Appendix I
Water assessment

EMM
creating opportunities

HVO Continuation Project - Amendment

Water Assessment

Prepared for HV Operations Pty Ltd

July 2025

HVO Continuation Project - Amendment

Water Assessment

HV Operations Pty Ltd

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Executive Summary

ES1 Project introduction and overview

Hunter Valley Operations (HVO) is a multi-pit open cut mining complex approximately 24 kilometres north-west of Singleton in the Hunter Valley of New South Wales. HVO comprises two mine sites separated by the Hunter River, HVO North (approved under development consent DA 450-10-2003) and HVO South (operating under Project Approval 06_0261). While the two mine sites are approved under separate development consents, they are operated as one complex with fully integrated environmental management systems.

The HVO Continuation Project broadly comprises the continuation of mining at HVO North and HVO South, from the current approved mining completion dates of December 2026 and March 2030, respectively. Development applications and a supporting environmental impact statement (EIS) was submitted for the HVO Continuation Project in 2022; referred to as the 'original Project' from herein. This original Project refers to all assessment documentation associated with SSD 11826621 and SSD 11826681 including the EIS (EMM 2022a), Submissions Report (EMM 2023a), HVO North Amendment Report (EMM 2023b) and related correspondence (including EMM 2024a and 2024b). Following public exhibition of the EIS, submissions were received by the NSW Department of Planning, Housing and Infrastructure (DPHI) from individuals, organisations, public authorities, councils, and government agencies for the two development applications.

Following the subsequent assessment of the original Project by DPHI and request to HVO for further information, HVO completed a detailed review of the original Project and is subsequently seeking to amend the State significant development (SSD) applications. The amendment (the amended Project) primarily relates to limiting the mine plan extent of coal extraction north of the Hunter Valley dyke at HVO North and reducing the proposed life of mining operations at HVO North by five years from the end of 2050 to the end of 2045 and at HVO South by three years from the end of 2045 to the end of 2042. The proposed annual Run of Mine (ROM) coal production limit has also been reduced.

The amended Project still includes several infrastructure upgrades and changes required to facilitate the amended Project, including realignment of part of Lemington Road and improvements to Lake James and Parnells Dam.

This water assessment forms part of the Amendment Report (EMM 2025) and provides an assessment of the potential impacts of the amended Project on water resources and water-dependent assets. It also presents an assessment of the potential incremental impacts of the continuation of HVO North and HVO South given separate development consents are being sought for each operation, where practical. The water assessment is an overarching report documenting and summarising the findings of the different water-related technical assessments conducted to support the Amendment Report, including:

- the groundwater modelling report prepared by EMM Consulting Pty Ltd
- the surface water impact assessment addendum prepared by Engeny Water Management (Engeny 2025)
- the aquatic ecology and groundwater dependent ecosystems (GDEs) assessment addendum prepared by Eco Logical Australia (ELA 2025).

The conceptual understanding of the hydrological and hydrogeological environment remains unchanged since the original Project (EMM 2022a). As such the assessment methods and tools (e.g. numerical models) which have been peer reviewed and deemed fit-for-purpose also remain unchanged since the EIS and response to submissions (RTS) phases.

This water assessment report documents the results of the assessments listed above, initiatives to avoid and minimise impacts and additional mitigation and management measures proposed to address residual impacts not able to be avoided (which remain largely unchanged since the original Project).

The potential impacts of the amended Project on water resources are generally consistent with the existing approved operations, given that the amended Project predominantly comprises mining through previously mined areas. Consistent with the findings presented in the original Project, some minor changes in impacts are predicted, including changes to timing as per the proposed changes to the project life and mining schedule.

The amended Project involves continued operations within portions of catchments that are currently or have been historically subject to extensive mining or impacts associated with mining, or areas of approved future mining. The existing operation has a well-established water management system (WMS) in place to minimise surface water impacts and operates in accordance with existing water access licences (for surface water and groundwater take) and environment protection licence (EPL) 640, as well as the Hunter River Salinity Trading Scheme (HRSTS) to manage excess water.

The existing WMS will continue to be used to manage runoff with all water captured in active mining areas and mine surface runoff directed to the WMS. The existing approved clean water diversions will continue to divert runoff around the WMS, which will also continue for the amended Project with the aim to minimise clean water take where practicable. There are no new creek diversions proposed or required as part of the amended Project, and there are no proposed changes to water access licences (WALs) or the EPL, consistent with what was presented in the original Project.

The proposed key changes at the HVO Complex (of relevance on water resources) are summarised in Table ES1.

Table ES1 Amended Project water-related activities that have the potential to impact water resources

Water-related activities for amended Project	Description of change from original Project
HVO North	
Continuation of mining operations at HVO North until 31 December 2045	Change – proposed mine life was to the end of 2050 in the original Project.
Production of up to 22 million tonnes per annum (Mtpa) with no separation of extraction limits between West Pit and Carrington Pit	No change
Continuing to mine down to the base of the Barrett Seam in the West and Mitchell Pit areas, and down to the base of the Bayswater Seam in the approved Carrington West Wing area	Change – mining to the base of the Barrett seam in the Carrington area was proposed in the original Project. Amendment mine plan limits extent of coal extraction north of the Hunter Valley dyke.
Realignment of Lemington Road and construction of a new Hunter River bridge crossing, which will significantly improve the flood immunity of this road adjacent to the Hunter River, reducing road closures in flooding events	No change
Improved flood protection levee for North Pit tailings storage facility (TSF) (up to 0.1% Annual Exceedance Probability (AEP)) as per Glencore's operating standard	No change
Improved flood protection for the Carrington West Wing levee (up to 0.1% AEP)	No change
Establishment of a new levee (Mitchell East Levee) to provide flood protection for the HVO North main final void.	Change
An increase in the capacity of Parnells Dam (Dam 9W) from approximately 1 gigalitre (GL) to approximately 4 GL	No change
Installation of the approved Carrington West Wing barrier wall across the western arm of the paleochannel, and prior to undertaking mining within 100 metres (m) of the remnant paleochannel	No change

Water-related activities for amended Project	Description of change from original Project
Reducing the number of approved final voids that will remain post closure from three to two final voids at HVO North - North Void and the approved Carrington Void	Change – one void was proposed in the original Project. Amended mine plan will not mine through the approved Carrington Void.
HVO South	
Continuation of mining operations at HVO South until 31 December 2042	Change - proposed mine life was to the end of 2045 in the original Project.
A reduction in the approved maximum extraction rate from 20 Mtpa to 13 Mtpa	Change – a maximum extraction rate of 18 Mtpa was proposed in the original Project.
Removal of coal extraction from the mine plan for the Riverview South East Extension (RSEE), South Lemington Pit 1 and 2 (SLP 1 and SLP 2) mining areas	No change
Remove approval for the construction and operation of the Lemington Coal Preparation plant (LCPP) and associated rail facilities, which is currently approved, but not constructed, under the HVO South Project Approval	Change – the original Project proposed to maintain approval to construct the LCPP and associated rail facilities.
Construction of the Cheshunt and Riverview Pit flood protection levees (up to 0.1% AEP)	No change
An increase in the capacity of Lake James (Dam 15S) from approximately 0.7 GL to approximately 2 GL	No change
One final void will remain largely the same as that currently approved at HVO South	No change

ES2 Water resources

Surface water resources in the vicinity of the HVO Complex include the Hunter River, Wollombi Brook and other minor watercourses such as Farrells Creek and Parnells Creek. The Hunter River, and highly connected alluvial groundwater within 40 m of the river bank, is managed under the NSW *Water Sharing Plan (WSP) for the Hunter Regulated River Water Source 2016*. The tributaries to the Hunter River are managed under the *WSP for the Hunter Unregulated and Alluvial Water Sources 2022*.

The *WSP for the North Coast Fractured and Porous Rock Groundwater Sources 2016* applies to the Permian groundwater resources within the amended Project area.

Consistent with the original Project, the main groundwater resources in the amended Project area include:

- Alluvial aquifers (including the paleochannel) form unconfined aquifers, and quality is fresh to brackish. The alluvium is generally more permeable than other lithologies, with recorded hydraulic conductivities ranging from 10^{-2} metres per day (m/d) to 10^{2} m/d (AGE 2022).
- The regolith does not form aquifers due to limited saturated thickness.
- Permian interburden layers form aquitards.
- Permian coal seams generally form low to moderately permeable confined aquifers, with poor groundwater quality. Hydraulic conductivity generally decreases with depth due to increased rock mass strength (AGE 2022).

The amended Project mine plan will intercept groundwater and result in changes to the existing groundwater and surface water environment. However, the HVO Complex already comprises active and approved open cut pits and the potential for the amended Project to result in a significant incremental impact on water resources is low.

Consistent with the original Project, water receptors include:

- downstream water users accessing surface water via water access licences and basic landholder rights
- third-party landholder bores located upstream and downstream of the HVO Complex, typically installed in the alluvium
- ecosystems that potentially rely on surface water and/or groundwater:
    - river red gum vegetation stands (including in the Carrington Billabong area) that opportunistically access shallow groundwater recharged by leakage from the Hunter River and Wollombi Brook, and rely on flooding for germination
    - Central Hunter Ironbark Grassy Woodland (formerly Bull Oak Grassy Woodland of the Central Hunter Valley) and Central Hunter Swamp Oak Riparian Forest (formerly Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley) vegetation
    - stygofauna occurring principally in alluvial sediments along the Hunter River and its tributaries
    - aquatic ecosystems
    - Warkworth Sand Woodland communities which rely principally on rainfall infiltration and a seasonal perched watertable observed to occur after large rainfall events.

ES3 Assessment findings

The assessment approaches and methods for the different technical studies (surface water (including modelling), groundwater modelling, aquatic ecology and GDEs) are described in the supporting appendices to the Water Assessment prepared for the original Project (EMM 2022a). The assessment methods have been peer reviewed and found fit for the intended purpose. As such, the assessment methods remain unchanged from the original Project.

The modelling and assessments show the amended Project can operate within and meet the requirements of the water regulatory framework. Key results are summarised in Table ES2.

Table ES2 Summary of assessment findings

Study	Impact aspect	Original Project findings	Amended Project findings
Surface water	Water management system performance	The existing WMS with the proposed additional components (dams, pumps and pipelines) will enable water at HVO to be managed in accordance with the water management plan objectives, current EPL and WALs.	
	Streamflow impacts – during operation	• Negligible impact on the regulated Hunter River, with any changes to leakage or baseflow managed via existing WALs. • Reduced operational impacts on Wollombi Brook when compared to approved operations. • Minor changes predicted to streamflows along three watercourses during operations when compared to approved operations (Parnells Creek, Unnamed Tributary 1 and Farrells Creek).	• Positive impact on Hunter River streamflow when compared to approved operations due to an increase in surface water catchment to Hunter River. • Reduced operational impacts on Wollombi Brook when compared to approved operations and the original Project. • No change to the number and duration of dry periods for Wollombi Brook in comparison to the original Project. • Minor changes predicted to streamflows along three watercourses during operations when compared to approved operations (Parnells Creek, Unnamed Tributary 1 and Farrells Creek) – but less impact when compared to the original Project.
	Surface water quality	Discharge under the HRSTS is not expected to have an adverse effect on surface water quality or change the beneficial use.	
	Flooding impacts	As the mine plan proposed for the amended Project does not encroach onto the floodplain further than the original Project or further reduce floodplain storage, flood modelling and associated impact assessment has not been re-simulated for the amended Project. The flooding assessment conducted for the original Project is described in the original Project Surface Water Impact Assessment (SWIA) (Engeny 2022).	

Study	Impact aspect	Original Project findings	Amended Project findings
Groundwater	Groundwater drawdown – during mining (Hunter River alluvium: Carrington Billabong)	Minimal incremental drawdown (0.2 to 0.5 m) is predicted in the Hunter River alluvium around the Carrington Billabong area, and up to 0.2 m at mapped river red gum stands. The predicted drawdown will be buffered by leakage through the riverbed. Predicted cumulative drawdown during operations is between 0.2 m to 1 m in the Hunter River alluvium and is due to depressurisation of the Permian hydrostratigraphy and an associated downward vertical gradient between the alluvial watertable and the Permian potentiometric surface. The depressurisation is related to mining at HVO North and HVO South and dewatering of the alluvium is not predicted to occur.	Minimal incremental drawdown of up to approximately 0.5 m in the Hunter River alluvium in a small area north of the Carrington Billabong, and up to 0.2 m at mapped river red gum stands. The area of predicted incremental drawdown (defined by the 0.2 m contour) is smaller than that predicted for the original Project, due to the amended Project mine plan not progressing as close the Hunter River or as deep. Cumulative drawdown in the Hunter River alluvium near Carrington Billabong is predicted to be similar to the incremental drawdown, covering a slightly larger area. This is a positive impact (i.e. less cumulative drawdown) in comparison to the original Project predictions.
	Groundwater drawdown – during mining (Hunter River alluvium: Carrington West Wing)	No incremental drawdown was predicted in the Carrington West Wing area, south of the low permeability barrier wall.	Consistent with the original Project, no incremental drawdown is predicted in the Carrington West Wing area, south of the low permeability barrier wall.
	Groundwater drawdown – during mining (Wollombi Brook alluvium)	No incremental drawdown predicted in the Wollombi Brook alluvium, given mining is no longer proposed at RSEE, SLP 1 or SLP 2. Up to 2 m cumulative drawdown in the Wollombi Brook alluvium above the historical Lemington underground mine. Drawdown is predicted due to the simulated continued use of groundwater from the Lemington underground for operational water use, continuing the downward vertical gradient between the Permian groundwater systems and the Wollombi Brook alluvium.	No incremental drawdown predicted in the Wollombi Brook alluvium, given mining is no longer proposed at RSEE, SLP 1 or SLP 2. This is consistent with the original Project. Cumulative drawdown around Wollombi Brook alluvium is up to 2 m. This is consistent with the original Project.
	Groundwater drawdown – post closure (Hunter River alluvium)	Incremental maximum drawdown of 0.5 m drawdown was predicted in the Hunter River alluvium around the Carrington West Wing area. Maximum cumulative drawdown was predicted to remain in the same areas as during operations but will spread slightly. This is due to the influence of the continuing evaporative pumping effect from the final voids post mining whilst the groundwater regime reaches a new equilibrium.	There is no incremental drawdown predicted in the Hunter River alluvium due to the amended Project. This is a positive impact in comparison to the original Project. Maximum cumulative drawdown of up to 2 m is predicted in the Carrington Billabong area and up to 0.5 m in the Carrington West Wing area.
	Groundwater drawdown – post closure (Wollombi Brook alluvium)	No incremental drawdown predicted in the Wollombi Brook alluvium. Cumulative drawdown in Wollombi Brook alluvium of up to 5 m in the vicinity of the Lemington underground mine.	No incremental drawdown predicted in the Wollombi Brook alluvium. Maximum cumulative drawdown in Wollombi Brook alluvium is predicted up to 2 m, upstream of the confluence with Hunter River in the vicinity of the Lemington underground mine. This is consistent with the original Project.

Study	Impact aspect	Original Project findings	Amended Project findings
	Groundwater quality	Consistent with the original Project, no changes to the environmental, community or cultural values of groundwater are predicted (negligible impact on groundwater quality). No changes to the environmental, community and cultural values referenced in Section 4.3.4 are predicted due to the amended Project.	
	Groundwater inflow to pits	Groundwater inflows to HVO mining areas peak at approximately 2,100 megalitres per year (ML/yr) in Year 18 (approximately 2040).	Groundwater inflows to HVO mining areas peak at 2,488 ML/yr in Year 13 (approximately 2039). The results are broadly consistent with the original Project with some variability owing to the updated numerical representation of mine progression and changes to the annual pit progression including size and timing of open areas and proximity to the Hunter River alluvium (noting hydraulic properties are the same as those adopted for the EIS modelling (AGE 2022)).
Geochemistry	Geochemical assessment	No change from the original Project, as no new material will be intercepted. This has therefore not been reassessed for the amended Project. The majority of rejects generated by the amended Project are likely to be non-acid forming (NAF). Although 15% of the rejects samples tested were potentially acid forming (PAF), the thorough intermingling of rejects and overburden, and the excess acid neutralising capacity in the overburden, suggests that these bulk fill zones are unlikely to result in any significant acid rock drainage issues or effects on rehabilitation. Existing waste management practices will continue to isolate PAF and manage any leachate or water quality risks.	
Water receptors	Third party bores	No impact is predicted at privately-owned groundwater bores.	
	Surface water users	Potential impacts on surface water downstream users will be negligible as no changes in streamflow regimes are predicted in the Hunter River, given it is a regulated system and HVO holds sufficient entitlement for the predicted reduction in streamflow due to the amended Project.	
	Terrestrial GDES	Consistent with the original Project, no significant impact on terrestrial GDEs associated is predicted. As the predicted drawdown extent and magnitude in the alluvium is less when compared with the original Project, there is a slight positive impact as slightly less drawdown is predicted in the Hunter River alluvium for the amended Project.	
	Subterranean GDEs (Stygofauna)	The risk to the stygofauna community associated with the amended Project is low because there will be no additional excavation in the alluvium beyond what has already been approved. The cumulative impact to the stygofauna community from already-approved mining in the paleochannel is high.	
Final voids	Residual void landform catchment area	The amended Project is consistent with the original Project final void assessment; both have an overall reduction in catchment area reporting to the final voids in comparison to the approved operations. This will result in increased catchment and surface runoff to the surrounding waterways, which is a positive impact in comparison to the approved operations.	
		Catchment areas reporting to voids: HVO South void: 714 hectares (ha) HVO North void: 720 ha Total: 1,434 ha	Catchment areas reporting to voids HVO South void: 570 ha HVO North (main) void: 706 ha Carrington void: 324 ha Total: 1,600 ha
	Long-term pit lake levels	Final void levels for the amended Project are generally consistent with that predicted for the original Project, with equilibrium predicted to occur several hundred years after cessation of mining and evaporation causing all final voids to act as groundwater sinks.	

Study	Impact aspect	Original Project findings	Amended Project findings
		Median long-term pit lakes: HVO South void: -83.9 mAHD (159 m freeboard) HVO North void: -80.4 mAHD (155 m freeboard)	Median long-term pit lake levels: HVO South void: -29.7 mAHD (110 m freeboard) HVO North void: -17.8 mAHD (100 m freeboard) Carrington void: 41.8 mAHD (14 m freeboard)
	Long-term pit salinity levels	All three pit lakes are shown to have an ongoing trend towards higher salinity over time with the forecast median total dissolved solids (TDS) values of 7,100 mg/L, 21,550 mg/L and 8,400 mg/L for North Void, Carrington Void, and South Void respectively when equilibrium water levels are reached. This is consistent with original Project predictions that also show increasing salinity over time.	

ES3.1 Water licensing

HVO holds considerable water entitlement in the relevant surface water and groundwater sources in the amended Project area, which is sufficient to account for the predicted take in most water sources.

During operations:

- the predicted take from the Sydney Basin North Coast Fractured Rock groundwater source is below HVO's existing entitlement
- the predicted indirect groundwater take from the Hunter regulated river alluvial water sources (and management zones) is below HVO's existing entitlement
- the small predicted peak indirect groundwater (alluvial) take from the Jerrys water source (4 ML/yr) exceeds HVO's entitlement. Prior to the take occurring, HVO will either apply to convert sufficient existing unregulated river entitlements to aquifer entitlements or purchase entitlement via the open market to account for the small predicted indirect groundwater take in the Jerrys Water Source
- the predicted indirect surface water take (associated with watertable drawdown) from the Hunter Regulated River Water Source and the unregulated river water sources can be met by HVO's existing entitlement
- consistent with the original Project, HVO is seeking an amendment of the WM Regulation hydroline to reflect the approved WMS, including approved stream diversions, and to have any residual licensing liability for captured rainfall runoff based on this amended drainage configuration. Once updated, the WMS only includes dams either off stream or located on minor hydrolines and therefore are exempt from requiring WALs as the dams meet the definition of excluded works in the WM Regulation (to prevent the contamination of a water source)
- the predicted peak water take from the Hunter Regulated River Water Source required to meet operational requirements is within HVO's existing high security entitlement.

Post-mining:

- During the closure period:
  - the water management structures identified within the conceptual final landform will act as sediment dams to control runoff water quality by retaining sediment until adequate vegetation cover is established. Post-mining, when the vegetation cover criteria have been met, the dams will be decommissioned or converted to dry retention basins, retained as harvestable rights dams (if on minor streams) or retained with the required water supply work approvals acquired (if on non-minor streams)
  - take associated with runoff captured from storages on non-minor streams within the Jerry water source (Jerrys management zone) during the transition period that exceeds HVO's existing entitlement will be sourced from the open market (including trade, in accordance with the water sharing plan rules). There is adequate share entitlement within the Jerrys Water Source for the predicted take. In addition, the Hunter Unregulated and Alluvial water sharing plan allows for trade (permanently and temporarily) into the Jerrys Water Source from several (17) other upstream water sources. This demonstrates there is sufficient entitlement within the water source and upstream water sources for HVO to obtain additional entitlement via the open market
  - HVO will apply to convert sufficient aquifer entitlements to unregulated river entitlements for the predicted peak take associated with dams on non-minor streams in the Lower Wollombi Brook Water Source during closure.
- At closure (i.e. in the long-term), residual take will be limited to direct take associated with evaporative losses from the final voids and associated indirect surface water and groundwater take:
  - the predicted long-term take from the Sydney Basin North Coast Fractured Rock groundwater source is below HVO's existing entitlement
  - the predicted indirect groundwater take from the Hunter regulated river alluvial water sources (and management zones) is below HVO's existing entitlement
  - the predicted peak indirect groundwater (alluvial) take from the Jerrys water source (26 ML/yr) exceeds HVO's entitlement. Prior to the take occurring, HVO will either apply to convert sufficient existing unregulated river entitlements to aquifer entitlements or purchase entitlement via the open market
  - the predicted indirect surface water take (associated with watertable drawdown) from the Hunter Regulated River Water Source and the unregulated river water sources can be met by HVO's existing entitlement.

The final detail of any post mining dam configuration, design of the drainage systems and associated licensing will be further investigated and resolved during preparation of the relevant stages of the Rehabilitation Management Plan and in the detailed closure planning process.

ES4 Monitoring, management and mitigations

As described in the original Project, the WMP will be reviewed and updated following Project approval. The update will include review of the existing surface water, groundwater and ecological monitoring, so that WMP performance criteria and verification of assessment findings can be assessed. The proposed management and mitigation measures listed in the water -related assessments are consistent with the existing mitigation measures in place at HVO and documented in the original Project. This is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance and changes to timing associated with the amended Project.

In addition to review and extension of the existing WMP and associated monitoring, HVO will augment the existing groundwater monitoring network to include additional monitoring bores in the Carrington West Wing alluvium area (south of the Carrington West Wing low permeability barrier wall). The bores will be installed approximately one year prior to mining commencing in the remnant paleochannel to allow collection of background groundwater level trends prior to the potential effects of mining.

The locations and designs of the additional groundwater monitoring locations will be determined in consultation with NSW Government during updates to the WMP.

In accordance with condition 25 of the HVO North development consent (DA 450-10-2003), HVO will develop a low permeability barrier monitoring and management plan following Project approval and in consultation with the NSW Government.

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1 Introduction

1.1 Background

Hunter Valley Operations (HVO) is a multi-pit open cut mining complex approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW) (Figure 1.1). HVO comprises two mine sites separated by the Hunter River, HVO North and HVO South. The sites operate under separate development consents issued under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) but operate as a single integrated operation with fully integrated environmental management systems. The layout of the HVO complex is shown in Figure 1.2.

The existing HVO North operates under Development Consent DA 450-10-2003, which allows for extraction of 22 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 31 December 2026. HVO North comprises the approved mining areas of West Pit, Mitchell Pit, Carrington Pit and North Pit, as well as the Hunter Valley (HV) and Howick Coal Preparation Plants (CPP) and the Howick and HVO North mine infrastructure areas (MIA). The Newdell Load Point (LP) and Hunter Valley (HVLP) train loading facilities are also at HVO North.

HVO South operates under Project Approval (PA) 06_0261 and comprises the approved mining areas of Riverview Pit, Cheshunt Pit, Riverview South East Extension (RSEE) and South Lemington Pits 1 and 2 (SLP 1 and SLP 2), as well as the MIA, and the Lemington CPP (LCPP) and rail loop (approved but not constructed). PA 06_0261 allows the extraction of up to 20 Mtpa of ROM coal until 24 March 2030.

HVO is seeking approval for the HVO Continuation Project, which proposes extending mining beyond the current approved mining end dates of 2026 at HVO North and 2030 at HVO South.

Given that the two mine sites operate as one complex, one environmental impact statement (EIS, EMM 2022a) was prepared to support the two State Significant Development (SSD) applications for the original Project, being:

- SSD-11826681 – HVO North Open Cut Coal Continuation Project
- SSD-11826621 – HVO South Open Cut Coal Continuation Project.

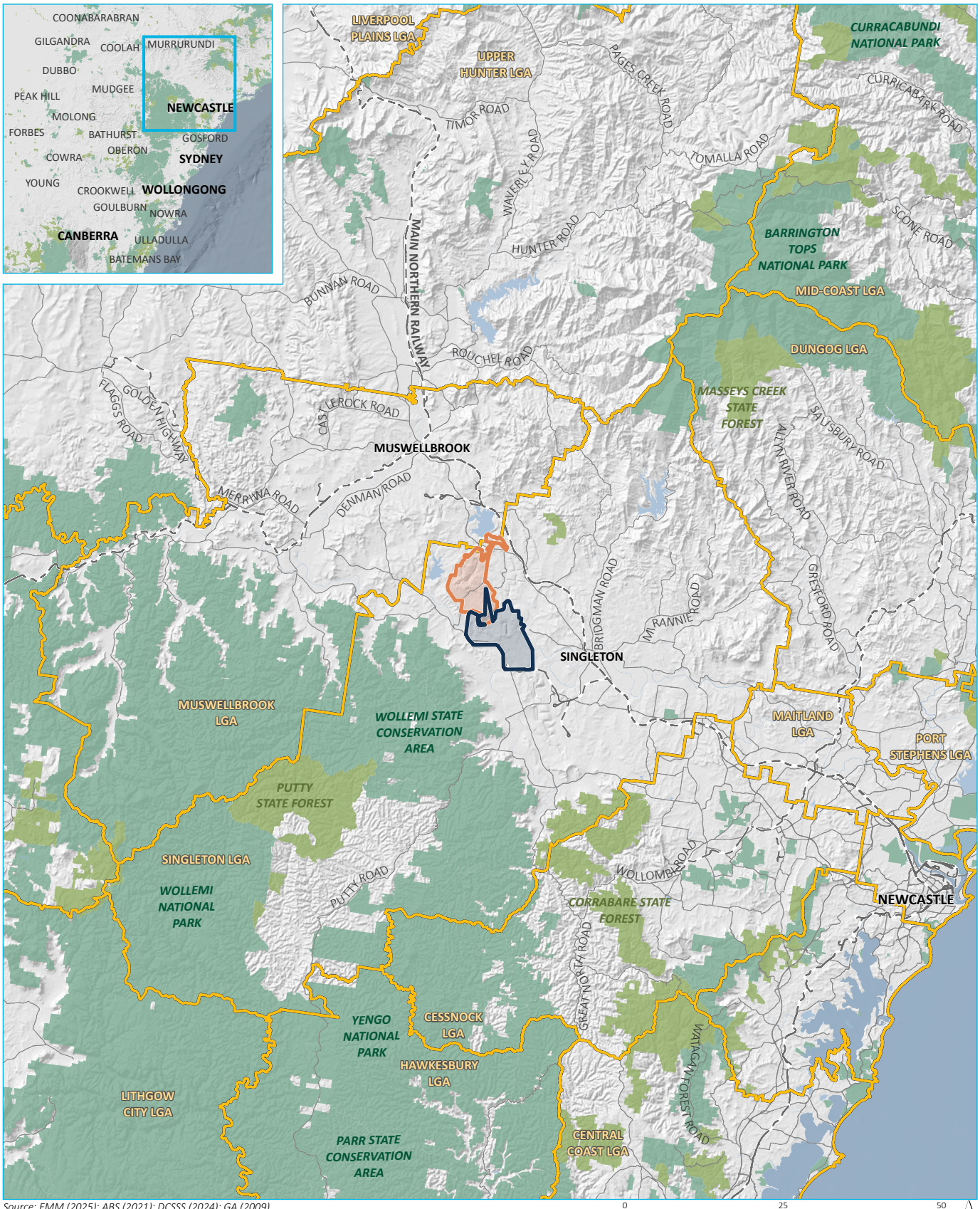
During the public exhibition of the EIS for the original Project, submissions were received by the NSW Department of Planning, Housing and Infrastructure (DPHI) from individuals, organisations, public authorities, councils, and government agencies for the two development applications. To respond to matters raised in submissions on the original Project during the public exhibition period, a Submissions Report (EMM 2023a) was prepared, along with an Amendment Report (EMM 2023b) outlining proposed amendments to the HVO North Project. It is noted that reference to the original Project refers to all assessment documentation associated with SSD 11826621 and SSD-11826681 including the EIS (EMM 2022a), Submissions Report (EMM 2023a), HVO North Amendment Report (EMM 2023b) and subsequent correspondence.

As part of subsequent assessment of the original Project by DPHI, HVO completed a detailed review of the original Project and is subsequently seeking to amend the SSD applications in the following ways that have relevance to water resources:

- Reduce the mine plan to avoid coal extraction within gas Domain 1 at HVO North and reduce the total ROM coal to be extracted by the amended Project by approximately 220 Mt.
- Maintain the current approved maximum annual ROM coal production from HVO North of 22 Mtpa but reduce the proposed maximum annual production limit at HVO South from 18 Mtpa to 13 Mtpa.
- Propose a maximum annual production limit for the HVO Complex of 26 Mtpa ROM, compared to the current approved maximum annual production of 42 Mtpa.

- Reduce the proposed life of mining operations at HVO North by five years, from the end of 2050 to the end of 2045.
- Reduce the proposed life of mining operations at HVO South by three years from the end of 2045 to the end of 2042.
- Expansion of the HVO North ROM coal stockpile to improve coal management.
- Remove approval for the construction and operation of the LCPP and associated rail facilities, which is currently approved, but not constructed, under the HVO South Project Approval.
- Temporary transport of product coal by truck from the Howick CPP to the Liddell stockpile for transport to market via the Liddell coal handling and train loading facilities during upgrades of the Newdell LP.
- Establishment of a levee (Mitchell East Levee) to provide flood protection for the final void in Mitchell Pit.
- Minor alterations to disturbance boundaries to accommodate construction activities such as Lemington Road and electricity transmission lines.

Further detail on the proposed amendments is provided in the Amendment Report (EMM, 2025a).



Source: EMM (2025); ABS (2021); DCSSS (2024); GA (2009)

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KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest
- Local government area

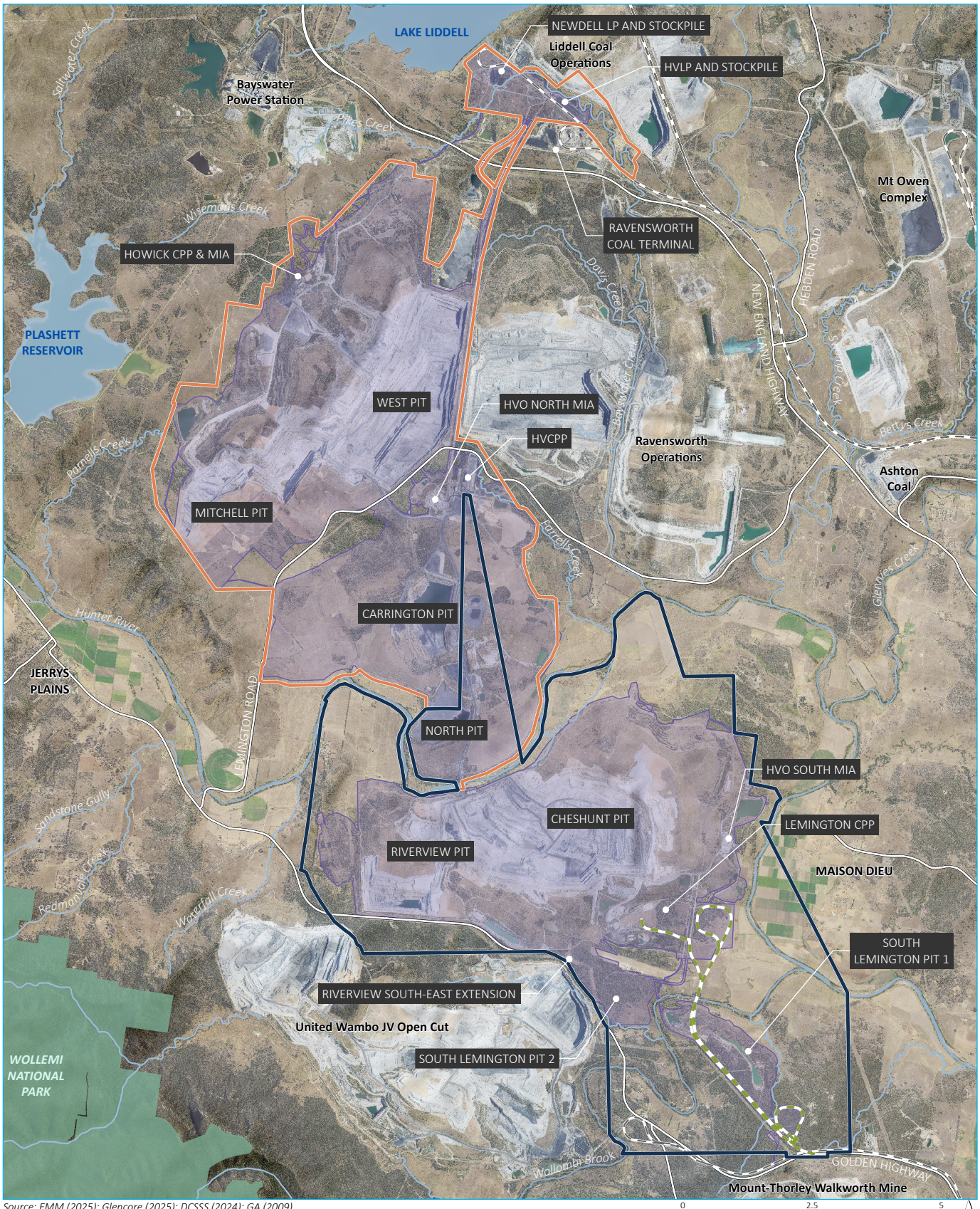
INSET KEY

- NPWS reserve
- State forest

Locality plan

HVO Continuation Project - Amendment
Water Assessment
Figure 1.1

EMM
creating opportunities



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)
- Existing and approved disturbance area
- South Lemington Rail Loop and haul route (approved, not yet constructed)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Local context

HVO Continuation Project - Amendment
Water Assessment
Figure 1.2

EMM
creating opportunities

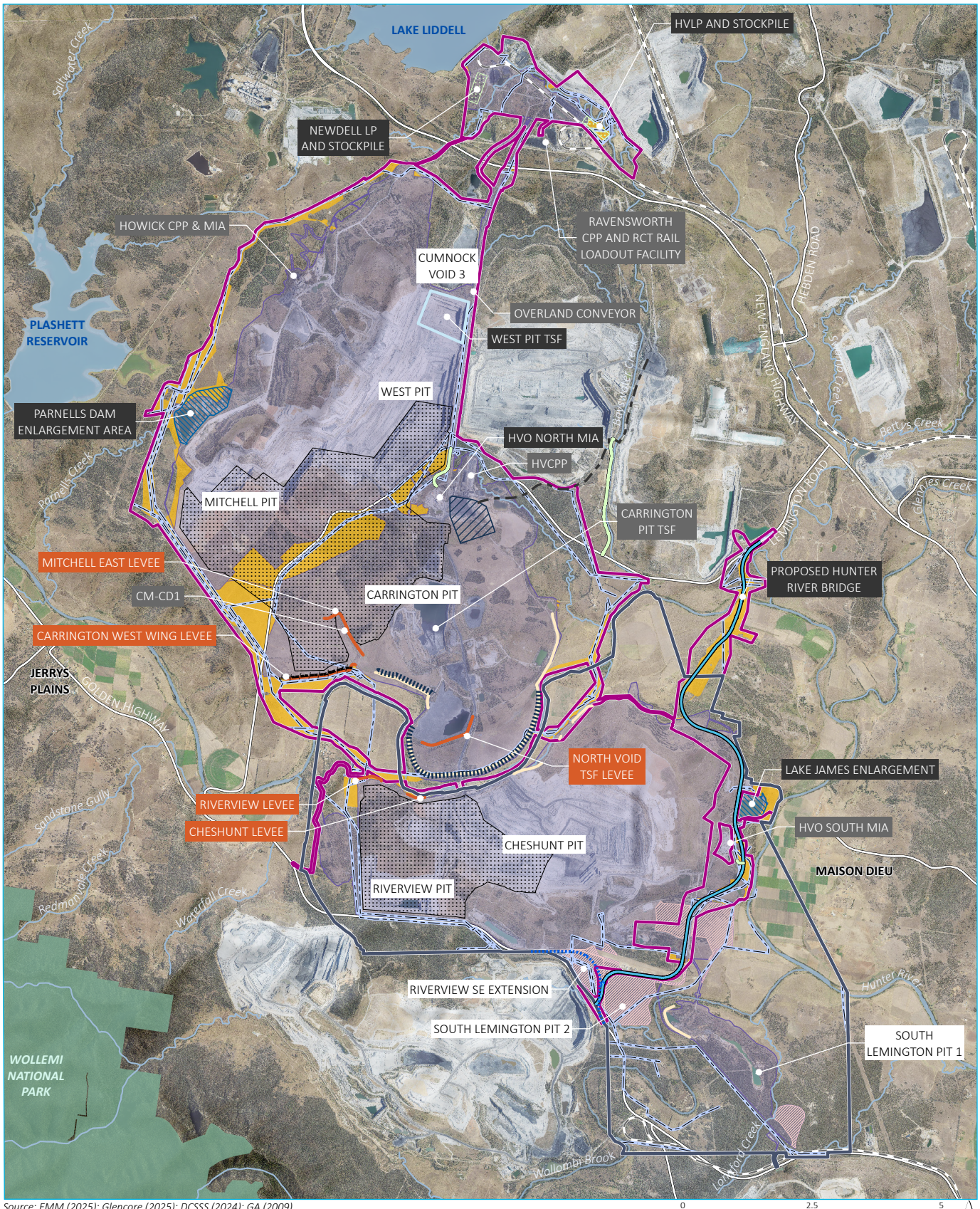
1.2 Project overview

As noted in Section 1.1, the amended Project broadly comprises the continuation of mining at HVO North and HVO South, beyond the current approved mining completion dates of 2026 and 2030, respectively. The key components of the amended Project are illustrated on Figure 1.3 and summarised (with a focus on aspects relevant to water resources) in Section 2.2.

1.3 Project terminology

The following key terms are used throughout this assessment to describe the amended Project:

- HVO Complex – comprises both HVO North and HVO South operations.
- Project area – the area that is the subject of the two development applications, i.e. the proposed development consent boundary for HVO North and the proposed development consent boundary for HVO South.
- Original Project – all assessment documentation associated with SSD-11826621 and SSD-11826681 including the EIS (EMM 2022a), Submissions Report (EMM 2023a), HVO North Amendment Report (EMM 2023b) and associated correspondence (including EMM 2024a and 2024b).
- Amended Project - the original Project, as amended as per the Amendment Report (EMM 2025a).



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Existing and approved disturbance area
- Additional disturbance area
- Previous approved area not retained
- Existing low permeability barrier wall
- Existing levee

Proposed HVO continuation project element

- Approved barrier wall (not yet constructed)
- Alternative Golden Highway alignment
- Lemington Road realignment
- Levee
- Mine access road
- Proposed haul route to Ravensworth Operations
- Transmission line
- Dam enlargement
- Mining area
- Product stockpile
- ROM coal stockpile enlargement area
- West Pit TSF

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Label format

- Existing item
- Levee
- Project related item

Proposed conceptual layout

HVO Continuation Project - Amendment
Water Assessment
Figure 1.3

EMM
creating opportunities

1.4 Purpose of this report

This water assessment forms part of the Amendment Report and provides an assessment of the potential impacts of the amended Project on water resources and water-dependent assets. It also assesses the potential incremental impacts of the continuation of HVO North and HVO South given separate development consents are being sought for each operation. The water assessment is an overarching report documenting and summarising the findings of the different water-related technical assessments conducted for the amended Project, including:

- the groundwater modelling report prepared by EMM Consulting Pty Ltd (EMM 2025b), attached in Attachment A of this report. This is based on work carried out by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE 2022) for the original Project
- the updated Surface Water Impact Assessment (SWIA) prepared by Engeny Water Management (Engeny 2025), attached in Attachment B of this report
- the updated Aquatic Ecology and Groundwater Dependent Ecosystems (GDEs) Assessment prepared by Eco Logical Australia (ELA 2025), attached in Appendix J of the Amendment Report.

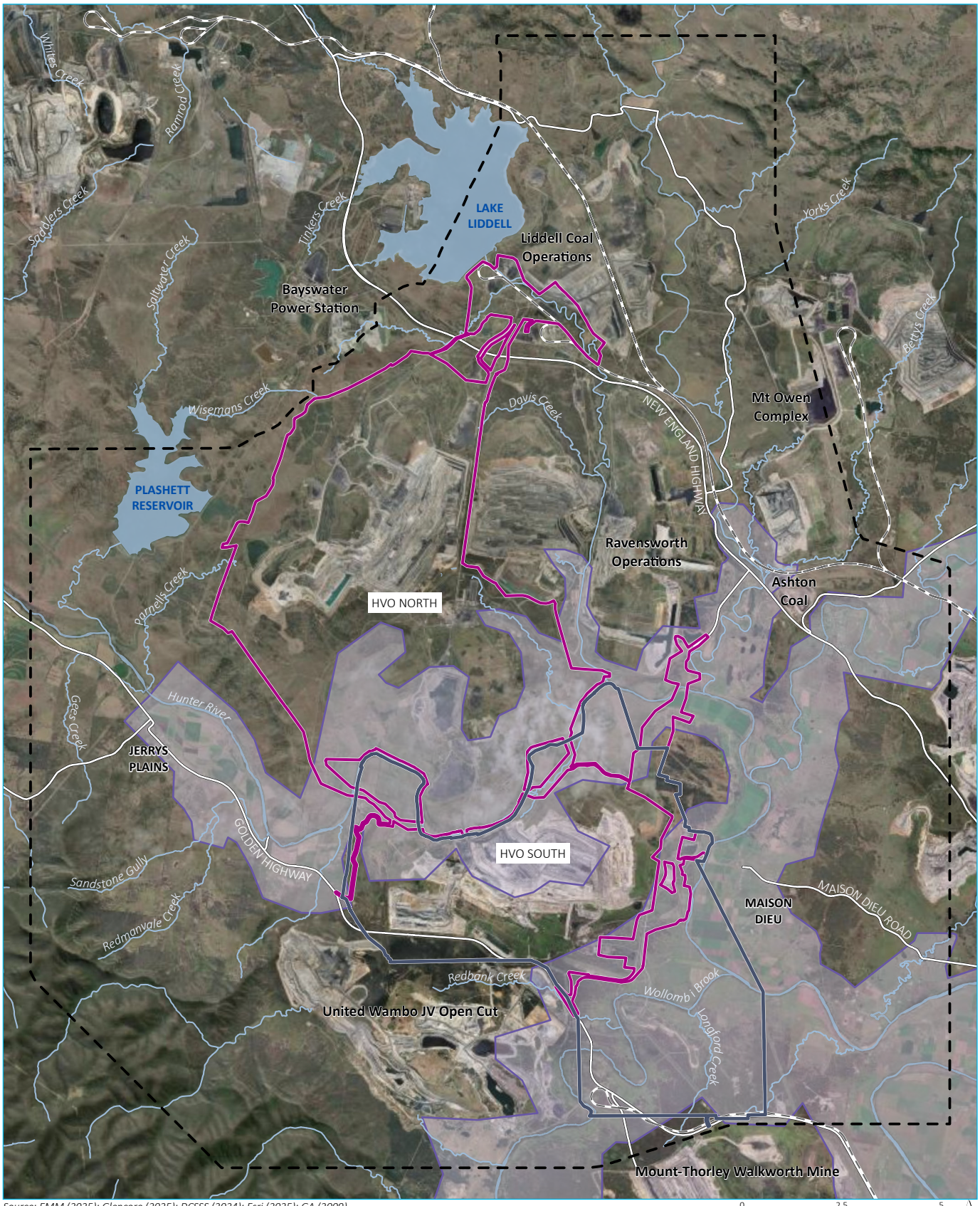
Note, the Geochemical Assessment prepared by Environmental Geochemistry International Pty Ltd (EGi 2022a) has not been updated for this Amendment Report as there are no significant changes to waste management and therefore no significant changes to water quality anticipated from the amended Project in comparison to the original Project.

The water assessment documents the results of the assessments listed above, initiatives to avoid and minimise impacts and additional mitigation and management measures proposed to address residual impacts not able to be avoided (which remain largely unchanged since the original Project).

1.5 Water study areas

Each technical assessment (as discussed in Section 1.4) focused on a particular area that was relevant to the subject matter. For example, the study area for the Groundwater Impact Assessment (GIA) is larger than that considered in the water balance.

The proposed development consent boundaries and study areas are illustrated in Figure 1.4. These study areas for each technical assessment are consistent with those used in the original Project (EMM 2022b).

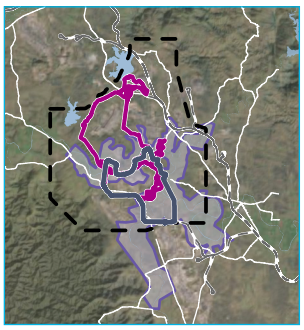


Source: EMM (2025); Glencore (2025); DCSSS (2024); Esri (2025); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater model extent
- Flood model boundary

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Water study areas

HVO Continuation Project - Amendment
Water Assessment
Figure 1.4

EMM creating opportunities

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2 Project context

2.1 Existing water management

The HVO Complex currently operates under an integrated water management system (WMS) across HVO North and South, in accordance with the approved water management plan (WMP). The existing WMS is detailed in the HVO Water Management Plan (HVO, 2018). It is noted that there is an updated WMP currently under review by NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW). The two WMPs are generally consistent with one another.

The HVO WMS consists of a network of infrastructure (i.e. dams, pipelines, contour banks) to control the movement of water around the site. Water is managed according to type, which is determined by catchment source, quality and use. Water managed at HVO includes mine water; sediment water; and clean water.

Clean water diversion structures and levees divert clean water away from the active pits. The majority of water used on site is for coal processing and dust suppression. Mine water is preferentially used to reduce the amount of water discharged to the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) and the extraction of water under the Hunter River surface water allocations.

Excess mine water can be released via licensed discharge points to the Hunter River. Discharges are only allowed during high and flood flow periods in the Hunter River as determined by Water NSW and DCCEEW. Discharges are regulated by conditions in the site Environment Protection Licence (EPL) and by the *Hunter River Salinity Trading Scheme Regulation 2000* (HRSTS).

HVO holds both high and general security Water Access Licences (WALs) to withdraw water from the Hunter Regulated River to meet water deficits. In addition, water transfer systems are in place with both Mount Thorley Warkworth and Glencore's Liddell Coal Mine.

The existing water management system is detailed further in the WMP and SWIA (Attachment B).



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)
- Existing levee
- Low permeability barrier wall
- Sediment dam
- Mine water storage
- Tailings dam
- Hunter River pump station
- HRSTS discharge facility

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Key existing water management aspects

HVO Continuation Project - Amendment
Water Assessment
Figure 2.1

EMM
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2.2 Key water affecting activities of the amended Project

The proposed key changes at the HVO Complex (of relevance to on water resources) are summarised in Table 2.1.

Table 2.1 Amended Project water-related activities that have the potential to impact water resources

Water-related activities for amended Project	Description of change from original Project
HVO North	
Continuation of mining operations at HVO North until 31 December 2045	Change – proposed mine life was to the end of 2050 in the original Project.
Production of up to 22 Mtpa with no separation of extraction limits between West Pit and Carrington Pit	No change
Continuing to mine down to the base of the Barrett Seam in the West and Mitchell Pit areas, and down to the base of the Bayswater Seam in the approved Carrington West Wing area	Change – mining to the base of the Barrett seam in the Carrington area was proposed in the original Project. Amended mine plan limits extent of coal extraction north of the Hunter Valley dyke.
Realignment of Lemington Road and construction of a new Hunter River bridge crossing, which will significantly improve the flood immunity of this road adjacent to the Hunter River, reducing road closures in flooding events	No change
Improved flood protection levee for North Pit tailing storage facility (TSF) (up to 0.1% Annual Exceedance Probability (AEP)) as per Glencore's operating standard	No change
Improved flood protection for the Carrington West Wing levee (up to 0.1% AEP)	No change
Establishment of a new levee (Mitchell East Levee) to provide flood protection for the HVO North main final void.	Change
An increase in the capacity of Parnells Dam (Dam 9W) from approximately 0.7 gigalitre (GL) to approximately 4 GL	No change
Installation of the approved Carrington West Wing low permeability barrier wall (LPBW) across the western arm of the paleochannel, and prior to undertaking mining within 100 metres (m) of the remnant paleochannel	No change
Reducing the number of approved final voids that will remain post closure from three to two final voids at HVO North - North Void and the approved Carrington Void	Change – one void was proposed in the original Project. Amended mine plan will not mine through the approved Carrington Void.
HVO South	
Continuation of mining operations at HVO South until 31 December 2042	Change - proposed mine life was to the end of 2045 in the original Project.
A reduction in the approved maximum extraction rate from 20 Mtpa to 13 Mtpa	Change – a maximum extraction rate of 18 Mtpa was proposed in the original Project.
Removal of coal extraction from the mine plan for the RSEE, SLP 1 and SLP 2 mining areas	No change
Remove approval for the construction and operation of the LCPP and associated rail facilities, which is currently approved, but not constructed, under the HVO South Project Approval	Change – the original Project proposed to maintain approval to construct the LCPP and associated rail facilities.
Construction of the Cheshunt and Riverview Pit flood protection levees (up to 0.1% AEP)	No change

Water-related activities for amended Project	Description of change from original Project
An increase in the capacity of Lake James (Dam 15S) from approximately 0.7 GL to approximately 2 GL	No change
One final void will remain largely the same as that currently approved at HVO South	No change

Further information on the key differences between the current approved, previously proposed (original Project), and current amendment is provided in the Amendment Report (EMM 2025a).

2.3 Proposed water management

2.3.1 Proposed WMS

Consistent with the original Project, the amended Project will continue the use of the existing integrated WMS, which includes water transfers to and from surrounding operations, while incorporating upgrades to facilitate the amended Project.

Key water management aspects for the amended Project are presented on Figure 2.2.

Conceptual WMS stage plans and design criteria are presented in the SWIA (Attachment B). Water management schematics for the amended Project are also presented and discussed in the SWIA (Attachment B).

Some components of the WMS have changed for the amended Project, compared to the WMS proposed in the original Project (Engeny 2022). These changes are largely driven by a reduced mining extent and modified sequencing, particularly in HVO North, a modified tailings strategy and more efficient infrastructure sequencing. An overview of the key differences compared to the original Project WMS included:

- fewer new dams proposed in HVO North, reflecting the reduced disturbance footprint
- fewer existing dams are proposed for upgrade, with some upgrade requirements resolved prior to the amended Project through PRP works (e.g. Dam 14W upgrade no longer required)
- no new sediment dams are proposed in the early stages of HVO North for pre-strip management, with sediment control managed by reclassifying and upgrading existing storages where possible
- reclassification of multiple storages to dry detention basins at closure, to align with the proposed final landform and long-term passive management
- fewer mine water storages proposed around overburden areas (classified as sediment dams instead).

2.3.2 Carrington West Wing low permeability barrier wall

As currently approved, a low permeability barrier wall (LPBW) is to be constructed in the western arm of the paleochannel in the Carrington West Wing area to limit groundwater migration from the Hunter River (and associated alluvium) into the HVO North mining areas and potential migration of water from the backfilled HVO North pit to the Hunter River alluvium.

The Carrington West Wing LPBW will be constructed prior to undertaking mining within 100 m of the western arm of the Hunter River paleochannel. This represents the approach documented as part of the original Project. The proposed location of the approved but not yet constructed Carrington West Wing LPBW is shown on Figure 2.2.

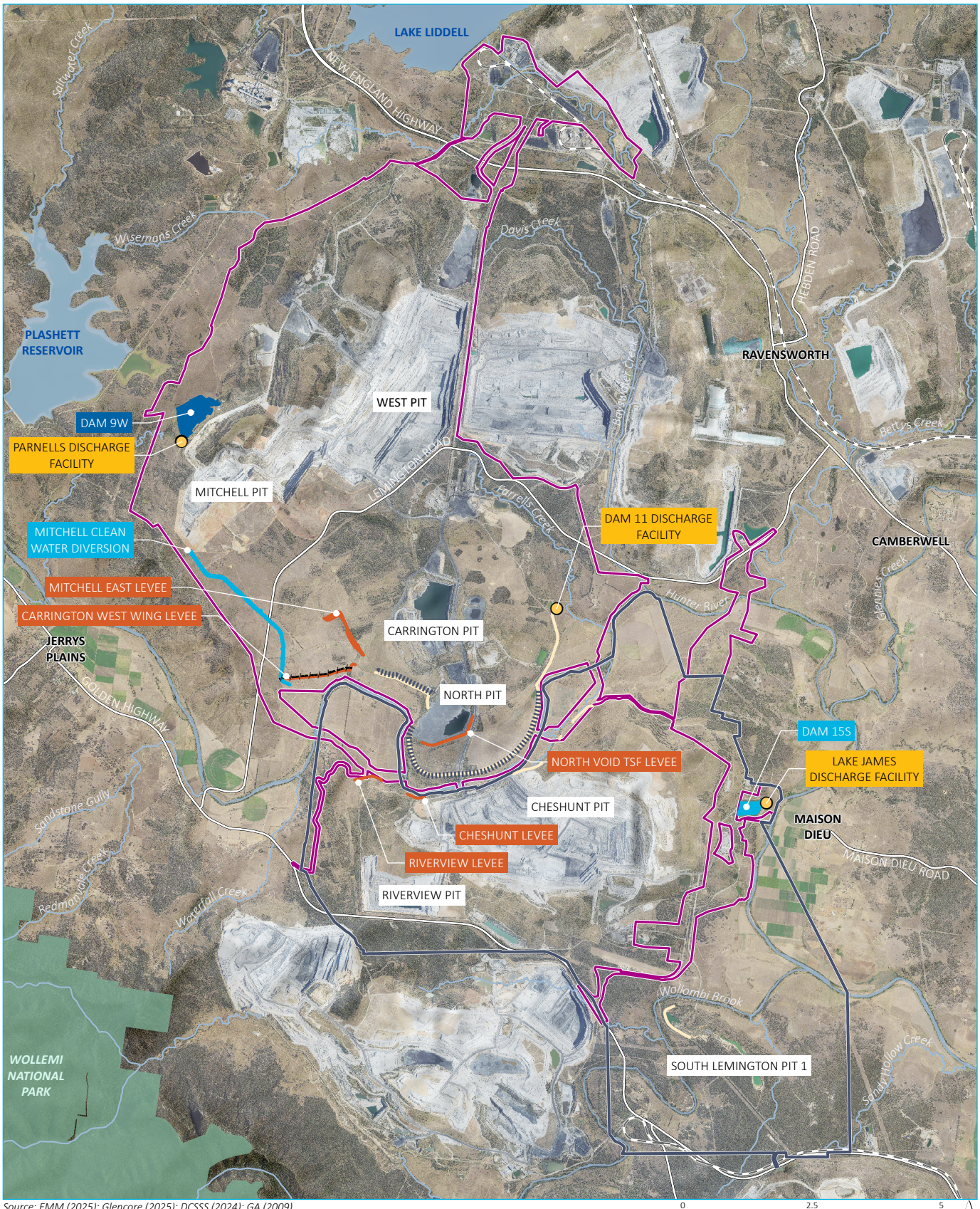
2.3.3 Final voids

Consistent with the original Project, the amended Project has been designed to optimise resource recovery and operational efficiencies at the HVO Complex whilst avoiding and minimising environmental and social impacts; ultimately resulting in final voids. The final landform proposed in the original Project contained two voids: one at HVO North and one at HVO South. The final landform for the amended Project now includes three residual voids: two at HVO North (North Void and Carrington Pit Void (already approved)); and one at HVO South (South Void). These proposed final voids and final landform are shown on Figure 2.3.

All final voids are predicted to be long-term sinks in which no water is expected to be released from the void to the receiving environment. A discussion on the predicted pit lake recovery is provided in Chapter 10 and Attachment B. The proposed final voids at HVO North and HVO South are briefly described below:

- **HVO North:** The approved final landform at HVO North includes three final voids, one in West Pit, one in Mitchell Pit and one in Carrington Pit. The amended Project will reduce the number of final voids that will remain post mining at HVO North, from the three approved to two voids: a main void (HVO North Void) and the Carrington Void, as shown in Figure 2.3. This will result in a reduction of the catchment area reporting to the voids at HVO North when compared to the currently approved operation.

- **HVO South:** Consistent with the current Project approval, one final void will remain at HVO South, in the south-western corner of Riverview Pit. The proposed final void dimensions will be smaller than currently approved due to mine sequencing refinement and infrastructure relocation.



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- HRSTS discharge facility
- Existing levee
- Existing low permeability barrier wall

Water management infrastructure upgrade

- Approved barrier wall (not yet constructed)
- Clean water diversion
- Levee
- Lake James capacity increase
- Parnells Dam capacity increase

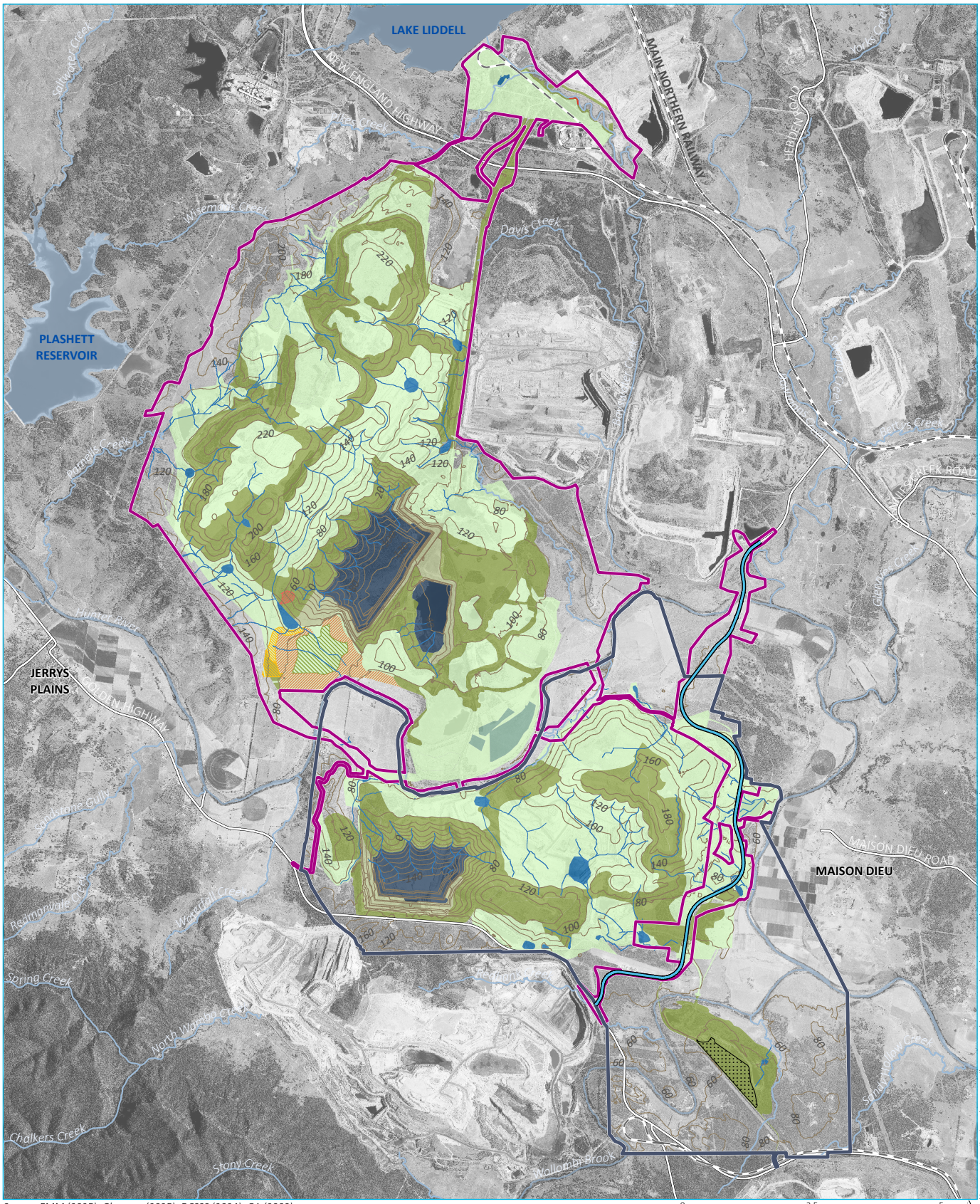
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Project water management

HVO Continuation Project- Amendment
Water Assessment
Figure 2.2

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Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Proposed South Lemington offset
- Predicted drainage
- Predicted 20 m contour
- Lemington Road realignment

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Final landform land use domain

- Domain A | Native ecosystem
- Domain A- Sub domain Ka | Other- Native ecosystem- partial vegetation on highwall benches
- Domain B | Agriculture- grazing
- Domain B- Sub domain Kb | Other- Agriculture- alluvial land
- Domain G | Water storage
- Domain J | Pit Lake

Existing commitments maintained by the Project (indicative location)

Rural land capability

- Class 2- DA 450-10-2003 MOD3
- Class 3- DA 450-10-2003 MOD3
- Class 4- DA 450-10-2003 MOD3

Native ecosystem

- Central Hunter Box-Ironbark Woodland - DA 450-10-2003 MOD3
- Swamp Oak Floodplain Forest - DA 450-10-2003 MOD5

Conceptual final landform

HVO Continuation Project - Amendment
Water Assessment
Figure 2.3

EMM
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3 Regulatory and policy context

An overview of the regulatory framework and guidelines relevant to the water assessments is provided in Sections 3.1 to 3.3. Further description and the requirements of the legislations, policies and guidelines are included in Attachment C.

3.1 Legislation overview

The primary water related statutes that apply to the amended Project are the *Water Act 1912* (Water Act), *Water Management Act 2000* (WM Act), *Protection of the Environment Operations Act 1997* (POEO Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The provisions of each Act are applied in accordance with their attendant regulation.

Table 3.1 lists the legislation relevant to the amended Project to assess potential impacts on water resources and water-dependent assets.

Table 3.1 Relevant legislation and regulations

Legislation	Authority	Relevant to
Environmental Planning and Assessment Act 1979	Department of Planning, Housing and Infrastructure (DPHI)	All water assessments
Water Management Act 2000	DCCEEW Natural Resources Access Regulator (NRAR)	All water assessments
Water Management (General) Regulation 2018	DCCEEW	Water licensing and approvals
Protection of Environment Operations Act 1997	NSW Environment Protection Authority (EPA)	All water assessments
Biodiversity Conservation Act 2016	DCCEEW Biodiversity, Conservation and Science Division	Aquatic and GDE assessment
Fisheries Management Act 1994	Department of Primary Industries	Aquatic and GDE assessment

3.2 Relevant NSW policies

3.2.1 Overview

Consistent with the original Project, the water assessments of the amended Project are required to consider the following policies and plans to characterise and assess potential impacts on water resources:

- relevant water sharing plans (WSPs)
- Aquifer Interference Policy (AIP; 2012)
- State Groundwater Dependent Ecosystems Policy (2002)
- Strategic Regional Land Use Policy (2012)
- Strategic Regional Land Use Plan – Upper Hunter (2012)
- Non-Urban Water Metering Policy (2020)
- Flood Risk Management Manual (2022).

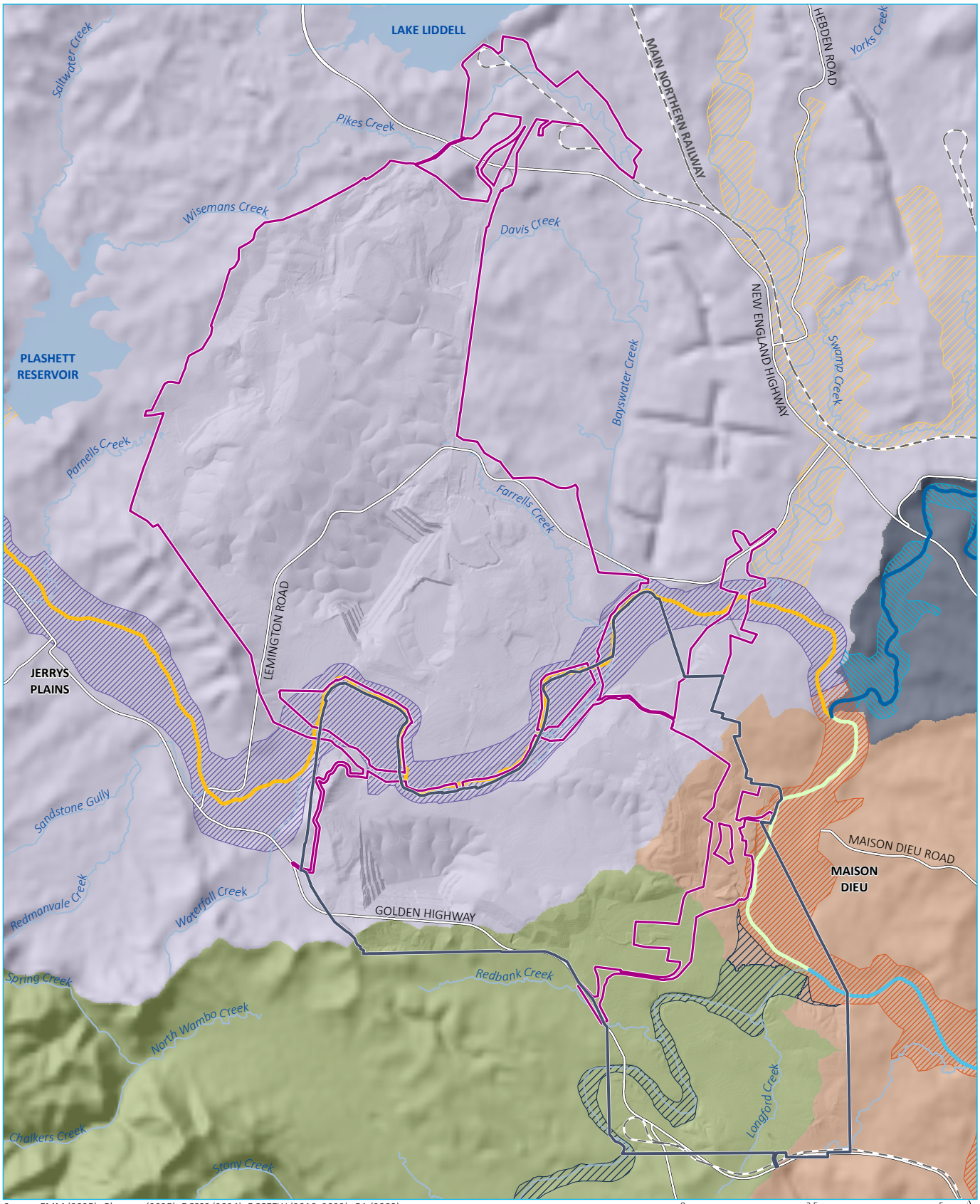
The relevant WSPs are key documents dictating the assessment of the potential impacts of the amended Project on water resources and are described in Section 3.2.2. Other relevant policies and plans are further detailed in Attachment C.

3.2.2 Water sharing plans

WSPs are statutory documents dictating the management and sharing of water sources. The WSPs set the water management vision and objectives, management rules for WALs, what water is available within the various water sources, and procedures for dealing in 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 (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, domestic and stock, basic rights and WALs.

The Study area is within the catchments of the Hunter River and its tributaries. Three WSPs apply to the groundwater and surface water resources in the Study area and are described in subsequent sections. Figure 3.1 shows the WSP and water sources for the Hunter River, tributaries and alluvium.



Source: EMM (2025); Glencore (2025); DCSSS (2024); DCCEEW (2016, 2022); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary

Hunter Unregulated and Alluvial Water Sources 2022 WSP

Unregulated River Water Sources

- Glennies Water Source
- Jerrys Water Source
- Lower Wollombi Brook Water Source
- Singleton Water Source

Hunter Regulated River Alluvial Water Source Management Zone

- Downstream Glennies Creek
- Glennies Creek
- Jerrys
- Upstream Glennies Creek
- Other alluvium

Hunter Regulated River 2016 WSP

- Management Zone 1B (Hunter River from Goulburn RiverJunction to Glennies Creek Junction)
- Management Zone 2A (Hunter River from Glennies Creek Junction to Wollombi Brook Junction)
- Management Zone 2B (Hunter River from Wollombi Brook Junction to Downstream Extent of the Hunter River)
- Management Zone 3A (Glennies Creek)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Water sharing plans

HVO Continuation Project- Amendment
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Figure 3.1

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i Hunter Regulated River Water Source 2016

The *WSP for the Hunter Regulated River Water Source 2016* (Hunter Regulated River WSP) covers the surface flows and highly connected alluvial aquifers within 40 m of the river banks of the Hunter River and Glennies Creek. The Hunter River is a regulated river, which are gazetted streams that have flows controlled by state-owned water storages. The Hunter River is regulated by releases from Glenbawn Dam upstream of HVO and Glennies Creek Dam further downstream. These storages are operated by WaterNSW to supply bulk, raw water for irrigation, towns and stock and domestic needs as far downstream as Maitland.

The long-term average annual extraction limit for the Hunter Regulated River is 217,000 megalitres per year (ML/yr).

The Hunter Regulated Water Source is divided into management zones, defined from the confluence of Glennies Creek with the Hunter River. The Study area encompasses multiple management zones:

- Zone 1B: Hunter River from Goulburn River junction to Glennies Creek junction
- Zone 2A: Hunter River from Glennies Creek junction to Wollombi Brook junction
- Zone 2B: Hunter River from Wollombi Brook junction to Oakhampton rail bridge
- Zone 3A: Glennies Creek.

Table 3.2 presents a summary of the total entitlement shares in the Hunter Regulated River zones relevant to the amended Project area. Table 3.3 summarises the entitlements held by HVO in the various entitlement categories in the Hunter Regulated River Water Source.

Table 3.2 Summary of Hunter Regulated River WSP water requirements and entitlements

Entitlement category	Zone 1A (from Glenbawn Dam to Goulburn River Junction)	Zone 1B (from Goulburn River junction to Glennies Creek junction)	Zone 2A (from Glennies Creek junction to Wollombi Brook junction)	Zone 2B (from Wollombi Brook junction to Oakhampton rail bridge)	Zone 3A (Glennies Creek)
Basic landholder rights (from WSP[1])					
Domestic and stock (ML/yr)	1,628	964	141	2,234	548
Water access licences (from WSP[1])					
Domestic and stock (ML/yr)	672	101	27	855	181
Major utility (ML/yr)	0	36,000	0	0	0
Local water utility (ML/yr)	5,800	32	0	0	5,000
Regulated river (High security) (unit shares)	5,182	5,128	2,809	6,971	1,650
Regulated river (General security) (unit shares)	46,925	29,475	3,053	43,298	5,793
Supplementary (unit shares)	4,441	40,166	505	3,289	117

Entitlement category	Zone 1A (from Glenbawn Dam to Goulburn River Junction)	Zone 1B (from Goulburn River junction to Glennies Creek junction)	Zone 2A (from Glennies Creek junction to Wollombi Brook junction)	Zone 2B (from Wollombi Brook junction to Oakhampton rail bridge)	Zone 3A (Glennies Creek)
Water access licences (from NSW Water Register[2])					
Domestic and stock (ML/yr)			1,812		
Major utility (ML/yr)			36,000		
Local water utility (ML/yr)			10,832		
Regulated river (High security) (unit shares)			21,740		
Regulated river (General security) (unit shares)			128,544		
Supplementary (unit shares)			48,519.22		

Notes: 1. Sourced from the Hunter Regulated River WSP.

2. Total share components were obtained from NSW water register (WaterNSW) for financial year 2024/25.

Table 3.3 Summary of entitlements held by HVO in the Hunter Regulated River Water Source

Entitlement category	Zone 1A (from Glenbawn Dam to Goulburn River Junction)	Zone 1B (from Goulburn River junction to Glennies Creek junction)	Zone 2A (from Glennies Creek junction to Wollombi Brook junction)	Zone 2B (from Wollombi Brook junction to Oakhampton rail bridge)	Zone 3A (Glennies Creek)
Domestic and stock (ML/yr)	0	8	0	16	0
Regulated river (High security) (unit shares)	0	3,183	1,506	0	0
Regulated river (General security) (unit shares)	0	5,244	1,393	613	0
Supplementary (unit shares)	0	98	301.5	128.4	0

ii Hunter Unregulated and Alluvial Water Sources 2022

The *WSP for the Hunter Unregulated and Alluvial Water Sources 2022* (Hunter Unregulated and Alluvial WSP) applies to watercourses and alluvial groundwater in the vicinity of the HVO Complex, except for the Hunter River. It also applies to the Hunter River alluvial groundwater at a distance greater than 40 m from the river banks.

The Hunter unregulated river has the following water sources of relevance to the amended Project area (refer Figure 3.1):

- Jerrys Water Source
- Lower Wollombi Brook Water Source
- Singleton Water Source
- Glennies Water Source.

The alluvial groundwater source (Hunter Regulated River Alluvial Water Source) has the following management zones of relevance to the amended Project area (refer Figure 3.1):

- Upstream Glennies Management Zone (MZ)
- Glennies MZ
- Downstream Glennies MZ.

Table 3.4 presents a summary of the total entitlement shares in the water sources of relevance to the amended Project area. Table 3.5 summarises the entitlements held by HVO in the various entitlement categories in the Hunter Unregulated River and Alluvial Water Sources.

Table 3.4 Summary of Hunter Unregulated and Alluvial WSP water requirements and entitlements

Entitlement category	Hunter Regulated River Alluvial Water Source			Jerrys Water Source	Lower Wollombi Brook Water Source	Singleton Water Source	Glennies Water Source
	D/S Glennies Creek MZ	Glennies Creek MZ	U/S Glennies Creek MZ				
Basic landholder rights (from WSP[1])							
Domestic and stock (ML/yr)		116		459	306	344	565
Harvestable rights (ML/yr)		N/A		4,869	2,913	2,947	3,743
Water access licences (from WSP[1])							
Domestic and stock (ML/yr)	0	0	0	10	53	13	0
Major utility (ML/yr)	0	0	0	7,700	0	0	0
Local water utility (ML/yr)	4,095	0	843	0	0	0	0
Unregulated river (unit shares)		N/A		2,097 (2,044 in the Jerrys MZ)	6,625.2	1,170	446

Entitlement category	Hunter Regulated River Alluvial Water Source			Jerrys Water Source	Lower Wollombi Brook Water Source	Singleton Water Source	Glennies Water Source
	D/S Glennies Creek MZ	Glennies Creek MZ	U/S Glennies Creek MZ				
Aquifer (unit shares)	7,130	10	15,960	1,241	3,745	230	10
Water access licences (from NSW Water Register[2])							
Domestic and stock (ML/yr)		0		10	53	13	0
Major utility (ML/yr)		0		7,700	0	0	0
Local water utility (ML/yr)		4,938		0	0	0	0
Unregulated river (unit shares)		N/A		2,097	6,663	1,170	446
Aquifer (unit shares)		24,118		1,251	3,745	230	10

Notes: 1. Sourced from the Hunter Unregulated and Alluvial WSP.

2. Total share components were obtained from NSW water register (WaterNSW) for financial year 2024/25.

Table 3.5 Summary of entitlements held by HVO in the Hunter Unregulated and Alluvial Water Sources

Entitlement category	Hunter Regulated River Alluvial Water Source			Jerrys Water Source (Jerrys MZ)	Lower Wollombi Brook Water Source	Singleton Water Source	Glennies Water Source
	D/S Glennies Creek MZ	Glennies Creek MZ	U/S Glennies Creek MZ				
Unregulated river (unit shares)		N/A		705	88	0	0
Aquifer (unit shares)	289	0	568	0	144	225	0

iii North Coast Fractured and Porous Rock Groundwater Sources 2016

The *WSP for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (North Coast WSP) applies to hard rock aquifers (porous or fractured). The water source of relevance to the amended Project area is the Sydney Basin-North Coast Groundwater Source. The LTAAEL for this water source is 90,000 ML/yr.

Table 3.6 presents a summary of the total entitlement shares in the Sydney Basin-North Coast Groundwater Source and entitlements held by HVO.

Table 3.6 Sydney Basin North Coast Groundwater Source water entitlement summary

Entitlement category	Total shares held in the water source	Share component held by HVO
Basic landholder rights [1]		
Domestic and stock (ML/yr)	5,087	0
Water access licences [2]		
Domestic and stock (ML/yr)	0	0
Local water utility (ML/yr)	1,525	0
Aquifer (unit shares)	67,492.5	5,560

Notes: 1. Sourced from the North Coast WSP

2. Total share components were obtained from NSW water register (WaterNSW) for financial year 2024/25

3.3 Relevant guidelines

The guidelines used in the technical water assessments are presented in Table 3.7.

Table 3.7 Relevant guidelines

Guidelines	Developed by	Relevant to
Guidelines for the preparation and review of groundwater assessments for major projects in NSW: • Guidelines for Groundwater Documentation for SSD/SSI projects (DPE Water 2022b) • Minimum Requirements for Groundwater Modelling (DPE Water 2022c) • Cumulative Groundwater Impact Assessment Approaches (DPE Water 2022d) • Groundwater Assessment Toolbox.	DPE Water 2022 (now DCCEEW)	GIA and this Water Assessment report
Australian Groundwater Modelling Guidelines	National Water Commission (Barnett et al. 2012)	Groundwater modelling
Uncertainty analysis – Guidance for groundwater modelling within a risk management framework (IESC explanatory note)	Middlemis and Peeters 2018	Groundwater modelling
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZG 2018	All water assessments
Risk Assessment guidelines for groundwater dependent ecosystems	NSW DPI Office of Water (Serov et al. 2012)	Water assessment (this report) Aquatic ecology and GDE assessment
Water and river flow objectives	DECCW 2006	SWIA
Australian Rainfall and Runoff (ARR 2019)– a Guide to Estimation	Commonwealth of Australia, Geoscience Australia (Ball et al. 2019)	SWIA

4 Description of the environment

4.1 Introduction

The conceptual model for the HVO Project has been detailed fully in the 2022 EIS (AGE 2022; EMM 2022b). The following sections present a summary of this information. It is noted that this conceptualisation built upon many years of monitoring and assessments in the area, forming a robust conceptual understanding of the amended Project area.

Graphs in the following sections have been updated with recent information where appropriate. This additional data has confirmed that there is no change to the conceptualisation of the Study area.

4.2 Climate

The regional climate of the amended Project area is characterised by hot summers and mild dry winters. Figure 4.1 compares the mean monthly evaporation and rainfall from the SILO dataset. Rainfall is relatively consistent throughout the year, although slightly lower in winter than in summer. Evaporation exceeds rainfall throughout the year, and a soil moisture deficit is likely (especially in the summer months). Annual average evaporation is 1,538 millimetres (mm).

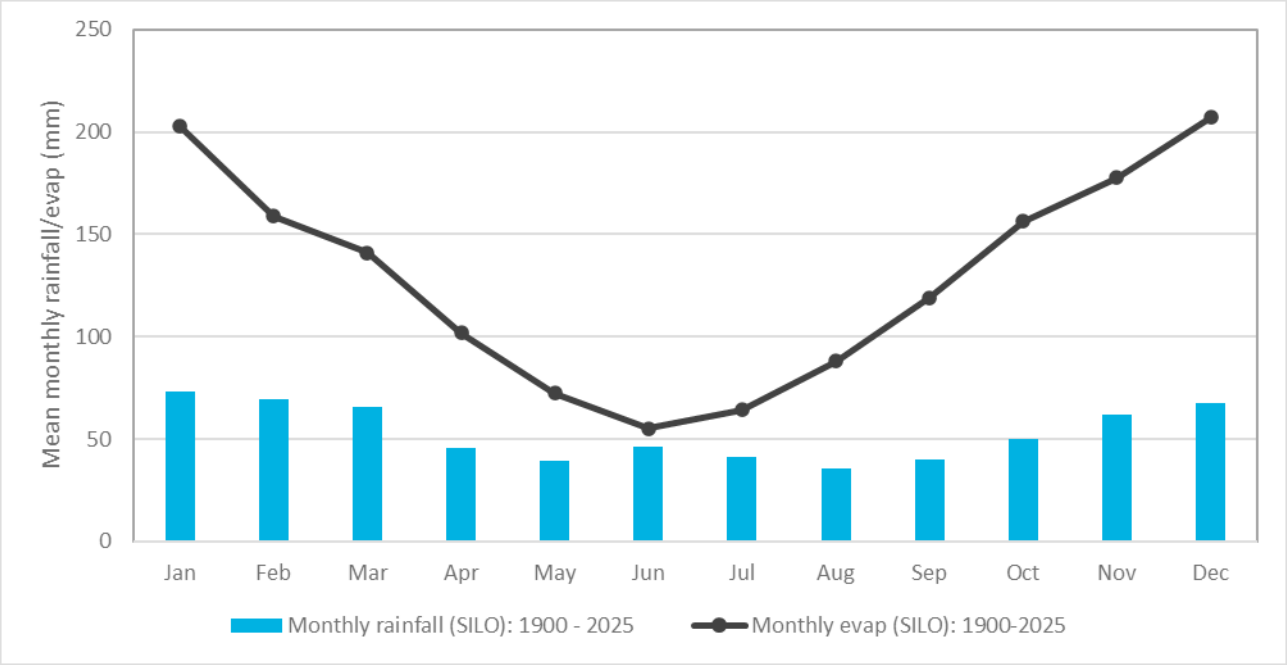


Figure 4.1 Mean monthly rainfall and evaporation (SILO data)

4.3 Hydrological setting

4.3.1 Watercourses and catchments

The HVO Complex is within the Hunter River Basin catchment and is drained by the Hunter River, Wollombi Brook and tributary drainage channels, including Parnells Creek, Farrells Creek, Bayswater Creek and Hobden Gully (Figure 4.2). As discussed in Section 3.2.2, the Hunter River is a regulated river, regulated by releases from Glenbawn Dam and Glennies Creek Dam. The Hunter River flows in an easterly direction between the HVO North and HVO South, then flows in a southerly direction.

Other minor watercourses in the vicinity of the amended Project are ephemeral, flowing after rainfall events. There are also several unnamed tributaries within the amended Project area. Streamflow analysis indicates many of the ephemeral watercourses are dry (on average) more than half the year.

The flow duration curve analysis for the Maison Dieu gauge (gauge 210128; see Figure 4.2 for location) shows the Hunter River is perennial with daily flows typically exceeding 100 megalitres per day (ML/d) 90% of the time. The flow duration curve analysis at the Warkworth gauge (210004; see Attachment B) shows that Wollombi Brook stops flowing (i.e. is dry) 12% of the time and daily flows typically exceed 100 ML/d only 29% of the time at Warkworth.

4.3.2 Surface water monitoring

Extensive monitoring at watercourses and within the HVO WMS has been occurring in the amended Project area since 2011, in accordance with the WMP. The surface water monitoring program is described in the WMP (HVO 2018) and Attachment B. Monitoring locations are presented in Figure 4.2.

4.3.3 Surface water quality

i Hunter River basin

Water quality is generally poor due to typically high salt concentrations in the Hunter River basin. This is largely due to the geology of the area and groundwater discharge contributing to the high salinity in the Hunter River catchment (McVickar et al 2015).

The HRSTS was introduced in 1995 to minimise the impact of saline water discharges from industry. There are three key salinity monitoring stations located on the Hunter Regulated River: Denman, Glennies Creek and Singleton (McVickar et al 2015). Salinity levels are typically low in the north-east of the Hunter River basin; however, high variability was observed, particularly at low flows when baseflow discharges dominate the streamflow response (McVickar et al 2015).

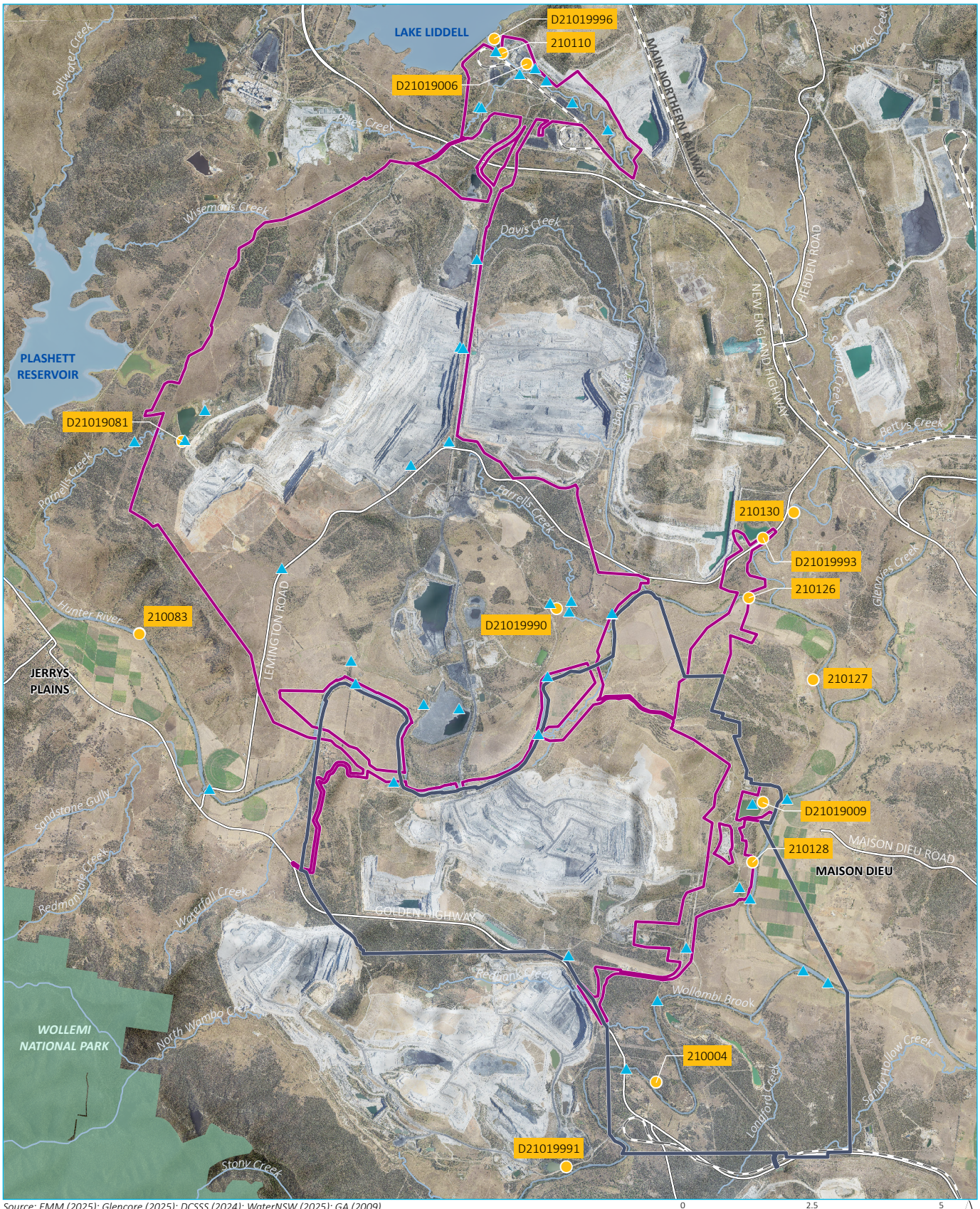
ii Local setting

Recorded ranges in pH, electrical conductivity (EC) and total suspended solids (TSS) have been compared to ANZG (2018) default guideline values and Blue Book (Landcom 2004). Further statistical analysis conducted by Engeny (2025) is provided in Attachment B.

Historical water quality data (2011 to 2025) for the Hunter River, Wollombi Brook and the ephemeral creeks, generally complies with relevant water quality objectives for pH, EC and TSS for the 80th percentile, with the following observations:

- pH within the Wollombi Brook and ephemeral creek systems typically lies within the ANZG default guideline values. pH values for the Hunter River are consistently higher with a typical range of 8.0 to 8.4.
- EC is below the ANZG (2018) default guideline value and is generally higher in the Hunter River than Wollombi Brook and ephemeral creeks.
- TSS records typically range between 6 to 51 milligrams per litre (mg/L) in the clean water systems (with the higher values typically occurring in the ephemeral creek systems).

In addition to routine parameters, surface water quality monitoring has been undertaken regarding nutrients and metals/metalloids in all clean water systems, the sediment water system and mine water system for the complex. The statistical analysis for metals and nutrients at each monitoring location is detailed in Attachment F of the SWIA (Engeny 2025, see Attachment B).



Source: EMM (2025); Glencore (2025); DCSSS (2024); WaterNSW (2025); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- HVO surface water monitoring location
- Stream flow gauge

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Surface water context

HVO Continuation Project - Amendment
Water Assessment
Figure 4.2

EMM
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4.3.4 Environmental and community values

An environmental and community value is defined in the national water quality guidelines (ANZG 2018) as a particular value or use of the environment that is important for a healthy ecosystem or for public benefit, health, safety or welfare, and requires protection from the effects of stressors. The term 'beneficial use' is also often used to describe the same term. Environmental and community values recognised by the national water quality guidelines (ANZG 2018) and listed in the NSW *Guidelines for Groundwater Documentation for SSD/SSI Projects* are described in the original Project Water Assessment report (EMM 2022b).

The Hunter River catchment has undergone extensive modification in the Study area. It is generally considered as having low to medium instream value. There are some medium and high value areas, particularly in the upper regions of the regulated river. The regulated river has generally low diversity and no vital habitat value. The sub-catchments of the Hunter River are generally considered as under medium or high environmental stress. They have relatively poor bank condition, bed condition and riparian vegetation (DPI Water 2017). Within the amended Project area, the Hunter River and its tributaries are considered as having Poor Ecological Value (ELA 2022 and ELA 2025).

The Hunter River supports a variety of uses including irrigation, town water supply, mining and power generation. Downstream of the HVO Complex, the town of Singleton relies on the river for its industries and water supply.

Landholders also access water through basic landholder rights and/or through WALs (refer Sections 3.2.2 and 4.7.1 for further discussion).

In addition to environmental, social and economic value, the Hunter River also has cultural value for Aboriginal people. Aboriginal names for the Hunter River include *Coquun*, *Myan*, *Coonanbarra*, *Terrybong* or *Gingamboon*, depending on the point of its course (Wafer 2014); *Terrybong* appears to be the *Wonnarua* name for the Hunter River within the amended Project area (Gardner 1854). Derived from the *Awabakal* language, Wollombi means 'meeting of the waters' (NSW Geographical Names Board n.d.).

4.4 Geological setting

The coal seams at HVO are contained within the Late Permian Wittingham Coal Measures which are further sub-divided into the Vane subgroup and the Jerrys Plains subgroup. The coal measures are stratified sequences dipping in a general west to south-easterly direction and outcrop over most of the mapped extent.

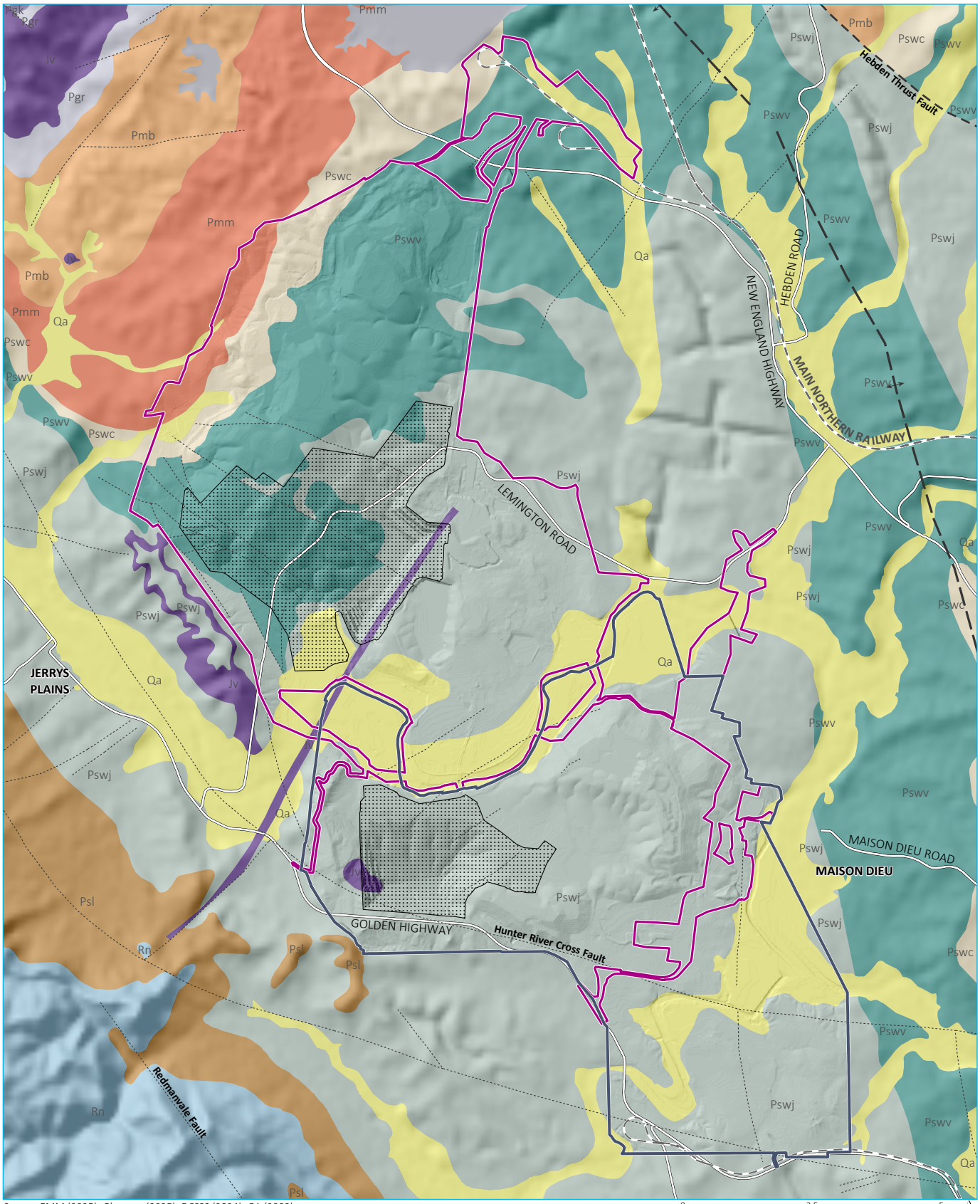
The main geological units present within the amended Project area are summarised in Table 4.1. The surface geology in the Study area is presented in Figure 4.3.

Table 4.1 Summary of main geological units in the amended Project area

Geological unit	Description
Quaternary/Tertiary alluvium	The Quaternary alluvium occurring along the Hunter River and Wollombi Brook floodplains contains two main depositional units, a surficial fine-grained sediment (clay, silt and sand) overlying a coarser basal material (sand and gravel). The alluvial sediments are generally confined to the current course of the Hunter River and some tributaries near the confluence with the Hunter River.
Paleochannel alluvium	An ancient river meander carved into the Permian sediments at HVO and infilled with alluvial sediments forming a paleochannel to the north of the Hunter River near Carrington Pit (refer Figure 4.3). The paleochannel was formed during the Tertiary period and consists of silt, sand and gravel. MER (2010) discusses the investigations conducted in the paleochannel area to define the geometry, lithology and hydrogeological properties of the paleochannel. Exploration drilling and groundwater monitoring installations, and associated monitoring, and resulted in a robust conceptual understanding of the paleochannel. The depositional environment for the unconsolidated paleochannel alluvium was characterised by frequent flooding and resulting deposition of gravelly sandy material with silts and clays. Colluvial deposits are also present from hill slope runoff and sheet wash from surrounding hard rock (MER 2010). The alluvium thickness varies and ranges from 11 to 18 m, pinching out at the channel perimeter. The bottom 3 to 6 m generally comprises fine to coarse gravel contained within a silty-clayey matrix that is overlain by clay 2 to 8 m in thickness. This clay is overlain by relatively thin surficial sands, silts, clays and loams (MER 2010).
Aeolian deposits	Cenozoic dune sands and associated high level sand deposits mapped in the state geology dataset is locally referred to as 'Warkworth Sands' in the amended Project area. The feldspathic quartz aeolian sands are approximately 3 m (1 to 6 m) thick and form a thin capping on the underlying Permian bedrock. The fine-grained sands overlie a low permeability base of residual clay associated with the underlying strata (AGE 2022).
Permian Wittingham Coal Measures • Jerrys Plains subgroup • Vane subgroup	The Permian strata, underlying the Quaternary alluvium, comprise sequences of coal seams separated by layers of sandstone, siltstone, tuffs and conglomerate and are generally referred to as overburden and interburden in the context of mining. In the amended Project area, the regular layered sedimentary sequence dips gently to the south-east. The Jerrys Plains subgroup outcrops in HVO North, gradually thickens from its outcrop towards the south and is up to 300 m thick at HVO South. It is underlain by the Archerfield Sandstone consisting of a massive light brown or honey coloured well-sorted quartz lithic sandstone which marks the change into the underlying Vane subgroup. Mining at both HVO North and HVO South has intersected the Jerrys Plains subgroup. The Vane subgroup comprises six coal seams with the Lemington seam at the top and the Hebden seam at the base. The interburden consists of sandstone and siltstone. Mining at the Mitchell /West Pit at HVO North is currently approved to mine to the base of the Barrett seam. The amended Project proposes to extend mining to the base of the Barrett seam in the Carrington area.

In the Hunter Coalfield, a group of small thrust faults running parallel to subparallel to the Hunter-Mooki thrust fault and a series of northerly trending folds displaces the Permian sequences. The amended Project area is incised by a series of faults that trend in a north-west to south-east direction.

The main mapped structures in the amended Project area include the Hunter River Cross Fault, Muswellbrook Anticline, Bayswater Syncline, Hunter Valley Dyke (Jurassic Volcanics). These are shown on Figure 4.3.



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Mining area

Geological feature

- Anticline
- Thrust fault
- Fault

Existing environment

- Rail line
- Major road

Geology - Hunter coalfield 100K

- Qa - Quaternary Alluvium
- Jv - Jurassic Volcanics
- Rn - Narrabeen Group
- Psl - Wollombi Coal Measures
- Pswj - Wittingham Coal Measures, Jerrys Plains Subgroup
- Pswv - Archerfield sandstone, Vane Subgroup
- Pswc - Wittingham Coal Measures, Saltwater Creek Formation
- Pmm - Maitland Group, Mulbring Siltstone
- Pmb - Maitland Group, Branxton Formation
- Pgr - Greta Coal Measures, Rowan Formation
- Pgk - Greta Coal Measures, Skeletar Formation
- Water

Geological setting

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Water Assessment
Figure 4.3

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4.5 Hydrogeological setting

4.5.1 Hydrogeological units

Consistent with the original Project, the main groundwater resources in the amended Project area include:

- Alluvial aquifers (including the paleochannel) form unconfined aquifers, and quality is fresh to brackish. The alluvium is generally more permeable than other lithologies, with recorded hydraulic conductivities ranging from 10^{-2} metres per day (m/d) to 10^{2} m/d (AGE 2022).
- The regolith does not form aquifers due to limited saturated thickness.
- Permian interburden layers form aquitards.
- Permian coal seams generally form low to moderately permeable confined aquifers, with poor groundwater quality. Hydraulic conductivity generally decreases with depth due to increased rock mass strength (AGE 2022).

4.5.2 Groundwater monitoring

There is an extensive groundwater monitoring network at HVO that spans the various mining areas, targeting various lithologies including the alluvium and deeper Permian units. Groundwater monitoring commenced in 1995. Monitoring locations and frequency have been revised and updated over the operating years and in accordance with the WMP. Groundwater monitoring is also undertaken at surrounding mines including Ravensworth Operations, LCO, Mt Owen Complex, Integra, MTW, and United-Wambo. In addition, there is groundwater monitoring data available from Government-owned/monitored bores in the Study area.

Current HVO groundwater monitoring locations in the amended Project area are shown in Figure 4.4. In addition, there are numerous groundwater monitoring sites near the HVO Complex and good spatial coverage in the alluvium. Annual groundwater monitoring reports prepared by HVO also provide details of groundwater level and quality monitoring data (temporal and spatial).

4.5.3 Groundwater levels and flow direction

Groundwater levels and flow direction in the alluvium is largely controlled by surface topography and surface water flows.

The potentiometric surface in the Permian is generally at a lower elevation than the alluvial watertable (downward gradient from the alluvium to the Permian) due to historical mining in the area. As such, there is expected to be downward leakage from the alluvium to the Permian that will be limited by hydraulic properties of the regolith and interburden.

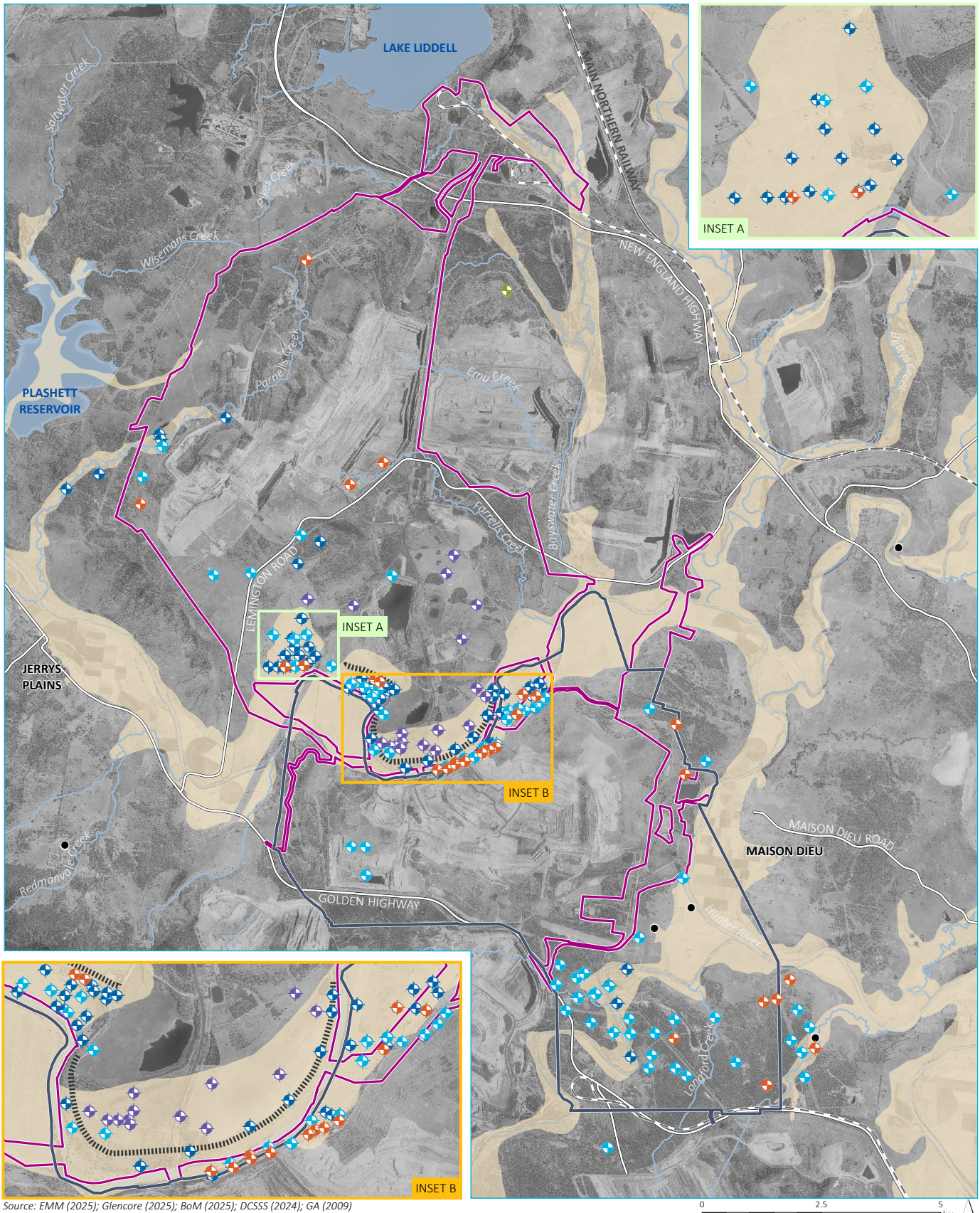
Detailed groundwater level and spatial analysis for bores at HVO has been conducted as part of the original Project GIA (AGE 2022). The analysis shows a strong connection between groundwater level trends in the alluvium and Hunter River flows. This observation is supported by observations provided in the Annual Reviews and by groundwater level monitoring.

4.5.4 Groundwater quality

Groundwater sampling for water quality analysis has been undertaken extensively within the amended Project area and surroundings.

Monitoring shows the alluvial aquifer in the Hunter River has relatively low salinity (brackish) and variability, thereby meeting the criteria to be classified as “highly productive” groundwater source (defined under the AIP). Historically, the salinity of the paleochannel alluvium has been elevated, freshening in areas close to the river where the effects of recharge and mixing are more evident (MER 2010).

The Permian groundwater is characterised by higher salinity (moderately saline).



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Source: EMM (2025); Glencore (2025); BoM (2025); DCSSS (2024); GA (2009)

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Alluvial extent
- Government monitoring bore
- Existing low permeability barrier wall

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Groundwater monitoring location (HVO)

Lithology

- Alluvium
- Spoil
- Regolith

Permian

- Coal seam
- Interburden

Groundwater monitoring network

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Water Assessment
Figure 4.4

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4.6 Geochemistry

Results of geochemical testing from 2022 (EGi 2022) indicate the vast majority of overburden/interburden materials represented by the samples tested is:

- non-acid forming (NAF)
- of low sulphur content
- has an excess of acid neutralising capacity
- low leachable salinity.

Potential acid forming (PAF) materials are estimated to comprise only 3% of overburden/interburden. Thin pyritic zones of elevated sulphur were identified generally close to coal seams, but dilution and mixing during mining should be sufficient to mitigate any acid rock drainage generation.

Most coal samples tested were PAF. Approximately half of immediate seam roof, floor and partings materials is also likely to be PAF, with non-acid forming (NAF) materials estimated to be 52%. These materials are generally thin (less than 0.3 m) and are expected to report to the raw coal process stream, however if they were to report to overburden/interburden then dilution and mixing during mining would be sufficient to negate acid rock drainage risk from these materials.

Further discussion is provided in the EIS Water Assessment (EMM 2022b).

4.7 Water receptors

4.7.1 Surface water users

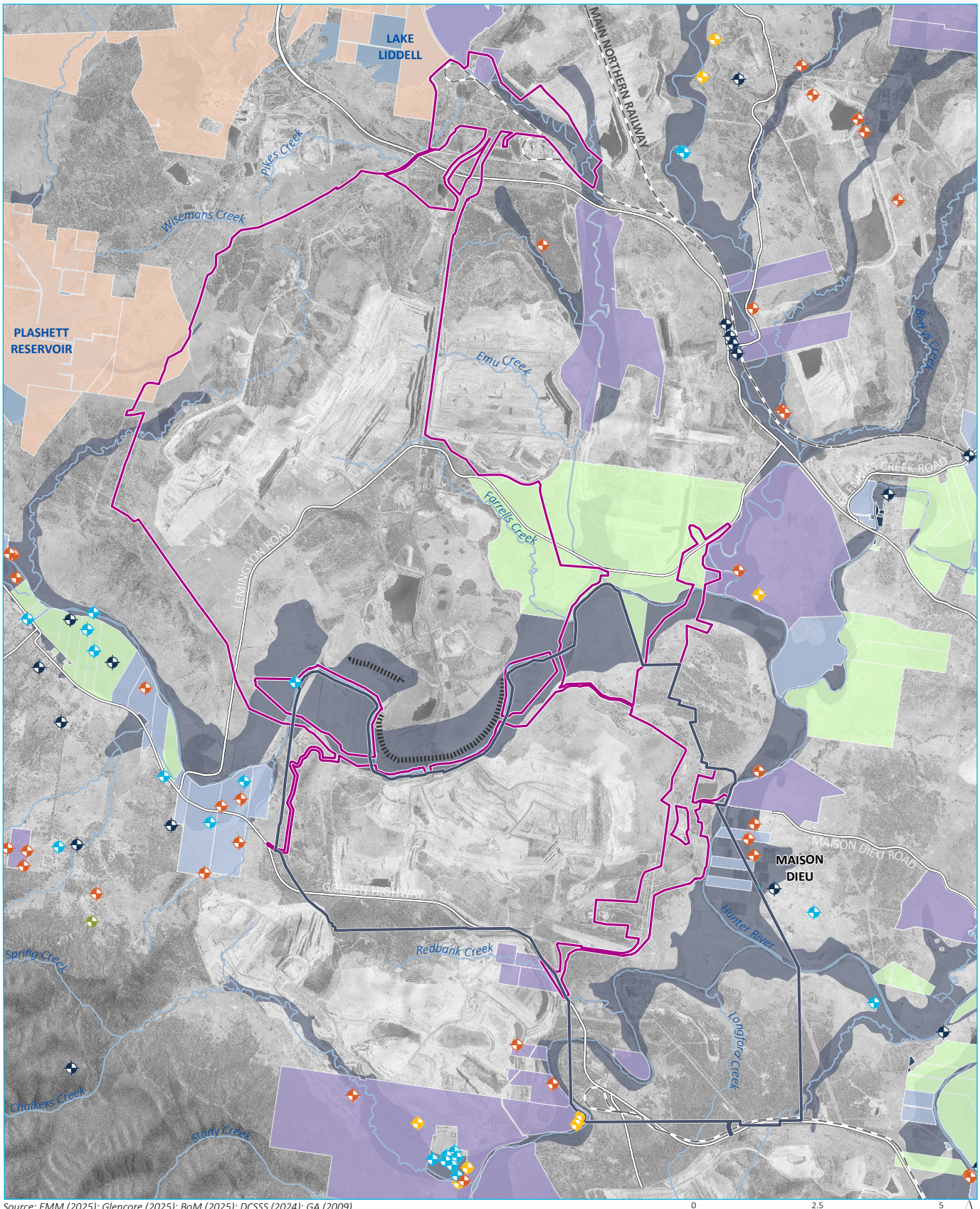
There are non-mining water users downstream of the HVO Complex within the Hunter River catchment (refer Figure 4.5). Extraction from the Hunter River and tributaries in the Study area is mainly for town water supply, power generation, mining, industrial, agriculture and irrigation purposes.

It is assumed that water is captured for domestic and stock rights and harvestable rights in the Study area. The specific location of these activities is not known; however, most of the land adjacent to the HVO Complex is owned by the HVO JV parties or other mining operations.

4.7.2 Groundwater users

Most third-party (non HVO JV) landholder bores are primarily located upstream and downstream of the amended Project area along the Hunter River and are screened within the Quaternary alluvium (AGE 2022).

Figure 4.5 shows the locations of the third-party bores and the bore type.



Source: EMM (2025); Glencore (2025); BoM (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Alluvial extent
- Existing low permeability barrier wall

Bore type

- Water supply
- Commercial and industrial
- Irrigation
- Stock and domestic
- Unknown

Other water access user

- Domestic and stock
- Local water utility
- Major utility
- Regulated river
- Supplementary water
- Unregulated river

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Third party water users

HVO Continuation Project - Amendment
Water Assessment
Figure 4.5

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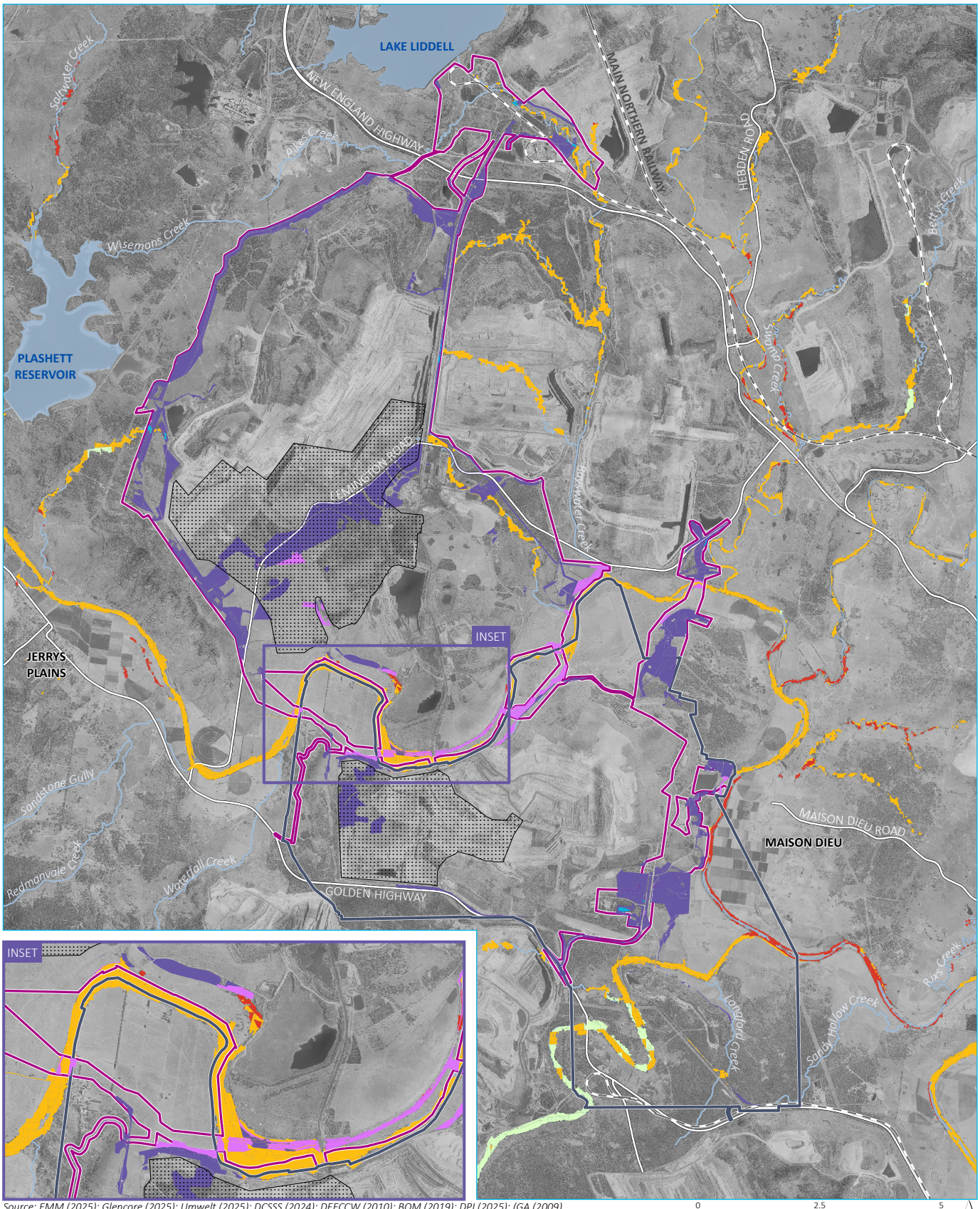
4.7.3 Water-dependent ecosystems

Ecosystems that are potentially reliant on surface water include: instream ecosystems that depend on streamflow (including in-stream ecosystems reliant on groundwater baseflow), and riparian ecosystems that depend on surface water and overbank flows. GDEs are ecosystems that potentially rely on either the surface or subsurface expression of groundwater. The locations of the potential terrestrial and aquatic water-dependent ecosystems within the Study area are shown in Figure 4.6 and Figure 4.7 respectively. These GDEs and their conceptual water dependency are consistent with those evaluated in the original Project.

An aquatic ecology and GDE assessment of the Study area was conducted by ELA (2022, 2025) and comprised a desktop assessment to identify potential GDEs in the Study area and follow-up field surveys to identify aquatic habitat and assess ecological condition of identified potential GDEs and aquatic ecology. This desktop phase of the aquatic ecology and GDE assessment identified the following potential water dependent ecosystems in the Study area (ELA 2022):

- Baseflow discharge to the Hunter River.
- Aquifer ecosystems of the Hunter River alluvium and associated tributary aquifers.
- River red gum populations at Carrington Billabong, and along the Hunter River and Wollombi Brook. Figure 4.8 presents a conceptual diagram of the river red gums and their reliance on water.
- Central Hunter Ironbark Grassy Woodland (in the Hunter River riparian zone).
- Warkworth Sands Woodland community associated with the unconsolidated aeolian sediments in the area. The groundwater levels monitoring this community are shown in Figure 4.9 and show the aeolian sediments are predominantly dry, with saturation occurring after wet rainfall periods. A diagram showing the conceptual understanding of the Warkworth Sands Woodland in the SLP 1 area and the interaction between terrestrial vegetation with water is presented in Figure 4.10.
- Stygofauna are known to occur in alluvial sediments within the Study area along the Hunter River, Bowmans Creek, Glennies Creek and Wollombi Brook (ELA 2022, 2025). They may also occur in the shallow fractured rock up to 60 m depth where they colonise fracture networks of secondary porosity.

ELA conducted field surveys in April 2020, September 2020 and January 2022 to validate the desktop assessment. The ecological surveys conducted for the original Project observed that all vegetation stands were in low to moderate condition. Further information regarding these field surveys can be found in ELA (2022).



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); DEECCW (2010); BOM (2019); DPI (2025); (GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Mining area

Groundwater Dependent Ecosystem (GDE) probability

- High
- Medium
- Low

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

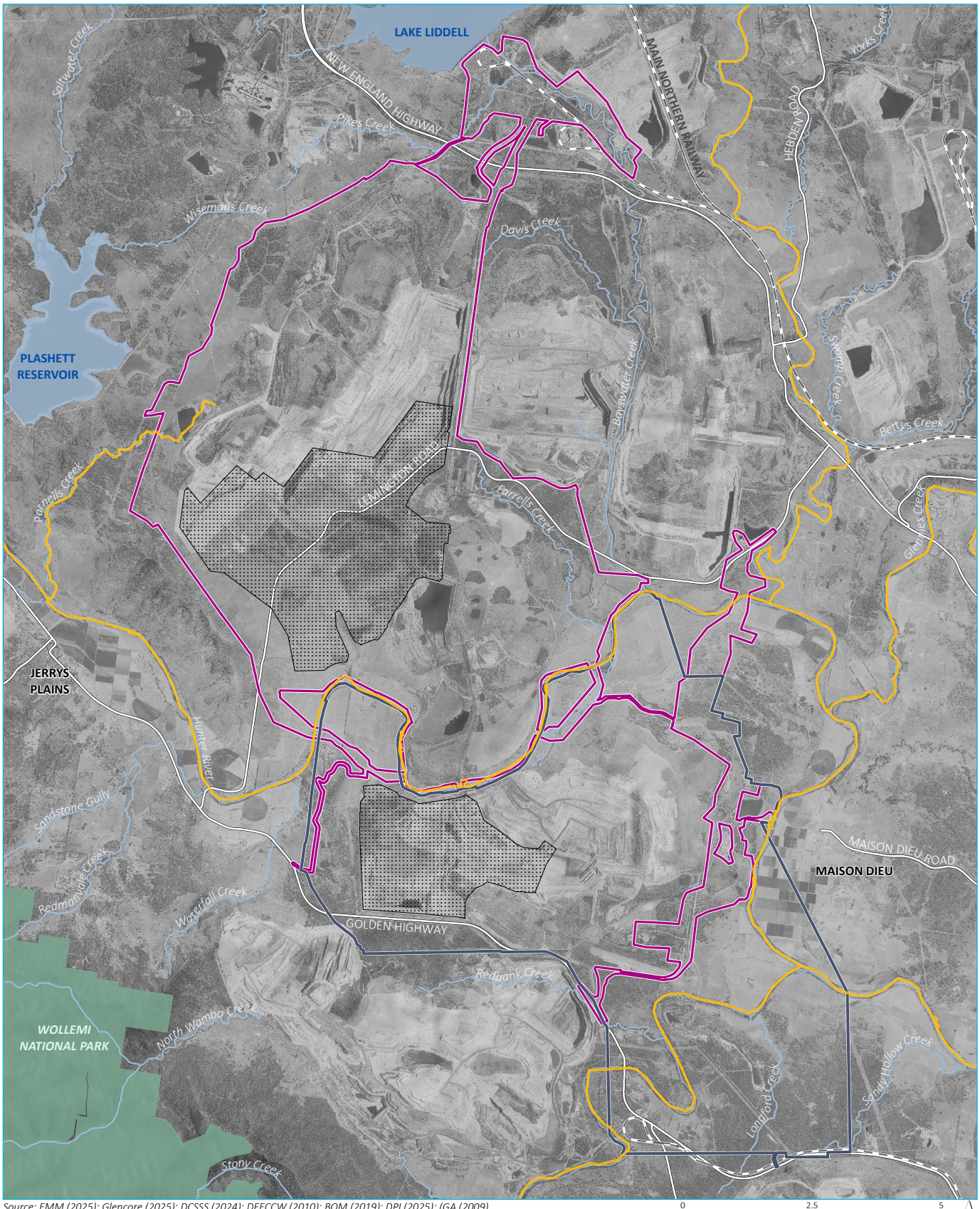
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Terrestrial potential GDEs

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Water Assessment
Figure 4.6

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Source: EMM (2025); Glencore (2025); DCSSS (2024); DEECCW (2010); BOM (2019); DPI (2025); (GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Mining area
- Aquatic GDE

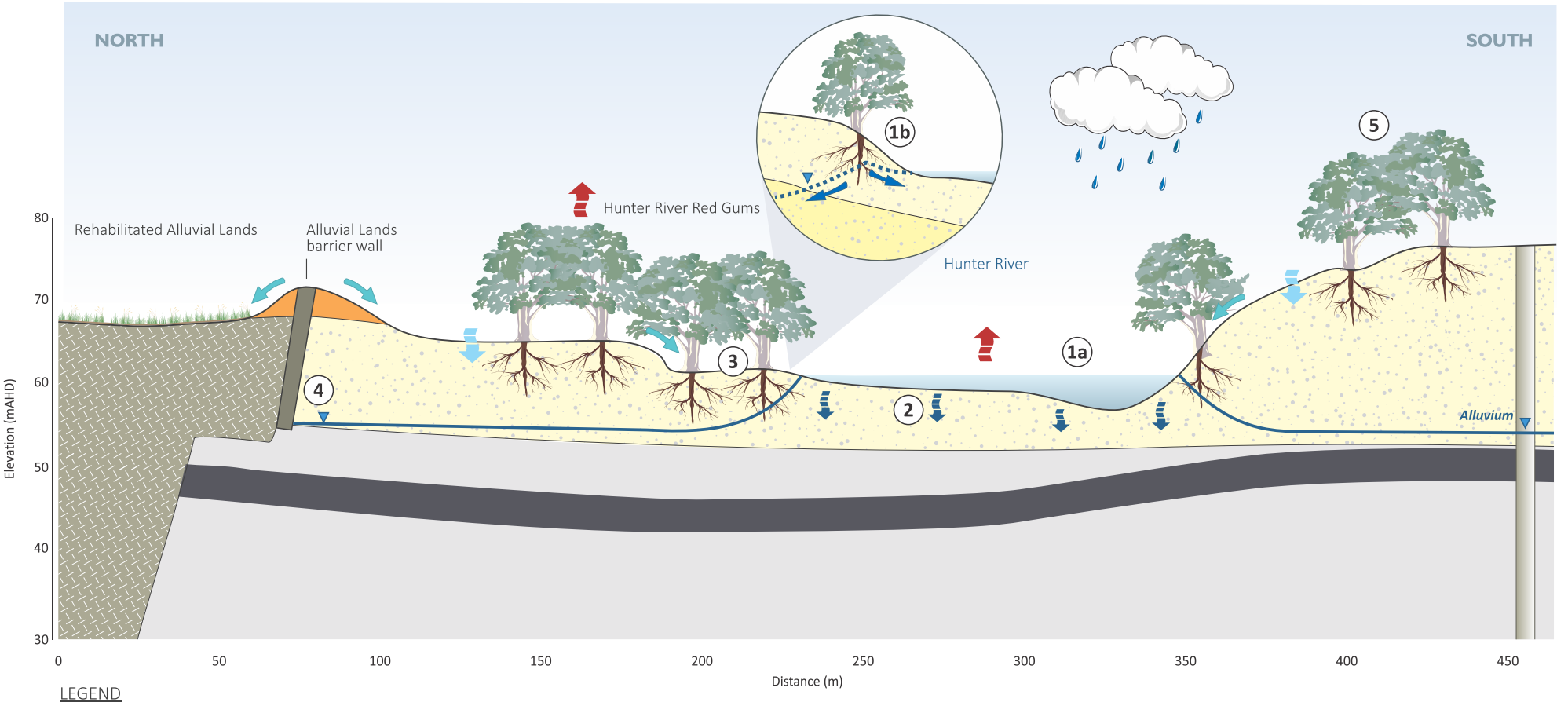
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Aquatic potential GDEs

HVO Continuation Project - Amendment
Water Assessment
Figure 4.7

EMM
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LEGEND

- Clay/soil
- Hunter River Alluvium
- Overburden/interburden waste
- Jerrys Plain sub-group (bedrock)
- Coal seam
- Watertable (inferred)
- Inferred groundwater flow direction
- Rainfall runoff
- Rainfall infiltration
- Evapotranspiration
- Downward leakage

This diagram is a conceptual representation only

1a Hunter River surface water flows are maintained by regulated releases from Glenbawn Dam.

1b Following high streamflow events and as the river level declines, water stored in the river bank will flow back to the river maintaining water in the channel.

2 The dominant source of recharge to the shallow alluvium is leakage from the Hunter River (surface water) and infiltration of rainfall, with minimal seasonal variation in levels observed.

3 Hunter River Red Gums are thought to be dependent on shallow groundwater for their water requirements.

4 The Alluvial Lands barrier wall was constructed to prevent groundwater flow from the Hunter River alluvium towards the active mining area in HVO North. Monitoring shows that the barrier wall has been effective at limiting drawdown in the Hunter River alluvium.

