Appendix J

Surface water impact assessment

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METALS Ltd.

New Cobar Complex Project State Significant Project (SSD-10419)

Surface water assessment

Prepared for Peak Gold Mines Pty Ltd
January 2021

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New Cobar Complex Project State Significant Project (SSD-10419)

Surface water assessment

Report Number

J190278 RP14

Client

Peak Gold Mines Pty Ltd

Date

12 January 2021

Version

v1 Final

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12 January 2021

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Executive Summary

ES1 Project overview

Peak Gold Mines Pty Ltd (PGM), a wholly owned and operated subsidiary of Aurelia Metals Limited (Aurelia), owns and operates the New Cobar Complex located 3 kilometres (km) south-east of Cobar, far western New South Wales (NSW).

The New Cobar Complex Project State Significant Development (SSD) (the project) is an amalgamation of underground mining at New Cobar, Chesney and Jubilee deposits and development of new underground workings of the Great Cobar and Gladstone deposits to create the New Cobar Complex Project.

PGM is also seeking to consolidate all existing development approvals applicable to the New Cobar Complex into a single modern consent issued by the Department of Planning, Industry and Environment (DPIE). Approval will be sought for project elements accessed from, and undertaken within, the existing New Cobar Complex located within consolidated mining lease (CML) 6, mining purposes lease (MPL) 0854 and mining lease (ML) 1483 and ML 1805.

ES2 Existing environment

The project is located within the Yanda Creek Water Source which is managed by the *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011*. The regional climate is characterised by low rainfall and high evaporation. Annual runoff coefficients are also low and typically range between 1% and 2% of annual rainfall.

Most of the surface infrastructure associated with the New Cobar Complex is located on top of a ridgeline and is not impacted by local watercourse flows. The main drainage features in the vicinity of the New Cobar Complex are two second order ephemeral watercourses that flow through the northern and southern extent of the project area.

The watercourse to the north receives runoff from an upstream catchment along with any discharge from the mine water management system. The watercourse is impounded by Spain's Dam prior to discharging via the Spain's Dam emergency spillway to a waterbody known as the Salty (not associated with mining operations, captures runoff from industrial and residential areas of Cobar). Downstream of the New Cobar Complex, the watercourse crosses Kidman Way and discharges to an unnamed watercourse (hereinafter referred to as Watercourse A) prior to flowing south-west around the existing Great Cobar open cut and into Newey Reservoir.

The watercourse to the south receives runoff from a natural catchment that is diverted around the mine via a series of diversion banks and drainage channels. The watercourse re-joins its original flow path downstream of the Young Australia 3 water management dam prior to crossing Kidman Way, where it becomes a third order watercourse referred to hereinafter as Watercourse B. The two watercourses join approximately 3 km downstream (south-west) of the project area.

No permanent watercourses exist within the New Cobar Complex and surrounding landscape. All watercourses upstream and downstream of the complex have ephemeral flow regimes.

ES3 Water management

An existing water management system is in place at the New Cobar Complex and is operated and managed in accordance with the current Water Management Plan (PGM 2020) (WMP). The overarching objective of the water management system is to maintain a zero-discharge site and to maximise the reuse of water onsite. The existing water management system will be used to manage water resources for the project.

Stormwater drainage at the New Cobar Complex comprises internal and external channels and diversion bunds. Clean water from upstream catchments is diverted around mine infrastructure via a series of diversion drains and diversion bunds. Runoff generated within the mine disturbance area is captured in a series of water management dams and tanks for reuse or evaporation.

Groundwater from the New Cobar Complex underground workings is pumped to the New Cobar Complex settling pond for treatment prior to reuse underground, or pumping to Peak Complex for reuse as process water. Excess dewatering water is discharged to Spain's Dam or the Young Australia dams for evaporation or later reuse.

Water supply for the project will be met by the dewatering of underground workings, reuse of water onsite, and from town water under an existing high security water supply allocation from Burrendong Dam that is held by PGM. Presently, dewatering of the Great Cobar historical workings is used to reduce PGMs reliance on the Burrendong Dam high security supply. This is as part of a move for PGM's operations to be more self-reliant and sustainable in times of drought. The water from the Great Cobar historical workings will be used to make up any shortfall in site demand that cannot be made up by dewatering of underground workings or from the Burrendong Dam.

ES4 Monitoring and mitigation

The WMP is in place for the existing operations, including the New Cobar Complex. The WMP is a sub-plan of the environmental management system and was most recently reviewed in May 2020 and distributed to the Natural Resources Access Regulator (NRAR) at that time. No response has been received to date. The WMP documents the proposed mitigation and management measures for approved activities, and includes the surface water and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies and responsibilities for management measures.

PGM will continue to monitor water usage, mine dewatering volumes, water transfers and surface water quality in accordance with the WMP. Additional monitoring within Spain's Dam is proposed to further inform operational water management. The objectives of the monitoring program are to collect data to:

- validate the modelling predictions described this assessment;
- identify and quantify water take and water transfers;
- assess the effectiveness of water quality controls and the broader water management system;
- identify and quantify water quality impacts; and
- assess compliance against relevant consent and licence conditions.

The WMP will be updated in consultation with relevant government agencies and will consider any comments made during the exhibition and approvals process for the project. The WMP will outline the compliance reporting requirements against each of the project approvals.

ES5 Residual impacts

Potential impacts have been assessed in accordance with the *NSW Water Quality and River Flow Objectives* (DECCW 2006) and project-specific Secretary's Environmental Assessment Requirements (SEARs). The performance of the water management system to mitigate or eliminate potential impacts has been assessed. Residual impacts associated with the project are anticipated to be consistent with those of the existing operations.

Overflows from Spain's Dam are predicted to occur during a typical wet (90th percentile) rainfall year, which equates to an average frequency of once every 10 years. Overflows from Spain's Dam are expected to occur due to intense rainfall or prolonged wet periods when substantial rainfall and runoff would be experienced across the Cobar region. Any additional flow that may discharge via Spain's Dam due to the project is expected to be negligible compared to runoff volumes generated by the broader catchment. Hence, no impacts to streamflow regimes are expected.

The water quality of Spain's Dam overflows may exceed WQOs for electrical conductivity, total dissolved solids, sulphate and some metals. Due to the predicted low frequency of overflows and rapid mixing that would occur immediately downstream of Spain's Dam (ie in the Salty), any residual water quality impacts are anticipated to be minor and only occur short-term.

No impacts to local flood characteristics are expected as a result of project surface infrastructure. The mixing of floodwaters and mine contact water is expected to occur when the capacity of existing diversion structures is exceeded. However, the risk of water quality impacts to downstream watercourses is considered low as floodwaters that enter the site are detained within water management dams for more frequent flood events up to about the 5% annual exceedance probability, and rapid mixing of waters is expected in larger and less frequent floods. Impacts to water quality are anticipated to be minor and of short duration only following such infrequent events.

The assessed residual impacts are expected to be similar to those of the existing New Cobar Complex operations. Hence, any additional risk or potential impacts to the receiving environment as a result of the project are anticipated to be minor.

ES6 Water supply security

Water requirements for PGM will be met by dewatering of underground workings and reuse of water onsite (60% of requirement), and external sources (40% of requirement) comprising dewatering from the Great Cobar historical workings and drawing from an existing high security allocation from Burrendong Dam. Water supply from the Great Cobar historical workings or Burrendong Dam will only be required if mine dewatering rates are less than mine water demands. Water supply security is of low risk to the project as:

- The probability of Burrendong Dam experiencing low water availability in any given year of the mine schedule is approximately 5%. PGM's high security water allocations is reduced to 80% during periods of low water availability. Hence, PGM can still access water from Burrendong Dam during periods of low water availability.
- Dewatering of the Great Cobar historical workings is predicted to have sufficient volume to supply process water requirements over the majority of the 12-year mine schedule in the absence of the Burrendong Dam water source.
- Groundwater available within the Great Cobar historical workings is expected to be far less sensitive to potential variability in future climate than surface water systems in the region.

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1 Introduction

1.1 Overview

Peak Gold Mines Pty Ltd (PGM), a wholly owned and operated subsidiary of Aurelia Metals Limited (Aurelia), owns and operates the Peak Gold Mines operation south-east of Cobar, far western New South Wales (NSW) see Figure 1.1.

The PGM operation comprises the New Cobar Complex located 3 kilometres (km) to the south-east of Cobar town centre and the Peak Complex located 10 km south-east of the town centre. Both complexes are located adjacent to Kidman Way, which connects Cobar to Hillston and Griffith to the south.

PGM has been operational since modern mining commenced at the Peak Complex in 1991 and all current mining operates under development approvals issued by Cobar Shire Council (CSC).

The New Cobar Complex Project State Significant Development (SSD) (the Project) is an amalgamation of underground mining at New Cobar, Chesney and Jubilee deposits and development of new underground workings of the Great Cobar and Gladstone deposits to create the New Cobar Complex Project.

PGM is also seeking to consolidate all existing development approvals applicable to the New Cobar Complex into a single modern consent issued by the Department of Planning, Industry and Environment (DPIE). Approval will be sought for Project elements accessed from, and undertaken within, the existing New Cobar Complex located within consolidated mining lease (CML) 6, mining purposes lease (MPL) 0854 and mining leases (ML) ML 1483 and ML 1805 (see Figure 1.2).

1.1.1 Background

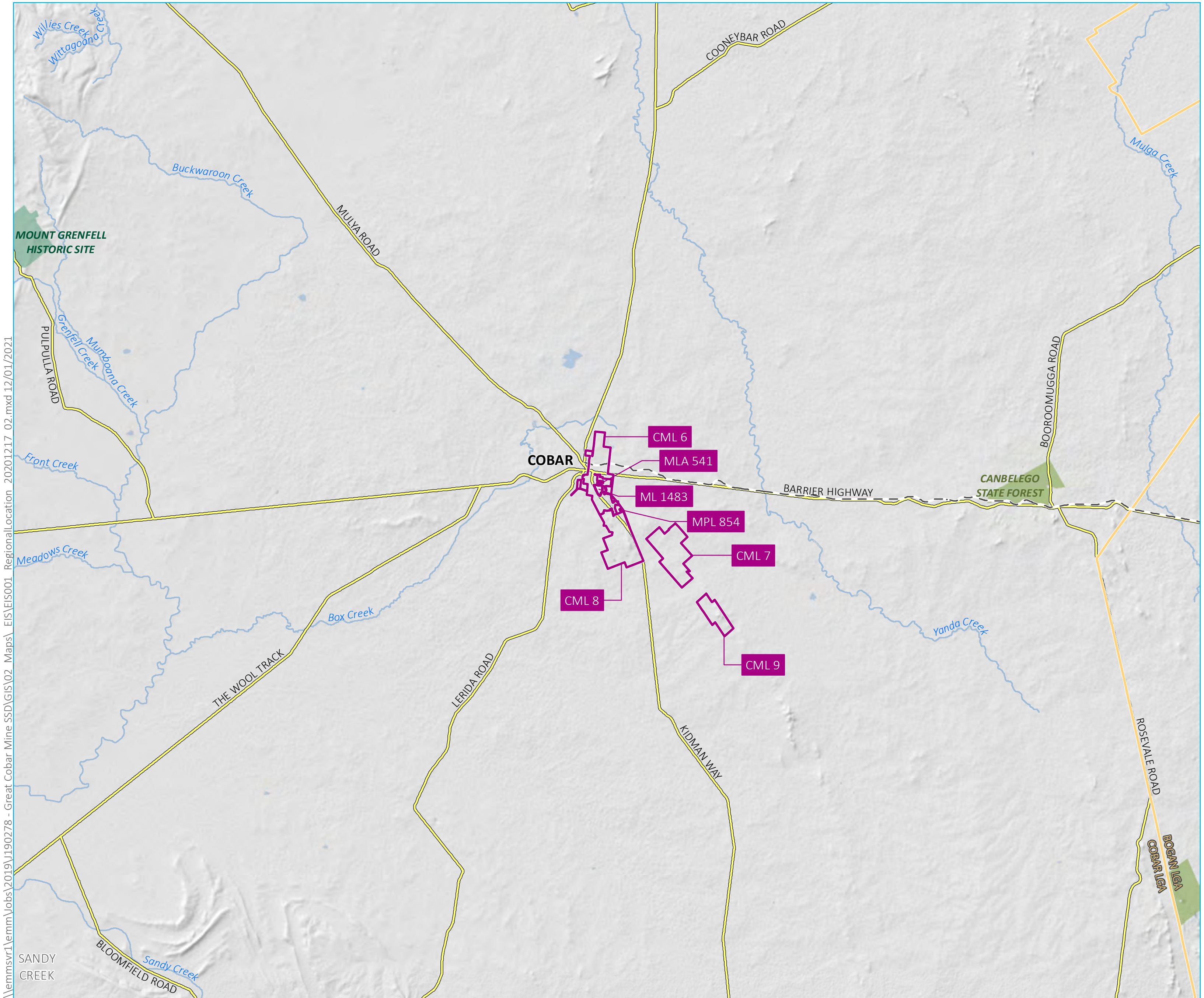
PGM has been operational since mining commenced at the Peak deposit in 1991 producing gold, copper, lead, zinc and silver. Mining at the New Cobar Complex commenced with the open cut in 2000, then transitioned to underground mining in 2004.

The current CSC development approvals at Peak Complex and New Cobar Complex allow for the operations to continue indefinitely and process up to 800,000 tonnes per annum (tpa) of ore. Ore processing, tailings storage and concentrate handling is undertaken at the Peak Complex with ore from the New Cobar Complex trucked by public road to processing facilities at the Peak Complex. Both the processing plant and the tailings storage facility (TSF) are located at the Peak Complex, and activities at those facilities are outside the scope of this Project.

PGM has identified the Gladstone and Great Cobar deposits as targets for further mining to extend the life of operations at the New Cobar Complex. The Great Cobar deposit was historically exploited by surface and shallow underground mining between 1870 and 1919, but no mining of that deposit has been undertaken since that time.

PGM has obtained conditional approval for development of an exploration decline to facilitate exploration activities within the Great Cobar deposit. The objectives of the exploration activities are to:

- further define the mineral resource through underground drilling from an exploration decline; and
- taking of a bulk sample to provide further samples for metallurgical, geotechnical and associated test work.



Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

KEY

- Mining lease boundary
- Rail line
- Major road
- Named watercourse
- Waterbody
- Local government area
- NPWS reserve
- State forest

Regional location of the Peak Gold Mine

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 1.1

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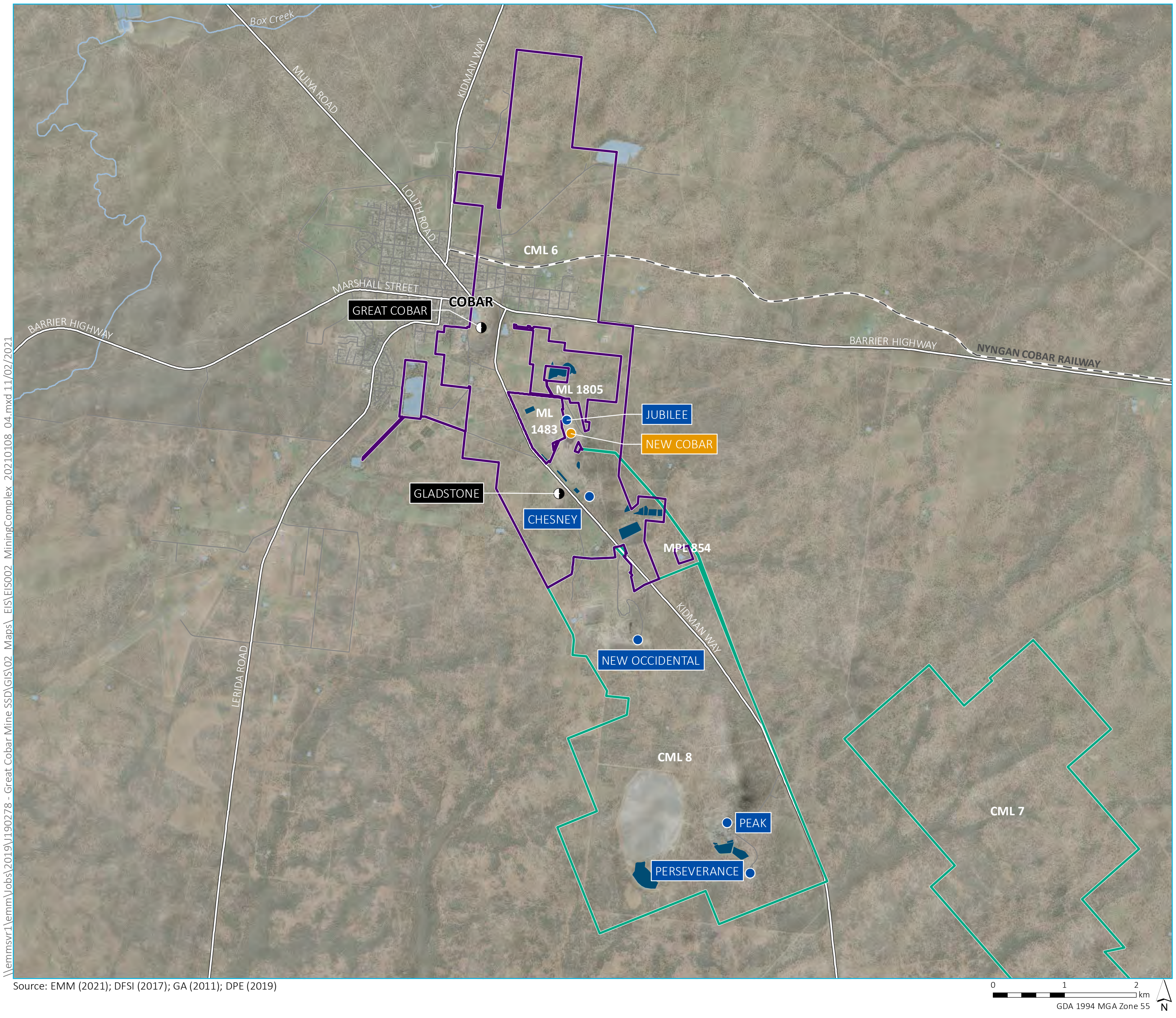


Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

Mining leases and mining complexes

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 1.2

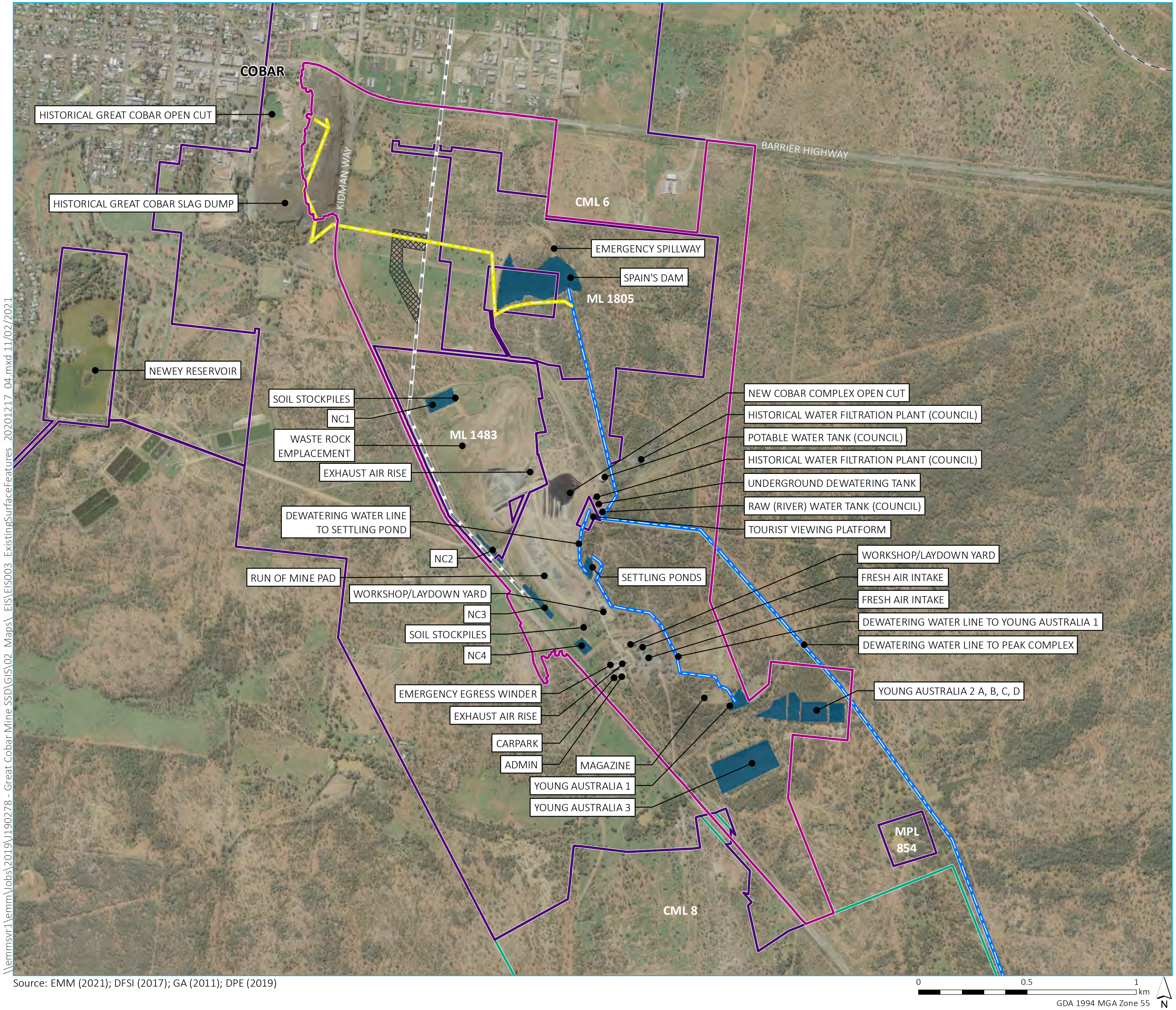
1.1.2 Project overview

All surface works associated with the Project will be located underground or in the existing, operational mining New Cobar Complex except for a short (no more than 400 m) power line from an existing 22 kV line servicing PGM to a compact substation within the fresh air intake footprint.

PGM proposes to use the decline, infrastructure and intake and exhaust ventilation elements developed for the Great Cobar exploration drive (approved, but not yet constructed) to facilitate project development. Surface ventilation fans are not required during the development of exploration activities, however as they will be necessary during operation of mining, construction of a new powerline and compact substation, to be located adjacent to the fresh air intake is required. The power line will continue to the exhaust air rise where a ventilation fan will be installed at a depth of approximately 100 m or greater below ground level (bgl). An emergency egress winder headframe and winder house will be installed at the fresh air intake for the purpose of mine rescue in the event of an incident below ground preventing evacuation by conventional means. No additional new surface infrastructure is proposed.

The existing surface infrastructure and facilities at the New Cobar Complex currently support underground mining of the New Cobar, Chesney and Jubilee deposits, and will continue to be used for this Project (Figure 1.3 and Figure 1.4). Access to all underground workings in the complex is from a portal and decline at the base of the New Cobar Complex open cut. SSD approval will be sought for the following project elements accessed from, and undertaken within, the existing New Cobar Complex:

- Underground mining of the New Cobar Complex including, but not limited to, New Cobar, Jubilee and Chesney (existing development approval issued by CSC).
- Underground mining of the New Cobar Complex including Great Cobar and Gladstone (not yet approved).
- Groundwater dewatering of the relevant historic and proposed underground workings via the Great Cobar shaft and historical workings (existing development approval issued by CSC).
- Increase of the number of ore haulage trucks between the New Cobar Complex and Peak Complex from 25 loaded trips per day (50 movements in and out) to 50 loaded trips (100 movements in and out) per day (daylight hours only) averaged over a calendar year. The increase of daily truck movements will provide flexibility to PGM if there are unforeseen production disruptions (eg bad weather).
- Crushing and screening of ore within the existing New Cobar Complex ROM pad (existing approval by CSC).
- Transportation of ore to the Peak Complex via Kidman Way for processing, using road registered heavy vehicles (existing approval by CSC).
- Harvesting of waste rock and:
    - immediately deploying the material underground for use in stope backfilling operations (waste rock will remain underground and will not be transported to the surface as a preference); and
    - transportation of non-acid forming material to the surface and storage within the existing waste rock emplacement (WRE) prior to use across the complexes for construction/rehabilitation tasks (eg tailings dam lifts), unchanged from current approvals.
- Deposition of potentially acid forming waste rock brought to the surface and stored within the WRE where it can be used for construction activities (eg internal batters of tailings dam lifts) or at end of mine life it will be capped, or progressively returned underground for disposal, unchanged from current approvals.
- Continuation of all other approved activities within the New Cobar Complex.



Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

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Existing surface features

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 1.3

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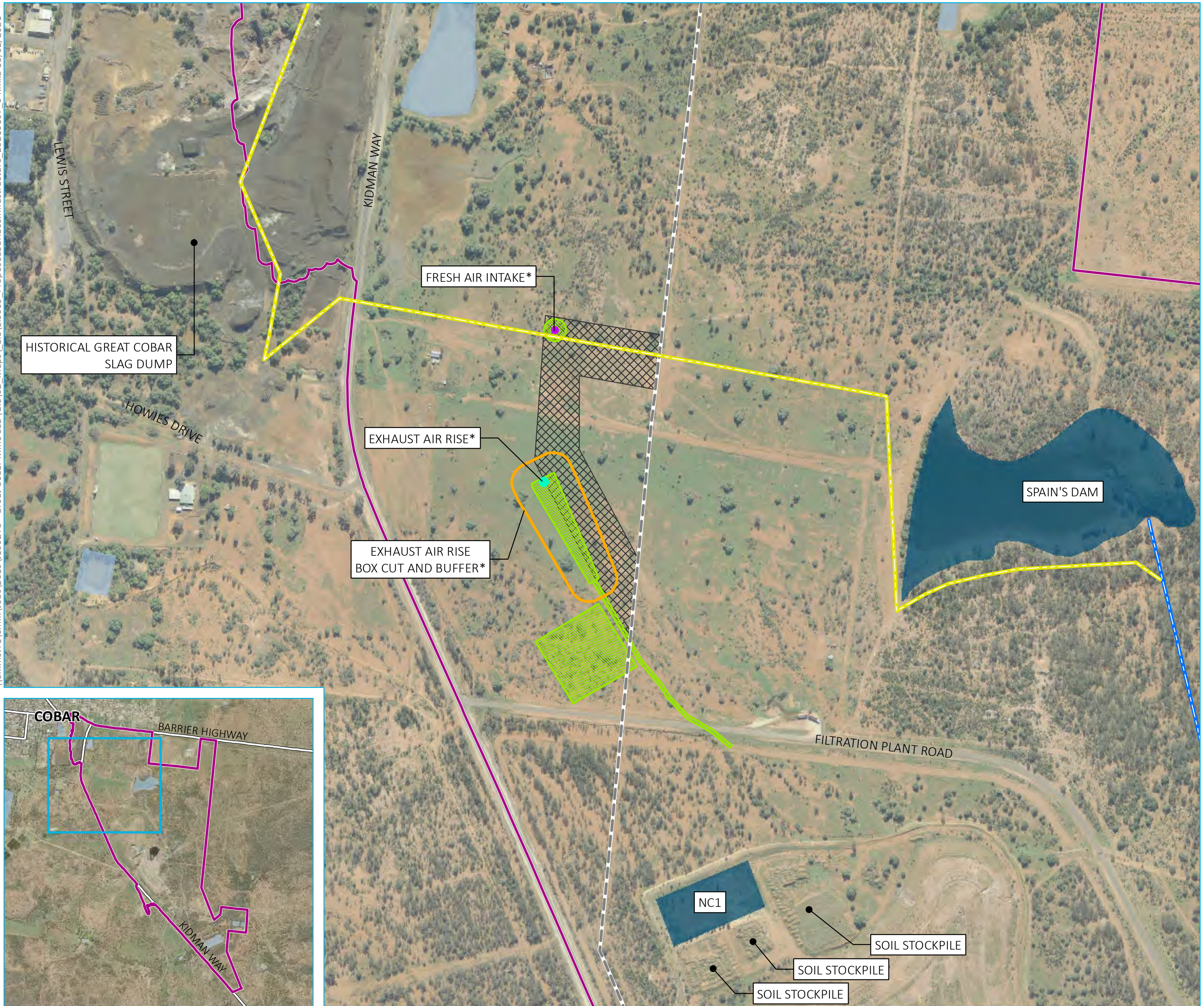

KEY
- Project area
- Major road
- Existing indicative pipeline route
- Existing Great Cobar dewatering pipeline
- Existing 22 kV powerline
- Exhaust air rise*
- Exhaust air rise buffer*
- Fresh air intake*
- Proposed power line corridor
- Waterbody
- Mine water management storage
- Approved area of disturbance*

*Approved under existing REF approvals, but not yet constructed.

Source: EMM (2021); DFSI (2017); DPE (2019); ELA (2018)

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Proposed surface infrastructure

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 1.4

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1.2 Purpose of this report

EMM Consulting Pty Ltd (EMM) has been engaged by PGM to prepare and submit an environmental impact statement (EIS) to support an SSD application for the project under the provisions of clause 8(1) and clause 5 of Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). The Peak Complex, which is not part of this SSD application will continue to operate under local government (CSC) approvals, as there is no proposed change to this arrangement.

PGM requested Secretary's Environmental Assessment Requirements (SEARs) from DPIE in December 2019; these were received in February 2020 and amended in October 2020 following the receipt of a BDAR Waiver. The SEARs included requirements to assess potential surface water risks associated with the construction and operation of the project. This surface water assessment has been prepared to address the relevant SEARs, provide information to be used in the EIS and support the SSD application for the project. The surface water related matters and EMM responses are tabulated in Table 1.1.

Table 1.1 Surface water related SEARs

Item no.	Assessment requirements	EMM responses
1	An assessment of the likely impacts of the development on the quantity and quality of surface and groundwater resources having regard to the NSW Aquifer Interference Policy.	Impacts to surface water resources are described in Section 7. Impacts to groundwater resources are described in the groundwater assessment (EMM 2020a).
2	An assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.	Impacts to surface water resources are described in Section 7.
3	A detailed site water balance, including a description of site water demands, water disposal methods (including the location, volume and frequency of any water discharges and management of discharge water quality), water supply arrangements, water supply and transfer infrastructure and water storage structures, including; • an assessment of the reliability of water supply, including consideration of climate change; and • demonstration that water can be obtained from an appropriately authorised supply in accordance with the operating rules of any relevant Water Sharing Plans (WSP).	A site water balance is provided in Section 5.6. An assessment of the reliability of supply including consideration of climate change is provided in Section 9.4.
4	Identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000, including a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo.	Water licencing is addressed in Section 9.
5	A detailed description of the proposed water management system (including sewerage), water monitoring program and other measures to mitigate surface water and groundwater impacts.	The water management system is described in Section 5. A monitoring program is described in Section 8.3.
6	A description of construction erosion and sediment controls, how the impacts of the development on areas of erosion, salinity or acid-sulphate risk, steep gradient land or erodible soils types would be managed and any contingency requirements to address residual impacts.	Construction erosion and sediment controls are described in Section 5.7.
7	An assessment of the potential flooding impacts of the project.	Flood impacts are described in Section 6.3.

In addition to the above SEARs, the following agencies have raised additional comments:

- DPIE Biodiversity and Conservation Division (DPIE-BCD) – letter dated 29 January 2020;
- DPIE Water and the Natural Resources Access Regulator (NRAR) – letter dated 22 January 2020; and
- NSW Environment Protection Authority (EPA) – letter dated 23 January 2020.

Agency comments and EMM responses are provided in Table 1.2.

Table 1.2 Additional agency comments related to surface water

Item no.	Agency comments	EMM responses
DPIE-BCD		
1	The EIS must map the following features relevant to water and soils including: … b) Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method). c) Wetlands as described in s4.2 of the Biodiversity Assessment Method… f) Proposed intake and discharge locations.	Surface water features are described and mapped in Section 4.
2	The EIS must describe background conditions for any water resource likely to be affected by the development, including: a) Existing surface and groundwater. b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. c) Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters. d) Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government. e) Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions.	The existing surface water environment is described in Section 4. The existing groundwater environment is described in the groundwater assessment (EMM 2020a). Water quality objectives and associated environmental criteria are described in Section 3.5.
3	The EIS must assess the impacts of the development on water quality, including: a) The nature and degree of impact on receiving waters for both surface and groundwater demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction. b) Identification of proposed monitoring of water quality. c) Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan).	Impacts to water quality are assessed in Section 7.3. A monitoring program is described in Section 8.3. The New Cobar Complex is not located within any Coastal Management Program areas.

Table 1.2 Additional agency comments related to surface water

Item no.	Agency comments	EMM responses
4	The EIS must assess the impact of the development on hydrology, including: a) Water balance including quantity, quality and source. b) Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas. c) Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems. d) Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (eg river benches). e) Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water. f) Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and reuse options. g) Identification of proposed monitoring of hydrological attributes.	A site water balance is provided in Section 5.6 . Impacts to hydrology and environmental surface water availability are assessed in Section 7. A monitoring program is described in Section 8.3. Impacts to groundwater, including groundwater dependent ecosystems, are addressed in the groundwater assessment (EMM 2020a). In relation to c) and d), a BDAR Waiver was granted by DPIE 0on 29 October 2020. Therefore no further assessment is required.
5	The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a) Flood prone land. b) Flood planning area, the area below the flood planning level. c) Hydraulic categorisation (floodways and flood storage areas). d) Flood hazard.	Exiting flood conditions and flood risk are described in Section 6.
6	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.	Existing flood characteristics are described in Section 6.2.
7	The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a) Current flood behaviour for a range of design events as identified in 14 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Flood impacts are described in Section 6.3.
8	Modelling in the EIS must consider and document: a) Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. b) The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood, or an equivalent extreme flood. c) Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories. d) Relevant provisions of the NSW Floodplain Development Manual 2005.	Exiting flood conditions and flood impacts are described in Section 6.

Table 1.2 Additional agency comments related to surface water

Item no.	Agency comments	EMM responses
9	The EIS must assess the impacts on the proposed development on flood behaviour, including: a) Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b) Consistency with Council floodplain risk management plans. c) Consistency with any Rural Floodplain Management Plans. d) Compatibility with the flood hazard of the land. e) Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. f) Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. g) Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. h) Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council. i) Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council. j) Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES. k) Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	Flood impacts are described in Section 6.3.
DPIE Water and NRAR		
10	The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.	Water licencing and security are described in Section 9.
11	A detailed and consolidated site water balance.	A site water balance is provided in Section 5.6 .
12	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	Impacts to surface water resources are assessed in Section 7.
13	Proposed surface and groundwater monitoring activities and methodologies.	A monitoring program is described in Section 8.3.
14	Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans.	The legislation, policies and guidelines considered are presented in Section 3.
EPA		
15	The EIS must demonstrate how the proposed development will meet the requirements of section 120 of the POEO Act (prohibition of pollution of waters).	Water quality impacts are described in Section 7.3.

