

Technical report: Surface water impact assessment

Fosterville Gold Mine Sustained Operations Project

Fosterville Gold Mine Pty Ltd

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EXECUTIVE SUMMARY

This technical report is an attachment to the Fosterville Gold Mine Sustained Operations Project (the Project) Environment Effects Statement (EES). It has been used to inform the EES required for the Project.

Overview

The Fosterville Gold Mine (FGM) is an operational gold mine located on mining licence MIN5404, approximately 20 km northeast of the city of Bendigo in Victoria, Australia. FGM is located between the rural towns of Goornong (to the north) and Axedale (to the south) on the historic Ellesmere goldfield, now known as Fosterville, where mining first commenced in 1894.

In 1996 an EES was prepared, exhibited and subject to review by a panel appointed by the Minister for Planning. That EES scoped the present-day operations. The Minister for Planning adopted the recommendations of the panel that the project proceed. Following approval of the work plan to mine and process deeper sulphide ore, underground mining operations commenced in 2005. Since then, Work Plan Variations have been approved under *the Mineral Resources (Sustainable Development) Act 1990* which have authorised mining operations from 2005 through to the present day.

The Project seeks approval to continue mining operations at FGM from previously unmined areas of MIN5404 and to provide adequate additional storage space for mine-generated waste products (e.g., tailings, waste rock, mine water) for at least another ten years of mining.

Requirement for an EES

An Environment Effects Statement (EES) was developed for FGM in 1996, which informed the mining lease and licence conditions, and a Work Plan and associated operational licences were approved in 2004. Since then, various Work Plan Variations have been approved under the *Mineral Resources (Sustainable Development) Act 1990*.

The Project was referred to the Minister for Planning (accepted on 10 September 2021 by the Minister) to seek advice on the need for an EES under the *Environment Effects Act 1978 (Vic)* (EE Act).

On 10 November 2021, the Minister for Planning issued his decision that an EES is required for the following reasons:

1. *The Project has the potential for a range of significant environmental effects, including on:*
 1. *Native vegetation and associated biodiversity values, including listed threatened species and communities;*
 2. *Environmental values of surface waters and groundwater (i.e., hydrology and quality);*
 3. *Amenity (i.e., air quality, noise, vibration and visual), as well as the landscape values of the surrounding area; and*
 4. *Aboriginal cultural heritage values.*
2. *The proposal has the potential for cumulative adverse effects on the above-mentioned values, from the proposed works, the existing mining activities and other approved works yet to be undertaken.*
3. *An integrated assessment is necessary to ensure the range of likely adverse effects and related uncertainties are sufficiently investigated. This includes examining the scope for further avoidance and minimisation of effects via feasible siting, design and operational alternatives for key and ancillary components of the proposal, as well as evaluating their effectiveness and acceptability.*
4. *There are other potential adverse effects from the proposal that are less significant but also need to be considered through impact assessment, including greenhouse gas emissions, impacts on historic*



cultural heritage and current land use of the area; and changes to local amenity associated with traffic and transport from construction and operational phases of the Project

5. *An EES would enable a transparent and rigorous process for consideration of potentially adverse effects of the Project, which would inform relevant statutory decision-making.'*

Surface water context

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs that scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective/s is/are relevant to the surface water assessment:

1. *The EES needs to address effects on water resources and their environmental values, including as a result of possible changes to groundwater, stream flows, discharge of sediment and contamination from mine tailings.*
2. *Avoid and, where avoidance is not possible, minimise adverse effects on water resources and on existing and potential future environmental values and licensed uses of surface water, groundwater and related catchment values over the short and long-term.*

A summary of the key assets, values or uses potential affected by the Project, and the associated impacts assessment are summarised below.

Existing conditions

The Project area is located approximately 1 km from the Campaspe River, the major waterway near the area, and the hydraulic assessment studies indicated that the Project area would not be impacted by riverine flooding even under extreme events. The existing surface water environment in proximity to the Project area is influenced by direct/localised catchment inundation caused by stormwater runoff. Surface water runoff within the Project area flows to the northeast, with a major overland flow path in the Gunyah Creek channel intersecting the north part of the Project area. Flow paths originating on the south-western side of the mining area are diverted through diversion drains, either around the southern end of the mining area or via the northern diversion drain through the central parts of the mining area. The runoff from these diversion drains flows into agricultural paddocks and dams, and crosses the Axedale-Goornong Road before terminating in the Campaspe River. The areas downstream of the mining area consists of agricultural cropping or grazing areas with isolated patches of vegetation mapped as inundated. Analysis of water quality data showed some parameters exceeding ERS water quality objectives or ANZECC guidelines.

Key findings

Developed conditions modelling was undertaken, showing some potential for the works to influence direct catchment water levels in proximity to the Project area. Increased water levels were observed where the Gunyah Creek overland flow path is led through the Project area, as well as upstream of bunds around the Project area. Decreased water levels were observed in the overland flow path leaving the southeast corner of the mining lease, flowing north towards the Campaspe River. Only minor areas of pooling of water is observed along the bunds, both inside and outside of the mining areas. Modelling with the inclusion of climate change showed increased in flood depth, but no overall change to the inundation characteristics.

Identified surface water impacts include:

- A reduction in surface water runoff to the areas under the overland flow path leaving the southeast corner of the mining area which could impact environmental values in this area, including runoff to farm dams and vegetation. This is considered a minor impact based on the limited reduction in depth (less than



100mm), this only occurring at this magnitude during rare storm events, the short lived nature of the impact and the low strategic biodiversity score in this area.

- Increased water levels in the Gonyah Creek overland flow path, increasing the risk of inundation of the northern part of the Project area which could potentially cause offsite transport of contaminants.

No changes to water quality in receiving bodies downstream from the Project area are to be expected, as runoff will not be discharged offsite.

Potential impacts on surface water due to the Project would be avoided, minimised or managed to required standards through the recommended mitigation measures. These measures are considered to be relatively standard. The overarching mitigation and contingency measures include development and application of a site risk management plan (including surface water).

These plans will identify specific performance standards/criteria to be achieved with mitigation measures in place, including monitoring programs for water quantity and quality. Water quality sampling and testing will be in accordance with the Environment Reference Standard (ERS). The plans will also detail a program to investigate and implement ways to improve the environmental performance of the Project over time and establish procedures to manage the following:

- Incidents and any non-compliance
- Stakeholder and community complaints
- Failure to comply with statutory requirements and/or performance standards
- Roles and responsibilities for implementing the plan
- A protocol for periodic review of the plan



Glossary and Abbreviations

Term	Definition	Abbreviation
Action/Activity	Part of the Project, such as installing infrastructure in a certain manner, that may have an impact on receptors	
Assess	To consider an action and the likely effects of that action	-
Annual Exceedance Probability	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.	AEP
Australian Height Datum	The datum that sets mean sea level as zero elevation.	AHD
Average Recurrence Interval	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.	ARI
Beneficial Uses	Specific environmental values/receptors/assets protected by legislation. These may include environmental matters such as natural resources or ecosystems. SEPP (Waters) refers to Beneficial Uses which has been updated to Environmental Values in the Environment Reference Standard.	-
Carbon-in-leach		CIL
Department of Energy, Environment and Climate Action	Department of Energy, Environment and Climate Action	DEECA
Department of Environment, Land, Water and Planning	Department of Environment, Land, Water and Planning	DELWP
Design Flood	A significant event to be considered in the design process; various works within the floodplain may have different design event requirements. E.g., some roads may be designed to be overtopped in the 1 in 10 year or 10% AEP flood event.	-
Digital Elevation Mode	A bare-earth elevation model of the earth's surface, with features such as vegetation, bridges and roads filtered out	DEM
Digital Terrain Model	A DTM is a mathematical representation of the ground surface. A DTM augments a DEM by including linear features of the bare-earth terrain	DTM
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.	-
Effect	The outcome of an event or a circumstance that is likely to occur. It may be caused directly or indirectly by an action. It can also be termed a consequence. The significance of the effect may vary.	-
Environment Effects Statement	Statement required under the Environment Effects Act (1978)	EES
Environmental Management Framework	The framework setting the limits and objectives for the scope of the EES.	EMF
Environmental Value	Particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharges and deposits	-



Term	Definition	Abbreviation
Environment Reference Standard	Much of the State Environment Protection Policy (Waters) (SEPP (Waters)) operating under the Environment Protection Act 1970 was replaced by the EP Act 2017, its regulations and the Environment Reference Standard (ERS), or through new guidance published by EPA. ERS includes environmental values, indicators and objectives.	ERS
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.	-
Flood Frequency Analysis	A technique to predict flow values corresponding to specific return periods or probabilities along a watercourse or flow path	FFA
Fosterville Gold Mine		FGM
North Central Catchment Management Authority	The North Central Catchment Management Authority	NCCMA
Hydrograph	A graph that shows how discharge changes with time at any particular location.	-
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs.	-
Impact	An adverse effect	-
Intensity Frequency Duration	An intensity-duration-frequency curve is a mathematical function that relates the rainfall intensity with its duration and frequency of occurrence	IFD
Light Detection and Ranging	A remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth	LiDAR
metres Australian Height Datum	Elevation of point relative to National datum	mAHD
metres below natural surface	Depth the natural ground level	mBNS
Milligram per litre, Total Dissolved Solids	The measure of the salinity of water, by the conversion of the measured electrical conductivity of the water,	mg/L (TDS)
Peak Flow	The maximum discharge occurring during a flood event.	-
Potential Acid Sulphate Soils	ASS which has not been oxidised by exposure to air	PASS
Receptors	Entities that may be impacted by a water affecting activity, such as GDEs or people. Also termed values or assets.	-
Reduced water level	The water level reported to a common datum; in this case m AHD	RWL
Risk	A description of the effects of an action	-
Regional Flood Frequency Estimation	Methods used to estimate design floods in ungauged and poorly gauged catchments. It is a data-based empirical procedure which attempts to compensate for the lack of temporal data at a given location by spatial data	RFFE
Rain on Grid	Method to model direct rainfall on an area using hydraulic model software and rainfall data.	RoG



Term	Definition	Abbreviation
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.	-
Salinity Management Overlay	Areas mapped by the NCMA as land requiring salinity management for infrastructure and farming	SMO
Significance	The relevance of an effect on the values held by a stakeholder. Significant matters are usually protected by legislation or raised by stakeholders during consultation.	-
Tailings Storage Facility		TSF



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1 INTRODUCTION

1.1 Purpose of this report

The purpose of this report is to assess the potential surface water impacts associated with the Fosterville Gold Mine Sustained Operations Project (the Project) to inform the preparation of the Environment Effects Statement (EES) required for the Project.

On 10 November 2021, the Minister issued a decision confirming that an EES is required for the Project due to the potential for significant environmental effects.

This assessment provides a detailed understanding of the surface water impacts of the Project, informing the development of management measures in the form of risk management plans within a robust Environmental Management Framework.

1.2 Why understanding surface water is important

In the context of this Project, the term surface water is used to describe water flowing in waterways and runoff from storm events, as well as water in water bodies such as lakes, wetlands and farm dams. Riverine and direct catchment inundation can impact the Project, while the Project can impact on surface water and consequently affect environmental values around the Project area. Surface water impacts are described as either impacting the quantity or quality of available surface water.



2 EES SCOPING REQUIREMENTS

2.1 EES evaluation objectives

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective(s) are relevant to the surface water assessment:

3. *The EES needs to address effects on water resources and their environmental values, including as a result of possible changes to groundwater, stream flows, discharge of sediment and contamination from mine tailings.*
4. *Avoid and, where avoidance is not possible, minimise adverse effects on water resources and on existing and potential future environmental values and licensed uses of surface water, groundwater and related catchment values over the short and long-term.*

2.2 EES scoping requirements

The aspects from the scoping requirements relevant to the surface water evaluation objective/s are shown in Table 2 1, as well as the location where these items have been addressed in this report.

Table 2-1 Scoping requirements relevant to surface water

Aspect	Scoping requirement	Section addressed
Key issues	Potential for adverse effects on licensed uses of groundwater and surface water due to the Project's activities.	Surface water related receptors are outlined in Section 6.3.7 Construction and operation related impacts are outlined in Section 8.1
	Waste rock, tailings and underground mine water management, in the context of potential water quantity or quality impacts including those arising from erosion, sedimentation, nutrients, other contaminants and pollutants, acid sulphate soils, acid/metalliferous drainage formation, or salinity.	Section 8.1.2
	Potential effects to groundwater and surface water values associated with the proposed managed aquifer recharge.	Addressed in the Groundwater Impact Assessment report
Existing environment	Identify and characterise groundwater and surface water environments potentially impacted by the Project in terms of their existing and future environmental values, existing drainage functions and behaviours and catchments.	Section 6.3



Aspect	Scoping requirement	Section addressed
	Characterise the ground and surface water relationships between the Project area and any potential groundwater dependent ecosystems.	Addressed in the Groundwater Impact Assessment report
	Identify existing groundwater and surface water users and allocations in the broader area, including downstream of the mine site and in areas where there is potential for surface or groundwater impacts.	Section 6.2
	Characterise the interaction between surface water and groundwater.	Section 6.3.2
	Model the area's hydrogeology with the current allocations, extractions and uses of groundwater and surface water (e.g. irrigation use, stock and domestic use and environmental flows) in the broader area of the mine site, including downstream of the site.	Section 6.3
	Characterise existing surface water and groundwater quality.	Section 6.3.5
	Characterise the physical and chemical properties of the Project area soils/mine geological materials including the potential environmental risks (e.g. potential for erosion, salinity, nutrients and acidification).	Physical/chemical properties of the Project area soils/mine geological materials including erosion potential are described in EES Chapter 23: Soils, waste and hazardous materials The potential impacts to groundwater from nutrients (nitrate) and acidification of potentially acid forming material are discussed in EES Technical Report F1: Groundwater impact assessment.
Assessment of likely effects	Use appropriate methods, including modelling, to identify and evaluate effects of the Project on groundwater and surface water environments, including: <ul style="list-style-type: none"> ■ Impacts on the hydrology and/or water quality of watercourses and wetlands ■ Changes to availability of surface water and groundwater for environmental values including from drawdown and rebound of groundwater levels (e.g. licenced users and/or ecological values), accounting for climate risks and the potential effects of climate change 	Section 0



Aspect	Scoping requirement	Section addressed
	<ul style="list-style-type: none"> ■ Risks associated with saline or potential acid forming materials (soil and rock) that may be disturbed or exposed by mining activities ■ Changes to groundwater and surface water quality at all Project phases, including effects salinity, nutrients, processing reagents and other contaminants, as well as effects on ecological values. ■ Potential impacts to surface water and downstream environmental values associated with uncontrolled release of tailings and or mine water to the environment. 	
Mitigation measures	Describe proposed design options and measures that could avoid or minimise significant effects on environmental values of surface water, groundwater and downstream water environments, accounting for climate risks and the potential effects of climate change.	Section 9
	Identify relevant guidelines and standards to be met for management of stormwater runoff, erosion and sediment control, and flood risk.	Section 4
Performance criteria	Describe monitoring programs and appropriate monitoring activities with specific, measurable, attainable, relevant, time-based indicators for monitoring and thresholds for action to be implemented to ensure prompt detection of any adverse water and catchment effects associated with the Project.	Section 9.1
	Describe possible contingency actions to respond to adverse effects identified through the monitoring program as well as for cases where risks to achieving Project benefits/objectives are identified.	Section 9.1



3 PROJECT DESCRIPTION

The Project consists of activities that are required to support the continuation of existing operations at FGM. All activities included in the Project are listed in Section 3.2. Activities that could impact on surface water are the cutbacks at existing open pits, the addition of an above ground waste rock dump, the addition of new tailings storage facilities within existing tailings compounds, the addition of new carbon-in-leach hardstands, an additional brine evaporation pond, the addition of a borrow pit and additional topsoil storage areas.

3.1 Project area

FGM is located on mining lease MIN5404, about 20km from the city of Bendigo in Victoria, Australia. The mining licence area MIN5404 is located between the rural towns of Goornong (approximately 4 km to the north of the MIN boundary) and Axedale (approximately 1.5 km to the south of the MIN boundary). Refer to Figure 3-1.

The Project will be undertaken entirely within the current mining licence boundary for MIN5404 and will take place either underground or on land already owned, or road reserves that are to be acquired, by Fosterville Gold Mine Pty Ltd, apart from the AR component which is partially located on Crown Land in Wellsford State Forest. "Project area" refers to the area within MIN5404 in which the Project components are proposed.



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LOCAL SETTING

- MIN5404 mining lease boundary
- MIN006267 and MIN4456 mining lease boundary
- Parks/ Forest
- Built up area
- Freeway/Highway
- Major Roads
- Rail
- Watercourse
- Waterbody



Figure 3-1 Project location



3.2 Project description

Figure 3-2 shows the Project components which are all located within MIN5404.

Key components of the Project are:

- Underground mining development to extend the existing underground mining operations:
 - Continued mining of the Harrier and Phoenix declines located within the southern underground mining precinct
 - Continued mining of the Robbins Hill decline within the northern underground mining precinct
- Exploration will continue within the underground precinct and extend:
 - to the south outside of the southern underground mining precinct
 - to the north outside of the northern underground mining precinct
- Open pit mining cutbacks at existing open pits – Farley’s Pit, O’Dwyer’s North Pit and O’Dwyer’s East Pit. No new pits are proposed
- An above ground waste rock dump (WRD) at Harrier Pit (at the conclusion of backfilling operations of the existing open pit)
- Construction and operation of new tailings storage facilities (TSFs) for flotation and neutralization tailings, including:
 - an extension to the existing TSF area in the northern part of MIN5404 (TSF5 and TSF6)
 - in-pit tailings storage in O’Dwyer’s North Pit, O’Dwyer’s East Pit and Farley’s Pit, following cutback operations
- Construction and operation of additional carbon-in-leach (CIL) tailings hardstands (CIL hardstand 5 and CIL hardstand 6) as an extension of the existing CIL hardstand area south of the treatment plant
- Potential for CIL tailings to be sold and transported offsite by a third party
- Construction and operation of a brine evaporation pond to the northwest of the TSF area.
- Water storages for underground mining water
- Managed aquifer recharge within the fractured bedrock aquifer, with up to five injection bores located in the northwest corner of MIN5404

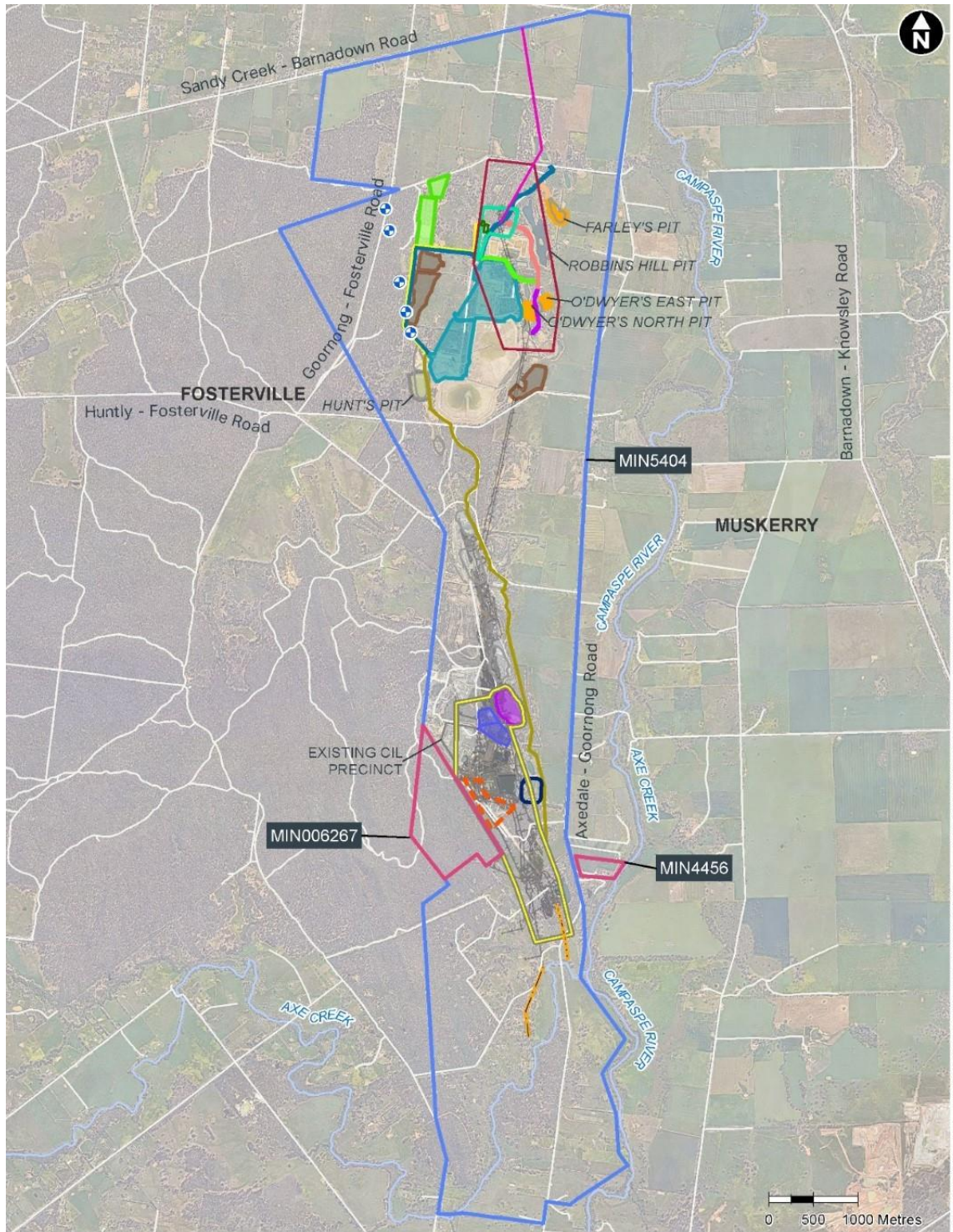
Ancillary components of the Project include:

- A vent shaft to surface (with fans located underground) from the northern underground mine extension of Robbins Hill decline
- A vent shaft to surface (with fans located underground) in the southern half of MIN5404 to support the existing infrastructure
- Construction of an embankment around Hunt’s Pit to provide additional freeboard to accommodate water decanted off TSF5 and TSF6.
- The upgrade of existing internal haul roads to replace haul roads displaced by TSF5 and TSF6
- A borrow pit to the east of the CIL storage area to provide additional material for rehabilitation
- Additional topsoil storage areas
- A combined services corridor (following existing infrastructure for:



- Energy supply from the Fosterville Terminal Station (FVTS) in the southeast of MIN5404 to the northern precinct
- Pipelines at surface for water, air and paste reticulation

With the exception of the aquifer recharge project, which is currently not part of the operations, and the location of the proposed vent shafts underground (as opposed to above ground), the proposed project components involve activities and works that are consistent with those already undertaken as part of current operations at Fosterville Gold Mine.



SUSTAINED OPERATIONS PROJECT

- | | | | |
|---|----------------------------------|--|-----------------------------|
| MIN5404 mining lease boundary | Brine ponds | Southern UG mining precinct | Haul 2 |
| MIN006267 and MIN4456 mining lease boundary | Top soil stockpile | Northern vent shaft area | Haul 3 |
| Open pit cutbacks | Northern Infrastructure Precinct | Borrow pit | Haul 4 |
| CILHS 5 and HS 6 | South vent shaft | Mining to date | Service Corridor |
| Harrier Waste Rock Dump | Hunts Pit embankment | Proposed managed aquifer injection bores | Haul 5 |
| TSF 5 and TSF 6 | Northern UG mining precinct | Haul 1 | Ancillary services corridor |
| | | | North UG exploration |
| | | | South UG exploration |



Figure 3-2 Project components



3.3 Key construction activities

Key construction activities for the Project would include:

- Clearing of vegetation, and the removal and stockpiling of topsoil and subsoil for rehabilitation
- Relocation of existing ancillary infrastructure as required (e.g., haul roads, pipelines, power supply)
- Construction of TSF 5 and TSF 6, CIL Hardstand 5 and CIL Hardstand 6, in-pit storage facilities and brine evaporation pond (activities include foundation preparation, excavation of base and underdrainage sumps, bunds, liner installation)
- Construction of additional site drainage and stormwater management systems, including diversion drains and sedimentation ponds where required
- Development of groundwater injection bores for MAR
- Construction of the vent shafts for the northern and southern underground mine extensions
- Construction of the Hunt's Pit embankment.
- Construction of underground declines, drives and drilling platforms
- Construction of the Harrier waste rock dump aboveground

3.4 Key operational activities

Key operational activities for the Project include:

- Continuation of underground mining activities via extensions to the south and north, including exploration, development and production, and using the same techniques used currently at FGM (i.e., drilling, blasting, conventional underground mining equipment)
- Open pit cutbacks using conventional earth moving equipment and mining techniques
- Continuation of existing mine waste management activities at proposed new facilities, including:
 - Disposal of overburden / waste rock and waste paste to the Harrier Pit WRD (following its backfilling)
 - Disposal of flotation and neutralisation tailings to TSF5 and TSF6 and in-pit facilities
 - Disposal of CIL tailings to CIL Hardstand 5 and CIL Hardstand 6
- Transport/sale of CIL tailings off the mining licence
- Treatment of mine water and injection to the fractured rock aquifer
- Storage and evaporation of brine water in the brine evaporation ponds
- Environmental monitoring and community engagement
- Progressive rehabilitation

All other operations at FGM will continue as per existing operations approved via the 1996 EES and Mine Work Plan at existing production rates of up to a nominal plant capacity of 960,000 tonnes per year and will continue to operate 24 hours/day, 365 days/year.

3.5 Key rehabilitation activities

The current approved work plan for FGM includes a Rehabilitation Plan as required under the *Mineral Resources (Sustainable Development) Act 1990*. As per the approved rehabilitation plan concept and objectives, final land uses would aim to return sites to a similar vegetation function and structure as existed prior to mining operations disturbance. This requirement was also a recommendation of the 1996 EES.



Therefore, FGM would aim to return agricultural land to an agricultural land use – for example cropping or grazing.

Where opportunity exists, water bodies such as surface water dams would remain, particularly when near or on agricultural land.

FGM would also aim to return areas of native forest back to a self-sustaining native forest while also taking opportunities to increase the number of indigenous species and link up biodiversity corridors where possible.

Industrial or commercial use of surface facilities has also been highlighted with the community and remains an option for future use pending outcomes of future stakeholder engagement and land use planning. Concepts for final landforms will continue to be investigated and discussed with the local community and regulators as operation continues and will be further detailed in the lead up to closure.

At this stage, it is proposed that final landforms will most likely consist of the following features:

- Pit lakes
- Rehabilitated waste dumps
- Backfilled pits to natural surface
- Agricultural land
- Native forests
- Drainage lines and catchment dams.

The current Rehabilitation Plan would be updated to incorporate the additional areas disturbed by the Project components and would form part of the Work Plan(s) prepared as part of the approval process as an outcome of the EES. For the purposes of the EES, a draft rehabilitation and closure plan that incorporates the new project components is provided in Chapter 21: Rehabilitation.



4 LEGISLATION, POLICY, GUIDELINES AND CRITERIA

The key legislation, regulations and guidelines that apply to the surface water impact assessment for the Project are summarised in Table 4-1.

