PRIMARY GOLD

Appendix L - Erosion and Sediment Control Plan

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PRIMARY GOLD

Rustler's Roost & Quest 29 Open-Cut Mine Redevelopment

Erosion and Sediment Control Plan

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Frontispiece: Rustler's Roost Pit looking north July 2021. Photograph K Evans.

ACRONYMS & ABBREVIATIONS

BOM	Bureau of Meteorology
CPEng	Chartered Professional Engineer
CPESC	Certified Professional in Erosion and Sediment Control
EMSP	Environmental Management System and Plans
ESCP	Erosion and Sediment Control Plan
IECA	International Erosion Control Association
LOM	Life of Mine
ML	Mineral Lease
MMP	Mining Management Plan
NT	Northern Territory
TSF	Tailing Storage Facility
WMP	Water Management Plan
WRD	Waste rock dump

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1 INTRODUCTION

1.1 Background

Rustlers Roost (RR) and Quest 29 (Q29) are brownfield sites on Mineral Leases (ML) located in the Mount Bundey locality, approximately 85 kilometres (km) south-east of Darwin in the Northern Territory (NT). Primary Gold Limited (PGO) (the Proponent) is proposing to redevelop the existing mine by expanding open-cut gold mining operations and connecting the two non-contiguous sites with a haul road and construction of an accommodation camp (the Project). The RR portion of the Project area and the accommodation camp are located on the Old Mount Bundey Station, Perpetual Lease (PPL) 1163 and the Q29 portion of the Project is located on the McKinlay River Pastoral Station (PPL1184). The haul road will extend for 11 km and is predominately within Old Mount Bundey Station. Primary Gold is a fully owned subsidiary of Hanking Australia Investment Pty Ltd. The location of the Project area is shown in Figure 1-1.

Primary Gold, via CDM Smith Australia Pty Ltd, have engaged Surface Water & Erosion Solutions and Elder Enviro to prepare Erosion and Sediment Control Plans (ESCPs) for RR and Q29 as supporting documentation for the draft Environmental Impact Statement (EIS to the Northern Territory Environmental Protection Authority (NT EPA) and to support renewal of the Mining Management Plan (MMP).

This ESCP applies to the proposed redevelopment of the RR and Q29 portions of the Project area.

1.2 Scope and purpose

This ESCP has been prepared by a Certified Professional in Erosion and Sediment Control (CPESC) and a Chartered Professional Engineer (CPEng) to provide a best-practice framework for implementation of effective erosion and sediment control over the life of mine.

The purpose of this ESCP is to:

- Identify areas vulnerable to erosion and receiving waters.
- Ensure stormwater is managed to protect downstream water quality.
- Prevent erosion and potential sedimentation associated with site activities.
- Provide an erosion assessment by a CPESC.
- Detail measures to be implemented to effectively manage erosion, and potential sediment mobilisation associated with the Project activities.

Recommendations and designs provided within this ESCP are consistent with the International Erosion Control Association (IECA) best practice guideline *Best Practice Erosion and Sediment Control* (IECA 2008).

This plan will be used to inform preparation of Progressive ESCP's that provide detailed site-specific controls relevant to the current operational phase and level of erosion risk (i.e., wet/dry season).

1.3 Reviews and updates

Review of this ESCP will be undertaken annually to assess effectiveness and performance. Where necessary, the ESCP will be updated to reflect identified changes or modifications.

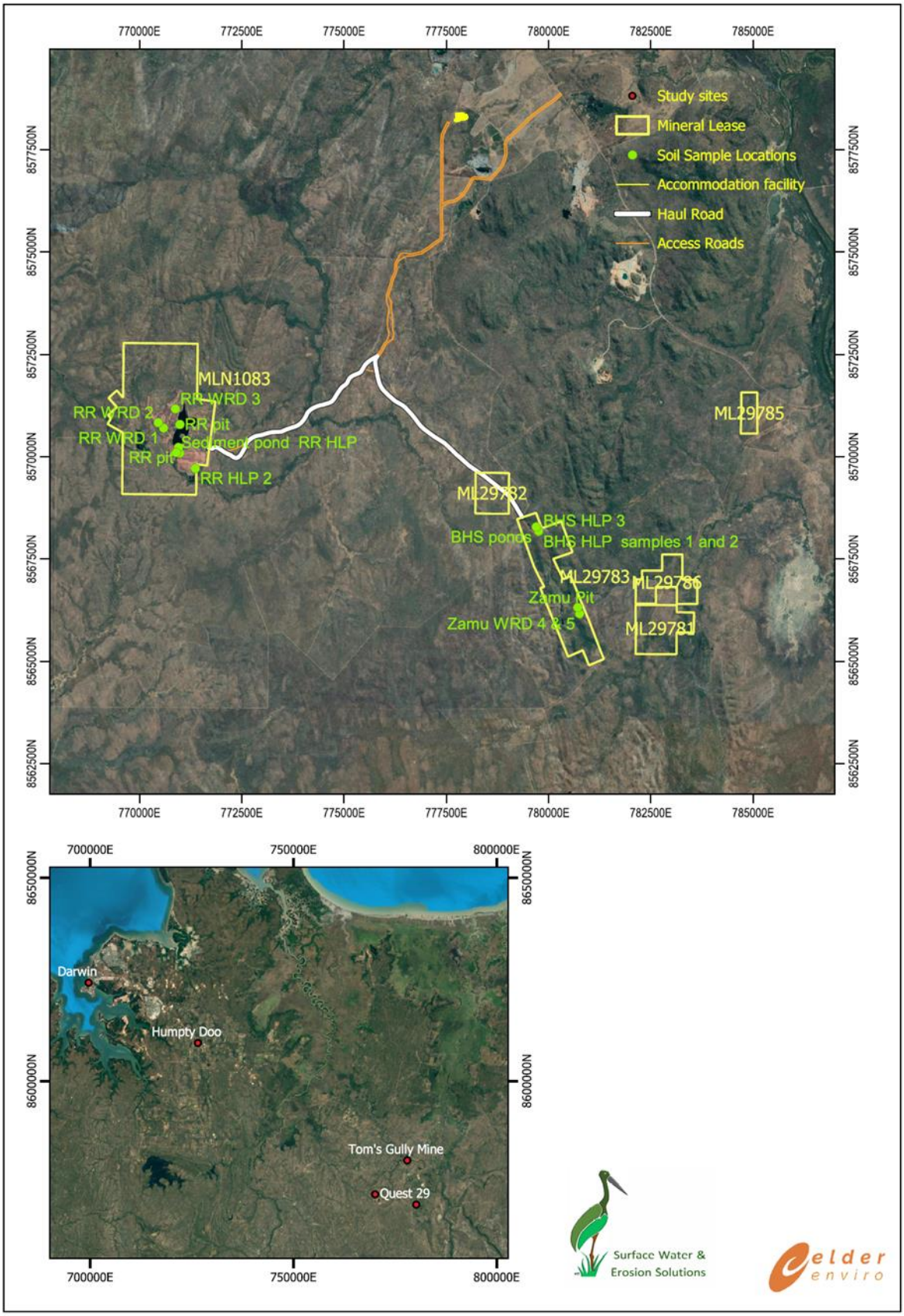

Figure 1-1. Study site location.

2 PROJECT DESCRIPTION

2.1 Historic and current land use

2.1.1 Rustler's Roost

The RR Project area is located on Mineral Lease 1083 (MLN1083) which covers approximately 756 ha. Rustlers Roost has been in care and maintenance since 1998, with exploration works being conducted by PGO in 2003, 2017 to 2018 and more recently during 2020.

The infrastructure and landforms that remain on the site are listed below and locations are shown on Appendix A-1.

- Waste rock dump (WRD) (approximate dimensions 30 m in height, 1,000 m length and 400 m width).
- Associated open pits that have flooded and are considered one pit (approximate dimensions 50 m, 1,000 m length and 300 m width). The pit lake currently holds approximately 3.16 GL of water based on post mining pit shell dxf. and current water level 56.90 mAHD (surveyed on 3 November 2020).
- Annie's Dam - an existing pastoral dam and a potential raw water resource for the proposal with nominal water storage capacity of 0.29 GL.
- Two heap leach pads (total approximate dimensions 20 m in height, 600 m in length and 450 m width) and heap leach ponds.
- Remnants of old processing plant. In 1997 most of the plant, buildings and other mining infrastructure were removed, apart from three large tanks and some concrete footings.

2.1.2 Quest 29

Quest 29 is located on Pastoral Leasehold land across five Mineral Leases – ML29785, ML29782, ML29783, ML29786 & ML29781 (Appendix A.2). Of these Mineral Leases, ML29783 is the only tenement that has had historical disturbance (aside from exploration drilling), across an area of approximately 21 ha.

The existing infrastructure and landforms on the site are listed below and locations are shown in Appendix A-2.

- Five open-cut pits (largest of the pits approximately 10 m depth, 280 m length and 50 m width).
- Five WRD's (largest of the WRDs approximately 10 m height, 280 m length and 80 m width).
- One heap leach pad (approximate dimensions 20 m in height, 200 m length and 200 m width).
- Heap leach ponds.
- Remaining infrastructure of the Carbon in-leach (CIL) tanks.

Quest 29 was operated as an open-cut gold mine from 1999 to early 2002. Under care and maintenance, the pastoral landowner of Old Mount Bundey Station has been engaged by PGO to assist in monitoring and managing the mining tenements in terms of weed, fire and water management compliance requirements (EcOz, 2021).

2.2 Proposed redevelopment

Details of the proposed redevelopment of the sites are provided in Section 1 and Section 4 of the draft EIS (CDM Smith, 2021).

The Rustlers Roost mine development envelope will encompass 611.0 ha, of which 277.6 ha is mapped as being previously cleared/disturbed by historic mining or pastoral activities. The Project will require clearing of

a further 333.4 ha of land mapped as containing native vegetation. This clearance value is based on disturbing the entire development envelope, which is considered overly conservative. The Project involves open-cut mining and expansion of all existing open-cut pits, and mining of two new pits (Annie's Dam and Annie Oakley) at RR, which will be conducted using a drill and blast technique.