Table 1.2 Additional agency comments related to surface water

Item no.	Agency comments	EMM responses
16	The EIS must include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and reuse options.	The water management system including a site water balance is described in Section 5.
17	If the proposed development intends to discharge waters to the environment, the EIS must demonstrate how the discharge(s) will be managed in terms of water quantity, quality and frequency of discharge and include an impact assessment of the discharge on the receiving environment. This should include: a) Description of the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges. b) Description of the receiving waters including upstream and downstream groundwater and surface water quality, as well as any other water users. c) Demonstration that all practical options to avoid discharge have been implemented and environmental impacted minimised where discharge is necessary.	The water management system including a site water balance is described in Section 5.
18	The EIS must refer to Water Quality Objectives for the receiving waters and indicators and associated trigger values or criteria for the identified environmental values of the receiving environment. This information should be sourced from the: a) NSW Water Quality and River Flow Objectives (2006); b) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2018) for all uses except primary industry; c) ANZECC & ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality for primary users.	Water quality objectives and associated environmental criteria are described in Section 3.5.
19	Assess impacts against the relevant ambient water quality objectives. Demonstrate how the proposal will be designed and operated to: a) Protect the Water Quality Objectives for receiving waters where they are currently achieved; and b) Contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved.	Impacts to water quality are assessed in Section 7.3.
20	The EA must describe how stormwater will be managed in all phases of the project, including details of how stormwater and runoff will be managed to minimise pollution. Information should include measures to be implemented to minimise erosion, leachate and sediment mobilisation at the site. The EA should consider the guidelines Managing urban stormwater: soils and construction, vol. 1 (Landcom 2004) and vol. 2 (A. Installation of services; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC 2008).	The water management system including stormwater management is described in Section 5.
21	The EA must describe any water quality monitoring programs to be carried out at the project site. Water quality monitoring should be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales (2004).*	A monitoring program is described in Section 8.3.

2 Project summary

Specific details of the Project are presented in Table 2.1 in the context of existing PGM approvals. For a full, detailed Project description, please see Chapter 2 of the New Cobar Complex EIS.

Table 2.1 Detailed overview of the Project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Tenement	Development approved to occur within the Development Application areas, including CML 6, CML 8, ML 1483, ML 1805 and MPL 854. Mining of the following deposits using underground mining methods, with each deposit accessed via the New Cobar Complex open cut: • New Cobar deposit; • Chesney deposit; and • Jubilee deposit. Minerals processing occurs at the Peak Complex within CML 8 and also includes CML 7 and CML 9.	No change to mine lease area. Mining of the following deposits using underground mining methods, with each deposit accessed via the New Cobar open cut: • New Cobar deposit; • Chesney deposit; • Jubilee deposit; • Gladstone deposit; and • Great Cobar deposit. Processing of materials from the New Cobar Complex will continue at the Peak Complex within CML8 under existing approvals and is therefore outside the scope for this Project.
Approvals	***Cobar Shire Council Development Consent*** • New Cobar South Open Cut - LDA 98/99:08 • New Cobar Open Cut - LDA 99/00:22 • New Cobar Underground – 2004/LDA 00003 PGM has received approval from CSC and the Resources Regulator (reference number MAAG0006783, approved in May 2020) to construct an exploration decline, ventilation shafts and associated infrastructure to facilitate exploration activities within the Great Cobar deposit. This is detailed in the Mine Operations Plan (MoP) for 2019-2022. ***Other Authorisations and Licences*** • EPL -3596 (EPA) • Licence to Manufacture Explosives (New Cobar) - XMNKF200002 (SafeWork NSW) • Dangerous Goods Notification - New Cobar: 35/035154 (SafeWork NSW). • Water Supply Works Approval reference 85WA753861 (Natural Resources Access Regulator)	PGM is seeking to consolidate all existing development consents applicable to the New Cobar Complex including existing mining, proposed underground mining of the Great Cobar and Gladstone deposits and existing surface infrastructure within a single consent issued by DPIE. Once approved, relevant CSC development consents for the New Cobar Complex will be surrendered. The Project will used infrastructure that has been approved but not yet constructed as a result of the exploration decline and associated infrastructure. Other approvals related to the Peak Complex, will be unaffected.
Mining method	Underground stope mining operations commence above a centrally positioned crown pillar and stopes will be extracted from the bottom-up. Bench stopes are backfilled progressively using waste from development and rock from the WRE. Upon completion of each stoping level, voids are backfilled. In some instances, mining against rock fill is required. In these instances, a	Expansion of underground stope mining operations will access new deposits at Great Cobar and Gladstone, as well as continued mining of New Cobar, Chesney and Jubilee deposits. The mining method will not change. There is no recorded history of significant subsidence or geotechnical failure associated with the current, modern mining operations at the Peak and New Cobar complexes.

Table 2.1 Detailed overview of the Project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
	rock and cement slurry is placed in the stope to provide additional stability. PGM undertake detailed geotechnical assessments of all stopes during the detailed stope design stage prior to mining.	
Blasting	Blasting will be used for the development of the underground workings and is proposed to occur under independent firing conditions (in the preliminary phases). Delays will be used to adjust sequencing and prevent any interaction or vibration enhancement from adjacent blastholes. The approximate number of blasts will be three per 24-hour period, 20 per 7-day period. Explosives are stored in the existing magazine at New Cobar Complex.	No change to blasting method.
Life of mine	Presently, the council approvals have no end date. Current mine plans envisage mining at New Cobar Complex to continue until 2023 under current market assumptions.	The Project will extend the life of mine by 12 years to 2035 under current market assumptions.
Production	Approved for the mining and processing of 800,000 tpa of ore to produce lead, zinc, copper, gold and silver from both the Peak and New Cobar complexes. Processing occurs at the Peak Complex.	The Project will produce ore within the mining and processing limit of 800,000 tpa for the Peak and New Cobar complexes. Ore will be transported to the existing processing plant at the Peak Complex. The ore will be processed at the Peak Complex processing plant, and tailings will be disposed of at the TSF at the Peak Complex under existing approvals. Processing of ore will only take place at the Peak Complex, therefore is outside the scope of this Project.
Mining extent	The New Cobar Complex comprises a surface disturbance area of approximately 425 hectares. The New Cobar open cut pit extends to a depth of approximately 100 mbgl. Development of underground working at Chesney, Jubilee and New Cobar deposits extends from a portal at the base of the New Cobar open cut pit.	Development of New Cobar Complex Project will be in stages. The Great Cobar and Gladstone deposits will be accessed via a decline extending from the existing New Cobar Complex underground workings. The proposed underground working depths are approximately 150–800 mbgl for Great Cobar and 350-500 mbgl for Gladstone. The Great Cobar deposit will be accessed by the approved exploration decline off the existing Jubilee workings at approximately 500 mbgl, and the Gladstone deposit will be accessed by a decline off the existing New Cobar underground workings at approximately 350 mbgl.
Tailings storage	All ore is processed at the Peak Complex, with tailings placed within the TSF.	No change.

Table 2.1 Detailed overview of the Project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Site access	Access to the New Cobar and Peak complexes is via Kidman Way.	No change.
Ore transportation	Ore is transported from the New Cobar Complex along 5 km of public road (Kidman Way) in road registered trucks at the rate of 25 trucks (50 truck movements) per day, seven days a week.	Ore will continue to be transported from the New Cobar Complex but at a maximum rate of 100 truck movements per day (in and out of site) (daylight hours only), seven days a week averaged over a calendar year. This is an increase in truck movements from a current maximum rate of 50 truck movements per day. The increase of daily truck movements will provide flexibility to PGM if there are unforeseen production disruptions such as poor weather or machinery breakdowns.
Waste rock management	Waste rock generated from underground workings is used preferentially as backfill in previously mined underground stopes. Some waste rock material may be brought to the surface and stored within the existing WRE at the New Cobar Complex until it's required for use in construction or rehabilitation across the Peak and New Cobar complexes.	No change.
Soil management	Application of soil resources management strategies/objectives in accordance with the existing Mining Operation Plan 2019-2022 (MOP 2019-2022) (PGM 2019) and Water Management Plan (PGM 2020)).	No change.
Mine ventilation	There are two existing exhaust air rises at the New Cobar Complex – one at the Jubilee workings and one at the Chesney workings. Fresh air is drawn down the portal at the base of the New Cobar Complex open cut and also via two fresh air intakes located near the Chesney ventilation fan. The infrastructure developed as part of the Great Cobar exploration decline will include an exhaust air rise and a fresh air intake.	No new ventilation shafts will be required; the ventilation shafts installed as part of the exploration decline will be required for ongoing mining operations and will remain in place. A new ventilation fan will be required to maintain a safe volume of air flow in the underground workings.
Surface infrastructure	All existing New Cobar Complex surface infrastructure operates under existing CSC approvals.	The Project will require the construction of a short (no more than 400 m long) power line spur between an existing 22 kV line and ventilation shaft (approved, but not yet constructed as part of the Great Cobar exploration decline approvals). This power line will connect to a pad-mounted compact substation to supply power for an emergency egress winder at the fresh air intake shaft and a ventilation fan to be installed at the exhaust air rise. No additional surface infrastructure will be required.

Table 2.1 Detailed overview of the Project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Water supply sources and infrastructure	The water requirements for the Peak Complex and the New Cobar Complex (combined) are approximately 580 ML/year. The source of this water is typically, comprised of approximately 212 ML/year from dewatering underground workings at the New Cobar Complex and approximately 368 ML/year of town water from Burrendong Dam. PGM is licenced to take up to 1,186ML/year from Burrendong Dam, however approximately 50% of this water is lost through seepage, evaporation and other methods before arriving at the New Cobar Complex. Following approval for the dewatering of the Great Cobar historical workings in 2019, up to 400 ML/year can be extracted to replace the town water currently being used. This is as part of a move for PGM's operations to be more self-reliant and sustainable in times of drought. The water from the Great Cobar historical workings will be used to make up any shortfall in site demand that cannot be made up by dewatering of underground workings. It will also reduce PGM's reliance on the town water supply during times of drought.	No change
Site water management infrastructure	A water management system is in place at the New Cobar Complex and is operated and managed in accordance with PGM's current water management plan (WMP). Dewatering water that is used in the New Cobar Complex underground workings is pumped to the New Cobar Complex settling pond for re-use. The water from these settling ponds is preferentially pumped back underground for reuse, or to the Peak Complex for use in the processing circuit. While it is PGM's preference to use water from dewatered mine workings for processing, this may not always be possible due to poor water quality and additional treatment requirements. Dewatering water excess to site requirements is pumped to Spain's Dam or Young Australia Dams for evaporation or storage for future reuse.	No change
Power supply	Electricity to the site is via a 22 kilovolt (kV) electricity transmission line (ETL) to the Peak Complex substation.	No change to power supply, but an additional power line spur will be required for the ventilation fan to be installed in the exhaust air rise and the emergency egress winder.
Hours of operation	Underground and above ground activities, 24-hour operations, seven days a week.	No change
Employment	The 2019/2020 workforce at PGM (including both the Peak and New Cobar complexes) totalled 404 full time equivalents (FTE).	Annual labour estimates for New Cobar Complex, being mining and underground maintenance staff range from 57 FTE in 2020/21 to a peak of 272 FTE in 2026/27. These however are not new employees; during the same period, as mining at the Peak Complex ramps down, staff will relocate to New Cobar Complex as their primary location of employment activity. PGM will continue to maintain operational control across the complexes.

Table 2.1 Detailed overview of the Project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Mining fleet	The existing/approved indicative mobile equipment fleet used for underground ore extraction, transport and waste rock handling includes: • articulated dump trucks; • cabletec; • compactors; • dozers; • drill rigs. • excavators; • graders; • haul trucks (50t); • jumbos; • LHD Loading dump trucks; • loaders; • rollers; • scrapers; • service truck; • underground development drill; • underground diamond drill rigs; • waste rock dump trucks; and • water trucks.	No change
Rehabilitation and mine closure	Current rehabilitation requirements as per MOP	Mine closure concepts and management measures will continue to be developed via the MOP 2019-2022, which outlines specific soil handling, rehabilitation and post mining landform objectives, in consultation with relevant regulatory authorities. The MOP will be updated and extended as required.

3 Assessment framework

3.1 Overview

This surface water assessment has been prepared in accordance with the SEARs that were issued February 2020, with consideration of relevant agency comments, as well as applicable guidelines and polices. This section provides a summary of relevant legislation, guidelines, plans and policies that have been considered in this assessment.

3.2 Relevant legislation

3.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. The project is deemed SSD under Schedule 1(5) of *the State Environmental Planning Policy (State and Regional Development) 2011*.

This surface water assessment forms part of an EIS to support an application under Part 4, Division 4.1 of the EP&A Act for the New Cobar Complex Project. The Minister for Planning and Infrastructure (or delegate) is the determining authority for the project.

3.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes the NSW environmental regulatory framework and includes licensing requirements for certain activities. Environment Protection Licences (EPLs) for water discharge are administered by the NSW EPA under the POEO Act.

EPL 3596 currently applies to the mine. The EPL includes two reference points (see Figure 5.2) that relate to surface water discharge and monitoring conditions at the New Cobar Complex. The two EPL points are described in Table 3.1.

Table 3.1 EPL 3596 monitoring point descriptions and discharge conditions

EPL point	Description	Parameters	Monitoring conditions	Monitoring frequency
6	Sample taken from Young Australia 1 near outlet location	• Oil and grease • Total suspended solids	• Quality monitoring during discharge	• Annual
7	Sample taken from the north-west portion of Spain's Dam[1]			

Notes: 1. Referred to as Spain's Tank in EPL 3596.

3.2.3 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WM Act recognises that water management decisions must consider: economic, environmental, social, cultural and heritage factors. The WM Act recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW.

The WM Act provides for water sharing between different water users, including environmental, basic rights or existing water access licence (WAL) holders, and provides security for licence holders. The licensing provisions of the WM Act apply to those areas where a WSP has commenced.

3.2.4 Water sharing plans

Water sharing plans outline the statutory water sharing obligations under the WM Act, dictating the management and sharing of water sources. The plans set the water management vision and objectives, management rules for WALs, what water is available within the various water sources, and procedures for dealing with licences and water allocations, water supply works approvals and the extraction of water. WSPs are designed to establish sustainable use and management of water resources and are periodically reviewed and updated (every 10 years).

Each WSP documents the water available and how it is shared between environmental, extractive, and other uses. The WSPs outline the water availability for extractive uses within different categories, such as: local water utilities, stock and domestic supply, basic rights, and access licences.

The project is located within the Yanda Creek Water Source which is managed under the *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011*. However, PGM hold a surface water allocation to take water from Burrendong Dam which is managed under the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016*. The relevant water sources and management zones, including relevant rules and conditions for WALs for the project are described in more detail in Section 9.

3.3 Local planning instruments

The Cobar Local Environmental Plan (LEP) 2012 is the statutory planning instrument that establishes what forms of development and land use are permissible and/or prohibited on all land within the Cobar Shire Council local government area.

The LEP guides planning decisions through zoning and development controls, which include considerations for stormwater management and development on flood prone land. The LEP been considered in the preparation of this surface water assessment.

3.4 Relevant policies and guidelines

3.4.1 Australian Rainfall and Runoff 2019

Australian Rainfall and Runoff (ARR2019) (Ball et al. 2019) is a national guideline document, data and software suite that can be used for the estimation of flood characteristics in Australia. It is widely accepted as a design guideline for all flood and stormwater-related investigation and design in Australia.

3.4.2 Floodplain Development Manual

The NSW *Floodplain Development Manual* (DIPNR 2005) details flood prone land policy which has the primary objective of reducing the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods. At the same time, the policy recognises the benefits from occupation and development of flood prone land.

3.4.3 Erosion and sediment control guidelines

The following NSW government guidelines provide guidance on best practice erosion and sediment control methods:

- *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004); and
- *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008).

3.4.4 National Water Quality Management Strategy

The *National Water Quality Management Strategy* (NWQMS) (Australian Government 2018) aims to develop and maintain a voluntary, nationally coordinated framework, supported by all Australian governments, to facilitate water quality management for the productive and sustainable use of Australia's water resources and to protect community values.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) is the central technical reference document for the NWQMS.

The NSW government has adopted the NWQMS as its policy to manage the quality of waterways and protect water resources in NSW.

3.4.5 Australian and New Zealand guidelines for fresh and marine water quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) describe water quality objectives for freshwater and marine environments, aquatic ecosystems and primary industries within Australia and New Zealand. The ANZG (2018) guidelines are a revision to the 2000 version of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality published by the Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

The ANZG (2018) guidelines provide a framework for the development, assessment and implementation of water quality objectives to sustain current, or likely future community values for natural and semi-natural water resources. The ANZG (2018) guidelines include default guideline values (DGVs) that define ranges and maximum values for certain parameters that are suitable for the protection of specific water uses or values. The ANZG (2018) guidelines for livestock drinking water (the most appropriate beneficial use downstream of the New Cobar Complex) are not yet available. Hence, the ANZECC/ARMCANZ (2000) DGVs for livestock drinking water are referenced in this assessment.

The DGVs do not make allowance for site-specific factors that may influence water quality. The DGVs may be superseded by site-specific trigger values (SSTVs) should sufficient baseline data (typically greater than 24 months) become available.

3.5 Water quality objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides water quality objectives (WQOs) that are consistent with the ANZECC/ARMCANZ (2000) water quality guidelines. The WQOs are "primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable water supply and the production of aquatic foods suitable for consumption and aquaculture activities" (DECCW 2006).

The river flow objectives (RFOs) are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

WQOs are provided for catchments throughout NSW (DECCW 2006). The New Cobar Complex lies within the Barwon Darling and Far Western Catchments. Watercourses in proximity to the New Cobar Complex are not identified in the DECCW (2006) watercourse mapping for the Baron Darling and Far Western Catchments. The nearest mapped watercourse is Sandy Creek, an "uncontrolled stream" approximately 50 km downstream of the mine. Hence, the "uncontrolled streams" classification has been adopted for watercourses near and downstream of the New Cobar Complex. Water quality and river flow objectives for "uncontrolled streams" within the Barwon Darling and Far Western Catchments are summarised in Table 3.2.

Table 3.2 Application of NSW water quality objectives

Environmental value	Objective	Application to the project
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	No permanent watercourses downstream of the project. Newey Reservoir (a regenerated man-made waterbody) is approximately 2 km downstream of Spain's Dam.
Visual amenity	Aesthetic qualities of waters.	No permanent watercourses downstream of the project. The visual amenity of Newey Reservoir is considered.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	No permanent watercourses downstream of the project. Newey Reservoir is used for recreational purposes.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	No permanent watercourses downstream of the project. Newey Reservoir is used for recreational purposes.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Some downstream users may capture and extract water for livestock water supply.
Irrigation water supply	Protecting the quality of waters applied to crops and pasture.	It is unlikely that downstream users capture and extract water for agricultural (irrigation) purposes. This WQO is not assessed.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is unlikely that downstream users capture and extract water for homestead water supply. This WQO is not assessed.
Drinking water – disinfection only, clarification and disinfection, and groundwater	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	The project is not located within a drinking water catchment. This WQO is not assessed.
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	No permanent watercourses downstream of the project. Fishing may be undertaken at Newey Reservoir, approximately 2 km downstream of Spain's Dam.
River flow objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	No permanent watercourses exist within the New Cobar Complex and surrounding landscape. This RFO is not assessed.
Protect natural low flows	Protect natural low flows.	The extraction of surface water from watercourses in proximity of the New Cobar Complex is not proposed. This RFO is not assessed.

Table 3.2 Application of NSW water quality objectives

Environmental value	Objective	Application to the project
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows.	The extraction of surface water from watercourses in proximity of the New Cobar Complex is not proposed. This RFO is not assessed.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	Predicted groundwater inflow rates (EMM 2020a) over the 12-year mine plan may impact the volume of water to be managed within mine water management dams. An increase or decrease in the volume of water discharged from the water management dams has the potential to impact existing flow regimes in downstream watercourses.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	Impacts to groundwater water levels are addressed in the groundwater assessment (EMM 2020a).
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures are proposed. This RFO is not assessed.
Minimise effects of dams on water quality	Minimise downstream water quality impacts of storage releases.	This RFO primarily relates to those streams with large weirs or dams. No large weirs or dams that allow for routine releases are proposed as part of the project. This RFO is not assessed. However, the impact of water management dam discharges on downstream water quality is addressed in line with the WQOs.
Make water available for unforeseen events	Ensure river flow management provides for contingencies.	This RFO primarily relates to streams with significant water extraction or dams from which releases can be made. No permanent watercourses exist near the New Cobar Complex and surface water extraction is not proposed. This RFO is not assessed.

3.5.1 Default guideline values

The DGVs applicable to each WQO are provided in the *NSW Water Quality and River Flow Objectives* (DECCW 2006). The DGVs vary depending on the environmental value, with the most appropriate beneficial use adjacent to, and downstream of the New Cobar Complex, being livestock water supply. DGVs are provided in Table 3.3.

The DGVs have been applied to this surface water assessment and are referred to as WQO values in the remainder of this report. The WQO values do not make allowance for site specific factors that may influence water quality. Site specific water quality characteristics are discussed further in Section 5.5.

Table 3.3 Default guideline (WQO) values

Indicator	DGV value (livestock water supply)
Physico-chemical	
Total dissolved solids (TDS)	2,400 mg/L (value for cattle health)
Salinity (electrical conductivity (EC))	3,582 µS/cm[1]
Calcium	1,000 mg/L
Sulphate	1,000 mg/L
Nutrients	
Nitrate	400 mg/L
Nitrite	30 mg/L
Chemical contaminants/toxicants	
Chemical contaminants/toxicants	ANZECC/ARMCANZ (2000), Chapter 4.3 and Table 4.3.2.
Biological	
Algae and blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11,500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.
Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).

Notes: 1. Calculated using Equation 4.6 (EC (µS/cm)*0.67 = TDS (mg/L)) provided in ANZECC (2000).

4 Existing environment

4.1 Overview

The New Cobar Complex is in a semi-arid region of the Darling River catchment and experiences hot summers, mild winters and generally low annual rainfall totals. This section describes the existing environment of the New Cobar Complex including regional topography, climate, local watercourses and groundwater. Flooding is addressed separately in Section 6.

4.2 Topography

The regional topography consists of a generally flat to undulating plateau that is broken by several ridgelines and scattered peaks. The mine is situated along a 2 km north-northwest trending ridgeline that rises approximately 50 m above the surrounding countryside. The existing New Cobar open cut lies immediately west of Fort Bourke Hill, the highest point along the ridgeline. Surface elevations at the mine range from approximately 295 m Australian Height Datum (AHD) at Fort Bourke Hill to 240 m AHD at Chesney to the south-east.

4.3 Climate data

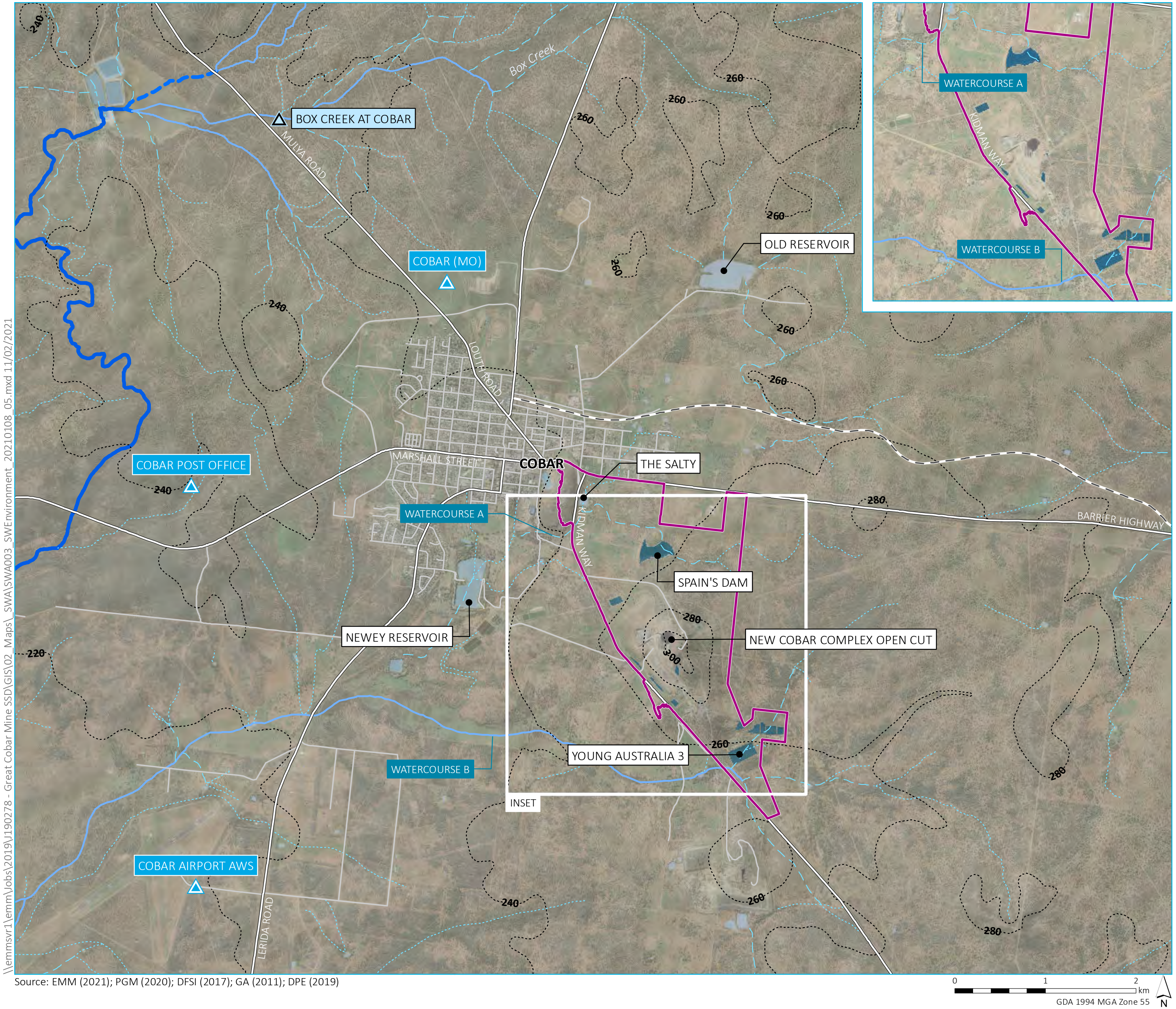
4.3.1 Rainfall records

There are several Bureau of Meteorology (BoM) operated rainfall gauges (see Figure 4.1) that provide representative records for the New Cobar Complex. Key information and statistical data for the three local gauges with the longest rainfall record are provided in Table 4.1.

Table 4.1 Local rainfall statistics

Statistic	Units	Cobar Post Office (48030)	Cobar Airport AWS (48237)	Cobar MO (48027)
Rainfall record		1881 – 1965	1994 – present	1962 – present
Distance from the site		5.4 km west	5.7 km south-west	4.5 km north-west
Elevation	(m AHD)	251	218	260
Average rainfall	(mm/year)	351	332	389
Lowest rainfall	(mm/year)	116	134	102
5th percentile rainfall	(mm/year)	159	178	174
10th percentile rainfall	(mm/year)	182	194	197
Median rainfall	(mm/year)	337	307	376
90th percentile rainfall	(mm/year)	537	559	626
95th percentile rainfall	(mm/year)	590	579	654
Highest rainfall	(mm/year)	800	583	710

Source: BoM website (climate data online).



Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011); DPE (2019)

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KEY
- Rainfall gauge
- Stream gauge
- Project area
- Contour (20 m)
- Rail line
- Major road
- Minor road
- Waterbody
- Mine water management storage

Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order

Existing surface water environment

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 4.1

EMM
creating opportunities

Comparison of the rainfall statistics shown in Table 4.1 indicates that the rainfall records for the three gauges generally correlate well. Higher rainfall totals are experienced at the Cobar MO gauge compared to the Cobar Post Office gauge. This is due to the drier climate conditions experienced in the first half of the 1900s. The Cobar MO gauge is expected to be more representative of recent rainfall conditions than the Cobar Post Office gauge. The Cobar MO gauge is considered to be most representative of site conditions due to proximity and recent length of record.

Daily rainfall data for the Cobar MO gauge was obtained as SILO (Scientific Information for Land Owners) Patched Point Data from the Queensland Climate Change Centre of Excellence. SILO Patched Point Data is based on historical data from the BoM rainfall stations, with missing data 'patched' in by interpolating data from nearby station records. The SILO data for Cobar MO provided rainfall depths for periods in the BoM records where data is missing, resulting in a continuous rainfall record at the gauge from 1962 to 2020.

Monthly rainfall statistics for the Cobar MO gauge are shown in Figure 4.2. Median monthly rainfall is shown to be similar throughout the year. Larger monthly rainfall totals are more likely to occur during summer months. Monthly evaporation totals are shown to substantially exceed monthly rainfall totals throughout the year.

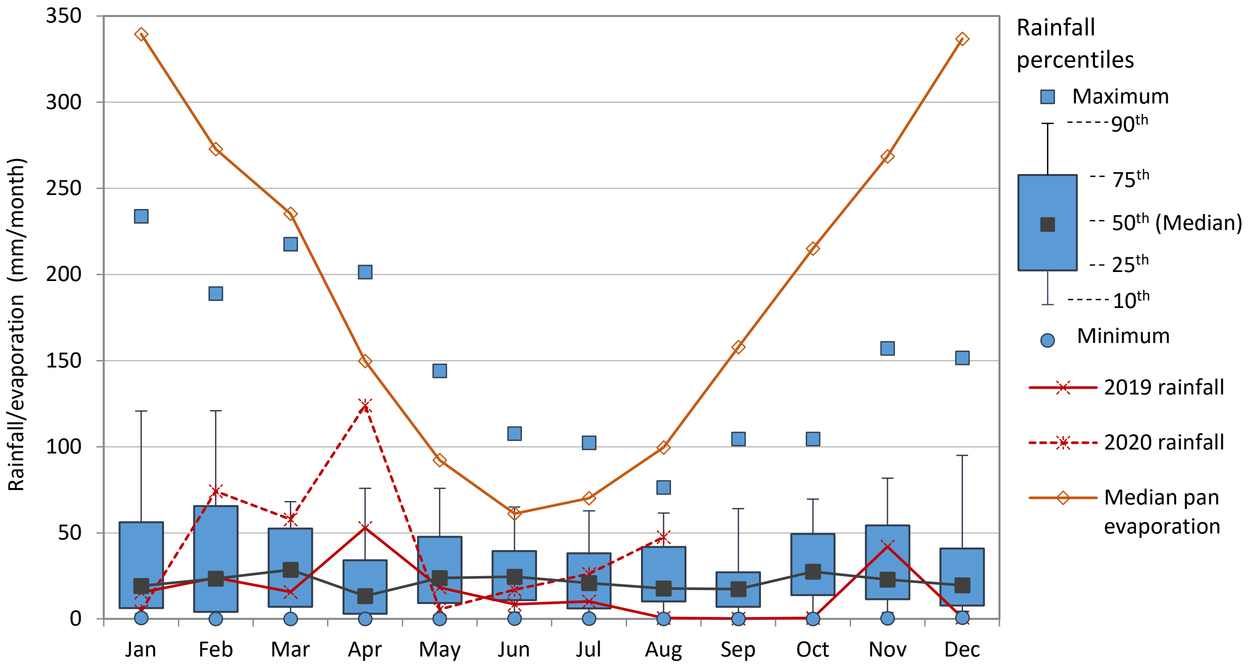


Figure 4.2 Monthly rainfall statistics – Cobar MO (48027)

4.3.2 Design rainfall data

Design rainfall information is used to inform an understanding of flood risk and calculate aspects of the stormwater management system. The following design rainfall information has been established for the site:

- Table 4.2 provides design rainfall depths for a range of annual exceedance probability (AEP) events of varying durations. This information was sourced from the BoM Design Rainfall Data System (2016); and
- Table 4.3 presents rainfall depths at the Cobar MO gauge for 2, 5, 10 and 20 day rainfall events.

Table 4.2 Design rainfall depths from Australian Rainfall and Runoff 2019

	Annual exceedance probability – rainfall depth (mm)						
Duration	**63.2%**	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
15 min	10.5	12.4	18.8	23.4	28.2	34.9	40.3
30 min	14.1	16.7	25.3	31.5	37.8	46.7	53.8
1 hour	17.9	21.2	31.9	39.6	47.3	57.8	66.2
2 hour	22.1	26.0	38.7	47.6	56.5	68.4	77.8
3 hour	24.8	29.1	42.8	52.4	61.9	74.7	84.8
6 hour	30.1	35.0	50.6	61.4	72.1	86.9	98.5
9 hour	33.5	38.8	55.8	67.5	79.1	95.5	108
12 hour	36.2	41.8	59.7	72.2	84.6	102	116
24 hour	42.8	49.4	70.5	85.3	100	122	139
48 hour	49.3	57.1	82.2	100	118	144	165
72 hour	52.7	61.2	88.8	108	128	156	178

Source: Data sourced from BoM Design Rainfall Data System (2016).

Table 4.3 Design rainfall depths for frequent events – Cobar MO (48027)

	Rainfall duration and depth (mm)			
	2 day	**5 day**	**10 day**	**20 day**
80th percentile event	12.7	20.2	29.7	47.1
85th percentile event	16.5	26.4	36.6	56.2
90th percentile event	22.4	34.0	45.8	68.7
95th percentile event	33.0	48.0	63.9	92.2

4.3.3 Evaporation data

Daily pan evaporation rates at the Cobar MO gauge were obtained as SILO Patched Point Data for the 1962 to 2020 period. Monthly pan evaporation statistics at the Cobar MO gauge are shown in Figure 4.3.

Monthly evaporation totals are shown to be greatest during summer months with evaporation rates declining into winter. Monthly evaporation totals during the 2019 calendar year are shown to generally be above median values with 75th to 90th percentile values occurring over the second half of the year. Monthly evaporation totals during the first half of the 2020 calendar year are shown to be below median values.

