Iluka Resources Ltd

Mineral Sands By-product Disposal

Planning Permit 15-105 (Pit 23)

Crown Allotments 91, 94, 95, 96

Parish of Telangatuk

Environmental Management Plan

Iluka Ref: UDOCS 0058-1414587248-1228

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Table of contents

1 INTRODUCTION 7
1.1 BACKGROUND 7
1.2 PURPOSE 10
1.3 SCOPE 11
2 PROJECT DESCRIPTION 14
2.1 BACKGROUND 14
2.2 DISPOSAL OPERATIONS 14
3 ENVIRONMENTAL CONTEXT 17
3.1 CLIMATE 17
3.2 LANDFORM 17
3.3 SOILS 17
3.4 RADIATION 17
3.5 GROUNDWATER 20
3.6 SURFACE WATER 24
3.7 NATIVE VEGETATION 25
4 ENVIRONMENTAL MANAGEMENT OBJECTIVES 27
5 ROLES AND RESPONSIBILITIES 28
6 RISK ANALYSIS AND RESPONSE PLAN (RARP) 29
6.1 RARP REQUIREMENTS AND APPLICATION 29
6.2 RISK ASSESSMENT OVERVIEW 30
6.3 RISK CONTROLS 31
6.4 RISK MATRIX 31
6.5 RISK REGISTER 37
7 GROUNDWATER MONITORING AND MANAGEMENT PLAN 39
7.1 SOURCES 40
7.2 SENSITIVE RECEPTORS 40
7.3 APPLICABLE LEGISLATION, STANDARDS AND GUIDELINES 41
7.4 RISK ANALYSIS AND RESPONSE 51
7.5 MONITORING PROGRAM 61
7.6 OBJECTIVES, MONITORING PROGRAM, TRIGGERS AND CONTINGENCY 70
7.7 REPORTING 70
8 SURFACE WATER MONITORING AND MANAGEMENT PLAN 72
8.1 SOURCES 73
8.2 SENSITIVE RECEPTORS 73
8.3 APPLICABLE LEGISLATION, STANDARDS AND GUIDELINES 74
8.4 RISK ANALYSIS AND RESPONSE 85
8.5 MONITORING PROGRAM 89
8.6 OBJECTIVES, MONITORING PROGRAM, TRIGGERS AND CONTINGENCY 98
8.7 REPORTING 99
9 AIR QUALITY / DUST CONTROL PLAN (AQMP) 102
9.1 SOURCES 102
9.2 SENSITIVE RECEPTORS 102
9.3 APPLICABLE LEGISLATION, STANDARDS AND GUIDELINES 105

9.4 RISK ANALYSIS AND RESPONSE 107
10 MANAGEMENT OF OTHER ENVIRONMENTAL ASPECTS 115
10.1 NOISE 115
10.2 WEEDS 119
10.3 VEHICLE HYGIENE 123
10.4 PUBLIC SAFETY 127
11 STAKEHOLDER ENGAGEMENT 131
12 REPORTING 132
12.1 ROUTINE REPORTING 132
12.2 EXCEPTION REPORTING 133
13 EXTERNAL AUDITING AND SUBJECT MATTER EXPERTS 134
13.1 EPA ACCREDITED AUDITOR FUNCTIONS 134
13.2 SUBJECT MATTER EXPERT FUNCTIONS 135
14 PLAN REVIEW AND AMENDMENT 136
15 REFERENCES 137
16 ACRONYMS AND ABBREVIATIONS 140
APPENDICES 142
APPENDIX A: RARP RISK REGISTER 142

List of tables

Table 1: Average background radiation levels for the Douglas Mine site (Iluka, 2016a) 17
Table 2: Pit 23 environmental management objectives 27
Table 3: Roles and responsibilities 28
Table 4: Consequence descriptions (adapted from Table A1 of DJPR (2019)) 32
Table 5: Risk matrix (adapted from Figure A1 of DJPR (2019)) 37
Table 6: Risk rating acceptability (adapted from Table A3, of DJPR (2019)) 37
Table 7: Likelihood description (adapted from Table A2 of DJPR (2019)) 37
Table 8: SEPP (Waters) groundwater segments 41
Table 9: SEPP (Waters) beneficial uses – groundwater Segments D to F 43
Table 10: Ratios of Cl:SO4 and Na:Ca in the groundwater down-gradient of Pit 23 47
Table 11: Pit 23 GWQOs - North-West Zone 48
Table 12: Groundwater travel times to sensitive receptors (adapted from EMM, 2019) 57
Table 13: Predicted quality of leachate from Pit 23 58
Table 14: Pit 23 monitoring bore network and monitoring schedule 63
Table 15: Groundwater laboratory analyte suite 67
Table 16: Groundwater - management objectives, monitoring requirements and measurement criteria 71
Table 17: Groundwater - triggers and management responses 71
Table 18: Groundwater - routine and exception reporting 71
Table 19: Groundwater-fed surface water sensitive receptors 77
Table 20: Runoff-fed surface water sensitive receptors 78
Table 21: Metals and metalloids requiring site-specific SWQOs, by site 80
Table 22: Pit 23 surface water quality objectives – surface water receptors 82
Table 23: Pit 23 surface water sites and monitoring schedule 91
Table 24: Surface water laboratory analyte suites 97
Table 25: Surface water - management objectives, monitoring requirements and measurement criteria 100
Table 26: Surface water - triggers and management responses 100
Table 27: Surface water - routine and exception reporting 101
Table 28: Air quality objectives and assessment criteria per the Mining PEM 105
Table 29: Air quality objectives and assessment criteria applicable to Pit 23 106
Table 30: PM_{10} statistics (Douglas life-of-mine) 108
Table 31: Wind Velocity and Direction Data for Months October to March 109
Table 32: Pit 23 dust and air quality monitoring program 111
Table 33: Air quality - management objectives, monitoring requirements and measurement criteria 114
Table 34: Air quality - triggers and management responses 114
Table 35: Air quality - routine and exception reporting 114
Table 36: Maximum noise levels at sensitive receptors (affected residences) (from EPA, 2011) 116
Table 37: Noise - management objectives, monitoring requirements and measurement criteria 118
Table 38: Noise - triggers and management responses 118
Table 39: Noise - routine and exception reporting 118

Table 40: Weeds - management objectives, monitoring requirements and measurement criteria 122
Table 41: Weeds - triggers and management responses 122
Table 42: Weeds - routine and exception reporting 122
Table 43: Vehicle hygiene - management objectives, monitoring requirements and measurement criteria . 126
Table 44: Vehicle hygiene - triggers and management responses 126
Table 45: Vehicle hygiene - routine and exception reporting 126
Table 46: Public safety - management objectives, monitoring requirements and measurement criteria 130
Table 47: Public safety - triggers and management responses 130
Table 48: Public safety - routine and exception reporting 130
Table 49: Structure of EMP and Rehabilitation Performance Reports 132

List of figures

Figure 1: Pit 23 regional location 8
Figure 2: Pit 23 site location 9
Figure 3: Regulatory instruments and management plans 11
Figure 4: Pit 23 Site Layout 13
Figure 5: Pit 23 pre-mining surface contours 18
Figure 6: Site soil types 19
Figure 7: Hydrogeological cross-sections (1 of 3) (EMM, 2019) 21
Figure 8: Hydrogeological cross-sections (2 of 3) (EMM, 2019) 22
Figure 9: Hydrogeological cross-sections (3 of 3) (EMM, 2019) 23
Figure 10: Regional pre-mining surface water features 26
Figure 11: Interpolated groundwater segments (TDS) relative to Pit 23 groundwater flow path 42
Figure 12: Registered domestic and stock bore locations 45
Figure 13: Douglas Mine / Pit 23 groundwater zones 50
Figure 14: Interpreted groundwater contours, years 2012 vs 2019 54
Figure 15: Douglas Mine and Pit 23 groundwater flow paths as particle tracks (EMM, 2019) 55
Figure 16: Pit 23 groundwater flow path (adapted from EMM, 2019) 56
Figure 17: Pit 23 monitoring bore network 64
Figure 18: Pit 23 surface water drainage system and battery limits 88
Figure 19: Pit 23 surface water monitoring points (regional) 94
Figure 20: Pit 23 surface water monitoring points (local) 95
Figure 21: Pit 23 air quality sensitive receptors 104
Figure 22: Pit 23 air quality (PM10) monitoring locations 112

1 Introduction

1.1 Background

In accordance with Planning Permit 15-105, issued by Horsham Rural City Council (HRCC, the 'Responsible Authority') Iluka Resources Limited (Iluka) is permitted to dispose of nominated wastes to a mining void known as Pit 23 (the 'subject land') located at its former Douglas Mine. The mine and subject land are located within the HRCC municipality in the Kanagulk area, as shown in Figure 1 and Figure 2.

Under the Horsham Planning Scheme, the subject land is in the Farming Zone and under the provisions of that zone, a permit is required for use and development for Industry (Refuse Disposal). The conditions in Planning Permit 15-105, (the Permit), issued by the Horsham Rural City Council as the Responsible Authority, includes the following:

Environmental Management Plan

16 Within 90 days of the commencement of this permit coming into operation an ***Environmental Management Plan (EMP)*** to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided.

17 The EMP must be accompanied by written endorsement from an environmental auditor appointed under the *Environment Protection Act 1970.*

18 When approved the EMP will be endorsed to form part of this permit and is to be placed on the permit holder's website.

19 The EMP must identify potential environmental impacts of the proposed use and development as derived from a risk analysis and set out monitoring programs and control measures to prevent any adverse impact on the environment, applicable for the duration of the planning permit.

20 The annual performance report must be reviewed by an independent suitably qualified person with expertise in risk management plans in the context of mines and quarries and appointed under the *Environment Protection Act 1970* pursuant to Condition 11.

21 The permit holder must amend the EMP to address any relevant issues, or changes or recommendations of the independent environmental reviewer to the satisfaction of the responsible authority. Amended EMPs are to be placed on the Permit Holder's website from the time of endorsement by the Responsible Authority.

22 No changes are to be made to the approved use and development or operational practices that may affect environmental quality under the scope of the EMP, unless these have been approved within a revised EMP and monitoring program by the responsible authority.

23 To address the above, the EMP must contain but is not limited to the following components:

(a) A risk analysis and response plan;

(b) A Groundwater Monitoring and Management Plan

(c) A Surface Water Monitoring and Management Plan

(d) An Air Quality / Dust Control Plan

(e) A due diligence program to ensure continual review, improvement and monitoring of operational practices, ;

(f) Reporting arrangements.

(g) Process for decisions on the need for and (as appropriate) requirements for ongoing monitoring and management programming for the above matters.

570000
580000
5910000
5900000
5890000
5880000

TOOLONDO
BALMORAL

Harrow---Clear-Lake-Road
Digger-Jims-Road
Jim-Mcdonalds-Road
Mt-Talbot-Road
Shrives-Road
Plushs-Road
Church-Lane
Pennys-Lane
Mckechnies-Road
Hobbs-And-Flynns-Road
White-Lake-Road
J-Quigleys-Road
Quigleys-Road
Carlins-Road
C205 Wombelano Road
Wades-Road
HRCC-PP-15-105
Brandts-Road
Fulham-No-1-Road
C214 Natimuk - Hamilton Road
Murrays-Road
B-Ross-Road
Harrow---Kanagulk-Road
Fitzgeralds-Road
Elliotts-And-Brandts-Road
Elliotts-Back-Lane
MIN5367
Jones-Road
Jasper-Lane
Jasper Lane
Ford-Lane
Edgewood-Road
Roberts-Road
Wades-Road
Burdetts-Road
Five-Ways-Road
Yat-Nat-Road
Rocklands-Road
Harrow---Balmoral-Road

HORSHAM RURAL CITY COUNCIL
PLANNING AND ENVIRONMENT ACT 1987
HORSHAM PLANNING SCHEME
I certify that this is the plan/documentation referred to in
Permit No: PA15-105
Appendix/Appendices
JOEL HASTINGS
Coordinator Statutory Planning
Dated 23/09/21

Legend

- Douglas mine
- Pit 23
- MIN5367 tenement
- HRCC-PP-15-105
- National Park
- Other Crown Reserve

N

0 2 4 km

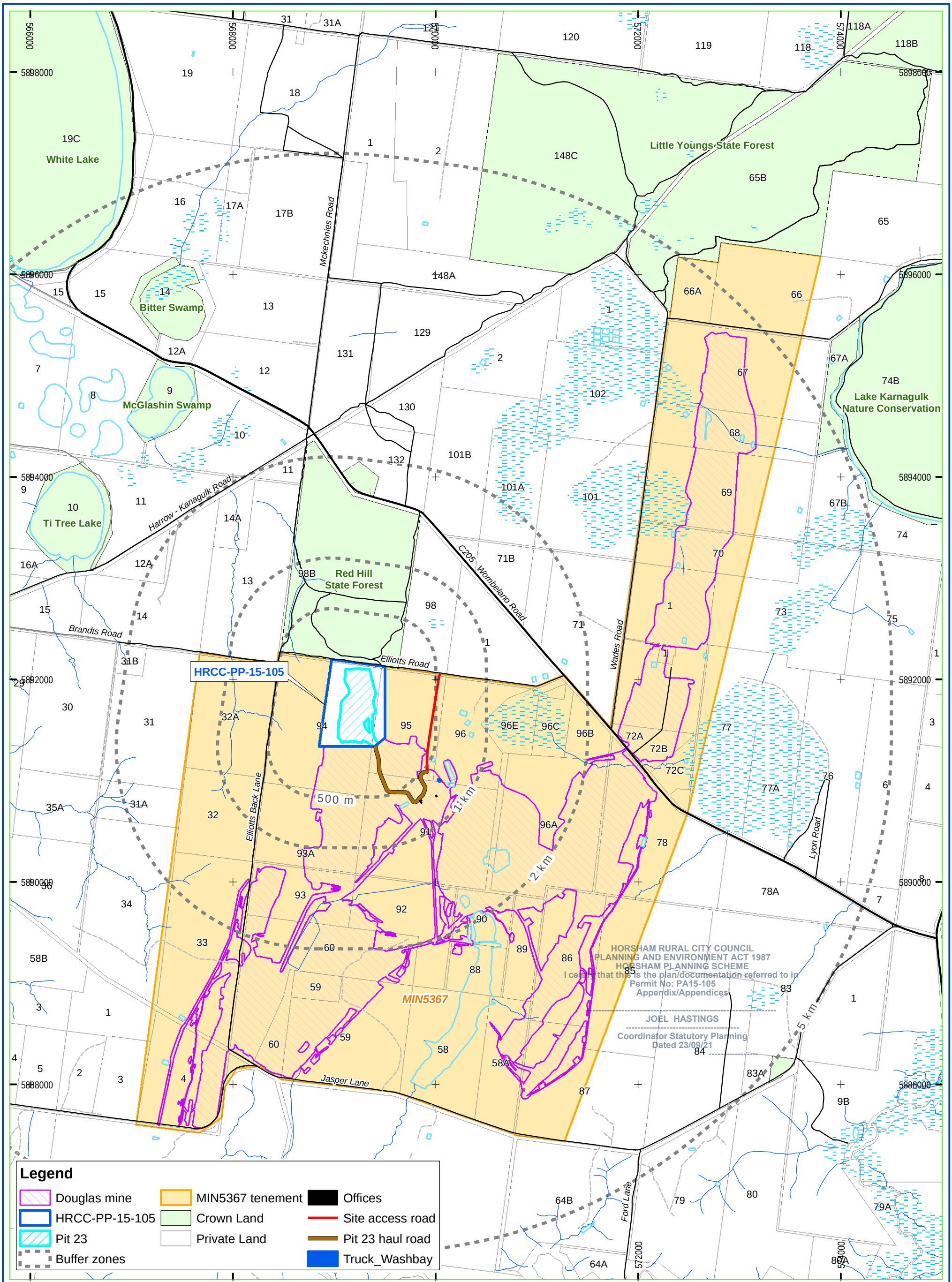
DOUGLAS MINE

REGIONAL LOCATION

ILUKA

Map Projection: UTM, MGA Zone 54 ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:100,000 (A3) DATE: Oct. 2019 DWG No: 257175 ver.00

FIGURE: 1



DOUGLAS MINE

WORK PLAN AREA (MIN5367)

ILUKA

Map Projection: UTM, MGA Zone 54

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:35,000 (A3) DATE: Oct. 2019 DWG No: 257176 ver.00

FIGURE: 2

1.2 Purpose

This Environmental Management Plan (EMP) provides the framework for disposal operations on, and rehabilitation of, the subject land. This EMP:

- describes the operational, environmental and legal context for the permitted development and use;
- describes the operational methods to be used;
- identifies key environmental risks and management controls to ensure that any impacts from waste disposal operations and site rehabilitation are appropriately mitigated; and
- defines the monitoring program to be used for assessing the environmental performance.

This EMP has been designed to address:

- the conditions of the Permit;
- Iluka's environmental management commitments as detailed in the planning permit application and further information provided in support of that application; and
- Iluka's Health, Safety, Environment and Communities (HSEC) Management System (HSECMS) and standards.

This EMP is one of a number of management plans required by permit conditions, which together form the overall framework for the environmental management of the permitted development and use.

These management plans will be implemented within the framework provided by Iluka's HSEC Management System. The Iluka HSEC Management System defines the requirements, processes and tools to assist with achieving the company's sustainability objectives. The HSEC Management System consists of policies, standards, procedures, guidelines and plans.

All Standards and Procedures provide auditable criteria, against which compliance can be measured. All HSEC Standards and Group Level Procedures are mandatory documents applying to all Iluka sites.

In particular, the HSEC Management System sets out how risk assessments and incident investigations are used to identify potential and actual hazards and risks, and the controls required to mitigate those risks.

HSEC Group Standard 01 – Risk and Hazard Management has been developed with the objective that environment, workforce and community risks associated with Iluka operations are assessed and managed, controls are implemented, communicated and monitored for their suitability and effectiveness, and planned and unplanned changes are managed effectively.

The required management plans include:

- Environmental Management Plan (this plan), which includes:
  - a Groundwater Monitoring and Management Plan (GWMMP);
  - a Surface Water Monitoring and Management Plan (SWMMP);
  - an Air Quality/Dust Control Plan (AQDCP); and
  - descriptions of the management of other environmental aspects; and
- an Incoming Waste Monitoring Plan (Iluka 2019a), hereafter referred to as the IWMP; and
- a Rehabilitation and Vegetation Management Plan (Iluka 2019b), hereafter referred to as the R&VMP.

In addition, some of the activities are subject to the *Radiation Act 2005* under which a Radiation Management Licence (RML; Licence No. 300042022) has been issued to Iluka. The conditions of

that licence include a requirement for compliance with an approved Radiation Management Plan (RMP) (Iluka 2016a) and a Radioactive Waste Management Plan (RWMP) (Iluka 2016b).

The hierarchy and periods during which the various plans apply is shown in Figure 3 below.

<table>
<tr><th>Phase</th><th colspan="2">Disposal</th><th>Rehabilitation and closure</th><th>Post-closure monitoring</th></tr>
<tr><td rowspan="2">Regulator & regulatory instrument</td><td colspan="3">HRCC – Planning Permit (PP)</td><td></td></tr>
<tr><td colspan="4">DHHS – Radiation Management Licence (RML # 300042022)</td></tr>
<tr><td rowspan="3">Relevant Management Plan (relevant regulatory instrument)</td><td colspan="3">Environmental Management Plan (PP)</td><td rowspan="2"></td></tr>
<tr><td>Incoming Waste Monitoring Plan (PP)</td><td colspan="2">Rehabilitation & Vegetation Management Plan (PP)</td></tr>
<tr><td colspan="4">Radiation Management Plan/Radioactive Waste Management Plan (RML)</td></tr>
</table>

Figure 3: Regulatory instruments and management plans

1.3 Scope

This EMP applies to:

- Pit 23 and the immediate surrounding area;
- the existing mine access road;
- the existing haul-road to Pit 23;
- a truck washing facility (and access road); and
- mine offices, ablution facilities and car park.

As shown in Figure 4, these features and facilities are located within parts of four Crown Allotments (CA) in the Parish of Telangatuk. Pit 23 is located predominantly on CA94. The mine access road, haul road, truck wash, offices, ablution facilities and car park are located on CA91, CA95 and CA96.

An area encompassing Pit 23 was excised from the Douglas Mining Licence (MIN5367) in April 2017 to enable current and future by-product disposal and pit rehabilitation to be regulated under Planning Permit 15-105, which was issued in accordance with the *Planning and Environment Act 1987* ('P&E Act').

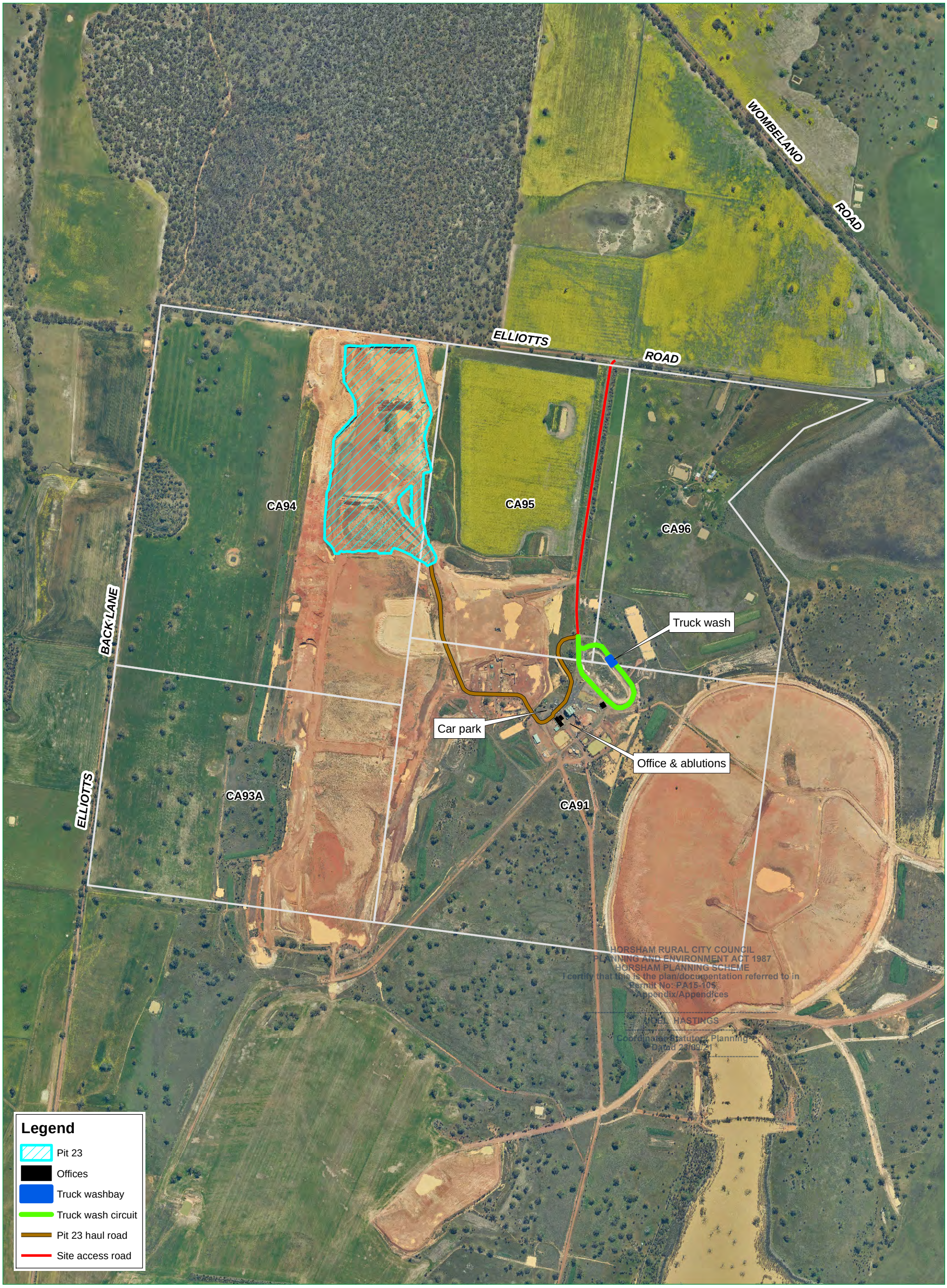
1.3.1 Exclusions

The following are outside the scope of this plan:

- all matters associated with the operation and rehabilitation of the Douglas Mine which is approved under Mining Licence No. 5367 and regulated under the *Mineral Resource (Sustainable Development) Act 1990* ('MRSD Act'). This extends to all applicable agreements, licences and permits attached to the Douglas Mine under other state and commonwealth legislation; and
- all matters associated with radiation protection and management (both occupational and environmental) which are regulated through the Radiation Management Licence 300042022, which is issued under the Victorian *Radiation Act 2005* by the Department of Health and Human Services (DHHS). In accordance with this Licence, Iluka manages radiation risk through implementation of the respective Iluka Resources Murray Basin Operations RMP (Iluka 2016a) and RWMP (Iluka 2016b), prepared in accordance with the requirements of the *Radiation Act 2005*, Radiation Regulation 2007 and Australian Radiation Protection and

Nuclear Safety Agency (ARPANSA) *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005).

The above exclusion on radiation protection matters extends to Condition 24(b)(ii) of the Permit on the basis that the Iluka RMP and RWMP include assessments of background radiation levels in groundwater and doses from radiation exposure pathways, which indicate that there is no significant exposure pathway through the groundwater. Accordingly, there are no measures for the protection of groundwater in the RMP or RWMP, other than monitoring of groundwater for radionuclides which is also addressed in this EMP.



Aerial photo: 5 Oct. 2018

DOUGLAS MINE

SITE LAYOUT

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:12,500 (A3) DATE: Oct. 2019 DWG No: 257177 ver.00

FIGURE: 4

2 Project description

2.1 Background

2.1.1 Land tenure

Crown Allotments 91, 94, 95 and 96 are owned by Basin Mineral Properties Pty Ltd (BMP), a wholly owned subsidiary of Iluka. The land is located within the Farming Zone of the Horsham Planning Scheme.

The land to the east, south and west of the subject land is privately owned while land to the north is Crown Land.

2.1.2 Land use

Prior to the commencement of mining, the subject land was used for agriculture. Agriculture remains the predominant land use surrounding the subject land, typically comprising sheep, pasture, and grain/legume crop production.

The Crown Land to the north is in the Public Conservation and Resource Zone.

2.1.3 Douglas Mine history

Mineral sand mining at the Douglas Mine commenced in 2004 and was completed in 2012. Mining of Pit 23 occurred between 2010 and 2012, with deposition of on-site Wet Concentrator Plant tailings occurring between late 2011 and early 2012. Since processing concluded in early 2012, the main activities at the Douglas Mine have been the deposition of MSP by-products into Pit 23 and rehabilitation of other parts of the mine.

All mining, processing, and disposal activities have been conducted under Mining Licence 5367 granted under the MRSD Act and in accordance with the Work Plan approved under that Act (the Douglas Mine Work Plan). The Douglas Mine Work Plan includes an Environment Management Plan addressing the management and monitoring of a full range of environmental aspects, and a Rehabilitation Plan. Implementation of these plans to-date has seen the successful operation and partial rehabilitation of the Douglas Mine site without unplanned or unexpected adverse impacts on the environment.

The cessation of mineral sands mining by Iluka in Victoria meant that the disposal operations could no longer be regulated under the MRSD Act thereby requiring planning approval to be obtained. In April 2017:

- approval was obtained to vary the Douglas Mine Work Plan (Iluka, 2017a) such that:
    - the prescribed end use of the area of Pit 23 and its surrounds was changed to Industry (Refuse Disposal) under conditions detailed in the Permit; and
    - rehabilitation of the area of Pit 23 and surrounds was removed because no such rehabilitation is required to make the land suitable for the now prescribed end use;
- the area of Pit 23 and surrounds was surrendered from the mining license; and
- the Permit commenced.

2.2 Disposal operations

The material to be disposed of to Pit 23 is limited to:

- by-products of the processing of heavy mineral concentrate (HMC) at the Hamilton MSP;
- used dust filter bags from the Hamilton MSP; and
- concrete and steel from plant and infrastructure, that contains or is contaminated with naturally occurring radioactive material (NORM).

2.2.1 MSP by-product types and quantities

The majority of Hamilton MSP by-products include:

- lighter mineral particles (sand and clay) of spadeable consistency;
- heavier mineral particles as dry sand; and
- gypsum, currently in the form of filter-cake.

The total quantity of Hamilton MSP by-products to be disposed of each year (under normal MSP operations) ranges between 50,000 and 120,000 tonnes and the Hamilton MSP has a further operational life of approximately 20 years.

2.2.2 Other materials

The dust filter bags from the Hamilton MSP are nylon that has become impregnated with NORM.

The concrete and steel to be disposed of will be from sources specified in the Permit and will be contaminated with NORM such that reuse, recycling or disposal elsewhere is impractical.

2.2.3 Acceptance for disposal

Waste acceptance criteria for the disposal of nominated waste streams into Pit 23 have been developed and are detailed in the IWMP.

2.2.4 Disposal method

MSP by-products and other materials to be disposed are transported to the subject land in accordance with the *Code of Practice for Safe Transport of Radioactive Material* (ARPANSA, 2008). For MSP by-products this requires sealed trailers. Vehicles carrying materials for disposal must only enter the site via the mine access road and, once on-site, must pass through the existing office area and onto a haul road to the Pit 23 entrance ramp. The vehicles drive directly into the pit to deposit their loads.

After depositing their loads, trucks exit Pit 23 and proceed to the truck wash facility to remove any residual materials. The operation of the truck wash is described in more detail in Section 10.3 of this EMP.

Disposal of materials to Pit 23 will be limited by the first of either:

- the completion of the rehabilitation of the Hamilton MSP site; or
- through remaining space available in Pit 23 becoming equal to that required to install a minimum cover (cap) depth of 5m over the materials disposed of and to reinstate the pre-mining surface landform.

Following completion of the disposal of materials from off-site locations the level of activity at the site will reduce significantly and the office, ablution facilities and parking area at the locations shown in Figure 4 will no longer be required. From this point in time, the office functions will be performed at house known as “Chadwick’s” that is located on the corner of Wombelano Road and Elliotts Road. This will enable the land occupied by the office, ablution facilities and associated parking area to be decommissioned as described in Sections 9.5.3 – 9.5.4 of the R&VMP.

Some support infrastructure (mine access road, haul road and truck wash) will be required for the duration of disposal operations and the post-operational rehabilitation period. Consequently, decommissioning of this infrastructure and rehabilitation of the land will occur towards the end of the rehabilitation phase, as described in the R&VMP.

2.2.5 Hours of operation

Works associated with the use and development will only occur between the following hours

- Truck/trailer deliveries: 24 hours a day, 7 days a week.
- Earthworks: 7am-6pm, 7 days a week, excluding emergency works.

Works outside these hours can only occur with written consent of the Responsible Authority.

3 Environmental context

3.1 Climate

The climate of the region is characterised by cool, wet winters and long, dry summers. Typical seasonal characteristics include irregular rainfall during warm to hot summers and relatively reliable, moderate rainfall during cool winters. The average annual rainfall is 617mm. Most rainfall occurs in winter and spring.

In summer, the mean daily maximum temperature is 25.9°C and the mean daily minimum temperature is 10.7°C. In winter, the mean daily maximum temperature is 12.7 °C and the mean daily minimum is 4.7°C.

Annual pan evaporation is estimated to be 1410mm, which is approximately 2.5 times the average annual rainfall.

3.2 Landform

The pre-mining landform of the subject land was very gently undulating to flat, typically ranging between 210mAHD and 190mAHD. The pre-mining topography of the Pit 23 area was similarly undulating with elevations ranging between 204mAHD and 199mAHD. The pre-mining landform contours overlaid on the current Pit 23 footprint are shown in Figure 5.

3.3 Soils

As shown in Figure 6, pre-mining soil surveys showed that the soils of the Pit 23 area comprise sand and sandy loam. The sandy loams have generally low salinity at the surface and are neutral to slightly alkaline at depth. During the development of Pit 23, topsoil, subsoil and overburden were sequentially removed and stockpiled. These materials are available for backfilling and rehabilitation.

3.4 Radiation

All orebodies of heavy minerals contain the natural radioactive elements uranium and thorium together with their decay products, i.e. NORM.

Table 1 presents the results of measurements of the background (or pre-mining) radiation levels for the Douglas Mine, as referenced in the Iluka *Resources Murray Basin Radiation Management Plan* (Iluka 2016a).

Table 1: Average background radiation levels for the Douglas Mine site (Iluka, 2016a)

Surface gamma dose rate (µSv/h)	Radionuclide activity concentration of soil (Bq/g)		Radionuclide activity concentration in groundwater (Bq/L)		Gross alpha activity concentration of airborne dust (mBq/m^3)	Radionuclide activity concentration in air (Bq/m^3)	
	Uranium	Thorium	Ra-226	Ra-228		Radon (Rn-222)	Thoron (Rn-220)
0.11 - 0.14	0.012	0.072	0.18	0.29	0.010	< DL*	< DL*

* Less than the detectable limit

N

0 50 100 m

Aerial photo: 5 Oct. 2018

DOUGLAS MINE

PRE-MINING SURFACE CONTOURS

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:3,000 (A3) DATE: Oct. 2019 DWG No: 257178 ver.00

FIGURE: **5**

Heavy Clay
Sandy Clay Loam
WOMBELANO
ROAD
Sand
Sandy Loam
Fine Sandy
Clay Loam
ELLIOTTS
ROAD
Sandy Loam
Sandy Clay
Sandy Loam
Heavy Clay
Fine Sandy Clay Loam
BACK LANE
ELLIOTTS
Loam Fine Sandy
Sandy Loam
Medium Clay
Sandy Loam
Sandy Clay Loam
Heavy Clay
Silt Loam
Loam Fine Sandy
Sandy Clay

HORSHAM RURAL CITY COUNCIL
PLANNING AND ENVIRONMENT ACT 1987
HORSHAM PLANNING SCHEME
I certify that this is the plan/documentation referred to in
Permit No: PA15-105
Appendix/Appendices

JOEL HASTINGS
Coordinator Statutory Planning
Dated 23/09/21

Legend

Pit 23

Soils

Soil description

- Fine Sandy Clay Loam
- Heavy Clay
- Loam Fine Sandy
- Medium Clay
- Sand
- Sandy Clay
- Sandy Clay Loam
- Sandy Loam
- Silt Loam

N

0 250 500 m

Aerial photo: 5 Oct. 2018

DOUGLAS MINE

SITE SOIL TYPES

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:12,500 (A3) DATE: Oct. 2019 DWG No: 257179 ver.00

FIGURE: **6**

3.5 Groundwater

The following sections provide an overview of the hydrogeology and hydrochemistry for the Douglas site.

A detailed assessment of risks to groundwater and associated sensitive receptors associated with the Pit 23 facility is provided in the enclosed Groundwater Monitoring and Management Plan (GWMMP), presented in Section 7 of this EMP.

3.5.1 Hydrogeology

The hydrogeology of the broader Douglas site is described in several groundwater studies completed prior to and during the commencement of the Douglas Mine (Smart 2001a; Smart 2001b; Smart 2001c; SKM 2004; SKM 2007). A more detailed hydrogeological characterisation was provided by CDM Smith (2014) in the report '*Douglas Mine Site Hydrogeological Modelling, 6 November 2014'* which was submitted in support of the planning permit application. In summary:

- there are four (4) hydrostratigraphic units (HSUs) in the region: the Shepparton Formation (SFM), Loxton-Parilla Sands (LPS), Basal Clay and Basement;
- the water table generally lies within the basal level of the LPS, which forms the uppermost saturated unit;
- where the Basement is high the water table locally occurs within the Basement;
- the water table is a subdued reflection of surface topography, which also mirrors the surface of the Basement;
- groundwater receives rainfall-derived recharge. The water table shows fluctuations in response to seasonal variations in rainfall, including a steady decline in groundwater levels during a period of low rainfall from 2005 to 2010. The response of the water table to seasonal variations in recharge becomes less pronounced with an increase in depth to groundwater, i.e. as the thickness of the unsaturated zone increases;
- regionally, groundwater flows to the north, north-east and north-west and is controlled by the saline lakes of the Douglas Depression to the north-west which act as groundwater discharge sites, including Tea Tree Swamp, White Lake, Centre Lake and North Lake;
- groundwater from the Douglas site mirrors this regional hydrogeology and flows to the north, north-west and east, away from an elongated mound which appears to mimic the Basement ridge located in the western section of the mine site. Localised groundwater mounding in the centre of the Douglas site, driven by seepage from the Douglas Mine Fresh Water Dam, also influences groundwater flow in these directions;
- McGlashin Swamp, a brackish swamp located to north-west of Douglas/Pit 23 and south of White Lake, is interpreted to be a flow-through water body receiving some base flow as surface runoff, while White Lake and Tea Tree Lake are saline/hypersaline closed lakes receiving primarily groundwater discharge;
- the saturated thickness of the aquifer (i.e. LPS) over most of the local area is typically small and of low-to-moderate permeability and groundwater flow rates are therefore low. Accordingly, groundwater originating from former mining voids and tailings facilities generally takes many hundreds of years to reach discharge locations / sensitive receptors.

An update of the conceptual and numerical hydrogeological model developed by CDM Smith (2014) was completed by EMM Consulting (EMM, 2019). The conceptualisation of the area hydrogeology based on various cross-sections is shown in Figure 7 – Figure 9.