The Quest 29 mine development envelope will encompass 139.5 ha, of which 46.7 ha is mapped as being previously cleared/disturbed by historic mining or pastoral activities. The Project will require clearing of a further 26.16 ha of land mapped as containing native vegetation. This clearance value is based on infrastructure footprints within the development envelope.

The accommodation camp development envelope encompasses 17.8 ha, of which 2.3 ha is mapped as being previously disturbed by existing roads. The Project will require clearing of a further 7.3 ha of land mapped as containing native vegetation. This clearance value is based on disturbing the entire development envelope, which is considered overly conservative.

Ore from Q29 will be processed at a new purpose-built facility located at the RR site to produce gold bullion. The 11 km existing haul road between RR and Q29 will be upgraded to accommodate heavy vehicles for haulage of ore. This will require widening the existing road from approximately 10 m to 20 m width, building up the road with screening of suitable material from the existing oxide WRDs, upgrade of existing culverts and construction of a new bridge at the creek crossing on the RR access and Q29 access (EcOz 2021).

The haul road development envelope will encompass 21.7 ha, of which 19.7 ha is mapped as being previously disturbed by the existing haul road and bridges. The Project will require clearing of a further 2 ha of land. This clearance value is based on disturbing the entire development envelope.

The total mapped vegetation clearing extent for the Project is conservatively calculated at 368.86 ha.

Waste rock at both sites will be deposited in surface WRDs and at Q29, also used to backfill several pits where mine scheduling permits. A new surface WRD is proposed to dispose of the waste from mining Zamu pit, with waste material from the remaining pits to be backfilled into Zamu pit and a portion of oxide material from BHS pit used for rehabilitation of the decommissioned heap leach facility.

At RR, most of the waste rock material will be deposited within the two surface WRDs (located partially over the historic WRD to the north-west of the main pit) and a portion backfilled into the two new minor pits (Annie's Dam pit and Annie's Oakley pit).

Mined ore will be processed using a Carbon in Leach (CIL) processing method, which extracts gold from the ore by mixing with a cyanide solution. Tailings produced from the processing facility will be deposited in a tailings storage facility (TSF) to be constructed in the RR portion of the Project area.

A mine accommodation camp will also be constructed as part of the proposal.

2.3 Schedule

Subject to approvals, PGO plan to commence mining activities in 2022 (Figure 2-1).

Construction at both RR and Q29 will occur within the first 12 months (scheduled for May 2022 – May 2023) and include the following activities:

- Upgrade of access/haul road
- Office/administration and amenities
- Processing facility
- Accommodation camp
- Construction of TSF.

Mining operations will commence in year two on completion of the critical infrastructure. The Rustlers Roost open-cut pit mining schedule is proposed to occur in five stages over an approximate 9 to 10 year duration.

Quest 29 will be mined over a 4 to 6-year period in five stages as a satellite reserve to feed the processing plant located at Rustlers Roost.

Mining operations will commence in Q2 2023 and continue until Q4 2032.

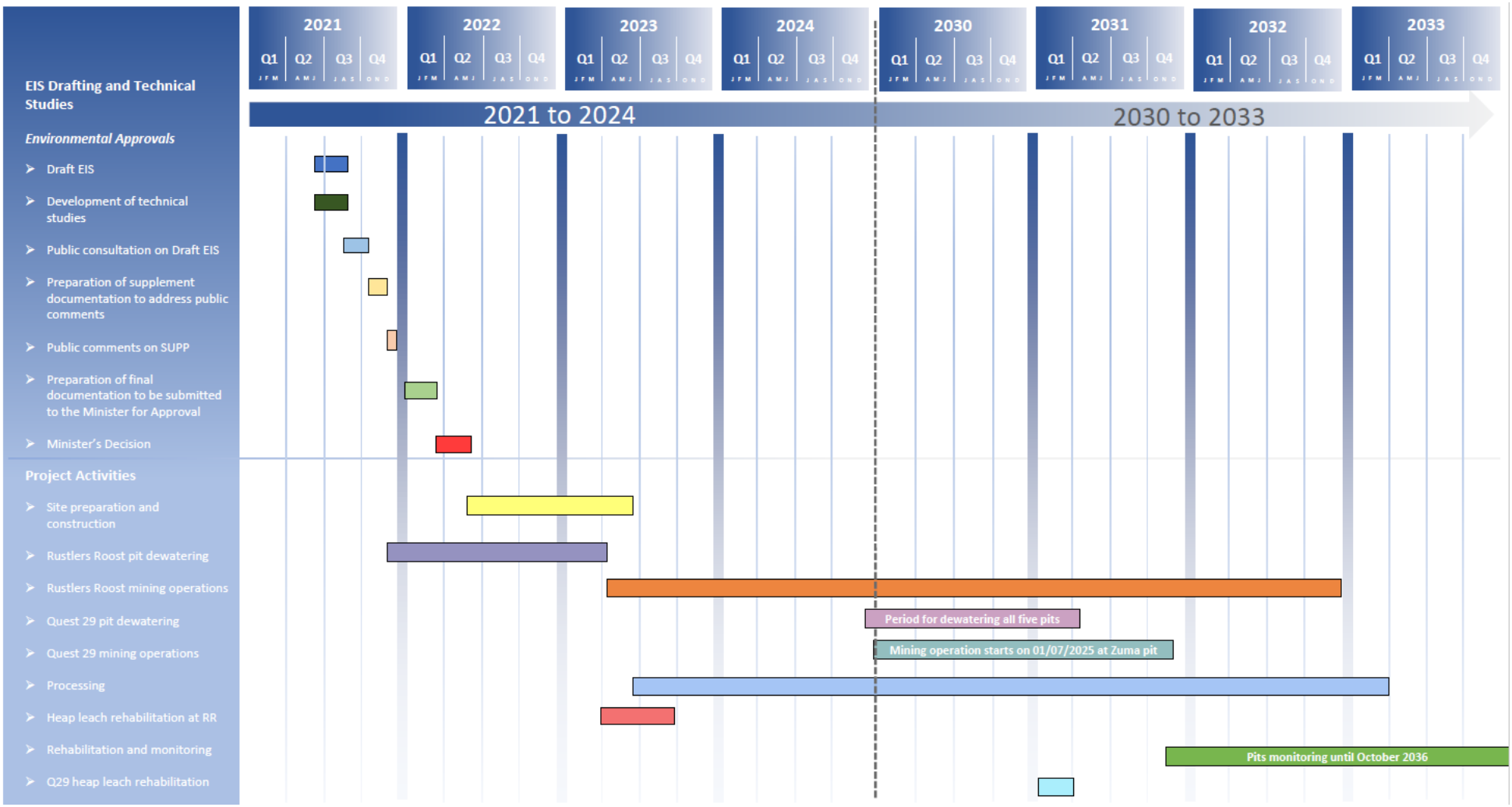

Figure 2-1. Rustler's Roost and Quest 29 Project Timeline

3 SITE CHARACTERISTICS

3.1 Climate

3.1.1 Rainfall

The Project area is situated within the tropics and experience two distinct seasons, the dry season from May to September and the hot and humid wet season from October to April.

Bureau of Meteorology (BOM) daily rainfall records are available for station 014090 Middle Point Rangers where data have been collected since 1957. The station has recorded average annual rainfall of 1420 mm with the greatest average monthly rainfall during January (350 mm). Cyclones and monsoons can occur during the wet season from October to April and very little rain falls during the dry season from May to September. Mean monthly rainfalls are shown in Figure 3-1.

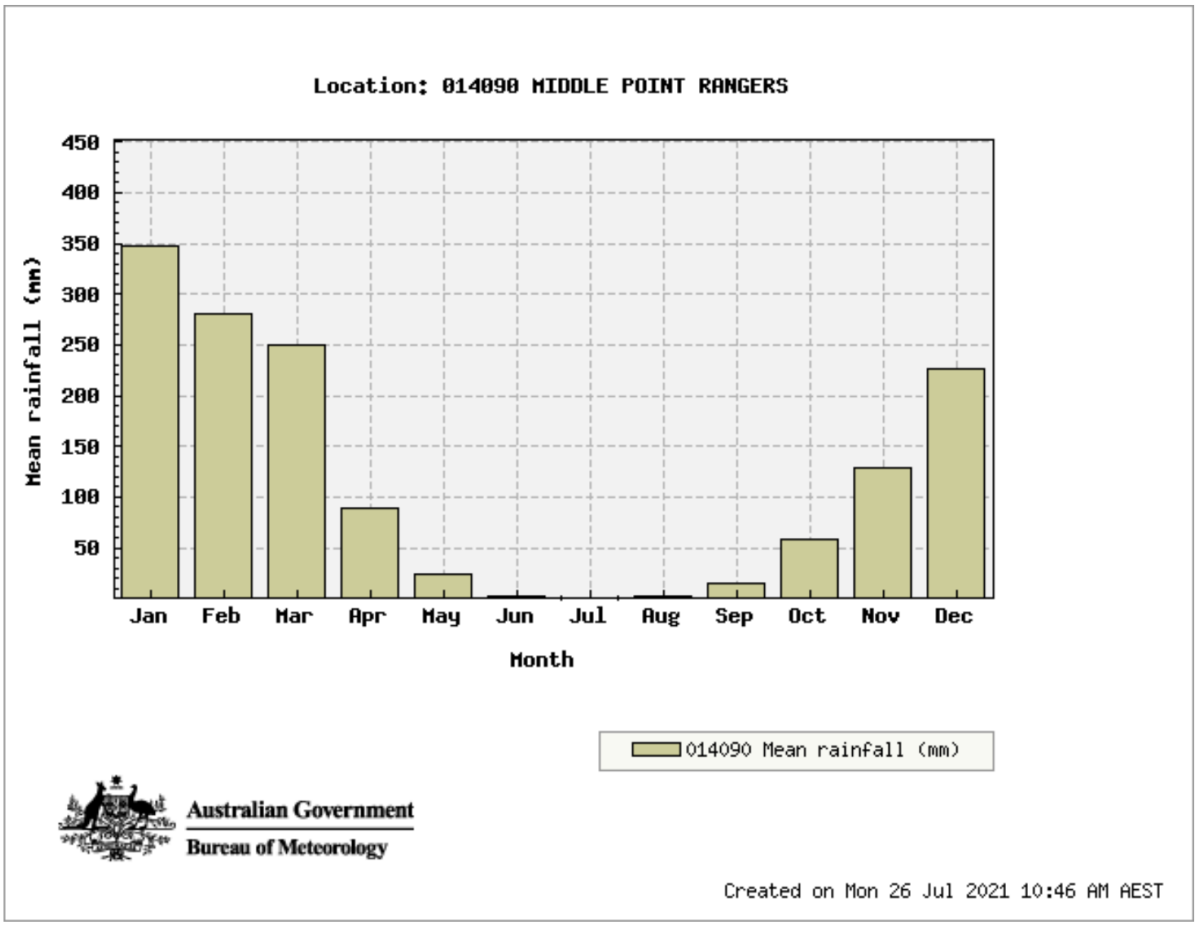

Figure 3-1. Mean monthly rainfall for BOM station 014090 Middle Park Rangers

3.1.2 Intensity, Frequency, Duration

Intensity frequency duration curves for the site were obtained from the BOM and are given in Figure 3-2. These were used to determine design peak discharges.