5 River Red Gums away from the river channel access infiltration of rainfall and water held within the unsaturated zone.

Receptor conceptual diagram – Hunter River and River Red Gums

HVO Continuation Project
Water Assessment
Figure 4.8

EMM creating opportunities

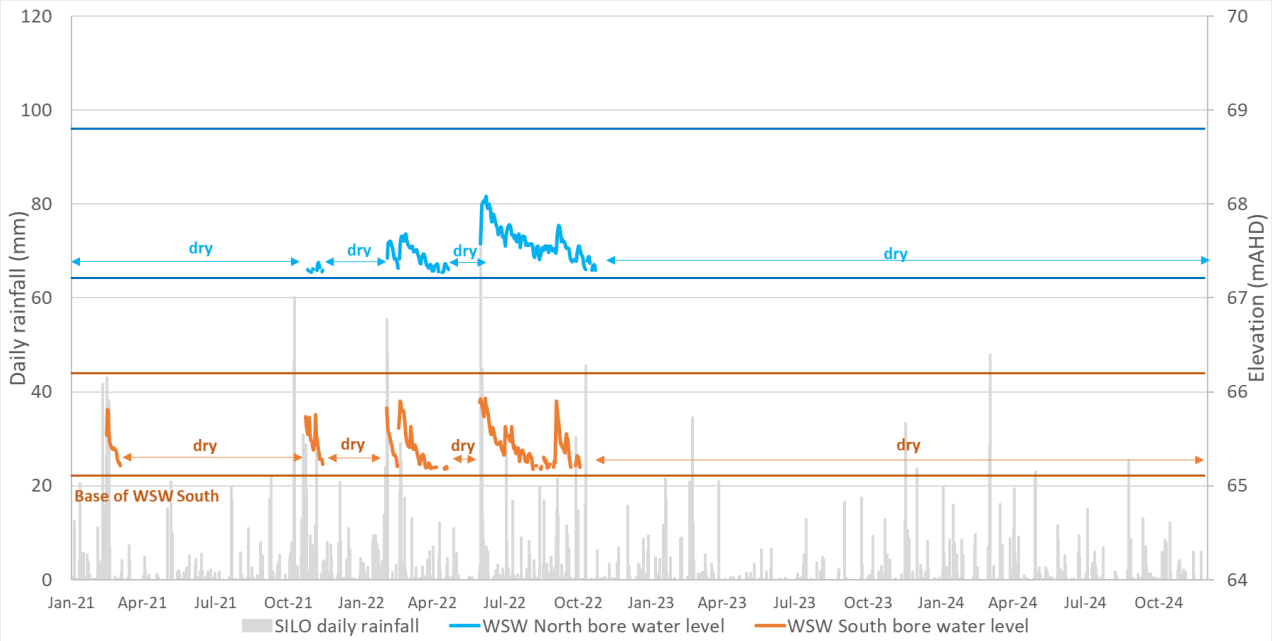
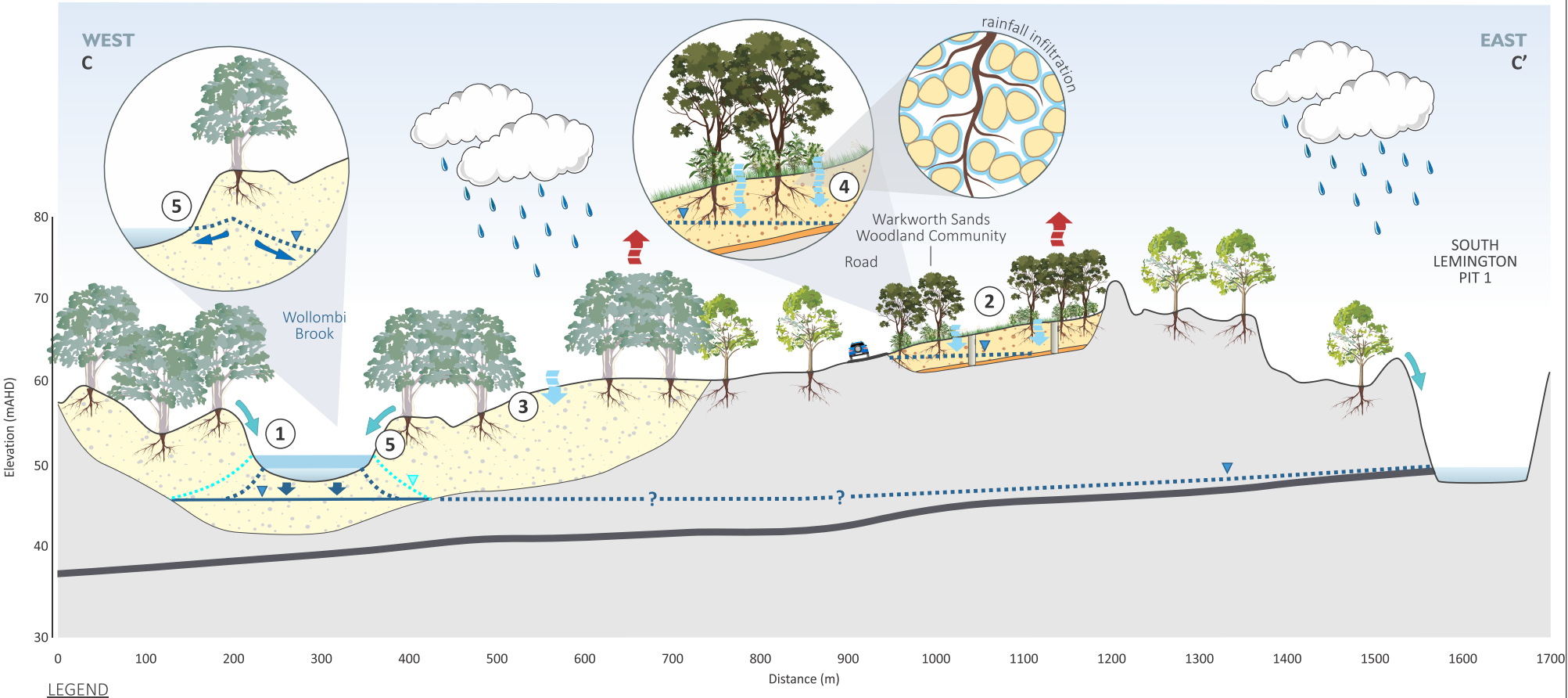


Figure 4.9 Warkworth Sands monitoring bore hydrograph



This diagram is a conceptual representation only

1. Flows in Wollombi Brook are variable, with no streamflow observed between 2017 and 2019. The main contribution to watercourse flows is rainfall runoff.
2. The Warkworth Sands Woodland Community occurs on aeolian sand deposits and comprises a small tree layer, shrubs and groundcover species.
3. Vegetation access water from infiltration of rainfall.
4. Vegetation in the Warkworth Sands Woodland Community access rainfall infiltration that creates a perched watertable following high rainfall events (eg March and November 2021). This ephemeral perched watertable is not in hydraulic connection with the deeper Permian coal measures.
5. Wollombi Brook is predominantly a losing watercourse. Surface water is the main source of recharge to the shallow alluvium. Following high streamflow events (occuring only 20% of the time according to WaterNSW stream gauge 210004), as the water level declines, water stored in the river bank will flow back to the river maintaining water in the channel until depleted.

Receptor Conceptual Diagram – Warkworth Sands and Wollombi Brook

HVO Continuation Project
Water Assessment
Figure 4.10

5 Conceptual model

A conceptual model describes the key processes in the hydrological and hydrogeological environment. It is based on hypotheses and assumptions, some of which will be derived from data sourced from the water environment under investigation and others will be based on general hydrogeological or hydrological principles. The conceptual model forms the basis of assumptions adopted in the numerical models and is the basis for the water-related impact assessments.

As mentioned above, the conceptual model remains unchanged from the original Project.

5.1 Existing conditions

Figure 5.1 provides a generalised illustration of the conceptual model under the existing conditions, which is discussed in Chapter 4 and the EIS Water Assessment report (EMM 2022b). The following points summarise the processes/activities shown with the corresponding numbers on Figure 5.1.

1. The Hunter River is a regulated river controlled by releases from Glenbawn Dam and Glennies Creek Dam, maintaining streamflow and supply to downstream entitlement holders and basic landholder rights.

2. The tributaries to the Hunter River are unregulated and as such are ephemeral. Some of the smaller watercourses (such as Farrells Creek and Parnells Creek) are mostly dry and only flow following high rainfall events.

3. Groundwater systems include:

    - alluvial aquifers (including the paleochannel) form unconfined aquifers, and quality is fresh to brackish. The alluvium is generally more permeable than other lithologies, with recorded hydraulic conductivities ranging from 10^{-2} m/d to 10^{2} m/d (AGE 2022)

    - the regolith does not form aquifers due to limited saturated thickness

    - Permian interburden layers form aquitards

    - Permian coal seams generally form low to moderately permeable confined aquifers, with poor groundwater quality. Hydraulic conductivity generally decreases with depth due to increased rock mass strength (AGE 2022).

4. Recharge to the alluvium occurs via infiltration of rainfall and leakage from surface water to the watertable. In the Hunter River alluvium, groundwater levels and aquifer saturation is predominantly due to leakage from the Hunter River, which is mostly a losing watercourse in the amended Project area. River leakage into the alluvium in the region is up to four times greater than direct rainfall recharge (McVicar et al 2015). The saturated thickness of the paleochannel ranges from 1 m to 6 m.

5. Recharge to the Permian groundwater system(s) occurs via downward leakage from the overlying saturated alluvium (with seepage rates limited by the vertical hydraulic conductivity of the regolith, overburden and interburden) and/or gradual infiltration of rainfall where the Permian outcrops.

6. Groundwater discharge occurs via:

    - evapotranspiration from vegetation, such as the river red gums, where the watertable is sufficiently shallow

    - seepage to active or disused mining areas (where in hydraulic connection)

- as baseflow to watercourses in areas where the watertable is in hydraulic connection with the watercourse and at higher elevation than the height of water in the watercourse (this may occur seasonally)

- from the alluvium to Permian strata via downward leakage where Permian potentiometric surfaces are lower than the base of the alluvium

- active pumping from bores.

7. The vertical hydraulic gradient between the alluvium and the Permian is generally downward, due to historical mining depressurising the Permian.

8. Surface water users in the Study area include water extracted from the Hunter River for industrial, mining, domestic and stock or agricultural purposes. Landholders with waterfront land also access have basic landholder rights.

9. The existing HVO WMS includes levees for flood protection and drains to divert clean water from undisturbed or rehabilitated areas.

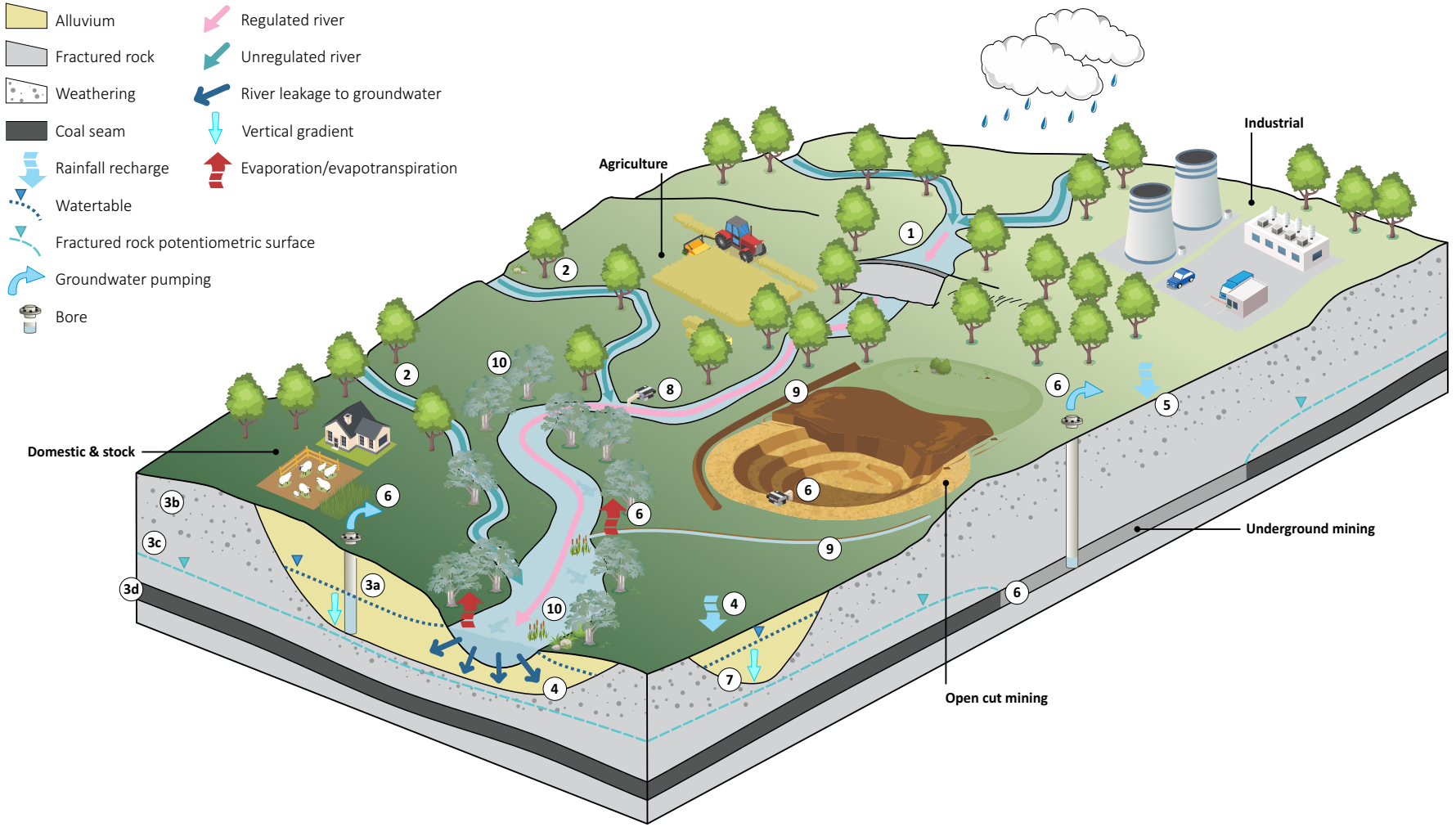
10. Ecosystems that potentially rely on surface water and/or groundwater:

    - river red gum vegetation (including in the Carrington Billabong area) that opportunistically access shallow groundwater recharged by leakage from the Hunter River and Wollombi Brook, and rely on flooding for germination

    - stygofauna occurring principally in alluvial sediments along the Hunter River and its tributaries

    - aquatic ecosystems

    - Warkworth Sand Woodland communities which rely principally on rainfall infiltration and a seasonal perched watertable observed to occur after large rainfall events.



NOT TO SCALE

Note: Conceptual representation only.

Conceptual Model

HVO Continuation Project

Water Assessment

Figure 5.1

5.2 Conditions during mining

The conceptual model will mostly remain the same during mining. As described in the EIS Water Assessment (EMM 2022b), the key changes associated with the amended Project that have the potential to affect water resources and water-dependent assets include:

- Permian depressurisation would increase as mining progresses to the deeper Barrett seam at HVO North. However, the potentiometric surface in the Permian strata is already lower than the alluvial watertable due to approved existing and historical mining.

- In the Carrington West Wing area in HVO North, where mining is approved to the base of the Bayswater seam. Differences between the approved operations and the amended Project would relate to the following:

    - The extent of the drawdown in the alluvium would be limited by installation of the Carrington West Wing LPBW and buffered by continued leakage from the Hunter River - the alluvium would remain saturated. The drawdown induced leakage from the Hunter Regulated River would be accounted for within HVO's existing entitlements (high security entitlements) and therefore streamflow in the Hunter River will not be affected.

    - Ecosystems that rely on groundwater, such as stygofauna and vegetation opportunistically accessing shallow groundwater, would continue to have access to groundwater due to continued recharge from the Hunter River regulated flows. In addition, any changes in the watertable would not prevent the long-term viability of the water-dependent assets.

- The main causal pathway for potential impacts from mining on the water dependent ecosystems is depressurisation of the Permian strata resulting in drawdown within the Hunter River and Wollombi Brook alluvium. However, the Permian is already depressurised in this area due to historical and approved mining and there is a downward hydraulic gradient from the shallow alluvial watertable to the Permian. Further depressurisation of the deeper Barrett seam in parts of HVO North is therefore unlikely to significantly affect the shallow groundwater table within the alluvium based on existing observations and the conceptual understanding. As a result, potential impacts on the Hunter River and associated alluvial aquifers are expected to be minor beyond already approved operations.

- Upgrades to Lake James and Parnells Dam would be conducted to increase the capacity to store water intercepted during mining. As these upgrades are being undertaken on existing dams with no change in the location of the dam, the upgrades would not result in a change to the contributing catchments.

- As the amended Project will not intercept new surface water catchments, the potential impact on streamflow is expected to be negligible.

- HVO is not seeking to change existing approvals or licences for the discharge of mine water under the EPL. Therefore, the potential impact of the amended Project on water quality is expected to be negligible.

A conceptual model of the conditions during mining across the HVO Complex is presented in Figure 5.2.

5.3 Post mining conditions

The key conceptual considerations post mining are:

- the amended Project will result in two final voids at HVO North, rather than three voids as per the current approved operations. HVO South will remain as one final void
- Permian potentiometric surface would slowly rise after cessation of mining activities. However, the final voids will remain groundwater sinks due to their depth and size
- the LPBWs will remain in place post mining. Therefore, groundwater inflows from the alluvium to the final voids and associated watertable drawdown are expected to be minor, due to the continued recharge from the Hunter River
- the LPBWs would also prevent potential seepage from the emplacement areas to the alluvium, thereby avoiding contamination of the Hunter River alluvium
- drawdown in the alluvium as a result of the final voids would be limited, therefore ecosystems that rely on alluvial groundwater would not to be significantly impacted
- following closure, the drainage systems in the amended Project area will be established to divert upstream catchment runoff away from the final voids (as much as practical) and to downstream watercourses
- where possible, levees will be incorporated into the final landform, including the Carrington West Wing levee to restore floodplain storage capacity for the Hunter River in this area.

A conceptual model of the conditions post-mining including the final landform across the HVO Complex is presented in Figure 5.2.

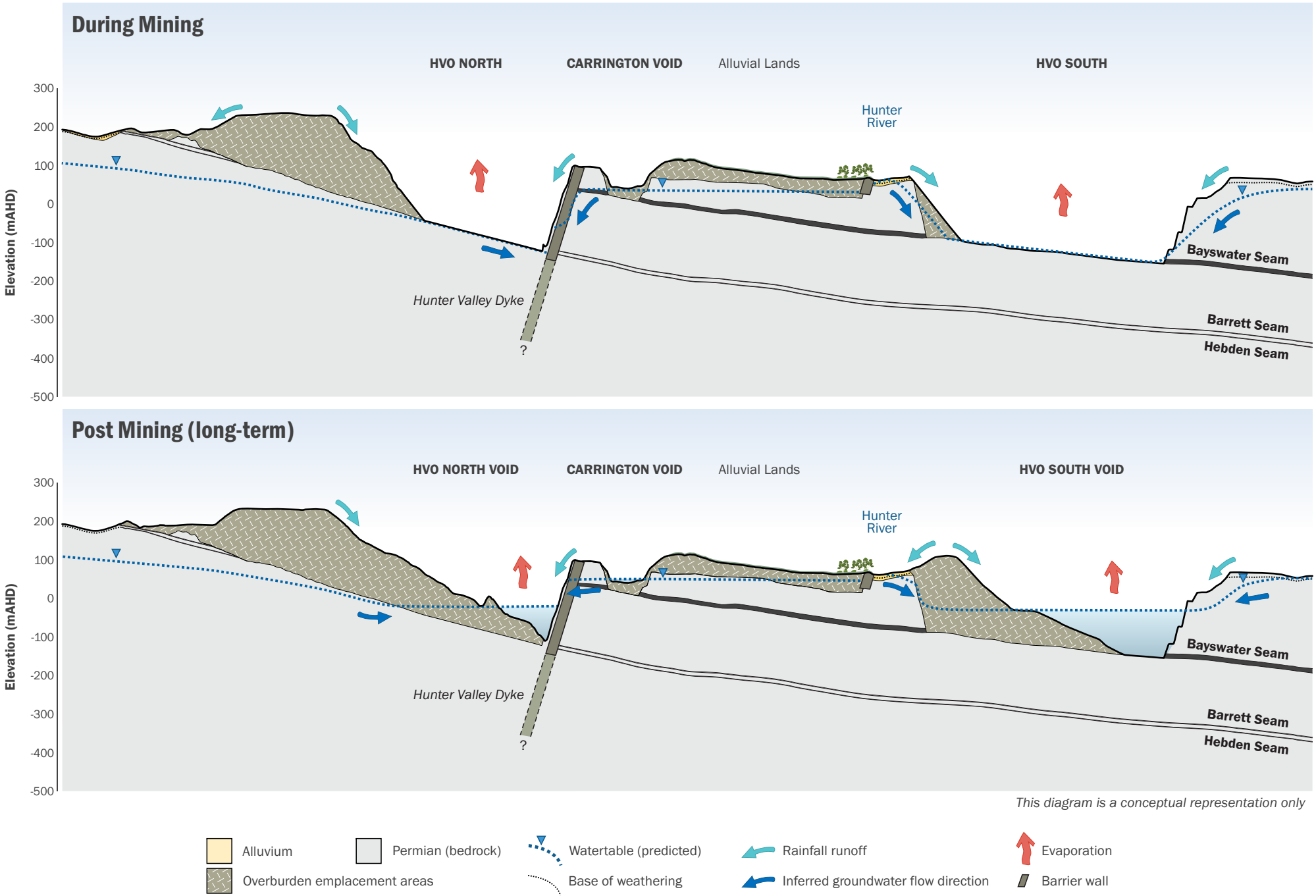


Figure 5.2 **Mining and post-mining conceptual cross-section across the HVO Complex**

6 Assessment approach

6.1 Introduction

The amended Project will include minor additional disturbance areas between West Pit and Carrington Pit at HVO North and will continue to operate the HVO integrated WMS for the amended Project.

The amended Project will intercept groundwater and has the potential to result in changes to the existing groundwater and surface water regime. The amended Project will result in additional depressurisation of the Permian strata directly intersected by mining. However, because the HVO Complex already comprises active and approved mining, the potential for the amended Project to result in a significant incremental impact on water resources is reduced due to existing and approved impacts and existing depressurisation.

Activities specific to the amended Project that have the potential to have an incremental impact on water resources and water users are detailed above in Section 2.2.

The assessment approaches and methods for the different technical studies (surface water (including modelling), groundwater modelling, aquatic ecology and GDEs) are described in the supporting appendices to the EIS Water Assessment (EMM 2022b). The assessment methods have been peer reviewed and found fit for the intended purpose. As such, the assessment methods remain unchanged from the original Project for the amended Project.

6.2 Avoidance and mitigation measures

The amended Project considers a design that avoids and minimises impacts to water resources and water dependent assets, including:

- removing the currently approved coal extraction in RSEE, SLP 1 and SLP 2 from the amended Project mine plan
- realignment of Lemington Road and improving flood immunity at the new proposed Hunter River crossing
- establishment of the Mitchell East Levee to provide flood protection for the main HVO North final void
- mainly limiting disturbance to previously disturbed or approved areas, thereby avoiding disturbing new catchments
- construction of the Carrington West Wing LPBW prior to mining within 100 m of the remnant western arm of the paleochannel (as approved)
- continued operation of the existing WMS, including preferential use of sediment-laden and mine water over extraction from the Hunter River
- operating in accordance with the requirements of EPL 640 and WALs.

These are generally consistent with avoidance and mitigation measures outlined for the original Project.

6.3 Assessment criteria

6.3.1 Overview

The adopted assessment criteria are based on the assessment requirements outlined in the relevant legislations, policies and guidelines detailed in Chapter 3. In addition, the licensing requirements of the amended Project have also been assessed against the WM Act, relevant WSPs and the AIP. The AIP assessment framework checklist is included in Attachment D.

Table 6.1 presents the water affecting activities and potential effects typically associated with, the potential duration of the effect and associated impact on a receptor and a summary of the assessment method(s) used for the impact assessment. These are consistent with the original Project (EMM 2022b).

Table 6.1 Water affecting activities, potential effects, impacts on receptors, and assessment methods

Direct effect	Water affecting activity	Potential effect	Potential duration	Potential impact at a receptor	Assessment method
During operations					
Quantity	Groundwater inflows to open cut pits, including mining deeper in previously mined areas.	Additional aquifer depressurisation or drawdown, changed groundwater flow paths, local induced flows, indirect take from overlying or adjacent water sources	Duration of the development, may take years to observe	Reduced access to water, reduced or loss of habitat	Groundwater modelling (Attachment A) Aquatic ecology and GDE assessment (ELA 2025)
	Built infrastructure (new or re-alignment of roads, WMS).	Minor change in watercourse catchment reducing or changing streamflow/flood regime, diversion of/changes to watercourses geomorphology		Changes to aquatic habitat, change to access during flooding events	Water balance modelling (Attachment B) Streamflow modelling (Attachment B) Flood modelling (Engeny 2022) Aquatic ecology and GDE assessment (ELA 2025)
	Tailings storage	Perched water table, seepage, water table mounding	Continuous (depends on management)	Waterlogging, detrimental changes to habitat	Not applicable – tailings will either be stored below the base of weathering and alluvium, if present, or a seepage assessment will be undertaken to prevent seepage and overtopping prior to depositing above the base of weathering
	Spoil emplacement	Altered recharge	Duration of the development, may take years to observe	Changes to habitat, reduced access to water	Groundwater modelling (Attachment A)
Quality	Groundwater inflows to open cut pits	Mobilisation of salt (water quality changes), development of acid sulphate soils or acid mine drainage from pit walls	Duration of the development	Change in beneficial use/environmental or cultural value, detrimental change to ecosystem, reduction in or removal of biodiversity or species	Soil and Land Impact Assessment Report (Minesoils 2022) Geochemistry Assessment (EGi 2022a)

Direct effect	Water affecting activity	Potential effect	Potential duration	Potential impact at a receptor	Assessment method
	Water storage	Leaching of solutes, overflow to watercourses altering surface water quality			Water balance modelling (Attachment B) Water quality assessment (Attachment B)
	Licensed water discharge	Mixing of water quality			Water quality assessment (Attachment B) Aquatic ecology and GDE assessment (ELA 2025)
	Spoil emplacement/tailings storage	Acid mine drainage, leaching of solutes, seepage from backfilled areas to the alluvium			Geochemistry assessment (EGi 2022a) Groundwater modelling (Attachment A)
Surface water-groundwater interactions	Groundwater inflows to open cut pits.	Altered baseflow to watercourse, increased leakage from watercourse to groundwater, induced inflows of different water quality	Duration of the development, may take years to observe	Increase in number of no flow days, reduced fish migration passage	Groundwater modelling (Attachment A) Streamflow modelling (Attachment B) Aquatic ecology and GDE assessment (ELA 2025)
Aquifer disruption	Excavation	Removal of part of whole of an aquifer and/or aquitard, change in groundwater flow paths (noting that the disturbance area for the amended Project will largely not change, so this included only for cumulative impact assessment purposes)	Permanent, unless backfilled	Reduction in ecosystem habitat, change in groundwater levels in adjacent water source(s)	Groundwater modelling (Attachment A) Aquatic ecology and GDE assessment (ELA 2025)
	Backfilling	Altered hydraulic properties, change in groundwater flow paths	May be permanent		Groundwater modelling (Attachment A)
Closure					
Quantity	Groundwater inflows to final voids	Evaporative losses of water from final voids, continued groundwater drawdown, slow groundwater level recovery	Often hundreds of years	Reduced access to water, reduced or loss of habitat (possibly permanent)	Groundwater modelling (Attachment A)

Direct effect	Water affecting activity	Potential effect	Potential duration	Potential impact at a receptor	Assessment method
	Tailings storage	Perched watertable, seepage, watertable mounding	Potentially hundreds of years	Waterlogging, detrimental changes to habitat	Not applicable – tailings will either be stored below the base of weathering and alluvium, if present, or a seepage assessment will be undertaken prior to deposition to prevent seepage and overtopping
Quality	Final pit lakes	Evapoconcentration of salts within the pit lake, potential acid mine drainage (acidification of pit lake)	Continuous	Change in beneficial use/environmental or cultural value, detrimental change to ecosystem, reduction in or removal of biodiversity or species	Groundwater model (Attachment A) Water balance modelling (Attachment B) Geochemistry assessment (EGi 2022a)
	Spoil emplacement	Seepage from backfilled areas to the alluvium	Potentially many years		Groundwater model (Attachment A) Geochemical assessment (EGi 2022a)
Surface water-groundwater interactions	Groundwater inflows to final voids	Altered baseflow to watercourse, increased leakage from watercourse to groundwater	Often hundreds of years	Increase in number of no flow days, reduced fish migration passage (possible permanent)	Groundwater model (Attachment A) Streamflow modelling (Attachment B) Aquatic ecology and GDE assessment (ELA 2025)
	Rehabilitation	Altered flow regimes	Potentially hundreds of years, dependent on rehabilitation		Streamflow modelling (Attachment B)

6.3.2 Groundwater

The potential impacts of the amended Project on groundwater resources and associated assets have been assessed against the minimal harm thresholds defined in the AIP. The AIP assessment framework has been completed and is included in Attachment D.

The amended Project area has the potential to impact both 'highly productive' alluvial aquifers (associated with the Hunter River and its tributaries) and a 'less productive' porous and fractured rock source (the Permian groundwater system). The applicable minimal impact considerations are shown respectively in Table 6.2 and Table 6.3. Impacts to groundwater are assessed via the consideration of water receptors discussed in Section 4.7. The AIP minimal impact considerations process is presented in Figure 6.1.

Cumulative variation in the water table and/or pressure head decline criteria in the AIP are for 'post-WSP' variations only. EMM understands the reference to 'post-WSP' (in regards to minimal impact considerations) to mean that projects /activities should be assessed against environmental conditions at the time of a WSP being enacted (or soon after), allowing for climate variation. For the Hunter River alluvium (managed under the Hunter Unregulated River and Alluvial WSP), this is late 2009. It is an acknowledgement of activities prior to commencement of the WSP.

Table 6.2 Minimal impact considerations for 'highly productive' alluvial aquifer

Watertable	Water pressure	Water quality
1. Less than or equal to a 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP. A maximum of a 2 m decline cumulatively at any water supply work.	2. A cumulative pressure head decline of not more than 40% of the post-WSP pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. 2. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. 3. No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the 3D extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. 4. Not more than 10% cumulatively of the 3D extent of the alluvial material in this water source to be excavated by mining activities beyond 200 m laterally from the top of high bank and 100 m vertically beneath a highly connected surface water source that is defined as a reliable water supply.

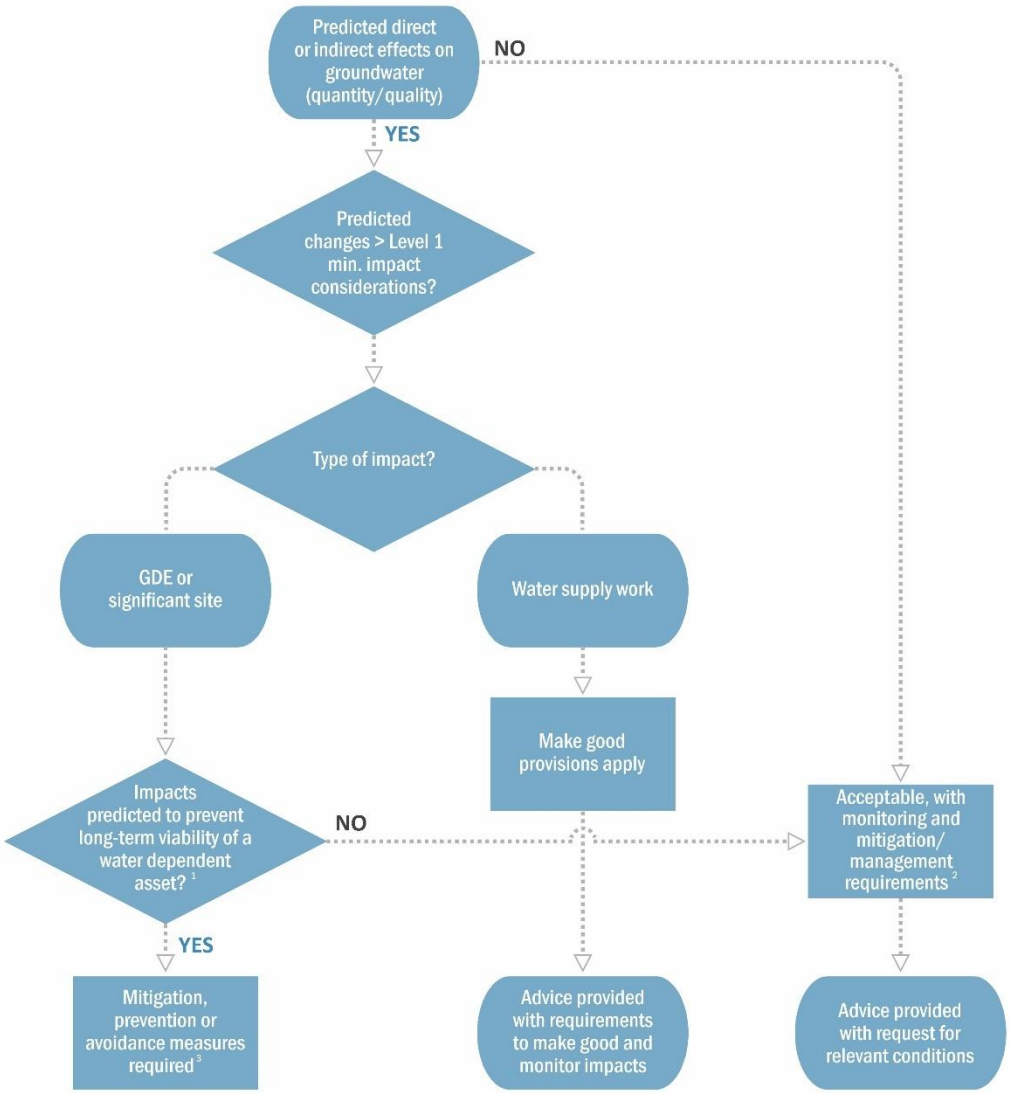
Watertable	Water pressure	Water quality
2. If more than 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP then appropriate studies (including the hydrogeology, ecological condition and cultural function) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	5. If conditions 1 to 4 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Source: NOW (2012).

Table 6.3 Minimal impact considerations for 'less productive' porous rock water source

Watertable	Water pressure	Water quality
1. Less than or equal to 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP. A maximum of a 2 m decline cumulatively at any water supply work.	1. A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.
2. If more than 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP then appropriate studies (including the hydrogeology, ecological condition and cultural function) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Source: NOW (2012).



1 Assessment as per Serov et al 2012, with consideration of uniqueness, ecological/cultural value and timeframe of the impact.

2 Conditions of approval may include requirements for adaptive management to monitor and mitigate or remediate impacts that exceed level 1 thresholds.

3 Where there are no suitable or practical mitigation or prevention options, the proponent may be asked to avoid impacts by modifying the proposed activity.

Source: adapted from DPI Water (2012a)

Figure 6.1 AIP minimal impact considerations process

6.3.3 Surface water

Consistent with the original Project, criteria for assessing potential impacts on surface water quantity, quality and the flooding regime is summarised in Table 6.4.

Table 6.4 Surface water assessment criteria

Water quantity (flow, level and availability)	Water quality	Flooding
WSP rules	Water quality objectives.	Improved flood immunity to public infrastructure.
River flow objectives	Site-specific trigger values and ANZG (2018).	Minimal change to existing maximum flood depth on third-party properties, based on the 1:100 AEP event (consistent with the Singleton Local Environmental Plan 2013 flood planning level).
Minimal change in number of no flow days	Operating within the requirements of EPL 640 and the HRSTS.	Minimal increase in flood velocity (<2 m/s).
No change in access to water for downstream users.		No change to the flood hazard category for primary transport corridors.
		No impact to land use during flood events.

6.3.4 Aquatic ecology and GDEs

Consistent with the original Project, criteria for assessing potential impacts on aquatic ecology and GDEs identified in Section 4.7 included:

- number of no flow days
- water quality objectives and ANZG (2018)
- risk assessment guidelines for GDEs (Serov et al 2012).

6.4 Cumulative impacts

As previously discussed, HVO is located in an area where the surface water and groundwater environment has been highly modified by historical mining, industrial and agricultural activities over the past 70 years or so. Due to the dynamic nature of the regional hydrogeology, ongoing impacts associated with approved and historic mining will continue to affect groundwater levels and pressures, and connected surface water resources, irrespective of whether the amended Project occurs.

Due to the minor change to the approved disturbance area, removal of coal extraction from RSEE, SLP 1 and SLP 2 from the mine plan and mainly restricting continued mining to deeper seams in previously mined areas, the potential incremental impact of the amended Project on water resources and water-dependent assets is expected to be minor. Cumulative impacts are more relevant for groundwater resources and water-dependent assets, including the predicted cumulative change in groundwater levels in the alluvium due to historical approved and proposed mining, which has the potential to affect receptors identified in Section 4.7. Cumulative drawdown is therefore assessed in Chapter 8.

As discussed above, the AIP requires assessment of cumulative impacts from the commencement of a WSP, which for the Hunter River alluvium is 2009.

7 Surface water impact assessment

7.1 Introduction

Consistent with the original Project, due to the integrated nature of the WMS, some aspects of the SWIA have been considered together (for the HVO North and HVO South). In general, impacts are presented for the HVO Complex with discussion provided on the two approvals where appropriate.

The amended Project will mine areas within existing approved disturbance boundaries, including mining previously disturbed areas. Consequently, the incremental impact of the amended Project on adjacent surface water systems is generally expected to be minor or negligible.

The following sections are a summary of the SWIA; further discussion is available in Attachment B (Engeny 2025).

7.2 WMS performance

The HVO WMS consists of a network of infrastructure (i.e. dams, pipelines, contour banks) to control the movement of water around the site. Water is managed according to type, which is determined by catchment source, quality and use. Water managed at the HVO Complex includes mine water, sediment water and clean water.

Clean water diversion structures and levees divert clean water away from the active pits. Most of the water used on site is for coal processing and dust suppression. Mine water is preferentially used to reduce the amount of water discharged to the Hunter River under the HRSTS and the extraction of water under the Hunter River surface water allocations.

Excess mine water can be released via licensed discharge points to the Hunter River. Discharges are only allowed during high and flood flow periods in the Hunter River as determined by WaterNSW and DCCEEW. Discharges are regulated by conditions in the EPL and by the HRSTS.

As outlined in Section 3.2.2, HVO holds both high and general security WALs to withdraw water from the Hunter Regulated River to meet water deficits. In addition, water transfer systems are in place with both Mount Thorley Warkworth, Wambo and the Liddell Coal Operations.

Model results indicate that average inflows are dominated by rainfall runoff (58% of the total inflow) while groundwater is only a small contributor (6% of the total inflow). Hunter River extraction via existing high security WALs represents the main water source (9% of the total inflow on average).

Most of the water used on site is for coal processing (38% on average) and dust suppression (24% on average). Discharge via the HRSTS represents approximately 16% of the average outflows over the life of the amended Project.

7.3 Streamflow impacts

As described above, the WMS for the amended Project will be consistent with the requirements of the approved operations, except for mining through new areas (between Mitchell Pit and Carrington Pit) and re-disturbance of some rehabilitated areas. As outlined in Chapter 6, lowering of the watertable due the amended Project has the potential to result in changes in surface water-groundwater interaction. Engeny (2025) has used the groundwater model (EMM 2025b) predicted changes in surface water-groundwater interaction to inform the streamflow impact assessment.

No new surface water catchments from the approved operations will be intersected as part of the approved Project. Consistent with the original Project, the streamflow assessment (Engeny 2025) indicates there will be minimal to no changes to the annual flow and average duration of dry periods for Hunter River and most of its tributaries. Only three ephemeral watercourses were found to have changes of 1% or more due to the amended Project:

- Parnells Creek: average duration of dry periods within the representative "dry" year increased from 150 days to 151 days (1% increase) during the Amended Project operations
- Unnamed Tributary 1 at HVO North: Average duration of dry periods within the representative "dry" year increased from 155 days to 163 days (5% increase) during operations, due to extending mining
- Farrells Creek: Average duration of dry periods within the representative "dry" year increased from 156 days to 159 days (1% increase) during operations.

The predicted change in streamflow is negligible for the Hunter River and Wollombi Brook and minor for the ephemeral tributaries. Potential impacts on surface water downstream users, including basic landholder users will be negligible. This is consistent with the original Project assessment (Engeny 2022), though it is noted that the Amended Project results in less impact to Wollombi Brook and the ungauged ephemeral streams than the original Project.

7.4 Surface water quality

Under the HRSTS, releases can occur during high flow periods. The water balance model (Engeny 2025) predicts that 79% of the time, the median discharge volume will be 100 times less than flows in the Hunter River. On 4% of release days, flow in the Hunter River is predicted to be 80 times greater than the discharge volume. Consistent with the original Project, Engeny (2025) has calculated the potential change to water quality in the Hunter River due to discharge via the HRSTS, using the more conservative dilution ratio of 80:1 (Hunter River flow 80 times larger than discharge volume).

Following mixing, water quality concentrations in the Hunter River are generally predicted to remain below the 80th percentile background concentrations; the parameter exclusions to this are the same as per the original Project (Engeny 2022). All mixed concentrations were found to remain below the 95th percentile background concentrations indicating that the expected water quality is within the existing natural range of the Hunter River. Therefore, discharge under the HRSTS is not expected to have an adverse effect on surface water quality or change the beneficial use. These are consistent with the original Project (Engeny 2022). The amended Project is expected to utilise, on average, 20% to 53% of the total allowable discharge opportunities to the HRSTS (compared to 20% to 40% for the original Project). Discharges continue to be skewed to wet years utilising more than the average annual allowable discharge potential in those periods (e.g. 95th percentile wet years) for both the amended Project and the original Project.

7.5 Flooding assessment

The amended Project does not encroach onto the floodplain further than the original Project or further reduce floodplain storage and as such it is considered that the impacts from the amended Project will be no worse than those modelled for the original Project and has not been re-simulated for the amended Project. The flood model development and detailed results are provided in the original Project SWIA report (Engeny 2022) and response to submissions (EMM 2023a).

8 Groundwater impact assessment

8.1 Introduction

The potential impact of the amended Project on the groundwater regime has been assessed from an incremental (comparison between approved and proposed) and cumulative perspective (estimating the effects of historic approved, the amended Project and other planned mining activities). Qualitative descriptions of impact differences against the original Project are also provided.

As part of the Amendment Report (EMM 2025a), groundwater modelling has been undertaken to reflect the changes to the mine plan (EMM 2025b, Attachment A). This groundwater modelling uses the latest version of the model from the HVO Continuation Project Groundwater Impact Assessment (AGE 2022) report prepared for the original Project.

This section is focused on the potential impacts during operations. The predicted incremental and cumulative drawdown is focused on the alluvium, as it provides habitat for and access to water for water-dependent assets. Assessment of potential post mining impacts is provided in Chapter 10, as this is inter-related with the final void water balance modelling completed by Engeny (2025).

The proposed change to mining at HVO South will result in less groundwater drawdown in the Wollombi Brook alluvium in comparison to the approved operations, through the removal of mining in the SLP 1 and SLP 2 areas from the mine plan. As such, the incremental drawdown in the Wollombi Brook alluvium due to proposed changes to mining is not presented. This is consistent with the original Project (AGE 2022 and EMM 2022b).

At HVO North, as mining will be progressing deeper through previously disturbed or currently approved mining areas (excluding Carrington West Wing area where mining depth remains consistent with the current approval), the incremental effects of the amended Project at HVO North are expected to be minor.

The following sections summarise the groundwater modelling results presented in Attachment A.

8.2 Watertable drawdown

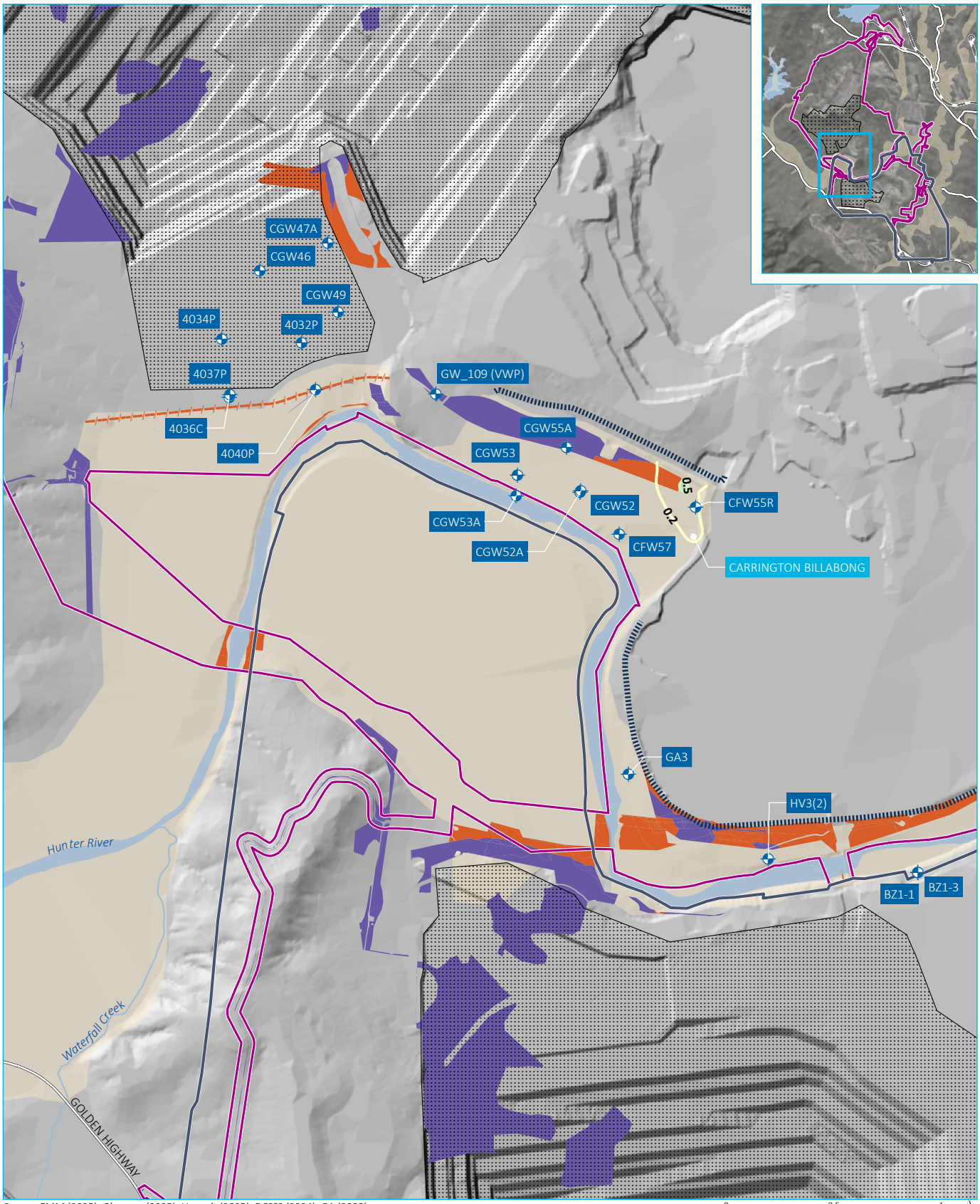
8.2.1 Incremental drawdown

Figure 8.1 shows the maximum incremental drawdown predicted to occur within the Hunter River alluvium. There is a negligible drawdown predicted in the Carrington West Wing alluvial area due to installation of the barrier wall prior to mining in the area.

The groundwater model predicts minor additional (incremental) drawdown in the Carrington Billabong area (between 0.2 and 0.5 m; Figure 8.1) due to mining to the deeper Permian seams north of Carrington Pit (mining down to the Barrett seam), compared to what is historical approved mining. The small area of drawdown is mainly due to an increased downward vertical gradient between the alluvial watertable and the Permian potentiometric surface.

The extent of the predicted incremental drawdown in the Hunter River alluvium is less than that predicted for the original Project (AGE 2022; EMM 2023a). This is due to the changes to the mine plan and the HVO North pit depth being shallower than and ceasing further from the Hunter River in the Carrington West Wing area than that proposed in the original Project.

Consistent with the original Project, there are no third-party water supply bores within the predicted extent of drawdown. Therefore, no third-party bores will be impacted by the amended Project.



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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km
GDA2020 MGA Zone 56

N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)
- 0.2
- 0.5

Plant community type (PCT) (Umwelt, 2025)
- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment
- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted incremental drawdown during operations in the Hunter River alluvium

HVO Continuation Project - Amendment
Water Assessment
Figure 8.1

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8.2.2 Cumulative drawdown

As described in the EIS Water Assessment (EMM 2022b), the predicted cumulative drawdown was calculated by comparing the results of a model scenario of the proposed mine plan (i.e. the amended Project) to a baseline scenario where simulated mining ceases after 2009 (which is when the Hunter Unregulated and Alluvial WSP commenced), effectively allowing groundwater levels to recover in this baseline 2009 scenario. This scenario is therefore conservative and results in exaggerated predictions of groundwater drawdown and changes in surface water-groundwater interaction due to the approved and proposed mining. This represents a limitation in the groundwater modelling and the requirements of the AIP to estimate cumulative drawdown effects "post-WSP".

Figure 8.2 and Figure 8.3 show the maximum cumulative drawdown predicted to occur within the Hunter River alluvium and the Wollombi Brook alluvium over the operational life of the amended Project (i.e. until 2045). The figures show the maximum drawdown predicted to occur due to the cumulative effect of historical approved and proposed mining at the HVO Complex and at other mining operations in the Study area.

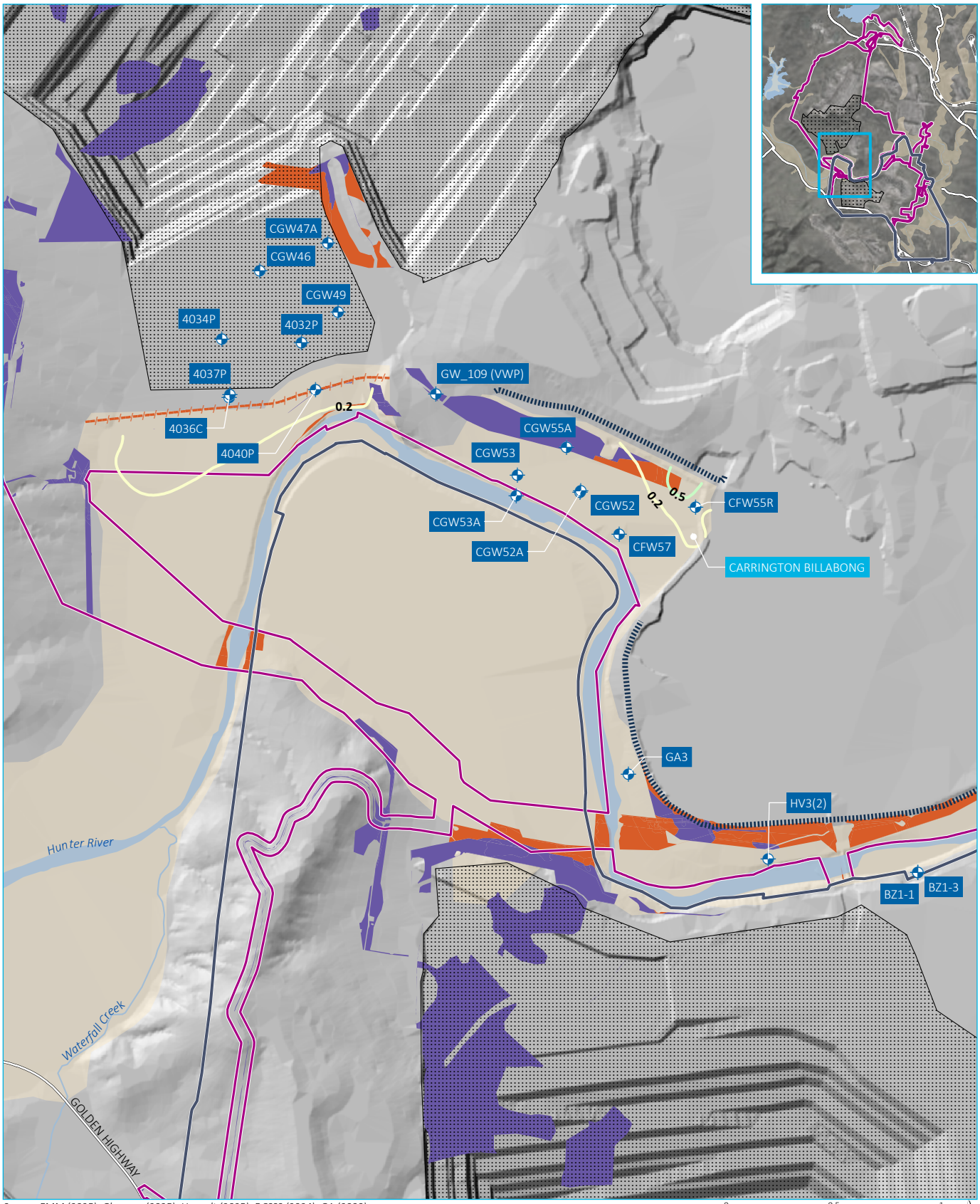
The cumulative maximum drawdown predicted in the Hunter River alluvium (up to 0.5 m during operations) is due to depressurisation of the Permian hydrostratigraphy and an associated downward vertical gradient between the alluvial watertable and the Permian potentiometric surface. The depressurisation is related to mining at HVO North and HVO South.

The extent and magnitude of the predicted cumulative drawdown in the Hunter River alluvium is less than that predicted for the original Project (AGE 2022; EMM 2023a). As discussed above, this is due to the changes to the mine plan and the HVO North pit depth being shallower than and ceasing further from the Hunter River in the Carrington area than that proposed in the original Project.

In the Wollombi Brook alluvium, a maximum cumulative drawdown of up to 2 m is predicted in the area above the historical Lemington underground mine (Figure 8.3). Drawdown is predicted due to the simulated continued use of Lemington underground as a water storage for operational water use for the United Wambo mining operation (as approved).

The coal seams intersected by Lemington underground mine subcrop under parts of the Wollombi Brook creating minor cumulative drawdown slightly further downstream towards the confluence with the Hunter River. The drawdown is a cumulative impact and not due to the amended Project.

The predicted cumulative drawdown in the Wollombi Brook area is consistent with the predictions derived for the original Project (AGE 2022).



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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km
GDA2020 MGA Zone 56
N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)
- 0.2
- 0.5

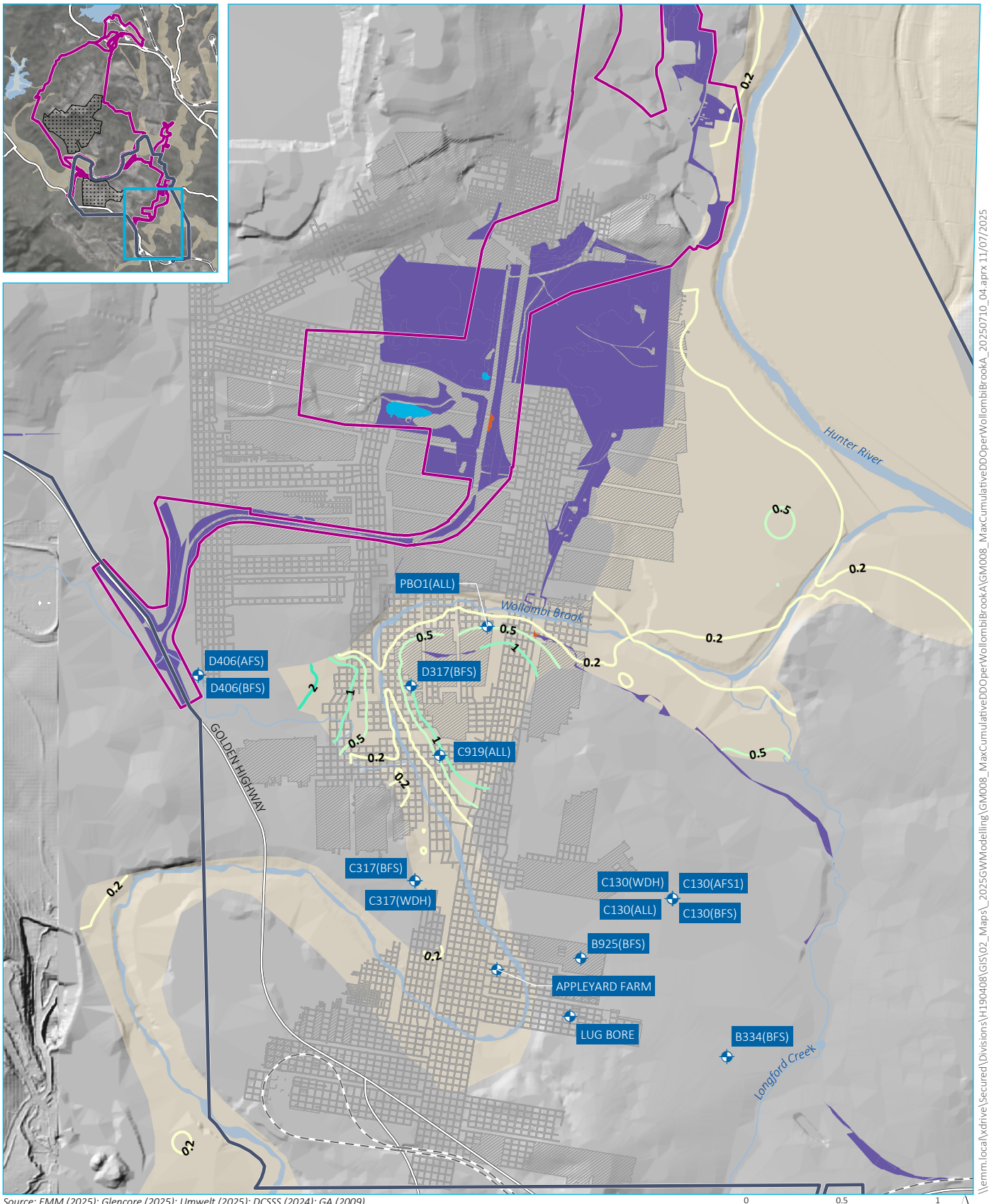
Plant community type (PCT) (Umwelt, 2025)
- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment
- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown during operations in the Hunter River alluvium

HVO Continuation Project - Amendment
Water Assessment
Figure 8.2

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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Lemington underground mine plan
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown during operations in the Wollombi Brook alluvium

HVO Continuation Project - Amendment
Water Assessment
Figure 8.3

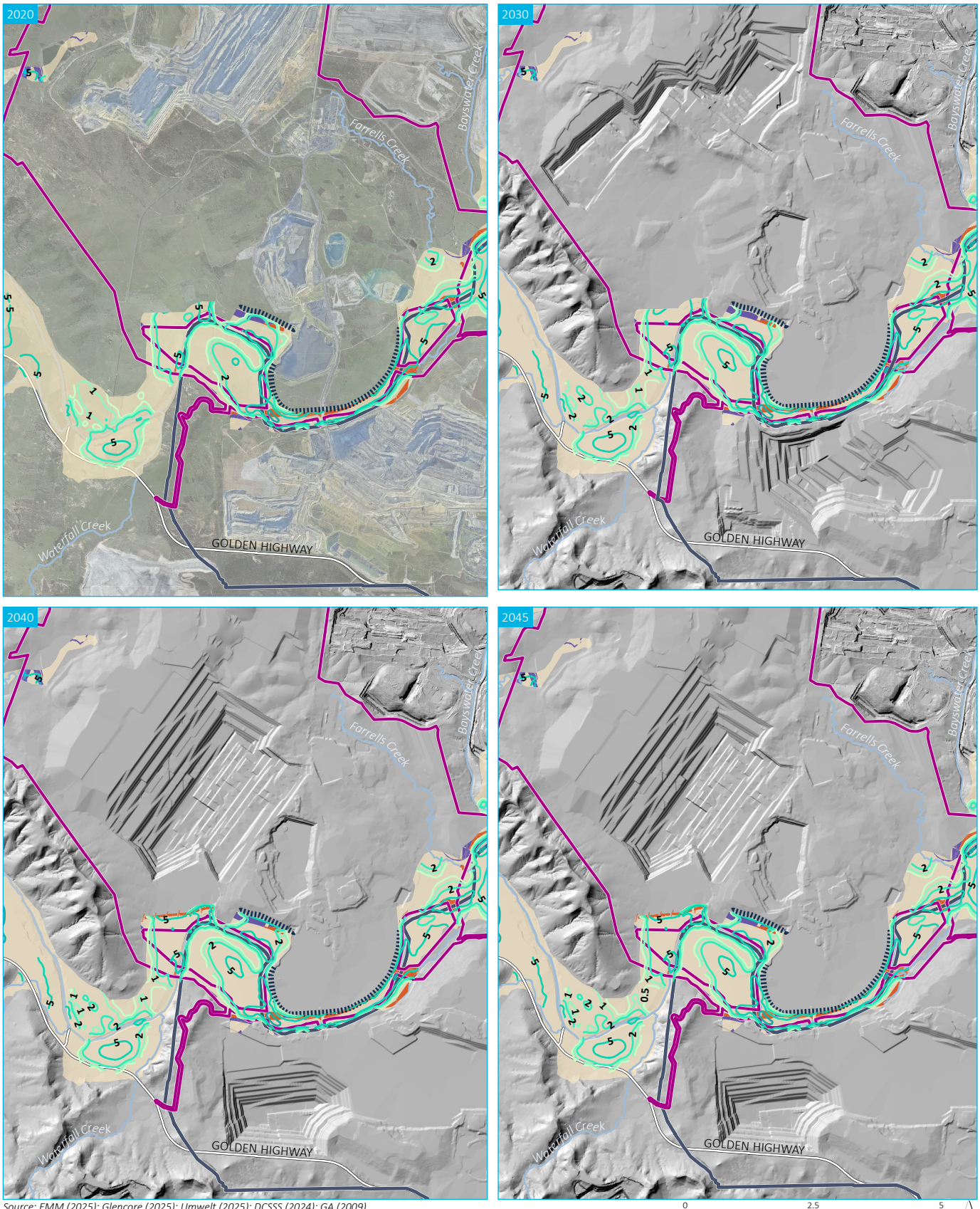
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8.3 Saturated thickness changes

Despite the minor drawdown predicted in the Hunter River alluvium, the alluvium will remain saturated largely due to leakage of surface water through the bed of the Hunter River and minor drawdown.

The predicted saturated thickness within the alluvial aquifer over the operational life of the amended Project is presented on Figure 8.4 for years 2020, 2030, 2040, and 2045 (i.e. at the planned end of mining at HVO North). The extent of the saturated areas remains largely unchanged over time and areas with potential GDEs are not predicted to be dewatered over the amended Project life, consistent with predictions for the original Project (AGE 2022; EMM 2023a).

The potential impact of the amended Project on water dependent receptors is discussed in Chapter 9.



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Existing low permeability barrier wall
- Carrington West Wing LPBW
- Alluvium extent

Saturated thickness (m)

- 0.5
- 1
- 2
- 5
- 10

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

- Major road
- Named watercourse
- Named waterbody

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Predicted alluvial aquifer saturation thickness contours during operations

HVO Continuation Project - Amendment
Water Assessment
Figure 8.4

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8.4 Groundwater inflows

The groundwater model has been used to predict annual volumes of groundwater intercepted by mining at HVO North and South.

The volume is predicted to peak at approximately 2,488 ML/yr in Year 13 (2039). Modelled predictions of inflows to mine workings are broadly consistent with the original Project (AGE 2022), with some variability owing to the updated numerical representation of mine progression and changes to the annual pit progression.

Further discussion is provided in the groundwater modelling report (EMM 2025b) in Attachment A.

8.5 Groundwater quality

There are no differences anticipated to groundwater quality from that previously assessed in the original Project (see EMM 2022 for more details on impact to groundwater quality).

9 Potential impacts on water dependent ecosystems

9.1 Groundwater dependent vegetation

River red gum vegetation stands, Central Hunter Ironbark Grassy Woodland and Central Hunter Swamp Oak Riparian Forest mapped by Umwelt (2022; 2025) are considered opportunistic users of alluvial groundwater. In addition, river red gums rely on river flooding for germination.

The river red gum community of the Hunter Valley is considered a threatened population under the *Biodiversity Conservation Act 2016* (BC Act), but at HVO it is highly disturbed so is classified as having a moderate ecological value (using the GDE Assessment Guidelines). Under the GDE Risk Matrix, the ecosystem is classified as D (moderate ecological value, low risk; ELA (2022; 2025)).

Groundwater modelling (EMM 2025b) predicts minor incremental drawdown during mining in the Hunter River alluvium near the riparian river red gum sites (see Figure 8.1 and Figure 9.1) and shows only small parts of the alluvial aquifer will be impacted (albeit minor impact) during the life of the amended Project. Alluvium along the main channel of the Hunter River is largely buffered from drawdown by the LPBWs installed along sections of the aquifer (adjacent to the HVO Complex). The predicted cumulative alluvial drawdown around the river red gum vegetation stands exceeds the AIP level 1 minimal impact considerations in a small area (refer Table 6.2). Minor cumulative drawdown of 0.2 to 0.5 m is modelled at Carrington Billabong during operations. However, any potential decline of the alluvial watertable is buffered by the leakage from the Hunter River, which has controlled flow through releases from Glenbawn Dam.

During periods of drawdown, river red gums and Central Hunter Ironbark Grassy Woodland vegetation will continue to have access to shallow alluvial groundwater. In addition, the amended Project is predicted to have a negligible impact on Hunter River flow and flooding regime (Engeny 2025). River red gum vegetation stands will continue to rely on flooding for germination. Therefore, impacts to this aquifer ecosystem and the river red gum populations are likely to be minor or negligible and the aquatic ecology and GDE assessment (ELA 2025) demonstrates that the variation will not prevent the long-term viability of the ecosystem.

No significant impact on groundwater dependent vegetation is expected due to the amended Project. This is consistent with predictions in the original Project.

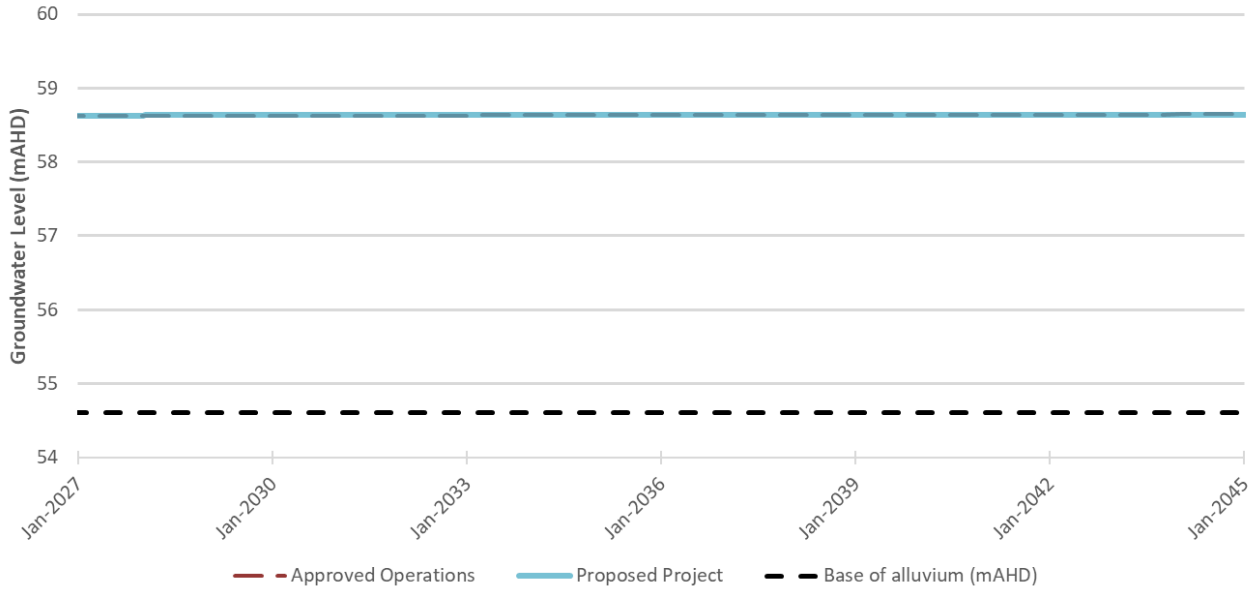


Figure 9.1 **Predicted groundwater levels at CGW52A (near Carrington Billabong) for the approved operations and proposed Amendment Project**

9.2 Aquifer ecological communities

As described in the original Project, there is a good understanding of the stygofauna presence in the Hunter River (and tributary) alluvium due to many years of research and surveys. The Hunter River alluvium in the amended Project area is a stygofauna habitat and hosts diverse stygofauna communities. As such, it is considered High Ecological Value. However, the stygofauna taxa within the amended Project area are known to be widespread throughout the Hunter Valley (ELA 2022; 2025).

As discussed in Section 8.2.1 and shown on Figure 8.1, the predicted maximum incremental drawdown during mining is predicted for a small section of the Hunter River alluvial aquifer in the Carrington area, reaching up to 0.5 m. Over most of the aquifer there is little change in saturated thickness between 2020 and 2045 as downward leakage of water through the bed of the Hunter River will maintain aquifer saturation. This indicates that there should be a sufficient amount of saturated sediments for stygofauna to inhabit. Therefore, impacts from the amended Project on stygofauna communities are predicted to be minor.

The western arm of the paleochannel will be mined during the excavation of Carrington West Wing as part of approved operations. This will have an impact on the local stygofauna community in the paleochannel, as they will not be able to migrate out of the impact area prior to excavation. However, this impact is already approved as part of Carrington West Wing extension (HVO North Mod 3, MER 2010).

The risk to the stygofauna community associated with the amended Project is low because there will be no additional excavation in the alluvium beyond what has already been approved. The cumulative impact to the stygofauna community from already-approved mining in the paleochannel is high and is categorised in the GDE Risk Matrix as C (High Ecological Value, High Risk; ELA (2022; 2025)).

This is consistent with the findings of the original Project.

9.3 Aquatic ecology

Some species of fish living in the Hunter River require access to estuarine reaches to spawn. Such species of fish could be impacted if river levels reduce to an extent where this migration is impaired for long periods of time. Flow in the Hunter Regulated River is maintained by releases from Glenbawn Dam and inflow from tributaries, rather than from contribution from groundwater. The results of the streamflow analysis (Engeny 2025; summarised in Section 7.3 and discussed in detail in Attachment B), show minor to negligible change in streamflow and duration of dry days due to the amended Project. This is consistent with results of the original Project.

The aquatic ecology and GDE assessment (ELA 2025) describes that there will be no additional impact to aquatic ecology in the Hunter River, and only minor impacts to the aquatic ecology in the Hunter River tributaries due to the amended Project. This is consistent with that of the original Project (ELA 2022).

10 Final void assessment

10.1 Introduction

When the final landform is achieved, all operations will be complete, and the disturbance areas will be rehabilitated. As discussed in Section 2.3.3, the final landform will result in two voids at HVO North and a single void at HVO South.

In comparison to the approved operation, the HVO South void will remain largely unchanged; however, the HVO North void is a reduction from three final voids (at West Pit, Mitchell Pit and Carrington Pit) to two voids (Mitchell Pit and Carrington Pit). This differs from that of the original Project, where two final voids (one at HVO North and one at HVO South) were proposed.

Consistent with the original Project, the voids have been designed to remain long-term sinks. As described in the SWIA (Attachment B), drainage systems will be established on rehabilitated overburden emplacement areas, as well as around the perimeter of the final voids to divert upstream catchment runoff away from the final voids and to downstream watercourses. As such, the final landform design minimises capture of surface water and thereby limits long-term impacts on streamflow. These drainage systems are shown on Figure 2.3.

Table 10.1 provides a comparison of the catchment areas of the approved final voids at the HVO Complex and the catchment areas of the proposed (indicative) final voids. An overall decrease in catchment area reporting to the voids across the HVO Complex will occur; this will result in increased catchment and surface runoff to the surrounding waterways, which is a positive change from the approved voids. This is consistent with the original Project final void assessment (Engeny 2022), where there was also an overall reduction in catchment area reporting to the final voids.

Closure options and strategies including the final land use are described in the EIS Mine Closure and Rehabilitation Strategy (Appendix T of the EIS Report).

Table 10.1 Comparison of approved and proposed (indicative) final void catchment areas

Proposed void	Approved void	Catchment area of approved void (ha)	Catchment area of proposed void – original Project (ha)	Catchment area of proposed void – amended Project (ha)	Change in catchment area (compared to approved; ha)
HVO South	Riverview Pit	1,145 [1]	714	570	-575
HVO North	West Pit	497 [2]	720	706	+55
	Mitchell Pit	154 [3]			
	Carrington Pit	120 [4]		324	+204
	Combined total	**1,916**	**1,434**	**1,600**	-316

Notes: 1. HVO South Mod 5 assessment (EMM 2016)
2. HVO North West Pit EIS (MER 2003)
3. Calculated (refer Chapter 3 of the EIS)
4. HVO North Mod 3 (Carrington West Wing) (MER 2010)

10.2 Final pit lake recovery

The predicted pit lake recovery and salinity (from the final void hydrology and salinity modelling base case (i.e. most likely scenario; Engeny 2025) are presented for HVO North, Carrington and HVO South proposed final voids in Figure 10.1, Figure 10.2 and Figure 10.3, respectively.

The North Void pit lake level is predicted to reach an equilibrium level of approximately -17.8 metres Australian Height Datum (mAHD) after approximately 600 years, which results in a freeboard of approximately 100 m. For the Carrington Void the model predicted a long-term pit lake level of 41.8 mAHD, resulting in a freeboard of approximately 14.0 m.

Consistent with the original Project, the HVO North Void will act as a strong sink, stronger than the current approved voids at HVO North.

The HVO South pit lake level is predicted to reach an equilibrium level of approximately -30 mAHD after approximately 600 years, which leaves a freeboard of approximately 110 m. The assessment for the approved operations estimated a long-term lake elevation of 30 mAHD. The modelling completed for the amended Project indicates the HVO South pit lake will be considerably deeper than previously predicted, with the HVO South void predicted to act as a regional sink.

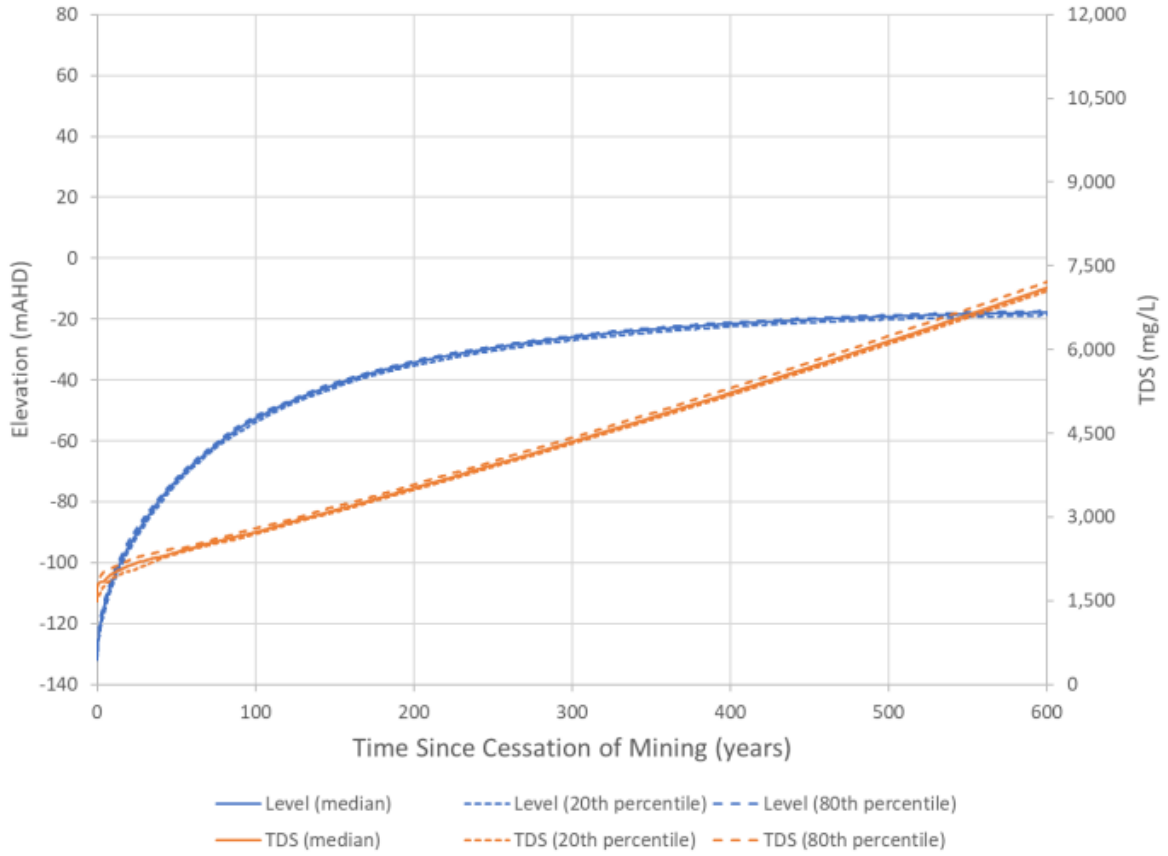


Figure 10.1 HVO North – North Void pit lake recovery and salinity (Engeny 2025)

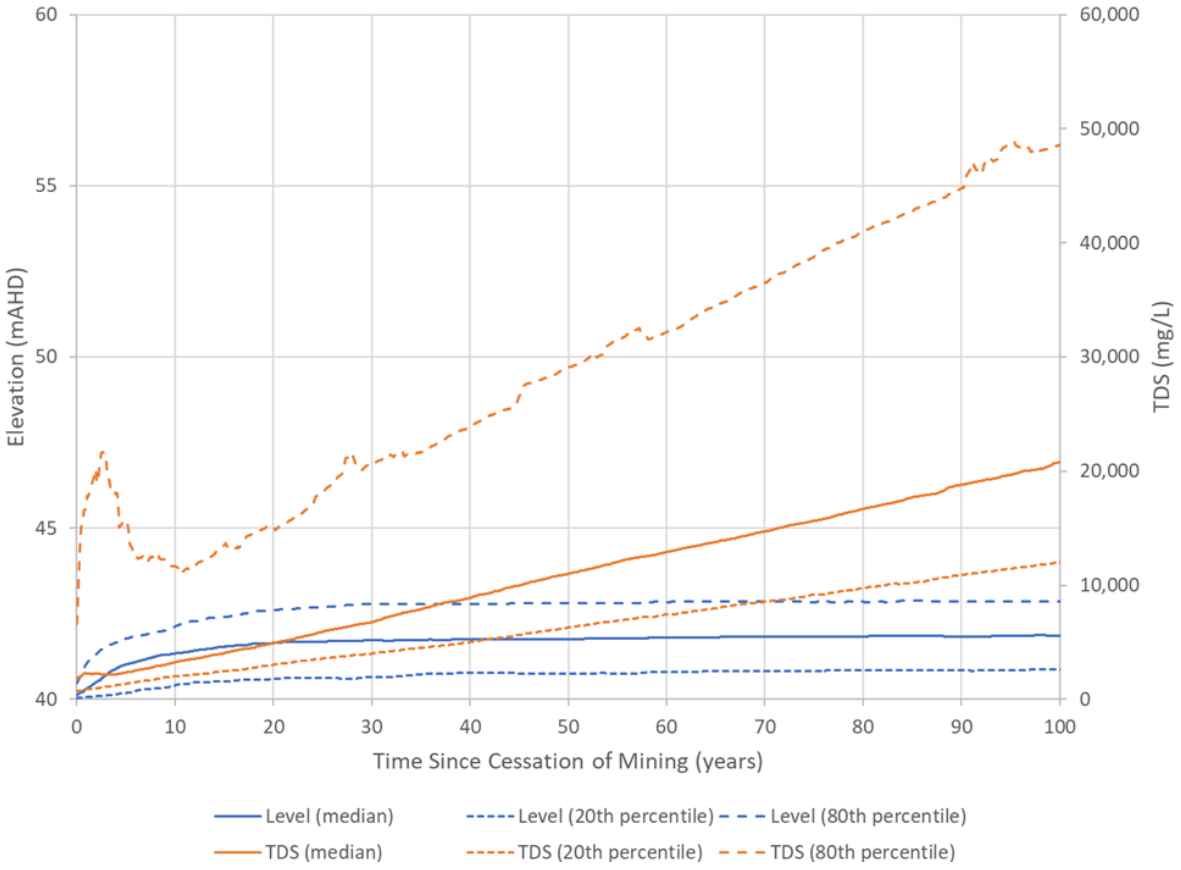


Figure 10.2 HVO North – Carrington Pit Void pit lake recovery and salinity (Engeny 2025)

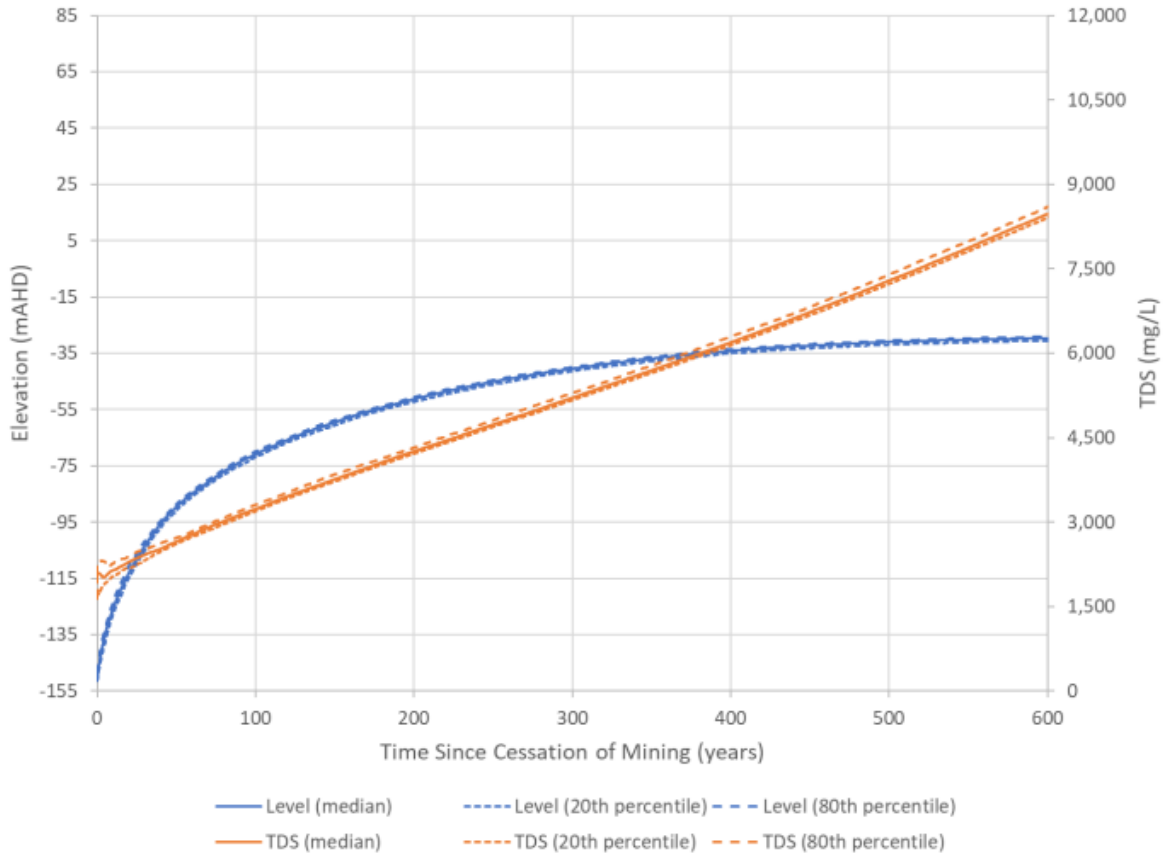


Figure 10.3 HVO South pit lake recovery and salinity (Engeny 2025)

These final void levels are generally consistent with that predicted for the original Project (Engeny 2022), with equilibrium levels predicted several hundred years following cessation of mining and evaporation causing all final voids to act as groundwater sinks. Equilibrium levels are slightly different between the North Void and South Void though both forecast long-term pit lake levels to have significant freeboard to the surface.

All three pit lakes are shown to have an ongoing trend towards higher salinity over time with the forecast median total dissolved solids (TDS) values of 7,100 mg/L, 21,550 mg/L and 8,400 mg/L for North Void, Carrington Void, and South Void respectively when equilibrium water levels are reached. This is consistent with original Project predictions that also show increasing salinity over time.

10.3 Post closure groundwater levels and flow direction

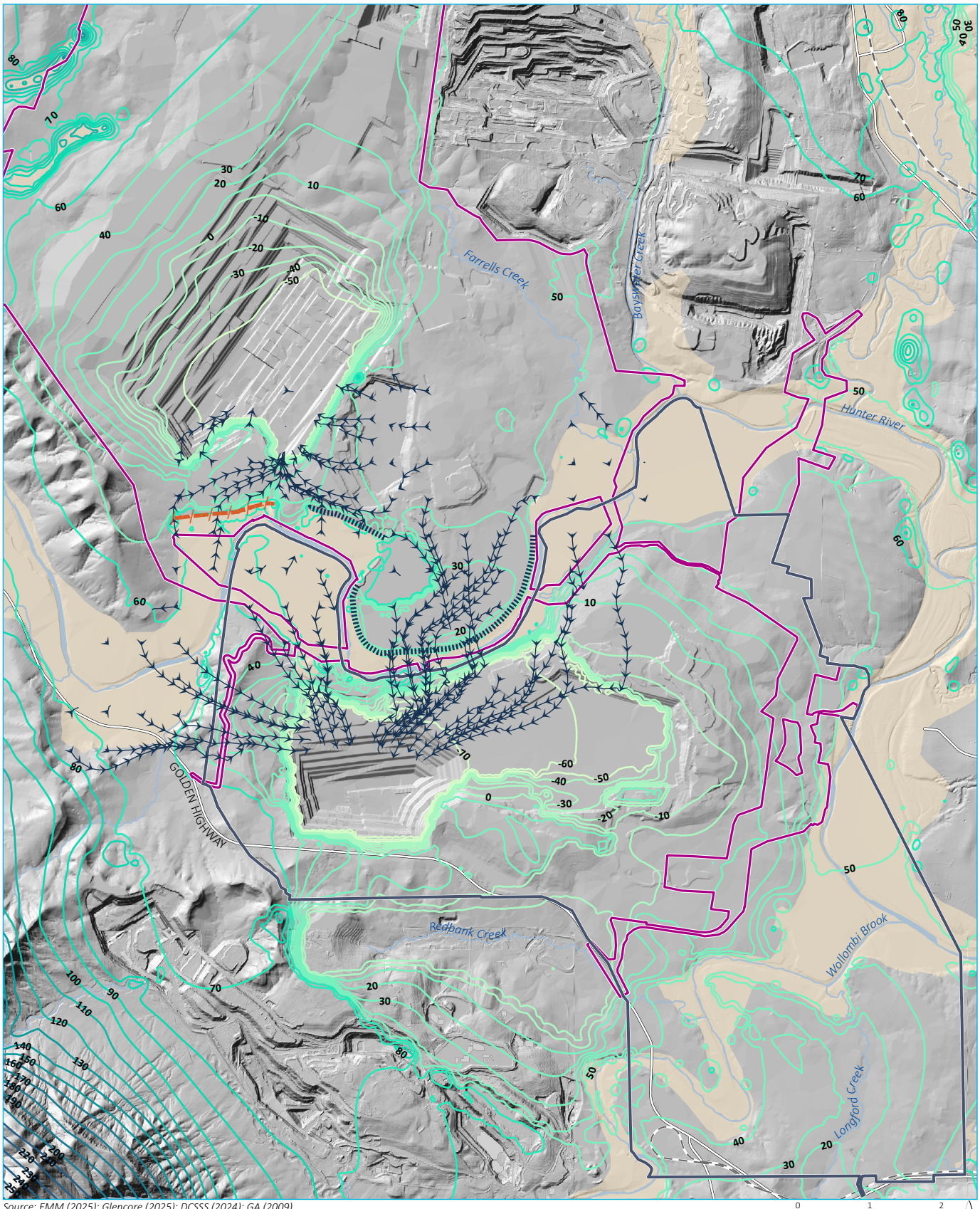
The groundwater model (Annexure A) predicted recovery within the groundwater flow regime over a period of 1,000 years, simulating the pit lake recovery predicted by the final void hydrology model (Engeny 2025).

The groundwater model was used to predict groundwater flow movement for 2,000 years from end of mining (particle tracking), focusing on:

- watertable recovery and groundwater flow direction in backfilled emplacement areas to evaluate the potential for groundwater to seep from these backfilled areas towards the alluvium and Hunter River
- the watertable in the Hunter River alluvium to evaluate groundwater flow direction and interaction with the voids long-term.

The simulated watertable at 100 years after closure and tracking of groundwater flow (over 2,000 years) is presented in Figure 10.4 (noting that the groundwater movement is lateral and vertical, i.e. three-dimensional).

The figure illustrates that the main final voids at HVO North and HVO South are predicted to act as sinks, with groundwater flow directed inward from the surrounding spoil towards the lakes, rather than outwards. This outcome is expected, given that pit lake levels are predicted remain significantly lower than the surrounding groundwater levels in the adjacent rock mass. There is therefore a low potential for a shallow watertable to form within in-pit spoils and migrate to the Hunter River alluvial aquifer. This is consistent with the predictions from the original Project groundwater modelling (AGE 2022).



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

0 1 2 km
GDA2020 MGA Zone 56

N

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Particle tracking result
- Alluvium extent

2150 Predicted watertable elevation (mAHD)

- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 75
- 75 to 100
- 100 to 125
- 125 to 150
- 150 to 200
- > 200

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Post-mining watertable and groundwater flow direction (particle tracking)

HVO Continuation Project - Amendment
Water Assessment
Figure 10.4

EMM
creating opportunities

10.3.1 Incremental drawdown

There is no incremental drawdown predicted in the alluvium post-mining due to the amended Project.

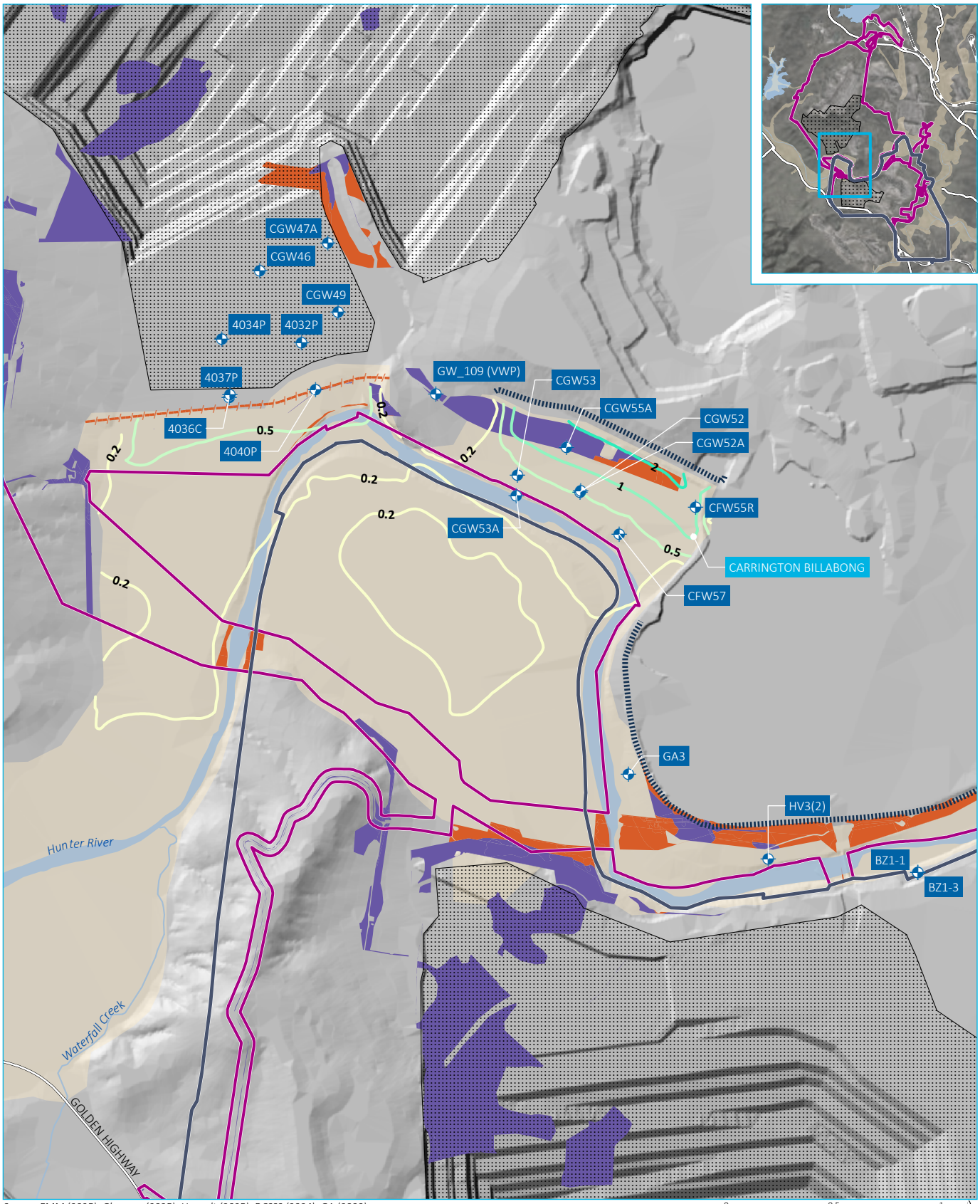
This is a reduced impact when compared to the original Project.

10.3.2 Cumulative drawdown

Figure 10.5 and Figure 10.6 show the maximum cumulative drawdown predicted to occur within the Hunter River and Wollombi Brook alluvium respectively, after closure of the amended Project.

Post mining cumulative drawdown in the Hunter River alluvium is predicted to increase in extent and magnitude (up to 1 m at Carrington Billabong) compared to during mining, due to ongoing evaporative losses from the final voids as the groundwater system gradually adjusts to a new post-mining equilibrium and the associated downward vertical gradient between the alluvial watertable and the Permian potentiometric surface.

Post-mining cumulative drawdown in the alluvium is predicted to be consistent with the predictions presented as part of the original Project (AGE 2022; EMM 2023a).



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km

GDA2020 MGA Zone 56

N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

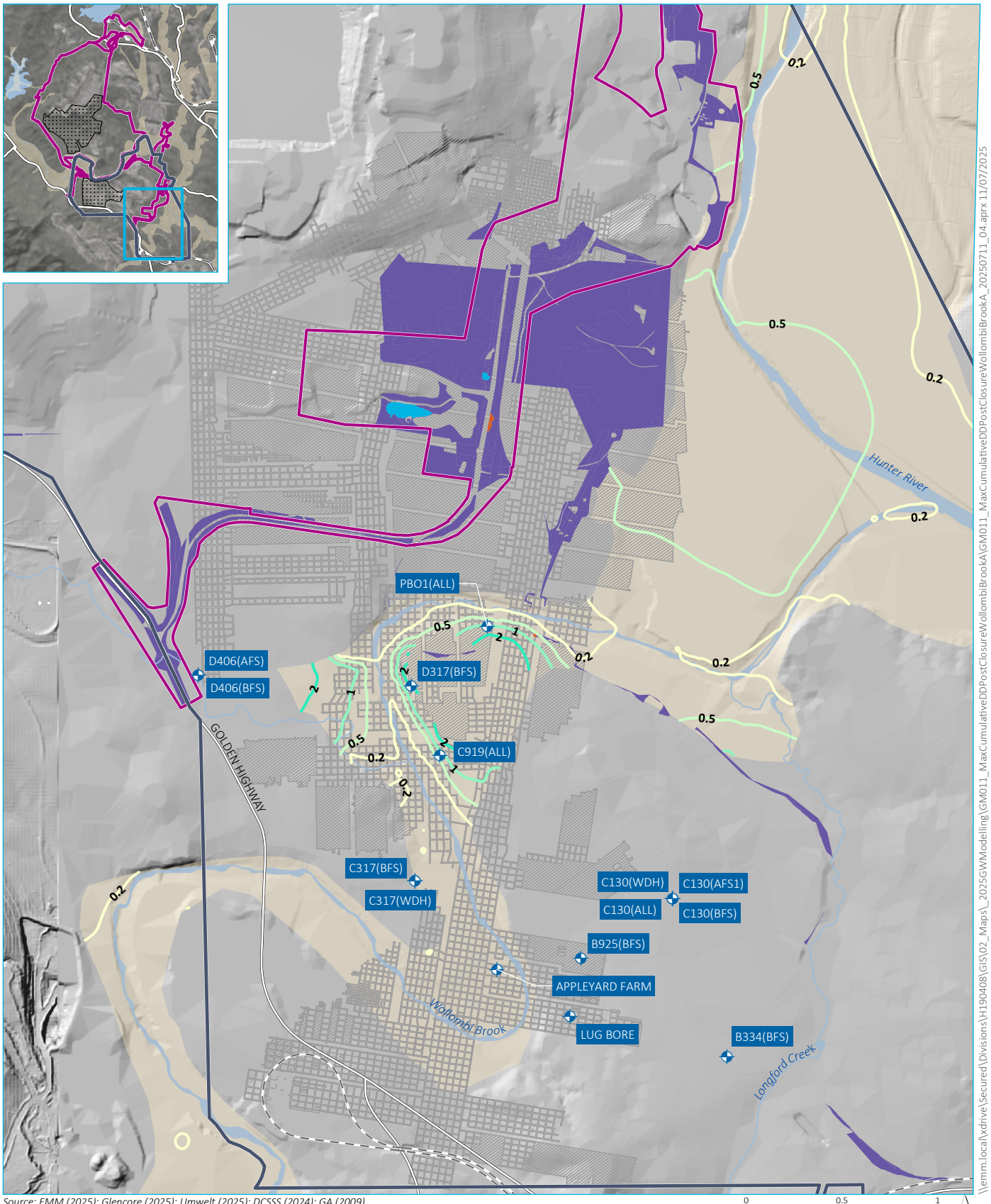
- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown post-closure in the Hunter River alluvium

HVO Continuation Project - Amendment
Water Assessment
Figure 10.5

EMM
creating opportunities

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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSS (2024); GA (2009)

0 0.5 1 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Lemington underground mine plan
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown post-closure in the Wollombi Brook alluvium

HVO Continuation Project - Amendment
Water Assessment
Figure 10.6

EMM
creating opportunities

10.4 Potential impacts on water-dependent assets

Consistent with the original Project, the groundwater flux is predicted to remain into the voids and the lakes will act as a groundwater sink with no risk of overflows to the surface environment.

A conceptual cross section through the HVO North and South voids is presented Figure 5.2. It illustrates the outcomes and conceptual understanding discussed in Sections 10.2 to 10.4 (consistent with the original Project):

- post mining, the predicted watertable and pit lake level are depressed, with groundwater flow directions towards the voids
- the Hunter River alluvium remains saturated due to the strong hydraulic connection with the Hunter River
- surface water drainage towards the voids is minimal, to limit the potential long-term impact on streamflow
- evaporation is the dominant loss from the voids and the voids are predicted to remain groundwater sinks
- the long-term pit lake level is considerably deeper than the base of the alluvium and the base of weathering, therefore the risk of seepage from the pit lakes to shallow groundwater is negligible
- the risk of spill from the pit lakes to the environment is negligible.

Consistent with the predicted drawdown during operations, the post mining incremental alluvial drawdown is not predicted to have a significant impact on GDEs or surface water.

River red gums and other riparian vegetation that opportunistically use shallow groundwater will continue to have access to shallow alluvial groundwater. In addition, the amended Project is predicted to have a negligible impact on Hunter River flow and flooding regime post mining. Therefore, river red gum communities will continue to rely on flooding for germination.

In addition, there are no third-party bores located within the zone of influence and there is negligible risk that groundwater levels at privately-owned bores will be affected by the amended Project or the proposed final voids.

The surface water, groundwater, aquatic ecology and GDE assessments demonstrate the proposed final voids are not predicted to have a significant impact on water resources and water-dependent assets.

10.5 Water quality

As described in the original Project (EMM 2022a), the landform has been designed to minimise the catchment reporting to the proposed voids in order to meet the amended Project objectives to balance economic, environmental and social benefits. The runoff area contributing to the voids is sufficiently small so that evaporation dominates, and the voids remain as strong long-term groundwater sinks. Post mining, the pit lake water will concentrate salts and become more saline over time due to evaporative losses.

As part of the updated groundwater modelling (Attachment A), particle tracking was conducted to observe movement of particles from backfilled areas, north of the existing and proposed barrier walls at HVO North. Figure 10.4 shows the voids remain strong sinks and dominate the groundwater flow direction. This is consistent with the original Project (AGE 2022).

The impact to water quality is not considered to significantly changed between the original and amended Projects. A full description of the anticipated impacts to water quality is presented in EGi (2022b) and summarised in EMM (2022b).

11 Water licensing

11.1 NSW water legislation and policies for licensing water take

11.1.1 Overview

HVO is required to license surface water and groundwater take in accordance with the WM Act, including the AIP and the relevant statutory WSPs. This includes water taken for use as well as water intercepted and managed as a result of mining activities (including runoff and groundwater inflows to pits), unless exempt under the Water Management (General) Regulation 2018 (WM Regulation). Sufficient entitlement must be held to account for the peak water take from each water source (directly or indirectly), prior to the take occurring.

11.1.2 Water access rights and exemptions

The WM Act establishes two fundamental types of rights to 'take' surface water and groundwater:

- A basic landholder right, being the right to take water without an access licence:
  - from any river, estuary or lake to which the land has frontage or from any aquifer underlying the land for domestic consumption and stock watering, but not for any other purpose
  - to construct and use one or more water supply works for the purpose of capturing and storing water of a kind specified by the harvestable rights order, and to take and use that water.
- An access licence, which entitles its holder to:
  - specified shares in the available water within a specified water management area or from a specified water source (the share component)
  - take water at specified times, at specified rates or in specified circumstances, or in any combination of these, and in specified areas or from specified locations.

It is an offence to take water from a water source other than pursuant to one of these rights, unless exempt from the requirement for an access licence under the WM Act or WM Regulation (Clauses 21 and Schedule 4). Of relevance, WALs are not required for the taking of water from 'excluded works' – that is, *dams that are located on minor streams* (defined in Section 11.1.4)*:*

- from which no water is reticulated or pumped, and are for the purpose of control or prevention of soil erosion, or for flood detention and mitigation
- that are solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority to prevent the contamination of a water source, or from which water is used solely for environmental management purposes
- that exceed the harvestable rights capacity, and were constructed before 1 January 1999, and that are used solely for domestic consumption and stock watering, or that do not result in the extraction of water.

The NSW AIP (NOW 2012) further clarifies that a WAL is required under the WM Act (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity (such as a mine void that intercepts groundwater) causes the removal of water from a water source; or the movement of water from one part of an aquifer to another part of an aquifer; or the movement of water from one water source to another water source. In addition, the AIP states that 'the post-closure continued take of water until an aquifer system reaches equilibrium may extend from months to centuries after cessation, depending on the scale of the activity, recharge relationships and aquifer characteristics. Where there is ongoing take of water, the licence holder must retain a water licence for the period until the system returns to equilibrium or surrender it to the Minister'.

In accordance with the AIP, HVO is required to hold licences for both the direct and indirect take from adjacent and overlying water sources. Water can be taken indirectly when an aquifer interference activity causes water to flow from another connected groundwater or surface water source. Flows induced from other water sources also constitute take of water.

11.1.3 Harvestable rights

Harvestable rights allow landholders in NSW to capture and store a proportion of the rainfall runoff from their landholding in one or more harvestable rights dams on minor streams without a WAL, water supply work approval or water use approval under the WM Act.

HVO has 13,343 ha of contiguous landholdings. This equates to 934 ML of 10% harvestable right dam capacity.

11.1.4 Minor streams and the WM Regulation hydroline

The 'hydroline' spatial dataset contains mapped information about watercourses and waterbodies in NSW. The purpose of the hydroline spatial data is to determine the Strahler stream order of a stream (Figure 11.1), which in turn identifies 'minor streams' for the purpose of determining:

- whether certain exemptions to the requirement for WALs and approvals apply under the WM Regulation
- dams that may be considered (or constructed) as harvestable rights dams or mixed rights dams
- where infrastructure is located in relation to mapped watercourses and waterbodies.

The term "minor stream" is defined under clause 3(1) of the WM Regulation as:

a) any stream or part of a stream:

   i) the location of which is specified in the hydroline spatial data, and

   ii) that is identified as a first or second order stream, or part of such a stream, as determined in accordance with the system set out in Schedule 2 [to the WM Act], and

   iii) that does not maintain a permanent flow of water, being a visible flow that occurs on a continuous basis, or would so occur if there were no artificial abstractions of water or obstruction of flows upstream, and

   iv) that does not at any time carry flows emanating from a third or higher order stream as determined in accordance with the system set out in Schedule 2 [to the WM Act], or

b) any stream or part of a stream the location of which is not specified in the hydroline spatial data.

For the purposes of paragraphs (a) (i) and (b), a stream is specified in the hydroline spatial data if it is identified as a watercourse (however described) in accordance with the legend or terms of that data.

The ‘regulation' hydroline dataset on which water management decisions are based is static and does not necessarily align with the more dynamic NSW Hydro Line dataset held and administer by Spatial Services (Department of Finance, Services & Innovation). Both datasets have evolved over the years, originally from the digitisation of hard copy maps from the 1980s.

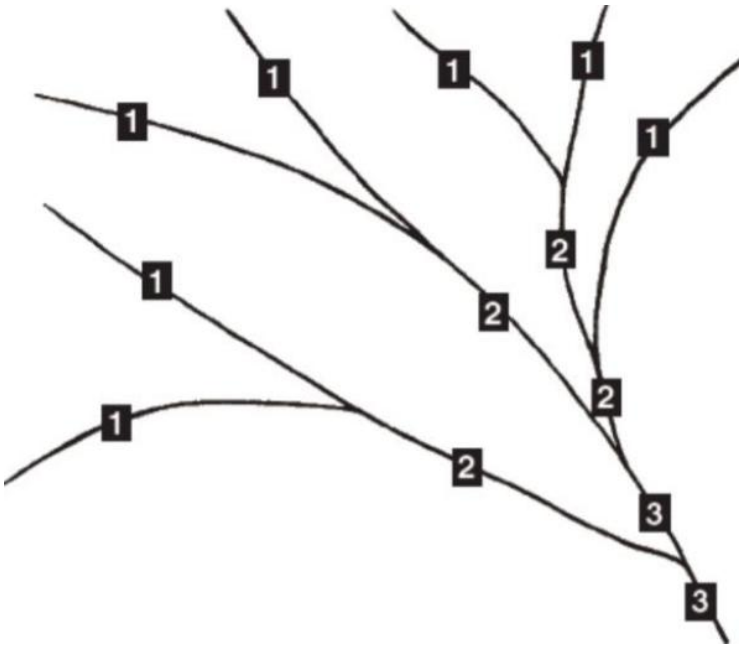


Figure 11.1 The Strahler method for assigning stream order to watercourses

11.2 Approach to licensing

HVO is required to hold licences for the following water take under the WM Act (and in accordance with the AIP):

- groundwater inflows to mining areas, which may be a combination of direct and indirect groundwater take and indirect surface water take
- reduction in baseflow to watercourses due to watertable drawdown – this is indirect groundwater take
- increase in surface water leakage to groundwater due to watertable drawdown – this is an indirect surface water take
- catchment runoff captured by the WMS, unless exempt under the WM Regulation – this is surface water take
- water taken for operational requirements from the Hunter Regulated River Water Source.

Baseflow is the component of streamflow that is sourced from groundwater. Some of the watercourses (or sections of watercourses) in the amended Project area are classified as gaining streams, which gain water from the inflow of groundwater through the stream bed (baseflow) where/when the groundwater table level is higher than the height of water in the watercourse.

Where groundwater extraction occurs through dewatering of the mine, the depressurised groundwater system causes drawdown effects for connected surface water systems. Where the watercourse(s) is gaining (receiving groundwater discharge), groundwater drawdown can result in reduction in groundwater baseflow to the stream (the source of this take is groundwater).

Watercourses can also be losing systems, where water from the stream seeps through the streambed to groundwater (termed “river leakage”). This occurs where the groundwater table is at a lower elevation than the height of water in the watercourse.

Groundwater drawdown induced by dewatering/extraction can lead to a gaining stream changing to a losing stream or can increase the natural rate of river leakage (to groundwater). Induced river leakage (i.e. via lowering of the groundwater table below the height of the stream bed) is considered as take from the surface water source.

Table 11.1 lists the approach used to estimate each of these elements of water take. For example, groundwater inflow to mining areas is calculated using the groundwater model (EMM 2025b) and water supply requirements from the Hunter Regulated River is calculated by the water balance model developed by Engeny (2025).

Due to the integrated nature of the WMS for the HVO Complex, it is not practically possible to separate out licensing requirement for HVO North and HVO South individually. As such, the water licensing requirements for the amended Project overall (HVO North and South) are presented in the following sections.

As mentioned in the response to submissions and the SWIA (Engeny 2025), water balance modelling has been undertaken for the full operational period of the amended Project, from mining year 1 through to 2045. The SWIA (Engeny 2025) presents annual median, 5th and 95th percentile water balance results for conceptual mine stages.

Table 11.1 Summary of methods used to estimate take

Type of take	Surface water or groundwater take	Method used to estimate take	WAL category needed for take (where not exempt)
Surface water (river) leakage to groundwater (indirect take)	Surface water	Groundwater flow model developed by EMM (2025b) – during operations and post mining	• High security or general security WAL if indirect take is from the Hunter Regulated River Water Source, or • Unregulated river WAL if take is from: – Jerrys Water Source – Lower Wollombi Brook Water Source – Singleton Water Source – Glennies Water Source.
Water extracted from the Hunter Regulated River Water Source to meet operational requirements	Surface water	Water balance model developed by Engeny (2025), noting actual take will be metered	High security or general security WAL for take from the Hunter Regulated River Water Source.
Runoff captured by the water management system under a range of climate scenarios	Surface water	Water balance model developed by Engeny (2025)	Unregulated river WAL if take is from: • Jerrys Water Source • Lower Wollombi Brook Water Source • Singleton Water Source.
Final landform (runoff to storages and final voids)	Surface water	Water balance model developed by Engeny (2025)	Unregulated river WAL if take is from: • Jerrys Water Source • Lower Wollombi Brook Water Source • Singleton Water Source.

Type of take	Surface water or groundwater take	Method used to estimate take	WAL category needed for take (where not exempt)
Reduction in baseflow (groundwater discharge to surface water) (indirect take)	Groundwater	Groundwater flow model developed by EMM (2025b) – during operations and post mining	Aquifer access licence if take is from: • Hunter Regulated River Alluvial Water Source (various management zones) • Jerrys Water Source • Glennies Water Source • Lower Wollombi Brook Water Source • Singleton Water Source.
Groundwater inflow to mining areas	Groundwater	Groundwater flow model developed by EMM (2025b) – during operations and post mining	Aquifer access licence from: • Sydney Basin-North Coast Groundwater Source. And from other water sources if indirect take: • Jerrys Water Source • Glennies Water Source • Lower Wollombi Brook Water Source • Singleton Water Source.

11.3 Water take and licensing strategy

11.3.1 Groundwater take – alluvial water sources

The predicted peak operational and post mining groundwater take from each alluvial groundwater source and management zone associated with the amended Project is summarised in Table 11.2, together with the HVO entitlement held in the corresponding area. Charts of the predicted take over time (during operations) for each water source are presented in Figure 11.5 to Figure 11.4.

Table 11.2 Groundwater take – alluvial water sources

Water Source/Zone	Peak take (Mining year) – ML/yr	Peak long-term (post closure) take – ML/yr	Aquifer access licence entitlement held – ML/yr
Hunter Regulated River Alluvial Water Source – U/S Glennies Creek Management Zone	132 (16)	175	568
Hunter Regulated River Alluvial Water Source – D/S Glennies Creek Management Zone	8 (19)	26	289
Hunter Regulated River Alluvial Water Source – Glennies Creek Management Zone	0	0	–
Jerrys Water Source – Jerrys Management Zone	4 (12–19)	12–26	–
Lower Wollombi Brook Water Source	1 (1–3)	0	144
Singleton Water Source	2 (19)	12–17	225

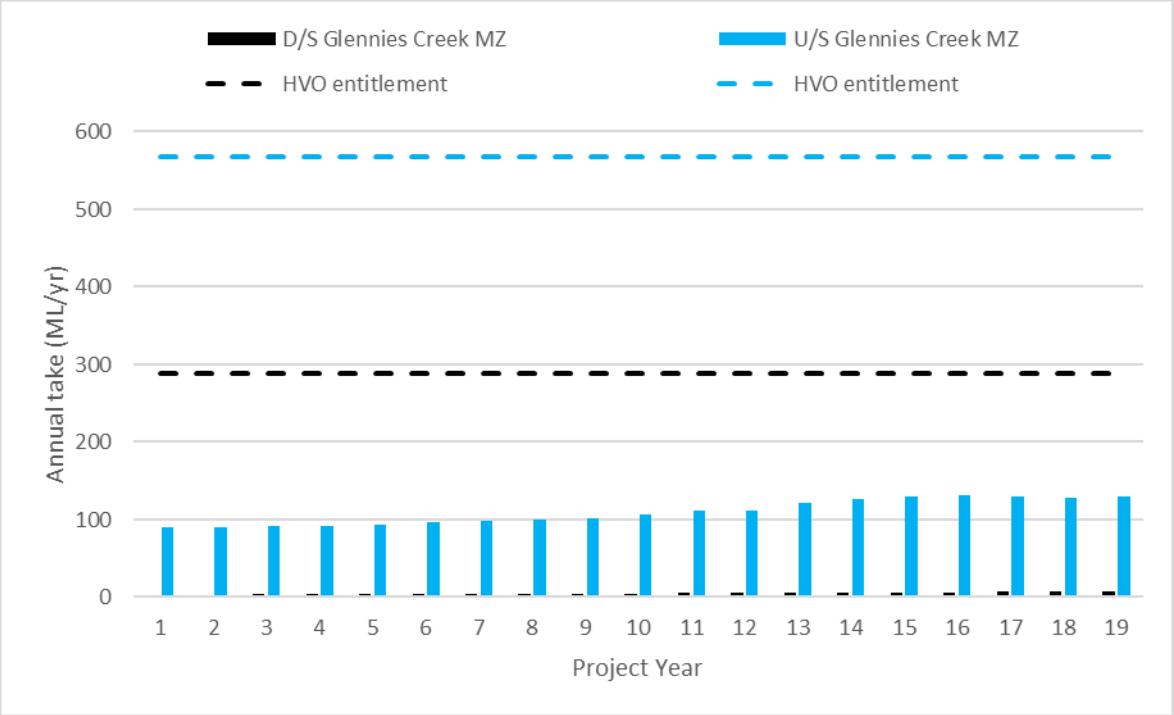


Figure 11.2 **Groundwater take during operations from the Hunter Regulated River Alluvial Water Source (downstream and upstream management zones)**

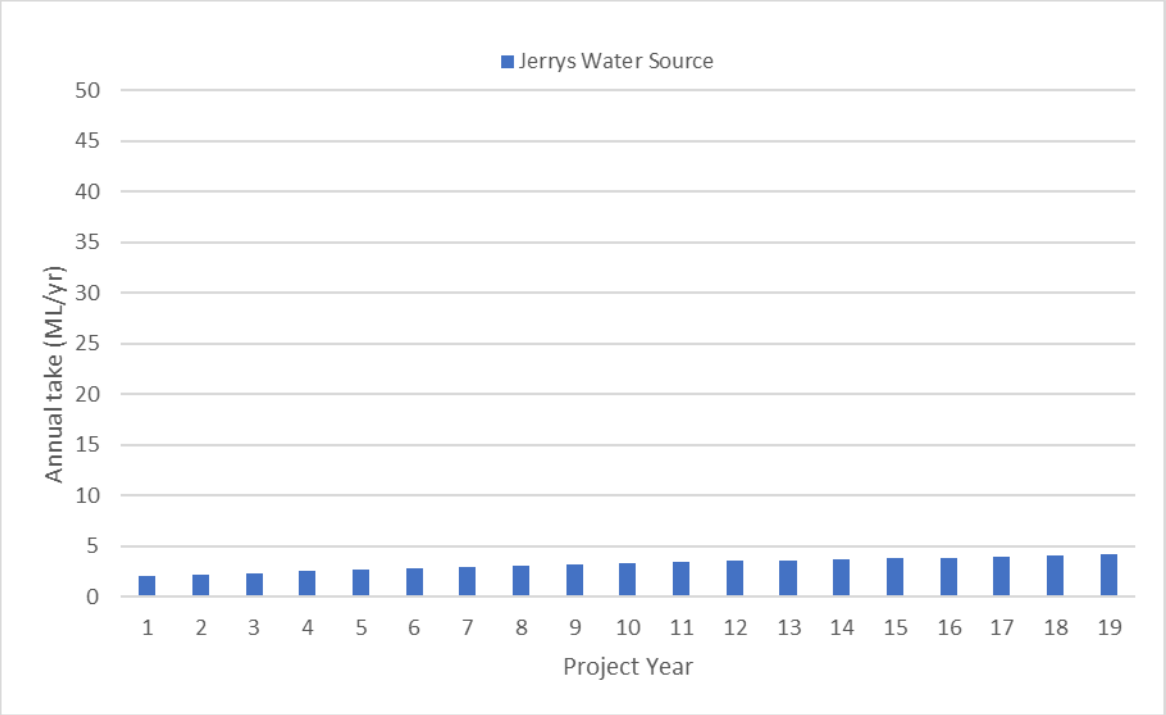


Figure 11.3 **Groundwater take from the alluvium associated with the Jerrys Water Source (Hunter Unregulated River)**

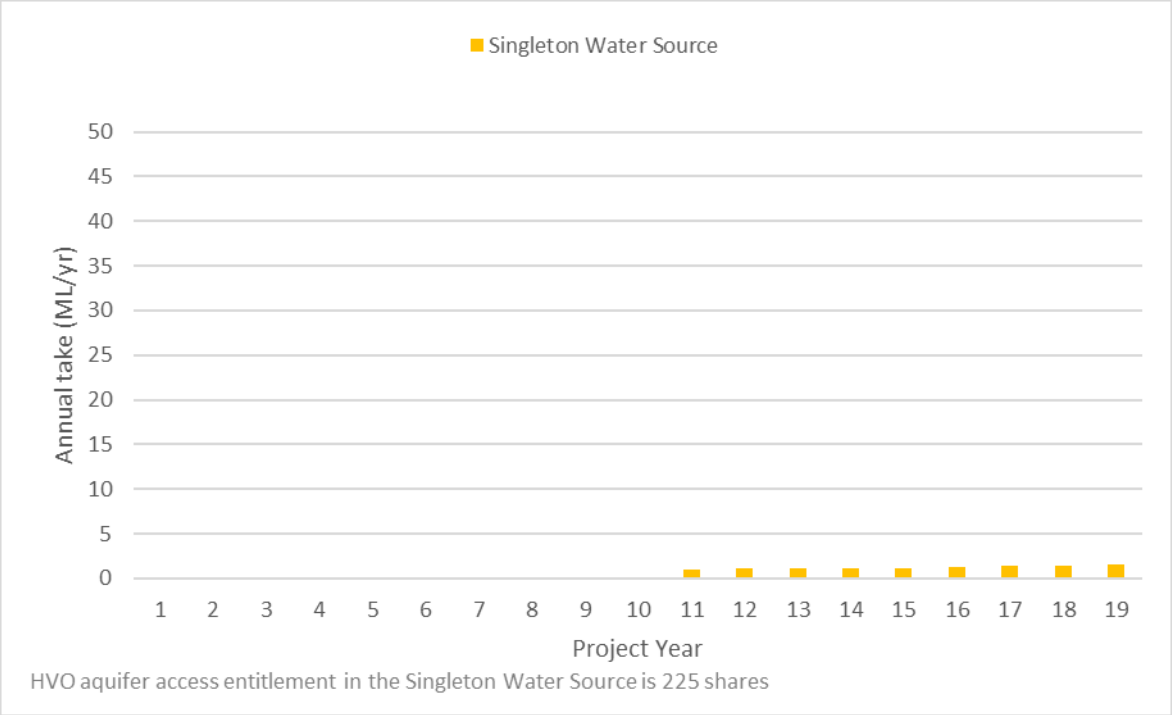


Figure 11.4 Groundwater take from the alluvium associated with the Singleton Water Source (Hunter Unregulated River)

i Licensing strategy

HVO holds more than sufficient entitlement to account for the predicted groundwater take over the amended Project life and beyond in most alluvial groundwater sources.

Groundwater modelling predicts a small indirect take from the Jerrys Water Source ranging from 2 ML/yr to a peak at 4 ML/yr during operations. HVO will purchase entitlement via the open market to account for the small predicted take in the Jerrys Water Source (prior to the take occurring).

As part of closure planning, HVO will review the post-closure entitlement requirements. If entitlements are required, HVO will purchase entitlement via the open market for the predicted take in the Jerrys Water Source (predicted peak of 26 ML/yr), prior to closure.

As summarised in Table 3.4, there 1,251 unit share entitlements (in aquifer category) within the Jerrys Water Source, demonstrating there is sufficient entitlement within the water source that HVO can obtain via the open market. In addition, the Hunter Unregulated and Alluvial WSP (Section 51b) allows for the conversion of unregulated river entitlement categories to aquifer entitlements in the same water source. Prior to the take occurring and rather than going to the market, HVO may consider applying to convert sufficient existing unregulated river entitlements to aquifer category entitlements for the predicted take in the Jerrys Water Source.

11.3.2 Groundwater take – Sydney Basin-North Coast water source

The predicted peak and post mining groundwater take from the Sydney Basin-North Coast Fractured Rock Groundwater Source is summarised in Table 11.3, together with the HVO entitlement. A chart of the predicted take over time (during operations) is presented in Figure 11.5.

Table 11.3 Groundwater take – Sydney Basin-North Coast water source

Water Source/Zone	Peak take (Mining year) – ML/yr	Ongoing (post closure) take – ML/yr	Aquifer access licence entitlement held – ML/yr
Sydney Basin-North Coast Groundwater Source	2,488 (13)	1,200–1,300	5,560

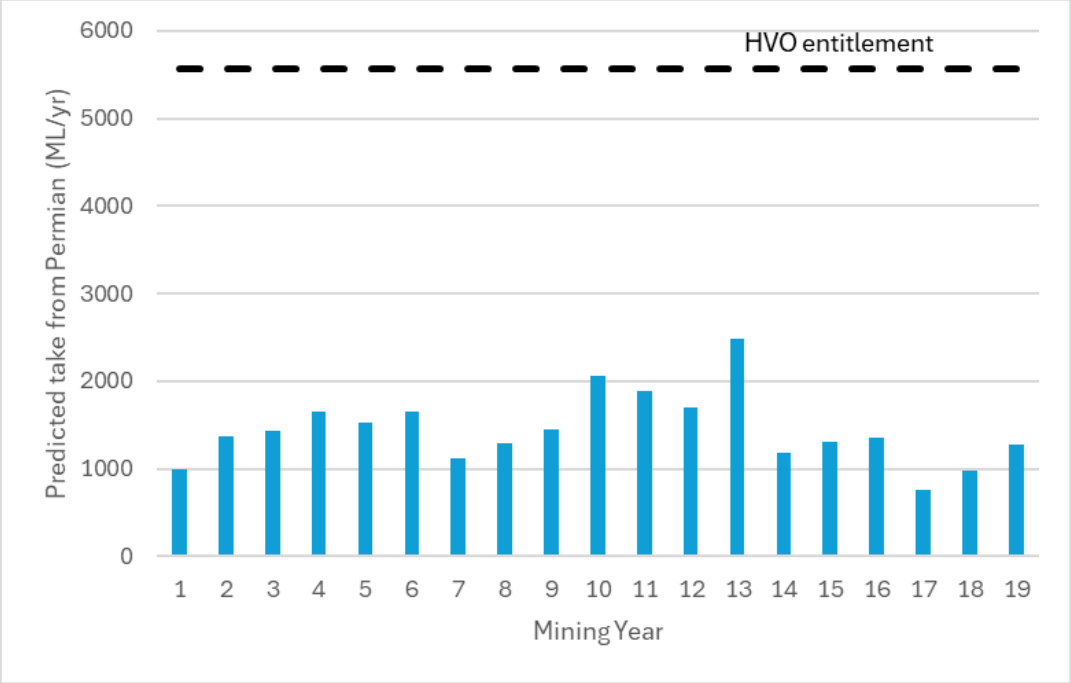


Figure 11.5 Groundwater take from the Sydney Basin-North Coast Groundwater Source (during operations)

i Licensing strategy

HVO holds more than sufficient entitlement to account for the predicted groundwater take over the amended Project life and beyond in the Sydney Basin-North Coast Fractured Rock groundwater source.

11.3.3 Surface water take – Regulated river

i Operational demands

As described in the WMP and SWIA (Engeny 2025), mine and sediment water is preferentially used to meet Project operational demands. Where required, shortfalls are met from the Hunter Regulated River Water Source. This is detailed in the SWIA and shown in Figure 11.6 for a range of rainfall scenarios over the amended Project life. The 95th percentile is indicative of dry conditions with a 5% chance of the resulting extraction being exceeded. The results indicate that operational water demands are satisfied by high security entitlements, therefore a comparison against general security entitlements is not provided.

The amended Project is expected to use up to 86% of HVO's existing 4,689 unit share high security entitlements (zone 1B and 2A) to maintain water supply in dry conditions (the 95th percentile). Modelling predicts the potential for the demand to exceed HVO's entitlement in zone 1B in mining year 2; however HVO can source the additional supply from extractions within zone 2A or draw on the extensive general security entitlement held in zone 1B (5,244 unit share entitlements). In the median forecast, the amended Project is expected to use up to 43% of HVO's high security entitlement.

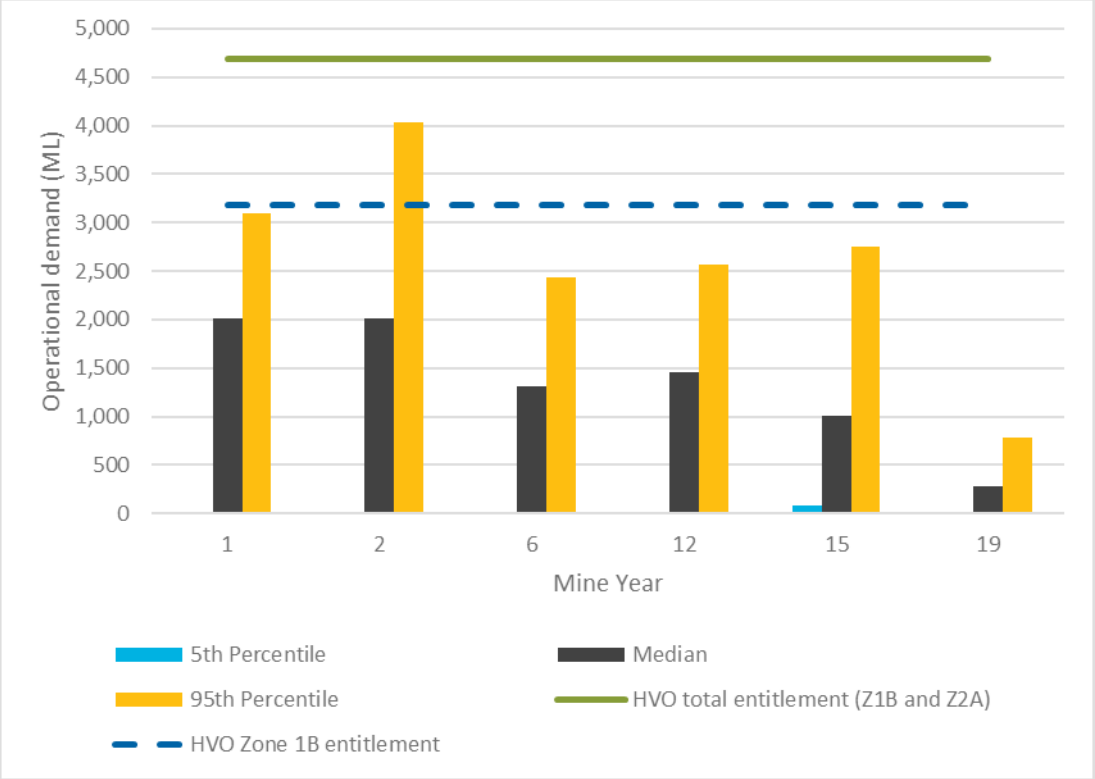


Figure 11.6 HVO predicted external water demands for operations (Engeny 2025)

ii River leakage

Groundwater modelling (EMM 2025b, Attachment A) has been used to predicted surface water leakage (to groundwater) during and post mining from each surface water source and management zone. The mechanism of this take is associated with watertable decline (drawdown) inducing leakage from surface water to groundwater.

The predicted peak indirect surface water take (as river leakage) from the regulated river is summarised in Table 11.4.

Table 11.4 Predicted river leakage from the Hunter Regulated River water source

Management zone	Peak take (Mining year) – ML/yr	Long-term take (post mining) – ML/yr
Hunter Regulated River – Zone 1B (U/S Glennies Creek)	90 (various)	50
Hunter Regulated River – Zone 2A (D/S Glennies Creek)	2 (16–19)	2
Hunter Regulated River – Zone 2B (D/S Wollombi Brook)	0	0

iii Licensing strategy

The total direct and indirect take (water supply and river leakage) is shown in Figure 11.7.

Section 3.2.2 lists the regulated river WALs held by HVO (with the full list provided in the WMP). HVO's existing high security regulated river entitlement (total) of 4,689 shares is sufficient to meet all predicted demands and river leakage.

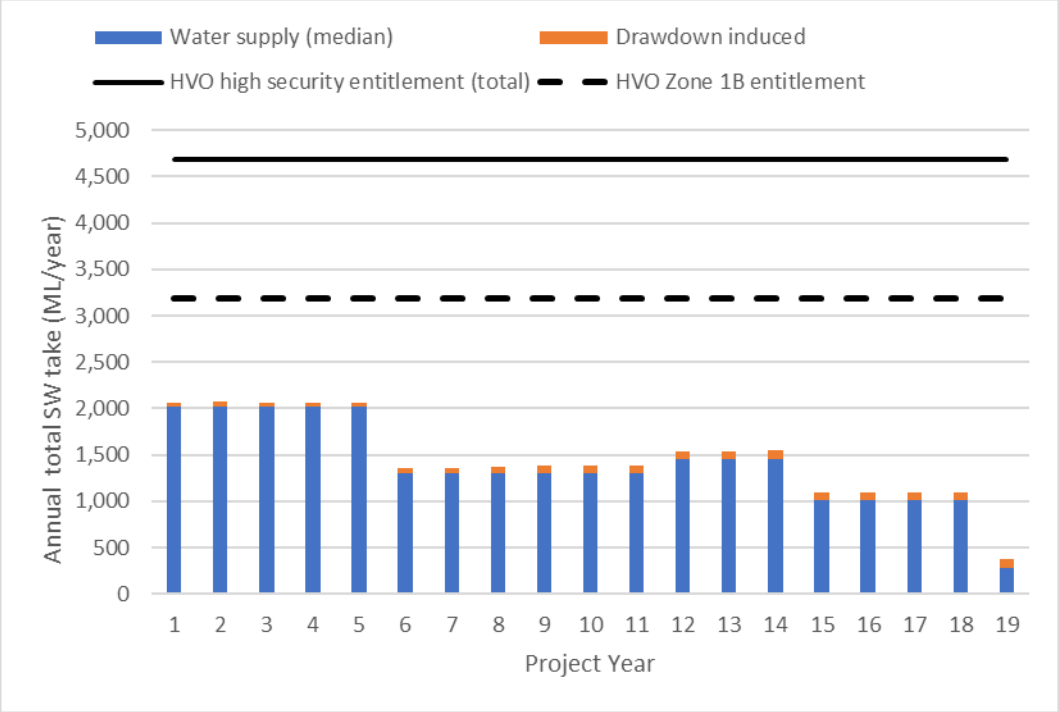


Figure 11.7 Total surface water take from the Hunter Regulated River Water Source

11.3.4 Surface water take – Unregulated river

i Capture of catchment runoff[1] - during operations

Take from unregulated rivers is mainly limited to incidental take of rainfall runoff into the amended Project's WMS infrastructure, with minor indirect take associated with groundwater drawdown. Note that the WMS is designed to exclude capture and take of clean water from undisturbed catchments. The WMS separates water by use and directs clean water away from pits, mine water dams and sediment dams as the clean water diminishes the utility of these structures.

As described by EMM (2024b), there are five existing dams within the WMS that, according to the current Regulation hydroline dataset, are on non-minor streams. All other structures are exempt from requiring WALs as they are either not on mapped streams or are on minor streams and meet the definition of excluded works in the WM Regulation.