Table 4-1 Key legislation and policy

Legislation, policy, guidelines	Relevance to technical discipline
Commonwealth	
Australian and New Zealand Governments (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality	The Australian and New Zealand Guidelines for Fresh and Marine Water Quality were prepared as part of Australia's National Water Quality Management Strategy, and contain guidelines for water and sediment chemical and physical parameters, and biological indicators to assess water quality. Where indicators and objectives are not prescribed in the ERS, trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems (lowland rivers) were used in the assessment of water quality.
Australian Rainfall and Runoff (2019)	The recommendations set out in ARR2019 are used as the base methodology for hydrology and hydraulics technical assessment.
Victorian State	
Catchment and Land Protection Act 1994 (Vic)	Provides a framework for the integrated management and protection of catchments. Considers adverse groundwater effects due to extraction on receptors. Guidance for works on waterways
Environment Effects Act 1978 (Vic)	Provides a framework for investigation under a range of outcomes. Requires methods for mitigating adverse environmental effects and risks. The Minister will assess this Project against the Act.
Environment Protection Act 2017	Established the legislative framework for protecting the environment in Victoria. Regulations regarding protection of environmental values and of the environment ensuring the Project demonstrates its implementing measures so far as 'reasonably practicable' to meet the general environmental duty.
EPA Victoria (2023) Publication 1834 Civil construction, building and demolition guide	Outlines controls for civil construction and earthworks to manage risks and obligations under the general environmental duty in relation to air, noise, land and water. This includes controls regarding the management of stormwater flows, stockpiles, works within waterways, and storage and handling of chemicals. Measures for the management of surface water developed in accordance with controls contained in EPA Victoria Publication 1834.
EPA Victoria (2020) Publication 1893 Erosion, sediment and dust: treatment train	Outlines measures to eliminate or reduce the risk of harm from erosion, sediment and dust using a treatment train approach. Measures to limit erosion and sedimentation of surface water considered the treatment train and an approach have been proposed.
EPA Victoria (2020) Publication 1894 Managing soil disturbance	Provides information about managing soil disturbance and how to eliminate or reduce the risk of harm from erosion, sediment and dust. Measures to reduce the risk of harm from erosion, sediment and dust from ground disturbance have been proposed.
EPA Victoria (2020) Publication 1896 Working within or adjacent to waterways	Provides information about how to eliminate or reduce the risk of harm from erosion, sediment and dust when working within or adjacent to waterways. Measures for conducting works within or adjacent to waterways have been proposed.



Legislation, policy, guidelines	Relevance to technical discipline
Environmental Reference Standard (ERS) 26 May 2021	Much of the State Environment Protection Policy (<i>Waters</i>) (<i>SEPP (Waters)</i>) operating under the <i>Environment Protection Act 1970</i> was replaced by the EP Act 2017, its regulations and the <i>Environment Reference Standard (ERS)</i> , or through new guidance published by EPA. ERS includes environmental values, indicators and objectives.
Flora and Fauna Guarantee Act 1988	Protect threatened species. Examine potential effects on biodiversity and ecological values.
Water Act 1989	Provides the legal framework for managing Victoria's water resources. Authorises Catchment Management Authorities (CMAs) various powers for the control, management and authorisation of works and activities in or over designated waterways in the CMA's waterway management district.
Catchment Management Authorities (CMAs)	
2021-27 North Central Regional Catchment Strategy	Each CMA prepares the RCS on behalf of their region. It's the overarching strategy for all involved in managing land, water and biodiversity. Works would be undertaken in accordance with North Central CMA Works on a Waterway permit licence requirements.
Victorian Planning Provisions	
14.02-1S Catchment planning and management, 14.02-2S Water quality	The objective of this strategy is to: <ul style="list-style-type: none"> - protect waterways from incompatible land uses in areas subject to flooding - ensure that land use activities potentially discharging contaminated runoff or wastes to waterways are sited and managed to minimise such discharges.

4.1 Water use

The Victorian Water Act (1989) provides the framework for allocating surface water and groundwater throughout Victoria. The Water Act details entitlements to water from all rivers, streams and groundwater systems in Victoria. It allows authorities and individuals to use water either through bulk entitlements, licences or sales of water.

The Water Act is administered by DEECA and regional water authorities. The Act applies to all surface water in Victoria, including river management, water supply, irrigation and sewerage. The Act encompasses:

- Environmental flows
- Rights to water
- Allocation of water entitlements
- Issuing of licences
- Control of construction of works on waterways
- Protection of groundwater
- Underground (groundwater) disposal
- Waterway management

Schedule 12 of the Act details the authorities empowered to carry out any function under the Act. The authorities relevant to the Project area are:

- Regional water authority: Goulburn–Murray Water (GMW)



- City council: (City of Greater Bendigo)
- Catchment management authority (North Central CMA)

The Water Act will primarily affect the Project through water licensing requirements for surface water harvesting, groundwater extraction (dewatering) and consumption of water through ore processing.

4.2 Water quality

4.2.1 Overview

From 1 July 2021, the *Environment Protection Act 2017* (EP Act 2017) as amended replaced the *Environment Protection Act 1970*. Much of the State Environment Protection Policy (*Waters*) (*SEPP (Waters)*) operating under the *Environment Protection Act 1970* was replaced by the EP Act 2017, its regulations and the *Environment Reference Standard* (ERS), or through new guidance published by EPA.

The ERS sets a statutory framework for the protection of uses and values of Victoria's fresh and marine waters. The ERS (Water) aims to ensure that catchments, rivers and coasts are managed in an integrated manner so that actions in the catchment do not have detrimental impacts on water quality in fresh and marine environments. To achieve this, ERS identifies protected environmental values and sets out a series of environmental water quality objectives and indicators to ensure the environmental values of waters are protected.

A limited number of clauses in the SEPP (Waters) will remain in force for up to two years from 1 July 2021 under the Environment Protection Transitional Regulations 2021. This allows more time for the Department and EPA to consult with duty holders and identify the most suitable replacement instrument to address the issues in these clauses. Where they are not expressly replaced, the content of some SEPP (Waters) clauses may remain useful and relevant to informing the state of knowledge.

4.2.2 Water Quality Objectives

As required by the EP Act 2017, the ERS 2021 outlines values of the environment that the community wishes to protect. Environmental values are defined as a use of the environment or any element or segment of the environment which:

- is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits or of the emission of noise; or
- is declared in State environment protection policy to be an environmental value.

Environmental quality indicators and objectives for rivers and streams (Water Quality Objectives or WQOs) have been outlined in the ERS 2021 for defined segments of landscapes/catchments to protect these environmental values (Victorian Government 2021). The regionalisation of environmental WQOs for different landscape segments accounts for natural variations due to processes related to soils, topography, meteorology and vegetation.

The surface water environments relevant to the Project area fall within the Murray and Western Plains segment. The Murray and Western Plains segment comprises river and stream reaches of lowlands (which are generally below 200 m in altitude) including the Campaspe River basin (part of the Murray-Darling basin). The water quality objectives for the Campaspe basin are set out in Table 4-2. In the absence of specific indicators/objectives not prescribed in the ERS, default ANZECC 2000/ANZG 2018 trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed freshwater ecosystems can be used (see Table 4-3).



Table 4-2 Environmental water quality objectives for Campaspe basin (Victorian Government 2021)

Water quality indicator	Physical/Chemical objective
Electrical Conductivity (EC) ($\mu\text{S}/\text{cm}$ @ 25°C)	≤ 2000 (75 th percentile)
Acidity/alkalinity (pH units)	≥ 6.8 and ≤ 7.8 (25 th and 75 th percentiles)
Total Phosphorus ($\mu\text{g}/\text{L}$)	≤ 50 (75 th percentile)
Total Nitrogen ($\mu\text{g}/\text{L}$)	≤ 900 (75 th percentile)
Dissolved oxygen (percent saturation)	≥ 65 and 130 (25 th percentile and maximum)
Turbidity (NTU)	≤ 40 (75 th percentile)
Toxicants – Water	95% protection

Table 4-3 Default trigger values for slightly to moderately disturbed lowland rivers (ERS2021/SEPP2018)

Parameter	Trigger Values
Total Phosphorus (TP) ($\mu\text{g}/\text{L}$)	50
Total Nitrogen (TN) ($\mu\text{g}/\text{L}$)	900
DO (% Sat.)	$\geq 65 - 130$
pH (pH units)	6.8 – 7.8
Electrical conductivity ($\mu\text{S}/\text{cm}$)	≤ 2200
Turbidity (NTU)	<40

For toxicants, ERS (Water) recommends using the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) guidelines (previously ANZECC (2000)) trigger values for 95% species protection (See Table 4-2). A summary of the ANZECC (2000)/ANZG (2018) toxicant trigger values for freshwater ecosystems and considered relevant by the Project team for the Project area is presented in Table 4-4.

Table 4-4 Toxicant trigger values for slightly to moderately disturbed waters (ANZECC 2000/ANZG 2018)

Water quality indicator	Physical/Chemical objective
Ammonia (NH_3) (mg/L)	0.9
Aluminium (pH >6.5) (mg/L)	0.055
Aluminium (pH <6.5) (mg/L)	0.0008
Arsenic (AsIII) (mg/L)	0.024
Arsenic (AsV) (mg/L)	0.013
Boron (mg/L)	0.370
Cadmium (mg/L)	0.0002
Chromium (CrVI) (mg/L)	0.001
Copper (mg/L)	0.0014
Lead (mg/L)	0.0034
Manganese (mg/L)	1.900



Water quality indicator	Physical/Chemical objective
Mercury (mg/L)	0.0006
Nickel (mg/L)	0.011
Selenium (mg/L)	0.011
Silver (mg/L)	0.00005
Thallium (mg/L)	0.00003
Uranium (mg/L)	0.0005
Zinc (mg/L)	0.008

4.2.3 General environmental duty

The general environmental duty is the cornerstone of the EP Act 2017 and is a continuing duty. It requires that a “person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable.”

To determine what is reasonably practicable, regard must be had to the following matters:

- elimination of risk,
- knowledge of risk,
- availability and suitability of controls; and
- cost of implementation.

The development of the mitigation measures in this report has been conducted with a view to complying with the duties under the EP Act 2017, including the general environmental (GED).

Further guidance as to what is considered reasonably practicable is set out in EPA Publication 1856.

4.3 Natural Watercourses

Mapping of waterways/watercourses can be separated into two distinct types:

VicMap Watercourses

VicMap watercourses are a spatial dataset which provides a visual representation of the alignment of drains, channels, creeks, rivers and water storages. The layer is maintained by DEECA and is purely indicative. The layer generally includes, but is not limited to, Designated Waterways (see below) and constructed channels. VicMap waterways are generally displayed in figures and maps as “Waterways” and are included in some maps within this report. Where available the dataset also indicates named waterways.

The VicMap watercourses layer gives a better representation of potential overland flow paths than Designated Waterways because it covers drainage lines and smaller flow paths which are not included in the Designated Waterway definition. Figure 4-1 shows the VicMap watercourses near the Project area.

Designated Waterways

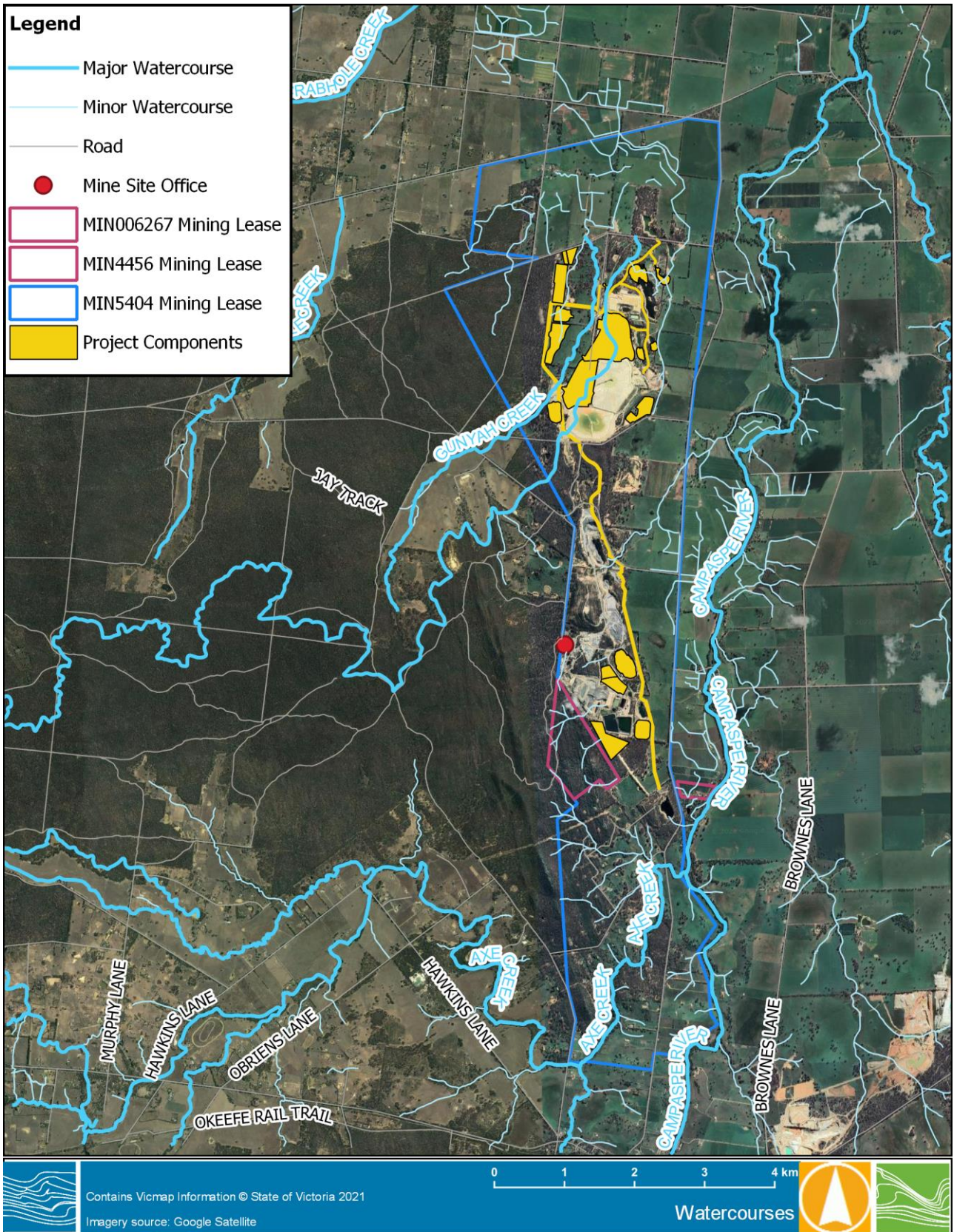
The *Water Act 1989* defines a ‘designated waterway’ as “a natural channel in which water regularly flows, whether or not the flow is continuous”. Within Victoria, each CMA has mapping of its designated waterways. North Central CMA have statutory responsibilities under the *Water Act 1989* and ‘By-law No.2 Waterway Protection 2014’ to monitor, manage, enforce, and administer control over all works which may impact upon



designated waterways throughout the Campaspe region, and to ensure works undertaken do not adversely affect the health of those waterways.

The only designated waterway nearby the Project area is the Campaspe River, located to the east. There is no designated waterway within the mining lease.

Any work in the vicinity of a designated waterway will be subject to a North Central works on waterways permit (depending on location and at the discretion of the CMA). Drainage works to be connected (directly or indirectly) to a designated waterway must not occur without the permission of the CMA through such a licence. Furthermore, drainage works that are connected to designated waterways cannot be altered or removed without the permission of the CMA.



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Figure 4-1 Watercourses near the Project area



4.4 Surface water assessment criteria

4.4.1 Construction, operation and rehabilitation criteria

The guidelines and standards against which the project is being assessed are outlined in Section 4. They focus on ensuring the development does not cause a change to water quantity or quality which will adversely impact areas external to the mine area. This includes ensuring the mine construction, operation and or rehabilitation does not:

- Cause a reduction in water quality at any sensitive receptors /environmental values. i.e. decreased water quality in waterways.
- Cause a decrease in water quantity sensitive receptors /environmental values. i.e. decreased water availability for native vegetation/dams.
- Cause an increase in water quantity sensitive receptors /environmental values. i.e. increased inundation depth in cropped paddocks, roads, houses, sheds etc.

The major driving guidelines and standards for this work include:

- Commonwealth Government
 - Australian Rainfall and Runoff (2019)
- Victorian State Government
 - Water Act 1989 (Vic)
 - Environment Reference Standard (2021)



5 METHODOLOGY

This section describes the method that was used to assess the potential impacts of the Project. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects.

The following sections outline the method adopted for the surface water impact assessment.

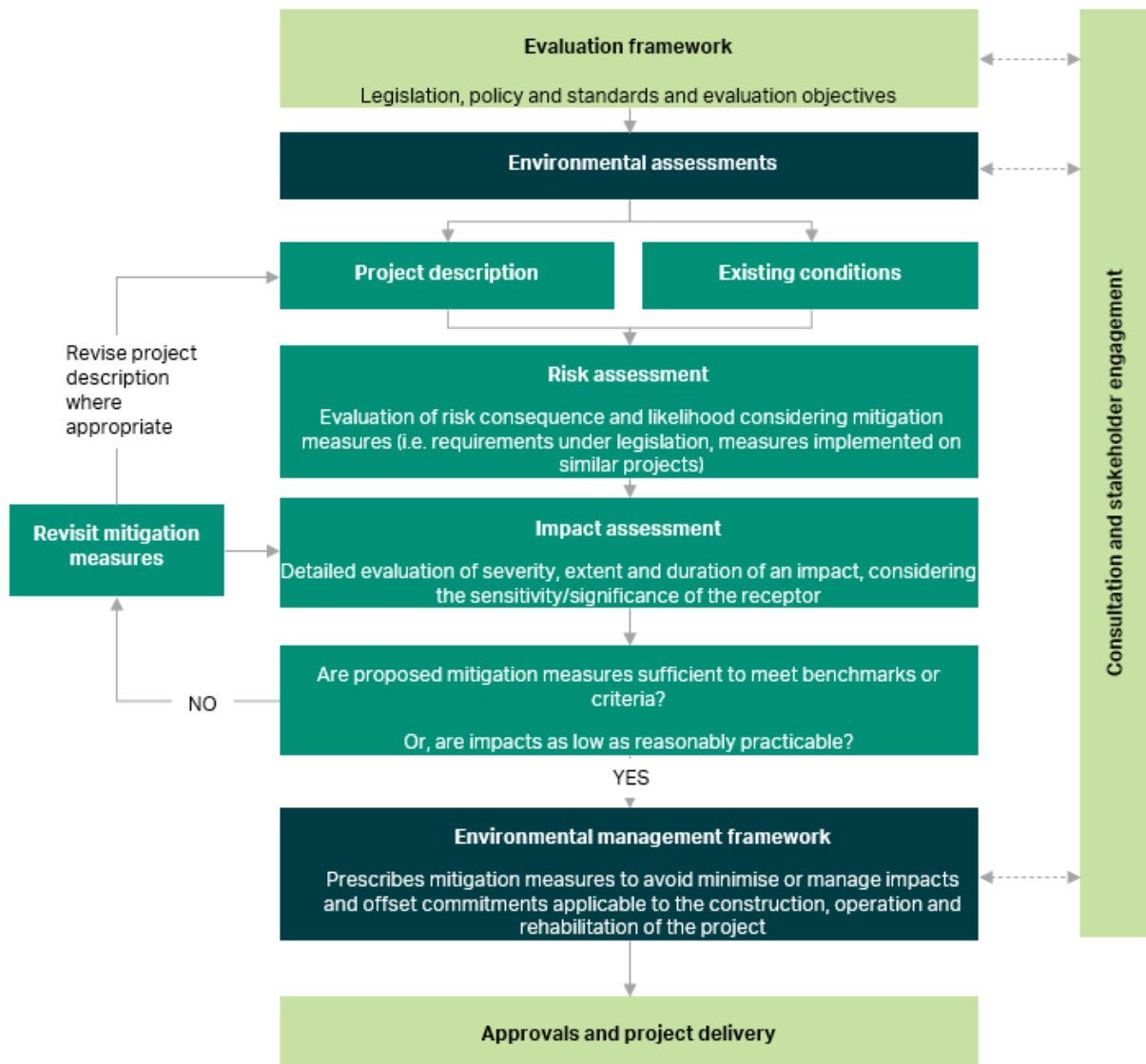


Figure 5-1 Overview of the assessment framework

The environmental assessments were undertaken according to the following steps:

- Establishment of a study area and characterisation of existing environment



- Review of the Project description, comprising the key Project components (including locations and form), proposed construction and operation activities (in the context of existing environment) and rehabilitation activities to determine the location, type, timing, intensity, duration and spatial distribution of potential Project interactions with sensitive receptors.
- An initial risk based analysis to evaluate the potential effects of proposed Project activities and their likelihood of occurring (considering initial mitigation measures) to determine the relative importance of environmental impacts associated with the Project and therefore prioritise issues for attention in the subsequent assessment of impacts. Initial mitigation measures would include measures that are common industry practice or required to meet legislation.
- An assessment of impacts that examines the severity, extent, and duration of the potential impacts and considers the sensitivity and significance of the affected receptors.
- Evaluation of predicted outcomes against benchmarks and criteria such as those described in applicable legislation, policy and standards.
- Evaluation of the potential for cumulative impacts (where relevant) caused by impacts of the Project in combination with impacts of other existing and proposed projects that may have an overall significant impact on the same environmental asset.
- Identification of additional mitigation measures where necessary to address potentially significant environmental impacts.
- Evaluation and reporting of the residual environmental impacts including magnitude, duration and extent, taking into account the proposed mitigation measures and their likely effectiveness.

Based on the findings of the environmental assessments, an Environmental Management Framework (EMF) has been prepared to monitor and control environmental performance during project implementation (EES Chapter 24:Environmental Management Framework). The EMF has specified the committed mitigation measures to avoid, minimise and manage impacts, proposed contingency measures and offset commitments, and describe the roles and responsibilities for implementation throughout project construction, operation and decommissioning.

The specific methods adopted during the key steps are described in the sections below.

5.1 Study area

The surface water study was conducted by modelling riverine inundation and direct/localised catchment inundation. The model extent was selected to include all local catchment drainage pathways leading to or from the Project area, as well as the Campaspe River floodplain along the Project area.

5.2 Existing conditions

A comprehensive assessment was undertaken to understand the existing environment of the study area to inform the environmental impact assessment for the works. This assessment incorporated:

- A review of available hydrological data
- Modelling of riverine inundation
- Modelling of direct/localised catchment inundation

5.3 Avoidance and minimisation

Relevant to this topic, the following measures have been adopted in relation to the design, construction and operation of the Project to avoid and minimise impacts:



- Designing the TSF5 and TSF6 based on the outcomes of the dambreak assessment consequence category – EES Technical Appendix. E1; TSF5 and TSF6 Life of Mine Concept Design assumed a consequence of major¹ for environmental receptors if a dambreak was to occur and used this consequence to inform the design of the TSFs in accordance with ANCOLD requirements for storm event design calculations, stormwater storage requirements and spillway design. The design has been conservatively estimated as High B which requires the spillway to be designed to accommodate the Probable Maximum Flood (PMF) and for the storm capacity to be designed to AEP of 1:100. No farmhouses/properties would be affected by failure of TSF5 or TSF6. The major environmental consequence is based on the inundation extents which Advisian estimated (refer to Figures 8.3, 8.4 and 8.5 in EES Technical Appendix E1. These extents do not extend outside of MIN5404 and therefore do not reach the Campaspe River (or Axe Creek) but do include the Gonyah Creek flowpath. EES Chapter 24 EMF outlines the mitigation measures which relate to the TSF design (MM-SW02 and MM-G01 to MM-G15). These mitigate the potential for failure as far as reasonably practicable, through design, construction and operation. These include monitoring to prevent failure (MM-G07) and contingency measures such as diverting tailings (MM-G12), repair work (MM-G13) and in the event of failure, emergency response measures (MM-G15).
- The potential for impacts to surface water related to brine pond failure is also not assessed. The brine pond will be designed such that the potential for failure is rare (1:10,000 to 1:1,000,000). EES Chapter 24 EMF outlines the mitigation measures which relate to brine pond design (MM-G31) which is intended to mitigate the potential for failure as far as reasonably practicable and provides evidence of monitoring which will be conducted and contingency actions which would be taken in the event of a failure occurring. MM-G15 (emergency response) also applies to the brine pond.
- Offsite water discharge - Given the likely poor water quality of mine impacted water the mine and storage design has been completed to ensure no surface water runoff will leave FGM. FGM is proposed to have sufficient water storage to store all runoff from disturbed areas with sufficient capacity.
- Infrastructure locations – Mining infrastructure is located outside key drainage areas. Results of the “Rain on Grid” (RoG) surface water modelling can be used to adjust placement with the optimum locations chosen to avoid overland flow paths and potential interaction with them.
- Internal site drainage – Mine contact water will be contained within the disturbance area using stormwater sumps and drainage lines. The drainage system (swales/culverts/drains/dams/bunds) will be designed with a 1% AEP (plus freeboard). The sampling points on these various drainage systems are shown in Figure 6-18.
- External site drainage - Stormwater runoff within undisturbed areas will be managed using existing surface drainage lines in keeping with current farm management practices. In instances where FGM is operating in a drainage line or overland flow path drainage lines will be diverted and returned to their natural termination points.
 - The main drains which control the diversion of upstream catchment flows through the site, without the external flows coming into contact with disturbed mine areas, are the northern and southern diversion drains The northern diversion drain (NDD) collects rainfall runoff from the Mount Sugarloaf Reserve and directs it through the site in a 3 m wide, 0.75 m deep channel which is designed to contain a 1 100 year flood. The NDD uses an existing ephemeral channel to join the Campaspe River northeast of sampling location NDD6 (see Figure 16-8). The southern diversion drain collects upstream flows from the southern portion of Mount Sugarloaf Reserve and directs it through the site to an old river terrace to the east of Johns Pit (SDD3 on Figure 16-8).

¹ “Major” refers to ANCOLD (2012) guidelines and equates to a major impact on stock and fauna, ecosystems and rare and endangered species.



- Gunyah Creek originates in the Gunyah Creek valley west of Mount Sugarloaf and enters the mining lease west of the TSF5/TSF6. It is then led through the northern parts of the Project area before reaching the open area north of Campaspe Road. Gunyah Creek is kept out of the current mining area by local bunds.
- Water use efficiency – To optimise water use a water efficiency program will be incorporated into the management of surface water at FGM. This program will provide a framework to investigate water use efficiency/recovery opportunities with consideration to any new or emerging technology over the life of FGM.
- A risk management plan for surface water will be updated for each work plan variation submitted to ERR..
- During active rehabilitation (revegetation and shaping of landforms) of the Project the NDD and SDD will continue to direct upstream catchment water through the site as described above and Gunyah Creek will continue to direct flows overland to the Campaspe.
- To achieve closure (relinquishment) FGM will conduct the investigations described in EES Chapter 21: Rehabilitation to achieve closure of the site. To achieve closure, the landforms will be capped, geotechnically stable, erosionally stable and the site will be non-polluting (through the assessment of potentially contaminated soils). All potential sources of spills such as machinery and infrastructure will have been removed from site. Once closure criteria are achieved, there are no post relinquishment impacts to surface water.

5.4 Risk assessment

An environmental risk assessment has been completed to evaluate the potential impacts of the Project. The risk-based approach is integral to the EES as required by Section 4 of the Scoping Requirements and the Ministerial guidelines for assessment of the environmental effects under the *Environment Effects Act 1978*.

The following tasks were undertaken to identify, analyse and evaluate environmental risks:

- Establishment of the context of the risk assessment – this identifies the boundaries of the Project including the Project definition, the duration of construction and operation, the design and environmental controls that would be in place, the location of the Project, and the environmental values, assets and uses with the potential to be impacted.
- Risk identification – identification of risk pathways that link Project activities (causes) to their potential effects on the environmental assets, values or uses
- Risk analysis – assessment of risk for each risk pathway, whereby risk is a combination of the likelihood of an impact on an environmental value, asset or use, and the magnitude of the potential impact (in terms of its extent, severity and duration).
- Risk evaluation – review key risks posed by the Project to focus effort in terms of impact assessment and mitigation.
- Risk treatment – identification of additional controls where required to reduce risk levels where possible.

An initial risk assessment was undertaken to assess potential impacts to the environment arising from the Project. The potential impact pathways are described in Table 7-1. These potential impacts were categorised as very low, low, medium, high or very high inherent risk based on Earth Resources Regulation guidance on work plans, (2020), (refer to EES Chapter 7: Assessment Framework). These potential impacts are described in Section 8 of this report, along with the mitigation measures proposed and their residual impact. A summary of the residual impact is provided in Section 9-2. The impact assessment methodology is described in Section 5.5 below.



5.5 Impact assessment

A change to baseline conditions (or the no-project case) caused by Project activities in any of the Project phases (construction, operation or rehabilitation) may give rise to impacts.

The impact assessment involved identifying the severity, extent and duration of any impacts, positive or negative, that the Project may have on the existing environment.

The significance of the impacts has been assessed in general accordance with the ERR likelihood and consequence guidance (refer to Chapter 7: Assessment Framework) from which Impact Assessment Significance Criteria have been developed, as provided in Chapter 7. These guidelines are based on applicable legislation, policy and standards and the evaluation objectives and environmental significance guidelines arising from the government terms of reference established to guide the assessments.