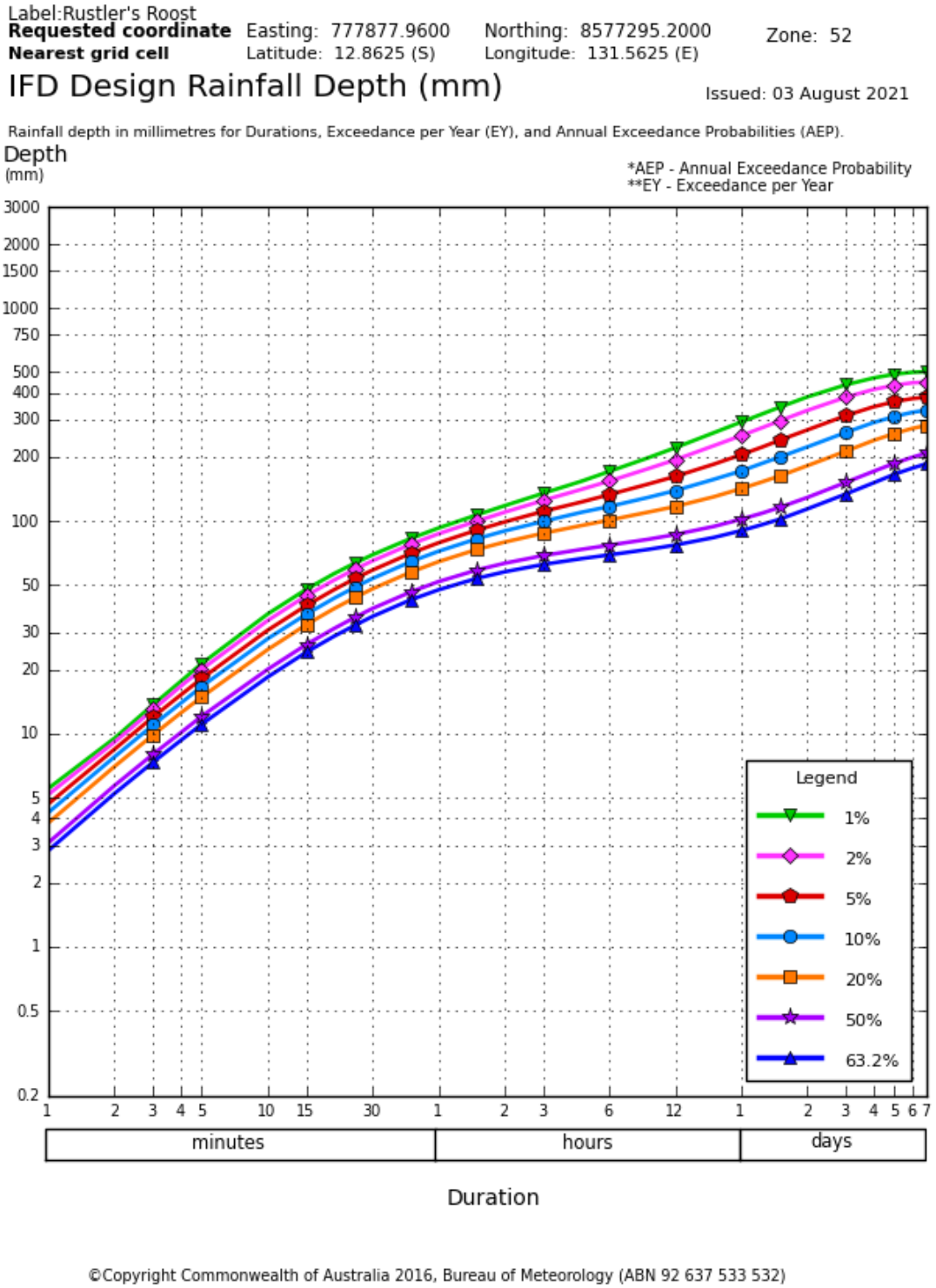

Figure 3-2. Intensity Frequency Duration curves for the study site

3.1.3 Evaporation

The mean daily evaporation at Middle Point Rangers BOM site, measured by class A evaporation pan from 1965 to 1998, is shown in Figure 3-3.

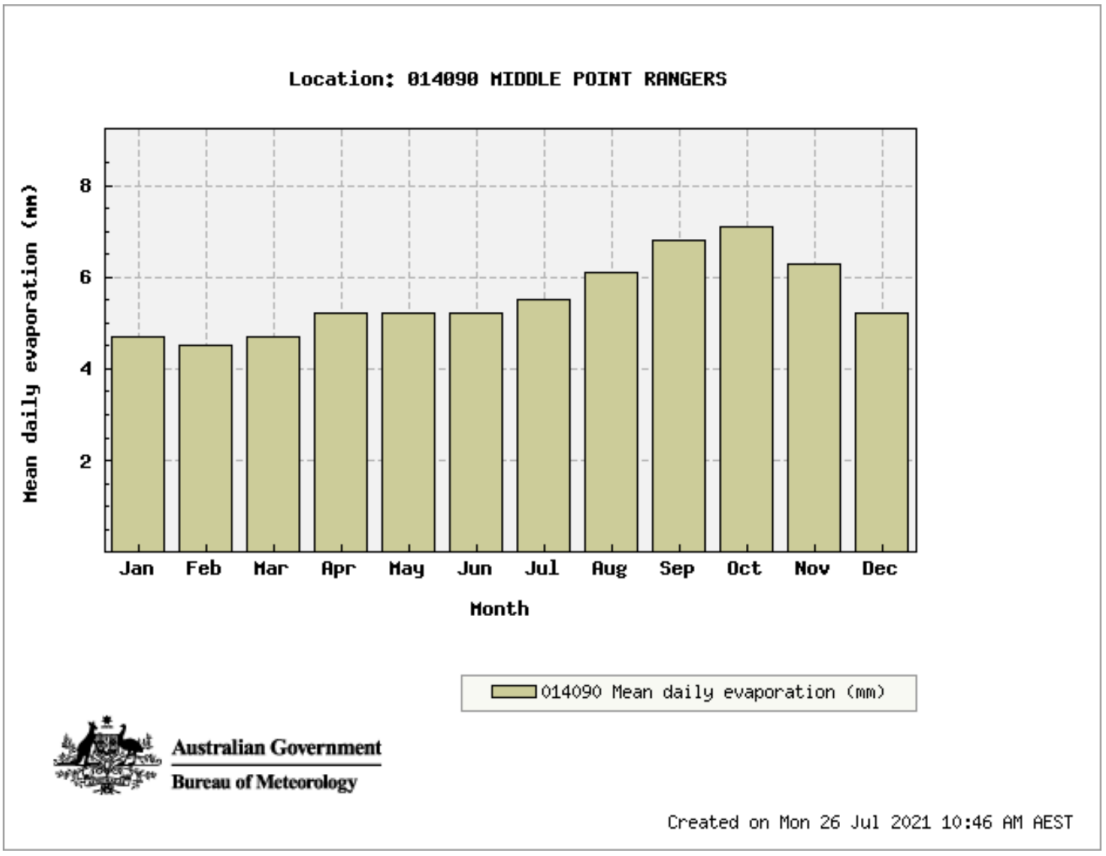

Figure 3-3. Mean daily evaporation for BOM station 014090 Middle Park Rangers

3.2 Topography and Infrastructure

The Project area is predominantly located on low hills and adjacent drainage lines. Existing vegetation and extensive stone surface outcrops provide some erosion protection.

Appendix A.1, Appendix A.2, and Appendix A.3 give the topography of the sites.

Proposed infrastructure is shown in Appendix B.1.

3.3 Drainage

The Q29 portion of the Project area is predominantly located in the McKinley River sub-catchment, which also flows into the Mary River system. A minor northern portion of Q29 is in the upper Mount Bundey Creek sub-catchment of the Mary River system.

The RR portion of the Project area is on the catchment divide and in the headwaters of Marrakai Creek and Mount Bundey Creek and the mineral lease extent is 9.35 km^2. Both creeks are ephemeral, flowing only through the wet season with the annual receding hydrograph continuing into the dry season.

The RR site has internally draining catchments reporting to the pit and the proposed TSF comprising 3.34 km^2 and externally draining catchments reporting to Marrakai and Mount Bundey Creeks comprising 6.01 km^2.

The local catchment is comprised of ridges and dissected hills that are drained by small step rivulets (CDM Smith 2019). Stream flows in these upper areas of the catchments are ephemeral, with flows occurring for only a few weeks-months each year throughout the wet season, in response to rainfall events (EcOz 2021).

Catchment analysis of the sites is show in Appendix D.1 and Appendix D.3.