[1] Catchment runoff excludes rainfall on the surface of a dam

The Regulation hydroline dataset does not reflect the on-ground reality at the amended Project site. Mine plans and water management infrastructure, and associated landform and drainage line (hydroline) changes have been approved by Government under the EP&A Act development consents and modifications over time. As the mine operations have progressed consistent with the approved activities, the Regulation hydroline has not been updated. The status of the hydroline in relation to mine infrastructure seems to be based on the original 1980s topographic map-based stream delineation.

Consistent with the responses to submissions (EMM 2024b), HVO is seeking an amendment of the WM Regulation hydroline to reflect the approved WMS, including approved stream diversions, and to have any residual licensing liability for captured rainfall runoff based on this amended drainage configuration. Specific details on each of the five structures, and a licensing pathway for each are discussed below.

As described in the responses to submissions (EMM 2024b):

- Dam 15S (Lake James): diversions are in place channelling water from upstream catchments around the dam. There is a small catchment area to the north of Dam 15S that drains directly to the dam. As part of the amended Project, Dam 15S is proposed to be enlarged into this northern area, effectively making Dam 15S a 'turkey's nest dam' with no contributing catchment and no water take. Therefore, there is no licensing requirement for water take by Dam 15S as part of the amended Project.

- Dam 14W: there is a diversion in place (approved under water supply work approval 20WA211427) that diverts water around Newdell LP. Revision of the WM Regulation hydroline dataset to reflect the approved diversion of Pikes Creek around Dam 14W would render the dam as an offstream storage that is not located on a hydroline. As the dam captures runoff from coal stockpile areas, it therefore meets the excluded works definition in the WM Regulation, as the purpose is to prevent the contamination of a water source. Therefore, there is no licensing requirement for water take by Dam 14W as part of the amended Project.

- Dam 9W/18W (Parnells Dam): as part of the amended Project, Parnells Dam will be upgraded (increasing capacity). As part of these works, Parnells Creek will be diverted around the new dam to the north-west, effectively making the new dam an offstream turkey's nest dam with no contributing catchment and no water take. Therefore, there is no licensing requirement for Dam 9W and Dam 18W (Parnells Dam) as part of the amended Project. Currently, the creek flows into Dam 18W and is then diverted around Dam 9W (under approval by water supply works approval 20WA210991). WAL 18307 with 500 unit shares in the Jerrys Water Source is held to account for the water take associated with Dam 18W.

- Dam 35S: diversions are in place to direct clean water from upstream catchments to the south-west of Dam 35S, flowing towards the Hunter River. Revision of the WM Regulation hydroline dataset to reflect the approved diversions would render Dam 35S as an offstream storage. As the dam captures sediment-laden runoff from the temporarily stabilised area, it therefore meets the excluded works purpose definition in the WM Regulation, as the purpose is to prevent the contamination of a water source, and there is no licensing requirement for water take by Dam 35S as part of the amended Project. In addition, this dam will be decommissioned early in the amended Project operation.

Table 11.5 lists the five dams located on non-minor streams according to the current WM Regulation hydroline dataset, and the proposed water licensing strategy.

Table 11.5 Dams on non-minor streams (as currently mapped)

Dam name	Status	Year constructed	Purpose	Diversions in place or proposed?	Water source	Stream order			Licensing pathway
						WM Regulation hydroline	Current drainage lines with revised hydroline	Proposed (project) drainage lines with revised hydroline	
Dam 15S (Lake James)	Existing – to be modified	<1990	Mine water, HRSTS discharge	Yes, and modification proposed	Singleton	3	2	2	Hydroline update to reflect diversion No water take – no WAL
Dam 14W	Existing	<1983	Mine water	Yes	Jerrys	3	N/A	N/A	Hydroline update Excluded works exemption
Dam 9W (Parnells)	Existing – to be augmented and combined with Dam 18W	1993	Mine water, HRSTS discharge	Yes, and modification proposed	Jerrys	3	N/A	N/A	Hydroline update to reflect diversion No water take – no WAL
Dam 18W	Existing – to become part of 9W	~2005	Mixed	Not currently but proposed	Jerrys	3	3	N/A	Hydroline update to reflect diversion No water take – no WAL
Dam 35S	Existing	2017	Sediment	Yes	Jerrys	4	2	2	Hydroline update Excluded works exemption

Notes: ML = megalitres; N/A = not applicable.

ii River leakage

The predicted peak indirect surface water take (as river leakage) from water sources within the Hunter Unregulated River water sources is summarised in Table 11.4.

Table 11.6 Predicted river leakage from Hunter Unregulated River water source

Water source	Peak take (Mining year) – ML/yr	Post mining (long-term take) – ML/yr	Unregulated river entitlement held by HVO (unit shares)
Jerrys (Jerrys MZ)	2 (various years)	3	705
Glennies	0	0	0
Lower Wollombi Brook	0	0	88
Singleton	0	0	0

HVO holds sufficient entitlement for the predicted indirect take during operations and post mining in the Jerrys water source.

iii Capture of catchment runoff – during closure

The SWIA (Attachment B) presents the conceptual locations of water management structures established on drainage lines within the conceptual final landform. During the closure period, these storages will act as sediment dams to control runoff water quality by retaining sediment until adequate vegetation cover is established. Post mining, when the vegetation cover criteria have been met, the dams will be decommissioned or converted to dry retention basins, retained as harvestable rights dams (if on minor streams) or retained with the required water supply work approvals acquired (if on non-minor streams).

The design criteria adopted for the sediment dams that form the closure water management system was described in the EIS SWIA (Engeny 2022) and amended SWIA (Attachment B). The dams have been sized based on the requirements of Managing Urban Stormwater: Soils and Construction (Landcom 2004).

Table 11.7 summarises the water management structures proposed for the closure period. Using the amended drainage configuration (i.e. final landform drainage lines), there are a total of 18 dams located on minor streams (i.e. first or second order streams or not located on a stream), with the remaining seven dams located on third or fourth order (i.e. non-minor) streams.

During the closure period when the water management structures are acting as sediment dams, the 18 dams located on minor streams will meet the excluded works purpose definitions in the WM Regulation. These dams are located on minor streams and will be solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice to prevent the contamination of a water source. As excluded works, these dams will be exempt from requiring a WAL for any associated take in accordance with the WM Regulation.

For the conceptual final landform, the 18 dams on minor streams will be converted from sediment dams to harvestable rights dams, or decommissioned. These storages will not meet the excluded works purpose definitions in the WM Regulation. Any water take associated with these dams for the final landform will be accounted for under harvestable rights. HVO has 13,343 ha of contiguous landholdings, which equates to a maximum harvestable rights dam capacity of 934 ML. The total capacity of harvestable rights dams, within the final landform, will not exceed the maximum harvestable rights dam capacity. This will be reviewed as part of detailed closure planning, in consultation with NSW Government.

The closure WMS, to support the final landform, includes seven dams on non-minor streams. During the closure period, when the water management structures are actively managed as sediment dams (i.e. dewatered to maintain sufficient capacity to capture sediment-laden runoff), the catchment runoff captured by these dams will be accounted for with sufficient entitlement in the appropriate water source. The water balance model developed by Engeny (2025) was used to estimate the water take by these dams under a range of climatic conditions. Table 11.8 presents the predicted surface water take for the closure period, along with the HVO entitlement held.

In the final landform, there will be no extraction (i.e. water 'take') from the dams on third order streams. They will be passive structures in the landscape for which water supply works approvals will likely be required. As is the case for other instream structure in NSW from which no water is taken, no WALs will be required.

Table 11.7 Closure water management structures

Dam	Stream order (amended to reflect final landform drainage)	Licensing strategy	
		Closure period	Final landform
DP2N	3	**WAL required**	No WAL required
DP5Na	3	**WAL required**	No WAL required
DP12N	3	**WAL required**	No WAL required
DP14N	3	**WAL required**	No WAL required
DP15N	4	**WAL required**	No WAL required
DP16N	2	Excluded works exemption	Harvestable rights
DP17N	2	Excluded works exemption	Harvestable rights
DP18N	2	Excluded works exemption	Harvestable rights
DP19N	1	Excluded works exemption	Harvestable rights
DP3S	N/A	Excluded works exemption	Harvestable rights
DP8S	2	Excluded works exemption	Harvestable rights
DP9S	1	Excluded works exemption	Harvestable rights
DP10S	3	**WAL required**	No WAL required
Dam 12S	N/A	Excluded works exemption	Harvestable rights
Dam 14W	N/A	Excluded works exemption	Harvestable rights
Dam 16S	1	Excluded works exemption	Harvestable rights
Dam 19S	3	**WAL required**	No WAL required
Dam 20N	N/A	Excluded works exemption	Harvestable rights
Dam 34S	1	Excluded works exemption	Harvestable rights
Dam 36S	1	Excluded works exemption	Harvestable rights
Dam 37S	1	Excluded works exemption	Harvestable rights
Dam 38S	N/A	Excluded works exemption	Harvestable rights
Dam 39S	2	Excluded works exemption	Harvestable rights
Dam 44S	1	Excluded works exemption	Harvestable rights

Dam	Stream order (amended to reflect final landform drainage)	Licensing strategy	
		Closure period	Final landform
Dam 4S-A	N/A	Excluded works exemption	Harvestable rights

Notes: Refer Annexure B for closure WMS and drainage lines

Table 11.8 Closure surface water take to sediment dams on non-minor streams

Dam	Water source and management zone	Median take (ML/yr)	80th percentile take (ML/yr)	Unregulated river entitlement held by HVO (unit shares)
DP2N	Jerrys Water Source – Jerrys Management Zone	57	146	705
DP5Na		86	219	
DP12N		47	119	
DP14N		72	183	
DP15N		211	537	
DP10S		142	361	
Total		**614**	**1,565**	
Dam 19S	Lower Wollombi Brook	66	169	88

a Licensing strategy for dams on non-minor hydrolines

As described above, during the closure period, when water management structures are actively managed as sediment dams, sufficient entitlement is required for the capture of catchment runoff in dams on non-minor hydrolines. The conceptual closure WMS identifies seven dams on non-minor hydrolines.

HVO holds sufficient entitlement for the predicted median (50th percentile) take in the Jerrys and Lower Wollombi Brook water sources. The predicted 80th percentile take in the Jerrys and Lower Wollombi Brook water sources exceeds HVO's entitlement.

The Hunter Unregulated and Alluvial WSP (Section 51b) allows for the conversion of aquifer access licence categories to unregulated river access licences in the Lower Wollombi Brook Water Source. HVO holds 144 units of aquifer entitlement within this water source. As there is no predicted long-term direct or indirect groundwater take from this water source due to the amended Project, HVO will apply to convert sufficient aquifer access licence entitlements to unregulated river entitlements for the predicted take in the Lower Wollombi Brook Water Source during closure.

For take within the Jerrys Water Source during closure, HVO will purchase additional entitlement required via the open market (including trade, in accordance with the WSP rules). As summarised in Table 3.4, there are 2,097 unit share unregulated river category entitlements within the Jerrys Water Source (2,044 in the Jerrys Management Zone).

In addition, the Hunter Unregulated and Alluvial WSP allows for trade (permanently and temporarily) into the Jerrys Water Source from several other upstream water sources. This includes 17 upstream water sources, with a total 645 WALs with a total of 35,746 unregulated river unit shares.

This demonstrates there is sufficient entitlement within the water source and upstream water sources for HVO to obtain via the open market.

As part of detailed closure planning, licensing requirements will be reviewed in consultation with NSW Government. Prior to the take occurring, HVO will purchase any additional entitlement required via the open market (including trade, in accordance with WSP rules).

As described above, once the complex is closed (i.e. once closure objectives are met), there will be no extraction (i.e. water 'take') from the dams on third order streams. They will be passive structures in the landscape for which water supply works approvals will likely be required. This is consistent with other instream structures in NSW where no water is taken and no WALs required.

b Runoff to final voids

There is currently no regulatory pathway or definition for the requirements for licensing runoff to final voids – this is a NSW water regulatory policy gap. There is also no known precedence in the Hunter Valley for the approach to licensing requirements of runoff to voids.

HVO and EMM's interpretation is that as water will not be leaving the water source and as there will be no extraction (i.e. surface water 'take' from the final voids), there will be no licensing requirement and WALs will not be required.

11.4 Summary

Table 11.9 summarises the proposed licensing pathways for water take associated with the amended Project.

HVO holds sufficient entitlement for the amended Project predicted surface water take from the Hunter Regulated River Water Source and unregulated river water sources during operations. HVO also holds more than sufficient entitlement to account for the predicted groundwater take over the amended Project life and beyond in most water sources.

During operations, HVO will purchase entitlement via the open market to account for the small predicted groundwater take in the Jerrys Water Source (due to long-term indirect take due to watertable equilibration) prior to the take occurring.

As part of detailed closure planning, licensing requirements will be reviewed in consultation with NSW Government. Prior to the take occurring, HVO will purchase any additional entitlement required via the open market (including trade, in accordance with WSP rules).

Table 11.9 Summary of water licensing strategy

Water source / management zone	Take type	During operations		During closure		Final landform (long-term)		HVO Entitlement (shares)
		Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing pathway	
Hunter Regulated River Water Source (high or general regulated river category)	Regulated river operational demands	Median: 2,017	Current entitlement	0	No take	0	No take	High security: • Total 4,689 • Zone 1B 3,183 • Zone 2A 1,506 General security: • Total 7,250 • Zone 1B 5,244 • Zone 2A 1,393
		95th percentile: 4,034		0		0		
	Regulated river losses (leakage to groundwater)	92		52	Current entitlement	52	Current entitlement	
	TOTAL (using 95th percentile demand)	**4,126**	**Current entitlement**	**52**	**Current entitlement**	**52**	**Current entitlement**	
Hunter Unregulated River Water Sources (unregulated river category)								
Jerrys (Jerrys Management Zone)	Catchment runoff to dams on non-minor streams	0	Hydroline update No take, no WAL	Median: 614	Current entitlement	0	No take, no WAL	705
				80th percentile: 1,565	Market purchase or trade before take occurs			
	Catchment runoff to dams on minor streams	N/A	Excluded works / Harvestable rights	N/A	Excluded works / Harvestable rights	N/A	No take / Harvestable rights	
	Flow losses (leakage to groundwater)	2	Current entitlement	2	Current entitlement	3	Current entitlement	
	TOTAL (using 80th percentile runoff)	**2**	**Current entitlement**	**1,567**	**Market purchase or trade before take occurs**	**3**	**Current entitlement**	

Water source / management zone	Take type	During operations		During closure		Final landform (long-term)		HVO Entitlement (shares)
		Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing pathway	
Lower Wollombi Brook	Catchment runoff to dams on non-minor streams	N/A	Hydroline update No take, no WAL	Median: 66	Current entitlement	N/A	No take, no WAL	88
				80th percentile: 169	Convert aquifer access licences to unregulated river for additional take			
	Catchment runoff to dams on minor streams	N/A	Excluded works / Harvestable rights	N/A	Excluded works / Harvestable rights	N/A	No take / Harvestable rights	
	Flow losses (leakage to groundwater)	0	No take	0	No take	0	No take	
	TOTAL (using 80th percentile runoff)	**0**	**No take**	**169**	**Convert aquifer access licences to unregulated river for additional take**	**0**	**No take**	
Singleton	Catchment runoff to dams on non-minor streams	N/A	No take	N/A	No take	N/A	No take	0
	Catchment runoff to dams on minor streams	N/A	No take	N/A	No take	N/A	No take	
	Flow losses (leakage to groundwater)	0	No take	0	No take	0	No take	

Water source / management zone	Take type	During operations		During closure		Final landform (long-term)		HVO Entitlement (shares)
		Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing strategy	Peak take volume (ML/yr)	Licensing pathway	
Alluvial groundwater sources (aquifer category)								
Hunter Regulated River Alluvial (U/S Glennies Creek)	Indirect take, including baseflow loss	132	Current entitlement	175	Current entitlement	175	Current entitlement	568
Hunter Regulated River Alluvial (D/S Glennies Creek)	Indirect take, including baseflow loss	8	Current entitlement	26	Current entitlement	26	Current entitlement	289
Hunter Regulated River Alluvial (Glennies Creek)	Indirect take, including baseflow loss	0	No take	0	No take	0	No take	0
Jerrys (Jerrys Management Zone)	Indirect take, including baseflow loss	4	Convert unregulated river access licences to aquifer for additional take or market purchase before take occurs	26	Convert unregulated river access licences to aquifer for additional take or market purchase before take occurs	26	Convert unregulated river access licences to aquifer for additional take or market purchase before take occurs	0
Lower Wollombi Brook	Indirect take, including baseflow loss	1	Current entitlement	0	No take	0	No take	144
Singleton	Indirect take, including baseflow loss	2	Current entitlement	17	Current entitlement	17	Current entitlement	225
North Coast fractured and porous rock (aquifer category)								
Sydney Basin-North Coast	Direct take	2,488	Current entitlement	1,730	Current entitlement	1,630	Current entitlement	5,560

Notes: 1. Assumes WM Regulation hydroline update.

Note: Drawdown induced take is reported as the peak and does not vary seasonally like rainfall runoff, and as such 50th and 80th percentile data is not applicable.

12 Risk assessment

12.1 Risk assessment and management framework

An evaluation of Project activities and potential incremental impacts on water resources and water-dependent assets, with consideration of the avoidance and mitigation measures listed in Section 6.2, was completed for the original Project and has been revisited for the amended Project.

The Glencore risk assessment matrix has been used to quantify the potential risks of the amended Project on water receptors and is presented in Table 12.1.

Table 12.1 Glencore risk assessment matrix

Basis of rating	Likelihood				
Consequence	**E - rare**	**D - unlikely**	**C - possible**	**B - likely**	**A - almost certain**
5 – catastrophic	15 (M)	19 (H)	22 (H)	24 (H)	25 (H)
4 – major	10 (M)	14 (M)	18 (H)	21 (H)	23 (H)
3 – moderate	6 (L)	9 (M)	13 (M)	17 (H)	20 (H)
2 – minor	3 (L)	5 (L)	8 (M)	12 (M)	16 (M)
1 – negligible	1 (L)	2 (L)	4 (L)	7 (M)	11 (M)

Note: L: low | M: medium | H: high

The classification of likelihood and risk factors used for the risk assessment are defined in Table 12.2 and Table 12.3.

Table 12.2 Classification of likelihood

Likelihood factor	Description
A – almost certain	• May occur several times a year; • expected to occur; or • has occurred several times within Glencore's operations.
B – likely	• May occur about once a year; • more likely to occur than not to occur; or • has occurred at least once within Glencore's operations.
C – possible	• Could occur more than once during a lifetime; • as likely to occur as not to occur; or • has occurred at least once in the mining/commodities trading industries.
D – unlikely	• Could occur about once during a lifetime; • more likely not to occur than to occur; or • has occurred at least once in broader worldwide industry.
E – rare	• Unlikely to occur during a lifetime; • very unlikely to occur; or • no known occurrences in broader worldwide industry.

Table 12.3 Classification of consequence

Risk factor	Environmental impact	Compliance impact
5 – catastrophic	• Unconfined and widespread; • environmental damage or long-term effect (permanent; >10 years); and • requires major remediation.	• Major litigation/prosecution at Glencore corporate level; • loss of licence to operate
4 - major	• Long-term (2 to 10 years) impact; and • requires significant remediation.	• Major litigation/prosecution at Department level.
3 - moderate	• Medium-term (<2 years) impact (typically within a year); and • requires moderate remediation.	• Major litigation/prosecution at Operation level.
2 - minor	• Near source; • short-term impact (typically weeks); and • requires minor remediation.	• Regulation breaches resulting in fine or litigation.
1 - negligible	• Near source and confined; • no lasting environmental damage or effect (typically <day); and • requires minor or no remediation.	• Regulation breaches without fine or litigation

12.2 Risk evaluation

The risks of potential impacts caused by the amended Project are summarised in Table 12.4. The risk evaluation assumes no additional controls (beyond those included as part of the amended Project design) are in place. This risk evaluation is consistent with the risk evaluation carried out for the original Project (EMM 2022b).

Table 12.4 Assessment of unmitigated potential impacts or events

Potential impact mechanism	Potential impact/event	Rating reasoning	Risk analysis	
			Environment	Compliance
Groundwater quantity: actual alluvial groundwater drawdown exceeds model predictions.	Exceedance of AIP minimal impact criteria at third-party bores.	Landholder bores well outside the 2 m predicted drawdown (including uncertainty results); past studies and substantial available data increase model reliability/confidence.	1 (L)	1 (L)
	Potential long-term loss of water-dependent ecosystem viability (and thereby impacts on the tangible and intangible cultural values) beyond already approved impact.	Past studies and substantial available data increase model reliability/confidence.	6 (L)	3 (L)
Groundwater quantity: predicted groundwater take exceeds licensed allocation.	Unlicensed water take.	Groundwater modelling shows groundwater takes well within existing entitlement; low uncertainty on results given substantial data available for the amended Project and surroundings.		5 (L)
Groundwater quality: enhanced mixing between aquifer units with different groundwater quality.	Groundwater quality changes in alluvial aquifers and/or watercourses affect water users.	Historically, upward leakage from the Permian to the alluvium occurred (and currently occurs in some areas). Minimal upward leakage from Permian brackish aquifers to the alluvium/watercourses is currently occurring within the amended Project area. All model scenarios predict lowering of Permian heads as a result of the amended Project. Upward leakage from the Permian to the alluvium in the amended Project area is unlikely.	3 (L)	
Groundwater quality: seepage of contaminated water from emplacement areas to alluvium and/or watercourses.	Groundwater quality changes in alluvial aquifers and/or watercourses, adversely affecting water users, aquatic ecosystems and social and cultural values.	Groundwater levels in the backfilled emplacement areas predicted to be well below the base of the alluvium – no seepage is predicted. Groundwater flow direction is predicted to be towards the pits/final voids (during and post mining); no seepage from backfilled emplacement areas to the alluvium predicted. Barrier walls exist and will be installed (as approved) in areas where overburden / interburden is adjacent to the alluvium; limiting seepage potential.	5 (L)	
Groundwater quality: seepage of saline void water to alluvium and/or watercourses.	Groundwater quality changes in alluvial aquifers and/or watercourses.	Final voids predicted to act as groundwater sinks in all model scenarios; seepage to the alluvium extremely unlikely.	6 (L)	

Potential impact mechanism	Potential impact/event	Rating reasoning	Risk analysis	
			Environment	Compliance
Surface water and groundwater interaction: actual groundwater drawdown exceeds model predictions.	Increased reduction in baseflow that affects streamflow and aquatic ecosystems, and having an indirect impact on social and cultural values.	Minimal predicted reductions in streamflow in main watercourses (Hunter River and Wollombi Brook); model considered reliable. The Hunter River is a regulated system and HVO holds considerable entitlement for the predicted take. Therefore, any surface water take due to changes in groundwater interaction will be offset through existing high security entitlement. Some ephemeral minor tributaries are predicted to experience an increased duration of dry periods; however the impact will be negligible as these watercourses are typically dry for more than half the year.	5 (L)	
Surface water quantity: reduction in streamflow within watercourses.	Streamflow impacted greater than predicted.	The amended Project will not impact new catchments. Mining activities are mainly within the existing approved disturbance area / mining tenement. Modelling is based on considerable data and therefore has low uncertainty.	3 (L)	
Surface water quality: enhanced erosion and sediment runoff.	Increased loads of suspended solids in site runoff.	Continued operation of the HVO WMS in accordance with the WMP. Sediment and erosion controls will be implemented prior to disturbance; these sediment and erosion controls will be designed and constructed in accordance with Blue Book and existing management measures.	5 (L)	
Surface water quantity: predicted surface water take exceeds licensed allocation.	Unlicensed water take.	Predicted takes are based on robust modelling informed by substantial data available for the amended Project. Water balance modelling assessed water requirements under a range of climate scenarios. HVO holds considerable water entitlement in the water sources and water entitlements are available for trade, if needed.		5 (L)
Aquatic ecology: Restriction to fish passage within the Hunter River due to construction of the Hunter River Bridge resulting in changes to Hunter River flow regimes, and the potential for damming.	Fish unable to migrate through Hunter River system; construction activities scheduled during native fish migratory season.	Detailed engineering design and construction plan so that no change to flow regimes or damming occurs; construction works to avoid being scheduled during native fish migratory season.	5 (L)	

Potential impact mechanism	Potential impact/event	Rating reasoning	Risk analysis	
			Environment	Compliance
Less than adequate assessment of geological faults and structures in groundwater impact assessment and model.	Groundwater inflows greater than predicted due to high hydraulic conductivity of geological structures; instability of pits.	Geological structures in the amended Project area are well known due to extensive investigations for historical mining and substantial dataset. At HVO North, mining will mainly involve mining deeper in previously excavated areas; uncertainty considered low.	3 (L)	
Cumulative impacts: multiple mining operations in proximity to Hunter River.	Unacceptable increase of cumulative mining impacts on the Hunter River and Wollombi Brook systems. Regulator and community concern.	The additional impact (contributing to the cumulative impact) due to the amended Project is minor, as predicted by robust modelling informed by substantial data available for the amended Project.	3 (L)	
Changes in flow velocity in the amended Project area due to levee construction or upgrades.	Channel stability adversely affected in the amended Project area.	The existing approved operations includes construction of levees, including the Carrington West Wing levee (designed for 1% AEP as per condition 26 of the HVO North consent), so the additional incremental change due to the amended Project is minor. Previous flood modelling shows low risk to channel stability.	5 (L)	

13 Monitoring, mitigation and management

13.1 Overview

As described in the original Project, the WMP will be reviewed and updated following Project approval. The update will include review of the existing surface water, groundwater and ecological monitoring, so that WMP performance criteria and verification of assessment findings can be assessed. The proposed management and mitigation measures listed in the water related assessments are consistent with the existing mitigation measures in place at HVO and documented in the original Project. This is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance and changes to timing associated with the amended Project.

The locations and designs of the additional groundwater monitoring locations will be determined in consultation with NSW Government during updates to the WMP.

In accordance with condition 25 of the HVO North development consent (DA 450-10-2003), HVO will develop a low permeability barrier monitoring and management plan following Project approval and in consultation with the NSW Government.

13.2 Groundwater monitoring program

The main alluvial drawdown impacts from the amended Project are predicted to occur in the Hunter River alluvium south of the existing barrier wall, in the Carrington Billabong area. There are five HVO monitoring bores in this location, with CFW55R being within the predicted area of incremental drawdown.

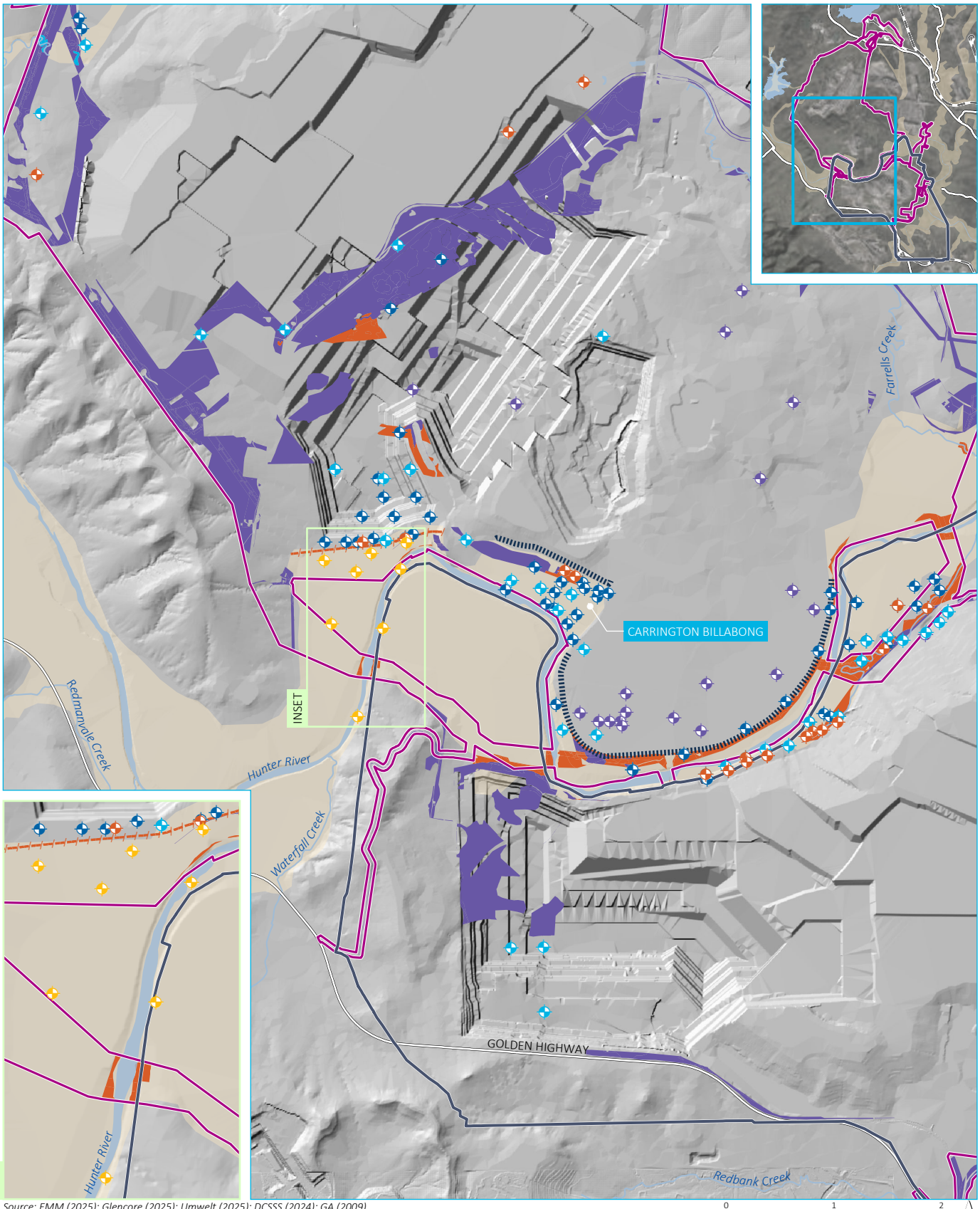
In addition to groundwater monitoring in the Carrington Billabong alluvial area, a review of the groundwater monitoring network and monitoring equipment will be conducted as part of updates to the WMP. In addition to review and extension of the existing WMP and associated monitoring, HVO will augment the existing groundwater monitoring network to include additional monitoring bores in the Carrington West Wing alluvium area (south of the Carrington West Wing LPBW). The bores will be installed approximately one year prior to mining commencing in the western arm of the remnant paleochannel in connection to the Hunter River to allow collection of background groundwater level trends prior to the potential effects of mining.

Eight additional bores were proposed for inclusion in the HVO groundwater monitoring network; these locations are shown in Figure 13.1. This would consider installation of additional pressure transducer data loggers at other monitoring bores to increase the monitoring frequency without affecting personnel time and associated cost.

13.3 Groundwater model validation

As described in the EIS Water Assessment (EMM 2022b), continuous improvements to the numerical groundwater flow model will be undertaken as and when new data become available, particularly where there is a divergence of observed groundwater system response from that predicted by the model. Groundwater monitoring data will be used to validate and verify the groundwater model predictions. New data may require a revision and update of the conceptual hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. Where this is deemed necessary, the WMP may also require updating depending on any changes to the conceptualisation and model predictions.

As mining progresses, a need for further model updates will be assessed every three years based on evaluation of groundwater monitoring data and findings of impact verification.



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 1 2 km
GDA2020 MGA Zone 56
N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Alluvium extent
- Existing low permeability barrier wall
- Carrington West Wing LPBW
- Proposed monitoring bore

Existing groundwater monitoring location (HVO)

Lithology
- Alluvium
- Spoil
- Regolith

Permian
- Coal seam
- Interburden

Plant community type (PCT) (Umwelt, 2025)
- PCT 3431 | Central Hunter Ironbark - Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment
- Rail line
- Major road
- Named watercourse
- Named waterbody

DRAFT

Proposed additional groundwater monitoring – Carrington West Wing area

HVO Continuation Project - Amendment
Water Assessment
Figure 13.1

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13.4 Residual risk assessment

Risk evaluation in Section 12.2 were re-assessed considering the recommended controls and management measures outlined above. A revised risk assessment is provided in Table 13.1.

Table 13.1 Assessment of residual risk of potential impacts or events

Potential impact mechanism	Potential impact/event	Management or mitigation	Residual risk	
			Environment	Compliance
Groundwater quantity: actual alluvial groundwater drawdown exceeds model predictions.	Potential long-term loss of water-dependent ecosystem viability beyond already approved impact	Additional groundwater monitoring bores to be installed in the alluvium south of the Carrington West Wing LPBW and low permeability barrier monitoring and management plan (LPB MMP) to be developed in consultation with DCCEEW, including development of early warning trigger levels and response plan. Ecohealth monitoring at Carrington Billabong to continue.	3 (L)	
Groundwater quantity: predicted groundwater take exceeds licensed allocation.	Unlicensed water take	Monitoring and measurement of take. Model review and validation to be conducted every three years to re-evaluate model predictions (including predicted take).		3 (L)
Groundwater quality: seepage of contaminated water from emplacement areas to alluvium and/or watercourses.	Groundwater quality changes in alluvial aquifers and/or watercourses	Additional groundwater monitoring bores to be installed in the alluvium south of the Carrington West Wing LPBW and LPB MMP to be developed in consultation with DCCEEW, including development of early warning trigger levels and response plan.	3 (L)	
Surface water and groundwater interaction: actual groundwater drawdown exceeds model predictions.	Increased reduction in baseflow that affects streamflow and aquatic ecosystems	Additional groundwater monitoring bores to be installed in the alluvium south of the Carrington West Wing LPBW and LPB MMP to be developed in consultation with DCCEEW, including development of early warning trigger levels and response plan.	3 (L)	
Surface water quantity: reduction in streamflow within watercourses.	Streamflow impacted greater than predicted	Continued operation of the WMS in accordance with the WMP.	3 (L)	
Surface water quantity: predicted surface water take exceeds licensed allocation.	Unlicensed water take	Monitoring and measurement of take.		3 (L)

14 Conclusions

The water impact assessments for the amended Project, including groundwater, surface water, aquatic ecology and GDE studies, considered potential impacts on water resources and water-dependent assets that could result from the amended Project during operations and after closure.

The assessments show the amended Project can operate within and meet the requirements of the water regulatory framework. Key results are summarised below.

14.1 Surface water impacts

Key outcomes of the SWIA and aquatic ecology assessment are summarised as follows:

- Impacts on Hunter River and Wollombi Brook streamflow will be negligible.
- Minor changes in streamflow are predicted for three ephemeral watercourses during operations. The predicted change in streamflow will have a minor impact on the number of dry days, as many of these ephemeral watercourses are dry (on average) for more than half of the year under current conditions. Post mining, potential streamflow impacts are expected to be negligible.
- Potential impacts on surface water downstream users will be negligible as no changes in streamflow regimes are predicted in the Hunter River, given it is a regulated system and HVO hold sufficient entitlement for the predicted reduction in streamflow due to the amended Project.
- No impacts are predicted on the aquatic ecology of the Hunter River, particularly as flow will be mitigated through regulated releases from Glenbawn Dam, and only minor impacts to the aquatic ecology in the tributaries to the Hunter River are predicted.
- The proposed WMS for the amended Project is predicted to maintain a sufficient water supply for the operation and discharge capacity to prevent flooding of operational areas of the mine.
- Potential impacts on surface water quality are expected to be minimal and will continue to be mitigated through an appropriately sized, designed and operated WMS, including release from sediment dams in accordance with their design and discharge of mine water in accordance with approved environment protection licence limits and HRSTS credits. Modelling indicates that the impact of approved HRSTS discharges will have a negligible impact on water quality. Concentrations of key analytes are predicted to remain within the existing ranges observed in the Hunter River.
- No changes to the flood impacts are anticipated from the original Project and have not been assessed in this report.

14.2 Groundwater impacts

Key outcomes of the GIA and GDE assessment are summarised as follows:

- No impact is predicted at third-party groundwater bores.
- Construction of the Carrington West Wing LPBW prior to mining in the paleochannel will limit the long-term drawdown in the Hunter River alluvium and the potential for seepage from the backfilled mine areas to the alluvium. The potential impact on water quality is minor. In addition, a LPB MMP will be developed, including development of early warning trigger levels and response plan, identifying mitigation measures to manage potential unexpected effects.

- Minimal incremental drawdown (less than 0.5 m) is predicted in the Hunter River alluvium around Carrington Billabong near mapped river red gum communities and widespread dewatering will not occur. This predicted drawdown will be buffered by leakage through the riverbed. Therefore, no significant impact in ecological receptors is predicted.

- No additional drawdown in the Wollombi Brook alluvium is predicted from the amended Project. In contrast, the avoidance measure of removing mining in the RSEE, SLP 1 and SLP 2 areas from the mine plan is predicted to result in a reduction in potential drawdown in the Wollombi Brook alluvium (in comparison to the approved operations).

- No changes to the environmental, community and cultural values referenced in Sections 4.3.4 are predicted due to the amended Project.

14.3 Final void

Key outcomes of the final void assessment are as follows:

- The predicted long-term watertable and pit lake level will be depressed, with groundwater flow directions towards the voids.

- The runoff area contributing to the voids is sufficiently small so that evaporation dominates, and the voids remain as strong long-term groundwater sinks thereby attracting seepage from the surrounding strata (at a very low rate).

- Infiltration of rainfall in the backfilled mine areas will gradually flow towards the pit lakes, as evidenced by the groundwater particle tracking completed as part of the updated groundwater modelling (Attachment A), and the risk of seepage from the backfilled mine areas migrating through the existing and proposed barrier walls to the Hunter River alluvium is negligible.

- The long-term pit lake level is considerably deeper than the base of the alluvium and the base of weathering, therefore the risk of seepage from the pit lakes to shallow groundwater is negligible.

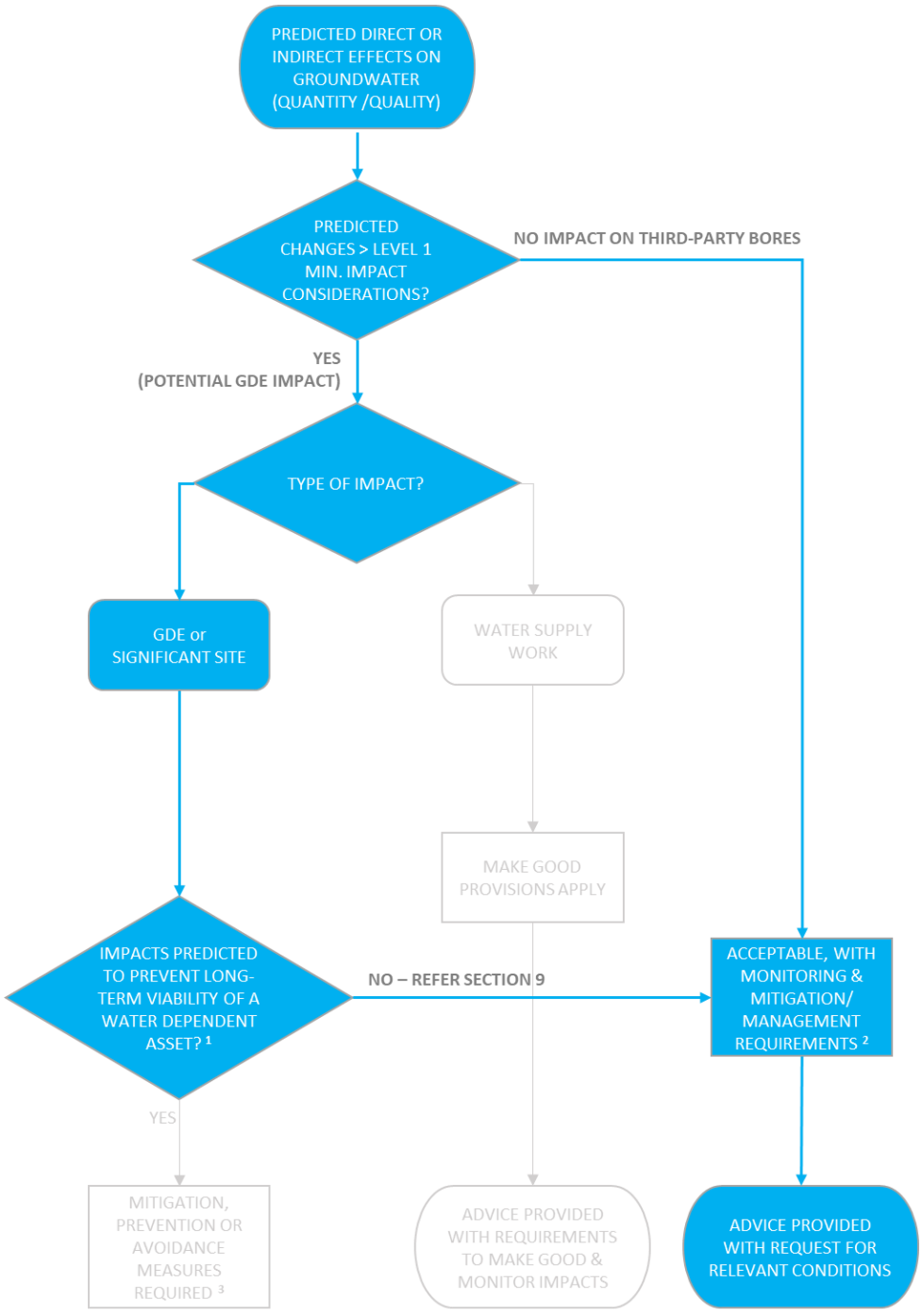
- The risk of spill from the pit lakes to the environment is negligible.

- The amended Project is predicted to have a negligible impact on Hunter River flow and flooding regime post mining.

- The Hunter River alluvium is predicted to remain saturated due to the strong hydraulic connection with the Hunter River.

- The predicted cumulative drawdown is very conservative as the long-term predicted watertable is compared to a model where mining effects cease in 2009, effectively allowing groundwater levels to recover. The maximum predicted cumulative alluvial drawdown (post mining) exceeds the NSW AIP level 1 minimal impact considerations; however, the GDE assessment (ELA 2025) demonstrates that the predicted change in watertable will not prevent the long-term viability of GDE ecosystems. This is illustrated in Figure 14.1.

- River red gums and riparian vegetation that opportunistically use shallow groundwater will continue to have access to shallow alluvial groundwater. Consistent with the predicted drawdown during operations, the post mining incremental alluvial drawdown is not predicted to have a significant impact on GDEs or surface water resources. Additionally, as mentioned above, the Hunter River flow and flooding will not be impacted by the amended Project, thereby river red gum communities will continue to rely on flooding for germination.



1. Assessment as per Serov et al 2012, with consideration of uniqueness, ecological/cultural value and timeframe of the impact.
2. Conditions of approval may include requirements for adaptive management to monitor and mitigate or remediate impacts that exceed level 1 thresholds.
3. Where there are no suitable or practical mitigation or prevention options, the proponent may be asked to avoid impacts by modifying the proposed activity.

Figure 14.1 Overview of Project assessment against the AIP minimal impact considerations process

14.4 Water licensing

HVO holds considerable water entitlement in the relevant surface water and groundwater sources in the amended Project area, which is sufficient to account for the predicted take in most water sources, with the exception of the following.

During operations:

- The small predicted peak indirect groundwater (alluvial) take from the Jerrys water source (4 ML/yr) exceeds HVO's entitlement. Prior to the take occurring, HVO will either apply to convert sufficient existing unregulated river entitlements to aquifer entitlements or purchase entitlement via the open market to account for the small predicted indirect groundwater take in the Jerrys Water Source.

Post-mining:

- During the closure period:
    - Take associated with runoff captured from storages on non-minor streams within the Jerry water source (Jerrys management zone) during the transition period that exceeds HVO's existing entitlement will be sourced from the open market (including trade, in accordance with the water sharing plan rules). There is adequate share entitlement within the Jerrys Water Source for the predicted take. In addition, the Hunter Unregulated and Alluvial water sharing plan allows for trade (permanently and temporarily) into the Jerrys Water Source from several (17) other upstream water sources. This demonstrates there is sufficient entitlement within the water source and upstream water sources for HVO to obtain additional entitlement via the open market.
    - HVO will apply to convert sufficient aquifer entitlements to unregulated river entitlements for the predicted peak take associated with dams on non-minor streams in the Lower Wollombi Brook Water Source during closure.
- At closure (i.e. in the long-term), residual take will be limited to direct take associated with evaporative losses from the final voids and associated indirect surface water and groundwater take:
    - The predicted peak indirect groundwater (alluvial) take from the Jerrys water source (26 ML/yr) exceeds HVO's entitlement. Prior to the take occurring, HVO will either apply to convert sufficient existing unregulated river entitlements to aquifer entitlements or purchase entitlement via the open market.

The final detail of any post mining dam configuration, design of the drainage systems and associated licensing will be further investigated and resolved during preparation of the relevant stages of the Rehabilitation Management Plan and in the detailed closure planning process.

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Attachment A

Groundwater modelling report

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HVO Continuation Project – Amendment

Groundwater Modelling Report

Prepared for HV Operations

July 2025

HVO Continuation Project – Amendment

Groundwater Modelling Report

HV Operations

H190408 RP1

July 2025

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1 Introduction

1.1 Background

Hunter Valley Operations (HVO) is a multi-pit open cut coal mining complex approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW) (Figure 1.1). HVO comprises two mine sites, HVO North and HVO South, separated by the Hunter River. The sites operate under separate development consents issued under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) but operate as a single integrated operation with fully integrated environmental management systems.

The existing HVO North operates under Development Consent DA 450-10-2003, which allows for extraction of 22 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 31 December 2026. HVO North comprises the approved mining areas of West Pit, Mitchell Pit, Carrington Pit and North Pit, as well as the Hunter Valley (HV) and Howick Coal Preparation Plants (CPP) and the Howick and HVO North mine infrastructure area (MIA). The Newdell Load Point (LP) and Hunter Valley (HVLP) train loading facilities are also at HVO North.

HVO South operates under Project Approval (PA) 06_0261 and comprises the approved mining areas of Riverview Pit, Cheshunt Pit, Riverview South East Extension (RSEE) and South Lemington Pits 1 and 2 (SLP 1 and SLP 2), as well as the MIA, and the Lemington CPP (LCPP) and rail loop (approved but not constructed). PA 06_0261 allows the extraction of up to 20 Mtpa of ROM coal until 24 March 2030.

HVO is seeking approval for the HVO Continuation Project (the Project), which proposes extending mining beyond the current approved mining end dates of December 2026 at HVO North and March 2030 at HVO South.

Given that the two mine sites operate as one complex, one environmental impact statement (EIS, EMM 2022) was prepared to support the two State significant development (SSD) applications for the Project, being:

- SSD-11826681 – HVO North Open Cut Coal Continuation Project
- SSD-11826621 – HVO South Open Cut Coal Continuation Project.

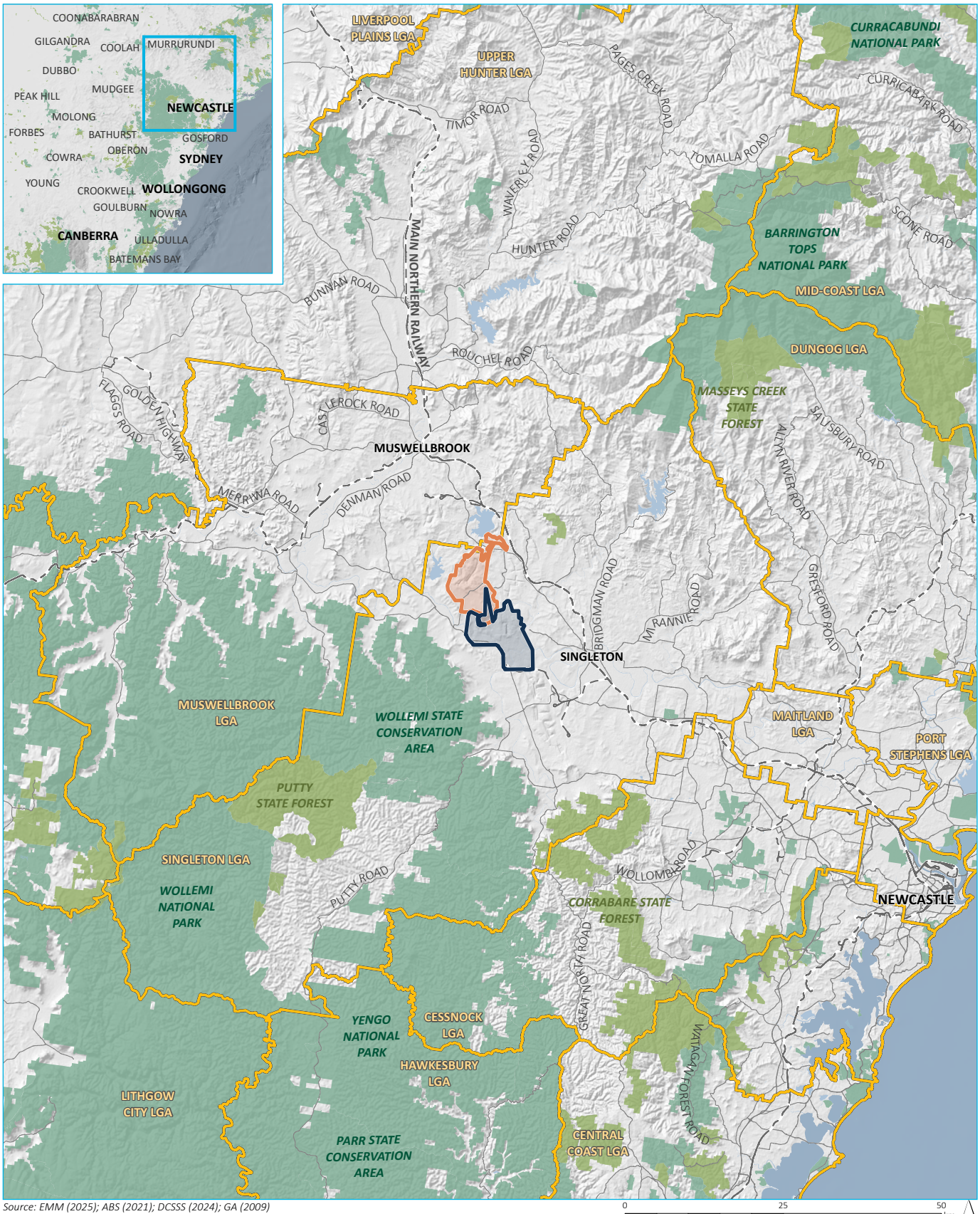
During the public exhibition of the EIS, submissions were received by the NSW Department of Planning, Housing and Infrastructure (DPHI) from individuals, organisations, public authorities, councils, and government agencies for the two development applications. To respond to matters raised in submissions on the Project during the public exhibition period, a Submissions Report (EMM 2023a) was prepared, along with an Amendment Report (EMM 2023b) outlining proposed amendments to the HVO North Project.

Following the subsequent assessment of the Project by DPHI and request for further information, HVO completed a detailed review of the Project and is subsequently seeking to amend the SSD applications in the following ways that have relevance to groundwater:

- Limit the extent of coal extraction north of the Hunter Valley dyke at HVO North and reduce the total ROM coal to be extracted by the Project by approximately 220 Mt:
  - Maintain the current approved maximum annual ROM coal production from HVO North of 22 Mtpa but reduce the proposed maximum annual production limit at HVO South from 18 Mtpa to 13 Mtpa.
  - Reduce the maximum annual production for the HVO Complex to 26 Mtpa from the current approved maximum production of 42 Mtpa.
- Reduce the proposed life of mining operations at HVO North by five years, from the end of 2050 to the end of 2045.
- Reduce the proposed life of mining operations at HVO South by three years from the end of 2045 to the end of 2042.

The EIS Project refers to all assessment documentation associated with SSD 11826621 and SSD 11826681 including the EIS (EMM 2022a), Submissions Report (EMM 2023a), HVO North Amendment Report (EMM 2023b) and related correspondence (including EMM 2024a and 2024b).

As part of the Amendment Report (EMM 2025) for the HVO Continuation Project, groundwater modelling has been undertaken to reflect the revised changes to the mine plan and support revised assessments of potential impacts on groundwater resources and associated receptors.



Source: EMM (2025); ABS (2021); DCSSS (2024); GA (2009)

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KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest
- Local government area

INSET KEY

- NPWS reserve
- State forest

Regional setting

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 1.1

EMM creating opportunities

1.2 Project overview

As noted in Section 1.1, the Project broadly comprises the continuation of mining at HVO North and HVO South, beyond the current approved mining completion dates of 2026 and 2030, respectively. For the purposes of the report, the Project as amended is referred to as the "Amended Project" hereafter. The key components of the amended HVO North Continuation Project and HVO South Continuation Project are illustrated on Figure 1.2 and summarised (with a focus on aspects relevant to groundwater resources) in the sections below.

1.2.1 HVO North

The key Amended Project elements at HVO North for which approval is sought include those activities required to carry out open cut coal mining and processing and include:

- Changes to the HVO North development consent boundary, as illustrated on Figure 1.2.
- Continuation of mining operations at HVO North from 1 January 2027 until 31 December 2045.
- Production of up to 22 Mtpa with no separation of extraction limits between West Pit and Carrington Pit (continuing to mine down to the base of the Barrett Seam in the West and Mitchell Pit areas, and down to the base of the Bayswater Seam in the approved Carrington West Wing area).
- Management of tailings in accordance with a Tailings Management Strategy.
- Implementation of the approved but not yet constructed Carrington West Wing low permeability barrier wall (LPBW) prior to mining within 100 m of the remnant paleochannel (consistent with the existing approval).
- Revised conceptual final landform, where two voids are proposed to be retained (refer Figure 1.3):
    - A final void associated with the main HVO North Pit (also referred to as the Mitchell Pit).
    - A final void in Carrington Pit (evaporative sink) as currently approved.
    - Representing a reduction in the number of voids that will remain post mining compared to existing approved operations (i.e. from three to two).

Other than as modified above, all activities that are currently approved under the existing HVO North development consent are intended to continue.

1.2.2 HVO South

The key Amended Project elements at HVO South for which approval is sought include those activities required to carry out open cut coal mining and processing and include:

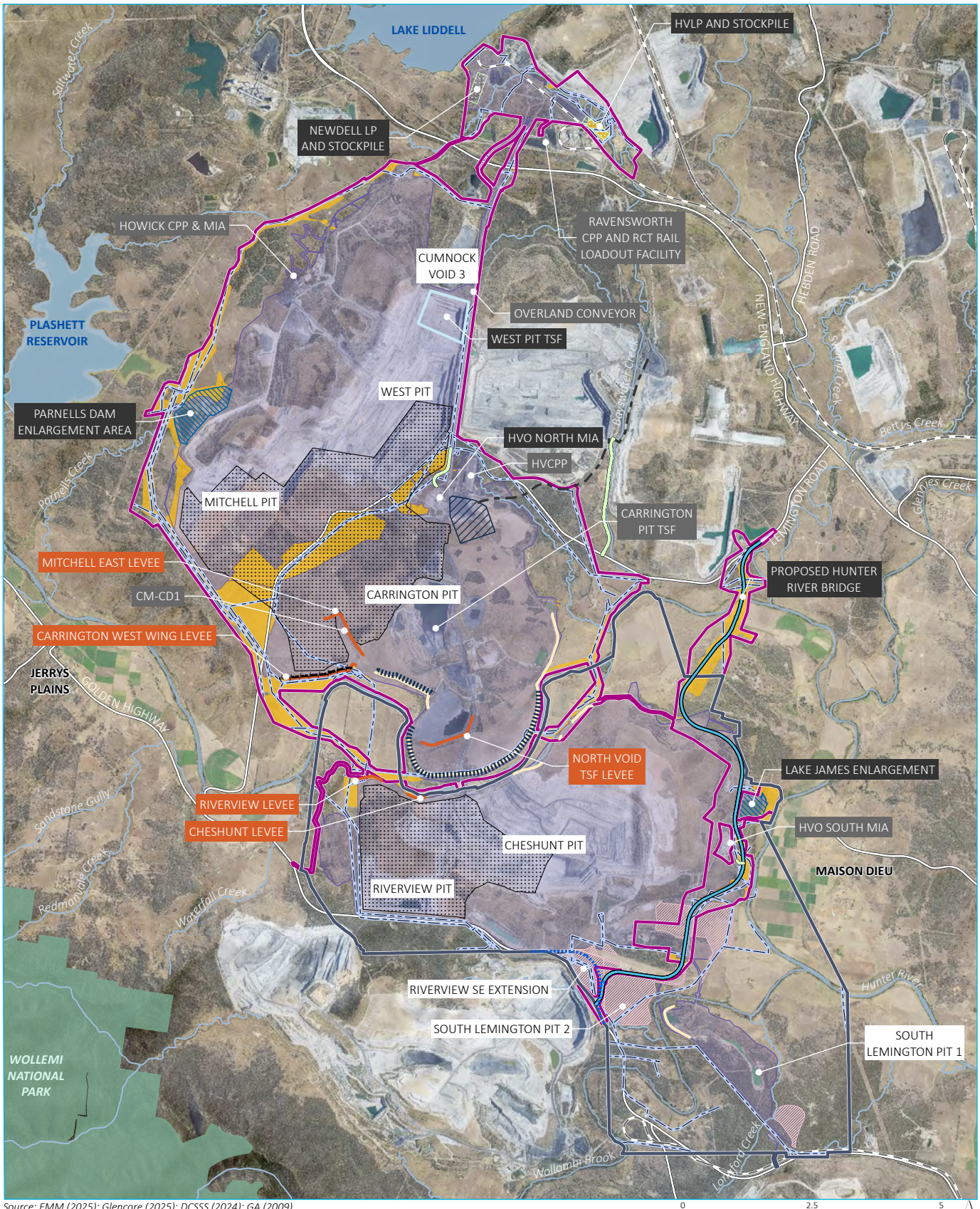
- Changes to the HVO South development consent boundary, as illustrated in Figure 1.2.
- Continuation of mining operations at HVO South from 24 March 2030 until 31 December 2042.
- A reduction in the approved maximum extraction rate from 20 Mtpa to 13 Mtpa.
- Removal of coal extraction from the mine plan for the RSEE, and SLP 1 and 2.

Other than as modified above, all activities that are currently approved under the existing HVO South approval are intended to continue, including a single final void that will remain post mining (refer Figure 1.3), consistent with existing approved operations.

1.3 Purpose of this report

Numerical groundwater modelling was undertaken to support the Amendment Report submission for the HVO Continuation Project (EMM 2025). This modelling builds on previous work completed for the EIS Project and incorporates updates in response to public exhibition feedback, agency submissions, and internal project review processes. The groundwater model developed for the EIS Project (AGE 2022) has undergone peer review and review by the Independent Expert Advisory Panel for Mining on behalf of DPHI, and was found to be fit for the intended purpose.

The current revised modelling is intended to reflect the proposed amended mine plan and uses the 'base case' from the AGE (2022) calibrated groundwater model (the 'best' calibrated model) for predictive simulations.



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Existing and approved disturbance area
- Additional disturbance area
- Previous approved area not retained
- Existing low permeability barrier wall
- Existing levee

Proposed HVO continuation project element

- Approved barrier wall (not yet constructed)
- Alternative Golden Highway alignment
- Lemington Road realignment
- Levee
- Mine access road
- Proposed haul route to Ravensworth Operations
- Transmission line
- Dam enlargement
- Mining area
- Product stockpile
- ROM coal stockpile enlargement area
- West Pit TSF

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

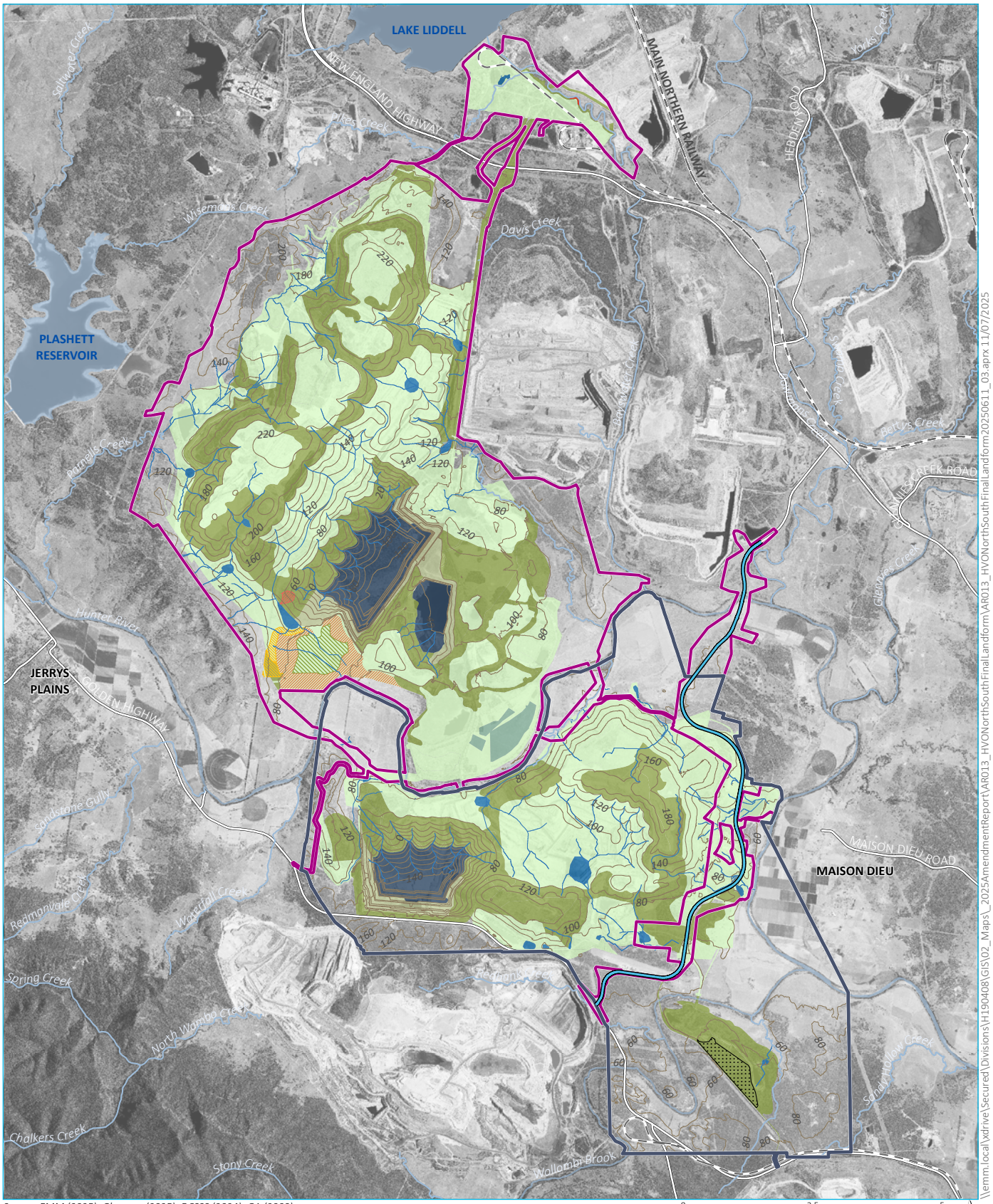
Label format

- Existing item
- Levee
- Project related item

HVO Complex conceptual layout

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 1.2

EMM creating opportunities



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Proposed South Lemington offset
- Predicted drainage
- Predicted 20 m contour
- Lemington Road realignment

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Final landform land use domain

- Domain A | Native ecosystem
- Domain A- Sub domain Ka | Other- Native ecosystem- partial vegetation on highwall benches
- Domain B | Agriculture- grazing
- Domain B- Sub domain Kb | Other- Agriculture- alluvial land
- Domain G | Water storage
- Domain J | Pit Lake

Existing commitments maintained by the Project (indicative location)

Rural land capability

- Class 2- DA 450-10-2003 MOD3
- Class 3- DA 450-10-2003 MOD3
- Class 4- DA 450-10-2003 MOD3

Native ecosystem

- Central Hunter Box-Ironbark Woodland - DA 450-10-2003 MOD3
- Swamp Oak Floodplain Forest - DA 450-10-2003 MOD5

HVO North and South conceptual final landform

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 1.3

EMM
creating opportunities

1.4 Previous modelling

Groundwater modelling for the Amended Project builds upon many previous groundwater modelling efforts in the region, reflecting the extensive and ongoing mining activity in the region surrounding the HVO Complex (as documented in AGE 2022).

The latest version of the model is from the *HVO Continuation Project Groundwater Impact Assessment* (AGE 2022) report prepared for the EIS, which serves as the foundation for the predictive simulations supporting the Amendment Report. This version incorporates updates to the modelling due to the Amended Project while maintaining consistency with the AGE (2022) model conceptualisation, design and structure. Table 1.1 summarises model versions and modifications undertaken since development of the initial model in 2011.

Table 1.1 HVO regional groundwater model versions and development

Model version	Model build	Project	Description of modification(s)	Model version number	Year released
1	0	Ravensworth	• Initial model construction. • Model calibration.	1	2011
1	1	Liddell	• Stochastic predictive simulations of proposed operations.	1.1 Liddell	-
2	0	-	• Refined historic mining and backfill sequencing at Ravensworth East, Glendell and Mount Owen operations. • Updated geology models for Mount Owen and Ravensworth areas.	2	-
2	1	Ravensworth East	• Stochastic predictive simulations of proposed RERR operations.	2.1 Rav	-
2	2	Liddell	• Updated stochastic predictive simulations of proposed operations.	2.2 Liddell	
3	0	-	• Refinement of historic Liddell open cut operations; Inclusion of additional coal barriers around Hazeldene workings.	3	-
3	1	Liddell	• Updated stochastic predictive simulations of proposed operations.	3.1 Liddell	-
4	0	-	• Inclusion of historic dewatering operations at Liddell underground workings. • Conversion of Bowmans Creek “River” boundary conditions to “Stream” boundary conditions. • Refinement of top and bottom elevations for Bowmans Creek alluvium based upon new LIDAR. • Recalibration (steady state and transient). • Creation/selection of new input datasets for stochastic simulations.	4	-
4	1	Liddell	• Updated stochastic predictive simulations of proposed operations.	4.1 Liddell	-
5	0	-	• Modification to underground working at Liddell; Addition of new dewatering bore at Middle Liddell underground workings.	5	-
6	0	-	• Refined model progression for mining and backfill sequencing based upon peer review comments. • Updated Horizontal Flow Barrier (HFB) package for faults regionally.	6	-
6	1	Liddell	• Updated stochastic predictive simulations of proposed operations.	6.1 Liddell	-

Model version	Model build	Project	Description of modification(s)	Model version number	Year released
7	0	Liddell	• Representation of Glennies Creek and Main Creek alluvium based upon LIDAR data. • Refinement of Glendell and Mount Owen approved mine sequences and plans. • Incorporation of Integra Underground mine. • Modification of hydrogeological parameters to account for enhanced conductivity above former underground workings and according to depth of overburden. • Modification of model size and stress periods to accommodate updated mine sequencing. • Recalibration (steady state and transient) to extended calibration dataset. • Updated stochastic predictive simulations of proposed operations.	7	-
7	1	Mount Owen	• Recalibration to refine specific yields.	7.1 Mount Owen	-
7	2	Liddell	• Incorporation of Liddell base case into Version 7.	7.2 Liddell	-
8	0	Mount Owen	• Recalibration of the model to account for: – Changes in evapotranspiration (ET) values: Non-mining areas. – Use Actual Areal Evapotranspiration values for maximum ET rates. – Inclusion of Liddell total dewatering rates for 2012 and 2013. – Inclusion of additional alluvial monitoring data.	8	-
8	1	Mount Owen	• Predictive simulations for Mount Owen Continued Operations EIS.	8.1 Mount Owen	-
9	0	Mount Owen Mine and Integra Underground Mine	• Modelling taken over by AGE. • Converted model to MODFLOW-USG including development of new mesh and layers. • Refined mesh along Bettys Creek and Main Creek alluvial aquifers. • Updating water level monitoring dataset. • Represented hydraulic conductivity as decreasing with depth in Permian model layers. • Adjusted coal seam levels based on updated geological model from Mt Owen mine. • Updated thickness of the alluvium based on borehole logs. • Recalibrated model to water level records and mine inflows at Integra. • Updated progression of approved and proposed mining at Integra Underground mine. • Added approved open cut mining at Rix Creek North Mine (former Integra open cut). • Updated progression of mining at Mt Owen Mine. • Predictive simulations for proposed mining at Integra Underground and Mount Owen.	9	2017

Model version	Model build	Project	Description of modification(s)	Model version number	Year released
9	1	Mount Owen Mine and Integra Underground Mine	• Update of open cut mine plan at Mount Owen. • North Pit to extend to the end of 2036.	9.1 Mount Owen	2018
9	2	Liddell Open Cut	• Reduced the depth of Liddell Open Cut to the base of the Barrett Seam (currently approved to the Hebden Seam). • Update of the planned end of mining/beginning of recovery year to 2023 (instead of 2022). • Introduction of the Davis Creek Fault and Dyke into the model, represented by the Horizontal Flow Barrier (HFB) package. • Representation of historical workings of Liddell Underground Mine in the model, using data from SKM's (2014) groundwater model and refinements. • Representation of coal barrier walls separating different areas of Liddell Underground Mine in the model. • Introduction of controlled water levels in the different areas of Liddell Underground Mine into the model, following detailed data provided by LCO.	9.2 Liddell (unpublished version)	2018
10	0	Glendell	• Refinement of Glendell and Mount Owen approved mine sequences and plans. • Revision of alluvial thickness along Bowmans and Glennies Creek. • Review and updates to coal seam surfaces based on Glencore's geological models. • Extended northern boundary to reduce potential for boundary condition to influence predictions. • Refinement of model cell sizes around the Glendell mining area and Bowman Creek. • Introduction of pilot point multipliers to improve calibration and uncertainty analysis (Kx, Kz, Sy, Ss, and recharge). • Recalibration (steady state and transient) to extended calibration dataset using surrogate child/parent technique. • Updated stochastic predictive simulations of proposed operations.	10.0	2019

Model version	Model build	Project	Description of modification(s)	Model version number	Year released
11	0	HVO	• Combined model layers from the existing Glendell and HVO South MOD5 numerical models to create layers for updated model. • Reduced the extent of the model, and centred it on HVO, to reduce numerical burden. The model excluded MTW to the south and Mt Owen/Integra to the east, but used boundary conditions at these locations to represent previously modelled impacts from these mining operations. • Updated historical mine sequences at HVO. • Revised the extent of Quaternary alluvium along Hunter River north of Cheshunt Pit. • Added pit lake areas in South Lemington Pit 1, Carrington Pit, Carrington Remnant Void. • Added controlled water levels to represent ongoing dewatering of the Lemington Underground Mine. • Adjusted river depth along Hunter River. • Recalibrated using pilot points (steady state and transient).	11.0	2022
11	1	HVO	• Updated and revised model packages representing mining activity built for the Amendment Report submission. • Updated using parameterisation from the 2022 history-matched model.	11.1	2025 (this report)

1.5 Modelling objectives

Groundwater modelling was conducted to inform an assessment of potential impacts of the Amended Project on the groundwater regime. The primary objective was to use the model framework developed by AGE (2022) to simulate groundwater-affecting activities associated with the Amended Project and provide predictions of potential changes in groundwater heads and fluxes, and pathways for impact on water resources and water-dependent assets. The specific objectives of the modelling are the same as those reported by AGE (2022):

- Predict groundwater inflows to HVO mining areas to inform water management (Engeny 2025) and licensing requirements (reported in the overarching Water Assessment report).
- Predict changes in groundwater heads in the alluvium due to the Amended Project (incremental and cumulative).
- Predict changes in surface water-groundwater interaction between the watercourses including the Hunter River/Wollombi Brook and the alluvium due to the Amended Project (to inform the streamflow impact assessment conducted by Engeny (2025)).
- Predict potential watertable drawdown at groundwater dependent ecosystems (GDEs) and third-party bores.
- Predict post-mining groundwater fluxes at the final voids to inform the pit lake recovery modelling (Engeny 2025).
- Predict fate of potential contaminants introduced to the groundwater system from backfilled mining areas at HVO (emplacement areas) near the Hunter River.

1.6 Model confidence classification

The Australian groundwater modelling guidelines (Barnett et al. 2012) developed a classification system for groundwater model confidence levels, categorising models as Class 1, 2, or 3, with Class 3 representing the highest level of confidence. Classification is based on factors such as data availability, calibration procedures, consistency between calibration and predictive analysis, and magnitudes and durations of stresses. While Class 3 modelling, supported by a well understood conceptualisation, provides the greatest confidence in predictions, few modelling exercises meet all criteria fully, and many sit between Class 3 and Class 2.

The AGE (2022) groundwater modelling, which the current Amended Project groundwater modelling is based on, is primarily classified as Class 3, with some Class 2 characteristics. Specifically, 79% of assessed performance indicators align with Class 3, 14% with Class 2, and 5% with Class 1. Table D14 in the AGE (2022) report outlines the evaluation parameters against defined performance criteria across four categories (data, calibration, prediction and quantitative indicators) and assigns a confidence level of Class 1, 2, or 3.

2 Hydrogeological conceptual model

The following points summarise the hydrogeological conceptual understanding illustrated and discussed in the overarching Water Assessment report and AGE (2022) report, which remains unchanged:

1. The Hunter River is a regulated river controlled by releases from Glenbawn Dam and Glennies Creek Dam, maintaining streamflow and supply to downstream entitlement holders and basic landholder rights.

2. The tributaries to the Hunter River are unregulated and as such are ephemeral. Some of the smaller watercourses (such as Farrells Creek and Parnells Creek) are mostly dry and only flow following high rainfall events.

3. Groundwater systems include:

    a) Alluvial aquifers (including the paleochannel) form unconfined aquifers, and quality is fresh to brackish. The alluvium is generally more permeable than other lithologies, with recorded hydraulic conductivities ranging from 10^{-2} m/d to 10^{2} m/d (AGE 2022).

    b) The regolith does not form aquifers due to limited saturated thickness.

    c) Permian interburden layers form aquitards.

    d) Permian coal seams generally form low to moderately permeable confined aquifers, with poor groundwater quality. Hydraulic conductivity generally decreases with depth (AGE 2022).

4. Recharge to the alluvium occurs via infiltration of rainfall and leakage from surface water to the watertable. In the Hunter River alluvium, groundwater levels and aquifer saturation is strongly correlated to Hunter River flows, which is mostly a losing watercourse in the Project area. River leakage into the alluvium in the region is up to four times greater than direct rainfall recharge (McVicar et al 2015). The saturated thickness of the paleochannel ranges from 1 m to 6 m.

5. Recharge to the Permian groundwater system(s) occurs via downward leakage from the overlying saturated alluvium (with seepage rates limited by the vertical hydraulic conductivity of the regolith, overburden and interburden) and/or gradual infiltration of rainfall where the Permian outcrops.

6. Groundwater discharge occurs via:

    a) Evapotranspiration from vegetation, such as river red gums, where the watertable is sufficiently shallow.

    b) Seepage to active or disused mining areas (where in hydraulic connection).

    c) As baseflow to watercourses in areas where the watertable is in hydraulic connection with the watercourse and at higher elevation than the water in the watercourse (this may occur seasonally).

    d) From the alluvium to Permian strata via downward leakage where Permian potentiometric surfaces are lower than the base of the alluvium.

    e) Active pumping from bores.

7. The vertical hydraulic gradient between the alluvium and the Permian is generally downward, due to historical mining depressurising the Permian.

8. Ecosystems that potentially rely on surface water and/or groundwater:

- River red gum stands (including in the Carrington Billabong area) that opportunistically access shallow groundwater recharged by leakage from the Hunter River and Wollombi Brook, and rely on flooding for germination.
- Stygofauna occurring principally in alluvial sediments along the Hunter River and its tributaries.
- Aquatic ecosystems.
- Warkworth Sand Woodland vegetation community which relies principally on rainfall infiltration and a seasonal perched watertable observed to occur after large rainfall events.

Further details can be found in the overarching Water Assessment report and AGE (2022) report.

3 Model design

3.1 Overview

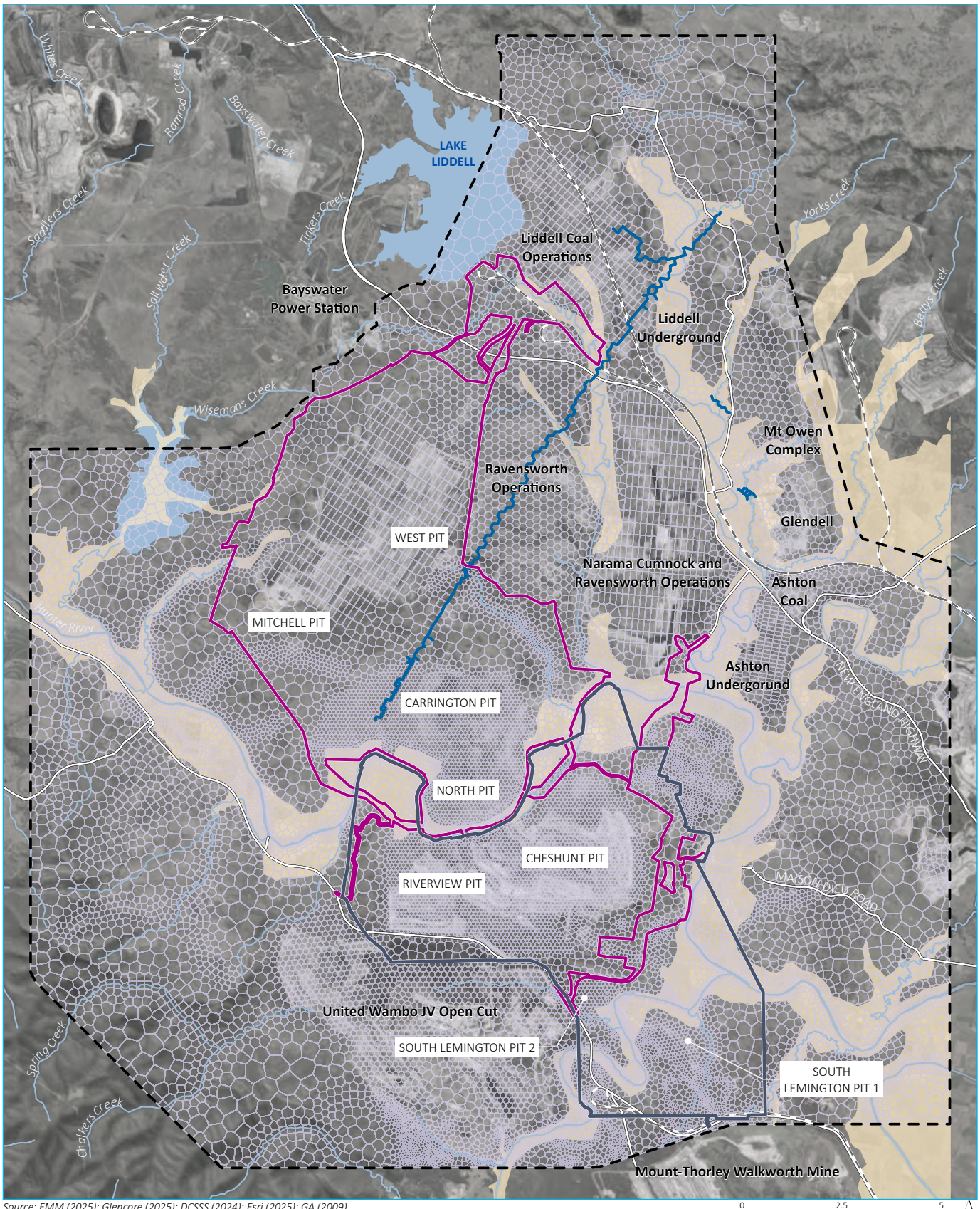
As discussed in Chapter 1, the HVO regional groundwater model was designed and history-matched in 2022, and reported as part of the EIS Project (EMM 2022, AGE 2022). That groundwater model has been updated to reflect the revised HVO mine plan (and updates to approved mines in the model domain since 2022). The model domain, geometry and design are largely the same as reported in AGE (2022). The following section provides a summary of model design aspects, with a focus on what has been updated in the recent modelling for the Amended Project.

Table 3.1 summarises the model design. Boundary conditions are summarised in Table 3.4.

Table 3.1 Summary of model design

Model design aspect	Description	Application for Amended Project
Software	MODFLOW-USG version 1.4.0 using unstructured 3D mesh generated using Algomesh (HydroAlgorithmics 2014).	No change from AGE (2022)
Model domain	Encompassing: • the HVO Complex • Liddell mining operations • Glendell mine • Ravensworth mining operations (open cut and underground) • Ashton mining operations (open cut and underground) • United and Wambo open cut mines.	No change from AGE (2022)
	Covering an extent of 23 km wide (west to east) and 28 km long (north to south) (Figure 3.1).	No change from AGE (2022)
Mesh	Discretised into 33 layers, each consisting of up to 22,577 cells with varying cell dimensions to reflect the spatial complexity of key features, with the greatest level of detail applied around the Project Area (AGE 2022). In total, the model is comprised of 415,385 cells. The following cell dimensions were applied (Figure 3.1): • Longwall mining areas: Rectangular cells ranging from 100 m × 200 m to 150 m × 300 m. • Open cut areas: A combination of polygonal cell shapes, including hexagonal Voronoi cells (100 m to 200 m in size) and rectangular cells ranging from 150 m × 200 m to 150 m × 300 m. • Streams and alluvial floodplains: Voronoi cells with dimensions varying from 50 m × 50 m to 200 m × 200 m. • Potential GDEs within alluvial floodplains: Finer-scale 50 m × 50 m Voronoi cells used to capture detailed hydrological processes.	No change from AGE (2022)
Layers	Table 3.2 presents the layers used to represent the key hydrostratigraphic units within the Quaternary and Permian formations, as identified in the conceptual model (Chapter 2).	No change from AGE (2022)

Model design aspect	Description	Application for Amended Project
Temporal discretisation	Stress periods from the AGE (2022) model were adopted, beginning with an initial steady state period to obtain pre-mining conditions, followed by a transient historical period simulating the progression of historical mining and groundwater-affecting activities. The transient simulation was designed with variable-length stress periods; longer intervals were applied at the beginning of the simulation where data were limited and less detail was required, while shorter intervals were adopted in more recent years to reflect the increased availability of monitoring data and the need for finer temporal resolution. The transient model stress period configuration is outlined in Table 3.3. All stress periods were discretised with MODFLOW-USG's Adaptive Time Stepping (ATS) function.	Minor revisions to reflect revised future mine plan and to adjust inconsistencies in representation of historical mining
	A separate post-mining recovery run was used to simulate pit lake recovery. The inputs/outputs of the recovery run were aligned with a surface water balance model used to simulate pit lake recovery predictions (Engeny 2025).	Minor revisions to reflect revised final landform
Hydraulic properties	Hydraulic properties including vertical and horizontal hydraulic conductivity, specific storage and specific yield were derived by AGE (2022) as part of model calibration for the EIS. Refer to Section D3 of AGE (2022) for discussion on the groundwater model calibration approach and results.	No change from AGE (2022)



Source: EMM (2025); Glencore (2025); DCSSS (2024); Esri (2025); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Model domain
- Mesh
- Alluvium extent
- Horizontal flow barrier

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Groundwater model domain and mesh

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 3.1

EMM creating opportunities

Table 3.2 Model layers

Geological age	Stratigraphic unit		Model layer
Quaternary	Shallow alluvium/regolith		1
	Deep alluvium		2
Permian (Wittingham Coal Measures)	Overburden		3
	Newcastle Coal Measures	Newcastle seam	4
	Jerrys Plain sub-group	Whybrow seam	4
		Interburden	5
		Wambo seam	6
		Interburden	7
		Whynot seam	8
		Interburden	9
		Blakefield, Glen Munro and Woodlands Hill seams	10
		Interburden	11
		Arrowfield seam	12
		Interburden	13
		Bowfield seam	14
		Interburden	15
		Warkworth seam	16
		Interburden	17
		Mt Arthur seam	18
		Interburden	19
		Piercefield, Vaux seams	20
		Interburden	21
		Broonie, Bayswater seam	22
	Vane sub-group	Interburden	23
		Interburden	24
		Lemington, Pikes Gully seams	25
		Interburden	26
		Interburden	27
		Arties, Liddell seams	28
		Interburden	29
		Barrett seam	30

Geological age	Stratigraphic unit		Model layer
		Interburden	31
		Hebden seam	32
	Saltwater Creek Formation		33

Table 3.3 Stress periods

Time period	Number of stress periods	Stress period length	Mode
Last day of 1969	1	n/a	Steady state
1970–1979	1	10 years	Transient
1980–1999	4	5 years	Transient
2000–2002	1	3 years	Transient
2003–2008	12	6 months	Transient
2009–2035	108	3 months	Transient
2036–2045	20	6 months	Transient
2045–2046	1	1 year	Transient
2047–2050	1	4 years	Transient
2051–2055	1	5 years	Transient
2056–2075	2	10 years	Transient
2076–2095	1	20 years	Transient
2096–2295	4	50 years	Transient
2296–2995	7	100 years	Transient
2996–3995	2	500 years	Transient

3.2 Boundary conditions

Boundary conditions were applied to simulate structural features, recharge and discharge mechanisms, and hydrologic features such as streams and lakes, and mining activities. Where appropriate, boundary conditions from the AGE (2022) model were kept unchanged for consistency and continuity with established conceptual and numerical approaches.

Table 3.4 below summarises the boundary conditions from the AGE (2022) model and applied in the current model.

Table 3.4 Summary of boundary conditions

Boundary condition	Description	Details in AGE (2022) report
Regional geological structures	• Features represented in model via Horizontal Flow Barrier (HFB) package in MODFLOW: Camberwell Anticline, Davis Creek Fault and adjacent unnamed dyke.	Chapter 4
General Head Boundary (GHB)	• MODFLOW's GHB package was applied at the north-eastern and southern boundaries to represent regional groundwater throughflow. • Model domain was designed by AGE (2022) to limit HVO-related drawdown (>1 m) from reaching model boundary and to prevent GHB boundary conditions from influencing predictions. • GHB boundary conditions act as a regional condition and in some areas include the influence of mining outside the model domain (e.g. Mt Owen or United Wambo). • Hydraulic heads and conductance values used for the GHB package were reused from AGE (2022) model.	Section D2.4.1 Section D2.5.3
Recharge and evapotranspiration	• Diffuse rainfall recharge represented via MODFLOW's Recharge (RCH) package using upstream weighting method and CONSTANTCV (no vadose zone simulation). • Consistent with AGE's (2022) soil moisture balance method based on historical rainfall data. • Recharge zones were defined according to surface geology and multipliers applied. • Evapotranspiration from the unsaturated zone is accounted for within recharge estimates and MODFLOW's Evapotranspiration (EVT) package was not used.	Section D2.5.1 Section D7
Watercourses	• Major waterways (such as the Hunter River, Bowmans Creek, Glennies Creek, and Wollombi Brook) were modelled with MODFLOW's Stream (STR) package. • Minor drainage features were represented with the River (RIV) package (configured to only allow groundwater discharge by assigning river stage equal to river bed elevation such that river boundary conditions behave as drains). • STR parameters (e.g. streambed levels, conductance, gauging data) same as the AGE (2022) model. • All river and stream boundary conditions were modelled in layer 1.	Section D2.5.4
Lakes and dams	• Lake Liddell, Plashett Reservoir and the Bayswater Power Station ash lake (north-western boundary of model) were represented with MODFLOW's Constant Head (CHD) package. • Static lake levels sourced from Feb 2020 LiDAR data and applied to layer 1.	Section D2.5.6

3.3 Project activities

3.3.1 Mining

The mining operations represented in the model were initially based on mine schedules from AGE (2022) and have been updated with data provided by HVO (and joint venture parties). The changes of hydraulic properties in model cells in response to mining (e.g. open cut voids, underground longwall goafing and spoil emplacement) were represented using a combination of MODFLOW's Drain (DRN) and Time-Variant Materials (TVM) packages, following the approach outlined in AGE (2022).

In the Project area and other open cut mining areas, drain boundary conditions were assigned to all model cells intersected by mining activities, with reference elevations aligned to the base of each cell down to the bottom of the target coal seam. The drains remained active for three years following mining operations before being deactivated. The gradual backfilling of open cut voids with spoil material was simulated by progressively updating the hydraulic properties (vertical and horizontal hydraulic conductivity, specific yield and specific storage) of the mined cells behind the active mining front after drain deactivation.

The mines represented as drains in the Approved and Proposed models are summarized in Table 3.5.

Figure 3.2 and Figure 3.3 show the footprint and timing of the deepest active drain elevation representing proposed mining between 2027 and 2045 (centred on HVO).

Consistent with AGE (2022), recharge was deactivated when drains representing mining were active. An enhanced recharge rate of 2.9 mm/yr (equivalent to 0.45% of average rainfall) was applied to spoil areas, aligning with recovery models from AGE (2022). Recharge was not applied in areas where mining voids were present.

Goafing and fracturing above underground longwall panels were simulated using a connected linear fracture network approach described by AGE (2017b) and applied in the AGE (2022) model. This method represents the fracture network using "stacked drains" with conductance values empirically derived based on the local intensity of fracturing within each model cell. In the post-closure model, the drain boundary conditions above longwall mines were removed and the hydraulic conductivity enhanced to represent the residual fracture network, ensuring equivalent mine inflows prior to the start of recovery (AGE 2017b).

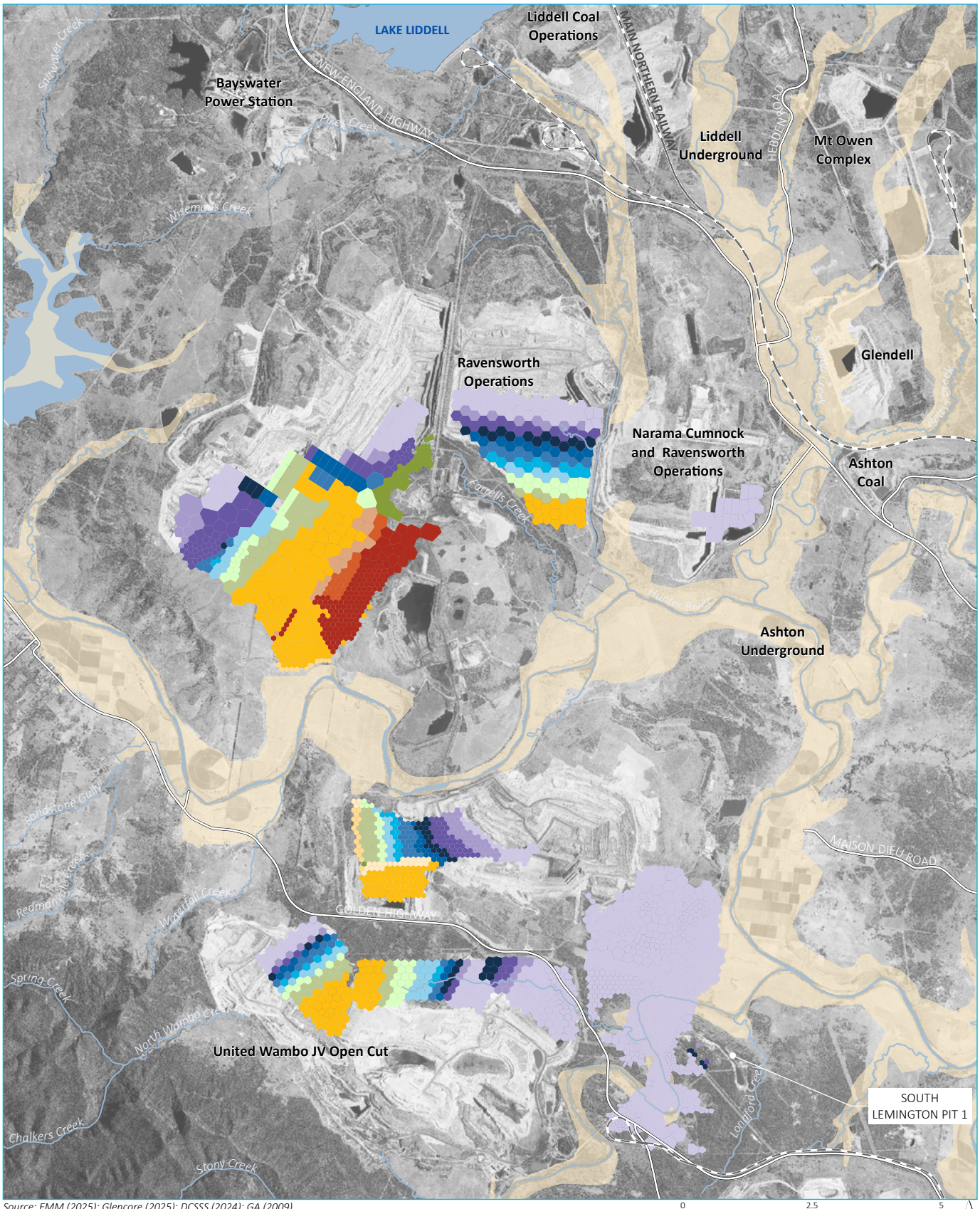
The simulation of bord and pillar areas and main/access underground roads was consistent with the AGE (2022) model, initially applying drain boundary conditions with a conductance of 100 m^2/d to lower heads to drain stages, and upon completion, converted to voids with high hydraulic conductivity (100 m/d) and storage properties (specific yield of 100%, specific storage of 5×10^{-6} 1/m).

Table 3.5 Mining progression – Approved and Proposed mining

Area	Mine	Basal seam(s)	Approved mine plan – years active	Proposed mine plan – years active
HVO North	West Pit/Mitchell Pit	Barrett	1979–2026	1979–2045
	Carrington West Wing Pit	Bayswater	2024–2026	2036–2039
HVO South	Cheshunt Pit/Riverview Pit	Bayswater	1997–2030	1997–2042
	Riverview South East Extension (RSEE)	Bayswater (Approved)| N/A (Proposed)	1997–2030	Removed mine from amended mine plan (consistent with the EIS Project).
	South Lemington Pit 1 (SLP 1)	Bowfield	1995–2000, 2026–2030	No future mining in amended mine plan (consistent with the EIS Project).
	South Lemington Pit 2 (SLP 2)	Vaux (Approved) | N/A (Proposed)	2024–2030	Removed mine from amended mine plan (consistent with the EIS Project).

Area	Mine	Basal seam(s)	Approved mine plan – years active	Proposed mine plan – years active
	Lemington Underground	Bowfield/Mt Arthur	1971–2036 Drain stage set to 30 mAHD aligned with Mt Thorley Warkworth existing approval (ends 2036).	Same as approved.
Glendell	Glendell Pit	Barrett	2008–2026	Same as approved.
Liddell Coal Operations	Liddell	Hebden	1990–2023	Same as approved.
Ravensworth Operations	Ravensworth Underground/Ashton integration	Pikes Gully/Liddell	2024–2030	Same as approved.
	Narama*	Bayswater	1991–1998	Same as approved.
	Ravensworth North*	Arties	Pre-1980–2013	Same as approved.
	Cumnock Open Cut*	Lemington	1949–2008	Same as approved.
	Cumnock Underground*	Barrett	1949–2008	Same as approved.
United – Wambo	Wambo Pit*	Whynot	1974–2017	Same as approved.
	Wambo Open Cut*	Mt Arthur	2017–2039	Same as approved.
	United Open Cut*	Vaux	2017–2039	Same as approved.

Notes: * Indicates no change from AGE (2022) model.



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

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N

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Alluvium extent

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

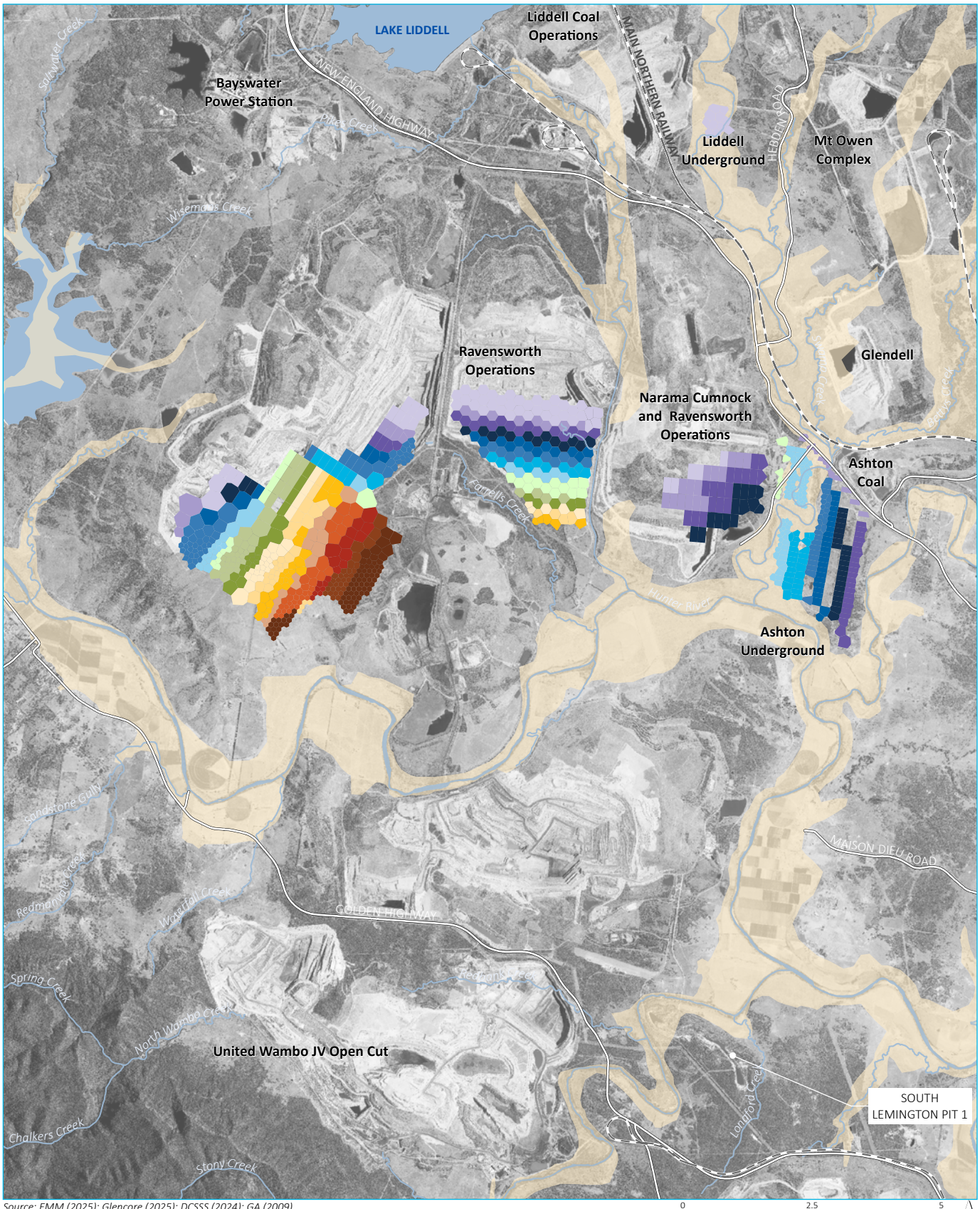
Mine progression

- 2027
- 2028
- 2029
- 2030
- 2031
- 2032
- 2033
- 2034
- 2035
- 2036
- 2037
- 2038
- 2039
- 2042
- 2043
- 2044
- 2045

Modelled HVO proposed mine progression from 2027 to 2045- from ground surface to base of Pikes Gully Seam

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 3.2

EMM creating opportunities



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Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Alluvium extent

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Mine progression

- 2027
- 2028
- 2029
- 2030
- 2031
- 2032
- 2033
- 2034
- 2035
- 2036
- 2037
- 2038
- 2039
- 2040
- 2041
- 2042
- 2043
- 2044
- 2045

Modelled HVO proposed mine progression from 2027 to 2045- from Liddell and Barrett Seams

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 3.3

EMM creating opportunities

Table 3.5 summarises the modelled tailings areas and in-pit water storages proposed for the Project (simulated using MODFLOW's General Head Boundary (GHB) package). The GHB package effectively simulates dynamic interactions between these features and the surrounding groundwater system. Stages used for the GHB package were derived from mine and tailings planning information provided by HVO.

Table 3.5 Proposed HVO tailings and in-pit storages

Type	Name	Active period	Description of modification(s)
In-pit TSFs	HVO North Void TSF	2004–2024	Same as existing approval; deactivated end of 2024.
	Carrington TSF	2020–2026	Same as existing approval; deactivated end of 2026. Stage increasing to 36 mAHD.
	Cumnock TSF	2013–2027	Same as existing approval; deactivated end of 2027.
	West Pit TSF	2025–2039	Specific to the Project; deactivated end of 2039.
In-pit storages	SLP 1	2003–2040	Active to 2040. Stage set to 49 mAHD.
	Riverview void	2014–2028	Stage linearly decreasing from 50 to 30 mAHD.

3.3.2 Low permeability barrier walls

Two LPBWs have been constructed across the Quaternary alluvium at HVO North (south of Carrington Pit, across the eastern limb of the paleochannel and around the Alluvial Lands pit) (see Figure 1.2) to limit drawdown effects in the alluvium and potential for leakage from the Hunter River.

The HVO North development consent requires the construction of a LPBW in the Carrington West Wing area within the western arm of the paleochannel, and prior to undertaking mining within 100 m of the western arm of the paleochannel. The location and design of the Carrington West Wing LPBW is consistent with the existing approved location and will be designed to meet the existing development consent specifications of a permeability of 1 x 10^{-8} metres per second (m/s). The LPBW will be constructed one year before the commencement of mining in the remnant paleochannel. For modelling purposes, the LPBW was activated in January 2034.

The LPBWs are represented in the model using TVM, with assigned low horizontal and vertical hydraulic conductivity values (consistent with AGE (2022).

3.3.3 Post-mining recovery

Consistent with the modelling completed for the EIS Project, a separate transient model run was used to simulate recovery of the groundwater system after cessation of mining operations at HVO. At the completion of mining, any remaining drain boundary conditions were deactivated, and the model was modified to reflect proposed post-mining conditions.

Within the model extent, residual voids remain in HVO North and South, Liddell Entrance Pit and South Cut, Ravensworth, Glendell, and United Wambo mines.

As outlined in Section 1.2, the Project involves amending the proposed final voids at HVO North from three voids to two voids (HVO North main void and Carrington void). The final void at HVO South is largely consistent with the current approval. Table 3.6 and Table 3.7 summarise the modelled final voids for the Approved and Proposed Project scenarios.

Final void pit lakes are represented using MODFLOW's Constant Head Boundary (CHD). Non-HVO pit lakes are consistent with AGE (2022), excluding Glendell pit which has been updated to reflect current approval (Umwelt 2007) rather than the Glendell Continued Operations Project. The final voids at HVO North and HVO South gradually fill with water over time, forming void lakes within the rehabilitated final landform.

The equilibrium pit lake water levels are calculated by the balance of inputs (direct rainfall, runoff from the catchments, groundwater inflow through spoils and through undisturbed geological units) and outputs (evaporation from void lake surfaces) predicted by Engeny (2025) as part of pit lake recovery water balance modelling for the Project.

The final void water level recovery at HVO was calculated through an iterative process:

1. A preliminary groundwater model was run with void hydraulic properties and no surficial fluxes. HVO voids were represented directly in MODFLOW's Layer Property Flow (LPF) package with high horizontal and vertical hydraulic conductivity (1,000 m/d) and storage parameters (specific yield of 1.0, storage coefficient of 5.0 x 10^{-6}) to simulate unrestricted water movement towards the voids.

2. This model generated a relationship between groundwater inflows and pit lake water level.

3. This relationship was used in the pit lake water balance model, incorporating pit geometry and surficial fluxes, to predict pit lake water levels over time (Figure 3.4; Engeny 2025).

4. The resultant pit lake recovery curves were incorporated back into the groundwater model to allow predictions of long-term drawdown and changes in surface water-groundwater interaction.

This approach aligns with the recovery modelling undertaken by AGE (2022) and aids consistency between surface water and groundwater modelling.

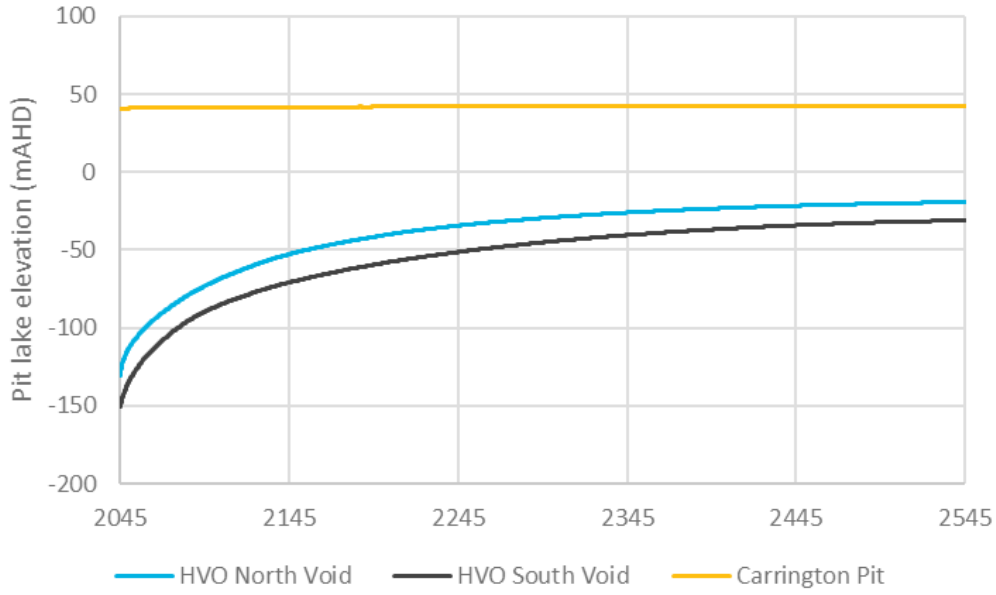


Figure 3.4 Proposed Project HVO final void pit lake elevations (Engeny 2025)

Table 3.6 Approved Project HVO final void pit lakes

Area	Void	Pit lake elevation
HVO North*	Carrington Void	40 mAHD
	West Pit North Void	-30 mAHD from 2046 to 2145, then increases linearly to 40 mAHD to 2245
	West Pit South Void	
HVO South	South Void	Consistent with AGE (2022) recovery model; starting at -81.6 mAHD (2046) and increasing to 30 mAHD (by 2496)

Notes: * HVO North voids were updated in the Approved Project scenario to reflect the current approval (corrections to the AGE (2022) model).

Table 3.7 Proposed Project HVO final void pit lakes

Area	Void	Long-term pit lake elevation (Engeny 2025)
HVO North	Carrington Void	42 mAHD (14 m freeboard)
	North Void	-18 mAHD (100 m freeboard)
HVO South	South Void	-30 mAHD (110 m freeboard)

4 Predictive modelling

4.1 Scenario definition

The model was used to predict incremental and cumulative changes to the groundwater regime due to the Amended Project by comparing outcomes from the approved (existing consents) and proposed (the Amended Project) mine plans. Current approved and proposed mine plans within the region were included to account for cumulative impacts. The following model scenarios were run:

Predictive model scenarios were developed to calculate incremental (Project-induced) and cumulative effects:

1. "Baseline" – approved operations within the region and mining does not continue beyond 2009 (discussed below), providing a 'null' model for assessment of cumulative effects.

2. "Approved" – currently approved operations at HVO North and HVO South and approved and foreseeable operations within the region.

3. "Proposed" – approved and foreseeable operations as well as the proposed mine plans associated with the Amended Project.

Climate stresses are consistent between the scenarios.

To meet the requirements of the NSW *Aquifer Interference Policy*, the predicted cumulative drawdown was calculated by comparing the results of the Proposed project scenario (i.e. the Amended Project) to the "baseline" scenario where simulated mining ceases after 2009 (which is when the Hunter Unregulated and Alluvial water sharing plan commenced), effectively allowing the groundwater system to recover in this baseline 2009 scenario. Comparison to this '2009' baseline scenario is therefore conservative and results in exaggerated predictions of alluvial drawdown and changes in surface water-groundwater interaction due to the approved and proposed mining. This is consistent with the AGE (2022) modelling approach and represents a limitation in the groundwater modelling and the requirements of the *Aquifer Interference Policy* to estimate cumulative drawdown effects "post-water sharing plan".

Modelled representation of mining is described in Section 3.3.

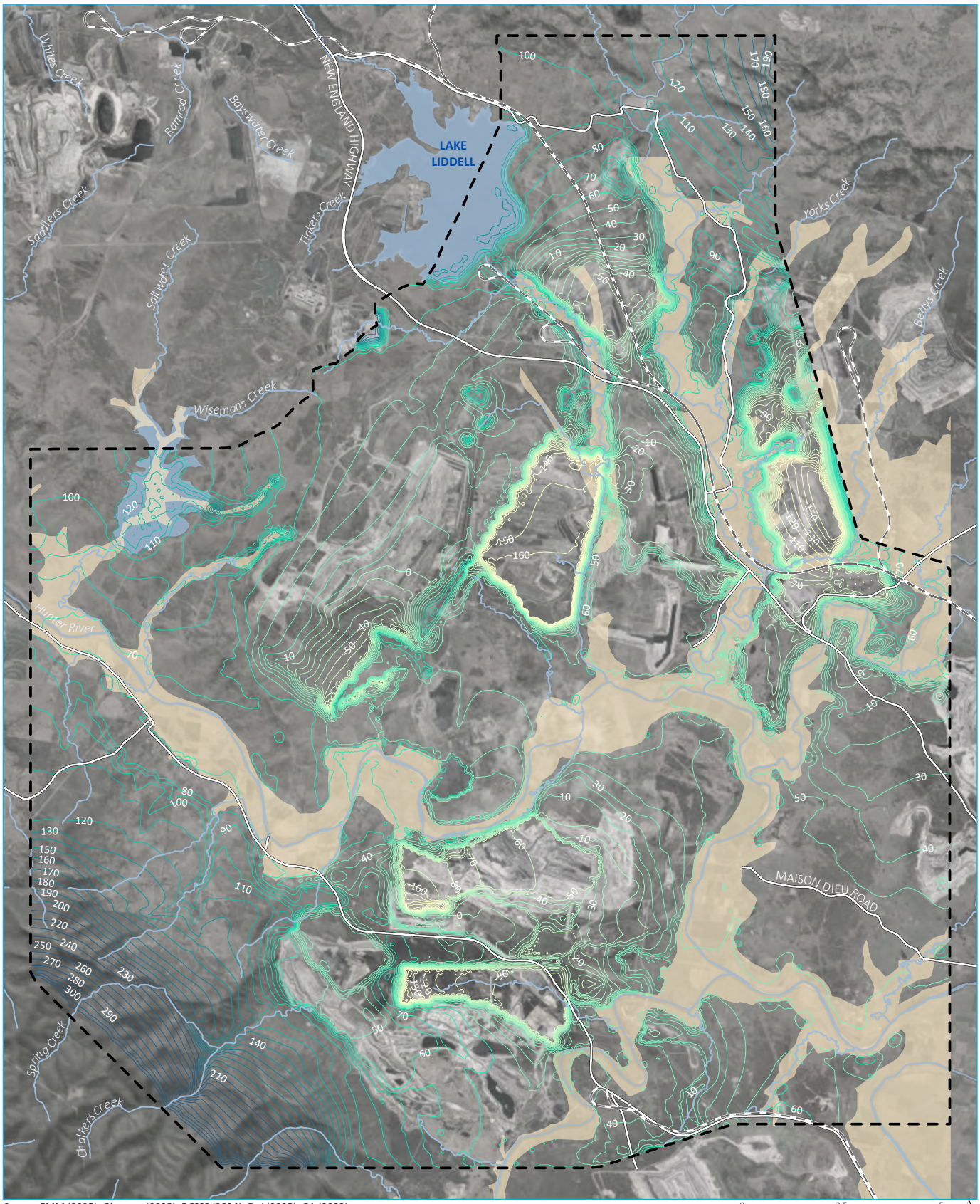
For each scenario, separate simulations were conducted for the operational period and for post-mining recovery. The recovery simulations were run for 1,950 years, the same as the AGE (2022) recovery modelling, to allow groundwater levels in the backfilled spoil, pit lake areas, unmined coal seams, and the overlying water-bearing strata to recover to a long-term post-mining equilibrium.

4.2 Results

4.2.1 During operations

i Watertable elevation

The modelled watertable elevation at the start of 2046, immediately following end of operations, is presented in Figure 4.1. The figure shows areas where the watertable is depressed at the end of operations, particularly in and around active mining areas such as HVO North, HVO South, and the United-Wambo area. Decreased hydraulic head elevations result in steeper local gradients and expanded influence of mine-related depressurisation, while the overall regional flow direction remains towards the south-east. These changes reflect the cumulative effect of mining activities over the life of the Project.



Source: EMM (2025); Glencore (2025); DCSSS (2024); Esri (2025); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Model extent
- Alluvium extent

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Watertable elevation (m AHD)

- < -100
- -100 to-50
- -50 to 0
- 0 to 50
- 50 to 75
- 75 to 100
- 100 to 125
- 125 to 150
- 150 to 200
- > 200

Predicted watertable- 2046 (end of operations)

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 4.1

EMM creating opportunities

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ii Mine inflows

Table 4.1 presents the predicted groundwater inflow to active HVO mining areas (represented as drain boundary conditions) for the Amended Project, and represents the water directly drained and excavated in the material from the rock formation – primarily the Permian coal measures. The table lists the volume of groundwater intercepted under the Approved Operations and Amended Project (i.e. proposed).

The groundwater model assumes the Amended Project activities begin in 2027 (Year 1) and the Approved Operations will have ceased at HVO South by the end of 2030 and at HVO North by the end of 2026 (drains conservatively remain active for three years after mining).

The predicted annual groundwater inflow volume for the Amended Project is predicted to peak in Year 13 at 2,488 ML. Note that evaluation of water licensing requirements is presented in and discussed in the overarching Water Assessment report.

Modelled predictions of inflows to mine workings are broadly consistent with the EIS Project (AGE 2022), with some variability owing to the updated numerical representation of mine progression and changes to the annual pit progression including size and timing of open areas and proximity to the Hunter River alluvium (noting hydraulic properties are the same as those adopted for the EIS modelling (AGE 2022).

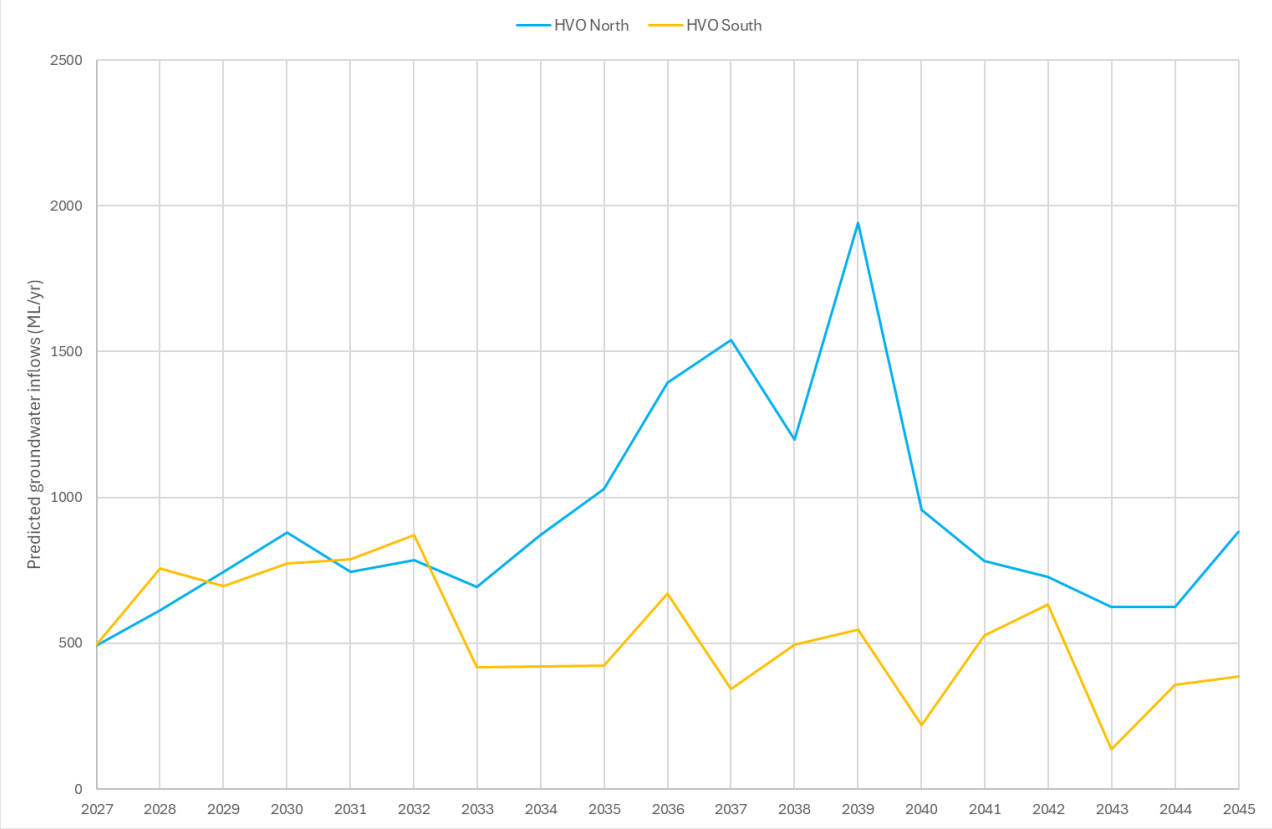


Figure 4.2 Predicted mine inflow during proposed operations

Table 4.1 Simulated mine inflow during operations

Year		HVO North		HVO South		Lemington Underground		SLP 1	SLP 2	Total	
Mining year	Calendar year	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Approved (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)
1	2027	610	492	2,498	494	148	142	134	210	3,600	1,128
2	2028	483	612	2,395	757	141	129	60	198	3,277	1,498
3	2029	501	744	1,833	695	139	101	56	56	2,585	1,540
4	2030	0	881	806	774	139	103	14	0	959	1,758
5	2031	0	744	262	788	96	101	0	0	358	1,633
6	2032	0	786	312	870	97	100	0	0	409	1,756
7	2033	0	693	656	419	97	99	0	0	753	1,211
8	2034	0	871	0	422	96	98	0	0	96	1,391
9	2035	0	1,028	0	423	96	98	0	0	96	1,549
10	2036	0	1,394	0	671	51	53	0	0	51	2,118
11	2037	0	1,540	0	343	0	0	0	0	0	1,883
12	2038	0	1,199	0	496	0	0	0	0	0	1,695
13	2039	0	1,942	0	546	0	0	0	0	0	2,488
14	2040	0	956	0	221	0	0	0	0	0	1,177
15	2041	0	781	0	528	0	0	0	0	0	1,309
16	2042	0	727	0	634	0	0	0	0	0	1,361
17	2043	0	624	0	135	0	0	0	0	0	759
18	2044	0	624	0	358	0	0	0	0	0	982

Year		HVO North		HVO South		Lemington Underground		SLP 1	SLP 2	Total	
Mining year	Calendar year	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)	Approved (ML/yr)	Approved (ML/yr)	Approved (ML/yr)	Proposed (ML/yr)
19	2045	0	884	0	385	0	0	0	0	0	1,269

iii Changes in surface water-groundwater interaction

The model was used to predict potential changes to surface water-groundwater interaction in the form of changes in baseflow (groundwater discharge to watercourses) and river leakage (leakage of surface water to groundwater). The predictions were used to inform the streamflow impact assessment being conducted by Engeny (2025). Note that evaluation of water licensing requirements is presented and discussed in the overarching Water Assessment report.

The predicted incremental change in river leakage and baseflow is presented in Table 4.2 . The incremental change reflects the difference between the Proposed and Approved scenarios.

A positive value in the change in baseflow indicates a reduction in groundwater discharge to the watercourse, meaning the Amended Project is predicted to result in less groundwater discharge to the watercourse than the Approved Project (i.e. negative impact). Positive change in leakage indicates an increase in leakage from the watercourse to groundwater (i.e. loss of water from the watercourse), meaning the Amended Project is predicted to result in greater leakage from the watercourse to groundwater compared to the Approved Project (i.e. negative impact on streamflow).

As per modelled inflows to mine workings, the predicted changes in surface water-groundwater interaction are broadly consistent with the EIS Project (AGE 2022), with some minor variations owing to the updated mine plan representation.

Table 4.2 Predicted incremental change in surface water-groundwater interaction

Year		Bayswater Creek		Bowmans Creek		Glennies Creek		Hobden Gully		Farrells Creek		Parnells Creek		Pikes Creek	
Mining Year	Cal	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)
1	2027	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2028	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2029	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2030	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
5	2031	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
6	2032	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
7	2033	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
8	2034	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
9	2035	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
10	2036	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
11	2037	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
12	2038	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
13	2039	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
14	2040	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
15	2041	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
16	2042	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
17	2043	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
18	2044	0	0	0	0	0	0	0	0	0	0	-1	0	0	0

Year		Bayswater Creek		Bowmans Creek		Glennies Creek		Hobden Gully		Farrells Creek		Parnells Creek		Pikes Creek	
Mining Year	Cal	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)
19	2045	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
20	2046	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
21	2047	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
22	2048	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
23	2049	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
24	2050	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
25	2051	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
26	2052	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0
30	2056	-1	0	-2	0	0	0	0	0	0	0	0	0	0	0
35	2061	-1	0	-2	0	0	0	0	0	0	0	0	0	0	0
45	2071	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
55	2081	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
75	2101	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
125	2151	-1	0	0	0	0	0	0	0	0	0	1	0	0	0

Table 4.3 Predicted incremental change in surface water-groundwater interaction (cont.)

Year		Redmanvale Creek		UN3		UN5		Wollombi Brook		Saltwater Creek		Hunter River to Maison D		Maison D to Wollombi	
Mining Year	Cal	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)
1	2027	0	0	0	0	0	0	-15	-3	0	0	-81	-39	0	0
2	2028	0	0	0	0	0	0	-18	-3	0	0	-83	-41	0	0
3	2029	0	0	0	0	0	0	-20	-4	0	0	-84	-41	0	0
4	2030	0	0	0	0	0	0	-20	-4	0	0	-88	-43	0	0
5	2031	0	0	0	0	0	0	-20	-5	0	0	-85	-43	0	0
6	2032	0	0	0	0	0	0	-20	-5	0	0	-80	-42	0	0
7	2033	0	0	0	0	0	0	-19	-5	0	0	-76	-40	0	0
8	2034	0	0	0	0	0	0	-20	-4	0	0	-56	-26	0	0
9	2035	0	0	0	0	0	0	-19	-4	0	0	-28	-9	0	0
10	2036	0	0	0	0	0	0	-19	-4	0	0	-24	-8	0	0
11	2037	0	0	0	0	0	0	-18	-4	0	0	-20	-6	0	0
12	2038	0	0	0	0	0	0	-18	-4	0	0	-14	-4	0	0
13	2039	0	0	0	0	0	0	-18	-4	0	0	-6	-1	0	0
14	2040	0	0	0	0	0	0	-17	-4	0	0	2	1	0	0
15	2041	0	0	0	0	0	0	-16	-4	0	0	8	4	0	0
16	2042	0	0	0	0	0	0	-16	-4	0	0	11	5	0	0
17	2043	0	0	0	0	0	0	-16	-4	0	0	14	6	0	0
18	2044	0	0	0	0	0	0	-16	-4	0	0	14	7	0	-1

Year		Redmanvale Creek		UN3		UN5		Wollombi Brook		Saltwater Creek		Hunter River to Maison D		Maison D to Wollombi	
Mining Year	Cal	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)	Baseflow (ML/yr)	Leakage (ML/yr)
19	2045	0	0	0	0	0	0	-16	-4	0	0	15	7	0	-1
20	2046	0	0	0	0	0	0	-11	-2	0	0	12	3	0	0
21	2047	0	0	0	0	0	0	-8	-1	0	0	8	1	0	0
22	2048	0	0	0	0	0	0	-8	-1	0	0	8	1	0	0
23	2049	0	0	0	0	0	0	-8	-1	0	0	8	1	0	0
24	2050	0	0	0	0	0	0	-8	-1	0	0	8	1	0	0
25	2051	0	0	0	0	0	0	-8	-1	0	0	5	1	0	0
26	2052	0	0	0	0	0	0	-8	-1	0	0	5	1	0	0
30	2056	0	0	0	0	0	0	-7	-1	0	0	5	1	0	0
35	2061	0	0	0	0	0	0	-7	-1	0	0	5	1	0	0
45	2071	0	0	0	0	0	0	-6	0	0	0	8	2	0	0
55	2081	0	0	0	0	0	0	-4	0	0	0	11	3	0	0
75	2101	0	0	0	0	0	0	-5	0	0	0	17	5	0	0
125	2151	0	0	0	0	0	0	-6	0	0	0	29	9	0	0

iv Alluvium drawdown during operations

'Drawdown' refers to a decrease in hydraulic head within an aquifer caused by the removal of groundwater. Common activities that can lead to drawdown include groundwater extraction through water supply bores, transpiration from vegetation, and dewatering associated with open cut or underground mining. In an unconfined aquifer, this lowering of the watertable is referred to as drawdown. However, in a confined aquifer – such as a coal seam – where the aquifer remains saturated, a drop in water pressure is referred to as depressurisation.

a Incremental drawdown

Figure 4.3 presents the maximum predicted incremental alluvial watertable drawdown during operations in the Hunter River alluvium. It shows there is negligible drawdown predicted in the Carrington West Wing alluvial area when the LPBW is installed prior to mining within 100 m of the remnant paleochannel, as per the HVO North consent. The results show the approved but not yet constructed LPBW is predicted to be an effective impact avoidance measure.

The groundwater model predicts minor additional drawdown near the Carrington Billabong (between 0.2 and 0.5 m; Figure 4.3). The cause of the drawdown relates to deeper mining in the HVO North main pit (mining down to the Barrett seam), compared to what is historical approved mining. The small area of drawdown is mainly due to an increased downward vertical gradient between the alluvial watertable and the Permian potentiometric surface.

There is no incremental drawdown predicted in the Wollombi Brook alluvium, given mining is no longer proposed at SLP 1 or SLP 2 (i.e. the Project is predicted to have a positive impact in this area compared to the Approved Project).

There are no third-party water supply bores within the predicted extent of drawdown. Therefore, no third-party bores are predicted to be impacted by the Project.

The extent of the predicted incremental drawdown in the Hunter River alluvium is less than that predicted for the EIS Project. This is due to the changes to the mine plan and the HVO North pit depth being shallower than, and ceasing further from the Hunter River in the Carrington area than, that proposed in the EIS Project.

b Cumulative drawdown

Figure 4.4 and Figure 4.5 show the maximum cumulative drawdown predicted to occur within the Hunter River alluvium and the Wollombi Brook alluvium over the operational life of the Amended Project (i.e. until 2045). The figures show the maximum drawdown predicted to occur due to the cumulative effect of historical approved and proposed mining at the HVO Complex and at other mining operations in the model domain.

The cumulative maximum drawdown predicted in the Hunter River alluvium (up to 0.5 m during operations) is due to depressurisation of the Permian hydrostratigraphy and an associated downward vertical gradient between the alluvial watertable and the Permian potentiometric surface. The depressurisation is related to mining at HVO North and HVO South.

The extent and magnitude of the predicted cumulative drawdown in the Hunter River alluvium is less than that predicted for the EIS Project. As discussed above, this is due to the changes to the mine plan and the HVO North pit depth being shallower than and ceasing further from the Hunter River in the Carrington area than that proposed in the EIS Project.

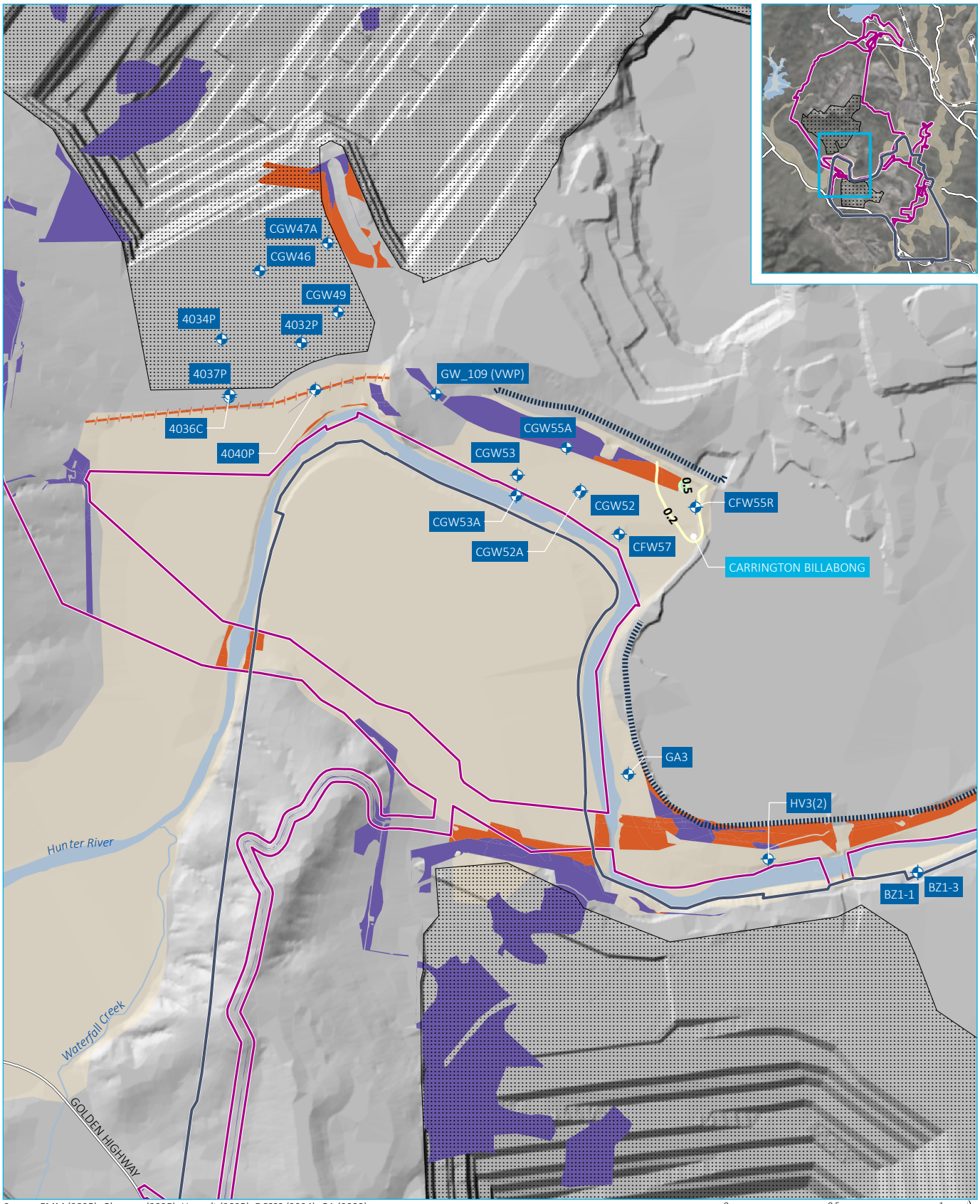
In the Wollombi Brook alluvium, a maximum cumulative drawdown of up to 2 m is predicted in the area above the historical Lemington underground mine (Figure 4.5). Drawdown is predicted due to the simulated continued use of Lemington underground as a water storage for operational water use for the United Wambo mining operation. This is predicted to result in lower groundwater levels compared to the "baseline" scenario, where mining stresses were deactivated after 2009, and heads allowed to recover.

