>
<td>84.2</td>
<td>106</td>
<td>126</td>
<td>138</td>
<td>156</td>
<td>180</td>
<td>199</td>
</tr>
<tr>
<td>1 hr</td>
<td>57.5</td>
<td>72.6</td>
<td>86.8</td>
<td>95.4</td>
<td>108</td>
<td>125</td>
<td>138</td>
</tr>
<tr>
<td>2 hrs</td>
<td>35.4</td>
<td>44.8</td>
<td>54.0</td>
<td>59.6</td>
<td>67.6</td>
<td>78.6</td>
<td>87.2</td>
</tr>
<tr>
<td>3 hrs</td>
<td>25.8</td>
<td>32.7</td>
<td>39.5</td>
<td>43.7</td>
<td>49.7</td>
<td>57.9</td>
<td>64.4</td>
</tr>
<tr>
<td>6 hrs</td>
<td>14.6</td>
<td>18.6*</td>
<td>22.8</td>
<td>25.3</td>
<td>28.9</td>
<td>33.9</td>
<td>37.8</td>
</tr>
<tr>
<td>12 hrs</td>
<td>8.56</td>
<td>10.9</td>
<td>13.5</td>
<td>15.1</td>
<td>17.4</td>
<td>20.6</td>
<td>23.0</td>
</tr>
<tr>
<td>24 hrs</td>
<td>5.30</td>
<td>6.83</td>
<td>8.62</td>
<td>9.75</td>
<td>11.3</td>
<td>13.5</td>
<td>15.3</td>
</tr>
<tr>
<td>48 hrs</td>
<td>3.32</td>
<td>4.32</td>
<td>5.60</td>
<td>6.43</td>
<td>7.57</td>
<td>9.16</td>
<td>10.5</td>
</tr>
<tr>
<td>72 hrs</td>
<td>2.38</td>
<td>3.12</td>
<td>4.09</td>
<td>4.75</td>
<td>5.63</td>
<td>6.88</td>
<td>7.91</td>
</tr>
</tbody>
</table>

*The 2 year ARI, 6 hour rainfall event (mm) is used in determining the monthly and annual rainfall erosivity factors (R factor) in accordance with the IECA Guidelines. This factor is used to calculate average annual soil loss (refer Section 4.1) based on long-term rainfall records.

3.6.5 Rainfall Events

The five day rainfall depths, based on rainfall intensity values for Weipa were utilised, due to the close proximity of the two locations. Relevant values are presented in Table 3-8.

The 90th percentile five day rainfall event (62.7 mm) has been used in the design of any sediment controls required on site. This is in accordance with IECA (Table B5) and is the conservative percentile to use in the instance as any sediment generated across the Project site will likely discharge to Skardon River, a sensitive receiving environment.

Table 3-8 Rainfall Event Data for Weipa

<table>
<thead>
<tr>
<th>5-day rainfall depths (mm)</th>
<th>75th percentile</th>
<th>80th percentile</th>
<th>85th percentile</th>
<th>90th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28.7</td>
<td>35.8</td>
<td>46.2</td>
<td>62.7</td>
</tr>
</tbody>
</table>
3.7 Determining the Sediment Control Standard

To ensure the prescribed ESCs identified for the site meet the site's soil conditions and potential environmental risk, the soil survey results used to inform the Land Chapter of the EIS have been used to determine baseline conditions. This survey program was completed by an experienced Certified Professional Soil Scientist (CPSS) and CPESC.

The objective of the soils investigation was to provide localised background soil data to assist in understanding the baseline conditions and informing the construction phase in terms of the stripping and handling of soils. The information obtained is also suitable to be used for developing the site's ESCs. This information further assists in reducing environmental risk and potential costs associated with civil works. This is achieved by identifying problematic soils in the planning phase and providing the opportunity for mitigation measures to be integrated into construction methodology. This has been addressed in this ESCP, taking into account construction schedule and current infrastructure footprints.

The sediment control types are nominated in Section 4.
Section 4  Erosion Hazard and Erosion Risk

A soils erosion hazard and soil erosion risk assessment is important when determining the appropriate controls to be implemented across the Project during the construction phase. These two elements are defined as:

- **Soil erosion hazard** is the susceptibility of a parcel of land to the main causes of erosion (rainfall erosivity, slope, soil type, flow concentration and ground cover); and

- **Soil erosion risk** is the likelihood of environmental harm occurring as a result of erosion.

### 4.1 Erosion Hazard Assessment

Conducting an erosion hazard and risk assessment provides important information pertaining to the required ESC standards to be applied to a site. RUSLE from IECA 2008, Appendix E, page E.3 was used as part of the soil risk assessment. The formula is as follows:

\[
A = K \times R \times LS \times P \times C
\]

Where:
- \(A\): is the predicted soil loss per hectare per year
- \(K\): is the soil erodibility factor
- \(R\): is the rainfall erosivity factor
- \(LS\): is the slope length/gradient factor
- \(P\): is the erosion control practice factor
- \(C\): is the ground cover and management factor

Each Mining Lease Application area (MLA) has been divided into sub-catchments (refer to sub-catchment numbers on ESC Design Drawing) based on nominated surface water flow directions and expected topography. Pre-mined (existing) topography was used in the initial conceptual ESC planning phase, where overall sub-catchments were rated based on the expected soil loss class. Sub-catchments have since been delineated for the mining phase including the mining pits and have been done so based on the assumption that a perimeter bund and external cut-off drain will keep water from flowing into the mining pits (refer ESC Design Drawing). It has also been assumed any water that falls within the mining pits will be contained within the pit and infiltrate through the mine pit floor with no actual surface water discharge over the mine pit walls. This allows for the mine pits to act as self-contained catchments.

For each of the sub-catchments, soil loss calculations have been completed using the topography layers and slope lengths. Results of these calculations are shown in Appendix A. The appended calculations have used conservative (steepest) slopes, allowing the nominated ESCs to be sufficient for the worst case scenario.

The following factors were used in these calculations.

**Soil Texture (K Factor)**

The texture of the soil varied across the site, with soils being classified as clayey sands through to heavy clays.

Based on Table E4 in the IECA Guidelines, a K-factor of 0.036 has been adopted across the site for soil loss calculations. This is a conservative number as it reflects the worst case scenario from
laboratory testing of soil (0.03) and has had a factor of 20% applied to it to account for dispersive soils.

**Rainfall Erosivity (R Factor)**

Rainfall erosivity (R factor) is a measurement of the energy associated with rainfall events. The 2 year ARI 6 hr rainfall event (18.6mm) has been used to calculate the R-factor for Skardon River using the following formula:

\[ R = 164.74 \times (1.1177)^S \times S^{0.6444} \quad (IECA, E3.2) \]

Where:

- \( S \) is the 2 year ARI, 6 hr rainfall event (mm)

The annual R factor for the area is 8585. A final R-Factor of 979 has also been applied across the Project site based on the nominated months in which mining will take place as described in Section 4.2. This has been calculated using the monthly percentage of rainfall (11.4% from April to November) for the Weipa area, as the Project site is in close proximity to Weipa, and the annual R-factor for Skardon River. The monthly percentages for these values in Table 4-1 below (IECA Table E2).

**Table 4-1 Monthly percentage and annual rainfall erosivity (R-factor) values**

<table>
<thead>
<tr>
<th>Location</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weipa</td>
<td>26.9</td>
<td>27.9</td>
<td>18.8</td>
<td>4.5</td>
<td>0.4</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>1.1</td>
<td>5.1</td>
<td>15.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*IECA, Table E2*

**Cover (C Factor)**

A C-factor of 1 has been applied to each of the sub-catchments. This value represents no cover and is the worst case scenario adopted when topsoil stripping is going to take place as is the case with bauxite mining.

**Erosion Control Practice Factor (P Factor)**

A P-factor of 1.3 has been applied to each of the sub-catchments. This is for compacted and smooth surfaces and is the default construction phase condition.

### 4.1.1 Sediment Type Controls

The minimum sediment control types required have been identified for each sub-catchment based on the expected soil loss rate. The RUSLE calculations completed for each of the sub-catchments identified across the Project site returned a minimum sediment control Type 3 device for all sub-catchments.

Table 4-2 below identifies typical Type 1, 2 and 3 devices based on soil loss rates.

**Table 4-2 Minimum sediment control standards based on soil loss**

<table>
<thead>
<tr>
<th>Soil Loss Rate (t/ha/year)</th>
<th>Sediment Control Technique</th>
<th>Default Sediment Control Treatment Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 75</td>
<td>Type 3</td>
<td>Sediment fence, sediment trap</td>
</tr>
<tr>
<td>75 to 150</td>
<td>Type 2</td>
<td>Filter tube dam, rock filter dam, sediment trench, sediment weir, compost/mulch berm</td>
</tr>
</tbody>
</table>

1 Information sourced from Table 4.5.1 and Table 4.5.3 of Section 4 IECA 2008.
4.2 Outcome of Erosion Risk and Hazard Assessment

The approach that has been adopted throughout the erosion hazard assessment is one that allows the worst case scenario to be identified taking into account available information around construction timing.

A yearly predicted soil loss rate was initially determined based on an annual R-Factor of 8585. This resulted in a minimum sediment control device of Type 3 (0 to 150 t/ha/year of soil loss) for 19 of the 23 sub-catchments and a minimum sediment control device of Type 2 (151 to 225 t/ha/year) for the remaining sub-catchments.

Metro Mining has nominated that all works will be undertaken between April and November which coincides with the drier season (typically April to November). Due to the seasonal variation at the Project site in terms of rainfall, a revised minimum sediment control type has been nominated based on an R-Factor of 979. This is a combined total of 11.4% of the yearly rainfall erosivity representing the monthly rainfall erosivity for April through to November (IECA Book 2, Tables E1 and E2). The resulting minimum sediment controls are all Type 3 across the Project site, which in some instances is lower than the minimum sediment control device type required when a full yearly rainfall erosivity value is applied.

Although Metro Mining is only operating during the drier seasons, the nominated controls will also remain in place for the duration of the wetter months, where the mine will be in ‘stand down’ mode. Metro Mining will have a skeleton crew onsite during this time, with staff ensuring that controls are maintained and repaired as required. Prior to site stand down period, a site close-out inspection checklist will be completed (refer Appendix E). This will include ensuring that all disturbed areas have been sufficiently stabilised (e.g. mine pit locations using Stonewall or something similar). The skeleton crew will complete weekly checks of the site and repair any ESCs as required. The close-out inspection checklist will also form the basis for this weekly inspection.

As the Project location is in close proximity to a sensitive receiving environment (Skardon River and its tributaries), the erosion hazard assessment has taken both the expected soil loss rate and the surrounding environment into consideration. Trafficable areas (external to the actual mine pits) including haul and access roads have been nominated Type 2 devices as a minimum because these traverse through marine tidal and mangrove areas. A heavy focus on erosion control has also been placed on these areas due to the potential to be inundated by storm tides.

The associated calculations for each of the scenarios presented in Table 4-4 (R-Factor of 8585 and 979) are shown in Appendix A.

<table>
<thead>
<tr>
<th>Sub-catchment</th>
<th>Predicted Soil Loss Rate (t/ha/year) (Yearly Erosivity)</th>
<th>Sediment Control Device Type</th>
<th>Predicted Soil Loss Rate (t/ha/year) (Construction Erosivity)</th>
<th>Sediment Control Device Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>138</td>
<td>Type 3</td>
<td>32</td>
<td>Type 3</td>
</tr>
<tr>
<td>1</td>
<td>84</td>
<td>Type 3</td>
<td>19</td>
<td>Type 3</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>Type 3</td>
<td>16</td>
<td>Type 3</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>Type 3</td>
<td>40</td>
<td>Type 3</td>
</tr>
<tr>
<td>4</td>
<td>89</td>
<td>Type 3</td>
<td>33</td>
<td>Type 3</td>
</tr>
<tr>
<td>5</td>
<td>199</td>
<td>Type 2</td>
<td>49</td>
<td>Type 3</td>
</tr>
<tr>
<td>Sub-catchment</td>
<td>Predicted Soil Loss Rate (t/ha/year) (Yearly Erosivity)</td>
<td>Sediment Control Device Type</td>
<td>Predicted Soil Loss Rate (t/ha/year) (Construction Erosivity)</td>
<td>Sediment Control Device Type</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>6</td>
<td>216</td>
<td>Type 2</td>
<td>51</td>
<td>Type 3</td>
</tr>
<tr>
<td>7</td>
<td>158</td>
<td>Type 2</td>
<td>47</td>
<td>Type 3</td>
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<tr>
<td>8</td>
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<td>Type 3</td>
<td>17</td>
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</tr>
<tr>
<td>28</td>
<td>123</td>
<td>Type 3</td>
<td>24</td>
<td>Type 3</td>
</tr>
</tbody>
</table>

As previously noted, any areas that present a higher risk in terms of ESC, particularly during construction, will have Type 2 control devices despite the predicted annual soil loss allowing for Type 3 devices across the Project site. Specific controls, including the location of nominated controls, are provided in Section 5.5.
Section 5  Management Measures

5.1 Roles and Responsibilities

The roles and responsibilities for employees, as they relate to ESC, are described below:

- **Project / Operations Manager:**
  - Ensure appropriate resources are available for the implementation of this ESCP;
  - Ensure effective implementation of controls nominated throughout the ESCP;
  - Ensure any identified potential or actual ESC issue is reported in accordance with legislative requirements and Metro Mining's corporate standard; and
  - Request and/or approve revisions of this plan as required.

- **Site Environmental Manager:**
  - Ensure appropriate resources are available for the implementation of this ESCP;
  - Manage and maintain the ESCP;
  - Ensure effective implementation of controls nominated throughout the ESCP and in the ESC Design Drawing;
  - Ensure ESCs are allowed for and taken into consideration with all infrastructure and construction;
  - Ensure surface water management controls are implemented;
  - Ensure any identified potential or actual ESC issue is reported in accordance with legislative requirements and Metro Mining's corporate standard;
  - Ensure monitoring and inspections take place and are accurately recorded and reported;
  - Provide leadership in relation to ESC;
  - Ensure any operational changes take ESC into account;
  - Prepare internal and external environmental reports as required;
  - Ensure all reporting complies with internal and external monitoring standards;
  - Coordinate incident investigations if required and ensure successful implementation of any mitigation measures;
  - Coordinate the ongoing review of the ESCP; and
  - Ensure all relevant employees and contractors receive general awareness training in accordance with this plan.

- **All employees and contractors:**
- Ensure effective implementation of this plan with respect to employee’s work area; and
- Ensure any potential or actual incidents related to ESC are reported to the Environmental Manager.

5.2 General ESC Risks and Management Strategies

There are a number of potential environmental impacts associated with general construction activities. These and the appropriate ESCs have been outlined below.

- **Exposure of soil to erosive forces (wind and rain) during earthworks** will be an ongoing potential environmental impact. Soil erosion and sediment transport can result in increased nutrient, sediment, salt and other contaminant concentrations being deposited into receiving waters. This can lead to a deterioration of water quality and of aquatic environmental health. Sedimentation in vegetated (including seagrass) areas can also result in reduced vegetation growth and health.

- **Mining** poses the risk of modification of natural overland flow paths as a result of the project. As well as resulting in risks similar to those outlined above (deposition of sediment into receiving waters), this can increase erosion and cause significant rilling.

- **Entrainment of sediment off site by construction vehicles and machinery** can also result in increased nutrient, sediment, salt and other contaminants in receiving waters as well as the deterioration of water quality and of aquatic environmental health.

- **Construction of mine infrastructure (including accommodation camps, accommodation camp access roads and the sewerage treatment plant)** can result in soil exposure and erosion and subsequent sedimentation.

- **Haul road crossings** present the risk of high environmental impacts and as such, have been discussed in detail in Section 5.3.1.3.

5.2.1 Construction Program

The key ESC strategy that will be adopted across the site utilises the wetter and drier seasons typical of the area around Skardon River. Metro Mining will undertake all construction and mining activities during the drier months of April to November, thereby greatly minimising the erosion risk and enabling any work areas to be either rehabilitated or stabilised with the required cover prior to the onset of the wetter months. The proposed construction schedule and the reduced rainfall expected to impact the Project due to site closure during the wetter months, has allowed for lower level ESCs to be used for the Project, whilst still ensuring that the necessary legislative requirements, including those pertaining to sediment retention and storm events, are achieved.

The ESCs nominated in this plan are to be in place before any clearing and construction works take place, and must remain in place until final rehabilitation has been completed and stable site achieved.

5.2.2 Disturbance Minimisation

The main land disturbance areas, and therefore the areas identified as the predominant risk for increased erosion and release of sediments for the Project, result from land clearing, open cut mining excavations, mine infrastructure, construction of haul roads and the construction of the BLF
and RoRo Facility. Mitigation measures to limit the impacts of land disturbance include the following:

- As an overriding principal, minimising all land disturbance, including vegetation clearance, to only that immediately required to achieve the mine plan;

- Where possible, vehicle movements will be restricted to nominated construction and haul roads to minimise ground and vegetation disturbance;

- Works will be scheduled to minimise the area of active disturbance at any one time, in accordance with construction timeframes; and

- Nominated ESCs will be installed in predetermined locations around the site in particular downslope of any disturbed lands. The instillation of effective ESC measures will assist in minimising impact on the surrounding environment.