The average annual pan evaporation total of 2,336 mm is approximately six times greater than the average annual rainfall total of 389 mm. This results in an average annual deficit (difference between annual rainfall and annual evaporation) of 1,947 mm.

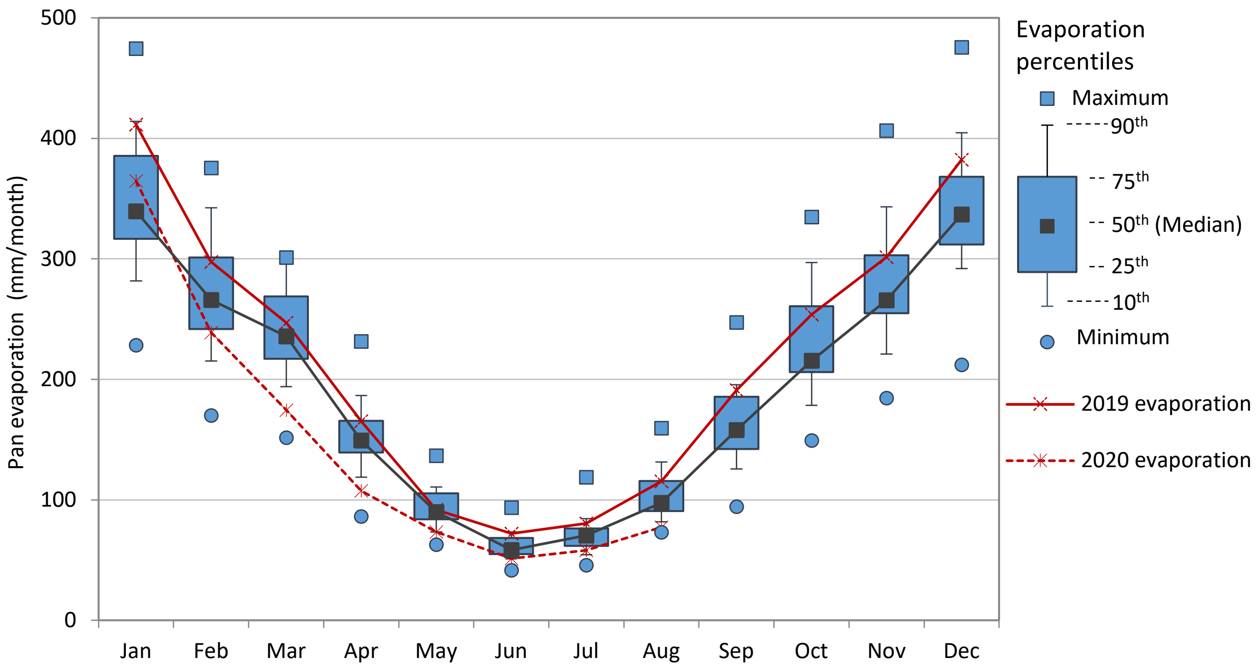


Figure 4.3 Monthly pan evaporation statistics – Cobar MO (48027)

4.4 Local watercourses

The majority of surface infrastructure associated with the New Cobar Complex is located on top of a ridgeline and is not impacted by local watercourse flows. The main drainage features in the project area are two second order watercourses that flow to the north and south of the existing New Cobar Complex surface infrastructure (see Figure 4.1).

The watercourse to the north (Watercourse A) receives runoff from an upstream catchment along with discharge from the mine water management system. The watercourse is impounded by Spain's Dam prior to discharging via the Spain's Dam emergency spillway to a waterbody known as the Salty. Downstream of the New Cobar Complex, the watercourse traverses Kidman Way via bed level crossing, prior to flowing south-west around the existing Great Cobar open cut and into Newey Reservoir.

The watercourse to the south (Watercourse B) receives runoff from an upstream catchment that is diverted around the mine via a series of diversion banks and drainage channels. The watercourse re-joins its original flow path downstream of the Young Australia 3 water management dam prior to crossing Kidman Way, where it becomes a third order watercourse. The two watercourses join approximately 3 km downstream of the New Cobar Complex.

No permanent watercourses exist within the New Cobar Complex and surrounding landscape. All watercourses upstream and downstream of the complex have ephemeral flow regimes.

Streamflow records at the NSW Department of Industry – Land and Water operated Box Creek at Cobar (425016)[1] gauge between 1974 and 2015 (gauge decommissioned in 2015) indicate an average annual runoff coefficient (the percentage of rainfall that turns into runoff) of 2%. Annual runoff coefficients for the Box Creek at Cobar gauge are variable with observed values ranging from below 1% to up to 6% for 2005, 2006 and 2007 consecutively. The Box

[1] The streamflow record for the NSW Department of Industry – Land and Water operated Box Creek at Cobar (425016) was obtained from Bureau of Meteorology Water Data Online website. The Bureau of Meteorology state 'the data provider releases the record set declaring that the data's ability to represent the monitored parameter is not known'. Hence, the quality of the Box Creek at Cobar streamflow gauge dataset is unknown.

Creek at Cobar gauge is subject to numerous gaps in the historical record and only years with a full record were used to determine annual runoff coefficients.

The annual runoff coefficient for the Box Creek at Cobar gauge is in line with the broader Barwon-Darling catchment annual runoff coefficient of 2% as determined by CSIRO (2008). Annual runoff coefficients were shown to be as low as 1% in the western portion of the Barwon-Darling catchment and up to 4% in the north-eastern portions of the catchment. Cobar is centrally located in the southern half of the Barwon-Darling catchment and is anticipated to have rainfall-runoff characteristics similar to the more western portions of the catchment.

Flooding conditions along local watercourses in the vicinity of the New Cobar Complex are described in Section 6.

4.5 Groundwater

Regional groundwater generally flows away from the Cobar region towards the Lachlan River to the south and Darling River to the north. Groundwater flow patterns near the New Cobar Complex have been altered by historical and current day underground mining. Groundwater levels vary throughout the New Cobar Complex and surrounds. Groundwater levels range from 3 mbgl near Newey Reservoir to 32 mbgl towards the New Cobar open cut, and are typically greater than 5 mbgl (EMM 2020a).

Connectivity between the groundwater and surface water environment is expressed via the following two mechanisms:

- Recharge to groundwater systems is expected to occur primarily via rainfall infiltration with an estimated average rainfall recharge of 0.5 mm/year (or 0.15% of annual average rainfall) (EMM 2020a).

- Discharge of groundwater primarily occurs via underground mine dewatering. Groundwater inflow into the underground workings is pumped to the surface where it is managed within the existing New Cobar Complex water management system (see Section 5.4.4).

There is limited natural groundwater discharge to surface water bodies (eg discharge to creeks) and/or loses via evapotranspiration given typical depths to groundwater across the site greater than 5 mbgl.

The existing groundwater environment including groundwater dependent ecosystems (GDEs) is described further in the groundwater assessment (EMM 2020a).

5 Water management system

5.1 Overview

An existing water management system is in place at the New Cobar Complex and is operated and managed in accordance with PGM's current WMP. The existing water management system will be used to manage water resources for the project.

This section describes the water management system and provides information on water management objectives, catchment areas, storages, stormwater drainage, process water use, water transfers and wastewater management. Water quality within the existing water management system is characterised and a site water balance is provided.

This section should be read in conjunction with Figure 5.1 which diagrammatically describes the water management system.

5.2 Water type classification

The New Cobar Complex water management system is designed to use and manage water from numerous sources and of varying quality. The terminology used to describe water managed by the mine varies depending on the source, quality, and end use. A description of the water types managed at the New Cobar Complex is provided in Table 5.1.

Table 5.1 Water type classification

Water type	Description
Clean water	Stormwater runoff from catchments that are undisturbed by mining or other mining related activities.
Dirty water	Stormwater runoff from catchments disturbed by mining activities such as topsoil stockpiles, rehabilitated areas that are yet to be stabilised and roads. Dirty water may contain elevated concentrations of suspended solids and sediments.
Mine contact water	Stormwater runoff that comes in contact with mine processing areas (such as the ROM pad and overburden stockpile) or water that is dewatered from the underground workings. Mine contact water may have elevated concentrations of metals, hydrocarbons, and/or other chemicals.
Potable water	Water that is suitable for human consumption and sourced from CSC (as part of the high security supply from Burrendong Dam) following treatment at the Fort Bourke Hill filtration plant.
Process water	Water that is used by or produced by mining activities including water used in the underground workings, at the surface for dust suppression, and water transferred to Peak Complex ore processing.
Raw water	Water that is sourced from CSC (as part of the high security supply from Burrendong Dam) prior to any treatment.
Recycled water	Process water that is reused within the water management system, generally following the settlement of suspended solids and sediment.
Stormwater	Surface water runoff that is generated from rainfall and any substance transported with it, including suspended solids, sediments, and contaminants.
Wastewater	Water generated from onsite amenities such as toilets and showers. Wastewater contains human waste and associated pathogens.

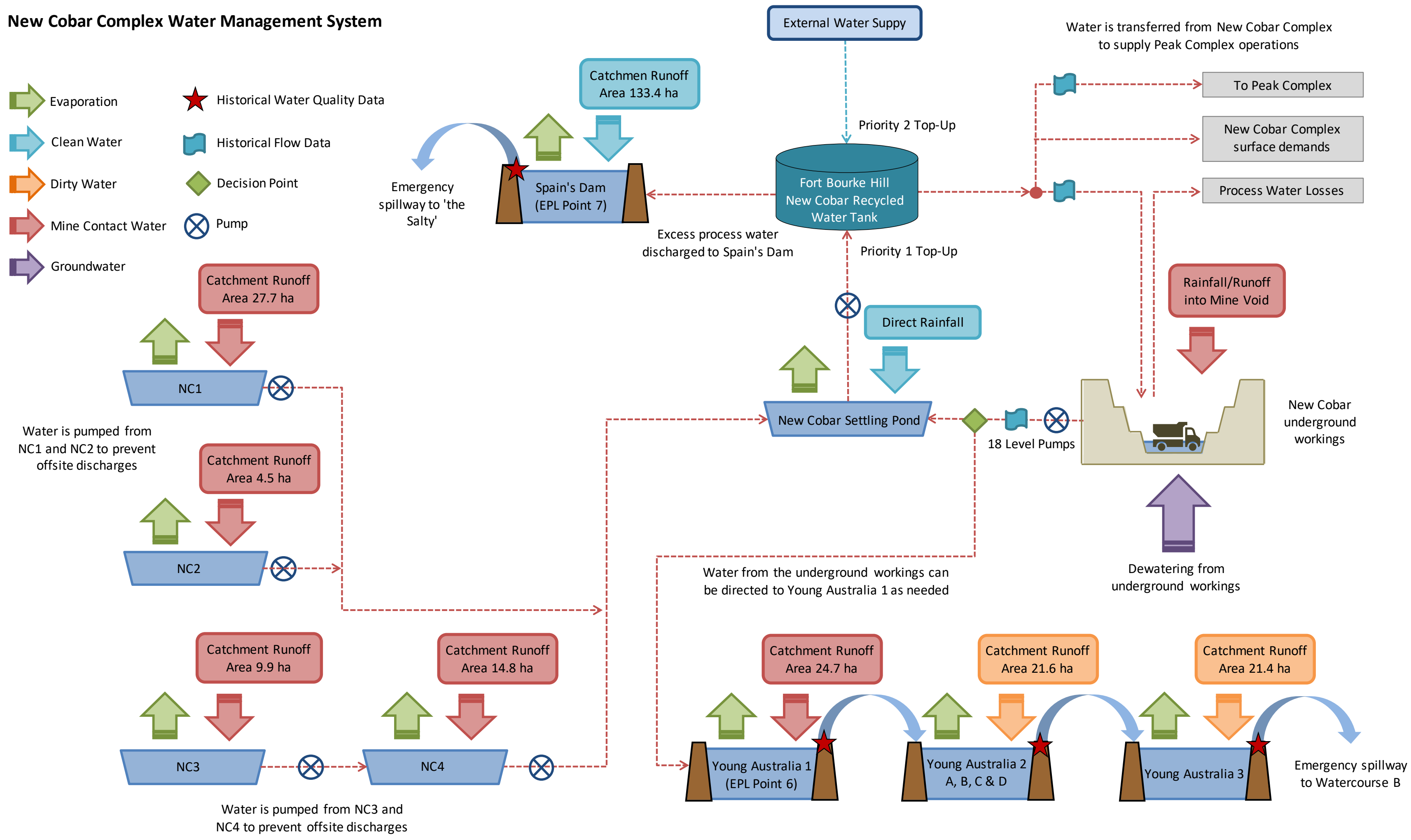


Figure 5.1 New Cobar Complex water management system schematic

5.3 Water management objectives

PGM's overarching water management objective is to maintain a zero-discharge site and to maximise the reuse of water onsite. The water management system is designed and operated with consideration of the key objectives described in Table 5.2.

Table 5.2 Water management objectives and approach

ID	Water management objective	Approach
1	Where practical, stormwater from upstream catchments is diverted around the working areas to reduce loading on the internal water management system.	A number of diversion bunds and drains exist upstream of the water management system. Diversion bunds and drains are generally in accordance with: • *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004); and • *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008).
2	Provide water quality and quantity controls to treat (via sedimentation) and prevent stormwater discharge offsite.	Water management dams are in place to capture and treat (via sedimentation) stormwater runoff. Water management dams are generally in accordance with: • *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004); and • *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries (DECC 2008).* Pump systems are in place to dewater the water management dams to prevent stormwater discharges offsite.
3	Provide water quantity controls to minimise or eliminate the discharge of mine contact water offsite.	Water management dams that receive mine contact water (via stormwater runoff or underground dewatering) include additional storage capacity and/or infrastructure (ie pumps) to minimise the risk of discharging mine contact water offsite. The New Cobar Complex is considered a zero-discharge site however Spain's Dam has potential to overflow during intense or prolonged rainfall events.
4	Maximise the reuse of water onsite to reduce demand on external water sources.	Water that is dewatered from the underground workings is either recycled back to the New Cobar Complex underground operations, used to supply water demand at the New Cobar Complex surface or transferred the Peak Complex for use as process water.

5.4 Existing water management description

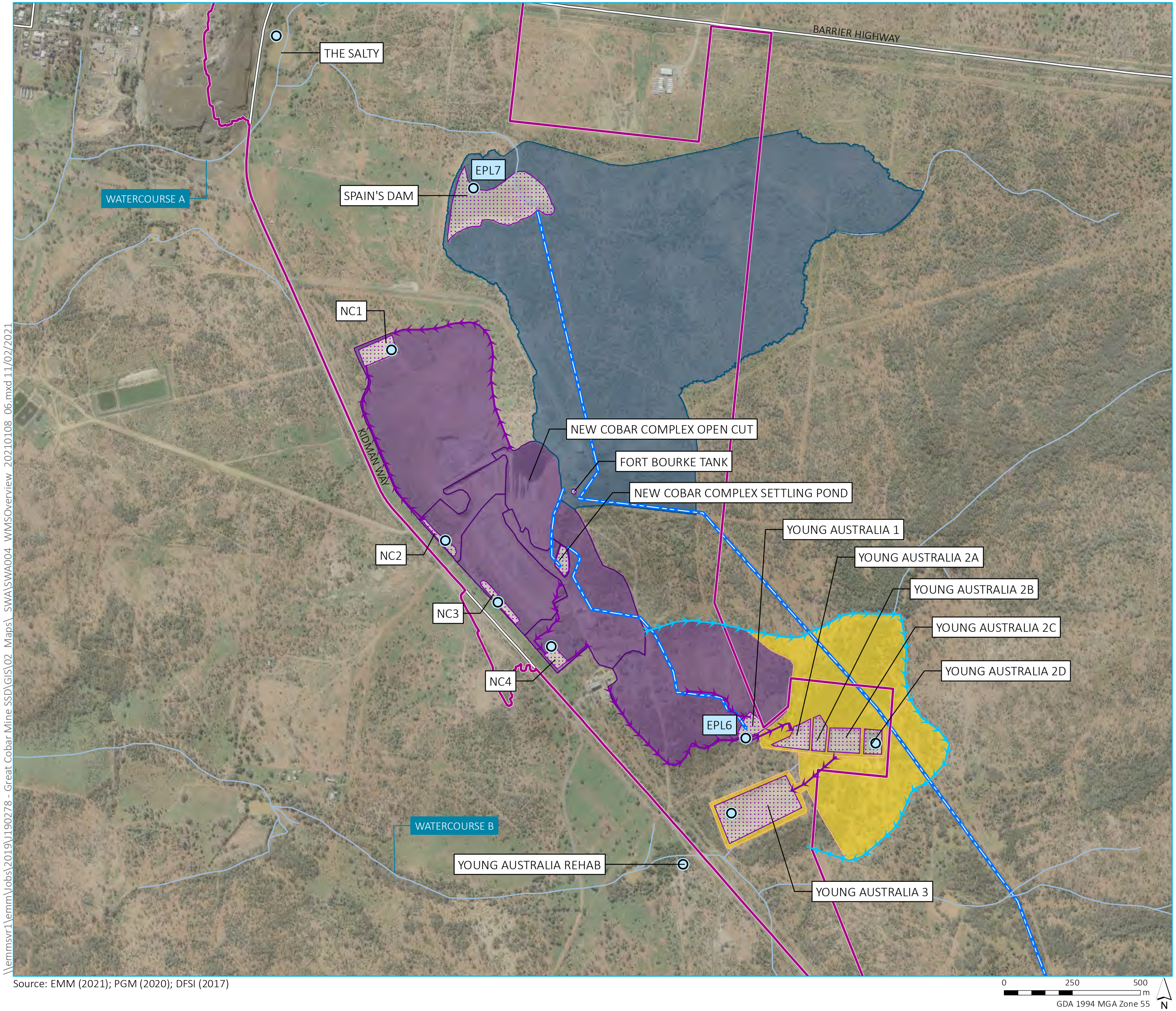
5.4.1 Water management area

There are several defined catchments within the site water management area. A summary of each catchment area and land-use characteristics is provided in Table 5.3. The extent of each catchment and the location of key water management infrastructure is shown in Figure 5.2.

Table 5.3 New Cobar Complex catchments

Catchment ID	Area (ha)[1]	Runoff quality	Land-use	Catchment land-use			
				Mine void	Overburden	Hardstand	Vegetated
New Cobar Complex open cut	6.2	Mine contact	Access road and void associated with New Cobar open cut.	100%	-	-	-
Spain's Dam	133.4	Clean water	Vegetated and unvegetated areas.	-	-	-	100%
NC1	27.7	Mine contact	WRE landform, vegetated and unvegetated areas.	-	70%	-	30%
NC2	4.5	Mine contact	WRE landform and access roads.	-	20%	70%	10%
NC3	9.9	Mine contact	WRE landform, run of mine area, vegetated and unvegetated areas.	-	20%	60%	20%
NC4	14.8	Mine contact	WRE landform, access roads, run of mine area, mine workings, workshop areas, settling pond overflow, vegetated and unvegetated areas.	-	20%	30%	50%
Young Australia 1[1]	24.7	Mine contact	Mine dewatering water, historic mine workings, run of mine area, vegetated and unvegetated areas.	-	-	20%	80%
Young Australia 2	21.6	Dirty water	Overflow from Young Australia 1, historic mine workings, run of mine area, unpaved access roads, vegetated and unvegetated areas.	-	-	10%	90%
Young Australia 3	21.4	Dirty water	Overflow from Young Australia 2, historic mine workings, run of mine area, unpaved access roads, vegetated and unvegetated areas.	-	-	10%	90%

Notes: 1. Catchment area includes the surface area of water management storage.



Source: EMM (2021); PGM (2020); DFSI (2017)

Mine water management system overview

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 5.2

EMM creating opportunities

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5.4.2 Water management storages

The water management system includes several dams and tanks that capture and store water from the water management catchments described in Table 5.3. The quality of water stored in each storage is a function of the contributing catchment surface runoff quality, overflows from upstream storages, and whether the storage receives mine dewatering water. The water management storages are described in Table 5.4 and shown in Figure 5.2.

Table 5.4 New Cobar Complex storages

Storage ID	Description	Water quality	Storage volume[1]	Overflows to
New Cobar Complex open cut	• Mine void associated with the New Cobar Complex open cut. • Groundwater inflows to the existing subsurface excavations are dewatered to New Cobar Complex settling pond and then onto Fort Bourke Hill Tank and either sent to Peak Complex for reuse or Spain's Dam for evaporation. If the settling ponds are being bypassed (eg de-sedimentation is required) water is pumped directly to Young Australia 1 for evaporation to maintain underground access. • Rainfall/runoff that falls directly over the open cut collects in a sump prior to being immediately pumped to New Cobar Complex settling pond or Young Australia 1 to maintain underground access. • Water from the New Cobar Complex open cut is reused underground or piped to Peak Complex for use in the processing circuit.	Mine contact	-	New Cobar Complex settling pond
New Cobar Complex settling pond	• Receives water from New Cobar Complex underground mine or open cut dewatering for settling prior to being transferred to Fort Bourke Hill Tank.	Mine contact	2.5 ML	Fort Bourke Hill Tank and then Peak Complex (reuse) or Spain's Dam[2] (evaporation)
Fort Bourke Hill Tank	• Stores water from New Cobar Complex underground mine or open cut dewatering prior to reuse underground, pumping to Peak Complex for use in the processing circuit or discharge to Spain's Dam when the rate of mine dewatering exceeds process water demand.	Mine contact	2.5 ML	Spain's Dam (via pipeline)
Spain's Dam	• Receives runoff from a relatively large natural catchment as well as from Fort Bourke Hill Tank when the rate of mine dewatering exceeds process water demand. • Licenced discharge point (EPL point 7).	Mine contact	90.2 ML	Emergency spillway to the Salty and then Watercourse A
NC1	• Captures mine contact water from adjoining catchment.	Mine contact	36.8 ML	Pumped to New Cobar Complex settling pond
NC2	• Captures mine contact water from adjoining catchment.	Mine contact	2.7 ML	Pumped to New Cobar Complex settling pond
NC3	• Captures mine contact water from adjoining catchment. • During extended periods of wet weather water is pumped to NC4 to reduce risk of discharge.	Mine contact	4.5 ML	Pumped to NC4

Table 5.4 New Cobar Complex storages

Storage ID	Description	Water quality	Storage volume[1]	Overflows to
NC4	• Captures mine contact water from adjoining catchment. • During extended periods of wet weather water can be pumped to New Cobar Complex settling pond to reduce risk of discharge.	Mine contact	4.4 ML	Pumped to New Cobar Complex settling pond
Young Australia 1	• Storage dam that receives runoff from mining areas (historical and current), and mine dewatering water pumped directly from New Cobar Complex underground mine. • Young Australia 1 acts as a settling pond prior to the water flowing to Young Australia 2 and 3. • Licenced discharge point (EPL point 6).	Mine contact	3.7 ML	Young Australia 2
Young Australia 2	• Series of storage dams that receive runoff from the adjoining dirty water catchment and overflow from Young Australia 1.	Mine contact	33.9 ML	Young Australia 3
Young Australia 3	• Storage dam that receives runoff from adjoining dirty water catchment and overflow from Young Australia 2.	Mine contact	123.8 ML	Emergency spillway to Watercourse B

Notes: 1. The storage volume presented relates to the maximum volume available prior to the storage overflowing to a downstream storage or offsite. The volume of each water management dam has been estimated using LiDAR data obtained by PGM in January 2020.
2. Overflows from the New Cobar Complex settling pond can also be directed to NC4 via a surface drain.

5.4.3 Stormwater drainage

Stormwater drainage at the New Cobar Complex comprises internal and external channels and diversion bunds. Clean water from upstream catchments is diverted around the New Cobar Complex via a series of diversion drains and diversion bunds. Runoff generated within the New Cobar Complex is conveyed to the water management dams via stormwater channels. Stormwater drainage and diversion infrastructure is generally in accordance with:

- *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004); and
- *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008).

Key stormwater drainage infrastructure is shown in Figure 5.2.

5.4.4 Mine dewatering

Groundwater from the New Cobar Complex underground workings is managed by pumping from development headings to various underground pump stations. The water is then pumped to the New Cobar Complex settling pond for treatment (via sedimentation) prior to reuse underground or pumping to Peak Complex for reuse as process water.

Groundwater inflow rates to the New Cobar Complex underground workings have historically averaged between 4 to 8 L/s. However, groundwater inflows are variable with rates of less than 1 L/s up to 15 L/s observed over the 2018 to 2019 period (EMM 2020a).

5.4.5 Water supply

The New Cobar Complex (and wider PGM operation) has historically sourced water from Burrendong Dam for potable water supply and to supplement process water demand. This is accessed via a high security allocation from the Macquarie and Cudgegong Regulated Rivers Water Source. Water is transported from Burrendong Dam, 335 km south-east of Cobar, via the Macquarie River to Warren, and then via the Albert Priest Channel to Nyngan. From Nyngan, water is pumped via a pipeline to the CSC raw water tank on Fort Bourke Hill and then via the CSC distribution network to various customers (including PGM). Existing water licensing is described in Section 9.

Historically, approximately 550 ML/year of high security water from Burrendong Dam has been used as make up water for the New Cobar Complex and Peak Complex operations. PGM's allocation is about 1,200 ML/year, however due to transmission losses of roughly 50% (primarily as a result of evaporative and seepage losses along the Albert Priest Channel) this allocation converts to a usable supply at the mine of about 600 ML/year.

Groundwater that is dewatered from the New Cobar Complex underground workings is also used as a source of water. Dewatering water is preferentially used to supply process water demands. The high security supply from Burrendong Dam is required when the dewatering rate is less than mine process water requirements.

Following approval of the SoEE for the dewatering of the Great Cobar historical workings in 2019, up to 400 ML/year can be extracted to reduce reliance on water sourced from Burrendong Dam. This is as part of a move for PGM's operations to be more self-reliant and sustainable in times of drought. The water from the Great Cobar historical workings will be used to make up any shortfall in site demand that cannot be made up by dewatering of underground workings or from Burrendong Dam.

5.4.6 Process water use

Process water is used in the New Cobar Complex underground workings, for dust suppression of roads and stockpiles within the New Cobar Complex, and transferred to the Peak Complex for use in the Peak process water system. Process water is preferentially sourced as follows:

1. dewatering of groundwater inflows to the New Cobar Complex underground workings; and
2. external water sources such as Burrendong Dam or groundwater within the Great Cobar historic workings.

Historical flow records are available for transfers to the New Cobar Complex underground, dewatering from the New Cobar Complex underground, transfers to Peak Complex, and water demand from CSC. The process water demand for New Cobar Complex surface activities (ie dust suppression) is assumed to be the difference between recorded system inflows (raw water and underground dewatering) and recorded system outflows (New Cobar Complex underground and to Peak Complex).

Historic flow records at the New Cobar Complex between July 2019 to March 2020 are shown in Figure 5.3. The following average annual process water demands have been estimated from the historical flow data:

- New Cobar Complex underground workings – 80 ML/year;
- New Cobar Complex surface (dust suppression, wheel wash etc.) – 101 ML/year; and
- transferred to Peak Complex – 479 ML/year.

Process water that is used in the New Cobar Complex underground workings is pumped to the New Cobar Complex settling pond for reuse.

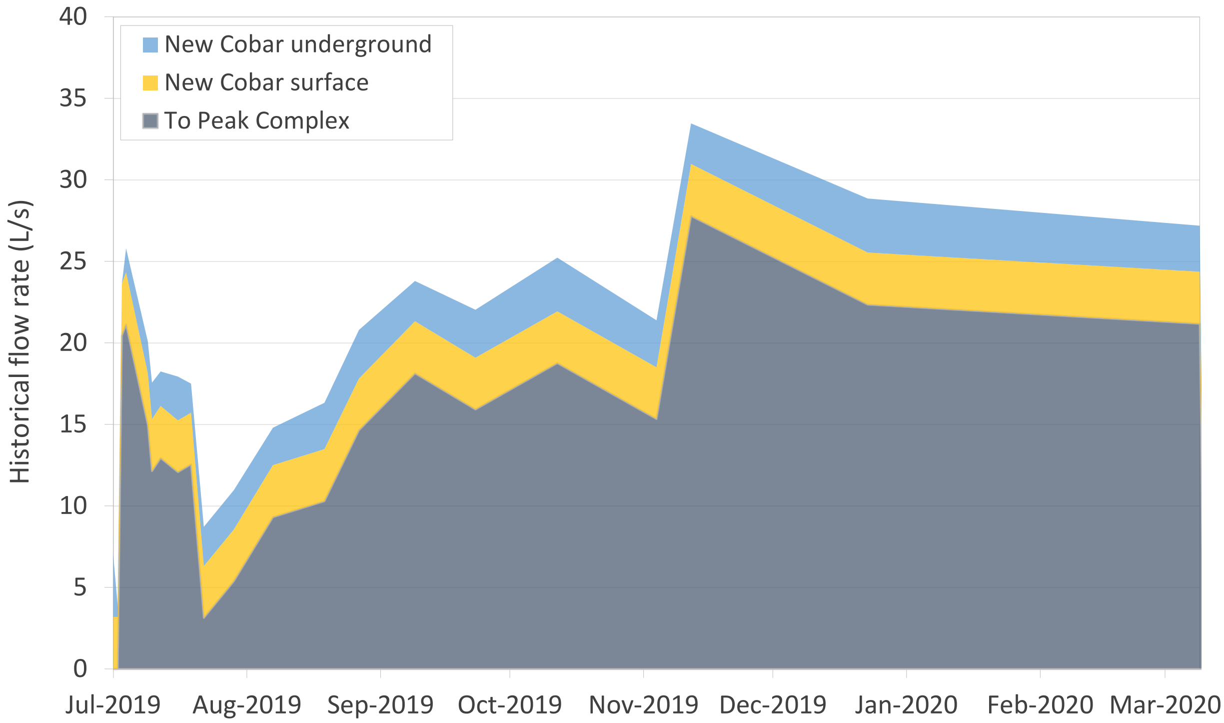


Figure 5.3 New Cobar Complex historical process water demand

5.4.7 Wastewater management

Wastewater is produced both above and below ground at the New Cobar Complex. Wastewater is managed as follows:

- Sewage from the New Cobar offices is treated at an onsite sewerage treatment plant comprising three 2 kL tanks that are serviced monthly and pumped out once a year to remove solids.
- Sewage from the New Cobar light vehicle workshop has a conventional septic tank which holds 3 kL. This tank is serviced monthly and pumped out twice a year to remove solids.
- Sewage produced underground is stored in two 1 kL tanks which are emptied and serviced every two weeks. Waste from the underground sewerage system is transferred to Peak Complex's sewerage treatment plant for disposal.

5.4.8 Erosion and sediment control

Erosion and sediment control measures are managed in accordance with PGMs Erosion and Sediment Control Plan (PGM 2016) and the following best practice guidelines:

- *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004); and
- *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008).

PGM implement the following steps to minimise the risk of erosion and sediment generation:

1. identify activities that could cause erosion and generate sediment;

2. describe the location, function and capacity of erosion and sediment control structures required to minimise soil erosion and the potential to transport sediment downstream; and

3. ensure erosion and sediment control structures are appropriately maintained.

Prior to surface disturbance or excavation, a "Permit to Disturb"/"Permit to Dig" is required to be submitted. The permit system ensures adequate erosion and sedimentation controls are identified and implemented prior to disturbance.

All major erosion and sediment control structures at the New Cobar Complex are described in the Erosion and Sediment Control Plan (PGM 2016). PGM manages these structures through regular inspections and preventative maintenance, as required.

5.5 Water quality characterisation

5.5.1 Water quality objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provide WQOs for catchments throughout NSW. WQO values are determined with consideration of receiving water environmental value and beneficial use. As no permanent watercourses exist in vicinity of the New Cobar Complex and downstream land use is primarily associated with livestock grazing, WQOs for livestock water supply are considered appropriate for receiving waters adjacent to and downstream of the project. WQO values for livestock water supply are established in Table 3.3.

Water quality data from the mine water management system and surface water monitoring network are compared against the WQOs for livestock water supply in the sections below. It should be noted the WQOs for livestock water supply are applicable to water quality downstream of the mine water management system rather than water contained within the water management system. The WQOs have been applied to water management system water quality for comparative purposes only.

5.5.2 Monitoring program

Water quality data is available from PGM's ongoing monitoring program. Water quality data for total suspended solids (TSS) and oil and grease are obtained as part of the New Cobar Complex EPL requirements (refer to Section 3.2.2). An extended water quality suite (including nutrients, major ions, and metals) is also sampled at some locations to provide further information on mine water quality to support operations.

Surface water quality monitoring locations are shown in Figure 5.2 and described in Table 5.5. The water quality parameters typically analysed in each monitoring event are provided in Table 5.6.

Table 5.5 Surface water quality monitoring

		Number of samples available	
Monitoring location	**Description**	**EPL suite[1]**	**Extended suite**
NC1	Sample taken from NC1 sediment basin.	-	1
NC2	Sample taken from NC2 sediment basin.	-	1
NC3	Sample taken from NC3 sediment basin.	-	1
NC4	Sample taken from NC4 sediment basin.	-	1
the Salty[2]	Sample taken from the Salty waterbody downstream of Spain's Dam.	-	2

Table 5.5 Surface water quality monitoring

Monitoring location	Description	Number of samples available EPL suite[1]	Number of samples available Extended suite
Spain's Dam	Sample taken from the western side of Spain's Dam.	46	13
Young Australia 1	Sample taken from Young Australia 1 water management dam.	15	-
Young Australia 2D	Sample taken from Young Australia 2D water management dam.	3	8
Young Australia 3	Sample taken from Young Australia 3 water management dam.	3	4
Young Australia Rehab	Sample taken from a rehabilitation area downstream of the Young Australia complex (comprised of Young Australia 1, 2 and 3).	-	1

Notes: 1. EPL suite relates to monitoring events where only TSS and oil and grease have been sampled.
2. Water quality at the Salty is monitored to provide an understanding of water quality downstream of the water management system.

Table 5.6 Analysis methods and parameters

Category	Monitoring analytes	Analysis method
Physico-chemical	pH, electrical conductivity, total suspended solids[1], total dissolved solids and oil and grease[1].	Analysis undertaken by NATA accredited laboratory
Alkalinity	Bicarbonate, carbonate, hydroxide and total alkalinity as $CaCO_3$.	
Nutrients	Nitrite (as N), nitrate (as N) and total oxidised nitrogen.	
Major ions	Calcium, chloride, sulphate, sodium, magnesium and potassium.	
Metals[2]	Arsenic (As), cadmium (Cd), total chromium (Cr), copper (Cu), lead (Pb), nickel (Ni) and zinc (Zn).	