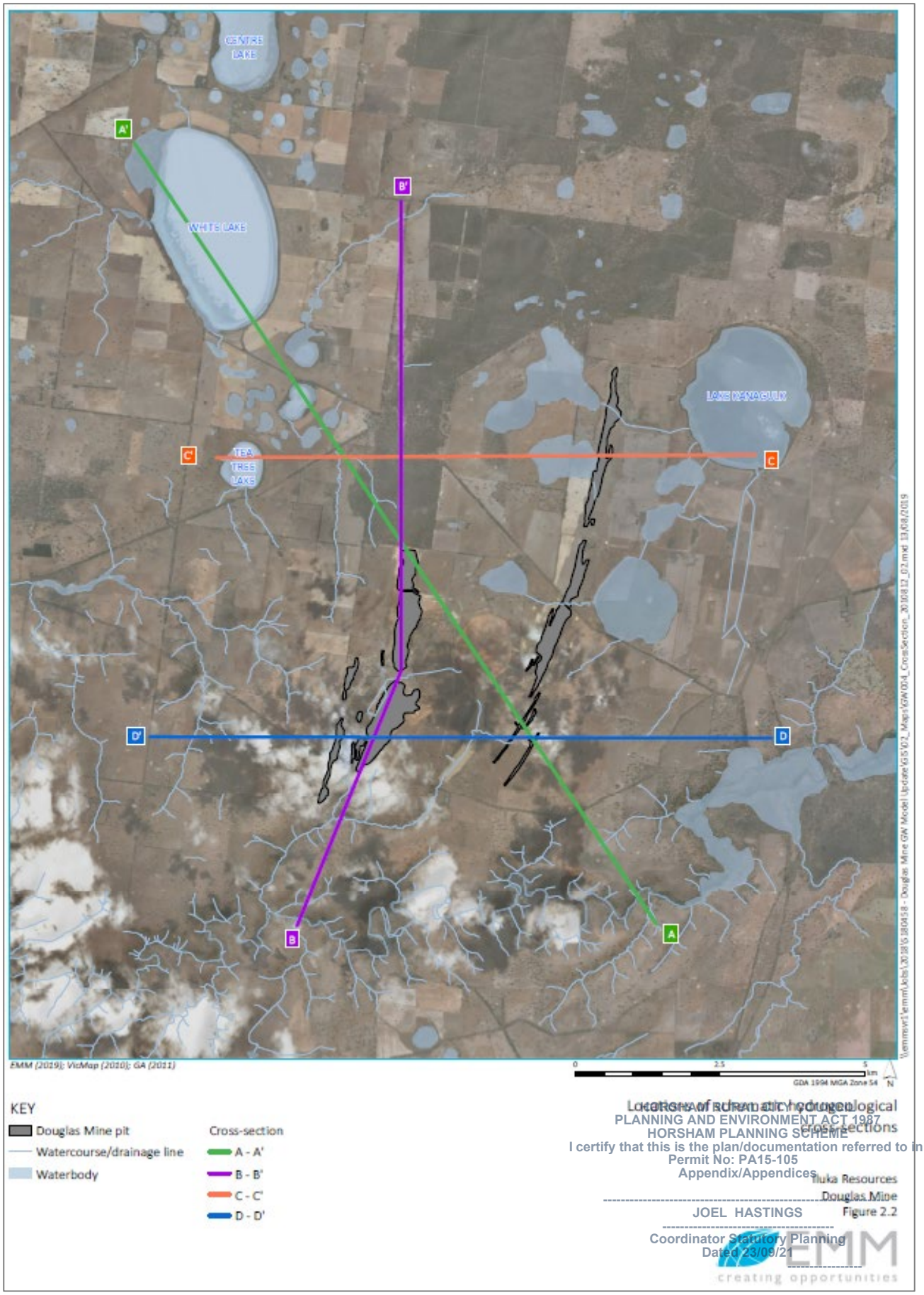


Figure 7: Hydrogeological cross-sections (1 of 3) (EMM, 2019)

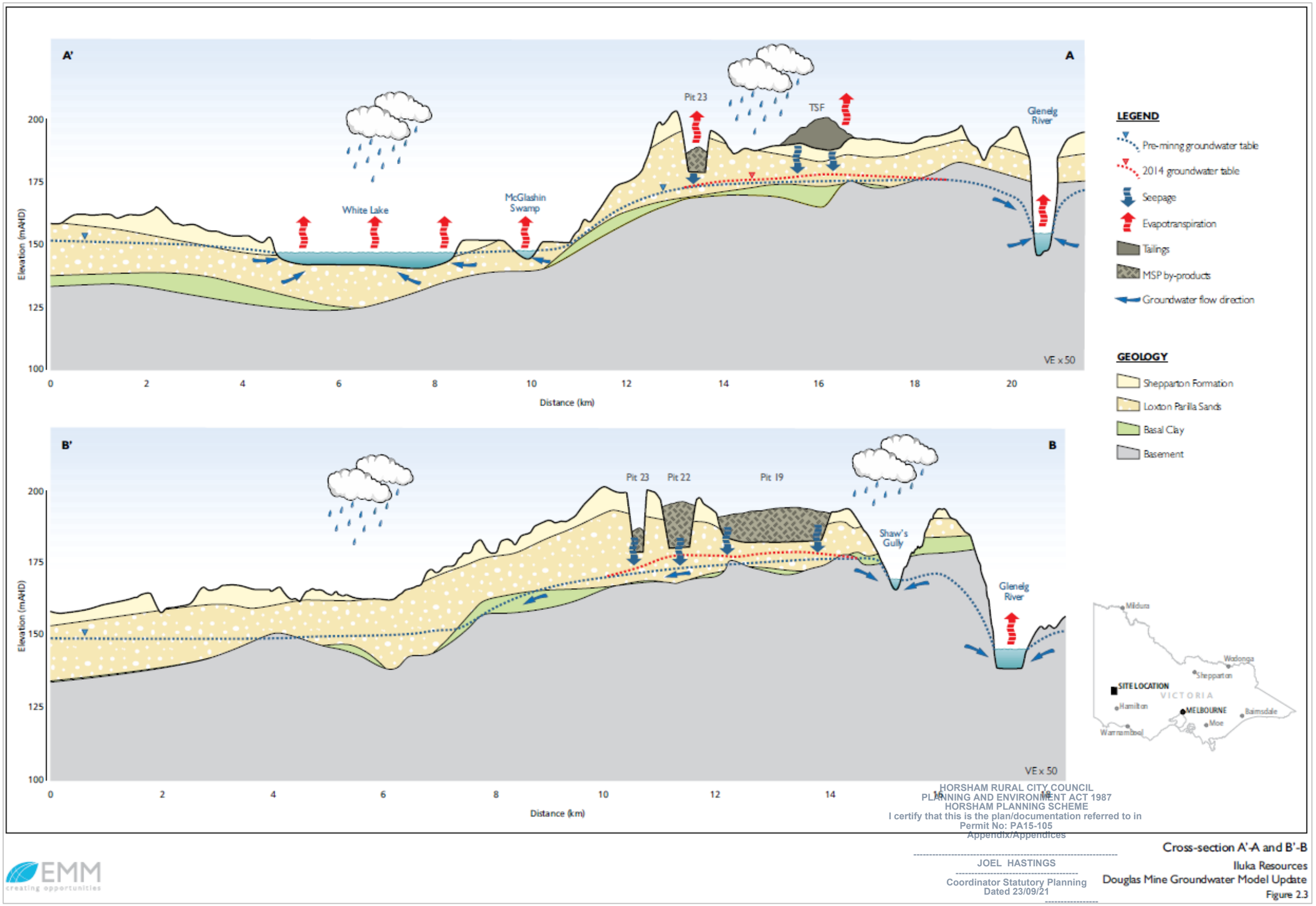


Figure 8: Hydrogeological cross-sections (2 of 3) (EMM, 2019)

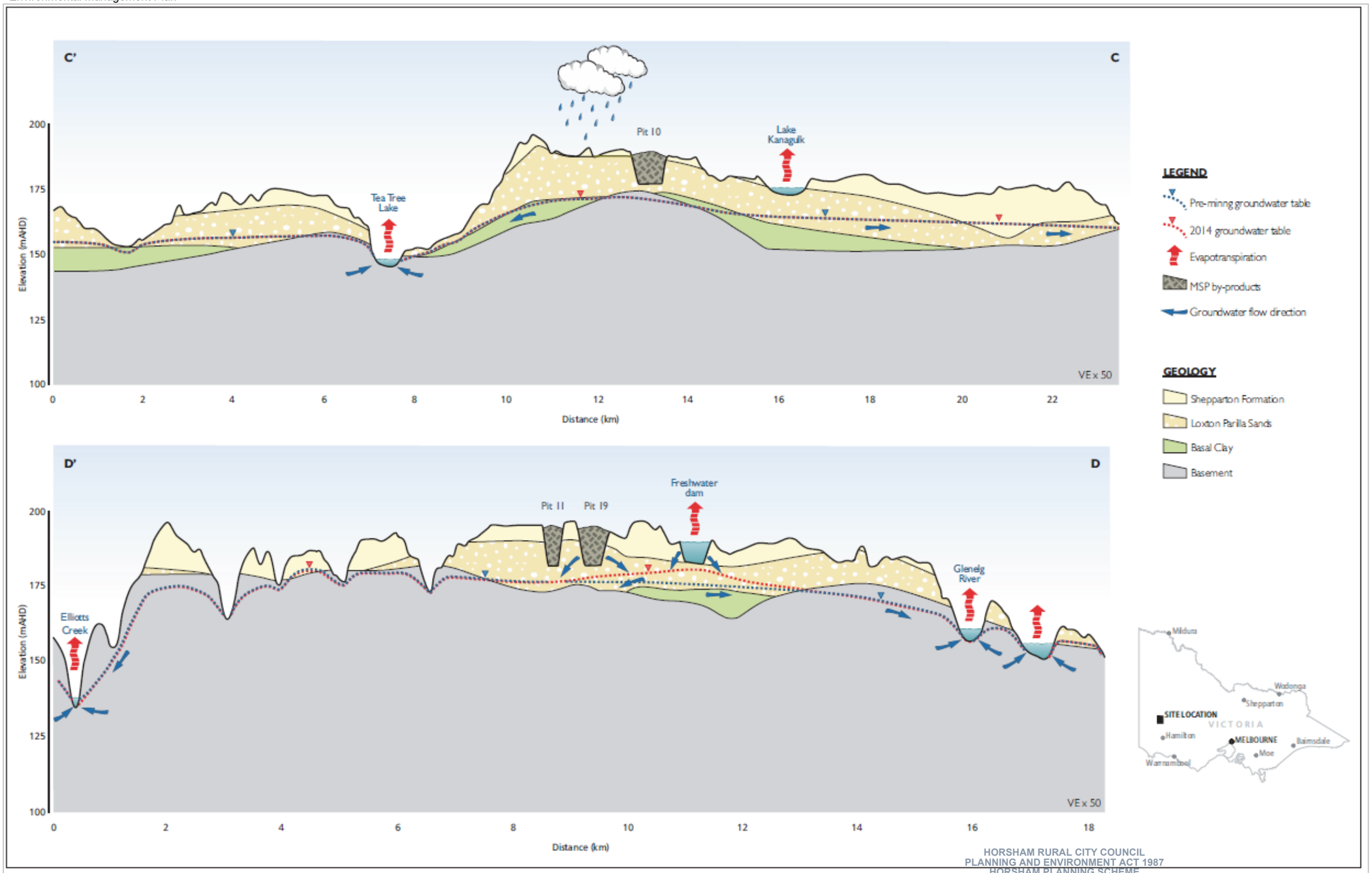


Figure 9: Hydrogeological cross-sections (3 of 3) (EMM, 2019)

3.5.2 Hydrochemistry

The hydrochemistry of the broader Douglas site is described in several groundwater studies completed prior to and during the commencement of the Douglas Mine (Smart 2001a; Smart 2001b; Smart 2001c; SKM 2004 and SKM 2007. More detailed assessments and characterisation of the baseline groundwater chemistry were undertaken by Jacobs (2014; 2016b) and CDM Smith (2014). In summary:

- groundwater salinity across the broader Douglas area as categorised by salinity (total dissolved solids, TDS) is highly variable ranging from brackish to highly saline (500 – 28,000 mg/L TDS) and slightly acidic with pH ranging from 5.0 to 7.6. The salinity of the local Douglas mine site is generally more uniform ranging from 5,000 – 10,000 mg/L;
- this natural temporal and spatial variability in salinity is evident in localised zones of much fresher groundwater to the west of the Douglas site (TDS 300 - 1500 mg/L) and highly saline groundwaters in the vicinity of the low-lying groundwater-fed lakes and swamps to the north and north-west of the Douglas site (e.g. McGlashin Swamp, White Lake and Tea Tree Lake). Areas of lower salinity generally correspond areas of elevated water table (i.e. rainfall/infiltration recharge zones) with TDS generally increasing down the groundwater hydraulic gradients moving away from the Douglas site;
- there is significant natural variability in other analytes across the greater Douglas monitoring bore network, with the following observed:
    - differences in chemistry may reflect the lithology or formation that is screened; and
    - groundwater chemistry east of the Douglas site appears chemically different to that in the west of the site with these differences likely linked to different lithologies and possibly strand line mineralisation;
- the baseline groundwater chemistry in the vicinity of pit 23 is not markedly different from the groundwater chemistry across the broader Douglas site, with similar temporal variability observed in the data.

3.6 Surface water

The Pit 23 footprint straddles what was a gentle NNW-SSE trending curvilinear coastal ridge which formed a surface water catchment divide. The topography of the area surrounding Pit 23 is relatively flat with gentle relief; elevation varies from 180 – 190 m Australian Height Datum (mAHD) in the lower swale areas to 200 – 210 m AHD at the crest of the ridge.

From the top of the ridge, surface water runoff would have predominately flowed to the west and east as overland flow, as no defined flow paths existed.

Drainage from the hill-slopes collects in the low gradient waterway depressions. The depressions are broad and shallow with no defined beds or banks connecting to the downstream waterways. Flow in these waterway depressions only occurs during heavy rainfall events. During such events the potential for erosion along the low gradient hill-slopes and waterway depressions is low because runoff would be shallow and spread across the width of the depression. Observations made by site personnel during the heavy rainfalls in late 2010 and 2011 confirm that runoff is conveyed through these waterway depressions as broad shallow flows. Following the events in 2010 and 2011, no visual signs of erosion were noted in these areas.

Drainage follows the natural downward direction of hill-slopes, sloping gently in all directions. As can be seen in Figure 10, surface flows from the western flank of the pre-mining Pit 23 surface flows west to collect into either the North-West Drainage Line or the Red Hill Drainage Line both of which ultimately report to McGlashin swamp within the White Lake catchment. Surface flows from the eastern flank of the pre-mining Pit 23 surface drain east to Chadwick's wetland and thence to Robertson's wetland within the Lake Kanagulk sub-catchment.

The pre-mine surface water flow paths are unchanged except for the isolation of the area of Pit 23 and immediate surrounds.

Figure 10 also shows that a number of surface water bodies (McGlashin Swamp, Tea Tree Lake and White Lake) occur as points of groundwater expression to the north, north-west and north-east of Pit 23; McGlashin Swamp is brackish (TDS of approximately 10,800mg/L) with Tea Tree Lake and White Lake being hypersaline (TDS ranging between 99,420 to 100,520 mg/L) (CDM Smith, 2014). These concentrations confirm these lakes as being groundwater-fed discharge features with McGlashin Swamp characterised as a flow-through feature with some recharge (CDM Smith 2014; EMM 2019).

During the disposal operations into Pit 23 no surface water flow will occur from the pit, as the pit floor level will be well below the surrounding topography until such time that the final landform surface is created during the rehabilitation phase. Water that has the potential to impact on surface water quality includes:

- run-off from the outer batters of the overburden stockpiles on the western and eastern sides of Pit 23, topsoil and subsoil stockpiles and relatively small volumes that may overflow from the truck wash facilities; and
- groundwater to which seepage from Pit 23 has been added that then discharges at the surface.

A detailed description of the surface water monitoring and management during disposal and rehabilitation phases can be found in Section 8 of this document.

3.7 Native vegetation

Prior to mining, the subject land was already cleared for agriculture. No further clearing of native vegetation is required or envisaged.

Remnant native vegetation in the Douglas Mine area includes the Little Young's State Forest that occurs to the north of the Douglas mine and the Red Hill State Forest immediately to the north of Pit 23.

These stands of remnant vegetation to the north of the Douglas Mine provide benchmark vegetation assemblages (Ecological Vegetation Classes, or EVCs) to guide the revegetation objectives for Pit 23. These objectives and the activities associated with revegetation during the rehabilitation phase are described in the R&VMP.

White Lake

Bitter Swamp

Little Youngs State Forest

McGlashin swamp

McGlashin Swamp

Ti Tree Lake

Toolondo Forestry Reserve

Red Hill drainage line

WOMBELANO ROAD

ELLIOTTS ROAD

North West drainage line

Robertson's wetland

Chadwick's wetland

BACK LANE

ELLIOTTS

HORSHAM RURAL CITY COUNCIL
PLANNING AND ENVIRONMENT ACT 1987
HORSHAM PLANNING SCHEME
I certify that this is the plan/documentation referred to in
Permit No: PA15-105
Appendix/Appendices

JOEL HASTINGS
Coordinator Statutory Planning
Dated 23/09/21

Gully

Shaw's

Legend

- Pit 23
- Crown Land
- Waterbody - Intermittent
- Land Subject to Inundation
- Watercourse

Pre-mining contours

- 2m contour
- 10m index contour

N

0 500 1,000 m

Aerial photo: Sept. 2015

DOUGLAS MINE

REGIONAL PRE-MINING SURFACE WATER FEATURES

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:25,000 (A3) DATE: Oct. 2019 DWG No: 257180 ver.00

FIGURE: **10**

4 Environmental management objectives

The environmental management objectives for this EMP are given in Table 2.

Rehabilitation objectives encompassing landform, hydrology, soil profile reinstatement, native revegetation (end land use) and agricultural production are covered in the R&VMP.

Incoming waste criteria and management objectives are covered in the IWMP.

Table 2: Pit 23 environmental management objectives

Aspect	Objectives	Plan Section
Groundwater	**Objective ID: GRW-01** Seepage from Pit 23 does not adversely affect the use of groundwater for stock watering.	Section 7 (GWMMP)
Surface water	**Objective ID: SFW-01** Surface water runoff, or groundwater discharge to surface waters, does not adversely affect beneficial uses.	Section 8 (SWMMP)
Air quality	**Objective ID: DST-01** Dust emissions to air are managed such that beneficial uses of the air environment are protected, with emissions reduced as far as is reasonably practicable by the application of best practice measures.	Section 9 (AQMP)
Noise	**Objective ID: NSE-01** Noise emissions comply with the maximum noise levels for earth resources activities as prescribed in EPA Publication 1411 – Noise from Industry in Regional Victoria (EPA, 2011).	Section 10.1
	Objective ID: NSE-02 Noise emissions from decommissioning activities comply with the Schedule for Construction and demolition site noise specified in the EPA Noise Control Guidelines (EPA, 2008).	
Weeds	**Objective ID: WDS-01** Declared weeds targeted for 'prevention and eradication' (as per Appendix 4 of the *Wimmera Invasive Plant and Animal Management Strategy 2019* (IPA)) identified within tenement boundaries are recorded and controlled.	Section 10.2
Vehicle hygiene	**Objective ID: HYG-01** No uncontrolled off-site movement of mud, debris, NORM or weed/organic matter on vehicles, plant and equipment leaving site.	Section 10.3
Public safety	**Objective ID: PSF-01** No public injuries or deaths to members of the public resulting from site activities that could have been reasonably prevented.	Section 10.4
	Objective ID: PSF-02 No harm to the public, property or infrastructure resulting from geotechnical instability.	

5 Roles and responsibilities

Roles and responsibilities for the implementation of this EMP are given in Table 3.

Table 3: Roles and responsibilities

Position	Role
Rehabilitation Superintendent	Oversight of activities at the Douglas Mine
Environment Superintendent	Oversight of environmental management and compliance for the Douglas Mine
Principal Environmental Specialist and Radiation Safety Officer	Specialist environmental and radiation technical support.
Environmental Advisor	Planning, coordination and reporting on environmental aspects of Douglas Mine activities
Environment Technician	Environmental monitoring
Senior Health and Safety Specialist	Occupational health and safety and emergency response
Transport Co-ordinator	Direction and co-ordination of transport of materials, including by-products, throughout the Murray Basin
* Hamilton Operations Manager	Overall responsibility for operations at the Hamilton Mineral Separation Plant
* Production Superintendent	Metallurgical control of Hamilton mineral separation plant, including sampling and analysis of by-products

* indicates positions that apply only when the Hamilton MSP is under normal operation. As at the date of issue of this plan these roles are redundant/vacant following the idling of the MSP in October 2017.

6 Risk Analysis and Response Plan (RARP)

6.1 RARP requirements and application

Condition 23 of the Permit requires that the EMP include a Risk Analysis and Response Plan (RARP). Specific requirements on the development and format of the RARP are subsequently defined in Conditions 25 – 26 of the Permit, as below:

Risk Analysis and Response Plan

25 The risk analysis is to be prepared by a suitably qualified person, to accord with best practice processes to identify and quantify uncertainties, and estimate their impact on outcomes.

26 The risk analysis is to include, at least:

(a) A risk register that identifies environmental risks, assigns and prioritises key design, operational and rehabilitation risks over the life of the use and development;

(b) Trigger levels and associated management responses for material identified environmental risks; and

(c) Contingency planning arrangements for any acute risks that could lead to an environmental hazard or pollution incident.

In the prior revision of this EMP (Rev 4, July 2017) the RARP was developed by AECOM Australia Pty Ltd (AECOM, 2017) utilising a risk assessment framework aligned with Australian Standard *AS/NZS ISO 31000:2009 Risk Management Process* and a semi-quantitative risk ranking methodology taken from Bowden et al. (2001).

In this revision of the EMP, the RARP and risk register have been updated to adopt the risk assessment framework developed by the Victorian Department of Jobs, Precincts and Regions (DJPR, 2019). This risk assessment framework has been used to assess environmental and mining-related hazards associated with the adjacent Douglas Mine (Iluka, 2018) and is considered appropriate for the assessment of similar hazards for Pit 23 given their shared mining history and operational and environmental setting.

The DJPR risk assessment framework is detailed in Section 6.4 below.

With reference to Condition 25 of the Permit, as it pertains to the update of the RARP, the following points are noted:

- in the context of general environmental risk assessment there is no statutory definition of '*suitably qualified person*'. An appropriate definition is given by the Australian Commonwealth Department of Environment and Energy (DoEE, 2018):

  > *"A suitably qualified person is a person who has professional qualifications, training or skills and at least five (5) years of experience relevant to the nominated subject matters to give authoritative assessment, advice and analysis about performance relevant to the subject matter using relevant protocols, standards, methods and/or literature".*

  The development of the enclosed RARP and EMP has been undertaken by the following Iluka and external environmental specialists having due regard to the Pit 23 site (and the surrounding Douglas Mine), monitoring history, studies/investigations and relevant legislation, policies and guidelines applicable to the development and use:

  - Nick Travers – Environment Superintendent, BSc Env Mgt (Hons), 16 years' experience;
  - Marcus Little – Principal Environmental Specialist, B (Env-Eng) (Hons), 20 years' experience;

    - John Nielsen – Principal Environmental Advisor, BSc (Hons), 32 years' experience;

- DJPR (2019) '*Preparation of Work Plans and Work Plan Variations – Guideline for Mining Projects (January 2019)*' and the risk framework therein is considered best practice as it aligns with Australian Standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines* (SA 2009) and *ISO 31010:2019 Risk Management - Risk Assessment Techniques* (ISO 2019) and its application to statutory assessment and approval of mining proposals in Victoria under the MRSD Act;
- as defined in Australian Standard AS/NZS ISO 31000:2009, risk is the effect of uncertainty, being an outcome of likelihood and consequence, both of which require a reasoned consideration of probability. Thus, the assessment of uncertainty is inherent in the assessment of risk and no additional assessment of uncertainty is required.

With reference to Condition 26 of the Permit, as it pertains to the update of the RARP, the following points are noted:

- the development and use of Pit 23 involves backfilling the existing Pit 23 void with nominated waste streams and cover (capping) materials. There are no relevant 'design' activities and no design-related risks are considered;
- the risk register considers the level of risk for relevant environmental aspects separately for both the active operations phase (disposal of nominated wastes and ancillary activities) and the rehabilitation phase (application of capping material and surface revegetation, as defined in the R&VMP). This recognises that environmental risks change over time and often have greater relevance in one phase than another. This is an important distinction as it dictates:
    - what (if any) management effort is warranted for a given risk during a given phase; and
    - when risk management effort is reduced, ceased or increased as the Pit 23 site transitions from operations to rehabilitation.
- as noted by AECOM (2017) in the original RARP, there are no statutory or other consensus definitions for 'material risk' or 'acute risk'. Given the ambiguity of these terms:
    - risks are only assessed and ranked within the risk framework of the DJPR Guidelines; and
    - trigger levels, management responses and contingency plans are only defined in the EMP where the following apply (in order of priority):
        - such requirements are specifically mandated in the Permit for a particular environmental aspect (i.e. for the GWMMP and SWMMP); and/or
        - where regulatory limits are mandated in EPA Victoria state environmental protection policy (SEPP) policies, guidelines or measures and such limits are compulsory to the scope of the Pit 23 site and activities; and/or
        - are otherwise warranted on the basis of the risk assessment in the RARP and applicability to the given phases of the Pit 23 operation. This follows the scale of 'risk acceptability' as applies within the DJPR Guidelines.

6.2 Risk assessment overview

The assessment of risk within this RARP follows the risk assessment framework presented in the DJPR (2019). Consistent with these Guidelines, the following is provided for each hazard/environmental aspect that has been considered:

- context for the relevance of that hazard/aspect;
- the sensitive receptor(s) at risk;
- the potential sources (pathways) of impact to receptors;

- the applicable legislation, standards and guidelines relevant to that hazard/aspect; and
- the controls applied to eliminate or reduce a risk.

The assessment of risk includes consideration of prior site experience, investigations/studies and monitoring history. Consistent with the DJPR (2019) guidelines, the risk ranking (consequence and likelihood) is based on the risk level after the implementation of risk controls (residual risk). This is consistent with the approach undertaken in the previous RARP and Pit 23 EMP (Iluka 2017b).

6.3 Risk controls

Risk controls are defined in the DJPR Guidelines as measures which eliminate the risk or minimise the risk as far as reasonably practicable. Risk controls follow a hierarchy of effectiveness (most effective to least effective). The hierarchy ranges from elimination through to administrative controls. Generally engineering control measures (primary control) and management system measures (secondary controls) are selected as suitable controls for risk treatment.

Risk controls are nominated for each identified hazard/environmental aspect considered in this RARP.

6.4 Risk matrix

The DJPR risk matrix and likelihood and consequence definitions used in this RARP as given in Table 4 to Table 7 below.

Table 4: Consequence descriptions (adapted from Table A1 of DJPR (2019))

Severity	Consequence descriptions		
	For public health, safety, amenity and Aboriginal Heritage	*For land, property and infrastructure (beyond the boundary of the licence/permit area)*	*For the environment – air, water, soil, vegetation, flora and fauna species (other than for planned and approved disturbances within the licence/permit area)*
5 – Critical *Hazard has critical impact, in terms of severity and/or duration.* *Treatment or remediation effort is required, although some effects may be irreversible.* *Remediation of environmental contamination would require significant private and public resources.*	**Public health and safety:** • One or more fatalities or life threatening injuries or illness • Public exposed to a severely debilitating chronic health impact or life-threatening hazard • One or more injuries resulting in permanent disablement **Public amenity:** • Community or multiple individuals continuously experience major losses of amenity from dust, odour, fumes, noise, or other similar hazards over periods of weeks or longer. **Aboriginal heritage:** • Harm to features and/or places of Indigenous cultural value. **Heritage:** • Irreversible damage, or destruction of a place, object or historical archaeological site listed on the Commonwealth National Heritage List, Victorian Heritage Register, Victorian Heritage Inventory, or local Heritage Overlay.	**Land and land uses:** • Permanent loss of production from primary production land >10 ha. Loss of annual-seasonal primary production from >100 ha of land. • Irreversible or long-term environmental damage (with rehabilitation taking years or longer) to >1 ha of National Park or other conservation reserve. **Public and private property:** • Total damage to private or public property or infrastructure or loss of income resulting from this damage >$10 million. • Total loss of value of private property equivalent to >$10 million. **Services provided by infrastructure:** • Important community services (e.g. transport, energy, health, telecommunications, education, water) suspended or significantly disrupted for extended period (weeks or longer).	**Environmental contamination event:** • Environmental contamination event (of air, soil-land and/or water) of a magnitude that a State-level incident response is required. Incident response, clean-up and rehabilitation expected to run for years and/or cost ≥$10 million. **Native vegetation, flora species or fauna species:** • Environmental contamination event or other form of environmental damage leading to bioregional, State or national extinction of listed threatened species of native flora or fauna or vegetation community. • Irreversible or long-term (years) damage or environment harm to ≥10 ha of native vegetation (not listed threatened vegetation community) or to ≥1 ha listed threatened native vegetation community. Deaths of hundreds (or more) of listed native flora or fauna species or native mammals. • Contamination or other environmental damage leading to deaths of native fauna well beyond (>1 km) the boundaries of the operation. **Surface water or groundwater:** • Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by SEPP (Waters) for more than one year.

Severity	Consequence descriptions		
	For public health, safety, amenity and Aboriginal Heritage	*For land, property and infrastructure (beyond the boundary of the licence/permit area)*	*For the environment – air, water, soil, vegetation, flora and fauna species (other than for planned and approved disturbances within the licence/permit area)*
4 – Major *Hazard has major impact, in terms of severity, duration and/or frequency of occurrence. Treatment or remediation effort is required. Some effects may be irreversible.* *Remediation of environmental contamination would require significant private and public resources.*	**Public health and safety:** • One or more injuries or illness requiring surgery or resulting in long-term disablement. • Public exposed to a hazard that results in hospitalisation for treatment from injury or illness. **Public amenity:** • Community or multiple individuals regularly experience (weekly-monthly basis) major losses of amenity due to dust, odour, fumes, noise, or other similar hazards for multiple days on end. **Heritage:** • Damage to a place, object or historical archaeological site listed on the Commonwealth National Heritage List, Victorian Heritage Register, Victorian Heritage Inventory, or local Heritage Overlay. Removal or relocation of elements associated with places, objects or historical archaeological sites.	**Land and land uses:** • Permanent loss of production from primary production land <10 ha. Loss of annual-seasonal primary production from 10-100 ha of land. • Irreversible or long-term environmental damage to <1 ha of National Park or other conservation reserve or to ≥10 ha of other public land. Reversible damage to ≥1 ha of National Park or other conservation reserve or to ≥10 ha of other public land. **Public and private property:** • Total damage to private or public property or infrastructure or loss of income resulting from this damage $1-10 million. • Total loss of value of private property equivalent to $1-10 million. **Services provided by infrastructure:** • Important community services (e.g. transport, energy, health, telecommunications, education) suspended or significantly disrupted for days or experiencing minor disruptions for long periods (weeks or longer).	**Environmental contamination event:** • Environmental contamination event (of air, soil-land and/or water) of a magnitude that would necessitate a regional emergency management incident response. Clean-up and rehabilitation expected to run for months and/or cost $1-10 million. **Native vegetation, flora species or fauna species:** • Environmental contamination event or other form of environmental damage leading to local extinction of listed threatened species of native flora or fauna or vegetation community. Deaths of up to ~100 listed threatened flora or fauna species or native mammals. • Major damage or environment harm to 1-10 ha of native vegetation (not listed threatened vegetation community) or to <1 ha listed threatened native vegetation community that will be irreversible or take years to recover from. **Surface water or groundwater:** • Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by SEPP (Waters) for up to one year.

Severity	Consequence descriptions		
	For public health, safety, amenity and Aboriginal Heritage	*For land, property and infrastructure (beyond the boundary of the licence/permit area)*	*For the environment – air, water, soil, vegetation, flora and fauna species (other than for planned and approved disturbances within the licence/permit area)*
3 – Moderate *Hazard has moderate, noticeable impact, in terms of severity, duration and/or frequency of occurrence. Moderate treatment or remediation effort may be required.* *Hazard event would be the subject of limited community concern.*	**Public health and safety:** • One or more injuries or illness requiring treatment by a physician or hospitalisation. • Public exposed to a hazard that results in injuries or health effects requiring treatment by a physician. **Public amenity:** • Community or multiple individuals regularly (weekly-monthly basis) experience significant loss of amenity from dust, odour, fumes, light, noise, vibration or other similar hazards. **Heritage:** • Works to a place, object or historical archaeological site that will not alter the cultural significance as stated on the Commonwealth National Heritage List, Victorian Heritage Register, Victorian Heritage Inventory, or local Heritage Overlay.	**Land and land uses:** • Loss of annual-seasonal primary production from <10 ha of land. Short-term (days-weeks) disruption to 10-100 ha of primary production land. • Reversible damage to <1 ha of National Park or other conservation reserve or to <10 ha of other public land. **Public and private property:** • Individual hazard event causes total damage to private or public property or infrastructure or loss of income resulting from this damage $50k-$1 million. • Individual hazard event causes total loss of value of private property equivalent to $50k-$1 million. **Services provided by infrastructure:** • Important community services (e.g. transport, energy, health, telecommunications, education) suspended or significantly disrupted for up to 1 day or experiencing minor disruptions for weeks.	**Environmental contamination event:** • Environmental contamination event (of air, soil-land and/or water) with clean-up and rehabilitation expected to run for weeks and cost $10k-$1 million. **Native vegetation, flora species or fauna species:** • Environmental contamination event or other form of environmental damage leading to deaths of a small number of listed threatened flora or fauna species or native mammals. • Reversible damage or environmental harm to <10 ha of non-listed native vegetation community or <1 ha of listed native vegetation community. **Surface water or groundwater:** • Localised contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by SEPP (Waters) for weeks to months.

Severity	Consequence descriptions		
	For public health, safety, amenity and Aboriginal Heritage	*For land, property and infrastructure (beyond the boundary of the licence/permit area)*	*For the environment – air, water, soil, vegetation, flora and fauna species (other than for planned and approved disturbances within the licence/permit area)*
2 – Minor *Hazard is perceived but has minor and typically temporary effects. Some remediation may be required.*	**Public health and safety:** • One or more injuries or illness requiring first aid treatment. • Public exposed to a hazard that could cause injuries or adverse health effects requiring first aid treatment. **Public amenity:** • Dust, odour, light, fumes, vibration or other similar hazards infrequently (no more than monthly) have a minor effect on the amenity of the community or individuals. **Heritage:** • Isolated damage to regionally or locally significant natural or historic heritage features that is readily rectified.	**Land and land uses:** • Minor damage to agricultural land or public land not requiring active rehabilitation. Temporary and small-scale disruption to agricultural production (days, 1-10 ha) **Public and private property:** • Total damage to private or public property or infrastructure $1-50k. • Total loss of value of private property equivalent to $1-50k. **Services provided by infrastructure:** • Important community services (e.g. transport, energy, health, telecommunications, education) suspended or significantly disrupted for short period (hours)	**Environmental contamination event:** • Minor environmental contamination event (of air, soil-land and/or water). Clean-up and rehabilitation may be required, but can be completed within days. **Native vegetation, flora species or fauna species:** • Minor damage or environment harm to <1 ha of native vegetation (not listed threatened vegetation community) that can be recovered in weeks to months. Minor contamination or other environmental damage that affects native fauna populations, but does not kill individuals or disrupt breeding or other important ecological processes. **Surface water or groundwater:** • Minor contamination of natural waterway or wetland occurs, but water quality remains within applicable EPA or ANZECC guidelines for existing beneficial uses. • Water extraction or diversion reduces surface water flows or groundwater available for environmental uses, but with no detectable effect on dependent species or ecosystems and carried out within terms of water licence.

Severity	Consequence descriptions		
	For public health, safety, amenity and Aboriginal Heritage	*For land, property and infrastructure (beyond the boundary of the licence/permit area)*	*For the environment – air, water, soil, vegetation, flora and fauna species (other than for planned and approved disturbances within the licence/permit area)*
1 – Insignificant *Impacts are barely recognised and/or quickly recovered from. No specific remediation required.*	**Public health and safety:** • An injury or ailment that does not require medical or first aid treatment. **Public amenity:** • Dust, odour, light, fumes, vibration or other similar hazards infrequently (no more than monthly) contribute to a small reduction in the amenity of the community or individuals.	**Land and land uses:** • Minor, temporary disruption to primary production (<days) from <1 ha of land. **Public and private property:** • Total damage to private or public property or infrastructure <$1k. • Total loss of value of private property equivalent to <$1k. **Services provided by infrastructure:** • Important community services (e.g. transport, energy, health, tele-communications, education) maintained, but experiencing minor disruptions or delays.	Hazard event with minimal environmental impact and no noticeable effect beyond the immediate occurrence or expression of the hazard.

Table 5: Risk matrix (adapted from Figure A1 of DJPR (2019))

		Consequence				
		1 – Insignificant	2 – Minor	3 – Moderate	4 – Major	5 – Critical
Likelihood	5 – Almost Certain	Medium	High	Very High	Very High	Very High
	4 – Likely	Medium	Medium	High	Very High	Very High
	3 – Possible	Low	Medium	Medium	High	Very High
	2 – Unlikely	Low	Low	Medium	High	High
	1 – Rare	Low	Low	Medium	Medium	High

Table 6: Risk rating acceptability (adapted from Table A3, of DJPR (2019))

Risk level	Description
Very High	Totally unacceptable level of risk. Controls required to reduce the risk.
High	Generally unacceptable level of risk. Controls required to reduce the risk, or seek specific guidance from the Responsible Authority.
Medium	May be acceptable provided the risk has been minimised as far as reasonably practicable.
Low	Acceptable level of risk provided the risk cannot be eliminated.

Table 7: Likelihood description (adapted from Table A2 of DJPR (2019))

Severity	Description	Probability of occurrence
Almost certain	The risk event is expected to occur in most circumstances.	90-100%
Likely	The risk event will probably occur in most circumstances.	70-90%
Possible	The risk event might occur at some time.	30-70%
Unlikely	The risk event could occur at some time.	5-30%
Rare	Highly unlikely, but may occur in exceptional circumstances.	0-5%

6.5 Risk register

The RARP Risk Register is provided in **Appendix A** to this EMP. Thirteen risk scenarios were assessed for the operations and rehabilitation phases comprising risks relating to:

- Groundwater;
- Surface water;
- Air quality;
- Noise;
- Weeds;
- Hazardous materials (e.g. hydrocarbons);

- Public safety; and
- Land rehabilitation and revegetation.

No risk scenarios were rated as being inherently High or Very High risks. Five risk scenarios were rated as Medium inherent risks and eight were rated as Low inherent risks (Appendix A). After the consideration of Iluka's standard management controls, all risk scenarios were rated as a Low residual risk.

Irrespective of these risk rankings, in most cases, monitoring and the application of trigger-response management controls and contingencies were mandated under Victorian legislation and Planning Permit 15-105. Detailed commentary on the risks and associated management and monitoring activities, aligned with the Risk Register, are presented in Section 7 to Section 10.

7 Groundwater Monitoring and Management Plan

This Groundwater Monitoring and Management Plan (GWMMP) has been prepared to satisfy Condition 24 of the Permit, which specifies the following requirements:

Groundwater Monitoring and Management Plan

27. A *Groundwater Monitoring and Management Plan (GWMMP)* (component of the *EMP*) must be prepared to the satisfaction of the responsible authority.

28. The GWMMP must be generally in accordance with the plan in Appendix A to the *Supplementary Response to Amended Notice* provided to the EPA and the Responsible Authority, but modified or added to so as to include:

    (a) the applicable recommendations contained in section 6.2 of the report prepared by Environmental Earth Sciences titled *Independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria No. 215071v2* dated April 2016 (**the EES April 2016 review**);

    (b) a discrete description of measures for groundwater protection and monitoring included in any approval in force under the *Radiation Act 2005*;

    (c) a plan showing the proposed location and spatial distribution of groundwater bores (including new drilled bores and replacement borehole locations) which must include as a minimum those recommended in the EES April 2016 review - Figure 6 on Page 32.

    (d) confirmation that all new and replacement bores are installed and tested under the supervision of a qualified, experienced hydrogeologist;

    (e) details of the frequency of monitoring of groundwater bores for groundwater levels;

    (f) details of the frequency of sampling of groundwater bores and the analytes to be tested and reported on;

    (g) appropriate trigger criteria and associated management responses for analytes of concern;

    (h) groundwater level and criteria for analytes of concern that will trigger the recalibration of the groundwater model and re-forecasting of predicted groundwater behaviour and transport of analytes of concern;

    (i) the means by which site-specific distribution coefficients will be determined, if such determination is required, to improve model predictions;

    (j) quality assurance controls and reporting;

    (k) criteria that will trigger points when it is appropriate to review and amend the GWMMP requirements.

This GWMMP provides the framework for the monitoring and management of groundwater potentially impacted by the disposal operations and the rehabilitation of the subject land. This includes:

- with reference to governing legislation and key groundwater investigations completed for the Douglas Mine and Pit 23:
    - identification of the groundwater beneficial uses relevant to Pit 23;
    - identification of the groundwater quality objectives to be maintained in order to protect these beneficial uses; and
    - a detailed analysis of risk.

- the monitoring program and methodologies to apply in order to detect any deleterious impacts on groundwater and beneficial uses/sensitive receptors associated with waste disposal into Pit 23, including:
    - target groundwater monitoring points;
    - target parameters (water quality indicators) including analytes of concern;
    - monitoring methods and frequencies; and
    - quality assurance controls and reporting.
- the trigger criteria, trigger responses and contingency actions to apply where groundwater quality (management) objectives have not been met.

As required by the Permit, this GWMMP has been prepared such that it is in general accordance with the plan in Appendix A to the *Supplementary Response to Amended Notice* provided to the Victorian Environment Protection Authority (EPA) and the Responsible Authority. In addition, the preparation of this plan has had regard to:

- the information pertaining to groundwater as described in the Section 4.4 of Attachment A to the Permit application;
- further information subsequently supplied within Appendix C of the document "Response to Notice to Supply Further Information – Hydrogeological and groundwater related matters" (Iluka, 2016c), submitted to the Responsible Authority and EPA;
- the State Environment Protection Policy Waters ('SEPP Waters') (GoV, 2018), previously the SEPP Groundwaters of Victoria);
- conditions of the Permit; and
- relevant policies, standards and procedures that comprise Iluka's HSEC Management System.

As noted above the SEPP Groundwaters of Victoria was superseded by the SEPP (Waters) which came into effect on 19th October 2018. References to and the requirements of the SEPP (Waters) now apply within this updated GWMMP.

7.1 Sources

With respect to the protection of groundwater and groundwater beneficial uses, the primary impact pathway is through the seepage of contaminants arising from the disposal of MSP by-products.

7.2 Sensitive receptors

The principal groundwater beneficial use relevant to the Pit 23 is stock water use, being the only substantive groundwater beneficial uses in the region.

Per CDM Smith (2014) and Jacobs (2014) groundwater-dependent ecosystems (GDEs) are also considered potential receptors. Those relevant to Pit 23 include:

- groundwater-connected surface water bodies sited down-gradient and north-west of Pit 23 specifically McGlashin Swamp and White Lake; and
- any springs sited down-gradient and north-west of Pit 23 in the North-West Drainage Line.

  With respect to GDEs it is noted that:
    - springs are also located west of the Douglas site (approximately 3.5km SSW of Pit 23) in Costello's Creek, however these are not on the groundwater flow path from Pit 23; and

- groundwater-supported water bodies and springs are classified as surface receiving waters under the SEPP (Waters) and associated risks and management are therefore addressed in the SWMMP (Section 8).

The identification and relevance of these receptors is based on the classification of the groundwater environment under the SEPP (Waters) and findings of relevant groundwater studies (as endorsed during the Pit 23 Victorian Civil and Administrative Tribunal (VCAT) determination[1]) which are detailed in Section 7.4 of this EMP.

7.3 Applicable legislation, standards and guidelines

7.3.1 State Environmental Protection Policy (Waters)

The primary legislation relevant to the management of risks to groundwater is the EP Act and the subsidiary and SEPP (Waters).

Schedule 1 of the SEPP (Waters) divides groundwater in Victoria into "segments" according to salinity, as measured by the background concentration of total dissolved solids (TDS). These segments determine which beneficial uses apply to that groundwater resource.

For purpose of comparison, the former Groundwater SEPP segments and new SEPP (Waters) segments are given in Table 8. It is noted that the SEPP (Waters) introduced additional groundwater segments, primarily by dividing the higher TDS segments in the former Groundwater SEPP into more distinct levels.

Table 8: SEPP (Waters) groundwater segments

SEPP Groundwaters of Victoria - Groundwater Segments (*former / revoked)*							
Segment	**A1**	**A2**	**B**	**C**	**D**		
TDS range (mg/L)	0 - 500	501 - 1000	1001 - 3500	3501 - 13000	>13000		
SEPP (Waters) - Groundwater Segments *(new)*							
Segment	**A1**	**A2**	**B**	**C**	**D**	**E**	**F**
TDS range (mg/L)	0 - 600	601 - 1200	1201 - 3100	3101 - 5400	5401 - 7100	7101 - 10000	>10001

Median TDS values[2] were used to construct Figure 11, which presents an inferred spatial distribution of median TDS concentrations across the Douglas Mine categorised according to the SEPP (Waters) segments[3]. The groundwater flow path from Pit 23, represented by groundwater model particle tracks (from EMM, 2019), are also shown to indicate the groundwater segments potentially impacted by Pit 23 seepage.