### 5.2.2.1 Vegetation Clearing

All works involving the clearing or interference with on-site vegetation should conform to the following requirements;

- Minimise forward clearing during months of high or extreme rainfall;

- Land clearing limited to an area of land suitable to complete eight weeks' worth of construction or mining work if rainfall is predicted (as per IECA Table 4.4.7);

- Maximum of 50 days after commencement of site stabilisation before specified minimum ground cover (e.g. organic or rock mulch, synthetic blankets, vegetation or combination thereof) is achieved in all areas with the exception of active areas including haul roads and mine pits;

- Root stock must be retained in the ground after clearing to reduce erosion and to facilitate rapid rehabilitation, where possible. This is excluding areas of permanent infrastructure, access routes, mining pits or where operational activities may be impacted. This should be achieved for intertidal areas;

- Vegetation should be progressively cleared to minimise the area of soil exposed;

- Identify, isolate and protect all mature native vegetation where appropriate. Protected vegetation areas should be identified and clearly marked out on site before commencing clearing works; and

- Vegetation that is cleared should be either mulched and used to stabilise exposed soils on site or strategically placed to provide habitat for local fauna.

A nominal 20 m wide ‘work area’ has been allowed for around the edge of each of the mine pits for machinery and other work-related needs as identified on the ESCP Design Drawing. This work area has a perimeter mulch berm to treat any dirty water generated in the work space. This additional cleared area has been nominated to provide sufficient work space for Metro Mining to complete necessary construction activities. Should this limit be exceeded, flow diversion berms must be installed in any cleared areas in accordance with Section 5.5.5.

### 5.2.2.2 Earthworks

All earthworks and ground disturbance should conform to the following minimum standards:
Use of any existing clearings through riparian vegetation, if any, must be maximised while new clearing is minimised;

Construction activities in watercourses must cease if a risk assessment indicates that any forecast rainfall event could cause unacceptable environmental harm or impact on safety. Construction activities may not recommence until a site inspection has determined that the watercourse has returned to stable flow (or no flow) conditions. Works to be completed in accordance with the Waterway Crossing Work Method Procedure (Appendix D); and

Diverting uncontaminated stormwater run-off around areas disturbed by construction activities and/or other potentially contaminating activities; and

5.2.2.3 Access Tracks

Existing tracks or final access road alignments are to be used whenever possible. The duplication of parallel / multiple tracks or turnouts shall be avoided;

Access track drains should discharge runoff water in a manner which does not lead to erosion or movement of sediment to surface waters;

Vehicle movement over both retained vegetation and newly cleared areas where the topsoil is yet to be stripped should be minimised;

Suitable sheeting material will be placed on all internal haul roads to provide additional cover and minimise sediment runoff, as well as providing suitable all weather access. Due to limited availability of rock and gravel in the area or located within an economical distance of the Project site, Metro Mining will explore the use of bauxite as an alternate sheeting material;

Maximum permitted vehicle speeds should be established;

Stabilisation of access tracks that are to be exposed for prolonged periods or have been identified as problem soils (erosive/dispersive) should be considered. This may include use of chemical surface stabilisers or physical alternatives such as crushed rock;

All construction vehicles, plant and equipment are only permitted within designated construction areas, and are not allowed within any “No-Go” or environmentally sensitive exclusion zones (i.e. mangrove area adjoining the Skardon River). Vehicle movement within the site must remain on designated site access routes; and

Controls should be at entrances and exits of access tracks that track to public roads.

Construction of new access tracks may be required throughout the life of the mine. Where new access tracks are proposed, these will be constructed under the appropriate approvals. Where possible, access tracks will be constructed so as to:

Maintain a vegetation buffer between any access track and nearby watercourses;

Be positioned along contour lines limiting grade changes;

Minimise the disturbance of existing ground; and

Limit construction taking place across existing drainage lines or, where construction across drainage lines is unavoidable, provide a means for the transport of water preventing concentrated runoff.
5.2.3 Topsoil Management

Maintaining the integrity of the topsoils stripped prior to mining is integral for final rehabilitation, as these soils are necessary for future regeneration of vegetation in the area. Compaction, as a result of handling wet soils or stockpiling soils for extended periods of time, may greatly reduce soil quality. The following mitigation measures have been described in Section 4.8 – Land of the EIS in relation to soil handling:

- No topsoil stripping works should occur during significant rainfall events or when significant rainfall events are expected;
- Following clearing, topsoil will be stripped to an average 200 mm depth across all of the mining areas, however if deeper topsoil resources are located, the maximum amount of topsoil that is available will be collected;
- Topsoil stripping will be carefully timed in accordance with site conditions, once topsoil moisture following the wetter months has decreased enough to minimise compaction issues;
- Any grass or understorey vegetation that has been left following clearing will be incorporated into the topsoil to retain the biological activity of the stored topsoil and provide propagules for regrowth which will stabilise the stockpiles during storage or provide a natural seed store for rehabilitation;
- Where topsoil is being stripped within an economic distance of a prepared rehabilitation area, topsoil will be directly placed on the rehabilitation area without stockpiling. Note that this will be a focus for mine planning, so that direct placement is maximised for the Project. Where this will not be feasible, topsoil stockpiles will be constructed;
- Where practicable, soils should be replaced in the order of excavation;
- The height of topsoil stockpiles will be minimised where possible, and will typically be 2 m in height with suitable batters (generally 1:3);
- Topsoil stockpiles will be stored on the high side of slopes and will be stored separately from subsoils; and
- Topsoil will not be used as backfill material.

5.2.4 Stockpile Management

- Where possible, stockpiles should be located 100 m away from drainage lines / waterways;
- Stockpiles which are exposed for prolonged periods or have been identified as problem soils should be assessed and be stabilised where required using chemical surface stabilisers or by other acceptable methods (e.g. Stonewall or something similar);
- Excavated soil must be stockpiled separately from other materials (e.g. vegetation), where it can be readily recovered for reuse; and
- Stockpiles should not impede natural or constructed surface drainage channels or access tracks.
5.2.5 Soil Treatment

- In areas where there is little topsoil or there is evidence of existing salinity, topsoil may be ameliorated with mulch, or another approved ameliorant (i.e.; gypsum) to facilitate revegetation.

5.2.6 Surface Water Management

The following measures are provided to specifically manage impacts to local waterways:

- Maintain average slope gradients as close as possible to pre-existing slope gradients, whilst allowing for natural drainage;

- The erosion potential of longer slopes will be minimised through the use of contour diversion berms;

- Minimise slopes gradients adjacent to waterways. Banks have naturally steeper gradients and as such, care should be taken to ensure that these gradients are not unnecessarily increased;

- Earthworks that are being carried out adjacent to a water course, e.g. the haul road crossings, the BLF, RoRo Facility and MIA that are in places less than 40 m from a water course will:
  - Be revegetated and stabilised immediately on completion of the work wherever possible;
  - Minimise slope gradients while maintaining appropriate drainage requirements in areas adjacent to creeks (i.e. within 40 m from the water course);
  - Have temporary earth banks (or other appropriate controls) installed along cleared slopes, diverting dirty water away from the watercourse and into vegetated area;

- Where it is not possible to maintain riparian vegetation, any vegetation that has been cleared near waterways should be removed from the area and stockpiled away from the watercourse with appropriate erosion controls;

- Wherever possible, work that crosses drainage lines will be scheduled for construction early in the dry season, allowing enough time for backfilling and stabilisation prior to the onset of the wet season; and

- All water that discharges to a waterway will meet nominated Project-specific water quality criteria, as listed in Chapter 9 – Water Quality of the EIS.

5.2.7 Storm Surge and Storm Management

There is limited storm surge data available for the Skardon River. A detailed storm tide assessment has been carried out at Weipa by WorleyParsons (2008) which has been used to provide an indication of likely storm tide conditions for the Skardon River. The assessment found that the potential for a high storm tide (combined tide and surge) to occur at Weipa was reasonably low, with a 100 year ARI of approximately 2m AHD (compared to an HAT level of 1.63m AHD). The reasons for the predicted relatively low storm tide level was mainly a result of less intense cyclones tending to occur in the area and the likelihood that a rare severe cyclone crosses at the same time as a spring high tide is very low. Based on this analysis and combined with high water levels for the Skardon River expected to be similar as at Weipa, the storm tide levels for the Skardon River are expected to be comparable to Weipa and therefore storm tides are not considered to present a
significant risk in the area. To further minimise the risk of environmental harm in the event of unpredicted high storm tides the following should be completed:

- No temporary storage or laydown areas to be constructed within the storm surge zone; and
- The use of sediment controls within the storm surge zones is to be minimised with the focus on erosion control. Where erosion control is constructed within these zones, particularly the haul roads, the materials will be of a nature suitable for this environment, mainly geofabric and larger rock.

The high storm tide (2 mAHD) has been shown on the ESC Design Drawing (Appendix B) as a blue line. Areas lower than this may become inundated on occasion.

### 5.2.8 In Stream Works / Waterway Crossings

In stream works and works within watercourses (including Skardon River and its tributaries) may need to take place, including removal of riparian vegetation for the construction of the BLF and RoRo facility. Works within these zones will only commence after the necessary approvals have been sought.

Nine permanent waterway crossings have been nominated along the two main haul roads (refer Figure 5-1). Crossings include reinforced concrete box culverts and reinforced concrete pipes. ESCs must be installed during construction of permanent waterway crossings.

A waterway crossing procedure has been developed as part of this ESCP and should be followed for any instream works and or works within a watercourse, refer to Appendix D.

### 5.2.9 Revegetation

Disturbed areas are to be revegetated as soon as practicable after the completion of any earth disturbance works. All revegetation efforts and construction work therefore should confirm to the following:

- Upon completion of construction works the area of disturbance will be reinstated in accordance with pre-determined rehabilitation objectives;
- Staged rehabilitation should be undertaken where possible. Rehabilitation includes the reinstatement/amelioration of subsoil and the placement of topsoil.
- Re-vegetation/rehabilitation activities will be in accordance with desired rehabilitation objectives and will generally include but not be limited to the following strategies:
  - Strategic reburial of excavated material/spoil (during backfilling activities);
  - Scarification of subsoil;
  - Respreading of topsoil (and included seed bank stock) to facilitate natural revegetation;
  - Revegetation of waterway crossings as soon as practical after completion of reinstatement;
  - Inspect the disturbance areas and maintain ESC measures as necessary during and after construction, until stabilisation is achieved. Stabilisation is achieved when there
is at least 60% cover within 30 days following completion of works (with the exclusion of mine pit areas and haul roads) as per IECA Table 4.4.7; and

- Disturbed creek banks and water courses must be rehabilitated to the extent practicable with vegetation consistent with the pre-cleared area and adjacent ecosystem.

5.2.10 Dust Control

Dust will be maintained using water trucks on the haul roads and in the mining pits. Water trucks and sprays will be deployed in the stockpiling, conveying and industrial areas as required.
5.2.11 Landform

Progressive rehabilitation blocks will be identified in the annual mine plan, based on a sufficient area of mined land that can be easily and logically worked by the available equipment and that will not negatively impact on the existing or future mining operations. A conceptual final landform design is provided in Chapter 4 – Land of the EIS however; as per the mine plan, the final landform and drainage design will be developed in more detail and incorporated into the annual Plan of Operations.

At a minimum, final landform design will be similar to that which was in the area pre-mining as all pits will be backfilled with subsoil and topsoil. It is anticipated that the final landform of mined areas will be lower than the natural surface elevation resulting in a general depression across the landscape. It is anticipated the rainwater that falls within the depressions will infiltrate through the mine pit floor. It is anticipated these areas will not have any slopes at a greater than 1:3 (V:H) ratio except in locations where this is consistent with the existing landscape or the EA conditions.

5.3 High Risk Construction Activities / Areas

Intertidal and marine areas are nominated as high risk areas as these are sensitive receiving environments and construction in these areas has the potential to disturb protected marine vegetation, disturb ASS and PASS, impact on water quality and interfere with surface water flow regimes.

The high risk areas and construction activities identified in Section 1.1 that have the potential to impact the environment have been identified below.

5.3.1.1 Barge Loading Facility

The proposed BLF will be located adjacent to the MIA containing the product stockpiles. The proposed berth is to be located at the river bend at the downstream extent of MLA 100051 (refer Figure 5-2) in deep water to achieve an alongside depth of 4.5 m at lowest astronomical tide (LAT).

The BLF consists of the following components:

- A causeway of approximately 100 m in length, with a 6 m wide crest;
- A piled jetty;
- A loading head deck to support the barge loader, to provide a small working deck for maintenance access to the barge loader, to provide access to berthed vessels and to allow turn-around space for vehicles; and
- Berthing Dolphins to act as a series of structures to berth the vessel against and to provide mooring points for the vessel.

The work activities associated with the construction of the BLF include the construction of 35 jetty bents, 10 dolphin structures with piles and fenders, the loading head deck structure (piles and slabs), as well as the installation of the dolphin bollards, the dolphin walkways, jetty roadway deck units, jetty conveyor and the loading conveyor.

The core of the causeway will be constructed from locally-won material if available or imported material that will be barged to site, which will be placed and compacted in layers. The sides of the core will be covered in geotextile and then armoured using imported durable rock. Typically these
rocks will have an average diameter of approximately 350 mm. This rock armouring will prevent erosion of the causeway.

A reinforced concrete abutment will be constructed at the seaward end of the causeway. This abutment will be constructed using conventional methods, involving excavation to the formation level, placement of blinding concrete to obtain a working base at the level of the underside of the abutment, placement of formwork and reinforcing steel cage and placement and compaction of the concrete.

The jetty construction will be performed with an over-the-top method. Marine access in the tidal zone is not suitable for floating equipment. All over-the-top build shall be serviced from the landward side.

5.3.1.2 Roll On/Roll Off Facility

The RoRo facility will be constructed adjacent to the MIA. The facility includes a concrete barge ramp to facilitate the unloading of cargo. The ramp will be located at approximately mean sea level to allow access at high tide by barges. To limit mangrove removal the ramp will be located at the narrowest section of mangroves that adjoins the MIA.

There is a requirement to clear mangroves to provide a construction clearance width of 15.0 m to allow for a ramp width of 7.2 m. The access roadway is reduced to 5.0 m nominal width, with ends of the reno-mattress providing protection to the edge of the fill.

The design allows for the excavation of the mangrove mud below the ramp and its replacement with gravel fill to minimise settlement. A reno-mattress layer will be used to prevent erosion of the fill material in a flood situation. A filter cloth layer will be placed below the reno-mattress to prevent the loss of fines from the fill due to tidal action. A layer of crushed gravel above the reno-mattress to protect the reno-mattress and provide a uniform running surface. This layer will require periodic re-leveling and trimming. Prior to the placement of any construction material on the natural ground a lime guard layer will be placed over the construction footprint. This layer will minimise the risk of oxidation of the insitu PASS material which may have been exposed after clearing and excavation works.

The construction sequence and methodology for the RoRo facility will commence with the testing of mangrove mud for PASS prior to the commencement of construction. If PASS is confirmed then the Acid Sulfate Soils Management Plan (ASSMP) will be implemented.

Clearing of mangroves will occur initially by hand with silt fences installed on stakes on the perimeter of the ramp works. The initial area of inshore mangroves will then be cleared from on-land using a swamp dozer at low tide. This will include excavating a small volume of material from below the low tide zone. Mangrove mud will be excavated and replaced with a gravel fill at low tide. Mangrove mud will be taken ashore and managed in accordance with the ASSMP.

Imported clean rock fill will be used in order to limit the requirement for compaction, to limit settlement and to reduce the generation of sediment that will cause turbidity during construction. Mangroves will be removed to allow barge access to the toe of the constructed ramp. A lime blanket will be placed on the insitu material to ensure any remaining PASS is not oxidised causing a potential leaching issue during tidal movements. Filter cloth, reno-mattresses and crushed rock running surface will then be placed commencing at the seaward end of the ramp and moving landwards. The reno-mattress will be pre-filled onshore and lifted into place by a crane.
5.3.1.3 Haul Roads

Haul roads can present a high potential environmental risk both while being constructed and due to being highly trafficked on a consistent basis. Without sufficient erosion control, haul roads can be a source of erosion and subsequent sediment tracking. The Project’s proposed haul roads are located in some low lying areas, below 5 m AHD. The construction of these roads therefore presents the risk of coming in contact with and/or disturbing ASS or PASS. The haul roads may also potentially be inundated during the wetter months. This has been taken into account in the design phase with the haul roads being designed such that inundation is able to occur and the roads be rebuilt at the start of each dry season.

5.3.1.4 Borrow Pits

A number of borrow pits will be required to supply material for the construction and ongoing maintenance of the haul roads and for bulk earthworks. The borrow pits are proposed to be located adjacent to the haul roads. Quarry materials will be sourced from borrow pits for use as road base, select fill, rock protection, sealing aggregates and other construction materials.