Notes: 1. Analytes comprise the 'EPL suite'.
2. Whether total or dissolved metals has been sampled varies across monitoring rounds.

5.5.3 Water quality results

Water quality results from the monitoring program are described in the following tables and figures:

- Table 5.7 summarises water quality statistics for Spain's Dam and the Young Australia dams (Young Australia 1, 2 and 3). Only parameters that exceed WQO values (see Section 3.5.1) are presented.
- Figure 5.4 displays box and whisker plots[2] for key physico-chemical and major ion parameters. Where relevant, WQO values are also shown as a dotted grey line.
- Figure 5.5 displays box and whisker plots for metals that exceed WQO values (shown as a dotted grey line).

Water quality results and statistics for all locations and parameters are provided in Appendix A.

[2] The box (the rectangle) represents the data range for the middle 50% of values (the data between the first and third quartiles). The horizontal line in the middle of the box represents the median value. The whiskers represent the smallest and largest values within 1.5 times the interquartile range.

Table 5.7 Water quality characteristics – Spain's Dam and Young Australia dams

			Spain's Dam				Young Australia dams[1]			
Parameter	**Unit**	**WQO value[2]**	**Samples/ exceedances**	**Average[3]**	**Min**	**Max**	**Samples/ exceedances**	**Average[3]**	**Min**	**Max**
Physico-chemical										
Electrical conductivity	µS/cm	3,582	12/11	**11,185**	445	**15,900**	11/9	**10,092**	99	**17,800**
Total dissolved solids	mg/L	2,400	12/11	**7,465**	236	**11,800**	12/10	**6,744**	335	**10,800**
Major ions										
Sulphate	mg/L	1,000	12/11	**2,428**	111	**3,060**	12/10	**2,163**	17	**3,700**
Metals[4]										
Cadmium	mg/L	0.01	13/12	**0.048**	0.0001	**0.104**	12/8	**0.018**	BDL	**0.030**
Copper	mg/L	1	13/12	**10.55**	0.063	**26.3**	12/5	1.53	0.015	7.35
Lead	mg/L	0.1	13/5	0.088	0.004	**0.202**	12/1	0.031	BDL	**0.188**
Nickel	mg/L	1	13/2	0.667	0.004	**1.16**	12/-	0.298	BDL	0.496
Selenium	mg/L	0.02	2/1	**0.025**	0.01	**0.04**	1/0	0.010	0.01	0.01
Zinc	mg/L	20	13/1	11.12	0.016	**21.4**	12/0	4.01	BDL	7.11

Notes: 1. Young Australia dams comprises sampling locations 'Young Australia 1', 'Young Australia 2D' and 'Young Australia 3'.
2. WQO values are established in Section 3.5 and relate to ANZECC/ARMCANZ (2000) livestock watering default trigger values.
3. Average values are based on results above the detection limit values. This is because below detection limit (BDL) results were reported as zero.
4. Results include both dissolved and total metals.
BDL denotes 'below laboratory detection limit'.
Bold denotes the WQO value is exceeded.

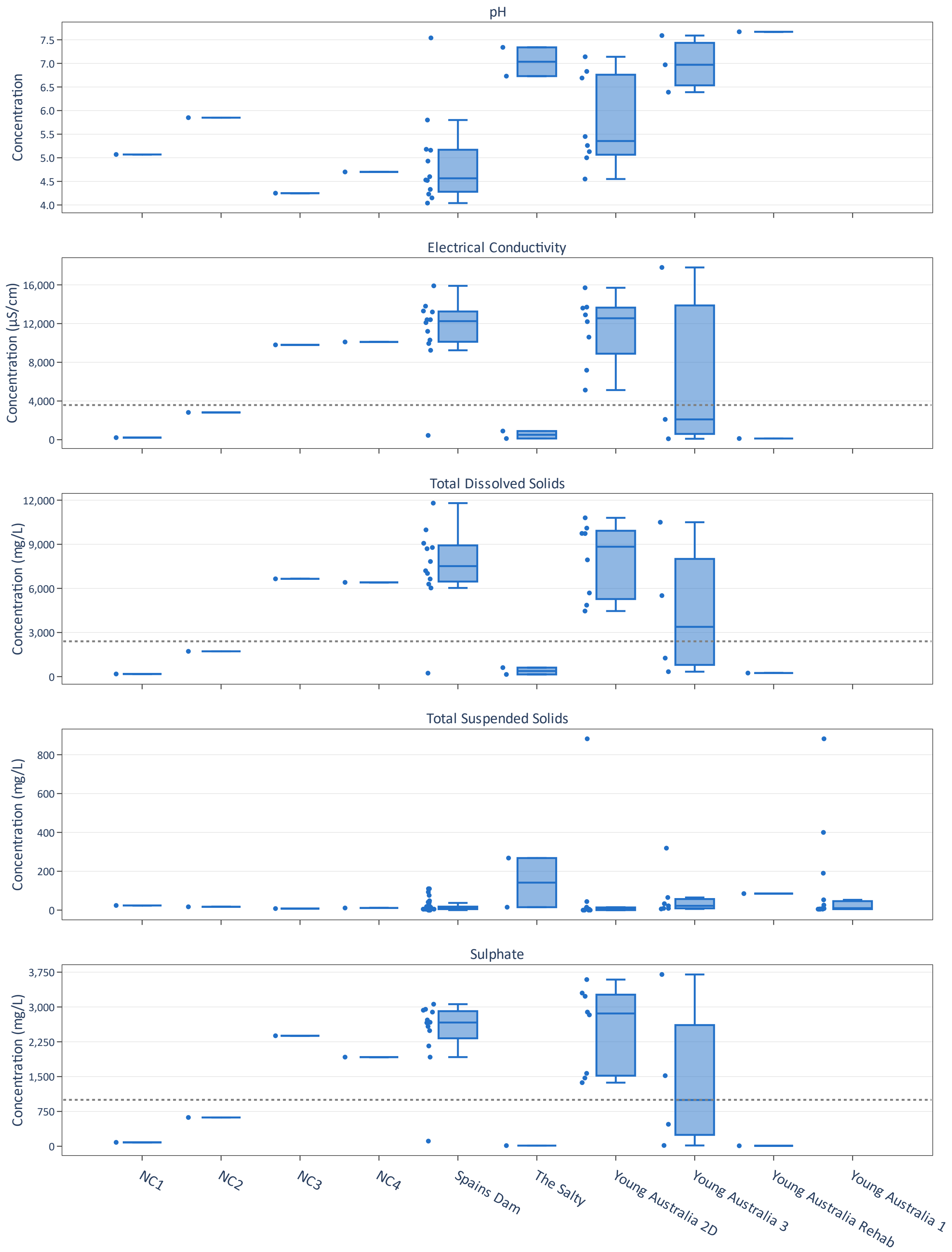


Figure 5.4 Water quality summary – general

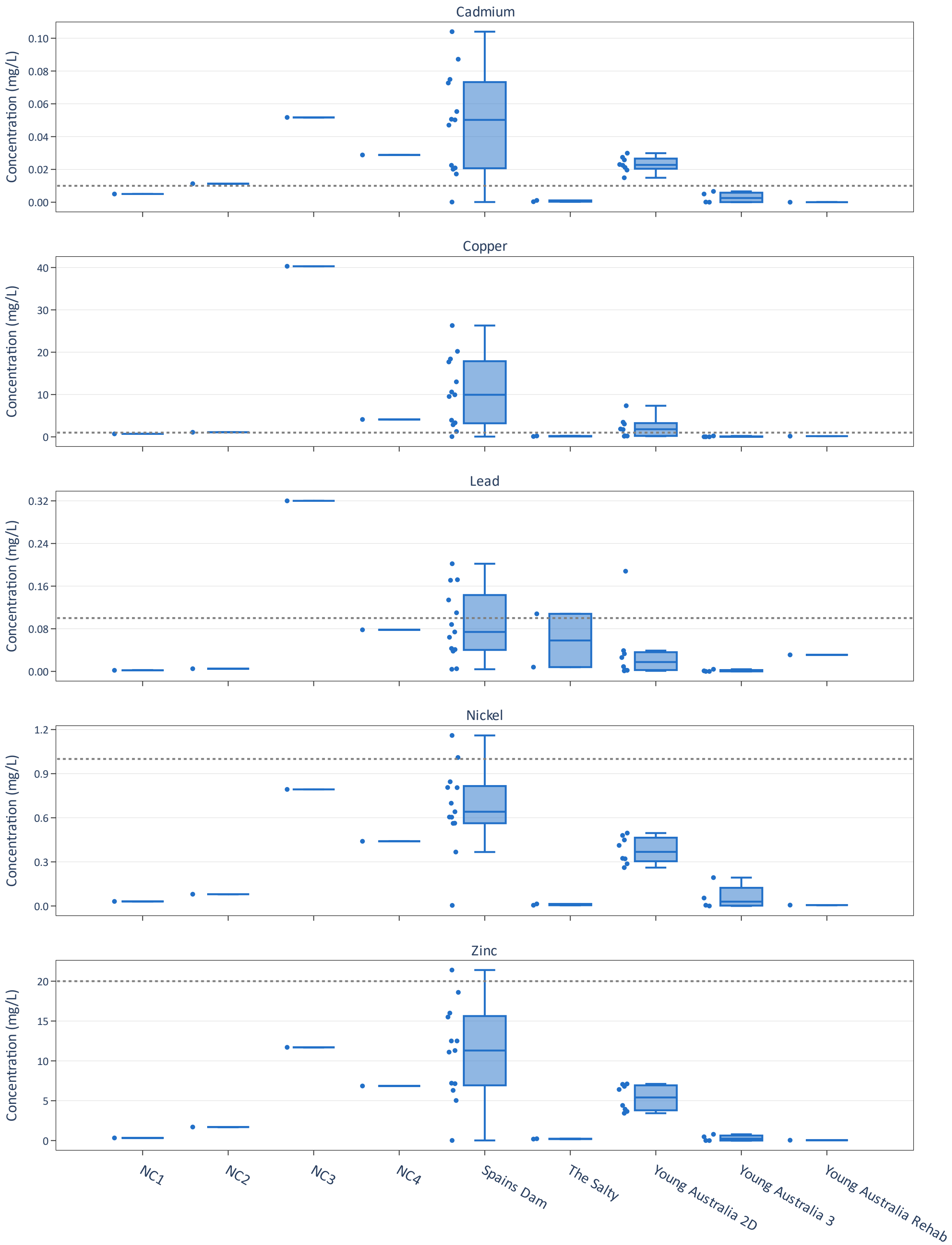


Figure 5.5 Water quality summary – metals

5.5.4 Water quality summary

The water quality results presented in Section 5.5.3 and Appendix A are summarised as follows:

- pH ranges between 4.0 and 7.7 and is generally found to be lower (more acidic) at Spain's Dam compared to the Young Australia dam locations. The Salty (downstream of the water management system), Young Australia 3, and Young Australia Rehab have near neutral pH (approximately a pH of 7).
- Salinity (as indicated by electrical conductivity) and total dissolved solids are elevated relative to WQO values in most mine contact water dam samples.
- TSS concentrations are generally similar across all locations. However, higher concentrations are occasionally observed at the Salty and Young Australia locations.
- Nitrate and nitrite concentrations are below WQO values in all samples.
- Calcium concentrations are below WQO values in all samples while sulphate concentrations frequently exceed WQO values in most mine contact water dams.
- Metal concentrations are generally below WQO values except for:
  - cadmium and copper exceed WQO values on a frequent basis in most mine contact water dams; and
  - lead, nickel, selenium and zinc exceed WQO values on an occasional basis at Spain's Dam. Lead is elevated in one New Cobar 3 and Young Australia 2D sample.

Water quality across the site is influenced by whether a waterbody receives mine contact water or not. Water management dams that receive mine contact water are shown to have higher electrical conductivity and concentrations of total dissolved solids, sulphate, and metals. Spain's Dam generally has the highest concentrations of these substances which may be attributed to it being the primary discharge point for excess mine process water.

The one sample taken at NC1 and NC2 is shown to generally be of better water quality than the other water management dams that receive mine contact water. The observed water quality (based on the one sample) at NC1 and NC2 is more typical of dirty water stormwater runoff than mine contact water.

Young Australia 2D generally experiences poorer water quality than Young Australia 3, indicating that water quality improves moving downstream in the Young Australia complex. Water quality improvements may be attributed to runoff from a broader catchment area diluting mine contact discharge, and/or the settlement of sediment as water passes through the series of water management dams.

The water quality of waterbodies that receive runoff from dirty water or rehabilitated catchments is generally within WQO ranges. This is also the case for the Salty which is located downstream of Spain's Dam and receives runoff from both a natural catchment and the Cobar town stormwater network which captures residential and industrial runoff. TSS concentrations are relatively high in one of the two samples taken at the Salty. TSS concentrations are often attributed with stormwater runoff from urban/developed areas. Water quality at the Salty is expected to be primarily influenced by runoff from the upstream stormwater network.

5.6 Site water balance

A site water balance has been developed for the New Cobar Complex water management system. The purpose of the model is to estimate site water transfers, assess the frequency and volume of discharges, and assess the reliability of water supply for the project. The water balance model is informed by:

- rainfall and evaporation data;
- groundwater inflow estimates that were established in the groundwater assessment (EMM 2020a); and
- the existing water management system described in Section 5.4.

Further details on the water balance model setup and assumptions are described in Appendix B.

5.6.1 Modelling approach

The water balance model applies a continuous simulation methodology that simulates the response of the water management system under a range of climatic conditions (ie rainfall and evaporation). A 57-year simulation period was adopted for the water balance model using daily rainfall and evaporation data from the Cobar MO (48027) rainfall gauge between 1963 and 2020. Two separate modelling approaches have been used to simulate the site water balance:

- Deterministic modelling approach – used to provide typical water balance results based on the average estimated groundwater inflow rate over the 12-year mine schedule. Results are presented in schematic format for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years.
- Probabilistic modelling approach – used to investigate the security of water supply in more depth. Probabilistic modelling simulates the water management system response for each individual year of the 12-year mine schedule using predicted groundwater inflow volumes. Results are presented as a time series.

i Mine dewatering

The groundwater assessment (EMM 2020a) estimates groundwater inflows to the New Cobar Complex underground workings and hence the volume of water that requires dewatering to the mine water management system. Several groundwater model scenarios were run to determine the sensitivity of the results to variations in assumed hydraulic parameters. Results from the groundwater model scenario that best match historical inflows are considered the most appropriate for estimating operational groundwater inflows to mine workings (EMM 2020a) and have been applied to the water balance model. The groundwater inflow timeseries applied to the water balance model is shown in Figure 5.6. The average groundwater inflow over the 12-year mine schedule is estimated to be 860 kL/day (10 L/s).

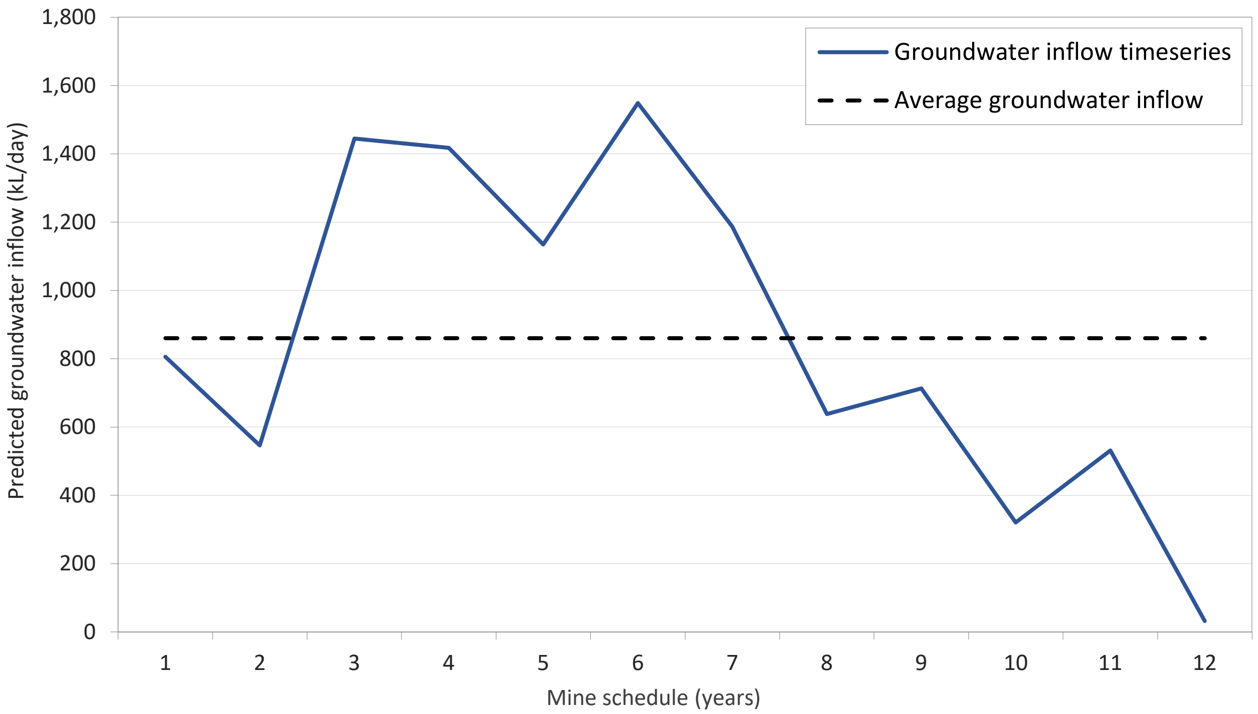


Figure 5.6 Groundwater inflow estimates (EMM 2020a)

ii External water supply

The water balance model sources external water supply on an as needs basis and is only required when the mine dewatering rate is less than mine process water requirements. This is in line with historical operations and how the mine will continue to be operated (refer to Section 5.4.5). The water balance model has been setup to determine the total external water supply required by the project. External water supply can be sourced from either the Great Cobar historical workings or Burrendong Dam.

5.6.2 Water balance results

Water balance model results for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years are presented in Figure 5.7, Figure 5.8 and Figure 5.9, respectively.

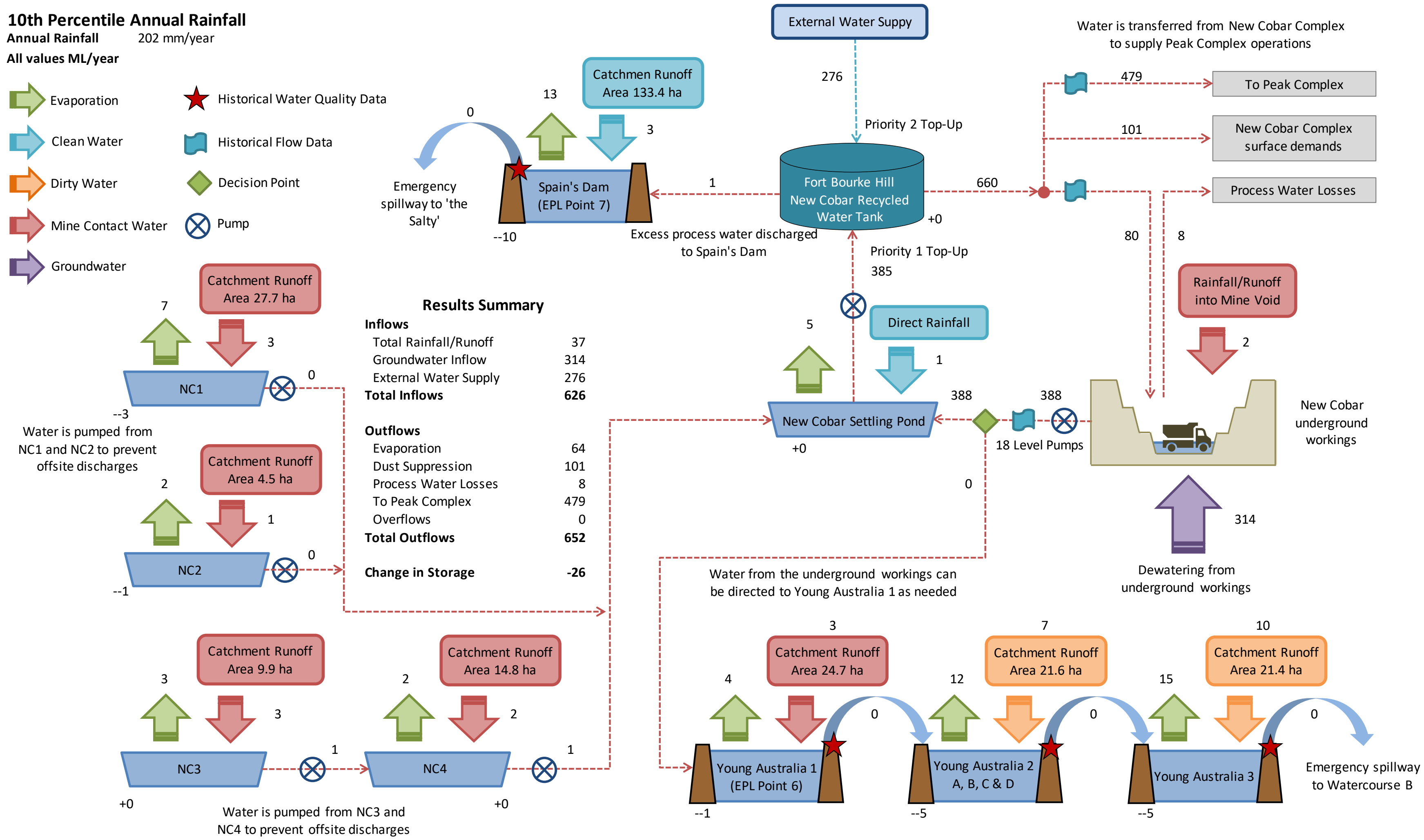


Figure 5.7 Water balance results for a typical dry rainfall year

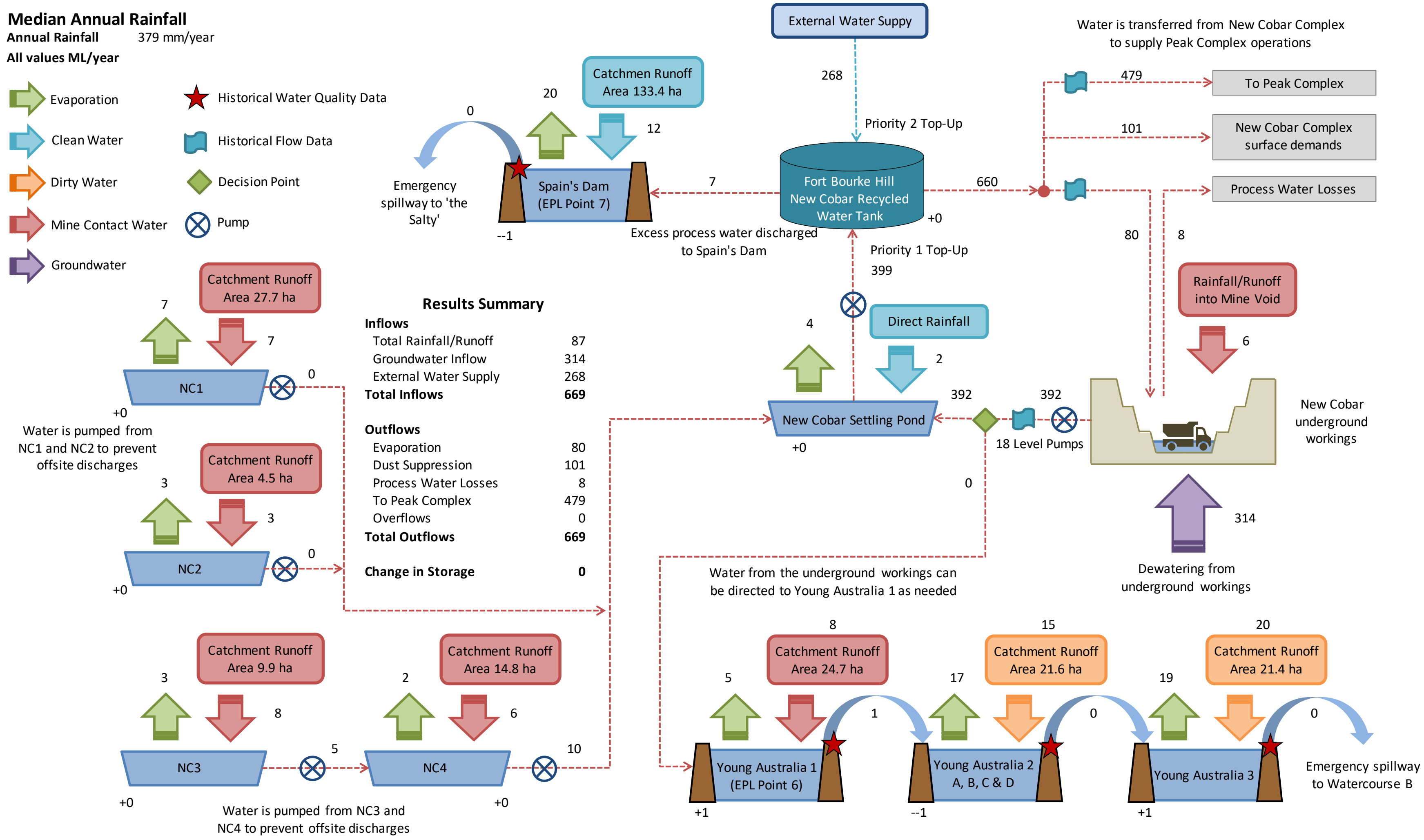


Figure 5.8 Water balance results for a typical median rainfall year

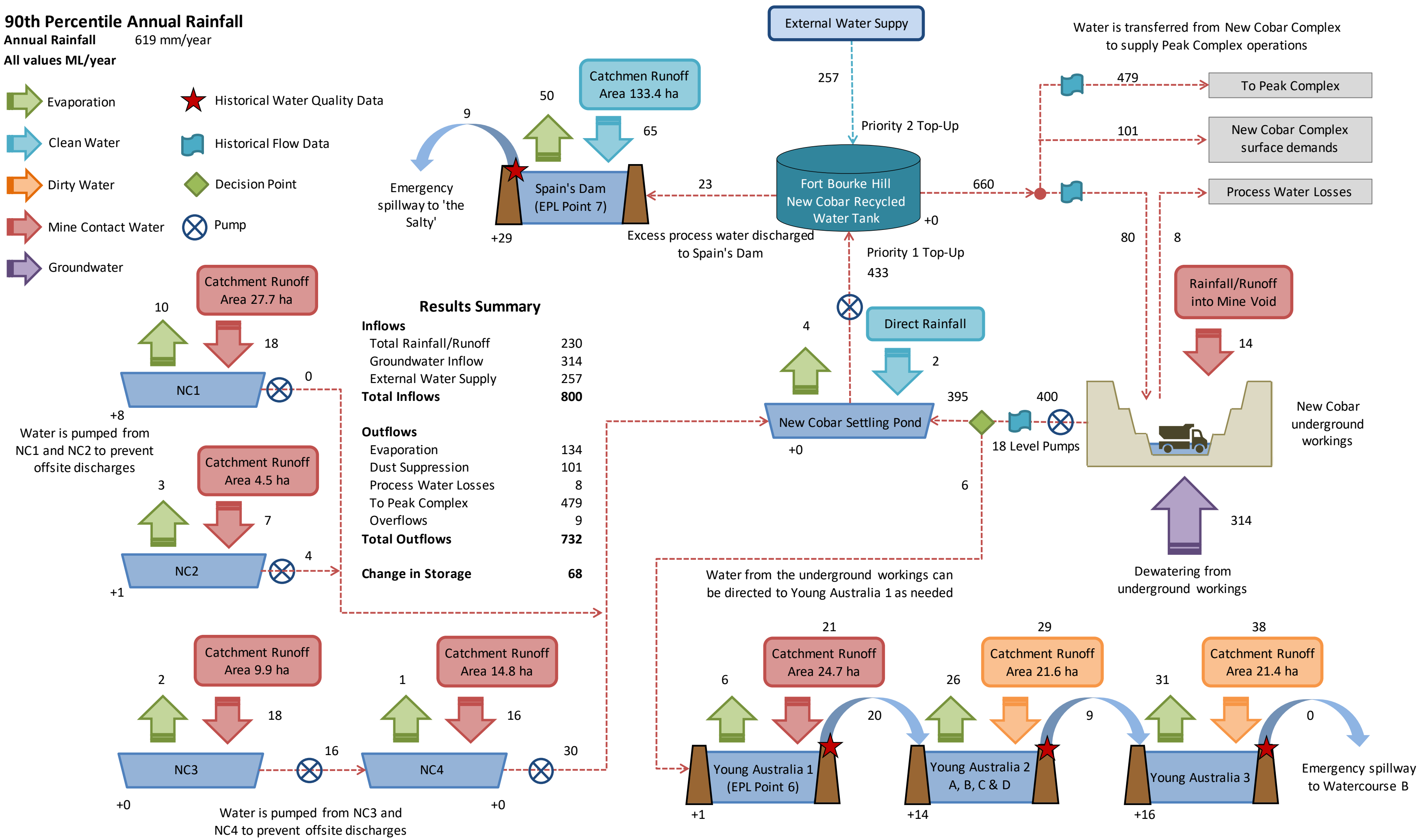


Figure 5.9 Water balance results for a typical wet rainfall year

i Site discharges

The water balance results show that no overflows occur for dry (10th percentile) and typical (median) annual rainfall conditions. During a typical wet year (90th percentile), overflows of 9 ML/year are expected to occur from Spain's Dam.

Overflows from Spain's Dam are a function of runoff from the adjacent catchment and the volume of excess water that is dewatered from the underground workings and discharged to the dams. Overflows from Spain's Dam are predicted to occur once every 10 years on average and are associated with extended periods of wet weather or significant rainfall events. Discharges due to mine dewatering volumes alone (ie in the absence of significant catchment runoff) are not expected to occur.

ii Reliability of water supply

The water balance results show external water supply falls in a fairly tight range from 257 ML/year in a wet (90th percentile) year to 276 ML/year in a dry (10th percentile) year. To better understand the reliability of water supply, the water balance model was used to undertake a probabilistic assessment of water demands over the 12-year mine schedule.

The probabilistic assessment involved simulating the New Cobar Complex water management system over the 12-year mine schedule with the inclusion of the groundwater inflow time series shown in Figure 5.6. A total of 57 model runs were undertaken where each run commenced at a different year within the 57-year climate record from the Cobar MO (48027) rainfall gauge between 1963 and 2020. Simulating the 12-year mine schedule from different starting points within the historical climate sequence allows for a more robust assessment of the water management system under varying climatic conditions.

The assessment generates outputs as percentiles that represent the probability of a particular result occurring during a specific year of the 12-year mine schedule. The probabilistic model results for the external water supply demand are shown in Figure 5.10. The results are presented as the range between the minimum and 10th percentile, 10th percentile and 15th percentile, 15th percentile and median, median and 85th percentile, 85th percentile and 90th percentile, and 90th percentile and maximum values.

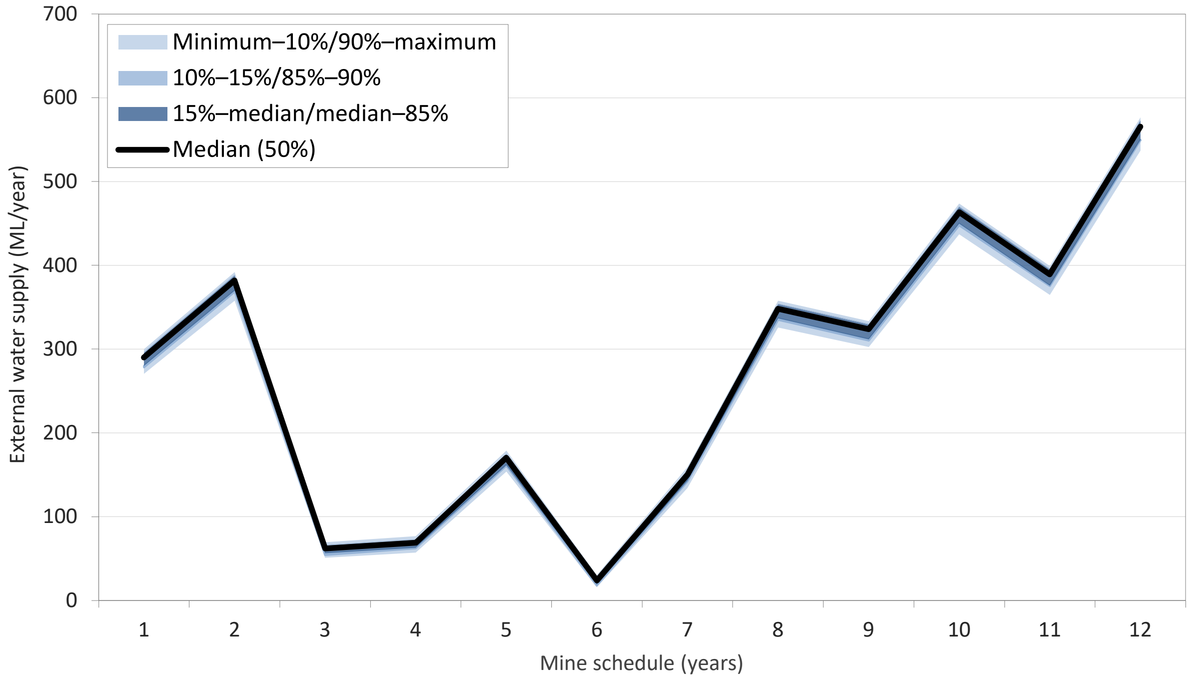


Figure 5.10 Required water supply from external source

The results in Figure 5.10 show the reliance on external water demand will be greater in the second half of the proposed mine schedule. This is due to the predicted decrease in groundwater inflow (which is dewatered to the surface for use as process water) as mining progresses. The maximum volume of water that would need to be sourced externally is estimated as 577 ML/year and occurs in year 12 of the mine schedule.

The results in Figure 5.10 also show the modelled external water supply experiences low variability as the percentile bands cover a narrow range for each year of the mine schedule.

External water supply can be sourced by dewatering the Great Cobar historical workings and from Burrendong Dam (refer to Section 5.4.5). As the volume of water in the Great Cobar historical workings is groundwater dependent, an assessment of the Great Cobar historical workings water supply reliability is provided in the groundwater assessment (EMM 2020a). The assessment determined that water stored in the Great Cobar historical workings is sufficient to supply external water requirements for the project in the absence of the Burrendong Dam water source. The assessment concluded that risks associated with water supply security for the project are low.