This study has assessed the impacts of construction, operation and rehabilitation of the Project on surface water assets and values to be protected using the following impact assessment methodology:

- The key Environment Effects identified by the Minister in the scoping requirements were reviewed along with the key EES evaluation criteria (Section 2).
- The scoping requirements and evaluation criteria were used to define the key technical components of the study, this included:
 - Quantity of available water
 - Groundwater/surface water interaction – There are inherent links between groundwater and surface water within the hydrologic cycle, within the Project area the surface water component of this is “losing” water to groundwater (further detail is available in the Groundwater Impact Assessment Report). Surface water outputs (losses) were provided to the groundwater assessment team to assist with their investigation.
 - Riverine flooding (Section 6.3.4) – The potential impact from riverine flooding from the Campaspe River was assessed through the development of a hydraulic model using riverine flows determined using flood frequency analysis (FFA). The results from this model were used to assess the Project’s interaction with riverine flooding.
 - Direct/localised catchment inundation (Section 6.3.3) – The potential impact of direct/localised catchment inundation was assessed through the development of a RoG hydraulic model. The model identified existing overland flow paths, depths and velocities of water flowing into and within FGM. The model was then modified to represent developed conditions and assess the potential for the Project to impact surface water flow paths, depths, duration of inundation and extents.
 - Water quality assessment (Section 4.2 and Section 6.3.5) – Water samples were obtained from six sites by FGM on two occasions during 2021, in autumn and spring. Although the data does not provide information on the temporal variability of ambient water quality in the sampled sites, an indicative understanding of local water quality was derived and compared to surface water quality relevant guidelines. Twelve months of water quality data from a monitoring site on the Campaspe River was also obtained.
 - Climate change modelling (Section 6.3.8) – To test the sensitivity of surface water to potential climate change impacts, modelling of water availability was undertaken with the inclusion of the climatic changes expected.
- All surface water relevant policy and legislation was reviewed to ensure the technical assessment methodology would cover the required detail (Section 4).



- The existing surface water environment, data availability and sensitive receptors / environmental values were identified and made a focus for the technical assessment outcomes (Section 6).
- The potential surface water impact and impact characterisation was determined based on the same focus areas listed above (Section 7).
- Mitigation measures were identified in consultation with the Proponent with consideration to the mitigation hierarchy to avoid or minimise impacts as far as reasonably practicable (Section 8).
- An assessment of residual impacts following implementation of the proposed mitigation measures and controls (Section 9.2).

Modelling and assessment was undertaken conservatively assuming all proposed developments were implemented concurrently. The assumption that all Project components are implemented at the same time represents the maximum catchment disturbance as well as the final operational condition of the Project (i.e. at Year 10). This therefore represents the maximum potential change in surface water quantity across the site. This then allows the maximum height of the bunds to be defined and these can be included in the detailed design of the Project components. This also enabled all proposed developments to be assessed as a complete package, rather than assessing multiple points in time. Additional to current climatic conditions a climate change scenario was also assessed increasing the design rainfall intensity. This is further discussed in Section 6.3.8.

5.6 Cumulative impacts

The only major projects in the vicinity of the Project are two proposed solar farms.

The Axedale Solar Farm, which has obtained planning approval but is yet to be constructed, is located approximately 3 km east of the Project, on the eastern side of the Campaspe River. Surface water runoff from this site flows northeast to Forest Creek which joins the Campaspe River just north of the Barnadown stream gauge 11 km north of the Project.

The Fosterville Solar Farm, still in a planning process, is located approximately 2 km east of the Project, also east of the Campaspe River. Surface water runoff from this site flows both northeast to Forest Creek and west directly to the Campaspe River.

Based on their locations, surface water runoff from these sites is highly unlikely to influence the surface water conditions in the Project area. Based on the nature of solar farm projects, they are unlikely to result in cumulative water quality impacts for the Campaspe River.

In addition, any planning permits in the area are for residential purposes only and the Project will not have an impact on these developments and vice versa.

5.7 Rationale

The assessment of quantity of available water was investigated using two separate hydraulic models, modelling riverine inundation and direct/localised catchment inundation separately. Since there are no major waterways intersecting the Project area, these can be seen as two separate processes affecting the Project area and can therefore be investigated separately.

For the direct/localised catchment inundation RoG modelling was adopted, due to its ability to represent the complex interaction between overland flow paths and depressions to be represented across flat terrain. RoG modelling is a robust method to determine both runoff volumes, peak flow rates and areas of high flood risk in sites with complex topography.



For the riverine inundation a 2D hydraulic model was adopted, producing results showing the maximum inundation depths across the Project area.

5.8 Limitations and assumptions

The following limitations, uncertainties and assumptions apply to this assessment:

- The mining operation will not allow mine impacted water to exit the operational mine area through containment and water reuse. Only rehabilitated areas of FGM may release surface water run off outside the mining area, as runoff from rehabilitated areas no longer produces mine impacted runoff. This has been assessed for the existing conditions by implementing bunds at locations of runoff exiting from FGM as well as locations where upstream runoff is entering the Project area. In a similar way, bunds have been implemented for the developed conditions scenario.
- The base LiDAR data is an accurate reflection of the current topography.
- The proposed developments are proposed to occur over a 10 year timespan. The direct catchment surface water modelling undertaken in this impact assessment has assumed all proposed development to be implemented concurrently. This gives the worst case scenario in terms of surface water impacts. It also negates the need to assess the Project for multiple points in time and allows FGM potential flexibility in its staging of surface water management, see Section 5.5.

5.9 Stakeholder engagement

Watertech attended a community Open House held at Axedale Town House, in November 2022, and spoke to local community members in relation to surface water aspects of the Project. This did not result in changes to the Project design, however the community queries have been noted in EES Chapter 6: Stakeholder Engagement.



6 EXISTING CONDITIONS

The existing conditions of the assets, values and uses being considered throughout this assessment are described in the following sections.

6.1 Information sources

6.1.1 Hydrological data

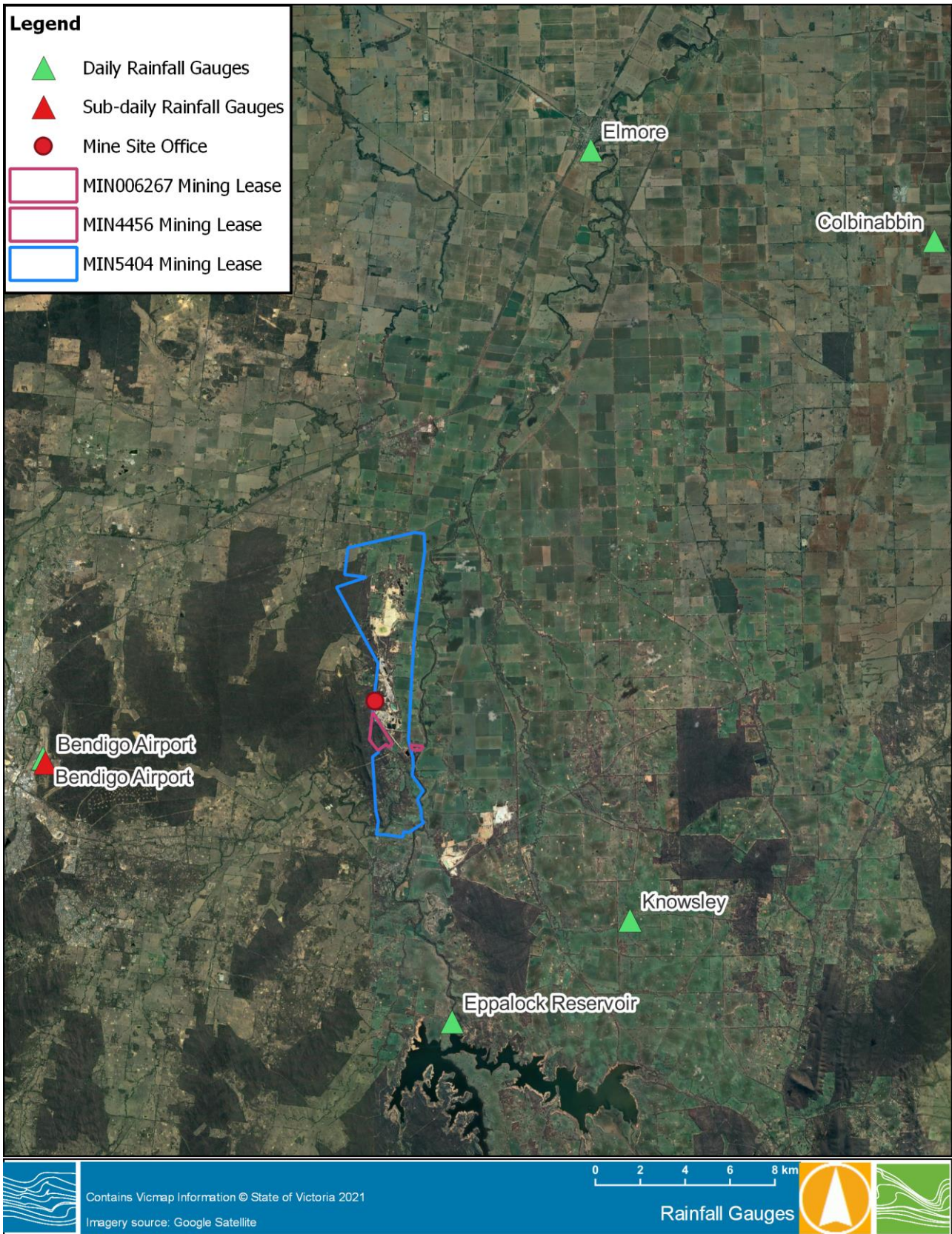
6.1.1.1 Rainfall data

Rainfall data was accessed via the Bureau of Meteorology (BoM)² where gauged rainfall data is available on a daily and sub-daily basis. Daily rainfall gauges exist across Australia at relatively high densities; however, the number of sub-daily gauges is limited. Figure 6-1 shows the location of the following available rainfall gauges close to the Project area:

- Daily gauges
 - Bendigo Airport (081123)
 - Available from Nov 1991, located 15 km west of the Project (FGM office)
 - Knowsley (081118)
 - Available from Jan 1984, located 15 km southeast of the Project
 - Eppalock Reservoir (081083)
 - Available from Mar 1965, located 15 km south of the Project
 - Elmore (081016)
 - Available from Jan 1882, located 26 km north of the Project
 - Colbinabbin (081008)
 - Available from Mar 1889, located 32 km northeast of the Project
- Sub-daily gauges
 - Bendigo Airport (081123)
 - Available from Nov 1991, 15 km west of the Project

The average annual rainfall within the Project area is around 500 mm/yr, compared to an average annual pan evaporation of 1400mm.

² Bureau of Meteorology, Climate Data Online, <http://www.bom.gov.au/climate/data/>



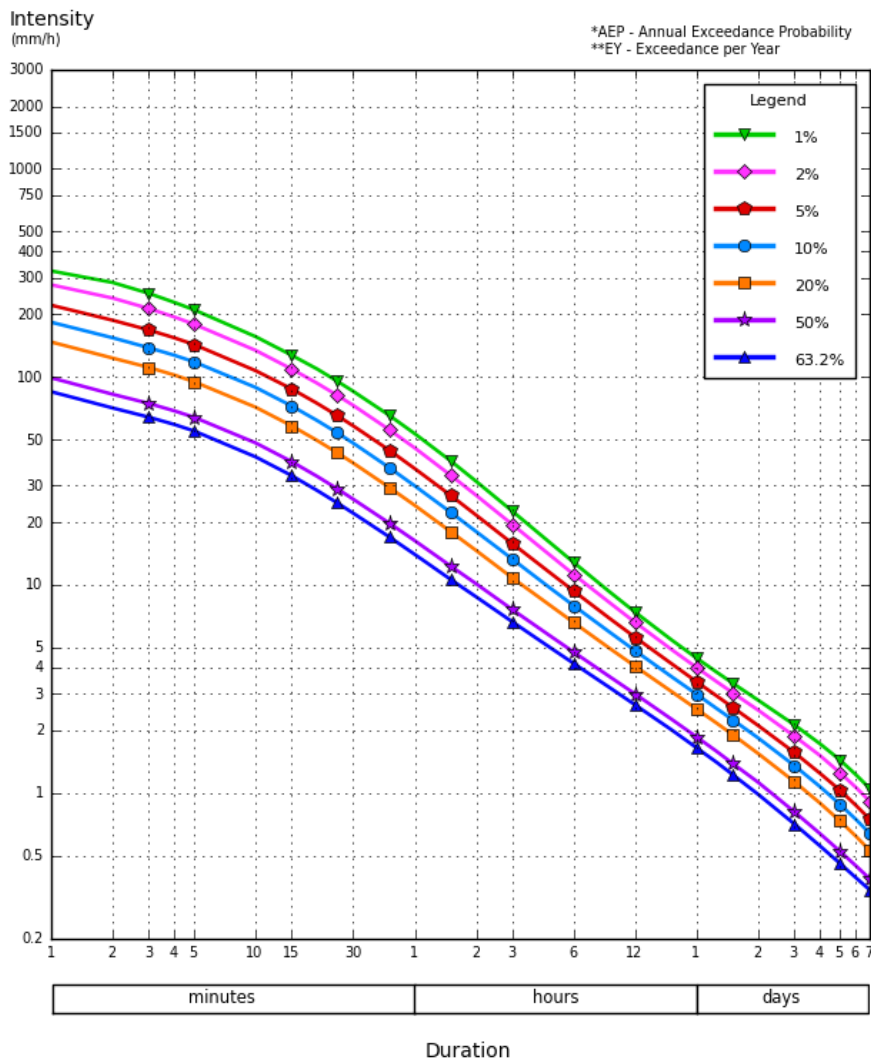
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Figure 6-1 Rainfall gauges near the Project area



6.1.1.2 IFD data

Intensity Frequency Duration (IFD) curves and underpinning data for the Project area were downloaded from the BoM website³. The IFD curves are presented in Figure 6-2, showing the relationship between rainfall duration and intensity for each Annual Exceedance Probability (AEP) event. Each AEP is represented as a % probability of exceedance. For example, a 1% AEP event is an event that has a probability of 1% of occurring in any given year. It is equivalent to a 1 in 100 year event. For the general area, rainfall intensity reaches 7.37 millimetres per hour (mm/hr) for a 1% AEP, 12 hour storm event, equal to a total rainfall depth of 88.44 mm. IFD curves are used to determine the likelihood of rainfall and, therefore, inundation. They are used to define design rainfall depths for the RoG modelling.



©Copyright Commonwealth of Australia 2016, Bureau of Meteorology (ABN 92 637 533 532)

Figure 6-2 IFD curves at the Project site (35.7125°S, 144.5125°E)

³ Bureau of Meteorology, Design Rainfall Data System (2016), <http://www.bom.gov.au/water/designRainfalls/revise-ifd/>



6.1.1.3 Streamflow data

There were no streamflow gauges within the Project area; however, Figure 6-3 shows there are several gauges nearby which can be used as indications of flows in the waterways potentially impacting the hydrological study area. Historical streamflow data is used to determine design flows as well as the existing water quality of waterways. They include:

- Campaspe River at Barnadown (406201)
 - Available from 1978, 11 km northeast of the Project
- Campaspe River at Eppalock (406207)
 - Available from 1997, 14 km south of the Project
- Axe Creek at Longlea (406214)
 - Available from 1965, 8.5 km southwest of the Project

6.1.1.4 Topographical data

A Light Detection and Ranging (LiDAR) data set with a 1-metre resolution, extending across the entire catchment, was available through the Victorian Department of Environment, Land, Water and Planning (DELWP – now known as DEECA). It provides a raster representation of the area capturing details of natural relief features across the catchment, as shown in Figure 6-4.

Other features, such as major roads, railways, waterways, water bodies, townships and alignment details were available through other VicMap data.

The area surrounding the Project area is characterised by the eastern slope of Mount Sugarloaf west of FGM and the valley containing Gonyah Creek which flows northwest past FGM. The area east of FGM is dominated by the Campaspe River floodplain. Surface water in the area generally flows northeast from Mount Sugarloaf towards the Campaspe River, however flow from the northern slopes of Mount Sugarloaf and nearby hilly bushlands flow north in Gonyah Creek and is diverted towards northwest by FGM.

6.1.1.5 Site Investigations

A site visit was undertaken by Water Technology on 10 March 2022 to gain a better understanding of the existing operations at FGM, local topography and land use.

Based on review of the topographic data, further site investigations were undertaken by FGM to locate and inspect culvert assets on and around the Project area, to include these in the hydraulic model.

6.1.1.6 Water quality data

Water quality data used to establish the existing water quality was accessed from several sources. Historic water quality observations were available through DELWP (now DEECA) for the Campaspe River, recorded at the Campaspe River at Eppalock gauge (406207). This gauge is located 14 km upstream of the Project area, see Figure 6-3. Water quality data from sampling undertaken by FGM was also available. See Section 6.3.5 for further details.

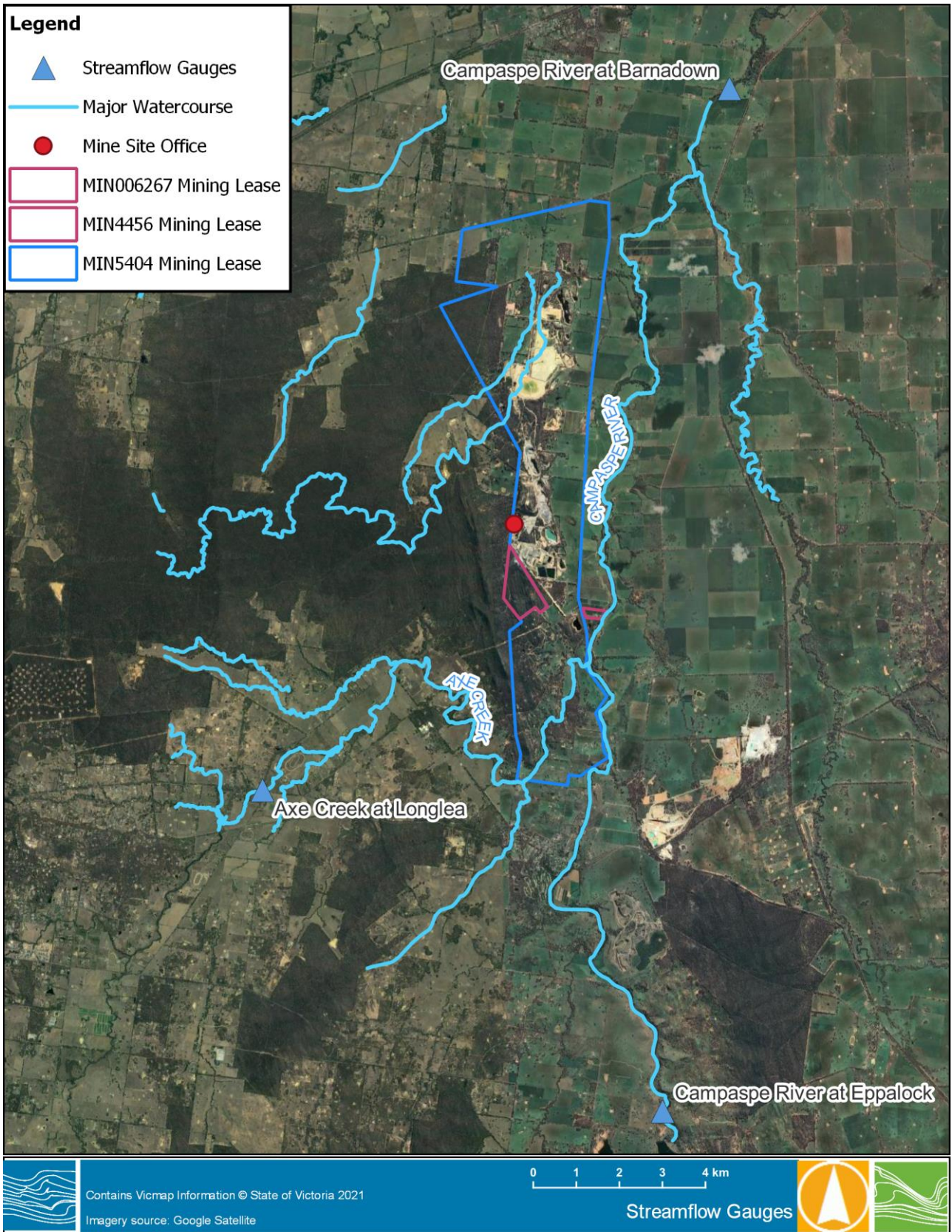


Figure 6-3 Streamflow gauges near the Project area

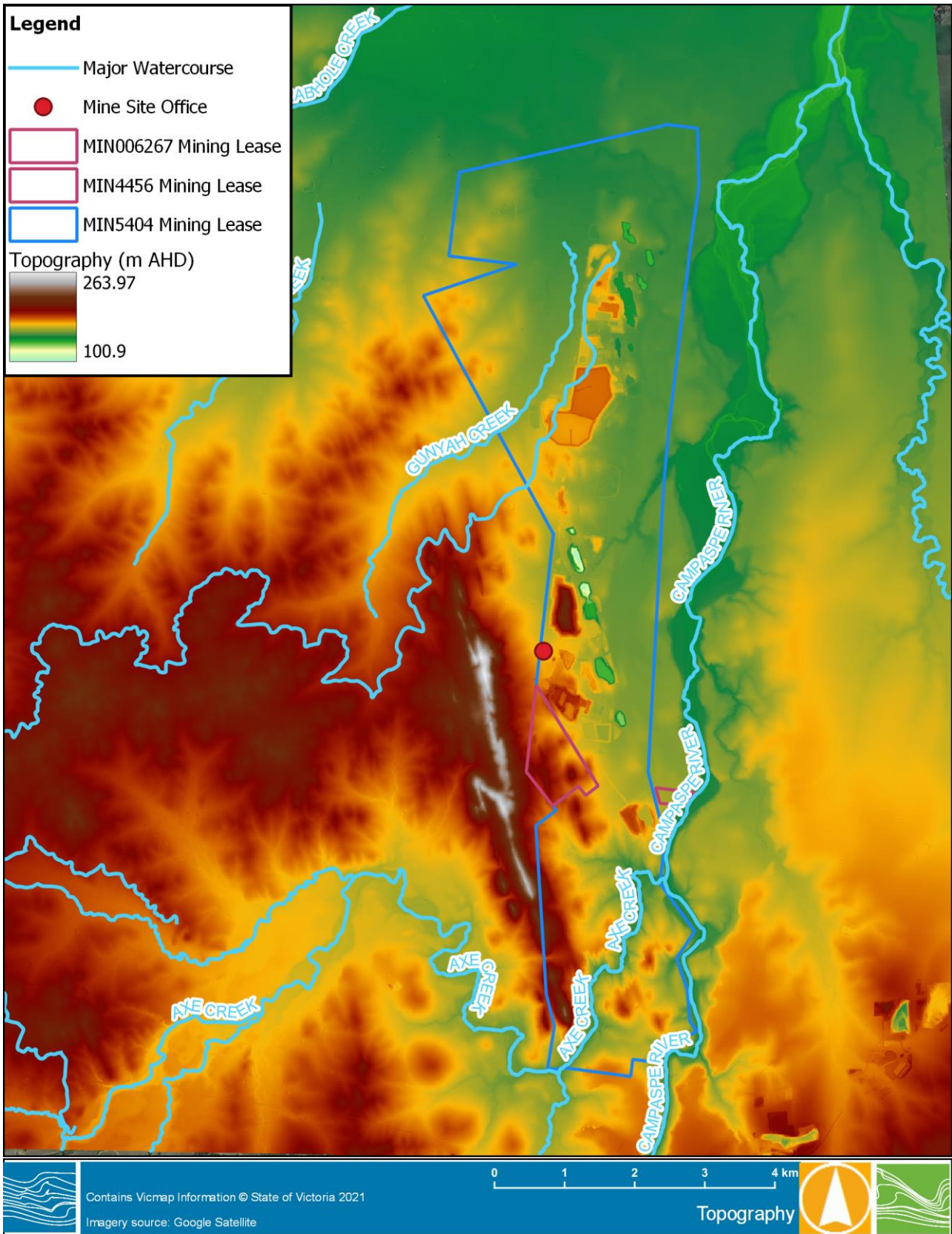


Figure 6-4 Topographical data for the Project area. Note: m AHD = metres above Australian Height Datum



6.2 Sensitive receptors / environmental values of site runoff

The ERS identifies environmental values of water environments that that need to be protected and enhanced. Rainfall runoff from the Project area flows toward the Campaspe River or Gunyah Creek (if not contained). Environmental values and sensitive receptors of water are predominantly related to these receiving waterways. The environmental values listed in the ERS can be categorised into 13 themes, these themes and their relevance to the Project are listed in Table 6-1.

Table 6-1 Sensitive receptors / environmental values and their relevance to the Project area

Sensitive receptors / environmental values	Relevance to project area
Water dependent ecosystems and species that are slightly to moderately modified.	Rainfall runoff from the Project area flows toward the Campaspe River or Gunyah Creek (if not contained).
Human consumption after appropriate treatment.	The Project area is not within a declared Special Water Supply Catchment Area; however, Goornong receives drinking water from the Campaspe River which is first treated at the Goornong Water Treatment Plant.
Potable water supply.	The Project area is not within a declared Special Water Supply Catchment Area.
Potable mineral water supply	The Project area is not within a declared Special Water Supply Catchment Area.
Agriculture and irrigation.	There are numerous farm dams in proximity of the Project area and more than half of the area around the site is agricultural.
Human consumption of aquatic foods (natural populations - commercial and recreational catch).	The Project area is not within the catchment of any aquatic food operations; however, consumption of recreationally caught fish from the Campaspe River is common.
Aquaculture	The Project area is not within the catchment of any aquaculture operations.
Water based recreation.	The Campaspe River is used for a significant number of water-based recreation activities; these include: Fishing/boating Swimming Kayaking/canoeing. Bird watching. Camping. Caravanning
Traditional Owner cultural and spiritual values.	The Campaspe River is of significant Traditional Owner cultural and spiritual value. It forms the boundary between Dja Dja Wurrung and Taungurung country.
Navigation and shipping.	The Campaspe River is not used for navigation or shipping.



Sensitive receptors / environmental values	Relevance to project area
Protection of buildings and structures.	There are numerous rural residential properties and local roads in proximity to the Project area.

Figure 6-5 shows the determined water receptors within a 2 km buffer of the Project area. They are mainly used for residential or agricultural purposes. These receptors include

- 412 farm dams
- 362 dwellings

It is noted that the Goornong township, located approximately 10 km north of FGM, receives raw water from the Campaspe River. The water is treated at the Goornong Water Treatment Plant in a process including coagulation and flocculation, clarification, media filtration and pH correction. The water is then chlorinated and stored in clearwater tanks. Taste and odour issues were experienced in December 2022; however the water, was determined safe to drink according to a press release from Coliban Water⁴.