5.3.1.5 Bulk Fuel Storage

A number of small self-bunded tanks (200,000L) for bulk diesel storage will be located near the BLF and LBF. The fuel storage area will be bunded so that the base and bund walls are all impermeable. The design, storage and handling of fuel on the Project site will be undertaken in accordance with the relevant Australian Standards including AS1940 – The storage and handling of flammable and combustible liquids. All plant and machinery (including fuel lines and hydraulic hoses) will be inspected regularly and repaired as required.
5.4 Impacts and Management Measures

The impact associated with each area/activity outlined above as well as mitigation and management measures is presented in Table 5-1 below.

|-----------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Intertidal and Marine Areas | Construction of BLF             | • Overclearing of protected vegetation  
• Disturbance of ASS and PASS  
• Increased nutrient and sediment load, resulting in deteriorated water quality  
• Deteriorated aquatic health due to sediment deposition  
• Interference of surface water and groundwater flow regimes  
• Interference of tidal movement                                                                                                                                                 | High               | • Delineate construction work area prior to commencing  
• Site-specific ASS investigation and ASS Management Plan  
• Minimise disturbance  
• Treatment and validation of ASS and PASS  
• Works to be completed in accordance with the Waterway Crossing Procedure  
• Geofabric lined with rock                                                                                                                                                        | Medium              |
|                             | Construction of RoRo Facility   |                                                                                                                                                                                                            |                    |                                                                                                                                                                                                                                                  |                      |
|                             | Works within watercourses       |                                                                                                                                                                                                            |                    |                                                                                                                                                                                                                                                  |                      |
| Haul Road Easements         | Construction of Haul Roads      | • Exposure of soil to erosive forces (wind and rain) during earthworks  
• Soil erosion and sediment transport resulting in increased nutrient, sediment, salt and other contaminant concentrations being deposited into receiving waters  
• Interference of surface water and groundwater flow regimes  
• Entrainment of sediment off site by construction vehicles and machinery resulting in increased nutrient, sediment, salt and other contaminants in receiving waters                                                                 | High               | • Delineate construction work area prior to commencing  
• Clean water diversions  
• Sediment fences  
• Geofabric lined with rock  
• Dust control  
• Topsoil management  
• Stockpile management  
• Works to be completed in accordance with the Waterway Crossing Procedure                                                                                                                                                         | Medium              |
<table>
<thead>
<tr>
<th></th>
<th>Borrow Pits</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
</table>
| General Project Area      | Construction of Mine Infrastructure including accommodation camp and camp access roads | • Exposure of soil to erosive forces (wind and rain) during earthworks  
• Soil erosion and sediment transport resulting in increased nutrient, sediment, salt and other contaminant concentrations being deposited into receiving waters  
• Interference of surface water and groundwater flow regimes  
• Entrainment of sediment off site by construction vehicles and machinery resulting in increased nutrient, sediment, salt and other contaminants in receiving waters  
• Changing site topography and landform resulting in changed final land use | High                | • Delineate construction work area prior to commencing  
• Clean water diversions  
• Sediment fences  
• Glue / mulch administered as erosion control in general areas  
• Dust control  
• Topsoil management  
• Stockpile management                                                                 | Medium               |
|                           | Bulk Fuel Storage Area                                                   | • Major and minor spills impacting terrestrial and marine flora and fauna  
• Spills impacting water quality in sensitive receiving environment  
• Combustion / fire  
• Contamination of soil | High                | • Emergency response plan (ERP)  
• Refuelling areas surrounded by impermeable base and bund with ramp over bund for access  
• Refuelling undertaken with necessary controls to minimise the potential for spills Controls may include:  
  • Nozzles with automatic cut-offs  
  • Emergency shut off systems for fuel  
  • Procedures related to operating the refuelling equipment  
  • First flush diversion system  
  • Spill response kits  
  • Spill response equipment  
  • Oil absorbents  
  • Sand bags  
  • Earth moving equipment to install temporary bunds for containment                                                                 | Medium               |
5.5 Site Specific Controls

Site specific controls and locations have been nominated within this ESCP. There will be a variety of permanent and temporary drainage structures in place that will control and manage the flow of water across the site and prevent the discharge of uncontrolled water from the site. The controls are nominated below with typical details and sections provided in Appendix C.

If the design life of ESCs nominated in the Typical Sections (Appendix C) is expected to be exceeded, a review or the controls will be required prior to each wet season shutdown as part of the pre-wet season shutdown management plan, to determine whether they are still adequate or to revise controls as necessary.

The nominated controls that will also remain in place for the duration of the wetter months, where the mine will be in ‘stand down’ mode, will be managed by the skeleton crew, ensuring they are maintained and repaired as required. The site close-out inspection checklist will be completed (refer Appendix E) prior to the start of the stand down period as well as weekly for the duration of this period.

5.5.1 Clean Water Diversions

5.5.1.1 Clean Water Diversion Drains

Clean water diversion drains are to be constructed under access tracks and minor roads as shown on the ESCP. The diversion drains have been designed as part of the Flooding and Regulated Structure – Chapter 11 of the EIS to carry water from the upstream side of access roads to the downstream side during construction, so as to not mix clean water with dirty water.

Temporary diversion drain locations are shown on the ESC Design Drawing at Appendix B.

5.5.1.2 Clean Water Diversion Bunds

Clean water diversions bunds are to be constructed across the Project site upstream of any location that is to be disturbed by construction activities. This is to convey clean water around disturbed areas and to prevent clean water from entering active areas. Clean water runoff will be diverted into nearby waterways.

Temporary clean water diversion bund locations, including upstream of the accommodation camp, are shown on the ESC Design Drawing (Appendix B) and are to be designed to the criteria nominated in Appendix C.

5.5.2 Sediment Fences

Sediment fences are to be located downstream of any active construction areas where sheetflow is expected to fall. This includes the camp accommodation facility.

5.5.3 Sediment Basins

The need to design and construct temporary sediment basins during the construction phase has been avoided across the site by nominating the proposed timing of the works to be between April and November. If during the detailed planning stage of the Project construction details change, such as the construction program or if any infrastructure footprints need to change, further review of the sites ESCs will be completed to determine if sediment basins are required.
One permanent sediment basin has been nominated for the site located in the bauxite stockpile area to capture runoff generated from the stockpile/ore dump station area. This basin has been sized for a 10 year Average Recurrence Interval (ARI), 24 hour rainfall event in accordance with The Department of Environment and Heritage Protection Stormwater Guideline (2014). Further provision has been provided for sediment capture via a wharf/conveyor drainage sump, which pumps return water to the sediment basin for treatment and possible reuse. The sump captures sediment-laden runoff from the conveyor system, as a sediment basin cannot practically be located between the sediment producing source and the Skardon River receiving environment. (Note that operations are not proposed during the wet season, so the significance of these controls may be more applicable to periodic wash-down and maintenance during the dry season or pre-shutdown before the wet season). A mine industrial area drainage slot is proposed to capture runoff from truck wash and workshop areas after oil has been separated. Bauxite is considered a non-hazardous material and thus water captured by the slot can either be reused within the mine industrial area or released to the environment under EA conditions.

5.5.4 Geofabric Lined with Rock

The two main haul roads located at the Project will experience a high level of traffic during the operational period of the mine life and traverse mangrove and low lying tidal areas. As a result, a more robust erosion control is necessary for these infrastructure areas to ensure the road structures are not eroded during higher tides. To minimise this risk, the outside of the haul roads will be covered with geofabric and rock lined as identified in the ESC Design Drawing.

5.5.5 Vehicle Wash-down / Stabilised Exit Points

Vehicular sediment mobilisation can be problematic if control measures are not in place to prevent sediment tracking off-site. Due to the remote location of the Project site vehicles are being transported via barge. Sediment tracking onto barge facilities could still potentially result in some limited deposition of sediment into water courses if not properly controlled. Metro will establish a vehicle wash-down and ensure all vehicles are free from sediment prior to loading onto barges. All site exit points will be installed with suitable controls to minimise material from leaving the site. The controls nominated for the Project site will be developed on a case by case basis pending work type and proximity to sensitive receptors. Controls may include rumble grids or rock pads and demarcation of site entry and exits. These will be designed in accordance with Appendix C.

Access roads managed by Metro Mining will be monitored for sediment loading and will be cleaned as necessary after unseasonal rain and also as part of the pre wet season shutdown plan.

5.5.6 Flow Diversion Banks

If Metro Mining clears outside of the nominated 20 m clearing limits, identified on the ESC Design Drawing as ‘No Go Zones’, then the cleared areas must be broken into acceptable drainage catchment sizes to prevent the potential for excessive erosion. The size of these catchments will be broken up using flow diversion banks placed at regular intervals down the slope with the intent of slowing the flow of water and divert surface runoff to the receiving environment. Table 5-2 provides the recommended maximum spacing of drainage systems down long exposed, non-vegetated or recently seeded slopes. Flow diversion banks are only required in those areas where clearing takes place. If no clearing is done outside of nominated areas, surface water can continue to flow through existing vegetation to the receiving environment as it naturally does pre-mining.
Table 5-2 Maximum flow diversion bank spacing

<table>
<thead>
<tr>
<th>Batter slope (percentage)</th>
<th>Horizontal spacing (m)</th>
<th>Vertical spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>80</td>
<td>0.8</td>
</tr>
<tr>
<td>2%</td>
<td>60</td>
<td>1.2</td>
</tr>
<tr>
<td>4%</td>
<td>40</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The spacing identified above is in accordance with the IECA Guidelines (Table 4.3.2).

### 5.5.7 Other Temporary Controls

Other temporary controls will be installed across the site as earthworks and construction activities progress. These controls include things such as sediment fences, rock check dams and any other sediment control measures nominated in the IECA Guidelines. These will be installed in locations so as to prevent sediment laden water leaving the site and entering any waterways.

The aforementioned temporary controls are to be designed in accordance with the IECA Guidelines and typical details are provided in Appendix C.

Direct seeding and revegetation will be used as the primary rehabilitation method where possible. Seeding will be with existing native plant/grass species to improve the chance of successful revegetation.

Temporary stockpiles will not be stored in areas where concentrated flows are expected and will be adequately covered if left exposed for extended periods of time.

### 5.6 Management Strategies

The management measures provided below are recommended to be implemented by Metro Mining to minimise the potential erosion risk of the Project. These management measures are additional to any measures that have been nominated throughout this plan.

#### 5.6.1 Pre-Construction Management Measures

- All relevant environmental approvals should be in place prior to any works being undertaken. This includes all required EMPs, procedures and other documentation;
- There should be clear delineation of ‘No Go Zones’ on the ESC Design Drawing and on site prior to any clearing;
- An ESC awareness program should be implemented as part of the project induction. All relevant personnel shall be trained in the requirements of the most current ESCP; and
- Installation of perimeter ESCs should be done prior to any construction where appropriate and where suitable access can be achieved.

#### 5.6.2 Construction Phase Management Measures

- Surface water run-on should be diverted around the perimeter of work areas as much as possible;
- Works should be planned to ensure high erosion risk construction is conducted during the dry months of April through November;
- Ongoing ESC awareness program should be implemented as part of the project induction. All relevant personnel shall be trained in the requirements of the most current ESCP;

- The ESCP should be updated regularly to reflect progressive work phases and potential risk changes;

- All reasonable and practicable measures should be implemented to control flow velocities in such a manner that prevents soil erosion along drainage paths and at the entrance and exit of all drains and drainage pipes during all storms up to the relevant design storm discharge; and

- If visible dust is observed from site, dust suppression measures should be implemented. This may include but not be limited to; the use of water trucks, fine mists or spraying stockpiles with suitable soil binders.

5.6.3 Post-Construction Management and Maintenance Measures

ESC devices should remain in place, and maintained to ensure effectiveness until the area has been effectively rehabilitated following completion of construction. ESCs should be routinely inspected and maintained to ensure they remain effective (i.e. removal of silt build up from sediment traps), particularly before the completion of work prior to the commencement of the wet period, and also after high intensity rainfall or run-off events.

Clear access should be maintained at all times to ESC devices to enable maintenance. Of particular importance is ensuring access during the wetter months of December to March where rainfall and subsequent water flows could impede maintenance.

ESC devices should be cleared, repaired or replaced whenever maintenance inspections show signs of non-compliance or ineffective capability or capacity.

5.6.4 Monitoring and Reporting

Management of the Project disturbance areas requires the ongoing implementation of an accurate and responsive monitoring and reporting program. This is essential in satisfying the legal obligations of the Project. The processes noted below should be adhered to by Metro Mining. This section provides a general overview of these processes.

As part of the monitoring and reporting program for ESC, a surface water quality monitoring program to detect impacts of sediment runoff to waters should be developed and implemented to determine the effectiveness of the ESCs. This program should be developed by Metro Mining taking into account the ESCP.

Metro Mining should undertake visual monitoring of roads outside of site boundary for evidence of sediment deposition or release from site. This is particularly important outside the Project perimeter boundary in places where dirt may be tracked on to public roads and people in the community may make complaints. As there are no public roads in the area and machinery is predominantly going to be brought in by barge, Metro Mining should ensure that all machinery is washed down prior to boarding the barge at the origin and destination.

All sediment, erosion and surface water quality incidents should be reported to the relevant Environmental Manager as soon as practical. Examples of incidents to report include:

- Degradation of surface water quality on and offsite;

- Build-up of sediment in sediment control devices;
- Uncontrolled discharge from the site; and
- Damaged or failed erosion control devices.

**Regulatory Compliance Monitoring**

Management of Project disturbance areas should seek to comply with all relevant monitoring obligations. With this, it is essential that the Project disturbance areas management regimes include regular monitoring and reporting of the work site and downstream environments. This program should involve the following:

- Establishment of strategic photo-monitoring points at identified major high risk erosion areas;
- Regular inspections of the Projects disturbance areas;
- Preparation of inspection reports;
- ESC device rectification where required;
- ESC device maintenance;
- Monitoring of receiving water bodies;
- Monitoring of revegetation;
- Areas of non-compliance and inclusion of remedial or corrective actions where required, this should include re-inspection and closeout; and
- Ensuring emergency ESCs or ESC material (for example silt fence material) are being held onsite and/or be readily available in relevant and suitable quantities and conditions.

Photo-monitoring points should be established in the high environmental value areas such as the riparian vegetation fringing the Skardon River. Monitoring points should be identified and located by the site Environmental Manager prior to the commencement of construction. Each photo-monitoring point should be identified by a hardwood timber stake that should be installed 1.5m out of ground and painted yellow on the top 30cm of that stake. Photographs should be taken from the same point the same elevation above ground and same time of the day at the intervals listed below.

Refer to the Land Managers Monitoring Guide – Photo-point Monitoring (DERM) for further information and guidelines on photo-monitoring.

All ESC measures should be inspected (and photographed where relevant):

- Daily when rain is occurring during the mining period;
- Weekly when conditions are dry during the wetter season (site shutdown); and
- Within 24 hours prior to an expected significant rainfall event during the mining period.

**Incident Reporting – Duty to Notify**

*Should site personnel become aware that environmental harm has or is occurring or likely to occur, action must be taken to report such an occurrence. Incident or potential incident will be reported to the Environmental Manager who will, in turn review and notify the administering authority as necessary to satisfy reporting requirements obligation (the ‘Duty to Notify’).*
An ESC Checklist has been appended to this report (Appendix F). This checklist, when signed, indicates that the ESC design package (this ESCP, the ESC Design Drawing and other nominated documents), complies with the relevant legislation and best practice standards.
Appendix A – RUSLE Calculations
<table>
<thead>
<tr>
<th>Site Location: Skardon River</th>
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</table>

### Site Details
- **Site Name:** Bauxite Hills
- **Site Location:** Skardon River
- **Sub-Catchment Number:** 01765243122181718192022212315910814131624252627
- **Total catchment area (ha):** 11518095186591546710860216526711582443728835446121377463319206

### Sediment Type
- **Type:** D
  - **% Sand:** 0.02 to 2.00
  - **% Silt:** 0.002 to 0.02
  - **% Clay:** Finer than 0.002
- **Soil Texture Group:** D

### Design Rainfall Parameters
- **Depth (no of days):** 5
- **Depth (percentile):** 90
- **Rainfall (mm):** 62.7

### Rainfall Erosion (R-factor)
- **Rainfall Erosivity (R-factor):** 979
- **Soil Erodibility (K-factor):** 0.036
- **Slope Gradient (%):** 1.48
- **Length/Gradient (LS-factor):** 0.70

### Erosion Control Practice (P-factor)
- **Ground cover (E-factor):** 1.3

### Soil Loss (t/ha/yr)
- **Minimum sediment control type:** Type 3
- **Erosion risk:** Very Low
refer to Erosion Sediment Control Plan

Work Area

The defined ‘Work Area’ is limited to areas as nominated design drawings, with the widths and alignments being defined through the information provided by the Client. All erosion and sediment controls are to be constructed, operated and maintained within the Work Area.

Key Management Practices

Soil Management (IECA Book 2, Appendix C)

Earthworks should be undertaken when the soil moisture content can maintain the soil properties. Earthworks on dry soil can cause excessive dust and soil structure decline. Saturated soils are more likely to slump and or disperse potentially causing excessive sediment loads and soil structure decline. Where topsoil is required to be stripped and stockpiled prior to construction, the topsoil should be managed appropriately to maintain its existing properties.

Soil Testing (IECA Book 2, Appendix C9)

Physical and chemical soil testing provides additional information on the characteristics of the soils within the Work Area. Testing related to erosion characteristics include; Soil texture, Carbon Exchange Capacity (CEC), Exchangeable Sodium Percentage (ESP), exchangeable cations, pH and Electrical Conductivity (EC), and Emerson Dispersion. As required, testing should be conducted to obtain additional information on the characteristics of the soils within the Work Area.

Limited specific soil information and testing requires conservative estimates for soil erodibility to be used. The use of conservative values to determine soil erodibility potentially increases the level of erosion and sediment control required.

Testing and analysis of topsoil to define and specify the parameters for rehabilitation (i.e. nutrient status) should be undertaken prior to rehabilitation. CDM Smith note the specification and the scope of works related to rehabilitation is nominated by others.

Principles of Erosion and Sediment Control (IECA Book 1, Section 2)

Avoiding erosion and minimising the potential for erosion is considered the most effective way of ensuring environmental objectives are achieved. Reducing or avoiding erosion can be achieved through the application of multiple techniques, often with one technique supplementing another. Example techniques include:

- Scheduling and Staging of clearing, earthworks and rehabilitation;
- Minimising disturbance;
- Increasing and or maintaining ground cover in high erosion risk areas.

Recommended Management Actions

- Wherever possible schedule work in high erosion risk areas in low erosion risk periods of the year (refer to Table 5);
- Restrict the disturbance created by the construction works to the minimum practical area;
- Disturbance or exposure of subsoil or highly erodible layers should be avoided wherever possible;
- Provide temporary ground cover during construction by applying mulch, rock mulch, gravel or soil binder to achieve at least 60% ground cover. This is of particular importance in Work Areas where sediment controls cannot be successfully incorporated into the works.