As PGM hold high security access to water from Burrendong Dam, their water allocation is expected to be available in all but severe drought periods. The effective storage of Burrendong Dam dropped below 5% of capacity during the 2019 drought and allocation of high security water to all entitlement holders was reduced to 80% as a result. Hence, an effective storage volume of 5% has been used to identify periods of low water availability in Burrendong Dam. It is noted this storage volume threshold is unlikely to prevent access to water altogether but rather, based on previous water determinations, may result in curtailment of allocations.

Historical storage levels in Burrendong Dam were obtained from the BoM Water Data Online website (BoM 2020) for the period 1967 to 2020. Review of the data shows Burrendong Dam experienced less than 5% effective storage on three separate occasions over the 53-year period between 1967 and 2020. The probability of Burrendong Dam having less than 5% effective storage is approximately 5% in any given year of the mine schedule, assuming historic data is representative of future conditions.

The security of water supply including water available in the Great Cobar historical workings and Burrendong Dam is discussed in Section 9.4.

5.7 Water management during construction

Water management during any construction works, including erosion and sediment control, is undertaken in accordance with *Managing Urban Stormwater: Soils and Construction: Volume 1 – Soils and construction* (Landcom 2004) and PGM's Erosion and Sediment Control Plan (PGM 2016).

6 Flooding

6.1 Overview

This section provides a summary of existing flood characteristics at the New Cobar Complex, potential flood impacts resulting from the project and describes flood risk considerations and proposed controls. A flood assessment for the project is provided in Appendix C.

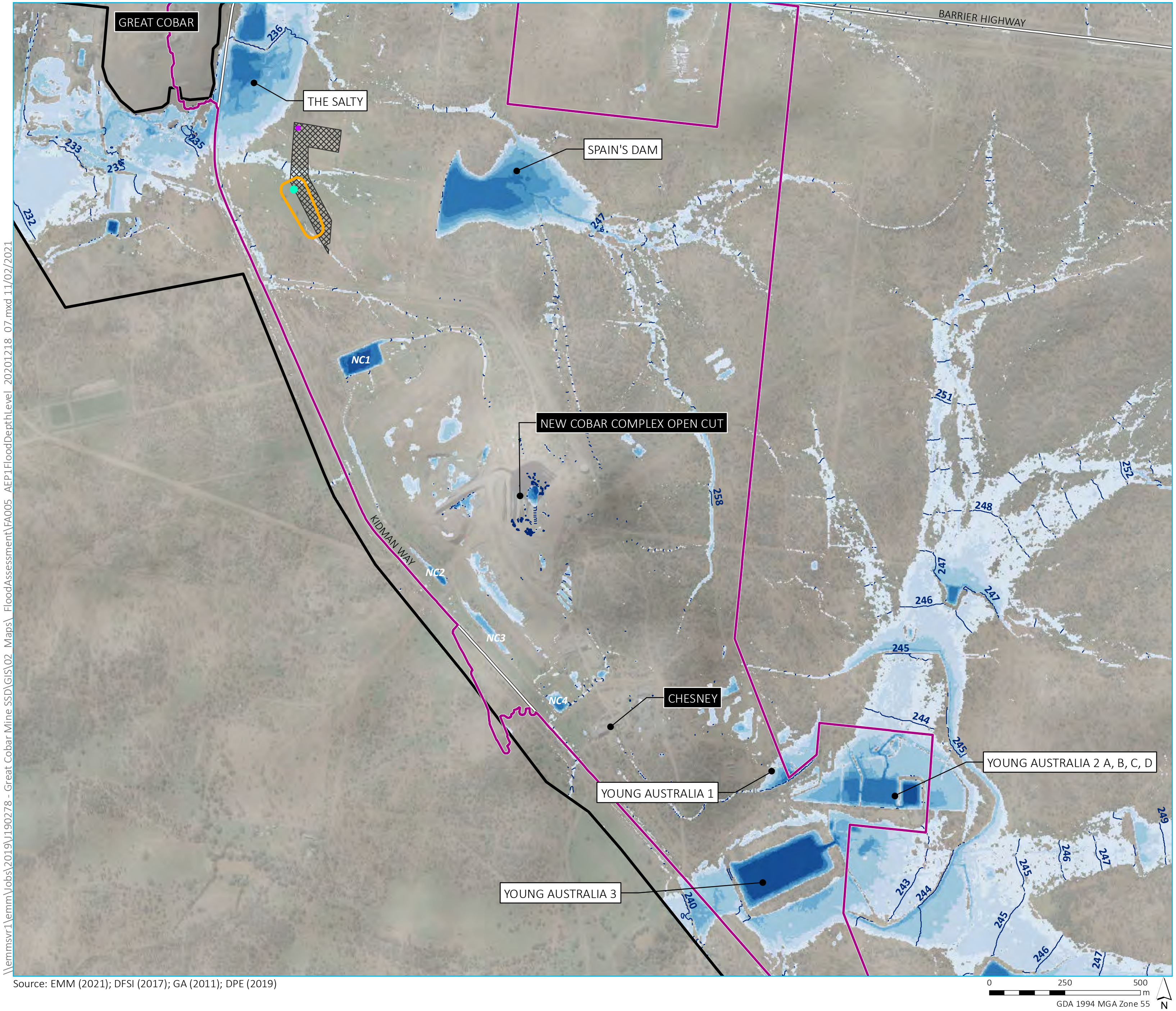
6.2 Existing flood characteristics

Flooding in vicinity of the New Cobar Complex is generally comprised of shallow overland sheet flow. Due to the flat terrain and low rainfall totals, drainage lines do not typically have a well-defined channel. Consequently, concentrated flows are typically wide and shallow with low velocities (less than 1 m/s). Flooding is generally associated with shorter duration storm events, where flood levels rise and fall rapidly (in the order of minutes to hours, rather than days).

The majority of surface infrastructure associated with the New Cobar Complex is located on top of a ridgeline and is unaffected by flooding from local watercourses. Flooding from the catchment upstream of the Young Australia dams overtops the diversion bunds that form the northern and eastern boundary of the New Cobar Complex water management system. This results in the inundation of the Young Australia 2 and Young Australia 3 water management dams. Floodwaters that enter the site area are attenuated by the water management dams, decreasing the peak flow downstream (ie across Kidman Way). The remainder of the New Cobar Complex is relatively unaffected by flooding away from defined drainage lines and some isolated low points in the terrain that receive local runoff.

Runoff from the catchment to the north of the New Cobar Complex drains through the Salty before traversing Kidman Way and discharging to Newey Reservoir. Flooding is primarily contained to the watercourse (the Salty) and overbank area and does not inundate the general area of the proposed power line or other New Cobar Complex infrastructure.

Runoff from within the New Cobar Complex is managed via the existing stormwater drainage network (see Section 5.4.3) with no material offsite discharges occurring from the stormwater drainage network for events up to and including the 1% AEP design flood event. Existing 1% AEP flood conditions at the New Cobar Complex are shown in Figure 6.1.



Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

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1% AEP flood depth and level

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure 6.1

EMM
creating opportunities

6.3 Flood impacts

A single powerline is proposed to supply power for the fan and emergency egress at the Great Cobar deposit. The powerline easement will be approximately 20 m wide and up to 400 m long. A pad mounted substation and an emergency winder is proposed at the fresh air intake. However, the footprint of permanent above ground infrastructure (and hence potential for flood impacts) is expected to be minimal. No other surface infrastructure is proposed as part of the project.

Some minor overland flows are shown to traverse the general area of the proposed powerline for the 1% AEP flood event (see Figure 6.1). No material flooding is shown to occur within the general area of the proposed powerlines.

No flood impacts are anticipated as:

- no material flooding is shown to currently occur within the general area of proposed powerline; and
- permanent infrastructure associated with the proposed powerline is expected to have negligible footprint within the flood extent.

6.4 Flood risk management

The following flood risks are relevant to the project:

- potential for floodwater to mix with mine contact water; and
- flood risk to staff and equipment.

6.4.1 Risk of mixing floodwater and mine contact water

The risk of floodwater mixing with mine contact water and then discharging offsite is low for most of the New Cobar Complex. This is due to limited inflows from upstream catchments and adequately sized water management dams (to capture runoff from mine operational areas).

Inundation of the Young Australia 2 and Young Australia 3 water management dams occurs as a result of floodwaters overtopping the upstream diversion bunds. This additional volume of floodwater that enters the dams increases the risk of discharging mine contact water downstream to Watercourse B during a flood event.

The water quality data presented in Section 5.5 identifies that water stored within the water management system exceeds livestock water supply DGVs for electrical conductivity, total dissolved solids, sulphate and some metals. Floodwaters that mix within the water management dams may also contain similar concentrations of these water quality parameters. The risk of water quality impacts to Watercourse B as a result of floodwaters mixing with mine contact water is low as:

- floodwaters that enter the site are contained within the water management dams for flood events up to and including 5% AEP, so the expected frequency of discharge is low;
- floodwaters that enter the site during floods that are larger in magnitude than 5% AEP are attenuated within the water management dams, reducing the overall volume of potentially mine impacted water that may discharge downstream; and
- mine contact water is expected to rapidly mix with floodwaters during a large flood event due to the significant volume of runoff that would occur both upstream of the New Cobar Complex and downstream into Watercourse B.

The volume of mine contact water that is stored within the Young Australia 2 and Young Australia 3 water management dams as a result of the project is not expected to be substantially different to that under existing operations. Hence, no impacts to flood regimes are anticipated.

Flood management controls to reduce the risk of floodwaters entering the site and mixing with mine contact water are described in Section 6.4.3 and Table 7.3. Surface water quality impacts associated with operation water management are described in Section 7.3.

6.4.2 Risk to life and equipment

Kidman Way is expected to be inundated to the north and south of the New Cobar Complex during a significant flood event. The inundation of Kidman Way is anticipated to be short-term, with the duration of any disruption likely measured in hours, rather than days. Due to its location on a ridgeline, the New Cobar Complex has sufficient flood refuge and shelter for staff to gather should the mine become cut-off during flooding.

Flooding within the New Cobar complex is primarily contained within defined drainage lines and some isolated low points of the terrain that receive local runoff. There is minimal risk to equipment within most of the New Cobar Complex. No active operations occur in vicinity of the Young Australia 2 and Young Australia 3 water management dams. Hence, there is a low risk of equipment becoming damaged should flooding inundate this area.

The flood immunity of the fresh air intake and exhaust air rise should be considered given the proximity to the watercourse that drains through the Salty.

Runoff to the New Cobar open cut is primarily associated with excess rainfall occurring within the open cut footprint. Runoff that ponds within the New Cobar open cut is dewatered to the surface to maintain underground access. Flooding of the New Cobar open cut is mitigated via this dewatering process.

6.4.3 Proposed controls

The following controls are proposed to reduce potential flood risks:

- where practical, upstream diversion drains will be sized to convey flows resulting from the 5% AEP flood event as per *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008);
- water management dams are to be routinely desilted to maintain adequate flood detention storage;
- the level of the fresh air intake and exhaust air rise will be constructed above the probable maximum flood level, which is estimated to be about 800 mm above existing ground level at the fresh air intake and 150 mm above existing ground level at the exhaust air rise;
- equipment will be stored outside of areas affected by substantial flooding, such as adjacent to Young Australia 2 and Young Australia 3; and
- sufficient flood refuge will be maintained for the length of the proposed mine schedule.

7 Surface water impacts

7.1 Overview

This section describes impacts to the surface water environment resulting from the project. The performance of the water management system against WQOs and RFOs is assessed. Mitigation measures and residual impacts are described.

7.2 Surface water quantity

7.2.1 Overflow characteristics

Surface water discharge from the New Cobar Complex will occur due to overflows from Spain's Dam. The circumstances that lead to overflows from Spain's Dam include significant rainfall events and extended wet periods. A summary of the circumstances that may result in overflows from the New Cobar Complex is provided in Table 7.1.

Table 7.1 Summary of overflow characteristics

Circumstance for overflow	Overflow description	Source of water	Applicable water management dam(s)
Overflows during a significant rainfall event	Overflows will occur during and shortly after rainfall events when total runoff exceeds the volume of Spain's Dam. Once Spain's Dam is full, overflows will occur at the same rate as inflows.	Excess mine dewatering water and runoff from upstream catchment.	Spain's Dam
Overflows during extended wet periods	Overflows will occur during extended wet periods when there is not sufficient time to restore the capacity (via evaporation or pump out) of Spain's Dam between small rainfall events.	Excess mine dewatering water and runoff from upstream catchment.	Spain's Dam

7.2.2 Streamflow regimes

Most of the New Cobar Complex water management dams are not predicted to experience overflow or discharges as a result of the project. This is due to existing clean water diversions minimising the contributing catchment to water management storages, the preferential use of mine dewatering water as process water, the use of pumps to dewater storages prior to overflows occurring, and the relatively large available storage capacity within the Young Australia dams.

Water balance modelling indicates an overflow of 9 ML/year will occur from Spain's Dam in a typical wet year (90th percentile). This equates to approximately one overflow event occurring every 10 years on average. Hence, the risk of Spain's Dam discharging more than once during the 12-year mine schedule is considered low. The volume and frequency of overflows from Spain's Dam are expected to be similar to existing conditions.

Existing management measures to reduce the risk of overflows from Spain's Dam mean that discharges are only predicted to occur as a result of significant rainfall or an extended wet period (refer to Table 7.1). During these wet weather events, overflows from Spain's Dam would combine with stormwater runoff from the town industrial area at the Salty prior to entering Watercourse A, downstream of Kidman Way. Impacts to the streamflow regimes in Watercourse A are not anticipated as:

- overflows are expected to occur infrequently (on average once every 10 years) and for a short period of time (one to two days); and

- overflows from Spain's Dam would be small compared to stormwater runoff volumes from the 16 km^2 catchment that drains to the Salty upstream of Watercourse A.

Impacts to other downstream watercourses are not expected as overflows are not predicted to occur from the rest of the New Cobar Complex water management infrastructure.

7.2.3 Construction phase impacts

Runoff regimes from disturbed construction areas may be materially different from undisturbed areas due to a change in land use associated with hardpacked or impervious areas. Generally, the frequency and volume of runoff will increase for the disturbed area.

Due to the relatively small disturbance footprint and short construction times, increases to streamflow volume and discharge rates during the construction of the proposed surface infrastructure are expected to be insignificant compared to runoff from the broader catchment.

7.3 Surface water quality

The water quality data presented in Section 5.5 identifies that water stored within the water management system exceeds livestock water supply DGVs for electrical conductivity, total dissolved solids, sulphate and some metals. Overflows from the water management system may also contain similar concentrations of these water quality parameters.

As described in Section 7.2.2, overflows from Spain's Dam are predicted to occur during a 90th percentile rainfall year, or approximately once every 10 years on average. Overflows from Spain's Dam are expected to mix rapidly with runoff from the town industrial area and broader catchment that drains to the Salty. Residual water quality impacts associated with overflows from Spain's Dam are considered to be minor and short-term as overflows are:

- expected to occur infrequently (on average once every 10 years) and for a short period of time (one to two days);

- predicted to coincide with substantial runoff from the town industrial area and broader catchment resulting in rapid mixing immediately downstream of the dam (ie in the Salty); and

- expected to have a similar discharge regime to existing conditions resulting in no additional risk or impact to downstream water quality.

Water quality impacts to other downstream watercourses are not expected as overflows are not predicted to occur from the rest of the New Cobar Complex water management infrastructure.

7.3.1 Construction phase impacts

Ground disturbance associated with the construction of the proposed surface infrastructure may increase concentrations and loads of suspended solids, nutrients and metals in runoff. Impacts to receiving watercourses may occur if runoff from disturbed areas is left unmitigated. As described in Section 5.7, construction activities will be undertaken in accordance with *Managing Urban Stormwater: Soils and Construction: Volume 1 – Soils and construction* (Landcom 2004) and PGM's Erosion and Sediment Control Plan (PGM 2016) to limit the potential for downstream impacts.

Impacts to water quality due to runoff from disturbed areas are considered minor and manageable with the proposed management measures in place. Any residual impacts to downstream water quality during construction will only occur short-term, during construction period.

7.4 Assessment against WQOs and RFOs

It is expected that WQO values for electrical conductivity, total dissolved solids, sulphate and some metals may be exceeded along Watercourse A downstream of the New Cobar Complex should overflows from Spain's Dam occur. As overflows from Spain's Dam are only predicted to occur due to intense rainfall or an extended wet period, water that is discharged from Spain's Dam is expected to rapidly mix with runoff from the broader catchment downstream of the dam. The infrequent occurrence and short duration of overflows from Spain's Dam are not anticipated to materially change or degrade the water quality of Watercourse A or immediate downstream areas. Furthermore, as the project is predicted to have similar discharge regimes to the existing New Cobar Complex operations, the project is not expected to increase the existing risk to water quality.

The performance of the New Cobar Complex water management system against the WQOs and RFOs identified as applicable to the project in Section 3.5 is assessed in Table 7.2.

Table 7.2 Potential impacts to water quality and river flow objectives

Environmental value	Objective	Potential impacts
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	No impacts to the water quality of Newey Reservoir are anticipated as overflows from Spain's Dam are predicted to be infrequent, short-term and rapidly mix with runoff from the broader catchment.
Visual amenity	Aesthetic qualities of waters.	No impacts to the visual amenity of Watercourse A and Newey Reservoir are anticipated as overflows from Spain's Dam are predicted to be infrequent, short-term and rapidly mix before flowing downstream of the Salty. In particular, overflows are not expected to have elevated concentrations of oils, suspended solids, petrochemicals, floating debris or nuisance organisms such as algae.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	No impacts to secondary or primary contact recreation activities of Newey Reservoir are expected as overflows from Spain's Dam are predicted to be infrequent, short-term and rapidly mix before flowing downstream of the Salty. In particular, overflows are not expected to have elevated concentrations of faecal coliforms, enterococci or protozoans as there is no source of these pollutants within the mine water management system.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Impacts to livestock water supply may occur due to Spain's Dam overflows or as a result of floodwaters mixing with mine contact water and then discharging offsite. Discharges may exceed the WQOs for electrical conductivity, total dissolved solids, sulphate and some metals.

Table 7.2 Potential impacts to water quality and river flow objectives

Environmental value	Objective	Potential impacts
		Overflows from Spain's Dam and discharges associated with flooding are anticipated to occur infrequently, be short-term and rapidly mix with surface water runoff from the broader catchment. Hence, any impacts to livestock water supply are anticipated to be infrequent, minor in consequence and only occur short-term.
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	The Newey Reservoir is an ephemeral waterbody. Although use of the waterbody for recreational fishing is unknown, recreational fishers could use the waterbody. However, no impacts to the water quality of Newey Reservoir are anticipated as overflows from Spain's Dam are predicted to be infrequent, short-term and rapidly mix with runoff from the broader catchment.
River flow objectives		
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	No water take from surface water sources is proposed. Overflows from Spain's Dam are expected to occur infrequently (approximately once every 10 years on average) and be similar to existing overflow characteristics. Hence, no impacts to the river flow objectives are anticipated.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	

7.5 Residual impacts

This section describes residual impacts and summarises the residual risks to the surface water environment. For each potential surface water related impact identified, Table 7.3:

- identifies the surface water affecting activity and potential risk/effect;
- lists the existing and proposed mitigation controls and actions; and
- provides an assessment of the residual risk.

Table 7.3 Mitigation measures and residual risk

Impact	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
Surface water quantity	• Construction activities	• Increase to hardpacked or impervious areas resulting in increased runoff from construction areas.	• Construction of proposed surface infrastructure will be undertaken in accordance with *Managing Urban Stormwater: Soils and Construction: Volume 1 – Soils and construction* (Landcom 2004) and PGM's Erosion and Sediment Control Plan (PGM 2016).	**Low** – management measures expected to mitigate impacts to the receiving surface water environment during construction.
	• Water management storages	• Overtopping of water management dams altering downstream flow regimes.	• PGM to implement a program of sequential desilting of all dams in the New Cobar Complex as part of an operation works program to reinstate and maintain full storage capacities. • Maximise the reuse of water from onsite storages – site water is preferentially and regularly reused onsite. • Pumps are implemented to dewater storages before overtopping can occur. • Diversion drains to be maintained to minimise the volume of stormwater runoff from upstream catchments entering the water management system. • Spain's Dam water level will be monitored to inform operational decisions and validate water balance predictions. • Redirection of excess mine dewatering water to Young Australia dams as needed to reduce risk of overflows from Spain's Dam.	**Low** – ongoing maintenance and management measures are used to maintain the volume of stored water in water management storages. Overflows from Spain's Dam predicted to occur once every 10 years on average.
	• Mine dewatering	• Mine dewatering rate exceeds capacity of the water management system. • Discharges from mine water management system alter downstream flow regimes.	• Mine dewatering water is preferentially used as process water. • Mine dewatering rates will continue to be monitored and used to validate the groundwater and water balance model. • Water Management Plan to address management measures to be implemented if mine dewatering rates exceed predicted rates.	**Low** – ongoing monitoring will be used to identify periods of higher mine groundwater inflow and appropriate management measures will be implemented.

Table 7.3 Mitigation measures and residual risk

Impact	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
Surface water quality	• Construction activities	• Surface disturbance during construction increasing concentrations and loads of suspended solids, nutrients, and metals in runoff.	• Construction of proposed surface infrastructure will be undertaken in accordance with *Managing Urban Stormwater: Soils and Construction: Volume 1 – Soils and construction* (Landcom 2004) and PGM's Erosion and Sediment Control Plan (PGM 2016).	**Low** – management measures expected to mitigate impacts to the receiving surface water environment during construction.
	• Mine contact water storages	• Overtopping of water management dams resulting in water quality impacts to downstream receiving environment.	• PGM to implement a program of sequential desilting of all dams in the New Cobar Complex as part of an operational works program to reinstate and maintain full storage capacities. • Maximise the reuse of water from onsite storages – site water is preferentially and regularly reused onsite. • Pumps are implemented to dewater storages before overtopping can occur. • Diversion drains to be maintained to minimise the volume of stormwater runoff from upstream catchments entering the water management system. • Spain's Dam water level will be monitored to inform operational decisions and validate water balance predictions. • Redirection of excess mine dewatering water to Young Australia dams as needed to reduce risk of overflows from Spain's Dam.	**Low** – ongoing maintenance and management measures are used to maintain the volume of stored water in water management storages. Overflows from Spain's Dam predicted to occur once every 10 years on average.
	• Mine dewatering	• Mine dewatering rate exceeds capacity of the water management system. • Discharges from mine water management system may exceed receiving environment WQOs, impacting downstream water quality.	• Mine dewatering water is preferentially used as process water. • Mine dewatering rates will continue to be monitored and used to validate the groundwater and water balance model. • Water Management Plan to address management measures to be implemented if mine dewatering rates exceed predicted rates.	**Low** – ongoing monitoring will be used to identify periods of higher mine groundwater inflow and appropriate management measures will be implemented.

Table 7.3 Mitigation measures and residual risk

Impact	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
	• Built infrastructure (roads, buildings, plant)	• Runoff may contain elevated concentrations and loads of suspended solids and nutrients.	• The stormwater management system directs surface water runoff from the existing mine disturbance area to water management storages for evaporation or reuse as process water. • Stormwater infrastructure will be maintained under PGM's Water Management Plan.	**Low** – stormwater infrastructure to be maintained to provide adequate drainage.
	• Hazardous goods storage (containment failure)	• Runoff may contain hydrocarbons and other chemical pollutants.	• Existing bunded storage areas for fuel, reagents, and other hazardous materials.	**Low** – hazardous goods storage isolated from surrounding area.
Flooding	• Mine contact water storages	• Mixing of flood waters and mine contact water resulting in water quality impacts to downstream receiving environment.	• PGM to implement a program of sequential desilting of all dams in the New Cobar Complex as part of an operational works program to reinstate and maintain full storage capacities. • Where practical, upstream diversion drains will be sized to convey flows resulting from the 5% AEP flood event as per *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008).	**Low** – water management infrastructure to be maintained to provide adequate flood protection.
	• Infrastructure located in flood extent	• Risk to life and equipment.	• Where practical, upstream diversion drains will be sized to convey flows resulting from the 5% AEP flood event as per *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008). • fresh air intake and exhaust air rise to be constructed above the probable maximum flood level. • Equipment stored outside of areas affected by substantial flooding, such as adjacent to Young Australia 2 and Young Australia 3. • Sufficient flood refuge will be maintained for the length of the proposed mine schedule.	**Low** – infrastructure and equipment to be located outside of flood extent where practical. Flood refuge provided.

8 Surface water monitoring

8.1 Overview

A surface water monitoring program for the New Cobar Complex is described in PGM's existing WMP. This section addresses updates to the WMP and describes a surface water monitoring program to be implemented as part of the New Cobar Complex Project.

8.2 Water Management Plan

A WMP is in place for PGM's existing Cobar operations, including the New Cobar Complex. The WMP is a sub-plan of the environmental management system and was most recently reviewed in May 2020 and distributed to NRAR at the time with no response received to date. The WMP documents the proposed mitigation and management measures for approved activities, and includes the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies and responsibilities for management measures.

The WMP will be updated in consultation with DPIE Water, NRAR and NSW EPA and will consider concerns raised during the exhibition and approvals process for the project. The WMP will outline the compliance reporting requirements against each of the project approvals. The existing EPL 3596 will be reviewed for adequacy against the project.

A summary of the surface water monitoring program to be implemented as part of the updated WMP is provided in Section 8.3. Groundwater monitoring is described in the groundwater assessment (EMM 2020a).

8.3 Monitoring program

Surface water monitoring at the New Cobar Complex is currently undertaken in accordance with PGM's existing WMP. Surface water monitoring is required to satisfy the requirements of EPL 3596 and to inform operational decisions. The objectives of the monitoring program are to collect data to:

- identify and quantify water take and water transfers;
- assess the effectiveness of water quality controls and broader water management system;
- identify and quantify water quality impacts; and
- assess compliance against relevant consent and licence conditions.

A summary of surface water monitoring to be implemented for the project is provided below. Further details of the surface water monitoring program will be included in the updated WMP.

8.3.1 Water quantity monitoring

Water take and transfer volumes are metered for key components of the New Cobar Complex water management system. Surface water transfers to be monitored as part of the project are described in Table 8.1.

Table 8.1 Monitoring of surface water transfers

Monitoring component	Objective	Monitoring description
Dewatering from New Cobar Complex underground	• Calculate volume of water take from groundwater sources for licencing purposes and to refine numerical groundwater model.	PGM to continue metering of water transfers. Flow meters are to be read on a weekly basis.
Process water from Fort Bourke Hill Tank to New Cobar underground	• Determine volume of process water use in underground workings to inform operational decisions.	
Water take from CSC (Burrendong Dam supply)	• Calculate volume of water take from Burrendong Dam for licencing purposes.	
Water take from Great Cobar historic underground workings	• Calculate volume of water take from Great Cobar historic underground workings for licencing purposes and to inform operational decisions.	
Discharge from Fort Bourke Hill Tank to Spain's Dam	• Understand the risk of Spain's Dam discharging overflowing due to the inflow of excess mine dewatering water.	
Spain' Dam water level.	• Understand the rainfall runoff relationship from the Spain's Dam catchment. • Understand the risk of Spain's Dam overflowing and inform operational decisions to redirect water to Young Australia dams.	
Discharge from New Cobar Complex settling ponds to Young Australia dams.	• Calculate the volume of water that is discharged to Young Australia dams to inform operational decisions.	
Process water transfer to Peak Complex	• Determine volume of process water transferred to Peak Complex to inform operational decisions.	

8.3.2 Water quality monitoring

Surface water quality monitoring is to be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (EPA 2004). Surface water quality monitoring locations are shown in Figure 5.2. The proposed sampling frequency at each location is provided in Table 8.2. The proposed suite of analytes and monitoring methods are presented in Table 8.3.

Table 8.2 Surface water quality monitoring locations and frequency

Monitoring location	Expected water quality	Proposed monitoring frequency	EPL monitoring frequency
Spain's Dam	Mine contact	Bi-annual	Annually when discharging
NC1	Mine contact	Annually	Not required
NC2	Mine contact	Annually	Not required
NC3	Mine contact	Annually	Not required
NC4	Mine contact	Annually	Not required
Young Australia 1	Mine contact	Bi-annual	Annually when discharging
Young Australia 2	Mine contact	Annually	Not required
Young Australia 3	Mine contact	Annually	Not required

Table 8.2 Surface water quality monitoring locations and frequency

Monitoring location	Expected water quality	Proposed monitoring frequency	EPL monitoring frequency
The Salty	Dirty water[1]	Annually	Not required

Notes: 1. Water stored in the Salty is considered 'dirty' as it receives runoff from the Cobar town stormwater network, including industrial land use areas.

Table 8.3 Surface water quality monitoring analytes

Category	Proposed sampling analytes	Analysis method
Physico-chemical properties	pH, electrical conductivity, temperature	Analysis to be undertaken by a NATA certified laboratory or measured in situ using a water quality meter.
	Total suspended solids, oil and grease	Analysis to be undertaken by a NATA certified laboratory.
Major ions	Calcium and sulphate	Analysis to be undertaken by a NATA certified laboratory.
Nutrients	Nitrate, nitrite, oxidised nitrogen	Analysis to be undertaken by a NATA certified laboratory.
Metals	Arsenic, cadmium, chromium, copper, lead, nickel, and zinc	Analysis to be undertaken by a NATA certified laboratory.

9 Water licencing and security

9.1 Overview

This section discusses the surface water licensing requirements for the project and includes a description of existing water licences held by PGM. Groundwater licencing requirements are described in the groundwater assessment (EMM 2020a).

9.2 Existing water access licence

PGM hold several existing WALs and approvals to extract surface water and groundwater. PGM's surface water allocation for Burrendong Dam is jointly held with several other mining operations in and around Cobar. PGM currently hold licences to extract:

- 620 ML/year of groundwater from the Lachlan Fold Belt Murray Darling Basin Groundwater Source under WAL31045; and
- approximately 1.2 GL/year of surface water from a shared allocation of 4.15 GL/year from the Macquarie and Cudgegong Regulated Rivers Water Source. Licence holders include all members of the Cobar Water Board (includes CSC, CSA Mine and Endeavour Mine). As described in Section 5.4.5, due to transmission losses PGMs allocation converts to a usable supply of about 600 ML/year.

Existing WALs and water supply work approvals relevant to the New Cobar Complex are presented in Table 9.1.

Table 9.1 Water access licences and approvals

Water access licence	Water supply work approval	Allocation	Source
WAL31045[1]	85WA752827	620 Units	Lachlan Fold Belt Murray Darling Basin Groundwater Source
WAL36334[2]	80WA704315	1,189 Units (High Security)	Macquarie and Cudgegong Regulated Rivers Water Source
WAL36335[2]	80WA704315	542.4 Units (High Security)	Macquarie and Cudgegong Regulated Rivers Water Source
WAL36336[2]	80WA704315	813.6 Units (High Security)	Macquarie and Cudgegong Regulated Rivers Water Source
WAL36337[2]	80WA704315	1,605 Units (High Security)	Macquarie and Cudgegong Regulated Rivers Water Source

Notes: 1. Peak Gold Mines Pty Ltd.
2. Holders: Peak Gold Mines Pty Ltd, Cobar Operations Pty Ltd, Acelight Pty Limited, Isokind Pty Limited.

9.3 Surface water licence requirements

9.3.1 Licencing estimates

Surface water licencing requirements have been estimated using the water balance model described in Section 5.6. A maximum of 577 ML/year is required to be sourced from an external surface water supply (see Section 5.6.2ii). The maximum external water supply volume will only be required in years where the groundwater dewatering rate is not meeting mine water demands. In this case the existing 1.2 GL (600 ML after accounting for transmission losses) of shared surface water allocation from Burrendong Dam is sufficient to cover the required volume of water.

9.3.2 Surface water management dams

Surface water runoff from the New Cobar Complex is captured in the water management dams. Captured surface water runoff is either used as process water within the mine operation or lost to evaporation.

The capture of surface water runoff in the water management dams is considered to be excluded works under *Water Management (General) Regulation 2011*, Schedule 1, item 3 (dams solely for the capture, containment or recirculation of drainage). Accordingly, no WALs are required for the capture of surface water runoff within the New Cobar Complex.

9.4 Water security

Water supply for the project will be sourced from the dewatering of groundwater inflows to the underground excavations, water stored within the Great Cobar historic workings, and via a high security water allocation from Burrendong Dam. Water supply from Burrendong Dam will only be required if mine dewatering rates are less than mine water demands.

The water balance model results provided in Section 5.6.2 indicate a maximum of 577 ML/year will need to be sourced from either the Great Cobar historic workings or Burrendong Dam in year 12 of the mine schedule. This is due to the predicted decrease in groundwater inflows as mining progresses and hence dewatering water available for use in mining processes. External water supply requirements for the first eight years of the mine schedule are substantially less with a maximum predicted volume of 30 ML/year required in year 6 of the mine schedule.

PGM hold a high security water access licence to Burrendong Dam which historically has enabled access to full water allocations in all but severe drought periods. PGM's water allocation to Burrendong Dam has been reduced to 80% of entitlement (ie about 960 ML/year) in recent history when Burrendong Dam has dropped below an effective storage volume of 5%. For a similar scenario in the future, and accounting for transmission losses, an approximate volume of 480 ML/year is expected to be available to supply the project under low water availability conditions. Review of historical data (refer to Section 5.6.2ii) indicates the probability of Burrendong Dam experiencing low water availability (ie less than 5% effective storage) in any given year of the mine schedule is approximately 5%.

Water balance model results indicate water security associated with Burrendong Dam is of low risk to the project based on historical observed storage volumes between 1967 and 2020. Water availability within Burrendong Dam may be impacted as a result of future climate variability beyond the recent historic range, or future climate change. The NSW Office of Environment and Heritage (OEH) climate change snapshot (OEH 2014) provides 'near future' (2020–2039) and 'far future' (2060–2079) climate change projections for regions of NSW. The proposed 12-year mine schedule falls within the 'near future' timeframe. The OEH climate change snapshot indicates the following 'near future' changes for central and far western NSW:

- minimum and maximum daily temperatures are projected to increase;
- the number of hot days (temperatures above 35°C) are projected to increase; and
- autumn rainfall is projected to increase while spring rainfall is projected to decrease.

While an increase in autumn rainfall has the potential to increase water availability in Burrendong Dam at this time of year, reduced rainfall during spring and increased evaporation rates as a result of higher temperatures and more hot days are expected to negatively impact water availability. Higher evaporation rates may also lead to an increase in the transmission losses associated with water transfers from Burrendong Dam to Cobar.