The coal seams intersected by Lemington underground mine subcrop under parts of the Wollombi Brook creating minor cumulative drawdown slightly further downstream towards the confluence with the Hunter River. The drawdown is a cumulative impact and not due to the Amended Project.

The predicted cumulative drawdown in the Wollombi Brook area is consistent with the predictions derived for the EIS Project.

v Alluvial aquifer saturation thickness

Figure 4.6 presents the predicted change in the saturated thickness within the alluvial aquifer over the operational life of the Amended Project. The extent of the saturated areas remains largely unchanged over time and areas with potential GDEs are not predicted to be dewatered over the Project life, consistent with predictions for the EIS Project.



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km
GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

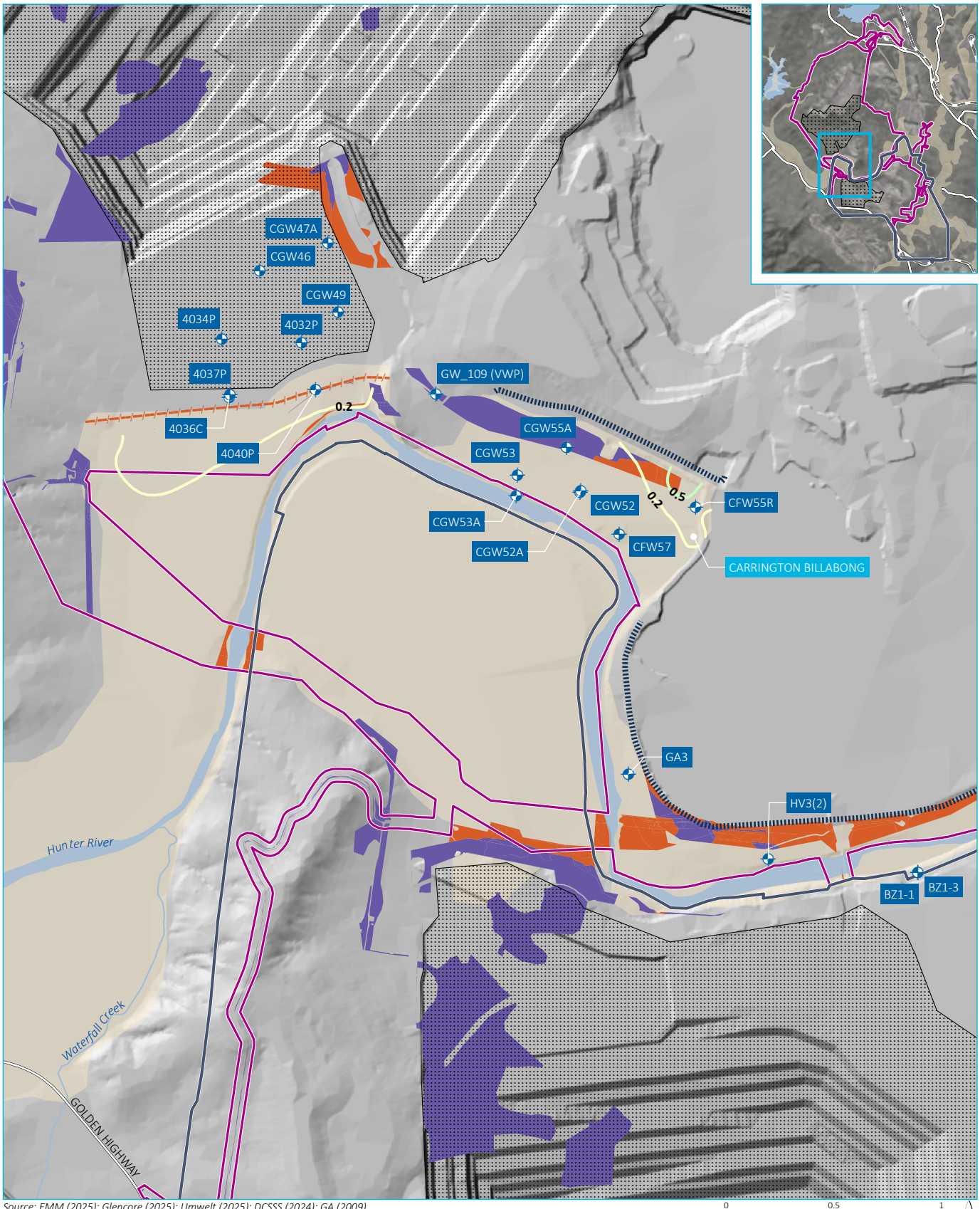
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted incremental drawdown during operations in the Hunter River alluvium

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Groundwater Modelling Report
Figure 4.3

EMM creating opportunities



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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

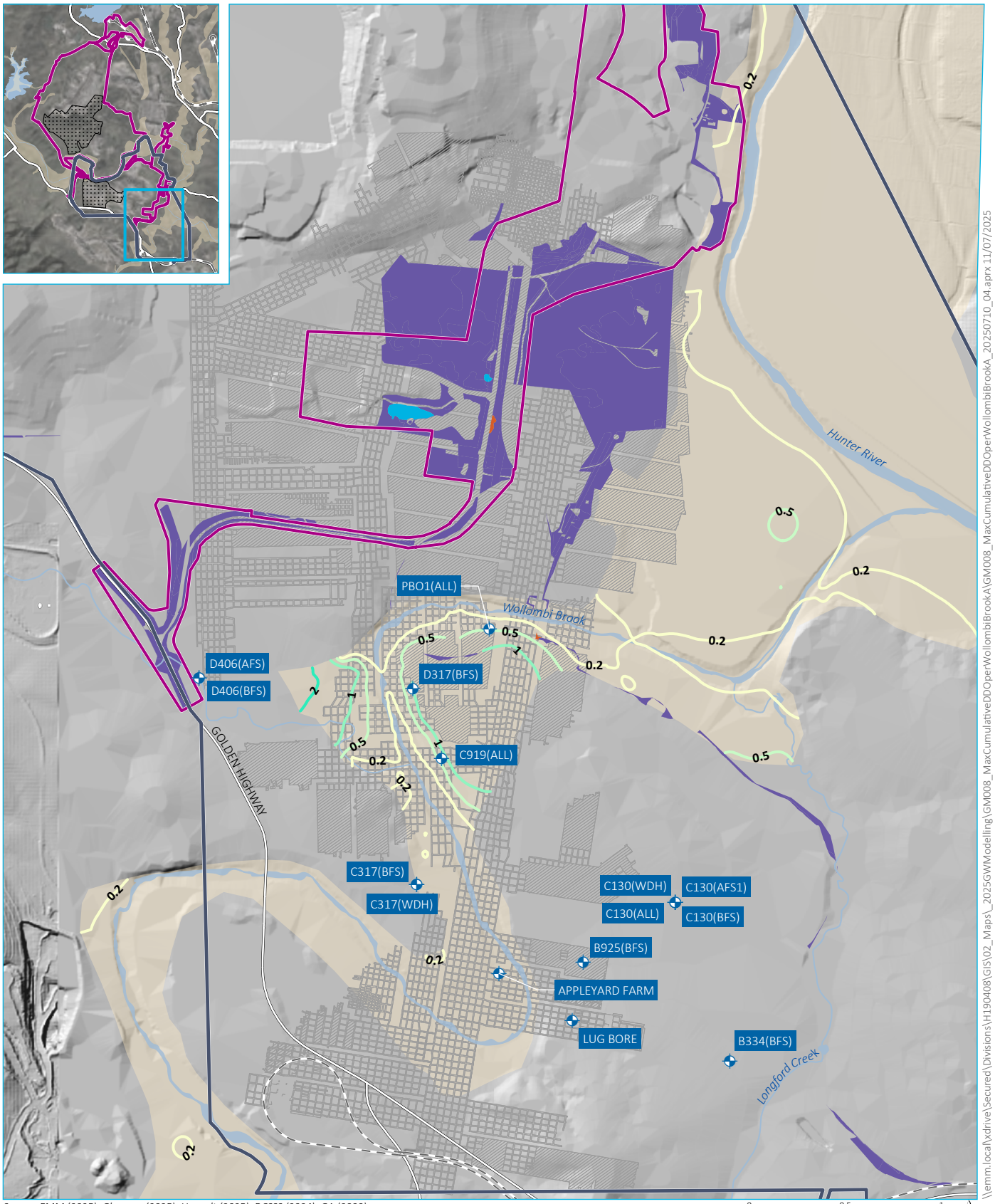
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown during operations in the Hunter River alluvium

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Groundwater Modelling Report
Figure 4.4

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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Lemington underground mine plan
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

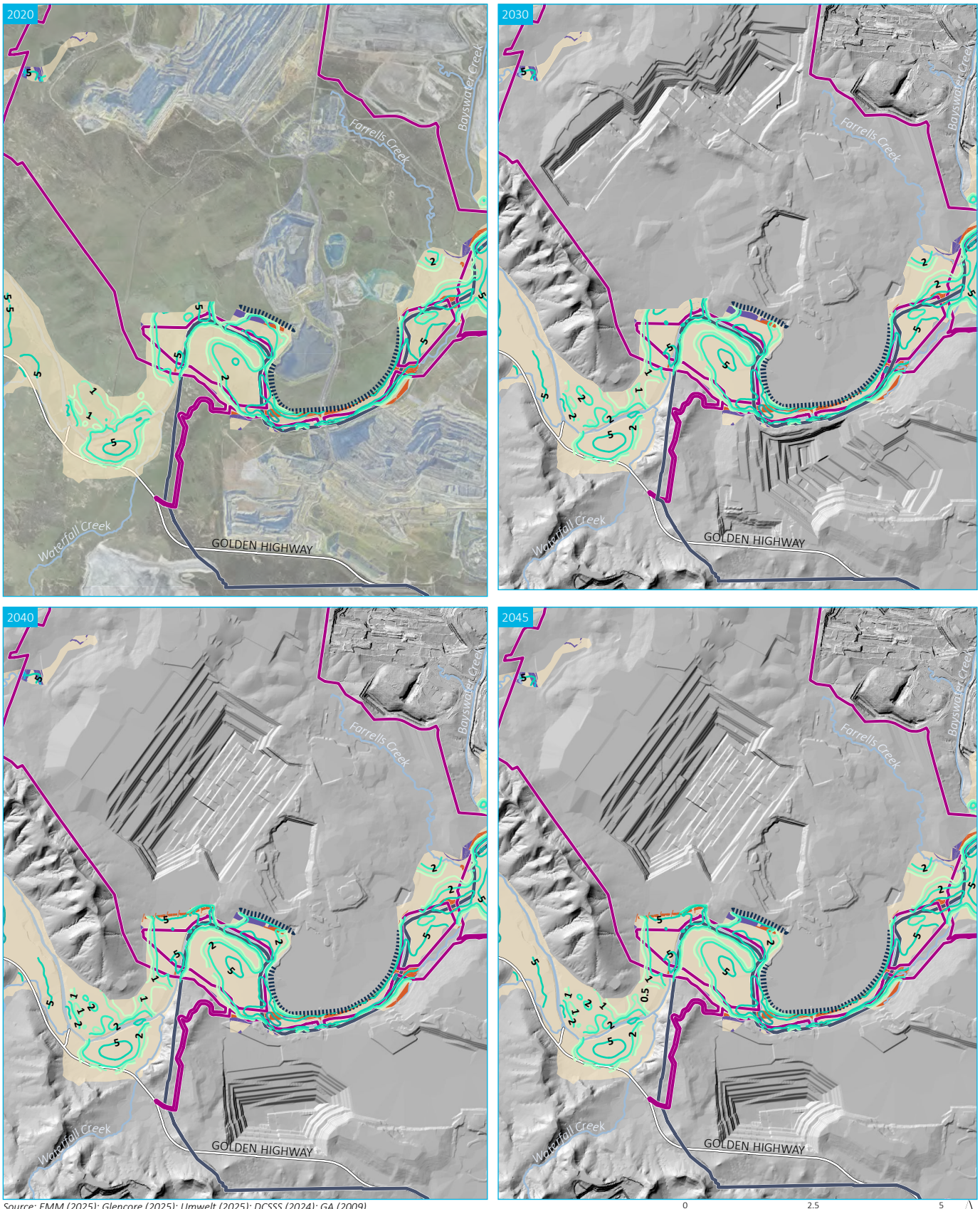
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown during operations in the Wollombi Brook alluvium

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Groundwater Modelling Report
Figure 4.5

EMM creating opportunities



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Existing low permeability barrier wall
- Carrington West Wing LPBW
- Alluvium extent

Saturated thickness (m)

- 0.5
- 1
- 2
- 5
- 10

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

- Major road
- Named watercourse
- Named waterbody

Predicted alluvial aquifer saturation thickness contours during operations

HVO Continuation Project - Amendment
Groundwater Modelling Report
Figure 4.6

EMM creating opportunities

vi Water balance

Figure 4.7 shows the water balance in megalitres per year over time for the Amended Project (Proposed scenario).

The predicted water balance for the Proposed scenario shows mining-related effects on groundwater fluxes, primarily through significant drainage (dewatering) during peak operations. This is most evident in the increased discharge via the drain boundary conditions during the operational period. This loss is compensated for mostly by water extracted from storage. The system begins to recover and stabilise post-mining (around 2045). The long-term effect includes lower groundwater storage and sustained changes in flux dynamics, though these effects diminish as the system recovers.

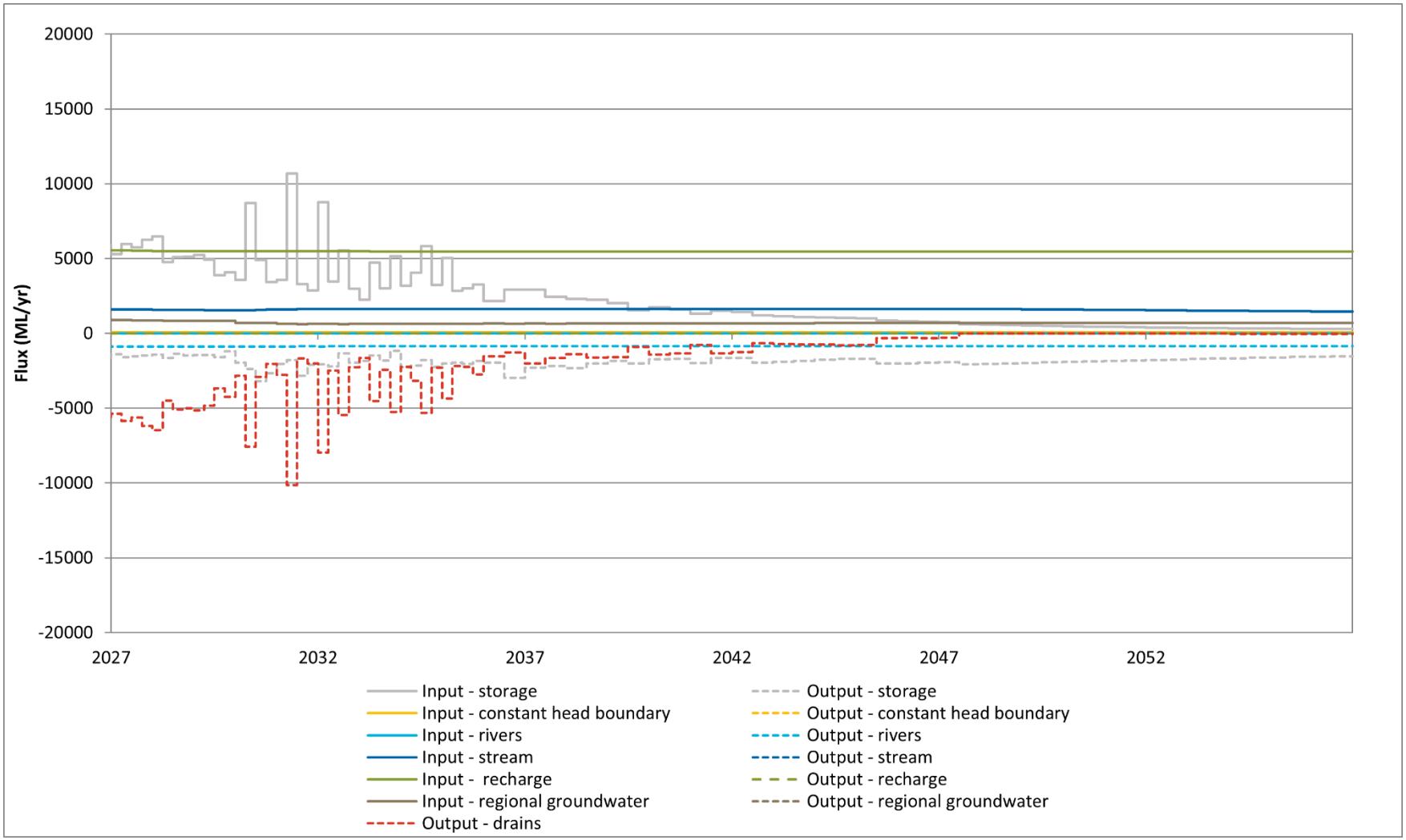


Figure 4.7 Predicted water balance for Proposed scenario during operations

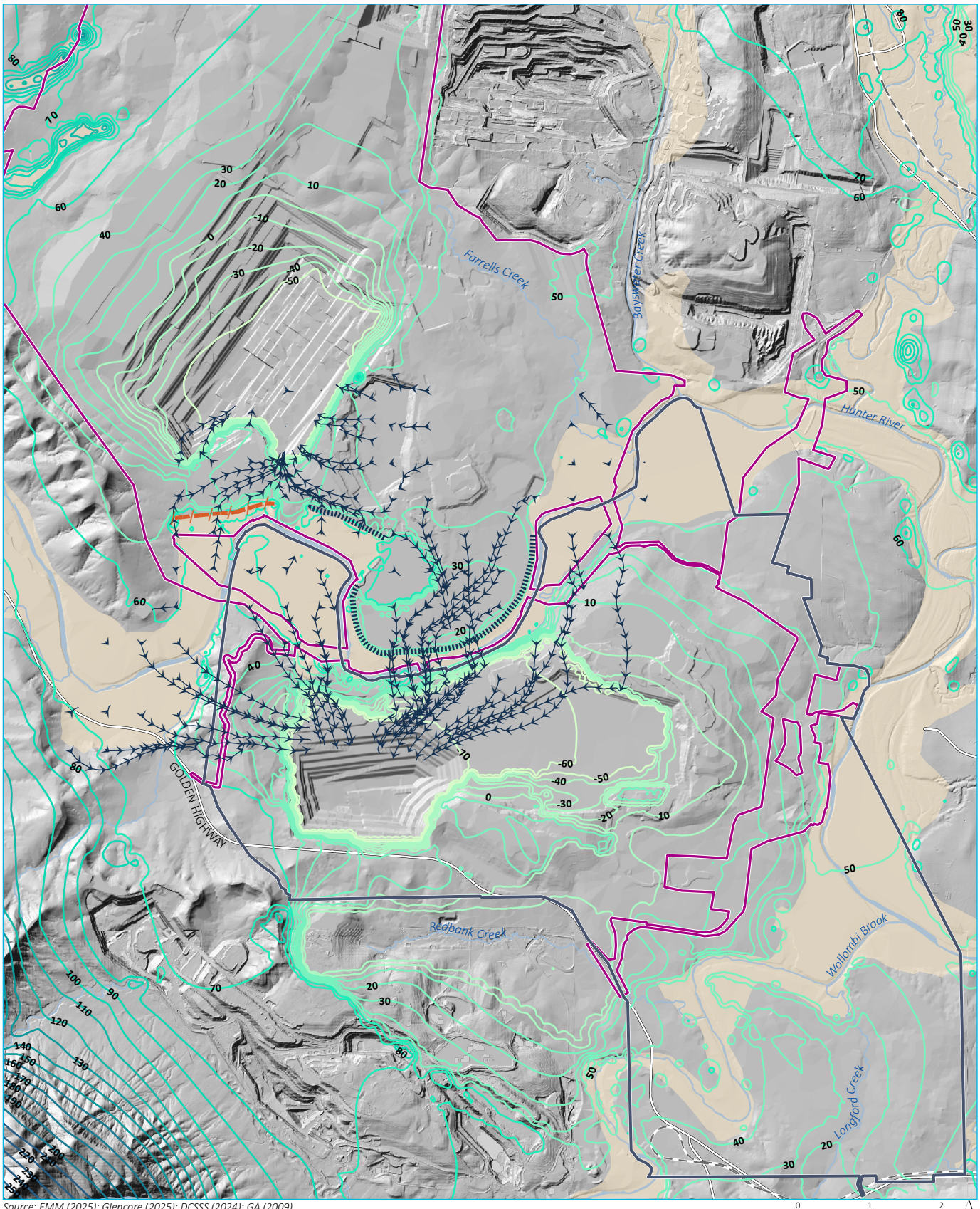
4.2.2 Post-closure

i Changes in groundwater flow post-mining

It is assumed no active water management from the open cut pits occurs post-mining, therefore no consumptive take is modelled. However, as groundwater elevations equilibrate, groundwater fluxes and elevations in the Permian and alluvial groundwater systems are expected to change, with the HVO voids acting as regional evaporative sinks.

Consistent with the EIS, the potential for seepage to migrate from backfilled mine areas (such as in the Carrington West Wing area) has been assessed using the groundwater model. The predicted long-term watertable elevation (at 100 years after mining ceases at HVO) and groundwater flow direction (shown as particle tracking, predicted over the full 2,000 year post-mining period) is presented on Figure 4.8. The figure illustrates the final voids at HVO North and HVO South are predicted to act as sinks, with groundwater flow directed inward from the surrounding spoil towards the lakes, rather than outwards. This outcome is expected, given that pit lake levels are predicted to remain significantly lower than the surrounding groundwater levels in the adjacent rock mass. There is therefore a low potential for a shallow watertable to form within in-pit spoils and migrate to the Hunter River alluvial aquifer.

This is consistent with the predictions from the EIS Project (AGE 2022).



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Particle tracking result
- Alluvium extent

2150 Predicted watertable elevation (mAHD)

- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 75
- 75 to 100
- 100 to 125
- 125 to 150
- 150 to 200
- > 200

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Post-mining watertable and groundwater flow direction (particle tracking)

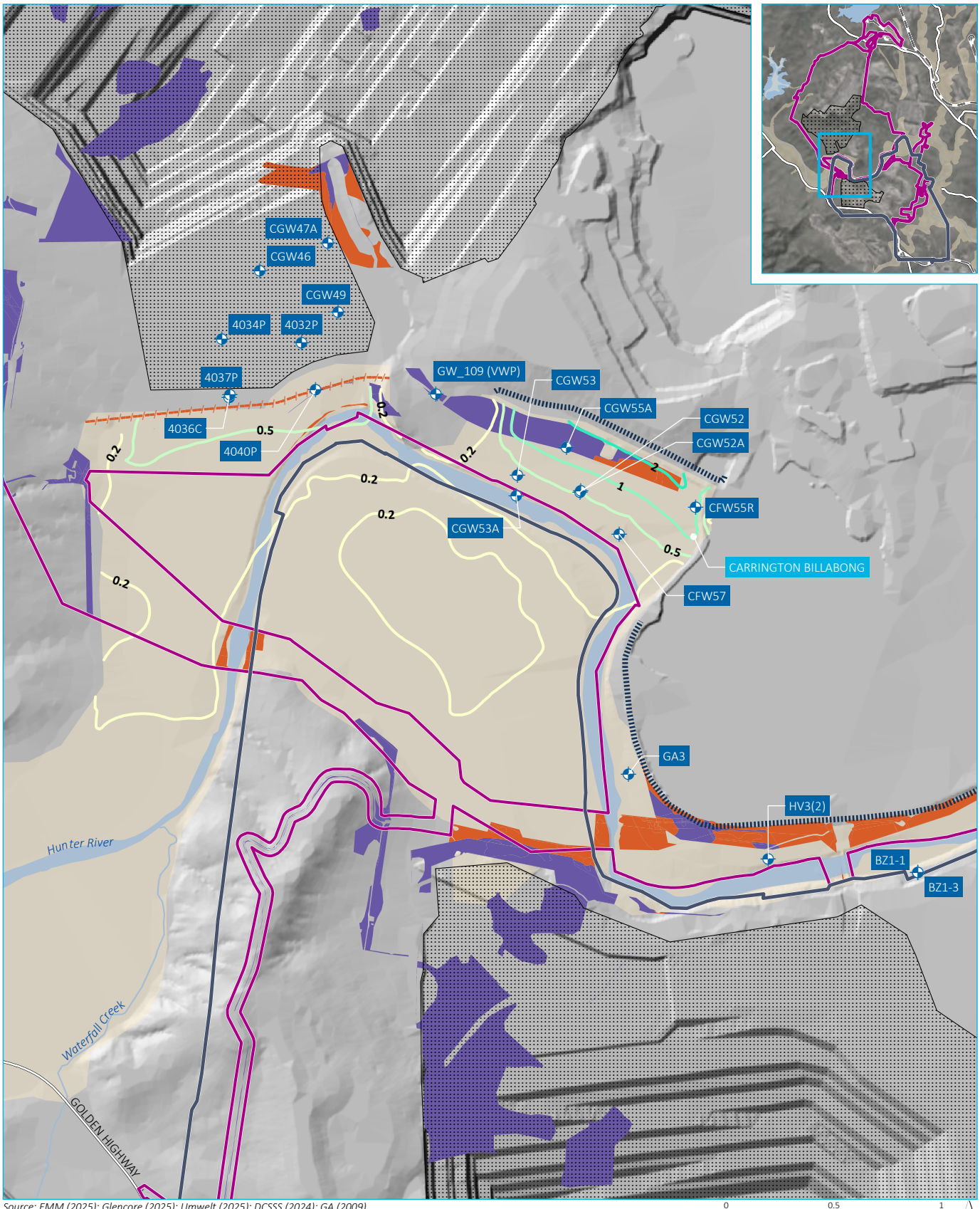
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Groundwater Modelling Report
Figure 4.8

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ii Alluvium drawdown post-closure

Figure 4.9 and Figure 4.10 illustrate the predicted maximum cumulative drawdown in the Hunter River and Wollombi Brook alluvium following project closure. There is no incremental drawdown predicted in the alluvium due to the Amended Project (in comparison to the existing approval). The figures illustrate that the maximum predicted cumulative drawdown post-mining is similar to that predicted for the EIS Project. Post-mining cumulative drawdown in the Hunter River alluvium is predicted to increase in extent and magnitude (up to 1 m at Carrington Billabong) compared to during mining, due to ongoing evaporative losses from the final voids as the groundwater system gradually adjusts to a new post-mining equilibrium (Figure 4.9).

Post-mining cumulative drawdown in the Wollombi Brook alluvial area is predicted to be consistent with the predictions presented for the EIS Project (up to 2 m in the Lemington underground mine area).



Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSSS (2024); GA (2009)

0 0.5 1 km

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N

KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Carrington West Wing LPBW
- Existing low permeability barrier wall
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

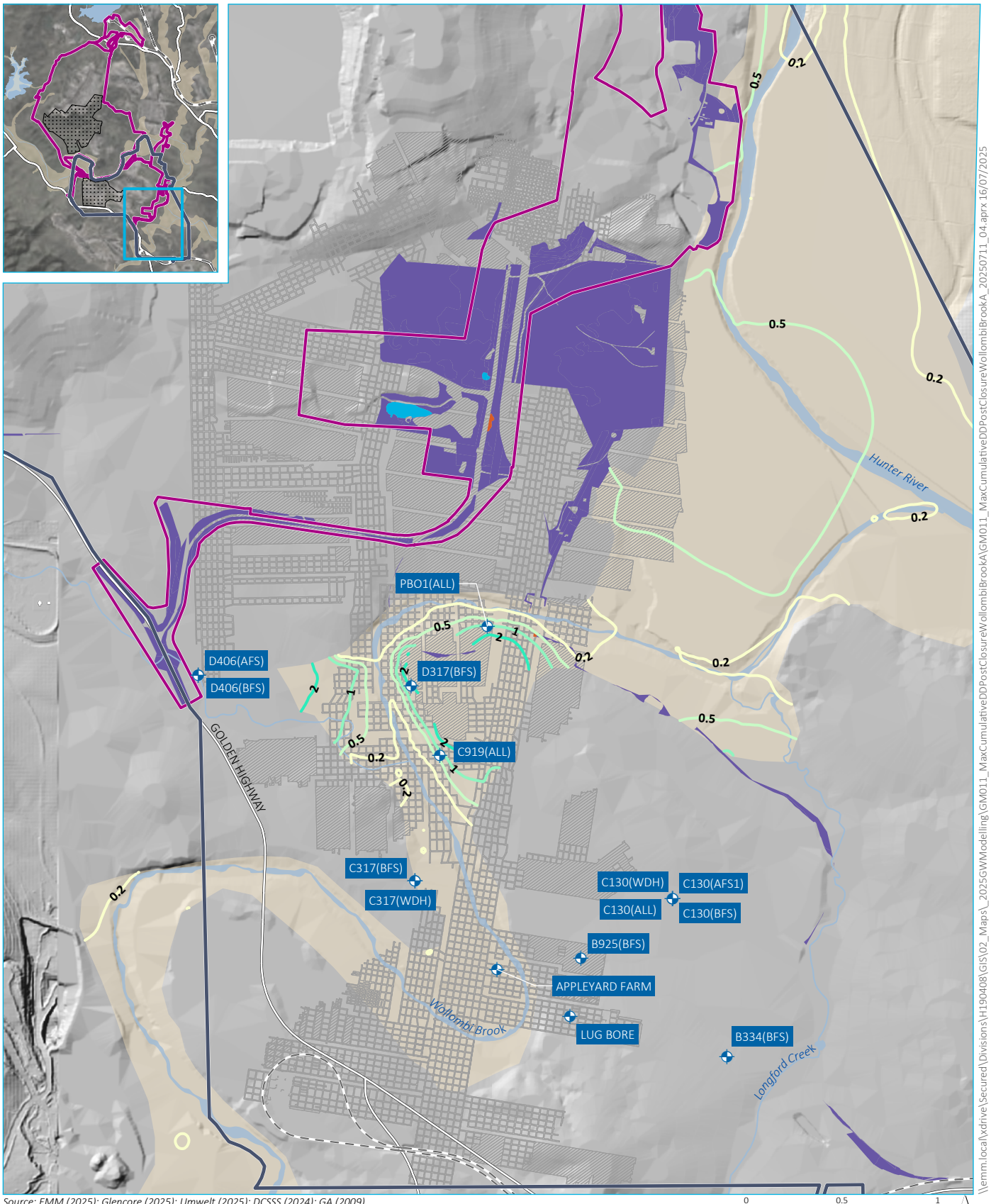
- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown post-closure in the Hunter River alluvium

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Groundwater Modelling Report
Figure 4.9

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Source: EMM (2025); Glencore (2025); Umwelt (2025); DCSS (2024); GA (2009)

0 0.5 1 km

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Groundwater monitoring location (HVO)
- Lemington underground mine plan
- Alluvium extent
- Mining area

Drawdown contour (m)

- 0.2
- 0.5
- 1
- 2

Plant community type (PCT) (Umwelt, 2025)

- PCT 3431 | Central Hunter Ironbark Grassy Woodland
- PCT 4015 | Central Hunter Riparian Forest
- PCT 4089 | Namoi-Upper Hunter River Red Gum Forest

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody

Maximum predicted cumulative drawdown post-closure in the Wollombi Brook alluvium

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Groundwater Modelling Report
Figure 4.10

EMM creating opportunities

5 Summary and comparison to EIS predictions

The results of the groundwater modelling conducted for the Amended Project are broadly consistent with the results presented for the EIS Project. The following is a summary of the prediction outcomes and comparison to previously presented results for the EIS Project:

- Alluvial drawdown is predicted to be constrained to a small area near the remnant paleochannel.
- The extent of the predicted incremental drawdown in the Hunter River alluvium is less than that predicted for the EIS Project. This is due to the changes to the mine plan and the HVO North pit depth being shallower than and ceasing further from the Hunter River in the Carrington area than that proposed in the EIS.
- Consistent with the modelling for the EIS Project, there is no incremental drawdown predicted in the Wollombi Brook alluvium, given mining is no longer proposed at SLP 1 or SLP 2 (i.e. the Amended Project is predicted to have a positive impact in this area compared to the Approved Project).
- There are no third-party water supply bores within the predicted extent of drawdown. Therefore, no third-party bores are predicted to be impacted by the Amended Project.
- Groundwater inflows to HVO mining areas peak at 2,488 ML/yr in Year 13.
- Post-mining, the final voids at HVO North and HVO South are predicted to act as sinks, with groundwater flow directed inward from the surrounding spoil towards the lakes.

6 Limitations

Numerical simulation of the hydrogeological regime in the study area has several limitations that reflect the complexity of the groundwater system, the project scope, data availability and software constraints. The main limitations are outlined below:

- Model stresses and features such as mining activities outside HVO, surface water features (streams and rivers), recharge zones, etc. were adopted directly from the AGE (2022) model. While some inconsistencies were corrected where identified, this approach assumes that these inputs were accurately represented in the previous model and remain appropriate for the current assessment.

- Predictive simulations relied on a single base case simulation from AGE's (2022) predictive modelling – the likelihood and range of possible drawdown and fluxes were not quantified with a formal predictive uncertainty analysis.

- The spatial and temporal resolution of the model may not capture small-scale processes or rapid changes. Activities of short duration such as rapid flood events would not be captured in the model due to their short duration and averaged representation of surface water features.

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Attachment B

Surface water impact assessment

EMM
creating opportunities

ENGENY

egis GROUP

HV OPERATIONS PTY LTD

Surface Water Impact Assessment

HVO Continuation Project – Amended Project

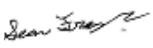
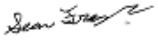
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3 JULY 2025

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EXECUTIVE SUMMARY

Overview

The Project

Hunter Valley Operations (HVO) is a multi-pit open cut mining complex approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW). HVO comprises two mine sites separated by the Hunter River, HVO North and HVO South (i.e. the HVO Complex). While the two mine sites are approved under separate development consents, they are operated as one complex with fully integrated environmental management systems. HVO is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HV Operations) is the appointed manager of the JV.

HVO is seeking approval for the HVO Continuation Project (the Project) from the NSW Minister for Planning and Public Spaces, or delegate, under the provisions of Part 4 of NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project broadly comprises the continuation of mining at HVO North and HVO South, beyond the current approved mining completion dates of 2026 and 2030 respectively. Given that the two mine sites operate as one complex, one environmental impact statement (EIS) (EMM, 2022) was prepared to support the two State significant development (SSD) applications for the Project, being:

- SSD-11826681 – HVO North Open Cut Coal Continuation Project.
- SSD-11826621 – HVO South Open Cut Coal Continuation Project.

The EIS was placed on public exhibition for a period of four weeks from Monday 30 January 2023 through to Monday 27 February 2023.

To respond to matters raised in submissions on the Project during the public exhibition period, a submissions report (EMM, 2023a) was prepared, along with an amendment report (EMM, 2023b) outlining proposed amendments to the HVO North Project.

During the subsequent assessment of the Project by the Department of Planning, House and Infrastructure (DPHI), DPHI issued a number of requests for information (RFI) to HVO, who provided responses as required.

Amendment Overview

In response to submissions received, HVO has completed a detailed review of the Project and is subsequently seeking to amend the SSD applications for the Project in the following ways:

- Reduce the project mine plan to avoid coal extraction within gas Domain 1 at HVO North and reduce the total run-of-mine (ROM) coal to be extracted by the Project by approximately 220 Mt.
- Maintain the current approved maximum annual ROM coal production at HVO North of 22 Mtpa but reduce the proposed maximum annual production limit at HVO South from 18 Mtpa to 13 Mtpa.
- Propose a limit to the maximum annual ROM coal production for the HVO Complex of 26 Mtpa from the current approved maximum rate of 42 Mtpa.
- Reduce the proposed life of mining operations at HVO North by five years, from the end of 2050 to the end of 2045.
- Reduce the proposed life of mining operations at HVO South by three years from the end of 2045 to the end of 2042.
- Expansion of the HVO North ROM coal stockpile to improve coal management.
- Remove approval for the construction and operation of the Lemington Coal Preparation Plant (LCPP) and associated rail facilities, which is currently approved, but not constructed, under the HVO South Project Approval.
- Temporary transport of product coal by truck from the Howick Coal Preparation Plant (CPP) to the Liddell stockpile for transport to market via the Liddell coal handling and train loading facilities during upgrades of the Newdell load point.
- Establishment of a new levee (Mitchell East Levee) near Carrington Mine – Colluvial Deposit 1 (CM-CD1) to provide flood protection for the final void in Mitchell Pit.

Further detail on the proposed amendments is provided in the Amendment Report (EMM, 2025a).

To enable the Amended Project to proceed, two new SSD consents are required; one for HVO North and one for HVO South, under Part 4, Division 4.1 of the EP&A Act. The Amended Project will seek to maintain separate development consents for HVO North and South, as is currently the case. Given that the two mine sites operate as one complex, one Amendment Report has been prepared to support the two development applications required for the Amended Project.

Assessment Overview

This Surface Water Impact Assessment (SWIA) forms part of the Amendment Report and provides an assessment of the potential impacts to surface water as a result of the Amended Project. It documents the assessment methods and results, initiatives to avoid and minimise surface water impacts and additional mitigation and management measures proposed to address residual impacts not able to be avoided.

A SWIA was prepared by Engeny in 2022 (EIS SWIA) and formed an appendix to the EIS (EMM, 2022). The EIS SWIA was also peer reviewed. Following the exhibition of the EIS SWIA additional information was provided as requested in the submissions, as well as from DPHI, IEAPM and BCD. Following the submissions report (EMM, 2023a) and responses to DPHI no additional information was sought by the IEAPM, DPHI or BCD regarding the EIS SWIA.

The approach for the assessment of potential impacts with the Amended Project follows the same approach as for the EIS SWIA (Engeny, 2022). The potential impacts of the Amended Project on surface water resources are minor and generally consistent with those predicted for the EIS Project. Some minor changes in impacts are predicted, including changes to timing as per the proposed changes to the Amended Project life and mining schedule.

Existing Surface Water Context

The Amended Project involves continued operations within portions of catchments that are currently or have been historically subject to extensive mining or impacts associated with mining (refer to Section 2). The existing operation has a well-established water management system (WMS) in place to manage onsite water and minimise surface water impacts.

As described in the EIS SWIA (Engeny, 2022), a review of water management infrastructure at the HVO Complex was undertaken in 2019 (following establishment of the JV) to identify reasonable and feasible improvements and works that were required to update the WMS to a modern containment standard. The review identified a series of projects proposed to achieve this outcome. The upgrades include increases to stormwater containment storage volumes, additional pipelines/transfer systems, monitoring systems, spillway upgrades and drainage improvements. It should be noted that key infrastructure identified as part of this Pollution Reduction Program (PRP) relevant to the Amended Project is proposed to be in place prior to the commencement of the Amended Project. The WMS is described in Section 3.

Surface Water Resources

The HVO Complex is located to the north and the south of the Hunter River upstream of Singleton. HVO North is bounded in the west by Saltwater Creek (Lake Plashett) and Parnells Creek, in the north by Lake Liddell, Pikes Creek and Bayswater Creek and in the east by Ravensworth Operations and Farrells Creek. The southern boundary of HVO North is the Hunter River. In addition, there are several unnamed tributaries of the Hunter River within the approved and Amended Project disturbance area.

HVO South is bounded in the west by Waterfall Creek and an unnamed tributary, to the south by the Golden Highway, and in the south-east by Wollombi Brook and its unnamed tributaries. In the north and north-east, the HVO South operations are bounded by the Hunter River, its floodplains and unnamed tributaries.

Water Management System

The HVO WMS consists of a network of infrastructure (i.e., dams, pipelines, contour banks) to control the movement of water around the site. Water is managed according to type, which is determined by catchment source, quality and use. Water managed at the HVO Complex includes mine water, sediment water and clean water.

Clean water diversion structures and levees divert clean water away from the active pits. The majority of water used on site is for coal processing and dust suppression. Mine water is preferentially used to reduce the amount of water discharged to the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) and the extraction of water under the Hunter River surface water allocations.

Excess mine water can be released via licensed discharge points to the Hunter River. Discharges are only allowed during high and flood flow periods in the Hunter River as determined by Water NSW and the Department of Climate Change, Energy, the Environment and Water (DCCEEW) - Water. Discharges are regulated by conditions in the site Environment Protection Licence (EPL) and by the HRSTS.

HVO holds both high and general security Water Access Licences (WALs) to withdraw water from the Hunter Regulated River to meet water deficits. In addition, water transfer systems are in place with both Mount Thorley Warkworth, Wambo and the Liddell Coal Operations..

Amended Project Water Management

It is proposed to continue to utilise the existing WMS for the Amended Project (this is consistent with the EIS Project). That is, the WMS for the Amended Project maintains and extends the existing WMS, with the inclusion of the PRP works, including infrastructure in areas of approved mining.

Consistent with the EIS Project, the WMS will be constructed and modified as and when required so as to support the infrastructure and mine development. The plans provided in this assessment (refer to Section 3) are conceptual and indicate only the components of the WMS which are required for a particular stage of the mine and does not preclude the construction of some components earlier and/or staging of construction as required.

The existing WMS will continue to be used to manage water by type, directing all mine affected runoff to the WMS. The existing approved clean water diversions will continue to divert runoff around the WMS. There are no new creek diversions proposed or required as part of the Project and there are no proposed changes to WALs or the EPL licence.

The SWIA has demonstrated that the existing approved WMS with the proposed additional WMS components (including dams, pumps and pipelines) will enable water at HVO to be managed in accordance with the current EPL and WALs (refer to Section 4).

Final Pit Lakes

The final landform proposed in the EIS contained two voids; one at HVO North and one at HVO South. The final landform for the Amended Project now includes three final voids: two at HVO North (North Void and Carrington Pit Void); and one at HVO South (South Void). The pit low wall dumps will be regraded, and the upstream clean catchments including areas of rehabilitated overburden will be diverted away from final voids where possible.

Filling of the pit lakes to equilibrium levels is predicted to take several hundred years after cessation of mining for North Void and South Void, while Carrington Pit Void is predicted to fill to equilibrium within 100 years (refer to Section 5). Due to the significant depth of the pit lakes, the groundwater flux is predicted to remain into the main voids (i.e., the lakes will act as a groundwater sink with no risk of overflows to the surface environment (greater than 100 m freeboard predicted for North Void and South Void). Salinity is expected to continue to increase over time in the pit lakes.

Predicted Impacts to Surface Water Resources

Streamflow

The assessment of the Amended Project on streamflow, used methodology consistent with the EIS Project, which was peer reviewed during the EIS Project. The assessment considered impacts of surface catchment area changes and predicted baseflow losses (refer to Section 6), including comparison to the approved impacts.

In summary, compared to the EIS Project, the Amended Project results in:

- Similar outcomes for the Hunter, which will still be likely to not be realised given any change in annual flow volumes will be mitigated through licensing in the regulated river system.
- Less impact on Wollombi Brook with the predicted reduction in catchment impacts associated with the Amended Project (including impacts on Unnamed watercourse (UN) 5 and UN6) associated with the removal of the Lemington Rail Loop from the Amended Project.
- Increases in potential baseflows in Wollombi Brook.

- Reduced impacts are generally predicted for ephemeral streams under the Amended Project, highlighted by increased annual flows and fewer dry days.
- Improvements are largely due to changes in drainage patterns as it is assumed all Amended Project Closure dams / dry detention basins are unmanaged and their catchments will therefore contribute to streamflow. This is a change in the final landform management strategy compared to what was presented in the EIS Project (and is considered further in the Water Assessment (EMM, 2025c)).

Flooding

Detailed flood modelling of the Hunter River was undertaken as part of the EIS SWIA (refer to Section 2). The modelling was undertaken in accordance with the methods recommended in Australian Rainfall and Runoff 2019 (Ball, et al., 2019). This included development and calibration of a flood model to define existing flooding conditions and allow assessment of the impact of the EIS Project. The flood modelling was also peer reviewed by BMT (refer to Section 1.5).

As the Amended Project does not encroach onto the floodplain further than the EIS Project or further reduce floodplain storage it is considered that the impacts from the Amended Project will be no greater than those modelled for the EIS Project (Engeny, 2022). As such, the flood assessment for the EIS Project is described in this Amended Project SWIA and has not been re-simulated for the Amended Project.

The existing flood ingress risks at the HVO Complex will continue to be reduced with the Amended Project (which is consistent with the EIS Project). All active open cut pits are shown to meet the minimum 0.1% AEP flood immunity standard adopted during the operational phase of the Amended Project. The final voids (i.e., HVO North, Carrington Pit and HVO South) will have flood immunity up to and including the Extreme Event.

Water Quality

The existing and proposed WMS (refer to Section 3) has been designed to continue to divert clean water around the mining operations and segregate, store and reuse mine impacted water to minimise potential adverse effects on water quality from mining operations to downstream surface waters. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during operational and rehabilitation phases to manage water quality (refer to Section 7).

Modelling indicates that the impact of discharges from the HVO Complex, under the HRSTS and EPL, on water quality will be negligible (i.e. the same as assessed for the EIS Project) (refer to Section 4.6) with the concentrations of key analytes lying within the existing ranges experienced in the Hunter River.

Mitigation Measures

Detailed environmental studies have been undertaken to inform the Amended Project design. The consideration of the outcomes of these studies in the design and integration with the approved operations minimise the potential for impacts on surface water resources. These considerations include:

- The management of impacts within the existing EPL and water allocations.
- WMS designed to meet legislative requirements and relevant guidelines (e.g., guidelines for treatment of runoff from disturbed areas).

These factors reduce the potential for significant impacts on existing surface water resources.

The range of potential impacts resulting from the Amended Project and a summary of the existing and proposed mitigation measures is included in Table 7.1. It should be emphasised that the majority of the proposed mitigation measures are consistent with the existing mitigation measures in place at the HVO Complex, and those proposed for the EIS SWIA. No new mitigation measures are proposed as a result of the Amended Project with the exception of incorporating the Riverview Levee into the final landform and construction of the Mitchell East Levee (or associated landform works), which achieve flood immunity outcomes consistent with the EIS SWIA. The lack of further new mitigation measures is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance and changes to timing associated with the Amended Project.

Monitoring and Management

The existing approved operation at the HVO Complex has well-established systems in place for monitoring and management of surface water. It is proposed that the Amended Project will maintain and build off these systems in the same way that the EIS Project proposed to.

The main document for management of surface water at the HVO Complex is the Water Management Plan (WMP), which allows for the ongoing assessment of risk as mining operations progress and the implementation of improvements and changes where required. The WMP is an adaptive and responsive document with regular annual reviews and reviews triggered by incidents, audits or regulatory and operational changes. Subject to approval of the Amended Project, the WMP will be updated in consultation with DCCEEW and the EPA relevant stakeholders. The updated WMP will address any specific development consent or licence conditions and will include:

- Proposed mitigation and management measures for the Amended Project.
- Objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with the Project.
- Details of monitoring, inspection and maintenance programs.
- Reporting procedures for the results of the monitoring program.
- Plans to respond to any exceedances of the performance criteria and indicators.

Trigger Action Response Plans (TARPs), which define contingency plans and remedial measures, will be reviewed as part of the update to the approved WMP.

Performance criteria are detailed in the approved WMP, and HVO has developed performance indicators to initiate site specific investigations regarding water quality. The primary objective of trigger levels is to provide an early indication of potential impacts to receptors and initiate a management response. They are not intended to be an instrument to assess 'compliance' and should not be used in this capacity (ANZG 2018). The outcomes of the investigation are reported in the Annual Review.

A summary of the surface water monitoring results will continue to be provided in the Annual Review for HVO. In addition, any significant findings regarding the implementation of the WMP will be reported in the Annual Review and will document reviews and feedback relating to the maintenance and performance of the WMS.

The range of existing and proposed additional mitigation measures are summarised in Table 7.1, with few additional controls required for the EIS Project.

1. INTRODUCTION

1.1 Background

Hunter Valley Operations (HVO) is a well-established multi-pit open cut coal mining complex, comprising two mine sites separated by the Hunter River, HVO North and HVO South (i.e. the HVO Complex). The HVO Complex is located approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW) (refer to Figure 1.1). While the two mine sites are approved under separate development consents issued under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), they operate as one complex, the HVO Complex, with fully integrated environmental management systems.

HVO North operates under Development Consent DA 450-10-2003 issued by the then NSW Minister for Infrastructure and Planning in 2004, which allows extraction of up to 22 million tonnes per annum (Mtpa) of run of-mine (ROM) coal until 31 December 2026. HVO North comprises the approved mining areas of West Pit, Mitchell Pit, Carrington Pit and North Pit, as well as the Hunter Valley (HV) and Howick Coal Preparation Plants (CPP) and the Howick and HVO North mine infrastructure area (MIA). The Newdell Load Point (LP) and Hunter Valley (HVLP) train loading facilities are also at HVO North.

HVO South operates under Project Approval (PA) 06_0261 issued by the then NSW Minister for Planning in 2009 and comprises the approved mining areas of Riverview Pit, Cheshunt Pit, Riverview South East Extension and South Lemington Pits 1 and 2, as well as the MIA, and the Lemington CPP (LCPP) and rail loop (approved but not constructed). PA 06_0261 allows extraction of up to 20 Mtpa of ROM coal until 24 March 2030.

The key components and approved disturbance areas associated with the HVO Complex are illustrated in Figure 1.2.

HVO is seeking approval for the HVO Continuation Project (the Project) from the NSW Minister for Planning and Public Spaces, or delegate, under the provisions of Part 4 of EP&A Act. The Project broadly comprises the continuation of mining at HVO North and HVO South, beyond the current approved mining completion dates of 2026 and 2030 respectively. Given that the two mine sites operate as one complex, one environmental impact statement (EIS) (EMM, 2022) was prepared to support the two State significant development (SSD) applications for the Project, being:

- SSD-11826681 – HVO North Open Cut Coal Continuation Project.
- SSD-11826621 – HVO South Open Cut Coal Continuation Project.

The EIS was placed on public exhibition for a period of four weeks from Monday 30 January 2023 through to Monday 27 February 2023.

To respond to matters raised in submissions on the Project during the public exhibition period, a submissions report (EMM, 2023a) was prepared, along with an amendment report (EMM, 2023b) outlining proposed amendments to the HVO North Project.

During the subsequent assessment of the Project by the Department of Planning, House and Infrastructure (DPHI), DPHI issued a number of requests for information (RFI) to HVO, who provided responses as required.

1.2 Amendment Overview

In response to submissions received, HVO has completed a detailed review of the Project and is subsequently seeking to amend the SSD applications for the Project in the following ways:

- Reduce the project mine plan to avoid coal extraction within gas Domain 1 at HVO North and reduce the total run-of-mine (ROM) coal to be extracted by the Project by approximately 220 Mt.
- Maintain the current approved maximum annual ROM coal production at HVO North of 22 Mtpa but reduce the proposed maximum annual production limit at HVO South from 18 Mtpa to 13 Mtpa.
- Propose a limit to the maximum annual ROM coal production for the HVO Complex of 26 Mtpa from the current approved maximum rate of 42 Mtpa.
- Reduce the proposed life of mining operations at HVO North by five years, from the end of 2050 to the end of 2045.
- Reduce the proposed life of mining operations at HVO South by three years from the end of 2045 to the end of 2042.
- Expansion of the HVO North ROM coal stockpile to improve coal management.

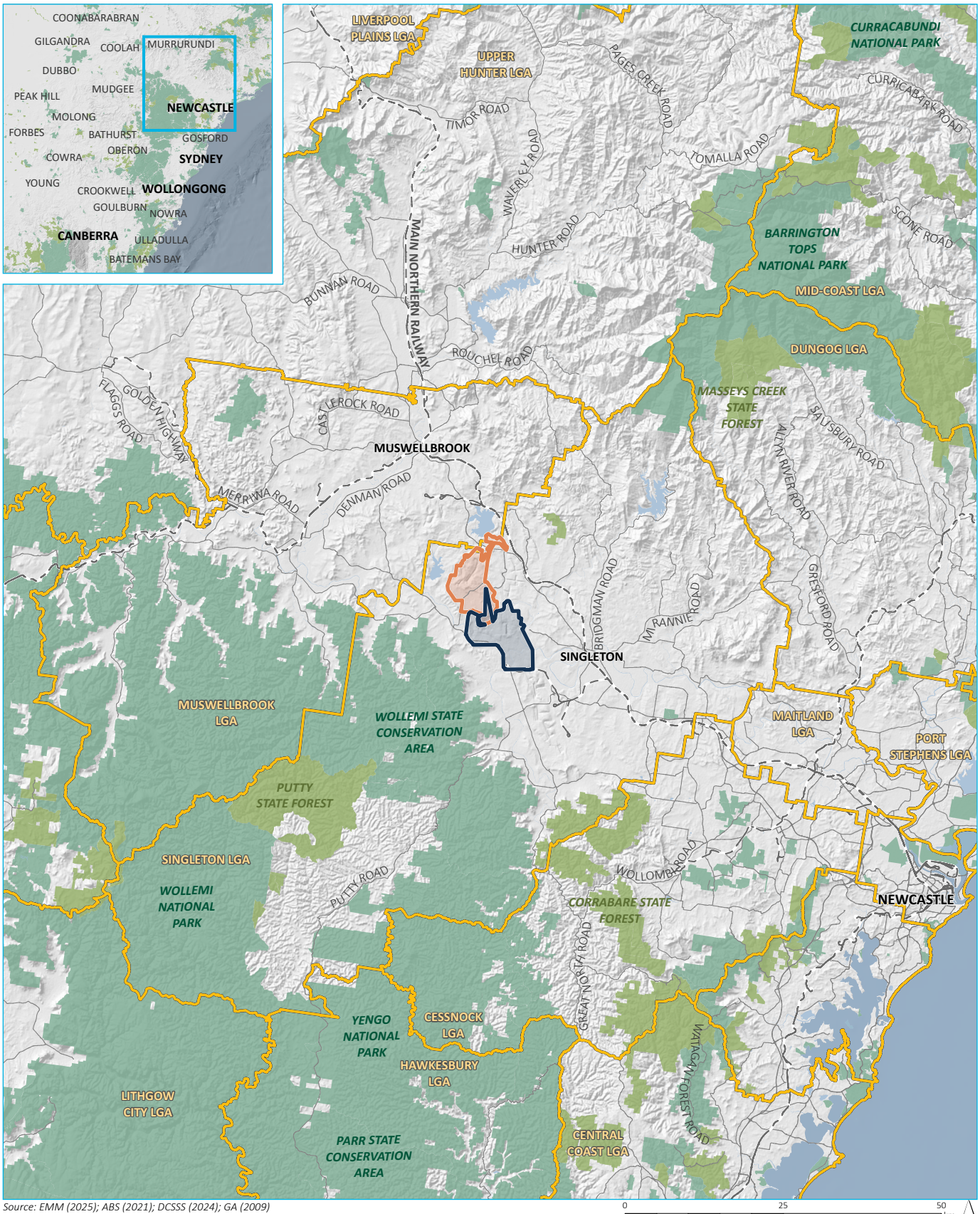
- Remove approval for the construction and operation of the LCPP and associated rail facilities, which is currently approved, but not constructed, under the HVO South Project Approval.
- Temporary transport of product coal by truck from the Howick Coal Preparation Plant (CPP) to the Liddell stockpile for transport to market via the Liddell coal handling and train loading facilities during upgrades of the Newdell LP.
- Establishment of a new levee (Mitchell East Levee) near Carrington Mine – Colluvial Deposit 1 (CM-CD1) to provide flood protection for the final void in Mitchell Pit.

Further detail of the proposed amendments is provided in the Amendment Report (EMM, 2025a).

To enable the Amended Project to proceed, two new SSD consents are required; one for HVO North and one for HVO South, under Part 4, Division 4.1 of the EP&A Act. The Amended Project will seek to maintain separate development consents for HVO North and South, as is currently the case. Given that the two mine sites operate as one complex, one Amendment Report has been prepared to support the two development applications required for the Amended Project.

This Surface Water Impact Assessment (SWIA) forms part of the Amendment Report and provides an assessment of the potential impacts to surface water as a result of the Amended Project. It documents the assessment methods and results, initiatives to avoid and minimise surface water impacts and additional mitigation and management measures proposed to address residual impacts not able to be avoided. The scope of the SWIA for the Amended Project is included in Section 1.5.

The full Project description is provided in the Amendment Report (EMM, 2025a). The proposed conceptual layout of the Amended Project, inclusive of both HVO North and South, is provided in Figure 1.3.



Source: EMM (2025); ABS (2021); DCSSS (2024); GA (2009)

0 25 50 km

GDA2020 MGA Zone 56

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KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest
- Local government area

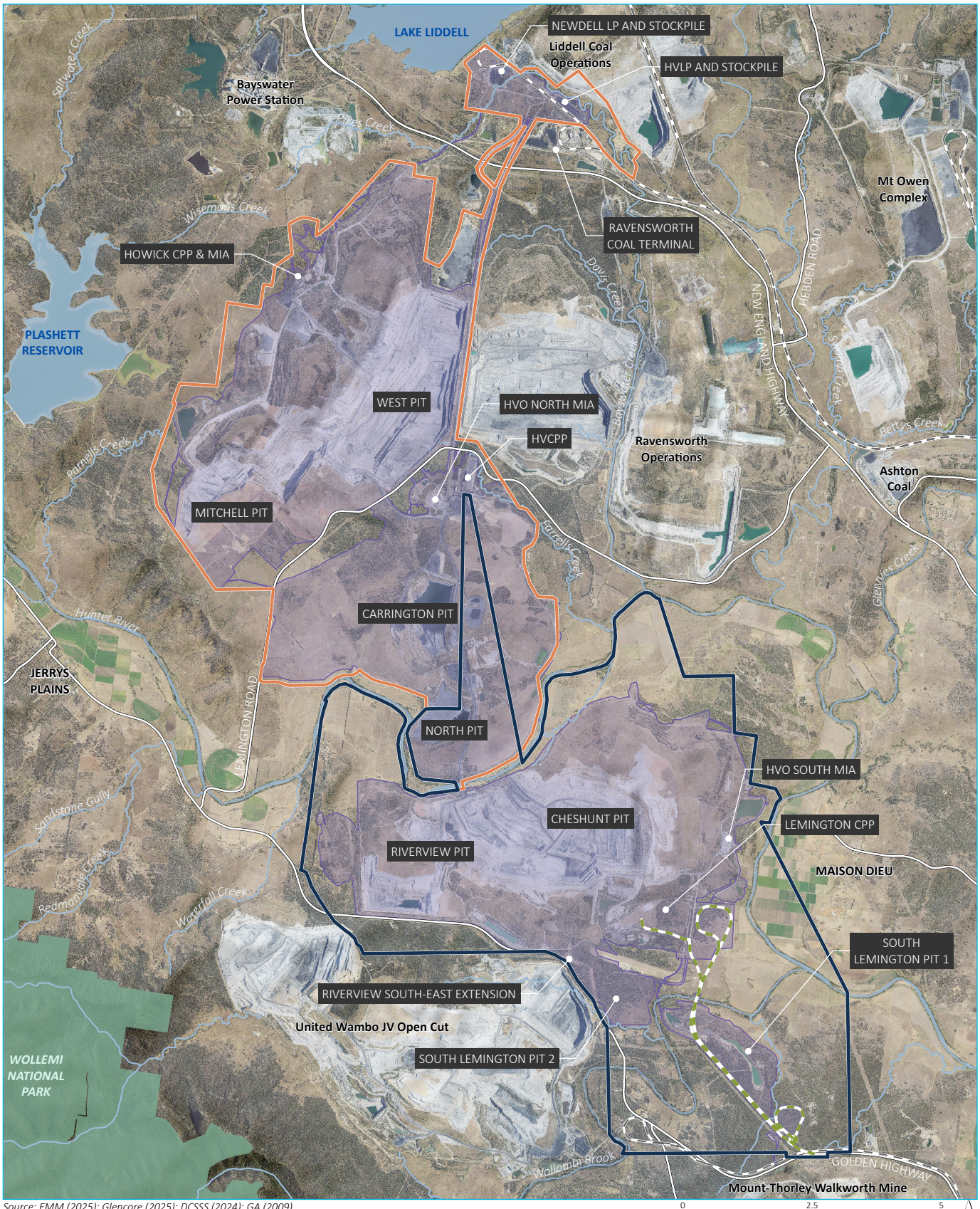
INSET KEY

- NPWS reserve
- State forest

Regional locality

HVO Continuation Project
Amendment - Surface Water Impact Assessment
Figure 1.1

EMM
creating opportunities



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Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

N

KEY

- Existing HVO North development consent boundary (DA 450-10-2003)
- Existing HVO South project approval boundary (PA 06_0261)
- Existing and approved disturbance area
- South Lemington Rail Loop and haul route (approved, not yet constructed)

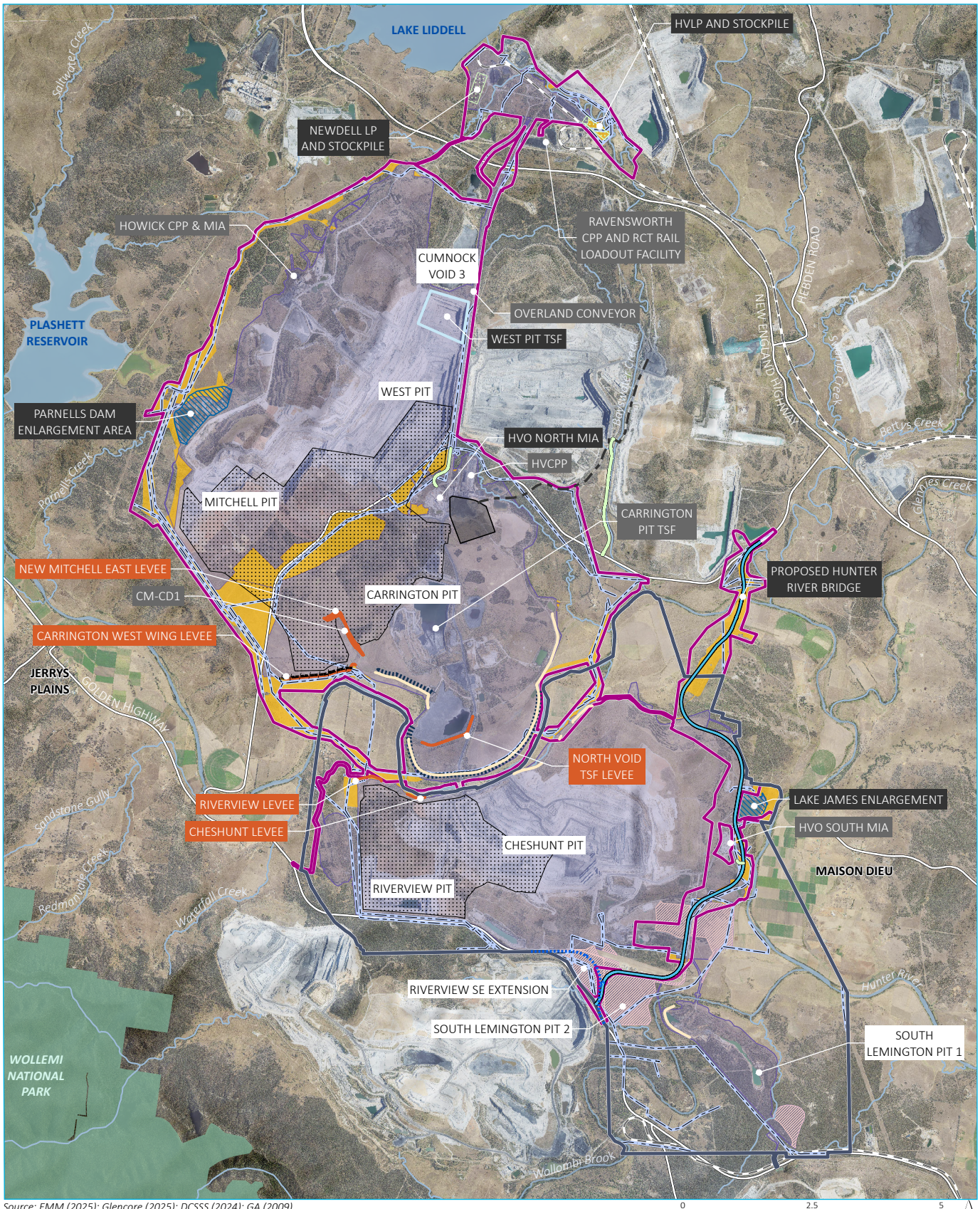
Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Approved disturbance area

HVO Continuation Project
Amendment - Surface Water Impact Assessment
Figure 1.2

EMM creating opportunities



Source: EMM (2025); Glencore (2025); DCSSS (2024); GA (2009)

0 2.5 5 km

GDA2020 MGA Zone 56

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KEY

- Amended proposed HVO North development consent boundary
- Proposed HVO South development consent boundary
- Existing and approved disturbance area
- Additional disturbance area
- Previous approved area not retained
- Existing low permeability barrier wall
- Existing levee

Proposed HVO Continuation Project element

- Approved barrier wall (not yet constructed)
- Alternative Golden Highway alignment
- Lemington Road realignment
- Levee
- Mine access road
- Proposed haul route to Ravensworth Operations
- Dam enlargement
- Mining area
- Product stockpile
- Sediment dam
- West Pit TSF

Existing environment

- Transmission line
- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Label format

- Existing item
- Project related item

Proposed conceptual layout

HVO Continuation Project
Amendment - Surface Water Impact Assessment
Figure 1.3

EMM
creating opportunities

1.3 Project Terminology

The following key terms are used throughout this assessment to describe the Project:

- **HVO Complex** – comprises both HVO North and HVO South operations.
- **The Project** – the Project in its entirety; encompassing the continuation of the life of the complex, i.e., both HVO North and HVO South, within their respective proposed development consent boundaries, as illustrated in Figure 1.3.
  - **EIS Project** – the Project that was submitted in 2022.
  - **Amended Project** – this project assessed in 2025, as described in Section 1.2 and illustrated in Figure 1.3.
- **EIS SWIA** – the SWIA to support the EIS Project.
- **SWIA** – this current SWIA prepared for the Amended Project.
- **Project area** – The area that is the subject of the two development applications, i.e., the proposed development consent boundary for HVO North and the proposed development consent boundary for HVO South.
- **Existing and approved disturbance area** – Areas that are disturbed, previously disturbed and/or approved under the NSW EP&A Act to be disturbed under the current development consents that apply to the HVO Complex.
- **Approved mining area** – The areas within the approved disturbance area that have been previously assessed and approved under the NSW EP&A Act for mining operations.
- **Additional disturbance area** – The areas that will be disturbed by the Project that are outside of the existing and approved disturbance area for the HVO Complex and other neighbouring mines (Ravensworth Operations, United Wambo and Liddell Coal Operations (LCO)).
- **Previously approved areas not retained** – Areas that are disturbed and/or approved to be disturbed under the current development consents that apply to the HVO Complex, that will no longer be disturbed by the Project, such as the LCPP short rail loop, the Riverview Southeast Extension and South Lemington Pit 2 mining areas, and the approved temporary crossing across the Hunter River between HVO North and South.
- **Proposed mining area, HVO North** – Areas where coal extraction will take place for the Project at HVO North and includes:
  - Areas already disturbed by mining at HVO North (e.g., West Pit, Wilton Pit, Mitchell Pit and Carrington Pit).
  - Areas not previously approved for mining (e.g., the area between the Mitchell Pit and Carrington Pit).
  - Areas approved but not yet disturbed (e.g., the Carrington West Wing area).
- **Proposed mining area, HVO South** – Comprises the Riverview Pit and Cheshunt Pit, where coal extraction will continue under the Project, down to the Bayswater seam. The HVO South proposed mining area does not include the previously approved South Lemington Pit 1, South Lemington Pit 2, or the Riverview Southeast Extension, as coal extraction is not proposed in these areas as part of the Project. However, rehabilitation activities will be required in some areas and form part of the Project.
- **Transmission line corridors** – Two categories of transmission line corridors have been defined for the purpose of quantifying the extent of disturbance for the Project:
  - Realigned transmission lines (i.e., new transmission line easements) – the extent of disturbance will be limited to transmission line poles/towers and an access road for maintenance along the alignment, as well as vegetation management to maintain safe powerline clearance; and
  - Existing transmission line easements to be decommissioned – disturbance will be confined to existing access tracks and cleared areas.
- **Realigned Lemington Road Corridor** – The corridor extends from the existing Comleroi Road intersection with the Golden Highway at the southern end of the new alignment, along the Comleroi Road alignment around the south-eastern side of HVO South and then extends in a northerly direction to join the existing Lemington Road approximately 2.3 km south of the existing New England Highway/Lemington Road intersection.

  The proposed realigned corridor forms part of the HVO North SSD application.
- **Project disturbance area** – this area is a combination of the additional disturbance area and the existing and approved disturbance area, minus the areas not being retained by the Project. If the Project is approved, this will become the 'approved disturbance area' under the new SSD consents.

1.4 Regulatory Framework

A summary of the relevant legislation is included below and is the same legislation that was considered for the EIS Project Surface Water Impact Assessment (EIS SWIA) (Engeny, 2022). These section have been included to assist the reader with the assessment context.

1.4.1 Commonwealth Legislation

The Amended Project will also be assessed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) water trigger.

The EIS SWIA and this report both have been prepared in consideration of the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE, 2013).

1.4.2 Relevant NSW Legislation

The HVO Complex exists within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take with consideration of environmental flow requirements of watercourses and the needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems (WMS) for mines to provide for appropriate water quality in accordance with Environment Protection Licence (EPL) requirements. Further details of the NSW surface water regulatory framework and how it will continue to be applied to the Project is provided below.

There are two key acts that provide the regulatory framework for water management in NSW. These acts are the *Water Management Act 2000 (WM Act)* and the *Water Act 1912*. The key provisions of these acts relevant to the Project are outlined in Section 1.4.3.

At a state level, there is one other key water management regulation relevant to mining operations: *Protection of the Environment Operations Act 1997* (POEO Act). The POEO Act is the key piece of environmental protection legislation administered by the NSW Environment Protection Authority (EPA). The key components of the POEO Act relevant to surface waters are outlined in Section 1.4.5.

1.4.3 NSW Regulatory Requirements - Water Use/Take

The objective of the WM Act is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. The WM Act supersedes the provisions of the *Water Act 1912* in regard to water take when a Water Sharing Plan (WSP) is in place and in regard to works adjacent to or within watercourses.

As part of the WM Act, WSPs have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSPs specify maximum water extractions and allocations. By complying with the requirements of the WSPs, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2022* (Hunter Unregulated and Alluvial Water Sources WSP) applies to watercourses and alluvial groundwater (greater than 40 m from the riverbanks) in the vicinity of HVO, with the exception of the Hunter River.

The *Water Sharing Plan for the Hunter Regulated River Water Source 2016* (Hunter Regulated WSP) applies to a single water source that covers the surface flows and highly connected alluvium (within 40 m of the riverbanks) of the Hunter River and Glennies Creek. The Hunter Regulated Water Source is divided into management zones, defined from the confluence of Glennies Creek with the Hunter River. The proposed development consent boundaries for HVO North and HVO South encompasses multiple Management Zones (Zone 1B, 2A and 2B).

As such water use from surface and alluvial waters in and adjacent to the HVO Complex are governed by the WM Act.

Groundwater associated with the Permian coal measures is managed under the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (North Coast Fractured and Porous Rock Groundwater Sources WSP) which commenced on 1 July 2016. Refer to the Water Assessment (EMM, 2025c) for further information.

1.4.4 Water Access Licensing

All water take in NSW, apart from some exemptions and basic landholder rights, must be authorised by a water licence.

Each water licence, referred to under the WM Act as a Water Access Licence (WAL), specifies a share component. The share components of specific purpose licences such as local water utility, major utility, domestic and stock, and Aboriginal cultural WALs are expressed as a number in megalitres per year. The share components of regulated river (high security and general security), unregulated river, aquifer and supplementary WALs are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWD's) as specified by ministerial orders made each year, with full entitlement equivalent to 1 ML/share. A summary of the licences currently held by HVO is included in Table 1.1.

Further discussion on water licensing is provided in the Water Assessment for the Amended Project (EMM, 2025c).

TABLE 1.1: SUMMARY OF HVO SURFACE WATER EXTRACTION ENTITLEMENTS

Water Sharing Plan	Water Source – Management Zone	Regulated River – High Security Entitlements (units)	Regulated River – General Security Entitlements (units)	Unregulated River Entitlements (Units)
Hunter Regulated River 2016	Hunter River Zone 1b	3,183	5,244	-
	Hunter River Zone 2a	1,506	1,393	-
Hunter Unregulated and Alluvial Water Sources	Lower Wollombi Brook	-	-	88
	Jerrys Management Zone	-	-	705

1.4.5 Environment Protection Licences

Activities that may lead to pollution of waters in NSW are regulated by the EPA under the POEO Act. Where discharge of waters is permitted, it is controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under Section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an EPL if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act).

Discharges from the HVO Complex are licensed under EPL 640, as well as operating in accordance with the Hunter River Salinity Trading Scheme (HRSTS). The HRSTS is a cap-and-trade system designed to facilitate saline discharges into the Hunter River, without compromising sustainable water quality. The HRSTS is administered under the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002*. EPL requirements for the approved operations at the HVO Complex are included in Section 3.

1.5 Amended Project – Surface Water Impact Assessment - Scope

A SWIA was prepared by Engeny in 2022 for the EIS Project (EIS SWIA) and formed an appendix to the EIS (EMM, 2022). The EIS SWIA (Engeny, 2022) was prepared in accordance with requirements of the Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 11 March 2021.

To inform the preparation of the SEARs, the (then) Department of Planning and Environment (DPE) (now DPHI) invited other government agencies to recommend matters to be addressed in the EIS. NSW Biodiversity and Conservation Division, DPIE Water and NRAR (now the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW)), EPA, Department of Regional NSW - Mining, Exploration & Geoscience and Singleton Council raised matters relevant to the surface water assessment. These matters raised were also taken into account in preparing the SWIA (Engeny, 2022).

The flooding assessment in the EIS SWIA (Engeny, 2022) was peer reviewed by Barry Rodgers (BMT). Barry Rodgers was engaged throughout the development of the HVO flood model to provide peer review and to align methodologies and broad outcomes of the HVO studies with concurrent Council studies.

A peer review of the EIS SWIA (Engeny, 2022) was conducted by Ian Rowbottom (EMM) apart from flooding (see above). Ian Rowbottom was involved throughout the development of the EIS SWIA, with his review comprising inputs and involvement in the water management system, water balance modelling, streamflow impact assessment, water quality assessment and cumulative impact assessment, and final void hydrology and climate change assessment.

The EIS Project was referred to the Independent Expert Advisory Panel for Mining (IEAPM) by DPHI. The IEAPM has been established to provide access to world-best scientific advice when assessing mining proposals and post-approval matters under the *Environmental Planning and Assessment Act 1979.*

Following the exhibition of the EIS (EMM, 2022) the DPHI requested additional information in response to the Flooding Peer Review and the BCD submission. A response was submitted to DPHI in August 2024. The Flooding Peer Review prepared for the DPHI, undertaken by Torrent Consulting, stated the following "*Notwithstanding these limitations, the modelling, impact assessment and design are considered to appropriately consider and address flood risk for the proposed development in accordance with industry practice and requirements of the SEARS".*

Following the submissions report (EMM, 2023a) and responses to DPHI no additional information was sought by the IEAPM, DPHI or BCD regarding the EIS SWIA.

The Amended Project aspects that have the potential to impact on surface waters, are summarised in Table 1.2. This table includes a description of the potential impacts and considerations of the assessment along with the selected study area and scope of the assessment. The assessment for several of the Amended Project aspects are noted to extend beyond the proposed development consent boundaries for HVO North and HVO South – this is consistent with the EIS Project.

The approach for the assessment of potential impacts with the Amended Project follows the same approach as for the EIS SWIA (Engeny, 2022). This report outlines the assessment of the Amended Project impacts relative to the EIS Project impacts relevant to surface water.

TABLE 1.2: SUMMARY OF AMENDED PROJECT ASPECT, STUDY AREA, POTENTIAL IMPACTS AND SCOPE

Amended Project Aspect	Potential Impacts and Study Considerations	Study Area	Study Scope				
			Water Management System	Water Balance Model	Water Quality	Streamflow	Flooding
Mining Pit and Overburden Emplacement Area Extents	Mine and sediment water runoff	Proposed development consent boundaries	x		x		
Mining Infrastructure	Mine and sediment water runoff	Proposed development consent boundaries	x		x		
Mine Water Management System	Mine and sediment water runoff	Proposed development consent boundaries	x	x	x	x	x
Lemington Road Realignment	Flood behaviour (level, velocity) and access	Proposed development consent boundaries					x[1]
Clean Water Diversions	Clean water separation from mine areas	Proposed development consent boundaries	x		x	x	
Flood Levees	Flood behaviour (level, velocity) and infrastructure immunity	Proposed development consent boundaries	x				x[2]
Tailings Emplacement	Sufficient water demands and storage	Proposed development consent boundaries and disposal at LCO	x	x			
Water Sharing	Maintain existing agreements	Existing water sharing arrangements with nearby mines	x[1]	x[1]			
Water Balance	Manage water inventory, containment, supply and discharge	Proposed development consent boundaries	x	x	x		
Water Supply	Manage water inventory, containment, supply and discharge	Existing WALs	x	x			
Water Discharges	Manage water inventory, containment, supply and discharge	Existing licensed discharge points, EPL limits and HRSTS credits	x	x	x[1]		
Risk of Overflows Beyond Design Criteria	Manage water inventory, containment, supply and discharge	Receiving environment in vicinity and downstream of HVO	x	x	x		

Amended Project Aspect	Potential Impacts and Study Considerations	Study Area	Study Scope				
			Water Management System	Water Balance Model	Water Quality	Streamflow	Flooding
Hunter River Flooding	Flood behaviour (level, velocity) and infrastructure immunity	Hunter River in vicinity and downstream of HVO	x	x			x[2]
Flows in the Hunter River and local creek systems	Flow regime (volume, frequency) and dry periods	Catchment areas of the Hunter River and its tributaries	x		x	x	
Final Landform	Maximise clean catchment return to receiving environment	Proposed development consent boundaries	x		x	x	x[2]
Final Void	Lake level, quality and potential for discharge	Proposed development consent boundaries		x	x		

Note 1 – Assessed for the EIS Project and the Response to Submissions (i.e. not re-assessed for the Amended Project)

Note 2 – Assessed for the EIS Project (i.e. not re-assessed for the Amended Project)

1.6 Structure of this Report

The key components of the SWIA report for the Amended Project are included in the following sections:

- Surface water context, including existing watercourses, catchment context, flow regimes, flooding, water quality and water users; **Section 2** and **Attachments A** and **B.**
- Water Management System; **Section 3**.
- Water Management System Performance; **Section 4** and **Attachment C**.
- Final Void Hydrology Assessment; **Section 5** and **Attachment D**.
- Potential impacts, including consideration of cumulative impacts and proposed mitigation measures; **Section 6**.
- Mitigation, Monitoring and Management Measures; **Section 7**.

2. SURFACE WATER CONTEXT

The HVO Complex is located to the north and the south of the Hunter River upstream of Singleton.

HVO North is bound in the west by Saltwater Creek (Lake Plashett) and Parnells Creek, in the north by Lake Liddell, Pikes Creek and Bayswater Creek and in the east by Ravensworth Operations and Farrells Creek (refer to Figure 1.3). The southern boundary of HVO North is the Hunter River. In addition, there are several unnamed tributaries of the Hunter River within the Amended Project disturbance area.

HVO South is bound in the west by Waterfall Creek and an unnamed tributary, to the south by the Golden Highway, and in the south-east by Wollombi Brook and its unnamed tributaries. In the north and north-east, the HVO South operations are bound by the Hunter River, its floodplains and unnamed tributaries.

Consistent with the EIS Project the Amended Project involves continued operations within portions of catchments that are currently or have been historically subject to extensive mining or impacts associated with mining as well as catchments that are currently approved for mining. The existing operation has a well-established and robust existing WMS in place to minimise surface water impacts. The existing WMS is detailed in Section 3. The following sections describe the nature of these catchment areas and associated watercourses and existing water quality, as well as downstream water users.

2.1 Climate

The regional climate of the Hunter Region is sub-tropical to temperate, with more rainfall typically occurring during summer and autumn, with lower rainfall in winter and spring.

There are two key Bureau of Meteorology (BoM) operated long-term rainfall gauges within 20 km of the site. In addition, HVO operates two site rainfall gauges. These stations are listed in Table 2.1. Typical rainfall and evaporation rates for the site are presented in Figure 2.1 to Figure 2.3.

Climate data was also sourced from the Queensland Government Department of Environment, Science and Innovation (DESI) Synthetic Information for Landholders (SILO) database. The SILO database interpolates raw rainfall and evaporation data from gauges managed by the BoM to provide spatially and temporarily complete datasets for site specific locations across the whole of Australia. For the purposes of this report, data from a SILO Data Drill (January 1892 to December 2024) were used to represent the rainfall data set for the Amended Project.

Average daily pan evaporation data for each month of the year, presented in Figure 2.2, were adopted from the SILO data drill. SILO data drills are a derived data set from a combination of interpolated recorded data between weather stations and derived long-term average values. Due to poor distribution of evaporation monitoring stations, the interpolated evaporation data at the location of HVO may be inaccurate. Therefore, the long-term pan evaporation derived from the SILO data drill has been compared against the average daily recorded data from the Scone SCS BoM station (061069) (nearest station available) to validate the SILO data, presented in Figure 2.2. The long-term average SILO data match well with the data recorded at the Scone SCS Station from 1965 to 2014. On average, daily pan evaporation exceeds daily rainfall at HVO. A comparison of annual recorded rainfall on site and in the SILO data is presented in Table 2.1 for the period of records from 2014 to 2024 (i.e., where site data is available). The data shows good correlation in the ranges and averages of data over the time period for rainfall at the HVO Complex and provided via SILO.

TABLE 2.1: NEARBY RAINFALL GAUGING STATIONS

Source	Proximity to HVO[1]	Data Range
Bulga (South Wambo) (061191)	16.2 km	1960-2025
Jerrys Plains Post Office (061086)	7.8 km	1886-2014
HVO Cheshunt Weather Station	On-site	2014-2025
HVO Corp Weather Station	On-site	2014-2025

Note 1: Measured from HVO North Administration Building Office

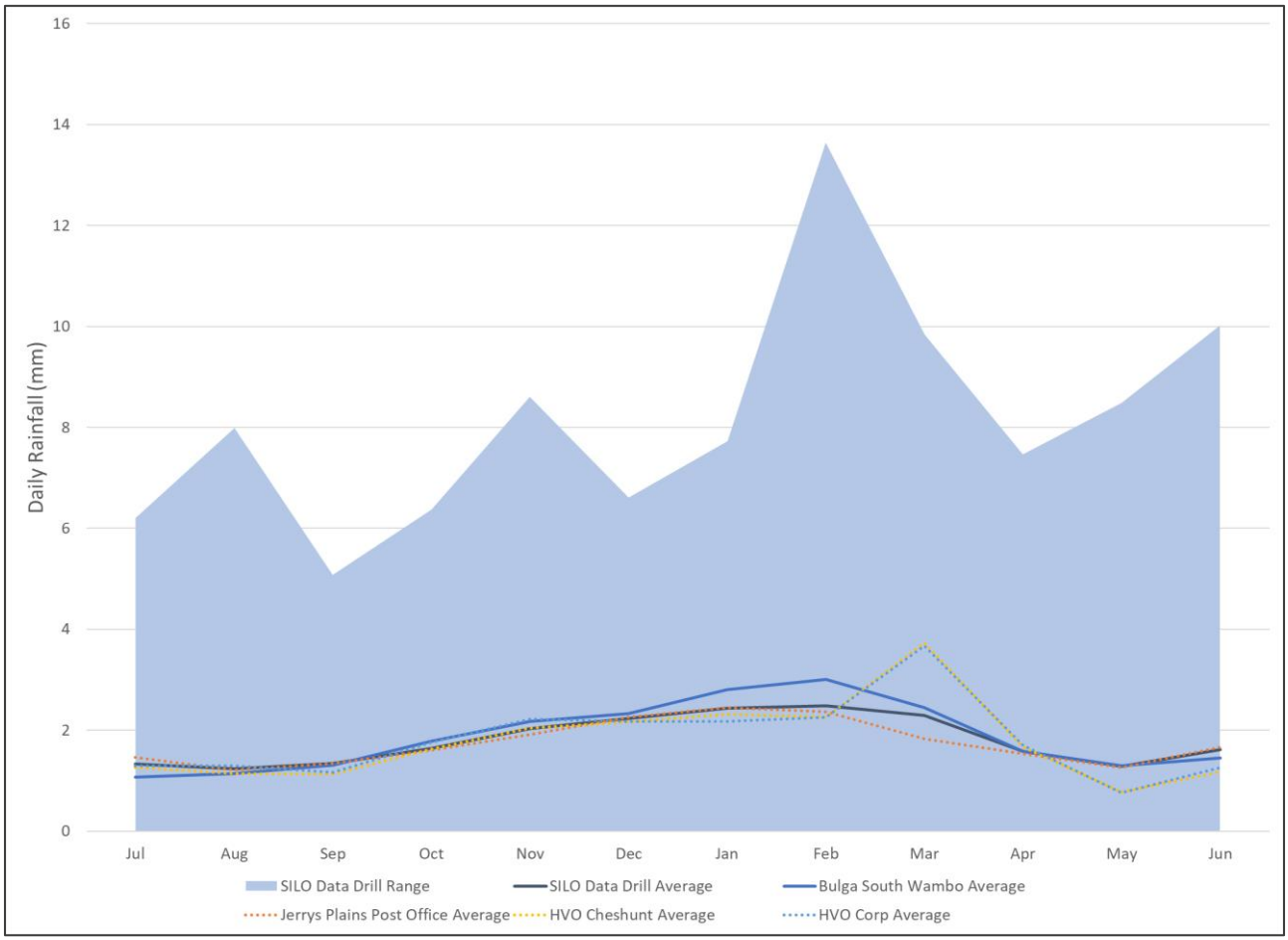


FIGURE 2.1: DAILY RAINFALL COMPARISON (RANGE AND AVERAGE)

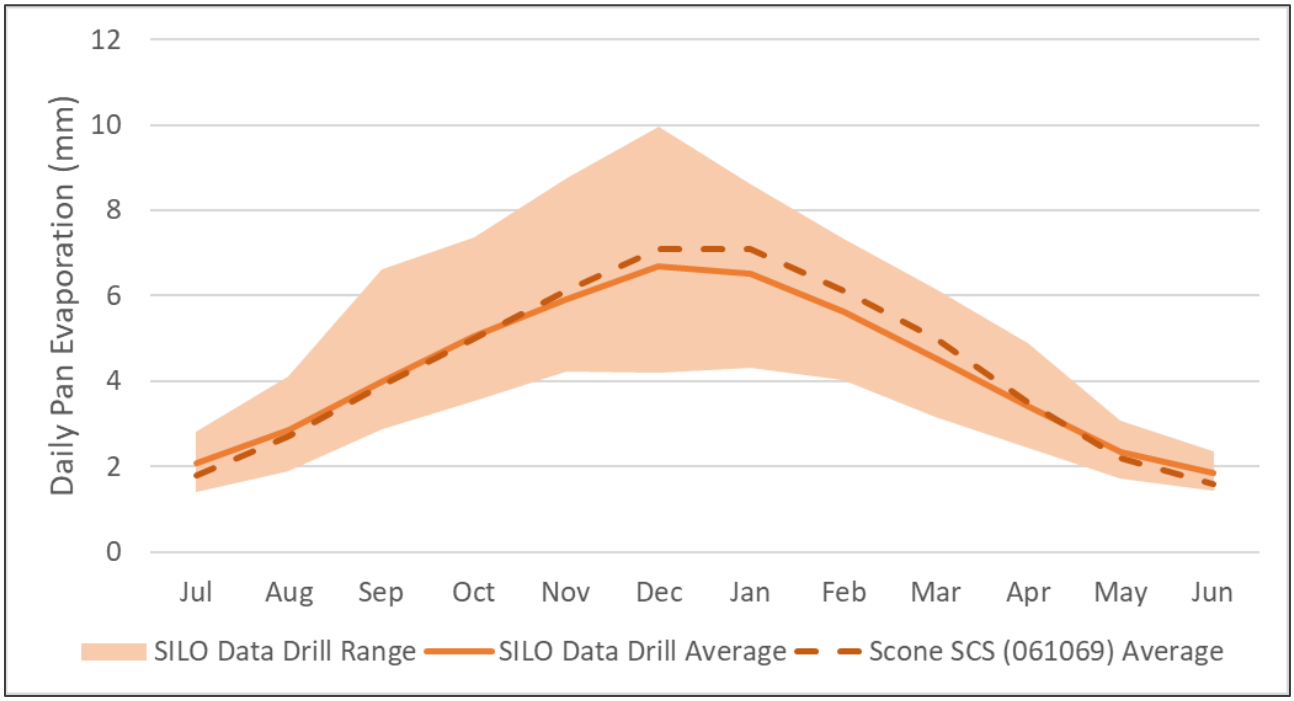


FIGURE 2.2: AVERAGE DAILY EVAPORATION

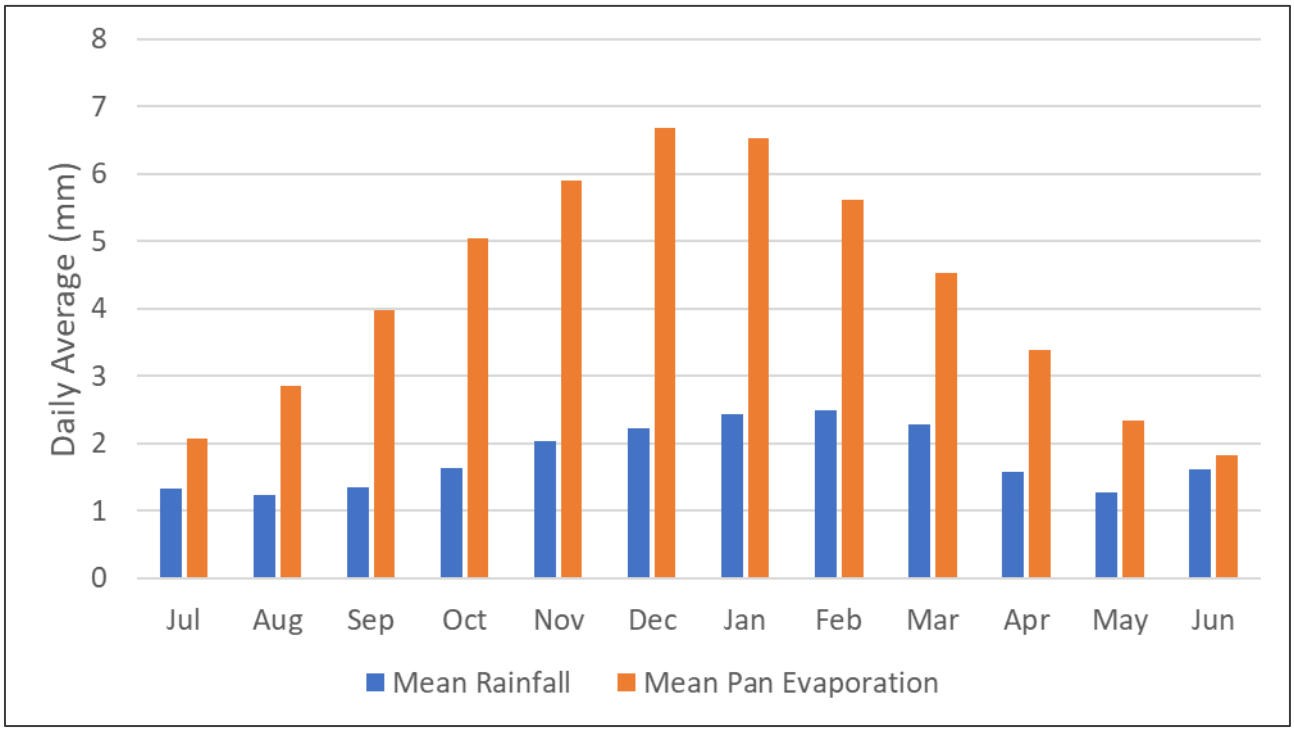


FIGURE 2.3: DAILY MEAN RAINFALL AND EVAPORATION (SILO DATA DRILL)

TABLE 2.2: COMPARISON OF SITE AND SILO DATA

Year / Statistic	HVO Cheshunt Weather Station (mm)	HVO Corp Weather Station (mm)	SILO Data (mm)
2014	615	615	621
2015	814	814	842
2016	693	693	698
2017	470	470	482
2018	409	477	461
2019	371	337	362
2020	758	808	876
2021	918	910	1,064
2022	997	1,048	1,069
2023	458	459	527
2024	628	645	663
10th percentile	409	459	461
20th percentile	458	470	482
Average	648	661	697
80th percentile	814	814	876
90th percentile	918	910	1,064

2.2 Catchment Areas and Watercourses

As discussed earlier, the Amended Project is located in the same catchment areas of the Hunter River and its tributaries as the EIS Project. Land uses within and immediately surrounding the HVO Complex primarily include other mining operations, agricultural land, and rural residential land holdings. Previous mining operations have modified local catchments through the capture of runoff from mining areas within the WMS and diversion of upslope runoff around the mining operations. Downstream water users are discussed further in Section 2.6.

A screening process was undertaken to determine the required extent of the streamflow assessment for the EIS SWIA. This involved determining which watercourses may be impacted by either change to surface catchment areas and/or predicted changes to surface water-groundwater interaction (i.e., baseflow and river leakage). It is noted that most of the catchment disturbance is authorised under existing approvals with only small incremental catchment changes required for the Amended Project. Key findings of the screening process were consistent with the EIS Project as follows:

- No reduction in approved catchment areas at HVO South. This is consistent with the proposed mining at HVO South being within the current approved mining area but with revised mine sequencing.
- Small changes in approved catchment areas at HVO North due to the small increase in the mining extent (between the existing West and Mitchell Pits and Carrington Pit).
- No new watercourse catchments are proposed to be intersected by the Amended Project.

The scoping assessment outcomes were reviewed for the Amended Project and the outcomes for the Amended Project are presented in Table 2.3 including a description of incremental catchment changes due to the Amended Project. An overview of the catchment areas, also showing the extent of the WMS catchment area is shown on Figure 2.4.

The adopted watercourses are described in the following sections while the stream order, existing catchment area and current approved operations catchment area are listed in Table 2.4. Further detail used to inform the screening process is provided in Attachment A (Streamflow Assessment Report).

TABLE 2.3: SUMMARY OF PREDICTED CATCHMENT AND/OR BASEFLOW IMPACTS TO WATERCOURSES

Watercourse System [1]	Catchment Change from Approved due to Amended Project Operation[2]	Baseflow Change from Approved due to Amended Project (Operations) [4, 5]	Baseflow Change from Approved due to Amended Project (Final Landform) [4, 5]	Assessed
Hunter River (Mason Dieu 210128)	Minor changes in upstream tributaries (Parnells Creek, UN1, Pikes Creek and Farrells Creek)	Yes (negative impact)	Yes (negative impact)	Yes
Parnells Creek	Change due to minor differences associated with mining haul roads and WMS (positive impact)	Yes (negative impact)	No	Yes
Unnamed Tributary 1	Change due to increase in mining area with realignment of Lemington Road (negative impact)	No	No	Yes
Unnamed Tributary 2	Change due to approved rehabilitation area being redirected (positive impact)	No	No	Yes
Hobden Gully	-	No	No	Yes[3]
Farrells Creek	Change due to increase in mining area with realignment of Lemington Road (negative impact)	No	No	Yes
Pikes Creek	Change due to extension of Newdell LP stockpile area (negative impact)	No	No	Yes
Bayswater Creek	Change in upstream tributary (Pikes Creek) (negative impact)	No	No	Yes

Watercourse System [1]	Catchment Change from Approved due to Amended Project Operation[2]	Baseflow Change from Approved due to Amended Project (Operations) [4, 5]	Baseflow Change from Approved due to Amended Project (Final Landform) [4, 5]	Assessed
Unnamed Tributary 3	-	No	No	Yes[3]
Unnamed Tributary 4	-	No	No	Yes[3]
Wollombi Brook	Change in upstream tributaries (Unnamed Tributary 5 and 6) (positive impact)	Yes (positive impact)	Yes (positive impact)	Yes
Unnamed Tributary 5	Change due to removal of Lemington Rail Loop from Amended Project area (positive impact)	No	No	Yes
Unnamed Tributary 6	Change due to removal of Lemington Rail Loop from Amended Project area (positive impact)	No	No	Yes

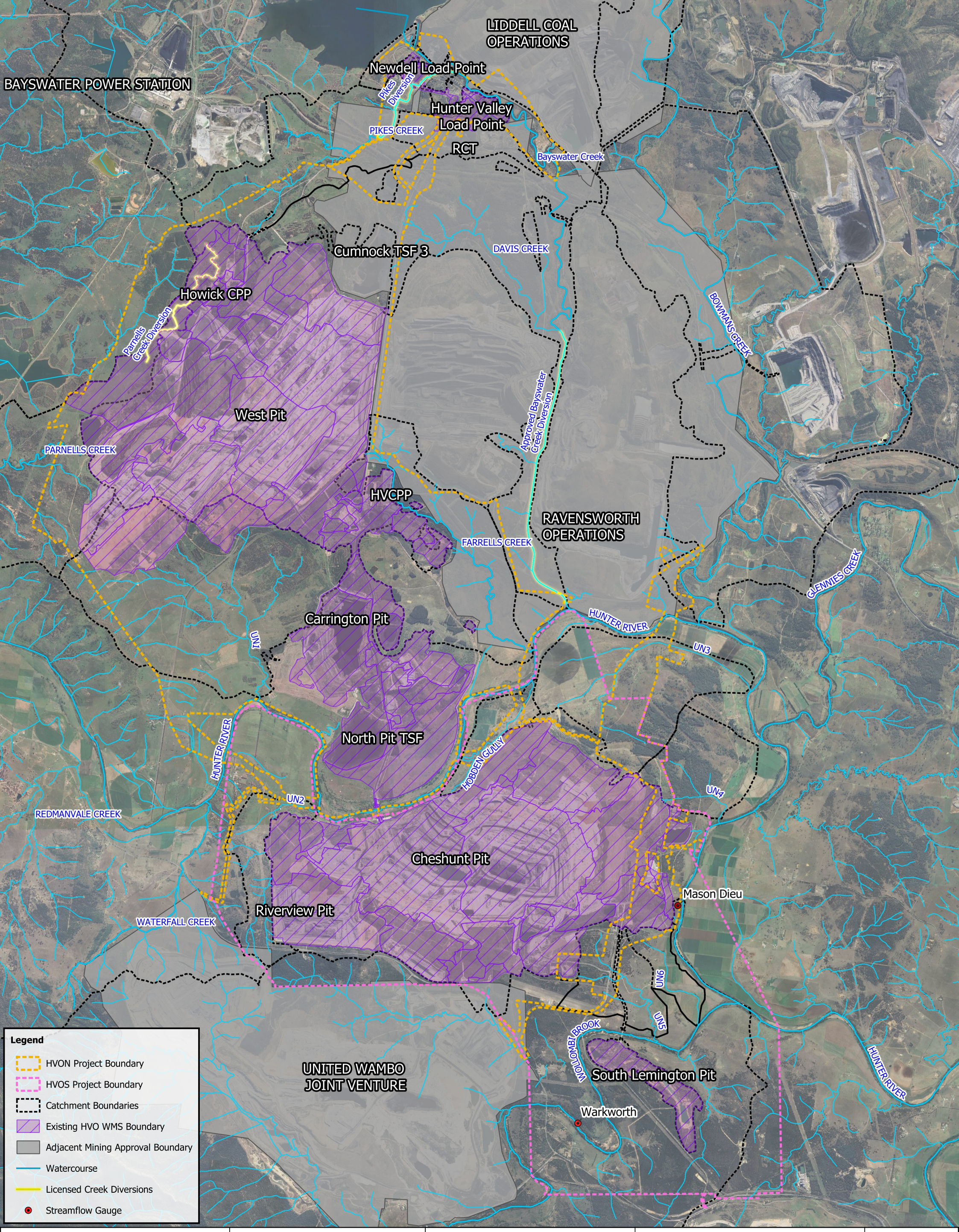
Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed as part of Groundwater Modelling (EMM, 2025b)

Note 2: Maximum impact associated with the Amended Project during operational period. Final landform catchments increase relative to existing and approved operations (positive impact) for all watercourses.

Note 3: No change to catchments or baseflow during operations, included to assess streamflow conditions for final landform catchment.

Note 4: Predicted as part of Groundwater Modelling (EMM, 2025b).

Note 5: Negative impact refers to a predicted reduction in baseflows, Positive impact refers to a predicted increase in baseflows.



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HUNTER VALLEY OPERATIONS

0 1.5 3 km

Scale in metres (1:60,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

HVO Continuaton Project - Amended Project

Figure 2-4:
Surface Water Catchment Context

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 1 /7 /2025

TABLE 2.4: WATERCOURSE CATCHMENT AREAS

Watercourse	Schedule (order)	Catchment Area (ha) – 2025	Catchment Area (ha) – Approved Operations
Hunter River (Mason Dieu 210128)	Schedule 3	1,439,000[1]	1,438,000
Parnells Creek	Schedule 2 (3rd order)	1,015	1,010
Unnamed Tributary 1	Schedule 2 (4th order)	1,015	765
Unnamed Tributary 2	Schedule 2 (4th order)	215	170
Hobden Gully	Schedule 1 (2nd order)	120	120
Farrells Creek	Schedule 2 (3rd order)	585	665
Pikes Creek	Schedule 2 (3rd order)	645	645
Bayswater Creek (including catchment area of Pikes Creek)	Schedule 2 (4th order)	2,040	2,045
Unnamed Tributary 3	Schedule 1 (2nd order)	615	615
Wollombi Brook	Schedule 3	187,500[2]	187,300
Unnamed Tributary 5	Schedule 1 (2nd order)	240	150
Unnamed Tributary 6	Schedule 1 (1st order)	105	85

Note 1: Source: WaterNSW real time data for gauging station 210128 (Hunter River at Mason Dieu)

Note 2: Source: Based on 1:25,000 LPI topographical map series

2.2.1 Hunter River

The HVO Complex is located within the catchments of several tributaries of the Hunter River, including Parnells Creek, Farrells Creek, Bayswater Creek, Hobden Gully and the Wollombi Brook (refer to Figure 2.4). Additional tributaries adjacent to the HVO Complex include Bowmans Creek and Glennies Creek. The confluences of these tributaries of the Hunter River occur between HVO North and HVO South however were not impacted by the EIS Project disturbance area and are also not impacted by the Amended Project disturbance area. The Hunter River is a regulated river and flows through the Amended Project area, between HVO North and HVO South.

The Hunter River has a catchment area of approximately 14,000 km^2 in the vicinity of HVO (i.e., at the Mason Dieu flow gauge (210128)) and 16,400 km^2 at the nearby town of Singleton.

In the vicinity of the HVO Complex, the Hunter River ranges in width from 30 m to 50 m and varies in depth. This section of the river is surrounded by moderate riparian vegetation and dominated by the Hunter soil landscape. The Hunter River (Mason Dieu flow gauge (210128)) is shown in Figure 2.5. Soils in the Hunter soil landscape range from being moderately to rapidly drained, with moderate to low fertility levels (Kovac & Lawrie, 1991).

The flow in the Hunter River is highly susceptible to rainfall and flood rises have the potential, consistent with the EIS Project, to impact the Amended Project.



(captured 10th November 2020)

FIGURE 2.5: HUNTER RIVER – LOOKING DOWNSTREAM (AT MAISON DIEU)

2.2.2 Parnells Creek

Parnells Creek is a third order tributary of the Hunter River and is an ephemeral creek system (refer to Figure 2.4). Parnells Creek is frequently dry except following large rainfall events. The catchment of Parnells Creek is highly modified, and a large portion of the upper Parnells Creek catchment is currently incorporated into the HVO North WMS.

A section of Parnells Creek, adjacent the HVO North WMS, has been historically diverted around the WMS with a trapezoidal channel. This diversion channel is licensed under the WM Act. Downstream of the HVO WMS, the natural Parnells Creek has a defined channel with width varying from up to 10 m in the upstream sections (refer to Figure 2.6) to 2 m further downstream towards the confluence with the Hunter River (refer to Figure 2.7). The channel batters are relatively incised due to erosion and have a depth of approximately 2 to 3 m. The Bayswater soil landscape occurs in the Parnells Creek catchment area and is susceptible to sheet and gully erosion (Kovac & Lawrie, 1991).

Parnells Creek is highly sinuous with a gradual bed slope towards the confluence with the Hunter River. Vegetation varies from sections that are limited to grassland to sections that are highly vegetated with shrubs and trees. Following rainfall events, standing water results in growth of dense reed and rush vegetation within the channel bed.

Parnells Dam (Dam 9W) discharges, via the HRSTS and EPL, to Parnells Creek (refer to Section 3.1.5).



(captured 10th November 2020)

FIGURE 2.6: PARNELLS CREEK – LOOKING DOWNSTREAM (DOWNSTREAM OF THE PROJECT AREA)



(captured 10th November 2020)

FIGURE 2.7: PARNELLS CREEK – LOOKING DOWNSTREAM (TOWARDS THE CONFLUENCE WITH THE HUNTER RIVER)

2.2.3 Unnamed Tributary 1

Unnamed Tributary 1 (UN1) is a fourth order watercourse that flows adjacent to the HVO North WMS, in a southerly direction towards the Hunter River (refer to Figure 2.4). The upper catchment has been partly modified due to mining and now includes areas of rehabilitated mine lands. UN1 is located entirely within the approved disturbance and mining area. As part of the Amended Project (and similar to the existing approved operation and the EIS Project), the catchment of UN1 will be partially mined through (including through previously mined areas) and then drainage reinstated as part of the Amended Project. The existing land use within the catchment is predominantly farming and grazing. Several farm dams are located on the tributaries of UN1, reducing flow in the main channel.

The tributary is dry between rainfall events, however, based on a site inspection following a rainfall event some pools of standing water tend to be present immediately after rainfall events in the downstream reaches, near the confluence with the Hunter River (refer to Figure 2.8).

The upper reaches of UN1 are characterised by a variable width floodplain with a wide notched shape channel. Towards the confluence with the Hunter River, the channel depth increases to up to 8 m with steep slopes on the left bank. The channel and floodplain are grass lined for the entire length of the tributary, as shown in Figure 2.9 (access road crossing). Some denser vegetation is present at the confluence with the Hunter River. The upper areas of the catchment are the Dartbrook soil landscape which can have minor to moderate sheet erosion on hilltops and moderately well drained soils. The Liddell soil landscape which occurs within the lower catchment is poorly/imperfectly to well-draining with moderate to low fertility levels (Kovac & Lawrie, 1991).



(captured 10th November 2020)

FIGURE 2.8: UNNAMED TRIBUTARY 1 – LOOKING DOWNSTREAM (TOWARDS CONFLUENCE WITH HUNTER RIVER)



(captured 10th November 2020)

FIGURE 2.9: UNNAMED TRIBUTARY 1 – LOOKING DOWNSTREAM (WITHIN THE PROJECT AREA)

2.2.4 Unnamed Tributary 2

Unnamed Tributary 2 (UN2) is a fourth order tributary of the Hunter River and is an ephemeral watercourse, with flow only following a significant rainfall event (refer to Figure 2.4). UN2 has a highly modified catchment due to mining activities. The rehabilitated overburden emplacement area for the Riverview Pit in HVO South is located partially over the original drainage line location. No formal channel has been constructed around the rehabilitated overburden emplacement area and the drainage line in this area is therefore not well defined. As a result, runoff makes its way from the upper catchment to the natural drainage line downstream of the rehabilitated overburden emplacement area via sheet flow and road drainage systems.

Significant erosion is evident in the natural, upstream reaches of UN2 (refer to Figure 2.10). Downstream of the overburden emplacement area, UN2 diverges from a wide floodplain to a defined notch-shaped channel approximate 1 to 2 m wide and 4 m deep, as shown in Figure 2.11. The upper reaches are moderately vegetated while the downstream floodplain has limited vegetation. The Hunter soil landscape which occurs within the catchment are moderately to rapidly draining with moderate to low fertility levels (Kovac & Lawrie, 1991).



(captured 11th November 2020)

FIGURE 2.10: UNNAMED TRIBUTARY 2 – LEFT BANK



(captured 11th November 2020)

FIGURE 2.11: UNNAMED TRIBUTARY 2 – LOOKING DOWNSTREAM (ADJACENT TO PROPOSED DISTURBANCE BOUNDARY)

2.2.5 Hobden Gully

Hobden Gully is a second order ephemeral watercourse and a tributary of the Hunter River (refer to Figure 2.4). The former Hobden Gully catchment has been highly modified due to mining within the approved HVO South operations. These modifications have reduced the length of the Hobden Gully catchment from approximately 8 km to the current 3 km.

The remaining length of Hobden Gully is sinuous in the upper reaches with limited bends towards the confluence with the Hunter River. Hobden Gully is a relatively wide, open channel with limited vegetation along most of the channel. Dense riparian vegetation is present at the confluence with the Hunter River, as shown in Figure 2.12.



(captured 11th November 2020)

FIGURE 2.12: HOBDEN GULLY – LOOKING DOWNSTREAM (TOWARDS CONFLUENCE WITH HUNTER RIVER)

2.2.6 Farrells Creek

Farrells Creek is a third order ephemeral creek watercourse which drains southwards towards the Hunter River (refer to Figure 2.4). The headwaters of Farrells Creek are located within the HVO North Project area and the catchment area is highly modified by historical approved mining activities. A section of Farrells Creek was modified as part of the approved HVO North mining operations. The modified section runs around the eastern boundary of the stockpiles at the HVCPP. HVO owns a large portion of the land within the Farrells Creek catchment area. The adjacent Ravensworth Operations is also located within the Farrells Creek catchment.

The soil landscape within most of the Farrells Creek catchment is the Liddell soil landscape. This includes low relief, gentle slopes, low fertility and slightly acidic topsoils. The area is imperfectly drained and has moderate erosion potential (Kovac & Lawrie, 1991). The Hunter soil landscape occurs around the lower reaches of Farrells Creek near its confluence with the Hunter River. Soils in this area of the catchment are moderately to rapidly draining with moderate to low fertility levels (Kovac & Lawrie, 1991).

The Farrells Creek channel ranges from 1 to 4 m wide and 0.5 to 5 m deep. Significant active bank erosion and moderate gully erosion is evident within sections of the creek due to flows during larger rainfall events.

The creek is surrounded by riparian vegetation, as shown in Figure 2.13 and Figure 2.14.



(captured 10th November 2020)

FIGURE 2.13: FARRELLS CREEK – LOOKING DOWNSTREAM (LOWER REACHES)



(CAPTURED 10TH NOVEMBER 2020)

FIGURE 2.14: FARRELLS CREEK – LOOKING DOWNSTREAM (UPPER REACHES)

2.2.7 Pikes Creek

Pikes Creek is a third order watercourse which flows in a north-easterly direction before joining Bayswater Creek (refer to Figure 2.4). Approximately 2 km of Pikes Creek is diverted around the HVO Newdell LP. This diversion is licensed under the WM Act. The Pikes Creek catchment area is highly modified and reduced due to the construction of the Ash Dam at Bayswater Power Station.

Pikes Creek is a relatively wide, open channel dominated by sedge and rush vegetation, particularly during wetter periods, as shown in Figure 2.15. The Pikes Creek catchment is made up of the Liddell soil landscape which has low relief, gentle slopes, low fertility and slightly acidic topsoil. The soils within the catchment are susceptible to moderate erosion (Kovac & Lawrie, 1991).



(captured 10th November 2020)

FIGURE 2.15: PIKES CREEK – LOOKING DOWNSTREAM

2.2.8 Bayswater Creek

Bayswater Creek drains southwards through Ravensworth Operations, towards the Hunter River (refer to Figure 2.4).. The headwaters of Bayswater Creek are located at the downstream boundary of Lake Liddell and the former catchment area is highly impacted by mining activities and the construction of Lake Liddell. Approximately 5 km of the Bayswater Creek channel has been realigned through Ravensworth Operations. The licensed diversion channel (under the WM Act) is part of the Ravensworth Operations and extends from downstream of the confluence with Davis Creek to approximately 100 m upstream of the confluence with the Hunter River.

Bayswater Creek (fourth order stream) and its tributaries, including Davis Creek and Pikes Creek (refer to Figure 2.4), are ephemeral creek systems which remain dry between rainfall events. Upstream and downstream of the approved Bayswater Creek Diversion, Bayswater Creek is well defined with varying channel width and often exceeding 4 m in depth. Well developed, riparian vegetation is present upstream of the diversion channel and at the confluence with the Hunter River (refer to Figure 2.16 and Figure 2.17).

The Bayswater soil landscape is susceptible to sheet and gully erosion (Kovac & Lawrie, 1991). The Hunter soil landscape also occurs within the lower reaches of Bayswater Creek which are moderately to rapidly draining with moderate to low fertility levels (Kovac & Lawrie, 1991).

HVO and Ravensworth Operations own most of the land within the Bayswater Creek catchment area.



(captured 10th November 2020)

FIGURE 2.16: BAYSWATER CREEK – LOOKING DOWNSTREAM (UPSTREAM OF DIVERSION)



(CAPTURED 10TH NOVEMBER 2020)

FIGURE 2.17: BAYSWATER CREEK – LOOKING DOWNSTREAM (TOWARDS CONFLUENCE WITH HUNTER RIVER (IMMEDIATELY DOWNSTREAM FROM DIVERSION DROP STRUCTURE)

2.2.9 Unnamed Tributary 3

Unnamed Tributary 3 (UN3) is a second order ephemeral watercourse which flows into the Hunter River from the west, approximately 1 km upstream of the confluence of the Hunter River with Glennies Creek (refer to Figure 2.4). The land use within the catchment is predominantly farming and grazing. The tributary is typically dry except following significant or prolonged rainfall events. Following rainfall events, some pools of standing water tend to be present in the downstream reaches, near the confluence with the Hunter River.

The tributary is located within a wide floodplain with a moderately defined channel of general width between 10 to 20 m. The banks and bed of within UN3 are vegetated with sedge and rush plants (refer to Figure 2.18). The Branxton soil landscape which occurs within the catchment typically has moderately well drained soils and low fertility levels (Kovac & Lawrie, 1991).



(captured 11th November 2020)

FIGURE 2.18: UNNAMED TRIBUTARY 3 – LOOKING DOWNSTREAM (DOWNSTREAM OF HVO NORTH PROJECT AREA)

2.2.10 Wollombi Brook

Wollombi Brook is a tributary of the Hunter River and flows in a northerly direction from Paxton and Millfield in the south to join the Hunter River near Warkworth (refer to Figure 2.4). Adjacent to the Amended Project Area (which is the same as the EIS Project Area), Wollombi Brook meanders east between the HVO South Cheshunt Pit and South Lemington Pit 1 before flowing into the Hunter River. The existing nature of Wollombi Brook downstream of the Amended Project area is shown in Figure 2.19.

Wollombi Brook has a highly variable flow pattern and Erskine (2008) reports that the watercourse is constantly responding to, and recovering from, flooding. Wollombi Brook also experiences significant dry periods when surface flows cease or are significantly reduced.

In the vicinity of the HVO South Amended Project area, Wollombi Brook is fed by several small, ephemeral tributaries including Redbank Creek, Unnamed Tributary 5 (UN5), Unnamed Tributary 6 (UN6) (refer to Figure 2.4) and Longford Creek. The current catchment area of Wollombi Brook is approximately 187,100 ha, with the Amended Project being located adjacent to the confluence of Wollombi Brook with the Hunter River.

Parts of the Wollombi Brook catchment area have been previously disturbed by mining activities including existing operations at Bulga Coal Complex, Mount Thorley Warkworth, United Wambo and HVO South. Land uses within the Wollombi Brook catchment in the vicinity of HVO include private residences and mining landholdings. Forest and bushland dominate land use within the catchment of Wollombi Brook (approximately 87 per cent of the total catchment area), with the catchment areas upstream of HVO supporting parts of the Corrabare, Olney, Pokolbin and Watagan State Forests, parts of the Yengo National Park and a component of the Greater Blue Mountains World Heritage Area (the boundary of which overlaps with the National Park). The remaining land uses in the catchment consist of pasture, grazing and cropping farmland, mainly constrained within the flat and fertile river valleys.

The soils within the Wollombi Brook catchment adjacent to the Amended Project area are predominately comprised of Jerrys Plains soil landscape which is typically sandy soils of moderate erodibility (Kovac & Lawrie, 1991). Moderate erosion is present within the bed and banks of the Wollombi Brook, adjacent to the Amended Project area.



(captured 11th November 2020)

FIGURE 2.19: WOLLOMBI BROOK – LOOKING DOWNSTREAM (SOUTH LEMINGTON VOID HAUL ROAD CROSSING)

2.2.11 Unnamed Tributary 5

UN5 is a second order watercourse that flows in a southerly direction, flowing into Wollombi Brook to the north of South Lemington Pit 1 (refer to Figure 2.4). A portion of catchment has been modified due to mining and construction of the HVO South MIA. The tributary is an ephemeral watercourse and is dry between rainfall events with isolated pools of standing water following a rainfall event.

The lower reaches of UN5 are sinuous with variable width floodplain and notched shape channel. The channel and floodplain are predominantly grassland (refer to Figure 2.20) except for sections of the upper reaches which are moderately vegetated with trees. Some denser riparian vegetation is also present at the confluence with Wollombi Brook. The soils within the catchment are Jerrys Plains soil landscape which is typically sandy soils of moderate erodibility (Kovac & Lawrie, 1991).



(captured 11th November 2020)

FIGURE 2.20: UNNAMED TRIBUTARY 5 – LOOKING DOWNSTREAM

2.2.12 Unnamed Tributary 6

UN6 is a first order watercourse that flows in a southerly direction, flowing into Wollombi Brook to the north of South Lemington Pit 1 (refer to Figure 2.4). A portion of catchment has been modified due to mining and construction of the HVO South MIA. The tributary is an ephemeral watercourse and is dry between rainfall events with isolated pools of standing water following a rainfall event. A mine dam and several farm dams have been constructed along the tributary.

The tributary is located within a wide floodplain with a moderately defined channel of general width around 20 m. The channel and floodplain are predominantly grassland except for the section upstream of a clean water dam, which is moderately vegetated with trees. The soils within the catchment are Jerrys Plains soil landscape which is typically sandy soils of moderate erodibility (Kovac & Lawrie, 1991).

2.3 Flow Regimes

The flow regimes of the watercourses described in Section 2.2 have been assessed to determine key flow characteristics including the frequency and magnitude of flow, annual flow volumes and the occurrence and duration of dry days. The methodology and detailed assessment are presented in Attachment A while Amended Project impacts are assessed in Section 6. Key baseline characteristics, i.e. present day, of the streams are in summary as follows:

- Flow duration curves are presented for the Hunter River, Wollombi Brook and the ephemeral watercourses in Figure 2.21 to Figure 2.23.
- The average annual dry days (defined as flows less than 100 ML/day (approximately 1,160 L/s) in the Hunter River and flows less than 0.1 ML/day (approximately 1 L/s) in its tributaries) and flow volumes are summarised in Table .

TABLE 2.5: AVERAGE ANNUAL FLOW CONDITIONS[1]

Watercourse	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)
Hunter River (Mason Dieu 210128)	24	410,000
Parnells Creek	274	640
Unnamed Tributary 1	252	140
Unnamed Tributary 2	304	130
Hobden Gully	318	80
Farrells Creek	274	370
Pikes Creek	270	400
Bayswater Creek	238	870
Unnamed Tributary 3	272	380
Wollombi Brook	52	172,400
Unnamed Tributary 5	301	150
Unnamed Tributary 6	320	70

1. Based on 2025 catchment areas.

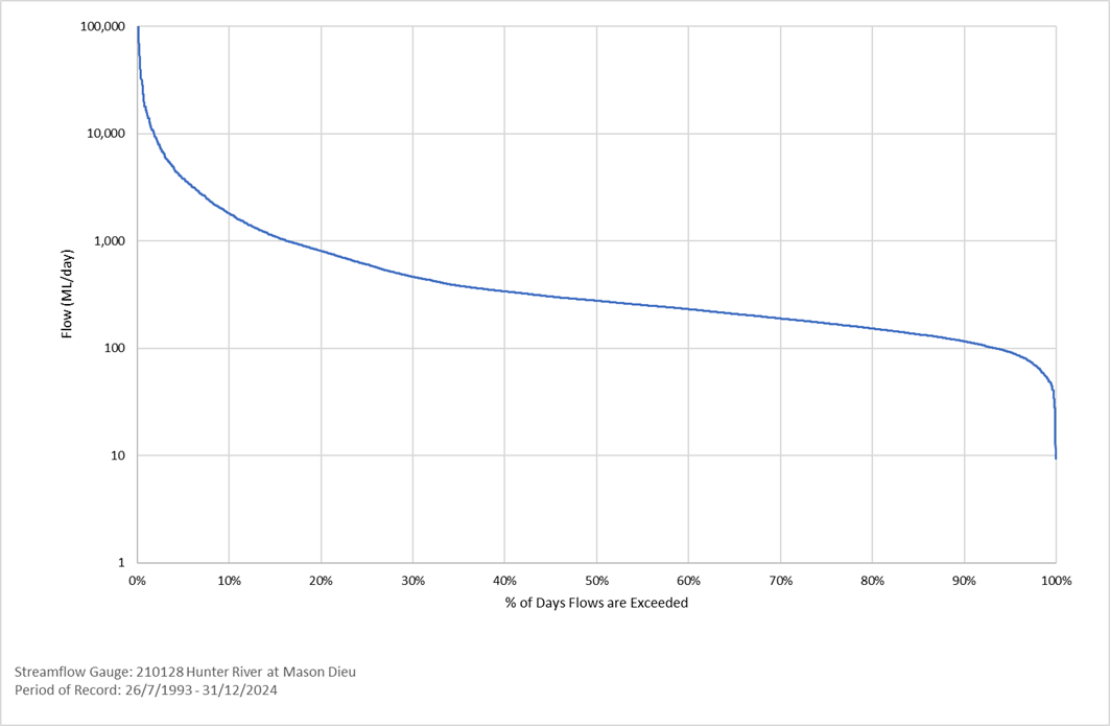


FIGURE 2.21: HISTORICAL FLOW GAUGING DATA – HUNTER RIVER AT MASON DIEU (210128)

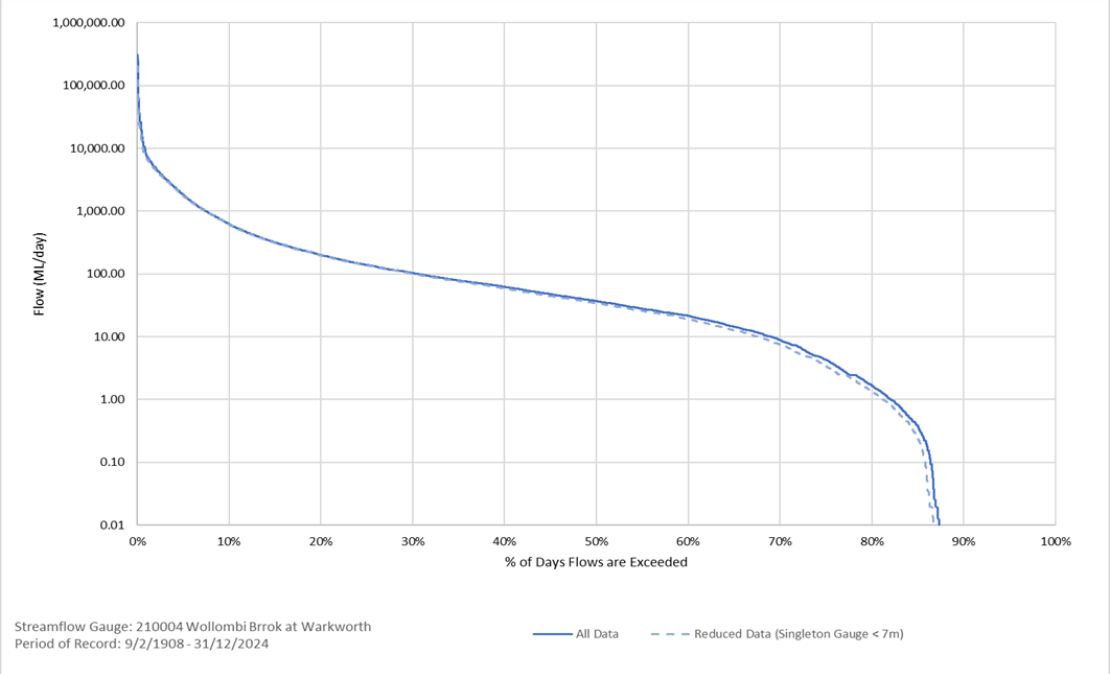


FIGURE 2.22: HISTORICAL FLOW GAUGING DATA – WOLLOMBI BROOK AT WARKWORTH (210004)

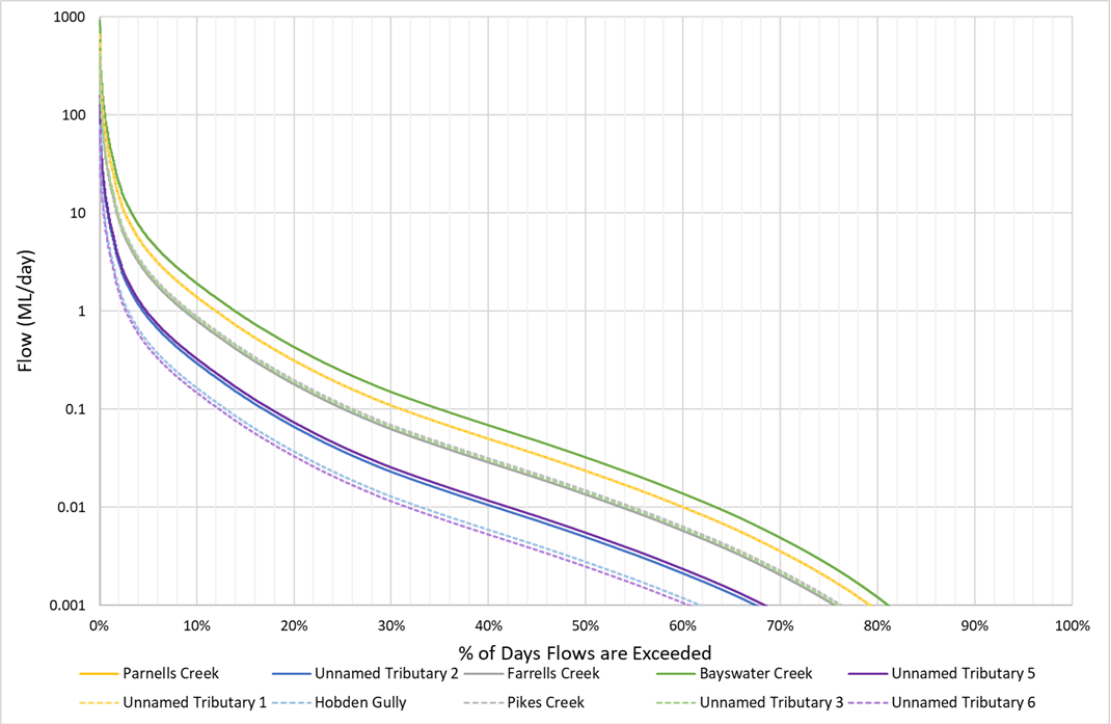


FIGURE 2.23: FLOW DURATION MODELLED RESULTS – EPHEMERAL WATERCOURSES

2.4 Flooding

A flood assessment was undertaken of the Hunter River to define baseline flooding conditions in the vicinity of the HVO Complex for the EIS Project SWIA (Engeny, 2022) and peer reviewed by Barry Rodgers (BMT) (refer to Section 1.5). This included development and calibration of a flood model to define existing flooding conditions and allow assessment of the impact of the EIS Project.