3.4 Landform and soil characteristics

Landforms and land units for the RR and Q29 portions of the Project area are shown in Table 3-1.

Table 3-1. Landform description of the RR and Q29 Project area

Landform class	Landform description	Soil	Soil description
Low hills	Rugged terrain associated with siltstones and greywacke of Burrells Creek formation and Upper Proterozoic dolomites and sandstones; relief of between 10 and 80 m; with slopes >10 %; extensive surface stone outcrop.	Rudosols	Very shallow stony lithosols
Low rounded hills	Low rounded hills; some upland surfaces; well-drained (nil to low level waterlogging); slope 3 to 4 %.	Kandolsols	Shallow brown sandy loam with scattered surface gravel
Rises	Low hills; ridges same lithologies as 2a; relief between 5 to 20 m, slope gradients between 6 -15 %, with extensive stone outcrop.	Kandolsols	Shallow stoney and gravelly lithisols
Creek channel	Creek channel ranging in width and depths forming large pools; poorly drained (wet season waterlogging); slope 1 to 4 %.	Hydrosol	Yellowish/brown sandy clay
Drainage lines	Minor creek lines and broad drainage systems; poorly drained (wet season waterlogging); slope 1 to 6 %	Hydrosol	Yellow/brown sandy clay

Source: NTG NR Maps

Soil samples from disturbed areas were collected as part of site investigations Figure 1-1. Laboratory analysis included soil erodibility (K-factor) and Emerson Class (Table 3-2) (Appendix G.1).

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008) and is used in calculation of potential soil loss.

The Emerson Class is determined from the Emerson Aggregate Test, an eight-class classification describing the behaviour of air-dried aggregates when placed in distilled water. Specifically, it describes whether the soil aggregates slake or disperse. Soil erodibility factors are required to be adjusted upwards for Emerson Class 1 and 2 soils (these classes were not observed from the collected samples).

Table 3-2. Soil erodibility and Emerson class[1]

Site	Location	Description	Soil erodibility (K-factor)	Emerson Class
Q29				
HLP 1 & 2	779756 E 8568170 N	BHS Heap Leach pad.	0.03	Class 8
HLP 3	779755 E 8568187 N	BHS Heap Leach Pad.		
Zamu WRD 3&4	780759 E 8566164 N	Current Zamu WRD	0.024	Class 5
RR				
RR WRD 1	770589 E 8570700 N	Waste rock material southern area of the Rustler's Roost WRD.	0.017	Class 8
RR WRD 2	770458 E 8570832 N	Waste rock material southwestern area of the Rustler's Roost WRD.		
RR WRD 3	770458 E 8571168 N	Waste rock material southern area of the Rustler's Roost WRD		
RR HLP 1	770902 E 8570101 N	Gravel sized material from the northwest corner of the heap leach pad	0.012	Class 8
RR HLP 2	771363 E 8569713 N	Gravel sized material from the southeast of the heap leach pad		

[1] Samples from the same collection unit were combined for analysis.

4 EROSION HAZARD AND RISK

4.1 Erosion hazard

Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This enables prediction of the long term, average, annual soil loss from sheet and rill erosion under specified management conditions.

The RUSLE is represented by the following equation: A = R K LS P C

where:

Factor	Description	Value	Comment
A	estimated soil loss (tonnes/ha/yr)	variable	As calculated per catchment
R	rainfall erosivity factor	7996	Application of the Renard & Freimund (1994) equation as described by Evans et al (2004)
K	soil erodibility factor	variable	4 analysis (Table 3-2).
LS	slope length/gradient factor	variable	Based on catchment characteristics. IECA 2008 – Section E3.3
P	erosion control practice factor	1.3	Construction phase condition Section 3.1.5
C	ground cover and management factor	variable	Based on catchment characteristics. Refer Section 4.1.4

4.1.1 Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. The adopted annual R factor is 7996. This adopted value is significantly higher than the value of 4860 derived from the IECA 2008 recommended methodology (using the 2-year 6-hour rainfall intensity for site).

4.1.2 Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). A K-factor of 0.03 has been adopted for all work areas at Q29 assessed as part of this ESCP, based on laboratory analysis of collected samples (Table 3-2) (Appendix G.1). At RR the following K-Factors were applied: 0.017 oxide waste rock, 0.012 heap leach gravels, and 0.01 Koolpinyah Surface (Surface Water & Erosion Solutions, 2019).

4.1.3 Slope (LS–factor)

The existing topographic slope grades for the accommodation camp, haul road and Q29 Project area range from approximately 4 – 11%.

Slope grades for RR range from 0 to 55% with a mean of 5.3%.

Due to the highly variable slopes, a spatially distributed LS-factor was determined using GIS analysis. This provided a graphical representation of the location of the most severe areas of erosion which can assist in focussing on those areas in erosion management.

4.1.4 Cover and management factor (C–factor)

Ground cover on site comprises vegetation, rock, competent gravel, and unprotected soil material. Soil binders may also be applied for dust suppression and erosion control. Existing roads are characterised by a stable gravel/soil surface. C-factors for various surface are summarised in Table 4-1.

Table 4-1. Adopted C-factors

Surface type	% Cover	C-factor
Concrete, bitumen	100	0
Vegetation (highly variable)	25 - 80	0.37 – 0.025
Soil stabiliser (e.g., Vital Bon-Matt HR or Bon-Matt RDS (S72)	80	0.025
Rock	80-100	0.025 - 0
Competent gravel/soil (e.g., haul roads)	20	0.44
Bare soil, erosive surface	0 - 20	1 - 0.44

4.1.5 Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas without permanent stable groundcover is 1.3 (based on the default construction phase condition).

4.1.6 Estimated soil loss - Operational

The RR Project area was separated into externally draining catchments, those debouching off the mineral lease; and internally draining catchments, those debouching to the pits or TSF (Appendix B.1). Potential soil loss calculations and associated erosion hazard for defined work areas in the externally draining catchments in RR are provided in Table 4-2. For internally draining catchments, potential soil losses are shown in Table 4-3. The site distribution of the potential operational erosion is shown in Appendix C.1.

Table 4-2. Soil loss and erosion hazard for RR external catchments

Project areas	RR Mine Area Externally Draining Catchments										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Catchment area (ha)	17.92	22.58	75.58	15.14	16.70	35.46	4.31	56.35	10.44	14.29	62.08
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.01	0.017	0.017	0.017	0.01	0.012	0.01	0.01	0.01	0.01	0.0135
Slope length (L)	25	28	31	30	39	32	23	46	24	80	38
Slope gradient (S)	13	15	9	26	11	9	15	5	8	1.2	17
Length/gradient (LS)	2.76	3.56	2.07	8.29	2.89	2.12	3.54	1.09	1.58	0.20	4.42
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Ground cover in disturbed catchment - %	0	0	0	0	0	0	0	0	0	0	0
Ground cover in disturbed catchment (C)	1	1	1	1	1	1	1	1	1	1	1
Soil Loss (t/ha/yr)	**287**	**629**	**366**	**1465**	**300**	**264**	**368**	**113**	**164**	**21**	**620**
Soil Loss Class	3	5	4	6	3	3	4	1	2	1	5
Erosion Hazard	Low-Mod	High	Moderate	Very high	Low-Mod	Low-Mod	Moderate	Very low	low	Very low	High

Table 4-3. Soil loss and erosion hazard for RR internal catchments.

Project areas	RR Mine Area Internally Draining Catchments					
	12	**13**	**14**	**15**	**16**	**17**
Catchment area (ha)	17.92	22.58	75.58	15.14	16.70	35.46
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.01	0.017	0.017	0.017	0.01	0.012
Slope length (L)	25	28	31	30	39	32
Slope gradient (S)	13	15	9	26	11	9
Length/gradient (LS)	5.13	5.06	6.90	2.50	5.43	1.88
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3	1.3
Ground cover in disturbed catchment - %	0	0	0	0	0	0
Ground cover in disturbed catchment (C)	1	1	1	1	1	1
Soil Loss (t/ha/yr)	**907**	**894**	**1219**	**442**	**960**	**332**
Soil Loss Class	6	6	6	4	6	3
Erosion Hazard	Very High	Very High	Very High	Moderate	Very High	Low-Mod

Potential soil loss calculations and associated erosion hazard for defined work areas in Q29 are provided in Table 4-4. The site distribution of the potential operational erosion is shown in Appendix C.2.

Table 4-4. Soil loss and erosion hazard for Q29 catchments

Project areas	Q29 Mine Area				Camp	Haul Road
	BHS Heap Leach Cover	**East Koolpin WRD**	**Zamu WRD**	**Taipan WRD**		
Catchment area (ha)	8.8	23	14.1	1.2	7.30	2.20
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.030	0.030	0.030	0.030	0.030	0.030
Slope length (L)	16	41	31	40	100	50
Slope gradient (S)	19	24	6	40	5 (av)	5
Length/gradient (LS)	2.08	3.04	0.75	6.18	3.80	0.91
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3	1.3

Project areas	Q29 Mine Area				Camp	Haul Road
	BHS Heap Leach Cover	East Koolpin WRD	Zamu WRD	Taipan WRD		
Ground cover in disturbed catchment - %	0	0	0	0	0	50
Ground cover in disturbed catchment (C)	1	1	1	1	1	0.145
Soil Loss (t/ha/yr)	**649**	**948**	**233**	**1929**	**284**	**41**
Soil Loss Class	5	6	3	7	3	1
Erosion Hazard	High	Very High	Low to Mod	Extremel y High	Low to Mod	Very low

4.2 Erosion risk

Erosion risk rating is determined from mean monthly rainfall depth for Middle Point Rangers (Table 4-5). Ratings range from moderate to extreme for the wet season (Oct – Apr), with dry season risk very low / negligible (May – Sep).