From Figure 11 it can be seen that the TDS along the flow path from Pit 23 ranges from Segment D to Segment F, i.e. groundwater salinity increases in a south-to-north direction between Pit 23 and the groundwater-fed saline surface water bodies to the north (McGlashin' Swamp and White Lake). This is consistent with the groundwater characterisations given in various studies for the Douglas site (CDM Smith 2014; EMM 2019; Jacobs 2014).

[1] Victorian Civil and Administrative Tribunal 107 [2017], paragraphs 152 and 153 (VCAT, 2017)

[2] based on both pre-mine data (where available) and data from bores assessed as non-mine impacted – see Section 7.3.2 for detail.

[3] developed in ArcGIS using kriging geo-statistical interpolation

White Lake
MCKECHNIES RD
Bitter Swamp
WOMBELANO ROAD
McGlashin Swamp
KANAGULK ROAD
Ti Tree Swamp
HARROW -
Red Hill Drainage Line
BRANDTS ROAD
North West Drainage Line
ELLIOTTS ROAD
Pit 23
LANE
ELLIOTTS BACK

HORSHAM RURAL CITY COUNCIL
PLANNING AND ENVIRONMENT ACT 1987
HORSHAM PLANNING SCHEME
I certify that this is the plan/documentation referred to in
Permit No: PA15-105
Appendix/Appendices
JOEL HASTINGS
Coordinator Statutory Planning
Dated 23/09/21

Legend

- Monitoring bore
- Pit 23
- Pit 23 Particle Tracks
- North West Drainage Line
- Red Hil Drainage Line

SEPP (Waters) Segments (TDS, mg/L)

- A1; 0 - 600
- A2; 600 - 1,200
- B; 1,200 - 3,100
- C; 3,100 - 5,400
- D; 5,400 - 7,100
- E; 7,100 - 10,000
- F; > 10,000

N

0 500 1,000 m

Inset aerial photo: Oct. 2018

DOUGLAS MINE

SEPP (WATERS) GROUNDWATER SEGMENTS (TDS, mg/L)

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:35,000 (A3) DATE: June 2020 DWG No: 257181 ver.01

FIGURE: **11**

Table 9 identifies the groundwater beneficial uses to be protected in segments D to F (from Table 2, Schedule 2) of the SEPP (Waters).

Table 9: SEPP (Waters) beneficial uses – groundwater Segments D to F

Beneficial Use	Segments		
	D	E	F
Water dependent ecosystems and species	Yes	Yes	Yes
Potable water supply (desirable)	---	---	---
Potable water supply (acceptable)	---	---	---
Potable mineral water supply	---	---	---
Agriculture and irrigation (irrigation)	---	---	---
Agriculture and irrigation (stock watering)	Yes	Yes	---
Industrial and commercial	Yes	---	---
Water-based recreation (primary contact recreation)	Yes	Yes	Yes
Traditional Owner cultural values	Yes	Yes	Yes
Cultural and spiritual values	Yes	Yes	Yes
Buildings and structures	Yes	Yes	Yes
Geothermal properties	Yes	Yes	Yes

Of the beneficial uses for Segments D – F listed in Table 9, only Agriculture and Irrigation (stock watering) is relevant to the assessment of groundwater risk associated with Pit 23. This follows that:

- while there are no registered stock water bores along the flow path from Pit 23 (see Figure 12), there are 39 registered stock and domestic bores in the greater Douglas area (CDM Smith, 2014) with only four within a 5km radius of Pit 23 and none along the path of groundwater flow (see Figure 12); and
- apart than cropping, sheep grazing is the main agricultural land use in the area and groundwater abstraction for stock water is the only substantive receptor-at-risk.

As noted in Section 7.2, groundwater-supported water bodies and springs are classified as surface receiving waters under the SEPP (Waters) and associated risks and management are therefore addressed in the SWMMP (Section 8).

Following Clause 15(2)(d) of the SEPP (Waters), all other default beneficial uses are not considered relevant on the following grounds:

- Industrial and commercial: no industrial or commercial uses of the groundwater along the flow path from Pit 23 exist and future uses are highly unlikely on the basis of the rural and environmental (reserved land) land use zoning;
- Water-based (primary contact) recreation: the aquifer does not recharge to surface at any location along the path of flow from Pit 23 whereby recreational use is possible (i.e. the 'groundwater yield' does not support or sustain this beneficial use / no mechanism for adverse impact exists). Further, as explained above, risks to any surface water features associated with seepage from Pit 23 is also discounted;
- Traditional Owner cultural values, and cultural and spiritual values: it is considered that such values are most likely to be associated with surface water features (lakes, streams, swamps and wetlands), which is consistent with cultural heritage sensitivity mapping in the Aboriginal Victoria *Aboriginal Cultural Heritage Register and Information System (ACHRIS)* database and explanatory notes to Clause 17 in the SEPP (Waters). On this basis, the protection and

maintenance of beneficial uses for receiving waters under the SWMMP will provide appropriate protection of any associated risk to any associated cultural and spiritual values;

- Buildings and structures: the native groundwater is likely to be hostile to such use on account of high salinity and mid-to-low pH (i.e. corrosivity) and no such use occurs along the path of flow from Pit 23;
- Geothermal properties: there were/are no mechanisms or inputs to the local groundwater system associated with historical mining operations, or future activities in Pit 23, that would affect the natural thermal capacity of local or regional groundwater. Likewise, any potential geothermal use of this groundwater would not be affected.

7.3.1.1 VCAT determination – beneficial use assessment

The above assessment of beneficial uses relevant to groundwater flows from Pit 23 is consistent with the VCAT determination (VCAT, 2017) which concluded that stock water was/is the principal beneficial use of concern. Relevant items in the VCAT determination are listed below.

Note that the VCAT determination refers to groundwater segment from the former SEPP Groundwaters of Victoria (now SEPP Waters), however the justification for the nomination of relevant beneficial uses and the exclusion of others remains unchanged.

Extract from VCAT 107 [VCAT 2017]

- *Item 150. The salinity along the groundwater flow path from Pit 23 has a salinity range that places it in Segment 'C' of the SEPP (Groundwaters of Victoria). Beneficial uses under this segment are stock water, ecosystem support, recreation (contact with skin) industrial water use and building and structures. Because of the low yields and depth to the regional groundwater in the Parilla Sands aquifer, the latter two uses are not considered viable or relevant. The EPA concurs with this view. At the higher end of the Segment 'C' range of salinity, even stock watering is marginal.*
- *Item 152. Overall, we are satisfied from the evidence that the substantive groundwater beneficial uses for the region are the interaction of groundwater with surface water ecosystems and stock water use. The other uses relevant to Segment C of the SEPP (Groundwaters of Victoria) are at a lesser risk given the depth to groundwater, the limited capacity to extract groundwater for non-potable uses and it's brackish to saline nature.*
- *Item 153. In respect to recreational contact we observe that there is very limited exposure pathways for people to conduct recreational activities at local lake and swamp systems, especially White Lake with its saline conditions. There is therefore a very limited risk of impact on direct contact or ingestion during recreational activities.*

Inset aerial photo: Oct. 2018

DOUGLAS MINE

REGISTERED DOMESTIC AND STOCK BORE LOCATIONS

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:100,000 (A3) DATE: June 2020 DWG No: 257182 ver.01

FIGURE: **12**

7.3.2 Applicable groundwater quality objectives (GWQOs)

7.3.2.1 Stressors and toxicants

As outlined in Section 7.3.1, stock watering is the principal groundwater beneficial use of relevance and hence Iluka's objective is to ensure that stock water use is not adversely affected by the disposal of approved wastes into Pit 23. For the purposes of monitoring and evaluating groundwater quality in relation to stock water use, the SEPP (Waters) adopts the stock drinking water quality criteria presented in Section 4.3 of the ANZECC&ARMCANZ (2000) water quality guidelines.

Although the SEPP (Waters) guidelines specify generic groundwater quality objectives (GWQOs), it also states that in circumstances where natural background values exceed the groundwater objectives, the background values become the objectives.

The methodology used to determine GWQOs for the Douglas Mine/Pit 23 follows the Department of Science, Information Technology and Innovation's (DSITI) paper titled *Using Monitoring Data to Assess Groundwater Quality and Potential Environmental Impacts* (2017) with the initial step of identifying specific 'groundwater zones' representative of the variability in TDS (and thus groundwater quality generally) across the broader Douglas site. This approach allows data from all bores within a given zone to be 'pooled' in order to increase the depth of data available for statistical analysis and derivation of GWQOs.

Based on analysis of TDS data, six (6) distinct groundwater zones are identified across the broader Douglas site. Referring to Figure 13, bores within the 'North-West Zone' are those relevant to groundwater compliance monitoring and reporting under this EMP.

To enable the derivation of valid GWQOs for each groundwater zone all bore data was screened following DSITI (2017):

- bores considered to be mine-impacted or potentially mine-impacted based on prior groundwater investigations (Jacobs 2014) and groundwater arrival time predictions from particle tracking (EMM 2019) were excluded from the data-set;
- time series data and box-and-whisker plots for each analyte from each bore were plotted to confirm both the absence of temporal trends that could indicate a mining-related influence, and as a cross-check that all bores within a nominated 'groundwater zone' were representative of the same aquifer/local groundwater conditions;
- results recorded as below the laboratory limit of detection (recorded as negative values or "<" prefix) treated as absolute values, consistent with ANZECC&ARMCANZ (2000); and
- null (erroneous) values and outlier values (defined as greater than ± four standard deviations from the mean following DSITI (2017) removed.

For each groundwater zone the GWQOs were then determined as follows:

- the 5th and 20th percentile values (pH only) and 80th and 95th percentile values were calculated for each analyte in each bore, and for the 'pooled' data across all bores for each analyte, with the latter compared against the default guideline value (objective) per the SEPP (Waters) or ANZECC&ARMCANZ (2000);
- the 'pooled' 20th percentile (pH only) and 80th percentile values were used to identify analytes that naturally exceeded default guideline values and for which site-specific GWQOs were warranted; and
- Per Step 4 of DSITI (2017) the 'pooled' 5th, 20th, 80th and 95th percentile values for each analyte were compared to the equivalent percentile values calculated for individual bores. Where a calculated 5th, 20th, 80th or 95th percentile value for an individual bore was lower (pH only) or higher than the 'pooled' value, this value was applied as the GWQO for that groundwater zone to ensure that site-specific GWQOs were correctly calibrated to account for the known statistical variation in the data-set and hence reduce the potential for "false exceedances".

Based on the screening process, it was determined that site-specific GWQOs were justified for the following analytes in the 'North-West Zone':

- pH (lower criterion);
- Selenium; and
- Uranium$_{238}$

It is noted that the Iluka groundwater data for heavy metals used in the above assessment and derivation of GWQOs is for total metal concentrations. Whilst the ANZECC&ARMCANZ (2000) guidelines stock water guideline values do not distinguish between total and dissolved concentrations, heavy metal toxicity (bioavailability) is associated with the latter. On this basis, the default guideline values and site-specific GWQOs implemented in this EMP can be considered conservative and analysis for dissolved concentrations may be used to validate the severity or otherwise of an identified exceedance.

7.3.2.2 Ionic balance ratios

Further, as discussed previously, the groundwater is dominated by the Na-Cl ion pair whereas the results of laboratory leach tests on MSP by-products (Iluka, 2016c) show that leachate is dominated by the Ca-SO4 ion pair (Table 10). Thus, leachate migration would be indicated by a decline in the Cl:SO4 and Na:Ca ratios as the concentrations of sulfate or calcium increases relative to the concentrations of chloride or sodium, respectively.

Table 10: Ratios of Cl:SO4 and Na:Ca in the groundwater down-gradient of Pit 23

Ratio	Groundwater within 2 Km of Pit 23 [1]				Leachate	
	Average	Maximum	Minimum	Median	Laboratory	Model
Cl:SO4	7.66	17.00	5.12	6.97	0.008	0.015
Na:Ca	27.13	63.16	5.98	27.69	0.017	0.050

[1] Based on 'pooled' Cl:SO4 and Na:Ca data for bores GW01, GW02 and GW03

The SEPP (Waters) does not include stock water quality objectives for Cl:SO4 and Na:Ca ratios. Consequently, in addition to GWQOs for stressors and toxicants, site-specific GWQOs were developed for Cl:SO4 and Na:Ca ratios using available data from wells representative of background conditions.

The same process was adopted for generating Cl:SO4 and Na:Ca ratio criteria using data from all background (non-mining affected) wells to develop 20th and 5th percentiles.

In all cases trends in the Cl:SO4 and Na:Ca ratios will be considered in parallel with the observed exceedances in other analytes. The GWQOs for these ratios do not represent compliance limits in and of themselves (i.e. they do not apply as standalone thresholds to be achieved/maintained) but are only used to confirm that trends of concern observed in other analytes are likely to be associated with seepage from Pit 23 and not the result of natural variation.

7.3.2.3 Pit 23 GWQOs

Table 11 summarises the GWQOs applicable to compliance (indicator) monitoring bores down-gradient of Pit 23 (see Section 7.3.2). These GWQOs are used to evaluate changes in groundwater chemistry that may be associated with seepage from Pit 23.

Table 11: Pit 23 GWQOs - North-West Zone

Indicator		Percentile	GWQO	Investigation Trigger
General				
pH (lower limit)	pH units	5th percentile	4.79	Three (3) consecutive data-points < objective (or any single exceedance if monitoring frequency is quarterly or greater)
		20th percentile	4.98	Rolling median of last eight (8) data-points is < objective
pH (upper limit)	pH units	---	8.5	Any single exceedance
TDS	mg/L	---	13,000	Any single exceedance
Major Ions				
Calcium	mg/L	---	1000	Any single exceedance
Sulfate	mg/L	---	1000	Any single exceedance
Fluoride	mg/L	---	2	Any single exceedance
Metals and metalloids *(from ANZECC/ARMCANZ – stock water guidelines)*				
Aluminium (Total)	mg/L	---	5	Any single exceedance
Arsenic (Total)	mg/L	---	0.5	Any single exceedance
Boron (Total)	mg/L	---	5	Any single exceedance
Cadmium (Total)	mg/L	---	0.01	Any single exceedance
Cobalt (Total)	mg/L	---	1	Any single exceedance
Chromium (Total)	mg/L	---	1	Any single exceedance
Copper (Total)	mg/L	---	0.4	Any single exceedance
Lead (Total)	mg/L	---	0.1	Any single exceedance
Mercury (Total)	mg/L	---	0.002	Any single exceedance
Molybdenum (Total)	mg/L	---	0.15	Any single exceedance
Nickel (Total)	mg/L	---	1	Any single exceedance
Selenium (Total)	mg/L	80th percentile	0.06	Rolling median of last eight (8) data points is > objective
		95th percentile	0.07	Three (3) consecutive data-points > objective (or any single exceedance if monitoring frequency is quarterly or greater)
Uranium (Total)	mg/L	---	0.2	Any single exceedance
Zinc (Total)	mg/L	---	20	Any single exceedance
Nutrients				
Nitrite-N	mg/L	---	9.1	Any single exceedance
Nitrate-N	mg/L	---	90.3	Any single exceedance
Radionuclides				
Ra-226	Bq/L	---	5	Any single exceedance
Ra-228	Bq/L	---	2	Any single exceedance

Indicator		Percentile	GWQO	Investigation Trigger
U-238	Bq/L	80th percentile	0.13	Rolling median of last eight (8) data points is > objective
		95th percentile	0.26	Three (3) consecutive data-points > objective
Ionic Balance – Ratios *(ratios do not apply as standalone objectives - see footnote)*				
Cl:SO4	*Ratio*	*5th percentile*	*3.3*	*Three (3) consecutive data-points < objective*
		20th percentile	*3.8*	*Rolling median of last eight (8) data points is < objective*
Na:Ca	*Ratio*	*5th percentile*	*6.0*	*Three (3) consecutive data-points < objective*
		20th percentile	*6.4*	*Rolling median of last eight (8) data points is < objective*

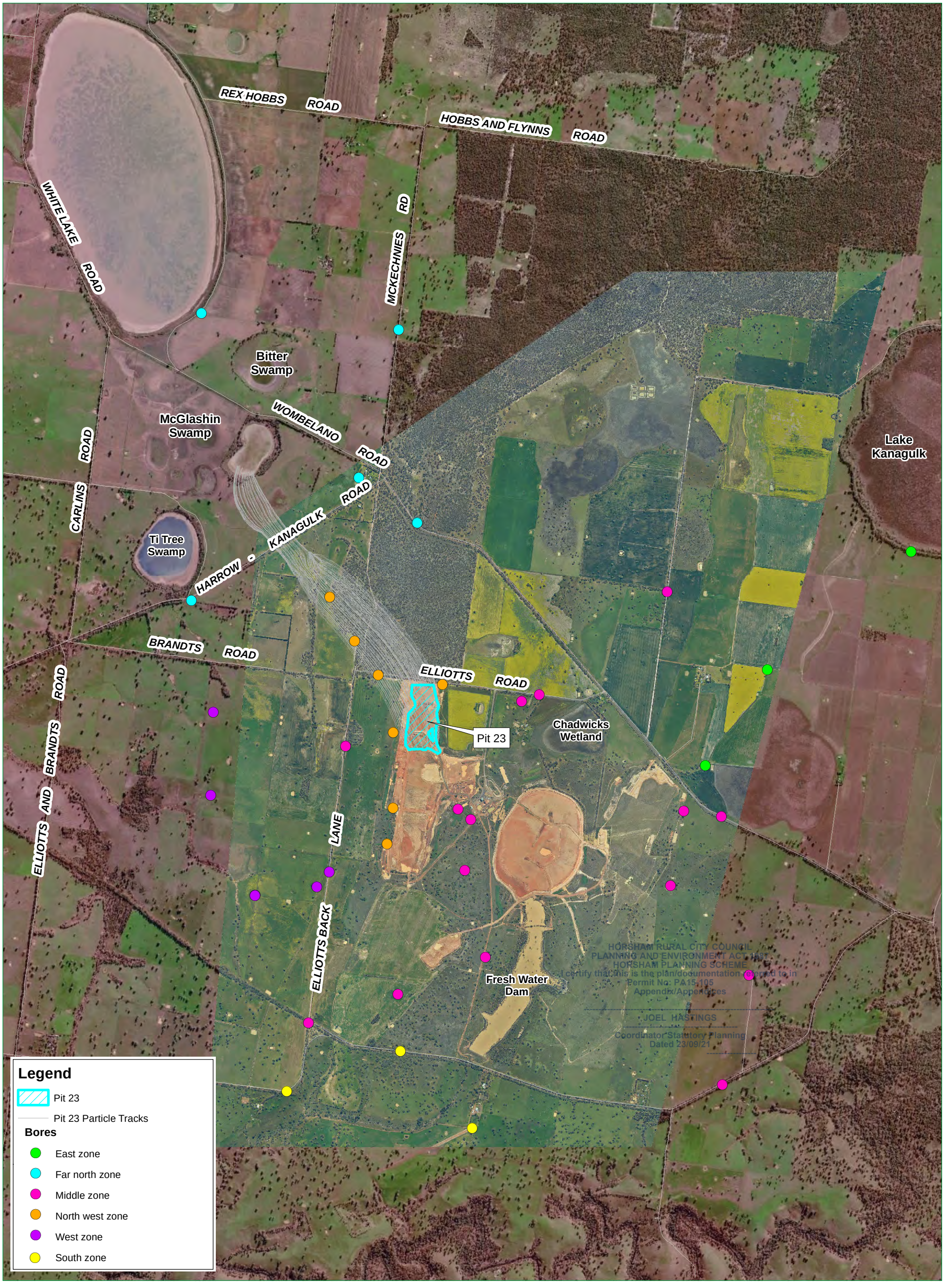
NOTES

- SWOQs shaded **orange** are default compliance limits per the SEPP (Waters) or ANZECC/ARMCANZ (2000) guidelines
- SWQOs shaded **green** are site-specific GWQOs

IMPORTANT

With regard to the GWQOs for CL:SO4 and Na:Ca ratios:

- objectives for these ratios are not prescribed in the SEPP (Waters); and
- the GWQOs for these ratios do not apply as standalone limits to be achieved / maintained and are only taken into consideration where they correspond to a simultaneous trend of concern in one or more other analytes listed in this table. I.e. they are used to confirm the likelihood of a Pit 23 related influence on groundwater quality and expression into surface waters where trends of concern are first observed for other analytes.



N

0 500 1,000 m

Inset aerial photo: Oct. 2018

DOUGLAS MINE

GROUNDWATER ZONES

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:40,000 (A3) DATE: 7 Aug. 2020 DWG No: 259133 ver.00

FIGURE: **13**

7.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to groundwater.

Given the number of groundwater studies and impact assessments completed for the Douglas Mine and Pit 23, several in support of the applications for the planning permit, these studies form the basis of the enclosed risk analysis. The studies referenced herein include:

- CDM Smith (2014) *Douglas Mine Site Hydrogeological Modelling*. Development of a conceptual and numerical hydrogeological model to enable prediction of future groundwater levels and flows;
- Jacobs (2014) *Proposed disposal of by-products to Pit 23 at the Douglas Mine Site*. Incorporating groundwater flow model predictions per CDM Smith (2014), this study consisted of initial solute transport modelling and hydrogeological risk assessment on the then proposed by-product disposal into Pit 23 on groundwater quality, existing groundwater users and sensitive receptors;
- CDM Smith (2015) *Douglas Mine – Particle Tracking of Seepage Water.* Use of the hydrogeological model per CDM Smith (2014) to investigate seepage from tailings disposal locations detailed in Douglas Mine, including confirmation of flow paths and groundwater travel times relative to sensitive receptors;
- SRS (2015) *Radiological impacts of proposed disposal operations at Douglas Mine*. Assessment of the consequences and likelihood of radionuclide contamination of groundwater arising from the by-product disposal to Pit 23 and the relevance of groundwater and groundwater contamination as a radiation exposure pathway.
- Jacobs (2016a) *Douglas Mine groundwater impact assessment – analytical solute transport modelling, White Lake Discharge Concentration*. Development and use of an in-pit dissolution model to provide a prediction of the quality of leachate from Pit 23. The modelling predicted the fate of potential key contaminants in the leachate and distance of travel/migration away from Pit 23 accounting for the starting properties of the leachate and contaminant attenuation/retardation through geochemical processes such as dilution, dispersion, sorption and decay;
- Jacobs (2016b) *Disposal of by-products at the Douglas Mine site – Groundwater chemistry baseline review*. Detailed review and characterisation of the baseline chemistry for the greater Douglas site and assessment of existing impacts to groundwater from historical mining or Pit 23 activities;
- EMM (2018) *Pit 23 groundwater – Assessment of Seepage Indicator Exceedances*. Investigation into the cause of surface water quality exceedances at McGlashin Swamp, observed in 2017 monitoring data. The assessment considered groundwater and surface water chemistries to identify any possible relationship to groundwater seepage from Pit 23;
- EMM (2019) *Groundwater model update and predictive scenario modelling*. Update and peer review of the model developed by CDM Smith (2014). This included the addition of new bores and data, scenario modelling to inform mine closure options analysis, detailed assessment of southerly flow potential to the Glenelg River and validation of prior modelling predictions.

7.4.1 Risk analysis

7.4.1.1 Groundwater levels and flow paths

CDM Smith (2014) described the development and calibration of a conceptual and numerical hydrogeological model of the Douglas mine site and surrounds and used that model to:

- estimate advective transport of water from Pit 23 and assess the potential for water from the Pit 23 to reach sensitive receptors;

- assess the potential impacts of disposal of by-products into Pit 23 on the groundwater levels and advective transport of water from Pit 23;
- identify any gaps in the existing monitoring network and schedule to manage and verify predicted impacts and future risks from by-products disposal at Pit 23;
- assess the long term, post closure impacts of disposal of by-products on the groundwater levels, particularly in the area of surface water/groundwater interaction, and expected duration of residual effects, if such effects were predicted.

The modelling work included predictions of changes in groundwater levels and flow directions under two operating/rehabilitation scenarios for Pit 23 being a '*base case*' scenario that applied at the time of modelling (early cessation of waste disposal and early rehabilitation in 2018) and a '*future disposal case*' (by-product disposal for a further 20 years with rehabilitation in ~2037).

Key conclusions relevant to Pit 23:

- groundwater flow beneath and from Pit 23 is to the north-west, towards the saline discharge lakes (McGlashin Swamp, Tea Tree Lake and White Lake) in the Douglas depression;
- under the modelled '*future disposal case*' scenario, groundwater levels under Pit 23 were predicted to be 1.3m higher than the '*base case*' due to enhanced recharge rate over the 20 year disposal period (i.e. to year 2036). However:
    - the difference in groundwater levels was predicted to become negligible within a period of 48 years after the completion of disposal; and
    - this would not result in any change in the groundwater flow path nor any significant change in groundwater levels along the flow path. That is, groundwater flow from Pit 23 will always be to the north-west.

In Jacobs (2016b) groundwater level data obtained in late 2015/early 2016 was used to construct updated groundwater level contours, which were compared against those generated by CDM Smith (2014). Jacobs (2016) concluded that the 2014 and 2016 contours were consistent and that the conceptual understanding of groundwater flows from Pit 23 had not changed. That is, that there was no evidence to suggest that groundwater levels and directions of flow from Pit 23 had changed from those determined by CDM Smith (2014).

EMM (2018) completed an assessment of the causal factors contributing to surface water quality exceedances in monitoring data for McGlashin Swamp, as based on then precautionary trigger levels for EC and pH prescribed within the previous revision of this EMP (Rev 4, April 2017). The assessment considered groundwater and surface water quality at points between Pit 23 and McGlashin Swamp to identify any potential association between the observed exceedances and contaminants originating from the pit. EMM (2018) concluded that:

- the observed surface water 'exceedances' in McGlashin Swamp were the product of natural phenomena, likely a combination of evapo-concentration and photosynthetic processes;
- no evidence existed to suggest the exceedances were caused by groundwater seepage or material transport (surface runoff) from Pit 23;
- no impact to groundwater beneficial uses (either groundwater accessibility or quality) or surface water beneficial uses had occurred and the risk of any impact is low, confirming the conclusions drawn by Jacobs (2014).

EMM (2019) also completed a comprehensive update and peer review of the existing CDM Smith (2014) model. The objectives of this model update were to:

- update the model to incorporate new monitoring bores, level data and updated basement relief information;
- assess calibration performance and re-calibrate the model, if required;
- assess the potential for and magnitude of any southerly groundwater flows to the Glenelg River, including potential pathways directly south of the Douglas mine and indirectly via the

Yarramyljup Fault. This included a comprehensive base-flow assessment of the Glenelg River to measure such flows, with the Glenelg River added as a groundwater discharge zone into the model domain;

- generate updated groundwater level contours and compare against the model predictions generated by CDM Smith (2014) i.e. identify any material deviation in expected groundwater levels and flow directions;
- re-assess advective flows from seepage sources including updated particle tracking; and
- undertake a series of hypothetical prediction scenarios to stress-test the model as it relates to flow directions and rates from Pit 23, and to support options analyses for Douglas Mine closure planning. These included various scenarios relating to Pit 23 by-product disposal duration and saturation, and the retention or decommissioning of the Douglas Mine Fresh Water Dam (FWD).

Key conclusions relevant to Pit 23:

- groundwater flows underneath and from Pit 23 are to the north-west, with no significant change from the prior CDM Smith (2014) predictions;
- the time taken for groundwater originating from Pit 23 to arrive at surface water bodies down-gradient of site (McGlashin Swamp, White Lake) were consistent with those predicted by CDM Smith (2014) with travel times between 200 – 510[4] years;
- despite the local influence of FWD seepage on groundwater levels and hydraulic gradients across the Douglas site, this does not cause any changes to the regional groundwater flow directions which remain to the west, north-west, north and north-east. This confirms the role of the basement relief as the main influence on flow direction;
- under all hypothetical future scenarios considered for the FWD and Pit 23 (which included re-simulation of the current Pit 23 operating schedule to ~2036, plus the theoretical 'worst-case' filling of Pit 23 with saturated tailings to near the pre-mine topographical surface[5]) groundwater flows from Pit 23 will always be to the north-west with only small variance to groundwater particle arrival times at down-gradient receptors across the modelled scenarios; and
- the CDM Smith (2014) model was robust with no re-calibration required.

Post-mining and current groundwater contours, particle tracks (which indicate flow directions) and groundwater travel times generated by EMM are given in Figure 14 - Figure 16 and Table 12 respectively.

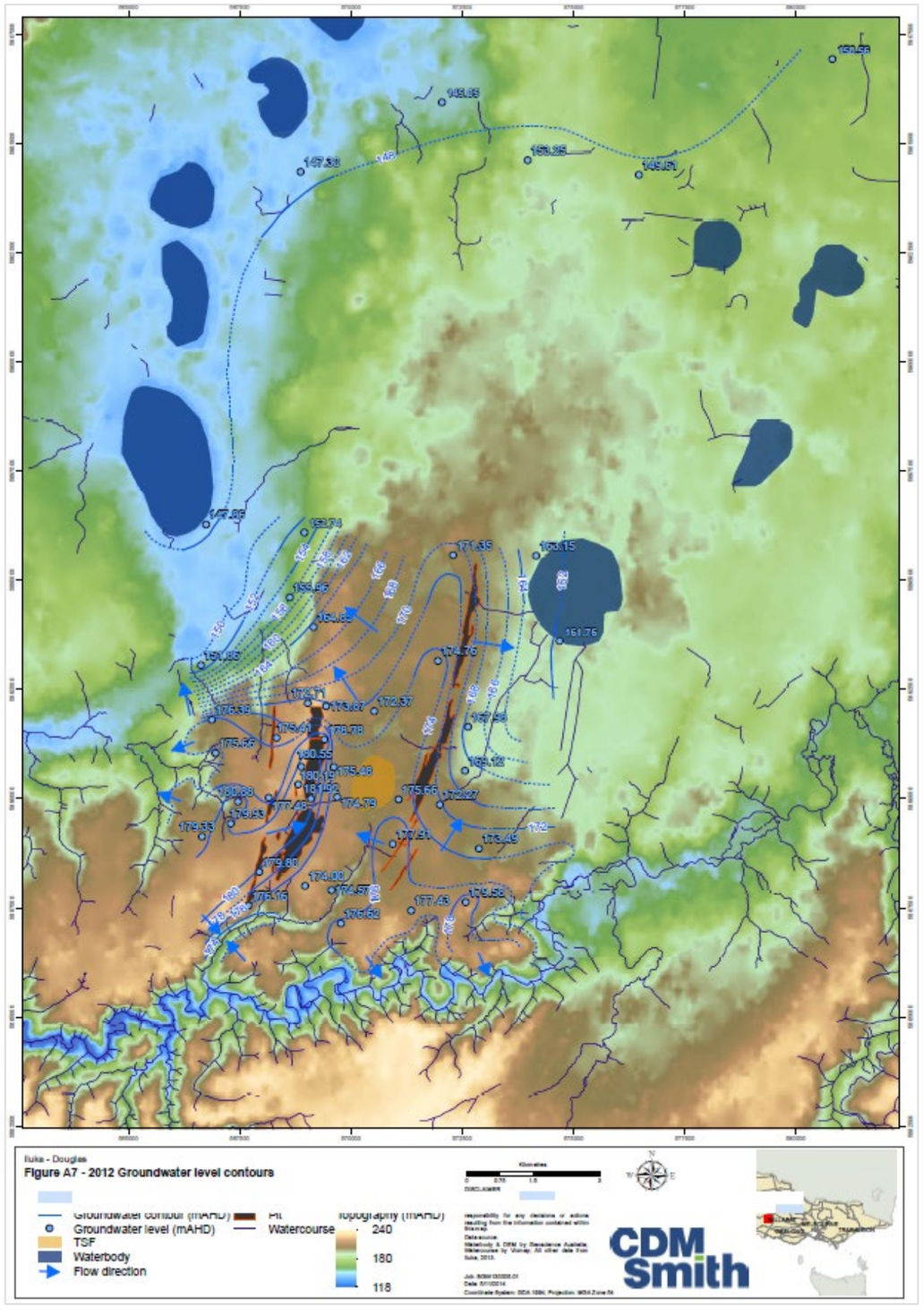
From these investigations, and with regard to risks to groundwater levels and flow paths, it is evident that irrespective of any actual or potential changes in the timing, duration or magnitude of disposal operations into Pit 23:

- groundwater flows beneath and from Pit 23 will always be to the north-west;
- groundwater levels at down-gradient bores and surface water bodies will not be affected (i.e. there is no risk to groundwater accessibility associated with changes in groundwater levels); and
- the time taken for groundwater originating from Pit 23 to reach these receptors is substantial, with travel times ranging from 200 – 500 years.

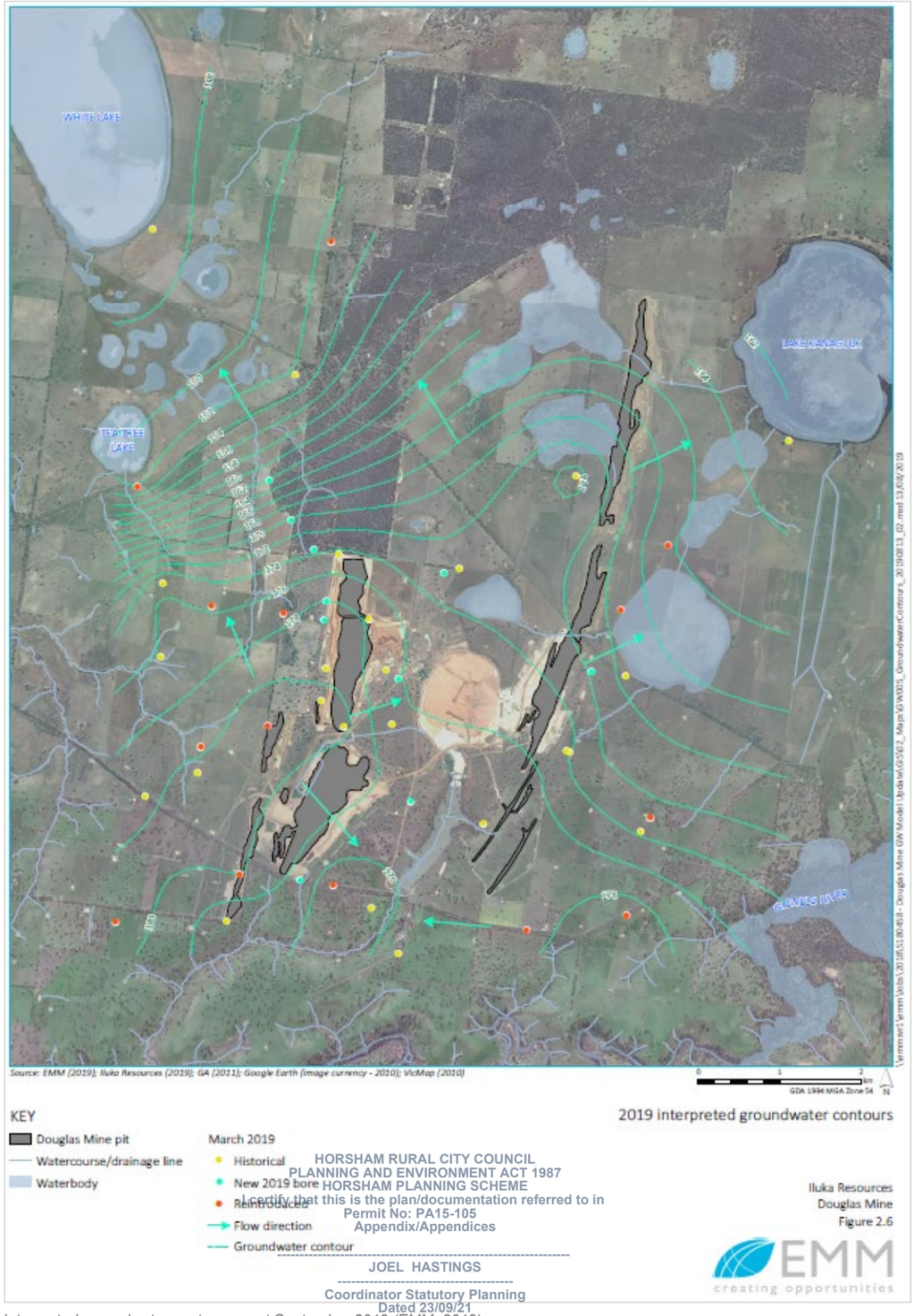
It is further considered that the consistency of the findings across the various hydrogeological modelling studies represents a definitive assessment of groundwater levels and flows associated with Pit 23 and, on this basis, the need for further investigations to re-affirm model predictions (other than that which may be undertaken during periodic updates of the model) is not warranted.

[4] 510 years being the computational prediction limit of the modelling software, i.e. real-world particles travel times may be >510 years

[5] Theoretical only, assumes significant disposal of non-dry/non-spadeable by-products contrary to IWMP requirements



Interpreted groundwater contours as at 2012 (completion of mining) (CDM Smith, 2014)



Interpreted groundwater contours as at September 2019 (EMM, 2019)

Figure 14: Interpreted groundwater contours, years 2012 vs 2019

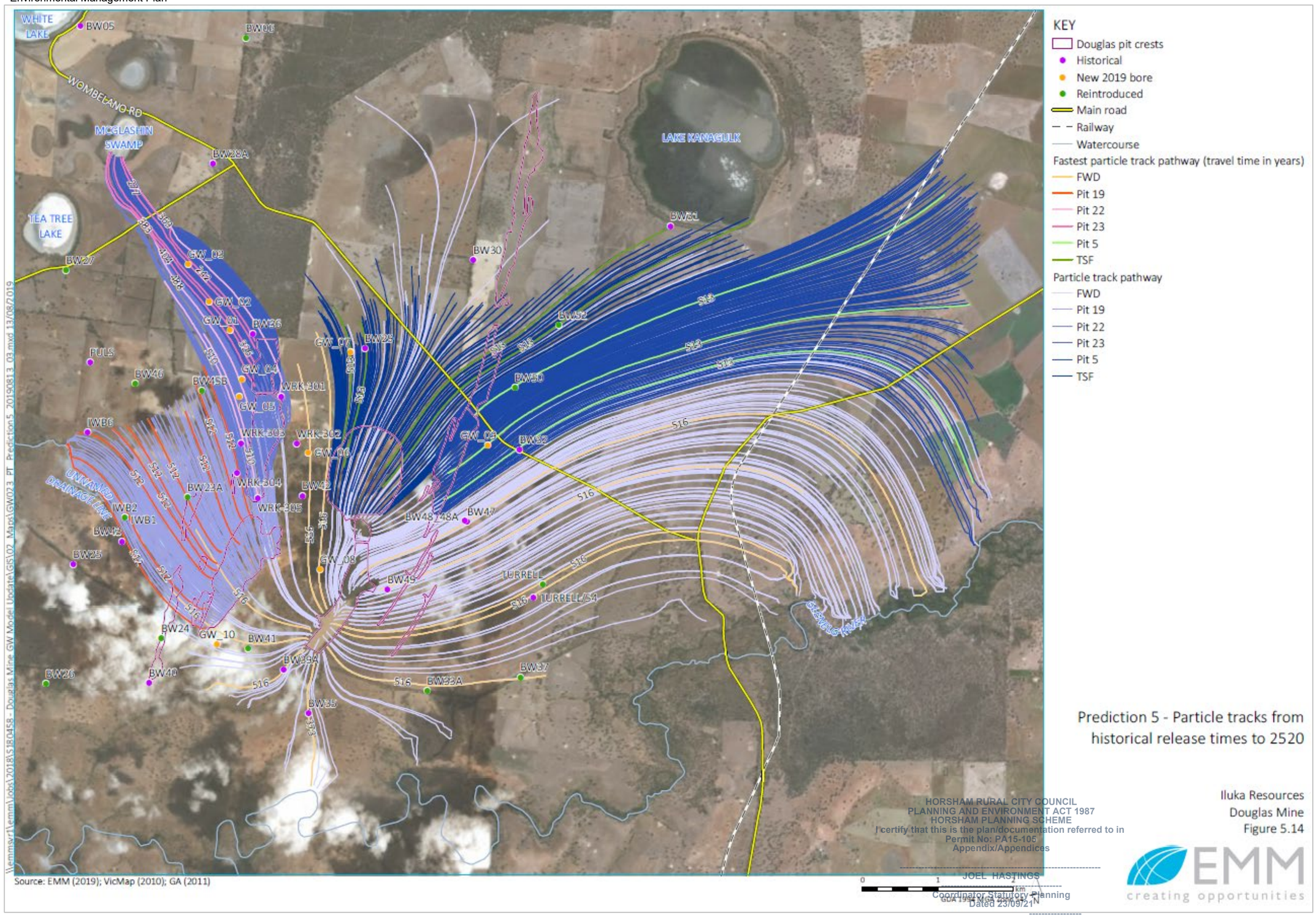


Figure 15: Douglas Mine and Pit 23 groundwater flow paths as particle tracks (EMM, 2019)

White Lake
WHITE LAKE ROAD
MCKECHNIES ROAD
Bitter Swamp
WOMBELANO ROAD
McGlashin Swamp
ROAD
CARLINS
Ti Tree Swamp
KANAGULK ROAD
HARROW -
BRANDTS ROAD
ROAD
ELLIOTTS AND BRANDTS
Red Hill Drainage Line
North West Drainage Line
ELLIOTTS ROAD
Pit 23
HORSHAM RURAL CITY COUNCIL
PLANNING AND ENVIRONMENT ACT 1987
HORSHAM PLANNING SCHEME
I certify that this is the plan/documentation referred to in
Permit No: PA15 105
Appendix/Appendices:
JOEL HASTINGS
Coordinator Statutory Planning
Dated 23/09/21
ELLIOTTS BACK LANE

Legend

- Pit 23
- Pit 23 Particle Tracks
- North West Drainage Line
- Red Hil Drainage Line

N

0 500 1,000 m

Site photo: 5 Oct. 2018

DOUGLAS MINE

PIT 23 GROUNDWATER FLOW PATH

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:25,000 (A3) DATE: Oct. 2019 DWG No: 257183 ver.00

FIGURE: **16**

Table 12: Groundwater travel times to sensitive receptors (adapted from EMM, 2019)

Bore / Receptor	Source	Release Year	Arrival Year	Travel Time
BW36	Pit 23	2011	2038	27 yrs
WRK300			2047	36 yrs
GW04			2054	43 yrs
GW01			2099	88 yrs
GW02			2155	144 yrs
North-West Drainage Line			2187	176 yrs
GW03			2187	176 yrs
McGlashin Swamp			2241	230 yrs
White Lake			Beyond maximum model prediction period (> 500 years)	> 500 yrs
BW05 (at White Lake)			Beyond maximum model prediction period (> 500 years)	> 500 yrs

Notes

- particle tracking relates only to the direction and rate of groundwater flow and does not imply the presence of a contaminant;
- the release year (2011) is based on first commencement of by-product disposal into Pit 23, i.e. an assumption that by-product leachate and seepage to groundwater (if this occurred) started immediately on first disposal.
- the stated groundwater particle travel times are based on:
    - modelling 'Prediction 5' per EMM (2019), which represents the current operating and rehabilitation 'base case' schedule for Pit 23; and
    - the travel time of the fastest particle identified in the simulation.