The EIS Project was referred to the IEAPM by DPHI. The IEAPM has been established to provide access to world-best scientific advice when assessing mining proposals and post-approval matters under the *Environmental Planning and Assessment Act 1979.*

Following the exhibition of the Project EIS (EMM, 2022) the DPHI requested for additional information in response to the Flooding Peer Review and the BCD submission. A response was submitted to DPHI in August 2024. The Flooding Peer Review prepared for the DPHI, undertaken by Torrent Consulting, stated the following "*Notwithstanding these limitations, the modelling, impact assessment and design are considered to appropriately consider and address flood risk for the proposed development in accordance with industry practice and requirements of the SEARS".*

Following the submissions report (EMM, 2023a) and responses to DPHI no additional information was sought by DPHI or BCD in regard to the flood assessment.

As the Amended Project does not encroach onto the floodplain further than the EIS Project or further reduce floodplain storage it is considered that the impacts from the Amended Project will be no greater than those modelled for the EIS Project (Engeny, 2022) and has not been re-simulated for the Amended Project. As such the flood assessment for the EIS Project is not included in this Amended Project SWIA.

2.5 Water Quality

The NSW Water Quality and River Flow Objectives (as published by the Office of Environment and Heritage (OEH)) are the agreed environmental values and long-term goals for NSW surface waters. The objectives are consistent with the agreed national framework for assessing water quality as set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) (ANZG, 2018).

2.5.1 Water Quality Monitoring Program

HVO monitors surface water quality in accordance with the approved WMP (HVO, 2018). The surface water monitoring program covers all three water category areas within the HVO complex; clean, sediment and mine water systems. The existing surface water quality monitoring locations are shown on Figure 2.24 below.

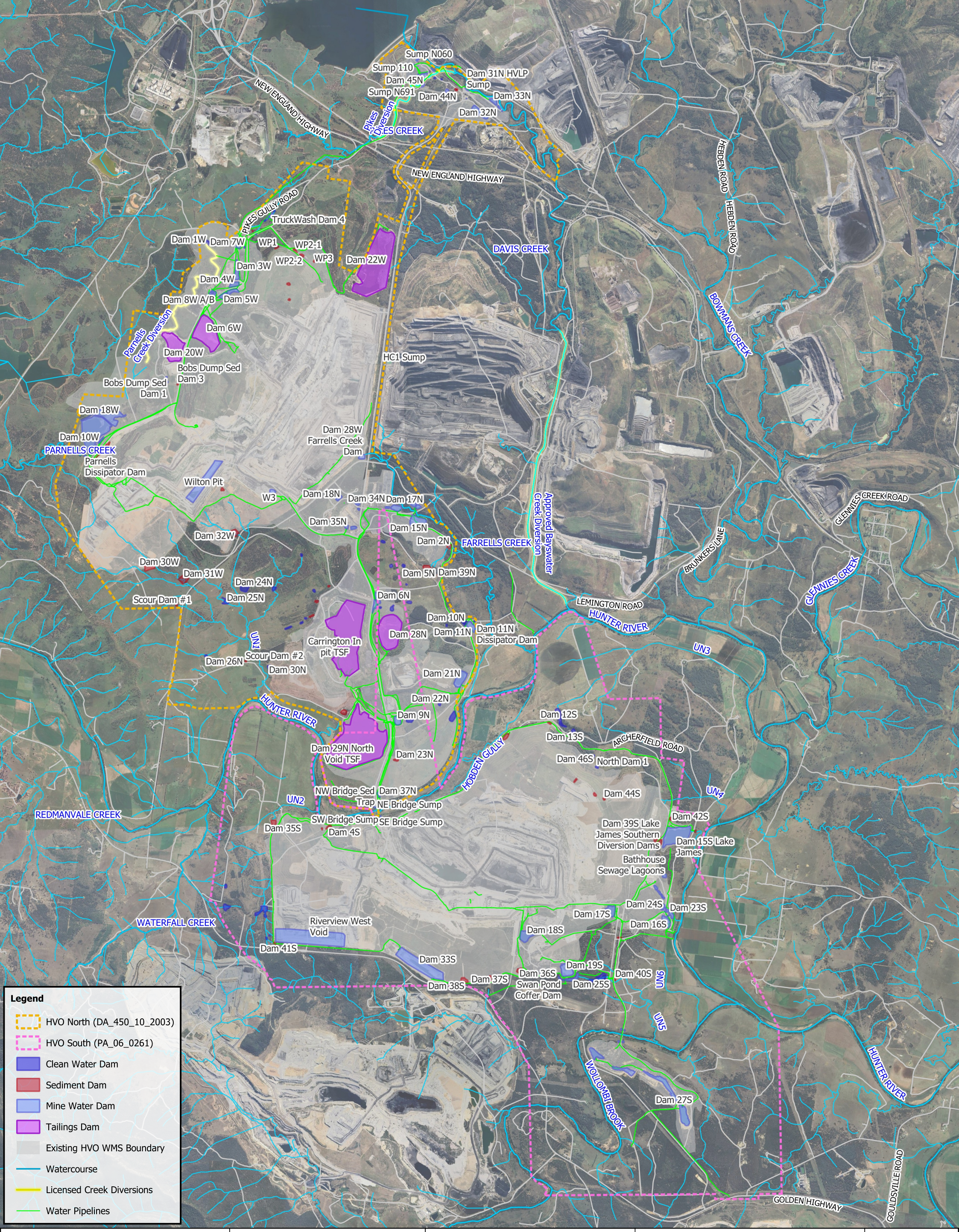
The surface water monitoring program requires the following:

- Basic Analysis:
  - Hunter River, Wollombi Brook and sediment water and mine water monitoring locations are sampled quarterly for pH, electrical conductivity (EC) and total suspended solids (TSS).
  - Ephemeral creeks are monitored for pH, EC and TSS following a rainfall event of 30 mm or greater in 24 hours. This is limited to a maximum of two sampling events per quarter.
- Comprehensive Analysis:
  - All sites are currently sampled on an annual basis (except two sites that are six monthly) for a range of total metals and elements/compounds.
  - Comprehensive testing, in addition to the basic suite, also occurs in the event of anomalous pH results (e.g., low pH).
  - Comprehensive analysis includes major ions, total dissolved solids (TDS), Aluminium (Al), Arsenic (As), Boron (B), Calcium (Ca), Cadmium (Cd), Chlorine (Cl), Carbonate (CO_3), Copper (Cu), Mercury (Hg), Potassium (K), Magnesium (Mg), Sodium (Na), Nickel (Ni), Lead (Pb), Selenium (Se), Sulfate (SO_4 or S), Zinc (Zn), Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity.

It is noted that the low risk of metal/metalloid contamination has driven the frequency of the comprehensive analysis suite.

As documented in the WMP, HVO uses the following performance indicators to initiate site specific investigations regarding surface water quality:

- Professional judgement determines that the single deviation or a developing trend could result in environmental harm.
- Three consecutive measurements of EC or pH exceed trigger values.
- One measurement of TSS exceeds the trigger value.



Legend

- HVO North (DA_450_10_2003)
- HVO South (PA_06_0261)
- Clean Water Dam
- Sediment Dam
- Mine Water Dam
- Tailings Dam
- Existing HVO WMS Boundary
- Watercourse
- Licensed Creek Diversions
- Water Pipelines

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HUNTER VALLEY OPERATIONS

0 1 2 km

Scale in metres (1:60,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 2-24:
Surface Water Monitoring Locations

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 1 /7 /2025

2.5.2 Review of Surface Water Quality

An assessment of the already extensive available historical water quality monitoring data was undertaken in 2018 (Engeny, 2018) with the surface water monitoring program subsequently extended for some locations and analytes to provide additional background data for this Project. Subsequently there is sufficient water quality monitoring data (greater than 2 years of monthly sampling, i.e., 24 samples) to confidently review the water quality data/trends for pH, EC, TSS and TDS, as well as nutrients and a range of metals/metalloids for all clean, sediment and mine water (excluding mine pits) systems.

A review of surface water quality was included in the EIS SWIA (Engeny, 2022)). Using extended historical data sets (2011 to 2024) and methods outlined in the ANZECC guidelines, the surface water quality has been reviewed and is presented in this section with analysis for the maximum, minimum, average, median, 80th percentile and 20th percentile. The same methods that were used for analysis in the EIS SWIA (Engeny, 2022) have been used for the extended data set.

Water quality monitoring data for pH, EC, TSS and TDS are reported in the HVO Annual Reviews. Data presented in the Annual Reviews indicate that water quality in downstream watercourses, including the Hunter River, Wollombi Brook and other ephemeral tributaries generally remain within historical trends and trigger levels.

Statistical analyses of the existing water quality monitoring data for pH, EC, TSS and TDS at each monitoring location along watercourses and tributaries and site storages were undertaken. A summary of the analyses within each WMS (clean, sediment and mine) is presented in a series of box and whisker plots (Figure 2.25 to Figure 2.28) for each watercourse within the clean water system, the sediment water system and the mine water system. The relevant default water quality objectives (i.e., the same as the ANZG default trigger values methods) for clean water systems are included in Table 2.6 with comparison to published values. Plots of recorded water quality parameters, including the water quality objectives identified in Table 2.6, as well as for the sites along each watercourse, within the sediment water system and within the mine water system are included in Attachment B.

TABLE 2.6: DEFAULT WATER QUALITY OBJECTIVES FOR CLEAN WATER SYSTEMS (GUIDELINE VALUES)

Aspect	pH	EC (µS/cm)	TSS (mg/L)
Hunter River	8.0 – 8.4[1]	959[2]	53[2]
Wollombi Brook	7.3 – 7.9[1]	908[2]	20[2]
Ephemeral Creeks	7.3 – 8.1[1]	3,806[2]	63[2]
ANZG default guidelines values	6.5 – 8.0	125 - 2,200	-
Blue Book (Landcom 2004) value	-	-	50[3]

Note 1: 20th/80th percentile of historical data

Note 2: 80th percentile of historical data

Note 3: Not a guideline value but included for context

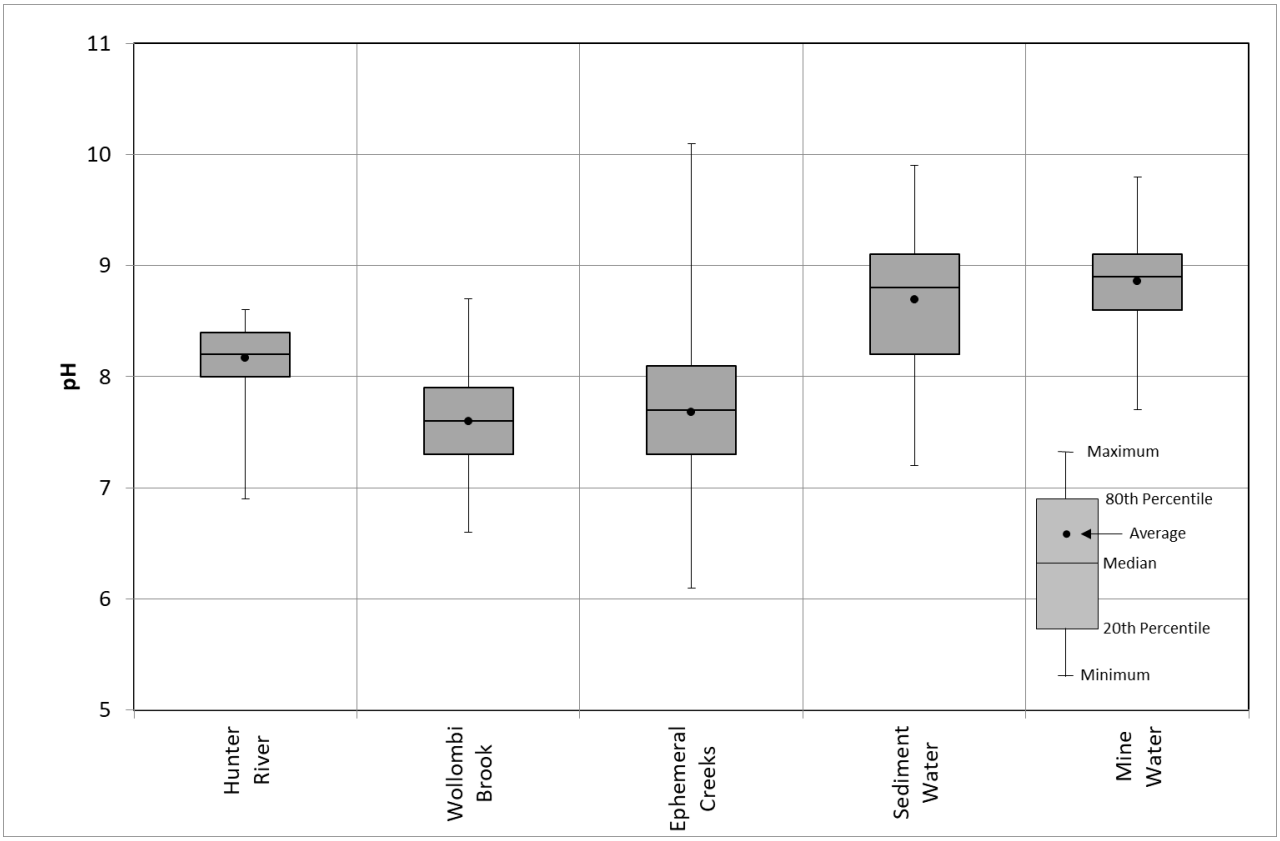


FIGURE 2.25: BOX AND WHISKER STATISTICAL ANALYSIS – PH

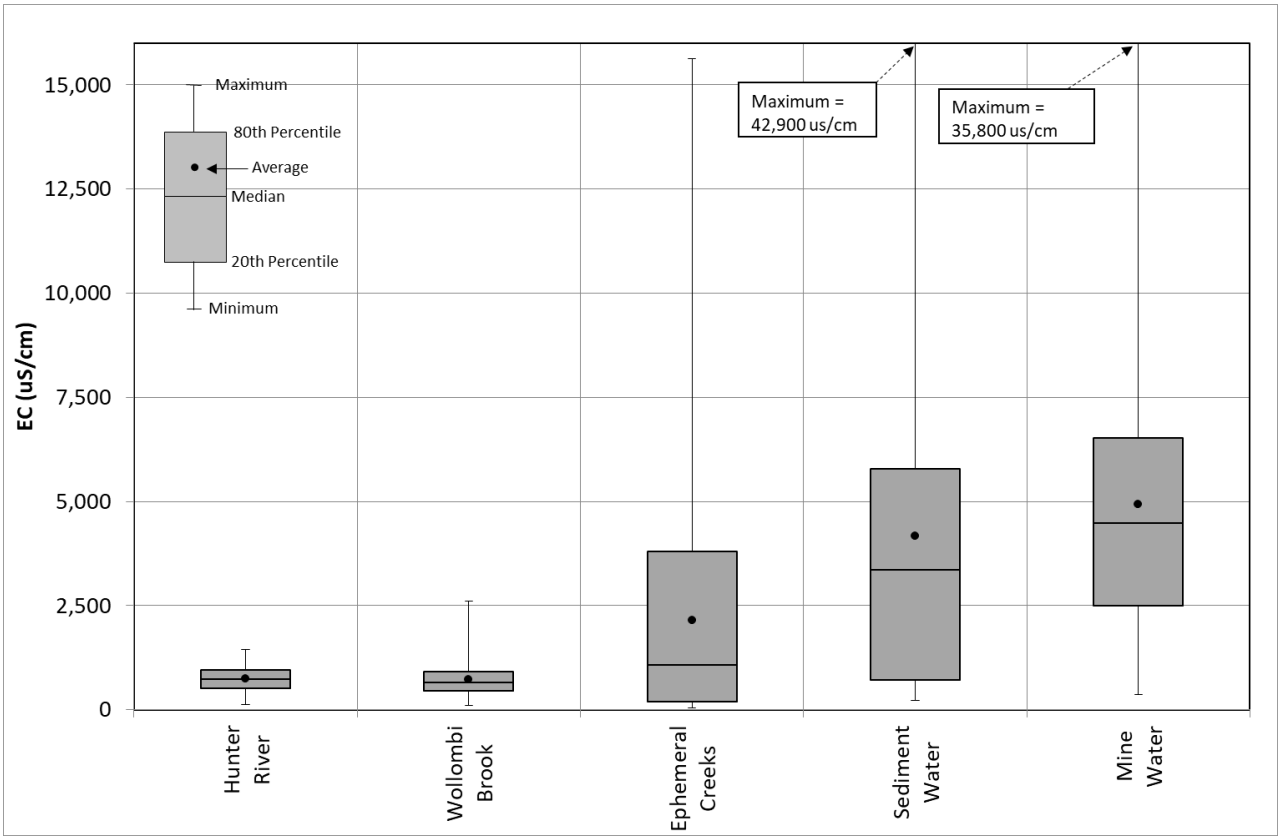


FIGURE 2.26: BOX AND WHISKER STATISTICAL ANALYSIS – EC

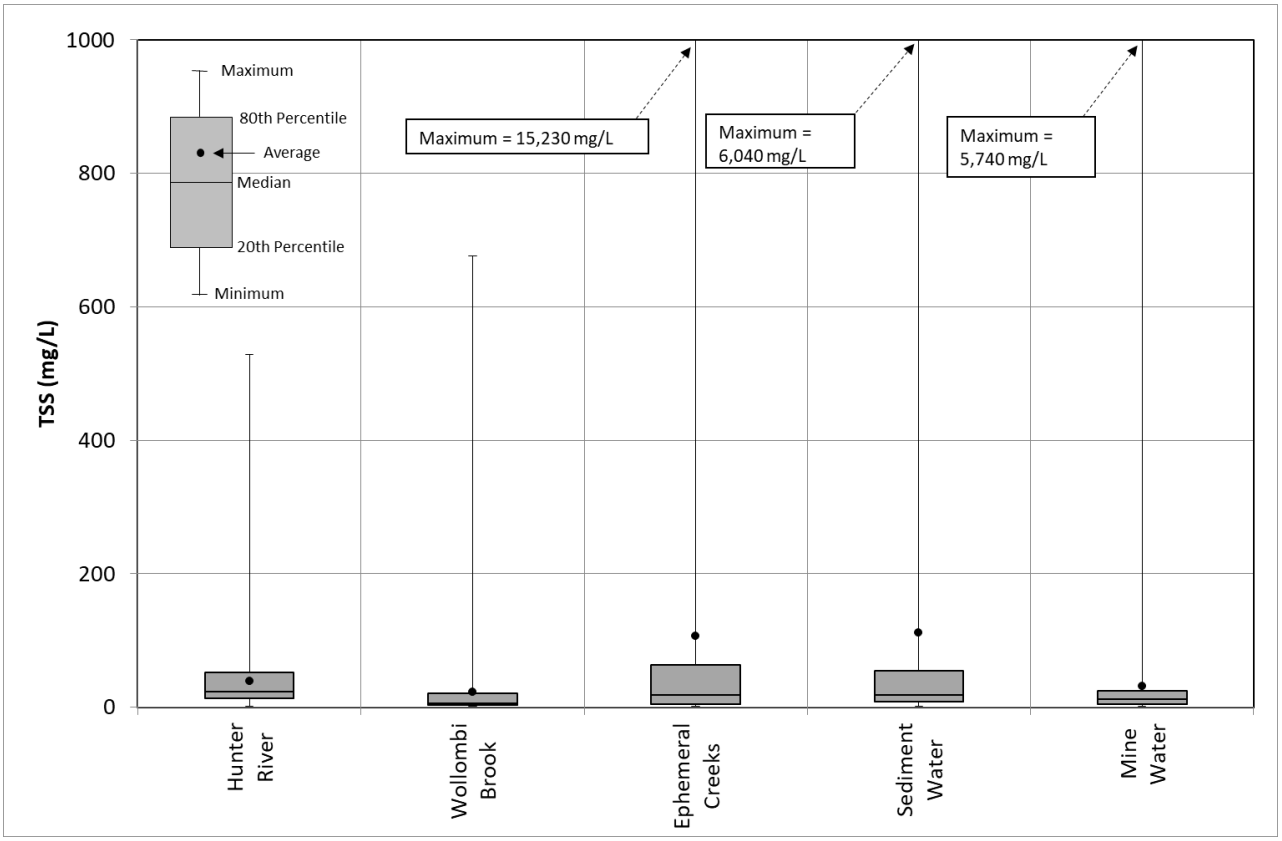


FIGURE 2.27: BOX AND WHISKER STATISTICAL ANALYSIS – TSS

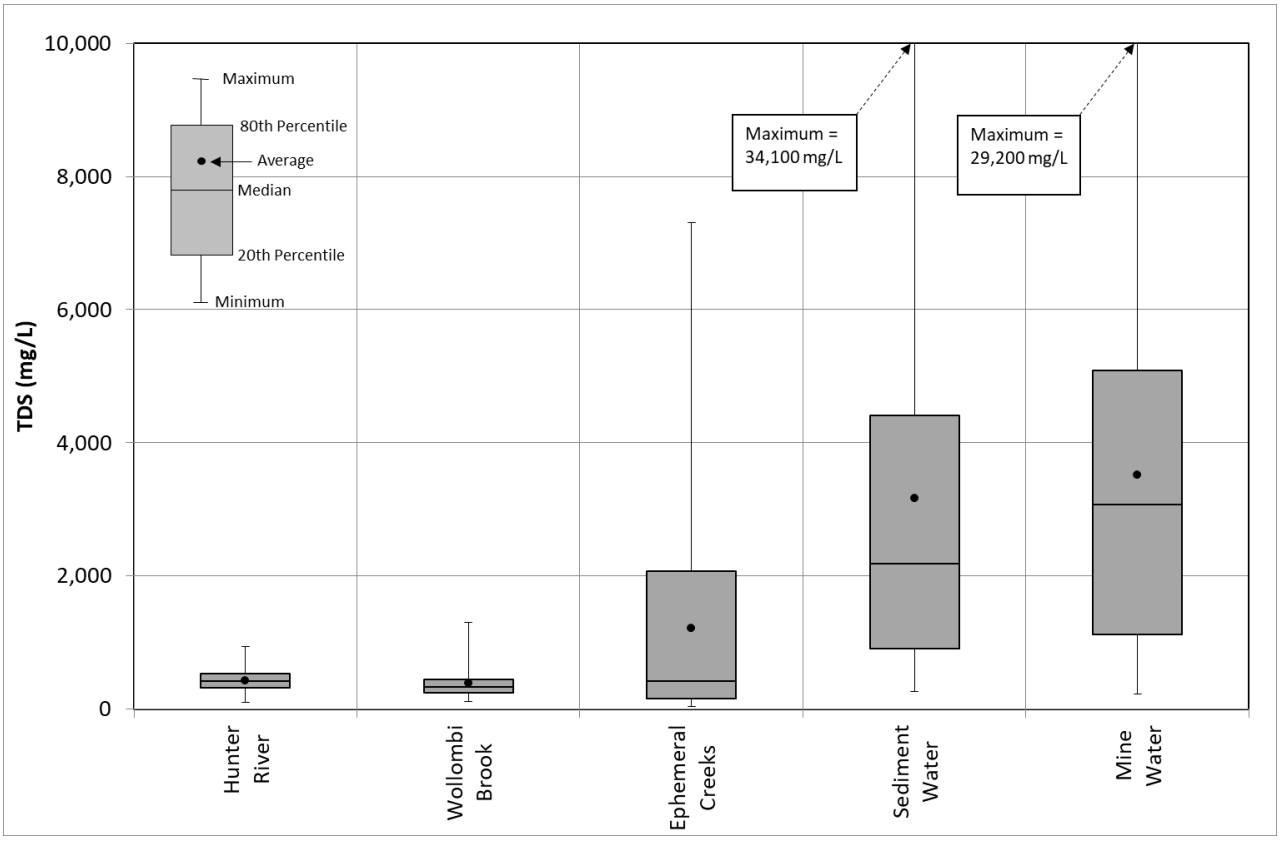


FIGURE 2.28: BOX AND WHISKER STATISTICAL ANALYSIS – TDS

The monitoring results indicate the following for the routine parameters of pH, EC, TDS and TSS (note: the typical ranges presented below correspond to 20th percentile and 80th percentile values):

- pH values in the watercourses typically range between 7.3 to 8.3 in the clean water systems, 8.2 to 9.1 in the sediment water system and 8.6 to 9.1 in the mine water systems. As such waters are typically neutral to alkaline in the various systems. Refer to Figure B.1 in Attachment B.
- pH within the Wollombi Brook and ephemeral creek systems typically lies within the ANZG default guideline values. pH values for the Hunter River are consistently higher with a typical range of 8.0 to 8.4.
- There are no visible temporal trends in the data available for pH for the clean, sediment or mine WMS. Refer to Figure B.1 to Figure B.5 in Attachment B.
- EC typically ranges between 370 to 1,746 µS/cm in the clean water systems (with the higher values typically occurring in the ephemeral creek systems), 724 to 5,780 µS/cm in the sediment water system and 2,490 to 6,528 µS/cm in the mine water systems. As such waters are typically more saline in the sediment water and mine WMS compared to the clean water systems. Refer to Figure B.6 to Figure B.10 in Attachment B.
- EC is typically lower than the ANZG default guideline value of 2,200 µS/cm in the clean water systems (except for the ephemeral creeks). Refer to Figure B.6 and Figure B.7 in Attachment B.
- TSS records typically range between 6 to 51 mg/L in the clean water systems (with the higher values typically occurring in the ephemeral creek systems), 8 to 55 mg/L in the sediment water system and 5 to 25 mg/L in the mine water system. Refer to Figure B.11 to Figure B.15 in Attachment B.
- TDS records typically range between 238 to 726 mg/L in the clean water systems, 907 to 4,408 mg/L in the sediment water system and 1,120 to 5,086 mg/L in the mine water system. Refer to Figure B.16 to Figure B.20 in Attachment B.

In addition to routine parameters, surface water quality monitoring has been undertaken regarding nutrients and metals/metalloids in all clean water systems, the sediment water system and mine water system.

A summary of statistics for metals and nutrients at each monitoring location along watercourses and tributaries within the clean water system, the sediment water system and the mine water system is provided in Table B.1 in Attachment B. The recorded water quality parameters for the sites along each watercourse and within the sediment and mine water systems are included in Attachment B.

2.6 Water Users

The Hunter River basin includes regulated and unregulated sections. Unregulated sections include tributaries upstream of Lake Glenbawn, the Goulburn River and its tributaries in the west and smaller tributaries along the regulated sections. The regulated section is mainly regulated by releases from Glenbawn Dam and Glennies Creek Dam (DAWE, 2019).

Surface water entitlements and water rights are used to manage water in the Hunter River basin, with approximately 767 GL/year of water managed. Approximately 50% of the entitlements are for major water utilities, followed by approximately 34% of entitlements associated with general security and unregulated river licences and the remaining entitlements being supplementary permits, high security licences, local water utilities and stock and domestic water licences. Coal mines hold about 47 GL of general, high and supplementary water licences, including 55% of high security licences (DAWE, 2019).

The HVO Complex is located downstream of Glenbawn Dam and upstream of the confluence of Glennies Creek with the Hunter River. The majority of land adjacent to HVO is owned by the HVO JV or other mining operations. Similar to the EIS Project, there are no water users downstream of the Amended Project within the ephemeral creek system catchments. There are water users downstream of the Amended Project area within the Hunter River catchment, with typical uses being for agriculture and mining. Water is also extracted from the Hunter River by HVO to supplement on site supply in accordance with water licences held. Extractions from the Hunter River downstream of HVO are regulated under the *Water Sharing Plan for the Hunter Regulated River Water Source 2016.*

3. WATER MANAGEMENT SYSTEM

Similar to the approach for the EIS Project, it is proposed to continue to utilise the existing WMS for the Amended Project. That is, the WMS for the Amended Project is generally proposed to maintain and build upon the existing WMS.

The WMS will be constructed and modified as and when required so as to support the infrastructure and mine development. The plans provided in this assessment (refer to Section 3.2)) indicate only the components of the WMS which are required for a particular stage of the mine and does not preclude the construction of some components earlier.

3.1 Existing Water Management System

The existing WMS was described in detail in the EIS SWIA (Engeny, 2022) and has only had minimal changes occur since that study with the progression of mining and previously described water improvement projects.

As described in the EIS SWIA (Engeny, 2022), a review of water management infrastructure at the HVO Complex was undertaken in 2019 (following establishment of the JV) to identify reasonable and feasible improvements and works that were required to update the WMS to a modern containment standard. The review identified a series of projects proposed to achieve this outcome. The upgrades include increases to stormwater containment storage volumes, additional pipelines/transfer systems, monitoring systems, spillway upgrades and drainage improvements. It should be noted that key infrastructure identified as part of this Pollution Reduction Program (PRP) relevant to the Amended Project is proposed to be in place prior to the commencement of the Amended Project.

The existing approved HVO WMS has the following key objectives:

- Fresh water usage is minimised.
- Impacts on the environment and HVO neighbours are minimised.
- Interference to mining production is minimal.

The functions used to achieve the above objectives include:

- Minimising water abstraction from the Hunter River.
- Preferentially using mine water for coal preparation and dust suppression.
- An emphasis on control of water quality and quantity at the source.
- Segregating waters of different water quality where practical.
- Recycling on-site water.
- Ongoing maintenance and review of the system.
- Disposing of water to the environment in accordance with statutes and regulations (refer to regulatory framework in Section 1.4).

Further details on the design standards and target design criteria for the existing water management system (i.e. clean and sediment water drains, sediment dams, and flood protection levees) are included in the EIS SWIA (Engeny, 2022).

To assist the reader with the understanding of the proposed WMS for the Amended Project, summaries of the existing WMS are included in Sections 3.1.1 to 3.1.6. The proposed conceptual WMS for the Amended Project is described in Section 3.2.

3.1.1 Overview of Infrastructure

The HVO WMS consists of a network of infrastructure (i.e., dams, pipelines, drains, pumps etc) to control the movement of water around the site. The elements of the WMS are depicted geographically in Figure 3.1 and Figure 3.2.

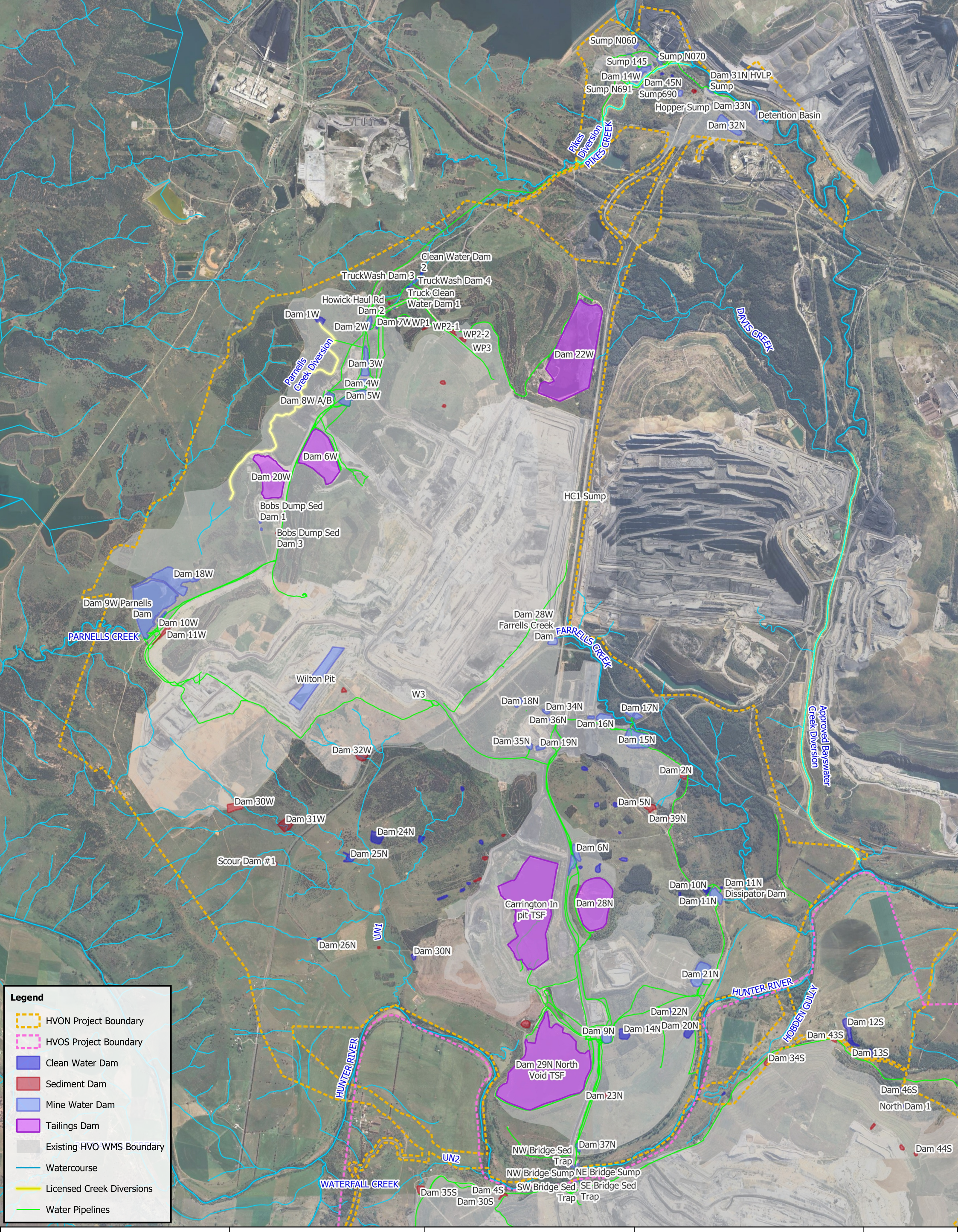
Mine water is pumped to out of pit storage dams or to available in-pit storages using mobile diesel or electric pumps and high-density polyethylene (HDPE) pipelines. Priority is given to water that accumulates in active mining areas, followed by areas to be mined in the short term, and last of all, inactive mining areas.

Water is shared between HVO South and HVO North via the Hunter River bridge. Water in the WMS can be moved around the system using a network of pipelines, although currently the majority of flows are from HVO South to HVO North.

3.1.1.1 Water Demands

Mine water is preferentially used to meet water demands at the HVO Complex. The largest water demands are for CPP processing of ROM coal and haul road dust suppression. Additional minor demands include the LP stockpile sprays, vehicle wash down and miscellaneous industrial usage as well as construction water when required.

When mine water inventory is insufficient to meet these demands, it is supplemented by raw water sourced from the Hunter River. Further detail of the magnitude of these demands and operational logic of the WMS is provided in Section 4.2.



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HUNTER VALLEY OPERATIONS

0 1 2 km

Scale in metres (1:40,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

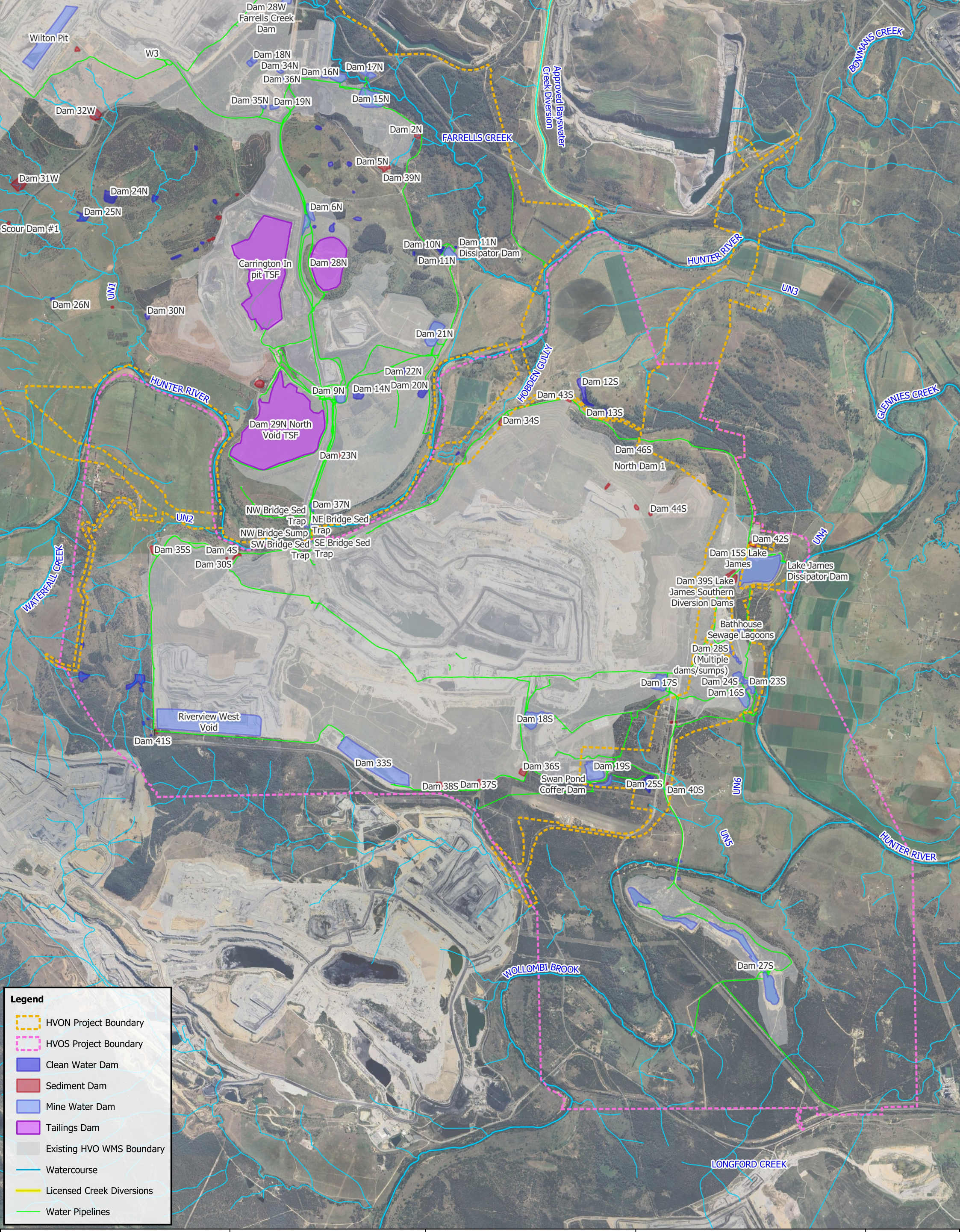
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Figure 3-1:
Existing Water Management System Layout - HVO North

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Revision: 1
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Checked: LV
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HUNTER VALLEY OPERATIONS

0 1 2 km

Scale in metres (1:40,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuaton Project - Amended Project

Figure 3-2:
Existing Water Management System Layout - HVO South

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 1 /7 /2025

3.1.1.2 Storages

Once CPP, dust suppression and other minor usage is met, excess mine water is retained in bulk storages including disused mining voids and out of pit dams. The water storages provide sufficient containment to minimise drought and flood interruptions to the operation and prevent off site discharge of mine water except in accordance with the EPL. The capacity and status of large storages located at HVO are listed in Table 3.1. Large mine water dams have sufficient stormwater containment capacity maintained to prevent overtopping during large or prolonged rainfall events.

In addition to the main water storages a series of smaller dams provide buffer storage for production and ancillary demands. Storage is also available in non-active pits, and if required active, mining pits.

TABLE 3.1: KEY MINE WATER STORAGE CAPACITIES

Area	Storage	Low Operating Volume (ML)[1]	Storage Capacity (ML)[2]
HVO North	Dam 9N	1.7	90
	Dam 11N	6.0	84
	Dam 15N	20	210
	Dam 16N	15	35
	Total	**43**	**419**
HVO West (part of HVO North)	Dam 4/5W	20	81
	Dam 9W (Parnells Dam)	184	634 – 4,300 (enlargement)
	Total	**204**	**715 – 4,381 (enlargement)**
HVO South	Dam 15S (Lake James)	190	739 – 1,900 (enlargement)
	Dam 16S[3] (Old East Cut)	4.1	263
	Dam 17S	4.6	73
	Dam 18S	20.5	166
	Dam 19S	1.0	210
	Dam 25S	N/A	114
	Dam 27S (South Lemington Void)	N/A	858
	Total	**220**	**2,423 – 3,548 (enlargement)**
Newdell and Hunter Valley Load Points	Dam 14W	10	48
	Dam 32N	6.5	152
	Dam 33N	0	40
	Total	**17**	**240**
Total		**484**	**3,797 – 8,588 (enlargement)**

Note 1: LOV – generally, when the water level falls below the volume, pumping out of the storage should cease, in order to provide sufficient water for production, dust suppression and wash-down demands.

Note 2: Also referred to as Full Supply Volume (FSV)

Note 3: Includes Dam 23S, 24S, 28S and Sewage Lagoons.

3.1.1.3 Inter-Mine Transfers

There are a number of water sharing agreements in place between HVO and nearby mine sites to provide flexibility in water management and water sharing between the operations. These include:

- Mount Thorley Warkworth Mine (MTW): A WAL allows water take from the decommissioned Lemington underground mine workings via a production bore. This bore can supply water to both HVO and the neighbouring MTW mining operation. The licence agreement allows MTW to operate a pipeline on HVO land and to store and recover water from either the Riverview Void or the South Lemington Pit 1 Void. Previous water balance assessments indicate that this transfer is infrequent.
- United Wambo Joint Venture: Separate water sharing agreements are in place between HVO and both United (23 August 2000) and Wambo (22 August 1997), which provide for United and Wambo to construct and operate pipelines through HVO land to access the Hunter River pump station.
- Ravensworth Operations: An agreement is in place to allow tailings from the HVO Complex to be deposited in the Cumnock Void 3 (Dam 22W) and associated decant water returned to HVO. There is pump and pipeline infrastructure in place to allow decant water to be returned for use at Howick CPP.

3.1.2 Tailings Water

Fine rejects (tailings) have been emplaced in various approved tailings storage facilities (TSFs) across the complex. Currently, tailings are emplaced within approved TSFs in Carrington Pit as well as Cumnock Void 3 (Dam 22W) under agreement with Ravensworth Operations to utilise the void capacity. Tailings from the Howick CPP are currently pumped via a pipeline to Cumnock Void 3, while tailings from the HVCPP are pumped via a pipeline to the Carrington Pit TSF.

Intermittent deposition of tailings occurs in Dam 6W TSF, and North Void TSF. Prior to TSFs reaching capacity a detailed closure plan is developed for the individual facility to determine effective closure requirements including capping depth. Active and inactive tailings facilities are managed in accordance with environmental procedures for coarse rejects and tailings disposal, and Operational and Maintenance manuals in accordance with requirements for management of prescribed dams.

3.1.3 Clean Water

HVO has licensed flood protection levees and clean water diversion structures to protect the mining areas as well as divert clean water away from the active pit. These are described in the SWIA EIS (Engeny, 2022).

3.1.4 River Water

HVO holds both High and General Security WALs to abstract water from the Hunter Regulated River. WALs are summarised in Table 1.1. The combined High Security Entitlement (HSE) is 4,689 units (ML/year or a share of the available resources). The currently licensed high security water extraction volume of 4,689 ML/year is adequate for both HVO North and HVO South requirements provided internal water use continues to be actively managed and high security water licence allocations are maintained at the current levels. River water is accessed from various pump stations located in Zone 1b and Zone 2a of the Hunter Regulated River source.

3.1.5 Licensed Discharges

Mine water can be released via licensed discharge points to the Hunter River. Licensed discharge points are located on Parnells Dam (9W), Dam 11N and Lake James (Dam 15S). Discharges are only allowed during high and flood flow periods in the Hunter River (refer to Section 4 and Attachment C for further detail). A summary of the current discharge limits under the HRSTS for EPL 640 are outlined in Table 3.2 below.

TABLE 3.2: HRSTS DISCHARGE LIMITS UNDER EPL 640

Release Point	Storage	EPL Maximum Release Rate (ML/day)	Infrastructure Capacity (ML/day)	Dam Capacity (ML)
3	Dam 11N	100	100	84
4	Dam 9W (Parnells Dam)	130	130	656
8	Dam 15S (Lake James)	200	200	700
TOTAL		430	430	1,356

3.1.6 Summary Water Balance

A summary of the overall site water balance for 2023 as reported in the Annual Environmental Review is provided in Table 3.3. It should be noted that during 2023 a total of 459 mm of rainfall was recorded at the HVO Complex, compared to the average annual rainfall of approximately 585 mm. The reported balance shows that despite being a below average water year, the HVO Complex was able to operate without needing to utilise any of the available WALs (i.e. zero extraction from the Hunter River). There was also no discharge to the HRSTS and the overall balance indicates that the HVO Complex was able to operate the WMS within the requirements of the EPL.

TABLE 3.3: 2023 SITE WATER BALANCE FROM ANNUAL ENVIRONMENTAL REVIEW (HVO, 2023)

Water Stream	Volume (ML)
INPUTS	
Fresh Water (potable)	46
Fresh Water (Hunter River extraction)	0
Groundwater	650
Rainfall Runoff	3,232
Recycled to CPP from Tails & Storage (not included in total)	3,429
Imported (Liddell / Ravensworth (via Cumnock))	825
Water from ROM Coal	832
Total Inputs	**5,585**
OUTPUTS	
Dust Suppression	3,135
Evaporation – Mine Water & Tailings Dams	2,770
Entrained in Process Waste	1,846
Discharged (HRSTS)	0
Vehicle Wash-down	310
Sent to Third Party	0
Miscellaneous Industrial Use	350
Water in Coarse Rejects	393
Water in Product Coal	756
Total Outputs	**9,560**

3.2 Project Water Management System

The conceptual water management system presented in the EIS SWIA (Engeny, 2022) was reviewed and updated to consider the changes in the mining extents and timing with the Amended Project. The proposed conceptual WMS for the Amended Project has minor changes relative to the EIS Project WMS and has been designed to meet the same performance criteria as outlined in the EIS SWIA (Engeny, 2022).

The Amended Project WMS described in the following sections should be considered a wholistic WMS for both existing approved operations and Amended Project operations rather than as an incremental WMS required solely for the Amended Project.

Consistent with the EIS Project, and the existing operations, the WMS will be constructed and modified as and when required so as to support the infrastructure and mine development. The plans provided in this assessment are conceptual and indicate only the components of the WMS which are required for a particular stage of the mine and do not preclude the construction of some components earlier and/or staging of construction as required.

Consistent with the EIS, it is emphasised that the Amended Project disturbance area is generally within existing approvals with relatively little additional disturbance area required. In particular, the following points are made regarding the WMS:

- No additional disturbance area at HVO South but rather changes to the approved mine sequencing within the current approved mining areas.
- Small increase in the mining extent (between the existing West and Mitchell Pits and Carrington Pit) and additional disturbance area at HVO North.
- As a result, the mine water dams, sediment water dams and various drains identified in the conceptual WMS for the Amended Project are generally covered by existing approvals. The Amended Project WMS described in the following sections should be considered a wholistic WMS for both existing approved operations and Amended Project operations rather than as an incremental WMS required solely for the Amended Project.

It is proposed to continue to utilise the existing WMS for the Amended Project. That is, the WMS for the Amended Project is generally proposed to maintain and build upon the existing WMS, consistent with the approach for the EIS Project. The existing WMS will continue to be used to manage runoff with all water captured in active mining areas and mine water surface runoff directed to the WMS. The existing approved clean water diversions will continue to divert runoff around the WMS. There are no new creek diversions proposed or required as part of the Amended Project. In addition, excess water that cannot be reused at the mining operations will continue to be discharged via the HRSTS and EPL in accordance with regulatory arrangements.

The primary proposed changes to the WMS with the Amended Project include expansion of the WMS at HVO North and changes to the timing of the WMS at HVO South. These aspects are described in the following sections:

- Section 3.2.1 summarises the key considerations of the Amended Project from the perspective of the WMS.
- Section 3.2.2 provides a summary of the mine progression and conceptual WMS for the life of the Amended Project.

The performance of the system and further detail of various aspects including catchment progression, water demands, etc are provided in Section 4 and Attachment C.

3.2.1 Key Considerations of the Amended Project

Key considerations of the Project relating to the WMS are summarised as follows:

- The existing WMS for the HVO Complex is fully integrated across both HVO North and HVO South. This includes transfer of water across the complex to achieve mine water containment, manage water inventories and meet process water demands.
- The integrated nature of the HVO WMS supports the WMP objectives of minimising freshwater usage and impacts on the environment and HVO neighbours while minimising interference to mining production. The Project will maintain the fully integrated WMS. As a result, it is not possible to separate Project impacts for the WMS for HVO North and HVO South and instead, impacts are presented for the HVO Complex.
- In general, the Project will mine areas within existing approved disturbance boundaries, including mining previously disturbed areas. Consequently, the incremental impact of the Project on adjacent surface water systems is generally expected to be minor or negligible. The findings of impact assessments are discussed further in later sections.
- The Project is not proposing any change to existing approvals or licences for the discharge of mine water under the HRSTS.
- No change to existing water sharing arrangements with other mining operations are proposed as part of the Project. The Project includes incorporation of tailings disposal at LCO. This option includes construction of a pipeline to send tailings to LCO for deposition in the existing in- pit tailings storage facility. The portion of recovered decant water attributable to HVO Complex tailings will be returned to HVO for reuse. As detailed further in subsequent sections, it is noted that during wet periods, the decant water may be temporarily held at LCO to improve management of excess inventory at the HVO Complex.

3.2.2 Proposed WMS

The proposed water management strategy is consistent with the existing and EIS SWIA strategies and can be summarised as:

- Diversions of clean catchment around mine infrastructure and disturbed land through catchment drains.
- Containment of mine affected runoff in dedicated storages for reuse in the WMS.
- Capture and treatment of sediment water runoff from disturbed areas in sediment dams.
- Minimise external catchment runoff reporting to the mining pits.
- Preferential re-use of mine water and sediment water captured by the WMS to supply operational water demands (dust suppression and CPP demands).
- Progressive rehabilitation/stabilisation of overburden emplacement areas and MIAs to reduce the generation of sediment laden runoff.
- Protection of mining infrastructure and open cut pits by the construction of flood protection levees.

The WMS includes mine water storages, sediment water dams, flood protection levees and drainage diversion of undisturbed catchments. The progression of the mine and proposed water management infrastructure is summarised in the following sections. The water management infrastructure for the Project and existing approved operations includes new storages (summarised in Table 3.4), new drains and flood protection levees (summarised in Table 3.5) and upgraded water storages (summarised in TABLE 3.6). The mine progression and WMS is illustrated in Figure 3.3 to Figure 3.17 (noting that this includes infrastructure required for existing approved mining) while system schematics are provided in Figure 3.18 to Figure 3.21.

The WMS presented for the final landform (Figure 3.7, Figure 3.12 and Figure 3.17) represents a transitional period at which mining has ceased and the landform has been reshaped but vegetation is not yet established. As the final overburden emplacement areas are no longer active and are shaped, the runoff ceases to be mine water at this stage. However, the runoff is not yet clean as there is an establishment period required. The Closure WMS as presented provides for management of the remaining sediment water during the establishment period. Ultimately, all rehabilitated areas will be suitably established to be considered clean runoff and suitable for direct release without sediment dams. At that stage, all dams would be decommissioned (with the exception of small storages that remain to support the final land use) to maximise return of runoff to the receiving environment and minimise licensing requirements (refer Water Assessment (EMM, 2025c)).

3.2.2.1 WMS EIS Project Versus Amended Project

Several components of the proposed WMS have had minor changes, compared to the WMS proposed in the EIS SWIA (Engeny, 2022). These changes are largely driven by a reduced mining extent and modified sequencing, particularly in HVO North, a modified tailings strategy and more efficient infrastructure sequencing. The proposed water management infrastructure is summarised in the following sections, with an overview of the key difference compared to the EIS Project WMS included below:

- Fewer new dams proposed in HVO North, reflecting the reduced disturbance footprint.
- Fewer existing dams are proposed for upgrade, with some upgrade requirements resolved prior to the Amended Project through PRP works (e.g. Dam 14W upgrade no longer required).
- No new sediment dams are proposed in the early stages of HVO North for pre-strip management, with sediment control managed by reclassifying and upgrading existing storages where possible.
- Reclassification of multiple storages to dry detention basins at closure, to align with the proposed final land landform and long-term passive management.
- Fewer mine water storages proposed around overburden areas.

TABLE 3.4: FUTURE WATER STORAGES (APPROVED AND PROJECT)

Storage ID	Classification					Adopted Design Volume (ML)
	2029	2032	2038	2041	Closure	
DP2N (Mitchell Dam)	Mine Water Dam	Mine Water Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	67
DP5N	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam	Decommission	81
DP5Na					Dam / Dry Detention Basin	145
DP6N	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Decommission	N/A[a]
DP7N	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Decommission	2.5
DP8N	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Decommission	2.9
DP11N				Sediment Dam	Decommission	107
DP12N			Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	78
DP14N			Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	229 [b]
DP15N					Dam / Dry Detention Basin	355
DP16N					Dam / Dry Detention Basin	71
DP17N					Dam / Dry Detention Basin	78
DP18N					Dam / Dry Detention Basin	40
DP19N					Dam / Dry Detention Basin	19
DP1S	Sediment Dam	Sediment Dam	Sediment Dam	Clean Water Dam	Decommission	55
DP3S	Mine Water Dam	Mine Water Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	162
DP5S			Sediment Dam	Clean Water Dam	Decommission	27

Storage ID	Classification					Adopted Design Volume (ML)
	2029	2032	2038	2041	Closure	
DP8S (Cheshunt Pit Stage Dams)	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	440 [b]
DP9S		Sediment Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	24
DP10S					Dam / Dry Detention Basin	328
West Pit Tailings Dam	Tailings Dam	Tailings Dam	Tailings Dam	Tailings Dam	Decommission	

Note a: accounted for in the Dam 14W storage capacity
Note b: opportunity to reduce through bypass of runoff from earlier established rehabilitation areas. Volume may also be achieved as sumps in the landform.

TABLE 3.5: FUTURE DRAINS AND LEVEES / LEVEE UPGRADES (APPROVED AND PROJECT)

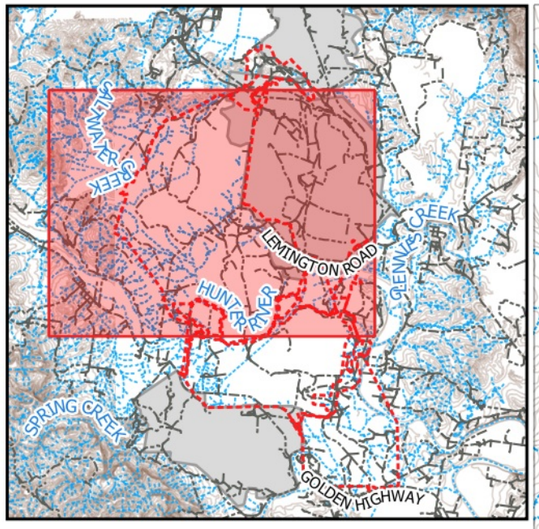
Infrastructure ID	Classification				
	2029	2032	2038	2041	Closure
DR01 (Mitchell CWD)	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Decommission with shaped landform
DR03	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Decommission with shaped landform
DR04	Mine Water Drain	Mine Water Drain	Sediment Drain	Clean Water Drain	Decommission with shaped landform
DR05	Sediment Drain	Sediment Drain	Sediment Drain	Clean Water Drain	Decommission with shaped landform
DR06B	Sediment Drain	Sediment Drain	Sediment Drain	Clean Water Drain	Decommission with shaped landform
DR07	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain
DR10	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain
DR11	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Decommission
DR12	Mine Water Drain	Mine Water Drain	Mine Water Drain	Mine Water Drain	Decommission
DR13	Mine Water Drain	Mine Water Drain	Mine Water Drain	Mine Water Drain	Clean Water Drain
DR14	Mine Water Drain	Mine Water Drain	Mine Water Drain	Mine Water Drain	Clean Water Drain

Infrastructure ID	Classification				
	2029	2032	2038	2041	Closure
DR15			Sediment Drain	Sediment Drain	Decommission
DR16			Sediment Drain	Sediment Drain	Decommission
DR18			Sediment Drain	Sediment Drain	Decommission with shaped landform
DR23			Sediment Drain	Sediment Drain	Decommission
DR26	Mine Water Drain	Mine Water Drain	Sediment Drain	Clean Water Drain	Decommission with shaped landform
DR27			Sediment Drain	Sediment Drain	Decommission with shaped landform
DR29				Sediment Drain	Decommission
Carrington West Wing Levee			Flood Levee	Flood Levee	Decommission
North Void TSF Levee 2	Flood Levee	Flood Levee	Flood Levee	Flood Levee	Flood Levee
Cheshunt Levee	Flood Levee	Flood Levee	Flood Levee	Flood Levee	Decommission
Riverview Levee	Flood Levee	Flood Levee	Flood Levee	Flood Levee	Decommission
Mitchell East Levee					Flood Levee

TABLE 3.6: FUTURE UPGRADED WATER STORAGES (APPROVED AND PROJECT)

Storage ID	Classification					Maximum Adopted Design Volume (ML)
	2029	2032	2038	2041	Closure	
Dam 24N-A	Upgrade (Sediment Dam)	Sediment Dam	Mined through			77
Dam 25N-A	Upgrade (Sediment Dam)	Sediment Dam	Mined through			67
Dam 4S-A	Reshape (Mine Water Dam)	Mine Water Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	7
Unnamed-1	Clean Water Dam	Clean Water Dam	Upgrade (Sediment Dam)	Sediment Dam	Decommission	34
Unnamed-2	Clean Water Dam	Clean Water Dam	Upgrade (Sediment Dam)	Sediment Dam	Decommission	34
Dam 12S	Clean Water Dam	Clean Water Dam	Clean Water Dam	Clean Water Dam	Dam / Dry Detention Basin	168
Dam 14W	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Dam / Dry Detention Basin	49
Dam 16S	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Dam / Dry Detention Basin	262
Dam 19S	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	Dam / Dry Detention Basin	210
Dam 34S	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention Basin	56[a]
Dam 36S	Sediment Dam	Sediment Dam	Clean Water Dam	Clean Water Dam	Dam / Dry Detention Basin	16[a]
Dam 37S	Sediment Dam	Sediment Dam	Clean Water Dam	Clean Water Dam	Dam / Dry Detention Basin	22[a]
Dam 38S	Sediment Dam	Sediment Dam	Clean Water Dam	Clean Water Dam	Dam / Dry Detention Basin	26
Dam 39S	Upgrade (Sediment Dam)[b]	Sediment Dam	Clean Water Dam	Clean Water Dam	Dam / Dry Detention Basin	106[a]
Dam 15S	Upgrade (Mine Water Dam)	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	1,900
Dam 9W / 18W	Upgrade (Mine Water Dam)	Mine Water Dam	Mine Water Dam	Mine Water Dam	Mine Water Dam	4,300

Note a: maximum capacity if dam is retained during closure
Note b: Upgrade to be completed prior to Project



Legend

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- Contours
- Lemington Road realignment (Amendment Report)
- Existing Clean Water Drain
- Existing Sediment Drain
- Existing Mine Water Drain
- Existing Levee
- Existing Culvert
- Existing Clean Water Dam
- Existing Sediment Dam
- Existing Mine Water Dam
- Existing Tailings Dam
- Proposed Clean Water Drain
- Proposed Sediment Drain
- Proposed Mine Water Drain
- Proposed Levee
- Proposed Clean Water Dam
- Proposed Sediment Dam
- Proposed Mine Water Dam
- Proposed Tailings Dam
- Indicative Haul Roads

Land Use

- Ancillary Disturbance / Infrastructure / Access
- Active Mining Area
- Topsoil Removal Strip / Preparation Area
- Active Overburden Emplacement Area
- Active Tailings Emplacement Area
- Inactive Emplacement Area
- Inactive Tailings Emplacement Area / Capping in Progress
- Product Coal Stockpile
- ROM Coal Stockpile
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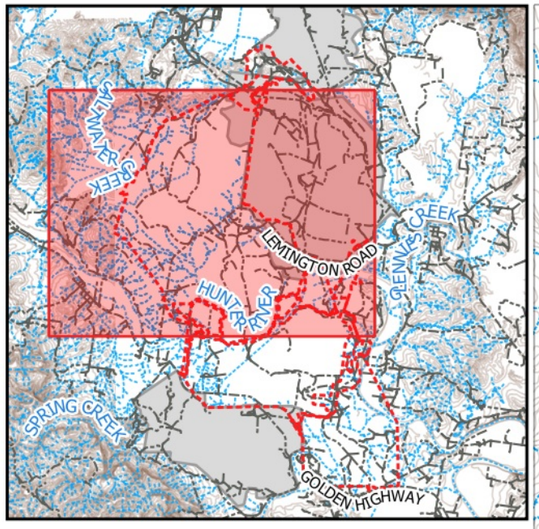
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Figure 3-3 - HVO North Proposed Conceptual WMS - Year 3

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- Proposed Mine Water Drain
- Proposed Levee
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Land Use

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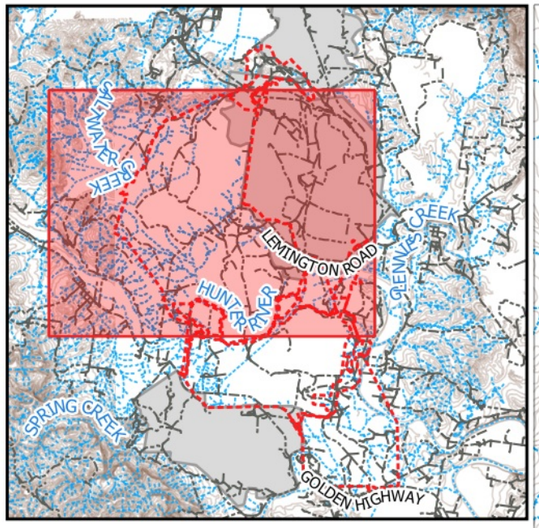
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Figure 3-4 - HVO North Proposed Conceptual WMS - Year 6

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Legend

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Land Use

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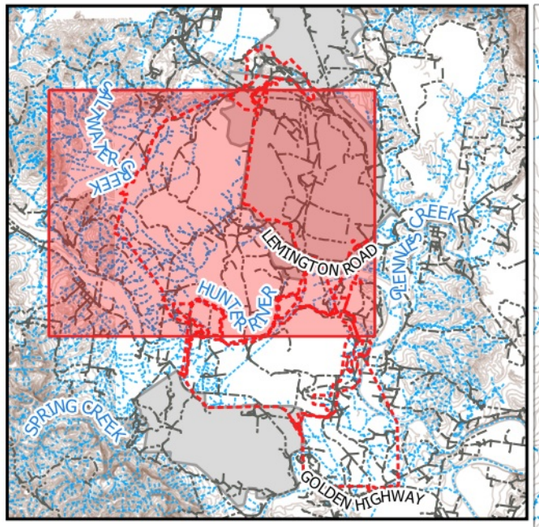
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Figure 3-5 - HVO North Proposed Conceptual WMS - Year 12

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- Existing Levee
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- Existing Clean Water Dam
- Existing Sediment Dam
- Existing Mine Water Dam
- Existing Tailings Dam
- Proposed Clean Water Drain
- Proposed Sediment Drain
- Proposed Mine Water Drain
- Proposed Levee
- Proposed Clean Water Dam
- Proposed Sediment Dam
- Proposed Mine Water Dam
- Proposed Tailings Dam
- Indicative Haul Roads

Land Use

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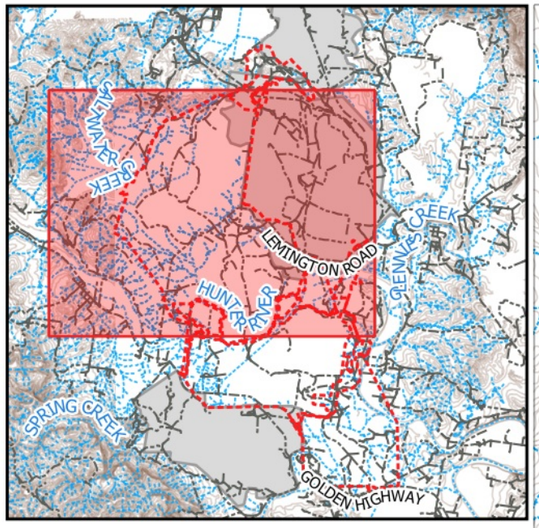
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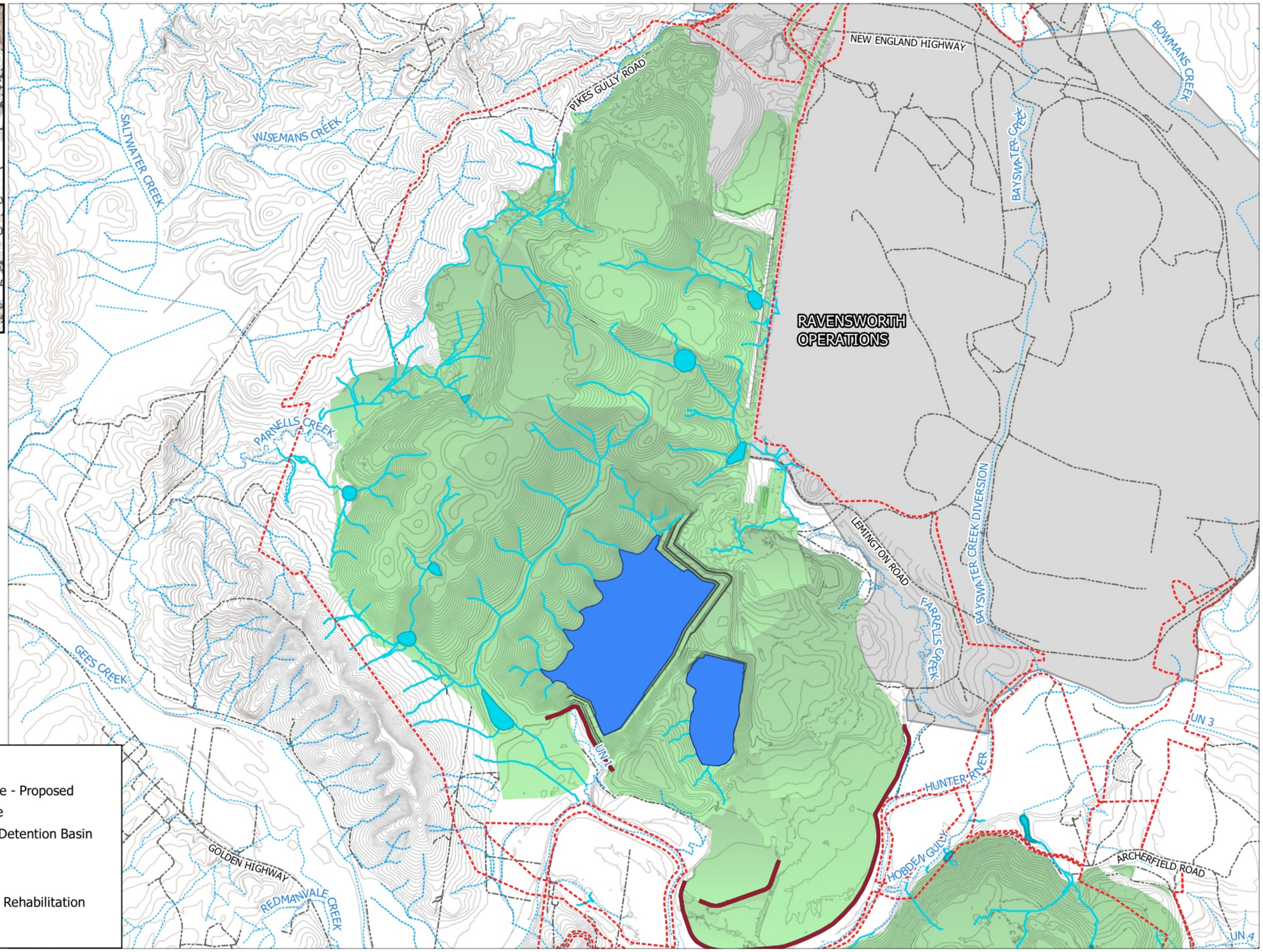
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Figure 3-6 - HVO North Proposed Conceptual WMS - Year 15

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Legend

- Proposed Development Consent
- Adjacent Mining Approvals Boundary
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- Contours
- Watercourse - Existing
- Watercourse - Proposed
- Flood Levee
- Dam / Dry Detention Basin
- Final Void

Land Use

- Established Rehabilitation

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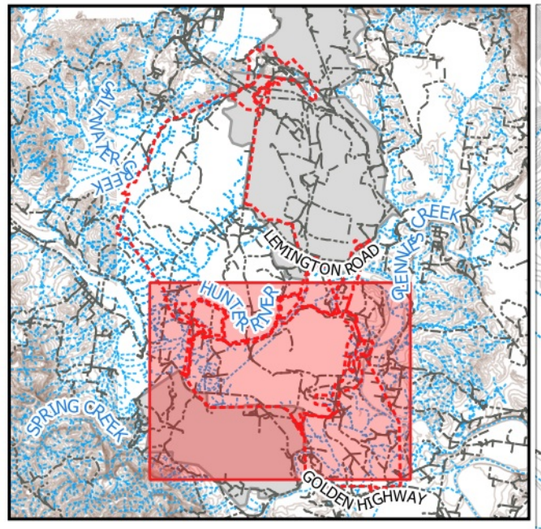
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Figure 3-7 - HVO North Proposed Conceptual WMS - Closure

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- Proposed Mine Water Drain
- Proposed Levee
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- Proposed Sediment Dam
- Proposed Mine Water Dam
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Land Use

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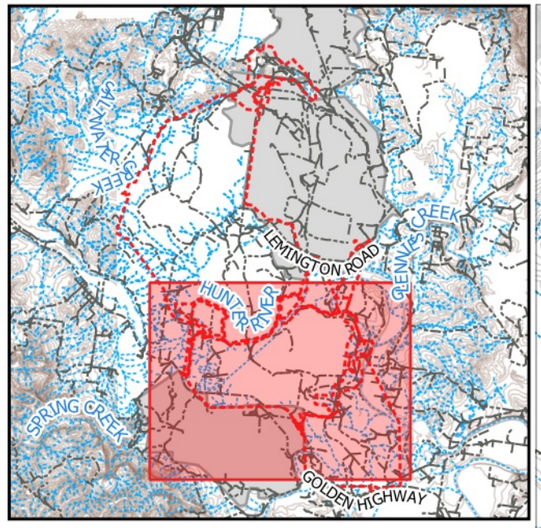
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Figure 3-8 - HVO South Proposed Conceptual WMS - Year 3

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- Existing Mine Water Drain
- Existing Levee
- Existing Culvert
- Existing Clean Water Dam
- Existing Sediment Dam
- Existing Mine Water Dam
- Existing Tailings Dam
- Proposed Clean Water Drain
- Proposed Sediment Drain
- Proposed Mine Water Drain
- Proposed Levee
- Proposed Clean Water Dam
- Proposed Sediment Dam
- Proposed Mine Water Dam
- Proposed Tailings Dam
- Indicative Haul Roads

Land Use

- Ancillary Disturbance / Infrastructure / Access
- Active Mining Area
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HUNTER VALLEY OPERATIONS

N

900 0 900 m

Scale in metres (1:40,000 @ A3)

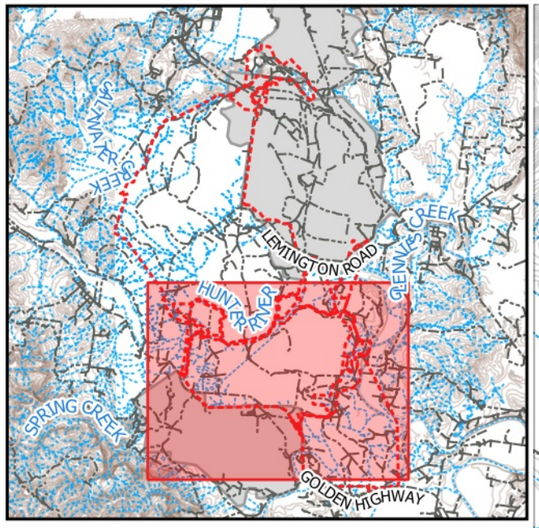
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Figure 3-9 - HVO South Proposed Conceptual WMS - Year 6

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Drawn: LV
Checked: SES
Date: 1 /7 /2025



Legend

- Proposed Development Consent
- Adjacent Mining Approvals Boundary
- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment (Amendment Report)
- Existing Clean Water Drain
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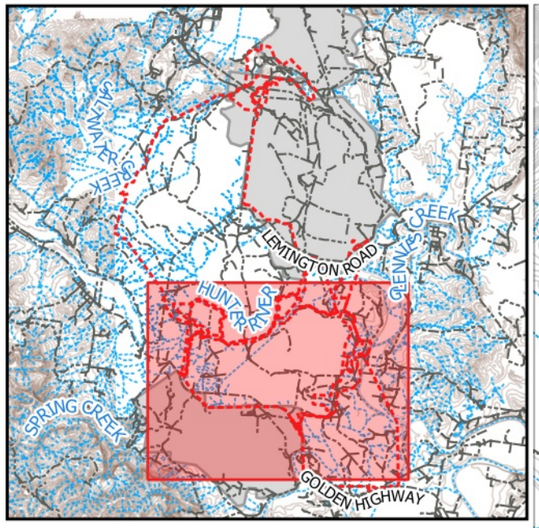
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Figure 3-10 - HVO South Proposed Conceptual WMS - Year 12

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Legend

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- Proposed Levee
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- Proposed Mine Water Dam
- Proposed Tailings Dam
- Indicative Haul Roads

Land Use

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HUNTER VALLEY OPERATIONS

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900 0 900 m

Scale in metres (1:40,000 @ A3)

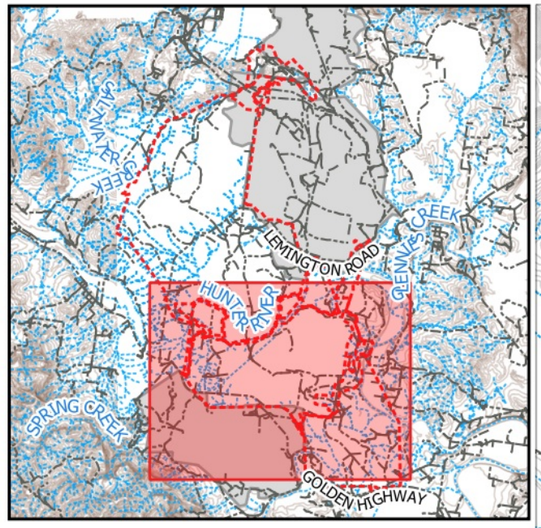
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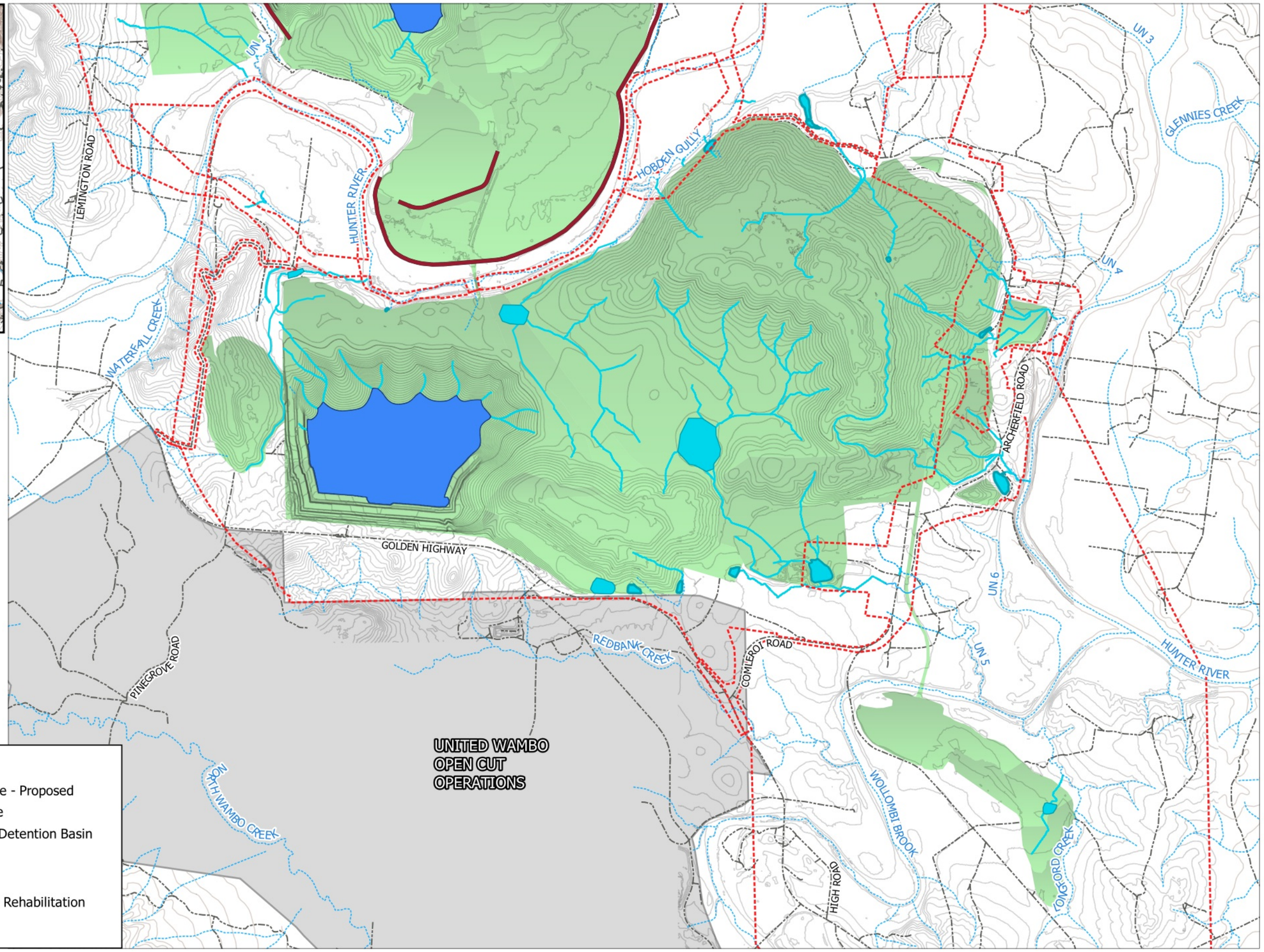
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Figure 3-11 - HVO South Proposed Conceptual WMS - Year 15

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Legend

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- Adjacent Mining Approvals Boundary
- Road - Existing
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- Contours
- Watercourse - Existing
- Watercourse - Proposed
- Flood Levee
- Dam / Dry Detention Basin
- Final Void

Land Use

- Established Rehabilitation

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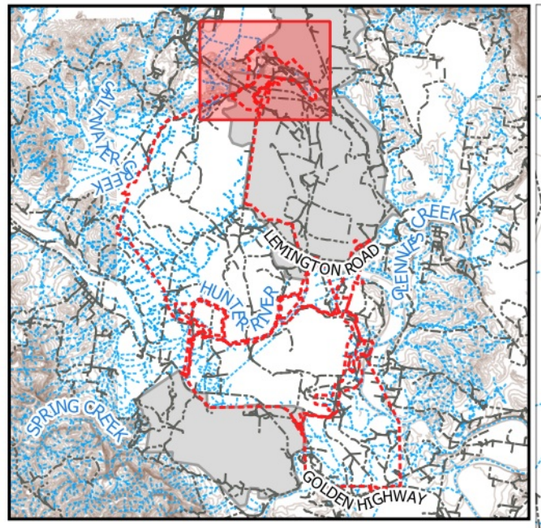
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Figure 3-12 - HVO South Proposed Conceptual WMS - Closure

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Legend

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- Indicative Haul Roads

Land Use

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HUNTER VALLEY OPERATIONS

N

400 0 400 m

Scale in metres (1:20,000 @ A3)

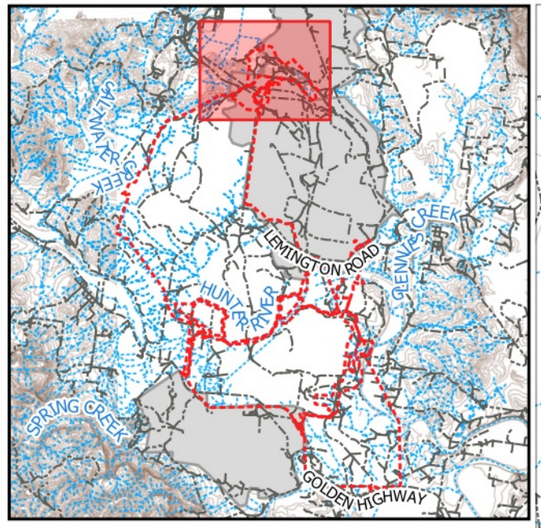
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Figure 3-13 - Newdell Proposed Conceptual WMS - Year 3

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Revision: 5
Drawn: LV
Checked: SES
Date: 1 /7 /2025



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HUNTER VALLEY OPERATIONS

N

400 0 400 m

Scale in metres (1:20,000 @ A3)

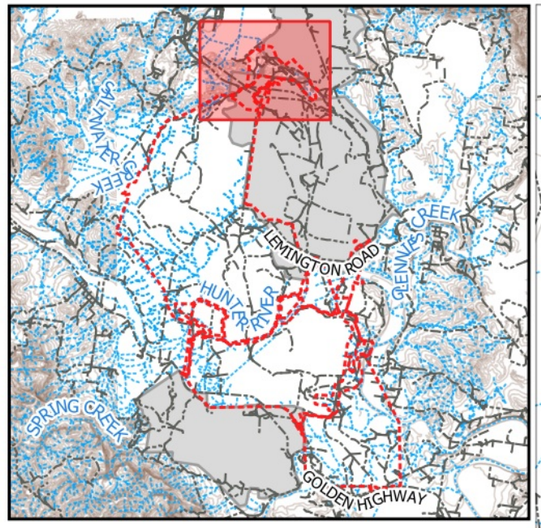
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Figure 3-14 - Newdell Proposed Conceptual WMS - Year 6

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HUNTER VALLEY OPERATIONS

N

400 0 400 m

Scale in metres (1:20,000 @ A3)

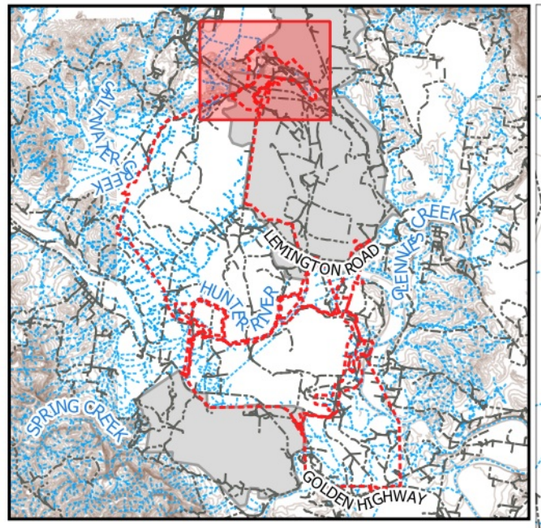
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Figure 3-15 - Newdell Proposed Conceptual WMS - Year 12

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Drawn: LV
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Legend

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HUNTER VALLEY OPERATIONS

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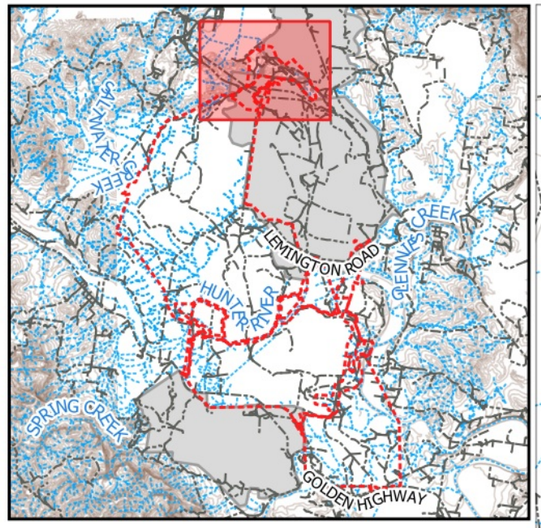
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Figure 3-16 - Newdell Proposed Conceptual WMS - Year 15

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BAYSWATER CREEK

LAKE LIDDELL

NEW ENGLAND HIGHWAY

PIKES DIVERSION

LIDDELL STATION ROAD

LIDDELL STATION ROAD

LIDDELL STATION ROAD

PIKES CREEK

RCT

NEW ENGLAND HIGHWAY

Liddell Coal Operations

Legend

- Proposed Development Consent
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- Dam / Dry Detention Basin
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Land Use

- Established Rehabilitation

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HUNTER VALLEY OPERATIONS

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Figure 3-17 - Newdell Proposed Conceptual WMS - Closure

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Checked: SES
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Dam ID	2029	2032	2038	2041
DP11N			Sediment Dam	Sediment Dam
Dam 24N-A	Upgrade Sediment Dam	Sediment Dam	Mined Through	
Dam 25N-A	Upgrade Sediment Dam	Sediment Dam	Mined Through	

Legend

- Pumped Flow
- Gravity Flow
- Overflow
- Seepage
- Tailings
- Watercourse
- Existing Water Store
- Proposed Water Store
- Existing Water Store to Be Upgraded
- Outflow
- Inflow

* Decommissioned in 2029

Farrells Creek

Dam 18N

Vehicle Washbay / Fire Suppression

HVCPP

Dam 19N

Dam 34N

Dam 35N

Dam 16N

Weir

Dam 17N

Hunter River Pump Station

DP5N (see HVO West Schematic)

West Pit (see HVO West Schematic)

DP11N

Dam 38N *

Bridge Sumps North

Riverview Void (see HVO South Schematic)

Dam 9W (see HVO West Schematic)

Dam 9N

Dam 29N *

Dam 28N *

Dam 27N *

Dam 21N

Dust suppression

Dam 2N

Dam 5N

Dam 15N

Dam 10N

Dam 11N

HRSTS Discharge

DP25N-A

DP24N-A

Dam 26N *

Hunter Valley Operations

HUNTER VALLEY OPERATIONS

Figure 3.18: Water Management Schematic HVO North

Job Number: BNTL00198_0002	Drawn: SGG	Checked: SES
Revision: 0	Date: June 2025	

Legend

- Pumped Flow
- Gravity Flow
- Overflow
- Seepage
- Tailings
- Watercourse
- Water Tank
- Mine Water Store
- Proposed Water Store
- Off-site Facility
- Outflow
- Inflow

Liddell - Reservoir North

Bayswater Creek

Fire water tank

Truck wash tanks

HVLP Sump

Dam 33N

Detention Basin

Pollution Control Sump

Pollution control sump overflows to stockyard before detention basin

Stockyard

Sump N070

Dam 44N

Sump N060

Overflow Sump

Dam 45N

Sump N145

Hopper Sump

Dam 32N

Ravensworth Coal Terminal (Highway Dam)

Sump N110

DP7N

Sump N690

Dam 14W

Stockpile Sprays

DP6N

Sump N691

DP8N

New Product Stockpile

Pikes Creek

Dam ID	2029	2032	2038	2041
DP6N	Mine Dam	Mine Dam	Mine Dam	Mine Dam
DP7N	Mine Dam	Mine Dam	Mine Dam	Mine Dam
DP8N	Mine Dam	Mine Dam	Mine Dam	Mine Dam

Hunter Valley Operations

HUNTER VALLEY OPERATIONS

Figure 3.19 Water Management Schematic Newdell and Hunter Valley Load Points

Job Number: BNTL00198_0002	Drawn: SGG	Checked: LV
Revision: 0	Date: March 2025	

Dam ID	2029	2032	2038	2041
DP2N	Mine Dam	Mine Dam	Sediment Dam	Clean Water Dam
DP5N	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam
DP12N			Sediment Dam	Clean Water Dam
DP14N			Sediment Dam	Clean Water Dam
West Pit Tailings Dam	Tailings Dam	Tailings Dam	Tailings Dam	Tailings Dam

Legend

- Pumped Flow
- Gravity Flow
- Overflow
- Seepage
- Tailings
- Watercourse
- Pit
- Existing Water Store
- Proposed Water Store
- Existing Water Store to Be Upgraded
- Outflow
- Inflow

* Decommissioned in 2029
^ Decommissioned in 2025

Pikes Creek

Dam 7W

Truck wash dam 1-4

Dam 2W

Dam 17N (see HVO North Schematic)

Dam 1W

Dam 3W

DP5N

West Pit Tailings Dam

Overflow via clean water diversion

Dam 8W A/B

Dam 5W

Dam 4W

Vehicle washdown

Haul road dust spray

Dam 22W TD (Cumnock) *

Overflow from Dam 11N (see HVO North Schematic)

West Pit

HCPP

6W and 20W not currently active

DP12N

Wilton Pit

Dam 28W

Dam 6W *

DP14N

Mitchell Pit

Hunter River

Overflows to Hunter River via Farrells Creek

Dam 20W *

Dam 11W

Dam 10W

Dam 30W

Miscellaneous industrial usage

Dam 31W ^

Dam 32W ^

Dam 18W *

Dam 9W (Parnell's Dam)

Dam 9N (see HVO North Schematic)

Parnells Dissipater Dam

DP2N (Mitchell Dam)

HRSTS Discharge

Parnells Creek

Hunter Valley Operations

HUNTER VALLEY OPERATIONS

Figure 3.20: Water Management Schematic HVO West

Job Number: BNTL00198_0002	Drawn: SGG	Checked: SES
Revision: 1	Date:June 2025	

Legend

- Pumped Flow
- Gravity Flow
- Overflow
- Seepage
- Tailings
- Watercourse
- Pit
- Existing Water Store
- Proposed Water Store
- Existing Water Store to Be Upgraded
- Off-site Facility
- Outflow
- Inflow

* Decommissioned in 2029
^ Decommissioned in 2032

Hunter River

HRSTS Discharge

Dam 42S

15S Dissipater Dam

Dam 34S

Dam 28S DS

Dam 28S US

Dam 24S

Sewage Lagoons

23S fills 16S first before overflow into Hunter River

Dam 16S

Dam 23S

Lemington Workshop

South Lemington Workshop

Mount Thorley Warkworth Operations

Unnamed 1-A

Unnamed 2-A

Dam 39S (A)

Dam 39S (B)

DP1S

DP9S

Dust suppression

Lake James (Dam 15S)

Cheshunt Pit

DP8S Staging Dams

Dam 18S

Dam 38S

Dam 19S

Dam 17S

DP3S

Coffer Dams

DP5S

South Lemington Void (Dam 27S)

Dam 27S, DP5S and Unnamed Dam 1-A and 2-A Overflow via Wollombi Brook

Hunter River

Dam 35S ^

Dam 30S *

Dam 4S-A

Riverview West (Dam 41S)

Riverview Void (Dam 33S) *

Dam 9N (see HVO North schematic

Bridge Sumps South

Dam ID	2029	2032	2038	2041
Dam 4S-A	Reshape (Mine Dam)	Mine Dam	Sediment Dam	Sediment Dam
Unnamed 1-A			Upgrade (Sed Dam)	Clean Water Dam
Unnamed 2-A			Upgrade (Sed Dam)	Clean Water Dam
DP1S	Sediment Dam	Sediment Dam	Sediment Dam	Clean Water Dam
DP3S	Mine Dam	Mine Dam	Sediment Dam	Clean Water Dam
DP5S			Sediment Dam	Clean Water Dam
DP8S	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam
DP9S		Sediment Dam	Sediment Dam	Sediment Dam

Hunter Valley Operations

HUNTER VALLEY OPERATIONS

Figure 3.21: Water Management Schematic HVO South

Job Number: BNTL00198_0002	Drawn: SGG	Checked: SES
Revision: 0	Date: June 2025	

3.2.2.2 Year 3 (approximately 2029) Water Management Infrastructure (Approved and Amended Project)

At HVO North, at this stage, West Pit continues to progress south-easterly. One new mine water dam (DP2N) and associated mine water drains (DR03 and DR04) are required. One additional sediment dam (DP5N) will be constructed to the north-east of West Pit to manage sediment water runoff associated with active overburden emplacement. Two existing clean water dams to the south of West Pit are required to be upgraded as sediment dams (Dam 24N-A and Dam 25N-A) to accommodate pre-strip operations as the disturbance area moves south. Two clean water drains will be constructed at the southern end of West Pit to convey clean catchment runoff around disturbance areas (DR01 and DR03).

The North Void TSF Levee (also known as North Void TSF Levee 2 for reference in the flooding assessment) is constructed at this stage to increase the flood immunity of the existing North Void TSF to exceed the 0.1% AEP design flood. Major dam upgrades are undertaken for Dam 15S (Lake James) and Dam 9W (Parnells Dam) to provide bulk storage capacity for the HVO Complex.

The Project upgrades at Newdell LP (if this option is selected) will involve construction of three new mine water storages (DP6N, DP7N and DP8N) and a series of clean water drains (DR10 and DR11) and mine water drains (DR12, DR13 and DR14).

Tailings disposal has commenced at LCO and in the HVO West Pit Tailings Dam (TD).

At HVO South, mining continues in a westerly direction. A new sediment dam (DP1S) and drains (DR05 and DR06B) will be constructed to capture runoff from active overburden emplacement areas while a new clean water drain (DR07) will manage disturbed and clean catchment to the west of the current Riverview Pit. A new mine water dam (DP3S) is proposed to the south-east of the current Riverview Void to capture runoff from inactive emplacement areas.

Shaping of the western HVO South overburden dump continues in a south-westerly direction. A staging dam (DP8S) is proposed ahead of the overburden emplacement area to reduce the catchment area reporting to the active mining area.

3.2.2.3 Year 6 (approximately 2032) Water Management Infrastructure (Approved and Amended Project)

The progression of mining at HVO North continues to the south-east with no new dams proposed for construction. Tailings disposal will continue at LCO and West Pit TD.

Mining at HVO South continues to progress to the west through already disturbed areas with one new sediment dam proposed for construction behind the Riverview Void Levee (DPS9) to manage runoff from active overburden emplacement in the coming years. Shaping of the western HVO South overburden dump continues in a south-westerly direction and additional DP8S staging dams are proposed ahead of the overburden dump.

3.2.2.4 Year 12 (approximately 2038) Water Management Infrastructure (Approved and Project)

At HVO North, mining continues to the south-east through several sediment dams, including Dam 24N-A and Dam 25N-A. Two new sediment dams and associated drains are proposed to be constructed to capture runoff from active overburden emplacement areas to the west (DP12N and DR18) and east (DP14N and DR27) of the pit. At this stage the catchment to DP2N ceases to receive runoff from mine affected areas and transitions to a sediment dam rather than mine water dam. Only a small area of pit pre-strip remains at this stage, which will be captured and managed via in-pit sumps.

The Carrington West Wing Flood Levee (abbreviated to Carrington WW Levee for mapping purposes) is constructed at this stage to provide flood immunity from the Hunter River as the HVO North Pit approaches its southernmost extent (in the Carrington West Wing area). A current approval exists for a levee in this area up to 1% AEP design flood.

Mining at HVO South continues to progress south through existing disturbed areas, to the existing Riverview West Void. Rehabilitation of the eastern overburden dump continues, with staging dams (DP8S series) proposed to manage runoff. The western portion of South Lemington Pit is backfilled with one new sediment dam constructed to contain runoff (DP5S). Shaping around the eastern portion of South Lemington Pit is commenced with two existing clean water dams converted to sediment dams (Unnamed-1 and Unnamed-2) to contain runoff. Three drains are proposed along the north-eastern edge of the South Lemington area to direct runoff to these sediment dams (DR15, DR16 and DR23).

3.2.2.5 Year 15 (approximately 2041) Water Management Infrastructure (Approved and Project)

As mining at HVO North continues in its south-easterly progression, the area behind the Carrington WW Levee is dumped out with overburden. A sediment dam and associated drain is proposed to prevent ponding against the Carrington WW Levee at this stage (DP11N and DR29). Rehabilitation and shaping for final landform of the overburden dump to the north and west of HVO North Pit progresses.

Mining at HVO South continues to the south to its final void location with shaping and rehabilitation of the eastern overburden dump continuing in a westerly direction.

The remainder of the South Lemington Pit 1 is filled, and the western portion has sufficiently established rehabilitation for DP5S to transition from a sediment dam to a clean water storage.

3.2.2.6 Closure

When the final landform is achieved, operations will be complete, and the disturbance areas will be rehabilitated. Two final voids will remain at HVO North with the HVO North Void and the Carrington Pit Void and one at HVO South in the existing Riverview West Pit area.

Drainage systems will be established on the final sections of the rehabilitated overburden emplacement areas, as well as around the perimeter of the final voids in order to convey upstream catchment runoff away from the final voids and to downstream drainage systems / watercourses.

The final detail of any remaining dam configuration, design of the drainage systems and associated licensing will be further investigated and resolved during preparation of the relevant stages of the Rehabilitation Management Plan and in the detailed closure planning process (see the Water Assessment ((EMM, 2025c) for discussion on the licensing strategy for operations and closure).

A description and assessment of the final voids is provided in Section 5.

4. WATER MANAGEMENT SYSTEM PERFORMANCE

As described in Section 3, the existing operation has a well-established WMS in place to minimise surface water impacts with this system described in the EIS SWIA (Engeny, 2022). By utilising and building upon the existing WMS and upgrades, water for the Amended Project will be able to be managed in accordance with conditions of the current EPL and WALs.

The potential impact of the Amended Project on the site water balance of the HVO WMS has been assessed using a water balance model (WBM) in the GoldSim software. The same approach and consistent methodologies that were used for the EIS Project WBM have been used for the Amended Project WBM. The modelling is further detailed in Attachment C.

The performance of the proposed WMS for the Project is presented in the following sections (Section 4.2 to Section 4.6). It is noted that as the WMS is fully integrated, consistent with the EIS SWIA, it is not possible to separate results of the system performance for HVO North and HVO South in isolation. All results as outlined in Section 3.2.1 are presented for the overall HVO WMS.

4.1 Climate Variability

Consistent with the EIS Project, historical climate records for use in the WBM were used from the SILO database for the HVO site from 1892 to 2012 (121 years). This 121 year time period was adopted to match the available Integrated Quantity and Quality Model (IQQM) streamflow data for the Glencore Coal Assets Australia (GCAA) Greater Ravensworth Area Water Balance Model (GRAWBM). The IQQM is an integral component of the HVO WBM to incorporate the Hunter River Salinity Trading Scheme (HRSTS) release logic.

The operational WBM uses a time shifting element and a Monte Carlo analysis to forecast 121 possible climate sequences ('realisations') over the Amended Project life (2027 – 2045). The first realisation is based on climatic data from 1892 to 1919, the second from 1893 to 1920, etc.

The results from all realisations are used to predict the model response to a range of climate conditions such as the median, 5th percentile and 95th percentile climate scenarios. Consequently, as a result of the use of long-term historical climate data and Monte Carlo analysis, the WBM inherently assesses climate variability.

4.2 Overall Site Water Balance

The average predicted annual water balance, for the Amended Project, is shown in Table 4.1. Model results indicate that, on average, rainfall/runoff provides the highest system inflow accounting for 53% to 59% of the total inflow.

Hunter River extraction via HSE WALs represent a significant water source with a peak average annual reliance ranging from in the order of 2.0 GL at the start of the Amended Project and reducing to around 250 ML near the end of the Amended Project. The modelling indicates that Hunter River extraction via GSE WALs are not used during the forecast period. Groundwater remains a small contributor to the overall balance over the life of the Project ranging between 5% to 7% of the total inflows.

Water supply to the CPPs is predicted to be the largest outflow throughout the Amended Project representing 44% to 51% of total outflows. Dust suppression is the second largest demand and in combination with the CPP represents 66% to 70%. Discharge to the HRSTS represents approximately 10% to 18% of average outflows over the life of the Amended Project.

TABLE 4.1: AVERAGE ANNUAL WATER BALANCE (ML/YEAR)

Water Stream	2029	2032	2038	2041
		INFLOWS (ML/year)		
Rainfall	920	918	900	886
Runoff	6,678	7,391	7,913	7,902
Groundwater Inflows[1]	886	1,044	1,072	782
Hunter River Extraction (HSE)	1,944	1,205	1,312	1,143
Decant Return	3,905	4,081	4,560	4,214
Total Inflows	**14,333**	**14,638**	**15,757**	**14,927**
		OUTFLOWS (ML/year)		
Evaporation	1,758	1,722	1,654	1,616
Pump to CPP	6,178	6,424	7,216	6,613
Dust Suppression	3,601	3,616	3,310	3,420
HRSTS Release	1,366	2,405	2,586	2,595
Overflows	375	179	181	197
Washdown	262	264	263	263
Miscellaneous Industrial Use	349	351	350	350
Load Point Sprays	142	144	143	144
Total Outflows	14,031	15,105	15,704	15,196

Note 1: Adjusted rates to consider highwall evaporation and water bound to coal/spoil (refer to Attachment C).

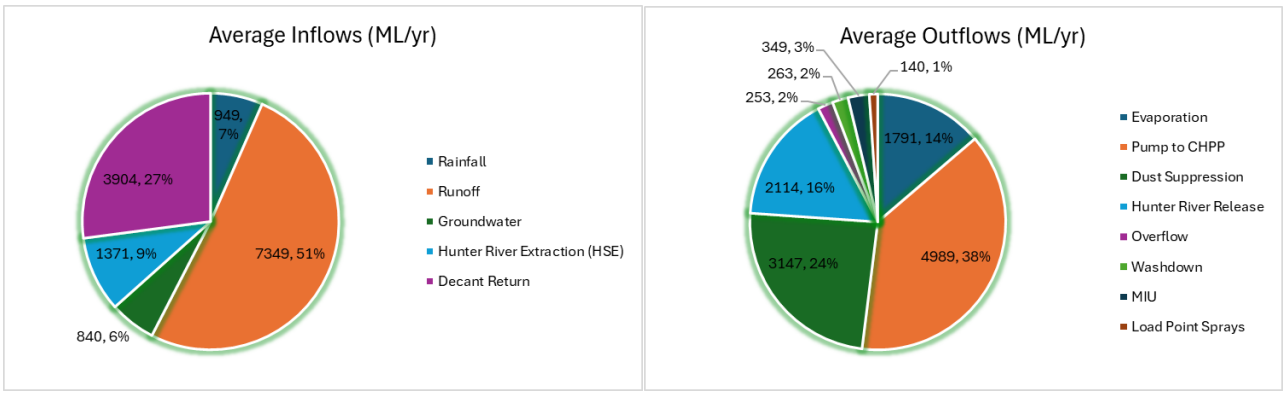


FIGURE 4.1: AVERAGE PREDICTED ANNUAL WATER BALANCE

4.3 Mine Water Inventory

Forecast mine water inventory is used to assess the overall performance of the system in maintaining water supply and allowing dewatering of active mining areas. The predicted total site water inventory (all storages, including open cut pits) is shown in Figure 4.2 for the median, 5th percentile and 95th percentile scenarios. The figure shows the range of likely total site water inventory, with a 90% chance that the total water inventory at any point in time will fall in between the 5th/95th percentile lines. It is important to note that none of these plots represents a single climatic realisation – these probability plots are compiled from all realisations (refer Attachment C) – e.g., the median volume plot does not represent model forecast volume for median climatic conditions.

The total out of pit storage capacity is expected to change over the course of the Project in line with the changes outlined in the WMS. Key changes to storage capacity are highlighted on Figure 4.2.

The figure indicates that total site inventory remains below the Full Supply Volume (FSV) in the 95th percentile, which indicates that the bulk storage capacity within the system is sufficient to maintain containment of mine water while operating in accordance with existing EPL and HRSTS release conditions. Secondarily, this indicates that the Amended Project WMS is well optimised to allow active dewatering of mining areas.

Median and 5th percentile (dry conditions) forecast inventories remain relatively steady and reflect the adopted HRSTS discharge and Hunter River extraction inventory triggers that have been adjusted to optimise containment and water security. There is a low likelihood of total site inventory dropping below 2 GL through the life of the Project, which indicates a high reliability of supply to various mine water demands (e.g., CPP and dust suppression).

The proposed WMS for the Project is forecast to maintain an overall balance without excessive accumulation or shortfall of mine water demands. In conjunction with the high water demands which drive regular consumption of mine water, this provides confidence that there is no trend toward salt accumulation in the system due to evapo-concentration effects.

Further detailed inventory forecasts for different parts of the system (e.g., HVO North, HVO South, release dams, active pits) are provided in Attachment C. Those detailed plots further support the outcomes described above.

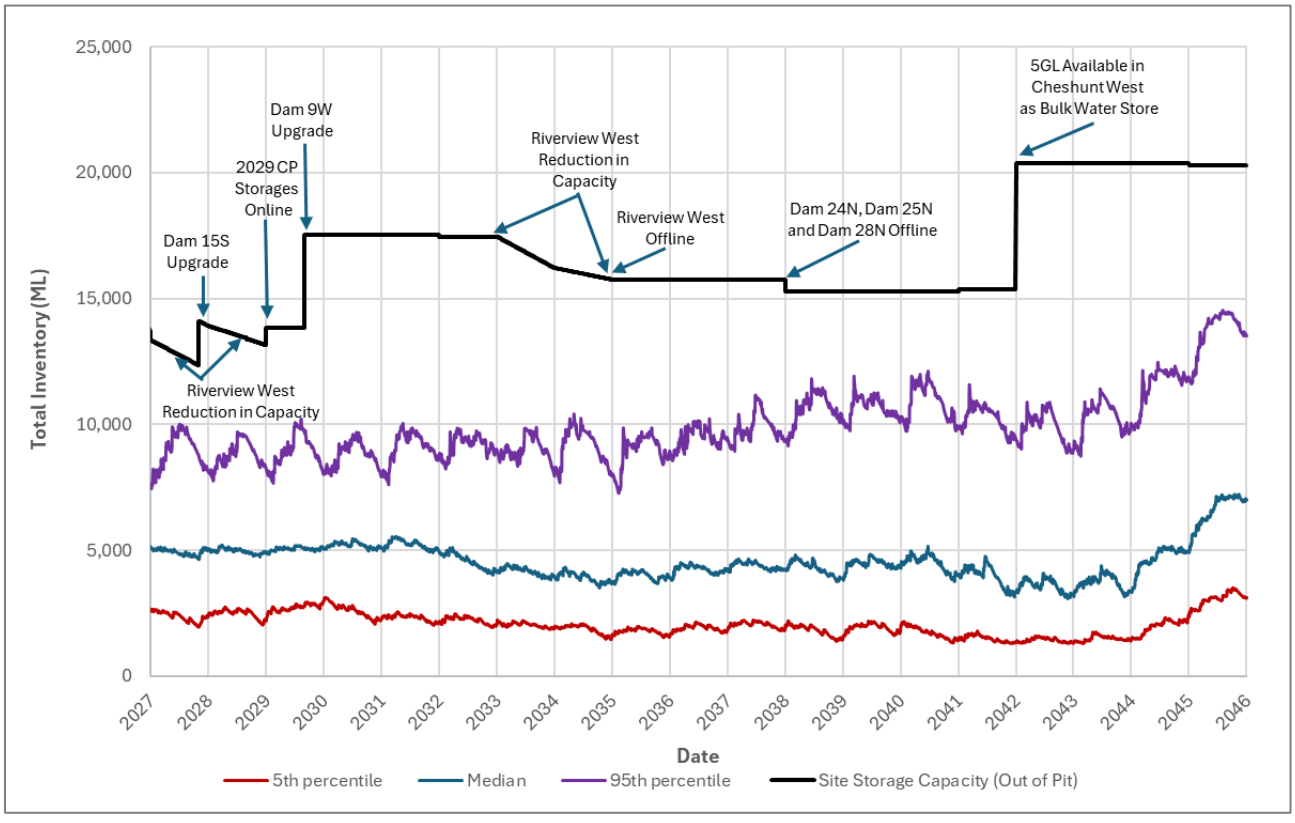


FIGURE 4.2: TOTAL SITE WATER INVENTORY FORECAST

4.4 Climatic Variability

Additional information regarding climatic variability was requested for the EIS in a submission from DPE Water (now DCCEEW). The WBM results for specific realisations for each of the stage plan years that equate to the 5th percentile (407 mm), median (664 mm) and 95th percentile (910 mm) rainfall years are included in Table 8.2 of Attachment C.

These realisations show:

- Increasing rainfall and runoff from the 5th to the 50th and then to the 95th percentile data sets (i.e. ranges from dry to median to wet years).
- Correspondingly reducing Hunter River extraction from the 5th to the 50th and then to the 95th percentile data sets (dry to median to wet years) (i.e. as rainfall increases, the need to extract water from the Hunter River generally reduces. There may be a lag in extraction after dry years as accumulated inventories are utilised).
- Varying evaporation (as this is driven by the surface area of the water inventory on site at the time which varies over the years depending on the climatic sequence and associated HRSTS discharge opportunities).
- Varying dust suppression (as this is driven by the climatic sequence rather than by the volume of rainfall).
- Increasing HRSTS discharges which correspond to using HRSTS discharge opportunities and relate to the increasing runoff from the 5th to the 50th and then to the 95th percentile data sets (i.e. as rainfall increases, the need to discharge via the HRSTS generally increases. There may be a lag in discharge after wetter years as water is first accumulated in available storages).

4.5 Water Supply Reliability

There is a very high reliability of water supply with negligible shortfalls over the Amended Project. Any shortfall is able to be managed with the current TARPs that reduce water demands during periods of extended drought. As described in Section 4.2 above, extraction via HSE WALs represent a significant water source with a peak average annual reliance ranging from in the order of 2.0 GL at the start of the Amended Project and reducing to around 250 ML near the end of the Amended Project (8% to 14% of total inflows). The modelling indicates that Hunter River extraction via GSE WALs are not required to meet water supply demands during the forecast period.

The total water predicted to be extracted from the Hunter River, using the existing HSE allocations for the Amended Project is shown in Figure 4.3 for the median, 5th percentile (wet) and 95th percentile (dry) statistics. The figures show the range of likely water extraction, with a 90% chance that the total water inventory will fall in between the 5th and 95th percentile amounts. It is noted that contrary to other results presented throughout Section 4, in the context of water supply reliability and water extraction (Section 4.5 – i.e. this section), the 95th percentile represents dry conditions (with only a small chance (5%) of the resulting extraction being exceeded) while the 5th percentile represents wet conditions with a large chance (95%) of being exceeded.

Demands have been separated for HSE and GSE to demonstrate the high reliability of the system even under the scenario of allocations being reduced under the regulated water supply scheme. The modelling indicates that the Amended Project would only require to use GSE WALs in extreme dry conditions (i.e. greater than the 95th percentile). Additional operational flexibility that is not directly represented in the WBM, but which further improves water supply reliability includes the option to access GSE WALs prior to HSE WALs or to adjust operational inventory targets prior to dry periods to maintain additional volumes on site.

The Amended Project is expected to draw up to 86% of the existing 4,689 ML HSE WALs to maintain water supply in dry conditions (the 5th percentile). In the median forecast, the Amended Project is expected to draw on up to 43% of the existing HSE WALs.

The water licensing strategy is discussed in the Water Assessment (EMM, 2025c).

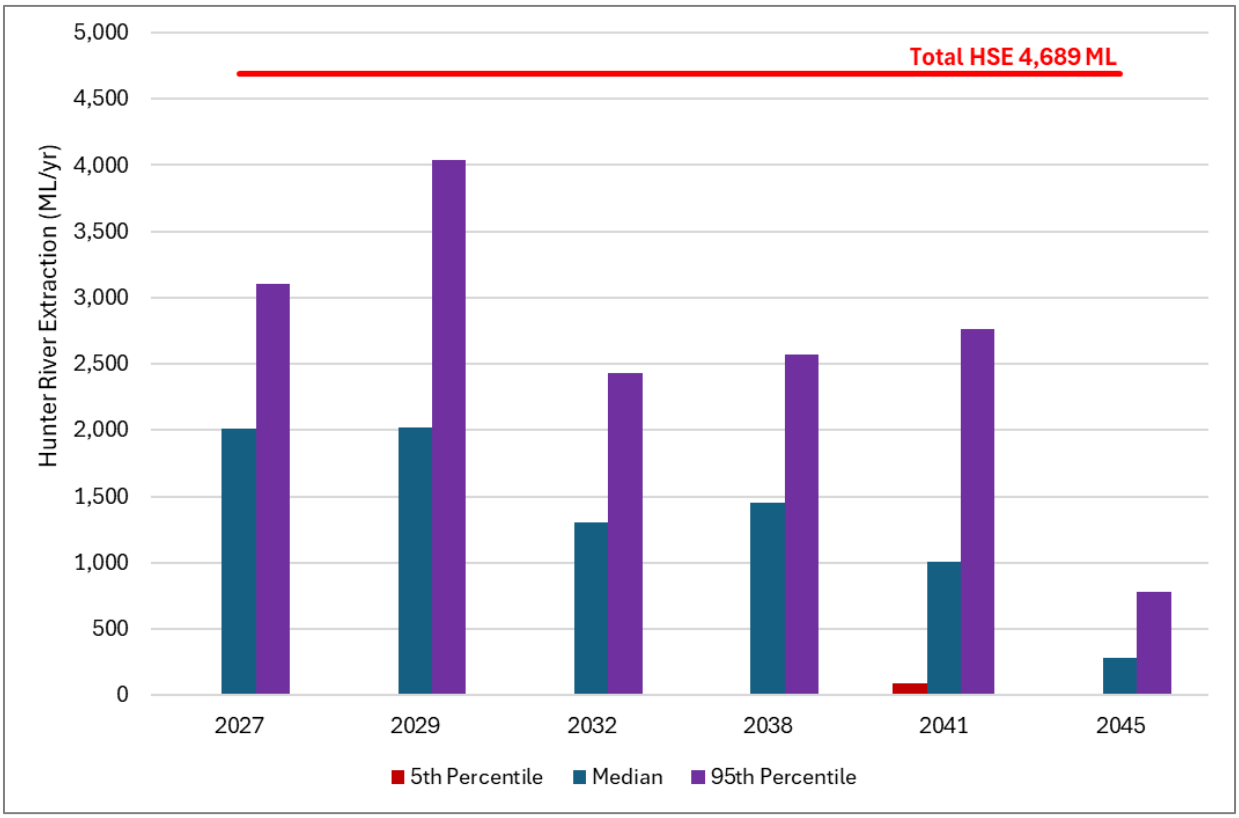


FIGURE 4.3: HUNTER RIVER EXTRACTION (HIGH SECURITY ALLOCATION) – STATISTICAL ANALYSIS

4.6 Controlled Release to HRSTS

As described in Section 4.2, discharge to the Hunter River via HRSTS is forecast to provide approximately 10% to 18% of average outflows for the Amended Project. Discharge to the HRSTS increases to approximately 18% of average outflows in the final years of the Amended Project (e.g., around Year 15, approximately 2041) as the production and water demands reduce and inventory is actively minimised in preparation for closure. It is noted that the Amended Project is not proposing any changes to existing EPL release limits.

The predicted average annual total controlled releases to the Hunter River via the HRSTS with 130 salt credits and within the requirements of the EPL, for each scenario and release storage is shown in Figure 4.4. In total, the Amended Project is forecast to utilise on average, 20% to 53% of the average total allowable discharge opportunities. The Amended Project does not fully utilise the average allowable discharge opportunity as the operating rules established in the WBM prevent releases from occurring when there are low inventories on site. This is consistent with the EIS Project, as well as discharges being skewed to wet years with the Amended Project utilising more than the average annual allowable discharge potential in those periods (e.g., 95th percentile wet years).

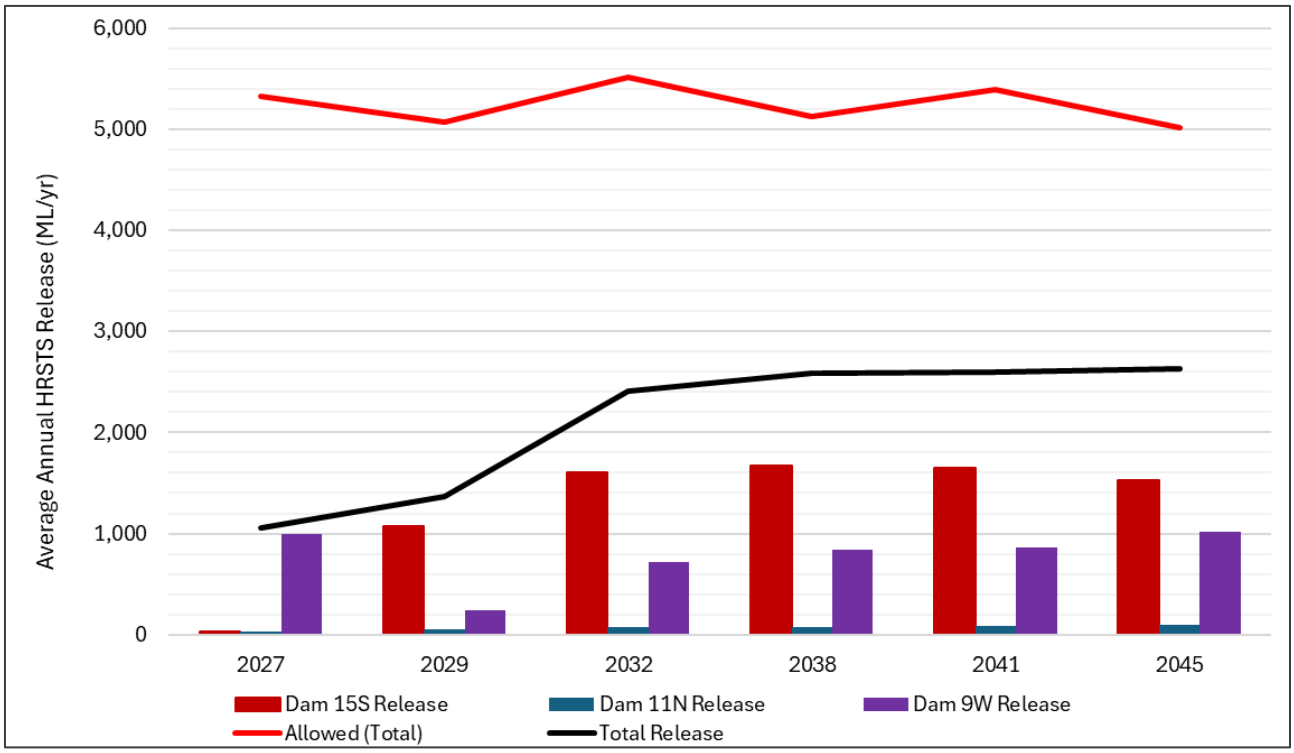


FIGURE 4.4: CONTROLLED RELEASES (HRSTS)

Consistent with the existing operation and the EIS SWIA, the WBM has been set up such that release only occurs within the existing EPL limits and the operation of the HRSTS (refer Attachment C). The exceedance plot in Figure 4.5 shows the resulting forecast dilution ratio of the total HRSTS release flows from Dam 15S, Dam 9W and Dam 11N to the corresponding receiving flow in the Hunter River for all forecast release days. The results indicate that a 1:100 dilution ratio (i.e., 1 unit of release flow to 100 units of river flow) is exceeded on 79% of release days while a 1:80 dilution ratio (i.e., 1 unit of release flow to 80 units of river flow) is exceeded on 96% of release days (this compares to 59% and 96% respectively for the EIS Project).

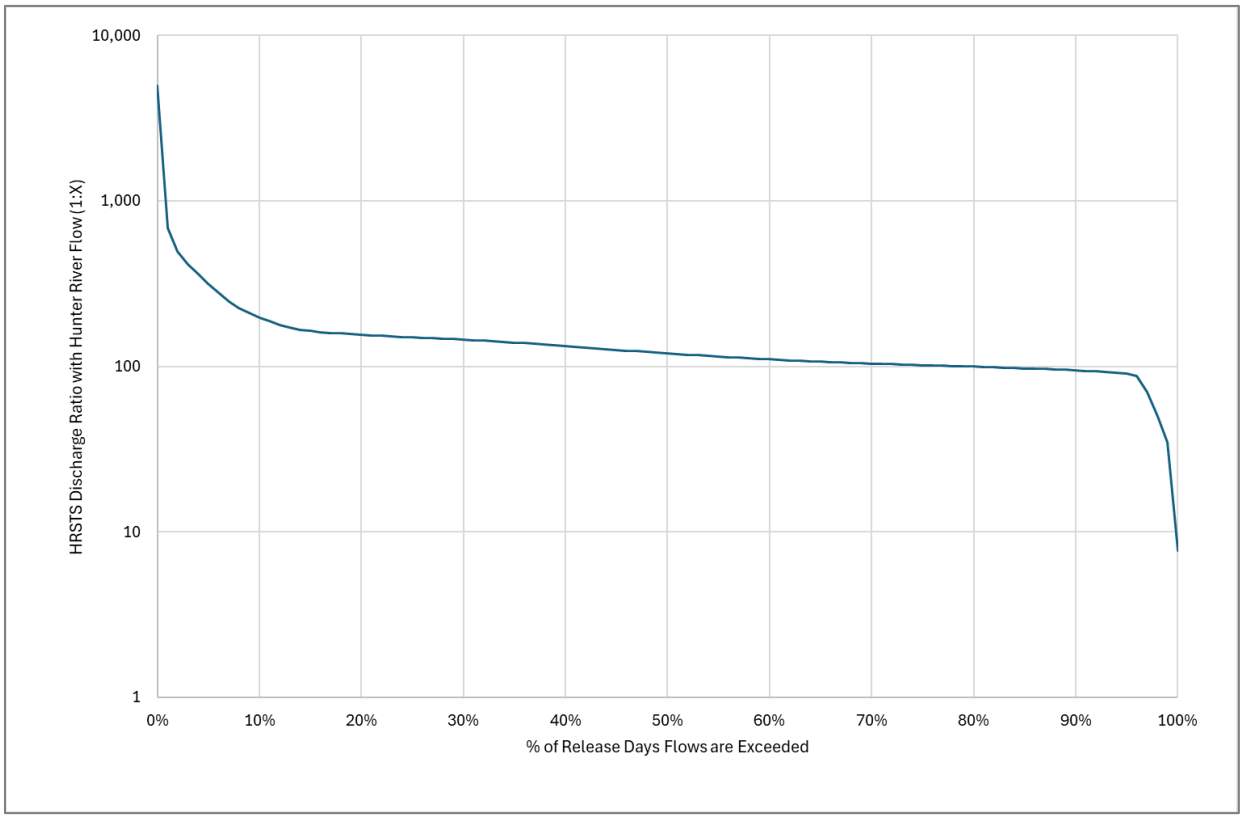


FIGURE 4.5: HRSTS FLOW DILUTION RATIO EXCEEDANCE CURVE

Consistent with the methodology used for the EIS Project, the potential for water quality impacts on the Hunter River due to discharge via the HRSTS has been assessed using a mixing calculation of the diluted water quality in the river.

The outcomes of the assessment for the Amended Project are the same as for the EIS Project.

The following methodology, outlined in the EIS SWIA (Engeny, 2022) has been continued to be used:

- Release water quality assumed equal to median historical value recorded in release storages.
- Hunter River Upstream water quality assumed equal to 80th percentile historical values. It is noted that this is a simplified assumption as water quality is likely to vary relative to flow, with lower concentrations of most analytes expected at high flows (with the exception of TSS).
- Flow ratio extracted from the WBM for days when discharge is simulated (as presented in Figure 4.5 above). A conservatively low flow dilution ratio of 1:80 (i.e., 1 unit of release flow to 80 units of river flow) has been adopted, which is exceeded on 96% of release days.
- Fully mixed water quality calculated and compared to Hunter River Upstream background values.

The analytes assessed for the EIS Project that had a mixed water quality exceeding the 80th percentile background concentration are presented in Table 4.2. The analysis forecast that exceedances of the 80th percentile background concentrations are of small magnitude (generally less than 5%) and all mixed concentrations were found to remain below the 95th percentile background concentration indicating that the expected water quality is within the existing range experienced in the Hunter River. Based on this assessment it is considered that no significant impact on water quality will occur due to the Amended Project. Further discussion of water quality impacts is provided in Section 6.3.

TABLE 4.2: FULLY MIXED HUNTER RIVER WATER QUALITY ASSESSMENT

Analyte	Mixed Concentration	Hunter River Upstream water quality		Increase Relative to Hunter River Upstream 80th Percentile	
	(mg/L)	80th Percentile (mg/L)	95th Percentile (mg/L)	(mg/L)	(%)
Carbonate Alkalinity	1.7	1.0	2.8	0.65	65%
Sulfate (SO_4)	42.6	40.0	53.3	2.6	6.6%
Sodium (Na)	84.2	80.4	97.3	3.8	4.7%
TDS	509.5	497.8	687.1	11.7	2.3%
Potassium (K)	6.0	6.0	21.0	0.05	0.8%
Total Alkalinity	257.3	255.8	269.0	1.5	0.6%
Magnesium (Mg)	33.6	33.4	34.0	0.19	0.6%
Bicarbonate Alkalinity	250.3	250.0	269.0	0.29	0.1%

4.7 Outcomes

The water balance modelling demonstrates the following outcomes consistent with the EIS Project (Engeny, 2022):

- The WMS can accommodate the inventory associated with large wet climate sequences (95th percentile) within available storage capacity.
- The conceptual WMS can achieve the adopted containment standards while enabling dewatering of active mining areas.
- The water supply has a high reliability with negligible shortfall volumes predicted in dry conditions (95th percentile).
- By utilising and building upon the existing WMS and current site upgrades, surface water for the Amended Project will be able to be managed in accordance with conditions of the current EPL and WALs.

In regard to WALs:

- The Amended Project is expected to draw up to 86% of the existing 4,689 units of HSE WALs to maintain water supply in dry conditions (the 5th percentile) and up to 43% of HSE WALs in median conditions during peak demand years. This compares to 100% during dry conditions and 91% during median conditions for the EIS Project. Consequently, the Amended Project is seen to be less reliant on HSE WALs to meet water supply demands.
- The modelling indicates that the Amended Project has no reliance on GSE allocations, compared to a small reliance on additional water in dry conditions (5th percentile) for the EIS Project.

For HRSTS discharges:

- The Amended Project is expected to utilise, on average, 20% to 53% of the total allowable discharge opportunities to the HRSTS (compared to 20% to 40% for the EIS Project). Discharges continue to be skewed to wet years utilising more than the average annual allowable discharge potential in those periods (e.g., 95th percentile wet years) for both the Amended Project and the EIS Project.
- Discharges to the HRSTS are well diluted by a factor of at least 80 times on 96% of release days. Regardless of the annual release volume, the releases as modelled operate within conditions of the HRSTS, available credits and EPL limits.

5. FINAL VOID HYDROLOGY ASSESSMENT

The final landform proposed for the EIS contained two voids; one at HVO North and one at HVO South. The final landform for the Amended Project now includes two final voids at HVO North (North Void and Carrington Void) and one at HVO South (South Void). The proposed final landform is shown on Figure 5.1.

North Void and Carrington Pit Void are located north of the Hunter River and west of Farrells Creek. At closure, North Void has a catchment area which includes a portion of the rehabilitated low wall dump. The highwall will remain exposed. Consistent with the current approval, Carrington Pit Void is a small final void which will have contributing catchment including highwall and rehabilitated low wall dumps. The Carrington Pit Void overflow path is to the North Void. The overflow path from North Void and South Void would be into the Hunter River.

South Void is located on the southern side of the Hunter River. All dumps and disturbed areas are assumed to be successfully rehabilitated at the time of closure, including the pit low walls. The highwalls will remain exposed.

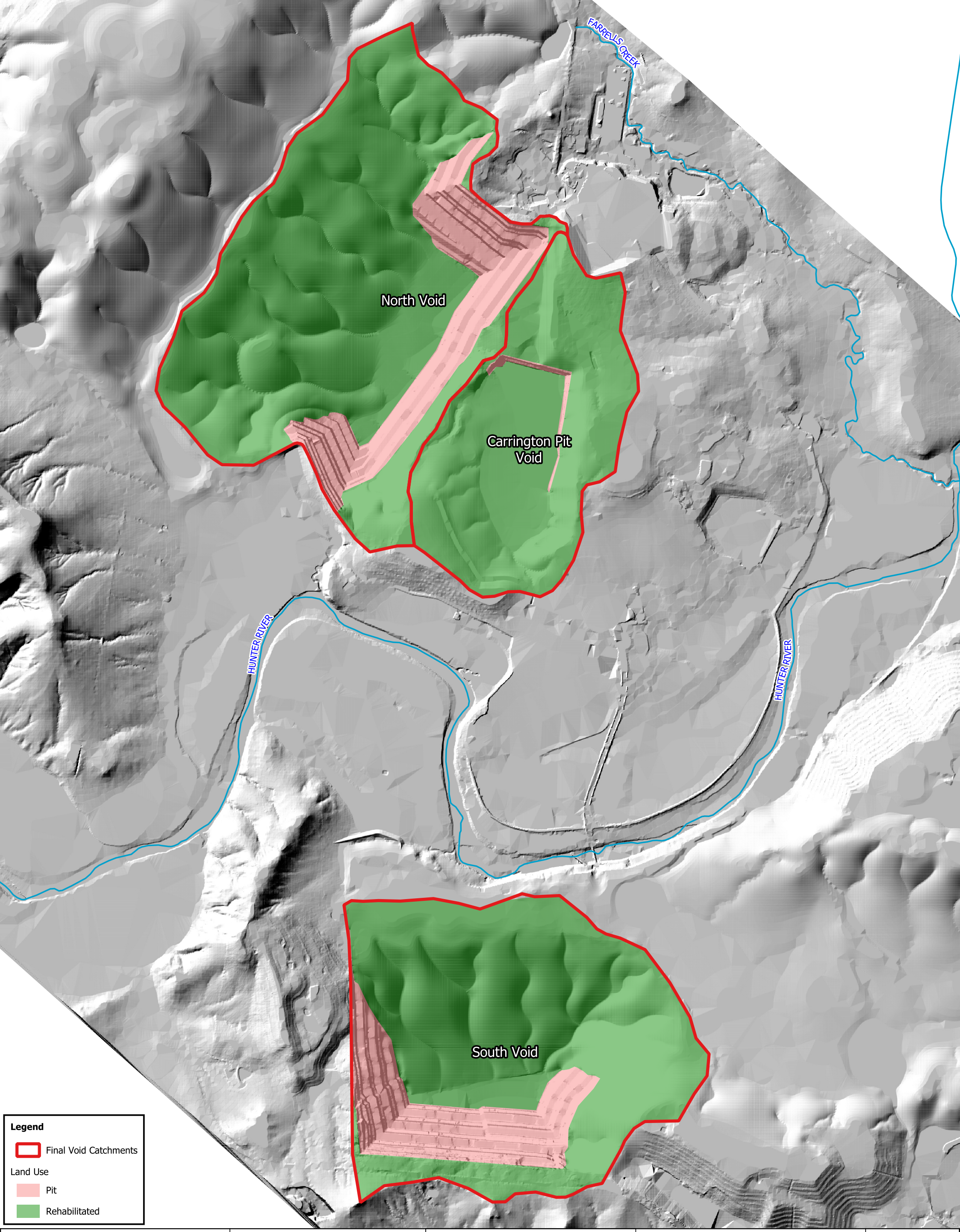
The pit low wall overburden emplacement areas will be regraded, and the upstream clean catchments including areas of rehabilitated spoil will be diverted away from the final voids. By minimising the contributing catchments, the voids have been designed to remain long-term sinks (i.e., with groundwater fluxes directed into the voids). As a result, the final landform also achieves the outcome of minimising capture of surface water.