Table 4-5. Monthly erosion risk rating for Middle Point Rangers

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall depth (mm)	347.4	280.1	249.0	89.1	23.5	1.4	0.7	2.2	14.0	57.7	128.0	226.8
Rating	Extreme	Extreme	Extreme	Moderate	Very Low	Very Low	Very Low	Very Low	Very Low	Moderate	High	Extreme

4.3 Erosion and sediment control requirements

Recommended erosion and sediment control measures are based upon the relationship between erosion hazard (as determined from Table 4-4 to Table 8-3) and erosion risk (Table 4-5). The Project site climate, with a reliable and prolonged dry season (May to September), provides a low risk of erosion from rainfall throughout these months, although wind erosion potential (dust) is significant.

It is essential that erosion and sediment control measures are fully implemented prior to the 1st October, in preparation for the wet season, and corresponding moderate to extreme erosion risk from October to April. Table 4-6 summarises erosion and sediment control requirements for all stages of project construction and operation across a full calendar year. Typical measures to be implemented during the Project are discussed in Section **Error! Reference source not found.** below, with specific design, timing, and location to be provided w ithin Progressive ESCPs and associated engineering drawings.

Table 4-6. Erosion risk and ESC requirements during construction

Erosion Risk Rating	Monthly Rainfall (mm)	Period	Erosion & Sediment Control Requirements
Very low	0 to 30	May – Sept (Dry Season)	• ESCs not required for activities which do not disturb groundcover. • Unfinished earthworks are suitably stabilised if rainfall is reasonably possible. • Sediment control to be installed around areas of erosion risk prior to 1st October (wet season commencement).
Moderate	45+ to 100	Oct & Apr	• Areas of erosion risk protected within 20 days' completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
High	100+ to 225	Nov	• Areas of erosion risk protected within 10 days' completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
Extreme	> 225	Dec - Mar	• Areas of erosion risk protected within 5 days' completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
Notes:	[1] Areas of erosion risk may be protected using the following types of cover: hardstand, soil binder (e.g., polymer), placement of mats, blankets (e.g., geotextile, jute) or vegetative cover (min 75% for all areas, with min 90% for drainage channels).		

5 EROSION AND SEDIMENT CONTROL MEASURES

Erosion and sediment control measures required during construction and operation have been derived based on the site erosion hazard and risk. Conceptual details of the controls are provided in the sections below based on the current level of design detail. The process for development of progressive ESCPs that will provide further detail on site-specific controls is also described.

5.1 Progressive ESCPs

As construction and operation activities advance, specific up-to-date details on the location and installation of ESC measures will provided within Progressive ESCPs. Typically, this will include the following construction stages/situations where erosion risk rating is assessed as moderate to extreme (i.e., October – April):

- Where a new stage of construction/operation works are commenced and/or controls require alteration due to change in work practices (e.g., clear & grub, topsoil strip, bulk earthworks, final stabilisation).
- Controls require alteration due to change in seasonal conditions (e.g., dry season vs wet season).
- Installation of road, drainage, and waterway crossings.
- A change in the project design occurs that potentially impacts ESC requirements.
- The desired outcome (e.g., protection of receiving environments) is not being achieved.

Where required, Progressive ESCPs will be developed when specific site conditions can be assessed, and appropriate control measures determined. All Progressive ESCP's are to be consistent with this Primary ESCP, with specific measures in accordance with IECA guidelines, project approvals and associated documentation.

5.2 Drainage control

Drainage controls, in accordance with IECA (2008) include measures for the diversion of 'clean' stormwater runoff around and through the site; and the diversion of 'dirty' site stormwater runoff to enable treatment of sediment prior to release offsite, as defined below:

Clean water:

Water that either enters site from an external source and has not been further contaminated by sediment within site; or water that has originated from the site and is of such quality that it does not need to be treated to achieve the required water quality standard (IECA 2008). Site clean water constitutes surface runoff from areas of non-erodible cover, including vegetation, hardstand, soil binder, mats, or blankets (e.g., geotextile).

Dirty water:

Water not defined as clean, thereby requiring treatment with appropriate controls prior to release from site (IECA 2008).

Temporary drainage controls installed as part of construction will enable management of stormwater within work areas. Drainage controls will perform the following functions:

- Enable diversion of 'clean' up-slope run-on water either around or through the site at non-scouring velocities.

- Enable collection of ‘dirty’ runoff generated within construction areas and the delivery of this water to an appropriate sediment control measure.
- Minimise the risk of soil erosion caused by site-generated flows within the project, using ‘intermediate’ flow treatment and release points.
- Control of the flow velocity, volume and location of water passing through the project at drainage line and waterway crossings.

5.2.1 Conceptual Drainage - RR

The drainage controls will perform the following functions:

- Diversion channels – These are used for diversion of large, concentrated flows. Locations and calculations for Stage 1 are given in Appendices D.1. Locations and calculations for the closure landform including WRDs are given in Appendix D.2. Calculations are given in Appendix D.3 and D.4 and typical detail is given in Appendix D.6.
- Check dams (e.g., Rock) – velocity control device within diversion channels. Also used as sediment control. Check dams are used in the diversion channels and the number used are shown in Appendix D.1 and D.2. Typical design details are given in Appendix D.6. Not all diversion channels have check dams.
- Flow diversion banks –On this site they are used as cross slope drainage to convey water from the slopes to diversion channels. Flow diversion banks are also used to direct clean water away from the site (Appendices D.1 and D.2). Sizing of the clean water flow diversion banks are given in Appendix D.3 and detail is given in D.6.
- Catch Drains - Will be used on the steep slopes of the final WRD for collection and diversion of sheet flow across a slope to chutes, or around soil disturbances. These should be implemented on the final WRD slopes (Appendix D.2). Because of the uncertain nature of the final WRD shape, detailed design has not been completed.
- Chutes – discharge of concentrated flows down steep slopes. This will be implemented on the WRD steep slopes to convey water down the slopes from the catch drains (Appendix D.2). These are discussed further in emergency spillway design Appendix F.
- At closure the northern WRD lays across a topographic high which may cause accumulation of water at the toe of the WRD. Water should be diverted away from the toes of the WRD in this location.

5.2.2 Conceptual Drainage - Q29

Drainage controls proposed for the Q29 mining areas include:

- Internal containment of site runoff within existing pits. The conceptual drainage layout is shown in Appendix D.5 with calculations.
- Flow diversion banks - to prevent ingress of upslope clean water into the project area, direct site water to sediment basins, and contain WRD runoff. Constructed from topsoil / compacted earth. Locations are given in Appendices D.5 and D.6.
- Diversion channels – for diversion of large, concentrated flows. Location and size data are given in Appendix D.5.
- Cross banks (‘whoa boys’) – cross drainage on unsealed roads.
- Catch drains (slope breaks) - construction of drains along slope contours to reduce slope length.
- Chutes – discharge of concentrated flows down steep slopes.

- Rock Check Dams – velocity control device within concentrated flow channels. Also used as sediment control.
- Culverts.

5.2.3 Drainage Controls - Accommodation Camp and Haul Road

Drainage controls proposed for the accommodation camp include:

- Flow diversion banks - topsoil berms around the site perimeter to enable diversion of external runoff.
- Protected flow paths within the accommodation camp to direct site runoff to sediment controls.
- Rock Check Dams – velocity control device within concentrated flow channels.
- Catch drains (slope breaks) - construction of drains along slope contours to reduce slope length.
- Culverts.

Drainage controls proposed for the main haul road include:

- Road graded to a crown, or with cross fall drainage
- Road runoff to be directed to stable outlets (vegetated or rock protected areas) via table drains and mitre drains.
- Drainage to incorporate check dam controls (e.g., rock check dam, filter bag/tube) to provide flow energy dissipation in addition to providing sediment control.

Typical designs are provided within Appendix B and applicable engineering plans.

5.3 Erosion control

Prevention of erosion is the primary approach for the prevention of adverse impacts associated with sedimentation. Construction and operation activities are to be undertaken to reduce the duration of soil exposure to erosive forces (wind and water), either by holding the soil in place or by shielding it. Measures to be used include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces.

The specific measure(s) implemented will be based on seasonal erosion risk and construction considerations. Measures will be documented in the most current Progressive ESCP and based upon IECA guidelines. Proposed controls are listed below:

- Undertaking initial construction in the dry season months as far as schedule allows.
- Minimise disturbance to existing vegetation as far as practical within the Project area. Land clearing will be undertaken in accordance with the Environmental Management System and Plans (Primary Gold, 2020), which includes procedures and methods for minimising levels of soil disturbance and impacts to natural drainage pathways.
- Promptly stabilising exposed areas once construction phase has been completed (e.g., protecting topsoil berms).
- Protection of soil surface (temporary and permanent) including placement of hardstand surfaces, use of soil binder, vegetation establishment (including mulch), and protection with mats & blankets (e.g., jute, geotextile) where practical.
- Application of dust suppression by wetting of exposed surfaces (water truck), application of soil binder, and/or application of soil cover.

5.4 Sediment control

Effective erosion and sediment hazard reduction is best achieved by undertaking initial construction activities during the dry season months (May - September) wherever possible. The current Project schedule has construction commencing in May 2022 and continuing through the Wet Season.

5.4.1 Sediment control standards

Sediment control measures are classified as being Type 1, Type 2, Type 3 or supplementary based on their ability to trap a specific particle size (Table 5-1).

Table 5-1. Classification of sediment control measures

	Type 1	Type 2	Type 3	Supplementary
Minimum particle size	< 0.045mm	0.045 to 0.14mm	> 0.14	> 0.42
Typical trapped particles	Clay, silt, sand	Silt (some) and sand	Sand	Coarse sand

The required standard is determined from the area of disturbance and calculated soil loss. Based on the scale of the Project and calculated potential soil loss (Table 4-4), a Type 1 sediment control standard applies for all RR and Q29 pit expansion areas, WRDs and the accommodation camp.

Type 1 sediment control standard

A Type 1 sediment control standard is provided by purpose-built sediment basins, designed to collect, and settle sediment-laden water. They perform two main functions:

- Rapid settlement of coarse-grained particles (e.g., sand, and coarse silt) during all storm events that flow through the basin.
- Settlement of fine-grained particles that are allowed to pass through the basin under controlled conditions.

This enables sediment basins to reduce turbidity levels of construction runoff water, thereby reducing potential for ecological harm.