Following approval of the SoEE for the dewatering of the Great Cobar historic workings in 2019, up to 400 ML/year can be extracted to reduce reliance on the Burrendong Dam high security supply. This is as part of a move for PGM's operations to be more self-reliant and sustainable in times of drought. Water stored within the Great Cobar historical workings is groundwater dependent and as such is less susceptible to variations in climate.

The project groundwater model and maximum external water supply requirements presented in Figure 5.10 have been used to assess the reliability of water supply from the Great Cobar historical workings. This is documented in EMM 2020a, but summarised here for context. The objective of the assessment was to determine whether water stored within the existing Great Cobar underground workings (and accessed via the Great Cobar historical workings) would be sufficient to supply external water requirements for the project in the absence of the Burrendong Dam water source.

Several uncertainty analysis runs were undertaken using the groundwater model to establish the sensitivity of water supply to variations in the assumed Great Cobar underground void dimensions (and hence available storage and predicted inflow rates). This included simulating a range of potential Great Cobar void volumes from 0.4 to 2.8 GL (the best-estimate volume is approximately 1.6 GL). Water security is assessed by monitoring the response of modelled water level in the void due to water extraction at various rates during mining.

The Great Cobar void was shown not to dry out in any of the modelled scenarios including the scenario with 0.4 GL of available storage volume. This indicates that there is still additional water available in the most conservative scenario, thus suggesting the risk associated with water security for the project is low. The Great Cobar historical workings water source is also expected to be far less sensitive to potential variability in future climate (due to its groundwater origin) than surface water systems in the region, which further strengthens the climate resilience of the proposed water supply strategy for the project.

10 Conclusion

A surface water assessment has been undertaken to assess the potential impacts of the project on surface water resources. The surface water assessment has considered the impacts the project may have to the receiving water environment with consideration of the relevant SEARs and the *NSW Water Quality and River Flow Objectives* (DECCW 2006). Potential flood impacts and risk have also been addressed. Residual impacts associated with the project include:

- All except one of the water management structures are not anticipated to discharge or overflow to the downstream receiving environment over the life of the project.
- Overflows from Spain's Dam are predicted to occur on average once every 10 years. Overflows from Spain's Dam are expected to occur due to intense rainfall or prolonged wet periods when substantial rainfall and runoff would be experienced across the Cobar region. Hence, no significant impacts to streamflow regimes are expected.
- The water quality of Spain's Dam overflows may exceed WQOs for electrical conductivity, total dissolved solids, sulphate and some metals. Residual impacts to downstream water quality are considered minor and short-term. This is due to the low predicted frequency of overflows and rapid mixing that would occur with runoff from surrounding areas, including industrial areas of Cobar, prior to discharging downstream of the project area.
- Most of the New Cobar Complex is unaffected by flooding. No impacts to local flood characteristics are expected as a result of proposed surface infrastructure.
- Flood management controls are proposed to reduce or eliminate potential flood risk to life and equipment for areas of the New Cobar Complex that are subject to flooding.
- Some mixing of floodwaters and mine contact water is expected to occur. However, the risk of water quality impacts to downstream watercourses is considered low as floodwaters that enter the site are detained within water management dams for more frequent flood events (up to 5% AEP) and rapid mixing of waters is expected in larger flood events (1% AEP and greater magnitude floods).
- Water requirements for PGM will be met by dewatering of underground workings and reuse of water onsite (60% of requirement), and external sources (40% of requirement) comprising dewatering from the Great Cobar historic workings and drawing from an existing high security allocation from Burrendong Dam.
- Water supply security is of low risk to the project as water supply from the Great Cobar historic workings is predicted to meet external water supply requirements should high security water supply from Burrendong Dam be unavailable due to severe drought.

The assessed residual impacts are expected to be similar to those of the existing New Cobar Complex operations. Hence, any additional risk or potential impacts to the receiving environment as a result of the project are anticipated to be minor.

PGM will continue to monitor water usage, mine dewatering volumes, water transfers and surface water quality. Additionally, water level monitoring within Spain's Dam will be undertaken to further inform operational water management. Monitoring each component of the water management system will inform when management responses are required. Monitoring of groundwater inflows will be used to validate mine dewatering estimates.

Triggers and thresholds will be reviewed and updated to provide context on if, how, and when management measures are required as part of the revised WMP.

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Abbreviations and units

Abbreviation/symbol	Definition
µS	micro-siemens
AEP	annual exceedance probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation
ANZG	Australian and New Zealand Government
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARR2019	Australian Rainfall and Runoff, 2019 edition (Ball et al 2019)
bgl	below ground level
BoM	Bureau of Meteorology
CAF	cemented aggregate fill
cm	centimetre
CML	consolidated mining lease
CSC	Cobar Shire Council
DGV	default guideline value
DPIE	Department of Planning, Industry and Environment
EC	electrical conductivity
EIS	environmental impact statement
EMM	EMM Consulting Pty Ltd
EPA	Environment Protection Authority
EPL	environment protection licence
ETL	electricity transmission line
GDE	groundwater dependent ecosystem
GL	gigalitre
km	kilometres
kV	kilovolt
L	litre
LEP	Local Environmental Plan
m	metre
mm	millimetre
mg	milligram
ML	megalitre
ML	mining lease
MOP	mining operation plan
MPL	mining purposes lease

Abbreviation/symbol	Definition
NAF	non-acid forming
NRAR	Natural Resources Access Regulator
NSW	New South Wales
NWQMS	National Water Quality Management Strategy
PAF	Potentially acid forming
PGM	Peak Gold Mines Pty Ltd
POEO Act	Protection of the Environment Operations Act 2007
ROM	run of mine
SAG	semi-autogenous grinding
SEARs	Secretary's Environmental Assessment Requirements
SILO	Scientific Information for Land Owners
SoEE	Statement of Environmental Effects
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2011
SSD	State Significant Development
SSTV	site-specific trigger value
t	tonne
TDS	total dissolved solids
tpa	tonnes per annum
TSF	tailings storage facility
TSS	total suspended solids
WAL	water access licence
WM Act	Water Management Act 2000
WMP	Water Management Plan
WQO	water quality objective
WRE	waste rock emplacement

Appendix A

Water quality data

Table A.1 Water quality summary – one off samples

Parameter	Unit	WQO value	New Cobar 1	New Cobar 2	New Cobar 3	New Cobar 4	The Salty		Young Australia Rehab
Date			**4/01/2019**	**4/01/2019**	**4/01/2019**	**4/01/2019**	**12/12/2017**	**2/08/2019**	**11/04/2019**
Physico-chemical									
pH (Lab)	-	-	5.07	5.85	4.25	4.7	6.73	7.34	7.67
Electrical conductivity	µS/cm	3,582	217	2,820	**9,800**	**10,100**	898	124	124
Oil and Grease	mg/L	-	-	-	-	-	-	-	-
Total suspended solids	mg/L	-	24	17	8	11	15	268	85
Total Dissolved Solids	mg/L	2,400	180	1,720	**6,650**	**6,410**	612	148	243
Hardness as $CaCO_3$	mg/L	-	-	-	-	-	-	-	46
Nutrients									
Kjeldahl nitrogen	mg/L	-	-	-	-	-	-	-	-
Nitrite (as N)	mg/L	30	0.02	0.06	BDL	0.11	0.01	0.08	0.09
Nitrate (as N)	mg/L	400	0.81	3.41	1.11	5.56	0.09	0.65	0.73
Oxidised nitrogen	mg/L	-	0.83	3.47	1.11	5.67	0.1	0.73	0.82
Nitrogen (total)	mg/L	-	-	-	-	-	-	-	-
Phosphorus	mg/L	-	-	-	-	-	-	-	-
Reactive phosphorus as P	mg/L	-	-	-	-	-	-	-	BDL
Alkalinity									
Bicarbonate as $CaCO_3$	mg/L	-	-	-	-	-	-	-	48
Carbonate as $CaCO_3$	mg/L	-	-	-	-	-	-	-	BDL
Hydroxide as $CaCO_3$	mg/L	-	-	-	-	-	-	-	BDL
Alkalinity (total) as $CaCO_3$	mg/L	-	-	-	-	-	-	-	48
Major ions									
Calcium	mg/L	1,000	19	171	412	280	-	15	15

Table A.1 Water quality summary – one off samples

Parameter	Unit	WQO value	New Cobar 1	New Cobar 2	New Cobar 3	New Cobar 4	The Salty		Young Australia Rehab
Date			**4/01/2019**	**4/01/2019**	**4/01/2019**	**4/01/2019**	**12/12/2017**	**2/08/2019**	**11/04/2019**
Chloride	mg/L	-	-	-	-	-	53	-	2
Magnesium	mg/L	-	-	-	-	-	-	-	2
Potassium	mg/L	-	-	-	-	-	-	-	4
Sodium	mg/L	-	-	-	-	-	-	-	2
Sulphate	mg/L	1,000	84	620	**2,380**	**1,920**	-	14	10
Anions Total	meq/L	-	-	-	-	-	-	-	1.22
Cations Total	meq/L	-	-	-	-	-	-	-	1.1
Ionic Balance	%	-	-	-	-	-	-	-	-
Metals									
Antimony	mg/L	-	-	-	-	-	BDL	-	-
Arsenic	mg/L	0.5	BDL	0.002	0.016	0.007	0.002	0.002	0.002
Cadmium	mg/L	0.01	0.005	**0.0113**	**0.0517**	**0.0288**	0.0011	0.0003	BDL
Chromium (III+VI)	mg/L	1	BDL	BDL	BDL	BDL	0.001	0.002	0.011
Copper	mg/L	1	0.707	**1.08**	**40.3**	**4.11**	0.093	0.212	0.168
Iron	mg/L	-	-	-	-	-	-	-	10.9
Lead	mg/L	0.1	0.002	0.005	**0.32**	0.078	0.008	**0.108**	0.031
Manganese	mg/L	-	-	-	-	-	0.13	-	-
Mercury	mg/L	0.002	-	-	-	-	BDL	-	-
Nickel	mg/L	1	0.031	0.08	0.793	0.44	0.014	0.005	0.006
Selenium	mg/L	0.02	-	-	-	-	BDL	-	-
Zinc	mg/L	20	0.329	1.7	11.7	6.85	0.23	0.185	0.045

Table A.2 Water quality summary – long-term data

Parameter	Unit	WQO value	Spain's Dam				Young Australia complex[1]			
			Samples/ exceedances	Average	Minimum	Maximum	Samples/ exceedances	Average	Minimum	Maximum
Physico-chemical										
pH (Lab)	-	-	12/-	4.9	4.04	7.54	11/-	6.1	4.55	7.59
Electrical conductivity	µS/cm	3,582	12/11	**11,185**	445	**15,900**	11/9	**10,092**	99	**17,800**
Oil and Grease	mg/L	-	57/-	5.9	BDL	22	32/-	BDL	BDL	BDL
Total suspended solids	mg/L	-	54/-	19.7	BDL	110	33/-	105	BDL	882
Total Dissolved Solids	mg/L	2,400	12/11	**7,465**	236	**11,800**	12/10	**6,744**	335	**10,800**
Hardness as $CaCO_3$	mg/L	-	-	-	-	-	-	-	-	-
Nutrients										
Kjeldahl nitrogen	mg/L	-	1/-	4.3	4.3	4.3	-	-	-	-
Nitrite (as N)	mg/L	30	12/0	0.1	BDL	0.21	12/0	BDL	BDL	1.05
Nitrate (as N)	mg/L	400	12/0	5.1	BDL	11.9	12/0	1.8	0.01	14.2
Oxidised nitrogen	mg/L	-	13/-	5.7	BDL	12.1	12/-	1.9	0.01	15.3
Nitrogen (total)	mg/L	-	1/-	14.5	14.5	14.5	-	-	-	-
Phosphorus	mg/L	-	1/-	0.0	0.01	0.01	-	-	-	-
Reactive phosphorus as P	mg/L	-	-	-	-	-	-	-	-	-
Alkalinity										
Bicarbonate as $CaCO_3$	mg/L	-	12/-	19.3	BDL	51	11/-	42.7	BDL	100
Carbonate as $CaCO_3$	mg/L	-	12/-	BDL	BDL	BDL	11/-	BDL	BDL	BDL
Hydroxide as $CaCO_3$	mg/L	-	12/-	BDL	BDL	BDL	11/-	BDL	BDL	BDL
Alkalinity (total) as $CaCO_3$	mg/L	-	12/-	19.3	BDL	51	11/-	42.7	BDL	100
Major ions										
Calcium	mg/L	1,000	12/0	333.8	40	505	12/0	354	8	858

Table A.2 Water quality summary – long-term data

Parameter	Unit	WQO value	Spain's Dam				Young Australia complex[1]			
			Samples/ exceedances	Average	Minimum	Maximum	Samples/ exceedances	Average	Minimum	Maximum
Chloride	mg/L	-	13/-	2,764	26	4,160	11/-	2,616	11	4,600
Magnesium	mg/L	-	12/-	332	10	525	11/-	325	3	588
Potassium	mg/L	-	12/-	41	28	65	11/-	45.5	7	130
Sodium	mg/L	-	12/-	1,563	15	2,370	11/-	1,525	10	2,500
Sulphate	mg/L	1,000	12/11	**2,428**	111	**3,060**	12/10	**2,163**	17	**3,700**
Anions Total	meq/L	-	12/-	128	4.06	181	11/-	121	1	209
Cations Total	meq/L	-	12/-	113	4.19	173	11/-	112	1.26	203
Ionic Balance	%	-	12/-	6.7	1.5	11.4	10/-	4.55	1.34	8.6
Metals										
Antimony	mg/L	-	2/-	0.002	BDL	0.002	-	-	-	-
Arsenic	mg/L	0.5	13/0	0.009	0.001	0.02	12/0	0.007	BDL	0.023
Cadmium	mg/L	0.01	13/12	**0.048**	0.0001	**0.104**	12/8	**0.018**	BDL	**0.0299**
Chromium (III+VI)	mg/L	1	13/0	0.002	BDL	0.003	12/0	0.038	BDL	0.038
Copper	mg/L	1	13/12	**10.55**	0.063	**26.3**	12/5	1.53	0.015	7.35
Iron	mg/L	-	-	-	-	-	-	-	-	-
Lead	mg/L	0.1	13/5	0.088	0.004	**0.202**	12/1	0.031	BDL	**0.188**
Manganese	mg/L	-	2/-	9.16	6.81	11.5	-	-	-	-
Mercury	mg/L	0.002	2/0	BDL	BDL	BDL	-	-	-	-
Nickel	mg/L	1	13/2	0.667	0.004	**1.16**	12/-	0.298	BDL	0.496
Selenium	mg/L	0.02	2/1	**0.025**	0.01	**0.04**	1/0	0.010	0.01	0.01
Zinc	mg/L	20	13/1	11.12	0.016	**21.4**	12/0	4.01	BDL	7.11

Notes: 1. Young Australia complex made up of sampling locations ‘Young Australia 1’, ‘Young Australia 2D’ and ‘Young Australia 3’.

Appendix B

Water balance method statement

B.1 Introduction

A site water balance model of the New Cobar Complex was developed in GoldSim version 12.1 (GoldSim Technology 2017). The water balance methodology and assumptions have been sourced from the Peak Gold Mines (PGM) Water Management Plan, available spatial data (including LiDAR data from January 2020), advice from PGM and site observations. An overview of the functionality of the water management system is presented in Figure B.1.

B.1.1 Model objectives

The objectives of the water balance model are to:

- assess the frequency and volume of site discharge;
- identify water management options for improved water use efficiencies;
- assess the security of water supply; and
- assist in the determination of water licensing requirements.

B.2 Modelling approach

B.2.1 GoldSim model

The water balance model applies a continuous simulation methodology that simulates the response of the water management system under a range of climatic conditions (ie rainfall and evaporation). The water balance model has been created by representing each process of the water management system with pre-determined responses that reflect how the proposed water management system will operate.

Rainfall, evaporation, and groundwater inflows are the key environmental variables applied to the model. The response of the system to these variables is evaluated by investigating specific outputs across the system over the simulation timeframe.

B.2.2 Time step and simulation time

The model simulated the water management system using 57 years of historical climate data, using daily time steps.

B.2.3 Operating scenario

The water balance model has been used to simulate the performance of the New Cobar Complex project water management system.

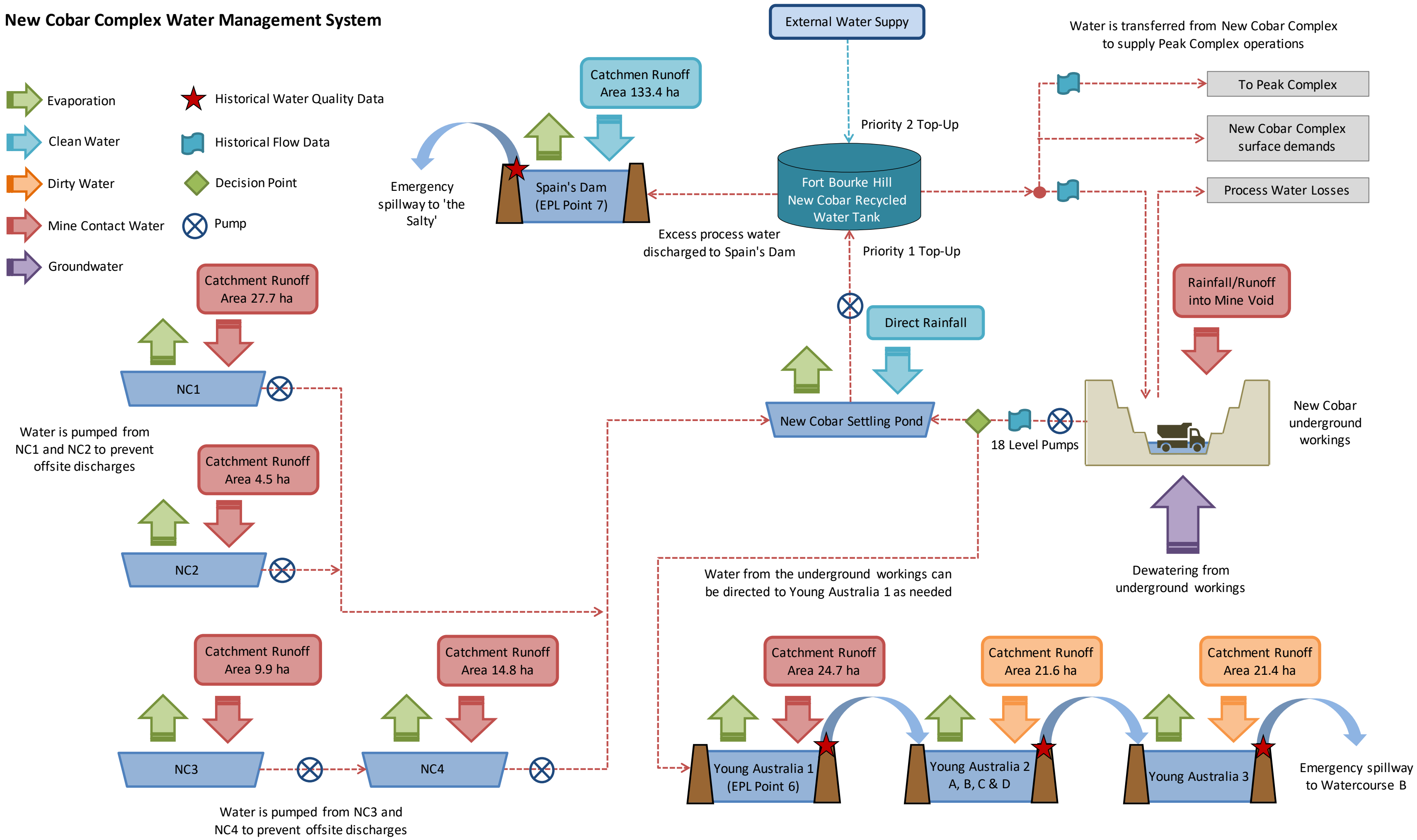

Figure B.1 New Cobar Complex water management system schematic

B.3 Model assumptions

B.3.1 Climate Data

i Rainfall

Daily rainfall data from the Bureau of Meteorology (BoM) operated Cobar MO (48027) rainfall gauge over the January 1963 to December 2019 period was applied to the model. SILO (Scientific Information for Land Owners) patched point data from the Queensland Climate Change Centre of Excellence was used to 'patch' any missing historical rainfall by interpolating data from nearby station records.

ii Evaporation

Daily evaporation rates were obtained as SILO patched point data at the Cobar MO rainfall gauge over the January 1963 to December 2019 period. Daily evaporation rates were applied to the model to calculate direct evaporation from water storages using a pan factor of 0.7. Each storage includes a stage storage relationship whereby the assumed exposed surface area of stored water varies with the volume of water stored each day.

iii Potential evapotranspiration

Daily potential evapotranspiration rates were applied to the model for use in the runoff calculations by estimating soil moisture losses. Potential evapotranspiration rates were obtained as SILO Patched Point Data at the Cobar MO rainfall gauge over the January 1963 to December 2019 period. The values for Morton's potential evapotranspiration were adopted.

B.3.2 Catchments

The New Cobar Complex catchments including contributing area and land-use are described in Table B.1.

Table B.1 New Cobar Complex catchments

Catchment ID	Area (ha)	Runoff quality	Land-use	Catchment land-use			
				Mine void	Overburden	Hardstand	Vegetated
New Cobar Complex open cut	6.2	Mine contact	Access road and void associated with New Cobar open cut.	100%	-	-	-
Spain's Dam	133.4	Clean water	Vegetated and unvegetated areas.	-	-	-	100%
NC1	27.7	Mine contact	Overburden landform, vegetated and unvegetated areas.	-	70%	-	30%
NC2	4.5	Mine contact	Overburden landform and access roads.	-	20%	70%	10%
NC3	9.9	Mine contact	Overburden landform, run of mine area, vegetated and unvegetated areas.	-	20%	60%	20%
NC4	14.8	Mine contact	Overburden landform, access roads, mine workings, vegetated and unvegetated areas.	-	20%	30%	50%

Table B.1 New Cobar Complex catchments

Catchment ID	Area (ha)	Runoff quality	Land-use	Catchment land-use			
				Mine void	Overburden	Hardstand	Vegetated
Young Australia 1[1]	24.7	Mine contact	Mine workings, vegetated and unvegetated areas.	-	-	20%	80%
Young Australia 2[2]	21.6	Dirty water	Vegetated and unvegetated areas.	-	-	10%	90%
Young Australia 3	21.4	Dirty water	Vegetated and unvegetated areas.	-	-	10%	90%

Notes: 1. Young Australia 1 previously referred to as Lake Jackson.
2. Young Australia 2 previously referred to as Sediment Cells 1, 2, 3 and 4.

B.3.3 Runoff

Surface water runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2003) and is widely used across Australia to estimate stream flow and runoff. Runoff was used to estimate the volume of water that would contribute to each of the water management dams over the simulation time frame.

The AWBM model was parameterised to achieve a long-term average volumetric runoff coefficient of 2% for natural catchment areas. This is based on observed annual runoff coefficients at the Box Creek at Cobar (425016) stream gauge and for the broader Barwon-Darling catchment (CSIRO 2008). Overburden areas were parameterised to have the same long-term volumetric runoff coefficient as natural catchments as similar infiltration and soil loss properties are expected.

Runoff from mine void and hardstand areas were parameterised to represent a 5 mm initial loss, which resulted in a long-term average volumetric runoff coefficient of 37%.

B.3.4 Storages

LiDAR data obtained in January 2020 was analysed to provide an updated understanding of water management system storages. The LiDAR data was used to determine overflow levels, storage extents, volume available prior to overflow and stage storage curves for both volume and surface area. The New Cobar Complex water management storages are described in Table B.2.

Table B.2 New Cobar Complex storages

Storage ID	Description	Storage volume[1]	Overflows to
New Cobar Complex open cut	Mine void associated with the New Cobar Complex open cut. Assumed to have negligible storage capacity as groundwater inflows and rainfall/runoff is pumped to the New Cobar Complex settling pond and then onto Spain's Dam or Young Australia 1 to maintain underground access.	N/A	New Cobar Complex settling pond
New Cobar Complex settling pond	Receives water from New Cobar Complex underground mine and open cut dewatering for settling prior to being transferred to Fort Bourke Tank.	2.5 ML	Fort Bourke Tank and then Spain's Dam[2]

Table B.2 New Cobar Complex storages

Storage ID	Description	Storage volume[1]	Overflows to
Fort Bourke Tank	Stores water from New Cobar Complex open cut dewatering prior to reuse or discharge to Spain's Dam when the rate of mine dewatering exceeds process water demand.	2.5 ML	Spain's Dam
Spain's Dam	Receives runoff from a relatively large natural catchment area as well as from Fort Bourke Tank when the rate of mine dewatering exceeds process water demand. Licenced discharge point.	90.2 ML	Emergency spillway to the Salty and then Watercourse A
NC1	Captures runoff from adjoining catchment. During extended periods of wet weather water can be pumped to New Cobar Complex settling pond to reduce risk of discharge.	36.8 ML	Pumped to New Cobar Complex settling pond
NC2	Captures runoff from adjoining catchment. During extended periods of wet weather water can be pumped to New Cobar Complex settling pond to reduce risk of discharge.	2.7 ML	Pumped to New Cobar Complex settling pond
NC3	Captures runoff from adjoining catchment. During extended periods of wet weather water can be pumped to NC4 to reduce risk of discharge.	4.5 ML	Pumped to NC4
NC4	Captures runoff from adjoining catchment. During extended periods of wet weather water can be pumped to New Cobar Complex settling pond to reduce risk of discharge.	4.4 ML	Pumped to New Cobar Complex settling pond
Young Australia 1	Storage dam that receives runoff from historical and current mining areas, and mine water pumped directly from New Cobar Complex underground mine.	3.7 ML	Young Australia 2
Young Australia 2	Series of storage dams that receive runoff from the adjoining catchment and overflow from Young Australia 1.	33.9 ML	Young Australia 3
Young Australia 3	Storage dam and licenced discharge point. Receives overflow from Young Australia 2.	123.8 ML	Emergency spillway to Watercourse B

Notes: 1. The storage volume presented relates to the maximum volume available prior to the storage overflowing to a downstream storage or offsite.
2. Overflows from the New Cobar Complex settling pond can also be directed to NC4 via a surface drain. For modelling purposes, it has been assumed that NC4 would also be near capacity when overflows from the water management system to Spain's Dam are required. Hence, overflows from the New Cobar Complex settling pond have been directed to Fort Bourke Tank prior to discharging to Spain's Dam.

B.3.5 Process water demands

Historical flow data from July 2019 to March 2020 has been used to estimate average annual process water demands. Historical flow data is available for transfers to the New Cobar underground, dewatering from the New Cobar underground, transfers to Peak Complex, and raw water demand from Cobar Shire Council. Process water demand for New Cobar surface activities such as vehicle wash and dust suppression is assumed to be the difference between recorded system inflows (raw water and underground dewatering) and recorded system outflows (New Cobar underground and to Peak Complex). Historical flow data for the New Cobar underground and Peak Complex along with the estimated New Cobar surface water demand are shown in Figure B.2.

The following annual average process water demands have been applied to the water balance model:

- New Cobar underground – 80 ML/year;
- New Cobar surface (dust suppression, vehicle wash, etc.) – 101 ML/year; and

- Transferred to Peak Complex – 479 ML/year.

Process water losses due to the New Cobar underground workings have been assumed to occur at 10% of the total underground process water demand.

For simplicity, the process water demands are based on the average values. In a real system, these values are likely to vary with changes in climatic and operational conditions. Hence, actual process water demands (dust suppression, to Peak Complex etc.) may be greater during dry conditions and less during wet conditions.

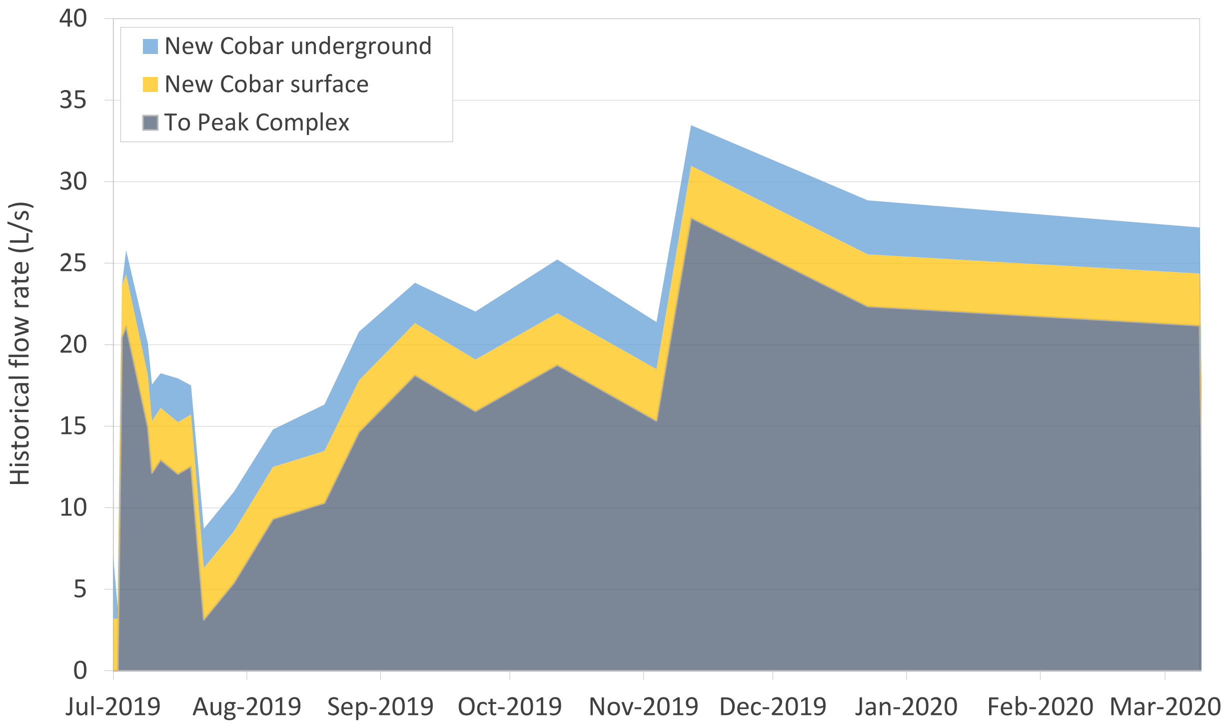

Figure B.2 New Cobar Complex historical process water demand

B.3.6 Groundwater flows

i Groundwater inflows

Groundwater inflows to the New Cobar underground workings over the proposed 12-year mine schedule are estimated in the groundwater assessment (EMM 2020a). The groundwater inflows are assumed to be equivalent to the volume of water that requires dewatering to the water management system. A time series of the predicted groundwater inflow is shown in Figure B.3. The average groundwater inflow and hence dewatering over the 12-year mine schedule is 860 kL/day.

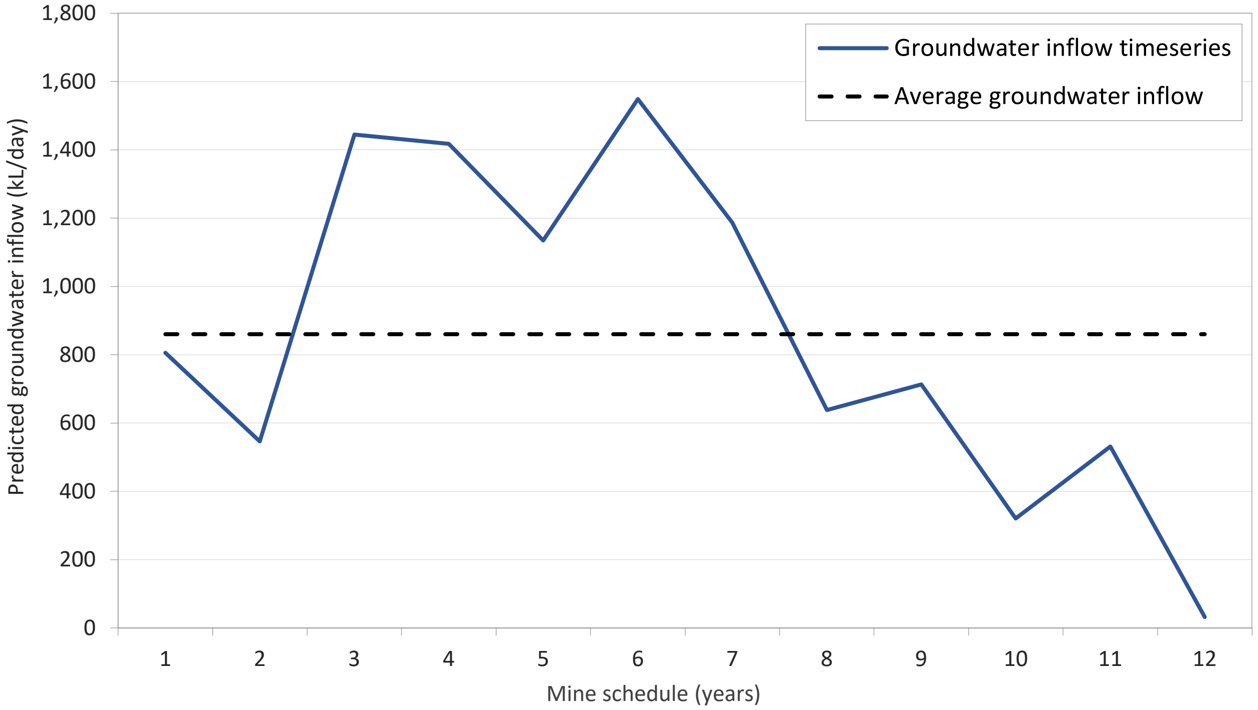

Figure B.3 Predicted groundwater inflow to New Cobar Complex

ii Seepage from water storages

The water storages described in Section B.3.4 have been assumed to experience no seepage to the underlying groundwater system. It is expected that seepage from water storages would be minimal compared to evaporation losses.

B.3.7 Transfers

Water transfer between storages, demands and sources are controlled using transfer rules based on storage levels, demand requirements and source availability. The transfer rules and rates adopted in the water balance model are described in Table B.3.

Table B.3 Water management system transfers

Category	Description	Transfer rule
Process water	External water supply	Process water sourced from external water supply on an as needs basis (ie during shortfall).
Process water	New Cobar Complex to Peak complex	Process water sourced from New Cobar Complex on at a rate of 1.3 ML/day (479 ML/year).
Pump	NC3 to NC4	Pump initiated when storage is greater than 60%[1] full. Pump rate assumed to be great enough to transfer all excess runoff in a given day.
Pump	NC4 to New Cobar Complex settling pond	Pump initiated when storage is greater than 80%[1] full. Pump rate assumed to be great enough to transfer all excess runoff in a given day.
Process water	Excess dewatering water directed to Spain's Dam	Excess dewatering water discharged to Spain's Dam when storage less than 80% full.
Process water	Excess dewatering water directed to Young Australia 1	Excess dewatering water discharged to Young Australia 1 when Spain's Dam storage is greater than 80% full.