Drainage Control (IECA Book 1, Section 2)

Up-slope ‘clean water’ must, wherever possible, be diverted around the disturbed or active Work Areas. Clean Water Flow Diversion Banks (generally constructed of topped stripped surface) are required to be constructed, and where required are provided with effective erosion controls to be constructed on the up-slope side of the Works Area as nominated on the ESC drawings. Dirty water drainage, as nominated on the ESC drawings is to be constructed to ensure that sediment laden runoff from disturbed or active Work Areas is appropriately directed into the nominated sediment control or sediment trap.

Design Assumptions

Erosion Hazard Assessment (IECA Book 2 Appendix E)

Soil loss estimation was conducted using the Revised Universal Soil Loss Equation (RUSLE). The RUSLE equation is defined as, A = R.K.L.S.C.P

Where:

- A = Annual soil loss due to erosion (tonnes/hectare/year)
- R = constant calculated rainfall erosivity factor site
- K = Variable based on soil type
- L = assumed for soils
- S = LS = 0.30 to 0.96
- C = variable calculated value based on length and slope
- F = based on no ground cover
- P = 13
default for construction phase

Seasonal Erosion Risk Rating and Rehabilitation Requirements (IECA Book 1, Section 4.4)

Recommended timeframes for land clearing, prior to construction works commencing are presented in Table 1. Table 5 has been reproduced from IECA Guidelines. The specification for rehabilitation are nominated within the rehabilitation plan or engineering specifications. Monitoring and maintenance of ground cover should be considered as part of the rehabilitation program.

Table 1: Erosion Risk, Timing of Works and Rehabilitation

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Time</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>

- Recommended Management Actions
  - Develop the clearing schedule based on recommendations as presented in Table 1.
- Drainage Design Standard (IECA Book 1, Section 4.3)

The anticipated timeframe of the construction works is estimated to be less than 12 months. A drainage design standard of a 1 in 2 year ARI is applicable to the design of temporary drainage works associated with the works.

Sediment Control Standard (IECA Book 1, Section 4.5)

The sediment control standard adopted is presented in Table 2. Areas which have a minimum requirement of a Type 3 device based on the size of the area, where potentially high erosion rates are likely to be experienced will require additional ground cover to prevent erosion of a alternatively a Type 2 sediment control device to be installed and maintained.

Table 2: Sediment Control Standard

<table>
<thead>
<tr>
<th>Area Limit (m²)</th>
<th>Sediment Control Standard for Soil loss rate limit (t/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tipe 1</td>
</tr>
<tr>
<td>350</td>
<td>N/A</td>
</tr>
<tr>
<td>1000</td>
<td>N/A</td>
</tr>
<tr>
<td>2500</td>
<td>N/A</td>
</tr>
<tr>
<td>&gt;2500</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The following notes relate to potential reductions in the Sediment Control Standard i.e. sediment controls that may be considered if the works proceeded during low risk periods of the year (as noted in Table 1), and or if ground cover is maintained e.g. mulch, rock mulch or soil binder. Ongoing assessment with regard to integrity of ground cover is required with regard to selection of sediment controls.

1. If works commence and are completed in accordance with Table 1 within a Low or Very Low Erosion risk period of the year, or at least 60% ground cover can be maintained throughout the year for part of the year, same Type 2 devices can be potentially be downsized to Type 3 devices.
2. Excavated sediment traps cannot be used in unstable soils due to the high probability of tunnel erosion and sediment trap failure.
3. Emerson Dispersion testing (a simple in-field dispersion test) must be conducted on the subsoil (0.30-1.0m) in a location where an Excavated Sediment Trap is proposed if the Emerson class is 4 or less, the soil is likely to be too unstable and an alternative, above ground device must be used.

Construction Assumptions

Assumptions have been made in regard to construction processes. During construction works, if the assumptions are identified or envisaged to be erroneous or inconsistent with the actual construction processes or site conditions, the ESC controls may require updating to reflect the additional or actual conditions experienced on site.

- Earthworks e.g. cut or fill batters slope will be constructed to allow all ESC devices to remain within the defined Work Area.
- Works will be staged to minimise the time of exposure of soils, particularly works associated with drainage paths and or waterways.
- Works will not commence in high risk areas if a forecast rainfall event is likely to produce more than approximately 25 mm in forecast, unless erosion and sediment controls can be effectively established prior to the event.
- Soil within the Work Area will be assessed for dispersion potential and treated with Gypsum if required.

Methodology and installation sequence for construction works

1. Assess timing of works with respect to Table 1.
2. Refer to the approved ESC drawing for the indicative location of location Drainage, Erosion and Sediment Controls.
3. Refer to Typical Details and technical notes for nominated Drainage, Erosion and Sediment Controls.
4. Clear and grub vegetation for processing into mulch and utilise as required.
5. Strip and relocate the topsoil to construct a ‘Clean Water’ Flow Diversion Bank on the up-slope as detailed on the approved ESC drawing or stockpile and provide adequate controls.
6. Excavated sections of the ‘Clean Water’ Flow Diversion Bank that will experience medium to high concentrations of velocities of clean water may require scour protection. Scour protection may include:

Medium protection, place a layer of coarse mulch (approximately 150 mm in thickness) on the up-slope side of the ‘Clean Water’ Flow Diversion Bank. The layer of mulch is to extend approximately 300 mm up the newly
a. Constructed face of the bank and 300mm on the up-slope existing ground surface.
b. Medium to high protection, install erosion control blanket (ECB) or geotextile fabric (approximate roll width 120m) to the up-slope surface of the ‘Clean Water’ Flow Diversion Bank. The lining is to extend approximately 500mm up the newly constructed face of the bank and remainder of roll to cover the up-slope existing ground surface. The lining is to be pinned as per the manufacturers recommendations to maintain contact with the soil.

3. Construct Catch Drains or Taped Diversion Banks on the down-gradient side of the works to retain water within the disturbed limits.

4. Install Cross Banks and sediment traps as soon as practicable or if rain is forecast within 24 hours during ground surface treatment operations.

5. Where significant quantities of subsoil are cut from the work area, the material is to be stockpiled in a dedicated area with appropriate erosion and sediment controls.

6. Install all erosion control measures (e.g. soil binder, mulch, gravel, or rock mulch) within the disturbed areas as soon as practicable, or if rain is forecast within 24 hours.

7. Control traffic on all areas where soil binder has been used for erosion control to prevent damage to the surface.

8. Waterway crossings (bed level crossings and or pipe culvert) or any are to be installed as required for access.

9. Clearing, grubbing and earthworks associated with drainage paths e.g. gully crossings areas to be delayed as long as is practicable and be miniised where possible.

10. Rehabilitation is recommended to commence as soon as practical with drainage paths e.g. gully crossings areas rehabilitated as a priority.

Operation, Monitoring and Maintenance

1. Monitoring of erosion and sediment controls should be conducted at intervals no greater than seven (7) days apart.

2. Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

3. Inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of erosion and sediment controls and adjoining drainage.

   General inspection considerations include:
   a. Inlet and discharge areas for damage or excessive scour;
   b. Channel banks directing runoff to the sediment trap for damage from overtopping flows;
   c. Excessive sedimentation e.g. more than 30% of original sediment trap volume;
   d. Integrity of temporary ground cover.

4. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e prior to rainfall events.

5. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.
CHUTES: Key Principles

- Used for conveying concentrated flows/water down steep slopes.
- Critical parameters are:
  - the slope of the chute, affecting the flow velocity;
  - lining type and or rock size;
  - flow entry conditions into the chute; and
  - reducing the energy at the base or outlet of the chute.

Operational issues include poor inflow or incorrect construction causing scour around the chute.

Diversion Drains: Key Principles

- Diversion Drains are used to convey clean or dirty water to the nominated point of discharge as specified in the plan.

In areas where water is trapped up-slope of the site, clean water diversion drains are used to convey the flow across the site. Examples include minor drainage paths, grade reversals across a slope and other areas where it is impractical to divert water around the site.

Construction

- Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

Materials

1. Where rock is specified:
   a. Installed without damaging geotextile lining (install protective layer of gravel/aggregate or sand if required);
   b. Specific gravity of 2.5 (desired);
   c. Hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (USD) rock size;
   d. The largest rock size should be no larger than 15 times the nominal rock size.
   e. Installed to achieve a relatively consistent graded and stabilised surface.
   f. Installed to fill the voids between the larger rocks.
2. Geotextile filter fabric heavy-duty non-woven, needle-punched filter fabric, minimum 43% or equivalent.
3. Coir or Jute Matting refer to supplier for product specifications. Typical claimed values for Coir mat: 400 gsm - 2.9 m/sec, 700 gsm - 3.3 m/sec, 900 gsm - 4.8 m/sec.

Installation

1. Remove all unsuitable material (i.e. dispersive soils or large rocks) from the area and replace with storable material to achieve the correct drain dimensions.
2. If subsoil is defined or suspected to be dispersive material, a layer of non-dispersive or ameliorated material is to be provided under the nominated channel lining.
3. Ensure the drain has a smooth surface and appropriate entry and exit flow conditions.
4. Where rock is specified allow for the required thickness of the rock when excavating.
5. Subgrade material is to be compacted to minimise water seepage.
6. Geotextile or jute mat lined chutes, compact and smooth the subgrade to achieve the correct drain dimensions.
7. Rock lined chutes: avoid over compacting the subgrade to a condition that would prevent the rock lining from adequately bedding into the subgrade.
8. On fill slopes, ensure that the soil is adequately compacted for a width of at least one metre each side of the chute to minimise the risk of soil erosion. Where required protect the soil with suitable slope protection measures such as turf or erosion control mats.
9. Geotextile fabrics, Coir or Jute linings:
   a. extend "side wings" a minimum of 300mm from the upper edges of the channel;
   b. trench (llyn) geotextile fabric "wings" in to a depth of 200mm, with excavated material returned to the trench and compacted prevent movement of the liner;
   c. overlap side laps edges (if required) a minimum of 300 mm.
   d. flow direction overlaps (if required) a minimum 300mm.
   e. fixed to the drain surface using the appropriate pins/staples to ensure contact between the liner and channel surface are to be pinned to the subgrade at regular intervals.
10. Chutes Geotextile Liners:
    a. extend "side wings" a minimum of 300mm from the upper edges of the channel;
    b. extend- and "up-slope wing" a minimum of 300mm from the top of the chute and trench (llyn) geotextile fabric in to a depth of 200mm, with excavated material returned to the trench and compacted prevent movement of the liner;
    c. Chutes install an appropriate outlet structure (energy dissipater) at the base of the chute.
    d. Chutes Ensure water leaving the chute and the outlet structure will flow freely without causing undesirable ponding or scour.
    e. Diversion Drains must be constructed to dissipate concentrated flows, without causing scour.
    f. Appropriately stabilise all disturbed areas immediately after construction.

Operation, Monitoring and Maintenance

- Impact weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the drainage structure. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.
- Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.
- General inspection considerations include:
  1. Embankments for excessive settlement, slumping or piping.
  2. Inlet and discharge areas for damage or excessive scour.
  3. Damage to the chute lining, including surface cracking.
  4. Scour adjacent the drainage structure.
  5. Where required restore the drainage structure to its original configuration unless an amended layout is required.

Decommissioning

1. When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised or when permanent drainage has been constructed, the chute or drain may be decommissioned. General considerations include:
   a. Removal and disposal of all materials including rock and lining materials,
   b. Diversion of water around the decommissioned area to discharge in a non-erosive manner while the chute area is reinstated;
   c. Disturbed areas associated with the chute are to be reinstated and rehabilitated to conform with the adjoining land features, e.g. compaction, slope, vegetation;
   d. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the chute.

### CONSTRUCTION TABLE - CHUTES AND DRAINS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Drainage of minor flows across the site</th>
<th>Drainage of moderate flows down steep slopes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>Drainage of minor flows across the site</td>
<td>Drainage of moderate flows down steep slopes</td>
</tr>
</tbody>
</table>

Typical application

- Open weave Coconut, Carp or Jute fibre mat
- Open weave Coconut, Carp or Jute fibre mat
- Open weave Coconut, Carp or Jute fibre mat
- TRM or heavy-duty Carp
- TRM or heavy-duty Carp

Maximum slope (°)

- 5°
- 10°
- 25°
- 25°
- 45°

Maximum slope rate (V/H)

- 1°
- 2°
- 3°
- 4°
- 5°

Maximum discharge rate (m³/s)

- 0.25
- 0.5
- 0.75
- 1.0
- 1.5

Min. velocity rating (V:H)

- 0.3
- 0.5
- 0.75
- 1.0
- 1.5

Drainage base width (m)

- 0.3
- 0.5
- 0.75
- 1.0
- 1.25

Maximum side slope (V/H)

- 0.5
- 1.0
- 1.5
- 2.0
- 2.5


**NOTE:** Channel lining must not be placed directly on dispersive soils. Refer IECA factsheet "Erosion Control Mats", "Special Requirements" for best practice installation procedure.

**+Refer to supplier for product specifications.**
Key Principles
Cross banks are drainage control devices that reduce erosion by limiting the slope length of an area and preventing excessive runoff velocities. Cross banks assist or limit the length of an area and preventing excessive runoff velocities. Cross banks are to be constructed using suitable material i.e. clean, non-dispersive soil slopes on low to moderately erodible soil.

Cross banks are installed to direct runoff in a controlled manner to structures to prevent scour of the invert of the drain section.

Where required or observed though onsite monitoring, Cross Banks may need to be lined with filter material to prevent scour of the invert of the drain section.

The recommended spacing of Cross Banks may need to be reduced from those specified on the approved plans i.e. location, while observing site conditions with respect to the recommended maximum slope lengths up-slope of the control as detailed in Table 1 and Table 2.

Table 1 Recommended maximum slope length up-slope of a Cross Bank on non-vegetated slopes on low to moderately erodible soil.

<table>
<thead>
<tr>
<th>Vertical</th>
<th>Horizontal</th>
<th>Batter Slope</th>
<th>Cross Bank (non-vegetated slopes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>10.0%</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>55</td>
<td>5.0%</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>35</td>
<td>3.5%</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>25</td>
<td>2.5%</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>2.0%</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>1.0%</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>0.5%</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>0.1%</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2 Recommended maximum slope length up-slope of a Cross Bank on vegetated slopes on low to moderately erodible soil.

<table>
<thead>
<tr>
<th>Vertical</th>
<th>Horizontal</th>
<th>Batter Slope</th>
<th>Cross Bank (vegetated slopes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>10.0%</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>55</td>
<td>5.0%</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>35</td>
<td>3.5%</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>25</td>
<td>2.5%</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>2.0%</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>1.0%</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>0.5%</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>0.1%</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

Materials
Cross banks are to be constructed using suitable material i.e. clean, non-dispersive soil free of woody vegetation and roots, rocks or other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Seek additional advice regarding material suitability if required.

Operation, Monitoring and Maintenance
Inspect regularly, particularly after rainfall events producing runoff to assess the ongoing integrity and functionality.

Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:
1. Damage from vehicles or livestock.
2. Slumping on banks or excessive sour of the invert or base on the drain section.
3. Damage or scarring from overtopping flows.
4. Discharge areas for damage or excessive scours.
5. Excessive sedimentation to be removed appropriately. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

Decommissioning
When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the cross bank may be decommissioned. General considerations include:
1. Disturbed areas associated with the cross bank are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
2. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment control.
**Key Principles**

Sediment Basins are generally used as the final sediment control measure at the end of dedicated drainage channels within a catchment area greater than 0.25ha.

Appropriately designed, constructed and operated Sediment Basins are classified as a Type 1 sediment trap. Sediment Basins are downgraded to a Type 2 sediment trap if inappropriately operated or maintained.

Sediment collection is achieved through gravity induced sedimentation. Under some circumstances sedimentation can be improved with the use of flocculants to achieve the required discharge criteria.

Type F (Fine) and Type D (Dispersive) are considered as wet basins with the treated water to be dewatered through a controlled discharges as soon as the discharge criteria are met. Suitable water quality is achieved. As soon as conditions allow the basin must be maintained in either a dry-bed condition or with a water level no greater than the top of the design sediment storage zone.

Sediment basins are normally designed for a 5-day cycle i.e. rainfall event producing runoff into the basin, water treatment and dewatering of the basin within a maximum 5-day period.

**Construction**

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications). An assessment of the ‘as constructed’ Sediment Basin is to be conducted by suitably qualified person/s.

**Materials**

Sediment Basins are to be constructed using suitable material i.e. clean (non-dispersive) soil. Soils to be free of woody vegetation and roots, rocks or other unsuitable material. Soils with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2 soil should be used only in unusual circumstances as the basin to be lined with as applicable. Seek additional advice regarding material suitability if required.