The methodology used for the EIS Project, which was peer reviewed (refer to Section 1.5), was also used for the Amended Project, as follows:

- A final void water and salt balance model was set up in GoldSim to simulate the behaviour of the lake that would form in each of the final voids. This model is informed by groundwater recovery curves determined from the Groundwater Modelling (EMM, 2025b). It is considered that a GoldSim model is the most reliable tool for assessing long term lake levels and recovery timeframes for the Project.
- Based on geochemical assessment (EGI, 2022b), runoff and seepage from overburden is not expected to be acidic and should not contain significant metals concentrations. Therefore, long-term salinity is expected to be the main issue for final pit lake water quality. The hydrological model is able to provide preliminary indication of fully mixed water quality trends but does not provide detailed assessment of the lake chemistry.

Further details are provided in Attachment D.

Outcomes for the level, recovery timeframe and quality trends of the final voids are summarised in Section 5.3. Surface water impacts associated with the final void are summarised in Section 6.7 while the overall impact assessment of the final voids on water resources and water-dependent assets is discussed in the Water Assessment (EMM, 2025c). Closure options and strategies including the final land use are described in the Mine Closure and Rehabilitation Strategy prepared for the EIS (EMM, 2022).



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HUNTER VALLEY OPERATIONS

0 0.5 1 km

Scale in metres (1:26,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

HVO Continuaton Project - Amended Project

Figure 5-1:
Final Landform - Void Conceptual Overview

N

Job: BNTL00198_0002
Revision: 0
Drawn: AH
Checked: LV
Date: 9 /6 /2025

5.1 Hydrological Model Results

Model predicted final pit lake water levels and TDS values are shown in Figure 5.2 to Figure 5.4 for the median (50th percentile) ('most likely'), 20th percentile and 80th percentile scenarios for the three voids. It is important to note that the results presented is the forecast value over the simulation period. This is opposed to presentation of a single representative climate sequence (or realisation). While both methods would ultimately provide consistent outcomes, presenting the median value allows the long-term trends to be more easily shown as a "smooth" line without the "noise" of a single assumed representative climate sequence.

The results predict a long-term pit lake level (600 years post closure) of -17.8 mAHD for the North Void. This results in a freeboard of approximately 100 m. For the Carrington Pit Void the model predicted a long-term pit lake level (within 100 years post closure) of 41.8 mAHD. This results in a freeboard of approximately 14.0 m for the Carrington Pit Void. For the South Void, the results predict a long-term pit lake level (600 years post closure) of -29.7 mAHD, which leaves a freeboard of approximately 110 m. All three pit lakes are shown to have an ongoing trend towards higher TDS over time with the forecast median values of 7,100 mg/L, 21,550 mg/L and 8,400 mg/L respectively for North Void, Carrington Pit Void and South Void respectively when equilibrium water levels are reached.

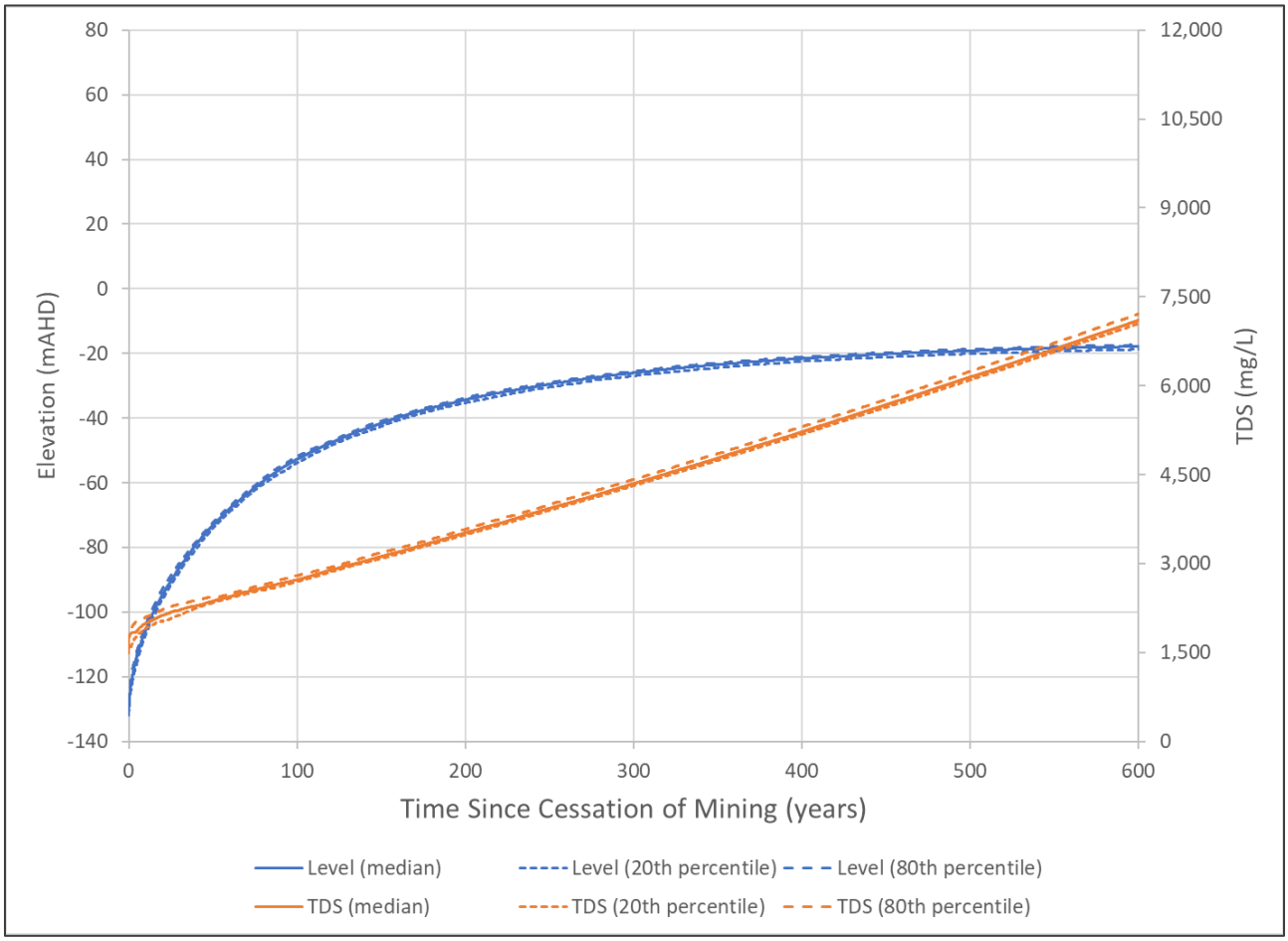


FIGURE 5.2: FINAL VOID WATER LEVELS AND QUALITY (NORTH VOID)

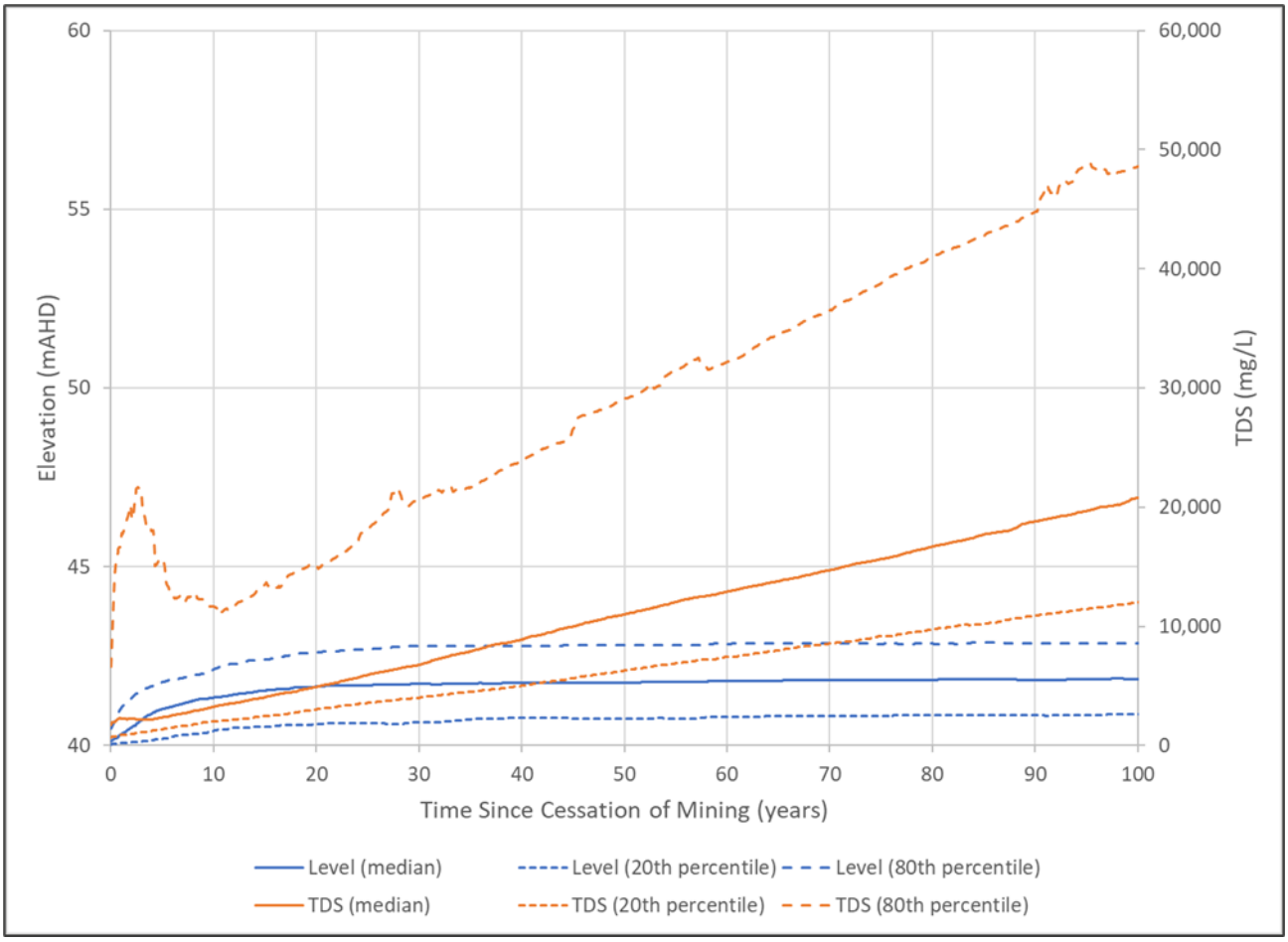


FIGURE 5.3: FINAL VOID WATER LEVELS AND QUALITY (CARRINGTON PIT VOID)

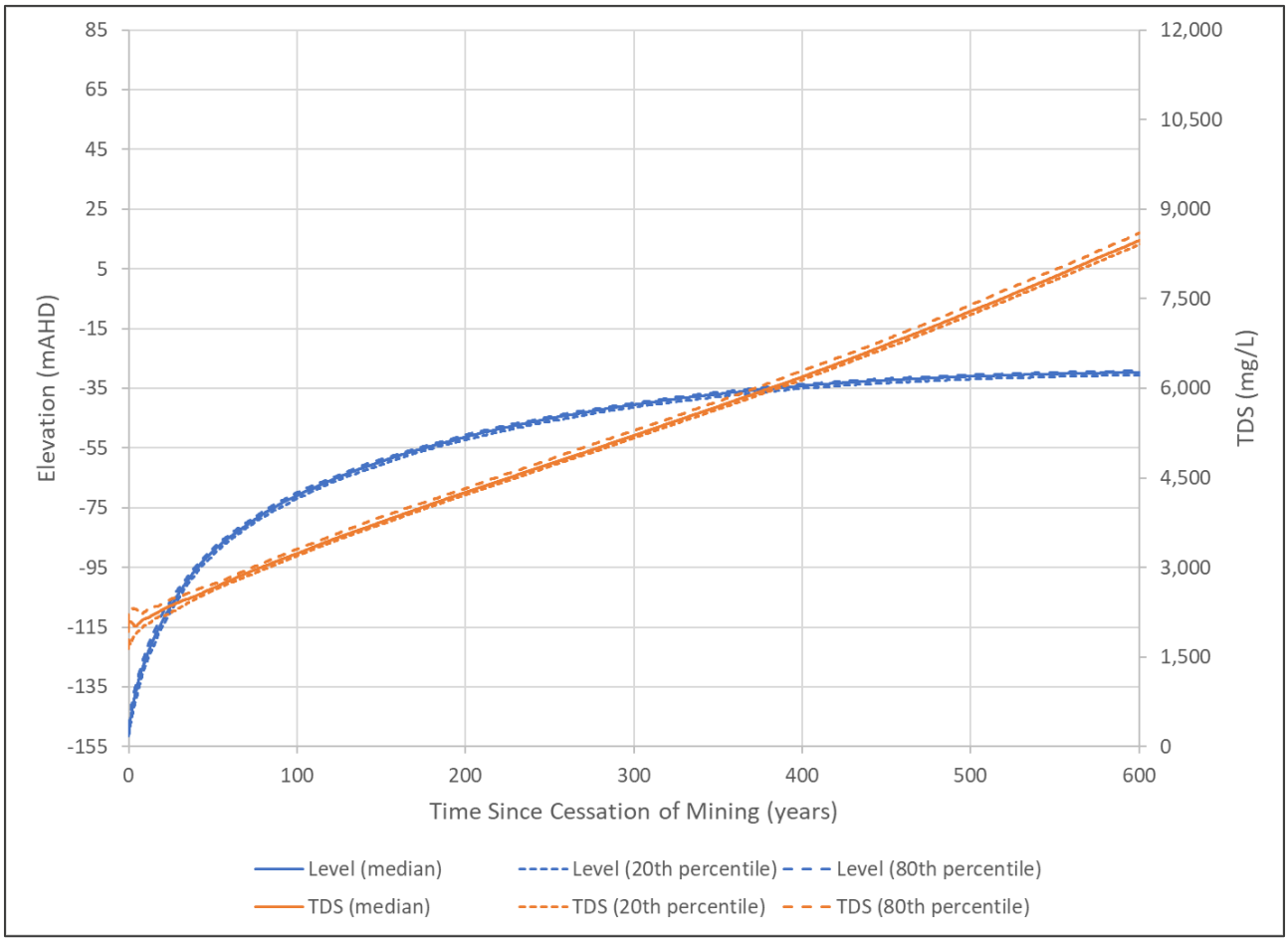


FIGURE 5.4: FINAL VOID WATER LEVELS AND QUALITY (SOUTH VOID)

5.1.1 Sensitivity Assessment

Sensitivity of the predicted final void pit lake outcomes has been undertaken on the following climate inputs:

- Pit Lake Evaporation – Reduced Lake evaporation from the pit lake surface areas by an additional 20%.
- Climate Change – Predicted changes to long-term annual rainfall and evaporation due to climate change.

Detailed methodology and results of the sensitivity assessments are provided in Attachment D. Key outcomes are:

- The impact of 20% further reduction on lake evaporation is increased lake levels. However, despite this increase in lake level, the overall outcome remains the same in that the North Void, Carrington Pit Void and South Void pit lakes remain significantly below spill levels with approximately 65 m, 10 m and 70 m of freeboard to surface respectively.
- All climate change scenarios result in lower lake levels and higher salinity with the exception of "RCP8.5 Higher" scenario. This shows that when considering climate change impacts the final pit lake levels are likely to be lower than the base case assessment (i.e., with greater freeboard to interface levels such as weathered zones or the surface topography).

5.2 Hydrogeochemical Final Void Assessment

Environmental Geochemistry International Pty Ltd (EGi) completed a geochemical assessment for the EIS Project. This assessment was not updated for the Amended Project but is considered to remain representative of expected water quality outcomes for the Amended Project final void lakes. The objectives were to assess the potential for acid rock drainage (ARD), salinity and metal/metalloid leaching (including neutral mine drainage) of the proposed mine materials; identify any geochemical issues; and provide recommendations for materials management and any follow up test work if required (EGI, 2022a). The assessment included geochemical analysis of the overburden / interburden, coal seams, rejects and tailings materials involved with the Project.

The geochemical assessment report derived several management strategies for the Project to reduce the risk of acid rock drainage (ARD) and metal leaching. These strategies are also proposed to be implemented for the Amended Project.

Following the geochemical assessment EGi developed a hydrogeochemical model (Pitchem) using the *Phreeqc* chemical speciation program to predict the water qualities of lakes that form within final voids (EGI, 2022b). The hydrogeochemical model utilised hydrology and groundwater inputs presented in this report and computed water chemistry on a monthly basis for a period of 1,000 years post closure.

The hydrogeochemical model has the capability to model pH and chemical speciation reactions including solubility, redox, ion exchange and surface complexation, adsorption, and mixes of two or more solutions. By contrast, the final void hydrology model, documented in Attachment D of this report (i.e., a fully mixed GoldSim model), models total dissolved solids based purely on mass-balance. The hydrogeochemical model developed by EGi is expected to produce more robust predictions of the final pit lake chemistry post closure.

EGi made the following conclusions about the model predictions (EGI, 2022b):

- Lake waters will be alkaline and brackish.
- Consistent with the hydrological model, the concentrations of TDS will increase in a near-linear manner with time.
- The dominant soluble salts will be sulphate, chloride, and sodium.
- Because the lakes behave as evaporative sinks, it is reasonable to conclude that the concentrations of soluble salts would continue to rise with time.
- There could also be slightly elevated concentrations (i.e., 0.1 to 1 mg/L) of some elements, including aluminium, boron, barium, manganese, nickel, selenium, and zinc, but other environmentally important metals and metalloids are predicted to occur at trace concentrations only.

The TDS concentrations post closure predicted by the final void hydrology model (i.e., GoldSim results in Section 5.1) for the EIS Project assessment were approximately 50% higher than the predictions from the hydrogeochemical model. This is likely due to the simplistic mass balance modelling approach of TDS in the final void hydrology model compared to the hydrogeochemical models' capability to model pH and chemical speciation reactions.

The predictions from the hydrogeochemical model are considered the best estimate of the HVO final voids lake chemistry post closure, as such it is considered that the TDS concentrations predicted by the final void hydrology models for the Amended Project will continue to be overestimated, which is consistent with the results for the EIS Project.

5.3 Outcomes

5.3.1 Comparison of Results to EIS Project – North Void and South Void

Results for North Void and South Void are discussed below with specific comparison to the previous EIS Project assessment. Consistent with the EIS Project, the Amended Project indicates that for North Void and South Void:

- Filling of the pits lakes to equilibrium levels is predicted to take several hundred years after the cessation of mining.
- Forecast long-term lake water levels (600 years post closure) have significant freeboard to the surface for North Void and South Void of greater than 100 m which is consistent with the EIS Project.
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant (greater than 60 m).
- All climate change scenarios result in lower lake levels and higher salinity except for the "RCP8.5 Higher" scenario. This indicates that when considering climate change impacts the final pit lake water levels are likely to be lower than the base case assessment.
- Salinity is expected to continue to increase over time in the pit lakes with concentrations of less than 9,000 mg/L TDS in North Void and South Void predicted at 600 years after closure.
- Due to the significant depth of the pit lakes, the groundwater flux is predicted to remain into the voids (i.e., the pit lakes will continue to act as groundwater sinks).

5.3.2 Comparison of Results to Approved Void - Carrington Pit Void

The Carrington Pit Void was incorporated into the North Void mine plan for the EIS Project Assessment and hence was not subject to particular assessment in the EIS SWIA. The proposed Carrington Pit Void was modelled by Mackie Environmental Research for the Carrington West Wing Modification (Mackie Environmental Research, 2010) which was part of the supporting documentation for

Modification 3 to the HVO North Development Consent (DA 450-10-2003). Modification 3 was approved by the then Department of Planning and Environment in 2013.

In the groundwater assessment for the approved Carrington Pit final void the outcomes were documented as follows for 50 years post closure, i.e. long term:

- Void acts as an evaporative sink.
- Long term steady state free standing water elevation of 40 mAHD.
- Water quality in the final void of around 3,000 to 4,000 mg/L TDS.

HVO is not proposing to change the configuration of the Carrington Pit Void relative to what was previously approved. As such the results for the Amended Project Carrington Pit Void are consistent with the current approved void, as follows:

- Reaches equilibrium levels within one hundred years after the cessation of mining.
- Has a forecast long-term lake water level (100 years post closure) that forms a shallow pit lake with a large freeboard (i.e. a lake depth in the order of 2 m, with a freeboard of 14 m), indicating a negligible risk of spill to HVO North void.
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant, in the order of 9 m.
- All climate change scenarios result in lower lake levels and higher salinity except for the "RCP8.5 Higher" scenario. This indicates that when considering climate change impacts the final pit lake water levels are likely to be lower than the base case assessment.
- Salinity is expected to continue to increase over time in the pit lake with median concentrations of 21,550 mg/L TDS predicted at 100 years after closure. The salinity at 50 years is predicted to be in the order of 10,000 mg/L. It is noted that at the time of the EIS Project Assessment (refer Section 5.3 of the Surface Water Impact Assessment for the EIS (Engeny, 2022)), the simplistic mass balance methodology used in the GoldSim model was found to result in TDS forecasts 50% higher than the predictions from the hydrogeochemical modelling methodology used by EGI (2022) for the EIS Project Assessment and by Mackie for Modification 3. When the difference in methodology is taken into account, the forecast Carrington Void salinity remains consistent with the previous assessment by Mackie (2010).

6. SURFACE WATER IMPACT ASSESSMENT

6.1 Catchment Areas and Streamflow

The predicted impacts on the flow regimes of the Hunter River and its tributaries in the vicinity of the Amended Project as a result of changes in catchment area and/or baseflow and river leakage have been assessed with the detailed methodology and results described in Attachment A. A summary of the changes and resulting predicted surface water impacts is provided in the following sections.

The following key points are reiterated regarding the incremental changes in surface water catchments resulting from the Amended Project (and are consistent with the EIS):

- No reduction in approved catchment areas at HVO South. This is consistent with the lack of additional disturbance area due to changes to the approved mine sequencing within the current approved mining areas.
- Small changes in approved catchment areas at HVO North due to the small increase in the mining extent (between the existing West and Mitchell Pits and Carrington Pit).
- No new watercourse catchments are proposed to be intersected by the Project.

In addition to the above, it is noted that an approved final void scenario was not available for direct comparison to the proposed final voids. However, the contributing catchments to the proposed final voids have been shown to reduce relative to the current approved final void (refer Section 6.7).

Detailed results are tabulated in Attachment A for long-term average annual and the representative dry year (2006), including average annual flows, average annual dry days, average annual dry period, annual dry days, number of dry periods and duration of dry periods. Flow duration curves for each stream and scenario are also provided.

The conclusions of the streamflow assessment are summarised below with a particular focus on predicted Amended Project related impacts during a representative dry year (assessed using 2006 actual climate data) as this is understood to be the key potential impact to ecosystems that rely on surface water:

- Hunter River:
  - There is minimal change in the calculated number of dry days and number of dry periods for the Hunter River. Furthermore, as a regulated river, the calculated values for changes to dry days are not likely to be realised given any change in annual flow volumes will be mitigated through licensing.
- Wollombi Brook:
  - Negligible changes to annual flow volumes (Amended Project Operations or Amended Project Closure relative to Approved Operations) are predicted.
  - The tabulated results also indicate negligible changes to the number and duration of dry periods.
  - The Project Scenarios (Amended Project Operations and Amended Project Closure) are shown to result in durations of dry days (average, maximum and minimum) that are equivalent to the Approved Operations scenario for the representative dry year (2006).
- Ungauged Ephemeral Streams:
  - The ephemeral streams all show a similar pattern for the occurrence of wet and dry periods as the AWBM methodology results in an estimated flow series that is intrinsically linked to the temporality of the adopted rainfall timeseries. All ephemeral streams are predicted to have two dry periods that finish within the representative dry year (2006) with a third that carries over into the following year. The dry period that extends into the following year is of intermediate duration and the tabulated values therefore provide a good indication of the maximum and minimum duration of dry periods within the representative “dry” year (2006).
  - The results have been interrogated to identify results where the changes for the representative dry year (2006) are non-negligible from a purely numerical perspective. This has been defined as an increase of 1% or more in the number of dry days or duration of

dry periods in the representative dry year (2006). Three of the ephemeral streams were found to have changes of 1% or more (when comparing Approved Operations versus Amended Project Operations), as discussed below:

  - Parnells Creek: Average duration of dry periods within the representative "dry" year (2006) increased from 150 days to 151 days (1%) during operations as a result of the Amended Project.
  - UN1: Average duration of dry periods within the representative "dry" year (2006) increased from 155 days to 163 days (5%) during operations as a result of the Amended Project.
  - Farrells Creek: Average duration of dry periods within the representative "dry" year (2006) increased from 156 days to 159 days (1%) during operations as a result of the Amended Project.
- Refer to Amendment Report (EMM, 2025a) for assessment of the impact of these changes to streamflow on aquatic ecology.
- For the Amended Project Closure, the occurrence and duration of dry days in the representative dry year (2006) was found to improve relative to existing for all ephemeral streams. This is due to an increase in catchment area reporting off-site, with only the final void catchments anticipated to act as sinks.

6.1.1 Comparison of Results to EIS Project

When comparing the predicted impacts to streamflow of the Amended Project to the predicted impacts for the EIS Project the following are found.

- Hunter River:
  - Similar results, which will still be likely to not be realised given any change in annual flow volumes will be mitigated through licensing in the regulated river system.
- Wollombi Brook:
  - Less impact on Wollombi Brook with the predicted reduction in catchment impacts associated with the Amended Project (including impacts on UN5 and UN6) associated with the removal of the Lemington Rail Loop from the Amended Project.
  - Positive baseflow impacts are anticipated under both the Amended Project and Amended Project Closure scenarios, further improving flow conditions in Wollombi Brook.
- Ungauged Ephemeral Streams:
  - Reduced impacts are generally predicted for ephemeral streams under the Amended Project, highlighted by increased annual flows and fewer dry days.
  - Improvements are largely due to changes in drainage patterns as it is assumed all Amended Project Closure dams / dry detention basins are unmanaged and their catchments will therefore contribute to streamflow, this is a change in the final landform management compared to what was presented in the EIS Project (and is considered further in the Water Assessment (EMM, 2025c)).

6.2 Flooding

The detailed Hunter River flood modelling that was undertaken to inform the impact assessment for the EIS Project is discussed in Section 2.4. The Amended Project does not encroach onto the floodplain further than the EIS Project or further reduce floodplain storage and as such it is considered that the impacts from the Amended Project will be no greater than those modelled for the EIS Project and has not been re-simulated for the Amended Project.The immunity of key mine infrastructure was assessed for the EIS Project and has been reviewed for the Amended Project. Major Amended Project elements and open cut mining pits with a potential risk of flood inundation up to the Extreme Event (determined to be four times the 1% AEP) are included. The flood mapping for the EIS Project has been used to determine the mine infrastructure flood immunity for the Amended Project, as follows:

- All active open cut pits are shown to meet the minimum 0.1% AEP flood immunity plus freeboard standard adopted by HVO during the operational phase of the Amended Project. North Pit will be exposed to a risk of flood ingress during the later years of operations via overtopping of the Carrington West Wing Levee in events exceeding the design standard (i.e., the Extreme Event).
- The final voids (i.e., HVO North, Carrington Void and HVO South voids) will have flood immunity up to and including the Extreme Event.

TABLE 6.1: SIMULATED EVENT THAT FIRST CAUSES INUNDATION (MINE INFRASTRUCTURE)

Element	Project Baseline	Project Operations	Project Closure
South Lemington Pit 1	0.5% AEP	N/A [1]	N/A [1]
North Void TSF	0.2% AEP	Extreme Event [2]	Extreme Event [2]
Cheshunt Pit	Extreme Event	No Ingress	No Ingress [4]
North Pit	No Ingress	Extreme Event	No Ingress [4]
Carrington Pit	No Ingress	No Ingress	No Ingress [4]
Lake James (Dam 15S)	Extreme Event	No Ingress	N/A [3]

Note 1 South Lemington Pit 1 back-filled progressively: Western half in 2033 stage plan improves immunity to approx. 0.1% AEP; Eastern half in 2041 stage plan and no longer subject to flood ingress

Note 2 North Void TSF capped in Year 3 stage plan (however timing is indicative and will occur as soon as practical once tailings crust strength is sufficient to enable capping). Extreme Event would flow over the capping layer rather than tailings after this stage plan.

Note 3 Lake James (Dam 15S) to be decommissioned and rehabilitated with the proviso that a small stock water dam may be formed at the time.

Note 4: For Project Closure, these elements represent the residual voids (North Void, South Void and Carrington Pit Void).

6.3 Water Quality

The proposed WMS as outlined in Section 3.2, has been designed to continue to divert clean water around the mining operations and segregate, store and reuse mine affected water to minimise adverse effects on water quality from mining operations to downstream surface waters. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during operational and rehabilitation phases to manage water quality (refer Section 7).

Consistent with the EIS Project, discharge of mine water from site via the HRSTS is proposed to continue as needed within the existing EPL limits and using available HRSTS salt credits. Assessment of mixed water quality downstream of the site due to these discharges (refer Section 4.6), has the same outcomes as for the EIS Project and indicates the Hunter River water is expected to remain within the 80th percentile background concentrations for most analytes and within the 95th percentile background concentration for all other analytes. As such, the water quality is expected to remain within the existing range experienced in the Hunter River with no significant adverse impacts identified.

6.4 Geomorphological and Hydrological Values

As described in Section 6, the predicted changes to streamflow volumes and the occurrence of dry days due to the Amended Project are generally minor or negligible. Flow duration curves for all watercourses assessed are presented in Attachment A for a range of scenarios (Approved and Operational Project and Project Closures cases) and indicate small changes in the magnitude and frequency of flow relative to the approved conditions. The forecast changes resulting from the Amended Project are typically less than for the EIS Project, and are not expected to result in any significant changes to the geomorphology or hydrological values of the downstream waterways.

Consistent with the EIS Project, it is proposed to manage and construct the proposed infrastructure using the same methods and controls as are currently in place and specified in the WMP. When work is required within or adjected to watercourses (i.e. waterfront land), work will be in accordance with guidelines from Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volumes 2A, 2C, 2D and 2E (DECC, 2008) (the Blue Book) (refer to Table 7.1).

Furthermore, as noted in Section 6.1, velocity impacts are generally localised around Project infrastructure (flood levees, Lemington Road, South Lemington Pit 1). The magnitude of velocities in areas of impact generally remain within the existing ranges experienced within the nearby area and remain a low likelihood of causing erosion or scour (<2 m/s). Further detailed design of localised scour protection will be included in the design of Project infrastructure. No significant change to flood velocities was observed on property not owned by the JV partners. As a result, no significant change to the geomorphology of the Hunter River or the watercourses surrounding the Amended Project is expected as a result of the Amended Project, this includes all identified Hunter Valley Flood Mitigation Scheme bank stabilisation works.

A focus of the geomorphic assessment for the EIS Project was the potential impacts associated with the Carrington West Wing Levee. It is noted that there is a current approval for a levee in this area for the 1% AEP flood, with the EIS Project proposing to increase this to 0.1% AEP immunity plus freeboard.

As the location, and the design, of the Carrington West Wing Levee is the same for the Amended Project as the EIS Project, the impacts are considered to be the same and as such the same management/monitoring measures will be required for the Amended Project.

Consistent with the EIS Project, the area should be monitored during the operational life of the Amended Project, particularly following large flood events (5% AEP or larger) to identify any signs of instability and potential corrective action. The combination of appropriate design, scour protection on the levee and monitoring is adequate to mitigate the risk of erosion as a result of the Amended Project.

6.5 Riparian and Ecological Values

As a regulated river, changes to the flow regime of the Hunter River are not expected as a result of the Amended Project, especially as the Amended Project assessment (consistent with the EIS Project assessment) indicates predicted minimal change in the calculated number of dry days and number of dry periods for the Hunter River. Predicted changes to the flow regimes of Wollombi Brook and the ephemeral watercourses have been shown to be of small magnitude (refer Section 6 and Attachment A) which is consistent with the EIS SWIA (Engeny, 2022). The aquatic ecology and GDE assessment (undertaken for the EIS Project) indicates no significant impacts on associated receptors due to these changes (ELA, 2022). The Amended Project is therefore not expected to have significant impacts on the riparian or ecological values of the adjacent and downstream watercourses.

6.6 Water Users

As identified in Section 2.6, there are no water users downstream of the Amended Project within the ephemeral watercourse catchments. There are water users downstream of the Project area within the Hunter River catchment; however, change in annual flow volume in the Hunter River will be accounted for using HVO's existing WALs and as such, as a regulated river, it is predicted there will be no impact on the occurrence of dry days. Consistent with the EIS Project, the Amended Project is therefore not expected to impact any water users.

6.7 Final Void

6.7.1 Streamflow Impacts

The catchment areas for the Amended Project final voids are presented in Table 6.2 along with the current approved void catchments. The Amended Project is shown to result in a reduction in catchment contributing to final voids relative to the current approvals. This will result in increased catchment and surface runoff to the surrounding waterways, which is a positive impact.

TABLE 6.2: FINAL VOID CATCHMENT AREAS

Mining Area	Approved Void	Current Approved Void Catchment (ha)	Amended Project Proposed Void Catchment (ha)
HVO North	West Pit	497 [1]	706 North Void, 324 Carrington
	Mitchell Pit	154 [2]	
	Carrington Pit	120 [3]	
HVO South	Riverview Pit	1,145 [4]	570
Total		1,916	1,600

Note 1: HVO North West Pit EIS (MER 2003)

Note 2: Calculated (refer Chapter 3 of the EIS)

Note 3: HVO North Mod 3 (Carrington West Wing) (MER 2010)

Note 4: HVO South MOD5 EA (EMM, 2016)

6.7.2 Flooding Impacts

The flooding assessment of the final voids (refer Section 6.2) indicates that the North Void, Carrington Pit Void and South Void will have immunity from Hunter River flooding up to and including the Extreme Event.

6.7.3 Water Quality Impacts

The hydrology assessment of the final voids (refer Section 5) forecast that a pit lake will form within the final landform at HVO North and HVO South. The long-term pit lake levels are expected to remain deep with significant freeboard to the surface (-16.1 mAHD with 97.6 m freeboard for North Void, 42.0 mAHD with 14.0 m freeboard for Carrington Pit and -28.0 mAHD with 108.0 m freeboard for South Void).

Salinity is expected to continue to increase over time in the pit lakes (concentrations of 10,770 mg/L, 19,720 mg/L and 13,050 mg/L TDS) in North Void, Carrington Pit and South Void respectively). Due to the characteristics of the voids the groundwater flux is predicted to remain into the voids (i.e., the lakes will act as a groundwater sink) with no risk of overflows to the surface environment.

6.8 Cumulative Impacts

The potential for cumulative impacts has been considered as presented in Table 6.3 and is consistent with the EIS Project. The impacts associated with cumulative baseflow and river leakage were identified as requiring further assessment and are presented in the following section.

TABLE 6.3: IDENTIFICATION OF CUMULATIVE IMPACT ASSESSMENT

Category of Impact	Consideration	Potential Cumulative Impact	Impact Assessment
Streamflow	Surface Catchments	No additional surface catchment impacts were identified for cumulative assessment.	Assess cumulative impacts for worst case baseflow and river leakage
	Baseflow / River Leakage	Estimated cumulative baseflow and river leakage impacts for both operations and closure (EMM, 2025b).	
Flooding	Hydrology	No change to Hunter River hydrology as a result of cumulative impacts identified	None
	Hydraulics	No change to Hunter River flood characteristics in the area of interest as a result of cumulative impacts identified	
Water Quality	Mine Water Containment	Mines conditioned to maintain WMS with defined containment performance	None
	Mine Water Release	Release managed within HRSTS	None
	Sediment Water Management	Development conditioned to implement ESC measures	None
Water Resource	Water Extraction	Use of existing HSE and GSE WALs	None

6.8.1 Cumulative Streamflow Impacts

An assessment of potential cumulative changes to groundwater-surface water interaction has been undertaken using the regional groundwater model developed for the EIS and updated for the Amended Project (EMM, 2025b). The groundwater model predicted

cumulative baseflow and river leakage changes for both operations and closure and are presented in Attachment B. To determine whether further assessment of surface water impacts is required, two criteria have been considered:

- The Amended Project is forecast to have an impact on baseflow and river leakage at closure (defined as 1 ML/year or more), and
- Amended Project closure impact is more than 1% of cumulative impact.

The Hunter River was identified for cumulative assessment due to the predicted negative impact on baseflow and river leakage at closure. Additionally, five ephemeral watercourses showed increases in the average duration of dry periods by more than 1%, including Parnells Creek, UN2, Farrells Creek, UN3 and UN5. The detailed methodology and results of the assessment are provided in Attachment B. Key cumulative impact outcomes are:

- The average annual flow in the Hunter River is increased by 0.3% or less (from 409,800 ML/year to 411,000 ML/year). Despite a negative cumulative impact to baseflow and river leakage, the increase in surface water catchment to the Hunter River results in an overall net increase in flows.
- No change in the average annual dry days is predicted for the Hunter River.
- The average duration of dry periods during closure increases by 2% (1 day increase) for Parnells Creek, UN2, Farrells Creek and UN3 and by 5% (3 days) for UN5. Despite this minor increase in duration of dry periods, the overall average number of annual dry days for these ephemeral watercourses is predicted to reduce, indicating an overall improvement in flow conditions.
- Refer to the Amendment Report (EMM, 2025a) for assessment of the impact of these changes to streamflow on aquatic ecology.

7. MITIGATION, MONITORING AND MANAGEMENT MEASURES

7.1 Summary of Impacts and Mitigation Measures

Detailed environmental studies were undertaken to inform the EIS Project design, including a Surface Water Impact Assessment (Engeny, 2022). Subsequently further studies have been undertaken to inform the Amended Project design, including the surface water assessments reported in this document. The consideration of the outcomes of these studies in the design and integration with the approved operations minimise the potential for impacts on surface water resources.

The range of potential impacts resulting from the Amended Project are consistent (or less) with those predicted for the EIS Project. A summary of the existing and proposed mitigation measures is included in Table 7.1. It should be emphasised that the majority of the proposed mitigation measures are consistent with the existing mitigation measures in place at HVO. This is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance and changes in timing associated with the Amended Project.

TABLE 7.1: SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

Potential Impacts	Existing Measures	EIS Project - Proposed Measures	Amended Project - Additional Measures
Mine and sediment water runoff	Appropriate design and operations of WMS (refer to Section 3).	Extension of existing WMS including construction of additional mine water and sediment dams over the life of the mine. Noting most of these dams are already required for existing approved mining.	None identified.
	Comprehensive water quality monitoring systems.	Upgrades to Lake James and Parnells Dam to increase onsite water storage and provide upgraded telemetry and release systems.	None identified.
		Continuation of existing water quality monitoring.	None identified.
Stormwater management and erosion and sediment control from construction areas	Implementation of Erosion and Sediment Control Measures during construction and design of scour protection measures during detailed design phase.	Continuation of existing measures. Extension of existing WMS.	None identified.
	Where works are within the areas defined as waterfront land (i.e., the bed of a watercourse and the land on each side within 40 metres of the bank), erosion and sediment controls are implemented to minimise the impact of the works on the watercourse and adjoining land.	The following specific controls are proposed to be included in the detail of the WMP: • Works within the riparian zone will maximise, where possible the preservation of any existing vegetation and minimise site disturbance.	None identified.

Potential Impacts	Existing Measures	EIS Project - Proposed Measures	Amended Project - Additional Measures
	Work are in accordance with guidelines from Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volumes 2A, 2C, 2D and 2E (DECC, 2008) (the Blue Book).	• Designs for works within or near water bodies will ensure the retention of natural functions and maintenance of fish passage in accordance with NSW Fisheries Guidelines (undated) Fish Friendly Waterway Crossings. • When designing individual catchment configurations, retain naturally functioning streams and drainage lines, avoid aggregation of several sub catchments and clearly define maintenance requirements prior to construction. • Hay bales will not be used for sediment control as hay bales can promote weed growth within waterways. • Where works are to be undertaken within the 2 year flood level, measures will be incorporated to ensure C-factors (i.e. factor relating to vegetation coverage as outlined in Appendix A of Volume 1 of the Blue Book (Landcom, 2004)) are always below 0.05 during possible erosion events. • Planned works will be scheduled for forecasted dry weather periods. • Planned works within or near watercourses will have inspections completed as per Ground Disturbance Permit (GDP) (as specified in the WMP).	
Capture of clean water into WMS	Separation of clean water systems where practicable.	Continuation of existing measures. Extension of existing WMS including the Mitchell Pit clean water drain.	None identified.
	Accounting for water take.		None identified.
Flood immunity	Existing levee systems to protect mine infrastructure.	Extension of existing WMS including the construction of flood levees to provide flood protection to mine workings during operations and final	Incorporation of the Riverview Levee into the final landform. Construction of the Mitchell East Levee / final landform to provide flood immunity for North Void.

Potential Impacts	Existing Measures	EIS Project - Proposed Measures	Amended Project - Additional Measures
		landform. Amended Project levees include: • Carrington West Wing Levee. • Cheshunt Levee. • Riverview Levee. • North Void TSF Levee 2 (South-East levee).	
	Existing operation flood upgrades including North Void TSF Levee 1 (North-West levee) and South Lemington Pit 1 ramp regrade.	Realigned Lemington Road with upgraded flood immunity to exceed the 10% AEP event (currently less than 10% AEP immunity).	None identified.
Flooding impacts on properties not owned by the JV partners		Project extent and proposed levee encroachment on Hunter River floodplain optimised to minimise potential impacts.	None identified.
		Decommissioning of the Carrington West Wing Levee at closure to reinstate floodplain storage.	None identified.
Localised flood velocity impacts in Hunter River	As per erosion and sediment control comments above.	Further detailed design of scour protection will be included in the design of Project infrastructure.	None identified.
Flooding impacts on emergency management (Emergency Services / Access)		No proposed changes to emergency services access.	None identified.
Loss of downstream water flows	Water take associated with Hunter River is licensed. Metering in accordance with the Non-Urban Metering Policy (where required).	Continuation of existing measures.	None identified.
	Rehabilitation of overburden emplacement areas with runoff returned to the receiving environment when established and suitable water quality has been demonstrated.		None identified.
	Minimisation of catchment contribution to the residual void.		None identified.

Potential Impacts	Existing Measures	EIS Project - Proposed Measures	Amended Project - Additional Measures
Surplus water on site	Water sharing with adjacent mining operations.	Continued water sharing with adjacent mining operations including tailings storage at Liddell Coal Operations.	None identified.
	Water discharge using HRSTS salt credits via EPL licensed discharge locations.	Continued water discharge using HRSTS salt credits via EPL licensed discharge locations.	None identified.
Water shortage on site	Water sharing with adjacent mining operations.	No proposed changes to WALs.	None identified.
	Water abstraction from Hunter River using regulated river WALs.		None identified.
Water overflows	WMS designed as per Section 3 and Blue Book (Volume 2E). As per sites existing emergency management system including pollution incident response plan.	No proposed changes to design criteria. Continuation and update as required of existing emergency management system including pollution incident response plan.	None identified.
Water quality impacts during HRSTS Release	Discharges considered to be in the natural range of the river.	No proposed changes.	None identified.
Final void extent and water flux	Approved extent of final void.	In comparison to the existing approved final landforms, the proposed final landform at HVO South and HVO North will result in a reduction in catchment area reporting to the final voids.	None identified.
	Pit lake acts as a sink.	Consistent with existing approved outcome - i.e., a residual void configuration resulting in a deep pit lake with a groundwater flux that is predicted to remain into the voids (i.e., the lakes will act as a groundwater sink) and significant freeboard to the surface with no risk of overflows to the surface environment.	None identified.

7.2 Surface Water Monitoring and Management

The existing approved operation at the HVO Complex has well-established systems in place for monitoring and management of surface water. It is proposed that the Amended Project will maintain and build off these systems. The proposed surface water monitoring and management measures are the same for the Amended Project as those for the EIS Project.

The main document for management of surface water at the HVO Complex is the WMP (HVO, 2018). As noted in Section 3, there is an updated WMP (HVO, 2022) currently under review by DPHI. The WMP includes, as sub sections, a Surface Water Management Plan and Groundwater Management Plan as well as sections that address erosion and sediment control and response plans. The WMP is available on the HVO website: https://www.hvo.com.au/documents.

The WMP allows for the ongoing assessment of risk as mining operations progress and the implementation of improvements and changes where required. The WMP is an adaptive and responsive document with regular annual reviews and reviews triggered by incidents, audits or regulatory and operational changes.

Following approval of the Amended Project, HVO will update the existing WMP in consultation with relevant agencies to reflect the changes to water management associated with the Amended Project. The updated WMP will address any specific development consent or licence conditions and will include:

- Proposed mitigation and management measures for the Amended Project. The range of additional mitigation measures are summarised in Table 7.1 above, with few additional controls required.
- Objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with the Amended Project. TARPs, which define contingency plans and remedial measures, will be reviewed.
- Details of monitoring, inspection and maintenance programs.
- Reporting procedures for the results of the monitoring program.
- Plans to respond to any exceedances of the performance criteria and indicators.
- Progressive update of the WMP to maintain a consistent summary of the WMS as additional infrastructure (e.g., dams, levees) are constructed and/or decommissioned.
- Update details of tailings storage and decant return from Liddell Coal Operations at commencement of this transfer.

HVO has a comprehensive existing water quality monitoring program as described in Section 2.5. This program is suitable for ongoing use to monitor the performance of the WMS and initiate investigations and corrective actions if required, with the following adjustment:

- Increased frequency of comprehensive analysis from annually to six monthly for all sites.

Performance criteria are detailed in the approved WMP, and HVO has developed performance indicators to initiate site specific investigations regarding water quality. The primary objective of trigger levels is to provide an early indication of potential impacts to receptors and initiate a management response. They are not intended to be an instrument to assess 'compliance' and should not be used in this capacity (ANZG, 2018). The outcomes of the investigation are reported in the Annual Review.

The Annual Review will also document reviews and feedback relating to the maintenance and performance of the WMS.

8. CONCLUSION

The Amended Project, consistent with the EIS Project, involves continued operations within portions of catchments that are currently or have been historically subject to extensive mining or impacts associated with mining. The continuation of mining across the HVO Complex as proposed by the Amended Project will increase resource recovery from the existing operation, predominantly by mining through previously mined areas and extracting coal from deeper seams at HVO North while at HVO South an extension to the life of the mine is proposed to facilitate improved mine sequencing outcomes and reduction in mining rate.

This SWIA forms part of the Amendment Report and associated Water Assessment and provides an assessment of the potential impacts to surface water as a result of the Amended Project. It documents the assessment methods and results, initiatives to avoid and minimise surface water impacts and additional mitigation and management measures proposed to address residual impacts not able to be avoided. The assessment for the Amended Project considers and documents the information provided for submissions and further requests for information following exhibition of the EIS Project

The existing operation has a well-established existing WMS in place to minimise surface water impacts. The Amended Project, consistent with the EIS Project, proposes to continue to utilise the existing WMS by maintaining and building upon the existing WMS including new dams, pipelines & pumps and flood levees (new and raising existing).

The predicted impacts of the Amended Project, similar to the EIS Project, are generally consistent with the existing approved operations. Some minor changes in impacts are predicted, including changes to timing as per the proposed changes to the project life and mining schedule. A summary of Amended Project outcomes is provided as follows:

- The SWIA has demonstrated that the existing approved WMS with the proposed additional WMS components (including dams, pumps and pipelines) will enable water at the HVO Complex to be managed in accordance with the current EPL and WALs.
- Three final void pit lakes will form with filling predicted to take several hundred years after cessation of mining for North Void and South Void, while Carrington Pit Void fills to equilibrium within 100 years. The groundwater flux is predicted to remain into the main voids (i.e., the lakes will act as a groundwater sink with no risk of overflows to the surface environment (greater than 100 m freeboard predicted for North Void and South Void). Salinity is expected to continue to increase over time in the pit lakes. The pit lakes will be immune from Hunter River flood ingress up to and including the Extreme Event.
- Construction of the proposed levees and Lemington Road realignment were forecast, as modelled for the EIS Project, to result in small changes to flood behaviour but with minimal material impact. Modelled impacts are noted to be conservative and greater than the incremental impact of the EIS Project in isolation. The Amended Project does not encroach onto the floodplain further than the EIS Project or further reduce floodplain storage and as such it is considered that the impacts from the Amended Project will be no greater than those modelled for the EIS Project and has not been re-simulated for the Amended Project. Key findings from the EIS SWIA (Engeny, 2022) include:
  - Maximum flood level changes in the range of 20-50 mm but generally less than 30 mm on properties not owned by the JV partners. The small change in flood regime (i.e., flood level or extent) are limited to agricultural land (grazing and cropping) or crown land and is considered to have no resulting impact on the use of the land.
  - Velocity impacts are generally localised around project infrastructure (levees, Lemington Road, South Lemington Pit 1). The magnitude of velocities in areas of impact generally remain within the existing ranges experienced within the nearby area and remain a low likelihood of causing scour (<2 m/s). No significant change to flood velocities was observed on property not owned by the JV partners.
  - There are no broad scale changes to flood hazard categories forecast as a result of the Project. Small changes in road inundation durations were forecast but for the land uses in the assessment area (i.e., agricultural and mining) the small changes are not expected to have an impact on use of the land or public safety. Furthermore, the small changes described are not expected to be material for emergency management. Overall, there is a significant benefit to the local community through improved immunity and access of the realigned Lemington Road.
- The small magnitude changes to streamflow characteristics (i.e., volume or dry days) are not considered to impact water users. Refer to the Amendment Report (EMM, 2025a) for assessment of the impact of these changes to streamflow on aquatic ecology and GDEs.

The range of potential impacts resulting from the Amended Project and a summary of the existing and proposed mitigation measures is included in Table 7.1. It is emphasised that the majority of the proposed mitigation measures are consistent with the existing mitigation measures used at HVO. This is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance associated with the Amended Project.

The existing approved operation at the HVO Complex has well-established systems in place for monitoring and management of surface water. It is proposed that the Amended Project will maintain and build off these systems. In summary, it is expected that integration of the Amended Project into this established management system will adequately mitigate the potential surface water impacts associated with the Amended Project.

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10. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

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ATTACHMENT A: STREAMFLOW ASSESSMENT

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Streamflow Assessment

HVO Continuation Project – Amended Project

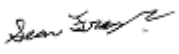
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3 JULY 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	5/06/2025	Draft Issue	Laura Vincent	Susan Shield	Susan Shield	Sean Frazer
1	3/7/2025	Client Issue	Laura Vincent	Susan Shield	Susan Shield	Sean Frazer
Signatures:						

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1. INTRODUCTION

Hunter Valley Operations (HVO) is a well-established multi-pit open cut coal mining complex, comprising two mine sites separated by the Hunter River, HVO North and HVO South (i.e. the HVO Complex). The HVO Complex is located approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW). While the two mine sites are approved under separate development consents, they are operated as one complex with fully integrated environmental management systems.

The HVO Continuation Project (the Project) broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 2026 and 2030 respectively, to the end of 2045 at HVO North and to the end of 2042 at HVO South. The continuation of mining across the HVO Complex will increase resource recovery from the existing operation, predominantly by mining through previously mined areas and to the extent of existing mining tenements and extracting coal from deeper seams at HVO North.

Streamflow impacts were assessed for the EIS Project in 2022 and documented in the Surface Water Impact Assessment (EIS SWIA) (Engeny, 2022). A peer review of the streamflow assessment for the EIS SWIA (Engeny, 2022) was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the development of the EIS SWIA, with his review comprising inputs and involvement in the water management system, water balance modelling, streamflow impact assessment, water quality assessment and cumulative impact assessment, and final void hydrology and climate change assessment.

The Project has subsequently been amended and as such an updated assessment on streamflow is required for the Amended Project, which is documented in this report.

The Amended Project is located in the same catchment areas of the Hunter River and its tributaries as the EIS Project. Land uses within and immediately surrounding the HVO Complex primarily include other mining operations, agricultural land, and rural residential land holdings. Previous mining operations have modified local catchments through the capture of runoff from mining areas within the WMS and diversion of upslope runoff around the mining operations.

This report summarises the technical assessment of streamflow and potential impacts. Groundwater modelling has been undertaken to support the Amendment Report and informs the streamflow assessment (EMM, 2025a). Water licensing for the Amended Project is assessed in the Water Assessment (EMM, 2025b). The Streamflow Assessment for the Amended Project follows the same methodology as undertaken for the Streamflow Assessment for the EIS Project (Engeny, 2022).

2. ASSESSMENT SCOPE

A screening process was undertaken to determine the required extent of the assessment for the EIS Project. This involved determining which watercourses may be impacted by either changes to surface catchment areas and/or predicted changes to surface water-groundwater interaction (i.e., baseflow and river leakage). The potential impacts on surface water catchment areas and/or surface water-groundwater interactions were reviewed for the Amended Project. It should be noted that the maximum impacts on baseflow associated with the Approved Operations have already occurred based on the data provided from the Groundwater Modelling (EMM, 2025a) and as such no additional impacts are predicted to baseflows for the Approved Operations. Similar to this there are only minor catchment changes when comparing the existing catchment areas of the WMS to the Approved Operations.

The outcomes of the scoping assessment for the Amended Project are presented in Table 2.1 and illustrated in Figure 2.1. No new catchment areas are proposed to be intersected by the Amended Project when compared to the EIS Project and the Approved Operations. It should be noted that in the table below a negative impact refers to a predicted decrease in baseflow in the watercourse, whilst a positive impact refers to a predicted increase in baseflow in the watercourse.

TABLE 2.1: SUMMARY OF PREDICTED CATCHMENT AND/OR BASEFLOW IMPACTS TO WATERCOURSES

Watercourse System [1]	Catchment Change from Approved due to Amended Project Operation[2]	Baseflow Change from Approved due to Amended Project (Operations) [4, 5]	Baseflow Change from Approved due to Amended Project (Final Landform) [4, 5]	Assessed
Hunter River (Mason Dieu 210128)	Minor changes in upstream tributaries (Parnells Creek, UN1, Pikes Creek and Farrells Creek)	Yes (negative impact)	Yes (negative impact)	Yes
Parnells Creek	Change due to minor differences associated with mining haul roads and WMS (positive impact)	Yes (negative impact)	No	Yes
Unnamed Tributary 1 (UN1)	Change due to increase in mining area with realignment of Lemington Road (negative impact)	No	No	Yes
Unnamed Tributary 2 (UN2)	Change due to approved rehabilitation area being redirected (positive impact)	No	No	Yes
Hobden Gully	-	No	No	Yes[3]
Farrells Creek	Change due to increase in mining area with realignment of Lemington Road (negative impact)	No	No	Yes
Pikes Creek	Change due to extension of Newdell Load Point stockpile area (negative impact)	No	No	Yes
Bayswater Creek	Change in upstream tributary (Pikes Creek) (negative impact)	No	No	Yes
Unnamed Tributary 3 (UN3)	-	No	No	Yes[3]
Unnamed Tributary 4 (UN4)	-	No	No	Yes[3]

Watercourse System [1]	Catchment Change from Approved due to Amended Project Operation[2]	Baseflow Change from Approved due to Amended Project (Operations) [4, 5]	Baseflow Change from Approved due to Amended Project (Final Landform) [4, 5]	Assessed
Wollombi Brook	Change in upstream tributaries (Unnamed Tributary 5 and 6) (positive impact)	Yes (positive impact)	Yes (positive impact)	Yes
Unnamed Tributary 5 (UN5)	Change due to removal of Lemington Rail Loop from Amended Project area (positive impact)	No	No	Yes
Unnamed Tributary 6 (UN6)	Change due to removal of Lemington Rail Loop from Amended Project area (positive impact)	No	No	Yes

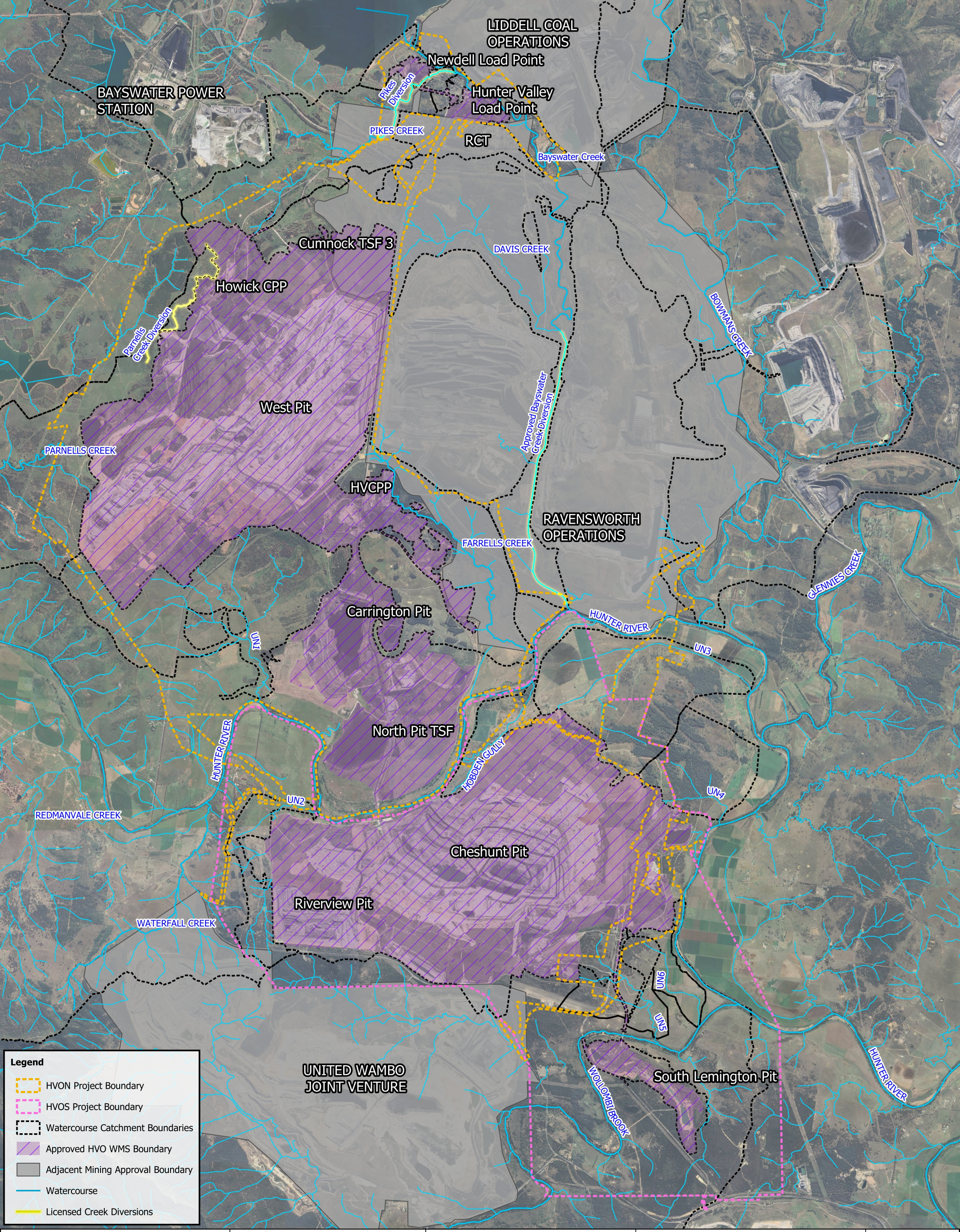
Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed in Water Assessment (EMM, 2025b)

Note 2: Maximum impact associated with the Amended Project during operational. Final landform catchments increase relative to existing and approved operations (positive impact) for all watercourses.

Note 3: No change to catchments or baseflow during operations, included to assess streamflow conditions for final landform catchment.

Note 4: Predicted as part of Groundwater Modelling (EMM, 2025a).

Note 5: Negative impact refers to a predicted reduction in baseflows, Positive impact refers to a predicted increase in baseflows.



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HUNTER VALLEY OPERATIONS

0 1.5 3 km

Scale in metres (1:60,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuaton Project - Amended Project

Figure 2-1:
Surface Water Catchment Context

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3. DEVELOPMENT OF STREAMFLOW SERIES

Streamflow gauging data is collected in NSW by WaterNSW. There is limited flow gauging data for ephemeral creek systems with streamflow gauging on these systems typically discontinued many years ago. No streamflow gauging is undertaken by HVO, however, there are current WaterNSW streamflow monitoring/gauging stations on Wollombi Brook and the Hunter River.

3.1 Gauged Streams

3.1.1 Hunter River

The Mason Dieu (210128) streamflow gauge is located adjacent to HVO South (refer to Figure 2.1).

The data recorded at the Mason Dieu (210128) streamflow gauge is considered to be representative of flows in the Hunter River adjacent to and immediately downstream of the HVO Complex. An analysis of all available data at this gauge, 1993 to 2024, is shown in Figure 3.1. The flow duration curve, which presents the total volume of flow in the Hunter River each day, indicates that daily flows typically exceed 100 ML/day 90% of the time.

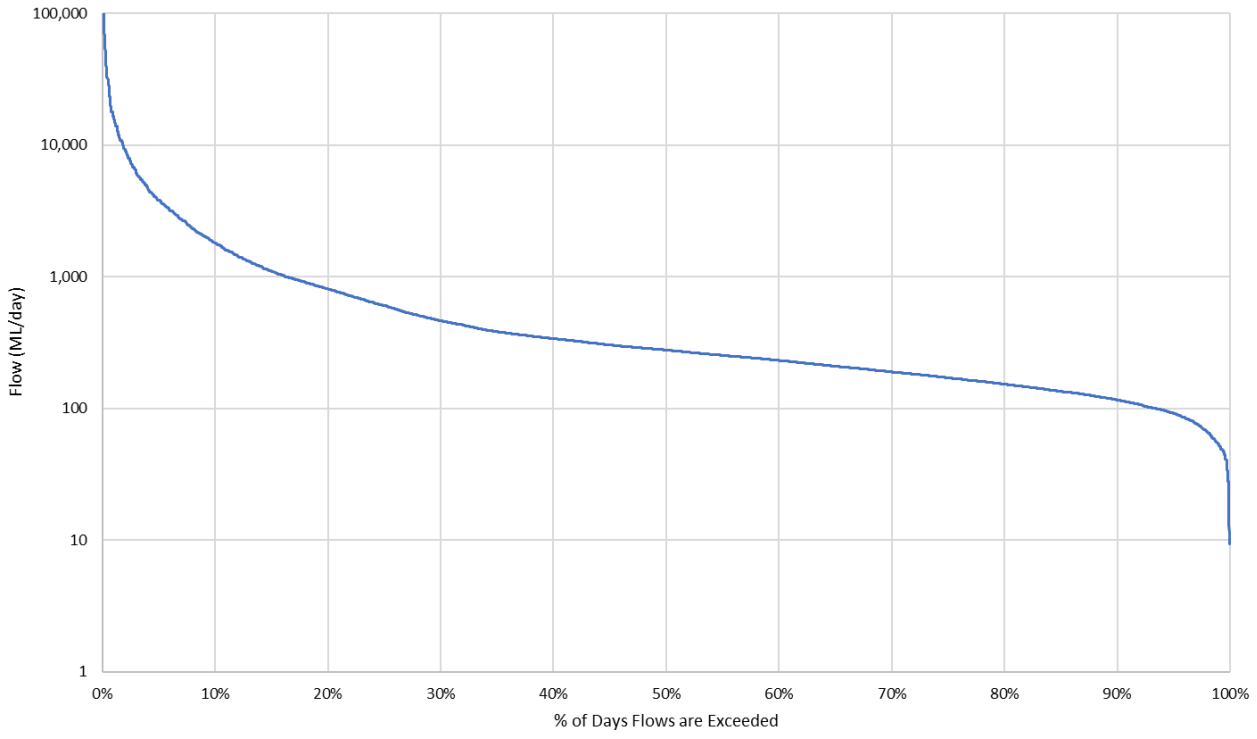


Figure 3.1: Historical Flow Gauging Data – Hunter River at Mason Dieu (210128) Flow Gaige

3.1.2 Wollombi Brook

The Warkworth (210004) streamflow gauge is located on Wollombi Brook adjacent to HVO South Lemington Pit 1 (refer to Figure 2.1). The data recorded at Warkworth (210004) is considered to be representative of the majority of flows in Wollombi Brook adjacent to and downstream of HVO. A review of flood levels in Wollombi Brook (Nittim, 1996) identified that the discharge records at Warkworth (210004) are affected by backwater from the Hunter River during floods which record above 7 m on the Singleton (210001) streamflow gauge on the Hunter River. Figure 3.2 includes the analysis of all data at Warkworth (210004) from 1908 to 2024 as well as analysis which excludes daily data for days when Singleton (210001) recorded flood depths above 7 m. An analysis of the flow duration data, which presents the total volume of flow in Wollombi Brook during each day, indicates that the impacts of backwater from the Hunter River have only minor influences on the flow duration curve, particularly for flows less than 100 ML/day. Figure 3.2 also indicates that daily flows typically exceed 100 ML/day only 30% of the time at Warkworth (210004).

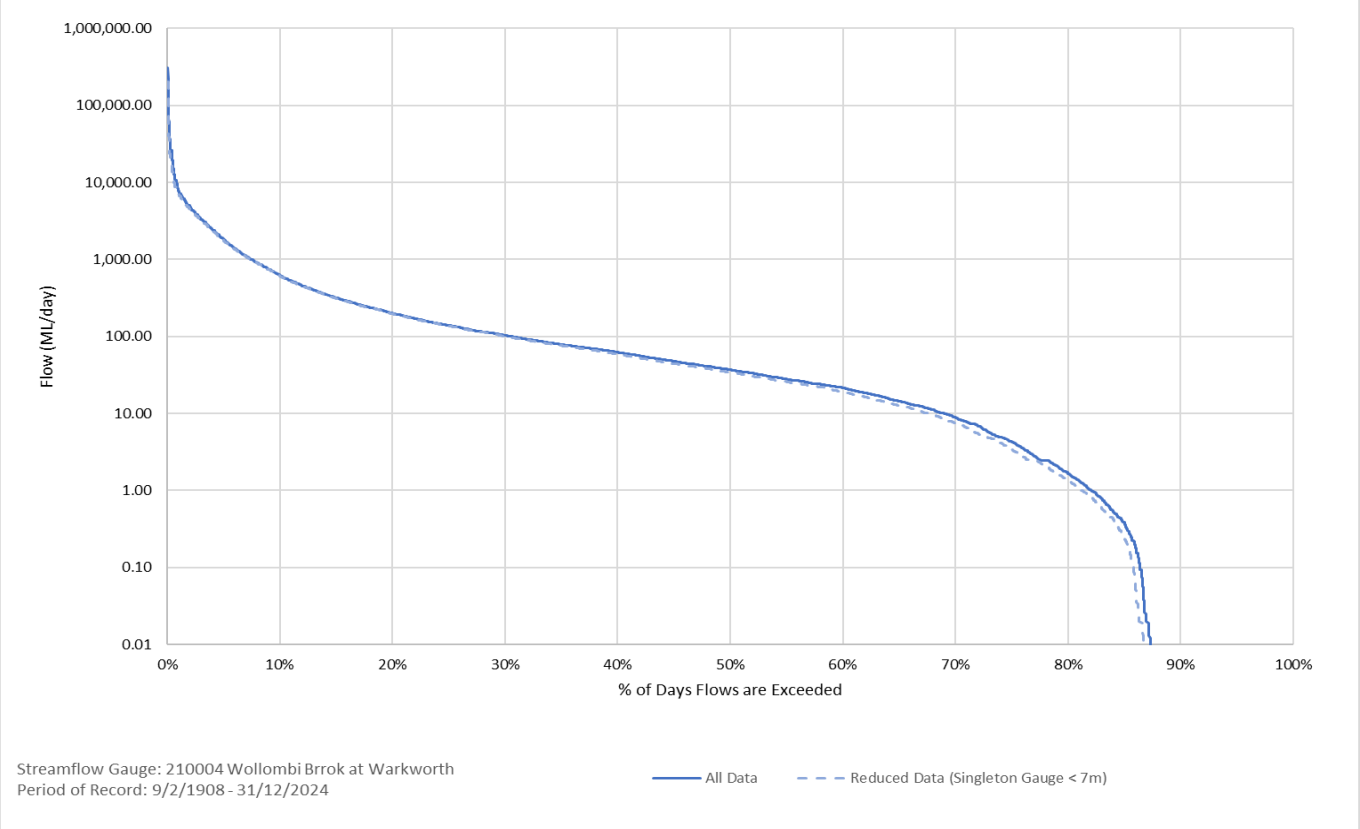


Figure 3.2:Historical Flow Gauging Data – Wollombi Brook at Warkworth (210004)

3.2 Ungauged Ephemeral Streams

There is limited streamflow gauging data for ephemeral creek systems in the Hunter River catchment, with the limited streamflow gauging that occurred typically having been discontinued during the 1960s or 1970s. As presented in the Mount Owen Continued Operations Modification 2 Surface Water Impact Assessment (MOCO Mod 2 SWIA) (Engeny, 2018), a hydrologic model was developed and calibrated using the Australian Water Balance Model (AWBM) and Swamp Creek streamflow data to determine flow sequencing impacts of Proposed Modification 2 at the Mount Owen Complex. Historical streamflow gauging and rainfall data are available for a discontinued site located on Swamp Creek (210050) streamflow gauge for the period from 1958 to 1968. This calibration period covers a range of both wet, dry and average rainfall years.

The model and process presented in the MOCO Mod 2 SWIA was accepted by both the NSW and Commonwealth government agencies. HVO North is located approximately 10 km from the Mount Owen Complex, exhibiting similar soil properties and similar order of magnitude

catchment areas (i.e., approximately 2,000 ha for Swamp Creek dataset and between 120 ha to 1,500 ha in watercourses surrounding HVO). The calibrated Swamp Creek model has therefore been identified as suitable for use for ephemeral watercourses surrounding the HVO Complex, which is consistent with approach adopted for the EIS Project (Engeny, 2022).

3.2.1 AWBM Catchment Model

The AWBM hydrologic model developed as part of the MOCO Mod 2 SWIA was used to model the baseline flow sequencing in ephemeral watercourses adjacent to and surrounding the HVO Complex.

AWBM relates daily rainfall and evapotranspiration to runoff using five functional stores; three surface stores to simulate partial areas of runoff, a baseflow store and a surface runoff routing store.

The hydrological model was calibrated to the historical flow gauging data available for Swamp Creek due to the completeness of the data. The calibration fit is presented in Figure 3.3 with the calibration parameters provided in Table 3.1, where:

- C1 to C3 = surface storage capacities.
- A1 to A3 = partial areas represented by surface storages.
- BFI = baseflow index.
- K = daily baseflow recession constant.
- Ks = daily surface flow recession constant.
- Kb = daily baseflow recession constant.

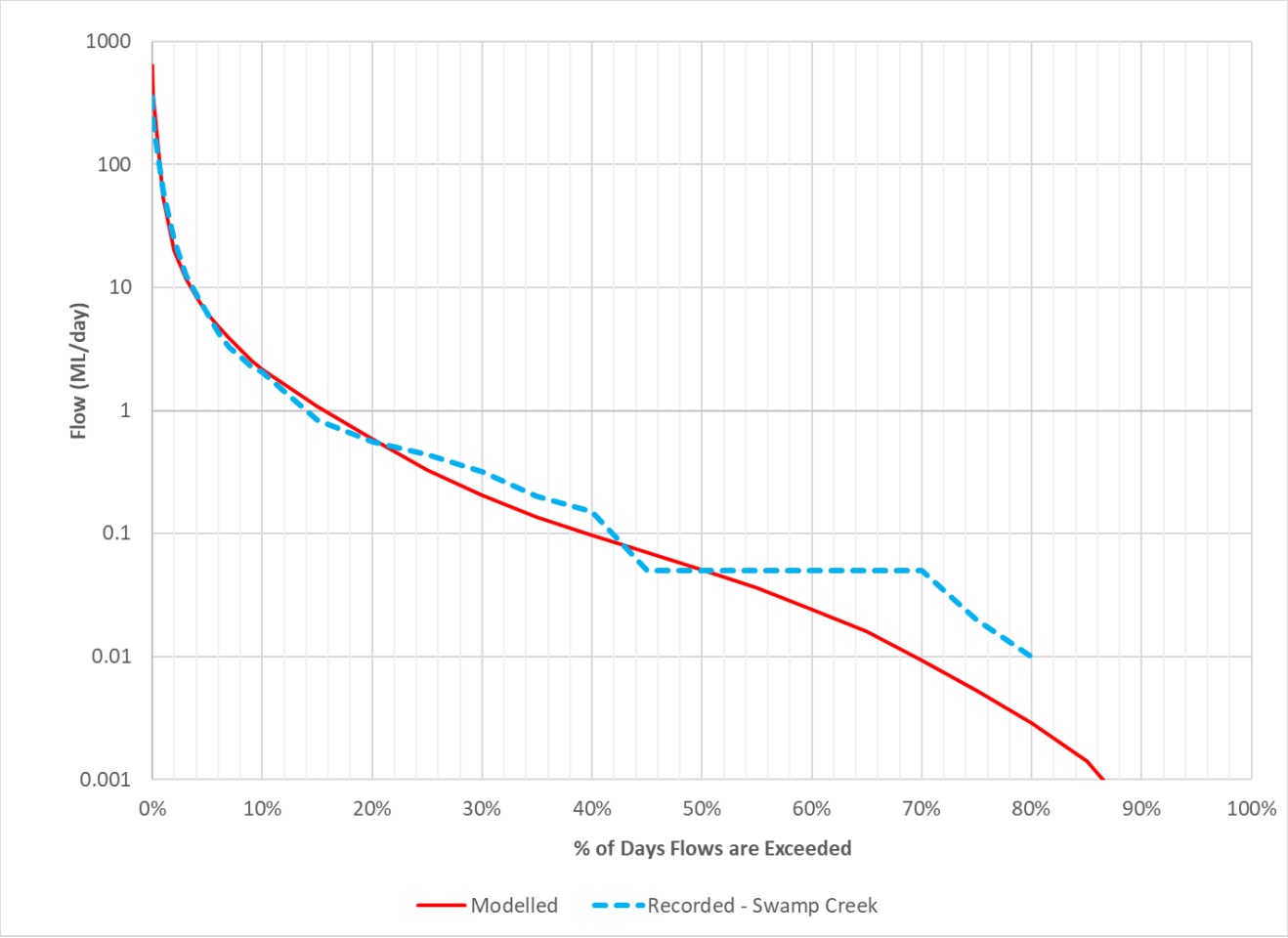


Figure 3.3: Calibration – AWBM Catchment Model – Flow Duration Curve

TABLE 3.1: AWBM PARAMETERS

Parameter	C1	C2	C3	A1	A2	A3	BFI	KS	KB
Value	20	60	80	0.10	0.45	0.45	0.15	0.95	0.5

It is noted that the AWBM parameters adopted for the streamflow assessment in Table 3.1 are different to those used in the water balance model (WBM) for the Project WMS. The soil stores in the WBM are generally higher for natural runoff than those adopted for the streamflow assessment. The adopted parameters for the streamflow assessment are based on a more detailed calibration for natural catchments in isolation and are considered to be more appropriate for assessing flow characteristics in ephemeral streams.

The calibrated AWBM model was used to simulate the baseline streamflow conditions (for the data period from 1958 to 1968). The modelling was undertaken using SILO climate data for 121 years of data.

The baseline hydrological modelling results for ephemeral creeks, based on existing (2025) catchment areas, are presented in Figure 3.4 with further detailed results provided in Section 5.

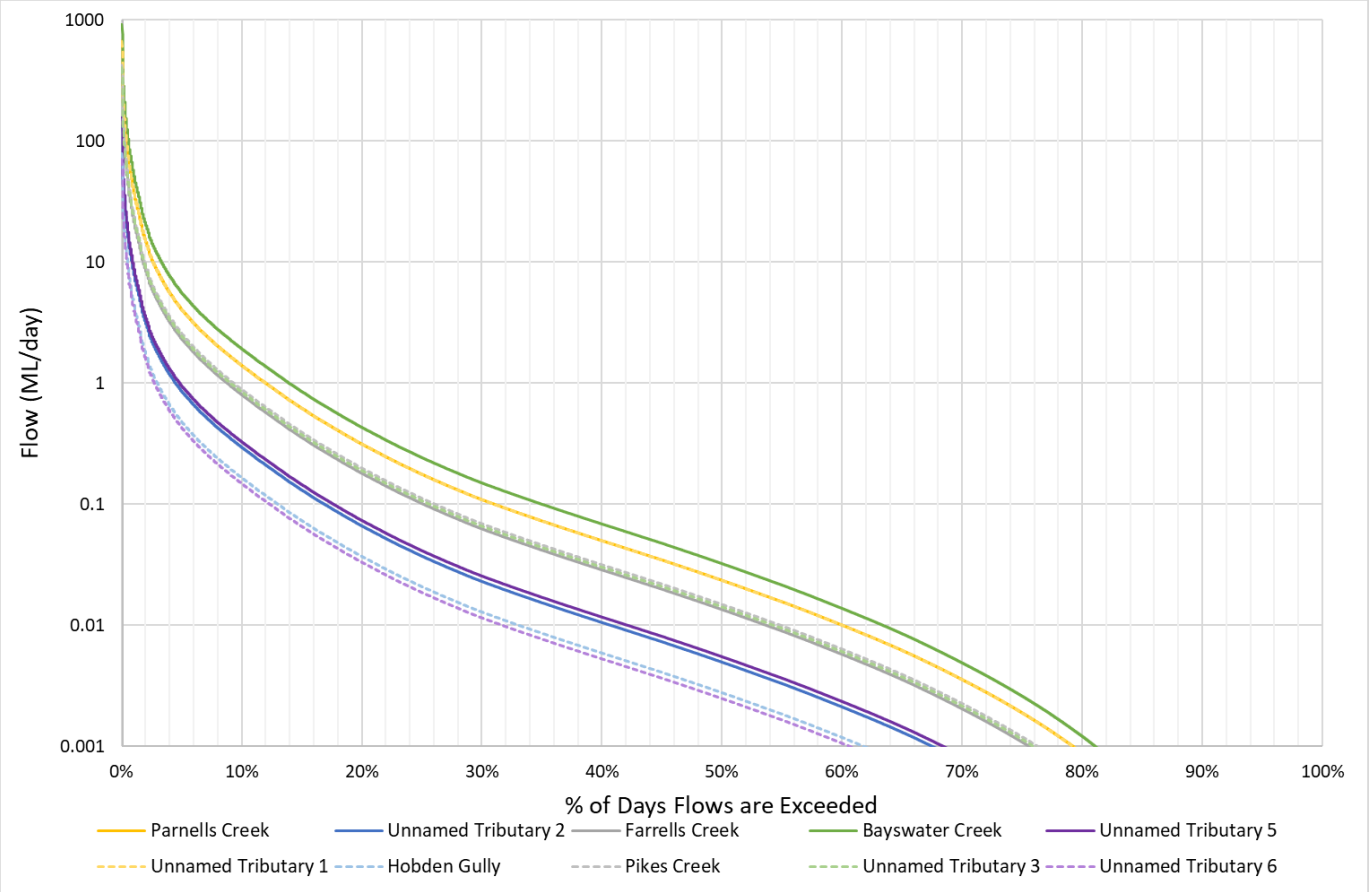


Figure 3.4: Existing (2025) Flow Duration Modelled Results – Ephemeral Creeks

4. IMPACT ASSESSMENT

The additional disturbance associated with the Amended Project (when compared to the Approved Project) is located within the catchment area of the Hunter River and its tributaries. A detailed assessment of the potential surface water impacts to the Hunter River catchment area and associated tributaries are discussed in the following sections. Only watercourses with predicted negative changes to catchment area and/or groundwater baseflows are included in the assessment for during operations and all watercourses with catchment areas changes and/or negative baseflow changes assessed for closure (refer to Section 2).

To assess impacts on the flow regimes, an analysis of flow sequencing for the Hunter River and its tributaries has been undertaken. The analysis identifies periods of low and zero flow.

4.1 Catchments

The predicted impacts on the catchment area of the Hunter River and its tributaries are included in Table 4.1 for the following scenarios:

- Approved Operations: maximum impact to watercourse catchments under approved conditions.
- Amended Project Operations: maximum impact to watercourse catchments under proposed conditions determined from stage plans.
- Amended Project Closure: Final Landform.

Existing catchment areas for the Hunter River and Wollombi Brook were derived from hydrological information obtained from WaterNSW and the *Water Sharing Plan – Unregulated River Water Sources* spatial dataset (DPIE, 2020). Catchment areas for the minor watercourses within and surrounding the Amended Project were delineated using from digital elevation data (LiDAR). These catchments were then adjusted to align with the Approved Operations, Amended Project Operations and Amended Project Closure WMS extents.

Compared to the approved operations, the proposed Amended Project Operations are predicted to have no reductions on the catchment areas of Parnells Creek, Unnamed Tributary 2, Hobden Gully, Unnamed Tributary 3, Unnamed Tributary 5, Unnamed Tributary 6, Wollombi Brook or Hunter River. For some of these catchment areas, the Amended Project will improve catchment impacts, compared to the approved operations.

TABLE 4.1: PREDICTED CATCHMENT AREAS (HA)

Watercourse System	Approved Operations	Amended Project Operations	Amended Project Closure	Comments (Approved Operations versus Amended Project Operations)
Hunter River (Mason Dieu 210128)[1]	1,438,000	1,437,000	1,443,000	Minor change in upstream tributaries (Parnells Creek, UN1, Pikes Creek and Farrells Creek)
Parnells Creek	1,010	1,015	1,940	Change due to minor increase in mining area associated with haul road and WMS

Watercourse System	Approved Operations	Amended Project Operations	Amended Project Closure	Comments (Approved Operations versus Amended Project Operations)
Unnamed Tributary 1	765	225	1,080	Change due to increase in mining area with realignment of Lemington Road.
Unnamed Tributary 2	170	205	230	Change due to approved rehabilitation area being redirected.
Hobden Gully	120	120	580	-
Farrells Creek	665 [2]	540	1,090	Change due to increase in mining area with realignment of Lemington Road
Pikes Creek	645	625	660	Change due to extension of Newdell Load Point stockpile area.
Bayswater Creek[1]	2,045	2,025	2,630	Change in upstream tributary (Pikes Creek).
Unnamed Tributary 3	615	615	870	-
Wollombi Brook[1]	187,300	187,400	188,100	Change in upstream tributaries (Unnamed Tributary 5 and 6).
Unnamed Tributary 5	150	175	875	Change due to removal of Lemington Rail Loop from Amended Project area.
Unnamed Tributary 6	85	105	105	Change due to removal of Lemington Rail Loop from Amended Project area.

Note 1: Includes impacts from all upstream tributaries

Note 2: Adopted catchment for Approved Operations has been conservatively delineated to include previously mined areas which are now rehabilitated

4.2 Baseflow and River Leakage

The predicted baseflow and river leakage impacts have been determined as part of the Amended Project Groundwater Modelling (EMM, 2025a). These flows are defined as follows:

- **Baseflow:** Groundwater discharge to surface water.
- **River Leakage:** Surface water discharge to groundwater.

Consistent with the EIS Project assessment (Engeny, 2022), baseflow and leakage fluxes less than 1 ML/year have not been considered in the assessment as these small values are within the accuracy of the model.

The predicted peak change in baseflow and river leakage values have been combined to obtain a net loss from the surface water system and are presented in Table 4.2. Table 4.2 presents the predicted peak net changes relative to existing for the Approved Operations, Amended Project Operations, Amended Project Closure which represents cumulative effects (i.e., effects of all mining activities simulated in the groundwater model (refer (EMM, 2025a)). A positive value in Table 4.2 represents a net reduction in groundwater discharge to surface water.

TABLE 4.2: PREDICTED PEAK CHANGE IN BASEFLOW AND RIVER LEAKAGE (ML/YEAR) FROM EXISTING

Watercourse System [1]	Approved	Amended Project Operations	Amended Project Closure
Hunter River (Mason Dieu 210128)	0	86	93
Parnells Creek	0	3	0
UN 1	0	0	0
UN 2	0	0	0
Hobden Gully	0	0	0
Farrells Creek	0	0	0
Pikes Creek	0	0	0
Bayswater Creek	0	0	0
UN3	0	0	0
Wollombi Brook	0	-8.4[2]	-5.8[2]
UN 5	0	0	0
UN 6	0	0	0

Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed in water assessment (EMM, 2025a).
Note 2: Positive baseflow and leakage impacts (compared to existing) have been conservatively modelled as zero as the impact assessment is focused on identifying potential negative impacts.

4.3 Cumulative Impacts

An assessment of potential cumulative impacts at closure has been undertaken. The Groundwater Modelling (EMM, 2025a) estimated cumulative changes to baseflow and river leakage for both operations and closure. The closure case potential changes to baseflow and river leakage and the resulting losses are presented in Table 4.2. Further assessment of surface water impacts was undertaken where there is forecast to be a cumulative negative change to baseflow and river leakage at closure (defined as 1 ML/year or more).

4.4 Assessment Methodology

An analysis of the potential impacts on surface water flow regimes in the identified streams has been undertaken using the long-term flow series presented in Section 3 by accounting for the changes in catchments and baseflow/river leakage presented in Section 4. The method applied is consistent with the method used for the EIS Project assessment, as follows:

- Gauged Streams:
  - Linear scaling of the daily streamflow based on the ratio of catchment area to the existing (2025) case, and
  - Subtraction of the average daily baseflow and river leakage loss from the streamflow.
- Ungauged Ephemeral Streams:
  - Adjust the catchment area applied in the AWBM runoff model, and
  - Subtraction of the average daily baseflow and river leakage loss from the streamflow.

Following adjustment of the long-term flow series, the data has been assessed to present plots of the daily flow duration for each scenario as well as to tabulate the average annual flow volumes and occurrence of dry days. Dry days have been defined based on flow below a threshold value with 0.1 ML/day for all streams except the Hunter River, for which a dry day threshold of 100 ML/day was adopted.

Three scenarios are presented:

- Approved Operations: maximum impact to watercourse catchments under approved conditions.
- Amended Project Operations: maximum impact to watercourse catchments and baseflows under proposed conditions determined from stage plans and Groundwater Modelling (EMM, 2025a).
- Amended Project Closure: Final Landform: impact to watercourse catchments and baseflows under proposed conditions determined from the final landform and Groundwater Modelling (EMM, 2025a).

Further investigation was undertaken to assess streamflow changes during particularly dry years as periods of low flow were considered to be the major potential impact on ecology. A recent dry period occurred in 2006 with an annual rainfall of 427 mm (9th percentile) based on 121 years of SILO data drill (1892 to 2012) from the HVO WBM and 371 mm (5th percentile) based on BoM rainfall data at Jerrys Plains Post Office (1884 to 2014). The 2006 climate data was adopted as a representative dry year, consistent with the EIS Project.

5. RESULTS

Results are provided in the following sections including:

- Long-term average annual results in Section 5.1.
- Results for the representative dry year (2006) in Section 5.2.
- Flow duration curves for each stream and scenario in Section 5.3.

5.1 Long Term Average Annual

TABLE 5.1: LONG TERM AVERAGE ANNUAL FLOW CHARACTERISTICS

Method	Watercourse System	Low Flow Trigger (ML/day)	Average Annual Flows (ML/year)			Average Annual Dry Days			Average Duration of Dry Period (days)		
			Approved Operations	Amended Project Operations	Amended Project Closure	Approved Operations	Amended Project Operations	Amended Project Closure	Approved Operations	Amended Project Operations	Amended Project Closure
Gauged Streams	Hunter River	100	409,800	409,400	411,000	24	24	24	5	5	5
	Wollombi Brook	0.1	172,300	172,300	173,000	52	52	52	32	32	32
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	630	630	1,220	252	256	222	63	63	64
	UN1	0.1	480	140	680	264	303	250	63	61	63
	UN2	0.1	110	130	140	310	305	302	60	61	61
	Hobden Gully	0.1	70	70	360	318	318	274	62	62	61
	Farrells Creek	0.1	420	340	680	269	276	249	62	61	63
	Pikes Creek	0.1	400	390	410	270	271	269	62	62	62
	Bayswater Creek	0.1	880	880	1,230	238	238	221	64	64	63
	UN3	0.1	380	380	550	272	272	259	62	62	63
	UN5	0.1	100	110	550	312	309	259	60	60	63
	UN6	0.1	50	70	70	325	320	320	63	62	62

TABLE 5.2: CHANGE IN LONG TERM AVERAGE ANNUAL FLOW CHARACTERISTICS

Method	Stream	Low Flow Trigger (ML/day)	Average Annual Flows (ML/year)		Average Annual Dry Days		Average Duration of Dry Period (days)	
			Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations	Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations	Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations
Gauged Streams	Hunter River	100	-0.1%	0.3%	0%	0%	0%	0%
	Wollombi Brook	0.1	0%	0%	0%	0%	0%	0%
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	0%	94%	2%	-12%	0%	2%
	UN1	0.1	-71%	42%	15%	-5%	-3%	0%
	UN2	0.1	18%	27%	-2%	-3%	2%	2%
	Hobden Gully	0.1	0%	414%	0%	-14%	0%	-2%
	Farrells Creek	0.1	-19%	62%	3%	-7%	-2%	2%
	Pikes Creek	0.1	-3%	3%	0%	0%	0%	0%
	Bayswater Creek	0.1	0%	40%	0%	-7%	0%	-2%
	UN3	0.1	0%	45%	0%	-5%	0%	2%
	UN5	0.1	10%	450%	-1%	-17%	0%	5%
	UN6	0.1	40%	40%	-2%	-2%	-2%	-2%

5.2 Representative Dry Year (2006)

TABLE 5.3: REPRESENTATIVE DRY YEAR (2006) FLOW CHARACTERISTICS

Method	Stream	Low Flow Trigger (ML/day)	Annual Dry Days			Number of Dry Periods [1]		
			Approved Operations	Amended Project Operations	Amended Project Closure	Approved Operations	Amended Project Operations	Amended Project Closure
Gauged Streams	Hunter River	100	40	41	40	10	10	10
	Wollombi Brook	0.1	23	23	23	2	2	2
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	325	327	300	2	2	2
	UN1	0.1	333	350	232	2	2	2
	UN2	0.1	351	351	350	2	2	2
	Hobden Gully	0.1	353	353	339	2	2	2
	Farrells Creek	0.1	336	341	323	2	2	2
	Pikes Creek	0.1	337	338	336	2	2	2
	Bayswater Creek	0.1	313	313	300	2	2	2
	UN3	0.1	338	338	329	2	2	2
	UN5	0.1	351	351	329	2	2	2
	UN6	0.1	354	353	353	2	2	2

Note 1 Based on dry periods that end within the calendar year

TABLE 5.4: REPRESENTATIVE DRY YEAR (2006) DURATION OF DRY PERIOD

Method	Stream	Low Flow Trigger (ML/day)	Average Duration of Dry Period (days) [1]			Maximum Duration of Dry Period (days) [1]			Minimum Duration of Dry Period (days) [1]		
			Approved Operations	Amended Project Operations	Amended Project Closure	Approved Operations	Amended Project Operations	Amended Project Closure	Approved Operations	Amended Project Operations	Amended Project Closure
Gauged Streams	Hunter River	100	4	4	4	18	18	18	1	1	1
	Wollombi Brook	0.1	12	12	12	22	22	22	1	1	1
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	150	151	137	272	273	259	27	29	14
	UN1	0.1	155	163	149	276	280	271	33	46	26
	UN2	0.1	164	164	163	281	280	280	47	47	46
	Hobden Gully	0.1	165	165	158	281	281	277	48	48	38
	Farrells Creek	0.1	156	159	149	277	278	271	35	39	26
	Pikes Creek	0.1	157	157	156	277	277	277	36	37	35
	Bayswater Creek	0.1	144	144	137	266	266	259	21	21	14
	UN3	0.1	157	157	152	277	277	274	37	37	30
	UN5	0.1	164	164	152	281	281	274	47	47	30
	UN6	0.1	166	165	165	282	282	282	49	48	48

Note 1 Based on dry periods that end within the calendar year

TABLE 5.5: CHANGE IN REPRESENTATIVE DRY YEAR (2006) FLOW CHARACTERISTICS AND DURATION OF DRY PERIOD

Method	Stream	Low Flow Trigger (ML/day)	Annual Dry Days		Average Duration of Dry Period (days) [1]		Maximum Duration of Dry Period (days) [1]		Minimum Duration of Dry Period (days) [1]	
			Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations	Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations	Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations	Amended Project Operations vs Approved Operations	Amended Project Closure vs Approved Operations
Gauged Streams	Hunter River	100	3%	0%	2%	0%	0%	0%	0%	0%
	Wollombi Brook	0.1	0%	0%	0%	0%	0%	0%	0%	0%
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	1%	-8%	1%	-9%	0%	-5%	7%	-48%
	UN1	0.1	5%	-30%	5%	-4%	1%	-2%	39%	-21%
	UN2	0.1	0%	0%	0%	-1%	0%	0%	0%	-2%
	Hobden Gully	0.1	0%	-4%	0%	-4%	0%	-1%	0%	-21%
	Farrells Creek	0.1	1%	-4%	2%	-4%	0%	-2%	11%	-26%
	Pikes Creek	0.1	0%	0%	0%	-1%	0%	0%	3%	-3%
	Bayswater Creek	0.1	0%	-4%	0%	-5%	0%	-3%	0%	-33%
	UN3	0.1	0%	-3%	0%	-3%	0%	-1%	0%	-19%
	UN5	0.1	0%	-6%	0%	-7%	0%	-2%	0%	-36%
	UN6	0.1	0%	0%	-1%	-1%	0%	0%	-2%	-2%

Note 1 Based on dry periods that end within the calendar year

5.3 Flow Duration Curves

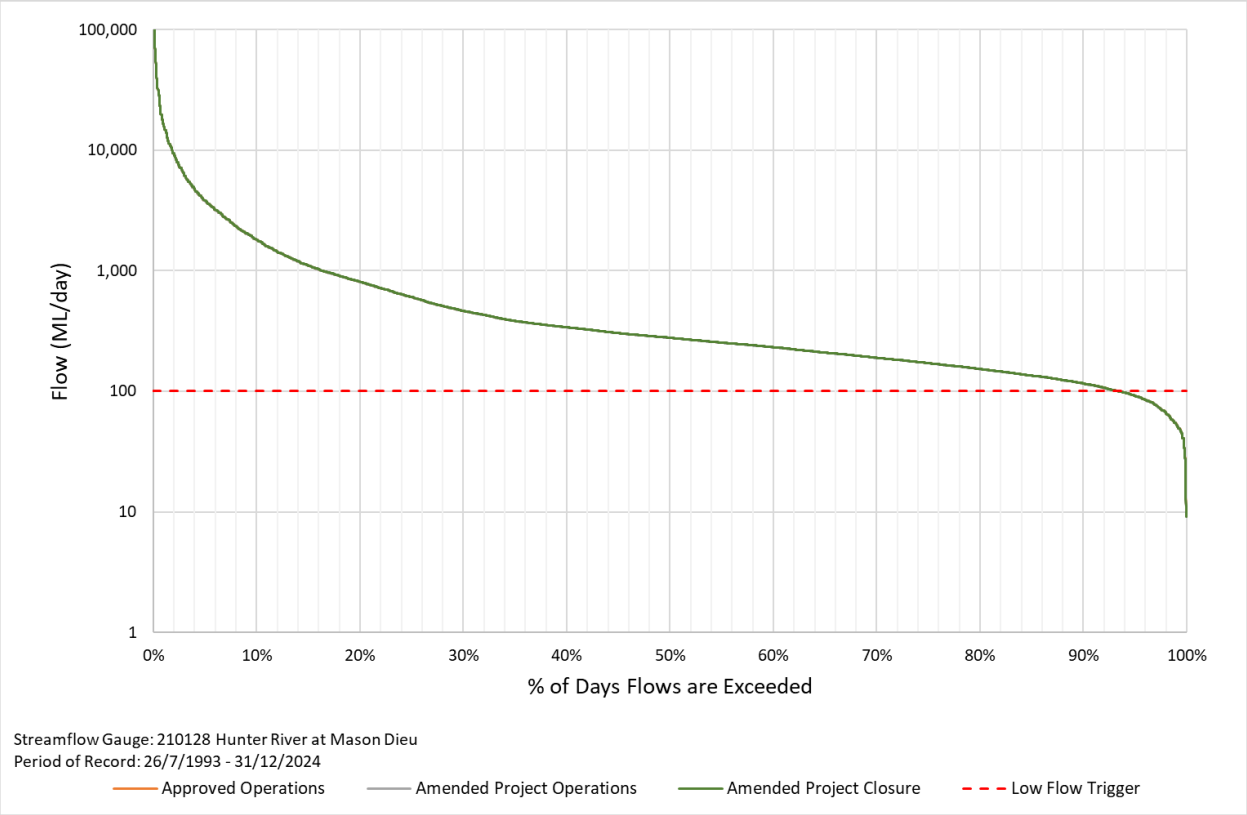


Figure 5.1: Flow Duration – Hunter River

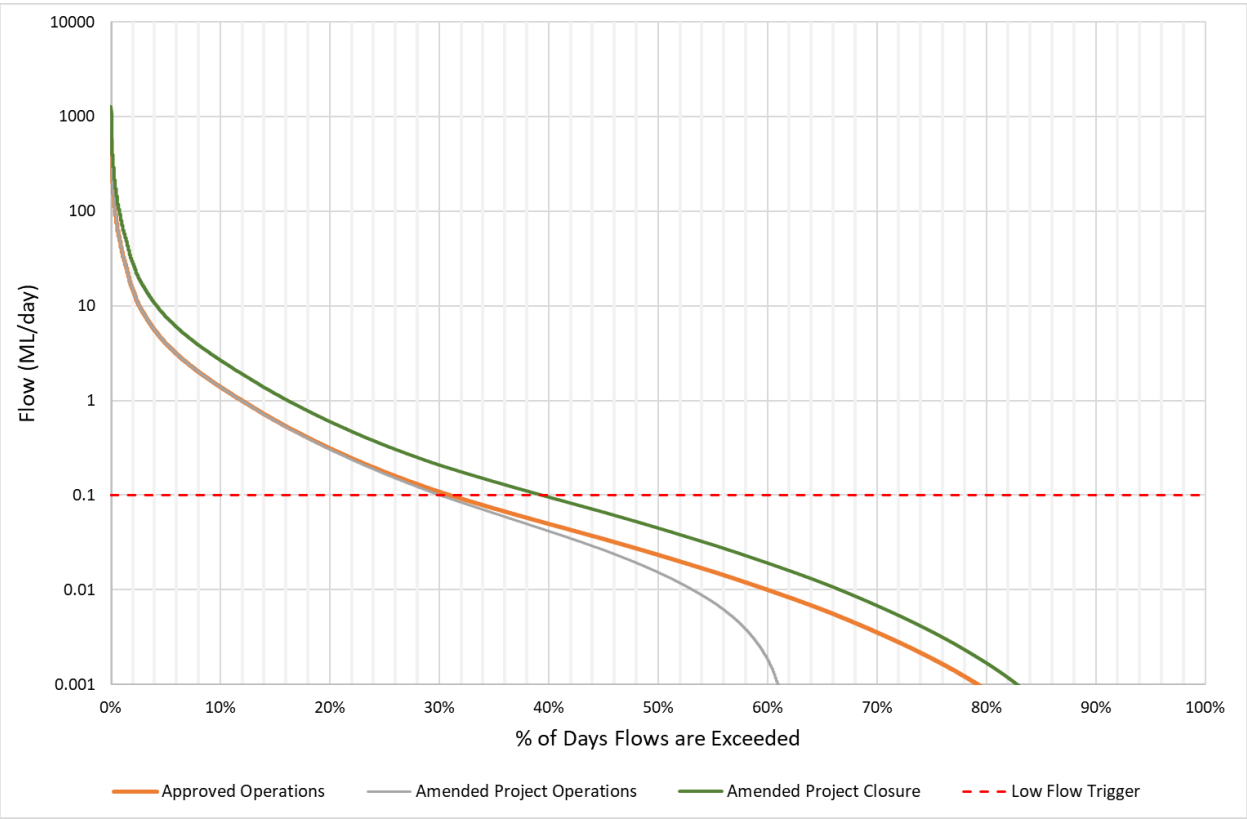


Figure 5.2: Flow Duration – Parnells Creek

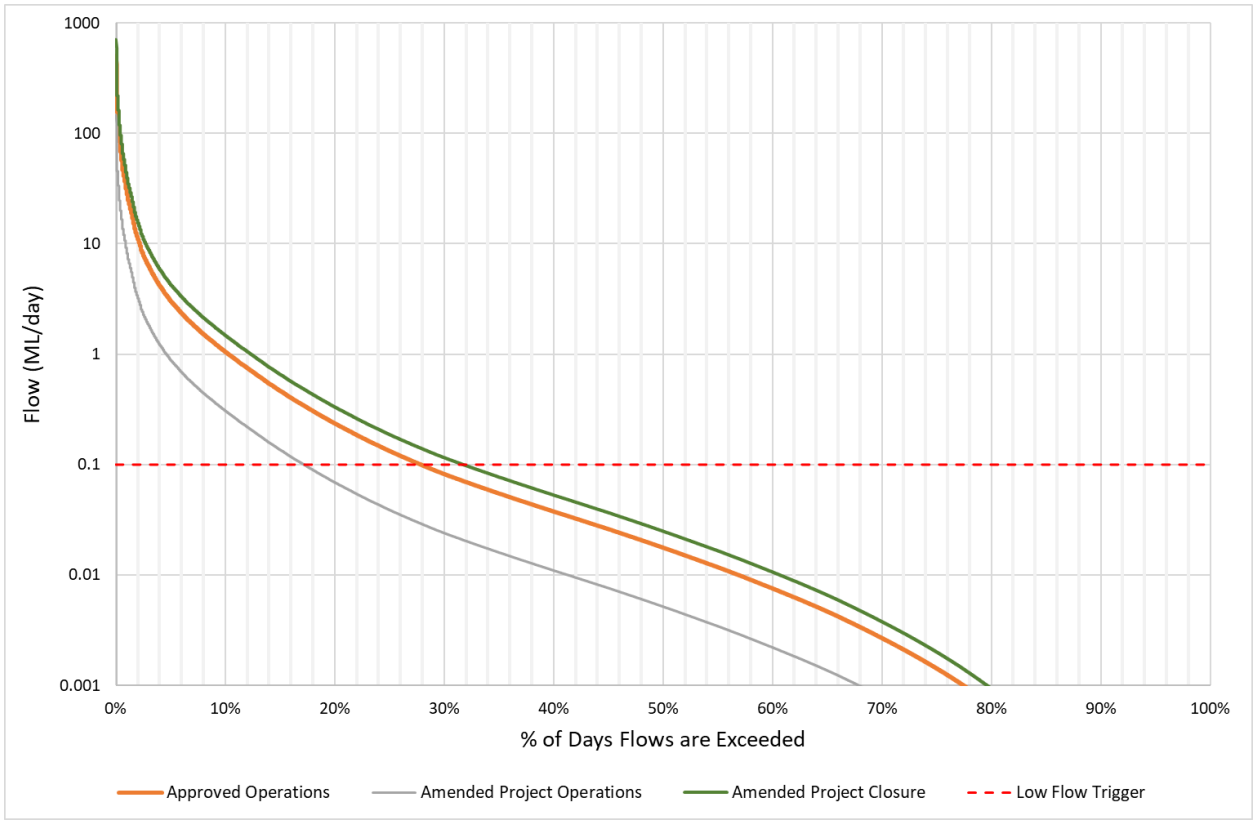


Figure 5.3:: Flow Duration – Unnamed Tributary 1

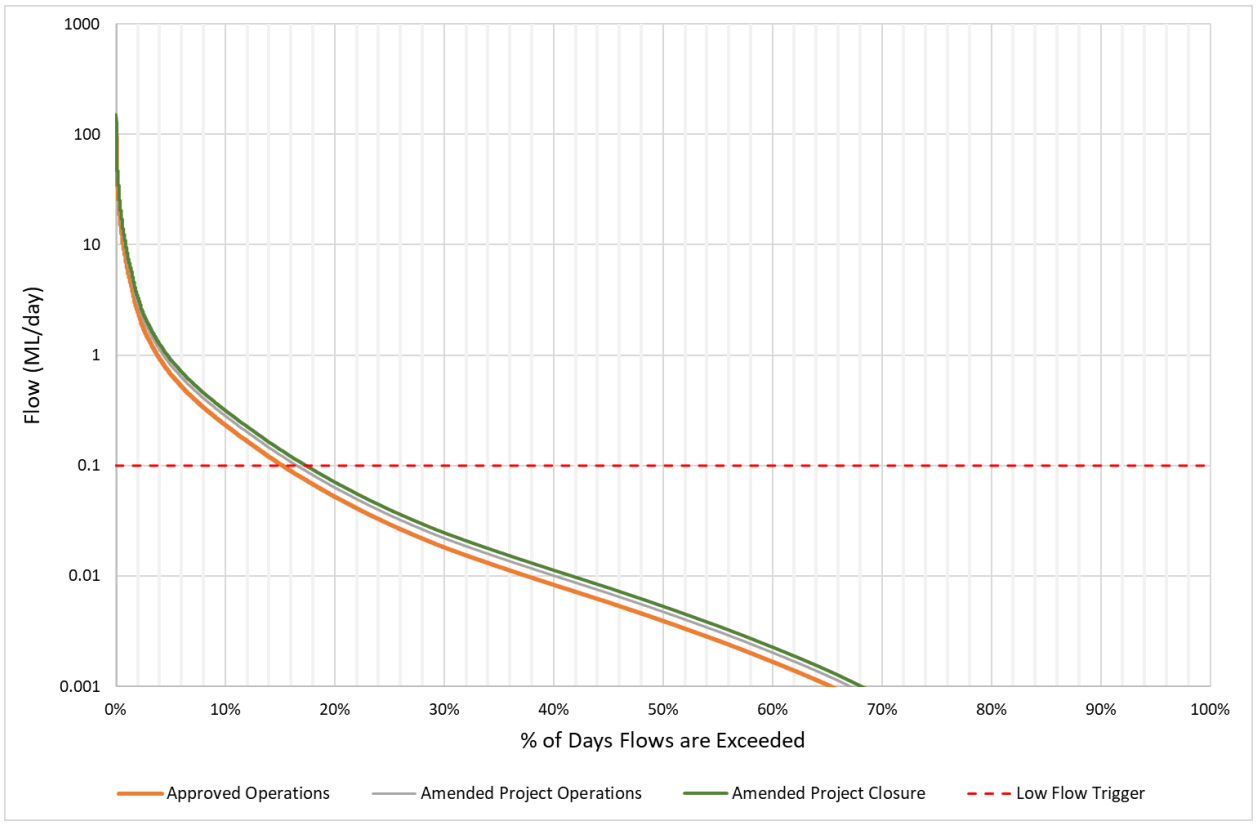


Figure 5.4: Flow Duration – Unnamed Tributary 2

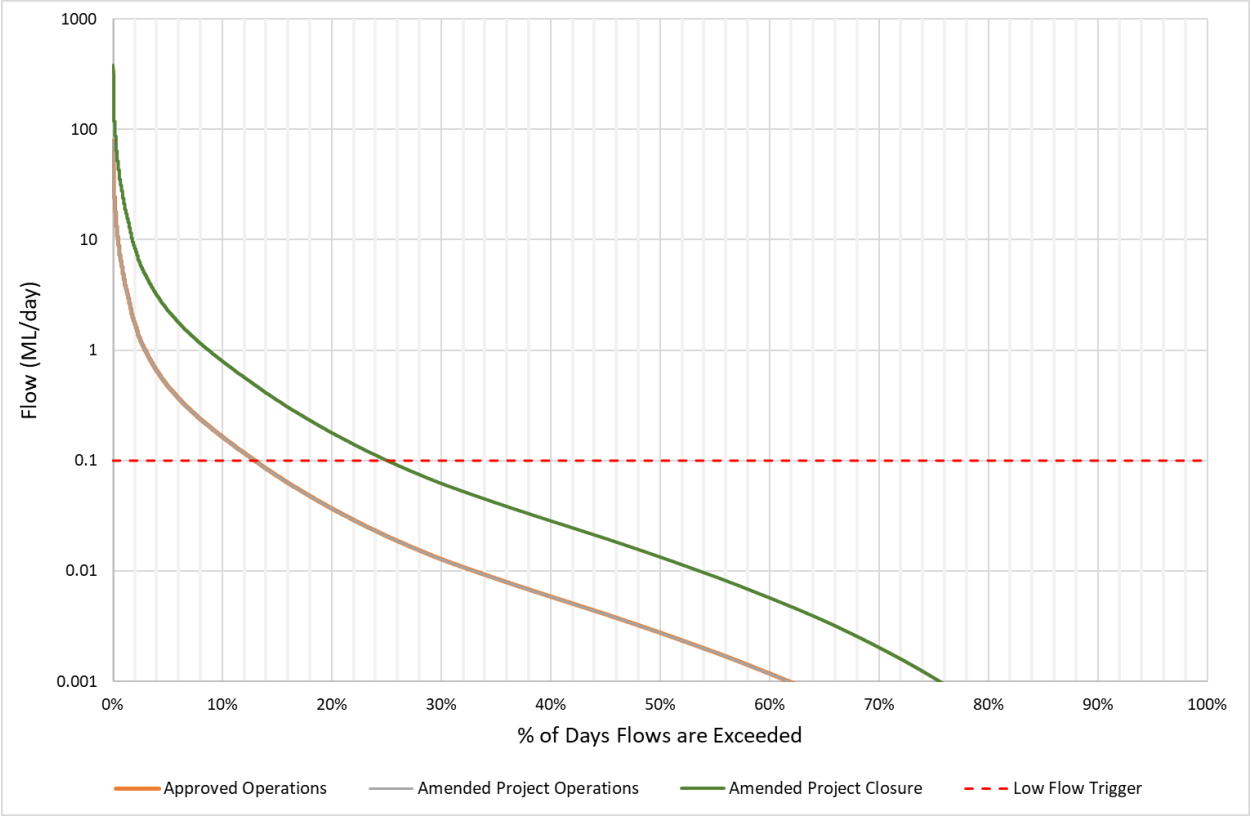


Figure 5.5: : Flow Duration – Hobden Gully

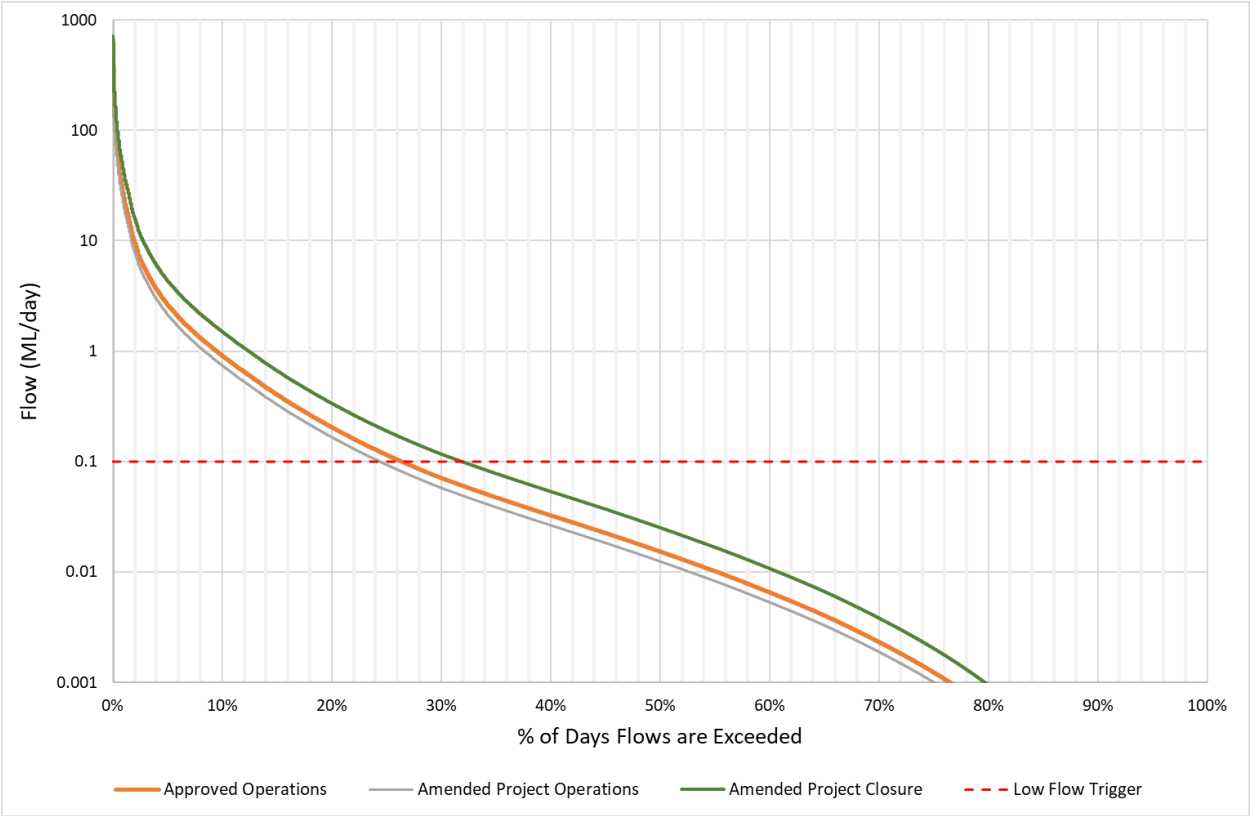


Figure 5.6: Flow Duration – Farrells Creek

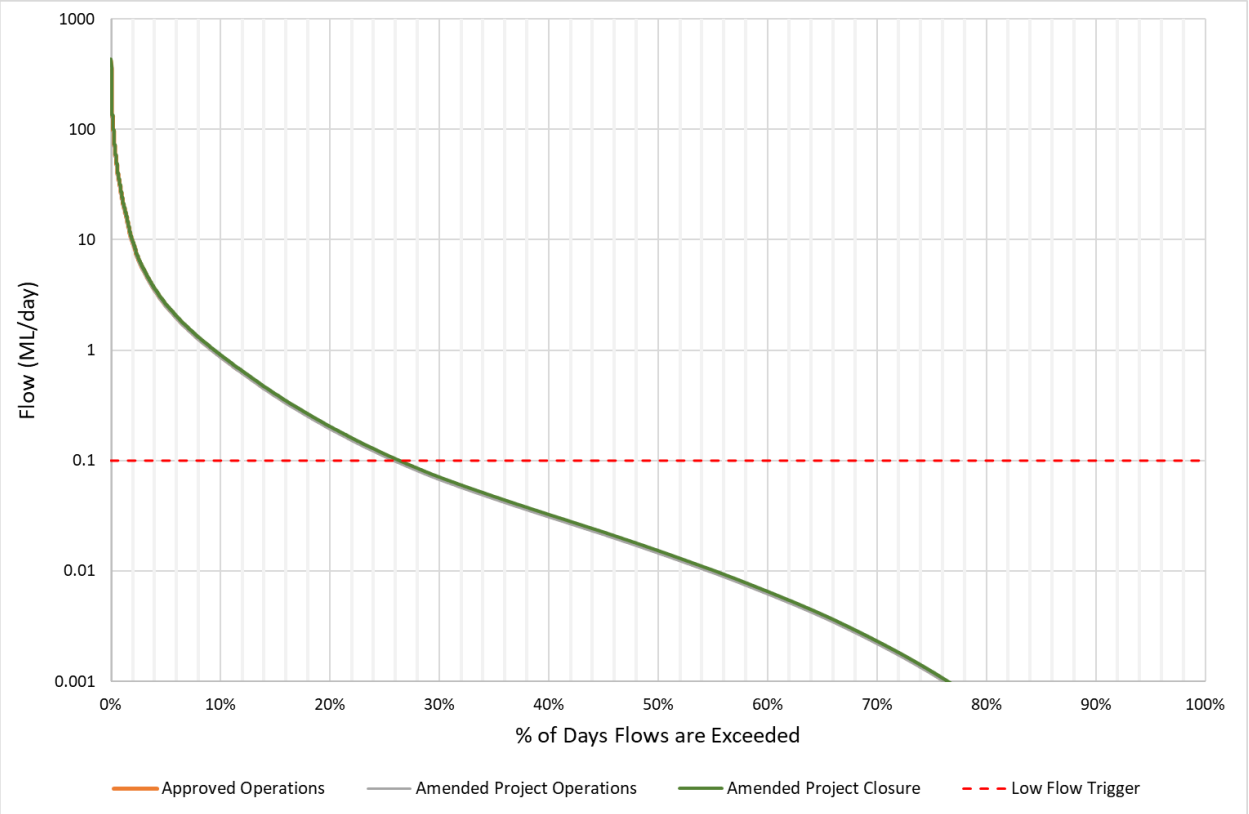


Figure 5.7: Flow Duration – Pikes Creek

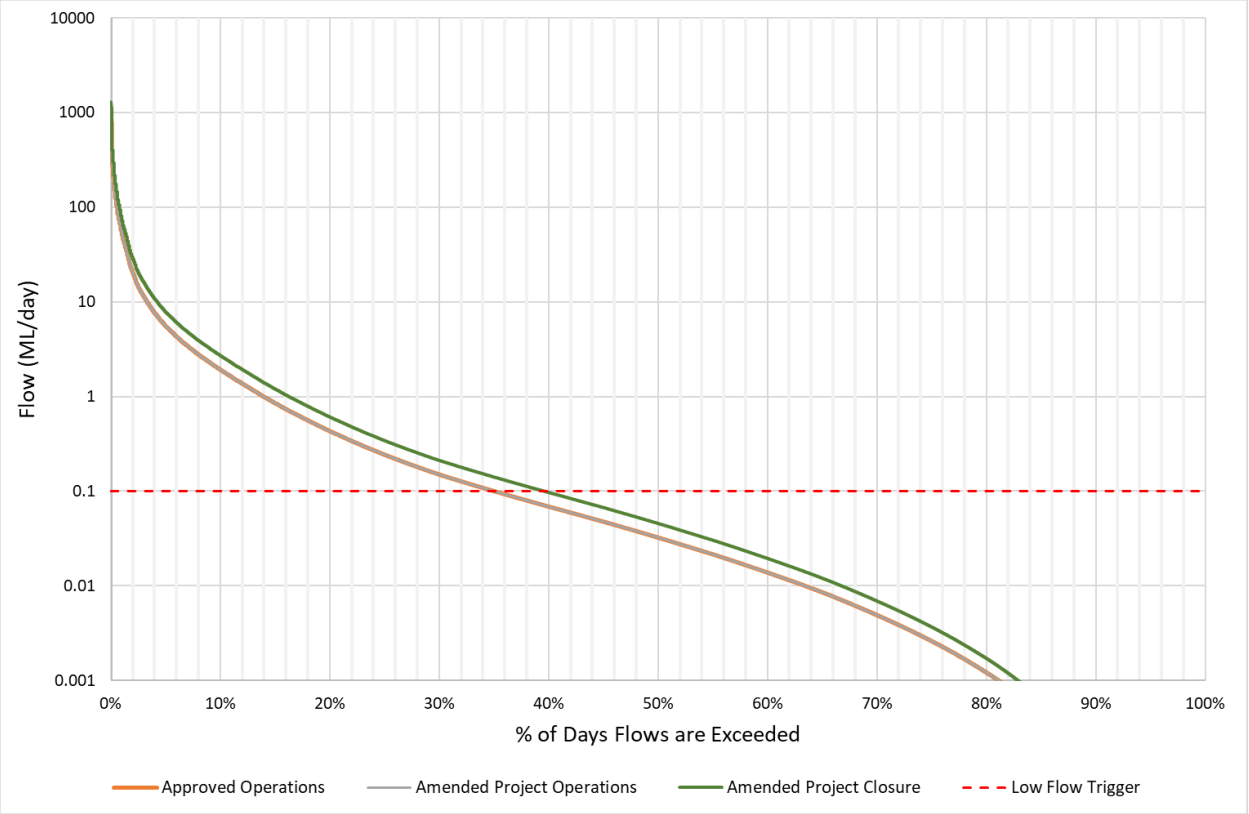


Figure 5.8: Flow Duration – Bayswater Creek

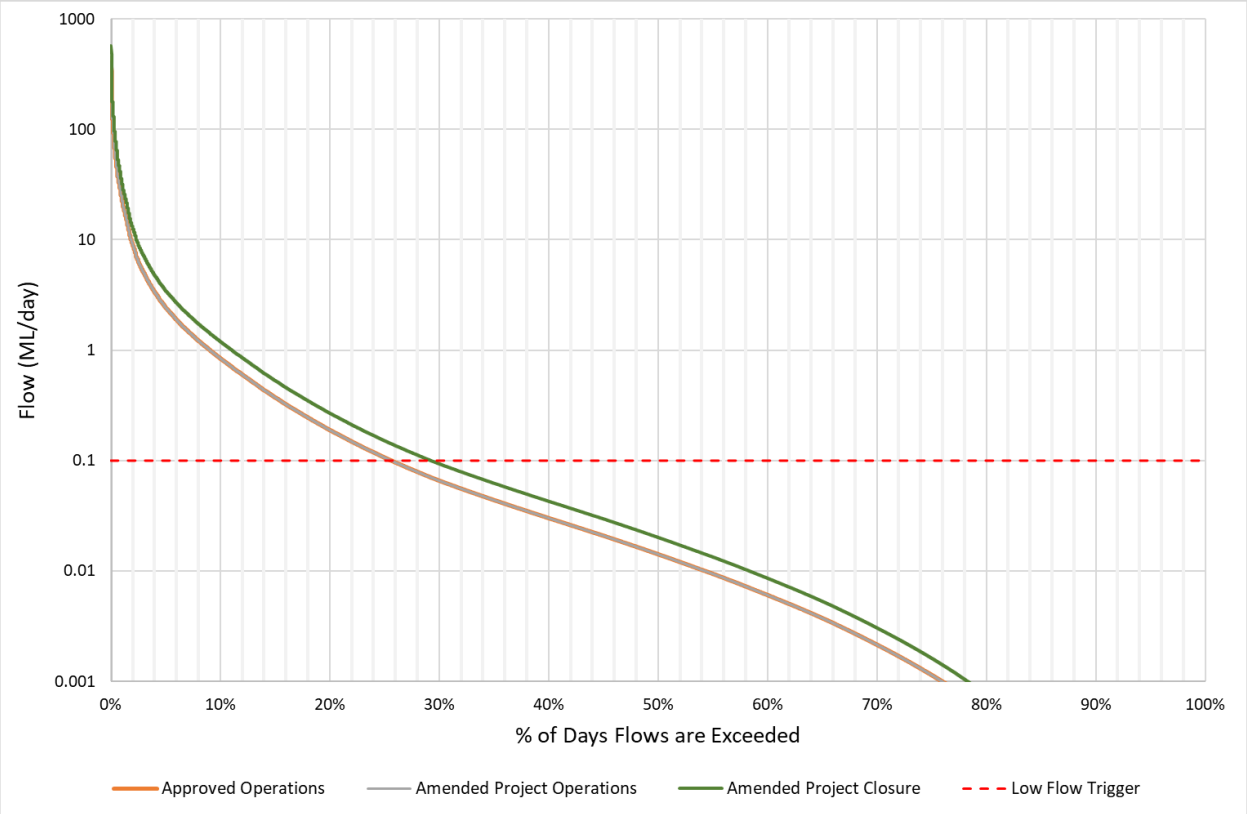


Figure 5.9:Flow Duration – Unnamed Tributary 3

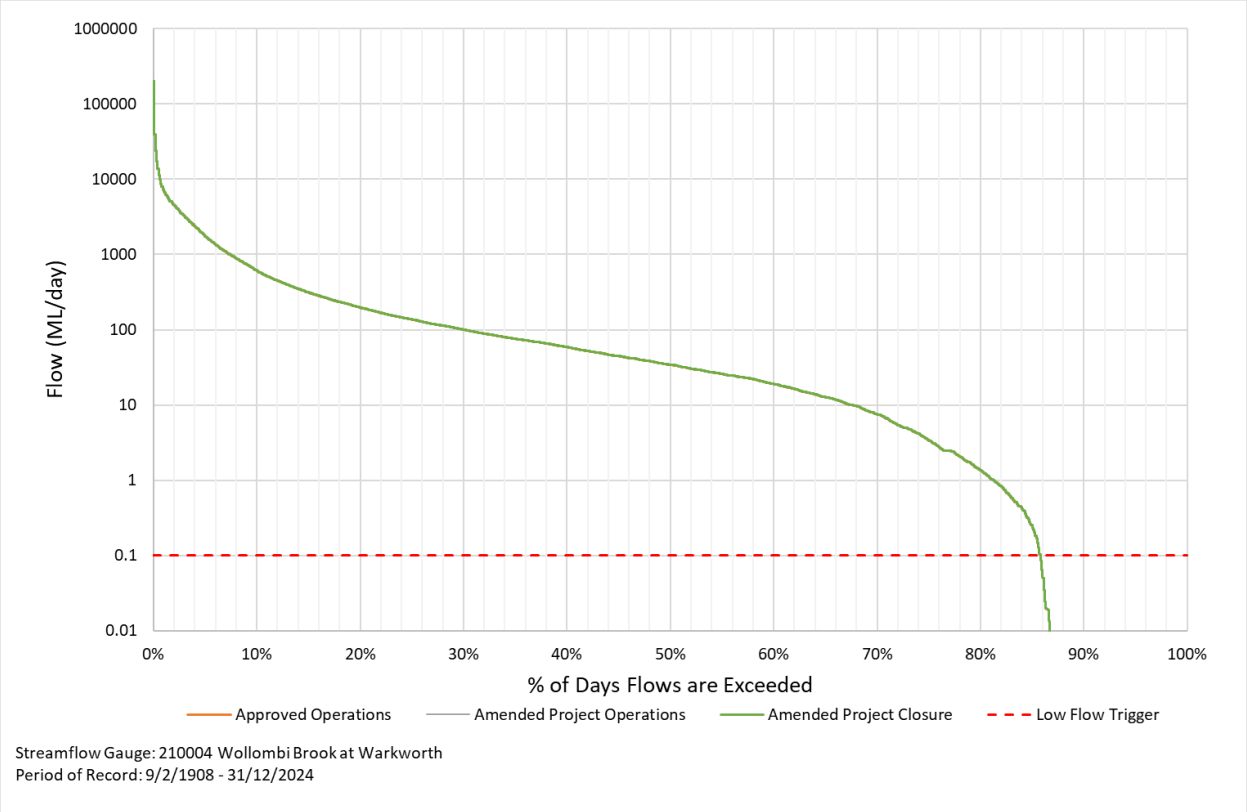


Figure 5.10:: Flow Duration – Wollombi Brook

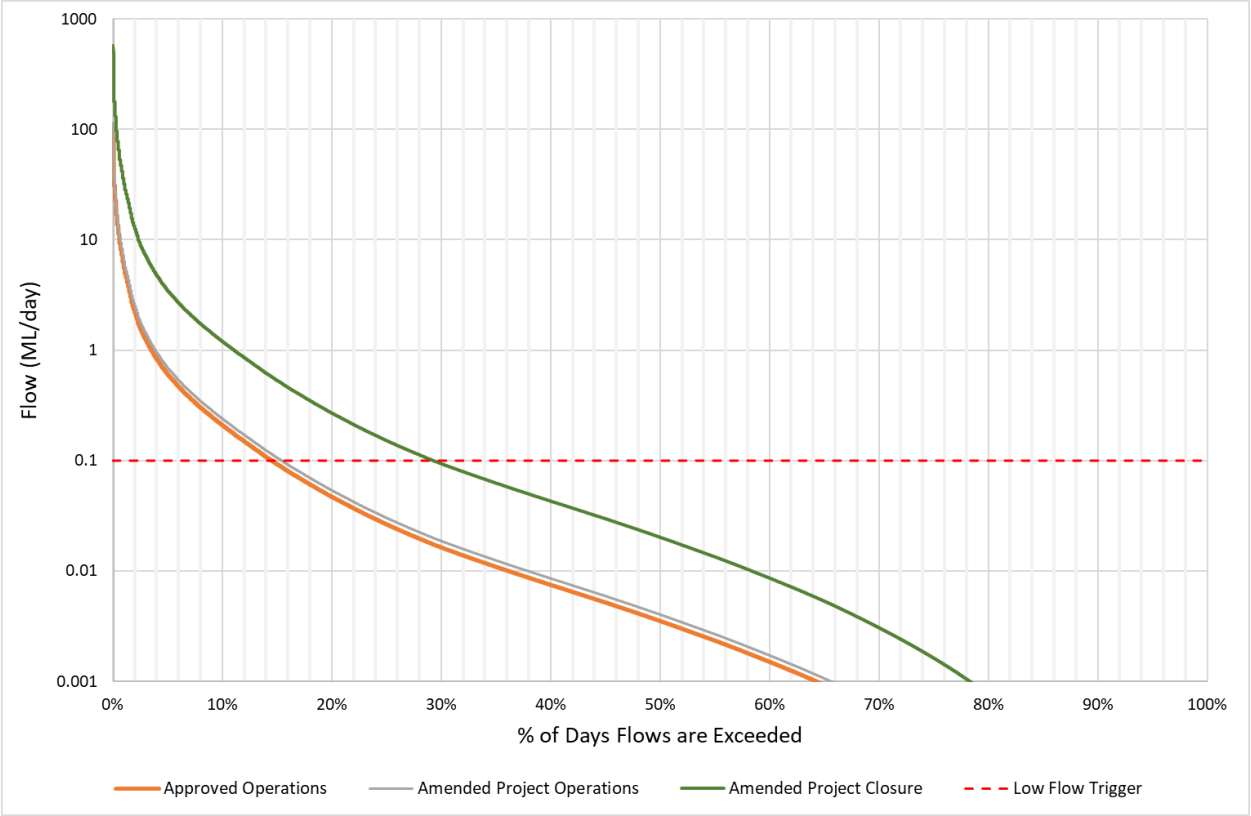


Figure 5.11: Flow Duration – Unnamed Tributary 5

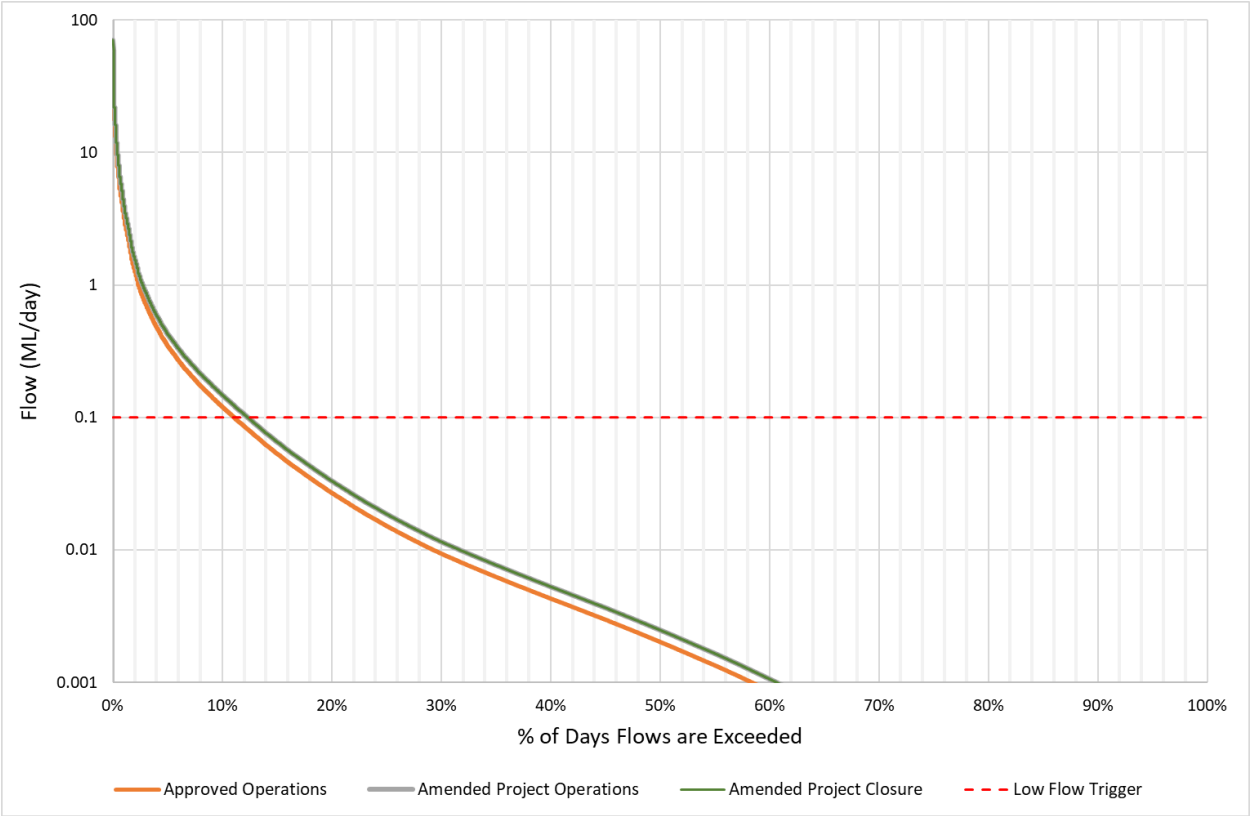


Figure 5.12: Flow Duration – Unnamed Tributary 6

6. CONCLUSIONS

The majority of land adjacent to the approved operations is owned by HVO or other mining operations. There are no water users downstream of the Amended Project within the ephemeral creek system catchments. As a result, there is little potential for impact to water users. The following conclusions are focused on potential for impacts on ecology.