⁴ <https://coliban.com.au/coliban-water-tweet-1603508294513217536>

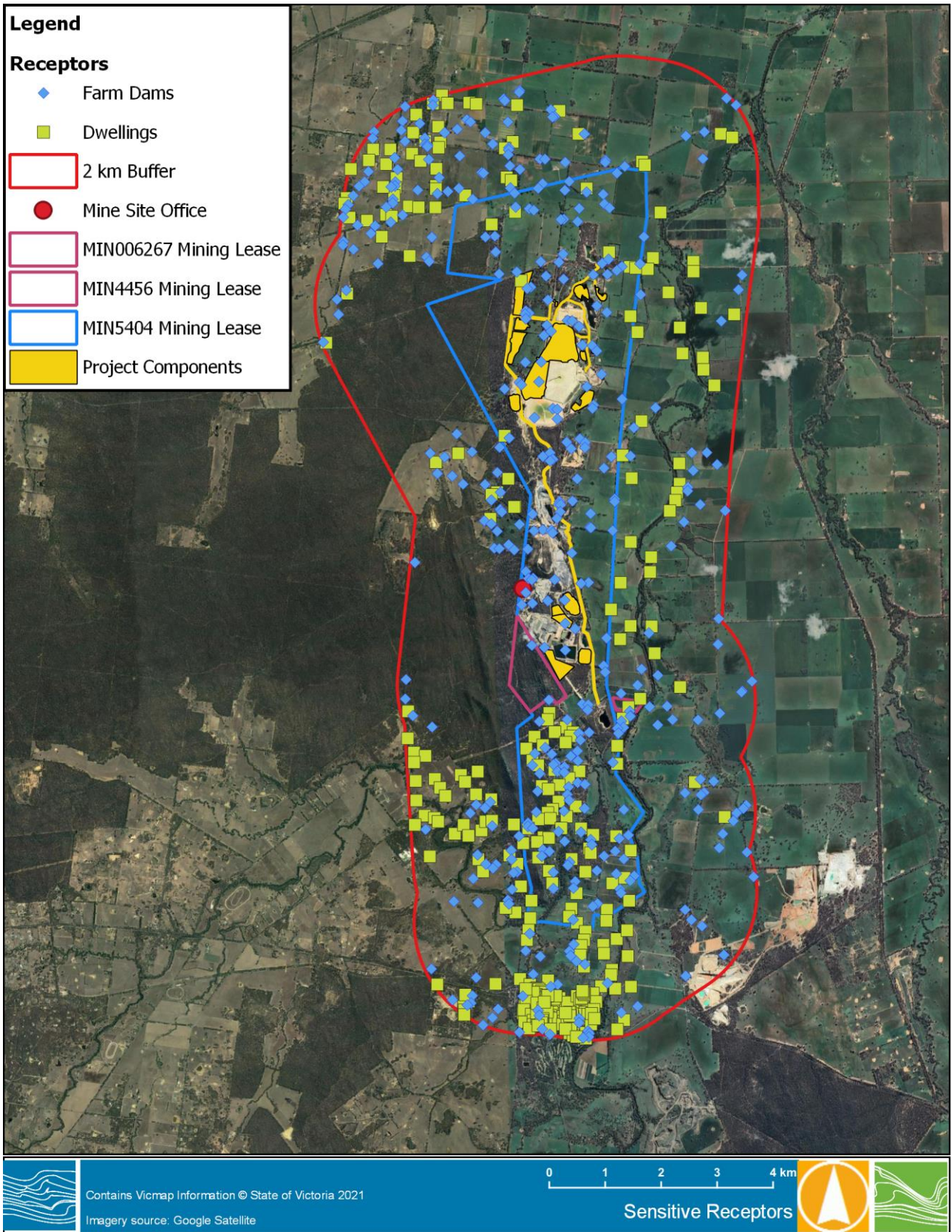


Figure 6-5 Receptors within the 2 km Project buffer



6.3 Characterisation of hydrological environment

6.3.1 Overview

FGM sits between Mount Sugarloaf and the Campaspe River. A majority of the Project area is outside the Campaspe River floodplain; however, Axe Creek and Gonyah Creek intersect FGM. Axe Creek flows towards the Campaspe River in a north-easterly direction across the southern part of the mining lease south of the mining facilities above ground. Gonyah Creek originates in a valley west of Mount Sugarloaf and flows north into the northern part of the mining lease, before dissipating into several channels on the fields north of the mining lease. The catchment generally slopes towards the northeast and the Campaspe River

The Campaspe River is the only designated waterway in the vicinity of the Project area, located approximately 1 km to the east.

Characterisation of the existing surface water environment was based around two key aspects; understanding the current quantity of water available and the quality of that water. This assessment included developing an understanding of the following:

- Direct/localised catchment inundation.
- Regional surface water contributions to downstream environments and the size of the required mine infrastructure to retain all surface water runoff from disturbed areas.
- Riverine flooding.
- Existing water quality.
- The potential impact of climate change.

6.3.2 Groundwater/surface water interaction

There are inherent links between groundwater and surface water within the hydrologic cycle. The surface water assessment carried out for the Project included estimation of infiltration losses; however, these were represented as a loss from surface water and may not necessarily contribute to groundwater. A large proportion of infiltration loss is retained as subsoil moisture to be taken up by plants (evapotranspiration) in the weeks following each rainfall event.

6.3.3 Direct/localised catchment inundation

6.3.3.1 Methodology and inputs

6.3.3.1.1 Overview

A Rain on Grid (RoG) modelling approach using TUFLOW was adopted for flood modelling of local storm events across the Project area. TUFLOW is an industry standard one and two-dimensional modelling package which has been used across numerous flood modelling projects across Victoria.

RoG modelling directly applies rainfall to a topographic grid of the catchment area, identifying all major flow paths through modelling of surface water runoff and then mapping of resulting depth, velocity and hazard (mapped as per the Australian Rainfall and Runoff recommendations⁵). RoG modelling is a robust method to determine both runoff volumes, peak flow rates and areas of high flood risk in sites with complex topography. RoG models are able to identify major flow paths, depressions/wetlands and the complex interactions of overland flow. A traditional rainfall runoff model (RORB, URBS etc.) would not be able to resolve these within

⁵ Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia



the Project area due to its inability to represent the complex terrain. Rainfall runoff modelling requires separation of flow paths and has no ability to hydraulically model discontinuous flow paths or wetland interactions (aside from a simple stage storage relationships). RoG modelling enables the complex of interaction between overland flow paths and depressions to be represented across the very flat terrain.

The modelling completed focused on using infiltration losses, hydraulic roughness (modelled as Manning’s ‘n’) and design rainfall intensities to produce runoff volumes (rainfall minus infiltration losses) and discharge rates covering the site, within upstream and downstream catchment areas.

The development of the TUFLOW model for the Project area consisted of the following components:

- Model extent
- Topography
- Material layer – representing hydraulic roughness
- Model boundaries – representing flows out of the model extent
- Rainfall

6.3.3.1.2 Model extent

Local catchments within and surrounding the Project area were delineated using the ESRI terrain modelling software ArcHydro, based on the 1m resolution DELWP LiDAR dataset (see Section 6.1.1.4 for further detail). Figure 6-6 shows the delineated sub-catchments (yellow polygons) and combined catchment (black polygon) which was used as the hydraulic model extent.

6.3.3.1.3 Model topography

The TUFLOW Digital Elevation Model (DEM) was developed using the 1m resolution DELWP LiDAR. This high-resolution dataset was able to represent the topography including open drains, using a model grid resolution of 4m to reduce model runtime. The DEM used in the TUFLOW model is shown in Figure 6-6

6.3.3.1.4 Material layer

A material layer was created based on planning and parcel layers available through VicMap and verified using aerial imagery. The hydraulic roughness coefficients (i.e. Manning’s n) and the rainfall loss values were assigned to each land use type. The catchment consists primarily of rural farming land and densely vegetated areas. Table 6-2 gives the Manning’s n-values adopted for the overland flow model based on land use type and standard industry values (e.g. VicRoads road design guidelines). Figure 6-7 shows the land use types corresponding with modelled Manning’s n-values for hydraulic roughness.

Rainfall losses were adopted from on Geoscience Australia’s Australian Rainfall and Runoff (ARR) 2019⁵ and adapted based on land use.

Table 6-2 Summary of hydraulic roughness and rainfall loss values

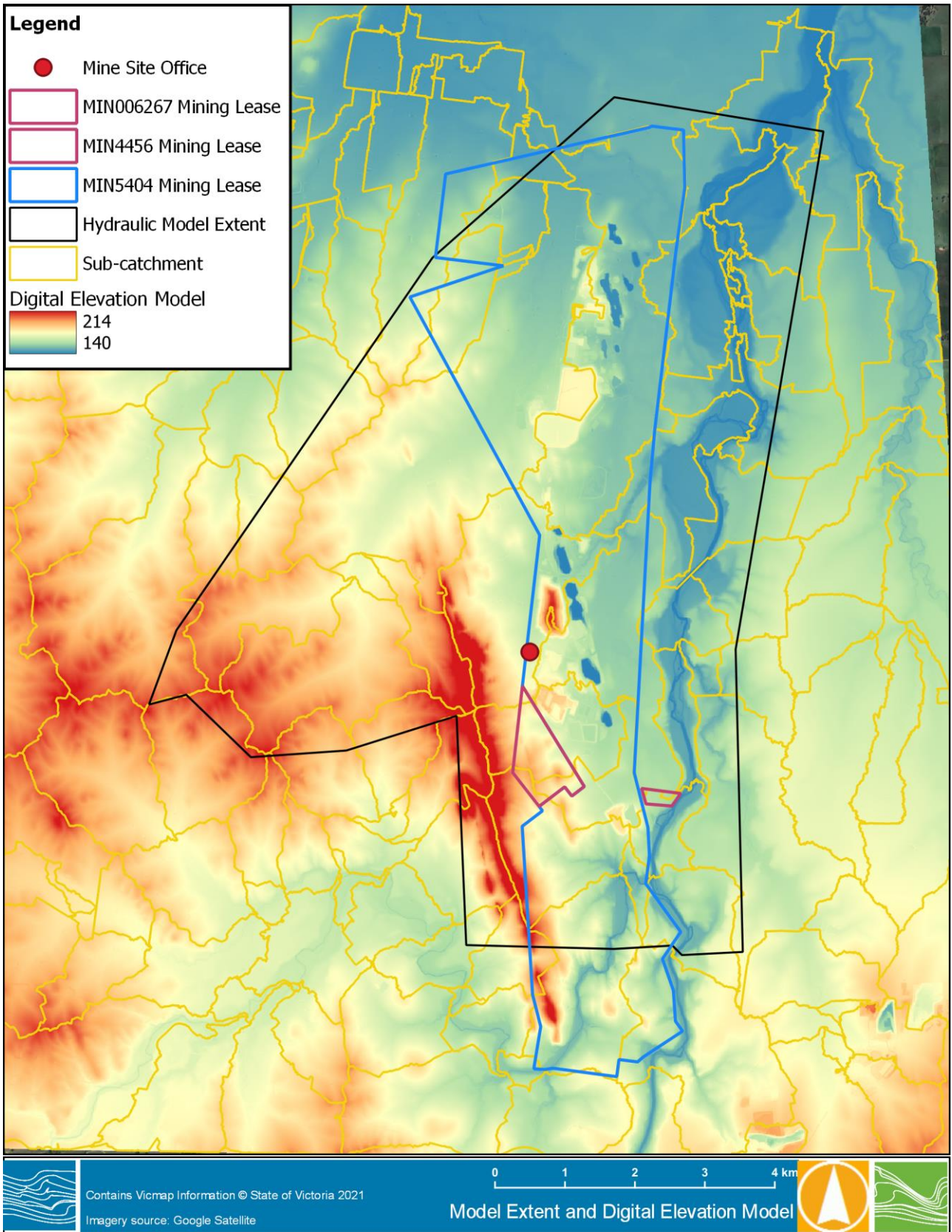
Land Uses	Manning’s ‘n’	Initial Loss (mm)	Continuous Loss (mm/hr)
Industrial or Commercial	0.3	2	0.5
Open Space or Waterway - minimal vegetation	0.04	25	4.7
Open Space or Waterway - moderate vegetation	0.08	25	4.7



Land Uses	Manning's 'n'	Initial Loss (mm)	Continuous Loss (mm/hr)
Open Space or Waterway - heavy vegetation	0.12	25	4.7
Waterway	0.04	0	0
Roads	0.02	1	0.5
Gravel or Sand	0.025	25	4.7

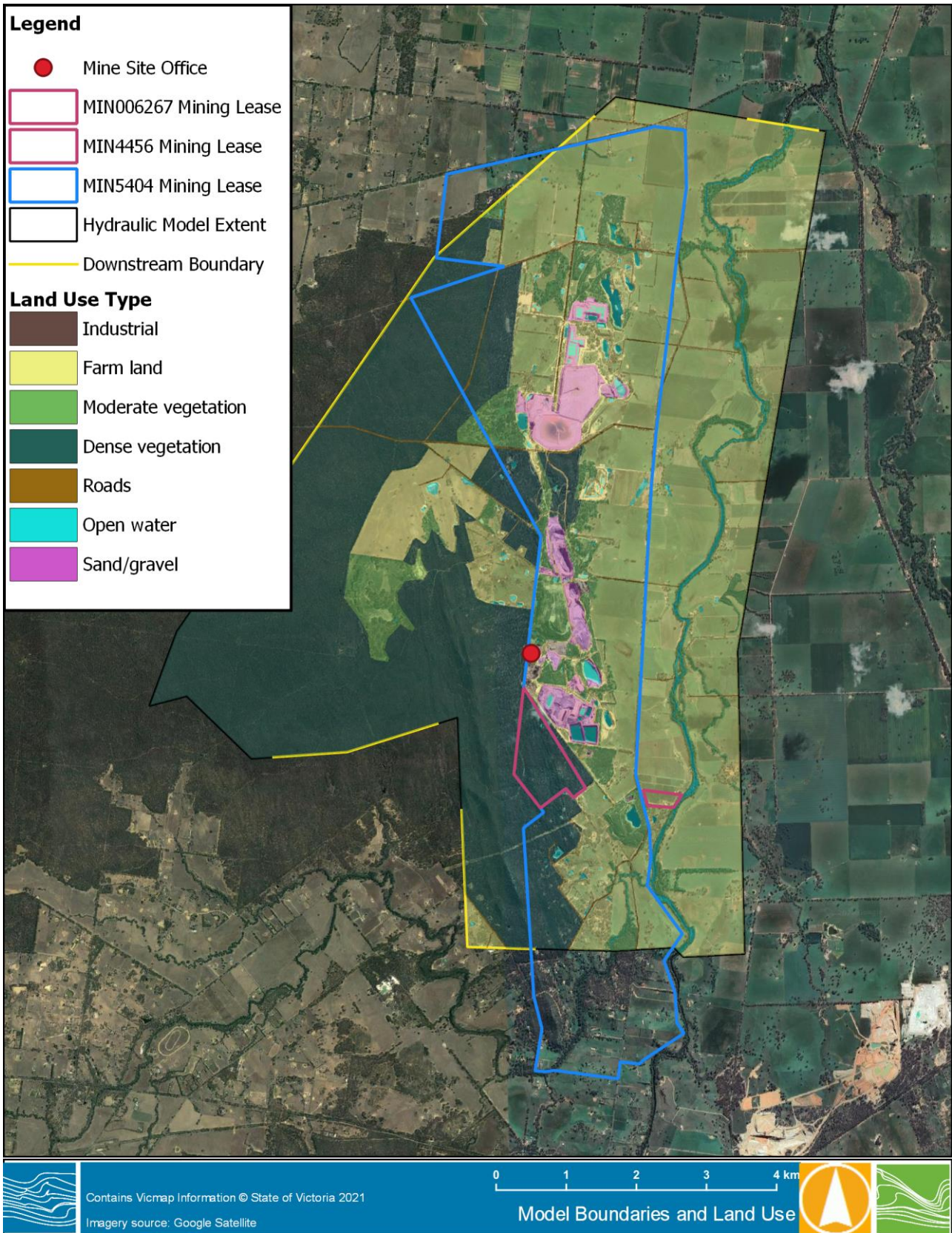
6.3.3.1.5 Model boundary

The downstream hydraulic model outflow boundaries were represented using a stage-discharge relationship (i.e. HQ type), as shown in Figure 6-7 (yellow lines). These boundaries allowed water to leave the model domain without influencing flood levels.



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Figure 6-6 Sub-catchments, model extent and model DEM



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Figure 6-7 Material layer and model boundaries



6.3.3.1.6 Rainfall input

Rainfall inputs to the TUFLOW model were derived from ARR 2019. They were extracted via the QGIS ARR2019⁵ plugin tool which downloads data from the ARR Data Hub and BoM. The 1% AEP rainfall depths across storm durations ranging from 2 hours to 24 hours were simulated, to ensure that the critical event duration for the catchment was captured. The ARR2019 design rainfalls assume present day conditions.

The ten recommended temporal patterns for each storm duration are provided to represent the variation in rainfall distribution over time. These temporal patterns are provided by ARR and were developed based on the long-term historical data in Australian rainfall gauges. Depending on the catchment characteristics, even for events with the same total rainfall depth, the variation of temporal distribution of rainfall depth could result in variation of flood extent and level within the catchment.

ARR 2019 recommends running an ensemble simulation using the ten temporal patterns to determine the temporal pattern which produces the median peak flow. This is typically selected by comparing hydrological model results; however, given the hydraulic modelling methodology used for this study, three rainfall temporal patterns representing a front loaded, back loaded and even intensity storm respectively were adopted for each modelled duration. Table 6-3 outlines the adopted TP for each modelled storm duration.

TUFLOW model flows were used to determine the duration and temporal pattern producing the peak flow at the Project area boundaries. Time (hours)

Figure 6-8 shows that the 9-hour storm and TP03 (dark blue line) produced the peak flow among the durations and temporal patterns modelled and was adopted for the design modelling.

Table 6-3 Modelled storm duration and TP adopted

Duration	Temporal patterns (TP) (Front, even, back loaded)
2 hours	TP02, TP06, TP09
6 hours	TP04, TP08, TP10
9 hours	TP05, TP06, TP03
12 hours	TP04, TP10, TP08
24 hours	TP05, TP01, TP10

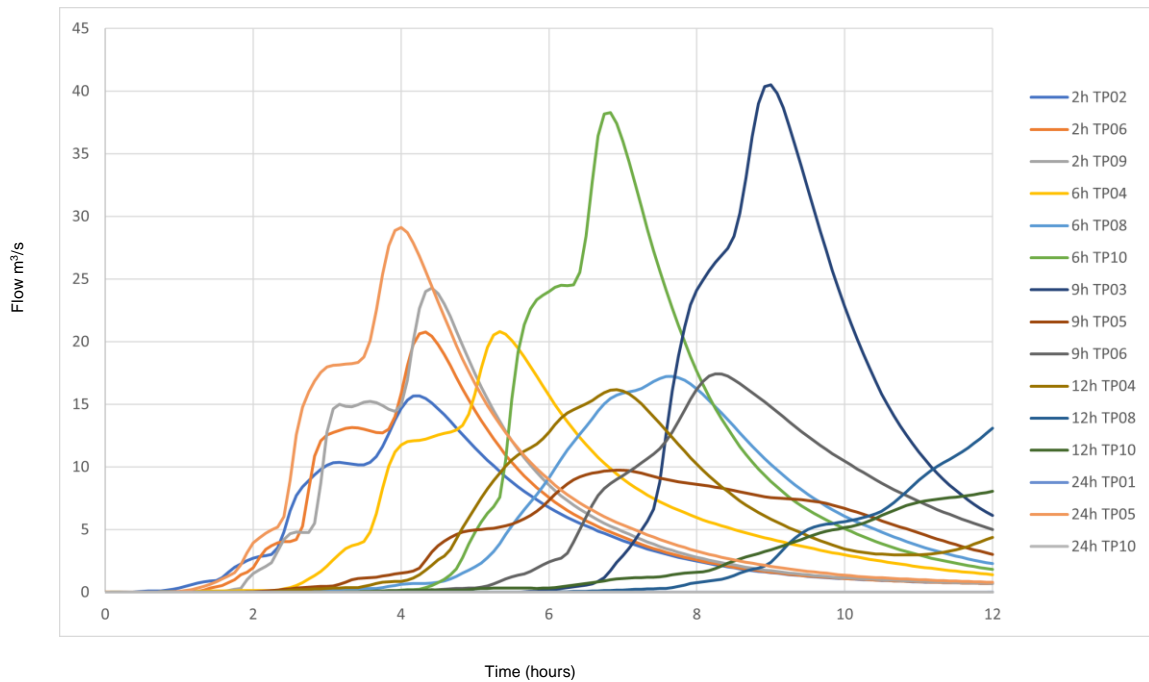


Figure 6-8 Peak flow comparison for all durations and selected temporal patterns

6.3.3.2 Model verification

There are several peak flow estimation methods that can be used for broad comparison to modelled peak flows. The Rational Method is a commonly adopted method to verify the flow at catchment outlet and a more recently developed and recommended method in ARR 2019⁵ is the Regional Flood Frequency Estimation Tool (RFFE).

Table 6-4 shows the comparison of modelled and estimated flows at the north-western model outlet from the Adams and RFFE Tool. The modelled peak flow is similar in order of magnitude to all of the estimated peak flows.

Table 6-4 Modelled flow verification

Estimation Method	1% AEP flow (m ³ /s)
Rational (Adams Method)	38.90
RFFE Tool	28.5
TUFLOW Model	36.70

6.3.3.3 Result

The 1% AEP hydraulic model results are outlined in Figure 6-9 and Figure 6-10. The results indicate that there are several major overland flow paths near the Project area. Surface runoff generated on the south-eastern side of Mount Sugarloaf flows towards the southern existing mining areas and are diverted southeast by an existing diversion drain. Runoff from the north-eastern side of Mount Sugarloaf flow towards the central existing mining areas and are diverted north by an existing diversion channel. External catchment runoff runs through some mining areas, running in bunded open channels, preventing mine impacted water from mixing with upstream catchment flows. One such channel is the Northern diversion drain, flowing through the central parts of the site before existing through the eastern boundary and flowing towards agricultural land that adjoins the Campaspe River. Prior to reaching the Campaspe River the flow paths cross the Axedale-Goornong Road.



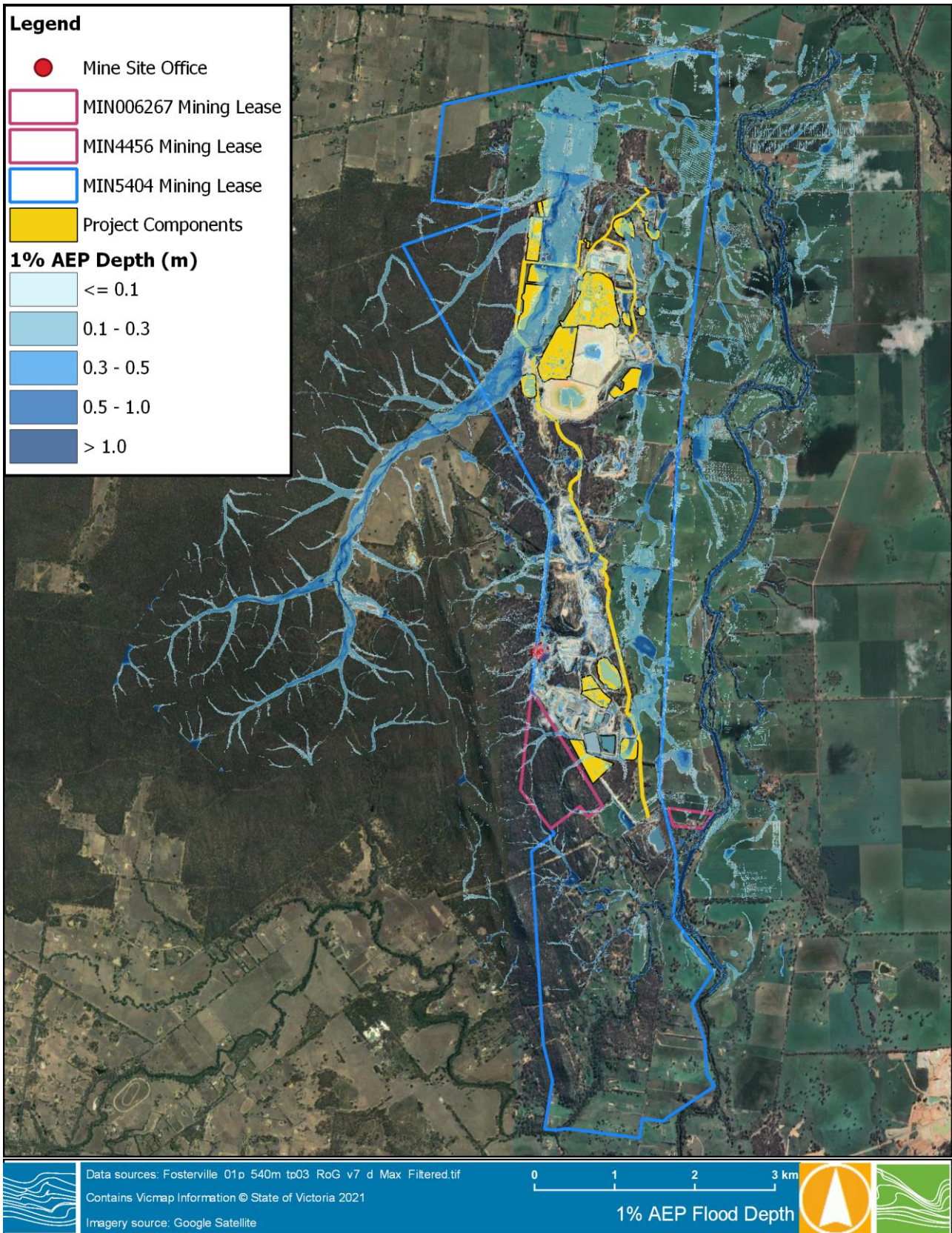
The flow paths through and around the southern mining lease areas result in large overland flow paths east of the mining lease leading to agricultural land and the Axedale-Goornong Road before joining the Campaspe River.

A major overland flow path originates in the Gunyah Creek valley west of Mount Sugarloaf and flows north along Gunyah Creek. This flow path enters the mining lease west of the TSF and flows through the northern parts of the Project area before reaching the open area north of Campaspe Road. The maximum flood depth across the mining area outside of existing pits and dams is 1.9m in Gunyah Creek.

Flow velocities within the major overland flow paths are generally high, with the velocities of up to 2 m/s found in the flow paths on the eastern side of Mount Sugarloaf, and velocities up to 1.3 m/s in the Gunyah Creek overland flow path. Velocities greater than 1.5 m/s may be a concern for access/egress restrictions and velocities greater than 1.0 m/s are a flag for considering erosion issues.

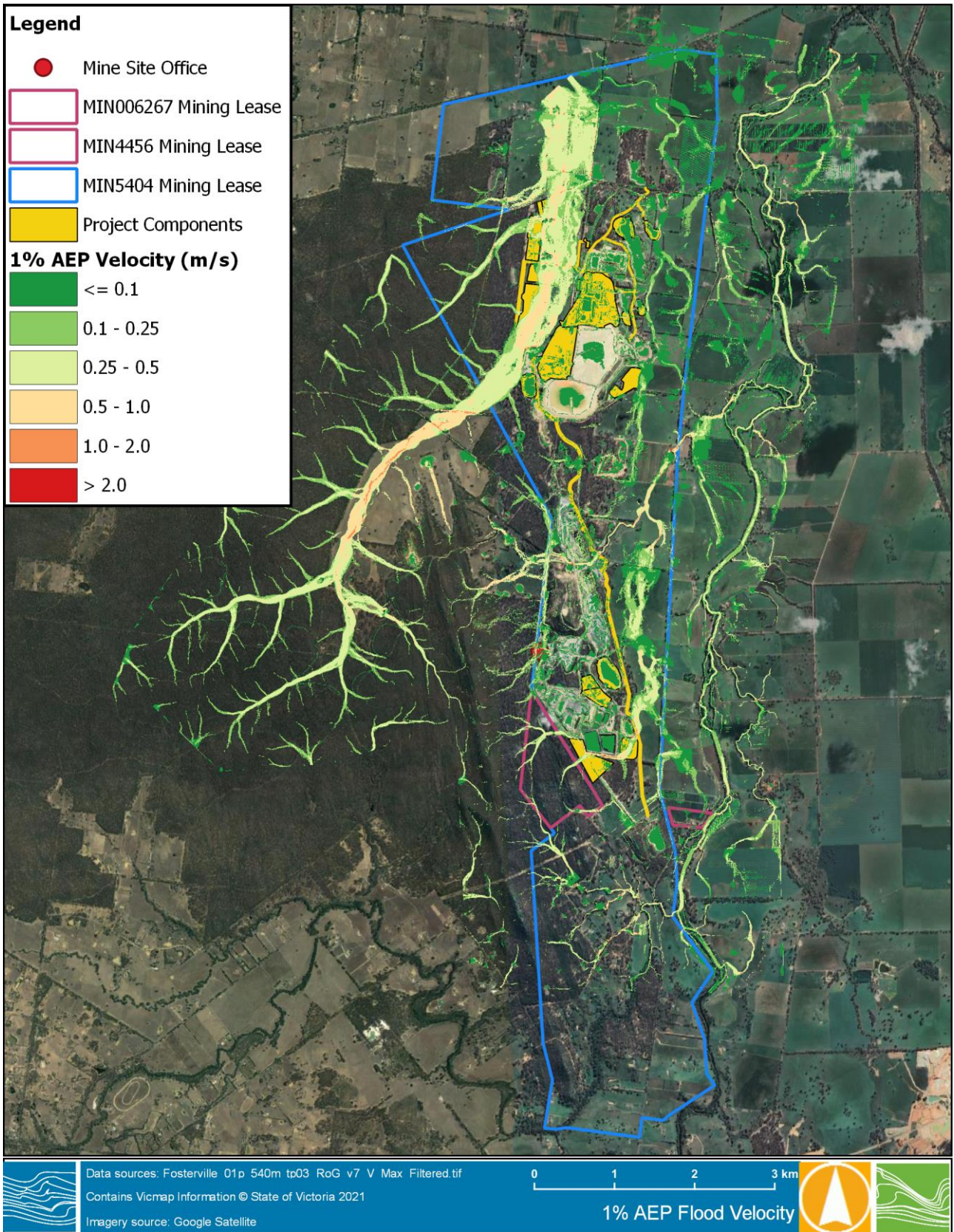
Surface water runoff enters the mining area from the western boundary. All remaining inundation is produced by rainfall directly onto the mining area. Flow exits the mining area to the north and east, flowing through agricultural land and farm dams before contributing to Axe Creek, the Campaspe River and Gunyah Creek.