7.4.1.2 Groundwater chemistry

7.4.1.2.1 Solute transport modelling

Analytical modelling was undertaken by Jacobs (2014) to assess the likely contaminant concentrations that might occur in groundwater plumes as they migrate away from Pit 23. Groundwater flow rates, aquifer properties and the potential plume dimensions at Pit 23 were obtained from the hydrogeological modelling by CDM Smith (2014) with solute transport modelling used to evaluate the impacts of dilution and dispersion on contaminant concentrations as they migrate away from Pit 23. The effects of retardation and degradation were not included in the analysis.

The results predict that significant decreases in concentrations will occur within 500 m of Pit 23 due to dilution as the leachate mixes with water in the aquifer. It is predicted that at steady state conditions (after more than 1000 years) a contaminant originating from Pit 23 would have a concentration at the nearest point of groundwater discharge (the North-West Drainage Line) equal to approximately 0.018 times its concentration at Pit 23.

Jacobs concluded that plume development and migration towards McGlashin Swamp is highly unlikely to lead to detrimental water quality outcomes in the future.

Additional solute transport modelling was also conducted by Jacobs (2016a). This modelling was based on the prediction of leachate quality obtained from the initial solute modelling discussed above (Jacobs, 2014) but expanded to include the effects of dilution, dispersion, retardation (absorption) and radioactive decay. Further, the update modelling included outputs from in-pit dissolution modelling (detailed in Iluka, 2016c) which considered the predicted starting quality of the leachate in Pit 23 for potential contaminants of concern (TDS and radionuclides) as summarised in Table 13 below.

Table 13: Predicted quality of leachate from Pit 23

TDS in leachate when above background	13,300 mg/L
Average activity concentration in first 100 years:	
Thorium-232	2 Bq/L
Radium-228	97 Bq/L
Uranium-238	15.5 Bq/L
Radium-226	55 Bq/L

Notes
- the stated values do not indicate or represent the risk of exposure to radiation as there is no exposure pathway from the water at the base of Pit 23;
- while these results were best available estimates:
  - the in-pit dissolution model has not been subject to calibration as there is no monitoring data directly indicating leachate quality; and
  - sensitivity analysis shows the results to be conservative (over-estimates).

Key findings from Jacobs (2016a):

- Of the radionuclides considered (Ra-226, Ra-228, U-238 and Th-232):
  - Th-232 will not migrate away from the pit due to its slow rate of decay, low solubility and with dissolved thorium strongly attenuated by retardation processes.
  - Ra-228 will not migrate away from the pit on the basis that it is a decay product of Th-232 and the immobility of Th-232 therefore applies to Ra-228. Ra-228 migration is also prevented by retardation processes, and with predicted activity concentrations in the pit strongly governed by its short half-life (5.75 years).
  - Ra-226 migration is controlled by adsorption-retardation processes with migration limited to a distance of 10m from the pit. Elevated activity concentrations will be confined to distance of 0.1m from the pit i.e. the SEPP (Waters) limit of 5.0 Bq/L will not be exceeded down-gradient of Pit 23.
  - U-238 is the only radionuclide predicted to migrate beyond Pit 23 with any potential exceedance of the SEPP (Waters) objective (0.2 Bq/L) limited to 15m from the pit. Any change in the predicted concentrations down-gradient detected at White Lake will occur after more than 500,000 years and the activity concentration of U-238 at that time will be less than 0.001 Bq/L.
- Potential increases in TDS concentration of up to 1500 mg/L in a region up to 1 km from the Pit 23 were predicted but with minimal impact on the beneficial use of the groundwater.
- No impact on the TDS concentration in groundwater discharging to White Lake.

It is noted that while the solute transport model provides best available estimates it has not been subject to calibration due to the non-availability of monitoring data that shows actual impact of seepage from Pit 23 on groundwater quality.

7.4.1.2.2 Groundwater risk and baseline chemistry assessments

Jacobs (2014)

Jacobs (2014) completed a detailed groundwater risk assessment based the results of the hydrogeological modelling completed by CDM Smith (2014) and incorporating the initial solute transport summarised in Section 7.4.1.2.1 above.

The risk assessment utilised relevant components of the risk assessment framework documented in Victorian EPA's *Guidelines for Risk Assessment of Wastewater Discharges to Waterways* (EPA 2009) and identified the key potential impacts as changes to groundwater levels and groundwater quality that have the potential to impact on groundwater users and groundwater dependent ecosystems. Jacobs (2014) concluded that:

"Overall the consequence of the potential impacts is considered to be low because the environmental impacts are described as:

- *negligible to minor, short-term stress on groundwater environment with rapid recovery;*
- *no change in aquifer yield or quality;*
- *groundwater beneficial uses remain protected;*
- *impacts within the range of natural variability; and*
- *inter-connected systems, including adjacent and overlying aquifers, hydraulically connected surface water systems and groundwater dependent ecosystems are unaffected.*

Overall the likelihood of the potential impacts is considered to be unlikely in consideration of the modelling results and the groundwater sampling and testing undertaken to date.

Overall the risk of the proposed continued disposal of MSP by-products in Pit 23 at Douglas Mine is low."

SRS (2015)

SRS (2015) examined the consequences and likelihood of radionuclides entering the environment through groundwater and airborne pathways as a result of MSP by-product disposal into Pit 23, with emphasis on radiological risks with the pit open/active and post-rehabilitation and closure. Consideration was also given to the results of prior groundwater modelling and quality investigations (CDM Smith 2014; CDM Smith 2015; Jacobs 2014).

With respect to groundwater, SRS (2015) concluded that:

- given the general insolubility of the radionuclides in the by-products it is highly unlikely that significant future radiological groundwater changes would be observed in the vicinity of Pit-23 as result of by-product disposal, or where groundwater from beneath Pit-23 is predicted to discharge to the surface (i.e. springs and groundwater-fed swamps and lakes down-gradient of Pit 23);
- in the event that minor leaching of radionuclides from buried by-products does occur, it is expected that dilution, dispersion and retardation through physical-chemical reactions between dissolved radionuclides and aquifer minerals/substrates would significantly reduce groundwater concentrations; and
- the ingestion of radionuclides through the use of groundwater for drinking, irrigation or stock watering at a distance from the site is not a viable exposure pathway.

Jacobs (2016b)

Jacobs (2016b) later completed a baseline review of groundwater chemistry at the Douglas Mine based on the monitoring data obtained in late 2015/early 2016. Conclusions drawn by Jacobs (2016b) in regard to groundwater quality were that:

- this data was comprehensive and was sufficient to enable the baseline chemistry for the area to be determined;
- this data represented the background chemistry across the area; and
- groundwater chemistry in the vicinity of Pit 23 was not markedly different from groundwater across the rest of the area sampled. That is:
  - total soluble salts concentrations indicated that groundwater chemistry at the sampled bores near Pit 23 had not been altered by mining (including MSP by-product disposal);
  - major ion concentrations and ionic ratios indicated that groundwater chemistry at the sampled bores near Pit 23 had not been affected by mining (including MSP by-product

disposal); and

- radionuclide activity concentrations indicated that there was no marked difference between the sampled bores near Pit 23 and those recorded in the nearby area.

Further, Jacobs (2016b) assessed the groundwater chemistry along the potential flow path from Pit 23 which they characterised as below:

- while the salinity of the groundwater across the Douglas site (as measured by total dissolved solids; TDS) ranges from fresh to brackish, the groundwater in the predicted flow path from Pit 23 is brackish, ranging in TDS concentration from 8,020 mg/L to 13,649 mg/L therefore being in Segment F as defined in the SEPP Waters (see Section 7.3);
- the majority of the dissolved ions in the groundwater were the stable ions (Ca2+, Mg2+, Na+, K+, Cl-, SO_4^{2-} and HCO^{3-}) with those ions, on average, constituting 96.1% of the dissolved ions in the groundwater at the Douglas site and 95.4% in the groundwater in the predicted flow path from Pit 23;
- the dominant salt pair in all groundwater tested was Na-CL being, on average, 79.0% of all ions in the groundwater at the mine site and 82.7% in the groundwater in the predicted flow path from Pit 23.

This characterisation does not represent groundwater quality criteria (objectives) that are to be maintained – these are presented in Section 7.3.2.

7.4.1.3 Independent desktop review

All of the reports completed up to 2016 – as summarised above in Sections 7.4.1.1, 7.4.1.2.1 and 7.4.1.2.2 above – were subject to review by an independent expert (EES, 2016) commissioned jointly by the Responsible Authority and the EPA, and assessed by the EPA.

The EPA published its findings in *Decision on proposed waste by-product disposal at Douglas Mine Pit 23* (EPA 2016; Publication 1626) including the following:

> *"EPA has not found any evidence to show that a condition of pollution or environmental hazard has arisen or is likely to arise from Iluka's proposal."* (EPA 2016; Page 1); and
>
> *"The independent desktop reviewer concluded that there is low to no likelihood of an environmental hazard occurring in groundwater due to the waste by-product in Pit 23"* (EPA 2016; Page 3); and
>
> while acknowledging a predicted increase in groundwater salinity down-gradient of Pit 23:
>
> *"this increase in salinity is unlikely to affect the beneficial uses of groundwater as the salinity would still remain within the limits of Segment C* [now Segment F]*. As such, this is not considered pollution."* (EPA 2016; Page 3)

7.4.2 Standard controls

Standard controls applicable to groundwater quality and the maintenance/protection of stock drinking water beneficial uses are limited to the monitoring of groundwater chemistry. This recognises that while no adverse impacts on groundwater quality are predicted or expected this must be confirmed through monitoring, as detailed in Section 7.5.

Where monitoring indicates a potential trend of concern in groundwater quality down-gradient of Pit 23 (following the investigations triggered according to Table 22) the management triggers, trigger responses and contingency planning as detailed in Section 7.6 will apply.

7.4.3 Risk assessment

It is evident from the results of the suite of hydrogeological studies and impact assessments completed for the Douglas site/Pit 23, and the outcomes of the independent review of relevant

studies (EES, 2016), that the risk to the groundwater is extremely low, providing that ongoing monitoring is undertaken to confirm these findings.

Should monitoring identify a variance to expected outcomes, the trigger responses and contingency measures given in Section 7.6 will provide appropriate mitigation of any adverse impact.

This assessment is summarised in the RARP Risk Register (RSK-001 and RSK-002; Appendix A).

7.5 Monitoring program

While no significant adverse impacts on groundwater quality are predicted or expected, this prediction must be confirmed through monitoring.

As detailed in Section 7.4.1.1 the results of long-term groundwater level monitoring and multiple iterations of the Douglas conceptual and numerical groundwater model (SKM 2004, CDM Smith 2014; CDM Smith 2015; EMM 2019) provide significant evidence that Pit 23 activities will not result in changes in groundwater levels and flow direction that would impact on the accessibility of this groundwater resource for stock water or any other use. To this end:

- monitoring of groundwater levels will be undertaken as standard practice only (completed in the course of groundwater quality sampling); and
- no compliance objectives, trigger and contingency plans relating to groundwater levels or flows are required or proposed.

7.5.1 Pit 23 monitoring bores and monitoring schedule

The groundwater bores monitored under the Pit 23 groundwater monitoring program are presented in Table 14 and Figure 17.

Monitoring bores are designated as compliance, impact or background bores as defined below:

Category	Description
Impact Bores	Bores immediately adjacent the Pit 23 crest and expected to be influenced by histrorical mine/tailings disposal, as based on groundwater arrival time predictions (EMM, 2019) and Pit 23 solute transport modelling (per Jacobs, 2016). **Not subject to exceedance reporting.**
Compliance / Indicator Bores	Bores not impacted by mining or Pit 23 by-product disposal acrivities and sited down-gradient of Pit 23 and directly on the path of groundwater flow. These bores are used to indicate the occurrence (or otherwise) of potentially-contaminated groundwater flows from Pit 23 and adverse impacts on stock water beneficial use. **Subject to exceedance reporting.**
Background Bores	Bores sited up-gradient, cross-gradient and far down-gradient of Pit 23 and representative of local or broader background groundwater condition not associated with Pit 23. Monitoring of these bores allows comparison of groundwater trends or observations in nominated compliance bores. **Not subject to exceedance reporting.**

With respect to these bores it is noted that:

- several are existing bores that were considered by Jacobs (2014) and CDM Smith (2014) as appropriate for the monitoring of groundwater flows from Pit 23 and background chemistry for comparison purposes;
- several bores were installed in May and October 2018 to either replace existing failed bores or to enhance the spatial coverage and measurement of groundwater chemistry up-, down- and cross-gradient of Pit 23 as recommended in the independent desktop review of proposed

by-product disposal (EES, 2016). New bores include BW45B (replaced failed predecessor BW45) and bores GW01-GW08 (variously up-, down- and cross-gradient of the pit). Bore BW36A (installed October 2019) replaces BW36 which was decommissioned due to bore failure (tree root blockage).

(NOTE: EES (2016) also recommended additional monitoring points along the North-West Drainage Line suspected to exhibit groundwater-seepage and discharge as springs. These recommendations have been accepted and implemented as part of the SWMMP detailed in Section 8).

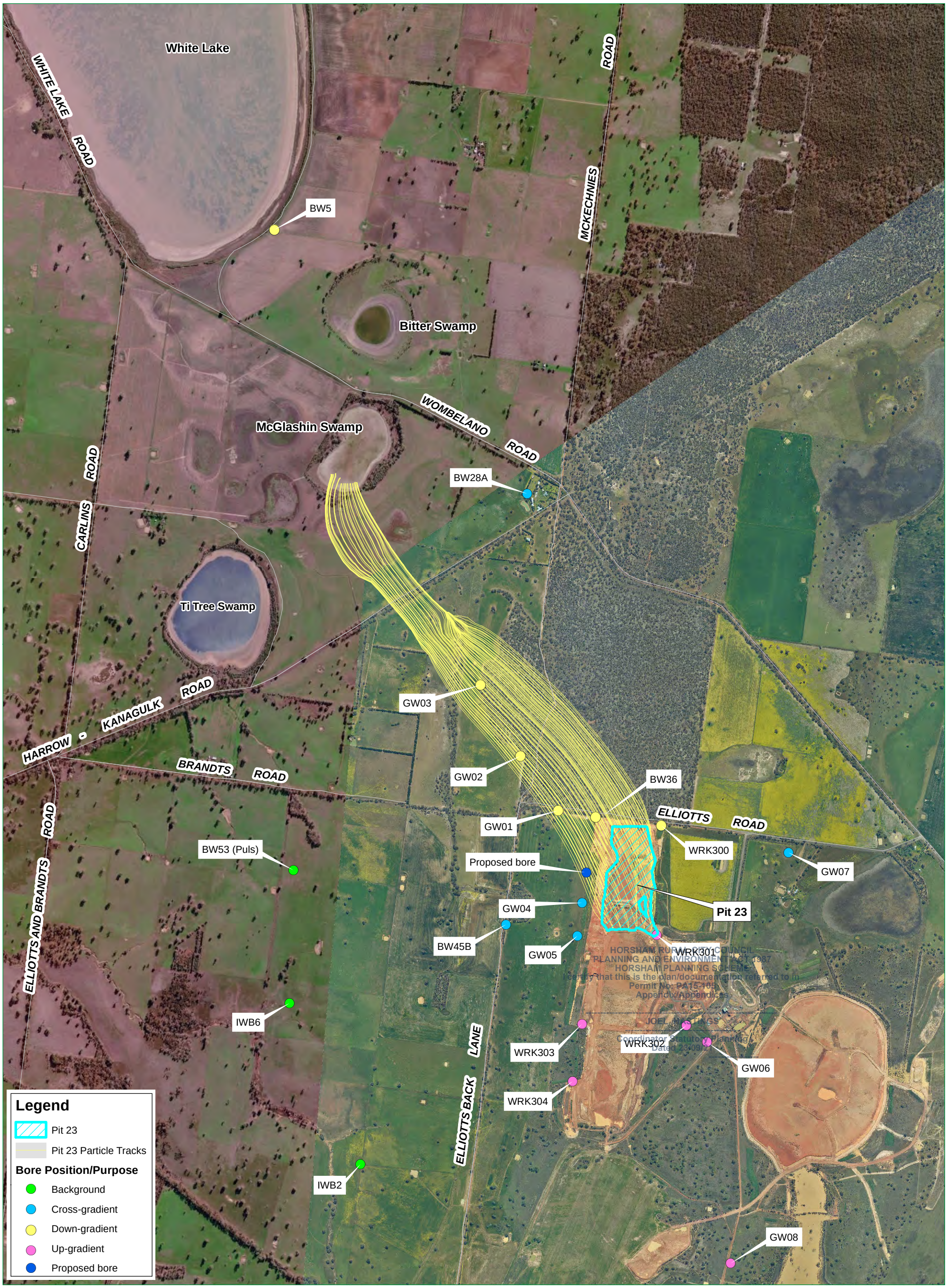
Condition 28(c) of the Permit requires that the groundwater monitoring network include additional bores recommended in Figure 6 in EES (2016; Page 32). Examination of the Figure 6 in the EES (2016) report identifies that:

- the base plan, including the locations of existing and proposed bores and proposed stream monitoring locations, was obtained from a report by SKM (2004) *Bondi West Hydrogeological Investigation, 19th March 2004*;
- the stated purpose of Figure 6 in EES (2016) is "*to show the approximate locations of springs in the vicinity of Pit 23*" (EES, 2016; Page 31); and
- there is no recommendation in EES (2016) for the additional monitoring bores proposed by SKM (2004) to be included in the monitoring network.

It is therefore apparent that there is no need for additional bores as illustrated in Figure 6 of EES (2016). It is considered that the nine (9) additional bores installed in 2018, along with existing bores, provides adequate spatial coverage and assessment of potential impacts to groundwater and satisfies the intent of Condition 28(c) in the Permit.

Table 14: Pit 23 monitoring bore network and monitoring schedule

Well ID	Location relative to Pit 23 and/or groundwater flow path from Pit 23	Applicable 'Groundwater Zone' and GWQOs	Status/required works (as at July 2020)	Monitoring Program		
				Water level	Water quality	
					Field	Laboratory
Impact Bores						
WRK300	Adjacent Pit 23 pit crest (NE corner)	N/A	OK	6 monthly	6 monthly	6 monthly
BW36A	Adjacent Pit 23 pit crest (NW corner)	N/A	OK – bore installed October 2019	6 monthly	6 monthly	6 monthly
Compliance / Indicator Bores*						
GW01	Down-gradient / on flow path	North-West Zone	OK – bore installed May 2018	Monthly	Monthly	Monthly
GW02	Down-gradient / on flow path	North-West Zone	OK – bore installed October 2018	Monthly	Monthly	Monthly
GW03	Down-gradient / on flow path	North-West Zone	OK – bore installed October 2018	Monthly	Monthly	Monthly
GW04A	Down-gradient / on flow path	North-West Zone	NA – bore to be installed H2 2020	Monthly	Monthly	Monthly
Background Bores						
WRK301	Up-gradient of Pit 23	North-West Zone	OK	6 monthly	6 monthly	6 monthly
GW04	Cross-gradient of flow path	North-West Zone	OK – bore installed October 2018	6 monthly	6 monthly	6 monthly
GW05	Cross-gradient of flow path	North-West Zone	OK – bore installed October 2018	6 monthly	6 monthly	6 monthly
WRK302	Up-gradient of Pit 23	Middle Zone	OK	6 monthly	6 monthly	6 monthly
GW06	Up-gradient of Pit 23	Middle Zone	OK – bore installed May 2018	6 monthly	6 monthly	6 monthly
GW08	Up-gradient of Pit 23	Middle Zone	OK – bore installed May 2018	6 monthly	6 monthly	6 monthly
GW07	Up-gradient of flow path	Middle Zone	OK – bore installed May 2018	6 monthly	6 monthly	6 monthly
BW45B	Cross-gradient of flow path	Middle Zone	OK – bore installed May 2018	6 monthly	6 monthly	6 monthly
BW28A	Cross-gradient of flow path	Far North Zone	OK	6 monthly	6 monthly	6 monthly
BW05	Far down-gradient	Far North Zone	OK	6 monthly	6 monthly	6 monthly
IWB2	Background - other	Representative of background	OK	6 monthly	6 monthly	6 monthly
IWB6	Background - other	Representative of background	OK	6 monthly	6 monthly	6 monthly



Site photo: 5 Oct. 2018

DOUGLAS MINE

PIT 23 MONITORING BORE NETWORK

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:25,000 (A3) DATE: June 2020 DWG No: 257184 ver.01

FIGURE: **17**

7.5.2 Monitoring bore integrity

The integrity of groundwater bores will be assessed during scheduled groundwater sampling events, or through targeted audits as required.

Integrity issues include:

- suspected blockages (e.g. tree roots, bore casing failure, other);
- condition of the bore casing, monument and concrete plinth;
- status of the bore cap (e.g. damaged or missing); and
- surface water ingress, tampering and other.

Any critical works such as bore alteration or decommissioning will be undertaken as outlined in Section 7.5.3 of this plan.

Miscellaneous works such as bore cap replacement, plinth/monument repair (repairs not altering the bore casing), well flushing/re-development and other will be assessed and managed by Iluka.

Issues with bore access or integrity will be reported on an as-needs basis within annual performance reports and only where such issues prevent compliance with the monitoring program specified in this GWMMP.

7.5.3 Monitoring bore installation, alteration or decommissioning

Where groundwater bores are to be installed, altered or decommissioned such works will be undertaken by licensed drillers and subject to an *Application for a Licence to Construct, Decommission or Alter a Bore* as issued by the relevant regional water authority under the *Water Act 1989.* In the case of Pit 23 the relevant water authority is GWM Water.

Drilling, well construction and decommissioning will adhere to the requirements of the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012).

7.5.3.1 Bore installation

Water bore drilling may be undertaken using mud-rotary, down-hole hammer, auger or other appropriate method and supervised by a qualified hydrogeologist.

Data collected during installation will include:

- borehole diameter and depth;
- annular fill and well construction materials used;
- lithological descriptions and screened aquifer information; and
- bore development technique and duration, including permeability assessment via slug-testing conducted post-development (where applicable).

Composite samples of aquifer material (adjacent to the screened section of the bore) may be collected and, if considered necessary, submitted for laboratory determination of partition (distribution) coefficients (Kd) and other sorption properties of radionuclides and potential contaminant ions.

The location of monitoring bores will be selected with consideration of potential surface water ingress/influence, impact from site or 3rd-party activities and safe access for monitoring. Where a new bore is required to replace an existing failed/damaged well the new well will be installed as near as possible to its predecessor.

Furthermore, monitoring bores will each be equipped with:

- protective and lockable steel monuments;
- well caps (if/where no protective monument exists);
- concrete plinths; and

- if necessary, co-installed with a high-visibility steel marker post (i.e. in locations where bores are considered at risk of contact/damage by vehicles or machinery).

7.5.3.2 Bore alteration and decommissioning

Bore decommissioning or alteration works (e.g. clearing of tree works, well re-development, repair/alteration of the bore casing) will be undertaken by a licensed driller with hydrogeologist supervision and/or advice at Iluka's discretion.

Decommissioning will follow the procedure as detailed in the *Minimum Construction Guidelines for Water Bores in Australia* (NUDLC, 2012), with inert sand and a 5% bentonite-cement grout used for backfill and sealing respectively.

7.5.4 Groundwater sampling methodology

Groundwater samples will be collected using methods in accordance with:

- EPA Publication 669: *Groundwater sampling guidelines, 7th edition, March 2000* (EPA, 2000a); and
- EPA Publication 441: *A guide to the sampling and analysis of waters, wastewaters, soils and wastes, 7th edition, April 2000* (EPA, 2000b).

7.5.5 Groundwater quality analysis

7.5.5.1 Field parameters

The following field parameters will be measured using a calibrated water quality meter:

- pH;
- Electrical conductivity (EC);
- Oxidation reduction potential (ORP / Redox);
- Dissolved oxygen (DO);
- Temperature.

7.5.5.2 Laboratory analysis

Groundwater samples will be supplied under chain-of-custody (CoC) documentation to a NATA-accredited laboratory for analysis as detailed in Table 16. This analysis includes:

- analytes recommended by EES (2016), as required by Condition 28(a) of the Permit; and
- other analytes which apply as 'water quality indicators' for stock drinking water quality as per Section 4.3.3 of ANZECC/ARMCANZ (2000) and which form the basis for monitoring and assessment of potential impact on stock water beneficial use as detailed in Section 7.3.2 of this EMP.

The exception is gross alpha and gross beta activity concentrations which have been replaced by activity concentrations of the radionuclides of interest. This follows ANZECC/ARMCANZ (2000) in which trigger levels for gross alpha and gross beta (minus Potassium-40) activity concentrations are used as a screening technique only to indicate the presence of specific radionuclides such as radium-226 and radium-228. Where gross alpha and beta concentrations suggest that specific radionuclides are present then these should be specifically tested for. It is also noted that:

- analyses for gross alpha and beta provide an "order of magnitude estimate" and lack the precision of activity concentration determinations for specific radionuclides; and
- radium-226 and radium-228 are the specific radionuclides of interest in this case as they are decay progeny of uranium-238 and thorium-232 which are present in the waste streams approved for disposal into Pit 23.

Given the activity concentrations of radium-226 and radium-228 will be determined, the testing of gross alpha and beta activity concentrations is not required.

As described in Section 7.3.2.1 and displayed in Table 11; site specific GWQO's were derived for a number of analytes at bores within the North-West Zone (GW01, GW02, GW03 and GW04A) which have naturally elevated background values above the default guideline values. Trigger values have been determined for the analytes listed in Table 15 below as per DSITI (2017).

Table 15 describes the analyte suites which have been developed to ensure all required analytes are monitored at a frequency that supports the objectives of this monitoring program. Applicable analyte suites are:

- **Suite A** – analyte suite for all bores listed in Table 11 (completed once every 6 months).
- **Suite B** – analyte suite for compliance/ indicator bores only. To be completed on a monthly basis other than the months where analysis for Suite A analytes occurs.

Table 15: Groundwater laboratory analyte suite

Analyte	Units	LOR	Suite A	Suite B	Method Reference *
General					
pH	Units	0.01	♦	♦	APHA 4500 H^+B
Electrical Conductivity (EC)	µS/cm	1	♦	♦	APHA 2510 B
Total Dissolved Solids (TDS)	mg/L	10	♦	♦	APHA 2540 C
Alkalinity					
Bicarbonate Alkalinity as CaCO3	mg/L	1	♦		APHA 2320 B
Carbonate Alkalinity as CaCO3	mg/L	1	♦		
Hydroxide Alkalinity as CaCO3	mg/L	1	♦		
Total Alkalinity (T-Alk. / MAlk)	mg/L	1	♦		
Major Ions					
Calcium (Ca)	mg/L	1	♦	♦	APHA 3120 and 3125
Magnesium (Mg)	mg/L	1	♦		
Sodium (Na)	mg/L	1	♦	♦	
Potassium (K)	mg/L	1	♦		
Sulfate (SO_4)	mg/L	1	♦	♦	APHA 4110 B
Chloride (CL-)	mg/L	1	♦	♦	APHA 4500 D
Fluoride (F)	mg/L	0.1	♦		APHA 4500 C
Total anions	meq/L	0.01	♦		Calculated
Total cations	meq/L	0.01	♦		
Charge Balance Error (Ionic Balance)	%	0.01	♦		
Metals and Metalloids (total concentrations)					
Aluminium (Al)	mg/L	0.01	♦		APHA 3120 and 3125
Arsenic (As)	mg/L	0.001	♦		
Barium (Ba)	mg/L	0.001	♦		
Boron (Bo)	mg/L	0.05	♦		
Cadmium (Cd)	mg/L	0.0001	♦		

Analyte	Units	LOR	Suite A	Suite B	Method Reference *
Cobalt (Co)	mg/L	0.001	♦		
Chromium (Cr)	mg/L	0.001	♦		
Copper (Cu)	mg/L	0.001	♦		
Iron (Fe)	mg/L	0.05	♦		
Manganese (Mn)	mg/L	0.001	♦		
Mercury (Hg)	mg/L	0.0001	♦		APHA 4500 3112 B
Molybdenum (Mo)	mg/L	0.001	♦		APHA 3120 and 3125
Nickel (Ni)	mg/L	0.001	♦		
Lead (Pb)	mg/L	0.001	♦		
Silver (Ag)	mg/L	0.001	♦		
Selenium (Se)	mg/L	0.001	♦	♦	
Thorium (Th)	mg/L	0.001	♦		
Uranium (U)	mg/L	0.001	♦		
Zinc (Zn)	mg/L	0.005	♦		
Nutrients					
Nitrite as N (NO2-N)	mg/L	0.01	♦		APHA 4500 B
Nitrate as N (NO3-N)	mg/L	0.01	♦		APHA 4500 F
Total ammonia as N	mg/L	0.01	♦		APHA 4500 G
Reactive phosphorous (SRP)	mg/L	0.01	♦		APHA 4500 PH
Radionuclides					
Radium-226 (Ra-226)	Bq/L	0.05	♦		APHA 7500
Radium-228 (Ra-228)	Bq/L	0.08	♦		APHA 7500
Uranium-238 (U-238)	Bq/L	<0.025	♦	♦	-

NOTES:

- analytes shaded in **orange** have default limits for stock drinking water assigned in ANZECC/ARCMANZ (2000);
- the laboratory method reference codes are indicative only and may be modified upon selection of external laboratory;
- gross alpha and gross beta (excluding K-40) are omitted from the radionuclide analytical suite as specific radionuclides (Ra-226, Ra-228 and U-238) are monitored for.

7.5.6 Quality control and quality assurance

Quality assurance/quality control (QA/QC) measures are activities undertaken to demonstrate the accuracy and precision of the groundwater monitoring program. Quality Control (QC) consists of the steps that will be taken to determine the validity of specific sampling and analytical procedures. Quality Assurance (QA) broadly refers to the plan for maintaining quality in all aspects of the GWMMP. The reliability of and confidence in the data collected as part of this GWMMP will be determined by implementing the following quality controls:

- routine and regular equipment maintenance, checks and calibrations;
- internal data validation;
- external data validation;

All QA/QC results will be considered to enable assessment of the overall adequacy and reliability of each parameter to meet the monitoring program objectives.

The following sub-sections outline the QA/QC plan associated with groundwater monitoring.

7.5.6.1 Equipment maintenance, checks and calibrations

Where field measurements are undertaken (e.g. pH, EC, DO, ORP), this will be undertaken using calibrated field instruments.

The calibrations will be carried out using standards and buffers that reflect the likely range of measurement.

Field calibration information will be recorded in an electronic calibration log, either within the database described in Section 7.5.7 or accessible from that database, that will include the instrument serial number and the measured parameter before and after calibration. This log will allow detection of possible instrument issues over time and serve as a reference to increase data confidence should future validation be required.

7.5.6.2 Internal data validation

The key procedures for internal data validation (QC) measures undertaken in the course of groundwater sampling include:

- *blanks* (such as field blanks, rinsate blanks and trip blanks) to monitor for potential contamination during sampling, cross-contamination between bores and during sample transit/storage; and
- *duplicates* to confirm the precision/repeatability of analysis.

Field blanks and/or duplicates will be performed by the specialist groundwater monitoring contractor engaged to undertake the monitoring with the number of QC samples and source/location (bore) selected at the contractor's discretion but in accordance with AS/NZS 5667.1:1998 (Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples) as referenced in ANZECC & ARMCANZ (2000).

Spike samples may also be obtained for investigate purposes, as required. Spike sampling involves the deliberate 'spiking' of an aqueous sample to test the reliability or appropriateness of the end-laboratory analytical method and/or the reliability of sample preservation along the sample chain-of-custody.

7.5.6.3 External data validation

All external data analysis will be undertaken by NATA-accredited laboratories, or at a minimum, by laboratories that hold NATA-accreditation for specific analytical methodologies.

It is noted, however, that in some cases NATA accreditation does not exist or apply to specialised analyses (e.g. radionuclide characterisation). In these cases, relevant analysis will be commissioned through recognised laboratories whose analytical methodologies are acknowledged as best-practice. For example, radiation screening and characterisation analyses undertaken through the Australian Nuclear Science and Technology Organisation (ANSTO) laboratories.

External laboratories will provide a QA/QC report with each batch of samples given. To avoid data entry errors, the laboratory will provide all data and reports electronically.

Inter- and intra-laboratory testing may be conducted, if required.

7.5.7 Data management

All groundwater monitoring data collected, including calibration and quality control and assurance data, will be stored and/or managed using an environmental data management system (currently Monitor Pro 5).

7.5.8 Updates to hydrogeological and solute transport models

Drivers to update and/or re-calibrate the hydrogeological and solute transport models may include:

- groundwater quality exceedances as described in Sections 7.6 and 7.7 of this EMP;

- in the case of the hydrogeological model, periodic review and update to accord with good practice, e.g. the addition of new monitoring bores, slug-test results and level monitoring data;
- in the case of the solute transport model, periodic review and update to accord with good practice, e.g. new partition coefficient data as obtained from lithological samples collected during bore installation (see Section 7.5.3.1).

Whenever models are re-calibrated:

- the re-calibrated model will be used as the basis for any future assessment of groundwater impact; and
- the results of these re-calibrations and any impact assessments will be used to determine if modifications to this plan are required to protect the beneficial uses of the groundwater.

7.6 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 16 and Table 17, respectively.

7.7 Reporting

Routine and exception reporting applicable to groundwater is summarised in Table 18.

Table 16: Groundwater - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
Seepage from Pit 23 does not adversely affect protected beneficial uses of groundwater.	Operations Rehabilitation	GRW-01	As per Section 7.4.2	Field and laboratory measurements and analyses • Standing water level • Groundwater quality	As per Section 7.5.1 (Table 14)	As per Section 7.5.5 (Table 15)	No exceedance of the groundwater quality criteria presented in Table 11 beyond natural background variability.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*

Table 17: Groundwater - triggers and management responses

Trigger	Trigger Response	Contingency
Monitoring or model predictions indicate that adverse changes to groundwater quality have affected, or may affect, stock water beneficial use.	In the event that an exceedance of one or more GWQOs occurs (i.e. according to Table 11): • follow-up sampling and analysis will be undertaken within one (1) month of receipt of the previous result. If the exceedance concerns one or more toxicants (e.g. heavy metal) analysis will include dissolved concentrations to allow a more informed assessment of stock exposure risk; • referring to the predicted groundwater particle arrival times from the updated hydrogeological model (per EMM, 2019), confirmation of the arrival of seepage from Pit 23 in a bore will be assumed if all the below apply: ○ the results of the follow-up sampling and analysis confirms a continued adverse trend/exceedance; ○ the exceedance(s) correspond with a simultaneous trend of concern/exceedance in Cl:SO4 and/or Na:Ca ratios; ○ the results are not consistent with the natural background chemistry in that bore or bores; and ○ the timing of the above adverse trends/exceedances is less than 90% of that predicted in the hydrogeological model (i.e. seepage from Pit 23 may have arrived at the bore(s) sooner than expected). Consideration should also be given to the chemistry of bores up-gradient from Pit 23 (i.e. Pit 23 local background quality), and up-gradient and cross-gradient to the bore in question, as this may infer the movement of contaminated groundwater from Pit 23 or the occurrence of some other natural phenomenon detected in the wider bore network. For example: ○ similar trends of concern/exceedances observed in multiple bores down-gradient of Pit 23, but not up-gradient to Pit 23; ○ no similar concern/exceedances in other bores up- and cross-gradient to the bore in question potentially indicating a bore-specific result. • where the above assessment indicates the arrival of seepage from Pit 23 in a bore: ○ disposal to Pit 23 will be reduced or ceased (if necessary/applicable) to allow more detailed investigations to occur; ○ the monitoring frequency will be increased to assess trends and understand the processes occurring; ○ the hydrogeological model will be updated (and if necessary, re-calibrated); ○ solute transport and/or impact assessments will be re-examined, including an evaluation of risk to stock water beneficial use; and ○ an Exception Report and Action Plan (per Table 18) below will be prepared and submitted to the Responsible Authority. Where the outcome of initial follow-up sampling, assessment of bore-specific data and comparison against hydrogeological model (groundwater travel time) predictions and ionic ratios do not suggest a seepage-related impact then no further action will be required or taken other than the continuation of routine monitoring.	Not applicable – The nomination of contingency measures is dependent on the outcomes of any formal investigations – to be implemented through an Action Plan (see Table 18 below)

Table 18: Groundwater - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
GRW-01	<u>EMP and R&VMP Performance Reports</u>: • groundwater quality monitoring results (screened against GWQOs), including discussion on any relevant trends or trigger exceedances; • issues with monitoring bore integrity and accessibility, including any actions undertaken to resolve; • if applicable, information on the outcome of any groundwater model reviews or other groundwater studies pertinent to Pit 23 and the GWMMP. This includes modelling/studies undertaken: ○ for routine purposes; and ○ in response to previous reported exceedances and exception reporting.	<u>Submission of an Exception Report outlining:</u> • details of exceedances of the groundwater quality objectives outlined in the GWMMP – as per the process outlined in Table 11 (GWQOs) and Table 17 above; • an Action Plan to prevent/remediate deleterious effects on beneficial uses, that may include any or all of the following: ○ further investigation of the cause, if not adequately understood; ○ detailed impact assessment based on re-calibrated models; ○ development and implementation of strategies to prevent future unacceptable results or to mitigate any impacts, potentially including groundwater abstraction immediately adjacent and down-gradient of Pit 23; ○ reducing or ceasing the disposal to Pit 23 until observations are stabilised and/or at acceptable level

8 Surface Water Monitoring and Management Plan

This Surface Water Monitoring and Management Plan (SWMMP) has been prepared to satisfy Conditions 29 – 32 of the Permit, which specify the following requirements:

Surface Water Monitoring and Management Plan

29 A *Surface Water Monitoring and Management Plan (SWMMP)* (component of the *EMP*) must be prepared to the satisfaction of the responsible authority.

30 The SWMMP must be prepared generally in accordance with the application and associated material addressing surface water management provided to the EPA and the Responsible Authority in response to the EPA's section 22 notice dated 11 February 2016, but modified or added to so as to include:

(a) Additional surface water monitoring points recommended by Environmental Earth Sciences in its report '*Independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria*' No. 215071v2 dated April 2016 and submitted to the EPA;

(b) Agreement of the location and number of surface water monitoring points;

(c) Additional surface water monitoring points (at least during periods of flow) are to include the Northern Drainage Line and McGlashin Swamp, and locations shown on the EES independent review report, Figure 6, Page 32 and analytical suites to include full ionic balances;

(d) Monitoring of run off during periods of flow in the drainage lines as identified in the previous point;

(e) A survey for the occurrence of springs in the vicinity of the Northern Drainage Line;

(f) Sampling of any identified springs;

(g) Collected samples analysed for the range of analytes advised by the Environment Protection Authority Victoria;

(h) Details of the hydrological conditions of surface water sampling regime, noting that this should be cognisant of hydrological conditions and the availability of water in the surface water bodies to be sampled;

(i) Field parameters which are to be recorded and measured using a calibrated water quality meter (with calibration records to be kept and reported):

i pH;

ii Oxidation reduction potential (ORP);

iii Electrical conductivity (EC);

iv Dissolved oxygen (DO); and

v Temperature;

(j) The suite of analytes and analysis to be undertaken on the surface water samples by a NATA accredited laboratory;

(k) Appropriate trigger criteria, actions and contingency planning and associated management responses;

(l) Quality Assurance controls and reporting.

31 The permit holder must submit an annual performance statement (within the wider EMP annual report).

32 The permit holder must amend the SWMMP to address any identified issues, or changes or recommendations of the independent environmental auditor to the satisfaction of the responsible authority.