The conclusions of the streamflow assessment are summarised below with a particular focus on impacts to the representative dry year (2006) as this is understood to be the key potential impact to ecology.

- Hunter River:
  - There is minimal change in the calculated number of dry days and number of dry periods for the Hunter River. Furthermore, as a regulated river, the calculated values for changes to dry days are not likely to be realised given any change in annual flow volumes will be mitigated through licensing.
- Wollombi Brook:
  - Negligible changes to annual flow volumes (Amended Project Operations or Amended Project Closure relative to Approved Operations) are predicted.
  - The tabulated results also indicate negligible changes to the number and duration of dry periods.
  - The Project Scenarios (Amended Project Operations and Amended Project Closure) are shown to result in durations of dry days (average, maximum and minimum) that are equivalent to the Approved Operations scenario for the representative dry year (2006).
- Ungauged Ephemeral Streams:
  - The ephemeral streams all show a similar pattern for the occurrence of wet and dry periods as the AWBM methodology results in an estimated flow series that is intrinsically linked to the temporality of the adopted rainfall timeseries. All ephemeral streams are predicted to have two dry periods that finish within the representative dry year (2006) with a third that carries over into the following year. The dry period that extends into the following year is of intermediate duration and the tabulated values therefore provide a good indication of the maximum and minimum duration of dry periods within the representative “dry” year (2006).
  - The results have been interrogated to identify results where the changes for the representative dry year (2006) are non-negligible from a purely numerical perspective. This has been defined as an increase of 1% or more in the number of dry days or duration of dry periods in the representative dry year (2006). Three of the ephemeral streams were found to have changes of 1% or more (when comparing Approved Operations versus Amended Project Operations), as discussed below:
    - Parnells Creek: Average duration of dry periods within the representative “dry” year (2006) increased from 150 days to 151 days (1%) during operations as a result of the Amended Project.
    - UN1: Average duration of dry periods within the representative “dry” year (2006) increased from 155 days to 163 days (5%) during operations as a result of the Amended Project.
    - Farrells Creek: Average duration of dry periods within the representative “dry” year (2006) increased from 156 days to 159 days (1%) during operations as a result of the Amended Project.
  - Refer to the EIS for assessment of the impact of these changes to streamflow on aquatic ecology (ELA, 2022).
  - For the Amended Project Closure, the occurrence and duration of dry days in the representative dry year (2006) was found to improve relative to existing for all ephemeral streams. This is due to an increase in catchment area reporting off-site, with only the final void catchments anticipated to act as sinks.

6.1 Comparison of Results to EIS Project

When comparing the predicted impacts with the Amended Project to the predicted impacts for the EIS Project the following are found.

- Hunter River:
  - Similar results, which will still be likely to not be realised given any change in annual flow volumes will be mitigated through licensing in the regulated river system.

- Wollombi Brook:
  - Less impact on Wollombi Brook with the predicted reduction in catchment impacts associated with the Amended Project (including impacts on UN5 and UN6) associated with the removal of the Lemington Rail Loop from the Amended Project.
  - Positive baseflow impacts are anticipated under both the Amended Project and Amended Project Closure scenarios, further improving flow conditions in Wollombi Brook.
- Ungauged Ephemeral Streams:
  - Reduced impacts are generally predicted for ephemeral streams under the Amended Project, highlighted by increased annual flows and fewer dry days.
  - Improvements are largely due to changes in drainage patterns as it is assumed all Amended Project Closure dams / dry detention basins are unmanaged and their catchments will therefore contribute to streamflow, this is a change in the final landform management compared to what was presented in the EIS Project (and is considered further in the Water Assessment (EMM, 2025b)).

7. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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ATTACHMENT B: WATER QUALITY ASSESSMENT

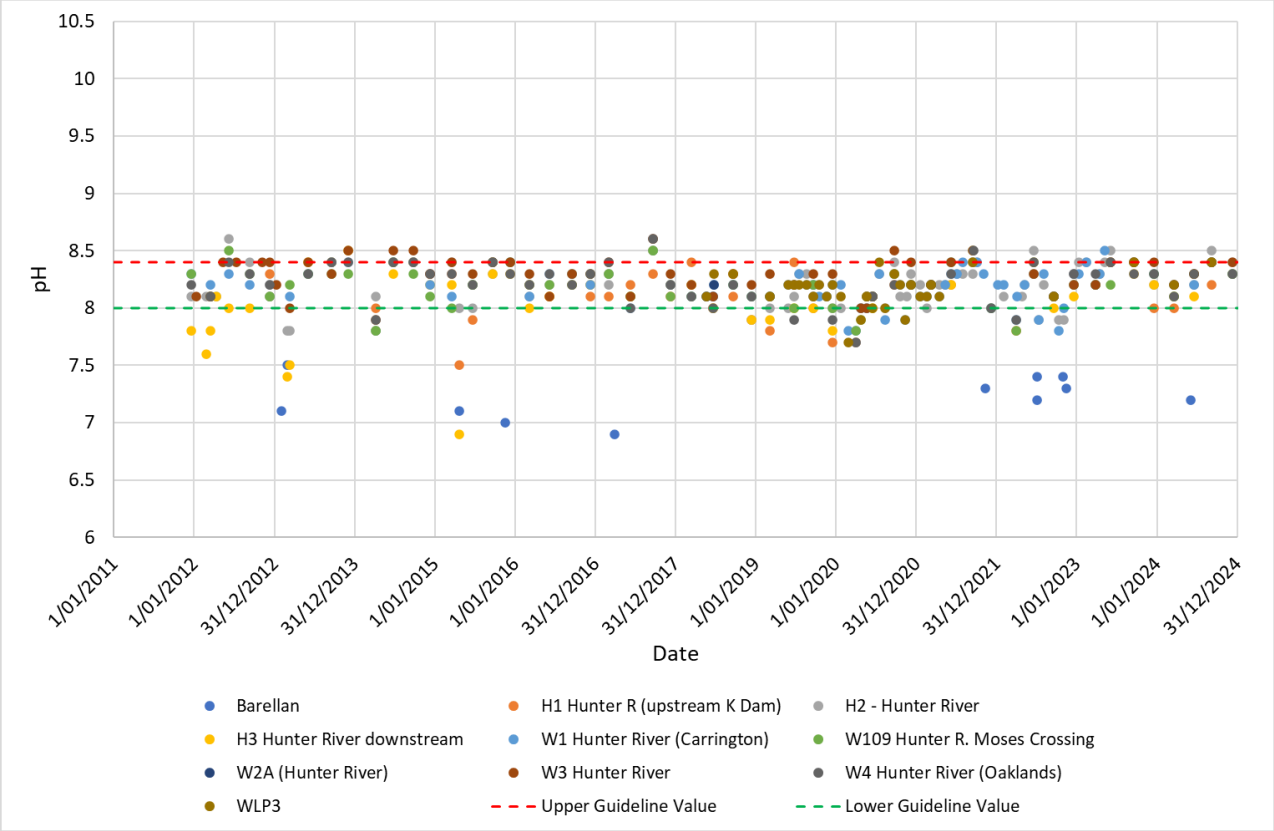


FIGURE B.1: HUNTER RIVER – PH

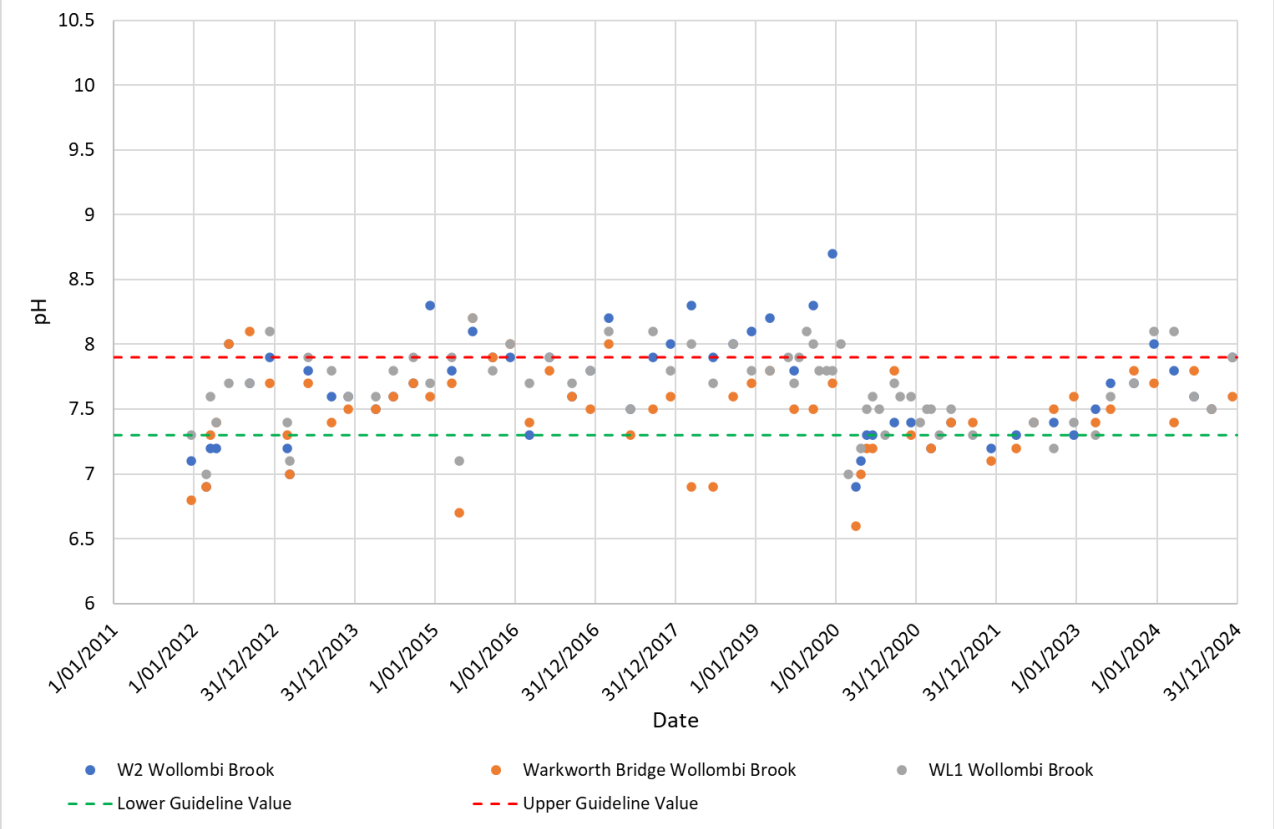


FIGURE B.2: WOLLOMBI BROOK - PH

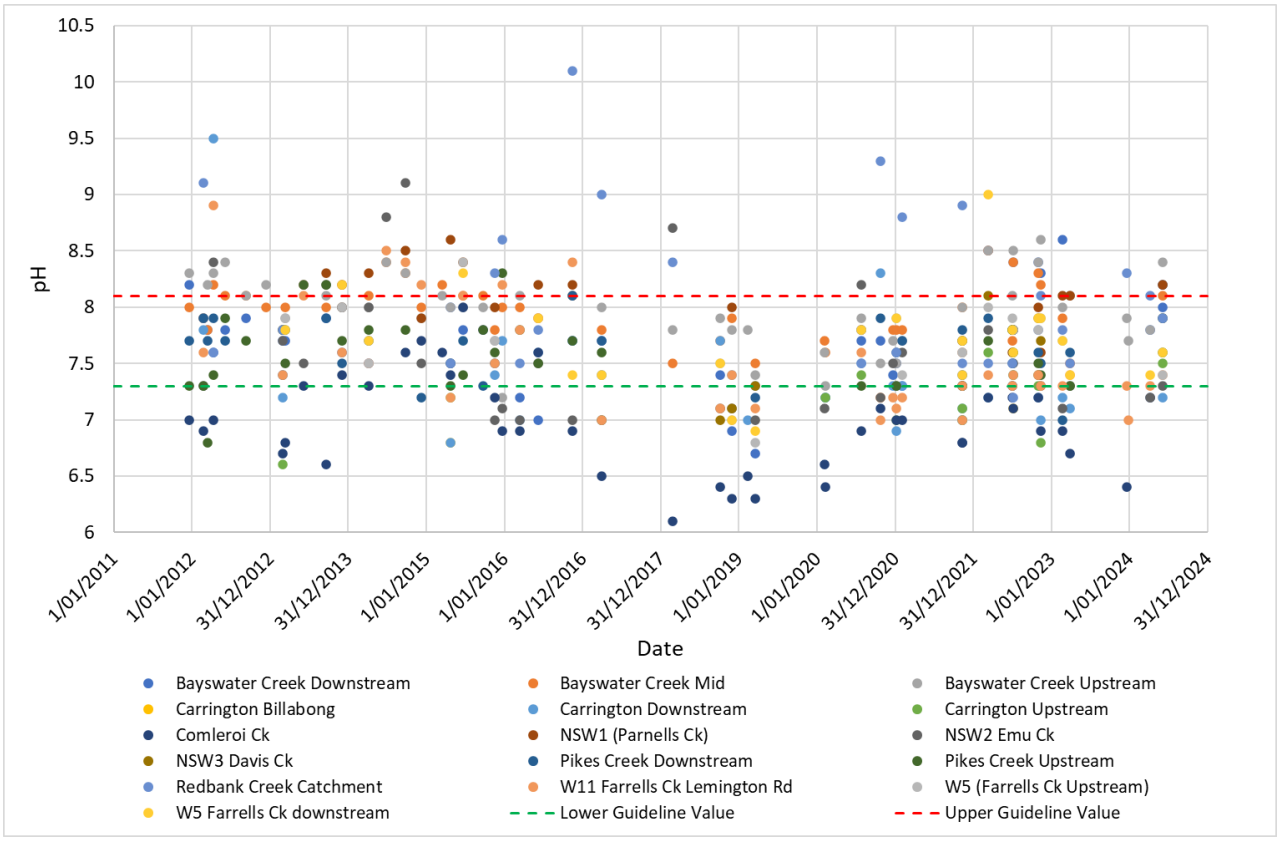


FIGURE B.3: EPHEMERAL CREEKS – PH

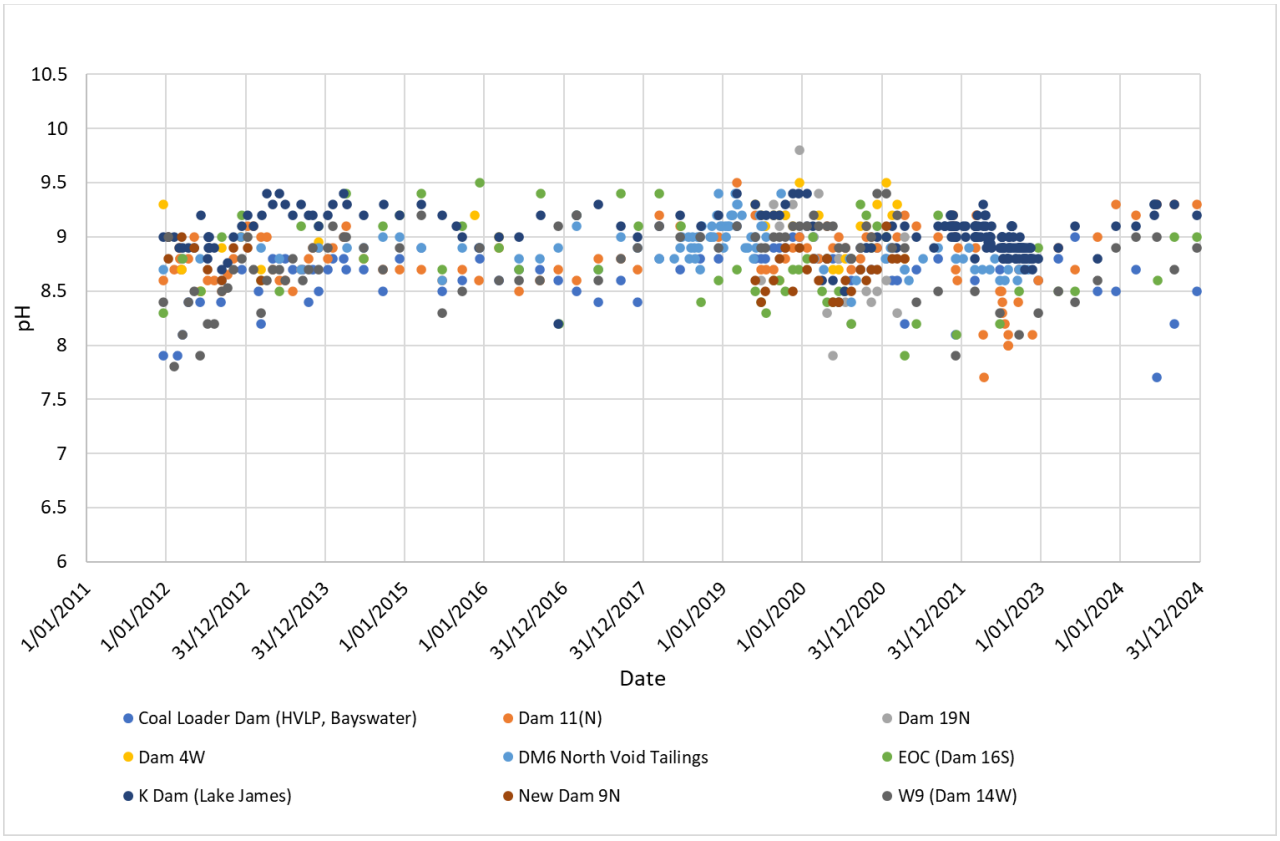


FIGURE B.4: MINE WATER SYSTEM – PH

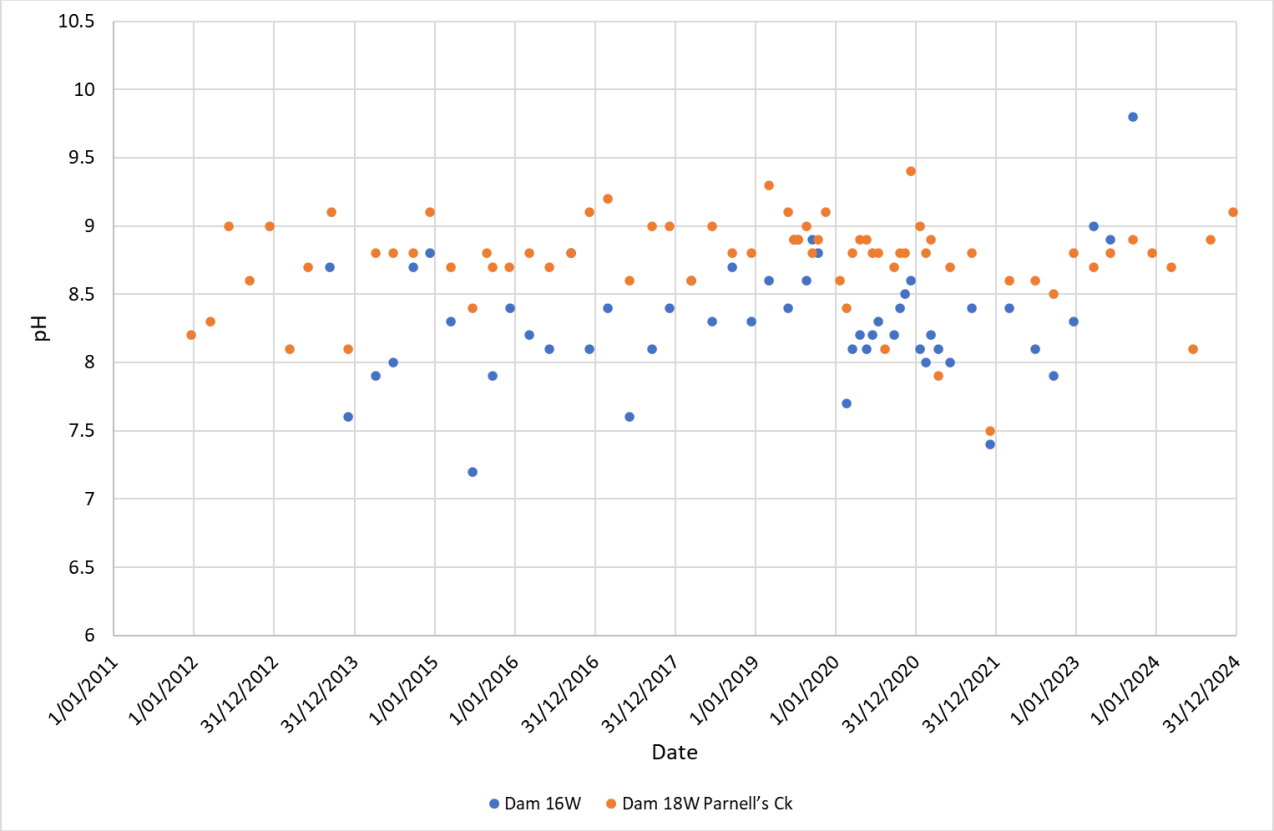


FIGURE B.5: SEDIMENT WATER SYSTEM – PH

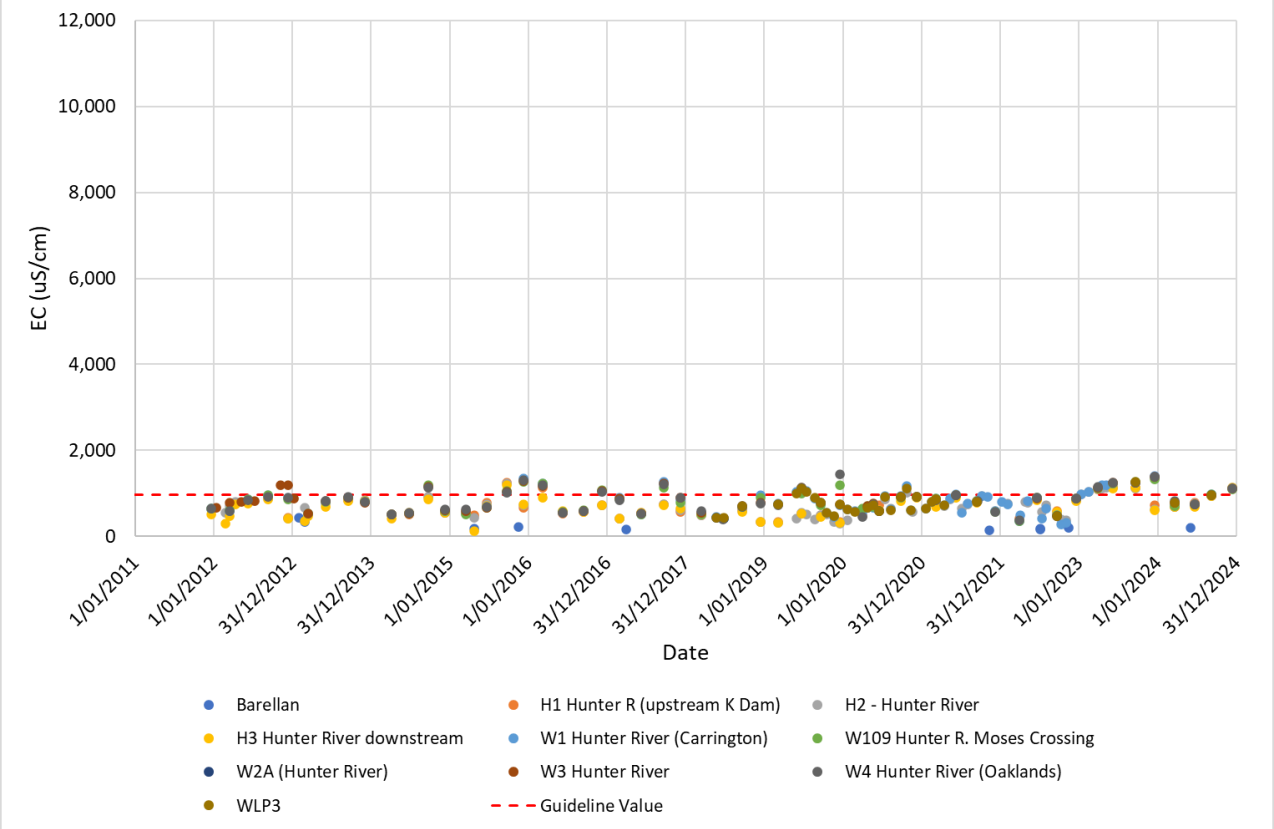


FIGURE B.6: HUNTER RIVER - EC

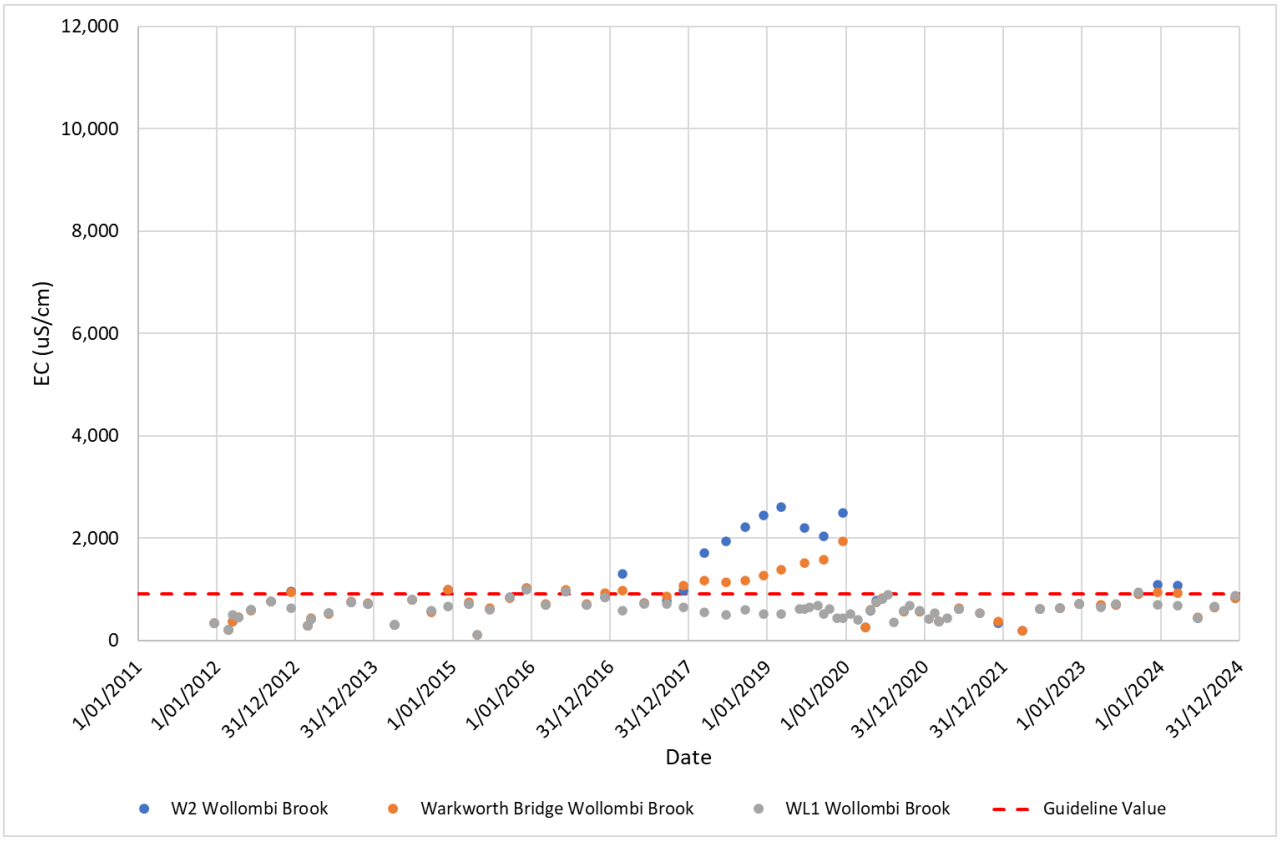


FIGURE B.7: WOLLOMBI BROOK – EC

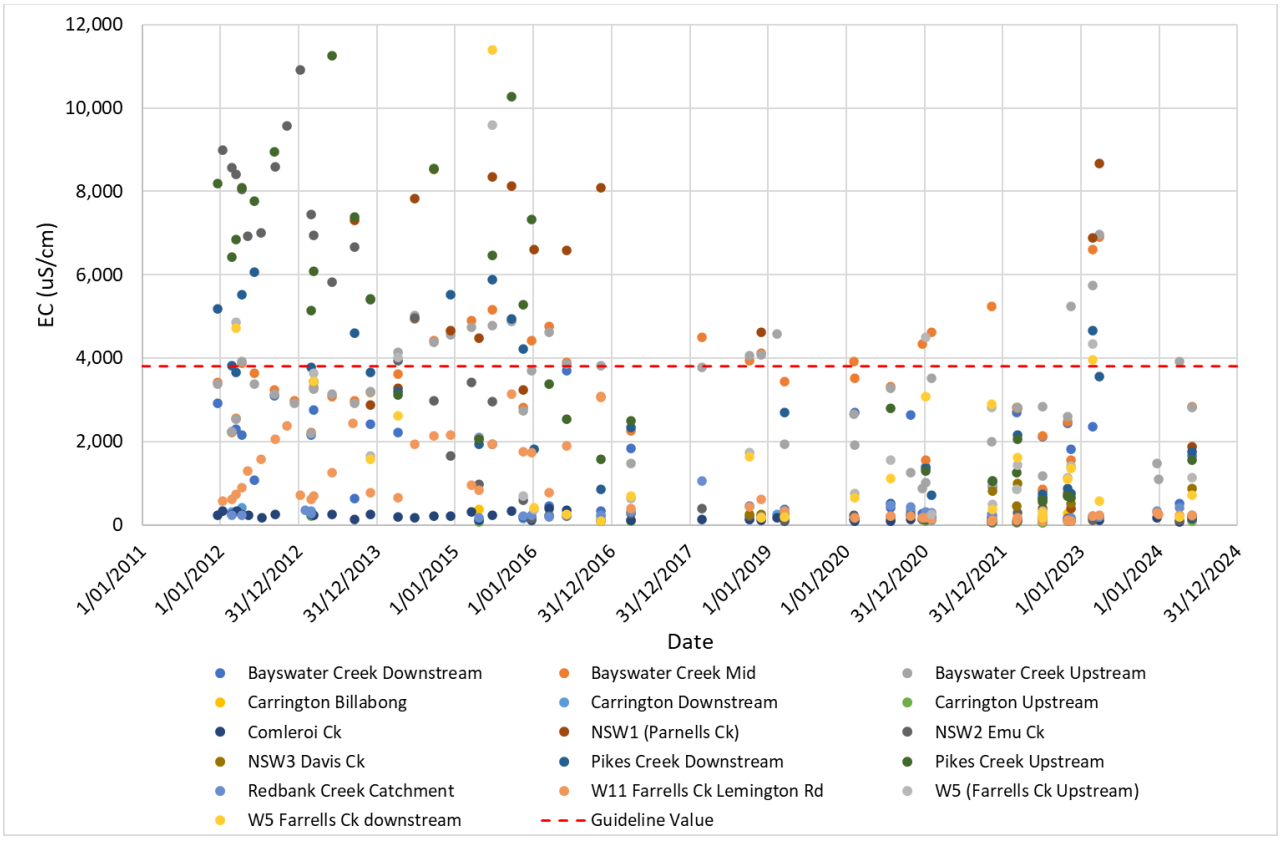


FIGURE B.8: EPHEMERAL CREEKS – EC

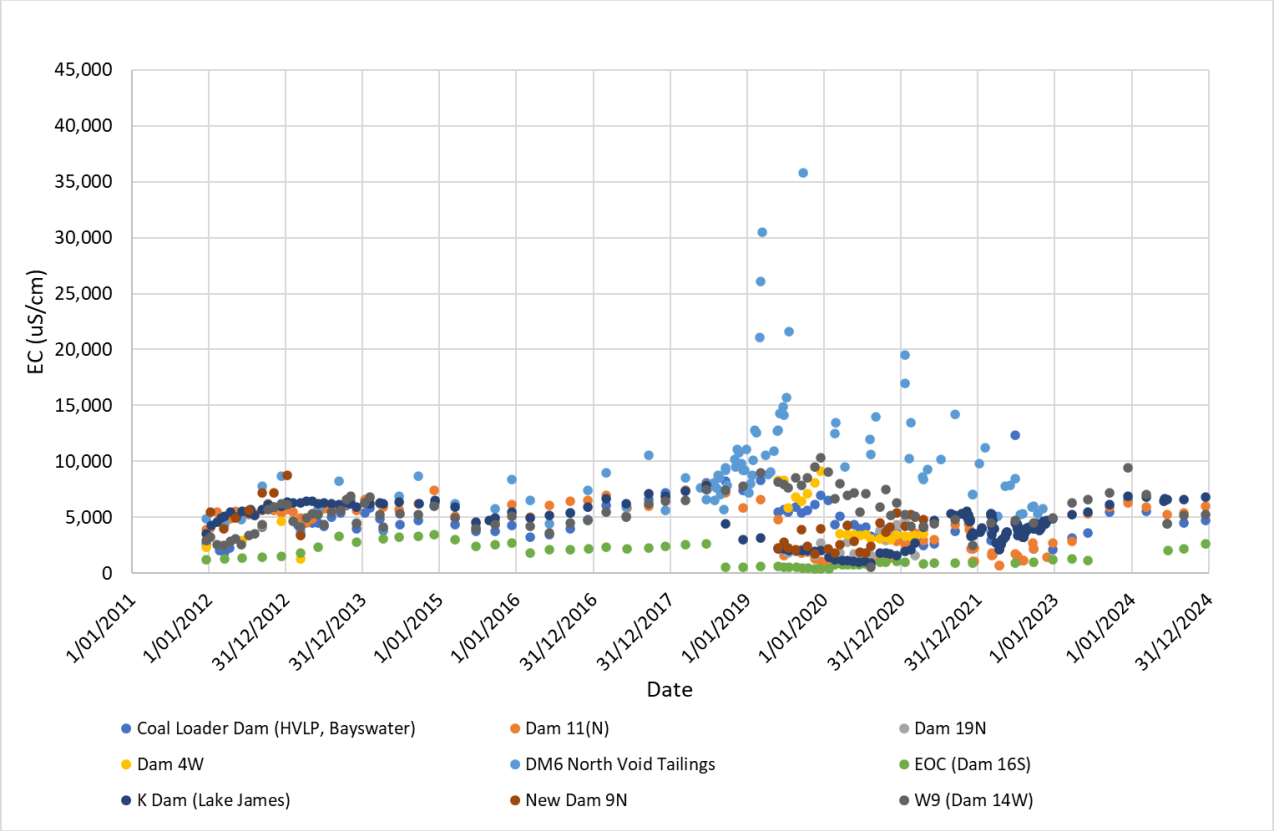


FIGURE B.9: MINE WATER SYSTEM – EC

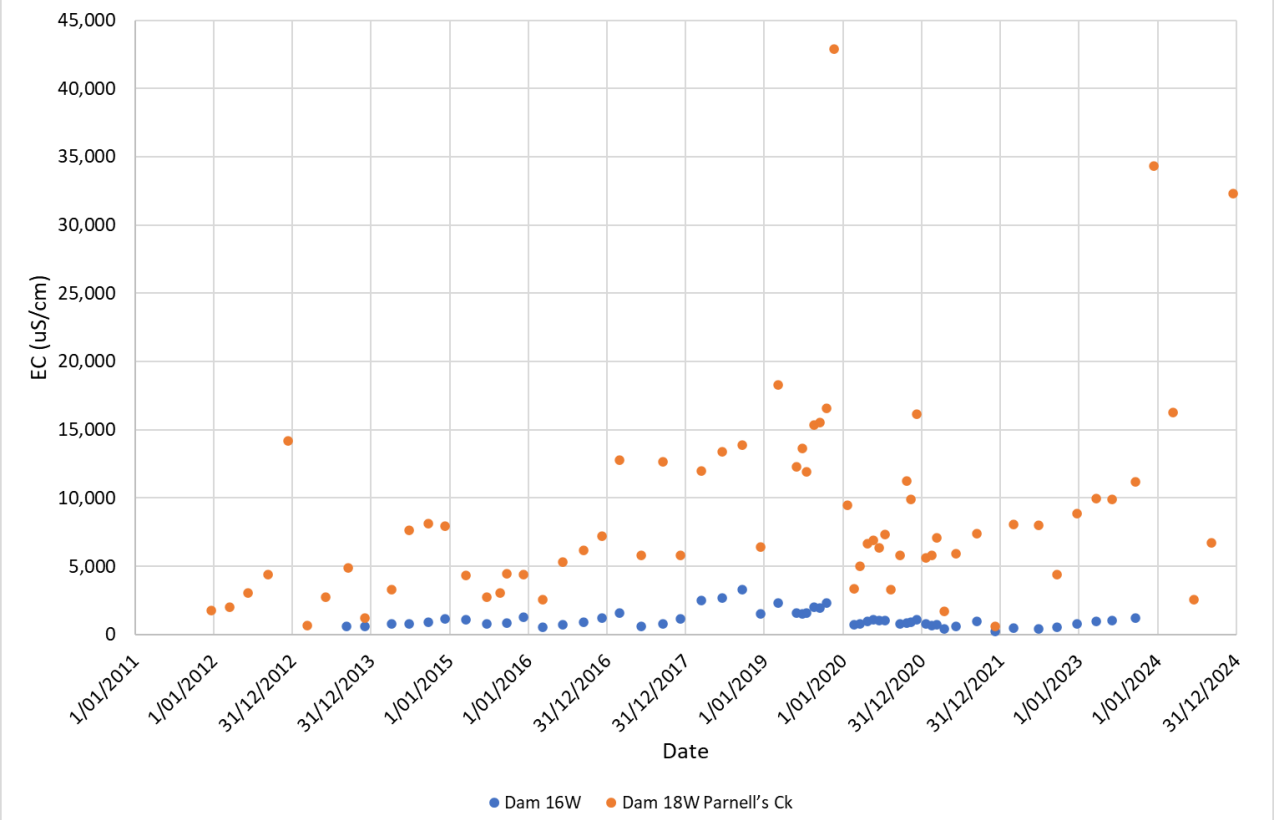


FIGURE B.10: SEDIMENT WATER SYSTEM – EC

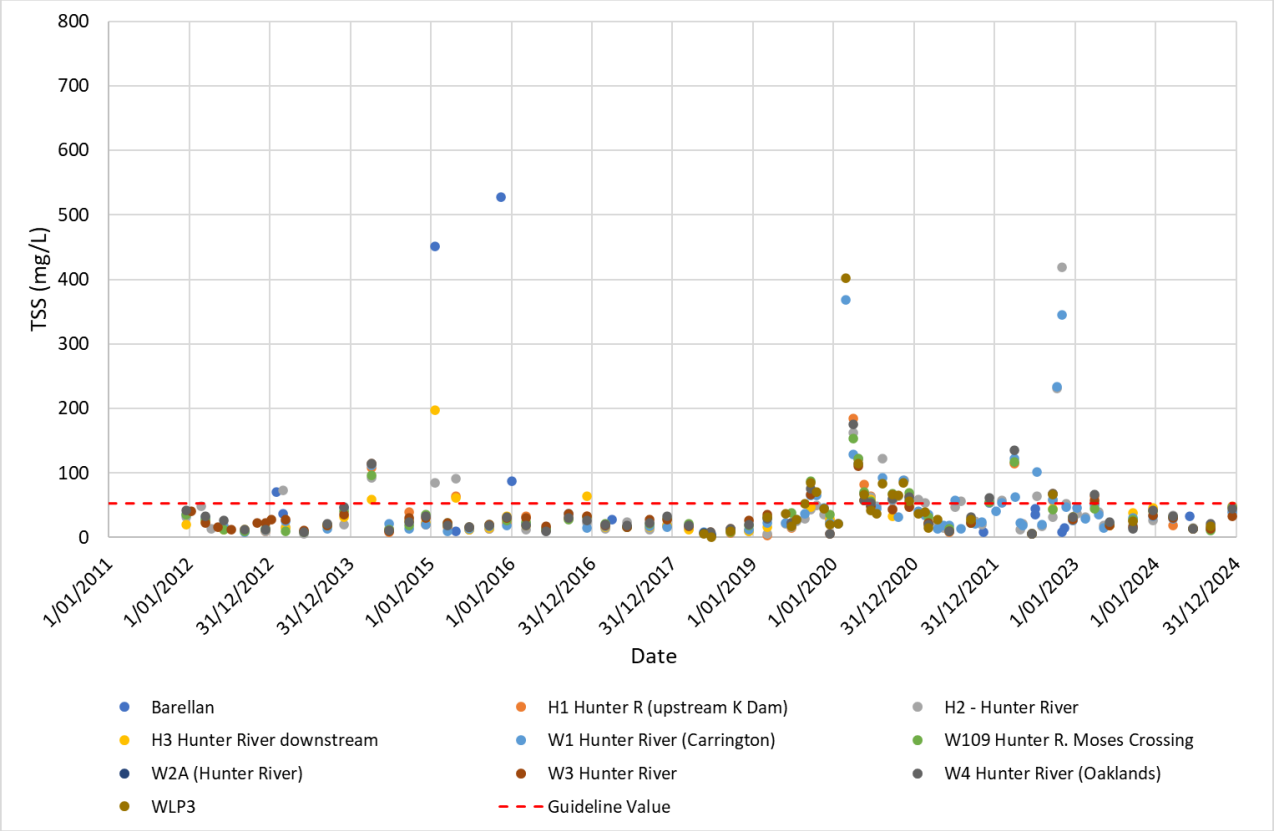


FIGURE B.11: HUNTER RIVER – TSS

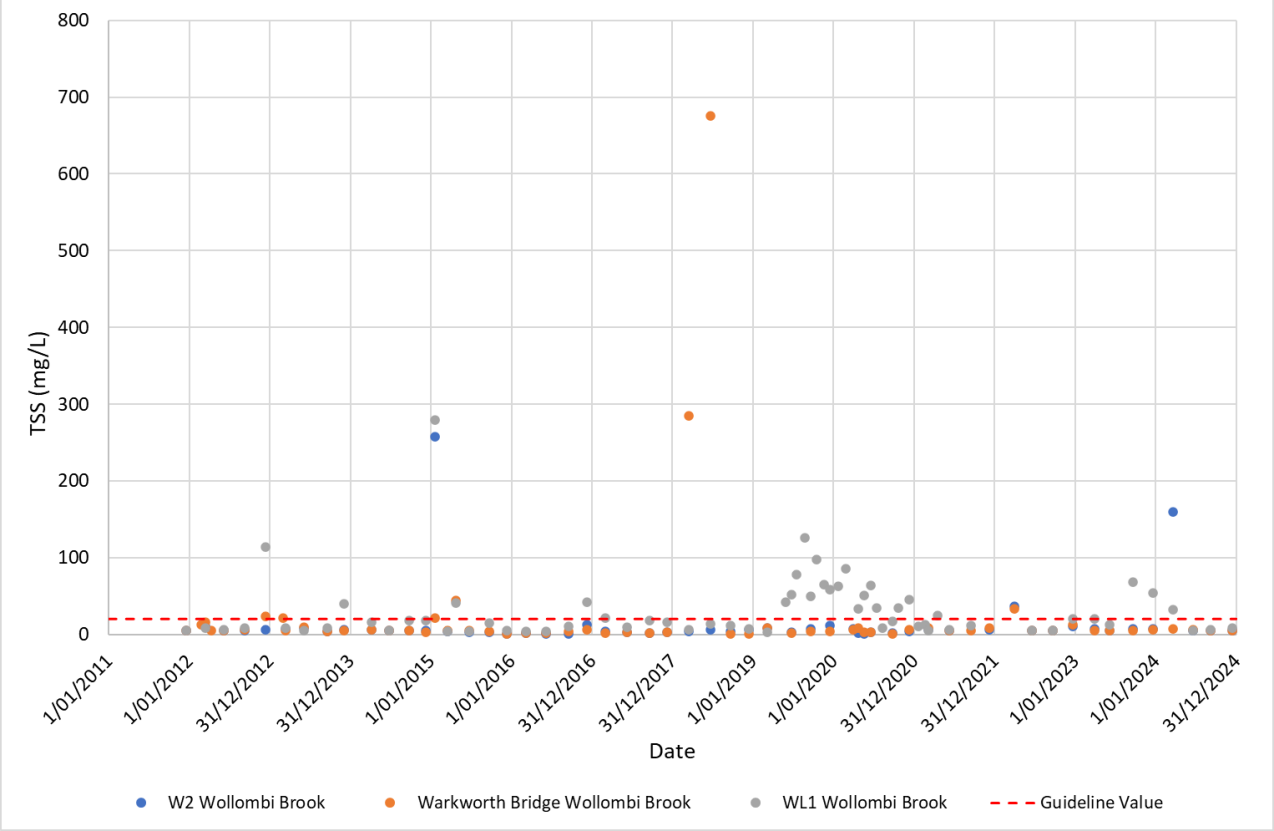


FIGURE B.12: WOLLOMBI BROOK - TSS

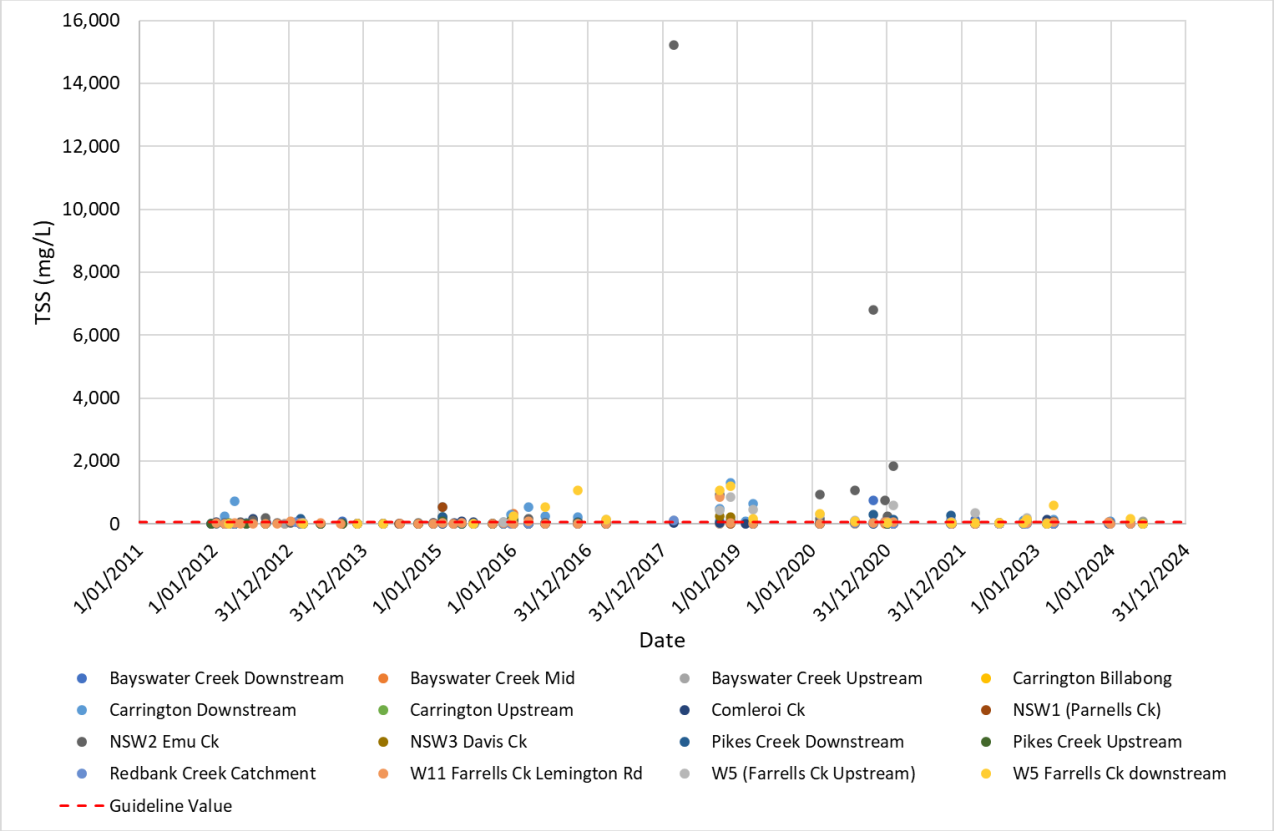


FIGURE B.13: EPHEMERAL CREEKS – TSS

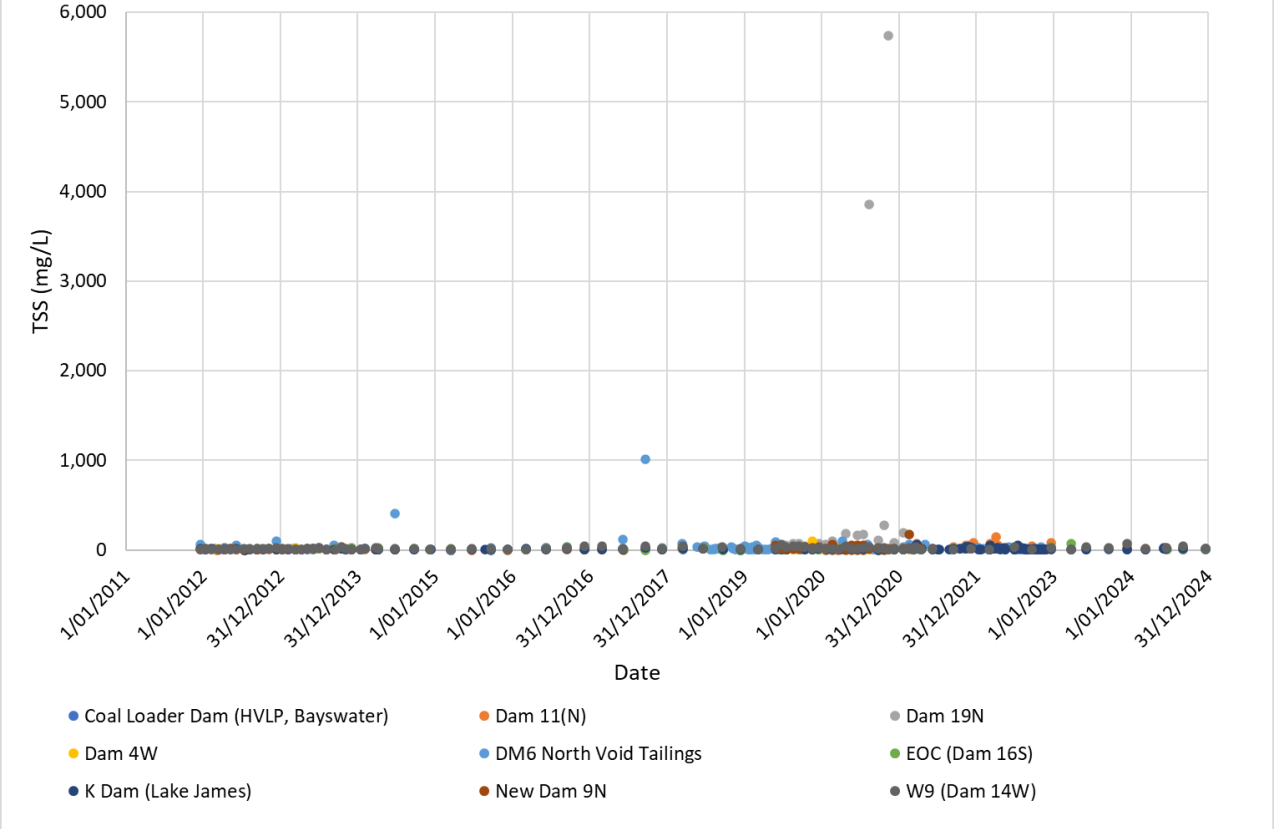


FIGURE B.14: MINE WATER SYSTEM – TSS

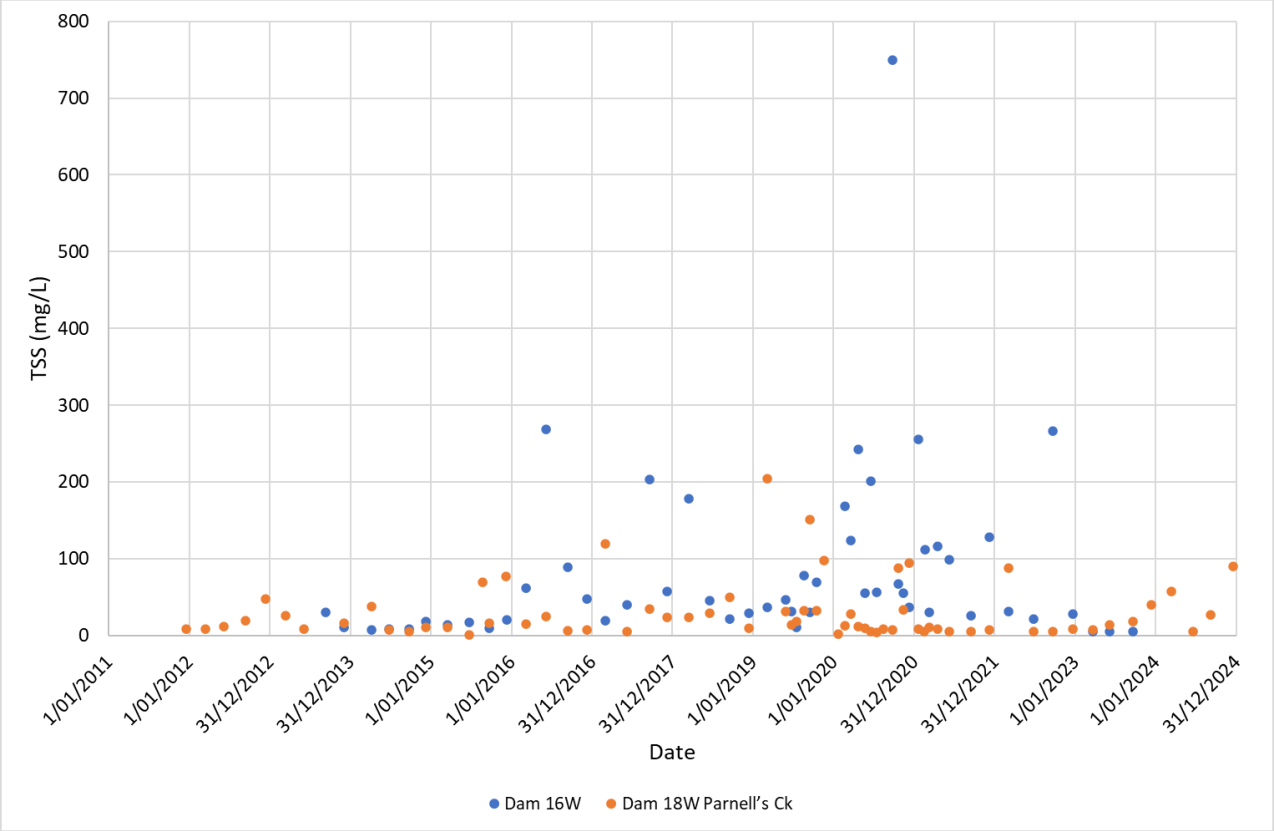


FIGURE B.15: SEDIMENT WATER SYSTEM – TSS

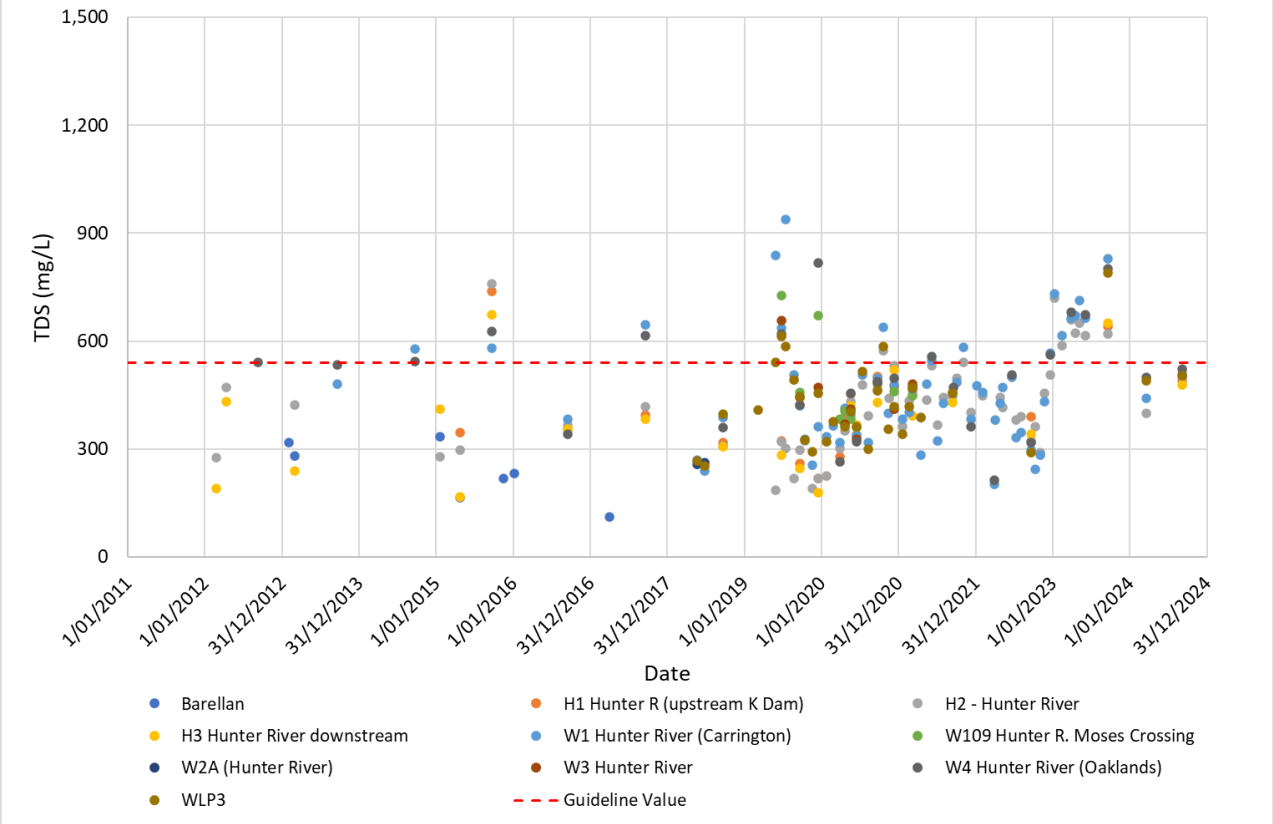


FIGURE B.16: HUNTER RIVER - TDS

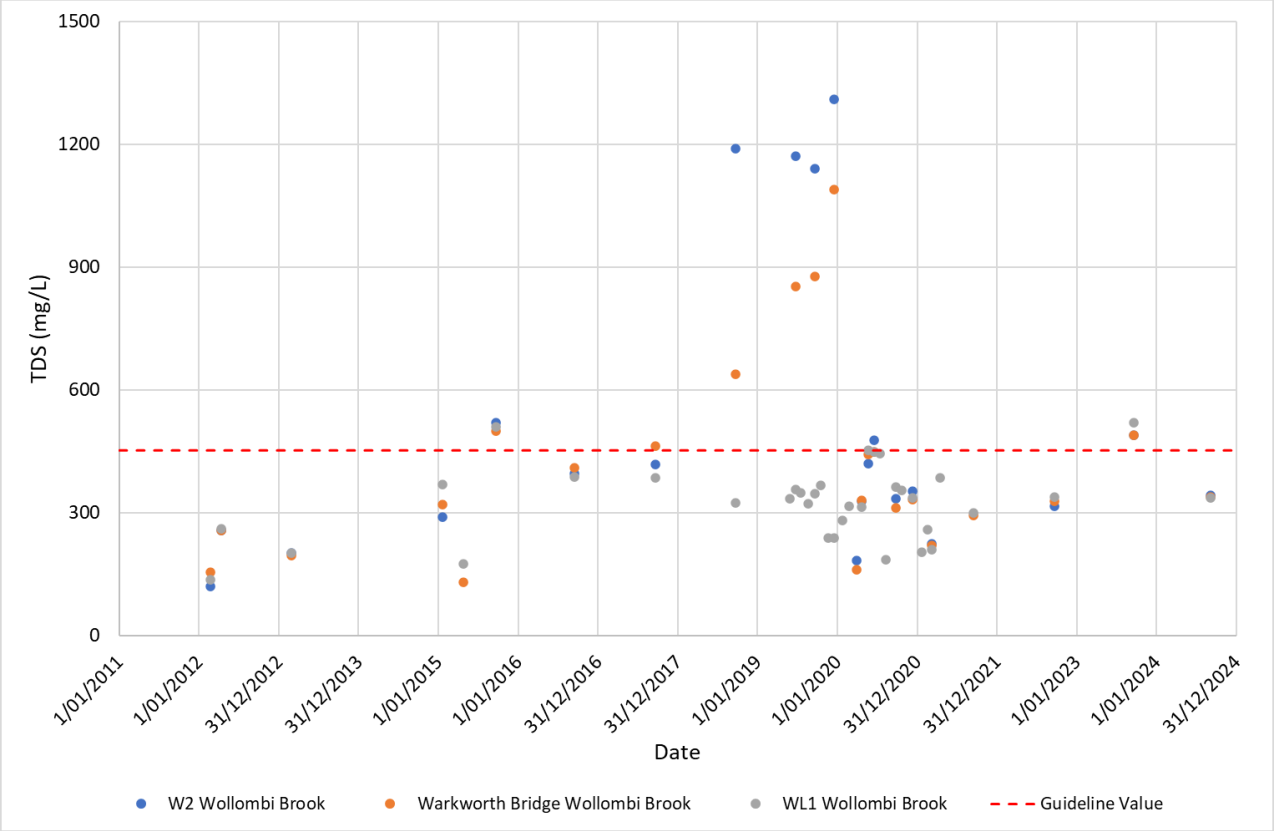


FIGURE B.17: WOLLOMBI BROOK – TDS

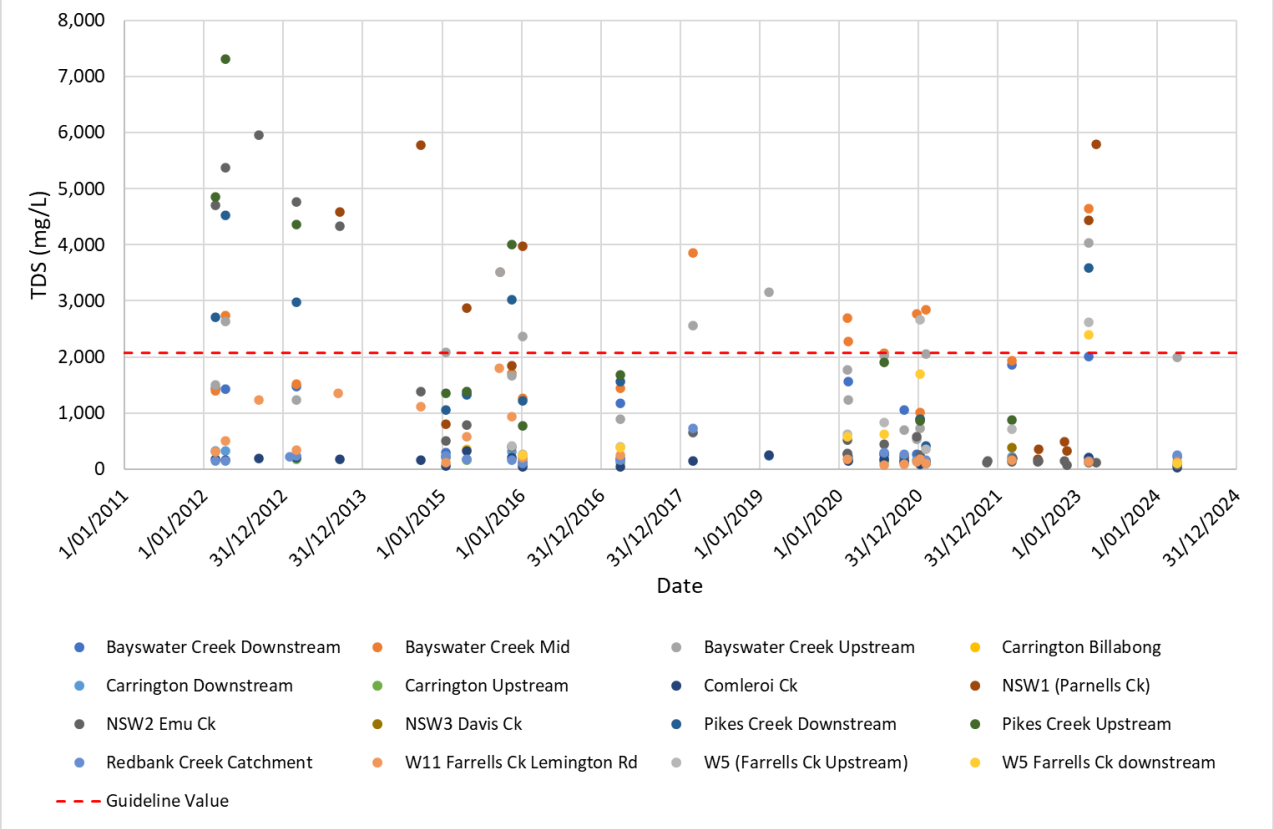


FIGURE B.18: EPHEMERAL CREEKS – TDS

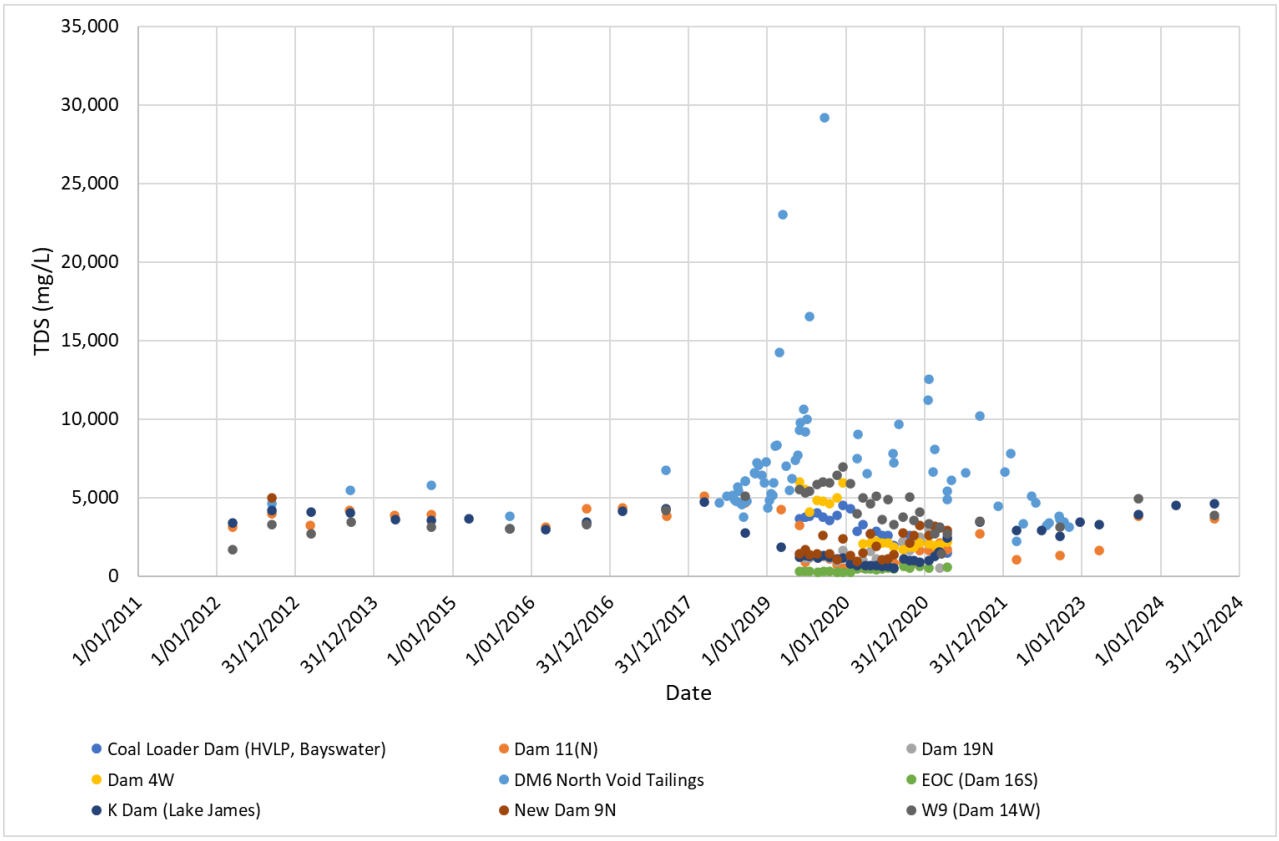


FIGURE B.19: MINE WATER SYSTEM – TDS

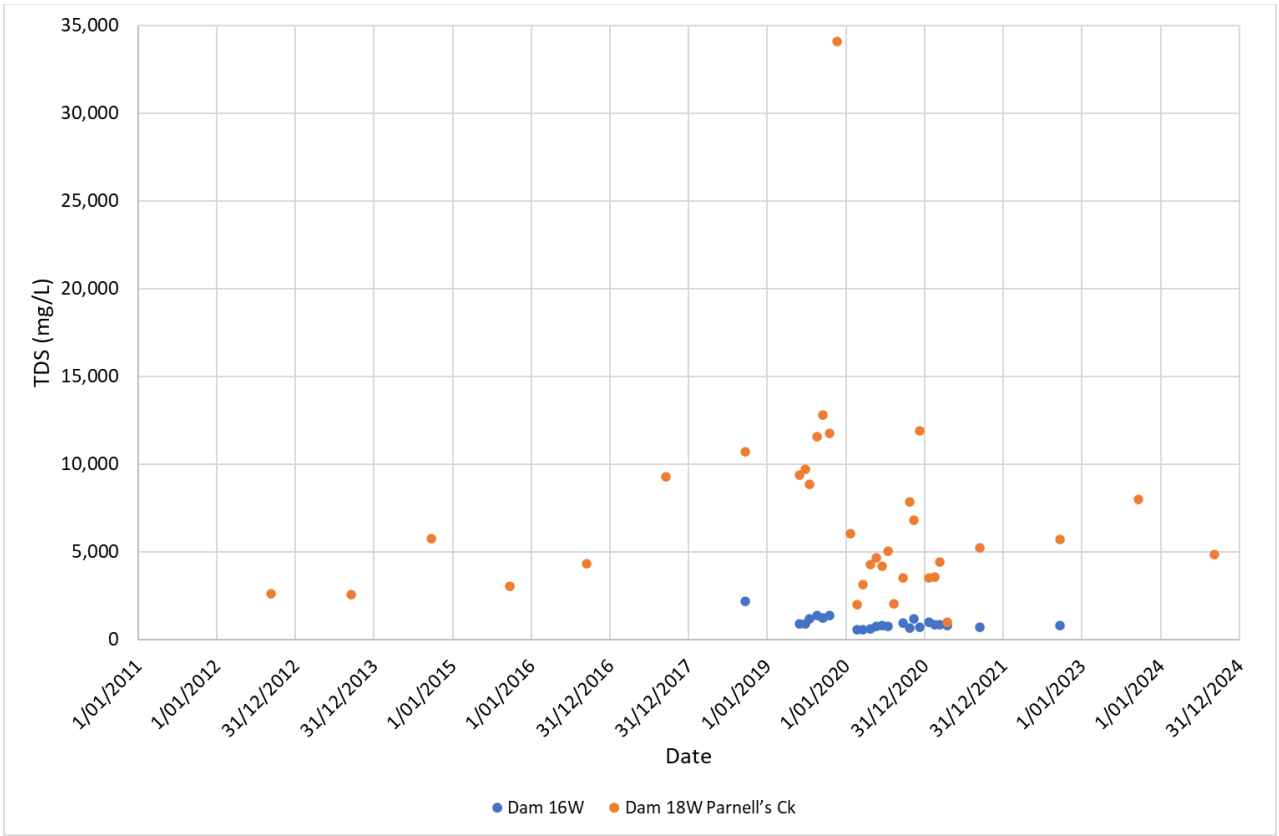


FIGURE B.20: SEDIMENT WATER SYSTEM – TDS

TABLE B.1: SUMMARY OF SITE WATER QUALITY DATA - METALS AND NUTRIENTS

Location	Statistic	Aluminium (Al) (mg/L)	Arsenic (As) (mg/L)	Boron (B) (mg/L)	Barium (Ba) (mg/L)	Calcium (Ca) (mg/L)	Cadmium (Cd) (mg/L)
Hunter River	Count	202	178	222	116	172	122
	Min	0.04	0.001	0.02	0.02	0.1	0.0001
	20th percentile	0.30	0.001	0.05	0.03	28.0	0.0001
	Median	0.89	0.001	0.05	0.04	40.0	0.0001
	80th percentile	2.61	0.001	0.05	0.046	52.0	0.0001
	Max	21.40	0.001	0.14	0.1	73.0	0.0010
	Average	1.74	0.001	0.05	0.0384	39.4	0.0002
Wollombi Brook	Count	69	69	69	41	50	46
	Min	0.01	0.001	0.02	0.03	0.1	0.0001
	20th percentile	0.05	0.001	0.05	0.04	7.8	0.0001
	Median	0.44	0.001	0.05	0.04	13.0	0.0001
	80th percentile	2.16	0.001	0.05	0.05	28.0	0.0001
	Max	7.96	0.001	0.07	0.14	50.0	0.0010
	Average	1.27	0.001	0.05	0.0487	16.3	0.0003
Ephemeral Creeks	Count	224	225	224	111	154	123
	Min	0.01	0.001	0.01	0.01	0.1	0.0001
	20th percentile	0.15	0.001	0.05	0.03	0.1	0.0001
	Median	1.01	0.001	0.06	0.05	8.0	0.0001
	80th percentile	3.26	0.001	0.44	0.09	74.8	0.0010

Location	Statistic	Aluminium (Al) (mg/L)	Arsenic (As) (mg/L)	Boron (B) (mg/L)	Barium (Ba) (mg/L)	Calcium (Ca) (mg/L)	Cadmium (Cd) (mg/L)
	Max	170.00	0.040	1.20	1.02	210	0.0010
	Average	3.60	0.002	0.23	0.07	33.1	0.0004
Sediment Water System	Count	132	132	131	56	121.0	111
	Min	0.01	0.001	0.03	0.02	0.1	0.00005
	20th percentile	0.06	0.001	0.05	0.03	14.0	0.0001
	Median	0.20	0.001	0.07	0.055	26.0	0.0001
	80th percentile	1.49	0.005	0.12	0.09	39.0	0.0001
	Max	100	0.020	0.51	0.19	90.0	0.0010
	Average	2.90	0.003	0.09	0.06	27.8	0.0002
Mine Water System	Count	307	308	306	218	295	270
	Min	0.01	0.001	0.03	0.01	0.1	0.00005
	20th percentile	0.04	0.001	0.05	0.02	15.0	0.0001
	Median	0.10	0.002	0.07	0.03	23.0	0.0001
	80th percentile	0.28	0.010	0.12	0.04	33.0	0.0001
	Max	50.00	0.080	0.32	0.85	128.0	0.0100
	Average	0.46	0.005	0.09	0.040	24.18	0.0002

TABLE B1: SUMMARY OF SITE WATER QUALITY DATA – METALS AND NUTRIENTS (CONTINUED)

Location	Statistic	Cobalt (Co) (mg/L)	Copper (Cu) (mg/L)	Iron (Fe) (mg/L)	Lead (Pb) (mg/L)	Mercury (Hg) (mg/L)	Potassium (K) (mg/L)	Magnesium (Mg) (mg/L)
Hunter River	Number of Samples	76	122	76	122	122	211	90
	Minimum	0.001	0.001	0.32	0.001	0.0001	1.6	12
	20th percentile	0.001	0.001	1.23	0.001	0.0001	2.7	19
	Median	0.001	0.001	1.92	0.001	0.0001	4.0	33
	80th percentile	0.001	0.0018	4.01	0.001	0.0001	4.6	49
	Maximum	0.010	0.02	22.90	0.001	0.0010	31.4	66
	Average	0.001	0.0018	2.81	0.001	0.0002	4.2	34
Wollombi Brook	Number of Samples	32	46	32	46	46	61	13
	Minimum	0.001	0.001	0.36	0.001	0.0001	2.0	11
	20th percentile	0.001	0.001	1.77	0.001	0.0001	4.4	15
	Median	0.001	0.001	2.92	0.001	0.0001	5.0	16
	80th percentile	0.001	0.001	4.80	0.001	0.0001	5.2	24
	Maximum	0.010	0.01	7.62	0.001	0.0010	8.0	36
	Average	0.001	0.001	3.27	0.001	0.0003	4.8	19
Ephemeral Creeks	Number of Samples	76	123	76	123	123	223	54
	Minimum	0.001	0.001	0.08	0.001	0.0001	2.0	2
	20th percentile	0.001	0.001	0.40	0.001	0.0001	4.8	4
	Median	0.001	0.002	1.40	0.001	0.0001	8.0	9
	80th percentile	0.001	0.005	3.17	0.001	0.0010	14.0	113

Location	Statistic	Cobalt (Co) (mg/L)	Copper (Cu) (mg/L)	Iron (Fe) (mg/L)	Lead (Pb) (mg/L)	Mercury (Hg) (mg/L)	Potassium (K) (mg/L)	Magnesium (Mg) (mg/L)
	Maximum	0.040	0.070	77.10	0.070	0.0010	29.0	266
	Average	0.002	0.004	4.50	0.002	0.0004	9.2	53
Sediment Water System	Number of Samples	48	110	45	111	111	131	34
	Minimum	0.0004	0.001	0.05	0.0001	0.000005	1.6	9
	20th percentile	0.001	0.001	0.09	0.001	0.0001	9.0	43
	Median	0.001	0.001	0.43	0.001	0.0001	16.0	115
	80th percentile	0.001	0.002	7.06	0.001	0.0001	24.0	201
	Maximum	0.013	0.027	30.60	0.020	0.0010	123.0	540
	Average	0.002	0.003	3.97	0.002	0.0002	19.7	137
Mine Water System	Number of Samples	208	268	200	270	270	312	86
	Minimum	0.0006	0.0008	0.03	0.0001	0.000005	2.0	15
	20th percentile	0.001	0.001	0.05	0.001	0.0001	9.0	49
	Median	0.001	0.001	0.10	0.001	0.0001	19.0	79
	80th percentile	0.001	0.001	0.28	0.001	0.0001	38.0	120
	Maximum	0.160	0.390	126.00	0.240	706*	190.0	240
	Average	0.002	0.003	0.96	0.002	2.6150	25.1	87

* Outlier value – understood to be a recording error

TABLE B1: SUMMARY OF SITE WATER QUALITY DATA – METALS AND NUTRIENTS (CONTINUED)

Location	Statistic	Manganese (Mn) (mg/L)	Sodium (Na) (mg/L)	Nickel (Ni) (mg/L)	Selenium (Se) (mg/L)	Sulfate (SO4) (mg/L)	Zinc (Zn) (mg/L)	Oil & Grease (mg/L)
Hunter River	Number of Samples	86	211	122	215	222	178	76
	Minimum	0.02	3	0.001	0.001	1	0.005	2
	20th percentile	0.07	37	0.001	0.001	20	0.005	5
	Median	0.10	61	0.002	0.010	33	0.005	5
	80th percentile	0.14	83	0.008	0.010	44	0.010	5
	Maximum	0.44	140	0.040	0.010	93	0.060	5
	Average	0.11	62	0.004	0.008	34	0.008	5
Wollombi Brook	Number of Samples	41	61	46	66	69	69	30
	Minimum	0.08	11	0.001	0.001	6	0.005	2
	20th percentile	0.14	43	0.001	0.001	11	0.005	5
	Median	0.26	68	0.001	0.010	18	0.005	5
	80th percentile	0.43	97	0.010	0.010	23	0.010	5
	Maximum	0.98	312	0.020	0.010	222	0.280	5

Location	Statistic	Manganese (Mn) (mg/L)	Sodium (Na) (mg/L)	Nickel (Ni) (mg/L)	Selenium (Se) (mg/L)	Sulfate (SO4) (mg/L)	Zinc (Zn) (mg/L)	Oil & Grease (mg/L)
	Average	0.32	75	0.004	0.008	23	0.012	5
Ephemeral Creeks	Number of Samples	111	223	123	224	212	225	72
	Minimum	0.01	4	0.001	0.001	1	0.005	2
	20th percentile	0.02	13	0.001	0.001	9	0.005	5
	Median	0.04	58	0.002	0.010	52	0.010	5
	80th percentile	0.13	462	0.005	0.010	622	0.030	5
	Maximum	1.52	1720	0.040	0.100	3390	0.720	12
	Average	0.13	252	0.004	0.010	339	0.030	5
Sediment Water System	Number of Samples	60	131	111	128	135	133	76
	Minimum	0.001	19	0.001	0.001	10	0.0001	2
	20th percentile	0.01	223	0.001	0.010	228	0.005	5
	Median	0.03	658	0.002	0.010	666	0.005	5
	80th percentile	0.07	1130	0.007	0.010	1458	0.010	5
	Maximum	1.07	8990	0.020	0.100	9800	0.190	117

Location	Statistic	Manganese (Mn) (mg/L)	Sodium (Na) (mg/L)	Nickel (Ni) (mg/L)	Selenium (Se) (mg/L)	Sulfate (SO4) (mg/L)	Zinc (Zn) (mg/L)	Oil & Grease (mg/L)
	Average	0.1	868	0.004	0.010	974	0.012	6
Mine Water System	Number of Samples	227	312	267	302	331	308	313
	Minimum	0.001	31	0.001	0.001	9	0.0002	2
	20th percentile	0.001	307	0.001	0.010	219	0.005	5
	Median	0.01	894	0.001	0.010	710	0.005	5
	80th percentile	0.02	1688	0.004	0.010	1470	0.010	5
	Maximum	2.56	9230	0.180	0.058	9420	1.450	5
	Average	0.0289	1086	0.003	0.011	988	0.010	4

TABLE B1: SUMMARY OF SITE WATER QUALITY DATA – METALS AND NUTRIENTS (CONTINUED)

Location	Statistic	Total Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Biochemical oxygen demand (BOD) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)
Hunter River	Number of Samples	222	175	186	186	74	76	76
	Minimum	0.2	64.0	1	1	2.0	0.01	0.01
	20th percentile	150.4	158.0	1	1	2.0	0.01	0.02
	Median	205.0	208.0	1	1	2.0	0.01	0.05
	80th percentile	259.0	256.4	1	1	2.0	0.01	0.25
	Maximum	319.0	319.0	31	20	13.0	0.05	1.83
	Average	198.1	205.4	3	2	2.3	0.01	0.19
Wollombi Brook	Number of Samples	69	46	49	49	31	32	32
	Minimum	9.0	33.0	1	1	2.0	0.01	0.01
	20th percentile	55.0	60.0	1	1	2.0	0.01	0.02
	Median	69.0	76.5	1	1	2.0	0.01	0.05
	80th percentile	127.2	151.0	1	1	2.0	0.01	0.09
	Maximum	224.0	224.0	20	20	16.0	0.24	0.39
	Average	85.8	100.5	2	2	2.6	0.02	0.08
Ephemeral Creeks	Number of Samples	225	123	123	123	71	76	76
	Minimum	1.1	12.0	1	1	2.0	0.01	0.01
	20th percentile	38.0	36.4	1	1	2.0	0.01	0.03
	Median	84.0	69.0	1	1	2.0	0.01	0.13
	80th percentile	274.0	245.8	1	1	3.0	0.04	0.46

Location	Statistic	Total Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Biochemical oxygen demand (BOD) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)
	Maximum	911.0	732.0	26	20	12.0	0.21	2.65
	Average	160.6	138.6	3	2	2.7	0.02	0.36
Sediment Water System	Number of Samples	136	114	118	118	44	43	43
	Minimum	0.4	52.0	1	1	2.0	0.01	0.01
	20th percentile	131.0	161.6	5	1	2.0	0.01	0.01
	Median	385.0	334.0	65	1	2.0	0.01	0.09
	80th percentile	627.0	506.8	137	1	4.0	0.01	0.57
	Maximum	1830.0	1810.0	388	20	22.0	0.11	1.41
	Average	420.5	355.8	80	1	3.4	0.01	0.31
Mine Water System	Number of Samples	331	293	302	302	204	212	212
	Minimum	93.0	82.0	1	1	2.0	0.01	0.01
	20th percentile	258.0	228.4	10	1	2.0	0.01	0.01
	Median	440.0	328.0	63	1	2.0	0.01	0.13
	80th percentile	799.0	618.8	138	1	4.0	0.08	1.96
	Maximum	1600.0	1150.0	469	20	34.0	0.88	15.60
	Average	535.3	414.2	82	1	3.8	0.1	1.12

ATTACHMENT C: WATER BALANCE MODELLING

ENGENY

egis GROUP

HV OPERATIONS PTY LTD

Water Balance Modelling

HVO Continuation Project – Amended Project

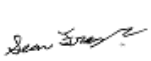
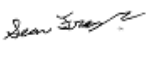
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3 JULY 2025

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1. INTRODUCTION

1.1 Background

Hunter Valley Operations (HVO) is a well-established multi-pit open cut coal mining complex, comprising two mine sites separated by the Hunter River, HVO North and HVO South (i.e. the HVO Complex). The HVO Complex is located approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW). While the two mine sites are approved under separate development consents, they are operated as one complex with fully integrated environmental management systems.

The HVO Continuation Project (the Project) broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 2026 and 2030 respectively, to the end of 2045 at HVO North and to the end of 2042 at HVO South. The continuation of mining across the HVO Complex will increase resource recovery from the existing operation, predominantly by mining through previously mined areas and to the extent of existing mining tenements and extracting coal from deeper seams at HVO North.

The water balance was modelled for the EIS Project in 2022 and documented in the Surface Water Impact Assessment (EIS SWIA) (Engeny, HVO Continuation Project - Surface Water Impact Assessment, 2022). A peer review of the water balance modelling for the EIS SWIA (Engeny, HVO Continuation Project - Surface Water Impact Assessment, 2022) was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the development of the EIS SWIA, with his review comprising inputs and involvement in the water management system, water balance modelling, streamflow impact assessment, water quality assessment and cumulative impact assessment, and final void hydrology and climate change assessment.

The Project has subsequently been amended and as such updated water balance modelling is required for the Amended Project, which is documented in this report. Groundwater modelling has been undertaken to support the Amendment Report and informs the water balance modelling (EMM, 2025a). Water licensing for the Amended Project is assessed in the Water Assessment (EMM, 2025b). The water balance modelling for the Amended Project follows the same methodology as undertaken for the EIS Project (Engeny, HVO Continuation Project - Surface Water Impact Assessment, 2022).

1.2 Overview

The site water balance model (WBM) was developed for the EIS Project was documented in the EIS SWIA (Engeny, HVO Continuation Project - Surface Water Impact Assessment, 2022). The water balance model was developed using the GoldSim modelling software and modelled the conceptual water management system (WMS) for the Project. The WBM uses the Australian Water Balance Model (AWBM) to estimate rainfall runoff from climate data inputs and considers:

- Direct rainfall onto water storage surfaces.
- Water loss due to evaporation from water storages and pits.
- Runoff from natural, rehabilitated, and disturbed catchments.
- Groundwater inflows into open cut pits.
- Water lost to product coal through the Coal Processing Plant (CPP).
- Water used on site for dust suppression and vehicle washdown.
- Transfers to and from other sites.
- Extraction from the Hunter River.

The WBM is linked to output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM is the model used by the Crown Lands Division of Water (CLWD) (formerly known as the Department of Primary Industries – Water (DPI Water)) to set Available Water Determinations (AWDs) in the Hunter Regulated River, in accordance and in conjunction with the Hunter Regulated River Water Sharing Plan 2016. The IQQM was run using climatic data from 1892 to 2013 to generate historical river flow data to simulate future opportunities for controlled release.

The same modelling methodology has been used to model the and review the key performance indicators of the WBM for the Amended Project that was used for the EIS Project, which include:

- Mine water accumulation in key water storages.
- Containment performance of the WMS and individual storages.
- Mine water release opportunities.
- External supply requirements.
- Supply reliability to Project demands.

The WBM time series commences at the start of the 2025 calendar year and is based on the 2025 site inventory as well as production/catchment areas forecast for 2025 to the commencement of the Amended Project in 2027. As such this report shows the input data to the model for 2025 to 2045 (inclusive) and the Amended Project modelling results for 2027 to the end 2045 (inclusive).

The methodology described in the EIS SWIA (Engeny, 2022) is included in this report to provide context for the reader.

2. CLIMATE INPUTS

Climate data inputs for the WBM, including rainfall and evaporation, were sourced from the SILO database for a location at the HVO Complex from 1892 to 2012 (121 years). Daily rainfall and daily pan evaporation over this period were input into the model, with lake evaporation and evapotranspiration factors applied (Table 2.1).

TABLE 2.1: EVAPORATION AND EVAPOTRANSPIRATION PAN COEFFICIENTS

Month	M Lake Factor	M Wet Factor
January	0.93	0.95
February	0.96	0.95
March	0.96	0.95
April	0.90	0.95
May	0.83	0.95
June	0.75	0.95
July	0.77	0.95
August	0.85	0.95
September	0.90	0.95
October	0.93	0.95
November	0.94	0.95
December	0.92	0.95

Note: ***M Lake Factor:*** *Converts Pan Evaporation to Lake Evaporation*
M Wet Factor: *Converts Lake Evaporation to Evapotranspiration*

Monthly average rainfall, lake evaporation and evapotranspiration adopted in the water balance are summarised in Table 2.2.

TABLE 2.2: MONTHLY AVERAGE CLIMATE DATA

Month	Rainfall (mm)	Lake Evaporation (mm)	Evapotranspiration (mm)
January	76	189	180
February	70	153	145
March	69	135	128
April	48	91	86
May	41	60	57
June	50	41	39

Month	Rainfall (mm)	Lake Evaporation (mm)	Evapotranspiration (mm)
July	41	49	47
August	39	75	72
September	41	108	102
October	51	146	138
November	59	168	159
December	71	191	182

3. WATER INFLOWS

3.1 Catchment Runoff

Catchment runoff has been simulated using the Australian Water Balance Model (AWBM). The model represents the catchment using three surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area on a daily time step. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the base flow store if there is a base flow component to the streamflow. A schematic representation of the AWBM model is provided in Figure 3.1.

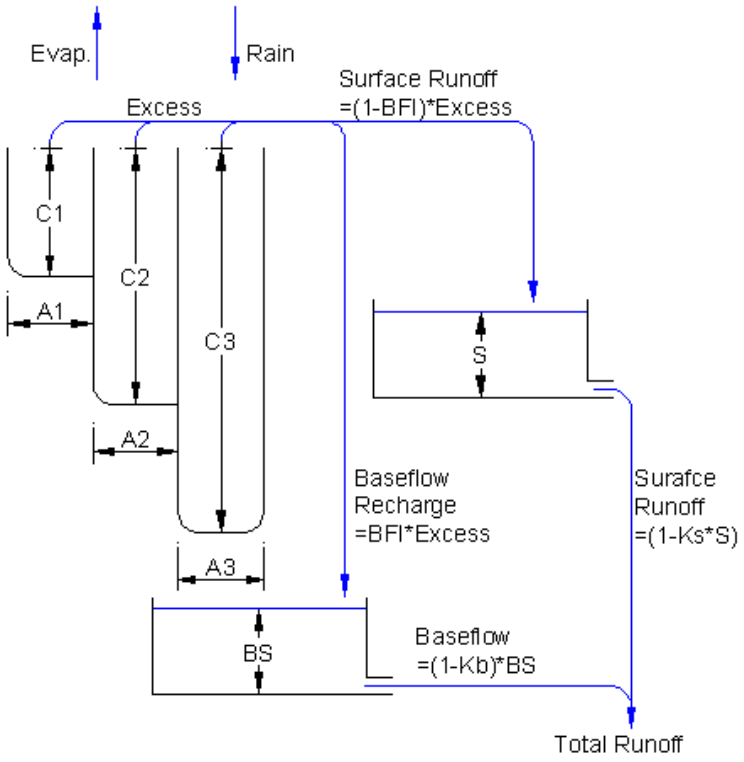


FIGURE 3.1: AWBM SCHEMATIC

The definition of the parameters used in the AWBM is provided in Table 3.1 and the adopted AWBM parameters are shown in Table 3.2. Different sets of parameters have been adopted for the following land uses to allow for changes in runoff characteristics:

- Natural.
- Hardstand.
- Pit.
- Spoil.
- Rehabilitated spoil.
- Cleared/Pre-strip.
- Stockpile.
- Tailings.

Existing calibrated AWBM parameters from the Greater Ravensworth Area WBM (GRAWBM) were adopted for the HVO WBM and validated against recorded mine water inventories at the HVO Complex over the period January 2018 to December 2023 (refer validation section below). The GRAWBM encompasses Ravensworth, Liddell and Mt Owen operations.

TABLE 3.1: AWBM PARAMETERS

Parameter	Description
A1, A2, A3	The partial areas of the overall catchment contributing to storages 1, 2 and 3 respectively.
C1, C2, C3	The capacity of surface storages 1, 2 and 3 respectively.
BFI	Baseflow Index – The proportion of excess rainfall flowing to the baseflow store (remainder in surface store).
Kb	Baseflow Recession Constant – The proportion of volume in the baseflow store remaining at the end of each day.
Ks	Surface Recession Constant – The proportion of volume in the surface store remaining at the end of each day.

TABLE 3.2: HVO AWBM RUNOFF PARAMETERS

Parameter	Natural	Hardstand	Pit	Spoil	Rehabilitated Spoil	Cleared / Prestrip	Stockpile	Tailings
A1	0.134	0.5	0.1	0.05	0.1	0.1	0.1	0.2
A2	0.433	0.5	0.9	0.95	0.3	0.9	0.9	0.8
A3	0.433	0	0	0	0.6	0	0	0
C1 (mm)	9.1	5	5	9	9	1	1	0
C2 (mm)	92.2	5	22	85	75	11	11	20
C3 (mm)	184.1	10	22	0	140	0	0	25
BFI	0.25	0	0	0.7	0.25	0	0	0
Kb	0.978	0.96	0.95	0.975	0.978	0	0	0.8
Ks	0.5	0	0.2	0.1	0.2	0	0	0
Average Annual runoff coefficient (%)	9.9%	50.2%	30.2%	10.0%	9.4%	41.6%	41.6%	36.8%

3.2 Catchment Areas

Catchment areas were delineated for all storages for the Amended Project. Catchment boundaries were defined using the proposed mine planning stages in conjunction with LiDAR survey of the existing topography in early 2025. A summary of the total catchments for the Amended Project is presented in Table 3.3 and Figure 3.2 and the land use breakdown for each stage plan year is shown on the stage plans in Section 3 of the SWIA (Engeny, 2025).

TABLE 3.3: TOTAL SITE STORAGE CATCHMENT AREA BY LAND USE AND MINING STAGE

Land Use	Base Plan	2027	2029	2032	2038	2041
Cleared / Prestrip (ha)	507	261	409	726	838	742
Hardstand (ha)	822	659	494	501	515	472
Pit (ha)	104	413	219	172	276	421
Natural (ha)	1,108	1,433	439	364	223	198
Spoil (ha)	1,786	1,790	2,415	2,098	1,938	1,643
Rehabilitated Spoil (ha)	1,668	1,599	1,663	1,862	2,400	2,725
Stockpile (ha)	47	41	94	82	83	81
Tailings (ha)	225	202	398	398	354	338
Total Area (ha)	**6,267**	**6,397**	**6,132**	**6,204**	**6,628**	**6,620**

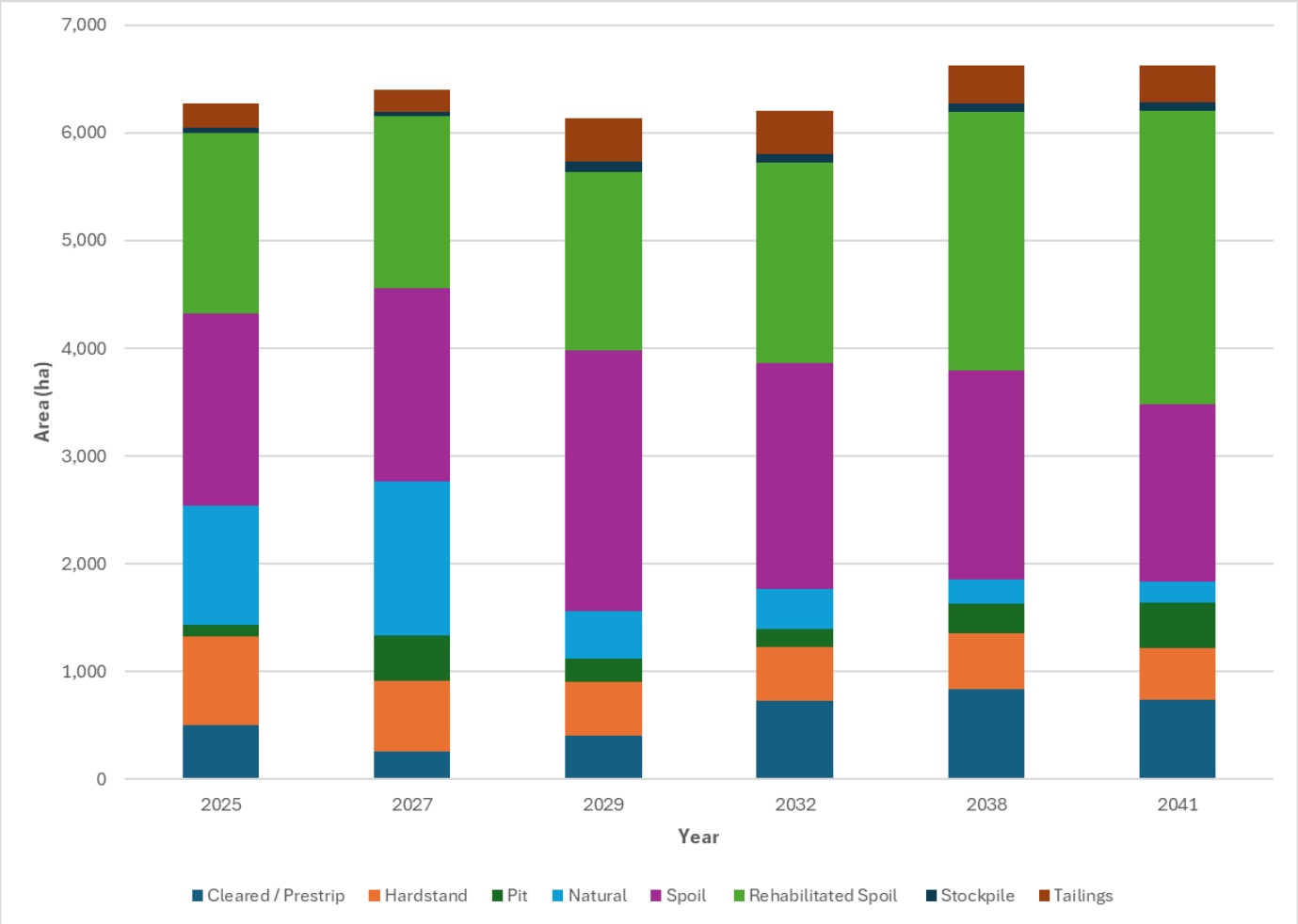


FIGURE 3.2: CONTRIBUTING CATCHMENT AREA

3.3 Groundwater Inflows

Groundwater ingress into open cut pits was updated to use outputs from the regional groundwater model for the Amended Project (EMM, 2025a). The groundwater model provides a prediction of all groundwater intercepted and therefore has been adjusted to estimate pumpable groundwater. There are two main processes that remove water prior to pumping including:

- Water evaporating directly from the highwall before it reaches the floor.
- Water adhered to the spoils and coal after blasting that does not flow to in-pit sumps.

Consistent with the EIS Project SWIA (Engeny, 2022), the following adjustments have been made:

- An estimate of the water evaporating from the highwall has been determined based on an average annual evaporation rate of 1,520 mm/year and a coal seam thickness of 30 m. Based on average strike lengths over the mine plan, the resulting evaporation rates are 128 ML/year and 137 ML/year for North Pit and South Pit respectively.
- An adjustment factor of 0.75 has been applied to the remaining groundwater to account for the water bound up in coal and spoil following blasting.

The resulting estimates of pumpable groundwater were input into the model as a time series to align with the mine plan. The average annual groundwater ingress is summarised in Table 3.4 and shown graphically in Figure 3.3.

TABLE 3.4: OPEN CUT PIT GROUNDWATER INGRESS (PUMPABLE GROUNDWATER)

Mine Plan Stage	Average Groundwater Ingress (ML/year)	
	HVO North	HVO South
2025	173	160
2029	494	549
2032	803	269
2038	490	293
2041	173	160
2045	568	186

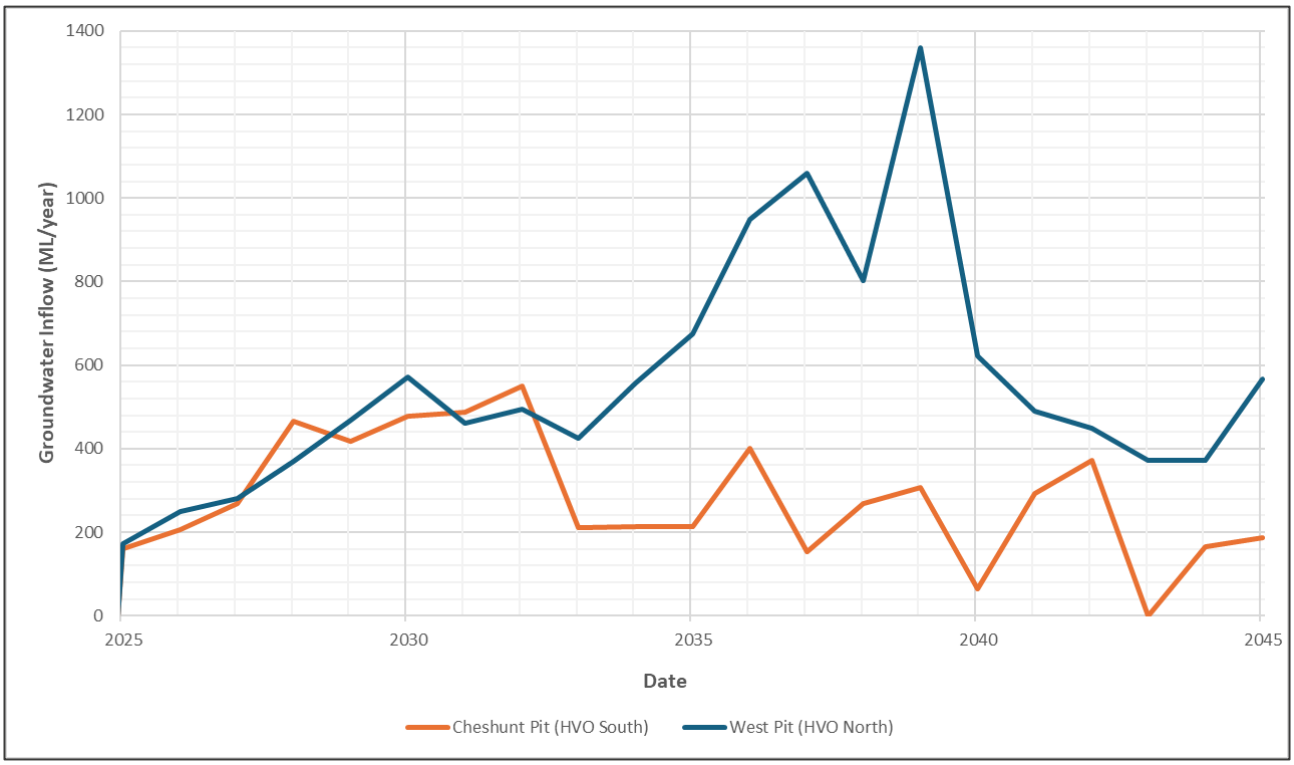


FIGURE 3.3: OPEN CUT PIT GROUNDWATER INGRESS (PUMPABLE GROUNDWATER)

3.4 Raw Water Extraction

HVO holds significant regulated river water access licences (WALs) to extract raw water from the Hunter River under the *Water Sharing Plan for the Hunter Regulated River Water Source 2016*. The WALs are defined as either High Security Entitlements (HSE) or General Security Entitlement (GSE). The WALS are applied to specific zones along the Hunter River and must be extracted from within the specified zones.

HVO also holds additional unregulated river WALs and groundwater extraction licences including a 1,800 ML/year groundwater extraction licence in the Lemington underground workings (WAL 39798) which is currently used to supply water to its neighbouring mine site, Mount Thorley Warkworth (MTW).

Available Water Determination (AWD) orders can be implemented by the NSW Government to reduce HSE and GSE during extended dry periods based on levels in the Hunter River regulated storages (i.e., Glenbawn Dam and Glennies Creek Dam) and the rules of the *Water Sharing Plan for the Hunter Regulated River Water Source 2016*.

4. WATER OUTFLOWS AND DEMANDS

4.1 Coal Processing and ROM Schedule

There are two existing coal processing plants (CPP) at HVO (Howick CPP and Hunter Valley CPP) at HVO. Consistent with the EIS SWIA (Engeny, 2022) it is proposed that the existing Ravensworth CPP, adjacent to HVO, will be utilised to process additional run of mine (ROM) coal associated with the Amended Project. The forecast ROM coal production schedule associated with the Amended Project is presented in Figure 4.1.

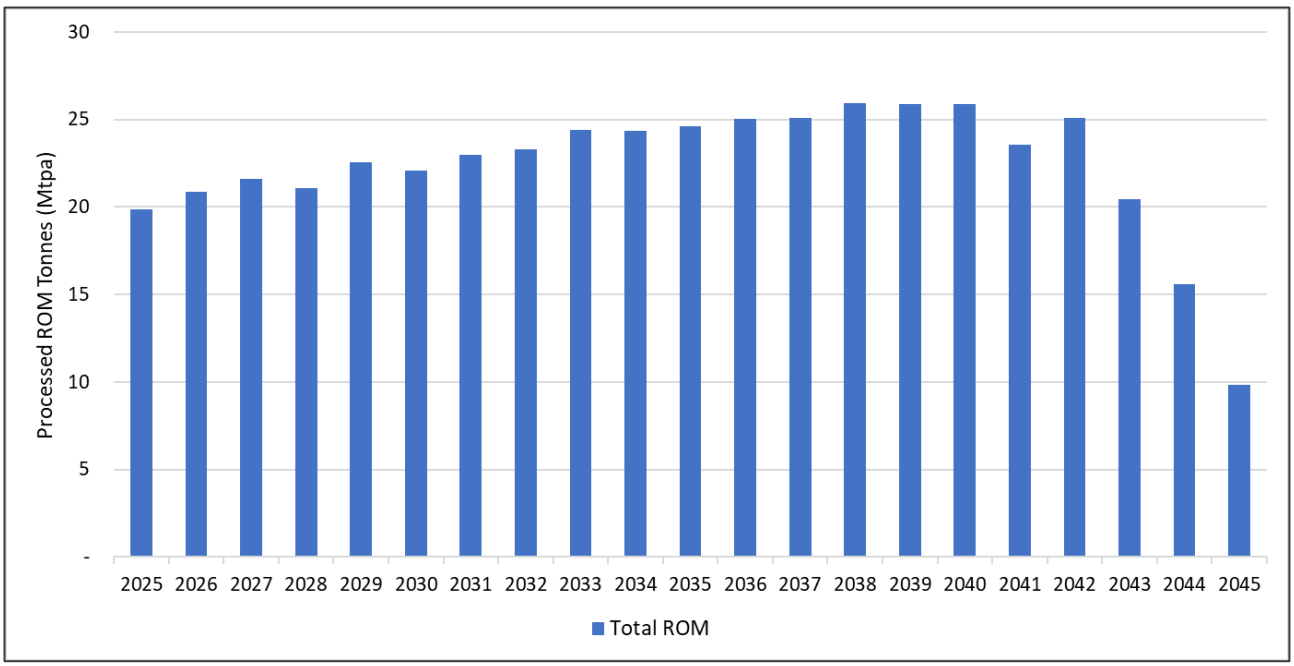


FIGURE 4.1: ROM PRODUCTION SCHEDULE

4.2 Tailings Strategy

The Amended Project proposes tailings disposal strategy is described below:

- Tailings from the Hunter Valley and Howick CPPs are sent to West Pit and Liddell.
- Tailings from the Ravensworth Operations CPP is sent to Liddell.
- Tailings decant water from Liddell sent back to the HVO Complex.

An overview of the current operations and Amended Project tailings schedule is shown in Figure 4.2. Most of the Amended Project tailings are proposed to be deposited at the Liddell tailings facilities with some tailings storage within the HVO West Pit.

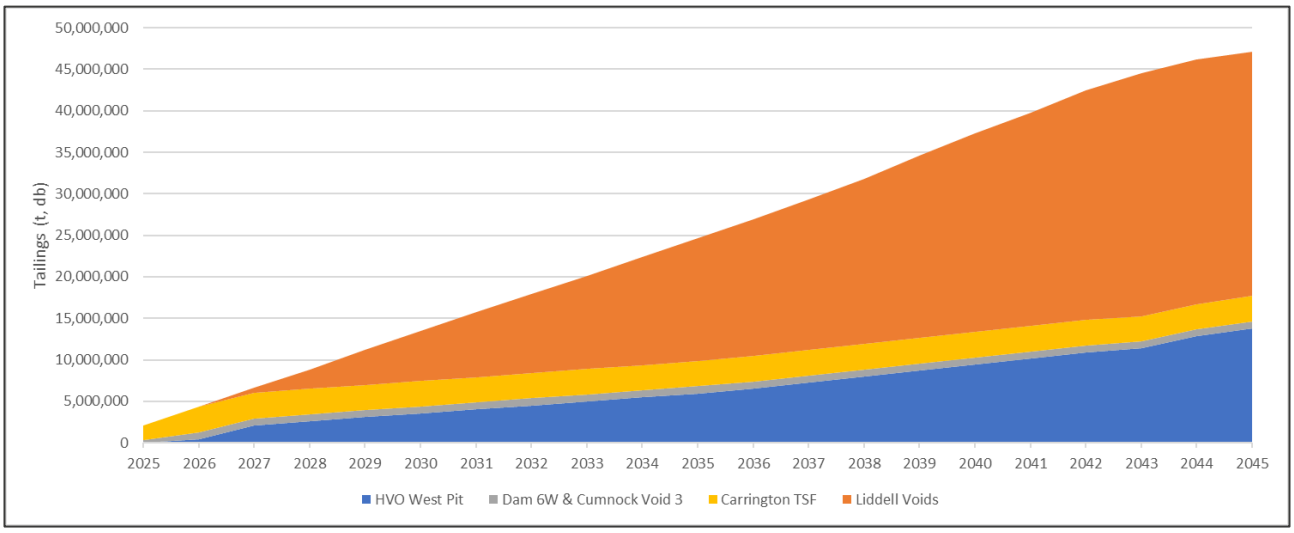


FIGURE 4.2: TAILINGS DEPOSITION SCHEDULE

4.3 Operational Water Consumption

The forecast water demand rates applied in the model are outlined in the following sections and presented graphically in Figure 4.4.

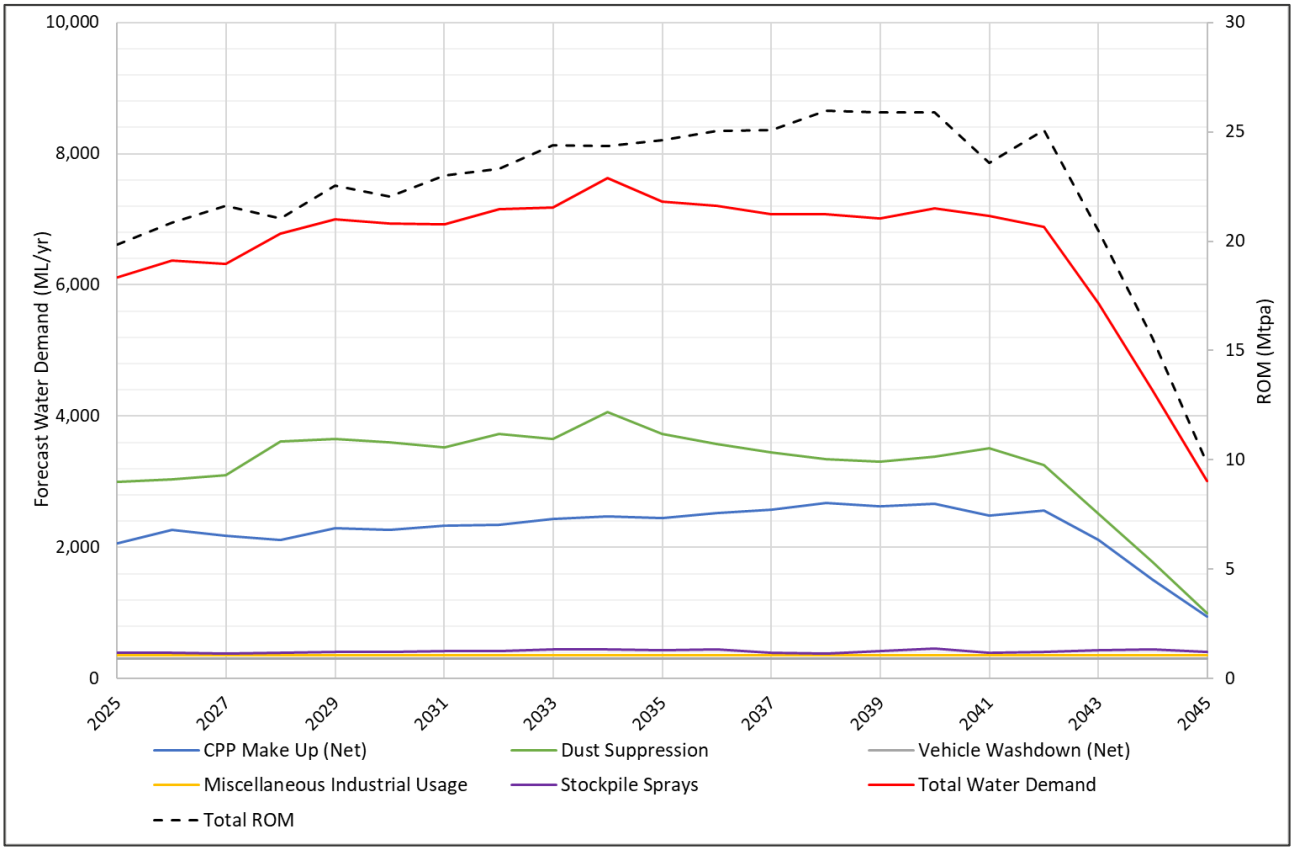


FIGURE 4.3: FORECAST SITE WATER DEMANDS

4.4 CPP Water Demands

The forecast CPP water demands for the WBM were calculated using a CPP and tailings moisture balance (CPP Demands – Tailings Decant Return) for the production and tailings schedule for the Amended Project. The adopted moisture balance parameters for CPPs and tailings storage facilities are summarised in Table 4.2 and Table 4.3

The forecast production schedule and estimated net CPP water demands are summarised in Table 4.4.

TABLE 4.1: CPP PARAMETERS

Parameter	Hunter Valley CPP	Howick CPP	Ravensworth CPP
Operational Period	2025 – 2045	2025 – 2043	2031 – 2038
ROM Coal Moisture Content (%)	7.0	7.0	7.1
Product Coal Moisture Content (%)	9.8	9.6	8.6
Coarse Rejects Moisture Content (%)	15.0	15.0	15.0
Wet Tailings Moisture Content (%)	70.0	70.0	70.0
Tailings Decant Return (%)	73.0	66.0	73.0
Tailings Facility Receiving Decant Return	• 2025: 100% Carrington TSF • 2026: 25% HVO West Pit TSF and 75% Carrington TSF • 2027: 25% HVO West Pit TSF and 75% Liddell Void • 2028 – 2045:100% Liddell Void	• 2025 – 2026: 100% Dam 6W and Cumnock Void 3 • 2027 – 2040: 100% HVO West Pit TSF • 2041: 50% HVO West Pit Tailings Dam and 50% Liddell Void • 2042 – 2043: 100% Liddell Void	• 2031 – 2038: 100% Liddell Void

TABLE 4.2: TAILINGS DISPOSAL PARAMETERS

Tailings Disposal Method	Water Recovery Rate (% of wet tailings moisture content)
Wet Tailings Disposal at Liddell	73%
Wet Tailings Disposal at West Pit (HVO North)	66%

TABLE 4.3: CPP PRODUCTION SCHEDULE AND ESTIMATED WATER DEMANDS

Year	ROM Feed (Mtpa)	Net CPP Water Demand (ML/year)
2025	19.86	2,061
2026	20.84	2,269
2027	21.60	2,176

Year	ROM Feed (Mtpa)	Net CPP Water Demand (ML/year)
2028	21.06	2,111
2029	22.53	2,287
2030	22.05	2,263
2031	22.99	2,327
2032	23.31	2,349
2033	24.38	2,430
2034	24.35	2,466
2035	24.61	2,448
2036	25.06	2,525
2037	25.07	2,570
2038	25.95	2,682
2039	25.88	2,623
2040	25.90	2,670
2041	23.57	2,487
2042	25.09	2,564
2043	20.47	2,114
2044	15.57	1,509
2045	9.84	945

4.5 Dust Suppression

The forecast haul road dust suppression demand for the Amended Project was estimated by scaling the current water cart usage (~2,200 ML/year) using forecast water cart operating hours and storage capacities (provided by HVO). Consistent with the EIS SWIA (Engeny, 2022), the proposed water cart fleet includes CAT 785 and CAT 789 water carts and not CAT 777 water carts. It is estimated water cart demands will increase to 4,060 ML/year which aligns with the forecast increase in production (refer Table 4.4).

Figure 4.4 shows the forecast water cart operating hours and overall scaling factors used to determine haul road dust suppression for the Amended Project. Figure 4.3 shows the total forecast water cart demands.

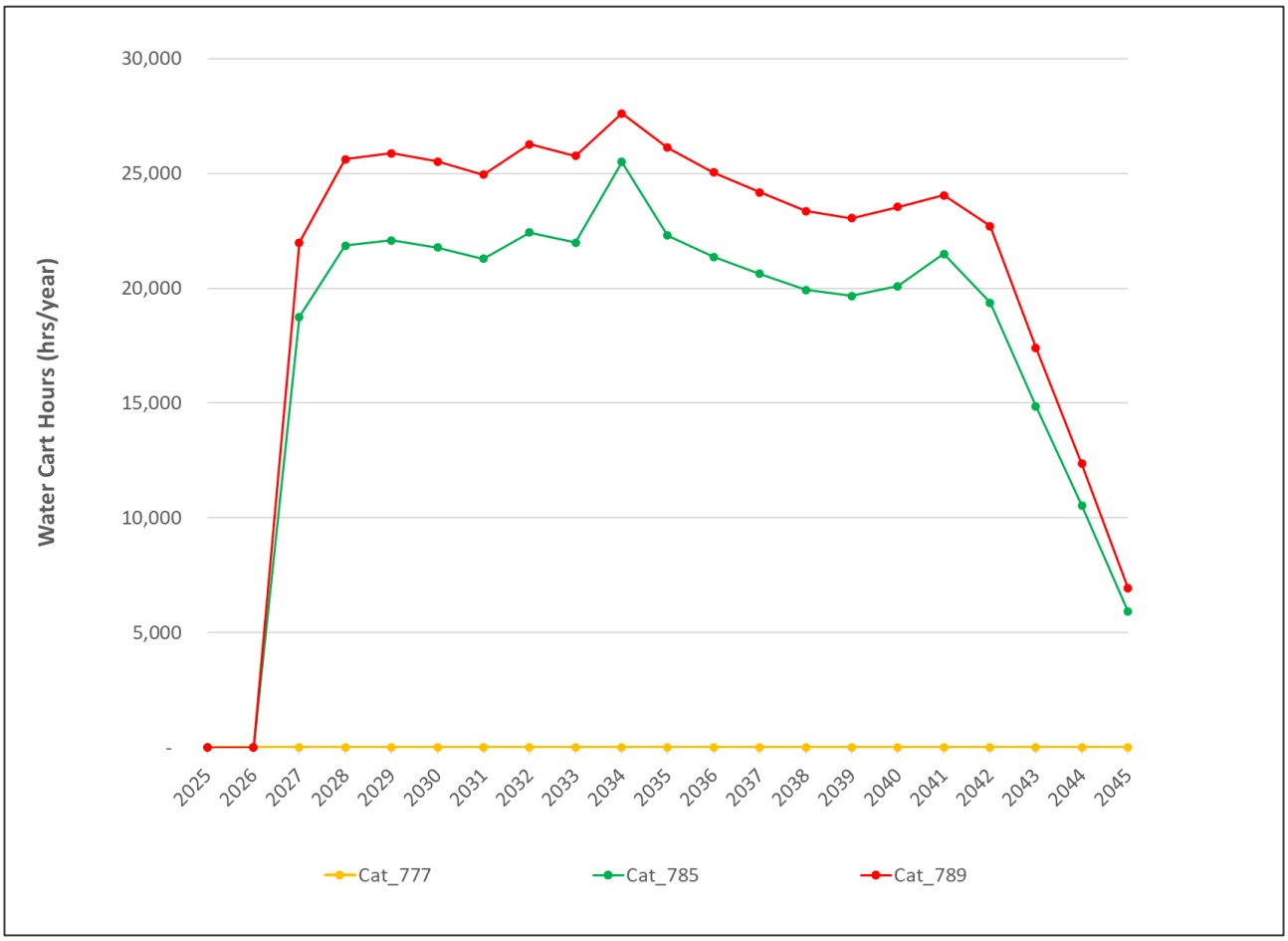


FIGURE 4.4: WATER CART OPERATING HOURS

4.6 Load Point Demands

Forecast load point demands (primarily for stockpile sprays) for the Amended Project were estimated, using the same method as for the EIS SWIA (Engeny, 2022) by applying a daily evaporation rate over the stockpile area. The average annual load point water demands are summarised in Table 4.4.

The load point demands are currently met by the water sharing agreement between HVO and Liddell which allows 35 ML/week to be sourced from Liddell. The current agreement is due to expire in 2032 and is proposed to be extended consistent with the EIS SWIA (Engeny, 2022).

TABLE 4.4: AVERAGE ANNUAL LOAD POINT WATER DEMANDS

Load Point	Stockpile Area (ha)	Average Annual Evaporation Rate (mm/year)	Average Annual Water Demand (ML/year)
Newdell (New Product Stockpile)	11.5	1,520	200
HVLP Stockpile	18.6	1,520	163

4.7 Miscellaneous Demands

Vehicle washdown and miscellaneous industrial use demands have been assumed to remain constant for the Amended Project (consistent with the EIS Project) and are based on the values reported on in the Annual Environmental Reports (AERs) for 2017 to 2020.

- Vehicle Washdown: 310 ML/year with a return rate of 15%.
- Miscellaneous Industrial Use: 350 ML/year with no return.

4.8 Seepage Losses

Seepage losses from out of pit storages is expected to be negligible and not included in the WBM as confirmed by the model validation. The open cut pits will maintain dewatering and act as groundwater sinks during operations with no groundwater/seepage outflows.

4.9 Inter-Mine Water Transfers

There are a number of water sharing agreements in place between HVO and nearby mine sites. A summary of these agreements is provided in the SWIA (Engeny, 2025).

5. HRSTS RELEASES

Discharge of mine water to the Hunter River is regulated under both the EPL and the Hunter River Salinity Trading Scheme (HRSTS). Under the HRSTS, discharges from mines and power stations are not permitted during periods when flow in the Hunter River is low. Discharge is permissible when flow in the Hunter River is high, providing sufficient salt credits and a discharge licence is held by the respective operation.

Surplus water from the HVO Complex is discharged under the HRSTS into Parnells Creek via Dam 9W (Parnells Dam) and the Hunter River via Dam 15S (Lake James) and Dam 11N. HVO currently holds 102 HRSTS salt credits, and plans to increase this to 130 HRSTS salt credits during 2026, and as such may currently release up to 10.2% of the declared total allowable salt discharge under the HRSTS, with a future predicted release of up to 13% of the declared total allowable salt discharge. The maximum allowable discharge rate is further constrained by the EPL and the infrastructure capacity. There are currently three licensed release points at HVO as summarised in Table 5.1.

TABLE 5.1: HRSTS RELEASE POINTS AND CAPACITY

Release Point	Storage	EPL Maximum Release Rate (ML/day)	Infrastructure Capacity (ML/day)
3	Dam 11N	100	100
4	Dam 9W (Parnells Dam)	130	130
8	Dam 15S (Lake James)	200	200
TOTAL		**430**	**430**

HRSTS releases are modelled in the WBM using long-term (IQQM) streamflow series and a stochastic decision matrix based on the daily flow rate to determine allowable releases (developed from previous HRSTS decision making by HEC). The HRSTS release is modelled to occur only when the mine water inventory exceeds specified volumes.

6. WATER BALANCE VALIDATION

As part of the 2024 update of the *HVO Water Accounting Framework* (Engeny, 2024), the HVO WBM validation was updated to the historical period January 2018 to December 2023, by comparing modelled site inventory to historical water inventory data. The key input parameters for the model are summarised in Table 6.1.