For the existing conditions it was assumed surface water runoff from external to FGM is kept out of the mining areas by existing diversion drains and/or bunds, as present-day operations would be subject to this condition. To represent the existing conditions with adequate boundaries between internal and external runoff, bunding was applied to the model where it is believed that the existing topography was not accurately represented by the DEM. The results from the 1% AEP hydraulic model with bunds included are shown in Figure 6-12 to Figure 6-14. Minor changes can be observed in Figure 6-12, indicating locations where bunding was not sufficiently represented by topographic data alone. Only a handful of locations were identified as having an inadequate topographic representation to fulfil the requirement to keep external surface water runoff out of the site. These locations were inspected by FGM to confirm the existence of earth bunds. The additional bunding was applied at the assumed location of the inadequately represented bunds, minor discrepancies from the real location does not have a major impact on the result.



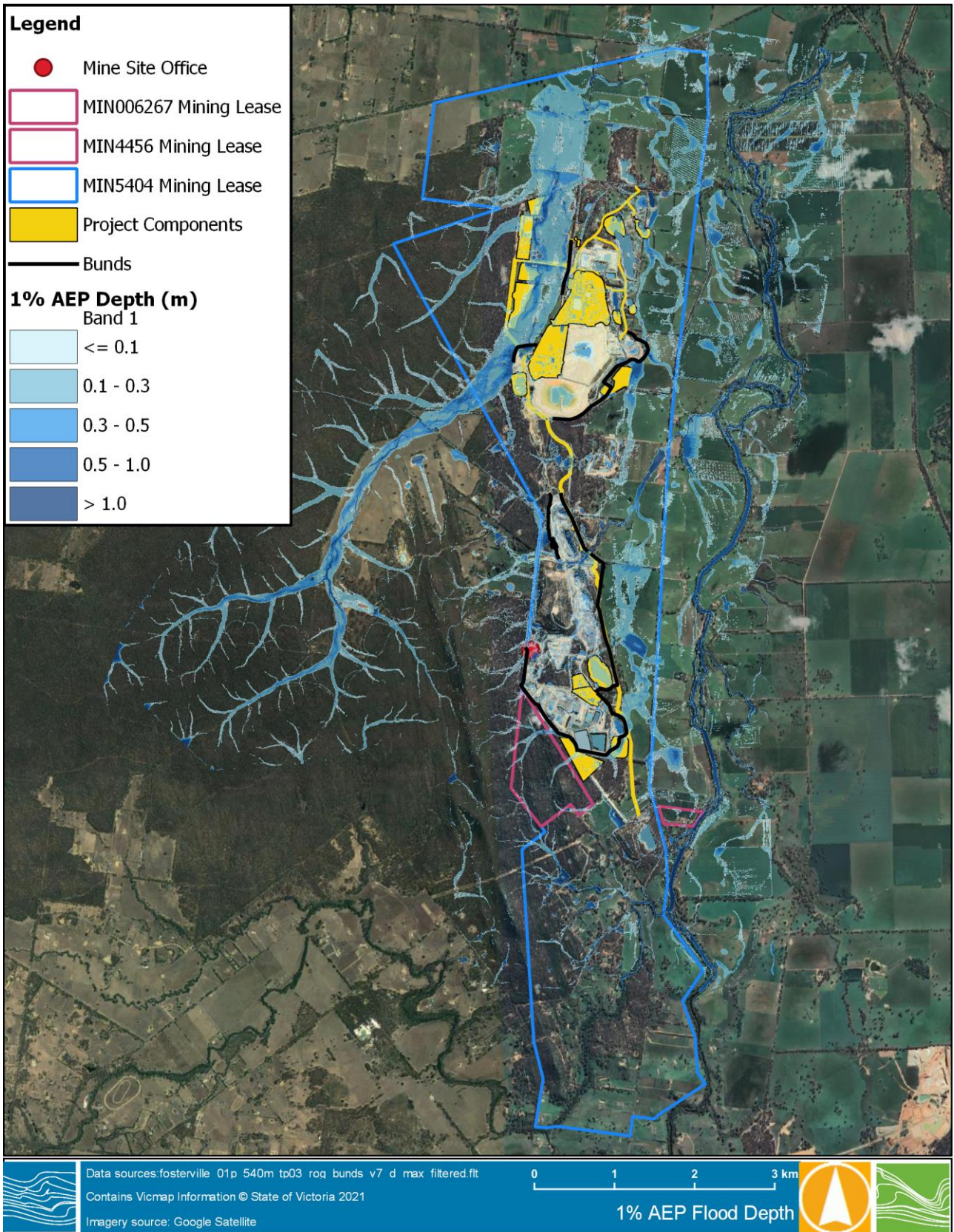
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Figure 6-9 Existing conditions – 1% AEP flood depth



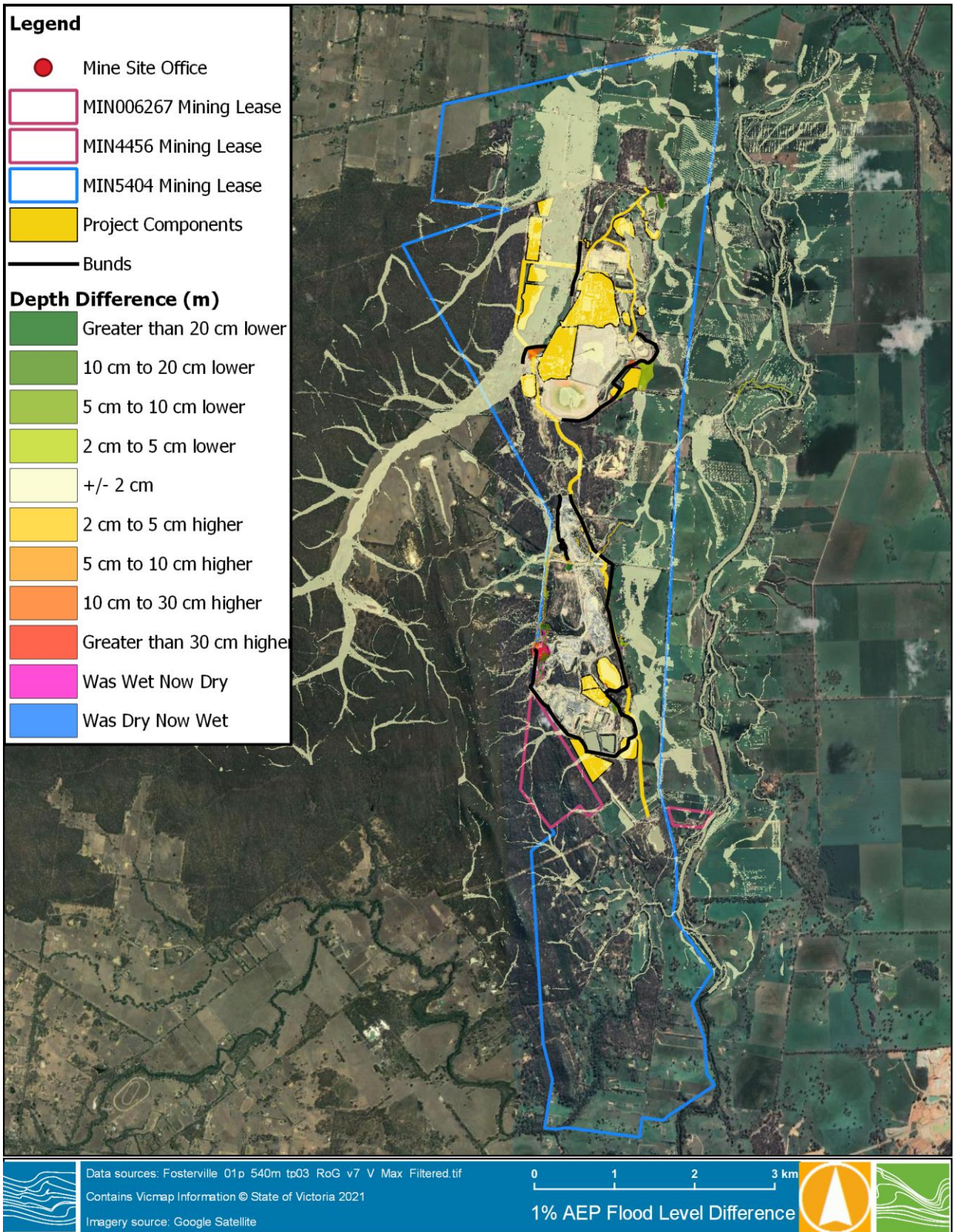
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Figure 6-10 Existing conditions - 1% AEP Flood velocity



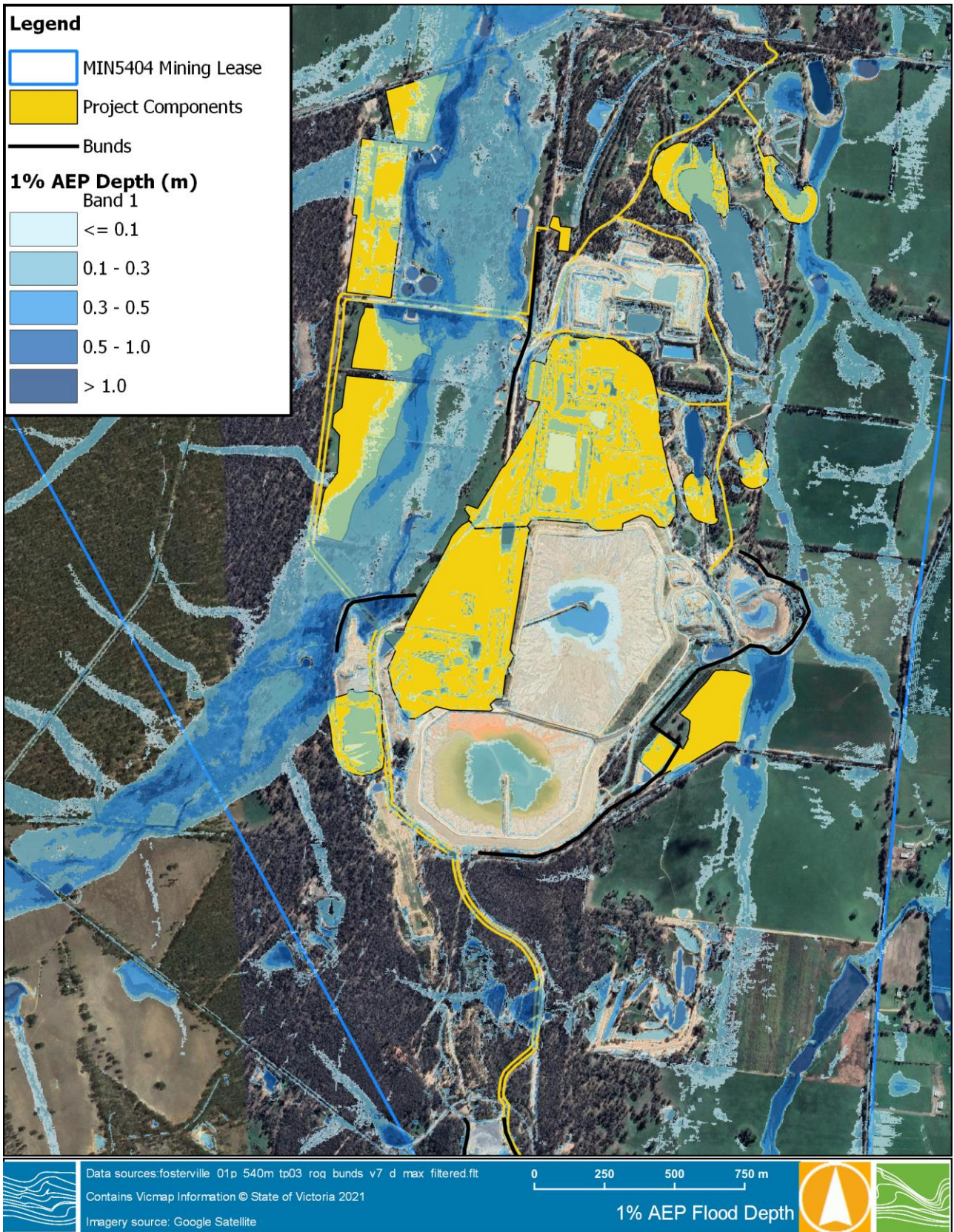
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Figure 6-11 Existing conditions with bunds – 1% AEP flood depth



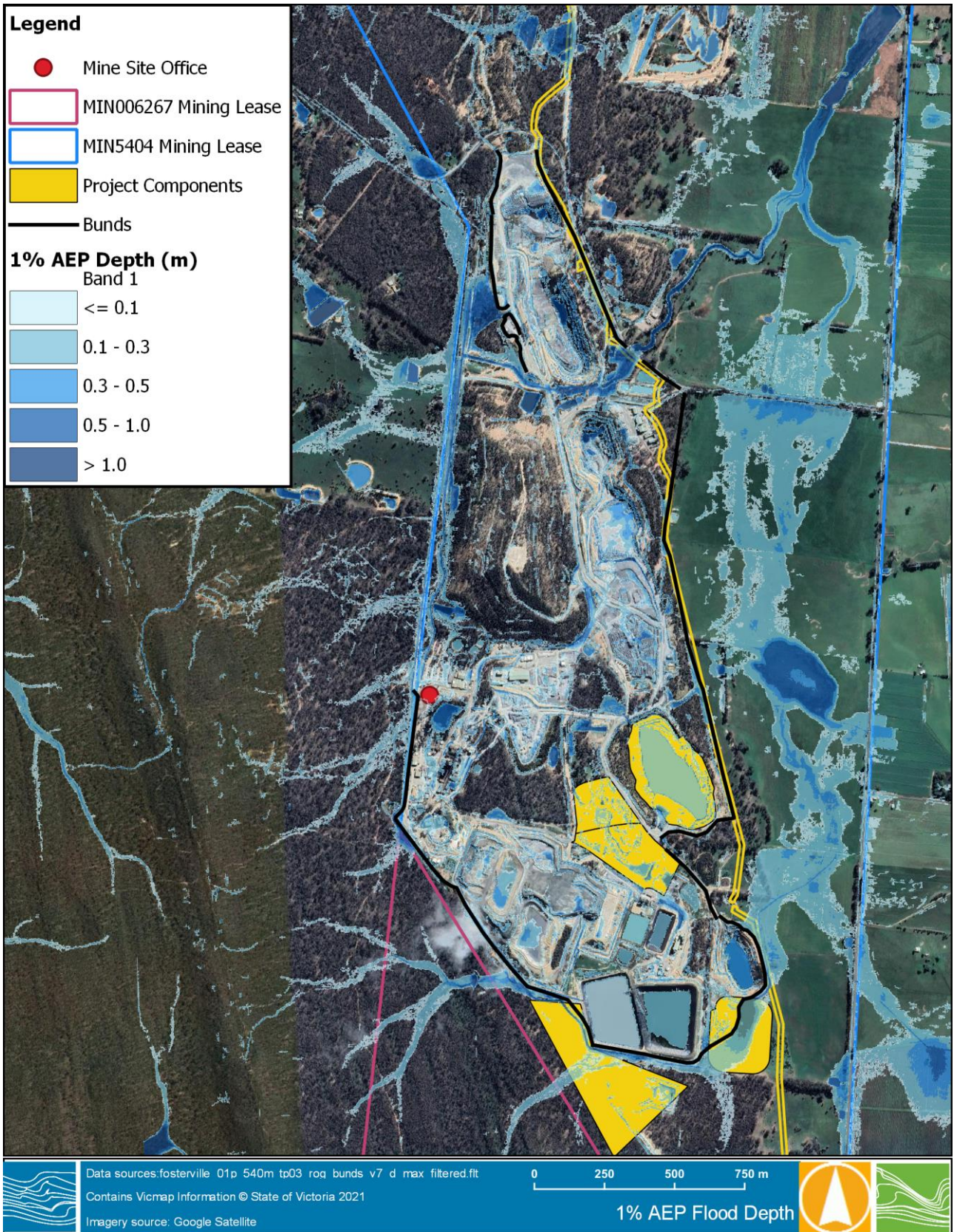
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Figure 6-12 Change in 1% AEP water levels due to implementation of bunds – Existing conditions



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Figure 6-13 Existing conditions with bunds – 1% AEP flood depth – North



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Figure 6-14 Existing conditions with bunds – 1% AEP flood depth – South



6.3.4 Riverine flooding

6.3.4.1 Methodology and inputs

6.3.4.1.1 Overview

The TUFLOW hydraulic model built for modelling direct catchment inundation was adapted to model riverine inundation from Axe Creek and the Campaspe River. Two upstream hydraulic model inflow boundaries were represented using steady-state inflow hydrograph. The inflow boundaries are shown in Figure 6-15. A constant 1% AEP flow was applied and split between the two boundaries. The split was based on the flow ratio of the largest historical event recorded until 2021 at the Campaspe River at Barnadown gauge (406201), corresponding to approximately a 1 in 74 years event. Using data from the upstream gauges Campaspe River at Eppalock (406207) and Axe Creek at Longlea (406214), the ratio was determined as 90% of flow at the Campaspe River inlet and 10% at the Axe Creek inlet, see Table 6-5. The Campaspe River 1% AEP streamflow was determined using flood frequency analysis (FFA) of data from the Campaspe River at Barnadown gauge (406201).

Table 6-5 Campaspe River and Axe Creek flow ratio

Event	Campaspe River flow (ML/d)	Axe Creek flow (ML/d)
14 January 2011	80,478	6,816
Ratio	0.92	0.08

6.3.4.1.2 Flood frequency analysis

FFA was undertaken using streamflow records from the Campaspe River at Barnadown gauge (406201), located downstream of the Project area. This gauge has a period of record from 1978 onwards, providing sufficient data for the FFA. The annual series used for the analysis consisted of the annual maximum streamflows recorded at the gauge, for the 44 years from 1978 to 2021. The largest annual maximum streamflows on record are:

- 2011: 61,815 ML/day
- 1983: 35,270 ML/day
- 2010: 33,157 ML/day
- 2000: 23,834 ML/day
- 1992: 23,404 ML/day

ARR2019 suggests testing of multiple statistical distributions when conducting a FFA for design flow estimation. FLIKE FFA software was used to estimate design flows using the Log Pearson III and Generalised Pareto distributions. The Multiple Grubbs Beck test was applied as a method of low flow censoring. The results from the FFA for the different distributions are presented in Table 6-6.

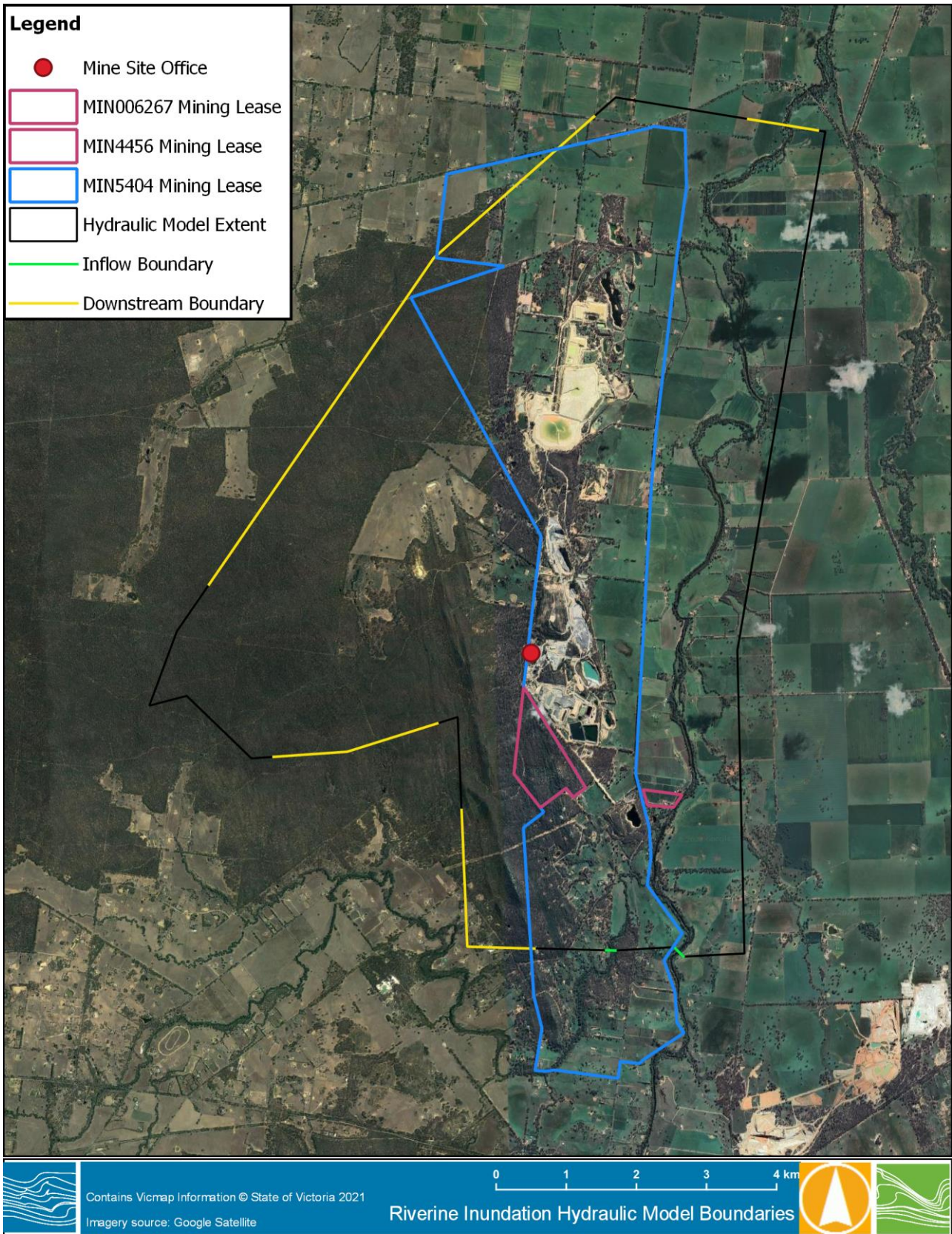
The Log Pearson III distribution with Grubbs Beck censoring applied was found to provide the best fit with the annual maximum streamflow series, see Figure 6-16. The resulting 1% AEP streamflow was 71,324 ML/day, equal to 826 m³/s.

Table 6-6 FFA design flows (ML/d)

Design flood (AEP)	50%	20%	10%	5%	2%	1%
LP III	2,390	10,395	20,817	35,599	62,636	89,279



Design flood (AEP)	50%	20%	10%	5%	2%	1%
10% confidence limit	1,540	7,002	13,665	22,038	34,229	43,418
90% confidence limit	3,779	15,960	32,519	67,184	164,533	310,931
LPlll with GB	4,021	15,921	27,795	40,833	58,441	71,324
10% confidence limit	2,303	10,689	19,089	28,373	39,772	47,486
90% confidence limit	6,811	25,151	42,372	62,783	103,012	140,720
GP	5,251	15,912	28,264	46,158	82,695	125,022
10% confidence limit	3,291	10,582	17,775	26,059	38,478	48,285
90% confidence limit	7,544	22,309	48,481	100,663	242,430	530,752
GP with GB	5,255	15,993	29,188	49,323	93,038	146,753
10% confidence limit	3,289	10,379	17,827	26,442	38,926	49,245
90% confidence limit	7,446	23,494	52,635	119,407	364,111	840,966



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Figure 6-15 Riverine inundation model boundaries

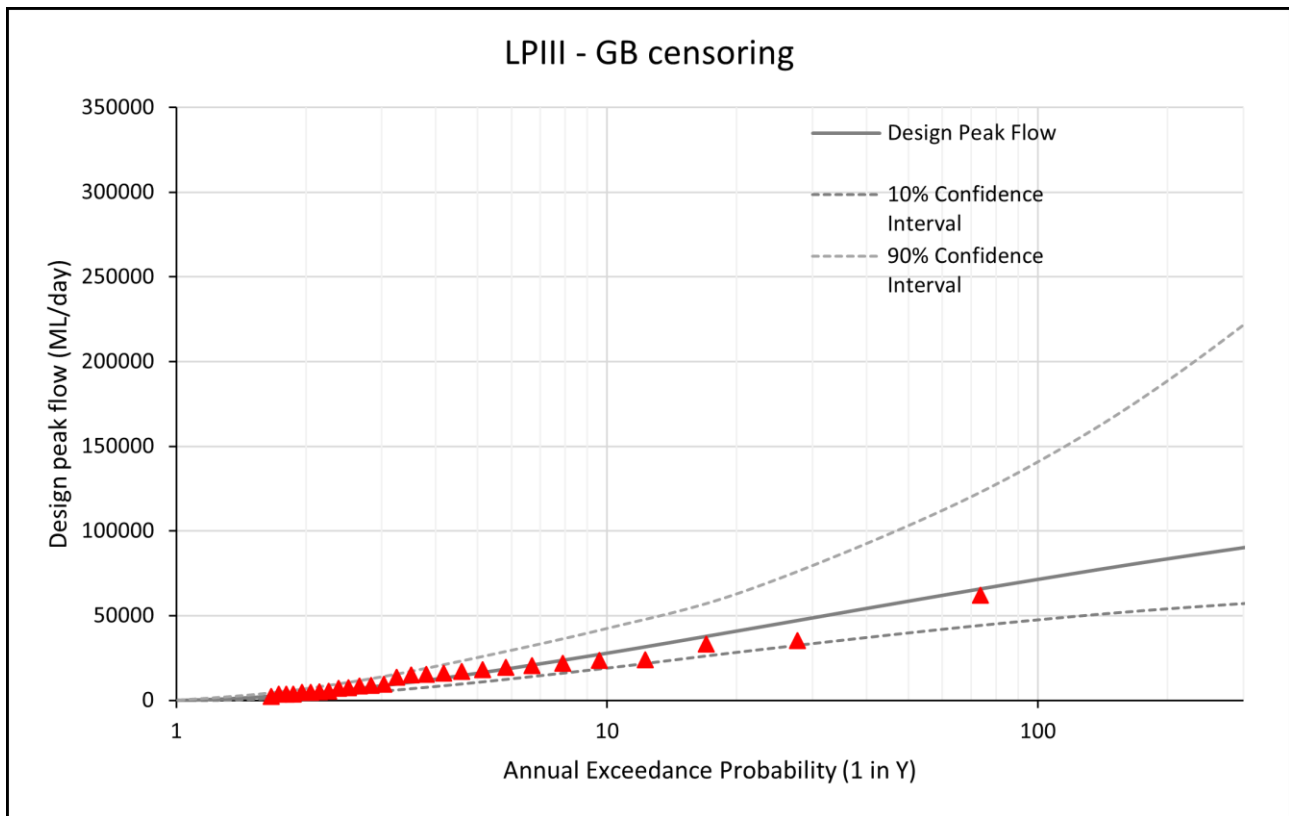
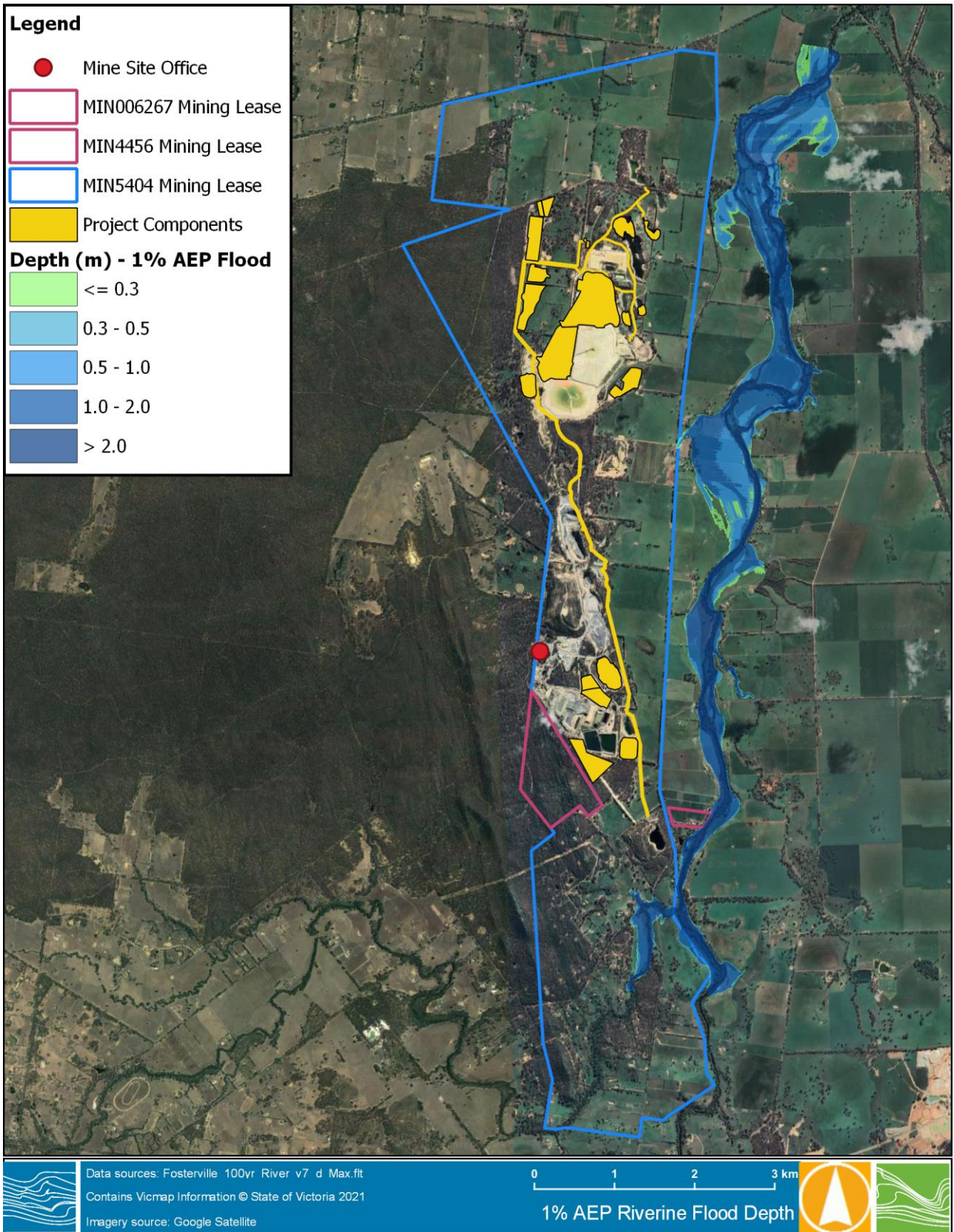


Figure 6-16 Annual maximum streamflow series and LPIII distribution with Grubbs Beck censoring

6.3.4.2 Results

The 1% AEP riverine hydraulic model results are shown in Figure 6-17. The majority of the mining lease area is shown to be outside of the modelled Campaspe River flood extent, aside from minor inundation near the south-eastern border which runs along the river. Axe Creek intersects the southern part of the mining lease, however given the steep topography surrounding the creek the inundation is not shown to extend much outside of the channel. No works are proposed in close proximity to Axe Creek.