The required sediment basin capacity may be able to be provided within mining pits. Where this is the case, discharge from the pit would be required to meet the same criteria as for a sediment basin. Sediment basin design is discussed in Section **Error! Reference source not found.**.

Type 2 & 3 sediment control standard

Type 2 and Type 3 sediment controls may be implemented in addition to sediment basins to provide supplementary controls throughout the project area. Specific requirements are to be documented within Progressive ESCPs and engineering plans, considering timing (i.e., season) and practicality of control measures.

Type 2 controls include:

- Rock Filter Dam (RFD) **-** RFDs are structures formed by the incorporation of geotextile (e.g., A19 bidum®) and a coarse rock filter (40-75 mm nominal diameter).
- Filter Bag/Tube - Filter tubes are geotextile bags through which site runoff is directed to enable filtering and treatment of sediment.

- Coir logs - Coir logs are biodegradable tubes filled with densely packed coconut fibre wrapped in coir netting. They can be used as flow diversion banks or to provide sediment control by providing temporary ponding and filtering of site runoff.
- Mulch berms - Berms of coarse mulch located along the contour. Often incorporate a rock filter dam discharge point.

Type 3 controls include:

- Rock berms - clean rock may be placed as a perimeter berm to filter sheet flow runoff from site (typical size 75-150 mm).
- Sediment fence - sediment fence may be used in locations where placement of rock berms is not practical (due to access, materials, and equipment constraints).

Supplementary sediment control

Supplementary sediment control measures form an important component of the erosion and sediment control system when implemented in conjunction with other measures. The following supplementary controls will be implemented where relevant to the project phase and site conditions:

- Vegetated filter strips
- Check dams
- Construction exits.

In addition to adopting measures as per IECA Standard Drawings, variations to these may be implemented where it can be demonstrated that they are equally as effective and meet the intent of IECA standards.

5.4.2 Adopted sediment control measures

Adopted sediment control measures are provided in Table 5-2. RR - adopted sediment control measures

Area	Maximum Predicted Soil Loss (t/ha/yr)	Minimum sediment control requirement	Adopted measure(s)
Externally draining catchments 1 to 11.[1]	21 to 1465	Type 1	• Sediment basin - capacity provided as separate sediment basin(s). • Dewatering in accordance with MMP and applicable water quality discharge criteria • See Appendices D.1 and D.2
Internally draining catchments 12 to 17[2]	332 to 907	Type 1	• Sediment basin - capacity provided within existing pit, TSF, or Annie Oakley's Pit (internal drainage). See Appendix D.2

[1] See Appendix D.1
[2] See Appendix D.2

Table 5-3 and Table 5-3. Typical designs are provided within Appendix D.6, with more detailed designs to be provided as engineering drawings and applicable site-specific Progressive ESCPs.

Table 5-2. RR - adopted sediment control measures

Area	Maximum Predicted Soil Loss (t/ha/yr)	Minimum sediment control requirement	Adopted measure(s)
Externally draining catchments 1 to 11.[1]	21 to 1465	Type 1	• Sediment basin - capacity provided as separate sediment basin(s). • Dewatering in accordance with MMP and applicable water quality discharge criteria • See Appendices D.1 and D.2
Internally draining catchments 12 to 17[2]	332 to 907	Type 1	• Sediment basin - capacity provided within existing pit, TSF, or Annie Oakley's Pit (internal drainage). See Appendix D.2

[1] See Appendix D.1
[2] See Appendix D.2

Table 5-3. Q29, Accommodation Camp & Haul Road - adopted sediment control measures

Area	Maximum Predicted Soil Loss (t/ha/yr)	Minimum sediment control requirement	Adopted measure(s)
Heap Leach Cover[1]	346	Type 1	• Sediment basin - capacity provided within existing pit (internal drainage) or as separate sediment basin(s). • Heap Leach Pad runoff managed within Heap Leach Pond (existing) • Dewatering in accordance with MMP and applicable water quality discharge criteria
East Koolpin WRD[1]	948	Type 1	• Sediment basin - capacity provided within existing pit (internal drainage) or as separate sediment basin(s). • Dewatering in accordance with MMP and applicable water quality discharge criteria
Taipan WRD[1]	1929	Type 1	• Sediment basin - capacity provided within existing pit (internal drainage) or as separate sediment basin(s). • Provision for creek diversion through northern end of existing pit area. • Dewatering in accordance with MMP and applicable water quality discharge criteria
Zamu WRD[1]	233	Type 1	• Sediment basin - capacity provided within existing pit (internal drainage) or as separate sediment basin(s) for expansion west of existing pit. • Construction of additional sediment basins (at least 2) for proposed expansion to the south – either side of creek channel. • Exclusion of undisturbed creek channel through southern expansion area (or provision for creek diversion). • Dewatering in accordance with MMP and applicable water quality discharge criteria.

Area	Maximum Predicted Soil Loss (t/ha/yr)	Minimum sediment control requirement	Adopted measure(s)
Accomm camp	1186	Type 1	• Sediment basin(s) – new • Stabilised site exits
Haul road	41	Type 3	• Check dams within drainage channels • Diversion of runoff to vegetated buffer areas

[1]See Appendix B.1

6 SEDIMENT BASINS

Sediment basins will be constructed at the RR and Q29 mining areas and the accommodation camp. Location of basins for RR and Q29 are shown in Appendices D.1 and D.2, and Appendix D.5 respectively. Runoff captured within these basins will be re-used within the Project area wherever practical (dust suppression, processing etc.), with excess treated runoff to be discharged to the receiving environment. Sediment basin capacity for the Project has been developed consistent with IECA guidelines (IECA 2008). Details are provided in Appendices E.1 to E.3.

The layout of the mine site includes flow diversion banks (topsoil) to separate external clean runoff from internal site runoff, forming a clear delineation between Project site water and external runoff. Within the RR and Q29 Project areas, runoff within the mining pit 'footprints' will drain internally and be managed via the pit dewatering process. Discharge requirements, management and monitoring are addressed in the Water Management Plan (Primary Gold, 2020).

Sediment basins proposed for the RR, Q29 mining areas and accommodation camp are sized as Type D basins, which assume dispersive soils requiring the use of flocculating agents for settlement. Basin design will be revised prior to implementation of mine development to ensure the most efficient basin configuration is adopted. Final basin location will be subject to final site layout; however, the following criteria will apply:

- Located to maximise collection of sediment-laden runoff generated within the site.
- Not located within waterways or drainage channels.
- Located above the 1 in 5-year ARI.
- Have suitable access for maintenance.
- Placed near site perimeter for ease of dewatering.

Conceptual drainage layout and sediment dam placement for RR is shown in Appendix D.1 and D.2.

The conceptual drainage for Q29 is shown in Appendix D.5.

6.1 Basin capacity

Sediment basin capacity is based on the following design parameters:

- 5-day, 80th %ile rainfall amount for the site; 35 mm (Table B6, IECA 2008).
- Project catchment areas and potential soil loss (Table 4-4 and Table 4-4).
- Project area runoff coefficients for 100 mm rainfall event:
  - 1 for heavily impacted areas (haul roads, pads, high traffic, compacted)
  - 0.75 for vegetated or less compacted (Table B7 IECA 2008).

Calculations for RR are provided within **Error! Reference source not found.**. The total required capacity is t o be provided by one or more sediment basins, with relative proportional volumes to be determined upon final site layout and contributing catchment areas.

Table 6-1. RR - calculation of maximum sediment basin capacity

Parameters	SB 1	SB 2	SB 3	SB 4	SB 5	SB 6	SB 7	SB 8	SB 9	SB 10	SB 11
Soil Loss (t/ha/y)	287	629	366	1465	300	264	368	113	164	21	620
Soil Loss Volume (m3/ha/y)	221	484	281	1127	231	203	283	87	126	16	477
Annual Soil Loss (m^3/y)	3955	10927	21266	17061	3860	7213	1220	4911	1319	229	29619
Soil Hydrologic Group	C	C	C	C	C	C	C	C	C	C	C
Volumetric runoff coefficient	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Settling Zone Volume (m^3)	5645	7113	23807	4769	5262	11169	1358	17749	3289	4502	19555
Storage Zone Volume (m3)	3955	10927	21266	17061	3860	7213	1220	4911	1319	229	29619
Total Volume (m^3)	9600	18040	45072	21830	9122	18382	2578	22660	4608	4730	49174

Note: Basin capacity is calculated for the anticipated highest disturbance condition during construction.

Table 6-2. Q29 - calculation of maximum sediment basin capacity.

Parameter	Heap Leach Cover	East Koolpin WRD	Zamu WRD	Taipan WRD	Accomm Camp
Soil loss (t/ha/yr)	**649**	**948**	**234**	**1927**	**284**
Soil loss (m^3/ha/yr)	499	729	180	1482	218
Annual soil loss (m^3/yr)	4401	16772	2537	1779	1594
Soil Hydrologic Group	C	C	C	C	C
Volumetric runoff coefficient	0.9	0.9	0.9	0.9	0.9
Settling Zone Volume (m^3)	2778	7245	4442	378	2778
Sediment storage volume (m^3)	4401	16772	2537	1779	4401
Total sediment basin requirement (m^3)	7179	24017	6978	2157	7179

Note: Basin capacity is calculated for the anticipated highest disturbance condition during construction.

6.2 Basin construction

Basin construction is to incorporate the following elements:

- Earth embankments to be certified as structurally sound by geotechnical engineer/specialist.
- Stable inflow system (e.g., rock chute).
- Minimum 3:1 length to width ratio (may require internal baffles).
- Primary outlet (e.g., siphon, perforated riser) for controlled release.
- Emergency spillway (minimum design storm 1 in 50-year ARI).
- Marker to identify the sediment storage zone depth.

6.3 Basin management

Sediment basins are to be managed as follows:

- Discharged within 5 days of cessation of rainfall (min 25 mm).
- Controlled sediment basin discharge to be in accordance with the MMP and project approvals.
- Prior to discharge, water quality to meet project discharge criteria specified in site Water Management Plan (Primary Gold, 2020) (flocculant or coagulant may be required).
- Designed to ensure easy and safe access to dose retained water with flocculants as required.