**Installation**

1. Delay clearing the up-slope pond area until the Sediment Basin is formed and is able to act as a suitable sediment trap.
2. Install required temporary sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.
3. Footprint of the embankment must be cleared of unsuitable material i.e. topsoil, unsuitable soil, vegetation material (trees, stumps, roots, dead timber), with large voids to be filled and compacted.
4. Clear the main pond area is to be delayed until the embankment is completed.
5. Topsoil is to be appropriately stockpiled for rehabilitation as necessary.
6. Excavate a cut-off trench along the centre-line of the earth embankments 600mm deep with side slopes no steeper than 1:1 (H:V).
7. The base of cut off trench is to be wide enough to allow adequate compaction and be free from loose or unsuitable material.
8. Backfill and compact with select earth/soil fill to the required compaction and moisture specification.
9. Key in main embankment to prepared footprint surface using scarification.
10. Construct the main embankment with select earth/soil fill in continuous 150 to 250mm layers and compact to the required compaction and moisture specification.
11. Unless otherwise specified on the approved plans, compact the soil at approximately 1% to 2% of optimum and to 95% modified or 100% standard compaction recognising the optimum moisture content.
12. All loose uncompact earth-fill material on the upstream and downstream batter must be removed prior to spreading of topsoil.
13. Stabilise associated exposed earth embankments immediately after construction through appropriate compaction, topsoil vegetation and/or erosion control matting.
14. Construct the spillway section to the specified flow rates or dimensions.
15. Where specified the spillway with geotextile fabric (heavy-duty, needle-punched, non-woven filter cloth, minimum ‘bidim’ A24 equivalent):
   a. Extend into the upstream base of pond and adequately secure.
   b. Overlap side laps edges a minimum of 300 mm.
   c. Flow direction overlaps (if required) to be key in by burying 300mm the up slope edge and re-compacting.
   d. Pinned overlaps at 1m spacing.
   e. Ensure fabric is not damaged during placement of rock. If required repair as necessary overlapping 300mm and securely pinning.
16. Where rock is specified:
   a. Install without damaging geotextile lining (install protective layer of gravel/aggregate or sand if required).
   b. Specific gravity of 2.5 (idealised).
   c. To be hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size.
   d. The largest rock size should be no larger than 15 times the nominal rock size.
   e. Installed to achieve a relatively consistent graded and stabilised surface.
   f. Small rock needs to fill the voids between the larger rock.
   g. The final discharge area must be stabilised to ensure controlled discharge flows and prevent scouring.
17. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
18. Install a sediment storage basin, bottom slope at a ratio of 1:2 (H:V), with a maximum runoff of 15%.
19. Install (if specified), internal sediment ponds baffles below, the elevation of the emergency spillway crest.
20. Install (as required) access points for operation and maintenance e.g. desilting access and stabilised dewatering points.
21. Potential safety and or environmental risks should be assessed for the construction and operational stages and managed appropriately e.g. barrier fencing or internal side slope to allow egress of wildlife or fauna as necessary.
22. Seek clarification if any aspect of the construction of the sediment trap is in question.

**Operation, Monitoring and Maintenance**

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corroborative or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

**Decommissioning**

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the sediment trap may be decommissioned.

**General considerations include:**

1. Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard.

Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:

1. Use of an appropriate flocculant that will be effective for the soil types in the area.
2. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
3. Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.

**Decommissioning**

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the sediment trap may be decommissioned.

**General considerations include:**

1. Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.
Summary of design requirements

Table 1 provides a summary of the recommended design requirements.

### Table 1 – Summary of sediment basin design requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type F &amp; D basins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil characteristic</td>
<td>Type F: More than 33% of soil finer than 0.02mm. Type D: More than 10% of soil dispersive, or where turbidity control is essential.</td>
</tr>
<tr>
<td>Setting pond sizing, surface area (As), or settling volume (Vs)</td>
<td>( As = 10 \times R(Y%, 5\text{-day}) \times Cv \times A )</td>
</tr>
<tr>
<td>Length to width ratio</td>
<td>( L:W ) of 3:1 is highly desirable</td>
</tr>
<tr>
<td>Minimum depth of settling zone</td>
<td>0.6m</td>
</tr>
<tr>
<td>Sediment storage volume</td>
<td>50% of settling volume</td>
</tr>
<tr>
<td>Use of inlet chamber</td>
<td>Desirable if length to width ratio is less than 3:1, or if inflow is concentrated with high flow velocity.</td>
</tr>
<tr>
<td>Internal baffles</td>
<td>Desirable if length to width ratio is less than 3:1</td>
</tr>
<tr>
<td>Use of outlet chamber</td>
<td>Use depends on type of outlet system adopted</td>
</tr>
<tr>
<td>Control inflow conditions</td>
<td>Used to control erosion at inlets and, where practicable, ensure the inflow pipe invert is above the spillway crest elevation.</td>
</tr>
<tr>
<td>Pre-treatment pond</td>
<td>Used to reduce the cost and frequency of de-silting operations.</td>
</tr>
<tr>
<td>Primary outlet</td>
<td>Ensure choice of outlet system is compatible with basin type</td>
</tr>
<tr>
<td>Emergency spillway minimum design capacity</td>
<td>Less and 3 month design life capacity of 1 in 10 year ARI. 3 to 12 months design life capacity of 1 in 20 year ARI. Greater than 12 months design life capacity of 1 in 50 yr ARI.</td>
</tr>
<tr>
<td>Elevation from top of riser pipe outlet to spillway crest</td>
<td>N/A</td>
</tr>
<tr>
<td>Freeboard from maximum pond water level to top of virgin soil bank</td>
<td>0.60m (min)</td>
</tr>
<tr>
<td>Freeboard from maximum pond water level to top of fill embankment</td>
<td>0.60m (min)</td>
</tr>
<tr>
<td>Minimum freeboard along spillway chute</td>
<td>0.60m (min)</td>
</tr>
<tr>
<td>Minimum embankment crest width</td>
<td>2.5m</td>
</tr>
<tr>
<td>Maximum gradient of access ramp</td>
<td>6:1</td>
</tr>
<tr>
<td>Chemical flocculation</td>
<td>Type F: As required to satisfy water quality objectives. Type D: Essential</td>
</tr>
</tbody>
</table>
**Key Principles**

Rock Filter Dams (RFD) are generally used at the end of minor table drains and drainage channels with a catchment area less than 0.25ha.

A RFD is a rock embankment generally constructed from large uniform-sized rocks, with a filter medium placed on the upstream face. The filter medium is generally:
- one or more layers of geotextile filter cloth, and/or
- a layer of smaller aggregate.

Appropriately designed, constructed and operated RFDs are classed as a Type 2 sediment trap. A RFD is to be downgraded to a Type 3 if inappropriately operated or maintained.

Sediment collection is achieved through gravity induced sedimentation in the up-slope ponded area and filtration through the filter medium. Under some circumstances sedimentation can be improved by the use of flocculants to achieve the required discharge criteria.

Other considerations include:
- Stable inflow conditions are required to avoid re-suspension of existing sediments.
- The downstream face of the rock embankment acts as a spillway.
- The discharge area must be stabilised to ensure controlled discharge flows and prevent scouring.
- Partial sediment blockage is required to achieve optimum filtration properties.
- An excavated sediment pit immediately upstream may reduce the risk of sediment blockage of the filter medium and in turn reduce maintenance.
- Access must be provided for maintenance.

Where specified the RFD is required to be keyed in a minimum of 200 mm into the bed of the ponded area and filtration through the filter medium. Under some circumstances sedimentation can be improved by the use of flocculants to achieve the required discharge criteria.

**Construction**

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

**Materials**

Primary core rock and Spillway Rock: well graded, hard, angular, erosion resistant rock; mean size as specified in the approved plan, but not less than 250mm, or greater than 350mm.

Aggregate filter fabric specified: 15 to 25mm clean aggregate.

Geotextile filter fabric: heavy-duty non-woven, needle-punched filter fabric, minimum 'bidim' A34 or equivalent.

**Installation**

1. Delay clearing the up-slope pond area until the RFD is formed and is able to act as a suitable sediment trap.
2. If earth abutments are specified, excavate a cut-off trench along the centre-line of the RFD and into the adjoining earth embankments 600mm deep with side slopes no steeper than 1:1 (H:V).
   a. The base of cut off trench is to be wide enough to allow adequate compaction and be free from loose or unstable material.
   b. Backfill and compact with select earth/soil fill to the required compaction and moisture specification.
   c. Flow direction overlaps (if required) 600mm.
3. Clear the area where the RFD is to be constructed of debris and sharp rocks that may puncture the geotextile, and install a geotextile fabric base sheet.
4. Place the RFD core rock to ensure:
   a. well compacted, erosion resistant soil, free of vegetation and roots, and
   b. up-slope fill batters slopes are a minimum 2:1 (H:V) or flatter;
   c. downstream face of earth abutments is a minimum 3:1 (H:V) or flatter;
   d. downstream slope of the rock spillway is a maximum of 3:1 (H:V);
   e. the thickness of armour rock protection is a minimum of 500mm, or twice the nominal rock size, whichever is the greater.
5. Construct the spillway of the RFD section using the specified armour rock to ensure:
   a. a minimum depth within the spillway section of 300mm;
   b. the spillway weir crest is level across its full width;
   c. the downstream slope of the rock spillway is a maximum of 3:1 (H:V);
   d. the thickness of armour rock protection is a minimum of 500mm, or twice the nominal rock size, whichever is the greater;
   e. the spillway extends downstream past the toe of the formed embankment until stable conditions are reached, or a distance equal to the height of the dam, whichever is the greater.
6. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
7. Install (as required) access points for operation and maintenance e.g. desilting access.
8. The discharge area is to be stabilised as necessary and discharge water to be directed off the site in a manner that will not cause erosion.
9. Clear the settling pond area of woody vegetation and organic matter to the dimensions specified within the plans.
10. If specified install the filter medium (aggregate and/or geotextile filter fabric) on the upstream face of the RFD.
   a. extend the fabric over the crest of the rock filter dam into the spillway chute;
   b. if the sediment trap is anticipated to be in place for greater than two (2) months, it is recommended the placement of sacrificial layers of fabric on the upstream face to allow a layer to be removed if the fabric becomes completely blocked with sediment.
11. The discharge area is to be stabilised as necessary and discharge water to be directed off the site in a manner that will not cause erosion.
12. The downstream face of the rock spillway acts as a spillway.
13. Install (as required) access points for operation and maintenance e.g. desilting access.
14. Potentially safety and environmental risks should be assessed for construction or operation stage and managed appropriately, e.g. barrier fencing or internal side slope to allow ingress of wildlife or fauna as necessary.
15. Seek clarification if any aspect of the construction of the sediment trap is in question.
16. Use of an appropriate flocculant that will be effective for the soil types in the area.
17. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
18. Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:
   - Use of an appropriate flocculants that will be effective for the soil types in the area.
   - Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
   - Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.
19. Decommissioning when the up-slope drainage area has been assessed and approved as being satisfactorily stabilized, the sediment trap may be decommissioned. General considerations include:
   - Water or sediment within the sediment trap should be managed and disposed of appropriately as necessary.
   - Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
   - Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.

Operation, Monitoring and Maintenance

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:
- Outlet or downstream water quality, clarity
- Embankments for excessive settlement, slumping or piping
- Inlet and discharge areas for damage or excessive scour
- Diversion banks and drainage directing runoff to the sediment trap for damage from overtopping flows
- Excessive sedimentation shall be removed appropriately i.e. greater than 10% of original sediment volume
- Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:
- Use of an appropriate flocculant that will be effective for the soil types in the area.
- Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
- Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.
Key Principles

Sediment Fences are used to manage sheet flow i.e. water flowing uniformly down a low to medium slope gradient. Sediment Fences are not recommended in areas of concentrated flow e.g. drainage channels or chutes.

Sediment Fences are relatively effective in trapping or retaining soil and silt size particles, however, are limited in capturing clay sized particles that increase the colour and turbidity of water passing through the fence.

Sediment collection utilizing Sediment Fences is achieved through gravity induced sedimentation as a result of water temporarily being ponded or retained on the up-slope side of the sediment fence. The surface area of the up-slope ponded area created during the construction and positioning of the sediment fence and or returns is critical to maximising sediment collection i.e. the greater ponded surface area, the greater potential for sediment collection. Filtration of water through the fabric provides limited or secondary sediment collection.

Filter fences, although constructed similarly to a Sediment Fence are not considered an acceptable replacement for sediment fences unless constructed directly down-slope of earth stockpiles. Filter Fences are used to manage coarse grained runoff from stockpiles and rely on filtration as the primary treatment mechanism.

Note: Specific considerations related to the construction of filter fences are noted in italics i.e. “Filter Fence: italics”. Filter Fences are not recommended in areas of concentrated flow. Appropriately constructed and maintained Sediment Fences are classed as a Type 3 sediment control, however are to be downgraded if inappropriately maintained.

Construction

1. Construct the Sediment Fence in accordance with the approved plans i.e. for location, extent, and required type of fabric (if specified) and the observed site condition with respect to the recommended maximum slope lengths up-slope of the sediment fence as detailed in Table 1. “Filter Fence: Table 1 not applicable, Filter Fence only to be used directly down-slope of earth stockpiles.”

Table 1: Recommended maximum slope lengths up-slope of a Sediment Fence on non-vegetated slopes on low to moderately erodible soil.

<table>
<thead>
<tr>
<th>Vertical Horizontal Spacing (m)</th>
<th>Lower Slope</th>
<th>Sediment fence</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>x 1.3%</td>
<td>60</td>
</tr>
<tr>
<td>35</td>
<td>x 1.5%</td>
<td>60</td>
</tr>
<tr>
<td>40</td>
<td>x 1.5%</td>
<td>50</td>
</tr>
<tr>
<td>45</td>
<td>x 2.0%</td>
<td>50</td>
</tr>
<tr>
<td>50</td>
<td>x 2.0%</td>
<td>60</td>
</tr>
<tr>
<td>55</td>
<td>x 2.5%</td>
<td>50</td>
</tr>
<tr>
<td>60</td>
<td>x 2.5%</td>
<td>60</td>
</tr>
<tr>
<td>65</td>
<td>x 3.0%</td>
<td>65</td>
</tr>
<tr>
<td>70</td>
<td>x 3.0%</td>
<td>65</td>
</tr>
<tr>
<td>75</td>
<td>x 4.0%</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>x 4.0%</td>
<td>60</td>
</tr>
<tr>
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<td>x 5.0%</td>
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<td>x 5.5%</td>
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<tr>
<td>125</td>
<td>x 7.0%</td>
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<tr>
<td>130</td>
<td>x 7.0%</td>
<td>60</td>
</tr>
<tr>
<td>135</td>
<td>x 7.5%</td>
<td>60</td>
</tr>
<tr>
<td>140</td>
<td>x 7.5%</td>
<td>60</td>
</tr>
</tbody>
</table>

Materials

Sediment fence fabric can be manufactured from polypropylene, polyamide, nylon, polyester, or polyethylene woven or non-woven fabric, and a minimum of 100mm in width and a minimum unit weight of 140GSM.

Fabric is to contain ultraviolet inhibitors and stabilisers to provide a minimum of 6 months of useful construction life.

If specified, fabric reinforcement wire or steel support mesh, minimum 1/4” gauge (approx. 2.0 mm) with a maximum mesh spacing of 200mm.

Support posts/stakes:
- 1500mm (e.g. 300mm x 50mm) (min) hardwood,
- 2500mm (e.g. 300mm x 50mm) (min) softwood, or
- 15kg (min) steel star pokers suitable for attaching fabric.

“Filter Fence: Geotextile fabric: non-woven filter cloth (minimum ‘beid’ A34 or the equivalent).”

Installation

1. Delay clearing or placing erodible material up-slope area until the sediment fence is constructed and is able to act as a suitable sediment control.
2. The fence is to be located:
   a. within the property boundaries;
   b. along a line of constant elevation or contour where possible;
   c. a minimum of 3m from the toe of any fill batters or earthworks to prevent damage to the fence.
3. Install returns within the fence at a maximum of:
   a. 20m intervals if the fence is installed along the contour;
   b. 5 to 10m maximum spacing (dependant on slope) if the fence is installed at an angle to the contour.
4. The returns can be constructed using:
   a. V-shaped section extending at least 15m up-slope, or
   b. sandbag or rock aggregate check dam a minimum 1/3 and maximum 1/2 fence height, and extending at least 15m up-slope.\n5. Extreme ends of the fence are to be turned up-slope at least 15m as necessary to minimise water bypassing around the fence.
6. Avoid concentration of flow along the fence and or discharge of water around the ends of the fence.
7. Protect existing trees and root systems and do not utilise vegetation to support fabric.
8. Unless otherwise directed or nominated on the approved plans, excavate a 200mm wide by 200mm deep anchor trench along the proposed fence alignment and place the excavated material on the up-slope side of the trench.
9. On the lower side of the anchor trench secure the support posts into the ground at the following spacing:
   a. no greater than 2m “Filter Fence: 1.5m”;
   b. no greater than 3m if supported by a top support wire or wire mesh backing “Filter Fence: 2m”;
10. Securely attach the support wire or mesh where specified to the up-slope side of the support posts. Support mesh to extend a minimum of 200mm into the anchor trench.
11. Fabric (and mesh where specified) is to be attached to the up-slope side of the support posts.
12. Join ends of fabric by overlapping to the next support post.
13. Securely attach the fabric to the support posts, maximum fixing spacing of 100mm.
14. Securely attach the fabric to the support wire/mesh (where specified) at a maximum fixing spacing of 3m.
15. The completed fence is to be a minimum of 450mm, but no greater than 700mm high from the finished up-slope surface. If a spill-through weir is installed ensure the crest of the weir is a minimum of 300mm above the finished up-slope surface.

Operation, Monitoring and Maintenance

Inspect sediment fences weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the sediment control.

Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:
1. Undertcutting, undermining, flood under the fence.
2. Damage from overtopping flows.
3. Discharge areas for damage or excessive scour.
4. Excessive sedimentation to be removed appropriately i.e. greater than the 1/3 of the height of the sediment fence. Removal and disposal of water, sediment and or corrective work is to undertaken in a manner that will not create an erosion or pollution hazard.

Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the sediment control may be decommissioned General considerations include:
1. Water or sediment within the sediment control should be managed and disposed of appropriately as necessary.
2. Disturbed areas associated with the sediment control are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment control.
Figure 1: General layout of sediment fence construction

Figure 2 Options for anchoring bottom of sediment and filter fence
Key Principles

Excavated Sediment Traps (ESTs) are generally used as a sediment control measure at the end of dedicated drainage channels.

Appropriately designed, constructed and operated ESTs are classified as a Type 2 sediment trap when a Rock Filter Dam (RFD) outlet is incorporated into the device. ESTs utilize other situations are classified as a Type 3 sediment trap.