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Figure 6-17 1% AEP riverine flood near the Project area



6.3.5 Water balance

A site-wide operational mine water balance model (WBM) was developed for FGM by WSP Golder during the Project EES. The objective of the WBM was to assess the likelihood of uncontrolled offsite discharges by tracking the water usage and inventory for two assessed scenarios: baseline site conditions and developed Project site conditions. The model demonstrated no uncontrolled site water releases for the baseline scenario and the developed scenario, indicating that there is sufficient storage within FGM to contain site water including rainfall onto the site. The WSP Golder report is attached as Appendix C.

6.3.6 Water quality

6.3.6.1 Background

The monitoring program for the existing management of surface water is devised to ensure that there are no detrimental impacts to adjacent waterways, such as the Campaspe River, Axe Creek and Gunyah Creek. The overall objective of surface water quality management is to ensure impacts from the mining operations on sensitive receptors are managed and minimised as far as reasonably practicable. Surface run-off from the disturbed areas of the site is directed to sedimentation dams at various locations around the site. These dams are designed to capture water and allow settlement prior to discharge as overland flow into receiving waters if it meets the requirements of the ERS.

The Northern and Southern diversion drains (see Figure 6-18) prevent inundation of the mine workings, prevent contact of the surface waters with the supernatant water within the dam, prevent erosion of disturbed areas of the site and to ensure that downstream water quality and quantity is not unduly affected by the mining activities.

The layout of FGM showing surface water quality monitoring locations at FGM are presented in Figure 6-18 below. Data sampled at these locations is attached in Appendix B. The available data for these locations primarily consist of toxicants and nutrients, however, is lacking some general water quality parameters (Dissolved Oxygen (DO), Turbidity, Temperature, etc.). To gain an understanding of these parameters additional sample data sets were obtained, containing data from different sampling occasions and locations, see Figure 6-19. However, this additional data cannot be used as a substitute for compliance data as it was sampled to meet a different objective. Historic water quality observations available through DELWP (now DEECA) for the Campaspe River, recorded at the Campaspe River at Eppalock gauge (406207) were also included in this assessment.

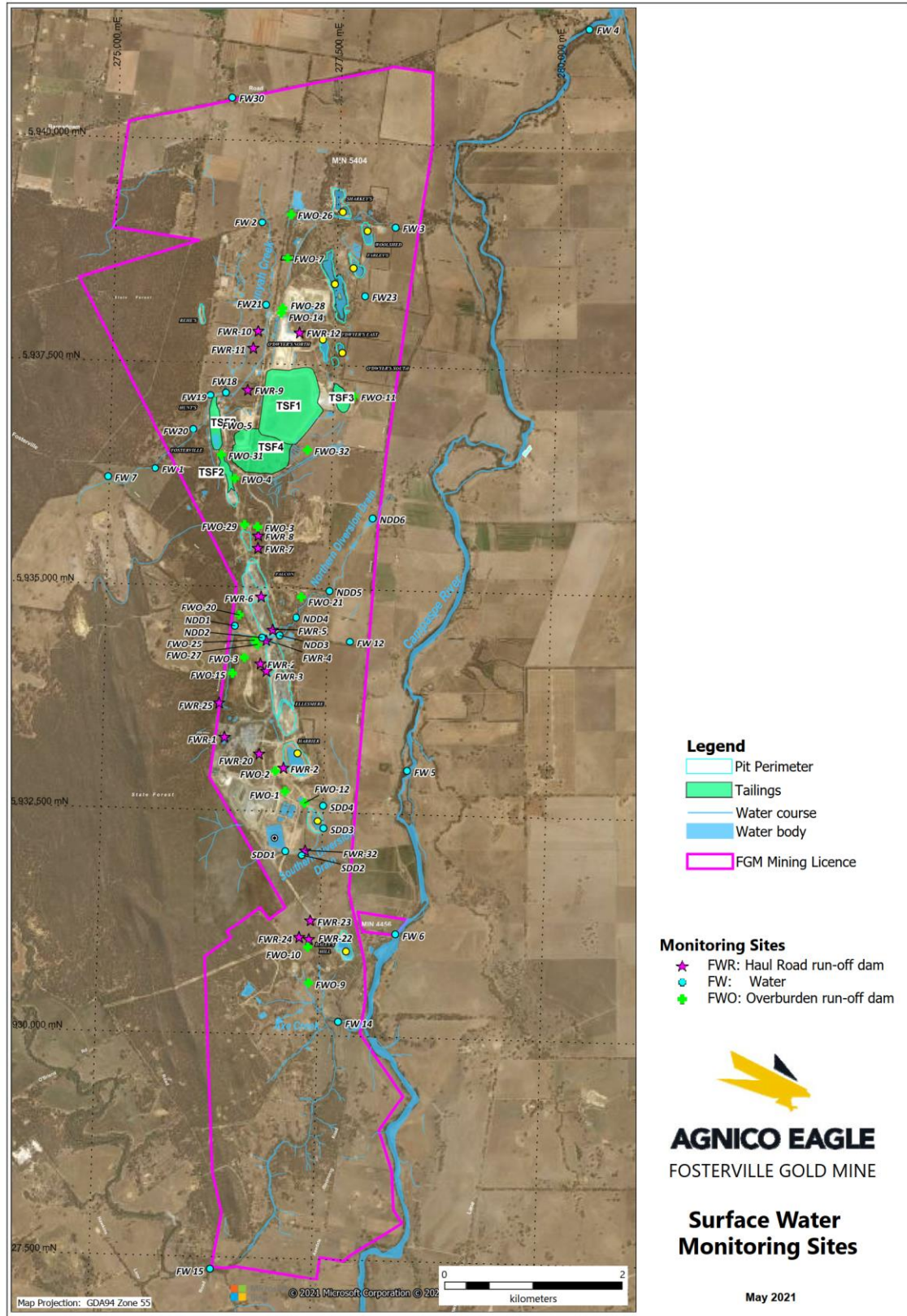


Figure 6-18 Surface water monitoring sites (Surface Water Management Plan, Fosterville Gold Mine Pty Ltd)



Figure 6-19 Additional water quality sampling locations



6.3.6.2 Sampled data overview

As discussed in Section 6.3.6.1, relevant sampling data (for the receiving environment) made available for this assessment are as follows:

- Nutrients and limited number of toxicants (August 2020 to February 2022), 7 sampling rounds (collected approximately every quarter) at 3 locations on Campaspe River. This data is used as compliance data and is in Table 6-7 and Table 6-8.
- In-situ water quality parameters, recorded in autumn and spring of 2021 at 5 locations in the Campaspe River and 1 location in Axe Creek. Axe Creek had been identified by Kirkland Lake Gold as a possible source of contaminants and reduced water quality to the Campaspe River (namely sediments). It is understood that the samples collected for the study were one off samples, therefore the values listed are not percentile values. This data is not used as compliance data and is in Table 6-7.
- Historic water quality observations were available through DELWP (now DEECA) for the Campaspe River, recorded at the Campaspe River at Eppalock gauge (406207). This gauge is discussed in Section 6.1.1.3 with respect to its location in proximity to the Project area (14 kilometres upstream of the Project area). This data is in Table 6-7.

The sampling locations are shown in Figure 6-20, and the location of the Campaspe River at Eppalock gauge is shown in Figure 6-3.

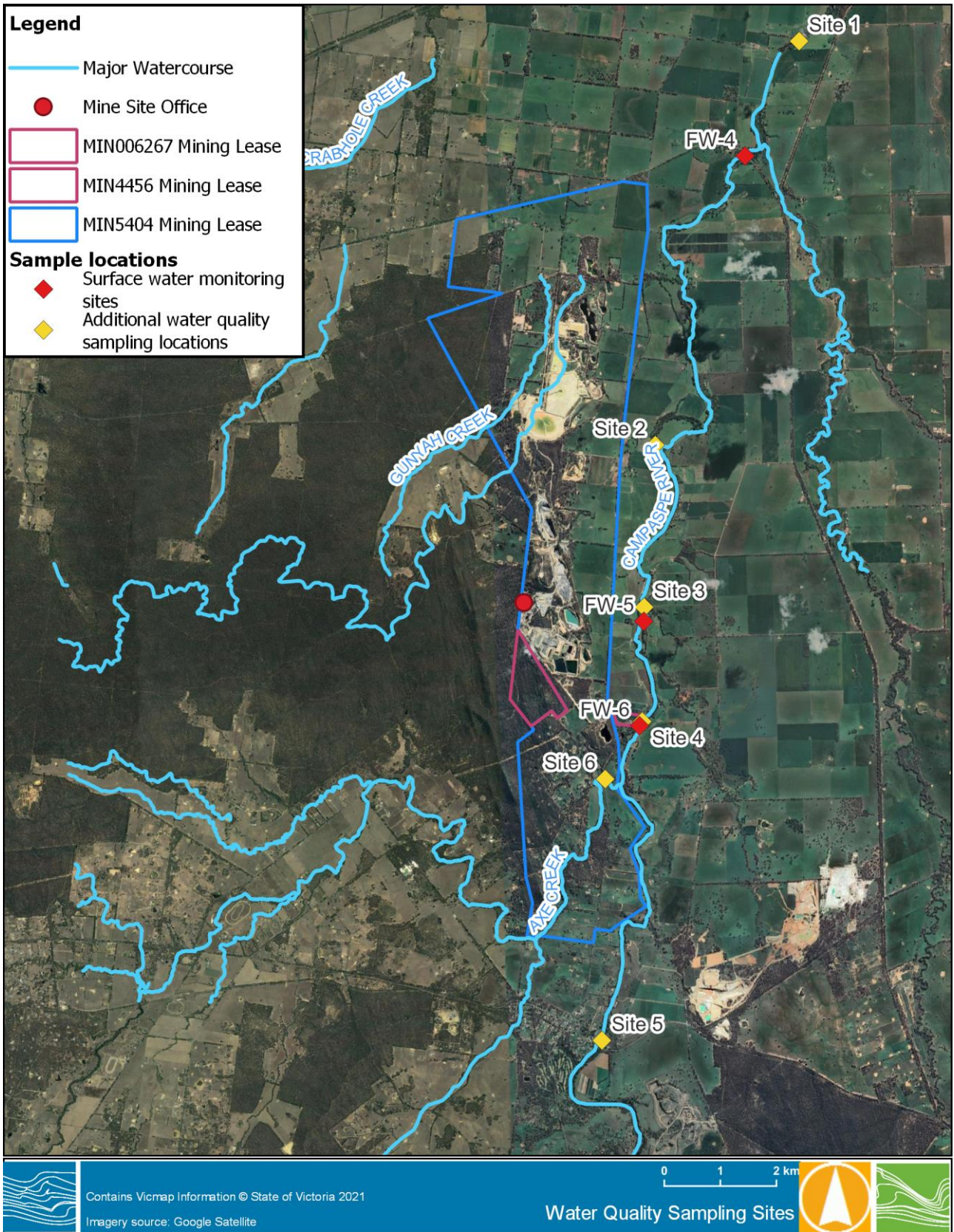
6.3.6.3 General water quality

Water quality parameters with respect to the relevant ERS or ANZECC/ANZG water quality objectives (where present) are presented in Table 6-7.

As the samples do not provide information on the temporal variability of ambient water quality in the sampled sites, an indicative understanding of local water quality can be derived. Values highlighted in orange indicate recorded values which exceeded the ERS water quality objectives. The following parameters exceeded ERS water quality objectives or ANZECC guideline values:

- Dissolved oxygen (Site 1, 2, 4 and 6)
- Turbidity (Site 6)
- pH exceeded marginally (FW4 and FW5)
- Total Nitrogen (FW5 and FW6)

We note that observations of historic data from the DELWP gauge showed that measured background pH and TN levels upstream of the site exceeded guideline values. Due to insufficient data, it is not possible to assess DO exceedances of the monitoring samples against background data. It is however, noted that DO exceeded the objectives at sites 4 and 6, which are both located upstream of the operations, which could explain the exceedances further downstream. Similarly, turbidity exceeded the objective at site 6 only.



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Figure 6-20 Sampling sites considered for this assessment



Table 6-7 Water quality sampling data – general parameters

	Guideline	DO (% Sat)	EC ($\mu\text{S}/\text{cm}@$ 25°C)	pH (pH Units)	Turbidity (NTU)	TP ($\mu\text{g}/\text{L}$)	TN ($\mu\text{g}/\text{L}$)
Water Quality Objective	ERS / SEPP / ANZECC	≥65 and 130 (25th percentile and max)	≤2000 (75th percentile)	≥6.8 and ≤7.8 (25th and 75th percentiles)	≤40 (75th percentile)	≤50 (75th percentile)	≤900 (75th percentile)
Autumn 2021 ⁶	Site 1	74.5	618	7.28	7.7	-	-
	Site 2	72.8	620	7.29	8.7	-	-
	Site 3	71.5	619	7.26	9.8	-	-
	Site 4	67	618	7.26	14.2	-	-
	Site 5	69.3	616	7.35	13.1	-	-
	Site 6	38	664	7.31	58.2	-	-
Spring 2021 ⁶	Site 1	58.1	549	7.04	14.5	-	-
	Site 2	63.1	563	7.22	15.7	-	-
	Site 3	67.2	519	7.5	12.1	-	-
	Site 4	64.5	475	7.07	14	-	-
	Site 5	68.9	502	7.11	9.5	-	-
	Site 6	47.2	1069	6.89	15	-	-
7 sample dates from Spring 2020 to Summer 2022 ⁷	FW4	-	617	7.5 and 7.9	-	50	900
	FW5	-	614	7.5 and 7.9	-	40	1,050
	FW6	-	632	7.5 and 7.8	-	40	1,100

⁶ Data reported by Aquatica Environmental

⁷ Data available from the Surface Water Management monitoring program. Note that the percentile values represent 7 samples collected over an 18-month period.



	Guideline	DO (% Sat)	EC ($\mu\text{S}/\text{cm}@$ 25°C)	pH (pH Units)	Turbidity (NTU)	TP ($\mu\text{g}/\text{L}$)	TN ($\mu\text{g}/\text{L}$)
Historic data: Site 406207 Campaspe River at Eppalock ⁸	-	-	610.75	7.7 and 7.8	-	23	1,100

⁸ Monthly data collected from January 2021 to December 2021.



6.3.6.4 Toxicants

Monitoring data collected as a part of the surface water management included data for a limited number of toxicants, taken during 7 sampling rounds (collected approximately every quarter) at 3 locations (FW4, FW5 and FW6) on Campaspe River. This data is presented in Table 6-8. Copper and zinc concentrations exceeded the ANZECC 95th percentile freshwater ecosystem guideline values. It should be noted the dataset is likely to contain numerous periods of low flow due to the impact of drought, changed climate and overextraction of catchment flow (largely captured in upper catchment dams, both farm dams and more formal storages). Low flows could make the water quality results less representative of the actual conditions. Also, it should be noted that location FW6 is located upstream of the operations.

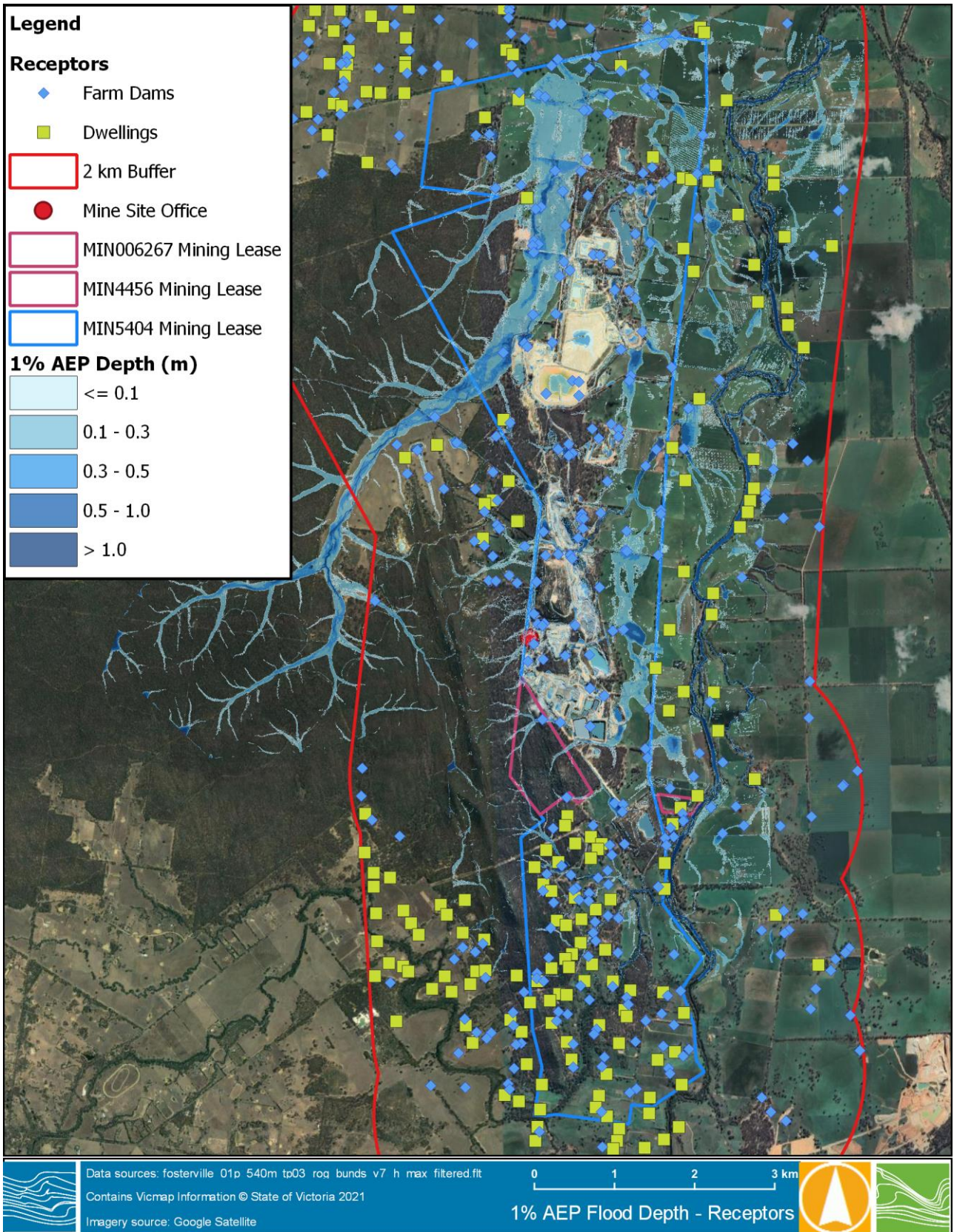
Table 6-8 Toxicants

	ANZECC Guideline	FW4	FW5	FW6
Antimony-Total (mg/L)	-	0.00295	0.0017	0.0017
Arsenic-Total (mg/L)	0.037	0.004	0.0047	0.0054
Cadmium-Total (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
Copper-Total (mg/L)	0.0014	0.002	0.002	0.002
Iron-Total (mg/L)	-	1.383	1.252	1.176
Lead-Total (mg/L)	0.0034	<0.001	<0.001	<0.001
Manganese-Total (mg/L)	1.9	0.1097	0.1202	0.1362
Zinc-Total (mg/L)	0.008	<0.005	0.0235	0.0121

6.3.7 Water receptors

All site runoff from the mining area will be captured within the disturbed area (i.e. zero offsite discharge). This will reduce the catchment area which is able to contribute runoff to its natural distribution point. Interception of water from the disturbed areas due to bunding and diversion drains will reduce flow rates and volumes discharging to downstream water receptors. Figure 6-21 shows the water receptors in proximity to the 1% AEP overland flow paths. The key receptors within the hydraulic model extent are detailed as follows:

- 209 farm dams – many of the located north or east of the Project area, likely to be impacted by changes in discharge volume
- 84 dwellings - the surface runoff for residential buildings has no environmental value so there is no impact



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Figure 6-21 Existing conditions (with bunds) – 1% AEP flood depth with all Project area water receptors



6.3.8 Climate change modelling

6.3.8.1 Overview

The Project is located in the “Murray Basin Climate Zone” according to BoM and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) classifications. There are a set of 40 global climate projection models used to assist in the analysis and representation of future temperature, evaporation, and rainfall. These models relate results to the Representative Concentration Pathway (RCP) projections and the specific locations throughout Australia. There are predictions for four RCPs, these are as follows:

- RCP8.5 - a future with little curbing of emissions, with a CO₂ concentration continuing to rapidly rise, reaching 940 ppm by 2100.
- RCP6.0 – lower emissions, achieved by application of some mitigation strategies and technologies. CO₂ concentration rising less rapidly (than RCP8.5), but still reaching 660 ppm by 2100 and total radiative forcing stabilising shortly after 2100.
- RCP4.5 - CO₂ concentrations are slightly above those of RCP6.0 until after mid-century, but emissions peak earlier (around 2040), and the CO₂ concentration reaches 540 ppm by 2100.
- RCP2.6 - the most ambitious mitigation scenario, with emissions peaking early in the century (around 2020), then rapidly declining. Such a pathway would require early participation from all emitters, including developing countries, as well as the application of technologies for actively removing carbon dioxide from the atmosphere. The CO₂ concentration reaches 440 ppm by 2040 then slowly declines to 420 ppm by 2100) (*Detlef P. van Vuuren et. al. (2011), The representative concentration pathways: An Overview*).

The future impacts from anthropogenic greenhouse gas and aerosol emissions remains highly uncertain with many known and unknown influences and of the above scenarios none is considered more likely given these uncertainties. A graphical comparison of the pathways is represented in Figure 6-22 below.

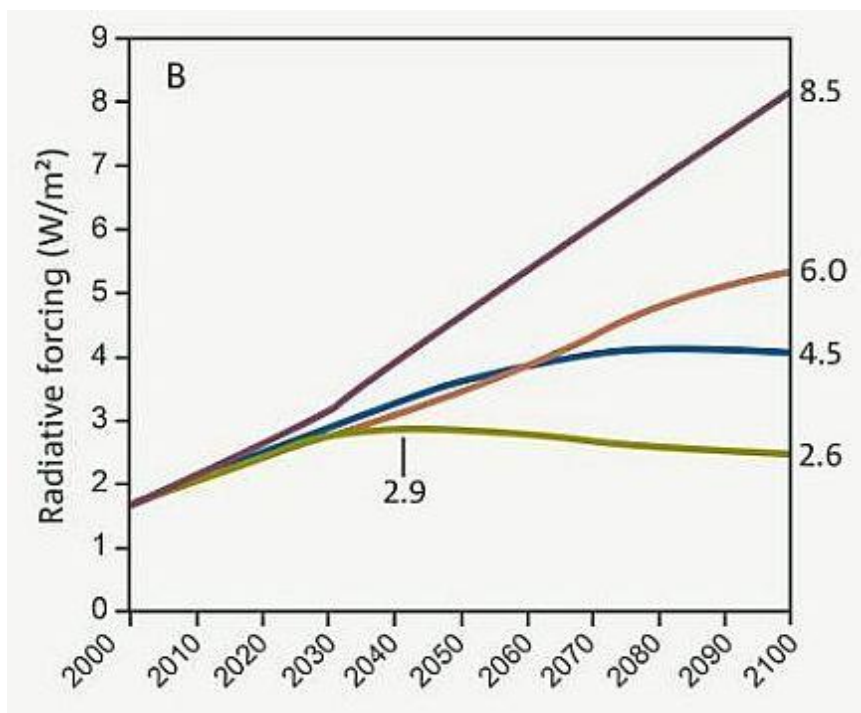


Figure 6-22 Radiative forcing for the different RCPs. The numbers on the right show the final radiative forcing at 2100 and give each scenario its name (8.5, 6.0, 4.5, and 2.6 W/m²) (Climate change in Australia Technical Report)



Given the uncertainty regarding which RCP scenario will be relevant in the future it was determined that RCP 8.5 by 2090 would be modelled in this Project giving the highest RCP scenario to achieve the most conservative assessment. Modelling all the available scenarios was not considered useful, just adding to the numerous uncertainties. Modelling of the RCP 8.5 demonstrates the worst case of the four options.

The following section details how climate change has been included in the event based hydraulic modelling.

6.3.8.2 Event based hydraulic modelling

Climate change modelling for direct rainfall flooding used the 2090 RCP 8.5 scenario. Predicted climate change rainfall was extracted via the ARR2019⁵ plugin tool which downloads data directly from the ARR Data Hub and BoM. The extracted data represents design rainfall under the selected climate change scenario. How these depths were determined for existing climatic conditions is detailed in Section 6.1.1.1.