Notes: 1. Pump initiated at storage capacity required to maintain 300 mm freeboard.

B.3.8 Water supply

Process water shortfalls occur when there is insufficient water available from inflows to existing underground works or stored within the water management dams. Process water shortfalls are assumed to be sourced from an external water source on an as needs basis.

B.4 Results

Water balance model results for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years are presented in Section 5.6 of the surface water assessment. The water balance results display the total water movement across the water management system over the year.

Appendix C

Flood assessment

New Cobar Complex Project State Significant Project (SSD-10419)

Flood assessment

Prepared for Peak Gold Mines Pty Ltd
November 2020

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New Cobar Complex Project
State Significant Project
(SSD-10419)

Flood assessment

Report Number

J190278 RP26

Client

Peak Gold Mines Pty Ltd

Date

23 November 2020

Version

v1 Final

Prepared by

Jason O'Brien
Water Resources Engineer
23 November 2020

Approved by

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Associate Water Resources Engineer
23 November 2020

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1 Introduction

1.1 Overview

Peak Gold Mines Pty Ltd (PGM), a wholly owned and operated subsidiary of Aurelia Metals Limited (Aurelia), owns and operates the Peak Gold Mines operation south-east of Cobar, far western New South Wales (NSW).

The PGM operation comprises the New Cobar Complex (the site) located 3 kilometres (km) to the south-east of Cobar town centre and the Peak Complex located 10 km south-east of the town centre; both complexes are located adjacent to Kidman Way which connects Cobar to Hillston and Griffith to the south. Mining at the New Cobar Complex is anticipated to cease in 2023 when the existing New Cobar and Chesney deposits are exhausted.

PGM seeks to extend the life of the New Cobar Complex through the New Cobar Complex Project (the project). The project involves the development of new underground workings to mine the Great Cobar and Gladstone deposits. This will be an extension of the existing operation as the mining of the New Cobar and Chesney deposits will ramp down as the mining of the Great Cobar and Gladstone deposits ramp up.

An environmental impact statement (EIS) is being prepared by EMM to assess the impacts of the project on the surrounding environment and address the Secretary's Environmental Assessment Requirements (SEARs), issued 13 February 2020 and amended in October 2020 to facilitate the issue of a BDAR Waiver by the Biodiversity and Science Directorate. One of the requirements of the SEARs is to assess the potential flooding impacts of the project.

This flood assessment provides a high-level characterisation of the existing flood conditions at the New Cobar Complex and provides context for the assessment of potential flood impacts resulting from the project.

1.2 Study area

There is no current understanding of flooding conditions or risks at the New Cobar Complex. The study area has therefore been selected to cover both existing mine infrastructure as well as new surface infrastructure proposed as part of the project.

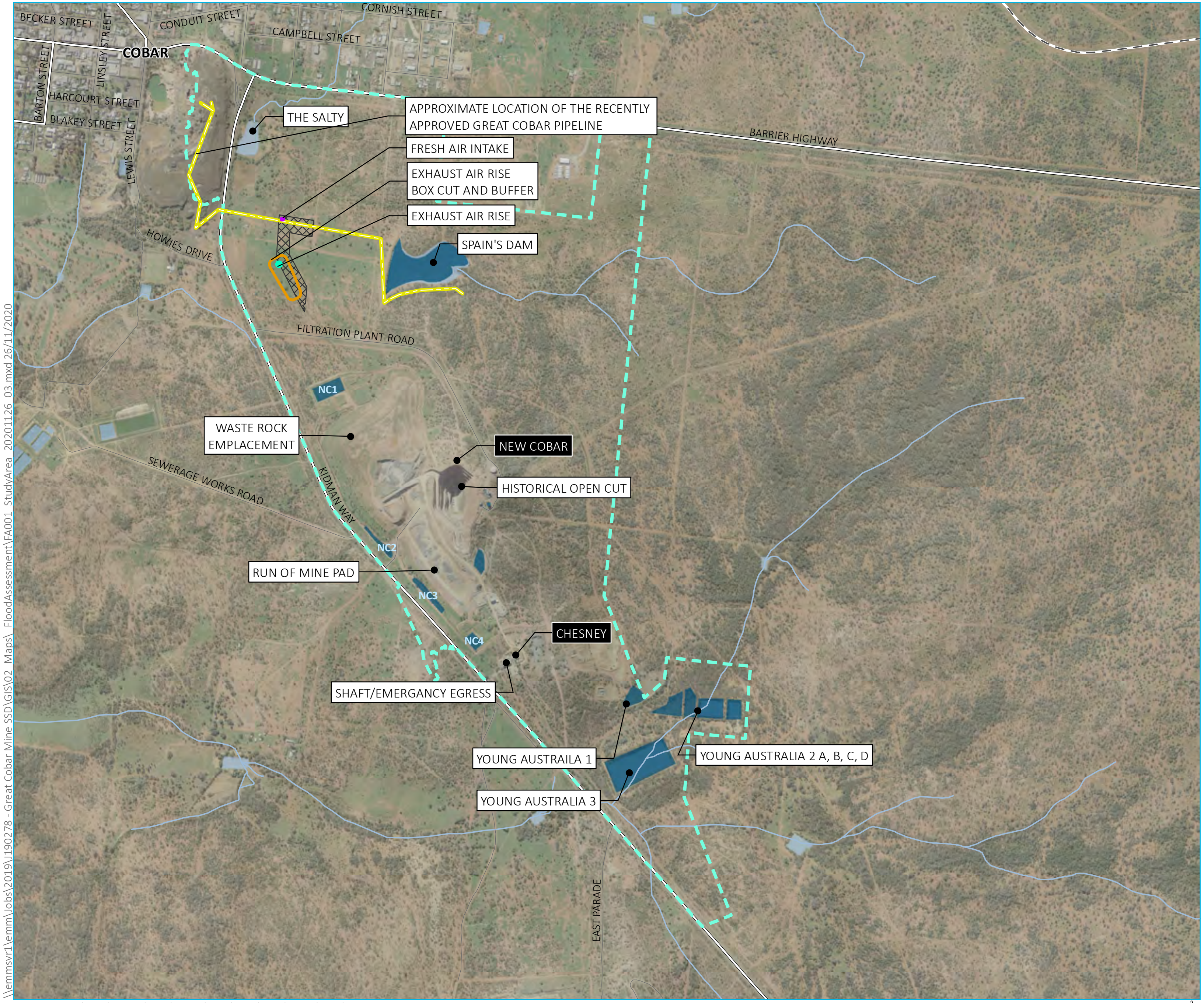
The study area and key features are shown in Figure 1.1. The study area encompasses existing diversion bunds and drainage channels upstream of the New Cobar Complex, internal surface infrastructure associated with the New Cobar and Chesney working areas of the New Cobar Complex, and the location of proposed new surface infrastructure.

The topography of the study area consists of a generally flat to undulating landscape that is broken by several ridgelines and scattered peaks. No permanent watercourses exist within the study area and surrounding landscape. All watercourses within and downstream of the study area have ephemeral flow regimes.

The majority of surface infrastructure associated with the New Cobar Complex is located on top of a ridgeline and is not impacted by local watercourse flows. The main drainage features in proximity of the mine are two second order watercourses that traverse the northern and southern extent of the complex.

The watercourse to the north is impounded by Spain's Dam prior to discharging via the Spain's Dam emergency spillway to a waterbody known as 'the Salty'. Flows from the Spain's Dam catchment join those from the eastern portion of Cobar town at the Salty. Downstream of the Salty, flows overtop Kidman Way prior to flowing south-west around the existing Great Cobar pit slag dump and into a reservoir at the Newey Reserve.

The watercourse to the south is diverted around the Chesney working area via a series of diversion banks and drainage channels. The watercourse re-joins its original flow path downstream of the Young Australia 3 water management dam before traversing Kidman Way, where it becomes a third order watercourse.



Source: EMM (2020); PGM (2020); DFSI (2017); GA (2011); DPE (2019)

Study area

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure 1.1

EMM
creating opportunities

2 Assessment approach

2.1 Overview

This chapter describes the assessment approach including data utilised and assessment methodology.

2.2 Available data

A desktop assessment of existing information was undertaken at project commencement. Additional project-specific information was provided by PGM. The following data has been used to inform the flood assessment:

- Design rainfall intensity and temporal pattern information obtained from the Bureau of Meteorology (BoM).
- Rainfall losses and temporal pattern information obtained from the Australian Rainfall and Runoff Data Hub (ARR Data Hub) (Babister et al. 2016).
- LiDAR data obtained by PGM in January 2020.
- Project-specific data from PGM:
  - aerial imagery of the study area (dated January 2020);
  - infrastructure and site plans of existing drainage diversion channels and bunds; and
  - geographic information system (GIS) files of the proposed surface works.
- Observations gathered during a site visit undertaken in May 2020.

2.3 Assessment methodology

2.3.1 Objectives

The key objectives of this assessment are to:

- provide an understanding of existing flood characteristics at the New Cobar Complex;
- identify flood-related risks and issues requiring further consideration as part of present and future mine planning; and
- assess potential flood impacts resulting from the project.

2.3.2 Modelling approach

A two-dimensional (2D) rain on grid TUFLOW model (version 2020-01-AA) has been developed to assess design flows and flood characteristics for the study area. A rain on grid 2D TUFLOW model was used in preference to development of separate hydrologic and hydraulic models as the terrain within and surrounding the New Cobar Complex is highly modified, making it difficult to accurately define catchment boundaries and flow paths. Modelling has generally been undertaken in accordance with the methodologies outlined in Australian Rainfall and Runoff (Ball et al. 2019), hereinafter referred to as ARR2019. The general process that has been used to determine flood characteristics at the site are as follows:

1. Model the full ensemble suite of ten temporal patterns for a range of design storm events and durations using the rain on grid TUFLOW model.

2. Determine the critical storm event at key locations (near the proposed surface works and upstream of the Chesney working area) for each annual exceedance probability (AEP) modelled. The critical storm is identified as the duration with the largest mean flow, and the temporal pattern which is closest to but greater than the mean flow.

3. Existing flood characteristics are described as the envelope of critical storm conditions from each storm duration for each AEP modelled.

The rain on grid TUFLOW model results were validated by comparison of peak flow estimates generated by TUFLOW at selected locations against alternative estimates generated using the Watershed Bounded Network Model (WBNM) and the Regional Flood Frequency Estimation (RFFE) Model. Calibration of the TUFLOW model is not possible due to the absence of suitable historic flood data.

2.3.3 Key storm events

The following storm events have been assessed:

- 5% AEP – used to assess the minimum recommended design criteria for upstream diversion controls at mine sites in accordance with *Managing Urban Stormwater: Soils and Construction – Volume 2E mines and quarries* (DECC 2008).

- 1% AEP – used to assess existing flood characteristics against typical flood planning and design criteria.

- Probable maximum flood (PMF) – used to assess the upper limit of flooding within the study area.

Adopted design storm information is described in Chapter 3.

3 Hydrology

3.1 Overview

This chapter describes the hydrologic characteristics of the study area including design rainfall depths, rainfall losses and temporal patterns. The information contained in this chapter has been sourced from the BoM, ARR Data Hub and site observations.

3.2 Design rainfall

3.2.1 General storm events

Design rainfall depths were obtained from the BoM Design Rainfall Data System (2016). An analysis of design rainfall depths across the study area was undertaken to identify potential design rainfall gradients. The analysis indicated that there is no significant design rainfall gradient across the study area. Hence, a single, uniformly applied rainfall depth has been adopted for each design storm event and duration. Design rainfall depths for the 1% AEP and 5% AEP storm events are provided in Table 3.1.

Table 3.1 Design rainfall depths – 5% and 1% AEP events

Duration	60 minutes	90 minutes	120 minutes	180 minutes	270 minutes	360 minutes	540 minutes
5% AEP rainfall depth (mm)	47.3	52.7	56.5	61.9	67.7	72.1	79.1
1% AEP rainfall depth (mm)	66.2	73.0	77.8	84.8	92.4	98.5	108

3.2.2 Probable maximum precipitation

Probable maximum precipitation (PMP) depths represent the upper limit of possible rainfall and are used to determine flood characteristics for the PMF. Due to the small catchment size, the Generalised Short Duration Method (GSDM) (BoM 2003) has been be used to estimate PMP depths for the study area, with the 'Inland Zone' applicable to the site. As the study area topography is generally flat, a smoothness factor of 1 has been adopted. A moisture adjustment factor of 0.7 has been applied to the PMP calculations. The calculated PMP design depths are provided in Table 3.2.

Table 3.2 Design rainfall depths – PMP event

Duration	30 minutes	45 minutes	60 minutes	90 minutes	120 minutes	150 minutes	180 minutes
PMP rainfall depth (mm)	200	250	300	340	390	410	430

3.3 Rainfall losses

The ARR Data Hub recommends initial and continuing losses for the study area of 80 mm and 5.4 mm/hour respectively. The *Floodplain Risk Management Guide: Incorporating 2016 Australian Rainfall and Runoff in studies* (OEH 2019) recognises that loss values for NSW from the ARR Data Hub have resulted in "a significant bias toward underestimation of flows", and recommends a hierarchical approach to estimating loss and pre-burst values in NSW. The preferred approach is calibration to site-specific data, followed by adoption of calibrated losses from other local studies, and finally use of the ARR Data Hub default values. As calibration to local data is not possible and there are no known suitable local studies from which to draw from, recommendations involving use of ARR Data Hub losses have been adopted. OEH (2019) recommends using default ARR Data Hub continuing losses with a multiplication factor of 0.4 and probability neutral burst initial losses.

The rainfall-runoff relationship at BoM operated streamflow gauge Box Creek at Cobar (425016), supported by the observed runoff response at the site and surrounds over time, indicates a typical initial rainfall loss of around 25 mm. Calibration to the Box Creek at Cobar gauge was not possible as the gauged data is considered to be unreliable[1]

The ARR Data Hub probability neutral burst initial loss values vary based on storm frequency and duration. For the study area, 1% AEP initial losses range from approximately 27 mm for the 6-hour storm up to 30 mm for the 1-hour storm. For the 5% AEP events, initial losses are slightly higher. These initial loss values would generate slightly less runoff in the model than the 25 mm that site observations and available streamflow gauging records would suggest.

The observed initial loss value of 25 mm was used in the model for all events. The OEH (2019) recommended continuing loss rate of 2.2 mm/hour, based on the ARR Data Hub value of 5.4 mm/hour with application of a multiplication factor of 0.4, was adopted for all events.

Zero initial and continuing losses have been assumed for impervious areas such as roads and waterbodies.

3.4 Rainfall temporal patterns

Rainfall temporal patterns are used to describe how rainfall is distributed as a function of time. The recommended ARR2019 ensemble approach to applying temporal patterns was utilised. The ensemble approach to flood modelling applies a suite of ten temporal patterns for each duration. Point temporal patterns were implemented as the study area catchment size is less than 75 km^2. The temporal patterns were obtained from ARR Data Hub for the 'Rangelands' region.

Temporal patterns for the PMP storm event were developed using the methodology recommended for the GSDM (BoM 2003).

1 The streamflow record for the Box Creek at Cobar (425016) was obtained from Bureau of Meteorology Water Data Online website. The Bureau of Meteorology state 'the data provider releases the record set declaring that the data's ability to represent the monitored parameter is not known'. Hence, the quality of the Box Creek at Cobar streamflow gauge dataset may be unreliable.

4 Hydraulic model setup

4.1 Overview

A TUFLOW model (version 2020-01-AA) was developed to assess existing flood conditions across the study area. This chapter describes the development of the TUFLOW model. Results are presented in Chapter 5.

4.2 Model version

TUFLOW is a hydrodynamic model used to simulate 1D and 2D flows for piped networks, watercourses, floodplains, estuaries, and coastlines. TUFLOW has been used in Australia by major consultancies and government departments to simulate flooding for a wide variety of rural and urban locations and is well known by the Australian hydrological profession as an appropriate tool for runoff simulation when appropriate site-specific parameters are used.

The high-performance computing (HPC) version of TUFLOW partitions 2D grid solutions into compartments for parallel solving, using either multiple computer processing units (CPU) or graphic processing units (GPU). Parallel computations reduce model runtimes, with GPU typically resulting in a faster solution than CPU. Hence, TUFLOW HPC (GPU) was used as the software platform for modelling runoff within the study area.

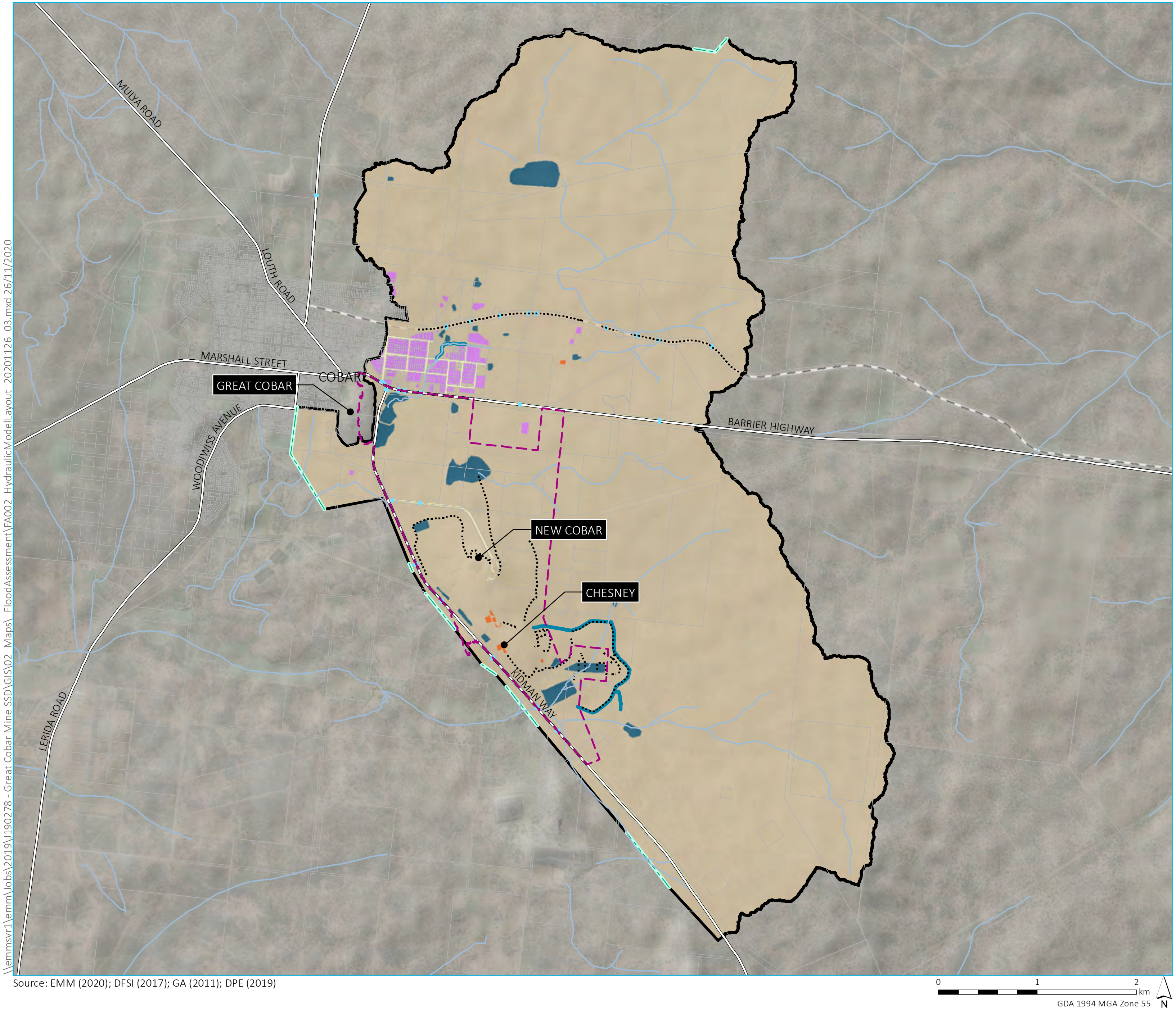
4.3 Model domain and grid size

The hydraulic model domain encompasses existing New Cobar Complex surface infrastructure, the upstream contributing catchment, and areas where new infrastructure is proposed. Due to the location of the proposed surface infrastructure, consideration of runoff from the Spain’s Dam catchment and eastern portion of Cobar town is also required. The model domain has therefore been extended to cover the Spain’s Dam catchment and the catchment that drains through the eastern portion of Cobar town. However, determining existing flood conditions and impacts within Cobar town are not part of the project scope and therefore the model results should not be relied on outside of the context of this study. The model domain and key model features in the vicinity of the New Cobar Complex are shown in Figure 4.1.

Site observations identified that many of the key drainage lines do not have well-defined channel. The primary site diversion drains and bunds were found to typically be in the order of 5 m wide. A model grid size of 5 m x 5 m was implemented to adequately model the key hydraulic features of the study area. TUFLOW’s sub-grid sampling capability was enabled to better define the underlying terrain within the 2D model. Sub-grid sampling was defined at 1 m spacing, which is consistent with the gridded resolution of the January 2020 LiDAR data.

4.4 Model terrain

The January 2020 LiDAR data was used to inform the 2D hydraulic model terrain. A digital elevation model (DEM) was created from the LiDAR data to represent the existing conditions of the study area. The DEM was cross-referenced against available aerial imagery, topography data, site infrastructure plans and field survey observations. Where required, the DEM was refined by use of topographic modifiers to ensure that hydraulic controls for key infrastructure and floodplain features (such as diversion bunds and drains) were adequately represented in the model, and to provide continuous flow paths through obstructed drainage lines (see Section 4.8).



Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

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Hydraulic model layout

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure 4.1

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4.5 Hydraulic roughness

Manning's n values to represent hydraulic roughness were selected based on inspection of aerial imagery and from site observations. Catchments were observed to primarily consist of bare earth and rock with sparse to medium density vegetation.

Shallow water flows would experience greater hydraulic roughness when flowing over rocky areas and through areas of vegetation where organic material may be present on the ground, while deeper flows may flow over these obstructions and experience lower roughness. To simulate this effect, depth varying roughness was applied to the Manning's n values described in Table 4.1. The Manning's n values presented in Table 4.1 are within the ranges published in ARR2019.

Table 4.1 Manning's n roughness values

Land use[1]	Lower Manning's n value[2]	Upper Manning's n value[2]
Sparse brush	0.10	0.04
Waterbodies	0.02	0.02
Roads	0.02	0.02
Hardstand areas including some obstructions	0.10	0.03
Residential block including some obstructions	0.10	0.10

Notes: 1. Spatial variation of land use categories shown in Figure 4.1.
2. Lower and upper depth triggers of 0.03 m and 0.05 m, respectively, were adopted. Manning's n value interpolated when depth of flow is between lower and upper triggers.

4.6 Boundary conditions

All inflow boundary conditions were modelled as rainfall hyetographs applied directly to the TUFLOW model domain. No additional upstream catchments contribute runoff to the model domain. Stage-discharge (HQ) boundary conditions were applied at all downstream model boundaries. The water surface slope at each downstream boundary was defined so that the stage-discharge relationship at each boundary was automatically generated by TUFLOW.

4.7 Initial water levels

Initial water levels were defined for several existing waterbodies within the 2D model domain. Spain's Dam and the Salty were conservatively assumed to be full at the beginning of each model simulation to reduce attenuation effects and maximise runoff to downstream areas (ie proposed surface infrastructure). The Young Australia Dams and NC1 to NC4 were assumed to be 50% full at the beginning of each simulation. This is also considered to be a conservative assumption as these water management dams are typically maintained at low storage levels.

4.8 Hydraulic features

Where visual inspection of the underlying terrain identified a potential drainage line obstruction (typically a road or access track), it was assumed that watercourse structures (eg a culvert or bridge) exist to allow overland flow to traverse the obstruction. In the absence of any watercourse structure details, these were typically modelled as a two-cell (10 m) wide opening in the 2D terrain.

5 Hydraulic model results

5.1 Overview

The hydraulic model described in Chapter 4 has been used to establish existing flood characteristics in terms of flood extent, depth and velocity within the study area. This chapter describes the critical storm duration for the key areas of interest, the process of validating design flow estimates, presents and discusses the TUFLOW model results, and identifies opportunities for future model refinement.

Flood mapping is provided in Appendix A, which includes figures showing indicative flood extents, depths, levels and flow velocities for the 5% AEP, 1% AEP and PMF events.

5.2 Critical storm

The critical storm peak flow upstream of the Chesney working area and downstream of the Salty (see Figure 4.1) has been determined using the ensemble method described in ARR2019. The critical storm is identified as the duration with the largest mean peak flow and the temporal pattern which is closest to, but greater than, the mean peak flow. Critical storm peak flows for the 5% AEP, 1% AEP and PMF are provided in Table 5.1 along with the corresponding temporal pattern, assessed critical duration and average ensemble peak flow.

Table 5.1 Critical storm flows

	Critical duration	Average ensemble peak flow (m^3/s)	Temporal pattern	Critical storm peak flow (m^3/s)
Upstream of Chesney working area				
5% AEP	120 minutes	21.7	TP05	23.5
1% AEP	90 minutes	45.0	TP08	46.0
PMF	30 minutes	-	-	407
Downstream of the Salty				
5% AEP	180 minutes	36.1	TP10	39.2
1% AEP	180 minutes	76.4	TP02	77.5
PMF	60 minutes	-	-	893

The temporal pattern ensemble results upstream of the Chesney working area and downstream of the Salty are presented in Figure 5.1 to Figure 5.4. Results are presented as box and whisker plots for each storm duration where:

- the median peak discharge is represented by the line that horizontally bisects the box;
- the 25th and 75th percentile peak discharge is represented by the lower and upper bounds of the box;
- the whiskers represent the minimum and maximum values for each storm duration, excluding outliers;
- the average peak discharge is represented by a dashed line;
- individual ensemble peak discharge is represented by an open circle; and
- the critical ensemble flow for each duration is represented by a red circle.

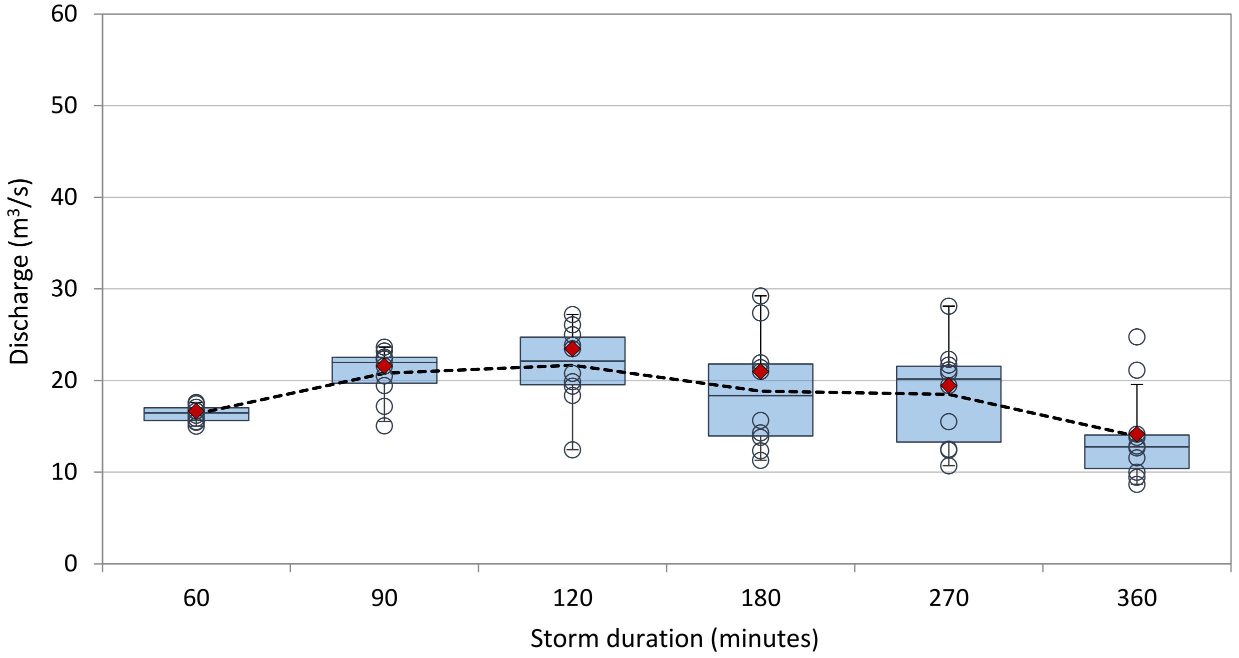

Figure 5.1 5% AEP critical storm duration – upstream of Chesney working area

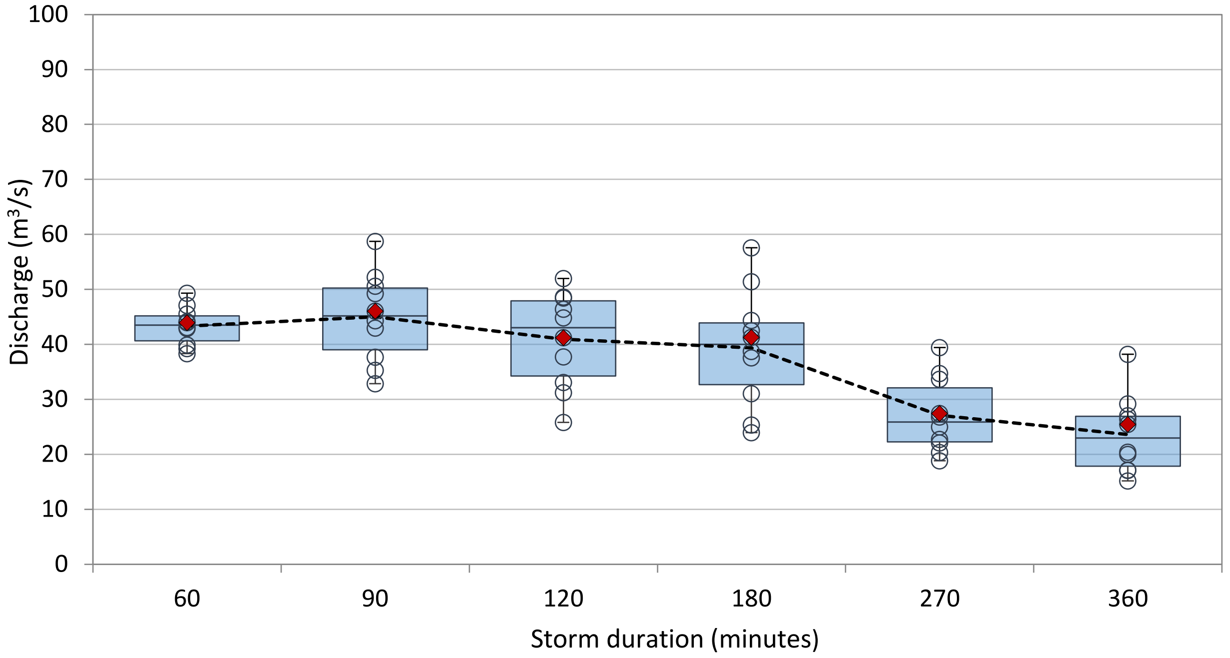

Figure 5.2 1% AEP critical storm duration – upstream of Chesney working area

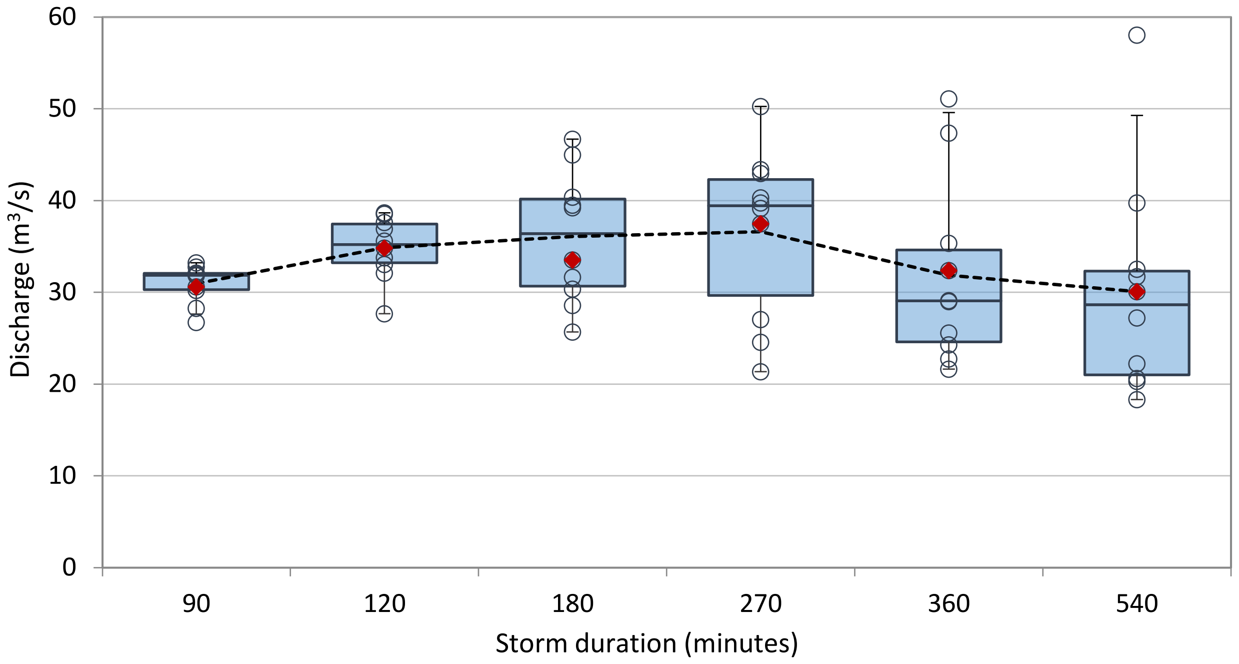

Figure 5.3 5% AEP critical storm duration – downstream of the Salty

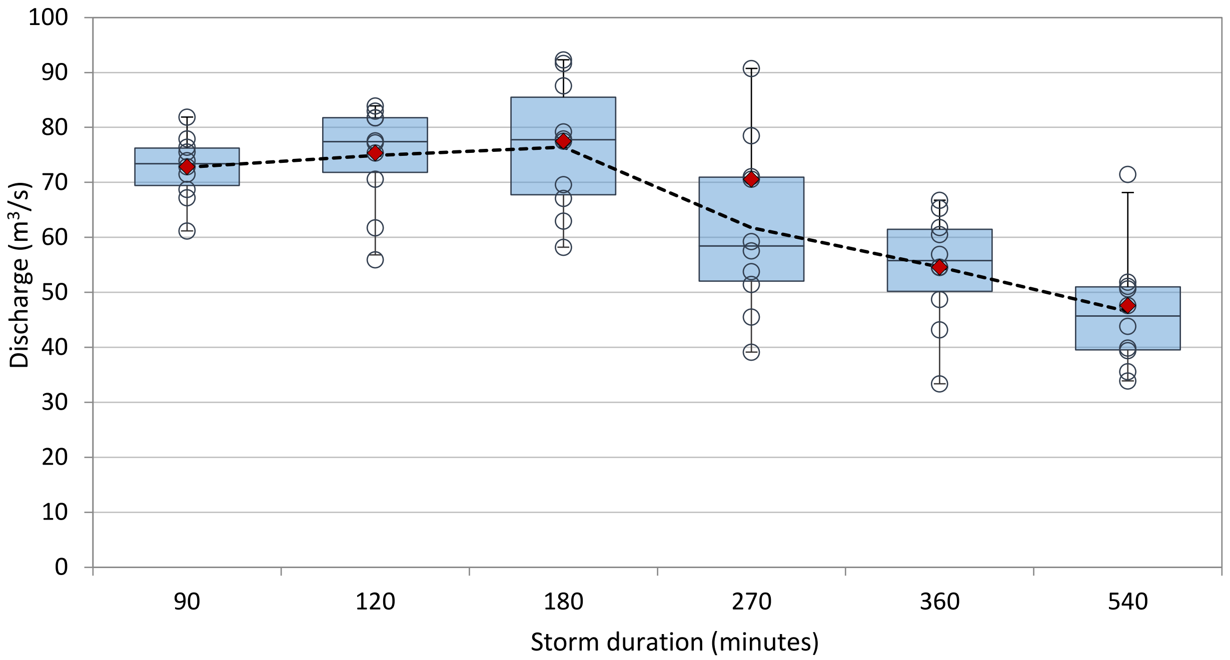

Figure 5.4 1% AEP critical storm duration – downstream of the Salty

5.3 Design flow validation

To improve confidence in the TUFLOW design flow estimates, a validation process was undertaken using the WBNM hydrology model software and the RFFE Model.