Sediment collection is achieved through gravity induced sedimentation. Under some circumstances sedimentation can be improved with the use of flocculants to achieve the required discharge criteria. ESTs provide limited control of fine sediment unless the settling area has a substantial surface area. ESTs should not be used constructed in dispersive soils.

Stable inflow conditions are required to avoid re-suspension of existing sediments. In addition, the discharge area of the sediment trap must be stabilized to ensure controlled discharge flows and prevent scouring.

Construction

Construct the Sediment Trap in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

Materials

Where specified as having a RFD outlet:
1. Rock and the spillway rock should be well graded, hard, angular, erosion resistant rock; mean size as specified in the approved plan, but not less than 225mm, or greater than 350mm.
3. Other areas requiring erosion protection can utilise geotextile filter fabric heavy-duty non-woven, needle-punched filter fabric, minimum ‘bids’ A3k or equivalent.

Installation

1. Delay clearing the up-slope pond area until the EST is formed and is able to act as a suitable sediment trap.
2. Where possible, the sediment trap is to be constructed with an internal side slope of 2:1 (H:V) or flatter.
3. Where excavation is limited, or the overall dimensions of the trap are too small for the practical use of 2:1 (H:V) internal side slopes the sediment trap may be constructed 1:1 (H:V) internal side slopes.
4. Where the excavation area is suspected or known to include problematic materials, e.g. large voids or unstable soils, soil testing, soil stabilization or relocation of the sediment trap should be undertaken.
5. Where specified on the approved plan, the inlet area and discharge area or RFD outlet are to be stabilised with geotextile fabric and hard angular durable rock where specified.
6. Placement and or stockpiling of excavated material is to be managed not to create an erosion or pollution hazard.
7. Establish all necessary up-slope drainage control measures to ensure that sediment-laden runoff is appropriately directed into the sediment trap.
8. Potential safety and or environmental risks should be assessed for the construction and operational stages and managed appropriately, e.g. barrier fencing or internal side slope to allow egress of wildlife or fauna as necessary.

Operation, Monitoring and Maintenance

As a minimum, inspections after rainfall events producing runoff are required to assess the ongoing integrity and functionality of the sediment trap and adjoining drainage. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

General inspection considerations include:
1. Outflow or downstream water quality; ‘clarity’.
2. Embankments for excessive settlement, slumping or piping.
3. Inlet and discharge areas for damage or excessive scour.
4. Diversion banks and drainage directing runoff to the sediment trap for damage from overtopping flows.
5. Excessive sedimentation be removed appropriately i.e. greater than 30% of original sediment volume.
6. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.

Flocculants may be used to assist water treatment within the sediment trap to achieve the required discharge criteria. General considerations include:
1. Use of an appropriate flocculants that will be effective for the soil types in the area.
2. Correct dosage of flocculants, which may require accurate estimation of the quantity of water within the sediment trap.
3. Ensuring the flocculants used will not have a detrimental effect on waterways, with particular caution required for aluminium based flocculants.

Decommissioning

When the up-slope drainage area has been assessed and approved as being satisfactorily stabilized, the sediment trap may be decommissioned. General considerations include:
1. Water or sediment within the sediment trap should be managed and disposed of as necessary.
2. Disturbed areas associated with the sediment trap are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. compaction, slope, vegetation.
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas associated with the sediment trap.
Key Principles
Mulch Berms are a similar sediment control to sediment fence and is used to manage sheet flow, water flowing uniformly down a low to medium slope gradient.

 Appropriately designed, constructed Mulch Berms are classified as Type 2 sediment control. Mulch Berms are relatively effective in trapping or retaining sand and silt size particles, however are limited in capturing clay sized particles that increase the colour and turbidity of water passing through the berm.

 Sediment collection utilising Mulch Berms is achieved through gravity induced sedimentation as a result of water temporarily being ponded or retained on the up-slope side of the berm.

 The surface area of the up-slope ponded area (created during the construction and positioning of the berm and or return) is critical towards maximising sediment collection i.e. the greater ponded surface area, the greater potential for sediment collection.

 Filtration of water through the berm provides limited or secondary sediment collection.

 Construction
Construct the Mulch Berm in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

 Materials
1. Mulch to be processed using onsite material, which contains woody vegetation, and is free of weed seeds.
2. Mulch to be processed using a tub grinder or similar process that fractures the vegetation to a fibrous product. Wood chipping is not acceptable.
3. Mulch to be 90% by mass of fibrous, woody material with a maximum size of 150mm.
4. Mulch should comply with the requirements of AS4454.
5. Maximum soluble salt concentration of 5dS/m.
6. Moisture content of 30 to 50% prior to application.

 Installation
1. When selecting the location of a mulch filter berm, to the maximum degree practical, ensure the berm is located:
   a. Totally within the approved area of disturbance;
   b. Along the contour of the slope;
   c. At least 3m, ideally 3m, from the toe of a fill embankment;
   d. Away from areas of concentrated flow.
2. Ensure flows are not concentrated along the length of the berm.
3. If the berm is installed diagonally across a slope, and concentration of flow is unavoidable, install regular "returns" at a 90° angle to reduce the potential velocity of flow along the berm.
4. Ensure water flows through the berm and is not discharged around the end of the berm.
5. Ensure the berm has been placed such that ponding up-slope of the berm is maximised.
6. Ensure both ends of the berm are adequately turned up the slope to prevent flow bypassing prior to water passing over the berm.

 Operation, Monitoring and Maintenance
Inspect weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to rainfall events.

 Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

 General inspection considerations include:
1. Undercutting, undermining flow under the berm or washouts.
2. Damage from overtopping flows.
3. Discharge areas for damage or excessive scour.
4. Excessive sedimentation to be removed appropriately i.e. greater than 100mm or the 1/3 of the height of the berm. Removal and disposal of water, sediment and or corrective work is to be undertaken in a manner that will not create an erosion or pollution hazard.
5. Where required restore the structure to its original configuration unless an amended layout is required.

 Decommissioning (if required)
1. When the up-slope drainage area has been assessed and approved as being satisfactorily stabilised, the mulch berm may be decommissioned.

   General considerations include:
   a. Disturbed areas associated with the berm are to be reinstated and rehabilitated to conform to the adjoining land features, e.g. slope and vegetation.
   b. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining areas.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Land slope perpendicular to bank</th>
<th>Maximum spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 5%</td>
<td>Greater than 5%</td>
</tr>
<tr>
<td></td>
<td>Minimum bank height at time of formation</td>
<td>750mm</td>
</tr>
<tr>
<td></td>
<td>Minimum bank height after natural settlement and organic breakdown</td>
<td>500mm</td>
</tr>
<tr>
<td>Top width of bank (mm)</td>
<td>100mm</td>
<td>150mm</td>
</tr>
<tr>
<td>Base width (mm)</td>
<td>1600mm</td>
<td>1600mm</td>
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<td>Side slope (H:V)</td>
<td>1:1 (H:V)</td>
<td>1:1 (H:V)</td>
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Table 1 provides the recommended maximum spacing of mulch filter berms down long slopes.

Table 2 provides the recommended minimum bank heights for mulch filter berms. The base width of berms should be at least twice its formation height.

Table 2 Recommended dimensions of mulch filter berms
The Waterway, Gully or Culvert Crossing Area. The Crossing Area is defined as the area with the banks of the natural drainage feature.

Key Principles

Avoiding erosion and minimising the potential for erosion are considered the most effective ways of ensuring environmental objectives are achieved during works. Reducing or avoiding erosion can be achieved through the application of multiple techniques, often with one technique implemented to complement another. Examples techniques include:

- Scheduling works in low erosion risk periods;
- Staging the works to minimise disturbance;
- Minimise erosion of exposed surfaces by increasing and or maintaining ground cover;
- Control the movement of water;
- Minimise movement of sediment or sediment laden waters; and
- Rehabilitate disturbed areas as soon as possible.

Construction

Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

Installation and General Notes

1. Wherever possible schedule work in high erosion risk areas in low erosion risk periods of the year (refer to Table 1);
2. Wherever possible schedule works during periods of no flow;
3. Stage and or restrict the construction works to the minimum practical area;
4. Disturbance or exposure of subsurface or highly erodible layers should be avoided wherever possible;
5. Provide temporary ground cover during construction by applying mulch, rock, gravel or soil binder;
6. Soil binder should be suitable for in-stream application;
7. Excavated material or erodible material is not to be stockpiled within the Crossing Area;
8. Divert up-slope stormwater (from the side banks) around the disturbed work area;
9. Provide adequate passage of upstream flows through the work area using diversion bunds/ barriers or pipes/ channels;
10. Provide adequate passage for aquatic fauna as required;
11. Avoid contamination of upstream flows wherever possible;
12. Sediment control devices should be positioned so that they are not damaged or washed away in a reasonably foreseeable stream flow event;
13. Where required, a bed level crossing should be installed, disturbing only the area that is required for the bed level crossing;
14. Earthworks works to establish entry and exit points and or a bed level crossing may require erosion protection through the use of hard, durable rock;
15. Access tracks into the work area should be sheeted with clean aggregate for the full extent of the Crossing Area, excluding the bed level crossing, aggregate to be angular d50 0.015m to 0.15m unless specified otherwise;
16. Work within the Crossing Area should not commence or be protected if significant rainfall is forecast within the scheduled period of works;
17. Removal and disposal of water, sediment is to be undertaken in a manner that will not create an erosion or pollution hazard;
18. Construct or rehabilitate as per the nominated engineering specification or rehabilitation plan as soon as possible;
19. Waterway crossing works should be managed in accordance with the relevant codes and approvals e.g. Code for self-assessable development, Temporary waterway barrier works, DAFF 2013. Code no: WWBW02

Construction

Construct the Chute or Drain in accordance with the approved plans (i.e. location, dimensions and construction details and specifications).

Materials

1. Geotextile filter fabric: heavy-duty non- woven, needle-punched filter fabric, minimum ‘bidim’ 124 or equivalent
2. Where rock is specified:
   a. Installed without damaging geotextile lining.
   b. Specific gravity of 2.5 (desired)
   c. Hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal d50 rock size.
   d. The largest rock size should be no larger than 15 times the nominal rock size.
   e. Installed to achieve a relatively consistent graded and stabilised surface.

Decommissioning

General considerations include:
1. Removal and disposal of all materials including rock and lining materials;
2. Disturbed areas to be reinstated and rehabilitated to conform with the adjoining land features, e.g. compaction, slope, vegetation;
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining area.

Installation

1. Refer to associated drawings for additional details.
2. Appropriately stabilise all disturbed areas remediately after construction.

Operation, Monitoring and Maintenance

Inspect weekly and after rainfall events producing runoff to assess the ongoing integrity and functionality of the temporary crossing. Corrective or restorative maintenance is to be scheduled and completed as necessary i.e. prior to stream flow or rainfall events.

Additional monitoring and maintenance should be conducted within 12 hours of a forecast rainfall event that would produce runoff.

General inspection considerations include:
1. Damage to the temporary crossing, including rocks surfaces.
2. Integrity of structure to pass anticipated flows i.e. blocked culverts.
3. Trafficable (frothed) sections for excessive sediment build up
4. Embankments and barriers for erosion scouring, slumping.
5. Associated erosion and sediment controls.
6. Where required restore the structure to its original configuration unless an amended layout is required.

Decommissioning

General considerations include:
1. Removal and disposal of all materials including rock and lining materials;
2. Disturbed areas to be reinstated and rehabilitated to conform with the adjoining land features, e.g. compaction, slope, vegetation;
3. Decommissioning is to be undertaken in a manner that will not create an erosion or pollution hazard in the direct or adjoining area.

![TABLE 1](Image)
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Author: Bridget Goldsworthy
Project Manager: Mike Mitchell
Client: Metro Mining
Document Title: Erosion and Sediment Control Plan Waterway Crossing Procedure
Document Version: REV 0
Project Number: BES150189.13
Section 1  Introduction

1.1 Background

Aldoga Minerals Pty Ltd, a wholly owned subsidiary of Metro Mining Limited (herein referred as Metro Mining) is proposing to develop an open cut bauxite mine and barging/transhipment operation on the western coastline of Cape York (the Project). The Project is expected to have a life span of 12 years at the maximum production rate of 5 million tonnes per annum (Mtpa). It is characterised by several shallow open cut pits that will be connected via internal haul roads, which in turn, will be connected to a main north-south haul road linking the Mine Infrastructure Area (MIA) and barge loading facility (BLF) located on the Skardon River.

Key components of the Project include:

- Shallow open cut pits (Bauxite Hills 1 (BH1), Bauxite Hill 6 (BH6) east and west pits);
- Internal haul roads, access roads and associated borrow pits (located within haul road corridors);
- BLF and roll on/roll off (RoRo) facility on the Skardon River;
- MIA including the run-of-mine (ROM) stockpile, bauxite stockpiles, barge loading conveyor load point, earthmoving equipment hard park, administration offices, workshops and fuelling facilities;
- Accommodation camp;
- Bulk fuel storage;
- Raw and potable water supply; and
- Sewage treatment plant.

CDM Smith has identified construction of the above mine infrastructure as high risk activities requiring an Erosion and Sediment Control Plan (ESCP) to minimise the risk of harm to the environment and impacts to environmental values (EV) as a result of the construction and operation of the mine and associated infrastructure.

This Waterway Crossing Procedure (WCP) forms part of the ESCP and the supporting information for subsequent environmental and statutory applications made as part of the Project approval process and informs the Environmental Impact Statement (EIS).

1.2 Scope of Waterway Crossing Procedure

The purpose of this WCP is to define the construction activities related to waterway crossings (WC) and works within a waterway with respect to managing erosion and sediment control (ESC) and general rehabilitation requirements. The environmental impacts associated with these works will be mostly temporary, however due to the location there is the potential for construction activities to have a higher level of environmental impact. The method of construction at each WC will be determined on a case by case basis based on the nominated WC type and the final construction materials and methods being used to construct each structure.
Construction of WCs has the potential to impact wetlands, waterways, and water resources including:

- Physical disturbance to waterways and wetlands, as well as the surrounding vegetation;
- Changes to surface flow and groundwater flow;
- Deterioration in surface water and groundwater quality by increased sediment loads;
- Creation of waterway barriers; and
- Increased erosion of the site if not properly stabilised and rehabilitated for the completion of the works.

The procedures and processes nominated throughout this WCP will be done in accordance with all relevant environmental commitments, permits and procedures including those contained in the ESCP and in each Chapter of the Bauxite Hills EIS.

1.3 Objectives

The overall intent is to minimise the degree of disturbance and the degree of vegetation cover that is removed. This is addressed in the ESCP and the EIS.

*This WCP is for information purposes only and is to supplement existing information contained in the ESCP and the EIS.*
Section 2  Pre-construction Phase

Prior to the construction of any WCs, Metro Mining should ensure that the necessary permits and approvals will be in place. Environmental approval conditions nominated as part of the Project’s Environmental Authority (EA) will be considered and adhered to at all times.

No works are to occur outside of the nominated construction corridor and disturbance for construction will be minimised as much as is practical. Prior to construction, a review of relevant codes and guidelines relating to works in a waterway for mining operations should also be undertaken.

A survey of the original profile of the area around all proposed WCs should be performed before construction so that the original profile can be restored post construction.

A pre-construction environmental inspection should also be conducted. This would include checking for unstable channels or banks slopes and any or head cuts downstream that might extend upstream along the valley. Head cuts include any erosional features in intermittent and perennial streams where an abrupt vertical drop occurs. Where these exist, bed stabilisation works should be designed and carried out.

In constructing the WCs, Metro Mining should take into consideration the following environmental constraints:

- Increased scouring of bed and banks;
- Water quality impacts as a result of increased sediment;
- Effects of the removal of vegetation;
- Waterway barriers;
- Fish kills;
- Notification; and
- Signage.

2.1 Pre-construction Activities

The following should be checked by Metro Mining prior to commencing works on any WC:

- Initial inspection of the site be completed and detailed survey data be obtained for design purposes;
- Water flows and levels should be checked and recorded to determine any construction impact;
- Relevant permits should have been obtained and reviewed;
- Relevant notification and signage should be installed;
- Construction methodology should be approved by Metro Mining;
- A site-specific Risk Assessment should be conducted and safe work method statement (SWMS) or similar should be completed and discussed by construction crew; and
All required machinery, equipment and materials should be readily available for undertaking the WCs.

2.2 Site Preparation and Clearing

Clear and grade operations should be restricted to the minimum necessary for construction purposes and should be performed in a manner which will minimise the reinstatement requirements.

The design and construction of the all WCs and potential waterway barriers should:

- Minimise impacts on riparian, aquatic and water dependent flora and fauna;
- When destroying vegetation Metro Mining should observe the following conditions:
  - The destruction should be confined to the minimum area necessary for the activity;
  - Limits of disturbance should be delineated in the field by clearly marking the vegetation on the outer perimeter of the activity site, e.g. with flagging tape or paint;
  - Mature trees should be destroyed only where there is no reasonable alternative where possible, trees should be cut near or at ground level to retain the root mass in the ground. This does not include areas of permanent infrastructure, where mining is taking place or where the presence of roots will impact operations; and
  - Progressive stabilisation and revegetation of disturbed areas should occur as soon as possible after completion of activities.
- Protect flora and fauna during construction and operation, including reduction or disruption to habitat, particularly any potential disruption of endangered species habitat;
- Placement of rock protection on the embankments to minimise risk of scouring as a result of the WC works; and
- Rehabilitate disturbed riparian areas including use of locally sourced species and intensive planting.

Crews should only undertake the required clearing at the time of construction. Where possible, trees should be cut down leaving stumps and roots intact. This does not include areas of permanent infrastructure, where mining is taking place or where the presence of roots will impact operations. Vegetation cleared from the banks of waterways should be stockpiled with other vegetation outside of the waterway for use in bank rehabilitation. Topsoil removed from the banks and approaches to the WCs should be conserved. All care should be taken to ensure that material from the stream or waterway bed does not become mixed with bank material. After vegetation and topsoil removal and stockpiling, the bed and bank material should be separately stockpiled in a location that will not obstruct the waterway. Banks should be backfilled with bank material compacted and stabilised.