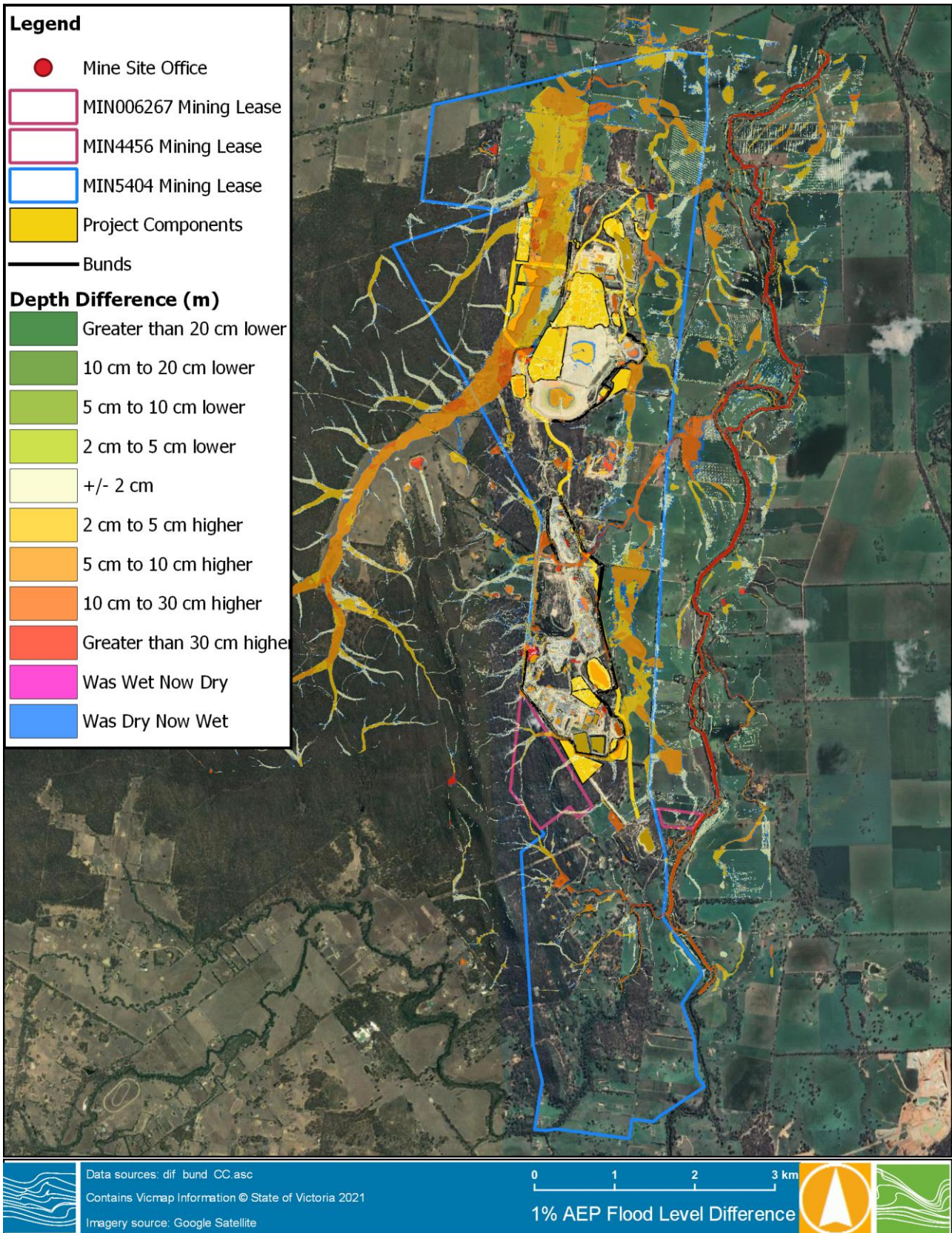
6.3.8.3 Results

Climate change modelling was included in both the existing conditions modelling and the proposed developed conditions with all Project components included. The effect of climate change on flood levels for the existing topographic conditions was assessed by comparing results obtained using current climatic conditions with results obtained using the climate change scenario. In a similar way, the effect of climate change on flood levels for the proposed developed conditions was assessed by comparing results obtained using current climatic conditions with results obtained using the climate change scenario

The change in water levels for the existing conditions scenario across the Project area due to climate change rainfall intensity increases is shown in Figure 6-15.

Increased rainfall under the climate change scenario has generally brought about greater flooding depths and a greater inundation extent, but no overall change to inundation patterns or runoff pathways.

The change in water levels for the developed conditions scenario across the Project area due to climate change rainfall intensity increases is discussed in Section 8.1.1.



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Figure 6-23 Change in 1% AEP water levels– Existing conditions – Climate change



7 POTENTIAL IMPACT PATHWAYS

Table 7-1 identifies the potential impact pathways which arose out of the initial risk assessment. The risk rating is based on the Earth Resources Regulation risk matrix, shown in Table 7-2. These impact pathways link Project activities (causes) to their potential effects on the environmental assets, values or uses and are the ones considered in more detail in the impact assessment, below.

A summary table of the potential for these impacts to occur, their consequence, the mitigation measures proposed and the associated residual impacts ratings are presented in Appendix A. Further detail on the impact pathways and the magnitude, extent and duration of the residual impacts is provided in Section 8.

Table 7-1 Surface water potential impacts

Potential impact No.. – Construction and operation	Potential impact pathway	Risk rating (ERR guidance)
SW-01	Surface runoff captured by the Project area reducing the water contributing to downstream receptors.	Medium
SW-02	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	High
SW-03	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Medium
SW-04	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	Medium
SW-05	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Medium

Table 7-2 Earth Resources Regulation Risk matrix

Likelihood	Almost Certain	Medium	High	Very High	Very High	Very High
	Likely	Medium	Medium	High	Very High	Very High
	Possible	Low	Medium	Medium	High	Very High
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Medium	Medium	High
		Insignificant	Minor	Moderate	Major	Critical
		Consequence				



8 IMPACT AND MITIGATION

This section discusses the potential impacts of the Project as a result of construction activities and operation of the Project and the associated mitigation measures that aim to reduce impacts to as low a level as possible. Mitigation measures referred to are summarised in Section 9.

The potential effects to surface water values associated with the proposed managed aquifer recharge project are discussed in **EES Technical Report F1: Groundwater impact assessment**. The potential for the injected water to result in water quality impacts to the surface water body of the Campaspe River was shown by modelling to have a low likelihood as the aquifer recharge is proposed to be injected into the fractured rock aquifer and not into the alluvial aquifer of the Shepparton Formation which is the aquifer which would have a hydraulic connection to the Campaspe River. To confirm this low likelihood of impact, WSP Golder modelled the potential flow path of metals and nitrate in the fractured rock aquifer and confirmed that the concentrations were below the respective environmental values for the metals and nitrate for water dependent ecosystems. Therefore, no impact to the surface water system from the aquifer recharge Project is predicted.

8.1 Construction, operation and rehabilitation impacts

8.1.1 Surface runoff captured by the Project area reducing the water contributing to downstream receptors

The Project intends to capture all site runoff from disturbed areas (i.e. zero offsite discharge), hence runoff to areas downstream of FGM will be reduced. Interception of water from the disturbed areas will reduce flow rates and volumes discharging to downstream water receptors.

Upon rehabilitation, these areas will allow runoff to continue along its natural flow path and therefore there will be no potential rehabilitation impact.

Impact

Modelling of direct/localised catchment inundation was undertaken to establish the existing conditions inundation depths, see Section 6.3.3.3. This showed that several of the proposed Project components are located within overland flow paths, especially within the northern parts of the Project area, including the brine ponds and top soil storages west of Gunyah Creek, the top soil storage east of the existing TSF and the Borrow pit in the south. These components have the potential to reduce the runoff to the north and east. The area east of the Project area drains to the Campaspe River. The area north of the Project area is predominantly comprised of farmland, containing several farm dams. A reduction in flow could reduce the water availability for these farm dams. The runoff from the areas surrounding the site constitutes only a minor contribution to the Campaspe River compared to other sources, and no impact to Campaspe River flows or levels are expected.

Modelling of direct/localised catchment inundation was undertaken including the proposed Project components as well as bunds around them, representing the proposed developed scenario. Modelling and assessment was undertaken conservatively assuming all proposed developments were implemented concurrently. This enabled all proposed developments to be assessed as a complete package, rather than assessing multiple points in time. This conservative scenario was used to assess the worst case scenario. It removes uncertainty in the potential mine scheduling and covers the maximum potential impact.

The baseline RoG model was modified to include the Project components and bunds around them. The modelled Project components and bunds are shown in Figure 8-1. The proposed vent shafts were not modelled, as the location is not yet finalised and the impacts on surface water is minor based on the small footprint at ground level (less than 1000m²) and both potential locations are outside of the 1% AEP flood extent. Impacts to surface water levels and velocity would be localised to the direct area surrounding the vent shaft. For similar reasons, the ancillary services corridor was not explicitly modelled either, assuming a localised temporary impact mainly during the construction phase as most of the components are expected to be under



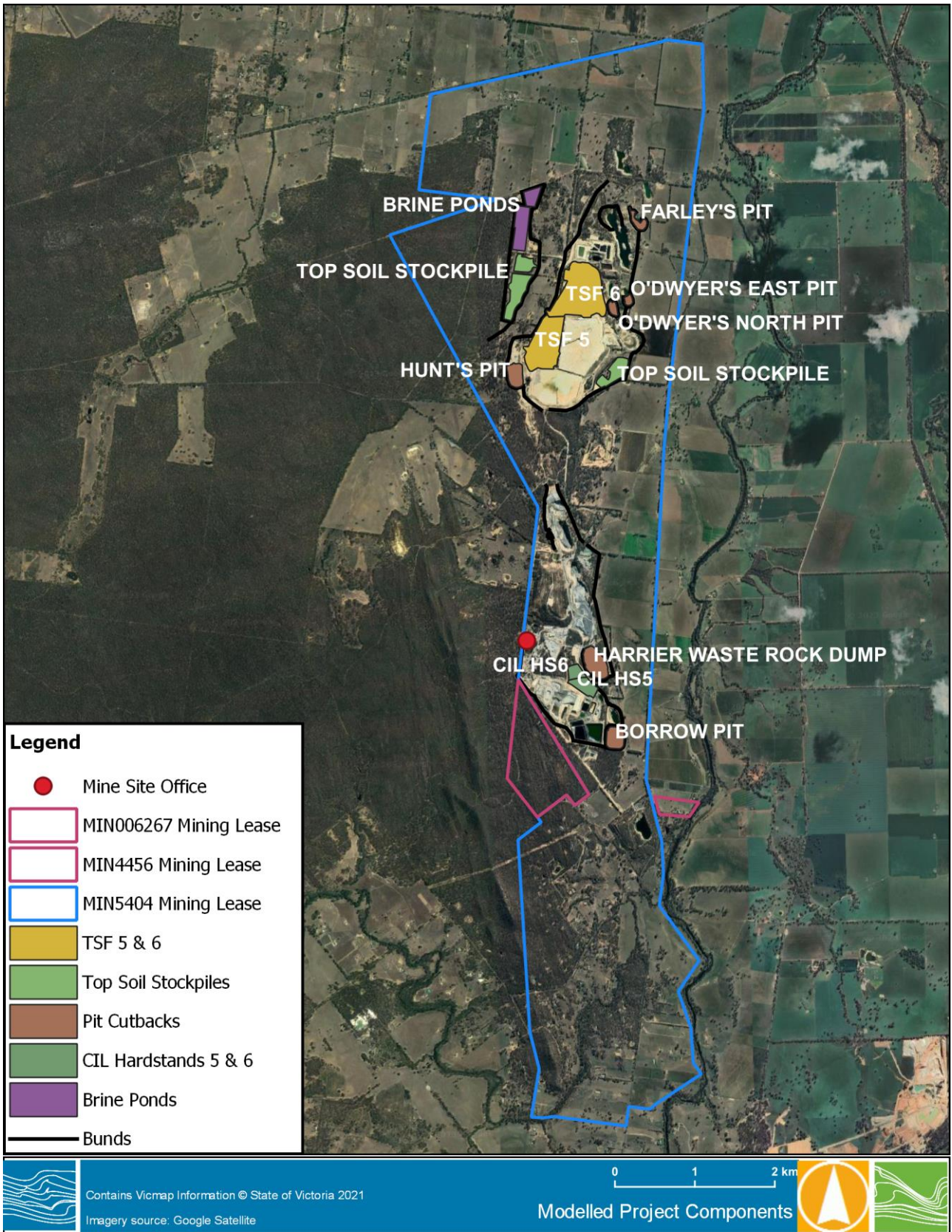
ground. Developed condition hydraulic modelling water level results were then compared to that of existing conditions (discussed in Section 6.3.3.3) to show the changes in water levels and inundation extents for the 1% AEP event caused by including the Project components and bunds.

The change in 1% AEP water levels is shown in Figure 8-2 to Figure 8-4.

The results show large changes to 1% AEP water levels where the Gonyah Creek flow path is led through the northern parts of the Project area. 1% AEP water levels are increased by the proposed development due to the narrow corridor created by the bunds. Increased water levels and flooded extents are also found upstream of bunds at other locations, for example upstream of Farley's Pit, the brine ponds and the eastern top soil stockpile. There is a slight reduction in the 1% AEP water levels in the overland flow path leaving the southeast corner of the mining area, flowing north towards the Campaspe River, caused by the bunding of the proposed borrow pit. Further downstream, this causes minor 1% AEP water level reductions in the Campaspe River. The decrease reaches a maximum of 5 cm, with less than a 10% decrease in peak flow. The reductions are considered a minor impact based on the limited reduction in depth. This only occurs at this magnitude during rare storm events, for a short period of time (hours) and in an area of low strategic biodiversity value.

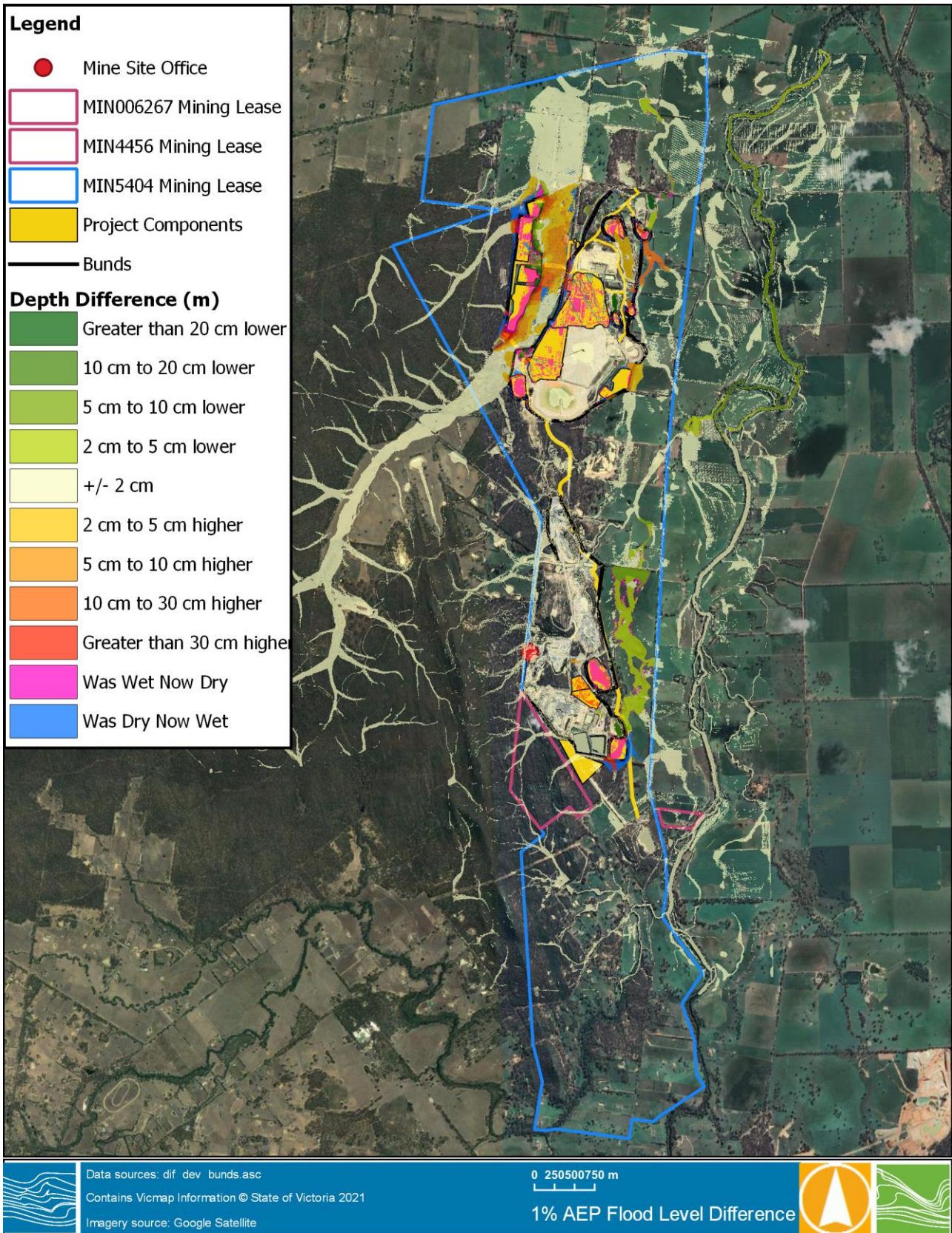
Only minor areas of pooling of water is observed along the bunds, both inside and outside of the mining areas.

This was also undertaken in a climate change scenario using RCP 8.5 2090 (as detailed in Section 6.3.8 for existing conditions). Similar difference plots to existing conditions were produced showing that the changes in water level between existing topographic conditions (with bunds) and the developed scenario are the same under current day climatic conditions and under a climate change scenario, indicating climate change (or rainfall intensities greater than a current climatic conditions for a 1% AEP event) will not change the outcomes of the existing conditions modelling. The comparison between developed conditions modelling with current climatic conditions and the modelled climate change scenario is shown in Figure 8-5.



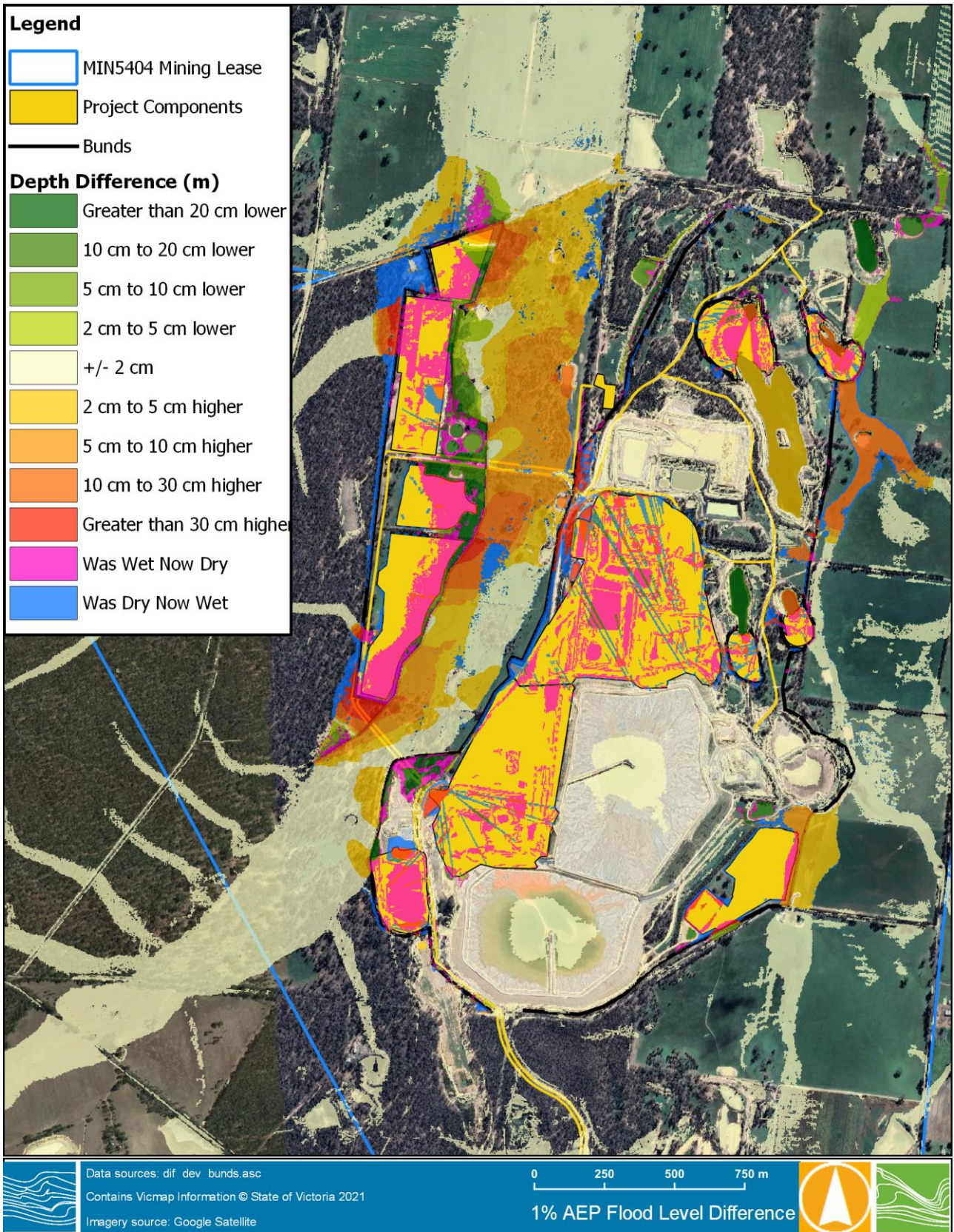
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Figure 8-1 Modelled Project components



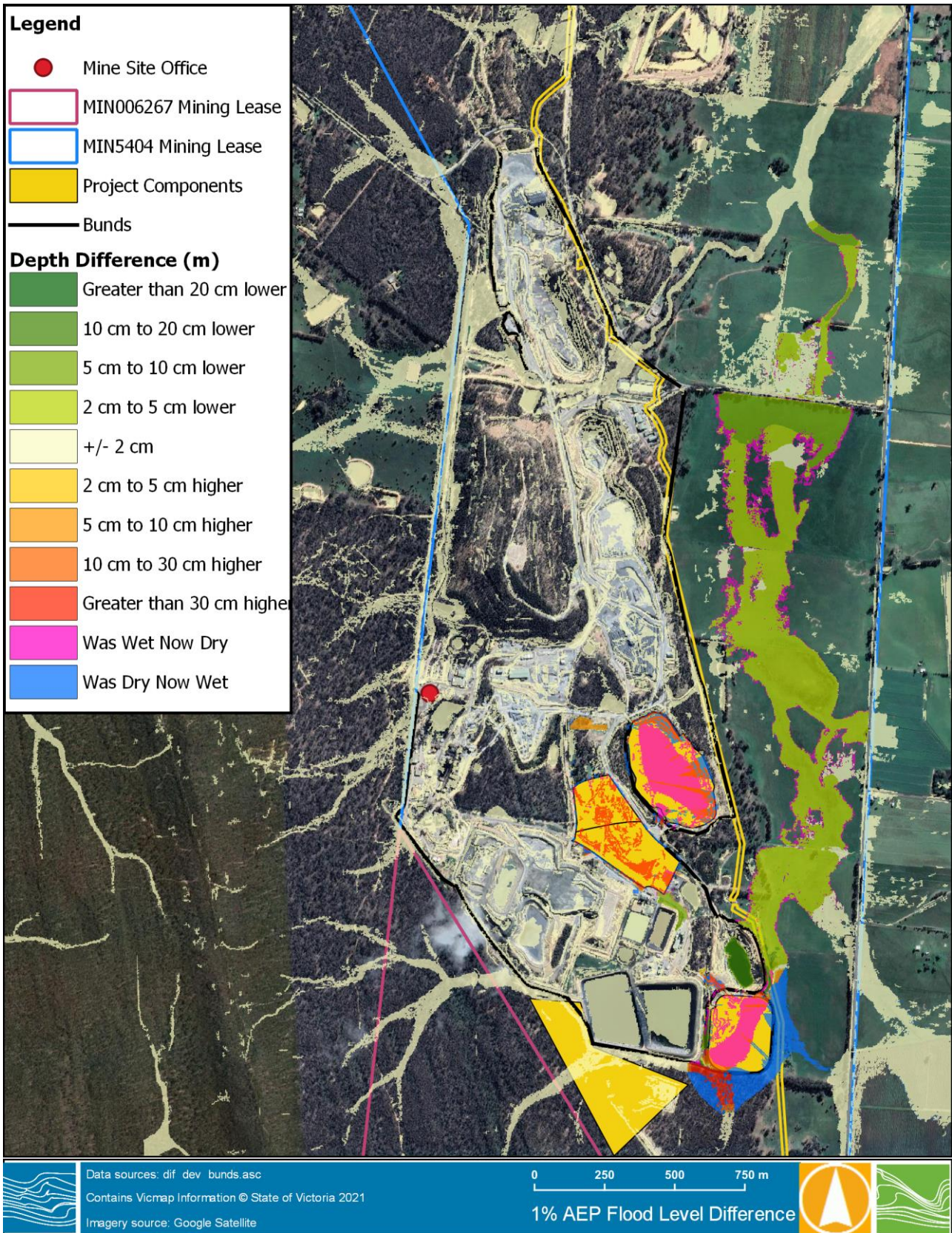
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Figure 8-2 Change in 1% AEP water levels – Developed conditions



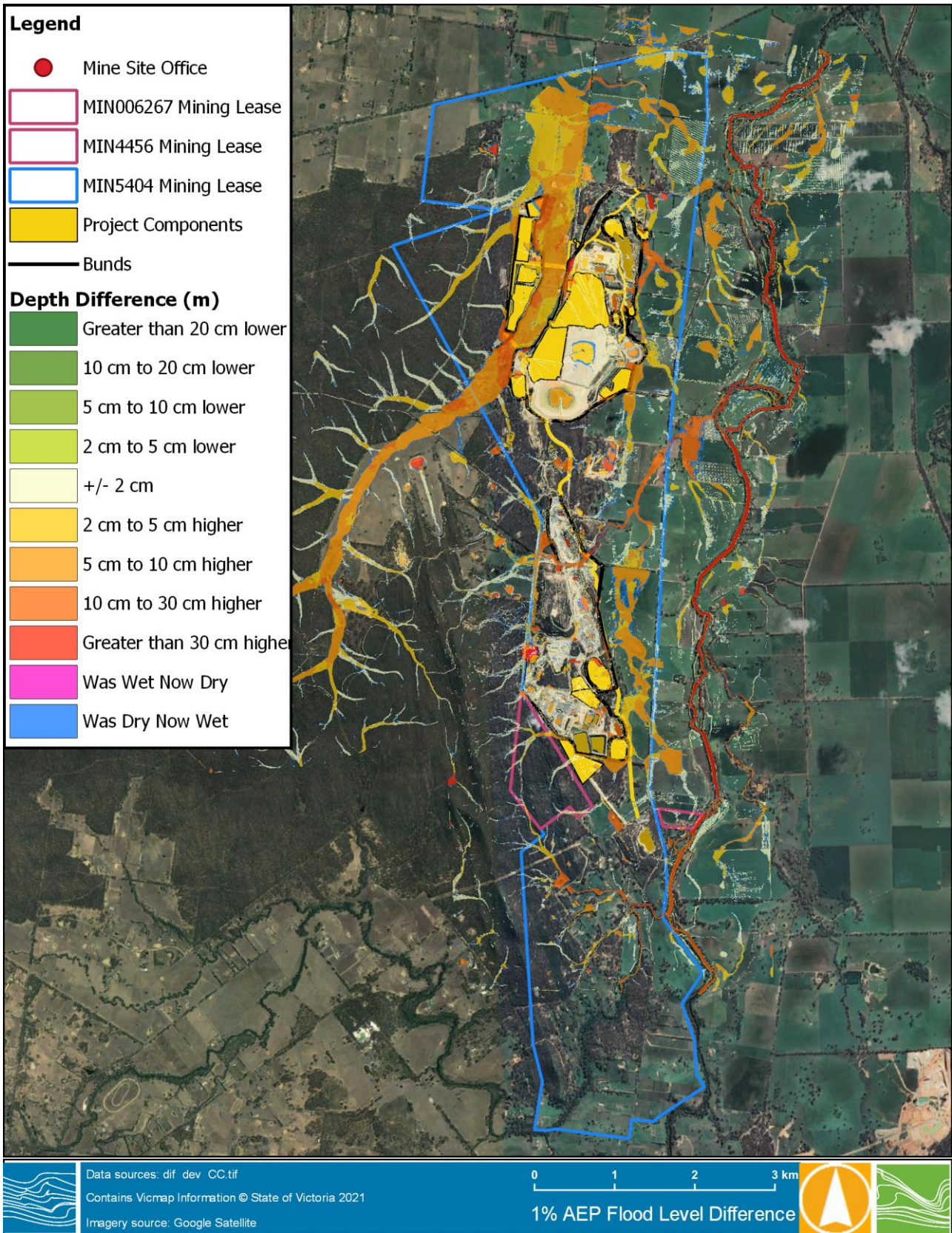
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Figure 8-3 Change in 1% AEP water levels – Developed conditions – North



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Figure 8-4 Change in 1% AEP water levels – Developed conditions – South



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Figure 8-5 Change in 1% AEP water levels – Developed conditions – Climate change



Mitigation

Accumulation of water is observed upstream of bunds at several locations, including upstream of Farley's Pit, the brine ponds and the eastern topsoil stockpile. To drain this water around the mining area the construction of drains will be required enabling free flow of surface water to prevent water logging of agricultural farmland. The design of the drains for each Project component will be completed at the time of detailed design and will form part of the work plan variation which will be submitted to ERR for approval, before construction will be able to commence. Slight reduction in flood levels is observed in the overland flow path leaving the southeast corner of the mining lease, flowing north towards the Campaspe River. The primary environmental values of surface water impacted in this instance include runoff to agricultural cropping areas, farm dams and further downstream the Campaspe River. At this stage no mitigation for this reduction is proposed, based on the minor impact as described above.