It is noted that Condition 30(c) of the Permit and other early documents refer to the 'Northern Drainage Line'. This is referred to as the 'North-West Drainage Line' in this SWMMP to better reflect its location relative to Pit 23 and to avoid confusion with the Red Hill Drainage Line which is to the north of Pit 23. These drainage lines are referenced in Figure 18 herein.

8.1 Sources

With respect to the protection of surface waters and applicable beneficial uses, the sources and pathways of impact are:

- groundwater discharge to surface via springs and to groundwater-connected lakes and swamps; and
- runoff of turbid water from areas devoid of vegetation, these include:
    - in the **operations phase**, runoff from overburden stockpiles surrounding/bordering the pit; and
    - in the **rehabilitation phase**, runoff from the reinstated landform/topographical surface prior to the re-establishment of native vegetation cover.

8.1.1 Surface water management battery limits

Given the interconnection of the surface water management systems for Pit 23 and the adjacent Douglas Mine it is necessary to define spatial and regulatory 'battery limits' as it relates to water transfers from Pit 23 into the Douglas Mine surface water drainage system.

These battery limits are important as they eliminate potential overlap/duplication in compliance and regulatory oversight between the different legislation and approval instruments governing the two sites. Further, these limits recognise that any turbid water inputs from Pit 23 into the Douglas mine surface water drainage system would be indistinguishable from those of the Douglas mine sub-catchments with respect to analysis and reporting of water quality.

To this end, the following battery limits apply to surface water management under this SWMMP:

- any incidental surface water runoff from Pit 23 access roads that flows into the Douglas Mine drainage system will fall under the jurisdiction of the Douglas Mine and the MRSD Act;
- any runoff from or overflow of the Douglas mine site truck wash facility falls under the jurisdiction of the Douglas Mine and the MRSD Act. This is appropriate given that the truck wash facility is principally associated with rehabilitation operations for the Douglas Mine and is physically sited within the former Douglas Mine processing plant area and tenement;
- turbid water that is captured in the Pit 23 drainage system falls under the jurisdiction of the Douglas Mine and the MRSD Act at the point of transfer into the Douglas mine drainage system.

These battery limits for surface water management (including nominated points of transfer for runoff between Pit 23 and the Douglas Mine) are defined in Section 8.4.3 and shown in Figure 18.

8.2 Sensitive receptors

As per Jacobs (2014) and CDM Smith (2014), groundwater discharges to the surface at a number of locations and hence any Pit 23-related seepage to groundwater may lead to surface water contamination down-gradient of the pit. These receptors include:

- groundwater-connected surface water bodies sited down-gradient and north-west of Pit 23 (McGlashin Swamp and White Lake); and
- springs sited down-gradient and north-west of Pit 23 (i.e. in the 'North-West Drainage Line').

It is noted that Condition 30(c) of the Permit requires that the Pit 23 SWMMP include "*additional surface water monitoring points*" including the 'Northern Drainage Line' (i.e. the 'North-West Drainage Line'), McGlashin Swamp and locations shown in Figure 6 (Page 32) of the EES (2016)

independent review. In reviewing the EES (2016) report it is clear that the base map used in Figure 6 from EES (2016) is drawn from Figure 7.1 in SKM (2004) *Bondi West Hydrogeological Investigation*, the purpose of which was to show proposed stream monitoring points being:

- the end of the North-West Drainage Line where it meets Harrow-Kanagulk Road;
- Costello's Creek; and
- the confluence of Shaw's Gully and the Glenelg River south of the Douglas Mine.

As surface water in Costello's Creek and the Shaw's Gully/Glenelg River confluence are not connected in any way to groundwater or surface water flows originating from Pit 23 (SKM 2004; SKM 2007; Jacobs 2014; CDM Smith 2014; EMM 2019), the only relevant surface water monitoring point referenced in Figure 6 in EES (2016) is that corresponding to the North-West Drainage Line, which is included in this SWMMP (monitoring point DUSW20). In other words, springs in Costello's Creek and drainage lines south of the Douglas site are not receptors-at-risk with respect to Pit 23 and are not considered further in this SWMMP other than as reference/analogue sites.

With regard to surface water flows, it is noted in Section 3.6 that the western flank of the pre-mining Pit 23 surface sheds water to the north-west to the Red Hill Drainage Line which ultimately reports to McGlashin Swamp, and surface flows from the eastern flank of the pre-mining Pit 23 surface drain east to Chadwick's wetland. Thus, the sensitive receptors relevant to turbid water runoff from Pit 23 open areas are:

- the Red Hill Drainage Line; and
- Chadwick's Wetland.

It is noted that due to the ephemeral nature of the surface water receptors identified above, historical monitoring data for these locations is typically limited or unavailable and for drainage lines in particular the availability of/access to flowing water for sampling is often difficult. As noted above, and following the ANZECC/ARMCANZ (2000) guidelines, reference/sites will be used to:

- determine the typical range of background surface water quality in the area for the different types of water features in question (drainage lines and swaps/wetlands) and to derive site-specific water quality objectives (SWQOs) (see Section 8.3.2 of this SWMMP); and
- to allow point-in-time comparison against water quality observations obtained from compliance monitoring points to support assessments of any impact/risk.

8.3 Applicable legislation, standards and guidelines

8.3.1 State Environmental Protection Policy (Waters)

The primary legislation relevant to the management of risks to surface waters is the EP Act and the subsidiary SEPP (Waters).

Schedule 1 of the SEPP (Waters) divides surface waters in Victoria into "segments" based on geographic regions and their quality/condition. The surface water receptors relevant to Pit 23 fall within the *"Murray and Western Plains Segment"* (Lowlands of the Glenelg, Hopkins, Portland, Corangamite and Millicent Basins).

Per Schedule 2 (Table 3 – Inland Waters) of the SEPP Waters, surface waters in this segment are classified as "*slightly to moderately modified*" with the following default beneficial uses assigned:

- water dependent ecosystems and species;
- agriculture and irrigation;
- human consumption after appropriate treatment (where water is sourced for supply in accordance with the special water supply catchments area set out in Schedule 5 of the *Catchment and Land Protection Act 1994* or the *Safe Drinking Water Act 2003*);
- human consumption of aquatic foods;

- aquaculture;
- industrial and commercial use;
- water-based recreation (primary contact);
- water-based recreation (secondary contact);
- water-based recreation (aesthetic enjoyment);
- Traditional Owner cultural values; and
- cultural and spiritual values.

Of the default beneficial uses assigned to Murray and Western Plans Segment, only water use by ecosystems and species is considered relevant to the assessment of surface water risk associated with Pit 23. This follows that:

- the springs and saline water bodies (McGlashin Swamp and White Lake) down-gradient from Pit 23 are groundwater-dependent; and
- that the Red Hill drainage line and Chadwick's wetland are respectively classed as streams and wetlands (albeit ephemeral) under the SEPP (Waters).

Following Clause 16 of the SEPP (Waters), and consistent with the VCAT determination regarding relevant beneficial uses (see GMMP Section 7.3.1.1) all other default beneficial uses are not considered relevant on the following grounds:

- Agriculture and irrigation: neither groundwater-seepage to surface nor surface water runoff is of sufficient yield or quality (e.g. elevated groundwater salinity – refer Section 7.3.1) to support these uses;
- Human consumption after appropriate treatment: this beneficial use is only considered if surface water receptors are located within declared special water supply catchments areas. The Douglas site, Pit 23 and receptors in question are not within any such catchments;
- Human consumption of aquatic foods: neither groundwater-seepage to surface nor surface water runoff is of sufficient yield to support aquatic fauna sourced for food, with all identified receiving waters being ephemeral;
- Aquaculture: neither groundwater-seepage to surface nor surface water runoff is of sufficient yield or quality to support aquaculture, with all identified receiving waters being ephemeral;
- Industrial and commercial: neither groundwater seepage to surface or surface water runoff is of sufficient yield or frequency to support industrial and commercial use, with all identified receiving waters being ephemeral. Likewise, no such use occurs down-gradient or downstream of Pit 23;
- Water-based recreation (primary and secondary contact): neither groundwater seepage to surface or surface water runoff is of sufficient yield or frequency to support recreational use and the quality of groundwater-fed surface waters does not favour recreational use;
- Water-based recreation (aesthetic enjoyment): all identified receiving waters relevant to Pit 23 are ephemeral. Further, the portion of the relevant catchments isolated by the Pit 23 facility (i.e. in an open/un-rehabilitated state) is insignificant and any impact on water flows into and any aesthetic enjoyment of the receiving waters in question is equally insignificant;
- Traditional Owner cultural values, and cultural and spiritual values: as noted in Section 7.3.1, such values are most likely to be associated with surface water features (lakes, streams, swamps and wetlands), which is consistent with cultural heritage sensitivity mapping in the Aboriginal Victoria *Aboriginal Cultural Heritage Register and Information System (ACHRIS)* database. Thus, the protection and maintenance of receiving water quality for ecosystems and species beneficial use provides equivalent protection of cultural and spiritual values. It is

also noted under Clause 17 of the SEPP (Waters) that no specific quality indicators or objectives apply to cultural and spiritual values.

8.3.2 Applicable Surface water quality objectives (SWQOs)

As noted in Section 8.3.1, the surface water receptors relevant to Pit 23 and this SWMMP fall into the SEPP (Waters) Segment *"Murray and Western Plains Segment"* (Lowlands of the Glenelg, Hopkins, Portland, Corangamite and Millicent Basins) for which a 95% ecosystem protection level applies.

Under Schedule 3 of the SEPP (Waters) default water quality objectives for this segment are given for basic water quality indicators being electrical conductivity (EC), pH, turbidity (NTU), dissolved oxygen (DO) and nutrients (Total Nitrogen, and Total Phosphorus). The default objectives for these indicators differ depending on the type of waterway in question, i.e.:

- rivers/streams; and
- lakes/wetlands.

Water quality objectives for toxicants in water are also required, which are determined through reference to the ANZECC/ARMCANZ (2000) guidelines. These toxicants include metals, non-metallic inorganics (e.g. chlorine, ammonia, cyanide and nitrate), hydrocarbons and pesticides. Similar to the SEPP (Waters), guidance limits are given for these toxicants based on categories of ecosystem condition with each category assigned a different level of ecosystem protection (e.g. 99%, 95%, 90% and 80%). Of these categories, the ANZECC classification for '*slightly-moderately disturbed*' is relevant for which a 95% ecosystem protection level also applies.

Importantly, both the SEPP (Waters) and ANZECC guidelines allow the development of site-specific water quality objectives. The derivation of SWQOs is important for several reasons:

- it accounts for natural variation in water quality, and recognises that natural background concentrations may exceed the default water quality objectives;
- with regard to toxicants in water, objectives need only be established for toxicants that are considered relevant to the receiving environment in question taking into account the environmental setting and likely inputs (i.e. identifying potential 'contaminants of concern' based on a known or potential pollutant source); and
- where surface water receptor sites have limited or no monitoring data and/or where biological and ecological effects studies have not been undertaken, data from appropriate reference/analogue sites can be used to derive SWQOs.

As surface water receptor sites relevant to this SWMMP are ephemeral, with existing monitoring data limited and difficult to obtain, data from locally appropriate reference sites has been used to develop guideline SWQOs. Whilst the ANZECC guidelines recommend that reference site data consist of a minimum of two-years of monthly data, this is not achievable given that the reference sites are themselves ephemeral. To overcome this constraint, data from reference sites has been grouped (or 'pooled') to provide sufficient depth of data and over sufficient timescales to reflect natural variation and seasonality. This approach will apply until such time that site-specific data for receptor sites is available to enable true site-specific SWQOs to be developed.

The categorisation of compliance monitoring points based on their classification (groundwater-fed and runoff-fed), and nominated reference/analogue sites, is given in Table 19 and Table 20 respectively. Justification for the selection of reference/analogue sites is also provided.

Monitoring point locations are given in Section 8.5.1 (Figure 19 – Figure 20).

Table 19: Groundwater-fed surface water sensitive receptors

Receptor Sites	Description	Ecosystem / Water Feature Type		Purpose of Monitoring	Compliance Monitoring Point(s)	Reference / Analogue Site(s)	Justification for reference/analogue sites
		Per ANZECC	Per SEPP (Waters)				
Receptors: Groundwater-fed							
North-West drainage line	Ephemeral drainage line – springs potentially present	Flowing waters – lowland rivers and streams	Rivers and streams	Monitor for changes in surface water quality potentially associated with Pit 23 groundwater seepage	DUSW20	DUSW01 – Glenelg River (U/S of Douglas Mine) DUSW04 – Costello's Creek DUSW14 – Costello's Creek DUSW38 – Un-named tributary into Glenelg River DUSW39 – Un-named tributary into Shaw's Gully DUSW40 – Un-named tributary into Shaw's Gully DUSW41 – Un-named tributary into Shaw's Gully DUSW41(East) – Un-named tributary into Shaw's Gully DUSW44 – Un-named tributary into Shaw's Gully DUSW49 – Spring Creek (Costello's Creek)	All reference/analogue sites are: • ephemeral drainage lines in an agricultural setting; • isolated from any surface water flows from the Douglas mine site or Pit 23; and • assessed as having likely groundwater influence based on chemical profiling (piper diagram). Costello's Creek contains springs and is an ideal analogue for any springs found in the North-West Drainage Line. The Glenelg River is also an appropriate reference/analogue site often being ephemeral on account of the upstream impoundment of water by the Rocklands Reservoir and ambient environmental/catchment conditions. Further, the river has a saline groundwater base-flow component which is analogous to spring seepage in the North-West Drainage Line. Significant water quality data exists for the Glenelg River at the Fulham Bridge (DUSW01) which is upstream of the Douglas Mine and representative of background quality.
White Lake	Ephemeral (perennial) shallow hypersaline lake (groundwater fed) Considered a closed system, but may outflow in extremely high rainfall events/periods, with outflows reporting to Centre Lake and North Lake. (refer Smart 2001c; CDM Smith 2014)	Standing waters – lakes and reservoirs	Shallow inland – no outflow	Monitor for changes in surface water quality potentially associated with Pit 23 groundwater seepage	DUSW05b	DUSW46 – Centre Lake DUSW47 – North Lake DUSW48 – Copper Colour Lake	All reference/analogue sites are: • ephemeral, hypersaline and groundwater-fed terminal lakes in the vicinity of White Lake (i.e. the water quality in White Lake and these other lakes is expected to be more representative of groundwater quality than local surface water runoff/inflow); and • isolated from groundwater and surface water flows originating from the Douglas mine site or Pit 23. Refer Smart (2001a; 2001b) and CDM Smith (2014; 2015).
McGlashin Swamp	Ephemeral, shallow brackish wetland with some groundwater base-flow Closed system with no outflow (Smart 2001a; Smart 2001b; CDM Smith 2014)	Standing waters – wetlands	Shallow inland – closed (no outflow)	Monitor for changes in surface water quality potentially associated with Pit 23 groundwater seepage	DUSW24	ECHO09 – Connangorach Swamp DUSW45 – Brooksby's Swamp W100SW03 – Jallumba Marsh (Toolondo) W100SW04 – Redgum Swamp (Toolondo)	All reference/analogue sites are: • ephemeral swamps in the region; and • isolated from any groundwater or surface water flows originating from the Douglas mine site or Pit 23. It is noted that all of the analogue swamps noted here are not groundwater-fed water features, being disconnected from the local water table (see Smart 2001a; 2001b). However, per EMM (2018), these sites exhibit variability in surface water quality similar to that observed at McGlashin Swamp with the same mechanisms driving such variation (evapo-concentration and photosynthetic processes).

Table 20: Runoff-fed surface water sensitive receptors

Receptor Sites	Description	Ecosystem / Water Feature Type		Purpose of Monitoring	Monitoring Point(s)	Reference / Analogue Site(s)	Justification for reference/analogue sites
		Per ANZECC	Per SEPP (Waters)				
Receptors: Runoff-fed							
Chadwick's Wetland (West)	Ephemeral, shallow fresh water wetland. No groundwater base-flow. Outflows in high rainfall events / periods only (per pre-mine hydrology, water reports to Robertson's Wetland)	Standing waters – wetlands	Shallow inland – with an outflow	Monitor for changes in surface water quality associated with: • a turbid water discharge during the operations phase; and • general runoff quality from the Pit 23 final landform (during and post-rehabilitation).	DUSW11	DUSW06 – The Morass North (Wades Rd swamp) DUSW08 – Lake Kanagulk (South) DUSW09 – Robertson's wetland (South) DUSW12 – Robertson's wetland (East)	Consistent with Chadwick's wetland all reference/analogue sites are: • located east of the Douglas site/Pit 23 in the same Lake Kanagulk catchment; • ephemeral, shallow fresh water wetlands; • disconnected from groundwater (i.e. perched above the local water table); and • receive agricultural inputs through runoff/inflows. Refer Smart (2001a; 2001b) and CDM Smith (2014). While the pre-mining hydrology has portions of the adjacent Douglas mine site draining to Robertson's wetland, it remains a valid reference/analogue site on the basis that: • this drainage line from the Douglas mine is intercepted and diverted by the Douglas Mine surface water management system (i.e. it is unlikely to have received mining-influenced runoff from the Douglas Mine); and • the nominated monitoring points in Robertson's Wetland are opposite this drainage line inflow from Chadwick's Wetland, with a ~1.4km separation/buffer from any such inflow and are therefore likely to be representative of local background conditions.
Red Hill drainage line	Ephemeral drainage line – no springs present	Flowing waters – lowland rivers and streams	Rivers and streams	Monitor for changes in surface water quality associated with: • a turbid water discharge during the operations phase; and • general runoff quality from the Pit 23 final landform (during and post-rehabilitation).	DUSW25	DUSW07 – Lake Kanagulk (SW tributary) DUSW15 – Un-named drainage line (Jaspers Lane) DUSW16 – Un-named drainage line (Jaspers Lane) DUSW28 – Un-named drainage line (Jaspers Lane) DUSW32 – Elliotts Creek (Jaspers Lane) DUSW36 – Un-named drainage line (Jaspers Lane) DUSW37 – Un-named tributary into Shaw's Gully DUSW43 – Un-named tributary into Shaw's Gully	All reference/analogue sites are: • ephemeral drainage lines in an agricultural setting with all sites (except DUSW15 and DUSW16); • isolated from any surface water flows from the Douglas mine site or Pit 23; and • assessed as having no groundwater influence based on chemical profiling (piper diagram). Sites DUSW15 and DUSW16 correspond to un-named drainage lines immediately south of the Douglas Mine site along Jaspers Lane, and may have received runoff as overland flow from undisturbed land west of the Douglas Mine Fresh Water Dam or runoff from rehabilitated land on former mining void Pit 19. On this basis it is unlikely that these drainage lines have received mine-impacted (i.e. contaminated or turbid) runoff and available monitoring data is considered reliable for their inclusion as reference/analogue sites.

8.3.2.1 Identification of relevant water quality indicators

Per ANZECC/ARCMANZ (2000) the development of site-specific SWQOs is only undertaken for water quality indicators deemed relevant to the monitoring sites and receiving environment. On this basis data was only assessed for:

- SEPP (Waters) basic water quality indicators: EC, pH, NTU, DO, Total Nitrogen and Total Phosphorus; and
- ANZECC toxicants in water:
    - metals and metalloids; and
    - non-metallic inorganics (specifically ammonia, cyanide and nitrate).

Other potential toxicants in water contemplated in the ANZECC guidelines such as alcohols, alkanes, pesticides/herbicides/fungicides, hydrocarbons and industrial chemicals were rejected on grounds that they are unlikely to be present in measurable concentrations in the environment.

Existing groundwater risk assessments and solute transport modelling investigations undertaken for the site (Jacobs 2014; Jacobs 2016a) do not identify any contaminants of concern arising from disposed by-products that would result in adverse impacts to down-gradient groundwater-fed surface water receptors. This is an outcome of the extremely low leachability potential of the by-product waste (and hence mobility of radionuclide, heavy metal and other contaminants), the extremely low rate of groundwater flow (EMM 2019) and the effects of retardation, degradation and decay processes along the path of flow.

The derivation of site-specific SWQOs was therefore focussed on determining the background (baseline) water quality of surface water receptor sites to be protected/maintained and the analytes of interest.

Data screening was undertaken according to the following process:

- historical data for compliance monitoring points and reference sites was combined according to the groupings identified in Table 19 and Table 20. This included comparison of inter-site data for the basic SEPP (Waters) indicators using box-and-whisker plots to validate their similarity and suitability to be grouped or ‘pooled’ for purposes of deriving site-specific SWQOs; and
- for each indicator, median values were compared against the default SEPP (Waters) or ANZECC guideline limits in order to identify those indicators for which a site-specific SWQO was warranted.

This process determined that, across all sites:

- non-metallic inorganics (ammonia, cyanide and nitrate) were not relevant and did not warrant further assessment or future monitoring; and
- the metals/metalloids for which site-specific SWQOs were warranted were Aluminium, Boron, Chromium, Cobalt, Copper, Iron, Nickel, Lead, Uranium, Vanadium and Zinc. Per Table 21 below, a greater number of metals were naturally elevated in lake/wetland sites compared to ephemeral drainage lines.

All other metals and metalloids were at/below the limit of detection or in concentrations well below the ANZECC guideline limits and are not considered further in this EMP.

Table 21: Metals and metalloids requiring site-specific SWQOs, by site

	DUSW05b	DUSW24	DUSW11	DUSW20	DUSW25
Feature Type:	*Lake*	*Wetland*	*Wetland*	*Drainage Line*	*Drainage Line*
Aluminium	*	*	*	*	*
Boron	*	*	*		
Chromium	*	*	*	*	*
Cobalt		*	*	*	*
Copper	*	*	*	*	*
Iron	*	*	*	*	*
Nickel	*	*	*		
Lead			*		
Uranium	*	*			
Vanadium	*	*	*		
Zinc			*	*	*

8.3.2.2 Site-specific surface water quality objectives

Following data screening site-specific SWQOs were generated in the following manner:

- null values (i.e. erroneous data) identified and omitted;
- values recorded as being at the laboratory limit of detection/limit of reporting (LOD/LOR) treated as absolute values, consistent with ANZECC & ARMCANZ (2000);
- outlier values (based on 4 x standard deviations from the mean following DSITI (2017)) were identified and removed;
- for basic water quality indicators per the SEPP (Waters):
    - where the 25th-percentile and/or 75th-percentile values of reference site data were outside the default SEPP limits (if applicable), these applied as site-specific SWQOs;
    - otherwise, the default SEPP (Waters) limits applied.
- for relevant toxicants in water:
    - site-specific SWQOs were generated based on the 80th and 95th percentiles of the reference site data;
    - otherwise, the default ANZECC guideline 95th-percentile limits applied. This only applied in one or two instances where insufficient data existed despite pooling data from multiple reference sites.

As with groundwater quality, surface water quality varies spatially and temporally and due to the influence of seasonality. Due to the ephemeral nature of surface waters in the greater Douglas area this seasonality is particularly evident in EC, Turbidity (NTU) and certain heavy metals (e.g. Aluminium, Iron, Copper, Nickel and Zinc) which from prior investigations for the Douglas Mine (Jacobs 2017; Jacobs 2018) are known to be associated with the suspended clay minerals entrained in surface water runoff. Jacobs (2017) identified that Aluminium in particular is naturally elevated in the Glenelg River (and hence other surface waters) due to the presence of Kaolinite clays (Al2Si2O5(OH)4]) in catchment soils. Typically, however, the dissolved (bioavailable) concentrations of these heavy metals are extremely low and well below ANZECC guideline limits.

To account for this wide range of natural variation, and to ensure that observed changes in surface water quality can be attributed to seepage or runoff from Pit 23 and not natural variation, Iluka proposes to adopt the control-charting method described by DSITI (2017) for evaluating surface water quality at sensitive receptor sites. This method comprises a two-tiered evaluation to detect exceedances of the applicable SWQOs:

- the rolling median of the eight (8) most recent data-points is compared to the SWQO. An exceedance triggers an investigation into potential causes e.g. whether it reflects seepage or runoff from Pit 23, or natural background trends/variation (see Section 7.6 of this EMP);

- where lower or upper objectives apply (based on 25th and/or 75th-percentile values for nutrients and physical-chemical indicators, and 95th-percentile values for metals) each individual data point is compared with these triggers. Three (3) consecutive exceedances triggers an investigation.

As Cl:SO4 and Na:Ca ratios are monitored for in groundwater as potential indicators of by-product seepage and groundwater contamination they will also be monitored for in surface waters at groundwater-fed receptor sites (White Lake, McGlashin Swamp and the North-West Drainage Line) for this same purpose. As with groundwater, these Cl:SO4 and Na:Ca ratios are only used to confirm the occurrence of by-product seepage and expression in surface waters where trends of concern or exceedances are first identified for other analytes (i.e. they do not apply as standalone water quality / compliance objectives).

Cl:SO4 and Na:Ca ratios have not been developed for runoff-fed surface water sites DUSW25 (Red Hill Drainage Line) and DUSW11 (Chadwick's Wetland) as these sites have no connectivity to groundwater from Pit 23.

Based on the above methodology, the SWQOs to be applied to compliance monitoring points (i.e. sensitive receptors) are given in Table 22.

It is noted that the Iluka surface water quality data and hence SWQOs for toxicants in water are for total concentrations. Per Section 3.4.3.2 of ANZECC&ARMCANZ (2000) the major toxic effect of metals comes from the dissolved fraction and hence the SWQOs in Table 22 can be considered conservative and analysis for dissolved concentrations will be undertaken to determine the validity of any identified exceedance. That is, where a dissolved concentration of a heavy metal (toxicant) is measured complies with a stated SWQO no non-compliance or continued investigation is required.

Table 22: Pit 23 surface water quality objectives – surface water receptors

Indicator		Percentile	Surface Water Quality Objectives (SWQOs)					Investigation Trigger
			DUSW20	DUSW05b	DUSW24	DUSW11	DUSW25	
Nutrients								
Total Phosphorus	mg/L	75th percentile	0.055	0.65	0.76 #	0.3	0.22	Rolling median of last eight (8) data-points is > objective
Total Nitrogen	mg/L	75th percentile	1.4	10	6.1 #	4.8	2.35	Rolling median of last eight (8) data-points is > objective
Physical and Chemical Indicators								
Dissolved Oxygen	% sat.	25th percentile	65	65	65	47	65	Rolling median of last eight (8) data-points is < objective
	% sat.	Maximum	130	120 **	120 **	120	130	Two (2) consecutive data-points > objective
Turbidity (NTU)	NTU	75th percentile	24.2	81.5 #	49.8 #	292	122	Rolling median of last eight (8) data-points is > objective
EC (uS/cm)	uS/cm	75th percentile	5,800	No Limit	No Limit	No Limit	281	Rolling median of last eight (8) data-points is > objective
pH	pH units	25th percentile	7.0	6.5	6.5	6.5	7.0	Any single exceedance
	pH units	75th percentile	8.0	8.5	9.4	8.5	8.0	Any single exceedance (for default SEPP (Waters) limits. For SWQOs, rolling median of last eight (8) data-points is > objective
Toxicants Water								
Aluminium (Total)	mg/L	80th percentile	5.6	17 **	8.1	27	11.3 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	14.0	59 **	34.5	38	21.2 #	Two (2) consecutive data-points > objective
Boron (Total)	mg/L	80th percentile	n/a	4.5 **	2.0	n/a	n/a	Rolling median of last eight (8) data-points is > objective
		95th percentile	n/a	6.5 **	2.4	n/a	n/a	Two (2) consecutive data-points > objective
Chromium (Total)	mg/L	80th percentile	0.005	0.02 **	0.009	0.028	0.013 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	0.016	0.063 **	0.038	0.043	0.021 #	Two (2) consecutive data-points > objective
Cobalt (Total)	mg/L	80th percentile	0.002	n/a	0.005	0.006	0.002 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	0.003	n/a	0.008	0.008	0.004 #	Two (2) consecutive data-points > objective
Copper (Total)	mg/L	80th percentile	0.003	0.01 **	0.005	0.015	0.071 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	0.027	0.038 **	0.022	0.043	0.095 #	Two (2) consecutive data-points > objective
Iron (Total)	mg/L	80th percentile	3.5	13 **	5.5	21.0	8.52 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	13.0	44.5 **	28.1	27.9	14.6 #	Two (2) consecutive data-points > objective

Indicator		Percentile	Surface Water Quality Objectives (SWQOs)					Investigation Trigger
			DUSW20	DUSW05b	DUSW24	DUSW11	DUSW25	
Lead (Total)	mg/L	80th percentile	n/a	n/a	n/a	0.013	0.004 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	n/a	n/a	n/a	0.016	0.009 #	Two (2) consecutive data-points > objective
Nickel (Total)	mg/L	80th percentile	n/a	n/a	n/a	0.015	n/a	Rolling median of last eight (8) data-points is > objective
		95th percentile	n/a	n/a	n/a	0.022	n/a	Two (2) consecutive data-points > objective
Uranium (Total)	mg/L	80th percentile	n/a	0.016 **	0.001	n/a	n/a	Rolling median of last eight (8) data-points is > objective
		95th percentile	n/a	0.02 **	0.007	n/a	n/a	Two (2) consecutive data-points > objective
Vanadium (Total)	mg/L	80th percentile	n/a	0.05 **	0.04	0.056	0.02 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	n/a	0.118 **	0.11	0.074	0.03 #	Two (2) consecutive data-points > objective
Zinc (Total)	mg/L	80th percentile	0.022	n/a	n/a	0.029	0.025 #	Rolling median of last eight (8) data-points is > objective
		95th percentile	0.041	n/a	n/a	0.04	0.043 #	Two (2) consecutive data-points > objective
Ionic Balance – Ratios *(ratios do not apply as standalone objectives - see footnote)*								
CL:SO4	*Ratio*	*5th percentile*	*4.98*	*8.27*	*1.84*			*Three (3) consecutive results < objective*
		20th percentile	*5.79*	*8.46*	*11.13*			*Rolling median of last eight (8) data-points is < objective*
Na:Ca	*Ratio*	*5th percentile*	*6.20*	*14.49*	*4.76*			*Three (3) consecutive results < objective*
		20th percentile	*7.68*	*16.43*	*6.51*			*Rolling median of last eight (8) data-points is < objective*

Indicator	Percentile	Surface Water Quality Objectives (SWQOs)					Investigation Trigger
		DUSW20	DUSW05b	DUSW24	DUSW11	DUSW25	

= interim guideline (trigger level based on < 18 samples)
** = Low reliability trigger (based on < 8 samples). Additional samples are required to refine.
n/a = not of interest for that site based on statistical analysis (e.g. concentrations typically at or below laboratory limit of detection)

NOTES

- SWOQs shaded **orange** are default compliance limits / guideline limits per the SEPP (Waters) or ANZECC/ARMCANZ (2000) guidelines
- SWQOs shaded **green** are site-specific SWQOs based on reference site data, with the exception of DUSW05b (White Lake) which are based on White Lake data only;
- For sites **DUSW11** and **DUSW25** an investigation trigger will only apply if there has been runoff generated from material stockpiled along the pit crest of Pit 23 and the final Pit 23 rehabilitated surface
- Per the SEPP (Waters) no EC upper limit applies to surface waters classed as "*shallow inland waters – with an outflow*" which applies to White Lake, McGlashin Swamp and Chadwick's Wetland;
- SWQOs for metals and metalloids are not legal compliance measures and apply as guidance limits / benchmarks for water quality protection only.
- Toxicity is based on dissolved concentrations as per ANZECC/ARMCANZ (2000). The stated SWQOs are based on total concentrations and are conservative. In the event of a toxicant (heavy metal) exceedance, analysis for dissolved concentrations may be undertaken to validate the occurrence or otherwise of an exceedance and adverse impact.
- All site-specific SWQOs for Chromium are based on data for total chromium, as no data is available for specific chromium species (Cr-III, Cr-VI). Caution is therefore required when interpreting any potential chromium exceedance as the ANZECC guidelines apply limits for specific chromium species only.
- For site-specific SWQOs for DUSW05B (White Lake):
  - these are based only on data for White Lake given lack of reference site data
  - the ANZECC limits for Copper and Nickel have been applied given the lack of site-specific and reference site data.

IMPORTANT

With regard to the SWQOs for CL:SO4 and Na:Ca ratios:

- objectives for these ratios are not prescribed in the SEPP (Waters) or ANZECC/ARMCANZ (2000) Guidelines; and
- the SWQOs for these ratios do not apply as standalone limits to be achieved / maintained and are only taken into consideration where they correspond to a simultaneous trend of concern in one or more other analytes listed in this table. I.e. they are used to confirm the likelihood of a Pit 23 related influence on groundwater quality and expression into surface waters where trends of concern are first observed for other analytes.

8.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to surface water.

8.4.1 Runoff from disturbed areas

Potential impacts to surface water receptors were identified in the Permit application and found to be related to the potential for turbid water runoff from disturbed areas devoid of vegetation. These include:

- in the **operations phase**, overburden stockpiles surrounding/bordering the pit; and
- in the **rehabilitation phase**, runoff from the reinstated landform/topographical surface prior to the establishment of native vegetation cover.

The potential for turbid water runoff and adverse impact to receiving waters in the **operations phase** is considered unlikely given that:

- the disturbed area associated with Pit 23 from which run-off can occur (i.e. the area of the outer batters of the overburden stockpiles bordering the pit, and the space between them and the turbid water interception drains) totals 13.7 ha;
- the contribution of run-off from these disturbed areas would be 0.67 to 3.3 ML representing 2.7% to 4% of water reporting into the surface water management system for the adjacent Douglas Mine (Water Technology, 2017);
- existing interception drains bordering the eastern and western flanks of the Pit 23 disturbance footprint exclusively capture and contain turbid water runoff, with non-impacted/non-turbid runoff from adjacent agricultural land diverted away from the turbid water management system directly to Chadwick's Wetland via a culvert under the Douglas Mine access road. This optimises the capacity of the drains, sumps and pumps (see Section 8.4.3) to manage turbid flows; and
- this Pit 23 drainage system, which intercepts and directs turbid water into the greater Douglas Mine drainage system, has proven to be adequate up to this point in time having prevented turbid water discharge to receiving waters throughout the Douglas life-of-mine to current date, and despite periods of high rainfall (in excess of rainfall with a recurrence interval exceeding 1:100 years and rainfall events of an intensity exceeding that of events with a recurrence interval of 1:100 years).

In the **rehabilitation phase** it is recognised that when the pit is backfilled to final surface, and prior to establishment of vegetation cover, the un-rehabilitated landform has greater potential to generate turbid runoff and the existing drainage system may no longer be capable of handling such flows. Measures to assess the adequacy of this drainage system and identify any required modifications or upgrade are as outlined in Section 8.4.3.3 of this SWMMP.

Should a turbid water discharge occur (i.e. due to the absence or failure of the drainage system) the consequence is considered insignificant, given that the contributing catchment areas are small and any downstream flows of limited volume. Further, the land immediately to the east and west of Pit 23 is agricultural land which may provide some reduction in sediment load before runoff enters Chadwick's Wetland or the Red Hill Drainage Line. On this point, it is also noted that:

- the catchment of the Red Hill Drainage Line (NNW of Pit 23) includes an unsealed section of Elliotts Road and the drainage line itself is not well vegetated. The quality of water in the drainage line during rainfall events could be expected to be similar to that of any overflow of the Pit 23 north-west dam (i.e. any adverse impact from Pit 23 related runoff would likely be negligible); and
- the catchment of Chadwick's Wetland (East of Pit 23) receives inflow from agricultural sources upstream and immediately surrounding this wetland. Although highly unlikely, this could include turbid water flows originating from the adjacent Douglas Mine. Accordingly, the

quality of any water runoff/discharge to Chadwick's Wetland from Pit 23 is not expected to vary significantly from that contributed by other sources.

In all instances the natural water quality of these receiving waters, turbid water within the drainage system and any unplanned discharges form this system will be validated through monitoring as detailed in Section 8.5.

8.4.2 Groundwater discharge to surface waters

As noted in the GWMMP and Section 8.1, groundwater discharges to the surface at a number of locations down-gradient of Pit 23 with the potential for contamination of surface waters.

Per the groundwater risk assessment in the GWMMP, the potential for adverse impacts to groundwater and thus groundwater-dependent ecosystems (GDEs) is extremely low on the basis that:

- per groundwater model and particle tracking (EMM, 2019), the time taken for groundwater seepage from Pit 23 to reach any of these receptors[6] would be significant, i.e.:
    - for springs in the North-West Drainage Line, after ~175 years;
    - for McGlashin Swamp, after ~230 years; and
    - for White Lake, >500 years (predicted arrival times exceed the computational limits of the modelling software).
- based on groundwater impact assessments, by-product leachate testing and solute transport modelling (Jacobs 2014; SRS 2015; Jacobs 2016a; Jacobs 2016b; EES 2016), MSP by-products are not readily leachable and no contaminants of concern are predicted to migrate beyond a distance of ~10m from the pit. An increase in TDS concentrations down-gradient of Pit 23 is predicted but this is not expected to exceed SEPP (Waters) objectives or adversely impact stock water beneficial use

In summary, no adverse impact to GDEs is expected, but these receptors will be monitored on precautionary grounds with results used to validate the groundwater flow and solute transport models, and to allow detection of any seepage from Pit 23 should this occur.

As required by Condition 30(e) of the Permit, an in-field survey for springs along the North-West Drainage Line between Elliotts Back Lane and Harrow-Kanagulk Road was completed in December 2016 whereby potential springs were identified, however, follow up surveys conducted in 2018 and 2019 failed to confirm the locations of such springs and therefore no additional sampling locations have been added to the monitoring program outlined in Section 8.5.

8.4.3 Standard controls

8.4.3.1 Groundwater discharge to surface waters

The standard controls applicable to groundwater-fed surface water receptors are the same as those for groundwater generally (per Section 7.4.2 of the GWMMP), that is, no standard controls apply other than monitoring to confirm existing model predictions and/or identify the possible influence of seepage from Pit 23.

Management triggers, trigger responses and contingency planning measures from the GWMMP (Section 7.6) also apply to groundwater-fed surface water receptors, i.e. where monitoring has indicated a potential trend of concern in surface water samples obtained from these locations following the process defined in Table 22.

[6] Based on seepage/groundwater flow from Pit 23 commencing in December 2011 (the time of first by-product disposal into Pit 23)

8.4.3.2 Containment of turbid runoff

The primary control for turbid runoff is a surface water drainage system which consists of:

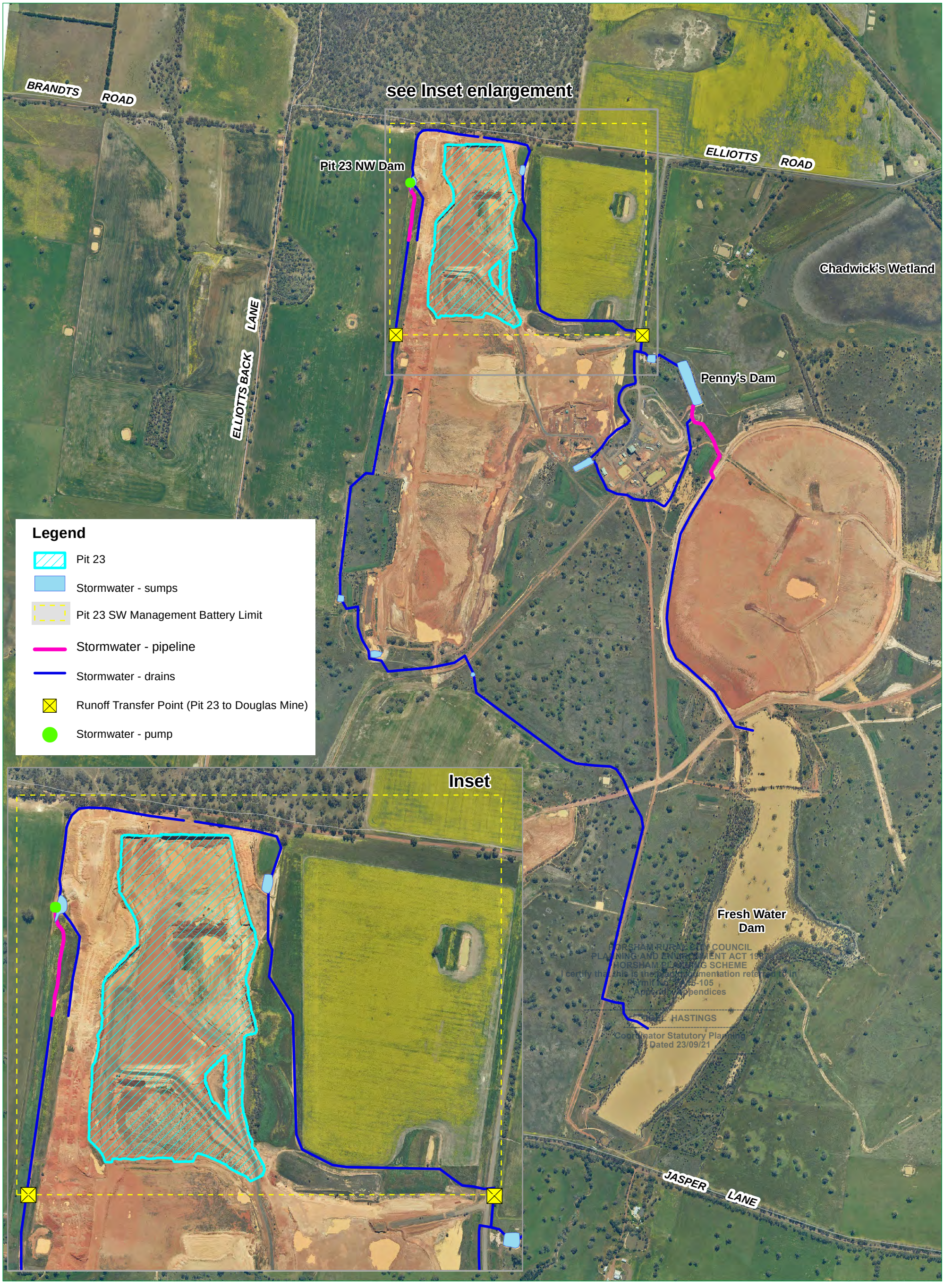
- diversion of runoff from undisturbed areas around disturbed areas returning flows to natural watercourses where possible. This avoids unnecessary inflow to and storage demand on the turbid water drainage system;
- earthen bunds and interception drains to intercept turbid water runoff, which is directed to on-site collection ponds; and
- a network of pumps, pipes and channels to deliver collected runoff into the surface water management system for the adjacent Douglas Mine site.