Cleared and pruned vegetation should be stockpiled onsite away from the riverbed for later use in bank stabilisation and rehabilitation and should not be placed in the waterway.
Section 3  Construction Methodology

3.1 Notification of Works Commencing

At least five but no more than 20 business days before work commences within a designated waterway, the Pre-Works Advice Sheet should be completed and issued to the District Officer of the Queensland Boating and Fisheries Patrol (QBFP) and the Manager (Planning and Assessment) of the Fisheries Centre.

3.2 Signage

- Two signs should be located at every works site, one facing the waterway and the other facing the opposite way at all times while works are proceeding under this code;
- The signs should have minimum dimensions of 500mm by 500mm;
- The following words should be included on the sign—Minor waterway barrier works constructed under Fisheries Queensland self-assessable code WWBW01. Tel. 132523; and
- Signs should be removed within 15 business days of completion of works under this code.

3.3 Installation of Crossing Access

3.3.1 Construction and Maintenance of Waterway Crossings

- New crossings should not be placed on bends or rapid sections of a waterway; and
- New crossings should be perpendicular (within 10°) to the water flow.

3.3.2 Crossing Dimensions and Design

- The width of a waterway crossing should not be greater than 20 metres (m), i.e. the bankfull width should be 20 m or less;
- The crossing should be installed at the existing waterway, no higher than the nominated design;
- The lowest point of the crossing should align with the natural low flow channel, with a height difference of at least 100 mm from the low flow channel to the edges of the crossing at the bankfull width;
- The crossing should be installed at the same gradient (upstream-downstream) as the waterway bed gradient; and
- Where the crossing is to be constructed from rocks, the rocks should be an equivalent (a minimum of 100 mm diameter) or larger size than the natural bed material at the site and the surface should be left rough and not be over compacted (e.g. track-rolled finish or rougher).

3.3.3 Post-construction Crossing Maintenance

- All new crossings should be inspected at least annually and reinstated to original design specifications if required; and
Where scouring has occurred upstream or downstream of the new crossing resulting in a headloss across the crossing, scour protection should be installed.

### 3.4 Earthworks

Bureau of Meteorology forecasts should be used to ensure that river, creek and drain crossings are scheduled during dry conditions or low flow periods wherever practicable. This is to prevent erosion from rainfall, flooding and run-off and to ensure that crossing will be finished safely and in a timely manner.

Material taken from the bed should not be mixed with bank material. All earthworks should be carried out to approved designs and checked against survey levels.

#### 3.4.1 Clean Down

To minimise the spread of declared weeds, diseases or pests, all plant mobilisation to site should be inspected and declared free of weed. All machinery required for operations on site should also be cleaned down at designated locations.

### 3.5 Restoration

The waterway crossing should be restored to the natural contours of the ground and should allow normal surface drainage. Waterways, terraces and levees disturbed by construction of the crossing should be restored to their original contours. Banks of waterways should be restored in a manner that will resist erosion.

Where erosion control is required, diversion banks should be constructed across the road easement to divert the flow of water away and into natural drainage courses to prevent erosion along the trench line. These banks should be constructed in accordance with the following requirements:

- Banks should be constructed across the entire disturbed width of the working area;
- The height of the banks should be such that they will be capable of retaining a depth of water behind the bank of not less than 150 mm. In areas of steep slopes height of bank may be varied by agreement; and
- Banks should be constructed so that water is discharged onto undisturbed land on the lower side of the crossing. The fall along the length of the contour bank channel should be a maximum of 1 in 35 and a minimum of 1 in 50.

All temporary works provided for construction should be removed and fences and private roads disturbed by construction of the waterway crossing should be restored to their original condition. All terraces, levees and waterways should be restored to their former condition.

Clear and pruned vegetation should be placed over the disturbed areas of the banks and secured to stabilise and minimise erosion when Skardon River is in flood and to encourage re-establishment of vegetation.

The beds of all stream and waterways should be restored to a profile that will be stable and resistant to erosion, and as near as practicable to the original profile. Obstructions resulting from construction of the crossing should be removed and disposed of.
The banks of waterway crossings should be restored by grading to the natural contours or to the natural angle of repose of the stream bank material, whichever is less steep. Special bank protection measures should be employed where specified or necessary. These may include stabilised sandbags, Reno mattresses or other approved alternatives.
Section 4  Environmental Controls

Environmental management for the Project will require the monitoring, management and mitigation of various environmental impacts identified as part of the Bauxite Hills EIS.

Environmental management measures which are specific to this WCP’s activities include but are not limited to the following:

- Water Quality, Drainage, Erosion and Sediment Control;
- Air Quality and Dust;
- Waste;
- Weed Disease and Pest;
- Complaints / Incidents and Communication;
- Acid Sulphate Soils;
- Contaminated Land;
- Flora and Fauna;
- Reinstatement and Rehabilitation; and
- Cultural Heritage Management.

Routine inspections should be conducted by the Metro Mining Environmental Advisor to monitor practices and identify areas and activities or work practices which could lead to environmental harm.

Checklists should be completed by the Environmental Advisor in conjunction with Supervisors and / or Engineers for each inspection and Corrective Actions added to a Project Corrective Action Register.

4.1 General Management Measures

Metro Mining should consider the following general management measures as they relate to WCs to control such impacts in accordance with the following principles:

- The area of disturbance should be no greater than the minimum area necessary for the purpose;
- The area of bed and banks disturbed by the activities should be stabilised regardless of previous stability;
- The extent and duration of bare surface exposure should be minimised, and protected from weathering;
- Water run-off should be diverted around areas of disturbance where practicable;
- Bed and bank stability should be managed to minimise erosion and reduce sedimentation i.e. avoiding scouring from abrupt changes in flow direction caused by a structure;
- Where practicable, sediment should be captured and retained on-site;
• Machinery to be used in carrying out the activities should be selected to achieve minimal disturbance of the site; and

• Constructed drainage and discharge structures should not alter the natural bed and bank profile.
Bauxite Hills Project
Erosion and Sediment Control Plan
Mine Stand Down and Monitoring Checklist
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Author: Mike Mitchell
Project Manager: Mike Mitchell
Client: Metro Mining
Document Title: Erosion and Sediment Control Plan Mine Stand Down and Monitoring Checklist
Document Version: REV 0
Project Number: BES150189.13
Section 1 Checklist

This mine stand down and monitoring checklist should be completed prior to the mine stand down period (wet period), weekly throughout that period, and as required based on rainfall events. Refer to ESCP for further information on timing of checklist completion.

Table 1 Mine Stand Down and Monitoring Checklist

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<td>1</td>
<td>Are site conditions nominated in the Environmental Authority consistent with those assumed within the approved ESCP?</td>
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<td>2</td>
<td>Was the full perimeter of the work site inspected?</td>
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<tr>
<td>3</td>
<td>Site inspections and monitoring are being carried out at appropriate times and intervals.</td>
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<td>4</td>
<td>Site access is controlled and the number of access points minimised.</td>
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<td>5</td>
<td>Adequate drainage and sediment controls exist at site entry/exit points.</td>
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<tr>
<td>6</td>
<td>Adequate drainage, erosion and sediment controls have been placed around the site compound.</td>
<td></td>
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<tr>
<td>7</td>
<td>Appropriate drainage and sediment controls are installed prior to new areas being cleared or disturbed.</td>
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<td>8</td>
<td>Site personnel have ready access to the Erosion and Sediment Control Plan.</td>
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<td>ESC measures are being installed in accordance with the approved ESCP.</td>
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<tr>
<td>10</td>
<td>Adequate supplies of ESC materials stored on-site: such as wire, stakes, sediment fence fabric, filter cloth, clean aggregate</td>
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<td>11</td>
<td>Temporary access roads are stabilised where appropriate.</td>
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<td>12</td>
<td>Sediment deposition is not observed external to the project area.</td>
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<td>13</td>
<td>Chemicals and petroleum products appropriately stored on site.</td>
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<td>14</td>
<td>Emergency spill response plan has been prepared for the site.</td>
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<td>15</td>
<td>Oil/petroleum spill containment/response kits available on-site where appropriate.</td>
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<td>16</td>
<td>Waste receptors have been emptied and located in approved locations.</td>
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<td>17</td>
<td>Any contaminated site water, liquid waste and wash-off water has appropriately disposed of to ensure it will not enter any waterways and stormwater systems.</td>
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<td>18</td>
<td>Waste water from construction activities such as wash water, de-watering operations, and dust control has been appropriately captured, treated and disposed of.</td>
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<td>Stripped topsoil has been stockpiled and is appropriately controlled to minimise the risk of sediment/turbid water discharge.</td>
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<td>Stockpiles located at least 5 m away from top of watercourse banks.</td>
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<td>Long-term soil stockpiles adequately protected against wind and rain.</td>
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<td>22</td>
<td>Stockpile sediment control (Filter Fence or Sediment Fence) is appropriate for the soil type and site conditions.</td>
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<td>Drainage Control measures are consistent with the ESCP.</td>
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<td>Drainage Control measures are being adequately maintained in proper working order at all times.</td>
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<td>Up-slope “clean” water is being appropriately diverted around/through the site in a non-erosive manner.</td>
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<td>Stormwater runoff diverted away from unstable slopes.</td>
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<td>Flow diversion channels/banks stabilised against erosion.</td>
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<td>28</td>
<td>Flow not unlawfully discharged onto an adjacent property.</td>
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<td>29</td>
<td>Earth batters are free of erosion.</td>
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</tr>
<tr>
<td>30</td>
<td>Catch Drains:</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(a) Adequate depth/width.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Adequate flow capacity is being maintained.</td>
<td></td>
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<tr>
<td></td>
<td>(c) Stabilised against soil scour.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(d) Clear of sediment deposition.</td>
<td></td>
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<tr>
<td></td>
<td>(e) Appropriate grass length is being maintained.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(f) Water discharges via a stable outlet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Channel Linings (mats):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Lining is well anchored.</td>
<td></td>
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<tr>
<td></td>
<td>(b) Mats overlap in direction of flow.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(c) Lining is appropriate for flow conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) No damage to the mat by lateral inflows.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Check Dams:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Flow is passing over the dams and not around them.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Check Dams are not causing excessive channel restriction.</td>
<td></td>
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<tr>
<td></td>
<td>(c) Rock Check Dams are not used in shallow drains.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(d) Check Dams are appropriately spaced down the drain.</td>
<td></td>
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</tr>
<tr>
<td>33</td>
<td>Temporary Watercourse Crossings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Sediment runoff from the approach roads is controlled.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Likely damage to the crossing and the stream caused by possible overtopping flows is considered acceptable.</td>
<td></td>
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</tr>
<tr>
<td>34</td>
<td>Erosion Control measures are consistent with the approved ESCP.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Erosion Control measures are being adequately maintained in proper working order at all times.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Erosion Control Blankets:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Blankets are well anchored.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Blankets overlap in direction of stormwater flow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Blanket strength is appropriate for site conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Synthetic blanket reinforcing will not endanger wildlife.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(e) Blankets not damaged by lateral inflows.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(f) Blankets protected against movement by winds.</td>
<td></td>
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<tr>
<td>37</td>
<td>Mulching (light):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Minimum 70% coverage of soil surface.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Suitable tackifier used on steep slopes.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(c) Drainage controls preventing mulch displacement.</td>
<td></td>
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</tr>
<tr>
<td>38</td>
<td>Mulch (heavy):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Minimum 100% coverage of soil.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Minimum depth adequate to control weeds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Drainage controls preventing mulch displacement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Soil Binders:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) No adverse environmental impacts observed.</td>
<td></td>
<td></td>
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<tr>
<td>40</td>
<td>Sediment Control measures are being adequately maintained in proper working order at all times.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Sediment control Buffer Zones are protected from traffic and are free of excessive sediment deposits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Neighbouring properties are being adequately protected from sedimentation.</td>
<td></td>
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<tr>
<td>43</td>
<td>Entry/Exit Points:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(a) Control measures are constructed to appropriate standards.</td>
<td></td>
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<tr>
<td></td>
<td>(b) Excessive sediment removed from sediment traps.</td>
<td></td>
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<tr>
<td></td>
<td>(c) Excessive sedimentation is not evident on roadway.</td>
<td></td>
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<tr>
<td></td>
<td>(d) Stormwater drainage is controlled such that sediment is not being washed onto the adjacent roadway.</td>
<td></td>
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<tr>
<td>Item No.</td>
<td>Item</td>
<td>Compliant (Yes / No)</td>
<td>Comment</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------</td>
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</tr>
<tr>
<td>44</td>
<td>Sediment Fences:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(a) Bottom of fabric is securely buried.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(b) Fabric is appropriately overlapped at joints.</td>
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<td></td>
<td>(c) Fabric is appropriately attached to posts.</td>
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<td></td>
<td>(d) Support posts are at correct spacing (2m or 3m with backing).</td>
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<tr>
<td></td>
<td>(e) Sediment Fence does not cause flow diversion/bypass.</td>
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<td></td>
<td>(f) Sediment Fence has regular returns.</td>
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<tr>
<td></td>
<td>(g) Lower end(s) of fence is/are returned up the slope.</td>
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<tr>
<td></td>
<td>(h) Sediment Fences are free of damage.</td>
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<tr>
<td></td>
<td>(i) All fences are free of excessive sediment deposition.</td>
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<tr>
<td></td>
<td>(j) Fences are adequately spaced from toe of fill banks.</td>
<td></td>
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<tr>
<td>45</td>
<td>Rock Filter Dams (Sediment Traps):</td>
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</tr>
<tr>
<td></td>
<td>(a) Excessive sediment removed from up-slope of all traps.</td>
<td></td>
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<tr>
<td></td>
<td>(b) The filtration system is free from sediment blockage.</td>
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<tr>
<td></td>
<td>(c) Rock Filter Dam and spillway are free of damage.</td>
<td></td>
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<tr>
<td>46</td>
<td>Temporary Watercourse Crossings (e.g. construction access) have been reduced to the minimum practical number.</td>
<td></td>
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<tr>
<td>47</td>
<td>Instream structures are not located on, or adjacent to, unstable or highly mobile channel bends.</td>
<td></td>
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<tr>
<td>48</td>
<td>Construction works are not unnecessarily disturbing instream or riparian vegetation.</td>
<td></td>
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<tr>
<td>49</td>
<td>Erosion is not occurring as a result of stormwater passing down channel banks.</td>
<td></td>
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<tr>
<td>50</td>
<td>Appropriate temporary erosion control measures are being applied to disturbed areas.</td>
<td></td>
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<tr>
<td>51</td>
<td>Synthetic reinforced erosion control blankets/mats are not being used where there is a potential threat to wildlife.</td>
<td></td>
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<tr>
<td>52</td>
<td>Sediment Fences have not been placed in areas of actual or potential concentrated flow.</td>
<td></td>
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<tr>
<td>53</td>
<td>Appropriate material (spoil) de-watering procedures have been adopted.</td>
<td></td>
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<tr>
<td>54</td>
<td>Site stabilisation/revegetation is occurring in accordance with approved Plans and/or programming.</td>
<td></td>
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<tr>
<td>55</td>
<td>Exposed areas are adequately stabilised given the site conditions, environmental risk, and construction schedule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Newly seeded areas are developing an appropriate grass cover (not just strike rate), density and grass type.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>No newly seeded areas require reseeding.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Soil erosion within revegetated areas is being adequately controlled (i.e. mulching) during the plant establishment phase.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Revegetation is controlling soil erosion as required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Newly seeded areas have been lightly mulched as specified.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ms Colleen Fish  
Manager - Environment  
Metro Mining Limited  
Level 8, 300 Adelaide Street, Brisbane QLD 4000

Dear Ms Fish,

RE: Certified Professional in Erosion and Sediment Control (CPESC) Acceptance Letter

This Erosion and Sediment Control Plan satisfies the following requirements:

1. The intent and minimum standards established by all relevant local, state and federal policies relating to erosion and sediment control.

2. Reviewed and approved by a person suitably trained and experience (to a degree appropriate for the given type and size of the land disturbance) in each of the following categories: construction, soil science, hydrology/hydraulics, and site revegetation and rehabilitation.

3. Is both reasonable and practicable.

4. Contains sufficient information to allow appropriate implementation of the plan.

Regards,

Mike Mitchell  
Managing Principal - Environment  
CPESC # 7718

Enclosures: Bauxite Mine Erosion and Sediment Control Plan

cc:
Erosion & Sediment Control Plan Checklist

CLIENT AND LOCATION OF DEVELOPMENT: Aldoga Minerals Pty Ltd, a wholly owned subsidiary of Metro Mining Limited is proposing to develop an open cut bauxite mine and barging/transhipment operation on the western coastline of Cape York, Qld.