The management of surface water through FGM's life should be undertaken through a risk management plan for surface water. The risk management plan for surface water will provide a management framework to mitigate potential impacts over the life of mine. It will be developed in consultation with relevant stakeholders and will be subject to approval by the relevant Authority. The risk management plan for surface water will:

- Summarise the baseline data and existing environment.
- Explain the relevant statutory requirements and context (including any relevant approvals).
- Identify specific performance standards/criteria to be achieved with mitigation measures in place. This will specifically include:
 - Monitoring programs for water quantity, controlling the amount of water stored across the site with relation to expected use, purchase, long and short term weather predictions.
 - Monitoring programs for surface water quality, sampling for mine storages, diverted overland flow paths and rehabilitated mine areas. Water quality sampling and testing will be in accordance with the Environment Reference Standard (ERS).
 - Monitoring programs for surface water diversions, ensuring any surface water diverted by drains is not pooling or impacting adjacent property.
- Describe the mitigation measures to be implemented to minimize surface water impacts to as low as reasonably practicable and meet the Project specific performance standards/criteria.
- Detail the monitoring to be undertaken for all phases of the Project to assess environmental performance and effectiveness of the mitigation measures.
- Describe mechanisms to assess the effectiveness of the Risk Management Plan and to determine when/if or contingency measures are required.
- Detail a program to investigate and implement ways to improve the environmental performance of the Project over time.
- Establish procedures to manage:
 - Incidents and any non-compliance.
 - Stakeholder and community complaints.
 - Failure to comply with statutory requirements and/or performance standards.
 - Roles and responsibilities for implementing the plan.
 - A protocol for periodic review of the plan.
- Include a community engagement strategy which will include a complaints handling system.

There are a number of relevant guidelines and standards to be met for management of stormwater runoff,



erosion and sediment control, and flood risk. These are as follows:

- Australian Rainfall and Runoff (Engineers Australia, 2019).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018).
- Guidelines for environmental management minerals exploration and mining (Department of Energy, 1994).
- Guidelines for the preparation of work plans (Victorian Department of Jobs, Precincts and Regions, Earth Resources Regulation, 2020).
- Environmental guidelines for management of tailings storage facilities (Victorian Department of Jobs, Precincts and Regions, Earth Resources Regulation, 2017).
- Environment Protection Agency best practice environmental management in Commonwealth of Australia mining Water management (1999).
- Environment Protection Authority State environment protection policy waters of Victoria (2003).
- Mine site water management handbook (Minerals Council of Australia, 1997).

Residual impact

The change in surface water contribution to areas downstream of the Project area is considered minor based on the limited reduction in depth (only occurring at this magnitude during rare storm events), the short lived nature of the impact and the low strategic biodiversity value in areas of reduced surface water levels.

As mentioned, upon rehabilitation, these areas will allow runoff to continue along its natural flow path and therefore there will be no potential rehabilitation impact.

8.1.2 Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream

During storm events there is potential stormwater runoff containing sediment and other contaminants could cause degradation of water quality downstream from FGM. This could occur as a result of a spill from FGM if there is not enough drainage, storage and bunding infrastructure to contain runoff within the site or lack of surface water management/sediment controls and contamination from fuels and other hazardous chemicals.

Stormwater runoff containing sediment and other contaminants from development activities exiting the Project area can lead to degradation of water quality (turbidity, etc), sedimentation of downstream waterways, hydrocarbon and chemical contamination from re-fuelling stations and chemical storage facilities, degrading in-stream habitats within downstream waterways.

The flood depths and velocities observed where the Gonyah Creek overland flow path passes through the Project area indicates risk for erosion and subsequent sediment discharge, as well as overtopping. Depths reach up to 1.5 m close to proposed bunds and velocities reach up to 1.8 m/s in the same areas under developed conditions, see Section 8.1.1.

During active rehabilitation this potential impact is similar to the operational impact but at a reduced level as there will be no active mining occurring. Once closure of the site occurs, all potential sources of spills such as machinery and infrastructure will have been removed from site and there are no residual impacts predicted.

Mitigation



Internal storages and drainage infrastructure should be designed to accommodate a sufficient volume to prevent spills, this can be facilitated by water-balance modelling. The site currently manages mine contact water within the disturbed area using stormwater sumps and drainage lines. The drainage system (swales/culverts/drains/dams/bunds) will be designed with a 1% AEP (plus freeboard). Appropriate sediment and erosion control measures should be implemented prior to any ground-disturbance works and throughout construction, including diversion of upstream flows around the construction zones through a Risk Management Plan. At FGM appropriate spill-control and bunding measures should be implemented to control and contain spills. The mine site water balance modelling undertaken by WSP Golder demonstrated that no uncontrolled discharges are predicted for the developed scenario, see 6.3.5.

To reduce risk of contamination from fuels and chemicals the amounts stored on site should be minimised and if stored on site, placed in facilities designed in accordance with EPA Victoria Publication 1698 – *Liquid storage and handling guidelines* and AS 1940:2004 – *The storage and handling of flammable and combustible liquids*. Contingency plans for clean-up and management of spills should be implemented.

A water quality monitoring program complying with applicable legislation and guidelines should be developed, together with development and implementation of a risk management plan for surface water, in accordance with EPA Victoria Publication 1834 – *Civil construction, building and demolition guide*, including a sediment, erosion and water quality management plan addressing the requirements of the ERS and relevant EPA publications e.g. 1893 – *Erosion, sediment and dust: Treatment train*, 1894 - *Managing soil disturbance* and 1896 – *Working within or adjacent to waterways*. The sediment, erosion and water quality management plan should be developed in consultation with the CMA and approved by the responsible authority before development commences. The plan should include contingency planning to apply in the event of detected degradation in water quality. It must also meet the general environmental duty, clearly indicating minimisation as far as reasonably practicable, monitoring and management of effectiveness and continuous improvement. Sediment control around access tracks is also a key issue with grassed swales necessary in order to trap sediment to prevent it from discharging into the downstream waterways.

The construction phase of sediment control in the Gonyah Creek area (near TSF5/ TSF6) is required to be developed in consultation with the North Central CMA and the Works on Waterways licence conditions minimising the risk of sediment discharging from the site as far as reasonably practicable with the inclusion of monitoring and management of effectiveness and continuous improvement through the risk management for surface water. Sediment control and bunding will be constructed according to best practice and with freeboard, see proposed mitigation measures in Section 9.1. The bunding design will be informed by at-site velocities, bunding material and vegetation cover. The site risk management plan will be updated as part of the relevant Project component work plan variation which is assessed post EES. This will include any changes to the site surface water management system, such as bunding, sumps and drains. Based on a requirement from the local water authority (Goulburn Murray Water) no construction can take place within 100 m of Gonyah Creek, meaning that any bunding southeast of Gonyah Creek must be constructed within the TSF5 footprint.

Residual impact

By implementing appropriately sized storages, bunds and drainage the risk of runoff exiting the Project Area is reduced and no residual impact is expected.

Once closure of the site occurs, all potential sources of spills such as machinery and infrastructure will have been removed from site and there are no residual impacts predicted.

8.1.3 Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds

The proposed Project components could cause modifications to the existing drainage paths, so could earthworks during construction. Alterations of drainage paths could redistribute existing flows, potentially impacting neighbouring properties, road infrastructure and/or preventing water from entering natural systems.



Mitigation

No major waterways intersect with the Project area but the overland flow path associated with Gunyah Creek intersects the northern part of the Project area. Modifications to existing natural waterways (predominantly Gunyah Creek) should be avoided or minimised. For works in the vicinity of any designated waterways, compliance with specific requirements in works on waterways permits is required along with specific inclusion in the risk management plan for surface water, however given the placement of the proposed Project Components is away from any such waterways this will not be required. Figure 6-13 and Figure 6-14 show the extent of drainage paths and surface water flows that are known to occur in relation to the Project Components. Any redistribution of existing flows on site is captured, managed and contained, meaning that no impact is anticipated from modified drainage paths which would result in damage to riverbeds, or neighbouring properties and road infrastructure. Runoff from around work areas should be captured in water treatment infrastructure (sedimentation ponds etc.).

Appropriately sized culverts or bridges on drainage lines crossed by access roads should be included, as stipulated in works on waterways permits. Allow time for assessment by local government and the North Central CMA. It should be ensured that any surface water diversions that are implemented discharge into the natural downstream discharge point or the same discharge point as prior to works commencement.

Water quality monitoring of any surface water diversions will be continued to ensure they have no impact on downstream ecosystems. If change in water quality parameters is detected, in accordance with the surface water management plan, actions will be initiated to identify whether ecological monitoring is recommended, and remedial actions must be made to rectify the problem immediately to avoid irreversible damage to downstream ecosystems.

Residual impact

Minimal alteration to existing drainage paths is expected during construction, operation and rehabilitation. By implementing recommended mitigation measures, for example by leading the Gunyah Creek overland flow path through the northern parts of the Project area, the likelihood of adverse impacts on natural waterways is reduced and no residual impact is expected in terms of redistribution of existing flows.

Upon rehabilitation, all flow paths aside from the NDD and SDD will be allowed to continue along their natural path and therefore there will be no potential rehabilitation impact.

8.1.4 Clearance of vegetation causing degradation of water quality and destruction of environmental values

Clearing of vegetated land might be required prior to construction of the Project area, access routes and other infrastructure. Clearance of vegetation would lead to increased erosion and sediment runoff due to lack of binding roots and more exposed soil, degrading water quality in downstream waterways and/or cause destabilisation of waterway banks. The clearance itself could cause destruction of environmental values in the region. This potential impact is not relevant to the rehabilitation phase as vegetation would be actively planted during this phase.

Based on aerial imagery and land use data, none of the proposed Project components are located in a moderately or densely vegetated area. The Ecological Impact Assessment report identifies approximately 19 ha of direct native vegetation clearance as well as clearance of approximately 170 large trees and 68 scattered trees. This clearance is spread over the Project components such as the TSF5, TSF6, haul routes, aquifer recharge and southern vent shaft areas and does not represent a single large area of clearance. These areas will not remain cleared for extended periods as the Project components (including any erosion control measures associated with them) will be constructed. Therefore, the likelihood of erosion occurring associated with vegetation clearance is low, resulting in low potential impact.



Based on the type of vegetation in areas of proposed works, there could be environmental impacts associated with ecological values. The potential impact of vegetation clearance from an ecological perspective is assessed in the Ecological Impact Assessment Report stating that land clearance will be unavoidable and will result in an impact on native vegetation, TECs and habitat for threatened species. Further details are provided in the Ecological Impact Assessment Report

Mitigation

Any works potentially occurring (including vegetation removal) within the riverbeds and riverbanks of a designated waterway are to be undertaken in accordance with a works on waterways permit from the CMA and the necessary vegetation removal permits, see Section 9.1 for a comprehensive list of proposed mitigation measures. Vegetation removal along drainage lines should therefore be avoided where possible and as far as reasonably practicable, by locating construction stockpiles, machinery, roads and other infrastructure away from areas supporting native vegetation.

Residual impact

No vegetation removed in proximity to waterways is expected and therefore no residual impacts are expected.

8.1.5 Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality

The location of the Project area generally avoids inundation from waterways (refer to Figure 6-17) but the area is intersected by major and minor overland flow paths from the local catchment flow. Inundation could be caused by under dimensioned external diversion drains and bunds to prevent water from entering the site via overland flow paths.

Inundation of the Project area may cause damage to infrastructure and disruption to mining operations or active rehabilitation activities, which could be halted during dewatering and recovery works. Inundation could also lead to transport of contaminants offsite, similar to the risks described in Section 8.1.2.

According to Section 6.3.4.2, 1% AEP riverine inundation occurs in the southern parts of the mining lease but away from the Project area. There is no risk of riverine inundation of the Project Area in a 1% AEP flood event. This does not mean the site will never be impacted by riverine flooding, however, inundation of the Project area is more likely to be caused by surface water runoff within the local catchment.

The depths and velocities observed where the Gonyah Creek overland flow path passes through the Project area indicates this area is at risk of flooding and subsequent transportation of contaminants offsite. Depths reach up to 1.5 m close to proposed bunds and velocities reach up to 1.8 m/s in the same areas under developed conditions, see Section 8.1.1.

Mitigation

Access routes are to be designed to maintain access to FGM and associated infrastructure with flood depths below 300 mm during construction and maintenance operations. Any infrastructure within the 1% AEP storm extent is to be designed to withstand potential flooding and would be subject to compliance with the specific requirements of ERR and the North Central CMAs' floodplain works approval process.

Modelling of direct/localised catchment inundation was undertaken for the proposed developed conditions including bunds to prevent runoff from entering the Project area, see Section 8.1.1. The modelling results can be used to determine location of bunds and external diversion drains.

The flood depths and velocities observed where the Gonyah Creek overland flow path passes through the Project area requires consideration when designing and constructing bunds in this area. Compliance with the North Central CMA works on waterways licence requirements is recommended. Project components located



in this area include topsoil stockpiles, the brine ponds and TSF 5 and TSF 6. Appropriate bunding and erosion control is required for these components. The modelling completed in this assessment has outlined areas of high velocity/erosion likelihood which enables its consideration in the detailed design. The modelling indicates the potential for erosion can be managed using standard erosion control methods as outlined in the North Central CMA works on waterways requirements (refer to MM-SW23 to MM - SW30) which will be issued when licences are applied for. The bunding design will be informed by at-site velocities, bunding material and vegetation cover.

Residual impact

By implementing recommended mitigation residual impacts are not expected during any of the Project stages. Upon rehabilitation, project area runoff and overland flow paths will be allowed to continue along their natural flow paths and once rehabilitation has finished, the likelihood of flooding is eliminated.



9 ENVIRONMENTAL MANAGEMENT AND MONITORING

9.1 Measures to be undertaken to minimise impact

The mitigation measures that are proposed to avoid, mitigate or manage surface water impacts associated with the Project are summarised in Table 9-1.

Table 9-1 Mitigation measures relevant to surface water

Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW01	Surface runoff captured by the Project area reducing the water contributing to downstream receptors.	Construction and maintenance of diversion drains to allow natural surface water to traverse across site unaffected.	Construction, operation, rehabilitation	
MM-SW02	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Tails dams are all maintained to the design freeboard of 1 metre and a 1 in 100 ARI event.	Construction	
MM-SW03	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Drainage channels and sedimentation ponds have been designed and constructed to intercept run off from all disturbed areas to allow settlement of water. The dams are designed to contain a 1 in 10 average recurrence interval (ARI) rainfall event or 200 m ³ for each hectare of catchment.	Construction	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW04	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	All operational dams that act as sediment traps or surge dams do not have a set freeboard level. The “end” dam in the catchment or dams with risk to overflow offsite are maintained with a maximum freeboard to allow for storm surge. Freeboard is managed with a level float system with low, moderate and high water levels.	Construction	Water quality monitoring
MM-SW05	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Run off from all cleared areas will be collected and directed to silt ponds. Ponds will be sized to have a capacity of 200m ³ for every hectare of catchment.	Construction, operation	Water quality monitoring
MM-SW06	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	During construction activities effective velocity checks and silt control structures are installed in drainage lines to minimise scouring and sediment leaving the construction area. Erosion measures will include: <ul style="list-style-type: none"> - Drain maintenance - Ripping of soil on contoured landforms - Use of geofabric to stabilise erosion prone surfaces - Use of hydro mulch to stabilise erosion prone surfaces 	Construction, operation	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW07	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Topsoil is to be stockpiled in heaps no higher than 2m. The stockpiles will be located on as flat an area as possible, away from water courses and in areas as close to source and end use area as practical.	Construction, operation	
MM-SW08	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Routine inspection of surface water storages, which includes visual observations and monitoring of dam water levels, to ensure there is appropriate storage capacity for significant rainfall events.	Operation	
MM-SW09	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Sediment which collects in the ponds will be periodically removed as necessary to maintain the dam's capacity.	Operation	
MM-SW10	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Implement appropriate spill-control and bunding measures to control and contain spills. Documented procedures exist in the site Risk Management Plan (RMP) for hydrocarbon and chemical spills, including appropriate containment and clean up processes, and procedures for the storage, handling and disposal of chemicals, reagents and hazardous materials, see following mitigation measures MM-SW11 to MM-SW22.	Construction, operation	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW11	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Bundings is designed and installed around processing facilities to contain any tailings water spillage, in accordance with EPA Liquid Storage and Handling guidelines.	Construction	Water quality monitoring
MM-SW12	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Any area on which a vehicle can stand while being fuelled shall be so graded that spilled liquid will flow away from any building, and will not flow off the site.	Construction	Water quality monitoring
MM-SW13	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	FGM has bulk fuel storage (Diesel) onsite comprising of storage tanks within a low permeability lined earthen bund.	Construction, operation	Water quality monitoring
MM-SW14	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Bulk chemical storage is stored according to AS 1940:2004, where bunds and other methods are to be capable of containing 125% of the volume of the largest tank.	Construction, operation	Water quality monitoring
MM-SW15	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Any drainage from an area that may be subject to hydrocarbon spillage, such as a machinery maintenance area, shall be free from hydrocarbon contamination and directed to a sump or interceptor trap.	Construction, operation	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW16	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	The quantities of fuel stored on site shall be minimised and must not be stored in or adjacent to surface waters, drainage lines or floodplains, unless the storage facilities prevent them from coming into contact with surface waters.	Operation	Water quality monitoring
MM-SW17	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Documented procedures for appropriate measures to contain and minimise impact from spills and leaks, including emergency preparedness and response procedures to ensure rapid and effective response to any major spill events to minimise impacts to the public health and safety, public infrastructure or the environment.	Operation	Water quality monitoring
MM-SW18	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Spill kits available at all times where mobile equipment is operated, refuelled, or any minor servicing and/or simple maintenance tasks are undertaken. Any major servicing/repairs conducted in a contained facility (e.g. workshop or laydown area).	Operation	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW19	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Clean up spills of fuels, lubricants and/or hazardous materials as quickly as practicable. Spills will not be cleaned up using methods which risk releasing contaminants into waterways. Equipment and material contaminated by fuels, lubricants and/or hazardous materials will be disposed of appropriately.	Operation	Water quality monitoring
MM-SW20	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Continue to conduct routine monitoring according to the site risk management plan (including surface water management) (monitoring details provided in the EMF Chapter 24).	Construction, operation, rehabilitation	Water quality monitoring
MM-SW21	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Ensure that best practice sedimentation and pollution control measures are undertaken at all times including a sediment, erosion and water quality management plan addressing the requirements of the ERS and relevant EPA publications: EPA Victoria Publication 1834 – Civil construction, building and demolition guide, EPA Victoria Publication 1893 – Erosion, sediment and dust: Treatment train EPA Victoria Publication 1894 - Managing soil disturbance and 1896 - Working within or adjacent to waterways.	Construction, rehabilitation	Water quality monitoring



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW22	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Avoidance/minimisation of any modifications to natural waterways (Gunyah Creek)	Construction	
MM-SW23	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Landforms are designed and constructed to minimise erosion and run off (e.g. diversion drains run away from upper benches, drainage channels to lower berms, windrows and crest berms direct water away from crest of slopes).	Construction	
MM-SW24	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Engineering design of slopes and embankments to limit water runoff speed and therefore increased risk of erosion. For erosion control of waste dumps/stockpiles, final slopes of 1V: 3H or shallower are recommended, with benches to break long slope.	Construction	
MM-SW25	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Utilise stabilising materials (e.g. liners, crushed rock, hydro mulch or chemical dust suppressants) on exposed areas, where practicable.	Construction	



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW26	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Geophysical characterisation of construction and capping materials to ensure they are appropriate for use and minimise the risk of sediment mobilisation in runoff (e.g., avoid use of highly dispersive material on exposed surfaces, where practicable).	Construction	
MM-SW27	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds. Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Site diversion drains and associated culverts to be designed to contain a 1 in 100 year flooding event through the deepening of the channel in some areas and the installation levee banks on either side of the drain. (1 in 100 ARI).	Construction	
MM-SW28	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	During construction works storm water will be diverted around the cleared work area and then back to the original drainage lines by drainage diversion works.	Construction	
MM-SW29	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Culvert and channel capacity can convey the relevant rainfall event design criteria (e.g. 1 in 20 years) and the integrity of the stormwater system is managed through a routine inspection and maintenance program.	Construction, operation	



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW30	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Drains and disturbed areas on the mining lease will be visually inspected after significant rainfall events to check on erosion to allow remedial work to be undertaken as soon as practicable.	Operation	
MM-SW31	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	Minimise impacts to biodiversity as far as reasonable practicable and by locating any proposed clearance as close to as possible to areas of existing clearance, avoiding fragmentation of native vegetation.	Construction	
MM-SW32	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	When clearing vegetation, minimise exposed areas by staging and/or progressively clearing areas, where practicable.	Rehabilitation	
MM-SW33	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	Stabilise landforms by establishing vegetation through progressive rehabilitation and maintenance programs.	Rehabilitation	
MM-SW34	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	During rehabilitation of barren rock dumps and heap leach pads, once the topsoil has been placed, the hills will be ripped on the contour to minimise erosion during re-vegetation. This also assists in directing water into the topsoil for plant growth and provides some shelter to germinating seeds.	Rehabilitation	



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW35	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	As far as reasonable practicable, locate construction stockpiles, machinery, roads, and other infrastructure away from areas supporting native vegetation, Large Trees and/or wetlands	Construction	
MM-SW36	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Interception drains are installed upstream and downstream of areas of disturbance to divert surface water away from active areas and minimise surface water flow and runoff from entering disturbed areas.	Construction	
MM-SW37	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Diversion of run-off from the up gradient catchment area around the crest of the slope.	Construction	
MM-SW38	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Diversion of runoff from the upper benches along drainage channels (toe drains) constructed on berms that allow gravity drainage to low points	Construction	
MM-SW39	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Drainage control works to divert surface water away from extraction areas and control erosion.	Construction	
MM-SW40	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Open pit design to with bund walls to prevent inundation from storm water runoff.	Construction	



Mitigation measure ID	Potential impact being mitigated	Mitigation measures	Stage	Performance Measures
MM-SW41	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Implement the site Flood Management Plan. The relevant Water Authority has been included in Community Engagement Plan and Emergency Management Plan and water management plans and meetings are used to increase communication across various departments and ensure management of surface water and minimising the risk of flooding is as effective as possible.	Operation	

9.2 Residual impact assessment summary

Table 9-2 shows the residual impact associated with each surface water risk that was identified in Section 7. By implementing the recommended mitigations including the bunding which was assumed for the developed conditions modelling, the likelihood of occurrence is reduced for each of the risks, resulting in a lowered risk rating. For two of the listed impacts, the rating remains at medium, reflecting the consequence of the impact.



Table 9-2 Residual impact ratings

Potential impact - Construction and operation	Potential impact	Inherent risk			MM#	Residual impact		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
SW-01	Surface runoff captured by the Project area reducing the water contributing to downstream receptors.	Possible	Minor	Medium	MM-SW01	Unlikely	Minor	Low
SW-02	Stormwater runoff containing sediment and other contaminants from mine activities and/or construction exiting the Project area causing degradation of water quality downstream.	Likely	Moderate	High	MM-SW02 to MM-SW21	Rare	Moderate	Medium
SW-03	Modifications to drainage paths within the Project area causing redistribution of existing flows and damage to riverbeds.	Possible	Moderate	Medium	MM-SW22 to MM-SW30	Rare	Moderate	Medium
SW-04	Clearance of vegetation causing degradation of water quality and destruction of environmental values.	Possible	Minor	Medium	MM-SW31 to MM-SW35	Unlikely	Minor	Low
SW-05	Construction in a flood prone area with flooding of mining area or other infrastructure leading to impacted water quality.	Rare	Moderate	Medium	MM-SW36 to MM-SW41 and MM-SW27	Rare	Minor	Low



10 CONCLUSION

The purpose of this report is to assess impacts on surface water to inform the preparation of the EES required for the Project. A summary of the key assets, values or uses potentially affected by the Project, and the associated impacts assessment are summarised below.

10.1 Existing conditions

The Project area is located approximately 1 km away from the Campaspe River, the major waterway near the area, and the hydraulic assessment studies indicated that the Project area would not be impacted by riverine flooding even under extreme events. The existing surface water environment in proximity to the Project area is influenced by direct/localised catchment inundation caused by stormwater runoff. Surface water runoff within the Project area flows to the northeast, with a major overland flow path in the Gunyah Creek channel intersecting the north part of the Project area. Flow paths originating on the south-western side of the mining area are diverted through diversion drains, either around the southern end of the mining area or via the northern diversion drain through the central parts of the mining area. The runoff from these diversion drains flows into agricultural paddocks and dams and crosses the Axedale-Goornong Road before terminating in the Campaspe River. The areas downstream of the Project area consists of agricultural cropping or grazing areas with isolated patches of vegetation mapped as inundated. Analysis of water quality data showed some parameters exceeding ERS water quality objectives and/or ANZECC guidelines.

10.2 Impact assessment and mitigation

Developed conditions modelling was undertaken, showing some potential for the works to influence direct catchment water levels in proximity to the Project area. Modelling and assessment were undertaken conservatively assuming all proposed developments were implemented concurrently. This enabled all proposed developments to be assessed as a complete package, rather than assessing multiple points in time. This conservative scenario was used to assess the worst case scenario. It removes uncertainty in the potential mine scheduling and covers the maximum potential impact.

Increased water levels were observed where the Gunyah Creek overland flow path flows through the Project area, as well as upstream of bunds around the Project area. Decreased water levels were observed in the overland flow path leaving the southeast corner of the mining area, flowing north towards the Campaspe River. Only minor areas of water pooling is observed along the bunds, both inside and outside of the mining areas. Modelling with the inclusion of climate change showed increased in flood depth, but no overall change to the inundation characteristics.

Identified potential surface water impacts include:

- A reduction in surface water runoff to areas within the overland flow path leaving the southeast corner of the mining area which could impact environmental values in this area, including reduced runoff to farm dams, and vegetation.
- Increased water levels in the Gunyah Creek overland flow path, potentially increasing the likelihood of inundation of the northern part of the Project area which in turn increases the likelihood of offsite transport of contaminants (largely sediment).

Through the implementation of the highlighted mitigation measures no changes to water quality in receiving bodies downstream from the Project area are expected, as no runoff will be discharged from the site.



10.3 Residual impacts

The proposed mitigation and contingency measures comprise of standard operational mining practices and will be included in the risk management plan for surface water. Each of the key measures are outlined in Section 9. By implementing the recommended mitigations, the likelihood of occurrence is reduced for each of the impacts, resulting in low to medium impact ratings, with medium impact reflecting the consequence (magnitude) of the impact.



11 REFERENCES

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Department of Environment, Land, Water and Planning 2022, *Scoping Requirements Fosterville Gold Mine Sustained Operations Project Environment Effects Statement*

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WSP 2024, *Water Balance Model Technical Report for Sustained Operations Project Fosterville Gold Mine*



APPENDIX A RISK REGISTER





See attached file “RiskRegister_SurfaceWaterImpactAssessment_V01.xlsx”



APPENDIX B

SURFACE WATER QUALITY MONITORING DATA





See attached file: "EES Surface Water - Data Table.xlsx"



APPENDIX C
WSP GOLDER WATER BALANCE MODEL
TECHNICAL REPORT





See attached file: "PS130553-006-R-RevA WBM Technical Report.pdf"



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