- Marker peg to be installed to indicate sediment storage capacity.
- Removal of sediment where sediment storage capacity exceeds 50% and disposal/management of sediment so as not to create an erosion or pollution hazard.
- Be regularly monitored to ensure structural integrity is maintained, including inlets and outlets.

6.4 Coagulants & Ameliorants

Flocculation of basins will be required where the contained water does not meet discharge criteria standard within five days of cessation of rainfall. The application of a coagulant is to occur within 12 hours upon receiving runoff producing rainfall. Typically, gypsum (calcium sulfate) is used for this purpose. This requires application across the sediment basin surface (spray or hand cast) at a rate of 32 kg per 100 m3 of water volume.

There are also a range of anionic polymers which may provide a more effective flocculation option. These are also well suited to flow-activated dosing systems, reducing labour associated with flocculation. Choice of flocculant and dosing methods will be managed adaptively based on monitoring of sediment basin performance over the first wet season of operations.

7 SPECIFIC AREAS AND ACTIVITIES

Best-practice erosion and sediment control guidance for specific areas and activities associated with the Q29 and haul road portions of the Project area are provided below. This guidance will be incorporated into Project designs and engineering drawings, management procedures and future Progressive ESCP's.

7.1 Haul roads

7.1.1 Main haul road

Entrance/exit grids are required at the entrances and exits to RR and Q29 (Appendix F.1). It is preferrable that only 1 entrance/exit be used at each site if operational requirements allow.

The 11 km existing access road between RR and Q29 will be upgraded to accommodate heavy vehicles for haulage of ore. This will include:

- Widening the existing road from approximately 10 m to 20 m width and grading to a crown (or with cross fall drainage).
- Resurfacing the road with low erodibility material (from existing oxide WRDs).
- Upgrading of existing culverts.
- Construction of a new bridge at the creek crossing on the Rustlers Roost – Q29 access road (EcOz 2021).

Road drainage will be provided by table drains and mitre drains directing road runoff to stable outlets (i.e., vegetated or rock protected areas). Drainage will incorporate check dam controls (e.g., rock check dam, filter bag/tube, coir logs) to provide flow energy dissipation in addition to providing sediment control.

Culverts and bridges will be installed and upgraded to traverse watercourses. Specific Progressive ESCPs will be prepared to guide implementation of specific engineering plans for these structures.

Dust suppression will be managed by water carts.

7.1.2 Minor haul roads

Internal Project haul roads and light vehicle access roads will be constructed in accordance with relevant engineering plans, incorporating the following:

- Graded to a crown, or with cross-fall drainage.
- Capped with competent gravel layer.
- Runoff to be directed to sediment control measures.
- Internal haul roads to incorporate safety perimeter bund, protected from erosion (soil binder).

7.2 Vegetation clearing

Clearing activities associated with the Project are to be undertaken consistent with the environmental management system and plans (EMSP) (Primary Gold, 2020) along with the following control measures:

- Vegetation clearing shall be kept to the minimum amount necessary.
- Protected vegetation and significant areas of vegetation are to be retained, and clearly identified prior to the commencement of clearing.
- Approved areas for native vegetation clearing to be clearly marked.

- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.

7.3 Stockpiles and inundation bunds

Earthworks are to incorporate the stripping and preservation of topsoil for reuse (wherever practical). The depth of topsoil stripping is dependent upon soil type; however, ideally the top 50 - 100 mm is to be retained separately from other material (contains most of the biological activity and nutrients required for successful rehabilitation). Topsoil is to be stored within topsoil berms or designated stockpile areas.

All stockpile areas are to be managed so as not to cause environmental harm as a result of sedimentation by adoption of the following:

- Stockpiles are not to be located within protected areas of vegetation, driplines of trees, or within 10 m of retained trees, drainage lines, flood zones or any area otherwise likely to be inundated with water.
- Avoid placement of stockpiles within 50 m of any drains, drainage lines or other waterways. Where not practicable, specific erosion and sedimentation controls to be implemented.
- Topsoil stockpiles/berms to be < 1.5 m in height as far as practical (to enhance preservation of biological activity).
- Spoil stockpiles are to be protected upslope by earth diversion banks to divert run-on water, and downslope by an appropriate Type 2/3 sediment control measure (e.g., mulch berm, rock berm).
- Long term (> 10 days) stockpiles, batters and other erosion sensitive areas shall be adequately stabilised through velocity reduction, covering, grassing, vegetation, soil binding, water diversion or other as appropriate.
- Topsoil berms are to be protected from erosion by:
    - Amelioration of topsoil layer for plant growth
    - Light ripping of final topsoil layer
    - Application of hydromulch at 4 t/ha complete with 40 kg/ha grass seed
    - Placement and pinning of jute matting over hydromulched surface on external batter.

7.4 Watercourse crossings

Watercourse crossings along the main haul road and internal access roads are to be constructed in accordance with relevant engineering plans, incorporating the following:

- Temporary stockpiling of soil, equipment, and materials within watercourses, or on adjacent banks and floodplains, is to be avoided (unless integral to drainage control requirements).
- Crossings constructed at right angles in locations where the stream is straight.
- Site runoff from exposed surfaces is to be prevented from directly entering watercourses.
- Where culvert pipes are to be utilised, the following guidelines are to be considered:
    - The long-term stability of the bed and bank of the waterway are not compromised.
    - Culverts are to have sufficient capacity to ensure minimal disturbance to stream flow for the design discharge.
    - Culvert cells are aligned with the channel.
    - Culvert cells extend well beyond the fill embankment.
    - Rock (or similar) is to be used to protect fill abutments.
    - Energy dissipation is provided downstream of culvert.

Additional contingencies are required in the event of wet conditions, which will include diversion of flows around active work areas, protection of disturbed areas, and restricting vehicular access as far as practicable.

7.5 Waste rock dumps

It is proposed that disposal of approximately 68.5 Mt of waste rock for the life of mine (LOM) into surface waste rock dumps at RR and Q29.

A total of 56.4 Mt of waste material will be produced from the pits at RR. Approximately 51.04 Mt will be placed within the surface WRD, and 5.36 Mt of fresh waste backfilled into the pits. The existing U-shaped WRD (Appendix A.1) to the north of the pit will be expanded and incorporated as part of the Southern WRD (Appendix B.1). A further WRD will be established to the north (Northern WRD, Appendix B.1).

Conceptual erosion and water management on the RR WRDs are (Appendix D.2):

1. The southern WRD will drain into the internally draining catchments,
    a. Water from the slopes will be collected in catch drains across the slope debouching to chutes,
    b. Diversion channels will collect water from the chutes and convey to the TSF, Pit 1 and Annie Oakley pit,
    c. Sediment basins are not required because the area is internally draining.
2. The northern WRD drains to externally draining catchments,
    a. Water from the slopes will be collected in catch drains across the slope debouching to chutes,
    b. Diversion channels will collect water from the chutes and convey to the appropriate sediment basins (Appendix D.2).

At Q29 (Appendix B.1), proposed main surface WRD will be developed in the area north of the Zamu Pit and adjacent to the North and South Koolpin Pits on their eastern sides. It is referred to as the East Koolpin WRD in this report. Total waste from Q29 is estimated to be 12.1 Mt.

A further WRD will be constructed to the west of the Taipan pit expansion. The Zamu pit will be infilled, and the remainder placed in a low waste rock dump.

The BHS heap leach cover will be treated as a WRD.

The WRD will be bordered by a flow diversion berm (topsoil) to divert external clean water runoff, including exclusion of the watercourse to the west of the WRD. Site runoff will be diverted to a sediment basin (s) for containment and treatment prior to reuse or discharge via internal drainage (Appendix D.5). The minimisation of sediment delivered to the sediment basins from the WRD will be achieved through:

Conceptual erosion and water management Q29

- A clean water channel running north south to the east of the pits between the pits and the East Koolpin WRD,
- Incorporation of diversion channels will be placed along the toe of East Koolpin WRD batters to enable diversion of runoff to rock check dam discharge points, prior to entering the sediment basin drainage network. The catchments main clean water channel to the west of the Taipan pit (Appendix D.5) will be diverted to the north of the Taipan pit and south of the south Koolpin pit.
- Construction of slope breaks to reduce slope length and promote infiltration.
- Application of soil binders to batters for dust suppression and temporary erosion control.
- Composition of the WRD will include a significant proportion of low erodibility material (i.e., rock), reducing sediment generation.

7.6 Watercourse diversions

The RR is at the top of the catchment and no watercourses will be diverted.

At Q29, where the proposed expansion of mining activities requires the diversion of watercourses, preparation of specific ESCPs prior to commencement of works, reflecting the specific engineering design requirements and construction sequence, will be required.

7.7 North & South Koolpin pit expansions

North and South Koolpin Pits are on the right bank of a 1st order watercourse (catchment area of approximately 69 ha) and the expansion will impinge on the stream channel. A clean water channel along the left bank of the pit is proposed to convey water from upstream to downstream without mixing with dirty water (Appendix D.5).

7.7.1 Taipan pit expansion

The existing Taipan pit is constructed on a 3rd order watercourse (catchment area of approximately 320 ha). The expansion of the Taipan pit will be undertaken to exclude disturbance to the current flow path of this previously altered watercourse, or construction of a stabilised creek diversion. This will enable the bypass of creek flow through mining areas in a relatively undisturbed state (appendix D.5).

7.7.2 Zamu pit expansion

The existing Zamu Pit is constructed on a 2nd order watercourse (catchment area of approximately 80 ha). Immediately downstream of the existing Zamu Pit, this 'contained' watercourse flows into the 3rd order stream that flows through the current Taipan Pit. The proposed Zamu pit expansion footprint extends from the confluence of these two watercourses for approximately 345 m downstream (stream length). The expansion of the Zamu pit will be undertaken to maintain this existing natural watercourse in an undisturbed condition to allow for clean water bypass through mining areas.