SIGNATURE

N/A – not applicable

4 – acceptable controls adopted

7 – measures are not acceptable, or a potential problem exists

Part A: Initial plan review

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Erosion Hazard Assessment Form completed for the site.</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Supporting Documentation supplied with the ESCP.</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Copy of calculation sheets supplied.</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>ESC specifications and construction drawings supplied.</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Inspection and Test Plan (ITP) supplied</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td>Legend provided to identify all ESC measures on the plans.</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>ESC Installation Sequence supplied.</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Installation Sequence is appropriate for the site conditions.</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Installation Sequence clearly indicates which sediment control measures must be installed prior to land disturbance.</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Soil test results (including soil erodibility) supplied.</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>Extent of land disturbance (including cut and fill areas) shown.</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Adequate identification/protection of non-disturbance areas.</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Protected trees and buffer zones identified.</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Appropriate staging of land clearing.</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>On-site watercourses and riparian zones protected.</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>Existing and/or final contours shown (as required).</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>Location of all ESC measures clearly shown.</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>All ESC measures located within the property.</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>Plans signed by appropriate professional(s).</td>
<td>4</td>
</tr>
</tbody>
</table>
### Part B: Site assessment

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>On-site water “values” and discharge standards (water quality objectives) identified.</td>
<td>4</td>
</tr>
<tr>
<td>21</td>
<td>Soil Map provided.</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>Location of potential dispersive soils identified.</td>
<td>4</td>
</tr>
<tr>
<td>23</td>
<td>Location of potential acid sulfate soils identified.</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>Potential landslip/mass movement areas identified.</td>
<td>4</td>
</tr>
<tr>
<td>25</td>
<td>High and extreme erosion risk areas identified and protected.</td>
<td>4</td>
</tr>
<tr>
<td>26</td>
<td>Soils of extreme pH identified and amelioration specified.</td>
<td>4</td>
</tr>
</tbody>
</table>

### Part C: Site establishment

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Site access points limited to the minimum necessary, clearly identified on plans, and appropriate controls specified.</td>
<td>4</td>
</tr>
<tr>
<td>28</td>
<td>Drainage controls indicated on the entry/exit pad (if necessary).</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>Site office and car parking areas identified and provided with adequate drainage, erosion and sediment controls.</td>
<td>4</td>
</tr>
<tr>
<td>30</td>
<td>Technical notes included on best practice site management including dust, chemical, oil, fuel, litter and debris control.</td>
<td>4</td>
</tr>
<tr>
<td>31</td>
<td>Stockpile locations clearly identified and located away from protected vegetation and overland flow paths.</td>
<td>4</td>
</tr>
<tr>
<td>32</td>
<td>Stockpiles located at least 5m away from top of watercourse banks.</td>
<td>NA</td>
</tr>
<tr>
<td>33</td>
<td>Adequate up-slope drainage controls (if necessary) and down-slope sediment controls placed adjacent to stockpiles.</td>
<td>4</td>
</tr>
<tr>
<td>34</td>
<td>Temporary access roads/tracks identified, with appropriate drainage/erosion controls specified.</td>
<td>4</td>
</tr>
<tr>
<td>35</td>
<td><em>Temporary Watercourse Crossings</em> identified and protected.</td>
<td>4</td>
</tr>
<tr>
<td>36</td>
<td><em>Temporary Watercourse Crossings</em> are appropriate for fish passage requirements.</td>
<td>4</td>
</tr>
<tr>
<td>37</td>
<td>Minimum non-disturbance zone between unsealed access tracks and the edge of streams is at least the width of the stream (measured at the top of the bank) or 30m whichever is the lesser.</td>
<td>4</td>
</tr>
</tbody>
</table>

### Part D: Drainage controls

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>38</td>
<td>Construction Drainage Plans prepared for each major stage of earthworks.</td>
<td>4</td>
</tr>
<tr>
<td>39</td>
<td>All temporary construction roads and access tracks shown on the Construction Drainage Plans.</td>
<td>4</td>
</tr>
<tr>
<td>40</td>
<td>Temporary drainage controls designed to the appropriate</td>
<td>4</td>
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</tbody>
</table>
standard and hydraulic analysis provided.

41 Hydraulic analysis indicates appropriate flow velocities. 4

42 Hydraulic analysis indicates appropriate flow capacity. 4

43 Flow from “clean” external catchments diverted around/through site in a non-erosive manner. 4

44 Internal “dirty” water drainage lines identified and directed to sediment controls. 4

45 Appropriate drainage controls located immediately up-slope of neighbouring, down-slope residential areas. 4

46 All site drainage inflow and outflow points identified. 4

47 All water discharges from the site at legal points of discharge. NA

48 All water discharges through stabilised outlets onto stable land. 4

49 Maximum spacing of drains on long, open soil slopes is appropriate for the gradient and soil type. 4

50 Appropriate flow velocity controls (e.g. Check Dams) or scour controls (e.g. turf or Erosion Control Mats) specified. 4

51 Catch Drains or Flow Diversion Banks located at top of cut and fill batters. 4

52 Temporary Catch Drains not indicated on dispersive soils. 4

53 Rock Check Dams not specified in shallow (i.e. < 500mm deep) drains. NA

54 Water flow is appropriately conveyed down constructed earth slopes (e.g. through Slope Drains or Chutes). 4

55 All Slope Drains and Chutes have stabilised inlets and outlets. 4

56 Appropriate drainage controls on unsealed roads and access tracks. 4

57 Technical notes require all runoff from newly constructed roofs to be immediately connected to drainage system. NA

58 Overland flow appropriately controlled around Temporary Watercourse Crossings. 4

Part E: Erosion control

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>59</td>
<td>The erosion control standard is consistent with the rainfall erosivity, environmental risk, and clay content of exposed soil.</td>
<td>4</td>
</tr>
<tr>
<td>60</td>
<td>The erosion control standard is consistent with the requirements of regulatory authority.</td>
<td>4</td>
</tr>
<tr>
<td>61</td>
<td>Application rates specified for mulching.</td>
<td>NA</td>
</tr>
<tr>
<td>62</td>
<td>Specified mulch stabilisation measures are appropriate for the soil slope (gradient).</td>
<td>NA</td>
</tr>
<tr>
<td>63</td>
<td>Appropriate drainage controls installed to minimise mulch being washed off the slope/site.</td>
<td>4</td>
</tr>
<tr>
<td>64</td>
<td>Synthetic (plastic) mesh reinforced Erosion Control Blankets not specified in or adjacent to susceptible wildlife habitats.</td>
<td>4</td>
</tr>
<tr>
<td>65</td>
<td>Emergency short-term erosion control measures specified (e.g. in event of construction delays, pre-storm activities).</td>
<td>4</td>
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</tbody>
</table>
Technical notes indicate what additional works are required if construction occurs during the wet season.

Dust control measures specified.

Disturbed soil with an Exchangeable Sodium Percentage (ESP) greater than 6% is to be treated to control soil dispersion.

### Part F: Site stabilisation/revegetation

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>69</td>
<td>Vegetation Management Plan and/or Landscape Plan provided.</td>
<td>NA</td>
</tr>
<tr>
<td>70</td>
<td>Site stabilisation/rehabilitation plan provided.</td>
<td>4</td>
</tr>
<tr>
<td>71</td>
<td>Minimum soil protective cover of 70% specified on ESCP or in the Supporting Documentation.</td>
<td>4</td>
</tr>
<tr>
<td>72</td>
<td>Appropriate soil preparation measures specified prior to revegetation.</td>
<td>4</td>
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<tr>
<td>73</td>
<td>Timing and specification for any temporary vegetation is provided.</td>
<td>4</td>
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<tr>
<td>74</td>
<td>Application of permanent site revegetation is appropriately staged.</td>
<td>4</td>
</tr>
<tr>
<td>75</td>
<td>Minimum specifications for imported topsoil supplied.</td>
<td>NA</td>
</tr>
<tr>
<td>76</td>
<td>Specifications and application rates for soil adjustments provided (soil report).</td>
<td>NA</td>
</tr>
<tr>
<td>77</td>
<td>Specifications and application rates for seeding, mulches and hydraulically applied soil covers provided.</td>
<td>NA</td>
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</tbody>
</table>

### Part G: Supplementary sediment controls

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>78</td>
<td>Every appropriate opportunity has been taken to trap sediment as close to the initial source of erosion as is practicable without placing sediment controls in locations where they could cause hydraulic, erosion, or safety issues.</td>
<td>4</td>
</tr>
<tr>
<td>77</td>
<td>Sediment traps placed on public roadways will not cause safety issues.</td>
<td>4</td>
</tr>
<tr>
<td>79</td>
<td>No sub-catchment relies solely on supplementary sediment control measures.</td>
<td>4</td>
</tr>
<tr>
<td>80</td>
<td>Straw Bales are not specified for sediment control, unless justified by exceptional circumstances (e.g. as a short-term control during the installation of the primary sediment trap).</td>
<td>4</td>
</tr>
<tr>
<td>81</td>
<td>The ESCP provides sufficient information to control the installation and use of supplementary sediment traps.</td>
<td>4</td>
</tr>
</tbody>
</table>

### Part H: Sediment control “sheet” flow

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>No sediment-laden water leaves the site untreated.</td>
<td>4</td>
</tr>
<tr>
<td>83</td>
<td>“Sheet flow” control measures (e.g. Buffer Zones, Grassed</td>
<td>4</td>
</tr>
</tbody>
</table>
Filter Strips, and Sediment Fence) not specified in areas of concentrated flow.

84 Grass Filter Strips will not cause water to be diverted along the up-slope edge of the filter strip. 4

85 The width of sediment control Buffer Zones is appropriate for the land slope (gradient). 4

86 Geotextile Filter Fences are only used to control sediment runoff from earth stockpiles. NA

87 Sediment Fences:
   (a) Located and detailed (i.e. with regular “returns”) such that runoff will pond uniformly or a regular intervals along the fence. 4
   (b) Ends of each fence turned up the slope to control flow bypass. 4
   (c) Each fence clearly identified as either “woven” or “non-woven” as appropriate, otherwise a summary table is provided identifying the fabric specification for each fence. 4
   (d) Specifications show a maximum 2m spacing of support post. 4
   (e) The fence is located at least 2m from base of fill slopes. 4
   (f) Specifications (design details) show adequate trenching of fabric. 4
## Part I: Sediment control “concentrated” flow

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>Appropriate sediment control standard specified (i.e. Type 1, Type 2, or Type 3)</td>
<td>4</td>
</tr>
<tr>
<td>89</td>
<td>Location of all sediment control measures clearly shown.</td>
<td>4</td>
</tr>
<tr>
<td>90</td>
<td>The location and operation of sediment control measures will not cause safety issues or flooding of adjacent properties.</td>
<td>4</td>
</tr>
<tr>
<td>91</td>
<td>Straw bale check dams not specified for sediment control.</td>
<td>4</td>
</tr>
<tr>
<td>92</td>
<td>Appropriate sediment control measures are specified for all “sag” and “on-grade” kerb inlets.</td>
<td>NA</td>
</tr>
<tr>
<td>93</td>
<td>Appropriate sediment control measures specified for all field (drop) inlets.</td>
<td>NA</td>
</tr>
<tr>
<td>94</td>
<td>Appropriate sediment control measures specified for all culverts and pipe inlets.</td>
<td>4</td>
</tr>
<tr>
<td>95</td>
<td>Where specified on stormwater outlets, end-of-pipe sediment traps are located well downstream (e.g. 10 x pipe dia.) of outlet.</td>
<td>NA</td>
</tr>
<tr>
<td>96</td>
<td>Type 2 sediment traps (e.g. Rock Filter Dams, Sediment Trenches, Sediment Weirs):</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>(a) Have adequate up-slope pond area.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Have an appropriately sized sediment collection pit.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Designed for an appropriate storm frequency.</td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>Appropriate access is provided to all sediment traps for maintenance and sediment removal.</td>
<td>4</td>
</tr>
<tr>
<td>98</td>
<td>Appropriate sediment control measures are specified for de-watering operations specified (technical notes).</td>
<td>NA</td>
</tr>
<tr>
<td>99</td>
<td>Sediment controls are placed within streams ONLY as a last resort, and only with written approval from all appropriate Regulatory Authorities.</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>Sediment controls placed in and around drainage channels are appropriate for the expected flow conditions.</td>
<td>4</td>
</tr>
</tbody>
</table>
## Part J: Sediment Basins

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>The location and operation of Sediment Basins will not cause safety issues or flooding of adjacent properties.</td>
<td>NA</td>
</tr>
<tr>
<td>102</td>
<td>Type of each Sediment Basin is appropriate for the soil conditions.</td>
<td>NA</td>
</tr>
<tr>
<td>103</td>
<td>Soil testing and all design calculations provided for all Sediment Basins.</td>
<td>NA</td>
</tr>
<tr>
<td>104</td>
<td>Appropriate construction specifications provided for all basin embankments.</td>
<td>NA</td>
</tr>
<tr>
<td>105</td>
<td>Actual size (including all dimensions) of each Sediment Basin, including spillway, is shown on the plans.</td>
<td>NA</td>
</tr>
<tr>
<td>106</td>
<td>Sediment-laden water is able to flow to the required basin during all stages of earthworks and soil disturbance.</td>
<td>NA</td>
</tr>
<tr>
<td>107</td>
<td>All Sediment Basins have: (a) Stable inflow conditions. (b) Inlet baffle (if required). (c) Minimum 3:1 length to width, otherwise baffles installed. (d) Suitable access for de-silting and maintenance. (e) Stabilised emergency spillway and energy dissipater. (f) Stabilised batters/embankments. (g) Safety or exclusion fencing (as required). (h) Operating conditions and water quality standards specified.</td>
<td>NA</td>
</tr>
<tr>
<td>108</td>
<td>Riser pipe outlet systems for “dry” basins: (a) Debris/anti-vortex inlet screen specified. (b) Anti-flotation weight specified. (c) Details for riser pipe filtration system specified. (d) Anti-seepage collars specified.</td>
<td>NA</td>
</tr>
<tr>
<td>109</td>
<td>Appropriate monitoring and maintenance requirements for all Sediment Basins provided.</td>
<td>NA</td>
</tr>
<tr>
<td>110</td>
<td>Basin sizing, hydraulic design (spillway) and embankment specification certified by appropriate professionals. (a) Review of spillway hydraulics. (b) Geotechnical review of embankment construction &amp; stability. (c) ESC specialist review of basin selection and design.</td>
<td>NA</td>
</tr>
</tbody>
</table>
## Part K: Instream works

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>All necessary site data (soil and flow conditions, stream type, site access conditions).</td>
<td>4</td>
</tr>
<tr>
<td>112</td>
<td>All necessary State and local government approvals have been obtained.</td>
<td>4</td>
</tr>
<tr>
<td>113</td>
<td><em>Temporary Watercourse Crossings</em> (e.g. construction access) have been reduced to the minimum practical number.</td>
<td>4</td>
</tr>
<tr>
<td>114</td>
<td>Instream disturbance is limited to the minimum necessary to complete the proposed works.</td>
<td>4</td>
</tr>
<tr>
<td>115</td>
<td>Instream disturbances have been appropriately staged to minimise exposure to storm runoff and stream flows.</td>
<td>4</td>
</tr>
<tr>
<td>116</td>
<td>Instream works have been programmed for that time of the year that will minimise overall potential environmental harm: (a) avoiding seasonal high flows; (b) avoiding periods of likely fish migration; (c) avoiding active bird migration periods (RAMSAR wetlands).</td>
<td>4</td>
</tr>
<tr>
<td>117</td>
<td>Instream structures are not located on, or adjacent to, unstable or highly mobile channel bends.</td>
<td>4</td>
</tr>
<tr>
<td>118</td>
<td>Construction works will not unnecessarily disturb instream or riparian vegetation.</td>
<td>4</td>
</tr>
<tr>
<td>119</td>
<td>Wherever reasonable and practicable, overbank disturbances will be limited to only one bank.</td>
<td>4</td>
</tr>
<tr>
<td>120</td>
<td>Stormwater runoff moving towards the channel from adjacent areas will be appropriately diverted around soil disturbances.</td>
<td>4</td>
</tr>
<tr>
<td>121</td>
<td>Where stormwater cannot be diverted around soil disturbances, stabilised bank <em>Chute(s)</em> have been provided to carry stormwater down the channel banks in a non-erosive manner.</td>
<td>NA</td>
</tr>
<tr>
<td>122</td>
<td>Wherever reasonable and practicable, dry-weather channel flows are diverted around in-bank disturbances: (a) dry channel conditions expected; (b) flow diversion using cofferdams and bypass pipes; (c) flow diversion using instream <em>Isolation Barriers</em>.</td>
<td>NA</td>
</tr>
<tr>
<td>123</td>
<td>Appropriate temporary erosion control measures (if necessary) have been proposed.</td>
<td>4</td>
</tr>
<tr>
<td>124</td>
<td>Synthetic reinforced erosion control blankets/mats have <em>not</em> been specified where there is a potential threat to wildlife.</td>
<td>4</td>
</tr>
<tr>
<td>125</td>
<td>All reasonable and practicable measures have been taken to avoid the need for instream sediment control measures within flowing streams.</td>
<td>4</td>
</tr>
<tr>
<td>126</td>
<td>Proposed instream sediment control measures are appropriate for the expected site access and stream flow conditions.</td>
<td>4</td>
</tr>
<tr>
<td>127</td>
<td>Appropriate material de-watering procedures and process areas have been identified.</td>
<td>NA</td>
</tr>
<tr>
<td>128</td>
<td>Appropriate bed, bank and overbank rehabilitation measures have been proposed.</td>
<td>4</td>
</tr>
</tbody>
</table>
## Part L: Site monitoring and maintenance

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>129</td>
<td>Site inspection program supplied.</td>
<td>4</td>
</tr>
<tr>
<td>130</td>
<td>Monitoring and Maintenance Program provided for all drainage, erosion and sediment controls.</td>
<td>4</td>
</tr>
<tr>
<td>131</td>
<td>Water quality monitoring program supplied, including construction phase Water Quality Objectives (WQOs).</td>
<td>NA</td>
</tr>
<tr>
<td>132</td>
<td>Water quality monitoring locations/stations identified.</td>
<td>NA</td>
</tr>
<tr>
<td>133</td>
<td>Appropriate safety issues addressed for site monitoring and data (e.g. water sample) collection.</td>
<td>NA</td>
</tr>
<tr>
<td>134</td>
<td>Adequate ESC maintenance requirements have been specified either on the ESCP or within the Supporting Documentation.</td>
<td>4</td>
</tr>
</tbody>
</table>