Cobar is located near the border of the RFFE Model arid and semi-arid fringe. The RFFE Model is currently unavailable for arid regions in Australia. The RFFE Model was therefore used to estimate design flows from indicative catchments 20 km to the east of the study area (ie within an area where the RFFE Model is available). The indicative catchments were assigned properties representative of the catchment upstream of the Chesney workings and downstream of the Salty.

A comparison of peak flow estimates upstream of the Chesney workings and downstream of the Salty for the 5% AEP and 1% AEP flood events are provided in Table 5.2 and Table 5.3 respectively.

Table 5.2 Comparison 5% AEP design flows

Location	TUFLOW hydraulic model (m^3/s)	WBNM hydrology model (m^3/s)	RFFE Model design estimates (m^3/s)		
			5% AEP estimate	Upper confidence limit	Lower confidence limit
Upstream of Chesney	23.5	12.3	24.0	105.0	5.7
Downstream of the Salty	39.2	32.4	64.6	277.0	15.6

Table 5.3 Comparison 1% AEP design flows

Location	TUFLOW hydraulic model (m^3/s)	WBNM hydrology model (m^3/s)	RFFE Model design estimates (m^3/s)		
			1% AEP estimate	Upper confidence limit	Lower confidence limit
Upstream of Chesney	46.0	23.1	42.0	182.0	10.0
Downstream of the Salty	77.5	61.6	113.0	481.0	27.3

The results presented in Table 5.2 and Table 5.3 show that peak flows from the TUFLOW and WBNM models are similar downstream of the Salty. The TUFLOW model peak flows are approximately double the WBNM model peak flows upstream of the Chesney workings area.

The TUFLOW and WBNM peak flows range from 50% less (5% AEP downstream of the Salty) to 10% greater (1% AEP upstream of Chesney) than the RFFE Model design flows. However, peak flows from both the TUFLOW and WBNM model are still within the upper and lower RFFE Model confidence limits.

When considering RFFE Model flow estimates, it is important to note ARR2019 states "that the relative accuracy of regional flood estimates using the RFFE Model is likely to be within ± 50% of the true value" and as such, RFFE Model design flows estimates should be carefully considered. This is particularly the case for arid catchments as the RFFE Model for arid areas is based on a small number of gauged catchments spanning a vast area of Australia.

While the RFFE Model design flow estimates provided in Table 5.2 and Table 5.3 have been determined at a location 20 km to the east of the study area, it is expected that there would be little variation in hydrologic processes between the study area catchments and RFFE Model catchments. RFFE Model estimates for arid zones are anticipated to result in lower peak flows than those presented in Table 5.2 and Table 5.3.

The similarities between the TUFLOW and WBNM model peak flow estimates provide confidence in the modelled design flows. While the 1% AEP TUFLOW model peak flow estimates are shown to be greater than WBNM model estimates upstream of the Chesney workings, the TUFLOW peak flows are still less than the RFFE Model 1% AEP estimate. The difference between the 1% AEP modelled design flows and the 1% AEP RFFE Model design flows is considered acceptable given that peak flow estimates are still within the confidence range.

5.4 Model results

TUFLOW model results showing the 5% AEP, 1% AEP and PMF flood depth, level, velocity and extent are provided in Appendix A. The flood maps in Appendix A were generated using the following steps:

1. Calculate the average value resulting from all 10 temporal patterns to determine the critical flow conditions for each storm duration.

2. Envelope the maximum value from each critical storm duration to determine the critical storm flow conditions for each AEP.

3. Apply a filter so that critical storm flow conditions are only shown if the flood depth is greater than 0.1 m and the product of flood depth and velocity is greater than 0.2 m^2/s. This removes the shallow, slow moving sheet flow across the entire model domain that results from a rain on grid model and is not considered representative of significant overland or mainstream flooding.

The following provides a summary of the key model results for each event:

- 5% AEP event:

  - Flooding in the vicinity of the proposed surface infrastructure is contained to the watercourse (at the Salty) and immediate overbank areas and does not inundate the general area of the proposed powerline or air intake and rise structures.

  - Flooding from the catchment upstream of the Chesney working area overtops the diversion bund that forms the northern boundary of the site. This results in the inundation of the Young Australia 2 and Young Australia 3 water management dams. Floodwaters that enter the site are shown to be contained within the water management dams.

  - The remainder of the New Cobar Complex is relatively unaffected by flooding away from defined drainage lines and some isolated low points in the terrain that receive local runoff.

- 1% AEP event:

  - Flooding in the vicinity of the proposed surface infrastructure is contained to the watercourse (the Salty) and overbank area and does not inundate the general area of the proposed power line or air intake and rise structures.

  - Some minor overland flows (greater than 100 mm depth) occur through the general area of proposed powerline.

  - Flooding from the catchment upstream of the Chesney working area overtops the diversion bunds that form the northern and eastern boundary of the site. This results in the inundation of the Young Australia 2 and Young Australia 3 water management dams. Floodwaters that enter the site area are attenuated by the water management dams, decreasing the peak flow downstream (ie across Kidman

Way). It is expected that there would be less attenuation of floodwaters if the water management dams were at greater than 50% capacity (see Section 4.7) prior to the occurrence of a flood event.

  - The remainder of the New Cobar Complex is relatively unaffected by flooding away from defined drainage lines and some isolated low points in the terrain that receive local runoff.

- PMF event:

  - Extensive out of bank flows are evident at this magnitude of flood event in the vicinity of the proposed surface infrastructure. The air rise and air intake shafts are estimated to be inundated by approximately 150 mm and 800 mm, respectively.

  - Widespread inundation occurs across the entire Chesney working area with both Young Australia 2 and Young Australia 3 experiencing substantial overtopping.

  - The remainder of the site does not experience any substantial flooding from upstream catchments. However, significant ponding from local runoff is expected to occur within the New Cobar pit.

  - Site drainage structures overtop and discharge offsite in several locations along the boundary to Kidman Way and to north of NC1.

5.5 Discussion of results

The following provides some additional interpretation and discussion of results:

- The majority of the existing New Cobar Complex has adequate flood immunity for the 5% AEP and 1% AEP events. Ponding may be experienced within the existing New Cobar Complex open cut for the 5% AEP, 1% AEP and PMF events. It is expected that ponding within the New Cobar Pit can be managed via an existing pump system used to dewater the underground workings and rainfall ingress.

- The capacity of the diversion drains and bund upstream of the Young Australia 2 and Young Australia 3 water management dams is exceeded in flood events of 5% AEP and greater. The water management dams provide attenuation of flood waters that enter the site.

- The proposed surface infrastructure is generally located outside of the 1% AEP flood extent and hence no flood impacts are expected as a result of the proposed works. Further consideration may be required to ensure adequate flood immunity is provided for the air rise and air intake shafts, which are inundated during the PMF.

5.6 Opportunities for model refinement

Based on the outcomes of this high-level flood assessment, further investigation of flood conditions to support future mine planning could include:

- Sensitivity analysis of the study area hydrology, particularly rainfall losses parameter selection.

- Refinement of the TUFLOW model in the vicinity the Chesney working area. Specifically, modelling the diversion drain and bund upstream of the Young Australia 2 and Young Australia 3 water management dams in more detail to provide a more accurate estimation of flood conveyance around the site.

- Use of anecdotal historic flood data to enable testing of combined hydrologic/hydraulic model performance in reproducing observed flood behaviour for historic events.

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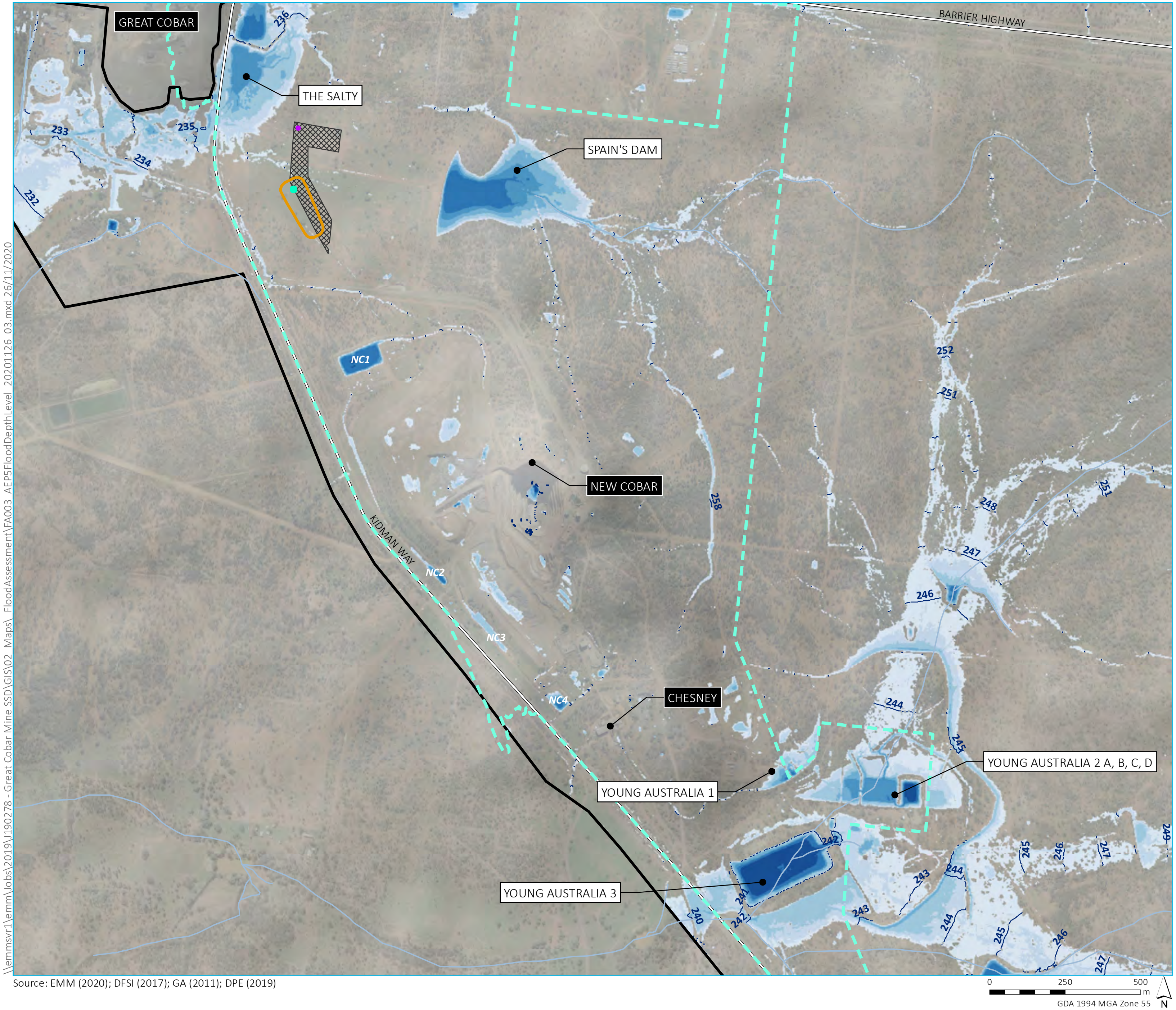
Appendix A

Flood mapping



Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

KEY
- Project area
- Exhaust air rise buffer
- Fresh air intake
- Exhaust air rise
- Proposed power line corridor
- Main road
- Watercourse/drainage line
- TUFLOW model boundary
- 5% AEP flood level contour

5% AEP flood depth (m)
- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

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5% AEP flood depth and level

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Flood assessment
Figure A.1

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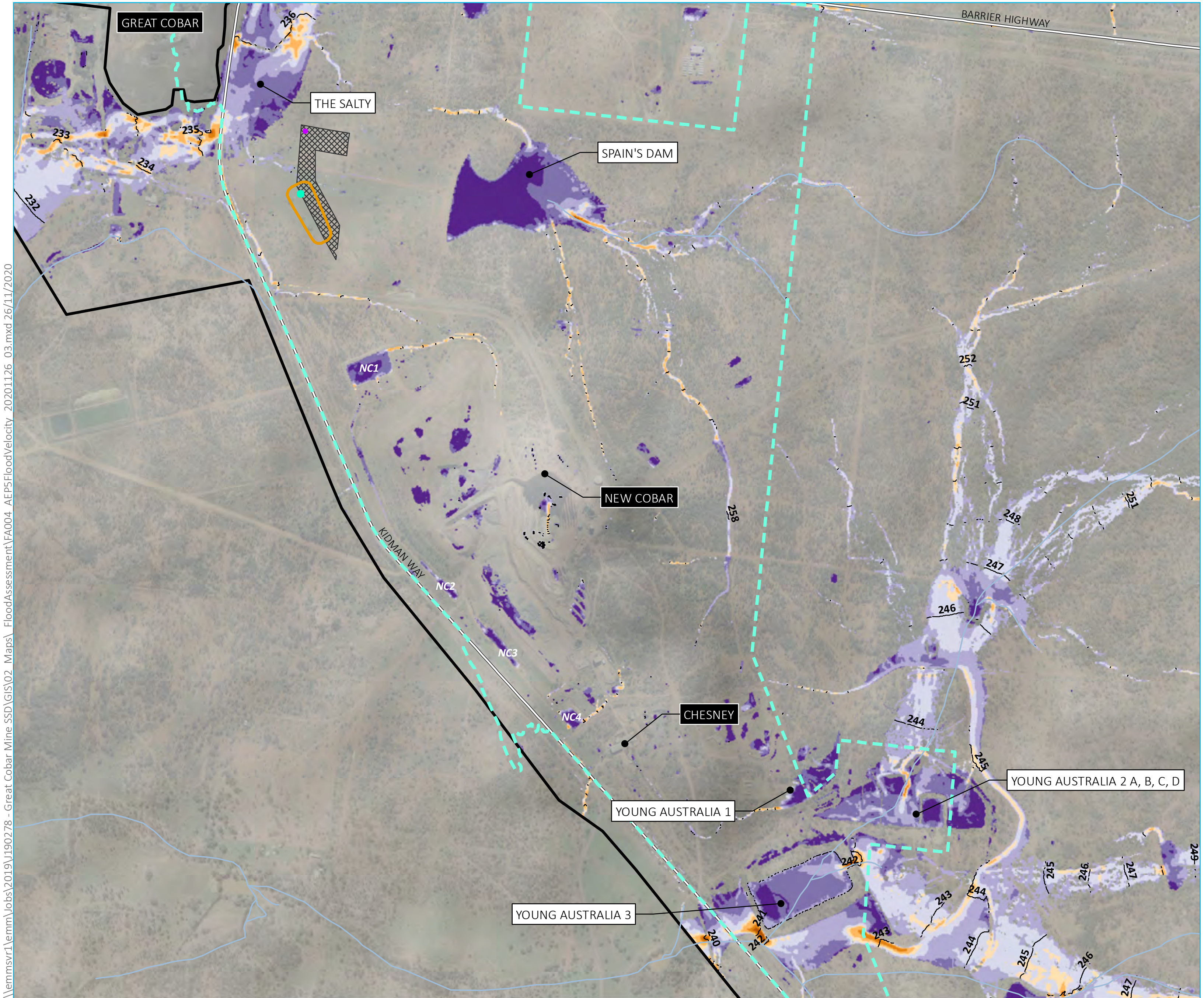

KEY

- Project area
- Exhaust air rise buffer
- Fresh air intake
- Exhaust air rise
- Proposed power line corridor
- Main road
- Watercourse/drainage line
- TUFLOW model boundary
- 5% AEP flood level contour

5% AEP flood velocity (m/s)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- >2

Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

0 250 500 m

GDA 1994 MGA Zone 55

N

5% AEP flood velocity

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure A.2

EMM creating opportunities

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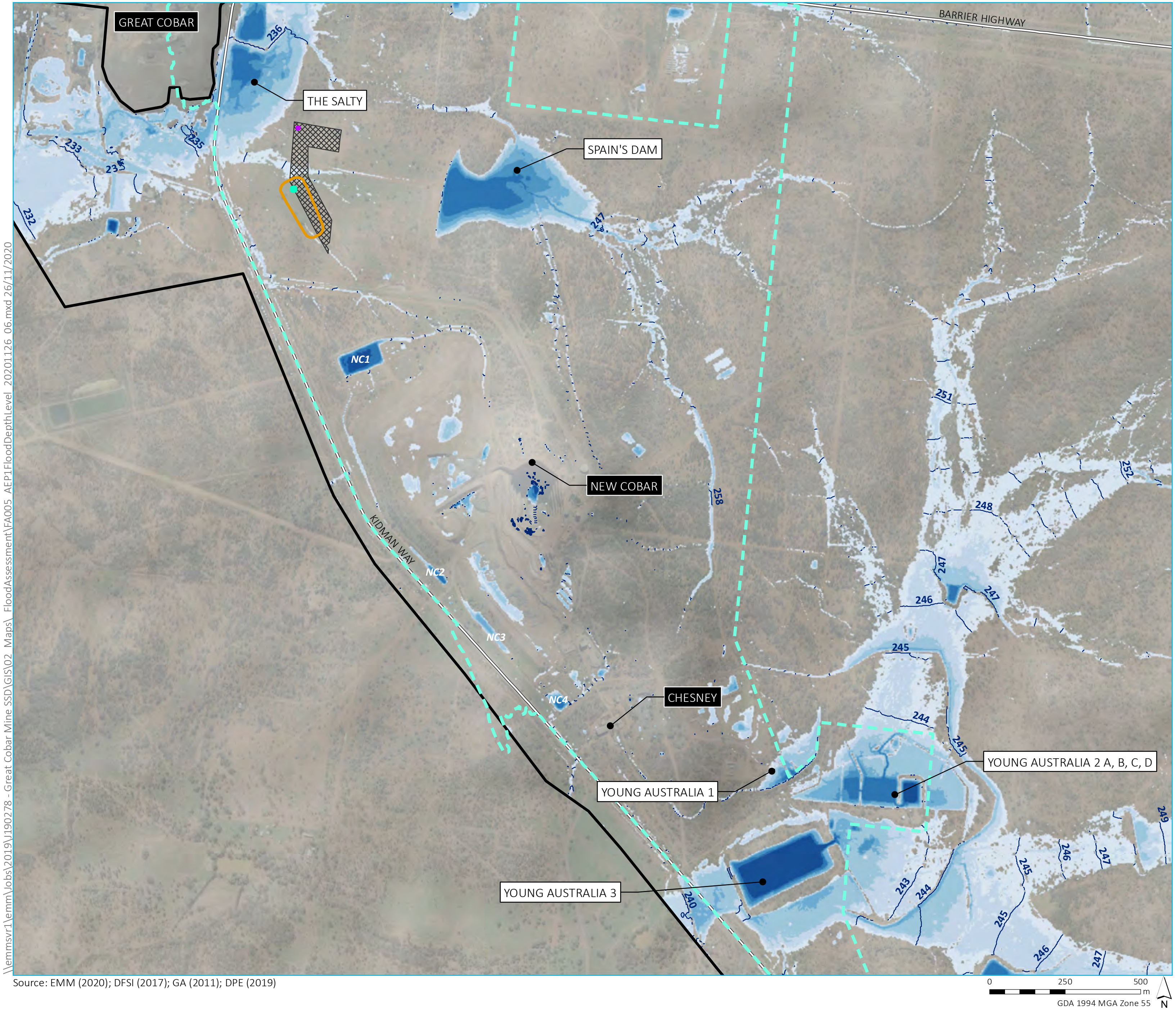

Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

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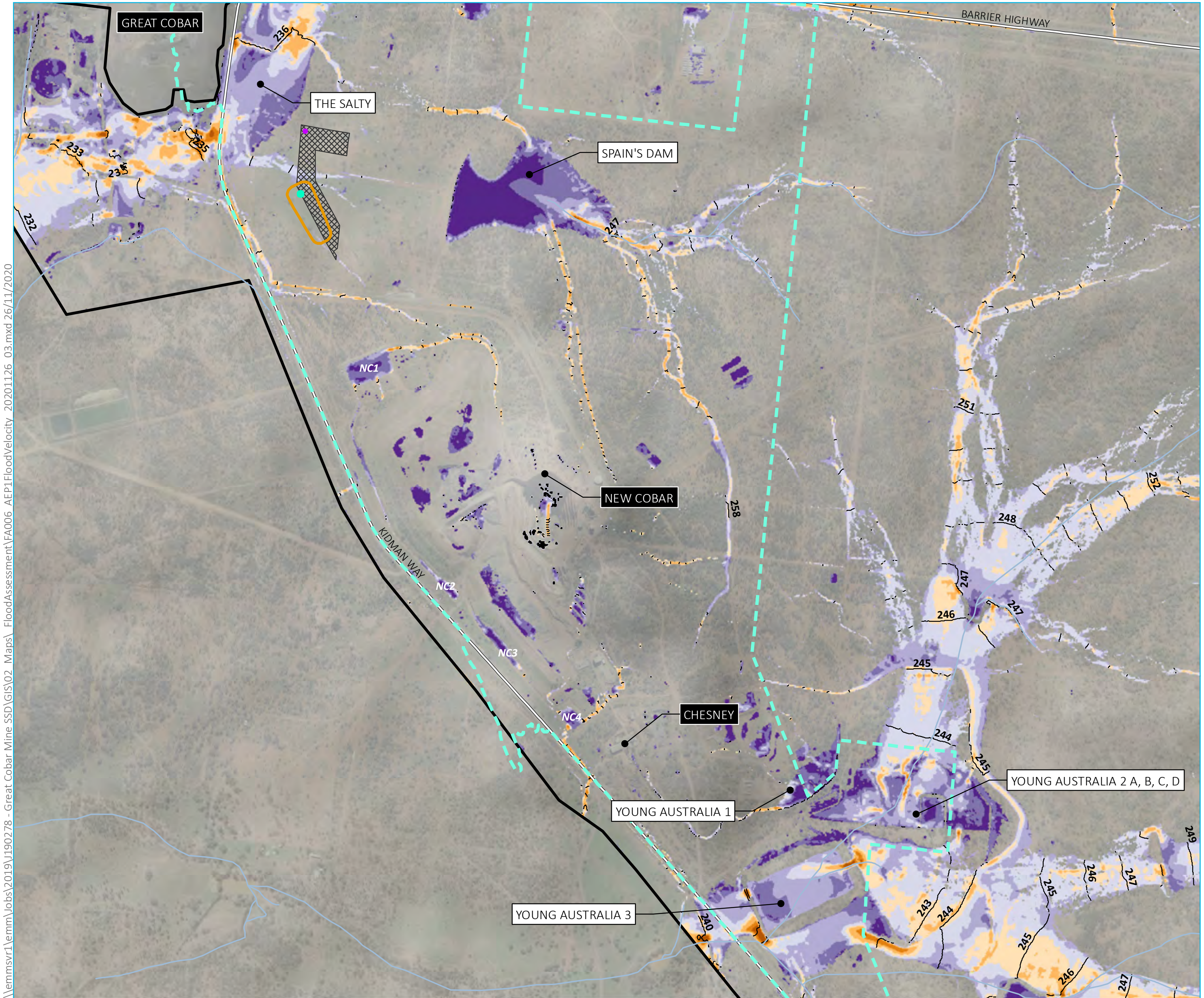
1% AEP flood depth and level

Peak Gold Mines
New Cobar Complex Project
Surface water assessment
Figure A.3

EMM
creating opportunities



KEY
- Project area
- Exhaust air rise buffer
- Fresh air intake
- Exhaust air rise
- Proposed power line corridor
- Main road
- Watercourse/drainage line
- TUFLOW model boundary
- 1% AEP flood level contour

1% AEP flood velocity (m/s)
- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- >2

DRAFT

Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

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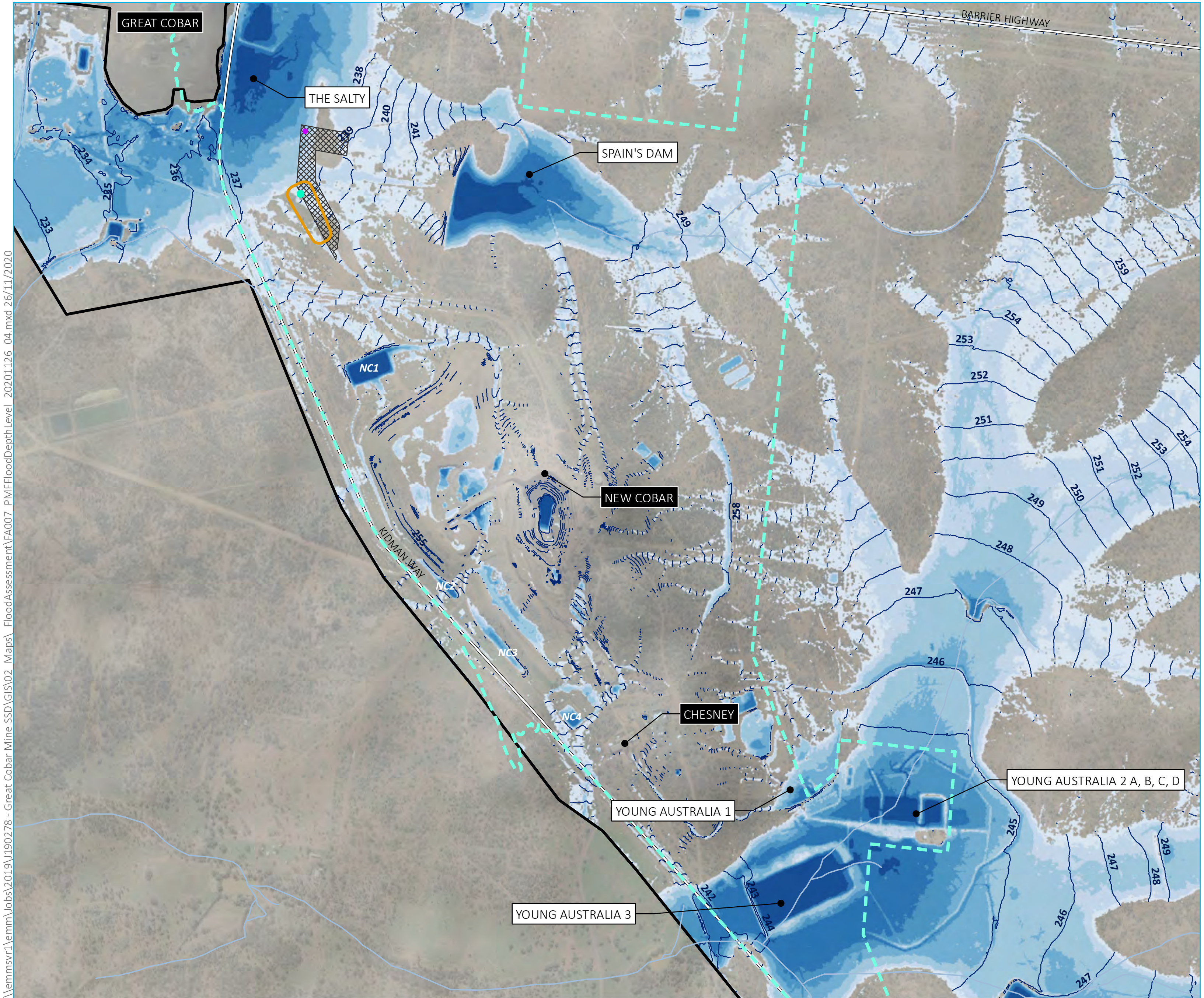
1% AEP flood velocity

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure A.4

EMM
creating opportunities



Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

0 250 500 m
GDA 1994 MGA Zone 55
N

KEY

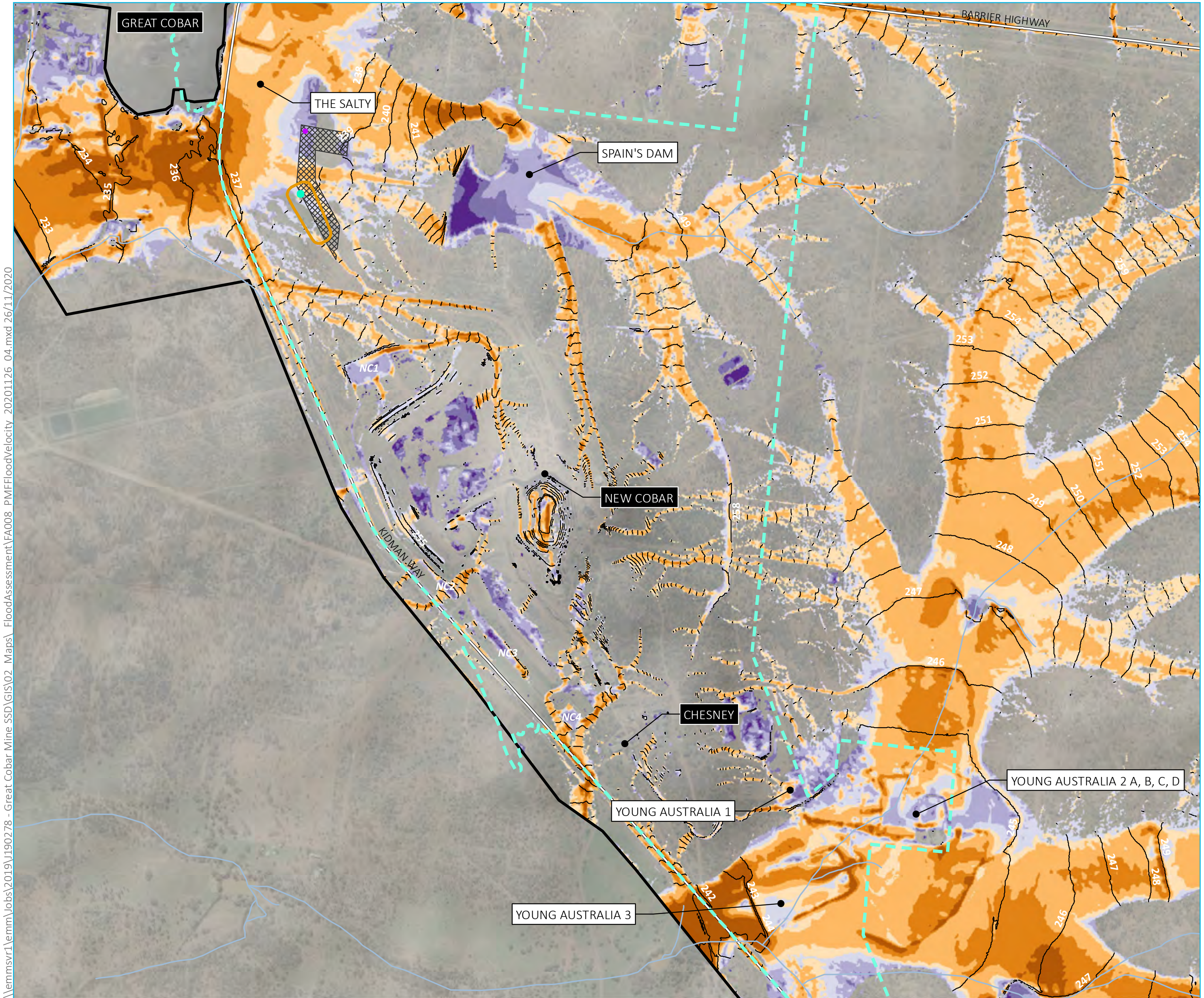
- Project area
- Exhaust air rise buffer
- Fresh air intake
- Exhaust air rise
- Proposed power line corridor
- Main road
- Watercourse/drainage line
- TUFLOW model boundary
- PMF flood level contour

PMF flood depth (m)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

PMF flood depth and level

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure A.5



KEY

- Project area
- Exhaust air rise buffer
- Fresh air intake
- Exhaust air rise
- Proposed power line corridor
- Main road
- Watercourse/drainage line
- TUFLOW model boundary
- PMF flood level contour

PMF flood velcoity (m/s)

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- >2

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PMF flood velocity

Peak Gold Mines
New Cobar Complex Project
Flood assessment
Figure A.6

EMM
creating opportunities

Source: EMM (2020); DFSI (2017); GA (2011); DPE (2019)

0 250 500 m
GDA 1994 MGA Zone 55
N

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C.1 Appendix Heading

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