In the case of runoff from Pit 23 access roads that reports into the pit, or rainfall that falls directly in the confines of the pit, such water does not require active management as it will be lost through infiltration and evaporation and no means exists for such water to leave the pit as surface flow.

This drainage system, including the battery limits for surface water management discussed in Section 8.1.1, is shown in Figure 18.

Additional controls to mitigate the risk of an off-site turbid water discharge include:

- monthly inspection of the drainage systems to ensure integrity, operability and storage capacity. This includes:
    - inspection of interception drain and bund condition;
    - inspection of collection pond condition and available storage capacity, including water transfers if necessary;
    - inspection of installed water transfer pumps for serviceability and if not in serviceable condition, replacement with portable pump if necessary; and
    - inspection of water transfer pipeline integrity.
- monitoring of daily rainfall forecasts from the Bureau of Meteorology rainfall forecast website whereby a daily rainfall of greater than 20mm will be the trigger for additional inspections or water transfers, if required.



N

0 250 500 m

Aerial photo: 5 Oct. 2018

DOUGLAS MINE

PIT 23 DRAINAGE SYSTEM & BATTERY LIMITS

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:15,000 (A3) DATE: Oct. 2019 DWG No: 257185 ver.00

FIGURE: **18**

8.4.3.3 Adequacy assessment and upgrade

With respect to the rehabilitation phase it is recognised that when the pit is backfilled to final surface, and prior to establishment of vegetation cover, the un-rehabilitated surface has greater potential to generate turbid runoff and the existing drainage system may no longer be capable of handling such flows.

Prior to the backfilling of the pit the capability of the current drainage system will be assessed through updated surface water modelling to inform any required modification or upgrade to the drainage system. This modelling will be performed by an expert in the field (hydrology and surface water flow modelling) and will seek to ensure that turbid run-off from disturbed areas will not result in impacts on surface receiving waters for the life of the development and use and beyond.

Modelling will generally include:

- an assessment of the current drainage system (i.e. design and capacity);
- mathematical simulation of the system in wet years of average recurrence intervals (ARI) ranging from one to 100 years and during intense rainfall events with ARI's in the same range. The simulations would identify any point in the system at which water would be discharged such as points of insufficient storage and insufficient transport capacity;
- recommendations on system modification or upgrades; and
- further mathematical simulations to demonstrate the adequacy of the upgraded system.

Such modelling may also be undertaken in the event of a non-compliant discharge as per the trigger responses and contingency planning outlined in Section 8.6.

8.4.4 Risk assessment

It is evident from the results of the suite of hydrogeological studies and impact assessments completed for the Douglas site/Pit 23 that the potential for adverse impacts to groundwater dependent, surface-water receptors is low. As these receptors are groundwater-fed and share the same source and impact pathway to groundwater generally, elements of the GWMMP will apply. That is:

- no standard controls apply other than monitoring to confirm existing model predictions and/or identify the possible influence of seepage from Pit 23, should this occur; and
- should monitoring identify a variance to expected outcomes the trigger responses and contingency measures given in Section 7.6 of the GWMMP will provide appropriate mitigation of any adverse impact.

Given the effectiveness of the existing surface water drainage system and limited potential for turbid water release, the risk of a turbid water runoff/discharge and adverse impact to receiving waters is also low.

This assessment is summarised in the RARP Risk Register (RSK-001 and RSK-003; Appendix A).

8.5 Monitoring program

While no significant adverse impacts on surface water quality at downstream receptors are predicted (in the case of GDEs) or expected (in the case of drainage lines/wetlands receiving runoff), this prediction must be confirmed through monitoring.

Monitoring of water quality will be achieved through Surface Water Monitoring Events (SWME) conducted monthly (provided there is sufficient water available for sampling) and on-event (see Section 8.5.1 below).

The results of routine monitoring will add to the understanding of the background water quality while incident-driven monitoring will enable assessment of any impacts.

8.5.1 Surface water monitoring locations and schedule

The surface water sites monitored under the Pit 23 surface water monitoring program are given in Table 23 and shown in Figure 19 – Figure 20. Monitoring points fall into the following categories:

Compliance Monitoring Points

- **Sensitive receptor monitoring points**. The purpose of monitoring at these locations is to establish and track the background quality of surface water at sensitive receptor sites, accounting for temporal and seasonal variation, and also to detect the occurrence of any potential Pit 23 related influence.
- **Monitoring points within the Pit 23 drainage system**. The purpose of monitoring at these locations is to monitor the quality of turbid runoff generated from the Pit 23 stockpiles and the final Pit 23 rehabilitated surface (in due course). This monitoring data would also inform an impact assessment in the event of an uncontrolled off-site discharge of turbid water.

Reference / Analogue Monitoring Points

- **Reference (analogue) sites**. As detailed in Section 8.3.2 these sites share similar environmental characteristics to the compliance monitoring points with data from these sites used to develop site-specific SWQOs. Water quality data from sites can also be used to compare point-in-time results obtained from the compliance monitoring points. This is important where the influence of natural variation may be misinterpreted as a Pit 23-related impact particularly in the case of groundwater-fed surface waters.

On-event monitoring includes either:

- opportunistic sampling where the surface water site has sufficient standing water (in the case of lakes/swamps/wetlands) or sufficient flowing water (in the case of drainage lines) to enable sample collection; or
- reactive monitoring in the event of an uncontrolled off-site discharge of turbid water.

It is noted that monitoring points DUSW23 (Pit 23 north-west dam) and DUSW26 (Pit 23 eastern drain) will be retained as compliance monitoring points during and post-rehabilitation of Pit 23 for purposes of monitoring the quality of runoff from the final landform. Appropriate reference/analogue monitoring points will be established in due course and will include sites representative of runoff from areas under native vegetation and/or agricultural land use.

Table 23: Pit 23 surface water sites and monitoring schedule

Compliance Monitoring Points	Location / Purpose	Compliance Point Monitoring Frequency	Reference / Analogue Sites	Analogue/Ref Sites Monitoring Frequency	Analyte Suite
DUSW20	**North-West Drainage Line** **Sensitive receptor (groundwater-fed).** Monitoring to develop baseline quality and/or detect possible seepage influence.	• Monthly#	DUSW01 – Glenelg River (U/S of Douglas Mine) DUSW04 – Costello's Creek DUSW14 – Costello's Creek DUSW38 – Un-named tributary into Glenelg River DUSW39 – Un-named tributary into Shaw's Gully DUSW40 – Un-named tributary into Shaw's Gully DUSW41 – Un-named tributary into Shaw's Gully DUSW41(East) – Un-named tributary into Shaw's Gully DUSW44 – Un-named tributary into Shaw's Gully DUSW49 – Spring Creek (Costello's Creek)	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite A (Refer Section 8.5.3.2 – Table 24)
DUSW05b	**White Lake** **Sensitive receptor (groundwater-fed).** Monitoring to develop baseline quality and/or detect possible seepage influence.	• Monthly#	DUSW46 – Centre Lake DUSW47 – North Lake DUSW48 – Copper Colour Lake	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite A (Refer Section 8.5.3.2 – Table 24)
DUSW24	**McGlashin Swamp** **Sensitive receptor (groundwater-fed).** Monitoring to develop baseline quality and/or detect possible seepage influence.	• Monthly#	ECHO09 – Connangorach Swamp DUSW45 – Brooksby's Swamp W100SW03 – Jallumba Marsh (Toolondo) W100SW04 – Redgum Swamp (Toolondo)	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite A (Refer Section 8.5.3.2 – Table 24)

Compliance Monitoring Points	Location / Purpose	Compliance Point Monitoring Frequency	Reference / Analogue Sites	Analogue/Ref Sites Monitoring Frequency	Analyte Suite
DUSW11	**Chadwick's Wetland** **Sensitive receptor (runoff fed).** Monitoring to develop baseline quality and/or assess impact in event of turbid water discharge from Pit 23. *(Note: Chadwick's Wetland may receive inflow from Douglas mine sources in addition to runoff from Pit 23. Monitoring therefore undertaken in conjunction with monitoring at DUSW27 to distinguish Pit 23-only inflows).*	• Monthly#	DUSW06 – The Morass North (Wades Rd swamp) DUSW07 – Lake Kanagulk (East) DUSW08 – Lake Kanagulk (South) DUSW09 – Robertson's wetland (South) DUSW12 – Robertson's wetland (East)	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite B (Refer Section 8.5.3.2 – Table 24)
DUSW25	**Red Hill Drainage Line** **Sensitive receptor (runoff fed).** Monitoring to develop baseline quality and/or assess impact in event of turbid water discharge from Pit 23.	• Monthly#	DUSW07 – Lake Kanagulk (SW tributary) DUSW15 – Un-named drainage line (Jaspers Lane) DUSW16 – Un-named drainage line (Jaspers Lane) DUSW28 – Un-named drainage line (Jaspers Lane) DUSW32 – Elliotts Creek (Jaspers Lane) DUSW36 – Un-named drainage line (Jaspers Lane) DUSW37 – Un-named tributary into Shaw's Gully DUSW43 – Un-named tributary into Shaw's Gully	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite B (Refer Section 8.5.3.2 – Table 24)
DUSW23	**Pit 23 north-west dam** **On-site ("in system") monitoring point. Runoff only.** Monitoring to assess in-situ turbid water quality in event of discharge to the Red Hill Drainage Line.	• On-event	N/A	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite B (Refer Section 8.5.3.2 – Table 24)

Compliance Monitoring Points	Location / Purpose	Compliance Point Monitoring Frequency	Reference / Analogue Sites	Analogue/Ref Sites Monitoring Frequency	Analyte Suite
DUSW26	**Pit 23 eastern drain** **On-site ("in system") monitoring point. Runoff only.** Monitoring to assess in-situ turbid water quality in event of discharge to Chadwick's Wetland.	• On-event	N/A	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite B (Refer Section 8.5.3.2 – Table 24)
DUSW27	**Douglas Mine Access Rd culvert. Runoff only.** Culvert directing clean water runoff from paddock east of Pit 23 / west of mine access road to Chadwick's Wetland. Monitoring to develop baseline quality of paddock runoff in event of a failure of the Pit 23 eastern drain and turbid water runoff into Chadwick's Wetland (DUSW11).	• On-event	N/A	On-event / as required	**Field parameters:** Refer Section 8.5.3.1 **Laboratory analysis:** Suite B (Refer Section 8.5.3.2 – Table 24)
# = In some circumstances the period between scheduled sampling events may be reduced to take advantage of surface water being available for sampling and analysis.					

DUSW05B
DUSW24
DUSW06
DUSW07
DUSW20
DUSW08
DUSW25
Chadwick's wetland
DUSW11
DUSW27
DUSW12
DUSW49
DUSW09
DUSW14
DUSW04
Costello's Creek
DUSW16
DUSW01
DUSW32
DUSW15
W100SW03
Jallumba Marsh
DUSW43
DUSW37
DUSW28
DUSW36
DUSW41
DUSW41 (East)
W100SW04
DUSW39
DUSW44
Red Gum Swamp
DUSW40
DUSW38
ECHO09
Connangorach Swamp
Copper Colour Lake
HARROW CLEAR LAKE ROAD
DUSW48
North Lake
DUSW45
Brooksby's Swamp
DUSW47
Centre Lake
DUSW46
White Lake
McGlashin Swamp
Lake Kanagulk
Ti Tree Swamp
Pit 23
Glenelg River

HORSHAM
NORADJUHA
ROAD
HAMILTON
ROAD
NATIMUK
ROAD
HAMILTON
NATIMUK
ROAD

Legend

Pit 23

Water monitoring - site type

- Compliance Point - Groundwater fed
- Compliance Point - Runoff fed
- Reference Site

N

0 2.5 5 km

Inset aerial photos: Oct. 2018

DOUGLAS MINE

PIT 23 SURFACE WATER MONITORING POINTS (REGIONAL)

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:125,000 (A3) DATE: June 2020 DWG No: 257186 ver.01

FIGURE: **19**

White Lake
DUSW05B
DUSW24
McGlashin Swamp
Ti Tree Swamp
DUSW20
Red Hill Drainage Line
North-West Drainage Line
DUSW25
DUSW23
DUSW26
DUSW11
Chadwick's wetland
DUSW27
DUSW06
Lake Kanagulk
DUSW07
DUSW08
Ti Tree Swamp
DUSW12
DUSW49
DUSW09
DUSW14
DUSW04
Costello's Creek
Fresh Water Dam
DUSW16
DUSW15
DUSW32
DUSW01
River
Glenelg
DUSW28
DUSW36
DUSW37
Shaw's Gully
DUSW43
DUSW41
DUSW41 (East)
DUSW44
DUSW39
DUSW40
DUSW38

Legend

Pit 23

Water monitoring - site type

- Compliance Point – Drainage System
- Compliance Point - Groundwater fed
- Compliance Point - Runoff fed
- Reference Site

N

0 1 2 km

Inset aerial photo: Oct. 2018

DOUGLAS MINE

PIT 23 SURFACE WATER MONITORING POINTS (LOCAL)

ILUKA

ORIG: S.Alexander DRAWN: D.G.S. SCALE: 1:45,000 (A3) DATE: June 2020 DWG No: 257187 ver.01

FIGURE: **20**

8.5.2 Sampling methodology

Surface water samples will be collected using methods in accordance with *A guide to the sampling and analysis of waters, wastewaters, soils and wastes* (EPA 2000b).

8.5.2.1 Recording of hydrologic conditions

The hydrologic conditions present at the surface water monitoring location at the time of sampling shall be recorded, including:

- for drainage lines – flowing/pooled/dry; and
- for sumps/dams/lakes/swamps – estimate of % water volume held.

8.5.3 Surface water quality analysis

8.5.3.1 Field parameters

The following field parameters will be measured using a calibrated water quality meter:

- pH;
- Electrical conductivity (EC);
- Turbidity (NTU);
- Oxidation reduction potential (ORP / Redox);
- Dissolved oxygen (DO); and
- Temperature.

8.5.3.2 Laboratory analysis

Surface water samples will be supplied under (CoC) documentation to a NATA accredited analytical laboratory for analysis.

Analyte suites have been established for groundwater-fed surface water monitoring locations and runoff-fed surface water monitoring locations. Note that the analyte suite for groundwater-fed surface water monitoring locations is the same as the analyte suite for groundwater bore monitoring (see Section 7.5.5 in the GWMMP). This is to allow the detection of any expression of groundwater originating from Pit 23 and any potential exceedances of trigger levels that may be attributed to seepage from Pit 23.

Applicable analyte suites are:

- **Suite A** – analyte suite for groundwater-fed monitoring points.
- **Suite B** – analyte suite for surface water runoff monitoring points.

Table 24: Surface water laboratory analyte suites

Analyte	Units	LOR	Suite A	Suite B	Method Ref *
General					
pH	Units	0.01	♦	♦	APHA 4500 H^+B
Electrical Conductivity (EC)	µS/cm	1	♦	♦	APHA 2510 B
Total Dissolved Solids (TDS)	mg/L	10	♦	♦	APHA 2540 C
Total Suspended Solids (TSS)	mg/L	1	♦	♦	APHA 2540 D
Alkalinity					
Bicarbonate Alkalinity as CaCO3	mg/L	1	♦		APHA 2320 B
Carbonate Alkalinity as CaCO3	mg/L	1	♦		
Hydroxide Alkalinity as CaCO3	mg/L	1	♦		
Total Alkalinity (T-Alk. / MAlk)	mg/L	1	♦		
Major Ions					
Calcium (Ca)	mg/L	1	♦		APHA 3120 and 3125
Magnesium (Mg)	mg/L	1	♦		
Sodium (Na)	mg/L	1	♦		
Potassium (K)	mg/L	1	♦		
Sulfate (SO_4)	mg/L	1	♦		APHA 4110 B
Chloride (CL-)	mg/L	1	♦		APHA 4500 D
Fluoride (F)	mg/L	0.1	♦		APHA 4500 C
Total anions	meq/L	0.01	♦		Calculated
Total cations	meq/L	0.01	♦		
Charge Balance Error (Ionic Balance)	%	0.01	♦		
Metals and Metalloids (total concentrations)					
Aluminium (Al)	mg/L	0.01	♦	♦	APHA 3120 and 3125
Arsenic (As)	mg/L	0.001	♦	♦	
Barium (Ba)	mg/L	0.001	♦	♦	
Boron (Bo)	mg/L	0.05	♦	♦	
Cadmium (Cd)	mg/L	0.0001	♦	♦	
Cobalt (Co)	mg/L	0.001	♦	♦	
Chromium (Cr)	mg/L	0.001	♦	♦	
Copper (Cu)	mg/L	0.001	♦	♦	
Iron (Fe)	mg/L	0.05	♦	♦	
Manganese (Mn)	mg/L	0.001	♦	♦	
Mercury (Hg)	mg/L	0.0001	♦	♦	APHA 4500 3112 B
Molybdenum (Mo)	mg/L	0.001	♦	♦	APHA 3120 and 3125
Nickel (Ni)	mg/L	0.001	♦	♦	
Lead (Pb)	mg/L	0.001	♦	♦	
Silver (Ag)	mg/L	0.001	♦	♦	
Selenium (Se)	mg/L	0.001	♦	♦	
Thorium (Th)	mg/L	0.001	♦	♦	
Uranium (U)	mg/L	0.001	♦	♦	
Zinc (Zn)	mg/L	0.005	♦	♦	
Nutrients					
Nitrite as N (NO2-N)	mg/L	0.01	♦		APHA 4500 B

Analyte	Units	LOR	Suite A	Suite B	Method Ref *
Nitrate as N (NO3-N)	mg/L	0.01	♦	♦	APHA 4500 F
Reactive phosphorous (SRP)	mg/L	0.01	♦	♦	APHA 4500-P H
Total Kjeldahl Nitrogen (TKN)	mg/L	0.2		♦	APHA 4500 N (Org)
Total Nitrogen (T-N)	mg/L	0.1	♦	♦	APHA 4500 N
Total Phosphorus (T-P)	mg/L	0.01	♦	♦	APHA 4500 B F
Radionuclides					
Radium-226 (Ra-226)	Bq/L	0.05	♦		APHA 7500
Radium-228 (Ra-228)	Bq/L	0.08	♦		APHA 7500
Uranium-238 (U-238)	Bq/L	<0.025	♦		-

NOTES:

- analytes shaded in **orange** have default limits for stock drinking water assigned in ANZECC/ARCMANZ (2000);
- analytes shaded in **purple** are identifed as toxicants (physical and chemical stressors) for aquatic ecosystems in ANZECC/ARCMANZ (2000);
- analytes shaded in **blue** are default indicators of concern for surface waters per the SEPP (Waters);
- the laboratory method reference codes are indicative only and may be modified upon selection of external laboratory;
- as per Section 7.5.5.2 of this EMP, gross alpha and gross beta (excluding K-40) are omitted from the radionuclide analytical suite as specific radionuclides (Ra-226, Ra-228 and U-238) are monitored for.

8.5.1 Quality control and quality assurance

Quality control and quality assurance measures will be the same as the described in Section 7.5.6 of the GWMMP.

8.5.2 Data management

All surface water monitoring data collected, including calibration and quality control and assurance data, will be stored and/or managed using an environmental data management system (currently Monitor Pro 5).

8.5.3 Post revegetation

Once the area of Pit 23 and surrounds has been revegetated the field measurements and laboratory analysis as detailed in Section 8.5.3 will be performed on samples of water flowing to the east (Red Hill Drainage Line) and the west (to Chadwick's Wetland).

Samples will be collected on-event (whenever run-off occurs) and sampling will continue until five consecutive sets of results collected over a period of at least one year show the quality of the water to be compliant with the relevant site-specific SWQOs in Section 8.3.2.2 (Table 22) of this SWMMP, or consistent with the quality of runoff as measured at analogue sites[7].

8.6 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 25 and Table 26, respectively.

[7] Based on SWQOs for DUSW25 (Red Hill Drainage Line) and DUSW11 (Chadwick's Wetland)

8.7 Reporting

Routine and exception reporting applicable to surface water is summarised in Table 27.

Table 25: Surface water - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
Surface water runoff, or groundwater discharge to surface waters, does not adversely affect beneficial uses.	Operations Rehabilitation	SFW-01	As per Section 8.4.3	Field and laboratory measurements and analyses	As per Section 8.5.1 (Table 23)	As per Section 8.5.3	No exceedance of the surface water quality criteria presented in Table 22 beyond natural background variability.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*

Table 26: Surface water - triggers and management responses

Trigger	Trigger Response	Contingency
Monitoring indicates that adverse changes to surface water quality have affected, or may affect, beneficial uses.	In the event that an exceedance of one or more SWQOs (i.e. following the investigations triggered according to Table 22 occurs): • follow-up sampling and analysis will be undertaken within one (1) month of receipt of the previous result. If the exceedance concerns one or more toxicants (e.g. heavy metal) analysis will include dissolved concentrations to allow a more informed assessment of stock exposure risk; • exceedances will be assumed as related to Pit 23 if all of the below apply: ○ <u>for groundwater-fed surface water sites</u>: ▪ the results of the follow-up sampling and analysis confirms a continued adverse trend/exceedance; ▪ the exceedance(s) correspond with a simultaneous trend of concern/exceedance in CL:SO4 and/or Na:Ca ratios; ▪ the timing of the above adverse trends/exceedances is less than 90% of that predicted in the hydrogeological model (i.e. seepage from Pit 23 may have arrived at the surface water site/receptor sooner than expected); ▪ the results are not consistent with the natural background chemistry at that site (where sufficient depth of data exists to allow this assessment). This recognises that some receptor sites have unique and variable chemistry that may naturally exceed the site-specific SWQOs); and ▪ similar trends of concern/exceedances are <u>not</u> observed in samples obtained from reference/analogue sites (per Table 19). Consideration should also be given to the chemistry of bores up-gradient from Pit 23 (i.e. Pit 23 local background quality), and up-gradient and cross-gradient to the receptor site in question, as this may infer the movement of contaminated groundwater from Pit 23 (and expression to surface waters) or the occurrence of some other natural phenomenon detected in the wider bore network. For example: ▪ similar trends of concern/exceedances observed in multiple bores down-gradient of Pit 23, but not up-gradient to Pit 23; ▪ no similar concern/exceedances in other bores up- and cross-gradient to the bore in question potentially indicating a bore-specific result. Where the outcome of above review does not suggest a seepage-related impact then no further action will be required or taken other than the continuation of routine monitoring. ○ <u>for runoff-fed surface water sites</u>: ▪ the observed exceedance corresponds with uncontrolled off-site discharges of turbid water from Pit 23. Where no causal link exists between the observed exceedances and Pit 23 (i.e. no evidence of turbid water runoff or discharge) then no further action will be required or taken other than the continuation of routine monitoring. • where the above assessment indicates an impact arising from Pit 23 operations: ○ where the impact relates to exceedances at a groundwater-fed surface water site: ▪ disposal to Pit 23 will be reduced or ceased (if necessary/applicable) to allow more detailed investigations to occur; ▪ the monitoring frequency will be increased to assess trends and understand the processes occurring; ▪ the hydrogeological model will be updated (and if necessary, re-calibrated); ▪ solute transport and/or impact assessments will be re-examined, including an evaluation of risk to groundwater-supported surface ecosystems; and ▪ an Exception Report and Action Plan (per Table 27) below will be prepared and submitted to the Responsible Authority. ○ where the impact relates to exceedances at a runoff-fed surface water site: ▪ contingency measures will be implemented to mitigate any further impact.	Where the impact relates to exceedances at a groundwater-fed surface water site – the nomination of contingency measures is dependent on the outcomes of any formal investigations which are implemented through an Action Plan (see Table 27 below). Where the impact relates to exceedances at a runoff-fed surface water site – determination will be made regarding the adequacy of the surface water drainage system as detailed in Section 8.4.3.3.

Trigger	Trigger Response	Contingency
Uncontrolled discharge of turbid water into the Red Hill Drainage Line or Chadwick's Wetland	In the event that an uncontrolled discharge of turbid water into the Red Hill Drainage Line or Chadwick's Wetland occurs: • the source of discharge and any failed drainage controls will be remedied as soon as practical; • follow-up field and sampling for laboratory analysis will be completed as soon as possible, and no later than one (1) week after the discharge; • results of this follow-up monitoring will be compared against the SWQOs in Table 22 to quantify the impact (if any) of the discharge; and • if that impact is found to be unacceptable, determination will be made as to any required upgrade of the management facilities (as detailed in Section 8.4.3.3) to prevent a recurrence, and implementation of such upgrades.	Not applicable – trigger responses (potential upgrade of the management facilities) are satisfactory.

Table 27: Surface water - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
SFW-01	EMP and R&VMP Performance Reports: • surface water quality monitoring results (screened against SWQOs), including discussion on any relevant trends or trigger exceedances. • if applicable, information on the outcome of any surface water exceedances or uncontrolled off-site discharges and status of any corrective/preventative actions planned or completed.	Submission of an Exception Report outlining: • details of exceedances of the SWQOs outlined in the SWMMP – as per the process outlined in Table 22 (SWQOs) and Table 26 above; • an Action Plan to prevent/remediate deleterious effects on beneficial uses, that may include any or all of the following: o further investigation of the cause, if not adequately understood; o detailed impact assessment based on re-calibrated models (i.e. groundwater models or surface water models); o development and implementation of strategies to prevent future unacceptable results or to mitigate any impacts; o reducing or ceasing the disposal to Pit 23 until observations are stabilised and/or at acceptable level

9 Air Quality / Dust Control Plan (AQMP)

Emissions to air of various pollutants may occur in the course of Pit 23 operations and rehabilitation.

Example air quality pollutants include carbon monoxide, volatile organic compounds (VOCs), ozone, nitrogen dioxide, sulfur dioxide, and fine and coarse particles (e.g. dust) that may result in adverse impacts to human health and the environment, local amenity and aesthetic enjoyment.

Under Victorian legislation these substances are used as indicators of both ambient air quality and as specific indicators of local air quality, the latter of which includes requirements for the management of emissions to air arising from mining and extractive operations. The legislation is based on the fundamental protection of beneficial uses of the air environment.

The Permit specifies the following requirements in regard to air quality/dust control:

Air quality / dust

33 The Air Quality / Dust Control Plan (AQMP) within the EMP must address and ensure compliance with the following requirements:

(a) Dust emissions to air must be managed to ensure that beneficial uses of the air environment are protected, and all emissions are reduced as far as is practicable by the application of best practice procedures and arrangements.

(b) The permit holder must ensure dust does not emanate from the Subject Land so as to exceed the Assessment Criteria for mining and extractive industries specified in Table 2, Clause 3.3 of the *SEPP (Air Quality Management) Protocol for Environmental Management: Mining and Extractive Industries* or any subsequent replacement document.

This Air Quality / Dust Control Plan (i.e. Air Quality Management Plan; AQMP) has been prepared to satisfy this permit condition.

9.1 Sources

The primary potential sources / impact pathways for dust and air quality impacts are:

- **operations phase** – activity of vehicles, plant and equipment (e.g. dust and exhaust emissions generated during waste deposition, placement of interim cover and ancillary activities) and passive dust lift-off from un-rehabilitated ground; and
- **rehabilitation phase** – rehabilitation earthworks (e.g. dust and exhaust emissions generated during backfilling of the pit and landform reinstatement).

9.2 Sensitive receptors

The relevant sensitive receptors are residences in the proximity of Pit 23. These are listed below and shown in Figure 21. Only residences within a 5km radius of Pit 23 are considered.

- Crown Allotment 96B (73 Elliotts Rd): approx.1.1km east of Pit 23, Iluka-owned and occupied;
- Lot 76 (134 Wombelano Rd): approx. 4.7km west south-west of Pit 23;
- Crown Allotment 96B (382 Jaspers Lane, but located at corner of Elliotts Rd and Wombelano Rd): approx. 2.0km east of Pit 23, Iluka-owned but vacant;
- Lot 1 (356 Wombelano Rd): approx. 3.1km east of Pit 23;
- Lot 15, 121 Brandts Rd: approx. 2.8km west north-west of Pit 23;
- Crown Allotment 87 (382 Jaspers Lane): approx. 4.9km south-east of Pit 23;

- Lot 2, 842 Jaspers Lane: approx. 4.8km south south-west of Pit 23;
- Crown Allotment 61A (567 Jaspers Lane): approx. 4.5km south south-east of Pit 23;
- Lot 10 (8 Harrow-Kanagulk Rd): approx. 2.6km north north-west of Pit 23 complex; and

Dust impacts to flora and fauna were assessed as negligible and rejected as receptors of concern in the pre-mine Environmental Effects Statement (EES) completed for the Douglas Mine (Martinick McNulty, 2001). As this assessment remains valid, and given the significantly smaller scale of the Pit 23 activities, air quality impacts to flora and fauna are not considered further within this EMP.

Inset aerial photo: Oct. 2018

DOUGLAS MINE

PIT 23 AIR QUALITY SENSITIVE RECEPTORS

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:35,000 (A3) DATE: Oct. 2019 DWG No: 257188 ver.00

FIGURE: **21**

9.3 Applicable legislation, standards and guidelines

The primary legislation relevant to dust and air quality emissions from the Douglas Mine is the EP Act and the subsidiary and *State Environment Protection Policy (Ambient Air Quality)* (SEPP AAQ) (GoV 1999) and *State Environment Protection Policy (SEPP) Air Quality Management* (SEPP AQM) (GoV 2001).

The SEPP AQM establishes the framework for managing emissions into the air environment in Victoria from all air pollutant sources, so that the air quality objectives outlined in SEPP AAQ are met.

Supporting the SEPP AQM is the *Protocol for Environmental Management for Mining and Extractives Industries* (Mining PEM) (EPA, 2007). This PEM is an incorporated document to the SEPP AQM and sets out the statutory requirements for the management of emissions to the air environment arising from mining and extractives operations. These statutory requirements are applied as *intervention levels* (assessment criteria) against which all sources within a defined area are assessed.

Further to setting the assessment criteria the Mining PEM sets requirements for air emissions modelling, monitoring and level of management effort required for different developments (i.e. sites or facilities). Developments are classed in order of risk as either Level 1, Level 2 or Level 3 developments based on the scale of the operation, its location (urban or rural) and proximity to sensitive receptors. Pit 23 meets the definition of a 'Level 3' developments being of a small scale, sited in a rural zone and with sensitive receptors located at some distance from site and with off-site impacts demonstrated as negligible (see further discussion below). Level 3 developments under the Mining PEM do not require modelling or continuous compliance monitoring against assessment criteria with emission risks deemed to be manageable using best-practice controls only.

The assessment criteria for air quality indicators specified in Table 2 of the Mining PEM are given in Table 28 below. Commentary on the relevance or otherwise of these indicators to Pit 23 operations and rehabilitation phase is also discussed.

Table 28: Air quality objectives and assessment criteria per the Mining PEM

Indicator	Units	PEM: Mining & Extractive Industries	
		Assessment Criteria	Averaging Period
Particles as PM_{10}	$\mu g/m^3$	60	24 hrs
Particles as $PM_{2.5}$	$\mu g/m^3$	36	24 hrs
Respirable crystalline silica as $PM_{2.5}$	$\mu g/m^3$	3	1 year
Arsenic (total inorganic) (As)	$\mu g/m^3$	0.003	1 year
Hydrogen cyanide	$\mu g/m^3$	340	1 hour
		9	1 year
Nitrogen dioxide (NOx)	ppm	0.14	1 hour
Carbon monoxide (CO)	ppm	29	1 hour
Polyaromatic hydrocarbons (PAHs)	ng/m^3	0.3	1 year
Asbestos	$\mu g/m^3$	0.2	1 year
	$fibres/m^3$	0.05	1 year
Radionuclides	-	ALARA *	1 year

* ALARA (as low as reasonably achievable)

Pre-mine air quality modelling (based on a theoretical, worst case maximum production rate of 800,000t/pa) predicted that CO and NOx emissions were only likely to exceed the Mining PEM assessment levels at three private residences adjacent the northernmost and southernmost zones of the 'Bondi East' deposit and only at discrete times (Collins & Associates, 2001; Environmental Health Services, 2002). On this basis no routine monitoring for CO and NOx was warranted during the life of the Douglas Mine.

These air quality indicators, along with PAHs, are therefore discounted as indicators of concern for both the operations and rehabilitation phases of Pit 23 given that:

- the scale of activities (size of earthmoving fleet and scale/extent of activities) is significantly less in comparison to the worst-case conservative scenario applied in the pre-mine air quality models for the greater Douglas mine (detectable concentrations of these indicators in air would be negligible); and
- the separation distances between Pit 23 site and occupied residences in the area.

With respect to hydrogen cyanide, asbestos and arsenic:

- there are no industrial processes, manufacturing, industrial cleaning or other activities undertaken on site that use hydrogen cyanide;
- there is no structural or natural asbestos fibre sources present on site; and
- the concentration of arsenic in the MSP by-products is approximately 52ppm and if this was the concentration of arsenic in the PM_{10} (conservative assumption), and the concentration of PM_{10} was continuously at the specified limit of 60µg/m^3, the concentration of arsenic in the air would be approximately 0.003µg/m^3. When annual averaging is considered any concentrations of arsenic in air associated with dust from Pit 23 would be insignificant.

The following air quality indicators are considered to be applicable based on a valid source/impact pathway. Commentary on their risk potential and methods of monitoring is given below.

- PM_{10} dust;
- $PM_{2.5}$ dust;
- Respirable crystalline silica as $PM_{2.5;}$
- Radionuclides.

Dust emissions from mining contain PM_{10} and $PM_{2.5}$ particulates in a ratio of between 13 and 28. A PM_{10} concentration at the 60µg/m^3 limit would therefore indicate a $PM_{2.5}$ concentration less than 5µg/m^3 i.e. significantly less than the assessment criteria of 36µg/m^3.

The maximum $PM_{2.5}$ concentration, 24-hour average, would be 5µg/m^3 or less, so the annual average is expected to be of the order of 1-2 µg/m^3. The proportion of the $PM_{2.5}$ material that is crystalline silica will be 30% or less so the annual average concentration of crystalline silica in the $PM_{2.5}$ can be expected to be 0.6µg/m^3 or less i.e. well below the assessment criteria 3µg/m^3.

The use of measures to keep exposure to radionuclides As Low As Reasonably Achievable (ALARA) is a requirement of Iluka's Radiation Management Licence issued under the *Radiation Act 2005*. As outlined in Section 1.3.1 of this EMP, radiation management and monitoring requirements are outside the scope of this EMP as they are regulated under other legislation and approvals.

In summary, demonstration of compliance with the PM_{10} assessment criteria will provide demonstration of compliance with the legislative assessment criteria for $PM_{2.5}$ and crystalline silica as $PM_{2.5}$. No other air quality indicators per Table 2 of the Mining PEM are relevant.

9.3.1 Pit 23 dust and air quality objectives

Based on the relevance of various air quality indicators and the Mining PEM, the dust and air quality objectives for Pit 23 are given in Table 29. Should any revisions to the PM_{10} or $PM_{2.5}$ objectives in the *National Environment Protection (Ambient Air Quality) Measure* or *State Environment Protection Policy (Ambient Air Quality)* or the Assessment Criteria in the *Protocol for Mining and Extractive Industry* occur the listed trigger values will be assessed and amended as appropriate.

Table 29: Air quality objectives and assessment criteria applicable to Pit 23

Indicator	Units	Threshold	Averaging Period	Method
Particles as PM_{10}	**µg/m^3**	**60**	**24 hours**	Hi-vol [A]

Particles as $PM_{2.5}$	$\mu g/m^3$	36	24 hours	
Respirable crystalline silica as $PM_{2.5}$	$\mu g/m^3$	3	1 year	

[A] High-volume air-samplers ('hi-vols') as per AS/NZS 3580.9.6:2015.

9.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to air quality.

9.4.1 Risk analysis

An extensive PM_{10} monitoring dataset exists for the greater Douglas site covering periods prior to mining (baseline conditions), active mining and post-mining rehabilitation phase. From the summary of life-of-mine PM_{10} data (refer to Table 30) and associated monitoring notes the following is observed:

- while PM_{10} concentrations were/are slightly elevated in the mining and rehabilitation phases compared to pre-mine, the average PM_{10} concentrations across all three sites over the Douglas life-of-mine have been uniformly low in the range of 12 $\mu g/m^3$, well below the 60$\mu g/m^3$ limit;
- only two (2) exceedances of the 60$\mu g/m^3$ PM_{10} concentration limit attributed to Douglas site operations were recorded over the entire monitoring period (from 2001 to 2018) noting that:
    - both occurred at 'The Rises' residence south of the Douglas Mine during the active mining phase, with the last exceedance in November 2009. Monitoring at this site ceased in December 2018 based on the life-of-mine data and absence of a valid dust source and pathway of impact; and
    - these two exceedances represent 0.08% of all measurements that have been obtained since monitoring commenced in 2001.
- all other measured 'exceedances' over the span of monitoring were attributed to non-mining sources including third-party agricultural activities, stock activity, bushfires/controlled burns or prevailing weather conditions upwind from the Douglas Mine and the air sampling units; and
- there is no evidence that the Douglas Mine (or Pit 23) has adversely impacted the local air environment.

When considering this data in the context of Pit 23 operations and rehabilitation it is evident that Pit 23 activities would not result in dust emissions that exceed the SEPP and Mining PEM Assessment Criteria for PM_{10} (and thus $PM_{2.5}$ and crystalline silica).

However, as Condition 33(b) of the Permit requires that Iluka demonstrate compliance with the assessment criteria in the Mining PEM (summarised in Table 29 above), monitoring and reporting for PM_{10} will be undertaken but will be limited to:

- the Pit 23 rehabilitation phase, when the potential for dust generation is the greatest (i.e. dust emissions from pit backfilling and rehabilitation earthworks); and
- only in the warmer/summer months of October through March inclusive, when prevailing wind and weather conditions are conducive to directing potential emissions towards sensitive receptors (refer to Table 31).

No continuous compliance monitoring and reporting for PM_{10} will be undertaken in the Pit 23 operations phase given that the limited frequency and intensity of activities has negligible potential for dust emissions and adverse impact on sensitive receptors, however should activities significantly increase the reinstatement of monitoring will apply (as defined in Section 9.4.4).

Table 30: PM_{10} statistics (Douglas life-of-mine)

Phase	Date Range	Data points (Count, n)	PM_{10} (µg/m³)				St. Dev (1σ)	Exceedances attributed to Douglas / Pit 23
			Min	Max	Med	Avg		
Monitoring Point: Chadwick's House (NB. Iluka-owned residence)								
Pre-mining	Jan 2001 - Oct 2004	149	1.0	76.3	5.6	7.6	9.2	
Mining	Nov 2004 - Feb 2012	321	1.0	64.1	7.7	10.5	9.1	
Rehabilitation	Mar 2012 - Jun 2019	396	1.0	74.4	6.2	9.1	9.0	
All Data	Jan 2001 - Jun 2019	866	1.0	76.3	6.6	9.3	9.1	
Monitoring Point: Lyon's House								
Pre-mining	Jan 2001 - Oct 2004	N/A – Hi-Vol unit installed March 2008						Not applicable
Mining	Nov 2004 - Feb 2012	137	1.0	87.3	7.6	10.6	11.2	
Rehabilitation	Mar 2012 – Jun 2019	403	2.0	130.9	8.6	13.0	13.5	
All Data	Jan 2001 – Dec 2018	540	2.0	130.9	8.5	12.4	13.0	
Monitoring Point: The Rises #								
Pre-mining	Jan 2001 - Oct 2004	148	2.0	42.2	4.4	5.4	5.0	
Mining	Nov 2004 - Feb 2012	324	1.0	124.5	7.6	13.0	13.1	2
Rehabilitation	Mar 2012 – Dec 2018	384	1.0	67.4	8.0	11.4	10.7	
All Data	Jan 2001 – Dec 2018	856	1.0	124.5	8.0	11.4	12.2	
SUMMARY								
Pre-mining	**Jan 2001 - Oct 2004**	**297**	**1.0**	**76.3**	**4.7**	**6.5**	**7.4**	
Mining	**Nov 2004 - Feb 2012**	**782**	**1.0**	**124.5**	**7.8**	**11.5**	**12.3**	**2**
Rehabilitation	**Mar 2012 - Jun 2019**	**1,183**	**1.0**	**130.9**	**7.8**	**11.2**	**11.3**	
ALL DATA	**Jan 2001 – Jun 2019**	**2,262**	**1.0**	**130.9**	**7.1**	**10.7**	**11.4**	**2**

High-volume PM_{10} monitoring at 'The Rises' ceased as of 31st December 2018 (as approved through the Douglas Mine 2018 Work Plan Variation, under Mining Licence MIN5367) on the basis of risk assessment and data as presented herein.