7.7.3 ESC considerations for watercourse diversions

Erosion and sediment control considerations to be incorporated within the ESCPs include:

- Diversion channels to be constructed as per applicable engineering designs, including rock erosion control protection to bed and banks. Upstream and downstream ends to remain blocked (e.g., earth bund or rock wrapped in geofabric) from clean water flows until works are completed, and stabilisation is achieved
- Active earthworks areas to be isolated and protected to maintain clean water separation from site runoff (e.g., perimeter berms, rock berm) during construction
- Topsoil to be stripped and temporarily stockpiled separately for reuse on batters of excavated diversion channels
- Spoil and topsoil stockpiles to be in a protected area > 50 m from creek channels
- Upper batters to have topsoil respread and vegetation sown. Jute mesh or mulch is recommended to assist with providing temporary groundcover until vegetation becomes established
- Cleared vegetation to be placed on the upper banks to provide channel roughness, habitat and encourage natural regeneration
- Channel blocks to be removed during periods of low / nil flow (dry season). Downstream channel block to be removed prior to upstream channel block
- Structural stability and vegetation establishment of diversion channel to be monitored.

8 REHABILITATION

Following the completion of construction and operational activities, long-term protection of the site from erosion will be provided by the final rehabilitated landform. The Project draft Mine Closure Plan provides details of the site closure objectives, closure criteria for each landform, a works program and monitoring methods.

Permanent erosion control measures will include a combination of vegetative, hardstand and structural erosion control techniques, implemented progressively. Sediment control measures will continue to be managed and maintained until the site is assessed as being adequately stabilised. Existing basins may be required to be retained beyond mine closure to provide ongoing water quality management (with appropriate modifications to outlets).

In relation to erosion and sediment control, the following practices will assist in achieving site stabilisation and long-term protection for downstream environments:

- Topsoil is managed to ensure preservation of its long-term value.
- Selected plant species for revegetation are appropriate for site conditions and endemic to local vegetation communities.
- Erosion and sediment controls are to remain in place until minimum 75 % self-sustaining groundcover (or equivalent) is achieved for disturbed areas, with minimum of 90 % for drainage features.

Site-specific controls will be provided in a closure ESCP, which will be prepared by a CPESC based on the as-constructed site and the proposed rehabilitation program.

8.1 Estimated Soil Loss Post-Rehabilitation

Estimated operational soil rates are estimated as per the IECA (2008) recommended standard for analysis and management C = 1 and P = 1.3. This does allow for a margin of error. However, it is unlikely the site will be left in a condition where these management practices apply.

The presence of large rock fragments makes up > 50 % of the WRD. Therefore, an erosion rate ratio (Simanton, Rawitz, & Shirley, 1982), (Alexander, 1981), (Evans, et al., 2004) was applied to the C-factor.

The P-factor was reduced based on the installation of contouring or catch drains, the benefit of which, are slope dependant (Panagos, et al., 2015).

The application of these management methods as part of the rehabilitation phase greatly reduces the erosion rate. Rates for RR are shown in Table 8-1 and Table 8-2. Rates of Q29 are shown in Table 8-3. The change in the distribution of erosion is shown in Appendix C.1 for RR and Appendix C.2 for Q29.

Table 8-1. Soil loss and erosion hazard for rehabilitation of RR externally draining catchments

Project areas	RR Mine Area Externally Draining Catchments										
	1	2	3	4	5	6	7	8	9	10	11
Catchment area (ha)	17.92	22.58	75.58	15.14	16.70	35.46	4.31	56.35	10.44	14.29	62.08
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.01	0.017	0.017	0.017	0.01	0.012	0.01	0.01	0.01	0.01	0.0135
Slope length (L)	25	28	31	30	39	32	23	46	24	80	38
Slope gradient (S)	13	15	9	26	11	9	15	5	8	1.2	17
Length/gradient (LS)	2.76	3.56	2.07	8.29	2.89	2.12	3.54	1.09	1.58	0.20	4.42
Erosion control practice (P)	0.6	0.7	0.55	0.95	0.6	0.6	0.7	0.5	0.5	0.4	0.6
Erosion Rate Ratio for Rock Fragments	0.5	0.35	0.35	0.12	0.5	0.5	0.5	0.5	0.5	0.5	0.35
Ground cover in disturbed catchment (C)	1	1	1	1	1	1	1	1	1	1	1
Soil Loss (t/ha/yr)	66	119	54	128	69	61	99	22	32	3	100
Soil Loss Class	1	1	1	1	1	1	1	1	1	1	1
Erosion Hazard	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low

Table 8-2. Soil loss and erosion hazard for rehabilitation implementation of RR internally draining catchments

Project areas	RR Mine Area Internally Draining Catchments					
	12	13	14	15	16	17
Catchment area (ha)	17.92	22.58	75.58	15.14	16.70	35.46
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.01	0.017	0.017	0.017	0.01	0.012
Slope length (L)	25	28	31	30	39	32
Slope gradient (S)	13	15	9	26	11	9
Length/gradient (LS)	5.13	5.06	6.90	2.50	5.43	1.88
Erosion control practice (P)	0.7	0.8	0.9	0.6	0.9	0.55
Erosion Rate Ratio for Rock Fragments	0.5	0.35	0.35	0.12	0.5	0.5
Ground cover in disturbed catchment (C)	1	1	1	1	1	1
Soil Loss (t/ha/yr)	59	66	101	102	100	17
Soil Loss Class	1	4	2	6	2	2
Erosion Hazard	Very low	Very low	Very low	Very low	Very low	Very low

Table 8-3. Soil loss and erosion hazard for rehabilitation implementation of Q29 internally draining catchments

Project areas	Q29 Mine Area				Camp	Haul Road
	BHS Heap Leach Facility	East Koolpin WRD	Zamu WRD	Taipan WRD		
Catchment area (ha)	8.82	230	14.1	1.2	7.30	2.20
Rainfall erosivity (R)	7996	7996	7996	7996	7996	7996
Soil erodibility (K)	0.030	0.030	0.030	0.030	0.030	0.030
Slope length (L)	16	41	31	40	100	50
Slope gradient (S)	19	24	6	40	5 (av)	5
Length/gradient (LS)	2.08	3.04	0.75	6.18	3.80	0.91
Erosion control practice (P)	0.8	0.9	0.4	0.95	1.3	1.3
Erosion Rate Ratio for Rock Fragments	0.12	0.12	0.12	0.120	0	50
Ground cover in disturbed catchment (C)	1	1	1	1	1	0.145

Project areas	Q29 Mine Area				Camp	Haul Road
	BHS Heap Leach Facility	East Koolpin WRD	Zamu WRD	Taipan WRD		
Soil Loss (t/ha/yr)	**48**	**79**	**9**	**169**	**284**	**41**
Soil Loss Class	1	1	1	2	3	1
Erosion Hazard	Very low	Very low	Very low	Low	Low to Mod	Very low

9 ESCP MANAGEMENT

9.1 Responsibilities

Responsibility for environmental management, including implementation of and adherence to this ESCP, is detailed within the MMP and summarised in Table 9-1.

Table 9-1. ESCP responsibilities (Primary Gold, 2017)

Party	Primary Responsibility
Employees and Contractors	Report any non-compliance with the erosion and sediment management requirements through the event/incident reporting system.
Site Environmental Officer	• Sign-off on ground clearance approvals as required by the system and in accordance with the approved ground clearance; and • Undertake inspections, reviews and monitoring as identified in Table 1.
Environment, Health and Safety Manager	• Ensure all employees and contractors are aware of all required procedures and systems to erosion and sediment management and are provided with all required resources to implement the requirements effectively; • Ensure all employees and contractors are provided with appropriate clearance approvals and on-ground guidance prior to giving any ground disturbance instructions; • Ensure all employees and contractors are provided with appropriate erosion and sediment management related training; and • Undertake annual review of the erosion and sediment control EMP.

9.2 Training and awareness

The requirements of this ESCP will be provided to contractors and employees through environmental training, site induction, toolbox talks and site alerts.

The site induction covers:

- Incident reporting procedure
- Identification of site environmental values
- An understanding of the requirements of applicable environmental management and monitoring plan/s
- Roles and responsibilities of site personnel
- Communication procedures (normal and emergency)
- Environmental emergency response procedures
- Site environmental controls (e.g., associated with ground clearing, weed management, erosion and sediment control, waste management, heritage, and archaeological sites / restricted work areas etc);
- The potential consequences of not meeting environmental obligations/responsibilities.

9.3 ESC installation and maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with the ESCP and any associated Progressive ESCPs.

All required temporary erosion and sediment control measures must be fully operational and maintained in proper working order until permanent stabilisation is achieved.

9.4 Monitoring & reporting

The ESC measures are to be inspected at least weekly during operation, within 24 hrs of expected rainfall and as soon as reasonably practical after receiving significant rainfall events (i.e., > 10 mm in 24 hr period). Visual assessment will be carried out of surface water runoff structures, drainage structures and erosion control structures to ensure they are operating efficiently. An inspection checklist is provided in Appendix G.1.

9.5 Updates and variations

An ESCP is a dynamic document, typically requiring updating as mining operations progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas are to be recorded and outlined in updated ESCPs. This may include the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced
- Controls require alteration due to change in seasonal conditions (e.g., dry season vs wet season)
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start
- A change in the design occurs that materially affects the site works
- The desired outcome (e.g., protection of receiving environments) is clearly not being achieved.

10 INCIDENT REPORTING

An Incident Management Procedure has been developed for the Project. All events (e.g. near misses, audit non-compliances), incidents and injuries shall be reported, assessed and recorded as per the Incident Reporting process illustrated in the draft EIS.

With regard to ESC, the following will be classified as lack of compliance with the Project EMP:

- Significant erosion incidences; and
- Sedimentation and erosion of local watercourses.

All non-compliances (including incidents and near-misses) will be reported and managed through to resolution via Primary Gold's event/incident reporting procedures.

This ESCP, or subsequent versions, will be reviewed on an annual basis. This review will be based on any Project changes, incident reports and compliance assessments.

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