Data as presented excludes statistical outliers (± 4 x standard deviations from the mean), null/zero values and erroneous values.

Table 31: Wind Velocity and Direction Data for Months October to March

Time period	Range of wind speed in km/h	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row totals
9 am Oct	>= 0 and < 10	3.6	7.6	4.7	6.1	5.5	**9.4**	4.1	4	3.6	48.5
	>= 10 and < 20	2.7	3.8	2	2.8	4	**7.2**	3.5	3.8	0	29.8
	>= 20 and < 30	1.2	1.9	0.6	0.8	2	**4**	1.6	2.5	0	14.6
	>= 30 and < 40	0.4	0.4	0.1	0.4	0.2	**1.6**	0.9	0.6	0	4.5
	>= 40	0.1	0.1	0	0.1	0.3	**1.2**	0.7	0.1	0	2.6
	Column Totals	8	13.8	7.4	10	12	**23.4**	10.8	11.1	3.6	100
3 pm Oct	>= 0 and < 10	2.5	4.1	2.7	5.7	5.4	**9.5**	4.4	5.4	1.5	41.3
	>= 10 and < 20	2.9	1.7	0.6	2.9	3.8	**9.2**	3.7	4.8	0	29.5
	>= 20 and < 30	1.4	1.4	0.4	1.3	2.6	**5.1**	2.9	3.2	0	18.2
	>= 30 and < 40	0.3	0.2	0	0.1	0.6	**1.8**	1.5	1	0	5.5
	>= 40	0.2	0	0	0	0.6	**2.1**	1.7	0.8	0	5.4
	Column Totals	7.3	7.4	3.8	10	12.9	**27.8**	14.1	15.1	1.5	100
9 am Nov	>= 0 and < 10	2.9	7.5	5.2	7.6	7.7	**10.7**	2.7	3.3	3.2	50.8
	>= 10 and < 20	1.3	3.8	2.5	3.9	3.9	**6.8**	2.7	2.4	0	27.2
	>= 20 and < 30	0.8	2.2	0.8	1.8	2.2	**4.9**	1.6	1.2	0	15.4
	>= 30 and < 40	0.5	0.3	0.4	0	0.5	**1.8**	0.4	0.3	0	4.3
	>= 40	0.1	0.1	0.1	0.1	0.3	**1.2**	0.3	0.2	0	2.3
	Column Totals	5.5	13.9	8.8	13.4	14.6	**25.4**	7.8	7.4	3.2	100
3 pm Nov	>= 0 and < 10	2.6	4	2.4	4.6	5.5	**10.1**	4.5	5.6	1.8	41
	>= 10 and < 20	1.7	1.5	1.6	2.5	5.3	**8.4**	3.1	4.2	0	28.4
	>= 20 and < 30	0.8	0.8	0.4	1.7	3.5	**7.4**	2.7	2.6	0	19.9
	>= 30 and < 40	0.3	0.3	0	0	0.4	**2.5**	1.4	0.7	0	5.6
	>= 40	0.1	0.1	0	0	0.6	**2.2**	1.4	0.7	0	5.1
	Column Totals	5.4	6.7	4.4	8.9	15.3	**30.7**	13.1	13.8	1.8	100
9 am Dec	>= 0 and < 10	2.5	7	4.8	**9.9**	7.1	8.7	3	3	2.8	48.7
	>= 10 and < 20	1	3.5	2.3	4.6	4.3	**7.9**	1.9	1.2	0	26.6
	>= 20 and < 30	0.8	1.7	1.2	1.8	1.8	**5.3**	1.1	1.4	0	15.1
	>= 30 and < 40	0.5	0.5	0.2	0.3	0.8	**2**	0.8	0.4	0	5.6
	>= 40	0.5	0.1	0.1	0.2	0.8	**1.6**	0.6	0.1	0	4
	Column Totals	5.3	12.8	8.5	16.7	14.9	**25.5**	7.3	6.1	2.8	100
3 pm Dec	>= 0 and < 10	2.4	3.2	2	6.4	5.4	**11.6**	4.5	6	2.3	43.8
	>= 10 and < 20	1.3	1.7	0.9	3.2	5.2	**8.7**	2.5	4.2	0	27.9
	>= 20 and < 30	0.3	0.7	0.2	1	1.9	**7.1**	2.7	2.5	0	16.4
	>= 30 and < 40	0.3	0.1	0.2	0.2	0.8	**2.3**	1.4	1	0	6.5
	>= 40	0.2	0.1	0	0.2	0.8	**2.4**	1.3	0.5	0	5.4
	Column Totals	4.6	5.8	3.4	11	14.1	**32.2**	12.4	14.2	2.3	100
9 am Jan	>= 0 and < 10	2.8	7.8	4.7	**10.9**	9.9	9.5	2.7	3.2	0	54.5
	>= 10 and < 20	1.2	2.9	3.1	4.1	4.3	**6**	2.1	1.5	0	25.2
	>= 20 and < 30	0.3	1.4	0.8	1.9	2	**4.3**	1.1	1.2	0	13
	>= 30 and < 40	0.5	0.4	0.2	0.3	0.9	**1.9**	0.5	0.4	0	4.9
	>= 40	0.4	0.2	0.2	0.3	0.3	**0.7**	0.1	0.2	0	2.4
	Column Totals	5.2	12.6	9	17.5	17.3	**22.5**	6.4	6.3	3.2	100
3 pm Jan	>= 0 and < 10	2.7	5.1	1.9	8.4	6.4	**10.2**	3.3	6.8	1.9	46.7
	>= 10 and < 20	1.1	1.2	0.9	3.8	4.8	**7.9**	3.2	3.8	0	26.6
	>= 20 and < 30	0.8	0.6	0.3	1.6	3.1	**5.9**	2.3	1.8	0	16.4

Time period	Range of wind speed in km/h	% of wind from (N)	% of wind from (NE)	% of wind from (E)	% of wind from (SE)	% of wind from (S)	% of wind from (SW)	% of wind from (W)	% of wind from (NW)	% of Calms	Row totals
	>= 30 and < 40	0.3	0.2	0.1	0.1	0.9	**1.8**	1.3	0.9	0	5.4
	>= 40	0.1	0	0	0.2	0.6	**1.9**	1.1	1	0	4.9
	Column Totals	4.9	7.1	3.1	14.1	15.9	**27.6**	11.2	14.2	1.9	100
9 am Feb	>= 0 and < 10	2	8.3	6.6	**13.5**	10.3	10.4	1.9	2.4	4.9	60.3
	>= 10 and < 20	1.5	3.2	2.5	**5.4**	4.6	5.1	0.8	1.5	0	24.5
	>= 20 and < 30	0.5	1.1	1	1.9	1.9	**3.5**	0.5	0.6	0	11
	>= 30 and < 40	0.2	0.2	0	0.3	0.6	**1.1**	0.3	0.1	0	2.7
	>= 40	0.3	0.1	0	0	0.2	**0.7**	0.1	0.1	0	1.4
	Column Totals	4.4	12.8	10.1	**21.1**	17.6	20.8	3.5	4.7	4.9	100
3 pm Feb	>= 0 and < 10	3.3	5.5	2.7	10.3	6.8	**11.7**	4	6.6	2.3	53.1
	>= 10 and < 20	1.5	1.9	0.8	4.2	5.2	**6.6**	2.3	2.8	0	25.4
	>= 20 and < 30	0.7	0.4	0.5	1.5	2.5	**4.9**	1.5	1.8	0	13.8
	>= 30 and < 40	0.4	0.1	0	0.1	1	**1.9**	1.2	0.5	0	5.2
	>= 40	0.1	0.1	0	0.1	0.3	**1**	0.6	0.2	0	2.5
	Column Totals	6	7.9	4	16.1	15.8	**26.3**	9.7	11.9	2.3	100
9 am Mar	>= 0 and < 10	2.4	10	6.2	11.4	9.1	**13.1**	2.9	2.3	4.2	61.8
	>= 10 and < 20	1	2.9	2.4	3.8	4.2	**5.9**	1.7	1.4	0	23.2
	>= 20 and < 30	0.6	1.3	0.8	1.9	1.9	**3**	0.7	0.5	0	10.8
	>= 30 and < 40	0.4	0.2	0.1	0.1	0.4	**1**	0.4	0.3	0	3
	>= 40	0.1	0.1	0.1	0.1	0.3	**0.3**	0.2	0.1	0	1.3
	Column Totals	4.5	14.4	9.6	17.4	15.9	**23.5**	5.9	4.7	4.2	100
3 pm Mar	>= 0 and < 10	3.1	6.5	2.5	8.4	7	**11.2**	4	7.3	2.2	52.3
	>= 10 and < 20	1.3	1.9	1.2	3.7	4.6	**5.6**	2.1	2.9	0	23.3
	>= 20 and < 30	0.8	0.4	0.4	1.6	2.8	**6.1**	2	2	0	16
	>= 30 and < 40	0.1	0	0	0.2	0.6	**1.7**	1	0.6	0	4.1
	>= 40	0.3	0.1	0	0.1	0.6	**1.9**	0.7	0.6	0	4.2
	Column Totals	5.6	8.9	4.2	14.1	15.6	**26.4**	9.7	13.4	2.2	100
Values in bold represent highest values for velocity in time period Data Sourced from BOM: http://www.bom.gov.au/climate/averages/climatology/windroses											

9.4.2 Standard controls

The following standard controls apply to dust and air quality risk management. These accord with 'best-practice' measures for dust management for 'Level 3 developments' in the Mining PEM and therefore satisfy the requirements of Conditions 33(a) and 33(b) of the Permit.

- designated Pit 23 access roads (sheeted);
- site vehicle speed limits;
- tarpaulins and sealed tailgates on all trucks/trailers carrying materials for disposal;
- prohibition on stockpiling of materials for disposal outside of the pit;
- application of interim cover (capping) on deposited wastes;
- limiting any dust creating works (i.e. earthmoving activities) on high dust-risk (e.g. dry and windy) days[8];

[8] wind speeds above 18-20 km/h are generally recognised as the point at which dust is generated by wind

- where practical, application via water truck of water and, if required, biodegradable crust forming chemicals to:
    - unsealed roads;
    - deposited materials within the pit;
    - stockpiles; and
    - other exposed areas.

9.4.3 Risk assessment

With the implementation of standard controls, the risk of dust and air quality impacts on sensitive receptors is low.

This assessment is summarised in the RARP Risk Register (RSK-004; Appendix A).

9.4.4 Monitoring

Monitoring of air quality follows the below program:

Operations Phase

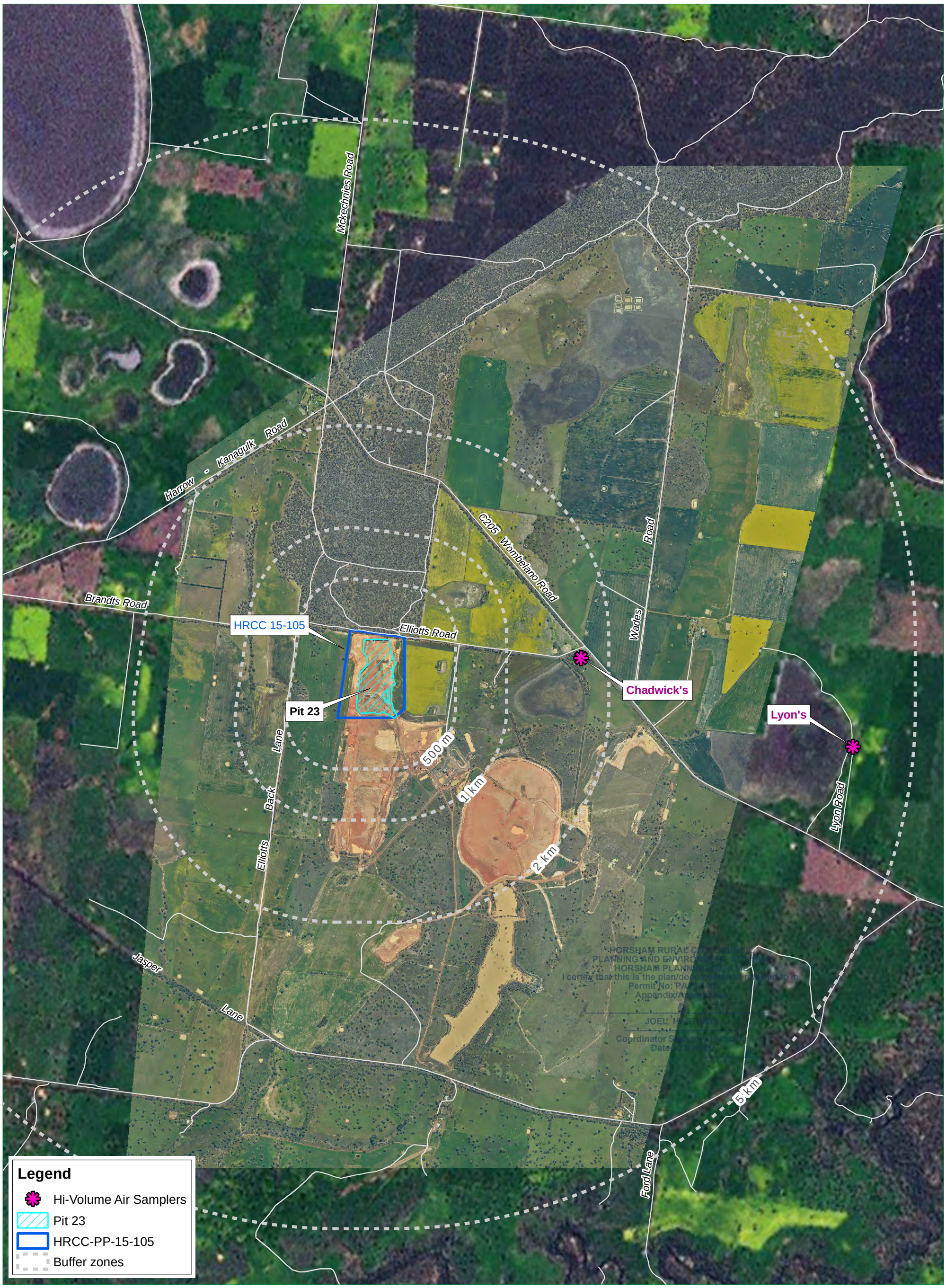
- Monitoring of wind forecasts (wind speed and direction) and visible dust emissions (on event) to inform in-field management (e.g. temporary suspension of dust generating activities, dust suppression).
- Monitoring of PM10 concentrations to commence in the event of significant increase in activity.

Rehabilitation Phase

- Monitoring of wind forecasts and on-event dust emissions as per above; and
- Monitoring of PM10 concentrations in air as per Table 32 below. Monitoring locations are shown in Figure 22.

Table 32: Pit 23 dust and air quality monitoring program

Sample Point ID	Location	When	Frequency	Method	Parameters
"Chadwick's House"	CA 96B 73 Elliotts Rd Kanagulk (Iluka owned but vacant)	October – March (inclusive)	1-in-6 day sampling	Hi-volume air sampler (per AS/NZS 3580.9.6:2003)	PM_{10} levels (24-hr averaged)
"Lyon's House"	CA 76 134 Wombelano Rd (private residence)				



Inset aerial photo: Oct. 2018

DOUGLAS MINE

PIT 23 AIR QUALITY (PM10) MONITORING LOCATIONS

ILUKA

ORIG: N.Travers DRAWN: D.G.S. SCALE: 1:35,000 (A3) DATE: Oct. 2019 DWG No: 257189 ver.00

FIGURE: **22**

9.4.5 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 33 and Table 34, respectively.

9.4.6 Reporting

Routine and exception reporting applicable to air quality is summarised in Table 35.

Table 33: Air quality - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
Dust emissions to air are managed such that beneficial uses of the air environment are protected, with emissions reduced as far as is reasonably practicable by the application of best practice measures.	Operations Rehabilitation	DST-01	As per Section 9.4.2	<u>Operations Phase</u> As per Section 9.4.4 <u>Rehabilitation Phase</u> As per Section 9.4.4			Records indicate that PM_{10} levels are within limits and complaints are addressed and management/corrective actions implemented.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*

Table 34: Air quality - triggers and management responses

Trigger	Trigger Response	Contingency
Visual dust emissions	Actions that may be taken if levels of visible dust are excessive include: • increased dust suppression by watering or application of commercial dust suppressants; • enforcement or reduction of speed limits and/or restriction of earthmoving activities in Pit 23; and • temporary suspension of dust generating activities.	Not applicable – trigger responses are satisfactory
Exceedance of PM_{10} assessment criteria *(PM_{10} monitoring undertaken in rehabilitation phase only)*	Assess whether site activities could have been responsible for the dust event. This will consider: • the type, timing and duration of site activities (if any); • the extent to which standard controls were, or were not, being implemented during or prior to the time of the dust event; • the occurrence of other non-site related activities in the area as potential causes/contributors (e.g. stock activity, fires, major weather events, 3rd-party agricultural activities); • the nature of the 3rd-party observation (e.g. dust plume near/at the Pit 23 site, ambient dust at the complainant's residence etc) and the location of the impacted residence (if applicable) relative to Pit 23; • the prevailing wind and weather conditions at the time, particularly wind speed and direction relative to Pit 23 and/or the complainant's residence. If no site activities were being undertaken at the time of the dust event(s) and 3rd-party activities, weather conditions and other data are identified as causal factors the exceedance will be deemed non-site related with no further action required. If this same assessment concludes that the exceedance was associated with site activities an Action Plan will be developed to investigate and rectify the issue.	For PM_{10} exceedances / dust complaints linked to site activities (*whichever applies*), implement an Action Plan that may include: • review of subsequent PM_{10} monitoring results to assess if adverse air quality impacts have continued; • reactive (real-time) PM_{10} monitoring, per Section 6.3 of the Mining PEM; • suspension of site activities; • investigation to identify any failings of the air quality management program, and corrections required; • amendment of this EMP to reflect modified practices, standard controls and/or monitoring; • for complaints, consultation with the complainant(s) to advise on the steps taken to address.
Dust complaint from member of the public	If a dust complaint is received the following actions apply: • implement field-level management responses, if required; • assess whether site activities could have been responsible for the dust event as outlined for PM_{10} exceedances (above), and including a review of available PM_{10} monitoring data for the period in question. If no site activities were being undertaken at the time of the dust event(s) and 3rd-party activities, weather conditions and other data are identified as causal factors the exceedance is deemed non-site related with no further action required. If this same assessment considers that the dust complaint is valid and is associated with site activities an Action Plan will be developed to investigate and rectify the issue.	

Table 35: Air quality - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
DST-01	<u>EMP and R&VMP Performance Reports</u>: • Results of dust (PM_{10}) monitoring undertaken in the reporting period, including discussion of any relevant trends and any exceedances attributed to Pit 23 activities; • Summary of any dust complaints received; and • For dust complaints or PM_{10} exceedances linked to Pit 23 activities, the actions undertaken to resolve.	<u>Submission of an Exception Report outlining:</u> • Details of the PM_{10} exceedance or complaint (whichever applies); • An Action Plan detailing the actions to be undertaken to resolve.

10 Management of other environmental aspects

10.1 Noise

Noise from industrial and commercial activities may impact on local residences and communities and human health impacts can arise in cases of ongoing noise disturbance. Factors that influence sensitivity to noise include the noise type, level, duration and frequency; the existing background noise level; weather conditions (e.g. wind, temperature); distance between the source and receptor; and human factors (physiological, psychological and social sensitivity).

Consistent with the surrounding agricultural land use, background noise levels in the area are typically low, but increase during crop sowing and harvesting when machinery can operate 24 hours a day. Traffic on local roads, particularly Wombelano Road, also increases during the summer harvest period.

The Permit specifies the following requirements in regard to noise:

Noise

10 The permit holder must comply with noise limits determined in accordance with the EPA Guideline Publication 1411 Noise from Industry in Regional Victoria (NIRV: EPA Publication 1411, 2011), or any subsequent replacement document.

10.1.1 Sources

The primary sources of noise emissions are:

- **operations phase** – activity of vehicles, plant and equipment (e.g. road traffic and waste deposition, the placement of interim cover and ancillary activities);
- **rehabilitation phase** – earthmoving activities associated with pit backfilling and landform reinstatement, and noise generated during decommissioning works.

Noise arising from any third-party activity within the Pit 23 area (e.g. noise from agricultural and land management activities such as slashing, ploughing, cropping, sowing and other), along with any emergency activities, are not considered 'operational noise' and are beyond the scope of this EMP.

10.1.2 Sensitive receptors

The relevant noise sensitive receptors are occupied private residences in proximity of the Pit 23.

These residences are the same as for air quality (refer Section 9.2, and Figure 21).

10.1.3 Applicable legislation, standards and guidelines

The primary legislation relevant to noise emissions is the EP Act and subsidiary EPA (2011) guidelines *Noise from Industry in Regional Victoria*. Condition 10 of the Permit mandates that Iluka complies with EPA (2011).

EPA (2011) provides a method for determining recommended maximum noise levels at sensitive receptors, and use of this method determines the Zone Levels. Applying this method and with consideration of the sensitive receptor zone (Farming, FZ) the maximum noise levels applicable to Pit 23 are given in Table 36.

Table 36: Maximum noise levels at sensitive receptors (affected residences) (from EPA, 2011)

Period	Times/days		Maximum noise level, dB(A)[9]
Day	07:00 – 18:00	Monday-Friday	46
	07:00 – 13:00	Saturday	
Evening	18:00 – 22:00	Monday-Sunday	41
	13:00 – 18:00	Saturday	
	07:00 – 18:00	Sundays and public holidays	
Night	22:00 – 07:00	All days	36

EPA (2011) provides for variations to these noise limits in certain circumstances including "final site rehabilitation", which is defined as "*any activity related to site closure occurring at the final surface level after normal operations have ceased. It does not include backfilling of a pit*" (EPA, 2011; Table 4). The allowed variation is for the recommended maximum noise level to be increased by +10 dB up to a maximum of 68 dB(A) subject to notification to affected neighbours and consideration of factors such as project duration, the timing of activities and weather conditions that may exacerbate noise impacts.

Landform reinstatement activities and the placement/profiling of topsoil and subsoil fit the description of final site rehabilitation therefore the noise limit at sensitive receptors during the "Day" as defined in Table 36 are expected to increase to 56 dB(A) during such activity.

Further, in accordance with the 'Schedule for Construction and Demolition Site Noise' within the *EPA Victoria Noise Control Guidelines* (EPA, 2008), a +10dB(A) increase in noise levels above background noise is permitted for deconstruction and demolition activities up to a limit of 68dB(A). Demolition-related noise must not exceed +10dB(A) on background for greater than 18 months, or +5dB(A) after 18 months. This exception applies to any 'decommissioning activities' as referenced in the Permit.

10.1.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to noise.

10.1.4.1 Risk analysis

While multiple factors influence noise impact (sensitivity) the risk is best considered in terms of the noise level, duration and frequency and distance to the receptor.

All occupied residences (sensitive receptors) are at significant distances from the Pit 23 facility, which buffers and attenuates effective noise levels between source and receptor.

With regard to the **operations** phase:

- waste disposal into Pit 23 is generally intermittent and the frequency, intensity and duration of noise emissions from vehicles, plant and equipment is therefore minimal; and
- noise emissions from within the Pit 23 are largely attenuated by the void and pit walls. While the efficacy of this attenuation will reduce over time as the void is filled, the by-product disposal surface will remain at least 5m below the natural topography and noise attenuation would continue.

With regard to the **rehabilitation** phase:

- no noise complaints have been recorded during the rehabilitation phase of the adjacent Douglas mine (February 2012 to current); Douglas mine rehabilitation works are equivalent in scope to the rehabilitation works that will apply to Pit 23 (i.e. pit backfilling and landform

[9] dB(A) = decibels, A-weighted

reinstatement, using similar plant and equipment), albeit much larger in scale/intensity and typically closer to the same receptors, and is an analogue for noise risk associated with Pit 23 rehabilitation activities;

- decommissioning activities will be undertaken infrequently and will be minor in nature given the absence of any large infrastructure within, or associated with, the Pit 23 facility. Noise emissions from these activities would be minimised in accordance with the principles for construction/demolition noise as per the Noise Control Guidelines (EPA, 2008).

10.1.4.2 Standard controls

Standard noise management and mitigation measures include:

- on-site speed limits;
- prioritising vehicle movements, waste deposition and interim capping activities for "day" hours as far as reasonably practical;
- undertaking rehabilitation earthworks during "day" hours; and
- for decommissioning activities, applying the demolition noise reduction principles as per the Noise Control Guidelines (EPA, 2008).

10.1.4.3 Risk assessment

With the implementation of standard controls, the risk of noise impacts on sensitive receptors is low.

This assessment is summarised in the RARP Risk Register (RSK-006; Appendix A).

10.1.4.4 Monitoring

Routine noise monitoring to confirm compliance with recommended noise limits is not warranted or proposed.

In the event that complaints regarding noise levels are received, measurements of 'effective noise level' will be made per the methodologies set in the *EPA Victoria Information Bulletin – A guide to the measurement and analysis of noise* (EPA, 1991).

As compliance with EPA (2011) is mandated by Condition 10 of the Permit, the end point for monitoring in response to noise complaints is on cessation of the Permit (or earlier, as otherwise agreed with the Responsible Authority).

10.1.4.5 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 37 and Table 38, respectively.

10.1.4.6 Reporting

Routine and exception reporting applicable to noise is summarised in Table 39.

Table 37: Noise - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
Noise emissions comply with the maximum noise levels for earth resources activities as prescribed in EPA Publication 1411 – Noise from Industry in Regional Victoria (EPA 2011).	Operations Rehabilitation	NSE-01	As per Section 10.1.4.2	Not applicable *On event only (on receipt of complaint)*	Not applicable *On event only (on receipt of complaint)*	Measurement of effective noise levels at location of receptor per methodology defined in *EPA Victoria Information Bulletin – A guide to the measurement and analysis of noise.*	Records indicate that all noise complaints are addressed, noise monitoring undertaken and findings communicated to complainants.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*
Noise emissions from decommissioning activities comply with the Schedule for Construction and demolition site noise specified in the EPA Noise Control Guidelines (EPA 2008).	Rehabilitation	NSE-02	As per Section 10.1.4.2	As above	As above	As above	As above	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*

Table 38: Noise - triggers and management responses

Trigger	Trigger Response	Contingency

Noise complaint from member of the public	If a noise complaint is received the following actions apply:
	• assess whether site activities could have been responsible for the noise event. This will consider the type, timing and duration of site activities (if any), the time of the alleged noise event(s) and wind and weather conditions at the time(s) in question;
	• if no site activities were being undertaken at the time of the noise event(s) the matter will be deemed non-site related with no further action required;
	• if site activities were being undertaken at the time of the noise event(s):
	  ○ noise levels at the sensitive receptor will be measured (if the activity will be repeated allowing such measurement, otherwise an estimate of noise levels will be undertaken based on available noise emission data); and
	  ○ results compared against the permitted noise limits in EPA (2011) (as per Section 10.1.3 above) including allowances for final site rehabilitation or demolition/decommissioning activities, if applicable.
	• if measured / estimated noise levels confirm that permitted noise limits were not exceeded then a noise-related incident (non-compliance) has not occurred and no follow-up actions will apply.
	• if measured / estimated noise levels did exceed or are exceeding the permitted noise limits:
	  ○ the sources of the noise will be investigated and those activities suspended;
	  ○ an Action Plan developed to prevent further exceedances of applicable limits;
	  ○ an Exception Report submitted to the Responsible Authority as described per Table 39, including any action plan that has been developed; and
	  ○ this EMP updated to incorporate the Action Plan outcomes, with the amended EMP approved of the Responsible Authority.
		Implement an Action Plan that may include:
		• additional monitoring;
		• noise modelling to assess alternative mitigation measures;
		• further restrictions on operating hours; and
		• modification of operations, e.g. speed limits, equipment used etc.

Table 39: Noise - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
NSE-01 NSE-02	EMP and R&VMP Performance Reports: • Summary of any complaints received and results of noise monitoring/investigation; and • For noise events deemed as site-related, the outcomes of any Action Plan(s) that were implemented.	Submission of an Exception Report outlining: • Details of the complaint(s); • An Action Plan detailing the actions to be undertaken to resolve.

10.2 Weeds

Declared, priority weeds (i.e. 'high-threat' environmental weeds) represent an environmental or economic risk through the infestation of agricultural land (loss of productivity) and competition with and exclusion of native flora in areas of remnant vegetation and revegetation. Given their potential impact, declared weed species are the priority for control and management.

No pathogens such as *Phytophthora cinnamomi* ('dieback'), Ovine Johne's Disease or others have been recorded in the area. As contaminated vehicles are a common route for both pathogen and weed movement, management for weeds (e.g. vehicle hygiene) is a complimentary control for pathogens and, on this basis, pathogen risks and controls are not considered further in this plan.

The Permit specifies the following requirement in regard to weeds and pathogens:

Weeds

12 All vehicles, earth-moving equipment and other machinery must be cleaned of soil and plant material before leaving the designated Pit 23 site, to prevent the spread of weeds and pathogens…to the satisfaction of the responsible authority.

39 The subject land must be managed so as to ensure that high-threat environmental weeds (as identified by the Responsible Authority) are eliminated, and other environmental weeds are controlled, to the satisfaction of the Responsible Authority.

This section of the EMP specifically addresses Condition 39. Compliance with Condition 12 of the Permit, while complimentary, is addressed separately under Section 10.3.

10.2.1 Sources

The primary potential sources/pathways for noxious weed incursion onto site are:

- weed seeds and vegetative matter contamination on vehicles, earthmoving equipment, mobile plant and agricultural machinery;
- wind; and
- import of contaminated soil, gravels and other substrates for site works.

10.2.2 Sensitive receptors

The relevant sensitive areas (receptors) for weeds are:

- native vegetation established during rehabilitation and re-vegetation;
- remnant native vegetation adjacent the Pit 23 site (e.g. Red Hill Forest Reserve); and
- agricultural cropping/grazing land within or adjacent to the Pit 23 boundary;

10.2.3 Applicable legislation, standards and guidelines

Statutory obligations for the management of declared, priority weeds apply under the *Catchment and Land Protection Act 1994* (CaLP Act). Under the Act all declared weeds require control with said programs falling to the State (DJPR), or the landowner or land manager, depending on the classification of the weed species in question.

At a regional level, the *Wimmera Invasive Plant and Animal Management Strategy 2019* (IPA) (WCMA, 2019) provides direction on weed management, prioritised according to a species-based and asset-based protection approach, with the highest priority activities being those listed under the species-based approach. Weeds are prioritised within Appendix 4 of the IPA and categorised with regard to the type of action required, being:

- prevent and eradicate;

- contain (and eradicate where practical); and
- asset protection

The IPA is the key reference document which guides control practices undertaken by Iluka and is consistent with the requirements of Condition 39 of the Permit.

10.2.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to weeds.

10.2.4.1 Risk analysis

With regard to the **operations phase**:

- no declared weed species have occurred to-date in the Pit 23 boundary since the commencement of the Planning Permit. The level of impact, should incursions occur, is negligible given the operating status of the facility and lack of receptors;
- waste consignments into Pit 23 originate primarily from the Hamilton MSP, with trucks subject to a hygiene wash-down at point-of-departure;
- transport routes to Pit 23 (up until the Douglas Mine boom gate) are via sealed roads and the opportunity for weed contamination of vehicles en-route is effectively nil; and
- earthmoving equipment operating within Pit 23 (e.g. access track maintenance, placement of interim capping and other works) are site based and their potential as a vector for weed incursion is highly unlikely.

On this basis the risk is considered to be acceptable and no formal weed management or routine monitoring programs are proposed during the operations phase.

The consequence of declared weed incursions is greatest in the **rehabilitation phase** given the threat to establishing revegetation. Standard controls to mitigate weed risks are given in Section 10.2.4.2. Specific weed management and monitoring measures that will apply prior to and during revegetation works are addressed within the R&VMP.

10.2.4.2 Standard controls

Standard controls to mitigate the incursion of declared weeds include:

- washing equipment prior to entry or exit through the Douglas Mine boom-gate access;
- nil importation of soil from external sources (not including soil, overburden and other resources required for Pit 23 operations and/or rehabilitation – i.e. materials sourced from the adjacent Douglas Mine);
- where gravel, crushed rock or other non-soil substrate is required to be imported to site, care will be taken to ensure that the material is free from noxious weed seed; and
- as-required removal of weeds through methods such as herbicide spraying, scalping and hand-pulling.

To limit any potential of spray drift and impact to native plants through the root zones, Glyphosate formulations will be used as the standard approach for weed control by herbicide.

10.2.4.3 Risk assessment

With the implementation of standard controls, the risks associated with declared weeds are low.

This assessment is summarised in the RARP Risk Register (Risk # RSK-007; Appendix A).

10.2.4.4 Monitoring

Routine monitoring for weeds during the operations phase is not warranted.

Monitoring for weeds during the rehabilitation phase includes general area inspections and assessment of weed infestations as part of scheduled revegetation monitoring events, as described in the R&VMP.

As management and monitoring of 'high-threat' weeds is mandated by Condition 39 of the Permit, the end point for monitoring is on cessation of the Permit (or earlier, as otherwise agreed with the Responsible Authority).

10.2.4.5 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 40 and Table 41, respectively.

No contingency measures are warranted as the trigger responses nominated in Table 41 are satisfactory for the management of declared weed incursions.

10.2.4.6 Reporting

Routine reporting applicable to weeds is summarised in Table 42.

The occurrence of a declared weed within the Pit 23 boundary does not warrant an exception report on the basis of risk. Standard controls and trigger responses provide appropriate management and routine reporting of such actions is adequate.

Table 40: Weeds - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
Declared weeds targeted for 'prevention and eradication' (as per Appendix 4 of the *Wimmera Invasive Plant and Animal Management Strategy 2019* (IPA)) identified within tenement boundaries are recorded and controlled.	Rehabilitation	WDS-01	• As per Section 10.2.4.2; • As per R&VMP (Section 9.4.7 – Weed control).	Operations Phase Not required	Operations Phase N/A	• location and abundance of weeds; • identification of any priority declared weeds per the IPA.	Records indicate that declared weeds targeted for 'prevention and eradication' as per Appendix 4 of the IPA were managed.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*
				Rehabilitation Phase As per Section 11.2 of R&VMP	Rehabilitation Phase As per Section 11.2 of R&VMP			

Table 41: Weeds - triggers and management responses

Trigger	Trigger Response	Contingency
Incursion of declared weeds within the Pit 23 boundary	If an incursion of a declared weed species is identified the following actions will be implemented: • herbicide spraying with Glyphosate formulations or scalping of weeds from operational areas, and from topsoil stockpiles; • spot spraying with Glyphosate formulations of identified weed infestations within revegetated areas; and • hand-pulling of weeds where appropriate.	Not applicable – trigger responses are satisfactory

Table 42: Weeds - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
WDS-01	EMP and R&VMP Performance Reports: • Summary of any declared weed incursions; and • Actions undertaken to resolve.	Not applicable – not warranted on the basis of risk.

10.3 Vehicle hygiene

Light vehicles, vehicles delivering materials for disposal and earthmoving equipment that have operated within Pit 23 and subsequently exit the site have the potential to transfer mud, clay, soil, NORM and organic material onto public roads. This risk is increased during wet conditions.

The Permit specifies the following requirement in regard to vehicle hygiene:

Vehicle-wash

12 All vehicles, earth-moving equipment and other machinery must be cleaned of soil and plant material before leaving the designated Pit 23 site, to prevent the spread of weeds and pathogens, and to ensure vehicles leaving the site do not deposit mud or other materials on roadways, to the satisfaction of the responsible authority.

Accumulated waste and debris from the clean-down process must be periodically removed from sediment traps associated with the clean-down facilities and disposed of within Pit 23, or otherwise in a manner to the satisfaction of the responsible authority.

13 The permit holder must ensure that all public roads within 200 metres of the intersection of the mine access road with Elliotts Road are maintained free of debris, mud, clay or other deposits, from the Subject Land, to the satisfaction of the responsible authority.

10.3.1 Sources

The primary source/cause of a hygiene non-compliance event is no, or inadequate wash-down of plant, vehicles and equipment.

10.3.2 Sensitive receptors

The relevant sensitive receptor associated with vehicle hygiene is public amenity.

10.3.3 Applicable legislation, standards and guidelines

Requirements to manage vehicle hygiene are mandated solely through Conditions 12 and 13 of the Permit. No legislation or other instruments apply to this aspect.

10.3.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to vehicle hygiene.

10.3.4.1 Risk analysis

Vehicle hygiene risks include the uncontrolled transport of mud, NORM or weeds/organic matter off-site with departing waste trucks the primary vector.

In a scenario where no wash-down or other standard controls applied:

- the potential for mud entrainment is mainly limited to winter months, when wet weather prevails and, should it occur, any off-site deposition would be confined to the Douglas mine access road and Elliotts Road;
- the potential for NORM entrainment is highly unlikely given the manner in which by-products are placed and managed (side-tipping, the application of interim cover/capping and dedicated site-based earthmoving equipment to manage this material); and
- weed/organic matter entrainment is also highly unlikely given the limited potential for vehicle and plant interaction with vegetation during active operations and rehabilitation earthworks. Similarly, vehicle interaction with vegetation post-rehabilitation is highly unlikely given the imperative to minimise disturbance to the rehabilitating system.

10.3.4.2 Standard controls

Standard controls for vehicle hygiene include:

- wash-down of all plant, vehicles and equipment leaving Pit 23;
- designated Pit 23 access roads (sheeted, with drainage);
- earthmoving equipment used in the operations phase for the management of deposited NORM wastes and interim capping (cover) is exclusively site-based;
- interim capping (cover) of deposited NORM wastes and by-products; and
- temporary suspension of waste disposal and earthmoving activities in wet weather, as required.

The Douglas mine truck wash accepts trucks and light vehicles. This facility is automatically activated and consists of:

- a series of three water tanks;
- a pump delivering water from the tanks to the wash bay; and
- a wash-bay fitted with spray nozzles and a collection pan.

Water and solids collected on the collection pan are returned to the tanks. When required, sediment collected in the tanks is removed, subjected to analysis for hydrocarbon contamination, treated to remove hydrocarbons (where required), and then transported by truck to Pit 23 for disposal as per Condition 12 of the Permit.

In the event that the truck wash facility is non-operational, alternative vehicle cleaning methods will be applied, including:

- use of the secondary wash-bay;
- brushing down in the pit;
- hose-down in the workshop wash down bay; and
- portable tank and pump for hose-down in the pit.

Oversize and/or tracked plant and machinery will be washed down at the workshop wash-down bay. The wash-down bay has a concrete surface that drains into a sump and triple interceptor. As with the main truck was facility, sediments collected in the triple interceptor are removed, subjected to analysis for hydrocarbon contamination, treated to remove hydrocarbons (where required), and then transported by truck to Pit 23 for disposal. Hydrocarbons collected in the triple interceptor are collected and disposed of by a licenced waste contractor.

10.3.4.3 Risk assessment

With the implementation of standard controls, the risk of uncontrolled off-site entrainment of mud, NORM and weed/organic matter is low.

This assessment is summarised in the RARP Risk Register (Risk # RSK-008; Appendix A).

10.3.4.4 Monitoring

Routine monitoring for vehicle hygiene includes:

- visual inspection of roads in proximity to site for the presence of mud or debris linked to vehicles, plant and equipment linked to Pit 23 activities; and
- targeted inspection of earthmoving equipment and related plant leaving site identified as contaminated with mud, debris, NORM or organic material (e.g. earthmoving machinery, drill rigs).

As compliance with vehicle hygiene requirements is mandated by Condition 12 of the Permit, the end point for monitoring and management is on cessation of the Permit (or earlier, as otherwise agreed with the Responsible Authority).

10.3.4.5 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 43 and Table 44, respectively.

No contingency measures are warranted as the trigger responses nominated in Table 44 are satisfactory for the management of off-site contamination linked to site activities.

10.3.4.6 Reporting

Routine reporting applicable to vehicle hygiene is summarised in Table 45.

A vehicle hygiene non-compliance (mud, debris, NORM or other material deposited on a public road within 200 metres of the intersection of the mine access road with Elliotts Road) does not warrant an exception report on the basis of risk. Standard controls and trigger responses provide appropriate management and routine reporting of such actions is adequate.

Table 43: Vehicle hygiene - management objectives, monitoring requirements and measurement criteria

Management Objective(s)	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
No uncontrolled off-site movement of mud, debris, NORM or weed/organic matter on vehicles, plant and equipment leaving site.	Operations Rehabilitation	HYG-01	As per Section 10.3.4.2	Visual inspection – public roads in proximity of Pit 23	Weekly	Presence of mud, debris, NORM or other material – deposited on a public road within 200 metres of the intersection of the mine access road with Elliotts Road.	Records indicate that clean-up was undertaken	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*
				Visual inspection – earthmoving equipment and related plant leaving site	On event (as required)	Equipment and plant are free of contamination	Records indicate that wash-down was undertaken	

Table 44: Vehicle hygiene - triggers and management responses

Trigger	Trigger Response	Contingency
Presence of mud, debris, NORM or other material deposited on a public road within 200 metres of the intersection of the mine access road with Elliotts Road.	If material is identified: • assess whether the deposited material is associated with site activities. This will consider the type, timing and duration of site activities (if any) as a potential source/pathway; • if a link to site activities is confirmed or suspected, complete recovery of the material with disposal to Pit 23.	Not applicable – trigger responses are satisfactory

Table 45: Vehicle hygiene - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
HYG-01	EMP and R&VMP Performance Reports: • Summary of any vehicle hygiene non-compliance events in the reporting period; and • Actions undertaken to resolve.	Not applicable – not warranted on the basis of risk.

10.4 Public safety

The Pit 23 void and associated activities have the potential to impact public safety, private property and public infrastructure.

Risks, controls and monitoring related to differential settlement of the final landform are addressed separately within the R&VMP.

10.4.1 Sources

Potential impact pathways that could result in harm/impact include:

- site-related traffic – road collision with public road user;
- illegal or inadvertent/accidental access to site by members of the public;
- injury to site visitors (slips/trips/falls, falls from pit crests); and
- geotechnical instability (failure of pit walls).

10.4.2 Sensitive receptors

The relevant sensitive receptors are:

- members of the public;
- private property; and
- public infrastructure.

10.4.3 Applicable legislation, standards and guidelines

Broad objectives for the protection of public health and safety as a result of business activities (undertakings) are prescribed within the *Occupational Health & Safety Act 2004*. Any health and safety hazard created as a result of work or work-related activities can be considered under the public safety scope of the Act. Relevant sections include:

- Section 2(1)(C) – to ensure that the health and safety of members of the public are not placed at risk by the conduct of undertakings by employers and self-employed persons.
- Section 23(1) – an employer must ensure, so far as is reasonably practicable, that persons other than employees of the employer are not exposed to risks to their health or safety arising from the conduct of the undertaking of the employer.

There are no requirements in the Permit that relate to public safety.

10.4.4 Risk analysis and response

This section addresses Condition 25 of the Permit with respect to public safety.

10.4.4.1 Risk analysis

The history of the adjacent Douglas mine, as it relates to public safety, provides relevant context for the assessment of public safety risks associated with Pit 23.

Over the Douglas life-of-mine:

- there were no recorded instances of injury or harm to members of public as a result of Douglas mine site-related traffic; and
- there were five recorded instances involving uncontrolled site access by members of the public. Three instances involved persons presenting to mine administration after accessing the site through the security gate (inadvertent access), one of undeclared access onto site and one instance involving multiple persons trespassing the southern mine site boundary via Jaspers Lane.

With respect to Pit 23, there have been no incidents involving site-related traffic, injury to visitors, trespass or inadvertent access to-date or since commencement of the Permit.

An assessment of risk to the public, private property and infrastructure associated with a pit wall failure considers whether the any receptors exist within the failure zone. The CSIRO *Guidelines for open pit slope design* (CSIRO, 2009) provide a method to determine the geotechnical failure risk associated with pits/voids. This method applies the concept of a 'geotechnical failure zone' as determined through either two-dimensional stability modelling, or minimum recommended factors-of-safety (FoS) for different slope categories.

Geotechnical audit, two-dimensional stability modelling and geotechnical risk assessment of the Pit 23 void commissioned by Iluka (Sonnekus, 2018) determined that:

- the only sensitive receptor relevant to Pit 23 was Elliotts Road, which parallels the Pit 23 north wall/pit crest. Based on stability modelling using a conservative factor-of-safety (FoS) the Pit 23 north wall is assessed as geotechnically stable (low geotechnical risk), with a failure zone that is well within the Pit 23 boundary and would not impact Elliotts Rd;
- the eastern pit wall, despite having experienced minor slumps in 2013/2014, presents a low geotechnical risk. However, the higher sand content in this wall requires effective surface water drainage at the pit crest and toe to mitigate any further instability;
- the western pit wall, despite minor slumps in 2013/2014, presents a low geotechnical risk with no applicable sensitive receptors. No specific controls are required; and
- the southern pit wall and access road embankments are stable and present low geotechnical risk with no applicable sensitive receptors. No specific controls are required.

10.4.4.2 Standard controls

Traffic

- site operations and associated traffic movements are prioritised for daylight hours.

Illegal/inadvertent public access

- secure site access (boom gate, locked outside of hours);
- alternative farm gate entry points padlocked;
- boundary fencing including chain-mesh security fencing along the northern boundary with Elliotts Rd;
- boundary signage "*Danger – Active Mine Site*"; and
- security cameras.

Visitor safety

- visitor induction, visitor PPE (personal protective equipment) and escort at all times.

Geotechnical stability (pit walls)

- determination of the geotechnical failure zone where sensitive receptor(s) exist;
- pit crest and toe drainage to reduce seepage and wall instability, as required; and
- exclusion zones to prevent unauthorised access to the toes of the pit walls.
- observance of exclusion zones at the toe of pit walls, including installation of safety bunds and warning signage.

10.4.4.3 Risk assessment

With the implementation of standard controls, the risk of harm to members of the public associated with Pit 23 operations and rehabilitation is low.

This assessment is summarised in the RARP Risk Register (Risk # RSK-009; Appendix A).

10.4.4.4 Monitoring

Routine monitoring to ensure public safety includes:

- visual inspection of security fencing and access points;
- review of security camera footage from Pit 23 and other areas;
- geotechnical general inspections (wall slumping/collapse, drainage conditions and exclusion zones); and
- geotechnical engineer audits.

10.4.4.5 Objectives, monitoring program, triggers and contingency

Management objectives, mitigation measures (standard controls), routine monitoring requirements (including end points for monitoring) and trigger levels and responses are summarised in Table 46 and Table 47, respectively.

10.4.4.6 Reporting

Routine and exception reporting applicable to public safety is summarised in Table 48.

Table 46: Public safety - management objectives, monitoring requirements and measurement criteria

Management Objective	Applicable Phase(s)	Objective ID	Standard Controls	Routine Monitoring			Measurement Criteria (Evidence of Compliance)	End point for monitoring
				Type	Freq.	Parameter(s)		
No public injuries or deaths to members of the public resulting from site activities that could have been reasonably prevented.	Operations Rehabilitation	PSF-01	As per Section 10.4.4.2	Visual inspection – security fence and access points	Quarterly	Fence and gate condition, access points secured	Should an incident occur, incident investigation concludes that the incident was not a result of site activities, or could not have been reasonably prevented.	Cessation of Permit *(or earlier, as otherwise agreed with the Responsible Authority)*
				Review of security camera footage	Monthly	Incident type, description, classification and action taken.		
No harm to the public, property or infrastructure resulting from geotechnical instability.	Operations	PSF-02	As per Section 10.4.4.2	Visual inspection – geotechnical stability	Monthly	Wall slumping/collapse, drainage, exclusion zones.	As above	When the Pit 23 void is backfilled
				Geotechnical Engineer Audit	Biennial (two-yearly)	As per *Guidelines for Open Pit Slope Design* (CSIRO, 2009)		

Table 47: Public safety - triggers and management responses

Trigger	Trigger Response	Contingency
Monitoring identifies that a site security measure has failed	Failed site security measures repaired or reinstated.	Not applicable – trigger responses are satisfactory
Pit wall slumping that is considered significant relative to the scale of the pit. This includes: • new locations of wall slumping/failure that are not localised or minor in nature; or • the expansion of existing slumping/failure zones which are not minor in nature; or • slumping and failures which may pose a risk to sensitive receptors.	Geotechnical inspection and risk assessment by geotechnical engineer that may lead to: • re-design of exclusion zones; and • immediate action to enhance pit wall stability.	Implement recommendations arising from geotechnical study that may include: • reduction in pit wall slopes; • buttressing of pit walls; and • controlled placement of material against pit walls.

Table 48: Public safety - routine and exception reporting

Management Objective(s)	Routine Reporting	Exception Reporting
PSF-01	<u>EMP and R&VMP Performance Reports</u>: • Summary of any public safety incidents in the reporting period; and • Actions undertaken to resolve.	A reportable incident has occurred in any instance where injury/harm to a member of the public has occurred related to site activities and investigation determines that the incident was attributed to site operations and could have been reasonably prevented. Incidents involving illegal activity and road traffic collisions involving members of the public will be escalated to police and emergency services. Incidents involving harm to site visitors shall be managed in accordance with Iluka injury management protocols and the Douglas Emergency Response Plan, including escalation to emergency services if required. Preliminary notification shall be provided to the Responsible Authority once initial incident and/or emergency response processes have concluded. Formal reporting will be provided to the Responsible Authority on completion of investigation, where applicable.
PSF-02	<u>EMP and R&VMP Performance Reports</u>: • Summary of any geotechnical incidents in the reporting period; and • Actions undertaken to resolve.	

11 Stakeholder engagement

In accordance with the requirements of the Permit:

- contact details will be provided of a person or people for the receipt and actioning of complaints and other comments relating to activity on the site;
- a register of complaints and other comments will be maintained; and
- EMP and Rehabilitation Performance Reports, which will be provided to the Responsible Authority and published on Iluka's website, will include a "complaints statement" summarising the complaints register and actions taken in response to complaints.

12 Reporting

12.1 Routine reporting

A review of performance will be completed and an EMP and Rehabilitation Performance Report prepared annually on a calendar year basis, or as otherwise agreed with the Responsible Authority.

The structure and content of each report will follow that given in Table 49. Where no activities applied in the reporting period for a certain aspect or activity this will be referenced as “Not Applicable” in the report with a brief supporting explanation provided.

EMP and Rehabilitation Performance Reports will be subject to review by an independent auditor as described in Section 13.1.2 below.

Table 49: Structure of EMP and Rehabilitation Performance Reports

Item	Information to be provided
General	
Applicable Reporting Period	Time period covered by report
Executive Summary	Summary of compliance to environmental objectives Summary of rehabilitation activities and performance
Waste Disposal Summary	
Waste Disposed	Summary of waste volumes disposed in the reporting period
Pit Backfill Status	The maximum elevation of the upper surface of materials disposed of at the end of the reporting period.
Environmental Performance	
Groundwater	Reporting as detailed in GWMMP (Table 19)
Surface Water	Reporting as detailed in SWMMP (Table 28)
Air Quality	Reporting as detailed in AQMP (Table 35)
Noise	Reporting as detailed in Table 39
Weeds	Reporting as detailed in Table 42
Vehicle Hygiene	Reporting as detailed in Table 45
Public Safety	Reporting as detailed in Table 48
Rehabilitation Performance	
Rehabilitation Summary	Detailed summary of rehabilitation activities undertaken in the reporting period (e.g. decommissioning, overburden return, revegetation activities).
Other	
Comments / Complaints	Summary of comments / complaints received and resulting actions
Outlook	Plans for the next reporting period
Other Matters	Discussion on other matters considered relevant by the Responsible Authority or Iluka.
Plan Amendment(s)	Summary of any amendments/updates to the EMP, IWMP or R&VWMP in the reporting period (if applicable)

12.2 Exception reporting

Triggers for exception reporting and the content of such reports are as specified in the relevant Sections of this EMP.

Should no response from the Responsible Authority be received within four (4) weeks of submission of an Exception Report, the actions taken and proposed will be deemed appropriate and sufficient, and it will be taken that no additional actions are required.

13 External auditing and subject matter experts

13.1 EPA Accredited Auditor functions

The following functions will be performed by accredited auditors:

- as required by Condition 17 of the Permit, this plan must receive the endorsement of an environmental auditor appointed under the *Environment Protection Act 1970* (EPA Accredited Auditor);
- as required by Condition 20 of the Permit, EMP and Rehabilitation Performance Reports must be reviewed by an independent, suitably qualified person with expertise in risk management plans in the context of mines and quarries who is an EPA Accredited Auditor;

13.1.1 Plan endorsement

While the Permit requires the endorsement of an EPA Accredited Auditor, the function of plan endorsement is not an audit function. The requirement for an EPA accredited auditor is one means by which a reputable and reliable person can be selected to complete the task. EPA accredited auditors are of three types: contaminated land, industrial facilities and natural resources. For audits of MSP by-product disposal operations into Pit 23, an industrial facilities or contaminated land auditor are considered appropriate.

The selected auditor will be commissioned to review the EMP to form a view as whether:

- the EMP fully meets the requirements of the Permit; and
- implementation of the EMP can be reasonably expected to result in the achievement of the objectives of the EMP.

If the appointed auditor is satisfied that the EMP satisfies the above outcomes then the auditor will provide formal endorsement of the plan.

With regard to this audit process it noted that:

- due to the range of environmental aspects covered by this EMP, the appointed auditor may seek to engage the services of other experts to assist in their review; and
- there is no requirement for the selected auditor to be independent of Iluka or to be to the satisfaction of the Responsible Authority.

A report by the selected auditor, including endorsement of the EMP, will be provided to the Responsible Authority with the submitted plan.

13.1.2 Performance Report review

The performance review function is, in part, an audit function in that the selected auditor will be required to audit EMP and Rehabilitation Performance Report to confirm its completeness and accuracy in terms of compliance of the implementation of the plan and compliance with established standards and limits.

In addition to these audit functions the selected auditor will be invited to recommend amendments to the EMP to ensure future compliance.

There are a number of requirements of the auditor in this case, including:

- EPA auditor accreditation;
- independence (from Iluka);
- suitable qualifications; and
- expertise in risk management plans in the context of mines and quarries.

It is extremely unlikely that an expert meeting all of these requirements exists, however, an expert may choose to direct the work of others.

A scope of works will be prepared and a number of EPA accredited auditors asked to submit proposals for the completion of Performance Report reviews.

A copy of the auditor's report will accompany each EMP and Rehabilitation Performance Report that is submitted by Iluka to the Responsible Authority.

Any deficiencies identified or recommendations made by the auditor will be dealt with in accordance with Conditions 44 and 45 of the Permit, which require:

- copies of the EMP and Rehabilitation Performance Report and the auditor's report to be provided to the Responsible Authority with 28 days of receipt of the auditor's report;
- a description of steps to be taken, including timeframes, to address any non-compliance and recommendations identified in the EMP and Rehabilitation Performance Report and the auditor's report be provided to the Responsible Authority within 28 days of submission of the EMP and Rehabilitation Performance Report to the Responsible Authority;
- the Responsible Authority to determine whether amendment to the EMP or R&VMP is required and the timeframe and conditions under which such amendment is to occur.

13.2 Subject matter expert functions

The following functions will be performed by subject matter experts:

- updates/re-calibration of the Douglas Mine / Pit 23 conceptual and numerical hydrogeological model (modelling reviews);
- updates to solute transport modelling;
- updates to the Douglas Mine / Pit 23 surface water runoff (hydrologic) model; and
- any independent reviews of such models commissioned at Iluka's discretion, at the recommendation of an EPA Accredited Auditor or as required by the Responsible Authority.

Copies of expert reports will be provided to the Responsible Authority.

14 Plan review and amendment

This plan will be reviewed every three (3) years at a minimum, but may be reviewed at any time for the following reasons:

- advances in knowledge gained from the results of monitoring, including updates to trigger levels to reflect new data;
- advances in knowledge and technology pertaining to disposal. This includes updated information obtained through technical studies and investigations;
- changes in applicable legislation, environmental protection policies and regulatory standards and guidelines;
- to address shortcomings in monitoring programs, management controls, trigger responses and contingency mechanisms identified as an outcome of exception reports, incident investigations, external auditor findings/recommendations or directives from regulatory authorities;
- changes in Iluka HSEC Management System standards; and
- in response to recommendations of an EPA Accredited Auditor made when undertaking plan review/endorsement (per Section 13.1.1) or Performance Report reviews (Section 13.1.2).

In the case of an amendment recommended by an EPA Accredited Auditor completing a review of the EMP and Rehabilitation Performance Report, Iluka will either:

- request an amendment as recommended by the Auditor; or
- request an amendment that achieves the objectives of that recommended by the Auditor but by alternative means.

In the case of the latter the requested amendment must be accompanied by an endorsement by the Auditor.

In accordance with Condition 47 of the Permit, the amended plan (once approved by the Responsible Authority) will be made available to the public via the Iluka website.

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16 Acronyms and abbreviations

ACHRIS	Aboriginal Cultural Heritage Register and Information System
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Bq/L	Becquerels per Litre
CaLP	*Catchment and Land Protection Act 1994* (VIC)
CO	Carbon monoxide
dB(A)	Decibels, A-weighted
DSITI	Department of Science, Information Technology and Innovation
DL	Detectable Limit
DO	Dissolved Oxygen
EC	Electrical Conductivity
EES	Environmental Effects Statement
EMP	Environmental Management Plan
EP Act	*Environment Protection Act 1970*
EPA	Environmental Protection Authority
EVC	Ecological Vegetation Class
FWD	Fresh Water Dam
GWQOs	Groundwater Quality Objectives
HMC	Heavy Mineral Concentrate
HRCC	Horsham Rural City Council
HSEC	Health, Safety, Environment and Community
HSECMS	Health, Safety, Environment and Community Management System (Iluka)
Iluka	Iluka Resources Limited
IWMP	Incoming Waste Monitoring Plan (Pit 23)
Km	Kilometre(s)
LOD	Limit of detection (laboratory)
LOR	Limit of reporting (laboratory)
m	Metre(s)
m^3	Cubic metre
mAHD	Metres Australian Height Datum
mBq/m^3	Millibecquerels per cubic metre
ML	Megalitres
MSP	Mineral Separation Plant
ng/m^3	Nanograms per cubic metre

NIRV	Noise from Industry in Regional Victoria (EPA Publication 1411)
NORM	Naturally Occurring Radioactive Material
NOx	Nitrogen oxides
NTU	Nephelometric Turbidity Unit
P&E Act	*Planning and Environment Act 1987*
PEM	Protocol for Environmental Management for Mining and Extractives Industries
pH	Potential of Hydrogen
$PM_{2.5}$	Particulate matter 2.5 micrometers or less in diameter
PM_{10}	Particulate matter 10 micrometers or less in diameter
ppm	Parts per million
SEPPs	State Environment Protection Policies
SEPP AQM	State Environment Protection Policy Air Quality Management
SEPP (Waters)	State Environment Protection Policy (Waters)
SWQOs	Surface Water Quality Objectives
TDS	Total Dissolved Solids
$\mu g/m^3$	Micrograms per cubic metre
µm	Micrometre(s)
µS/cm	Microsiemens per centimetre
µSv/h	Microsieverts per hour
R&VMP	Rehabilitation and Vegetation Management Plan (Pit 23)
WCMA	Wimmera Catchment Management Authority
WQOs	Water Quality Objective(s)

APPENDICES

Appendix A: RARP Risk Register

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-001 *(Iluka CGR Risk ID 5787)*	Operations Rehabilitation	Groundwater – change in groundwater quality impacting applicable beneficial uses (SEPP Waters - Segment F). Applicable receptors: • stock water bores (primary receptor); • groundwater dependent ecosystems (GDEs).	• Leaching from disposed by-MSP products; • Lack of hydrogeological assessment (no groundwater predictive model); • Inadequate or no assessment of leachability potential and fate of potential contaminants; • Groundwater predictive model not updated / maintained – prior modelling assumptions not validated.	<u>Key studies and Investigations</u> • Douglas Mine and Pit 23 groundwater predictive model (CDM Smith 2014; EMM 2019) – key findings: o groundwater flows from Pit 23 are to the north-west; o key sensitive receptors are an un-named drainage line north of Pit 23, McGlashin's Swamp and White Lake (GDEs); o no stock bores exist along the predicted flow path; o extremely slow rate of groundwater flow – no adverse impacts predicted to any receptor/GDE along the predicted flow path from Pit 23; • Pit 23 Groundwater Quality Risk Assessment inc. by-products leachability analysis (Jacobs 2014) – key findings: o MSP by-products not readily leachable: Radium-226 (0.4%), Radium-228 (0.2%); o negligible to minor, short-term stress on groundwater environment with rapid recovery; o no change in aquifer yield or quality; o impacts within the range of natural variability – beneficial uses remain protected; o no impact to connected surface water systems and GDEs. • Solute Transport Modelling (Jacobs 2016a) – key findings: o increases in TDS concentrations expected up to 500m beyond Pit 23 with minimal impact to beneficial uses; o nil predicted increases in any radionuclides beyond the boundary of Pit 23 – no adverse impact to beneficial uses or downstream GDEs. **Refer Section 7.4 of EMP for detailed summary of applicable studies and assessment of risk.** All above-listed studies and investigations have been tested and endorsed through VCAT (Reference No. P1368/2016) (VCAT, 2017).	Mod.	Unlik.	**Med**	<u>**Standard Controls (all phases)**</u> • Incoming waste acceptance criteria – refer to Pit 23 IWMP; • Groundwater monitoring – refer Section 7.5 of EMP; • Trigger levels derived in accordance with SEPP (Waters) and ANZECC Guidelines; • Trigger responses and contingency measures – Refer Section 7.6 of EMP	Mod.	Rare	**Low**	<u>**Operations Phase**</u> **Mitigation mandatory –** obligations for groundwater protection apply per the Planning Permit (Condition 23, 27 and 28) and the SEPP (Waters) irrespective of residual risk ranking. <u>**Rehab Phase**</u> As per above. **Risk is acceptable when the groundwater completion criteria specified in the R&VMP is achieved.**	<u>**Operations Phase**</u> **Yes –** Refer Section 7.5 of EMP <u>**Rehab Phase**</u> **Yes –** As per above	<u>**Operations Phase**</u> **Yes** – Refer Section 7.6 of EMP <u>**Rehab Phase**</u> **Yes –** As per above

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-002	Operations Rehabilitation	Groundwater – groundwater bores not accessible for monitoring.	**Operations Phase** • Access to bores prevented/prohibited by third-party (e.g. private landowner); • Bore damage or failure (e.g. blocked, damage prevents use of monitoring equipment). **Rehab Phase** • As for operations phase	• Eight (8) additional monitoring bores installed in 2018 to augment the Pit 23 bore network. All installed on Iluka-owned land or 3rd-party land with landowner agreement; • No further monitoring bores proposed; • No specific 'monitoring' of accessibity issues applies. Any issues are identifiable in the course of routine monitoring.	Insig.	Unlik.	Low	**Standard Controls** Operations Phase • Monitoring bores sited predominantly on Iluka-owned land or within local council roadside reserves; • Environmental monitoring access agreements for installation of / access to monitoring bores on private land, as required. Rehab Phase • As per above; • Progressive decommissioning of redundant bores.	Insig.	Rare	Low	**Operations Phase** **Acceptable** – standard controls are adequate, no further risk controls warranted.	**Operations Phase** **No**	**Operations Phase** **No**
												Rehab Phase **Acceptable –** As per above.	**Rehab Phase** **No**	**Rehab Phase** **No**
RSK-003	Operations Rehabilitation	Surface water – turbid water runoff from open areas impacting receiving waters / beneficial uses Applicable receptors: • Northern drainage line (ephemeral) • Chadwick's Wetland (ephemeral)	**Operations Phase** • Erosion of overburden stockpiles; • Overtopping, or embankment failure of north-west containment dam. **Rehab Phase** • Erosion of reinstated soil profile prior to effective stabilisation by vegetation; • Previous containment dams and drains removed (required as part landform / hydrology reinstatement).	• Nil failures or turbid water/sediment release events from the north-west containment dam have occurred over the Douglas life-of-mine or operation of the Pit 23 facility under Planning Permit 15-105; • The receptors at risk are "*slightly to moderately disturbed*" surface water systems with agricultural inputs. The consequence of turbid water runoff is considered to be insignificant.	Insig.	Poss.	Low	**Standard Controls** Operations Phase • Surface water management system (intercerption drains, containment dams and dewatering pumps); • Periodic inspection of containment dam integrity. Rehab Phase • Timing of earthworks and landform shaping in dry months of year; • Revegetation works (planting and seeding) undertaken before winter rainfall season to optimise establishment and stabilisation; • Landform design (reduced slope angles); • Contour ripping of final surface to reduce runoff potential and volume, and enhance infiltration; • Surface water modelling to assess drainage system design adequacy / upgrades (if req'd). All Phases • Trigger responses and contingency measures – Refer Section 8.6 of EMP	Insig.	Unlik.	Low	**Operations Phase** **Mitigation mandatory –** statutory obligations for the protection of receiving waters applies per the Planning Permit (Conditions 23, 29 & 30) and SEPP (Waters) irrespective of residual risk ranking.	**Operations Phase** **Yes –** Refer Section 8.5 of EMP	**Operations Phase** **Yes –** Refer Section 8.6 of EMP
												Rehab Phase **Mitigation mandatory –** Condition 36 of the Planning Permit requires that the R&VMP addresses matters related to landform stability and erosion. **Risk is acceptable when surface water completion criteria specified in the R&VMP is achieved.**	**Rehab Phase** **Yes** – as per above	**Rehab Phase** **Yes** – as per above

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-004	Operations Rehabilitation	Air quality (PM2.5 and PM10 dust) – concentration of PM2.5 and PM10 dust at sensitive receptors exceeds guideline values and affecting public health and amenity. Applicable receptors: • Occupied private residences in proximity to Pit 23	**Operations Phase** • Passive dust emissions from open void and overburden stockpiles; • Dust generated during waste disposal activities; • Dust arising from deposited waste materials; • Discrete short-term, high-intensity dust events caused by high wind events / wind gusts; • Emissions from fuel combustion sources (vehicles, plant and machinery). **Rehab Phase** • Dust emissions during rehabilitation earthworks; • Erosion of reinstated soil profile prior to effective stabilisation by vegetation.	• Prevailing wind directions are typically from the west/south-west (summer, spring and autumn) and from the north-west in winter; • Based on prevailing wind directions nearby sensitive receptors (occupied residences) are not sited downwind of Pit 23 - likelihood of dust from Pit 23 impacting receptors is therefore rare; • The primary dust generating source in the rehabilitation phase is rehabilitation earthworks. Dust risks will effectively cease once these activities are completed.	Insig.	Unlik.	Low	**Standard Controls** Operations phase • Wind monitoring and visual dust monitoring – dust generating activities postponed during unfavourable conditions; • Defined access roads, sheeted to minimise dust during vehicle/equipment movement; • Vehicle access speed limits; • Approved waste streams strictly disposed within the confines of the Pit 23 void; • Interim cover (capping) of disposed potentially dust-generating wastes; • Overburden stockpiles stabilised; • Dust suppression, as required. • Rehab phases per operations phase, except for controls not applicable post landform reinstatement (stockpile stabilisation and interim capping of deposited wastes)	Insig.	Rare	Low	**Operations Phase** **Mitigation mandatory –** statutory obligations for the protection of beneficial users of the air environment applies per the Planning Permit (Conditions 23 & 33) irrespective of residual risk ranking.	**Operations Phase** **Yes –** as per Section 9.4.4 of EMP (excludes PM_{10} monitoring)	**Operations Phase** **Yes –** in event of a visual emissions or public complaint (Refer Section 0 of EMP)
												Rehab Phase **Acceptable** (once rehabilitation earthworks are completed)	**Rehab Phase** **Yes** – as per Section 9.4.4 of EMP, until rehabilitation earthworks are completed	**Rehab Phase** **Yes** – as per Section 0 of EMP, until rehabilitation earthworks are completed
RSK-005	Operations Rehabilitation	Air quality (toxicants other than PM2.5 and PM10) – dust containing toxicants resulting in health impact. Applicable receptors: • Occupied private residences in proximity to Pit 23 SEPP AQM: Mining PEM air quality toxicants (other than PM2.5 and PM10): • Radionuclides • Arsenic (total inorganic) • Hydrogen cyanide • Nitrogen dioxide • Carbon monoxide • PAHs • Asbestos	**Operations Phase** • Passive dust emissions from open void and overburden stockpiles; • Dust generated during waste disposal activities; • Emissions from fuel combustion sources (vehicles, plant and machinery); • Dust arising from deposited waste materials; • Discrete short-term, high-intensity dust events caused by high wind events / wind gusts **Rehab Phase** • Rehabilitation earthworks; • Erosion of reinstated soil profile prior to effective stabilisation by vegetation	• Prevailing wind directions are typically from the west/south-west (summer, spring and autumn) and from the north-west in winter; • Low level of plant and vehicle activity. Contribution of nitrogen dioxide, carbon monoxide and PAHs to air are insignificant; • Concentrations of arsenic in MSP by-products are low, and potential arsenic concentrations within emitted dust is extremely low; • Nil sources of asbestos and hydrogen cyanide (sources not applicable); • Monitoring and reporting of airborne radionuclides managed under separate legislation and statutory approvals; • All occupied private residences (sensitive receptors) in proximity are sited at distances of 2km or more from Pit 23, liklelihood of adverse air quality impacts is therefore rare.	Insig.	Unlik.	Low	**Standard Controls** Operations Phase • As per Risk #OPS-004 Rehab Phase • As per Risk #OPS-004	Insig.	Rare	Low	**Operations Phase** **Acceptable** – sources and/or pathways of impact arising from other air quality toxicants are insignificant – refer Section 9.4 of EMP for detailed risk assessment and justification. Standard controls for management of PM10 provide complimentary control of risks / compliance to assessment criteria associated with all other air toxicants as listed in the SEPP AQM: Mining PEM.	**Operations Phase** **No** – Refer Section 9.4 of EMP for risk assessment and justification	**Operations Phase** **No** – Refer Section 9.4 of EMP for risk assessment and justification
												Rehab Phase **Acceptable –** As per above.	**Rehab Phase** **No –** As per above	**Rehab Phase** **No –** As per above

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-006	Operations Rehabilitation	Noise – noise at sensitive receptors above EPA Victoria NIRV Guidelines resulting in loss of amenity. Applicable receptors: • Occupied private residences in proximity to Pit 23	**Operations Phase** • Vehicle, plant and equipment operations. **Rehab Phase** • Plant and equipment operations (earthmoving); • Decommissioning activities.	• Minimal noise complaints received during full-scale operations of the Douglas Mine (MIN5367); • Nil noise complaints received to-date associated with Pit 23 operations; • All occupied private residences (sensitive receptors) in the area are sited at distances of 2km or more from Pit 23. This provides a significant noise attenuation buffer between source and receptor; • The primary noise generating sources in the rehabilitation phase are earthmoving equipment. Noise emissions will effectively cease once these activities are completed.	Insig.	Unlik.	Low	**Standard Controls** Operations Phase • On-site speed limits; • prioritising vehicle movements, waste deposition and interim capping activities for "day" hours; Rehab Phase • Earthmoving activities restricted to "day" hours except in emergency situations; • Applying noise-reduction principles for decommissioning works.	Insig.	Rare	Low	**Operations Phase** **Mitigation mandatory –** statutory obligations to comply with the EPA Victoria NIRV Guidelines (EPA publication 1411) applies per the Planning Permit (Condition 10) irrespective of residual risk ranking.	**Operations Phase** **Yes –** Refer Section 10.1.4.4 of EMP	**Operations Phase** **Yes –** Refer 10.1.4.5 of EMP
												Rehab Phase **Acceptable** (once rehabilitation earthworks are completed)	**Rehab Phase** **Yes** – as per Operations Phase monitoring, until rehabilitation earthworks are completed	**Rehab Phase** **Yes** – as per Operations Phase monitoring, until rehabilitation earthworks are completed
RSK-007	Operations Rehabilitation	Weeds – incursion of noxious declared weeds (competition with and exclusion of establishing vegetation) Applicable receptors: • Native vegetation.	**Operations Phase** • Weed seed migration (wind, water); • Weed / organic matter contamination on vehicles, plant and equipment entering Pit 23 **Rehab Phase** • As per operations phase	• Access to the Pit 23 site via predominantly sealed highways and roads which significantly reduces the potential for vehicle contact with organic matter en route to site (and increases opportunity for dislodgement of caught material) • Earthmoving machinery and other plant used for Pit 23 operations are already site-based; • No declared weeds have been identified within the Pit 23 boundary to-date; • Weed control activities undertaken for the adjacent Douglas Mine provides complimentary control; • The likelihood and consequence of incursion by significant weeds is most applicable to the rehabilitation and native revegetation establishment phase.	Insig.	Unlik.	Low	**Standard Controls** Operations Phase • Designated truck wash facility and secondary washbay; • Weed control if declared weed species are identified within the Pit 23 boundary. Rehab Phase • Weed control programs before and post- revegetation, as required	Insig.	Rare	Low	**Operations Phase** **Acceptable** – no formal weed management or routine monitoring programs to apply	**Operations Phase** **No**	**Operations Phase** **No**
												Rehab Phase **Mitigation mandatory –** statutory obligations to manage weeds during Pit 23 revegetation applies per the Planning Permit (Conditions 39, 41) irrespective of residual risk ranking. **Risk is acceptable when weed-related completion criteria specified in the R&VMP has been achieved.**	**Rehab Phase** **Yes** – Refer Section 10.2.4.4 of EMP	**Rehab Phase** **Yes** – Refer Section10.2.4.5 of EMP
RSK-008	Operations Rehabilitation	Vehicle hygiene – transfer of mud, debris and NORM onto public roads impacting amenity (plant, vehicles and equipment leaving Pit 23) Applicable receptors: • Public amenity	**Operations Phase** • Wet ground conditions; • No, or inadequate vehicle washdown **Rehab Phase** As per operations phase	• Mud/NORM entrainment only in wet weather (i.e. 5-30% likelihood predominantly in winter months); • Mud entrainment is most likely to occur; unlikely for NORM and weed/organic matter given other controls / potential for contamination on departing plant and vehicles; • Designated wash facilities further mitigate likleihood and severity of risk event.	Insig.	Unlik.	Low	**Standard Controls** Operations Phase • Designated truck wash facility and secondary washbay; • Access road maintenance (sheeting); • Waste disposal and/or earthmoving actvitiies suspended during wet weather as required. Rehab Phase • As per operations phase	Insig.	Rare	Low	**Operations Phase** **Mitigation mandatory –** statutory obligations to follow plant, vehicle and equipment hygiene protocols apply per the Planning Permit (Condition 12) irrespective of residual risk ranking.	**Operations Phase** **Yes –** Refer Section 10.3.4.4 of EMP	**Operations Phase** **Yes –** Refer Section 10.3.4.5 of EMP
												Rehab Phase **Acceptable** (once rehabilitation earthworks are completed)	**Rehab Phase** **Yes** – as per Operations Phase monitoring, until rehabilitation earthworks are completed	**Rehab Phase** **Yes** – as per Operations Phase monitoring, until rehabilitation earthworks are completed

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-009	Operations Rehabilitation	Hazardous materials – accidental spill or release of hazardous materials during normal use and handling Applicable receptors: • Soils (primary receptor) • Secondary receptors: ○ Surface waters ○ Groundwater	**Operations Phase** • Vehicles, plant and equipment – engine and hydraulic system failures; • Spills during refuelling / fuel transfers; • Storage of hazardous materials. **Rehab Phase** • As per operations phase	• There is no infrastructure associated with hazardous materials within the Pit 23 boundary.	Insig.	Rare	Low	**Standard Controls** Operations Phase • Routine vehicle, plant and equipment maintenance; • Minimal on-site refuelling, but with spill control and containment measures utilised as standard practice; • No hazardous materials storage on site; • Spill response and clean-up requirements apply by default per Iluka HSEC Management System requirements; • Recovery and compliant disposal of contaminated soils per EPA guidelines. Rehab Phase • As per operations phase	Insig.	Rare	Low	**Operations Phase** **Acceptable** **Rehab Phase** **Acceptable –** As per above.	**Operations Phase** **No** – not warranted on basis of risk **Rehab Phase** **No –** As per above	**Operations Phase** **No** – not warranted on basis of risk **Rehab Phase** **No –** As per above
RSK-010	Operations Rehabilitation	Public safety – harm to members of the public, private property and public infrastructure associated with Pit 23 activities Applicable receptors: • Members of the public; • Private property • Public infrastructure	**Operations Phase** • Traffic associated with Pit 23 - collision with public road user; • Unauthorised public access to site (deliberate/illegal or accidental). • Injury to Pit 23 visitors (slips/trips/falls, falls from pit crests; • Geotechnical instability – failure of pit walls due to erosion and subsidence. **Rehab Phase** • Traffic associated with Pit 23 - collision with public road user; • Unauthorised public access to site (deliberate/illegal or accidental).	• Nil injuries to members of the public have occurred to-date over the entire Douglas life-of-mine, nor since approval of the Pit 23 Planning Permit; • Nil illegal or inadvertent site access has occurred to-date over the period of approved Pit 23 operations under the Planning Permit; • Nil geotechnical failures have occurred since the approval of the Planning Permit; • All Pit 23 batters assessed as low geotechnical risk (Sonnekus, 2018) – nil ability for pit wall failures to impact public safety, property or public infrastructure; • With standard controls implemented, the most likely source of harm is considered to be injury to public visitors accessing the pit or rehabilitated areas (e.g. slips, trips) with a minor impact.	Major	Rare	Med.	**Standard Controls** Operations Phase • Site operations and traffic to/from Pit 23 in daylight hours; • Restricted site access (boom gates) via Elliotts Rd; • Site inductions and visitor escort; • Boundary security fence with warning signage; • Security cameras; • Geotechnical controls: ○ bunds and drains along pit crest to divert surface water away from soil stockpiles and pit crest; ○ exclusion zones at the toe of pit walls, including safety bunds and warning signage. Rehab Phase As per operations phase, except for geotechnical controls associated with pit walls and pit wall failures.	Minor	Rare	Low	**Operations Phase** **Mitigation mandatory –** statutory obligations to assess and manage risks to public health and safety apply under the *Occupational Health and Safety Act 2004* irrespective of residual risk ranking. This risk assessment and implementation of standard controls satisfies the requirements for identification and mitigation of risk per the OHS Act. **Rehab Phase** As per above	**Operations Phase** **Yes –** Refer Section 10.4.4.4 of EMP **Rehab Phase** **Yes -** As per above	**Operations Phase** **Yes –** Refer Section 10.4.4.5 of EMP **Rehab Phase** **Yes -** As per above

Risk ID	Applicable Phase(s)	Risk Description	Causes	Contextual Information	Inherent Risk Level (IRL)			Risk Controls	Residual Risk Level (RRL)			Risk Acceptability	Monitoring Required?	Trigger Levels, Management and Contingency Apply?
					C	L	R		C	L	R			
RSK-011	Rehabilitation	Drought causing revegetation failure, or impaired/delayed establishment Applicable receptors: • Establishing native vegetation	• Drought – natural event; • Reduced rainfall – lack of infiltration/recharge; • Lack of alternate water supply; • Alternative watering not undertaken, or inadequate.	• Local climate and rainfall characteristics are generally considered favourable for native vegetation establishment. Successful native revegetation at multiple sites in the adjacent Douglas Mine suggest establishment risks are low; • Risks associated with drought/reduced rainfall considered to be most relevant in the first five (5) years post-planting and seeding.	Mod.	Unlik.	**Med.**	**Standard Controls** Rehab Phase • Alternate watering using external fresh water source (e.g. from Douglas Mine Fresh Water Dam, other source).	Minor	Unlik.	**Low**	**Rehab Phase** **Mitigation mandatory –** Condition 34 of the Permit requires a R&VMP to address the rehabilitation and revegetation of Pit 23. Condition 44 requires that methods and techniques to achieve revegetation objectives be defined in the R&VMP. Risks associated with water supply fall within the scope of Condition 44.	**Rehab Phase** **Yes –** Refer Section 10.1 of R&VMP	**Rehab Phase** **Yes –** Refer Section 10.1 of R&VMP
RSK-012	Rehabilitation	Bushfire– rehabilitation phase – revegetation failure / loss of revegetation cover Applicable receptors: • Establishing native vegetation	• Bushfire – natural event; • Establishing native vegetation immature and lacks fire tolerance.	• Risks associated with bushfire considered to be most relevant in the first five (5) years post-planting and seeding.	Mod.	Unlik.	**Med.**	**Standard Controls** Rehab Phase • Bushfire Risk Assessment prior to revegetation establishment; • Maintenance of boundary fire-breaks in adjacent agricultural paddocks, as required; • Revegetation monitoring (refer to Section 10.1 of R&VMP).	Minor	Unlik.	**Low**	**Rehab Phase** **Mitigation mandatory –** Condition 34 of the Permit requires a R&VMP to address the rehabilitation and revegetation of Pit 23. Condition 44 requires that methods and techniques to achieve revegetation objectives be defined in the R&VMP. Risks associated with bushfire fall within the scope of Condition 44.	**Rehab Phase** **Yes –** Refer Section 10.1 of R&VMP	**Rehab Phase** **Yes –** Refer Section 10.1 of R&VMP
RSK-013	Rehabilitation	Grazing pressure from stock and native fauna and feral animals – harm to establishing vegetation Applicable receptors: • Establishing native vegetation.	**Operations Phase** • Not applicable **Rehab Phase** Fauna access, in order of risk: • rabbits; • stock; • Kangaroos / wallabies.	• Grazing risk not applicable during operations phase (nil vegetation yet established); • Inherent risk assumes grazing pressure will occur in the absence of exclusion fencing; • Exclusion fencing expected to be effective against stock and rabbits, but less effective for kangaroos and wallabies.	Minor	Likely	**Med.**	**Standard Controls** Operations Phase • None required or proposed Rehab Phase • Fauna exclusion fencing (rabbit proof) • Baiting and control programs, as required	Minor	Unlik.	**Low**	**Rehab Phase** **Mitigation mandatory –** statutory obligations to restrict access by grazing fauna, stock and pest animals to revegetated areas applies per the Planning Permit (Conditions 38, 41) irrespective of residual risk ranking. **Risk is considered to be acceptable once fauna exclusion fencing is installed.**	**Rehab Phase** **Yes** – until fauna exclusion fencing is installed Refer Section 10.1 of R&VMP	**Rehab Phase** **Yes** – until fauna exclusion fencing is installed Refer Section 10.1 of R&VMP