TABLE 6.1: MODEL INPUT PARAMETERS

Data	Details	Source
Rainfall	Daily rainfall data measured at HVO Corporate and Cheshunt rainfall gauges	Provided by HVO
Evaporation	SILO Data Drill daily pan evaporation, monthly average pan factors for lake evaporation, and a lake evaporation to evapotranspiration scaling factor of 0.95.	SILO database Previous OPSIM Model (HATCH, 2015)
Catchments and land use	Catchments and land use mapped based on site LiDAR survey and aerial imagery	Developed by Engeny
Catchment runoff characteristics	AWBM runoff model parameters used for daily runoff calculations.	GRAWBM, 2017
Storage Curves	Developed by Engeny from LiDAR survey for the operational pits. Bathymetry and LiDAR received as part of PRP Study using 2020/21 LiDAR. Bathymetry and LiDAR received as part of the 2023 HVO Operational Water Management Plan. Otherwise, OPSIM WBM curves used.	April 2021 LiDAR survey provided for operational pits. Provided by HVO Provided by HVO. HATCH, 2015
Historical water inventory data	Levels for key dams and volumes for pits from January 2018 to December 2023	HVO Inventory tracking sheet provided by HVO
Transfer rates and directions		HATCH, 2015 Engeny containment reviews and pipeline audit As advised by HVO during the development of the 2023 HVO Operational Water Management Plan.

The simulated water inventory for the model compared to the recorded site inventory is presented in Figure 6.1. The simulated inventory total includes the dams and pits with routine level/volume measurements, including Dam 9W, 11N, 21N, 15S, Riverview Void, West Pit, Wilton Pit, Carrington Pit and Riverview Pits. The following comments are made on the model accuracy, considerations and limitations:

- Modelled inventory matches the total inventory trend well during both dry (2018 - 2019) and wet (2020 - 2023) periods.
- The modelled inventory trend following rainfall events is generally representative of the observed inventory with increases in the volume stored matching well. This indicates that the AWBM runoff model parameters have been suitably estimated.
- Similarly, the modelled inventory drawdown during drier periods is reflective of the observed inventory drawdown. This indicates a good representation of evaporative losses in the model.

Limitations to input data:

- Dust suppression volumes are not measured on site and applied to the model as a constant rate based on historical estimated usage (8 ML/day) when daily rainfall is less than 1.5 mm.
- Groundwater volumes are not accurately recorded or measured and therefore groundwater inflow estimates from the regional groundwater model have been adopted in the validation model (AGE, 2018 and 2023).
- Moisture content of the process flows is not measured and therefore assumes constant moisture contents across the entire year (as per the sites Water Accounting Framework).
- Metered pumping data between storages is limited and therefore modelled transfers may not be representative of decision making by the site operators. It is therefore difficult to accurately compare runoff volumes and inventory for individual storages influenced by pumping.
- Seepage (e.g., from tailings) is not accounted for in validation, due to limited understanding of on-site seepage.
- Adopted rainfall is from the Corp rainfall gauge, and therefore rainfall variation across site is not captured. Rainfall variation across the site is better captured in the runoff estimates as HVO North and HVO West storages use the Corp gauge, while HVO South storages use the Cheshunt gauge.

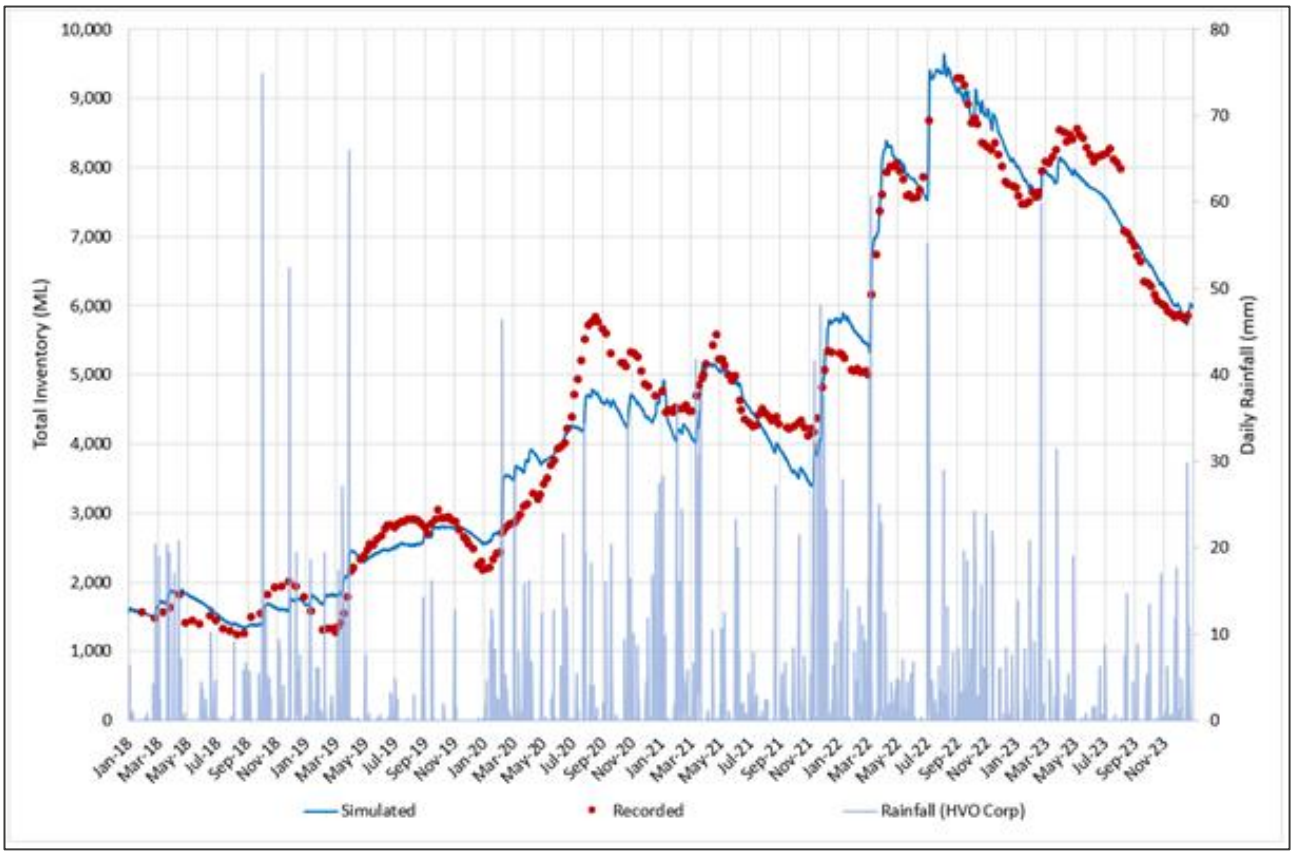


FIGURE 6.1: SIMULATED VERSUS HISTORICAL SITE INVENTORY

7. OPERATIONAL ASSUMPTIONS

A conceptual operational strategy has been developed to accompany the conceptual water management system layouts (refer to Section 3 of the SWIA (Engeny, 2025)). The key aspects of the conceptual operating strategy include:

- Enlargement of Lake James (Dam 15S) at the commencement of the Amended Project, followed by enlargement of Parnells Dam (Dam 9W).
- HVO North dewatering to Parnells Dam (Dam 9W) and HVO South dewatering to Lake James (Dam 15S).
- Lake James (Dam 15S) and Parnells Dam (Dam 9W) transfer water to Dam 9N to supply demands.
- Site inventory is mostly consolidated to Lake James (Dam 15S) and Parnells Dam (Dam 9W).
- HRSTS discharge occurs when mine water inventory levels increase above 6 GL prior to 2032, 4.5 GL between 2032 to 2037, and 3 GL from 2038.
- 130 HRSTS salt credits are held.
- No increase in EPL discharge limits.
- Hunter River extraction occurs when mine water inventory is less than 5 GL prior to 2032, less than 3.5 GL between 2032 and 2037, less than 2.5 GL between 2038 and 2040, and then less than 2 GL from 2041 onwards.
- HSE allocation is used in priority to GSE allocation.
- No increase in WALs held.
- Dust demands reduce by 30% when inventory is below 2.5 GL period to 2038 and 1.5 GL from 2038 onwards as a water conservation measure. This will be achieved via either temporary road closures and/or polymer dust suppressant additives.
- To reduce pit dewatering impacts, delayed decant return from Liddell occurs when the total mine water inventory is above 12 GL (temporary storage of water at Liddell).
- When Lake James (Dam 15S) is full, transfer excess water to South Lemington Void (Dam 27S).
- Non active mining pits can be used for water storage when required.

Operating volumes were applied to the model to inform pumping triggers and identify potential overflows. The full supply volumes (FSV) of key mine water storages are provided in Table 7.1.

TABLE 7.1: KEY WATER STORAGE OPERATIONAL ASSUMPTIONS

Area	Storage	Full Supply Volume (ML)	Comment
HVO North	Dam 9N	90	
	Dam 15N	210	
	Dam 16N	35	
	Dam 11N	84	
HVO West	Dam 9W	4,300	Dam 9W is upgraded to 4,300 ML by September 2029. Prior to this time Dam 9W is 634 ML.
	Dam 4W & 5W	81	
HVO South	Dam 15S	1,900	Dam 15S is upgraded to 1,900 ML by November 2027. Prior to this time Dam 15S is 739 ML.
	Dam 16S	263	Includes available capacity in Dam 23S, Dam 24S, Dam 28S.

Area	Storage	Full Supply Volume (ML)	Comment
	Dam 17S	73	
	Dam 18S	166	
	Dam 19S	210	
	Dam 25S	114	
	South Lemington Void	858	Offline from 2041 onwards.
Newdell and HVLP	Dam 14W	48	
	Dam 32N	152	
	Dam 33N	40	
New Project Dams	Project Dams	907[1]	Proposed Infrastructure

[1]Capacity excludes sediment storage capacity.

8. WATER BALANCE MODEL RESULTS

8.1 Average Annual Inflow and Outflow Volumes

The predicted annual inflows and outflows for the Amended Project, at various stages, is presented in Table 8.1. The average inflows and outflows are shown in Figure 8.1.

It should be noted that the inflow and outflow volumes presented are the averages for each of the individual water streams and are not representative of a water balance for an average water year. Water balances for various climatic conditions are presented in Section 8.2.

TABLE 8.1: AVERAGE ANNUAL INFLOWS AND OUTFLOWS (ML/YEAR)

Water Stream	2029	2032	2038	2041
INFLOWS (ML/year)				
Rainfall	920	918	900	886
Runoff	6,678	7,391	7,913	7,902
Groundwater Inflows	886	1,044	1,072	782
Hunter River Extraction (HSE)	1,944	1,205	1,312	1,143
Decant Return	3,905	4,081	4,560	4,214
Total Inflows	**14,333**	**14,638**	**15,757**	**14,927**
OUTFLOWS (ML/year)				
Evaporation	1,758	1,722	1,654	1,616
Pump to CPP	6,178	6,424	7,216	6,613
Dust Suppression	3,601	3,616	3,310	3,420
HRSTS Release	1,366	2,405	2,586	2,595
Overflows	375	179	181	197
Washdown	262	264	263	263
Miscellaneous Industrial Use	349	351	350	350
Load Point Sprays	142	144	143	144
Total Outflows	14,031	15,105	15,704	15,196

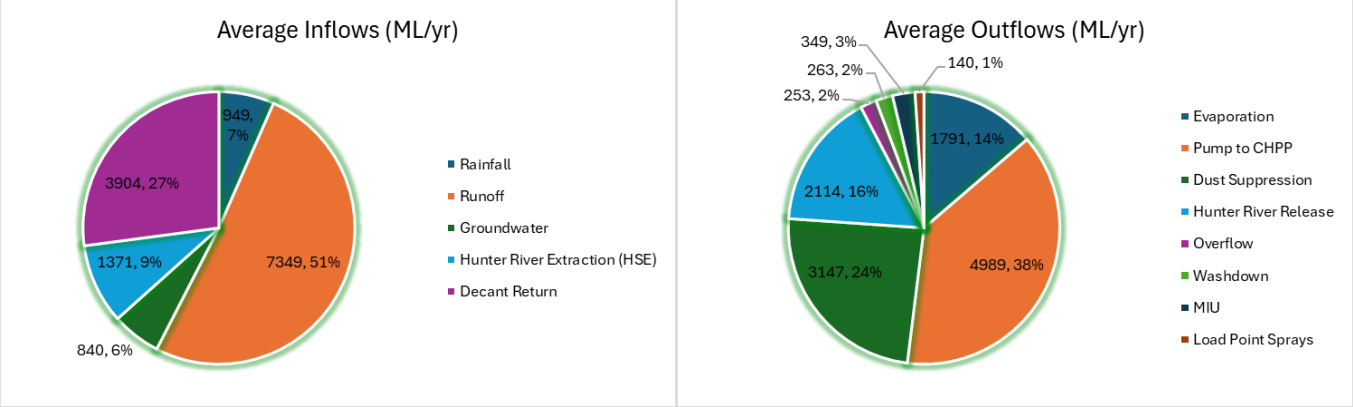


FIGURE 8.1: AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

8.2 Climatic Variability

Water balance data for a range of climatic scenarios during the EIS Project was requested by the (then) DPE Water (now the Department of Climate Change, Energy, the Environment and Water (DCCEEW)) in their submission for the EIS Project. This data has also been extracted for the Amended Project and is include in Table 8.2 and described below.

The modelled climate sequence was analysed to determine the 5th percentile (407 mm), median (664 mm) and 95th percentile (910 mm) rainfall years. Specific realisations were then extracted from the model results to show annual water balances for the 5th percentile, median and 95th percentile rainfall years for each of the stage plan years. These specific realisations show:

- Increasing rainfall and runoff from the 5th to the 50th and then to the 95th percentile data sets (i.e. ranges from dry to median to wet years).
- Correspondingly reducing Hunter River extraction from the 5th to the 50th and then to the 95th percentile data sets (dry to median to wet years) (i.e. as rainfall increases, the need to extract water from the Hunter River generally reduces. There may be a lag in extraction after dry years as accumulated inventories are utilised).
- Varying evaporation (as this is driven by the surface area of the water inventory on site at the time which varies over the years depending on the climatic sequence and associated HRSTS discharge opportunities).
- Varying dust suppression (as this is driven by the climatic sequence rather than by the volume of rainfall).
- Increasing HRSTS discharges which correspond to using HRSTS discharge opportunities and relate to the increasing runoff from the 5th to the 50th and then to the 95th percentile data sets (i.e. as rainfall increases, the need to discharge via the HRSTS generally increases. There may be a lag in discharge after wetter years as water is first accumulated in available storages).

TABLE 8.2: 5TH PERCENTILE, MEDIAN AND 95TH PERCENTILE RAINFALL YEAR WATER BALANCE

Water Stream	2029			2032			2038			2041		
	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile
INFLOWS (ML/year)												
Rainfall	414	849	1,407	401	863	1,305	372	830	1,087	372	931	1,190
Runoff	1,827	4,816	10,461	2,051	5,476	11,636	2,190	5,928	12,433	2,104	5,793	12,151
Groundwater Inflows	886	886	886	1,044	1,044	1,044	1,072	1,072	1,072	782	782	782
Hunter River Extraction (HSE)	3,491	2,068	425	2,488	1,199	806	2,627	1,354	1,559	2,689	719	1,005
Decant Return	3,926	3,926	3,871	4,081	4,081	4,081	4,560	4,560	4,560	4,214	4,214	4,214
Total Inflows	**10,544**	**12,546**	**17,050**	**10,064**	**12,663**	**18,872**	**10,822**	**13,744**	**20,711**	**10,161**	**12,439**	**19,342**
OUTFLOWS (ML/year)												
Evaporation	1,212	1,710	1,848	1,187	1,752	1,680	1,043	1,664	1,411	1,038	1,893	1,527
Pump to CCPP	6,211	6,211	6,126	6,424	6,424	6,424	7,217	7,217	7,217	6,613	6,613	6,613
Dust Suppression	2,557	3,653	3,652	2,900	3,732	3,732	2,993	3,345	3,345	2,905	3,504	3,504
HRSTS Release	0	0	4,471	0	0	8,943	0	0	10,104	0	104	9,309
Overflows	77	201	432	71	128	194	36	108	246	36	108	246
Washdown	263	261	261	264	264	264	263	263	263	263	263	263
Miscellaneous Industrial Use	350	350	349	351	351	351	350	350	350	350	350	350
Load Point Sprays	102	180	196	102	190	201	102	192	198	102	192	198
Total Outflows	**10,771**	**12,567**	**17,334**	**11,299**	**12,840**	**21,789**	**12,005**	**13,139**	**23,135**	**11,307**	**13,027**	**22,010**
Change	**-226**	**-21**	**-283**	**-1,235**	**-177**	**-2,917**	**-1,184**	**605**	**-2,424**	**-1,146**	**-588**	**-2,667**

8.3 Mine Water Accumulation in Dedicated Storages

8.3.1 Site Water Inventory

The predicted total site water inventory (all storages, including any water in open cut pits) is shown in Figure 8.2 for the median, 5th percentile (dry) and 95th (wet) climate scenarios. The total out of pit storage capacity is expected to change over the course of the Project in line with the changes outlined in the WMS. Key changes to storage capacity are highlighted on Figure 8.2.

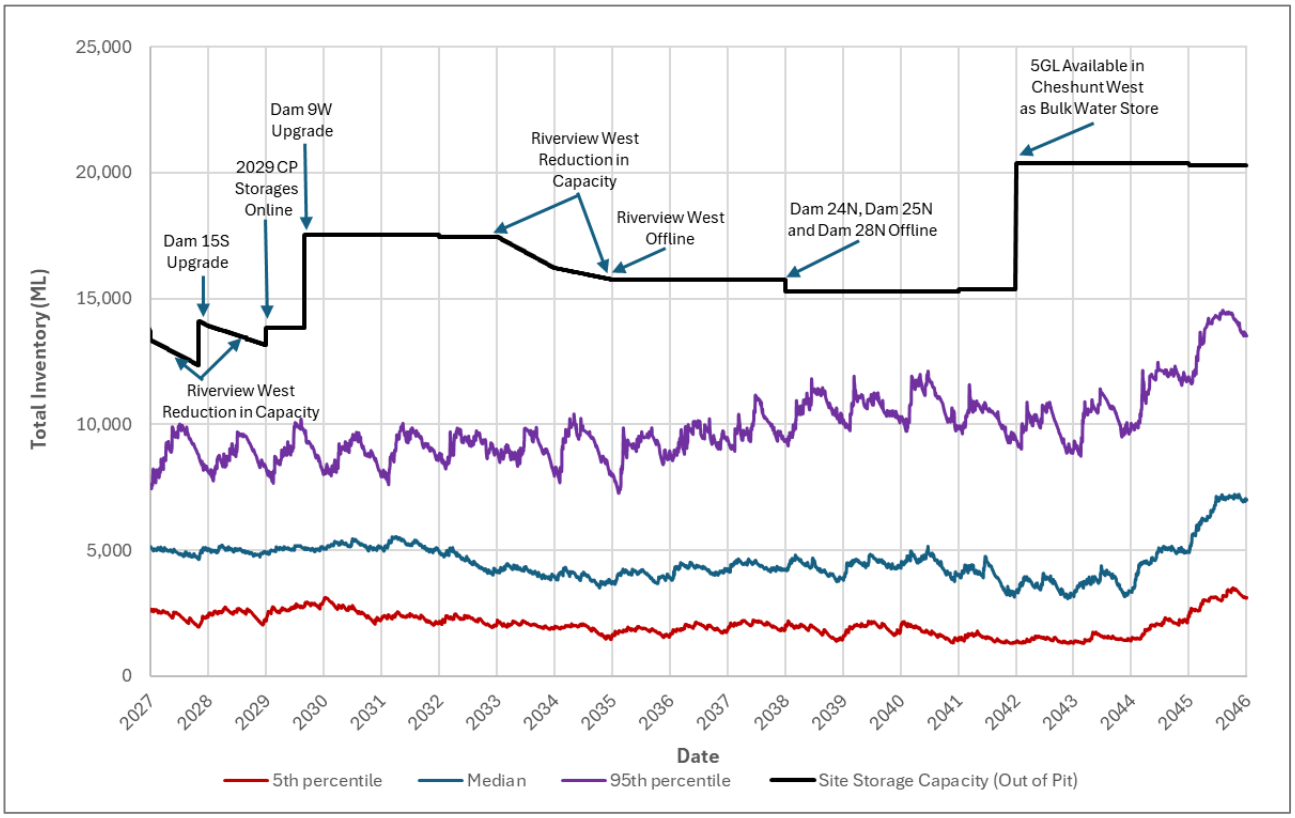


FIGURE 8.2: WHOLE OF SITE INVENTORY

A breakdown of how the site inventory is stored across key area of the site (HVO West, HVO North and HVO South) are included in the following sections, including in key water storages and open cut pits Figure 8.3 to Figure 8.15.

8.3.2 HVO West Inventory

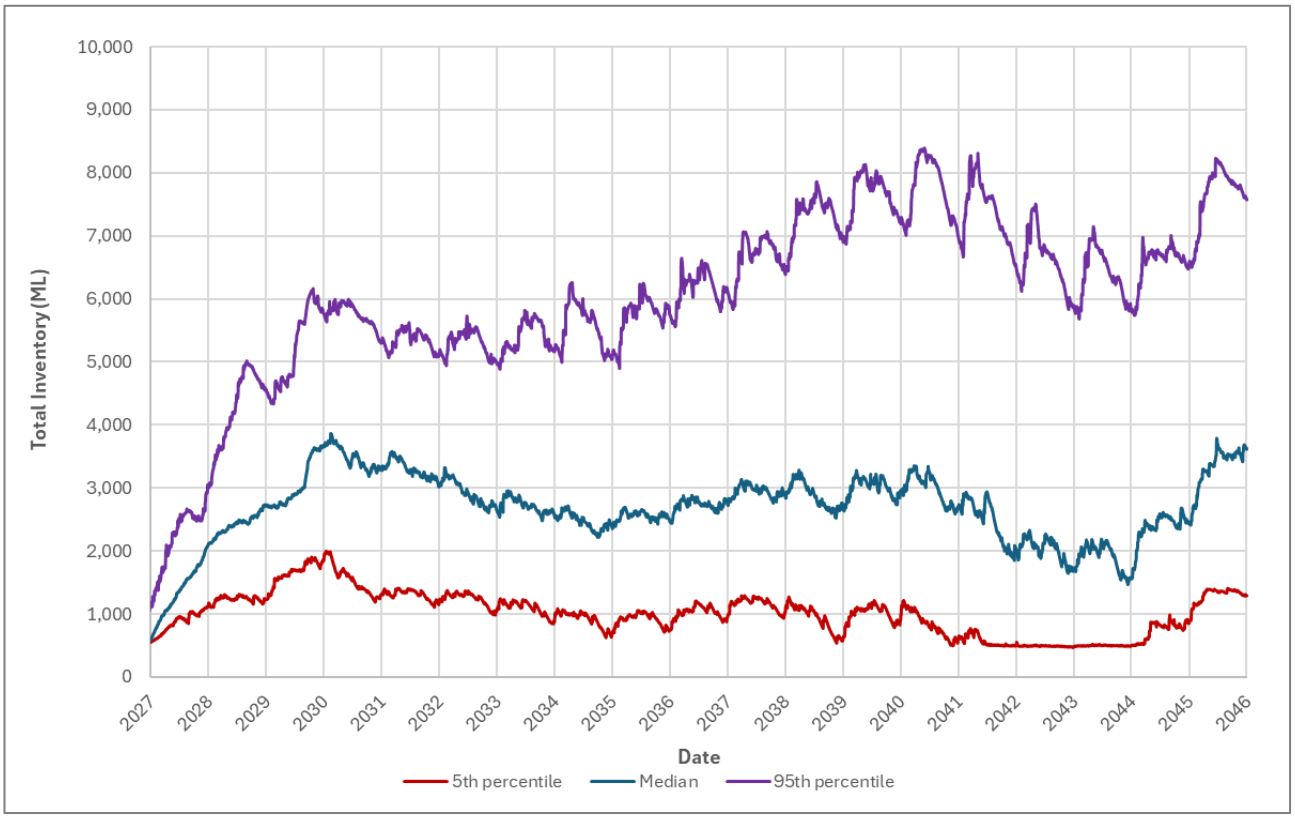


FIGURE 8.3: HVO WEST WATER INVENTORY FORECAST

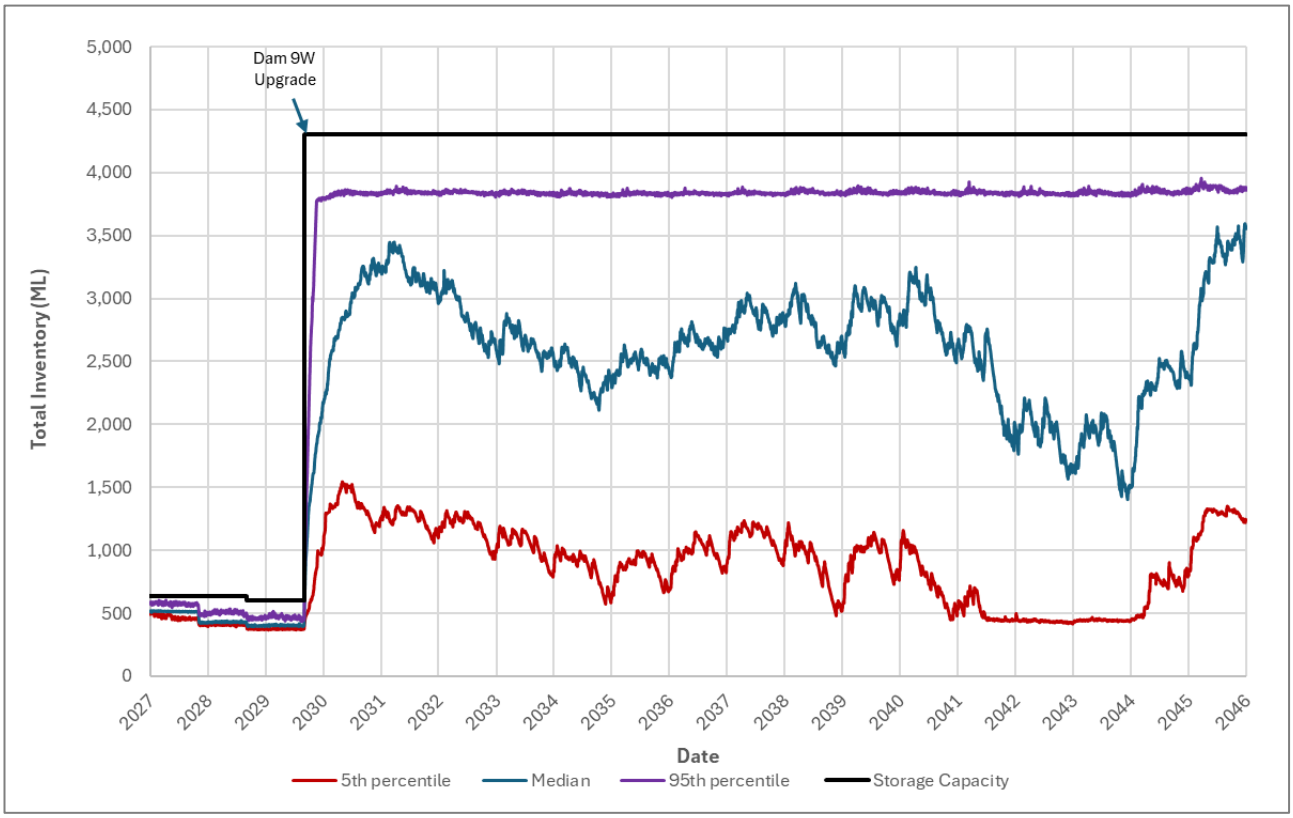


FIGURE 8.4: DAM 9W (PARNELLS DAM) WATER INVENTORY FORECAST

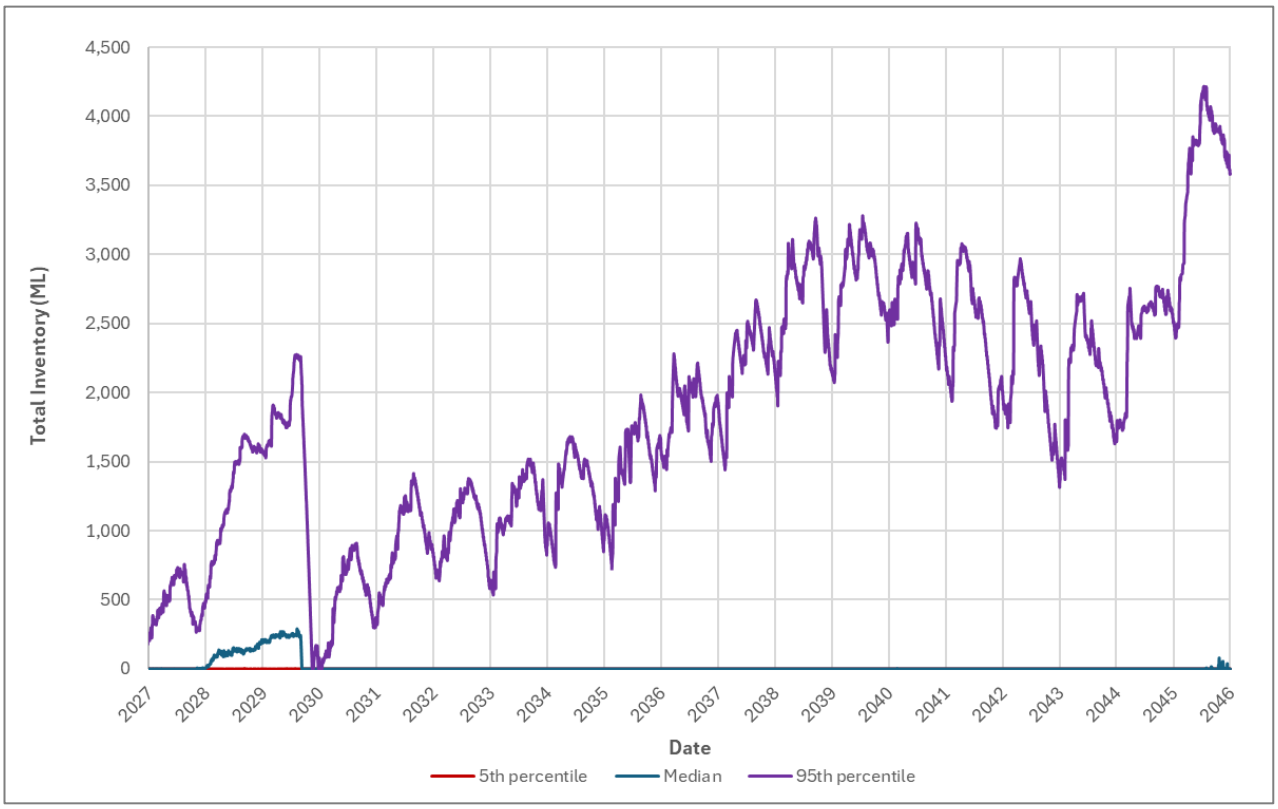


FIGURE 8.5: WEST PIT WATER INVENTORY FORECAST

8.3.3 HVO North Inventory

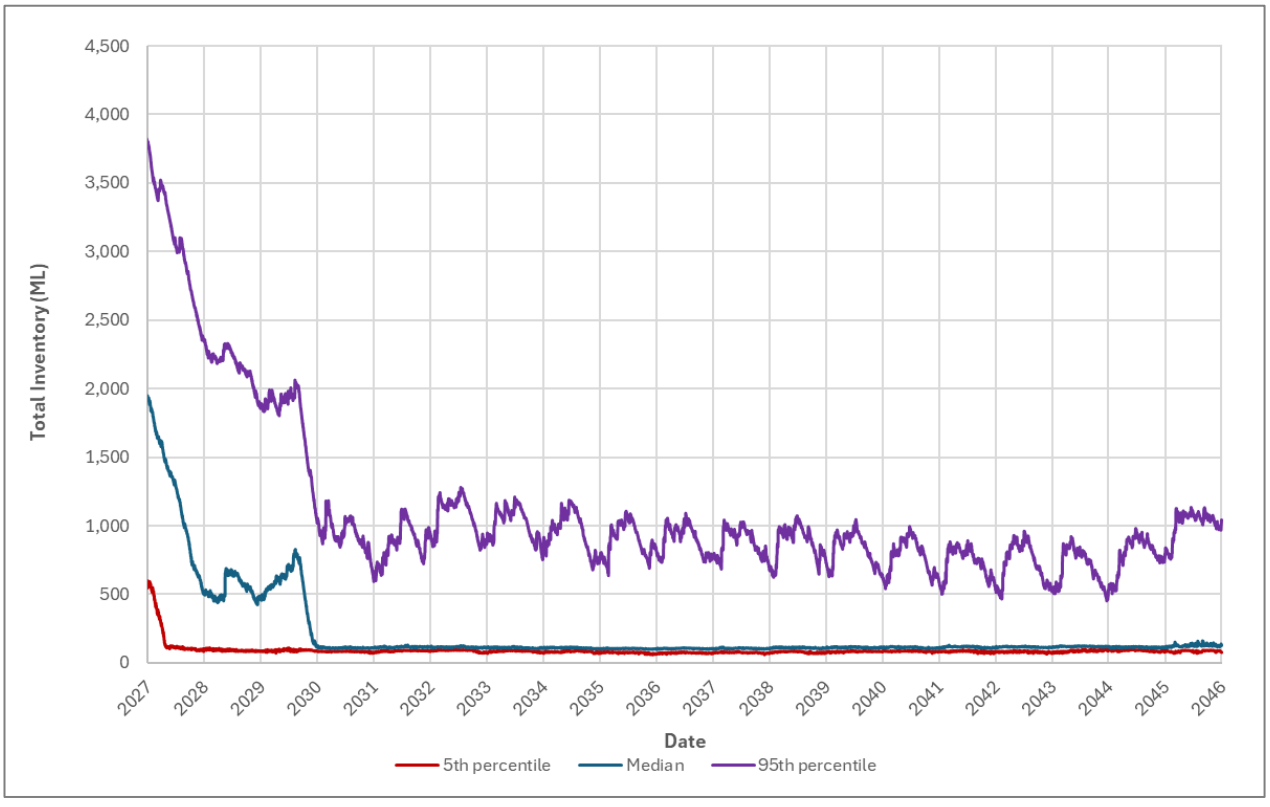


FIGURE 8.6: HVO NORTH WATER INVENTORY FORECAST

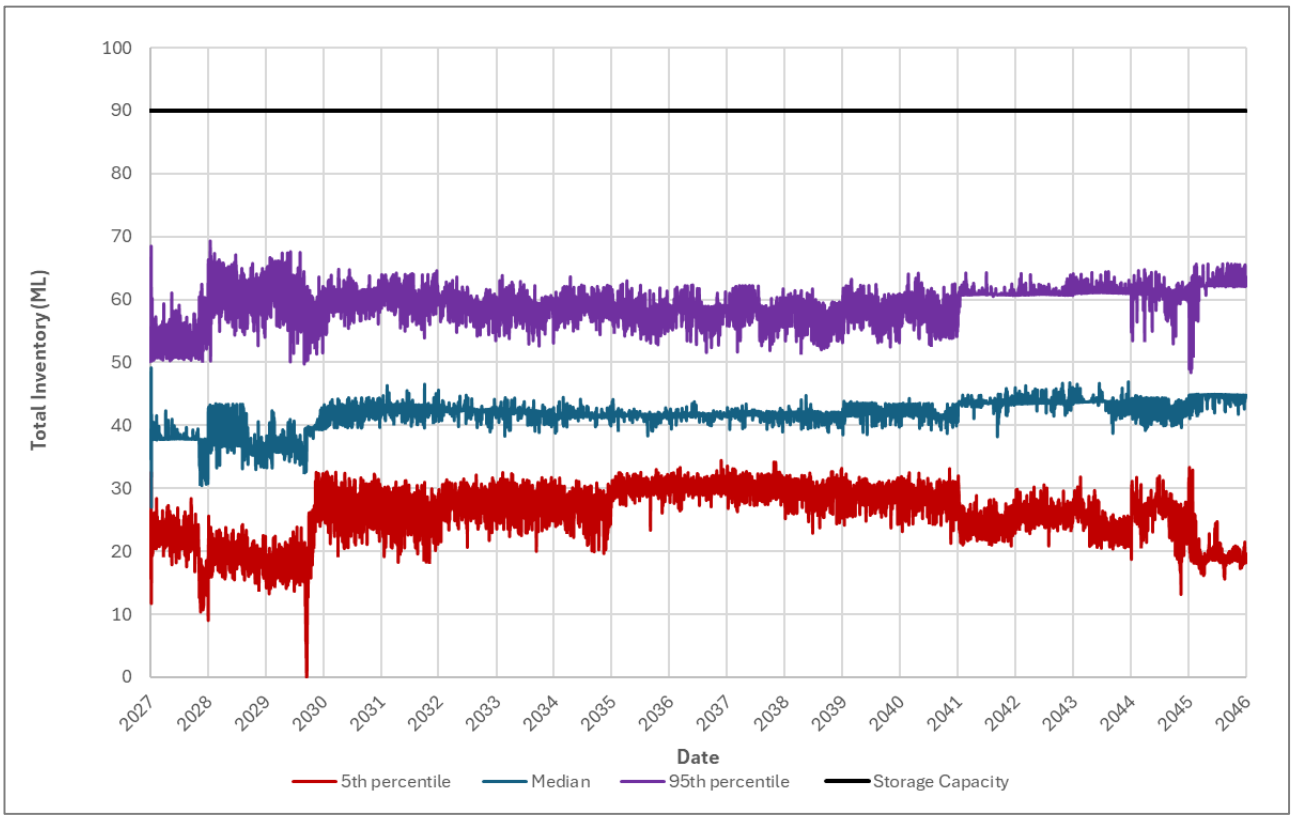


FIGURE 8.7: DAM 9N WATER INVENTORY FORECAST

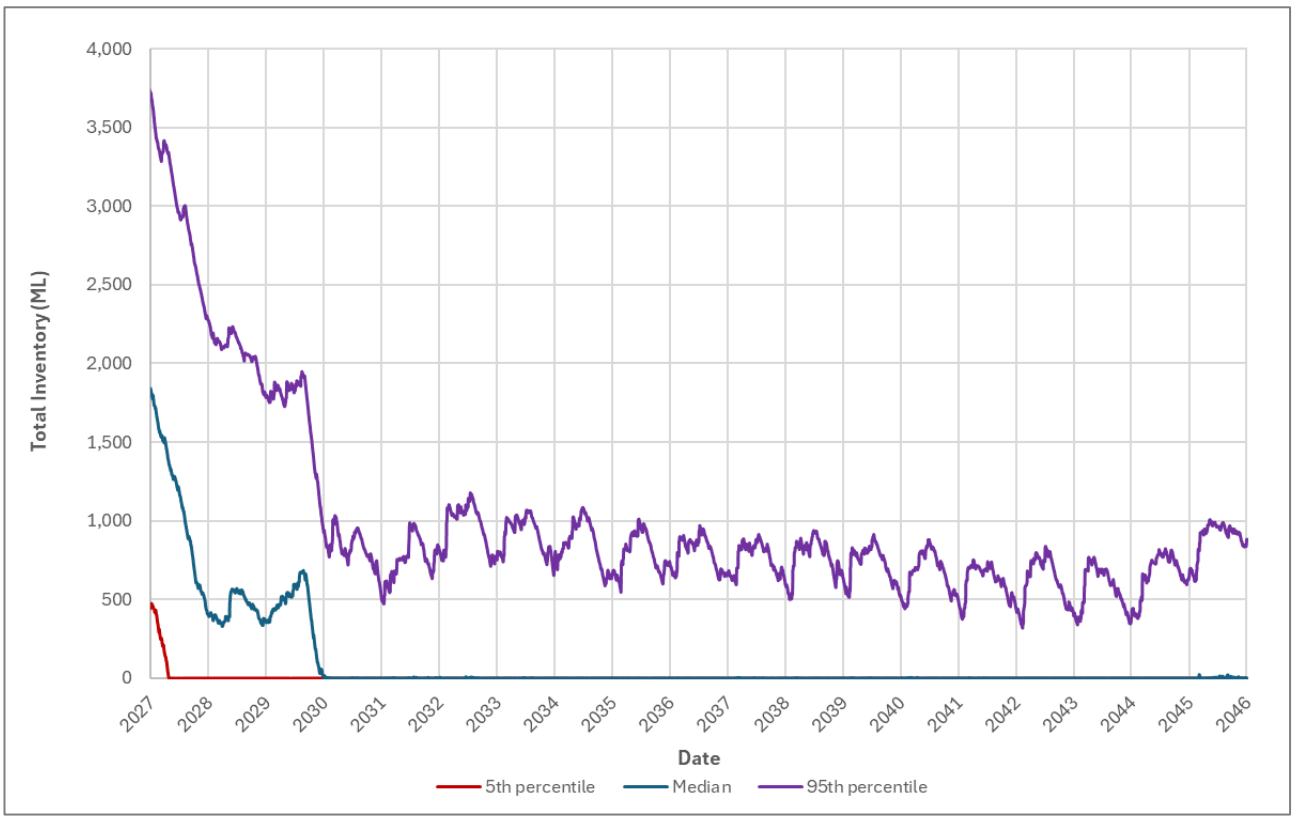


FIGURE 8.8: CARRINGTON PIT WATER INVENTORY FORECAST

8.3.4 HVO South

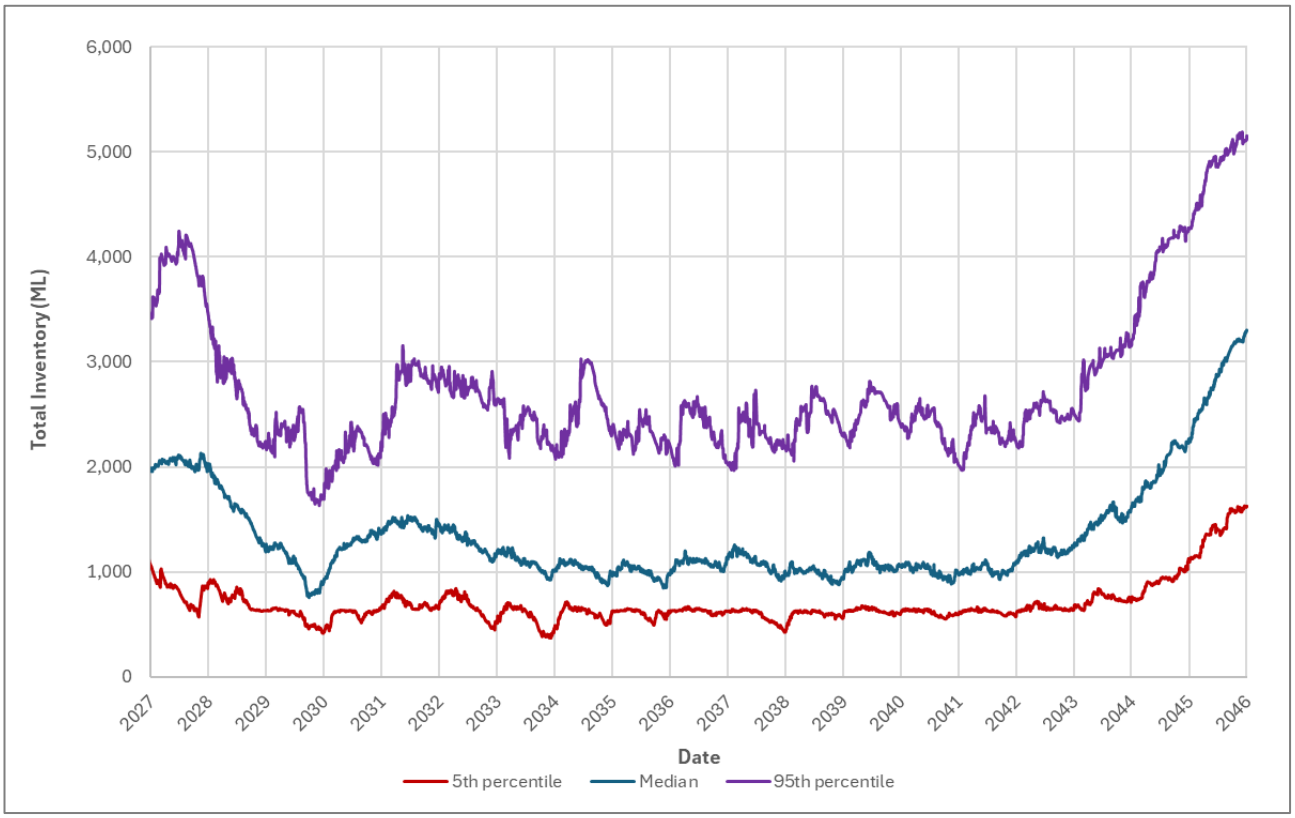


FIGURE 8.9: HVO SOUTH WATER INVENTORY FORECAST

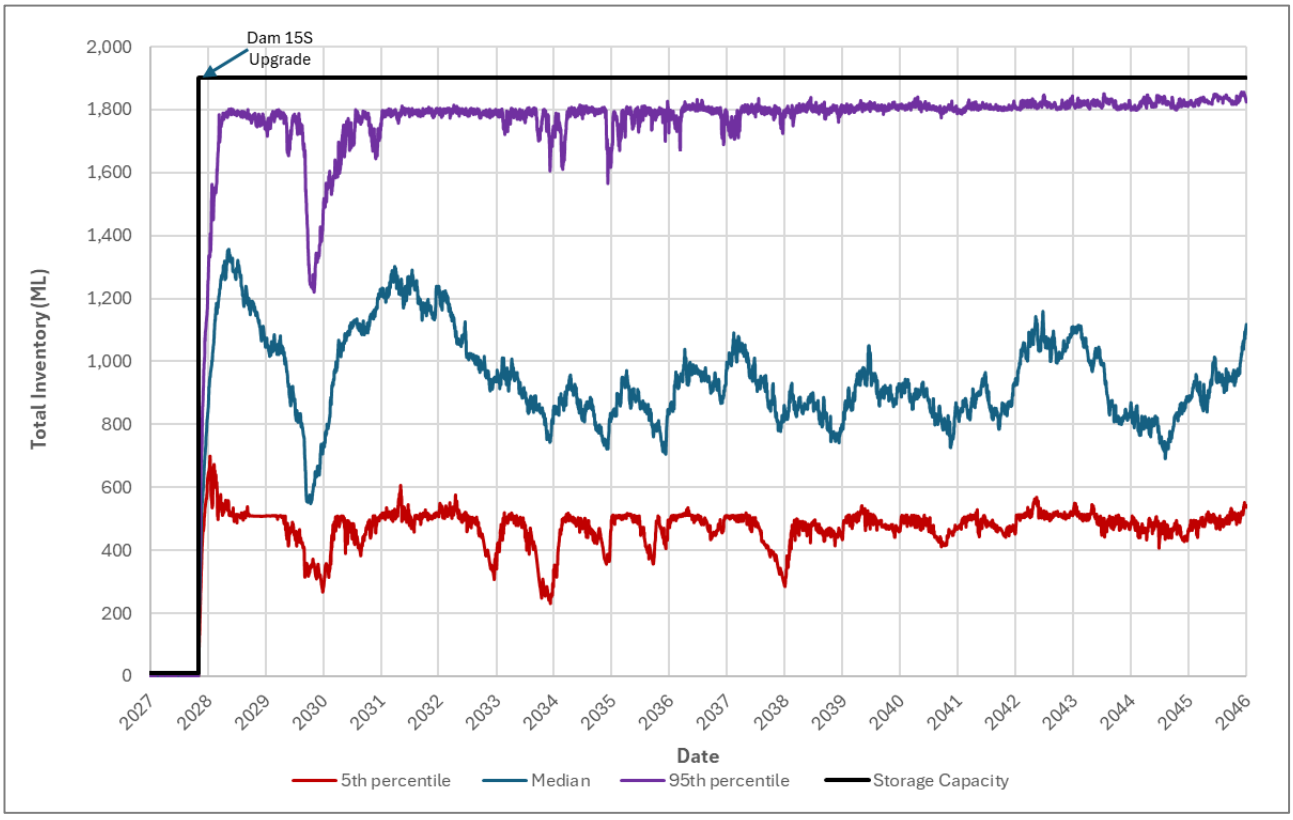


FIGURE 8.10: DAM 15S (LAKE JAMES) WATER INVENTORY FORECAST

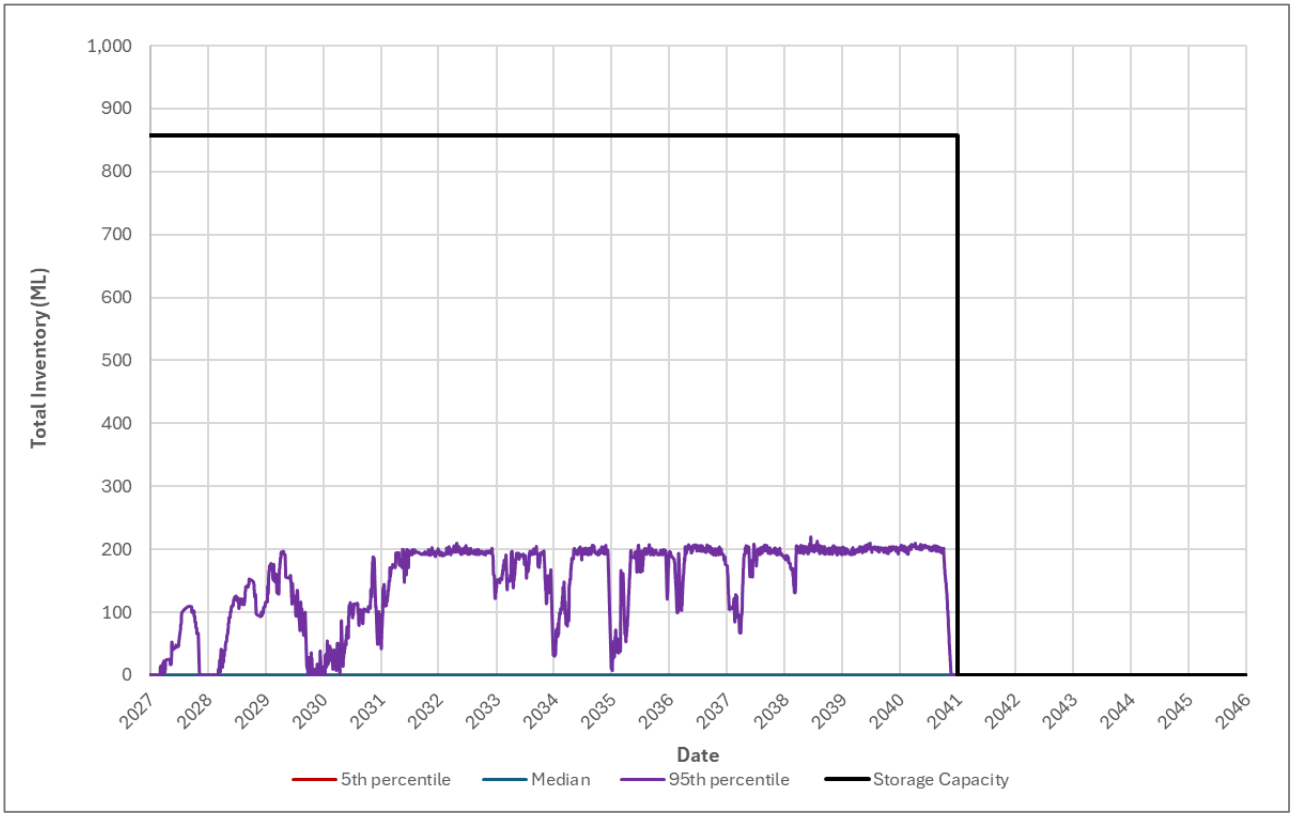


FIGURE 8.11: DAM 27S (SOUTH LEMINGTON VOID) WATER INVENTORY FORECAST

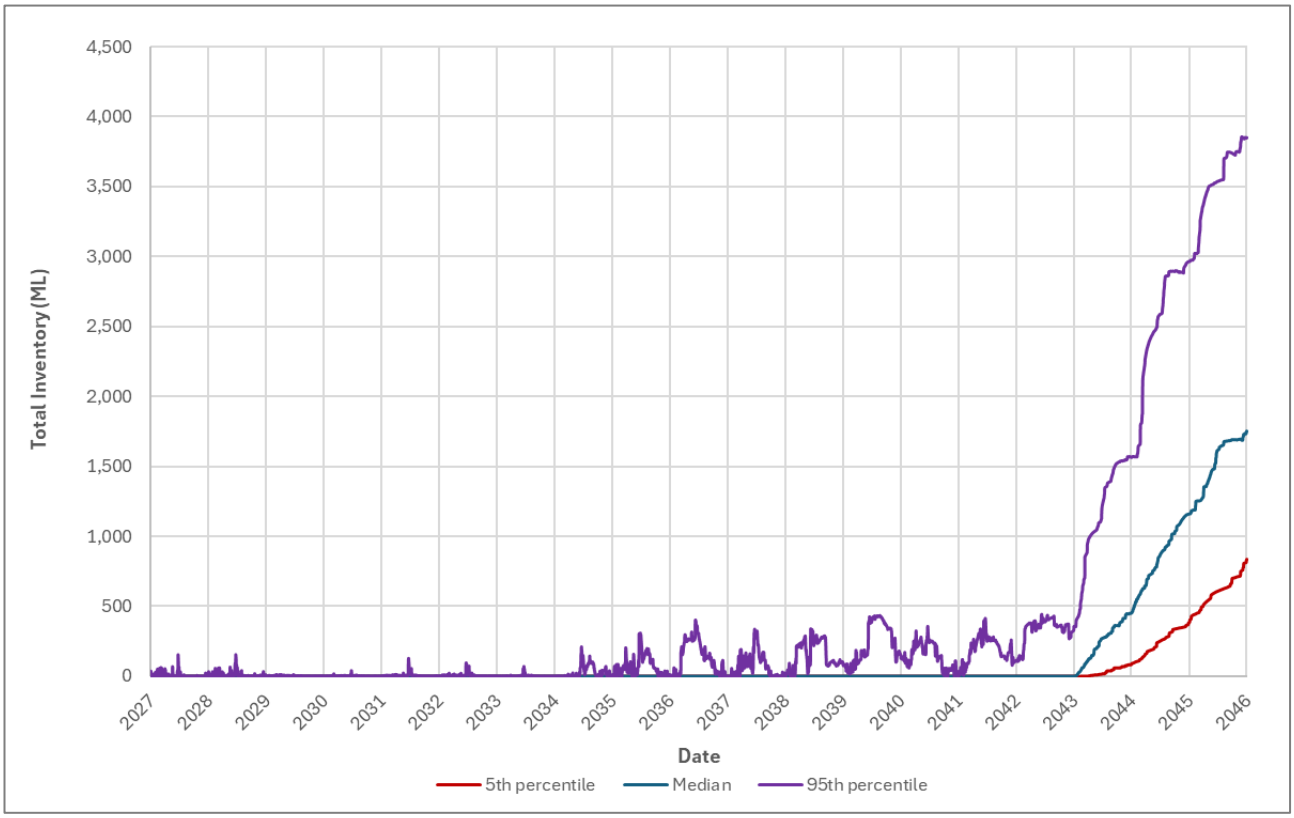


FIGURE 8.12: CHESHUNT PIT WATER INVENTORY FORECAST

8.4 External Supply - Hunter River Licensed Extraction

The total water predicted to be extracted from the Hunter River for the Amended Project, using the sites HSE allocations is shown in Figure 8.13. The 95th percentile is indicative of dry conditions with a 5% chance of the resulting extraction being exceeded. No results are presented for the GSE allocations as the model results indicate that the GSE allocation are note required to meet water supply demands during the forecast period.

The Amended Project is expected to use up to 86% of the existing 4,689 ML HSE WALs to maintain water supply in dry conditions (the 95th percentile). In the median forecast, the Amended Project is expected to use up to 43% of the existing HSE WALs.

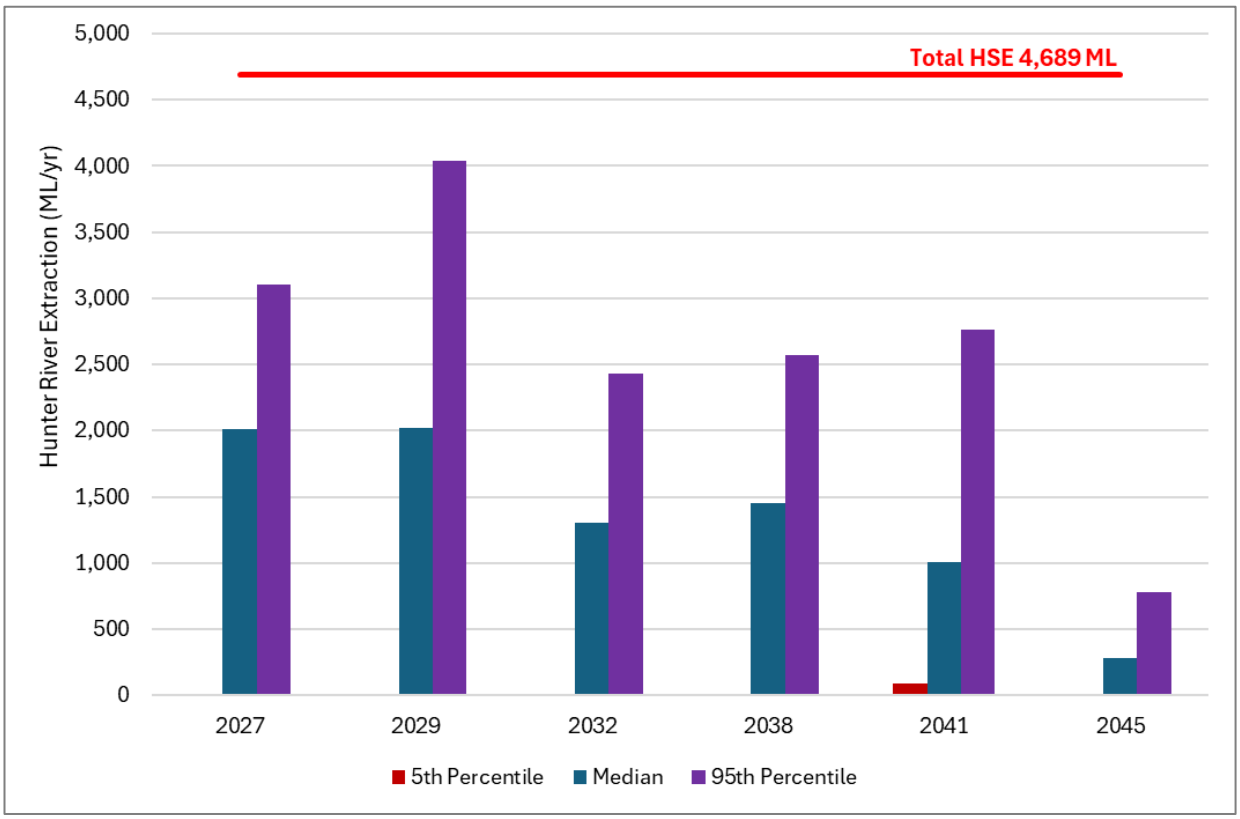


FIGURE 8.13: HUNTER RIVER EXTRACTION (HIGH SECURITY ALLOCATION)

8.5 Controlled Releases (HRSTS)

The predicted average annual total controlled releases to the Hunter River via the HRSTS, and release storage is shown in Figure 8.14. In total, the Amended Project is forecast to utilise on average, 20% to 53% of the average total allowable discharge opportunities. The Amended Project does not fully utilise the average allowable discharge opportunity as the operating rules established in the WBM prevent releases from occurring when there are low inventories on site. During very wet years (95th percentile) the Amended Project utilises more than the average allowable discharge potential (i.e., annual release volumes are skewed towards wet years).

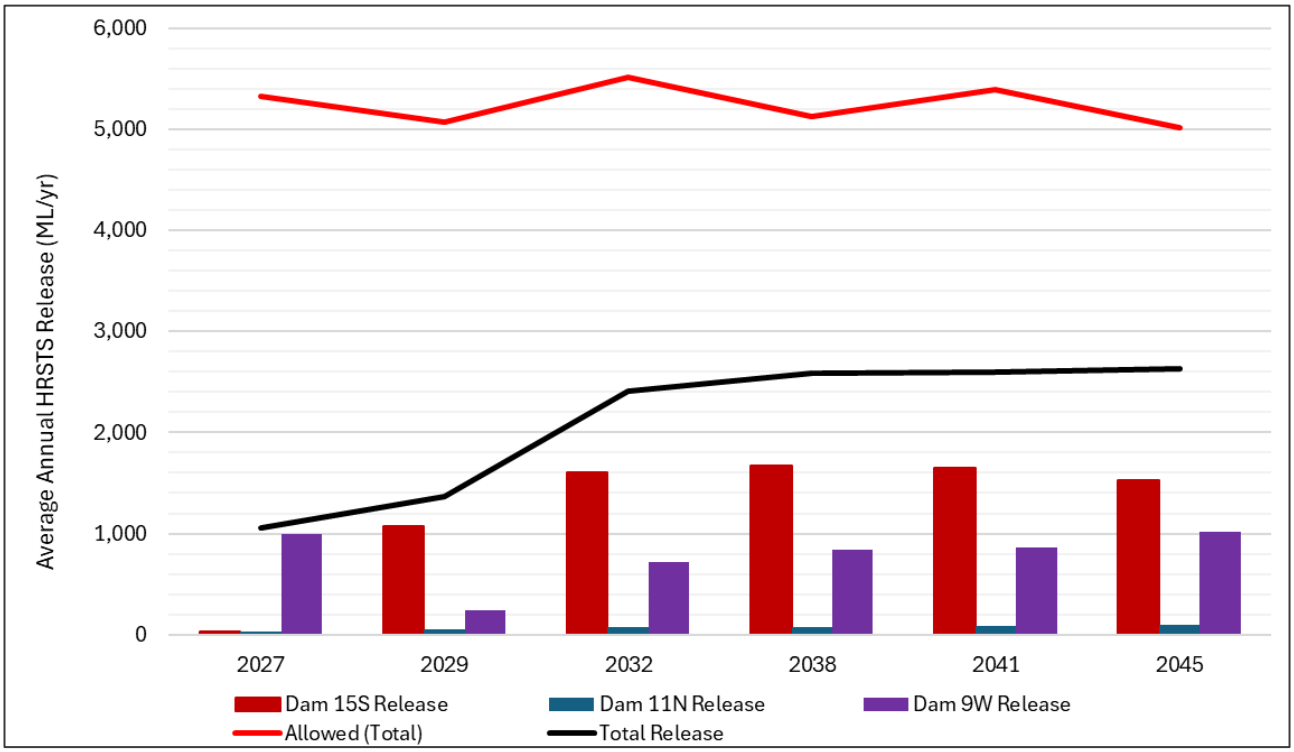


FIGURE 8.14: CONTROLLED RELEASES (HRSTS)

8.5.1 Flow Dilution Ratio

Consistent with the existing operation and the EIS SWIA, the WBM has been set up such that release only occurs within the existing EPL limits and the operation of the HRSTS. The exceedance plot in Figure 8.15 shows the resulting forecast dilution ratio of the total HRSTS release flows from Dam 15S, Dam 9W and Dam 11N to the corresponding receiving flow in the Hunter River for all forecast release days. The results indicate that a 1:100 dilution ratio (i.e., 1 unit of release flow to 100 units of river flow) is exceeded on 79% of release days while a 1:80 dilution ratio (i.e., 1 unit of release flow to 80 units of river flow) is exceeded on approximately 96% of release days.

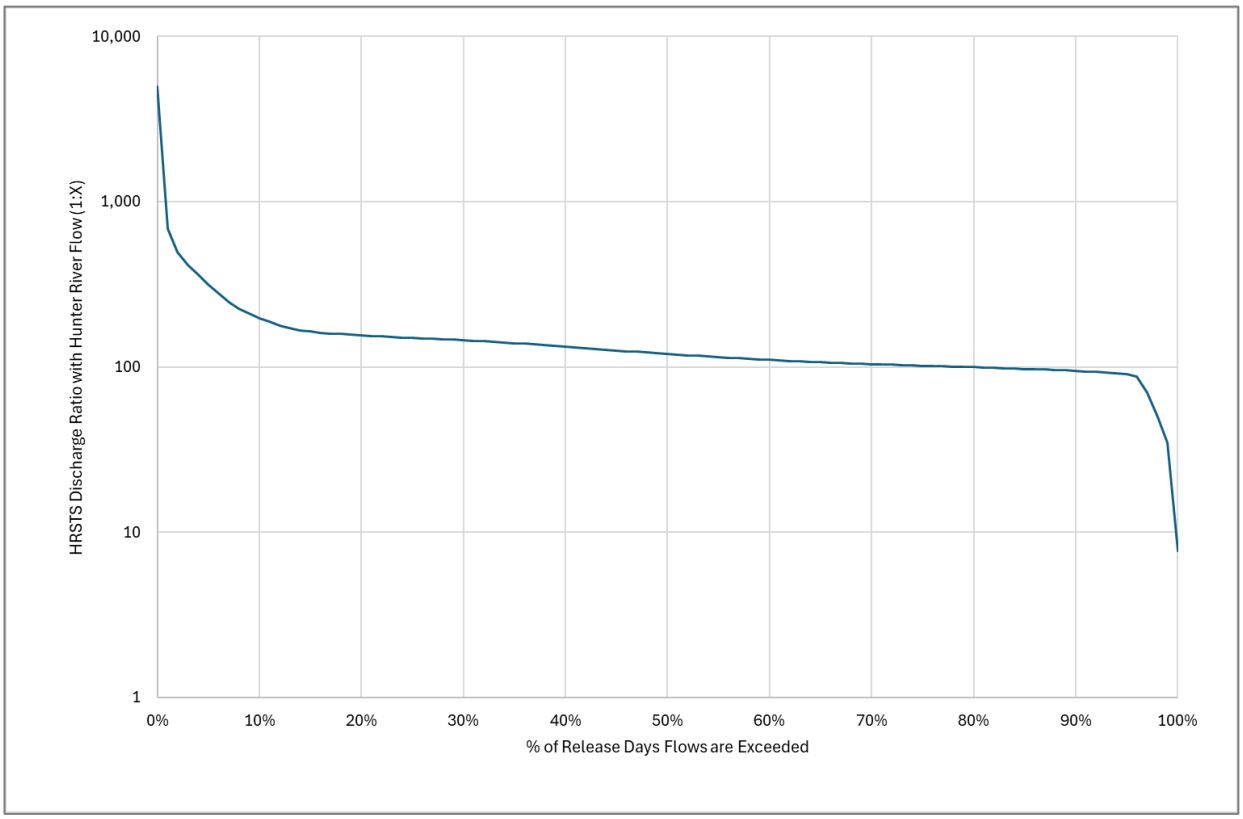


FIGURE 8.15: HRSTS FLOW DILUTION RATIO EXCEEDANCE CURVES

8.6 Water Supply Reliability

The ability of the WMS to provide sufficient water supplies to enable continued operations was assessed for the following demands:

- CPP Supply.
- Dust Suppression.
- Vehicle Washdown.
- Stockpile Sprays.

Negligible shortfalls are predicted, even under the 5th percentile dry climate scenario. As presented in Table 8.1, the annual inflow and outflow volumes indicate that water supplies will be met for the Amended Project. Notwithstanding, operational TARPs will be developed for the future HVO WMS to manage water supply/usage during extended dry periods to maintain water supply to site water demands.

9. CONCLUSIONS

The water balance modelling demonstrates the following outcomes consistent with the EIS Project (Engeny, 2022):

- The WMS can accommodate the inventory associated with large wet climate sequences (95th percentile) within available storage capacity.
- The conceptual WMS can achieve the adopted containment standards while enabling dewatering of active mining areas.
- The water supply has a high reliability with negligible shortfall volumes predicted in dry conditions (95th percentile).
- By utilising and building upon the existing WMS and current site upgrades, surface water for the Amended Project will be able to be managed in accordance with conditions of the current EPL and WALs.

In regard to WALs:

- The Amended Project is expected to draw up to 86% of the existing 4,689 units of HSE WALs to maintain water supply in dry conditions (the 5th percentile) and up to 43% of HSE WALs in median conditions during peak demand years. This compares to 100% during dry conditions and 91% during median conditions for the EIS Project. Consequently, the Amended Project is seen to be less reliant on HSE WALs to meet water supply demands.
- The modelling indicates that the Amended Project has no reliance on GSE allocations, compared to a small reliance on additional water in dry conditions (5th percentile) for the EIS Project.

For HRSTS discharges:

- The Amended Project is expected to utilise, on average, 20% to 53% of the total allowable discharge opportunities to the HRSTS (compared to 20% to 40% for the EIS Project). Discharges continue to be skewed to wet years utilising more than the average annual allowable discharge potential in those periods (e.g., 95th percentile wet years) for both the Amended Project and the EIS Project.
- Discharges to the HRSTS are well diluted by a factor of at least 80 times on 96% of release days. Regardless of the annual release volume, the releases as modelled operate within conditions of the HRSTS, available credits and EPL limits.

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HATCH. (2015). *HVO Water Balance Model - Baseline Scenario.*

11. QUALIFICATIONS

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ATTACHMENT D: FINAL VOID ASSESSMENT

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Final Void Assessment

HVO Continuation Project – Amended Project

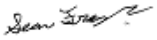
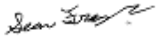
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3 JULY 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	19/05/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
1	9/06/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
2	3/7/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
Signatures:						

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1. INTRODUCTION

Hunter Valley Operations (HVO) is a well-established multi-pit open cut coal mining complex, comprising two mine sites separated by the Hunter River, HVO North and HVO South (i.e. the HVO Complex). The HVO Complex is located approximately 24 kilometres (km) north-west of Singleton in the Hunter Valley of New South Wales (NSW). While the two mine sites are approved under separate development consents, they are operated as one complex with fully integrated environmental management systems.

The HVO Continuation Project (the Project) broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 2026 and 2030 respectively, to the end of 2045 at HVO North and to the end of 2042 at HVO South. The continuation of mining across the HVO Complex will increase resource recovery from the existing operation, predominantly by mining through previously mined areas and to the extent of existing mining tenements and extracting coal from deeper seams at HVO North.

Streamflow impacts were assessed for the EIS Project in 2022 and documented in the Surface Water Impact Assessment (EIS SWIA) (Engeny, 2022). A peer review of the streamflow assessment for the EIS SWIA (Engeny, 2022) was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the development of the EIS SWIA, with his review comprising inputs and involvement in the water management system, water balance modelling, streamflow impact assessment, water quality assessment and cumulative impact assessment, and final void hydrology and climate change assessment.

The Project has subsequently been amended and as such an updated assessment for the proposed final voids has been undertaken for the Amended Project, which is documented in this report.

The final landform proposed for the EIS contained two voids; one at HVO North and one at HVO South. The Amended Project now includes two final voids at HVO North (North Void and Carrington Pit Void) and one void at HVO South (South Void). The pit low wall dumps will be regraded and free draining, and the upstream catchments areas will be diverted around the final voids. The Amended Project final landform and void arrangement is shown on Figure 1.1.

North Void and Carrington Pit Void are located north of the Hunter River and west of Farrells Creek. At closure, North Void has a catchment area which includes a portion of the rehabilitated low wall dump. The highwall will remain exposed. Carrington Pit Void is a small final void which will have catchment areas including highwall and rehabilitated low wall dumps. The Carrington Pit Void overflow path is to the North Void. The overflow path from North Void and South Void would be into the Hunter River.

South Void is located on the southern side of the Hunter River. All dumps and disturbed areas are assumed to be successfully rehabilitated at the time of closure, including the pit low walls. The highwalls will remain exposed.

A summary of the HVO final void characteristics is included in Table 1.1.

TABLE 1.1: SUMMARY OF HVO FINAL VOIDS

Void ID	Description	Catchment Area (ha)	Floor Level (m AHD)	Spill Level (m AHD)	Storage Volume (GL)
North Void	Approved void - final void in the northern part of the site, north of the Hunter River. Catchment consists of rehabilitated low wall dump and remaining pit high wall.	706	-140	81.5	541
Carrington Pit Void	Approved void - final void in the northern part of the site, north of the Hunter River. Catchment consists of rehabilitated low wall dump and remaining pit high wall.	324	40	56	13
South Void	Approved void - final void in the southern part of the site, south of the Hunter River. Catchment consists of rehabilitated low wall dump, remaining pit high wall and some natural catchment.	570	-154	75	405

A water and salt balance model of the final voids was developed to assess equilibrium pit lake water levels, pit lake recovery rate and water quality (as total dissolved solids (TDS)) long-term post closure for the EIS SWIA (Engeny, 2022). The final void water and salt balance model used for the EIS Project, and peer reviewed by Ian Rowbottom (EMM), has been updated for the Amended Project. The modelling methodology is consistent with the EIS Project, and simulates inflows from rainfall runoff over the residual final void catchment (including direct rainfall), groundwater fluxes (inflow or outflow) from bedrock and spoil seepage as well as outflow due to evaporation. The model uses a daily timestep with a sufficient period to achieve long term water level equilibrium.

To assist in the understanding of the reader the following sections outline the modelling methodology and inputs, model results and sensitivity assessment, which is consistent with the EIS Project assessment.

1.1 Approved Final Voids

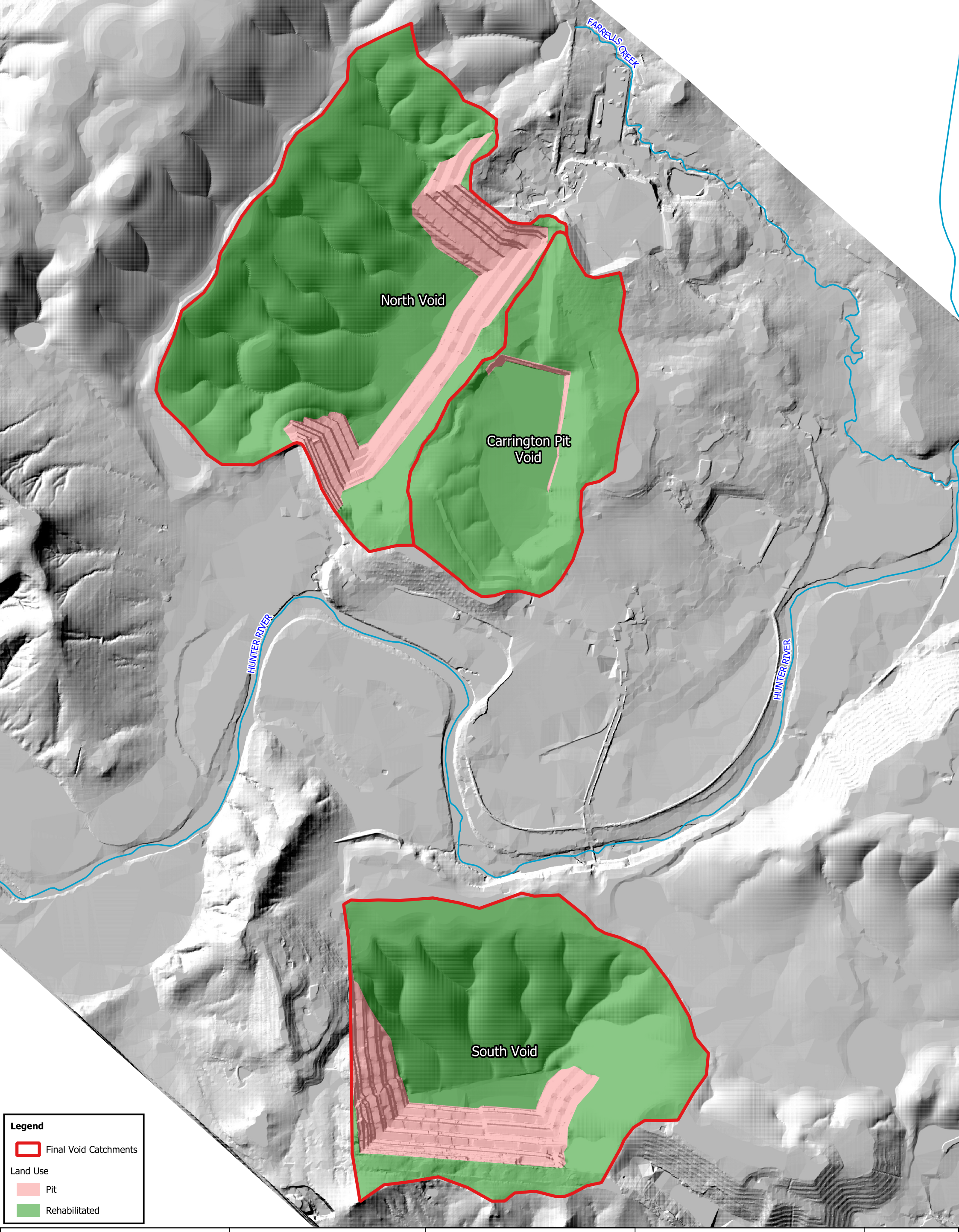
The current approved final voids, which were also listed in the EIS SWIA (Engeny, 2022) are described in Table 1.2, along with the comparison to the EIS Project proposed final voids. The approved final voids include three voids at HVO North and one void at HVO South. The EIS Project proposed two final voids: one at HVO North and one at HVO South. With the change in mine plan required for the Amended Project the approved Carrington Pit Void now remains in the final landform.

The total catchment area of the approved final voids is 1,916 ha compared to a proposed final void catchment area of 1,600 ha for the Amended Project.

TABLE 1.2: FINAL VOID CATCHMENT AREAS

Mining Area	Approved Void	Current Approved Void Catchment (ha)	EIS Project Proposed Void Catchment (ha)	Amended Project Proposed Void Catchment (ha)
HVO North	West Pit	497 [1]	720	706
	Mitchell Pit	154 [2]		
	Carrington Pit	120 [3]		324
HVO South	Riverview Pit	1,145 [4]	714	570
Total		1,916	1,434	1,600

Note 1: HVO North West Pit EIS (MER 2003)
Note 2: Calculated (refer Chapter 3 of the EIS)
Note 3: HVO North Mod 3 (Carrington West Wing) (MER 2010)
Note 4: HVO South MOD5 EA (EMM, 2016)



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HUNTER VALLEY OPERATIONS

0 0.5 1 km

Scale in metres (1:26,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

HVO Continuaton Project - Amended Project

Figure 1-1:
Final Landform - Void Conceptual Overview

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2. MODELLING METHODOLOGY

The modelling methodology for the Amended Project is consistent with methodology used for the EIS Project and is described below.

Key model inputs and assumptions include:

- Catchment area and land use:
  - Final void surface runoff catchment areas were derived from the final landform design surface for the Amended Project and the proposed rehabilitation strategy. The final void catchment and land use breakdown is shown in Figure 1.1 and catchment areas are summarised in Table 2.1.

TABLE 2.1: FINAL VOID CATCHMENT AND LAND USE BREAKDOWN

Area	Pit (ha)	Rehabilitated (ha)	Total (ha)
HVO North Void	132	574	706
Carrington Pit Void	6	318	324
HVO South Void	115	455	570

- Climate Data:
  - Daily climate data adopted from a 121 year climatic period (1889 to 2012) obtained from the SILO Data Drill. The data was repeated several times to obtain an extended period suitable for identifying equilibrium water levels.
  - Evaporation factors applied to daily pan evaporation to produce lake evaporation and evapotranspiration estimates. Pan factors have been calibrated as part of the operational WBM documented in Attachment C of the SWIA. The following pan factors have been applied:
    - Monthly lake pan factors (converts daily pan evaporation to lake evaporation) ranging from 0.75 to 0.96, as shown in Table 2.2.
    - A constant M Wet Factor (converts Lake Evaporation to Evapotranspiration) of 0.95.
    - A pit lake evaporation reduction factor of 0.8 was assumed for calculation of evaporation losses from the final pit lake.

TABLE 2.2: LAKE EVAPORATION PAN COEFFICIENTS

M Lake Factor	January	February	March	April	May	June	July	August	September	October	November	December
Month	0.93	0.96	0.96	0.9	0.83	0.75	0.77	0.85	0.9	0.93	0.94	0.92

- Rainfall runoff:
  - Rainfall runoff is calculated using the Australian Water Balance Model (AWBM) with a daily timestep. AWBM parameters adopted for the final void hydrology model for Pit and Rehabilitated Spoil catchment types as shown in Table 2.3. The adopted AWBM parameters have been calibrated with the existing site operational water balance as documented in the Attachment C of the SWIA.

TABLE 2.3: AWBM RUNOFF PARAMETERS

Parameter	Pit	Rehabilitated Spoil
Soil Store 1 (C1) (mm)	5	9
Soil Store 2 (C2) (mm)	22	75
Soil Store 3 (C3) (mm)	22	140
Partial Area 1 (A1)	0.1	0.1
Partial Area 2 (A2)	0.9	0.3
Partial Area 3 (A3)	0	0.6
Base Flow Index (BFI)	0	0.25
Baseflow Recession Constant (Kb)	0	0.978
Surface Flow Recession Constant (Ks)	0	0.2
Average Long-Term Runoff Coefficient (%)	30.0	9.5

- Storage:
  - Final pit lake level-volume-area relationships were derived from the conceptual final landform design. The final void storage characteristics are shown in Figure 2.1.
  - No allowance has been made for water storage in the spoil which provides a conservative estimate of pit filling rates and salinity.
- Groundwater:
  - Applied predicted groundwater inflow/outflow relationships between the final voids, spoil and hardrock (host) were estimate using groundwater modelling (EMM, 2025b). The groundwater inflow/outflow relationships applied to the final void models are shown in Figure 2.2.
- Water Quality:
  - Rainfall TDS of 13 mg/L was calculated from chloride concentration based on distance from the coast and latitude (Salinity Management Handbook).
  - Groundwater TDS based on water contaminant generation rates (EGI, 2022):
    - Host Rock: Adopted coal groundwater TDS generation rate of 4,357 mg/L.
    - Spoil Seepage: Adopted Spoil TDS generation rate of 895 mg/L.
  - Rehabilitated and Natural land use rainfall runoff TDS of 300 mg/L was assumed based on HVO monitoring data.
  - Pit land use rainfall runoff TDS of 2,000 mg/L was assumed based on HVO monitoring data.

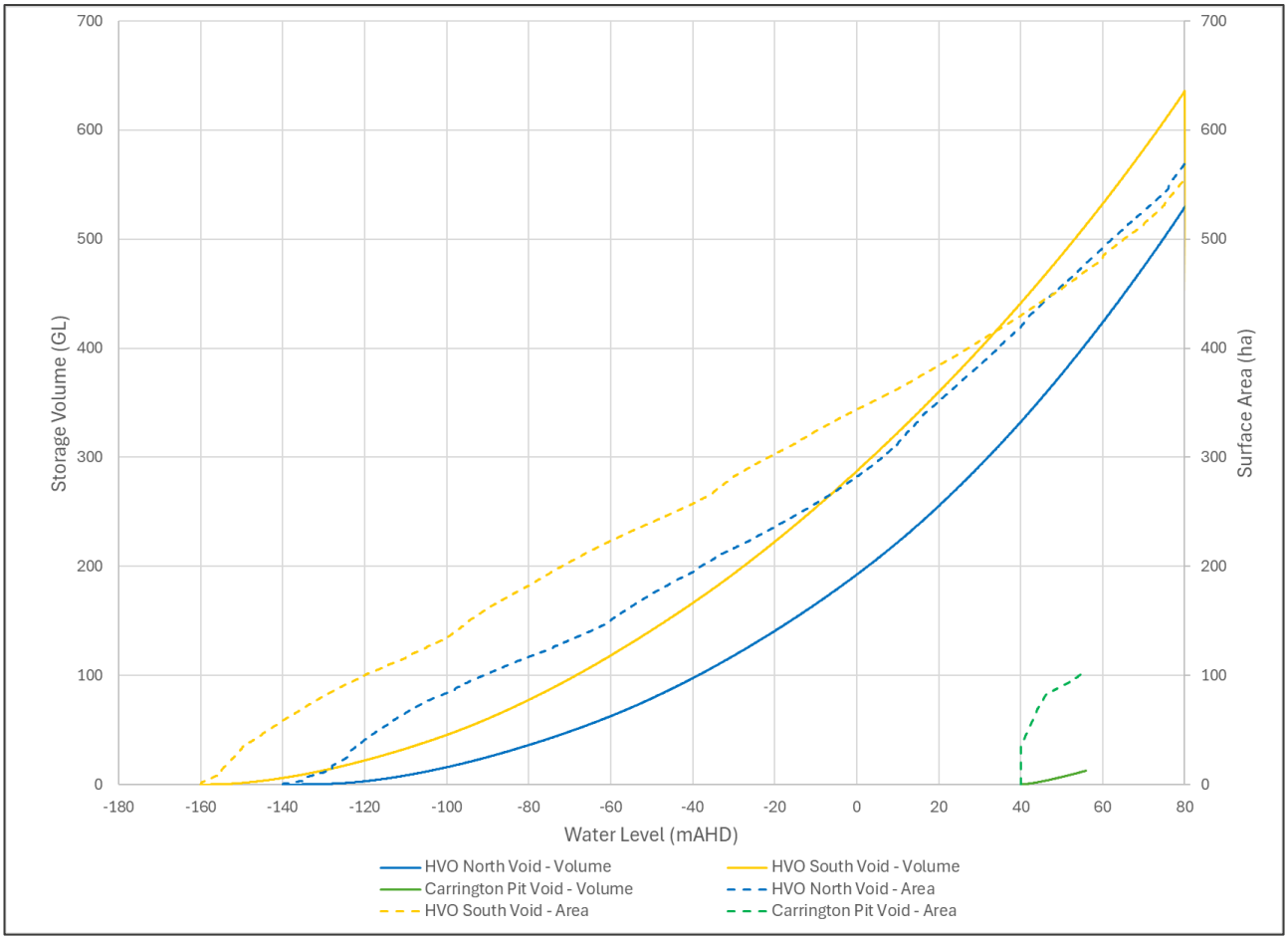


FIGURE 2.1: FINAL VOID STORAGE CHARACTERISTICS

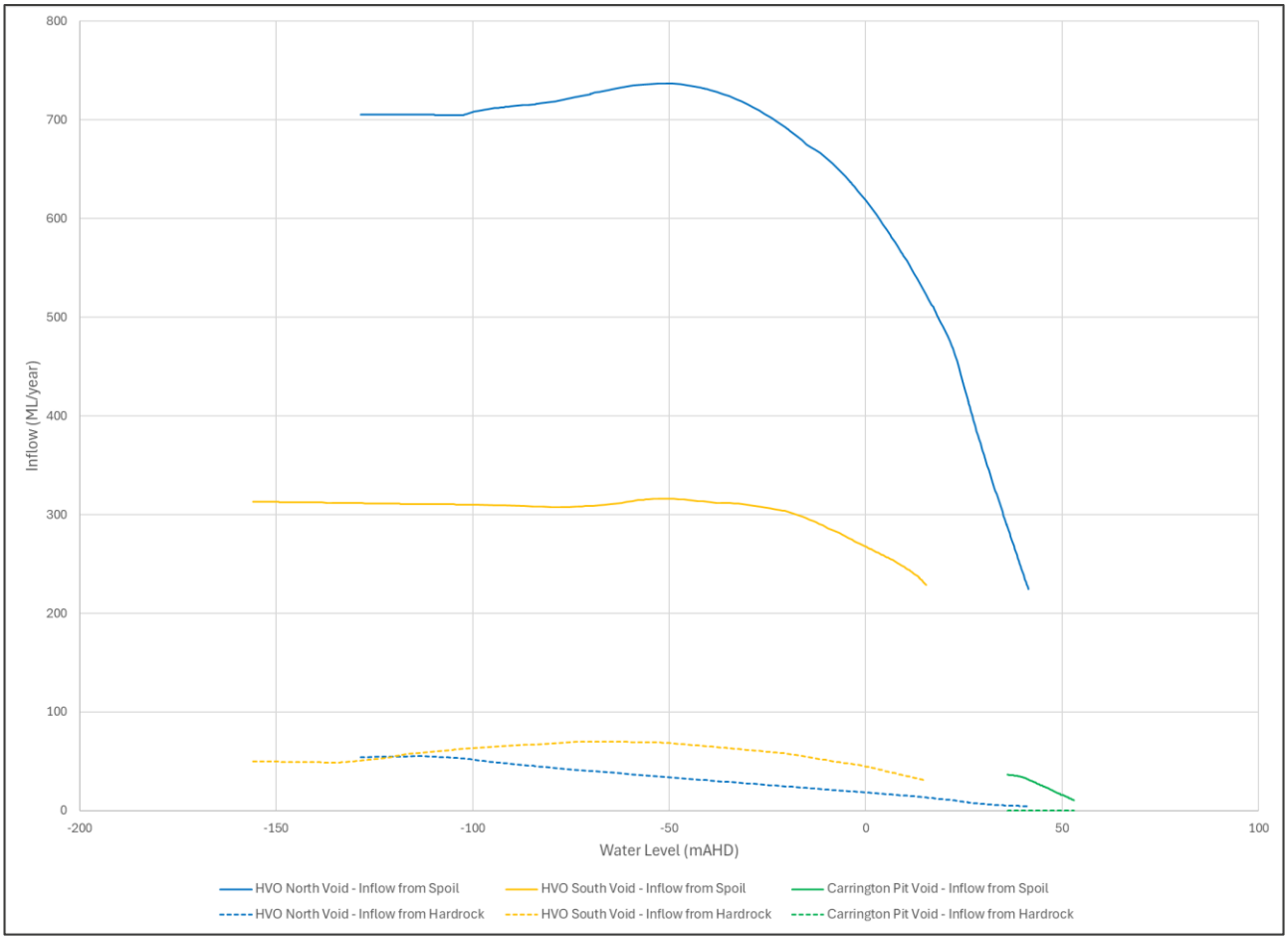


FIGURE 2.2: GROUNDWATER INFLOW RELATIONSHIPS (EMM, 2025B)

3. MODELLING RESULTS

The final void fully mixed water and salt balance model was simulated for the post closure period for 121 realisations to assess the variability in pit filling rates and produce a mean pit filling result. The results of the final void recovery model are presented in the tables and figures below for the three final voids for the average, median, 20th and 80th percentiles.

TABLE 3.1: WATER RECOVERY RESULTS – NORTH VOID

Parameter	Average	20th Percentile	Median	80th Percentile
Long-term pit lake level (600 years post closure) (mAHD)	-18.1	-18.7	-17.8	-17.4
Freeboard at long-term pit lake level (600 years post closure) (m)	99.6	100.2	99.3	98.9
Time to equilibrium water level (years)*	600	600	600	600
Water quality at 600 years post closure, TDS (mg/L)	7,130	7,050	7,100	7,200

* Approximate, continues to slowly rise

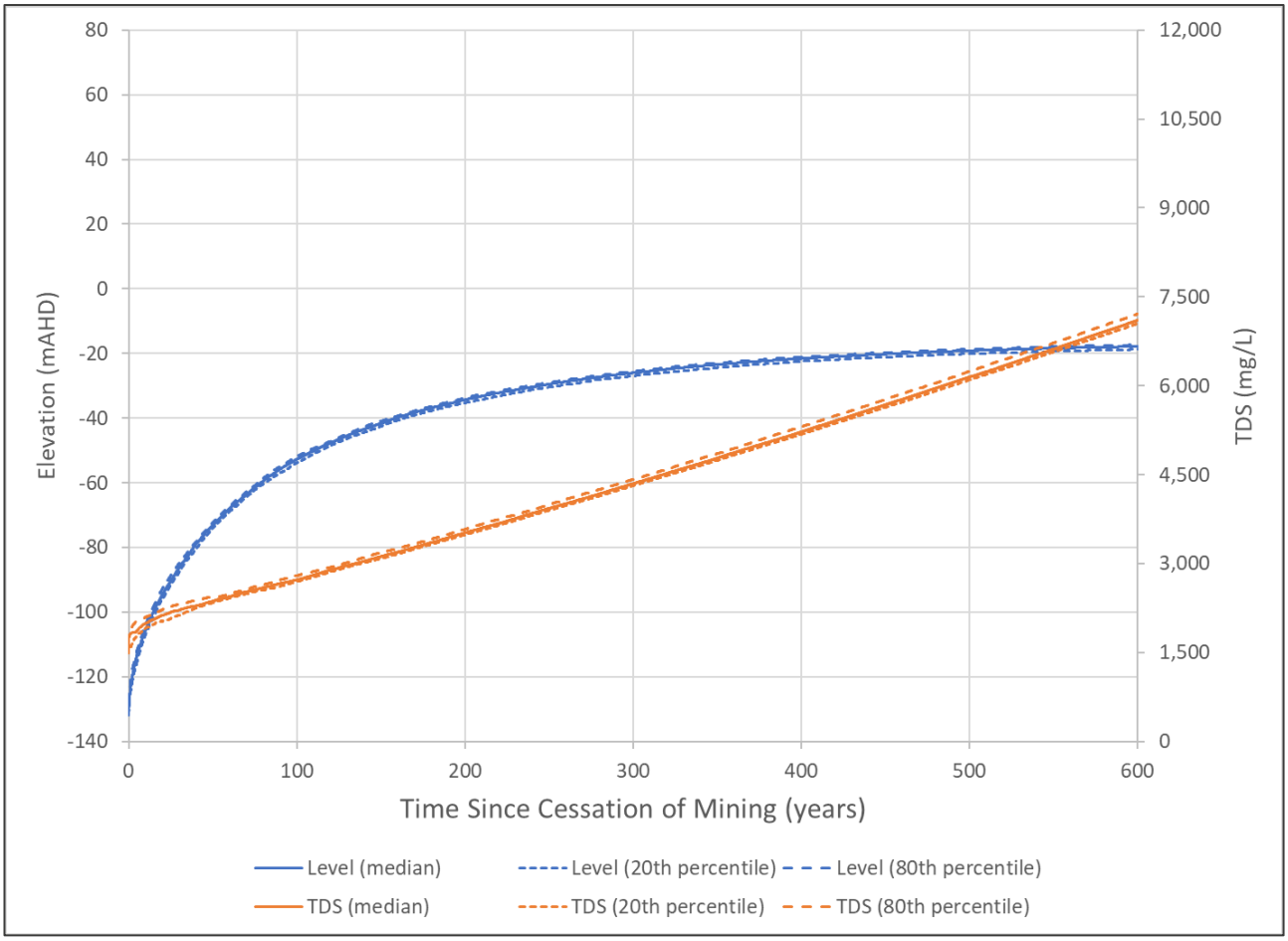


Figure 3.1: Predicted Final Void Water Levels and Quality (North Void)

TABLE 3.2: WATER RECOVERY RESULTS – CARRINGTON PIT VOID

Parameter	Average	20th Percentile	Median	80th Percentile
Long-term pit lake level (100 years post closure) (mAHD)	41.9	40.9	41.8	42.7
Freeboard at long-term pit lake level (100 years post closure) (m)	14.1	15.1	14.2	13.3
Time to equilibrium water level (years)1	100	100	100	100
Water quality at 100 years post closure, TDS (mg/L)	69,750[2]	12,910	21,550	47,200

Note 1: Approximate, continues to slowly rise

Note 2: Average is heavily influenced by the early years

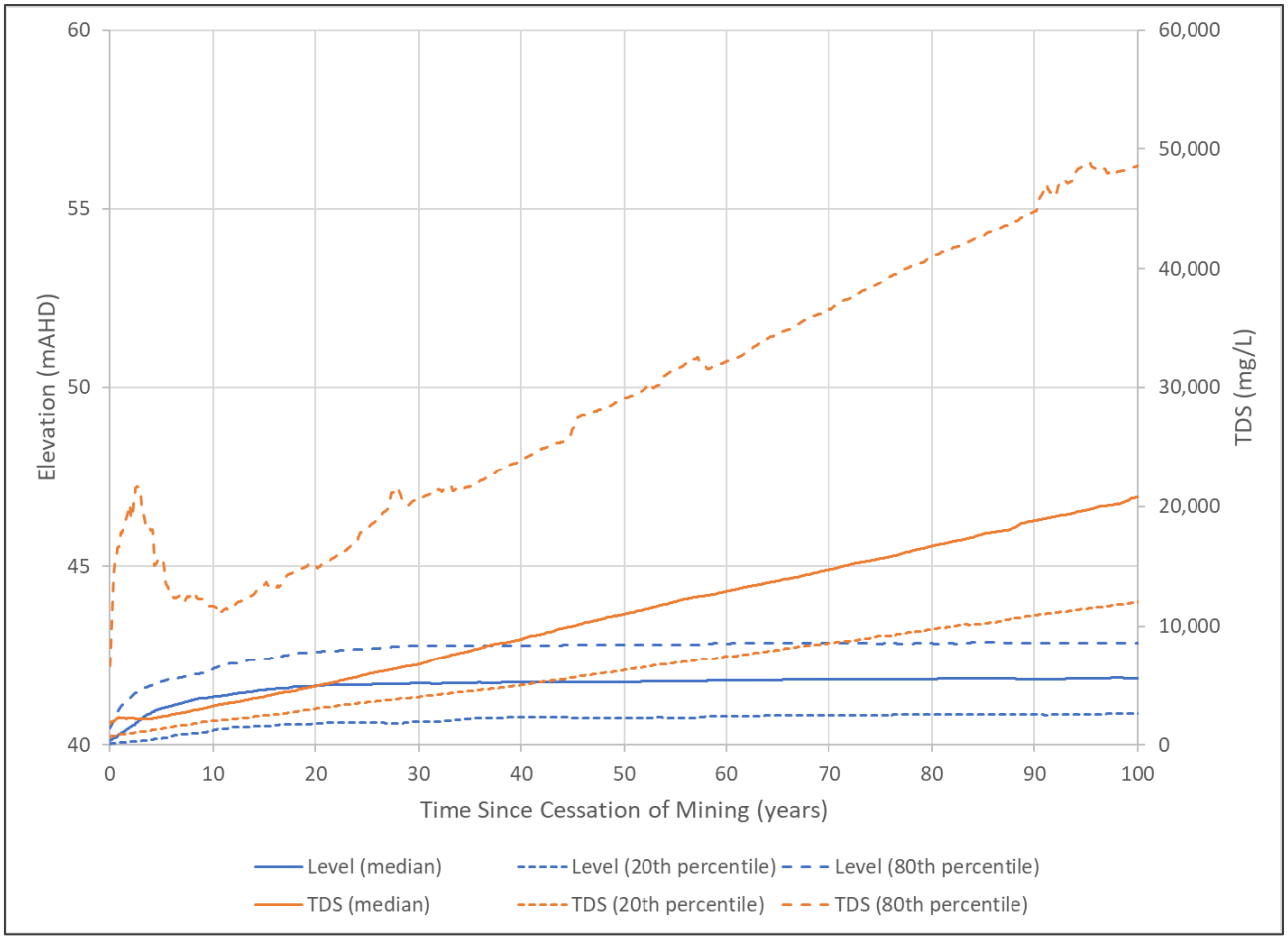


Figure 3.2: Predicted Final Void Water Levels and Quality (Carrington Pit Void)

TABLE 3.3: WATER RECOVERY RESULTS – SOUTH VOID

Parameter	Average	20th Percentile	Median	80th Percentile
Long-term pit lake level (600 years post closure) (mAHD)	-29.9	-30.6	-29.7	-29.2
Freeboard at long-term pit lake level (600 years post closure) (m)	109.9	110.6	109.7	109.2
Time to equilibrium water level (years)*	600	600	600	600
Water quality at 600 years post closure, TDS (mg/L)	8,510	8,400	8,480	8,600

* Approximate, continues to slowly rise

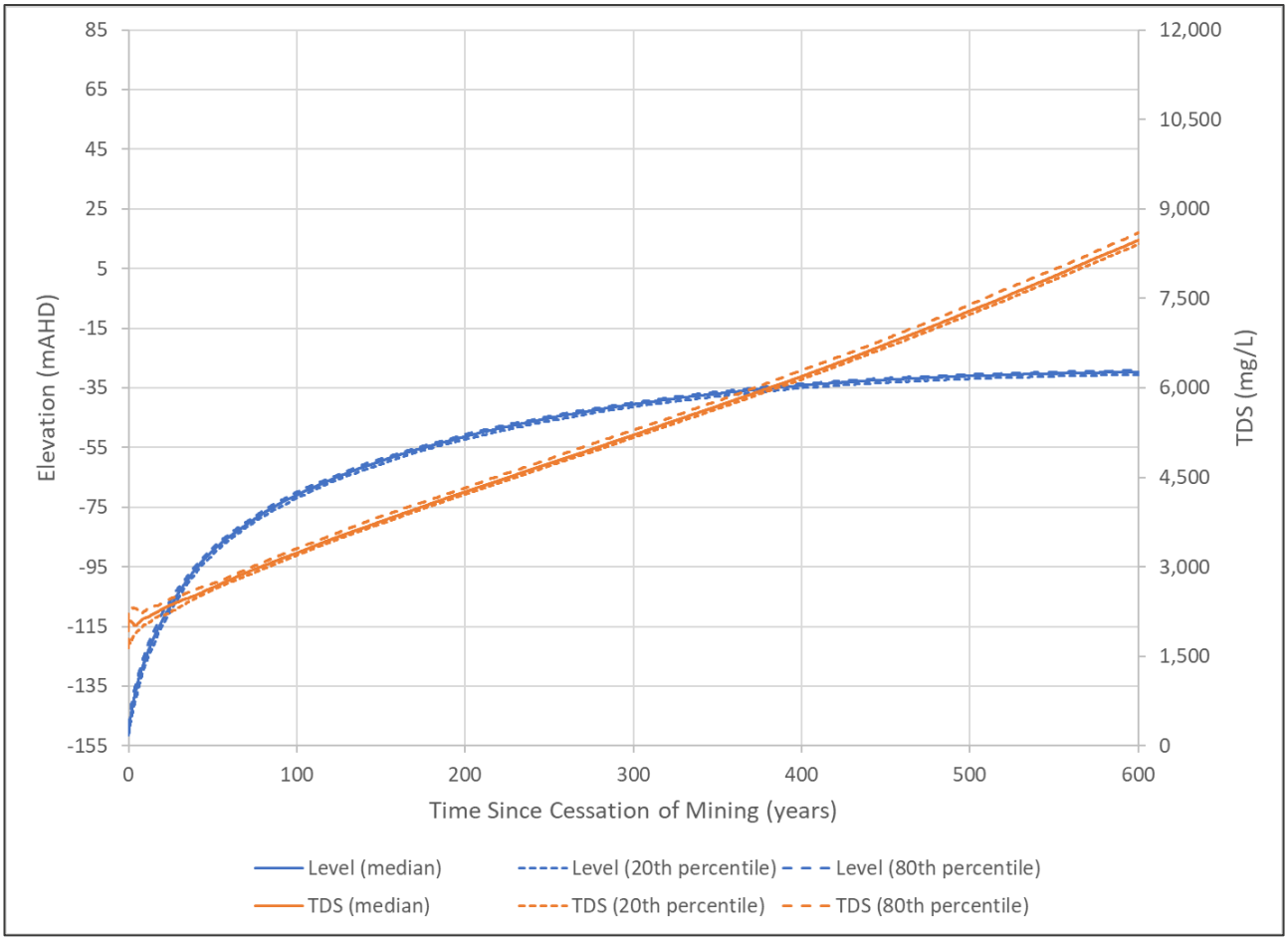


Figure 3.3: Predicted Final Void Water Levels and Quality (HVO South Void)

The 20th percentile, average and 80th percentile annual long-term water balance for each void is summarised in Table 3.4 to Table 3.6.

TABLE 3.4: ANNUAL LONG-TERM WATER BALANCE (600 YEARS POST CLOSURE) – NORTH VOID

Parameter (ML/yr)	Average	20th Percentile	Median	80th Percentile
Rainfall	1,570	1,218	1,569	1,873
Runoff	374	122	262	587
Groundwater Inflow – Hardrock	24	24	24	24
Groundwater Inflow - Spoil Seepage	685	683	684	687
Evaporation	2,629	2,498	2,603	2,772
Groundwater Outflow	0	0	0	0
Spoil Seepage Outflow	0	0	0	0

TABLE 3.5: ANNUAL LONG-TERM WATER BALANCE (100 YEARS POST CLOSURE) – CARRINGTON PIT VOID

Parameter (ML/yr)	Average	20th Percentile	Median	80th Percentile
Rainfall	332	232	336	410
Runoff	176	51	110	282
Groundwater Inflow – Hardrock	0	0	0	0
Groundwater Inflow - Spoil Seepage	30	29	31	32
Evaporation	537	461	540	631
Groundwater Outflow	0	0	0	0
Spoil Seepage Outflow	0	0	0	0

TABLE 3.6: ANNUAL LONG-TERM WATER BALANCE (600 YEARS POST CLOSURE) – SOUTH VOID

Parameter (ML/yr)	Average	20th Percentile	Median	80th Percentile
Rainfall	1,057	864	1,055	1,261
Runoff	356	131	259	569
Groundwater Inflow – Hardrock	61	823	61	62
Groundwater Inflow - Spoil Seepage	310	122	309	310
Evaporation	1,768	61	1,748	1,859
Groundwater Outflow	0	309	0	0
Spoil Seepage Outflow	0	1,680	0	0

The final void recovery analysis indicates that the North Void will have a median pit lake level of approximately -17.8 mAHD long-term post closure (600 years). At this level, the void has a freeboard (i.e., vertical elevation to spill point) of approximately 100 m, making the risk of potential spill to the environment negligible.

The Carrington Pit Void is predicted to have a median pit lake level of approximately 41.8 mAHD long-term post closure (100 years) which equates to a void lake water depth of approximately 2 m. At this level, the void would have a freeboard (i.e., vertical elevation to spill point) of approximately 14 m, making the risk of potential spill to the North Void negligible.

The South Void is predicted to have a median pit lake level of approximately -29.7 mAHD long-term post closure (600 years). At this level, the void would have a freeboard (i.e., vertical elevation to spill point) of approximately 110 m, making the risk of potential spill to the environment negligible.

The analysis indicates that salinity in each void lake is expected to continue to increase post closure as a result of evapo-concentration. The forecast TDS at long-term post closure pit lake level (600 years for North Void and South Void, 100 years for Carrington Pit) is approximately 7,100 mg/L for HVO North Void, 21,550 mg/L for Carrington Pit Void and 8,400 mg/L for HVO South Void.

3.1 Sensitivity Assessment

Consistent with the EIS SWIA (Engeny, 2022) a sensitivity assessment of the predicted final void pit lake outcomes has been undertaken on the following climate inputs:

- Pit Lake Evaporation – Reduced Lake evaporation from the pit lake surface areas by an additional 20%.
- Climate Change – Predicted changes to long-term annual rainfall and evaporation due to climate change.

Evaporation is the largest inflow/outflow from the pit lake water balance (refer Table 3.4) and if overestimated pit lake levels could potentially be higher than predicted. Lake evaporation rates have been estimated by applying monthly pan factors to daily pan evaporation data with an additional 0.8 pit lake evaporation reduction factor applied to account for solar radiation shielding and wind reduction from the pit walls. An evaporation sensitivity has been undertaken for a reduced lake evaporation by an additional 20% (applying a 0.6 pit lake evaporation reduction factor).

Climate change is predicted to impact long-term climate variables including temperature, annual rainfall and evaporation. Changes to long-term rainfall and evaporation will impact the estimated rainfall and runoff inflow volumes and pit lake evaporation losses. A climate change sensitivity has been undertaken for a range of predicted global climate change pathways.

3.1.1 Pit Lake Evaporation

The impact of 20% reduction on pit lake evaporation is presented in Figure 3.4 and indicates that the pit lake levels significantly increase by further reducing lake evaporation losses. However, it is noted that despite this increase in lake level, the overall outcome remains the same in that the pit lakes remain significantly below the spill levels with:

- North Void recovering to approximately 17 mAHD, a freeboard of around 65 m.
- Carrington Pit Void recovering to approximately 46 mAHD, a freeboard of around 10 m.
- South Void recovering to approximately 8 mAHD, a freeboard of around 70 m.

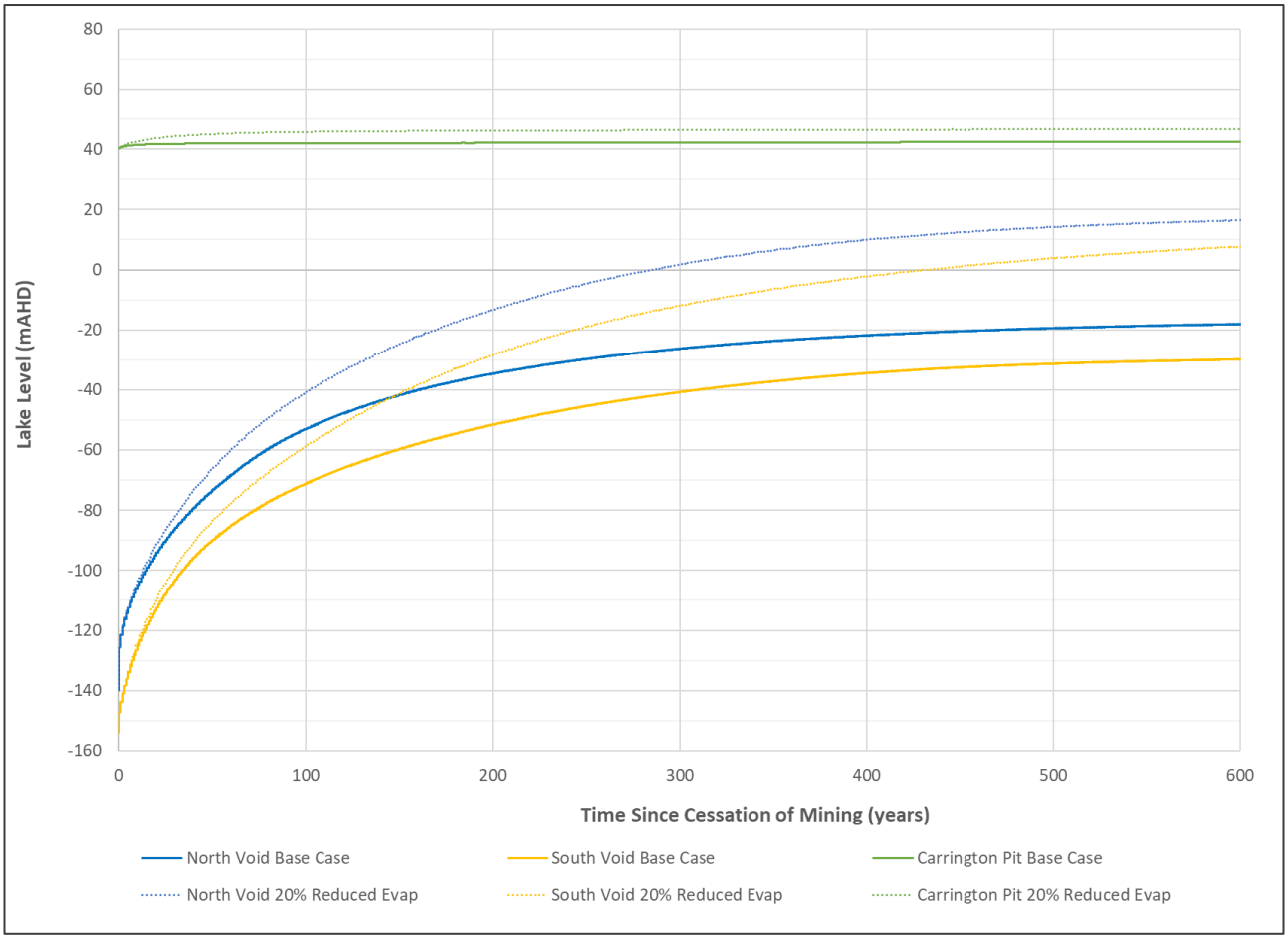


FIGURE 3.4: PIT LAKE EVAPORATION SENSITIVITY (20% REDUCTION) ON FINAL PIT LAKE WATER LEVELS

3.1.2 Climate Change

A climate change assessment has been undertaken on the final void pit lakes by applying predicted annual change to rainfall and evaporation (%) for various climate change scenarios, to the base case final void hydrology model. This process results in changes to rainfall runoff estimates as well as evaporation losses from the pit lake surface. At the time of the preparation of the EIS Project, climate scientists had developed four Representative Concentration Pathways (RCP) to predict how the earth's climate may change in the future. The four RCPs range from very high (RCP8.5) through to very low (RCP2.6). Subsequent to this the latest 'what if' scenarios used to explore the consequences of greenhouse gases accumulating in the atmosphere are called Shared Socio-economic Pathways (SSPs). SSP codes are based on five global socio-economic narratives and the predicted extra energy reaching the earth by 2100. The predicted extra energy reaching the earth by 2100 was also used for the previous RCP scenarios. To be consistent with the climate change methodology used for the EIS Project the analysis for the Amended Project has been undertaken for the same three RCP as the EIS Project. These RCPs are listed below, alongside their equivalent SSP.

The climate change assessment was undertaken for the following three scenarios:

- RCP2.6 – Limits global temperature rise to 1.5 degrees in line with the Paris Agreement - SSP1-2.6 "Sustainability".
- RCP4.5 – Limits global temperature rise to 2.0 degrees. This is considered a very stringent pathway - SSP2-4.5 "Middle of the Road".
- RCP8.5 – Emissions continue to rise throughout the 21st century with little climate change intervention. Considered a worst case climate change scenario – SSP5-8.5 "Fossil-fuelled Development".

The Projection Builder Tool is the recommended tool for undertaking climate change sensitivity assessment by "Climate Change Australia". The tool is used to develop projections that provide a "best case" and "worst case" outcome as well as a "maximum consensus" of the available climate model projections. For HVO final voids the "best case" and "worst case" outcomes are defined as:

- "best case" – Lower Pit Lake Level – Lower Rainfall and Higher Evaporation.

- "worst case" – Higher Pit Lake Level – Higher Rainfall and Lower Evaporation.

Nine sensitivity cases have been developed (three RCPs for each of the "best case", "worst case" and "maximum consensus"). Projections have been produced for the 2090 climate horizon. The predicted change to mean annual rainfall and evaporation for the nine climate change sensitivity cases is presented in Table 3.7.

TABLE 3.7: CLIMATE CHANGE VARIABLES

Scenario		Projections for 2090		
		Model	Rainfall	Evapotranspiration
RCP2.6 (SSP2-2.6)	'Best Case' Lower Lake Level	GFDL-ESM2M	-17.7%	4.6%
	'Worst Case' Higher Lake Level	NorESM1-M	-1.9%	3.1%
	Maximum Consensus	Bc-csm1-1	-9.4%	5.0%
RCP4.5 (SSP2-4.5)	'Best Case' Lower Lake Level	GDL-ESM2M	-19.8%	6.9%
	'Worst Case' Higher Lake Level	NorESM1-M	4.4%	5.5%
	Maximum Consensus	ACCESS 1-0	-10.1%	7.8%
RCP8.5 (SSP5-8.5)	'Best Case' Lower Lake Level	GDL-ESM2M	-34.0%	14.5%
	'Worst Case' Higher Lake Level	NorESM1-M	19.1%	8.3%
	Maximum Consensus	ACCESS 1-0	-15.4%	15.2%

The predicted change to mean annual rainfall and evaporation was applied to the daily rainfall climate data in the final void model to assess the change in predicted final void pit lake outcomes. Forecast lake levels for the climate change sensitivity are presented in Figure 3.5, Figure 3.5 and Figure 3.7 for the final voids along with a tabular summary of long-term water level and TDS in Table 3.8. All climate change scenarios result in lower lake levels and higher salinity with the exception of the "RCP8.5 Higher" scenario. This shows that when considering climate change impacts the final void pit lake levels for North Void, Carrington Pit Void and South Void are likely to be lower than the base case assessment (i.e., greater freeboard to surface).

TABLE 3.8: CLIMATE CHANGE SENSITIVITY ON FINAL VOID PIT LAKE AVERAGE WATER LEVELS AND QUALITY

Scenario		Lake Level Post Closure (mAHD)[1]			TDS Post Closure (mg/L)[1]		
		North Void	Carrington Pit Void	South Void	North Void	Carrington Pit Void	South Void
Base Case		**-18.1**	**41.9**	**-29.9**	**7,130**	**69,750**	**8,510**
RCP2.6	'Best Case' Lower Lake Level	-18.1	41.9	-29.9	8,910	278,670	12,250
	'Worst Case' Higher Lake Level	-52.2	40.4	-76.4	5,670	83,350	6,730
	Maximum Consensus	-27.5	41.4	-40.6	7,340	179,560	9,520

Scenario		Lake Level Post Closure (mAHD)[1]			TDS Post Closure (mg/L)[1]		
		North Void	Carrington Pit Void	South Void	North Void	Carrington Pit Void	South Void
RCP4.5	'Best Case' Lower Lake Level	-41.7	40.7	-62.3	9,920	322,210	13,970
	'Worst Case' Higher Lake Level	-57.2	40.3	-82.7	5,240	51,560	6,120
	Maximum Consensus	-22.0	41.8	-32.8	8,270	220,340	10,950
RCP8.5	'Best Case' Lower Lake Level	-47.3	40.6	-69.3	19,010	485,500	23,380
	'Worst Case' Higher Lake Level	-83.5	40.1	-105.4	4,010	13,160	4,720
	Maximum Consensus	-3.9	43.9	-13.0	11,330	345,570	16,040

Note 1: 600 years post closure for North Void and South Void. 100 years post closure for Carrington Pit Void.

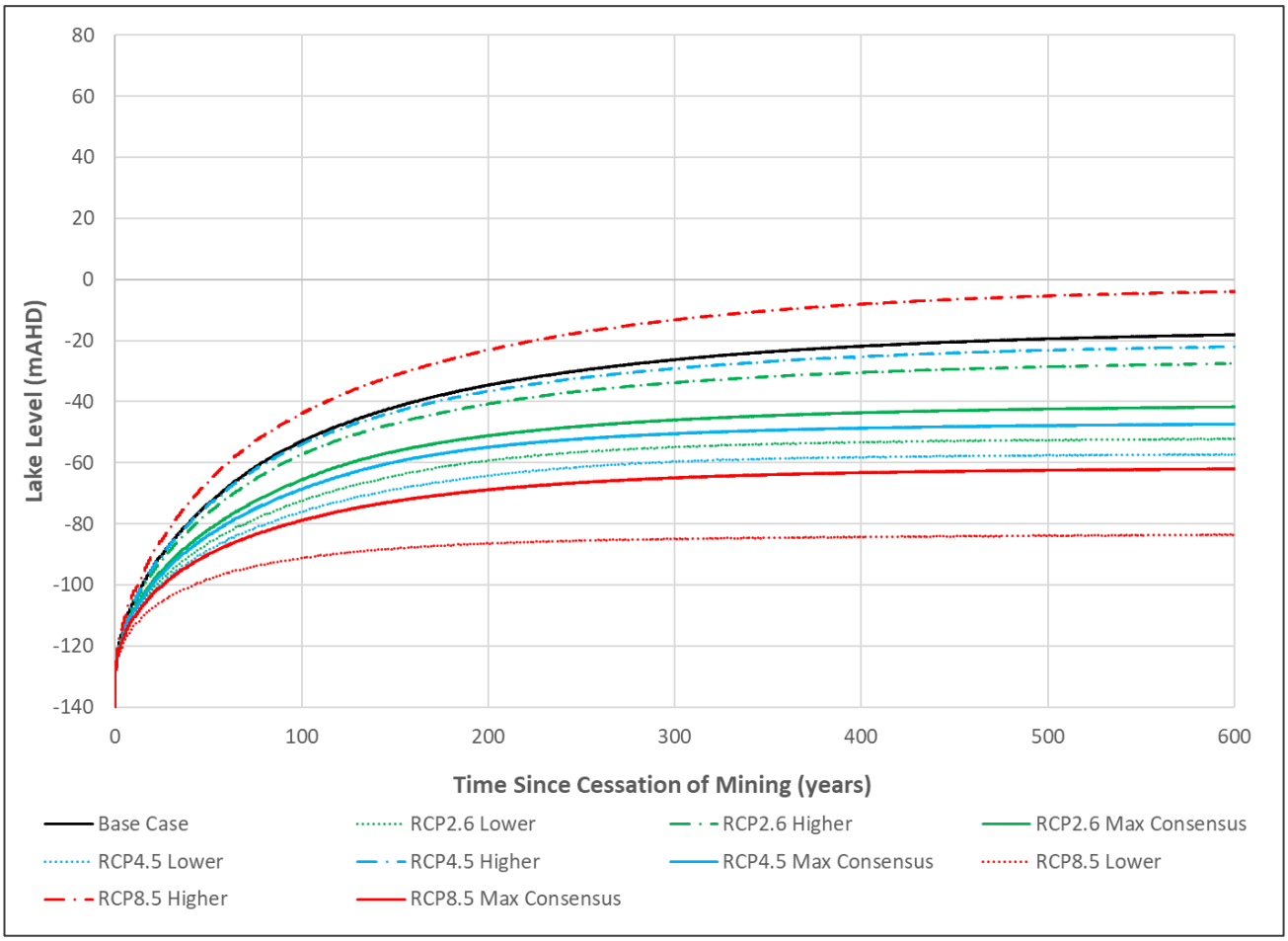


FIGURE 3.5: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (NORTH VOID)

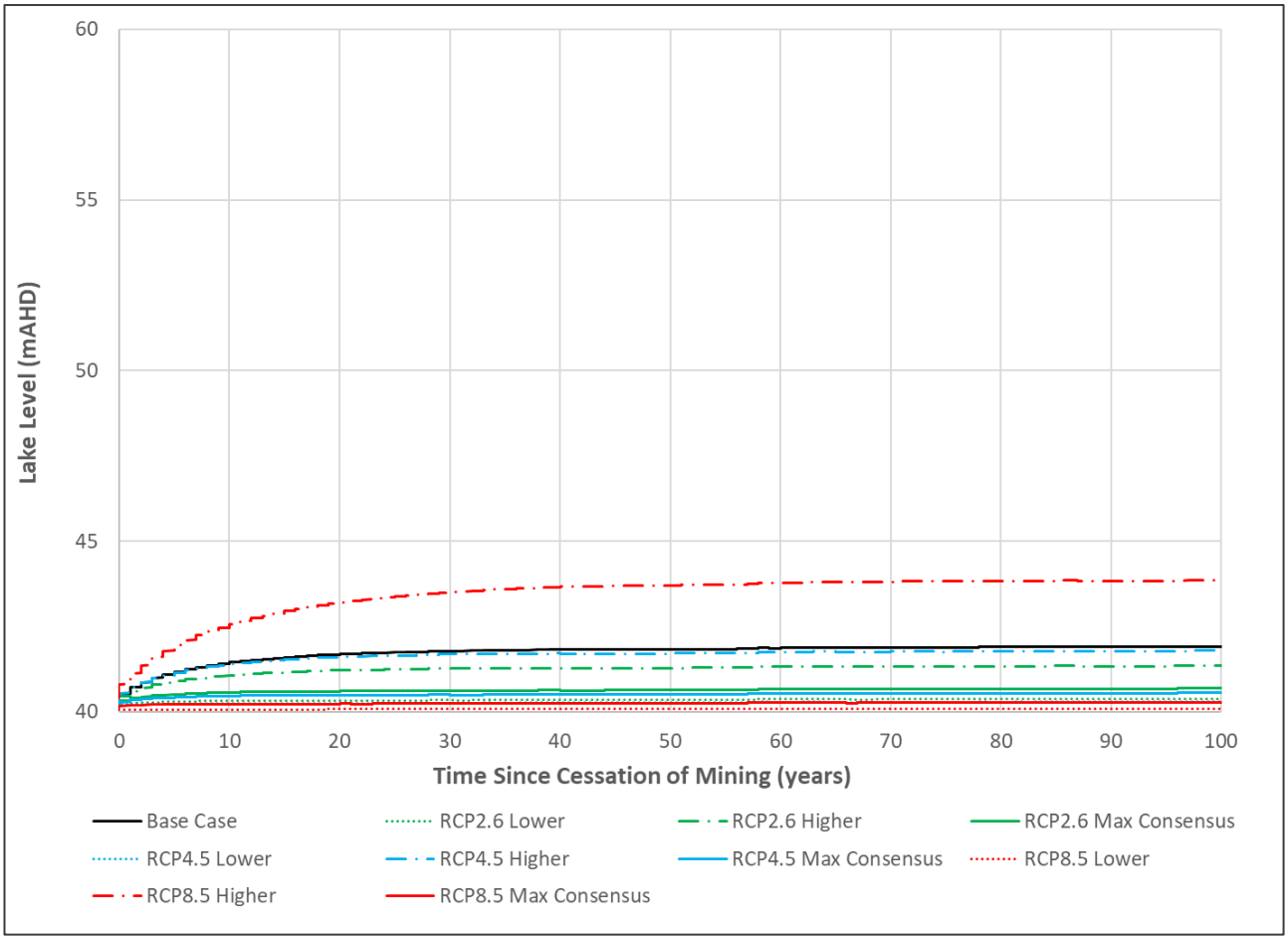


FIGURE 3.6: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (CARRINGTON PIT VOID)

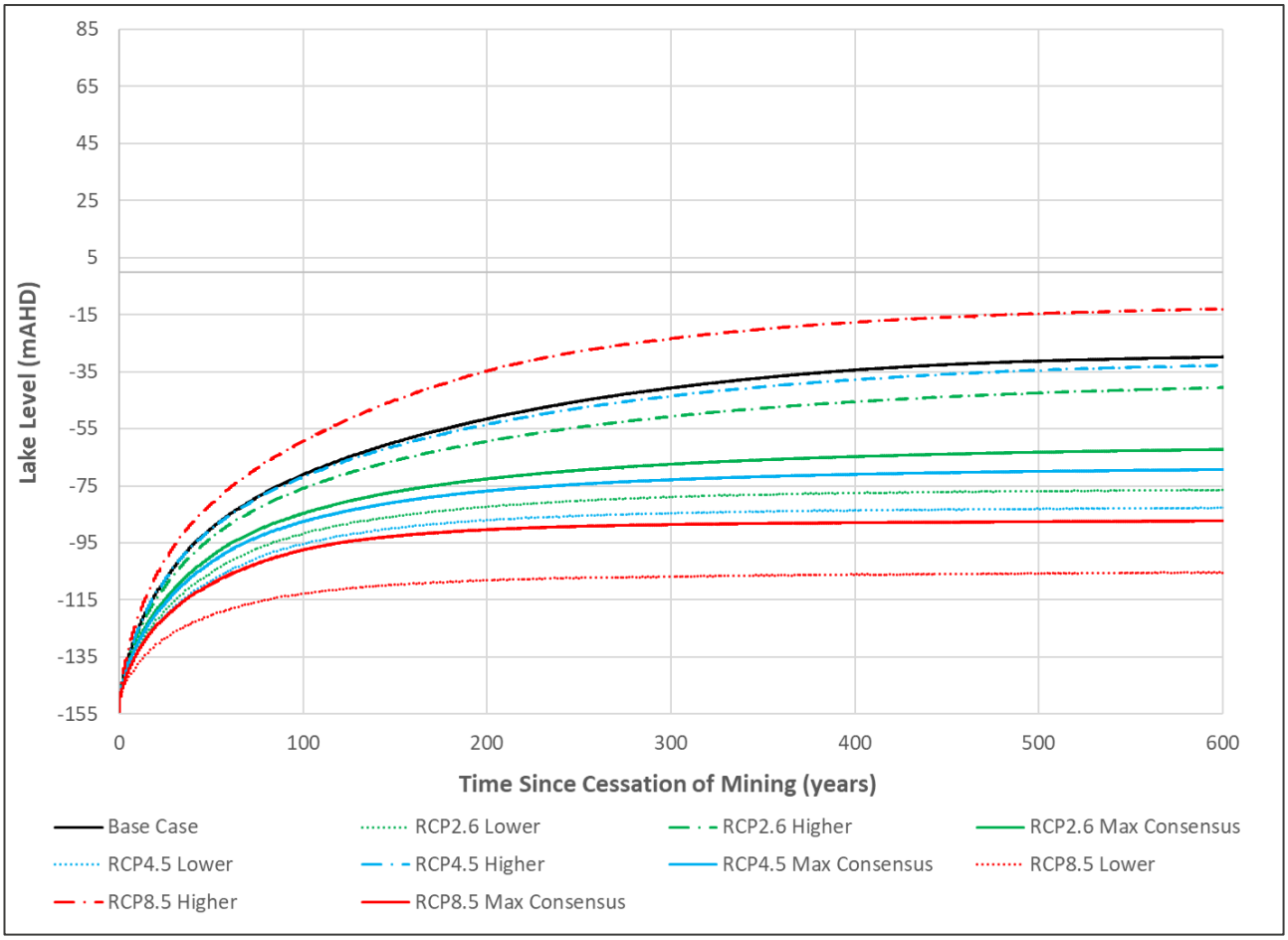


FIGURE 3.7: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (SOUTH VOID)

4. OUTCOMES

4.1 Comparison of Results to EIS Project – North Void and South Void

Results for North Void and South Void are discussed below with specific comparison to the previous EIS Project assessment. Consistent with the EIS Project, the Amended Project indicates that for North Void and South Void:

- Filling of the pits lakes to equilibrium levels is predicted to take several hundred years after the cessation of mining.
- Forecast long-term lake water levels (600 years post closure) have significant freeboard to the surface for North Void and South Void (100 m and 110 m respectively, compared to 155 m for North Void and 159 m for South Void for the EIS Project).
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant (greater than 60 m).
- All climate change scenarios result in lower lake levels and higher salinity except for the "RCP8.5 Higher" scenario. This indicates that when considering climate change impacts the final pit lake water levels are likely to be lower than the base case assessment.
- Salinity is expected to continue to increase over time in the pit lakes with concentrations of less than 9,000 mg/L TDS in North Void and South Void predicted at 600 years after closure.
- Due to the significant depth of the pit lakes, the groundwater flux is predicted to remain into the voids (i.e., the pit lakes will continue to act as groundwater sinks).

4.2 Comparison of Results to Approved Void - Carrington Pit Void

The Carrington Pit Void was incorporated into the North Void mine plan for the EIS Project Assessment and hence was not subject to particular assessment in the EIS SWIA. The proposed Carrington Pit Void was modelled by Macke Environmental Research for the Carrington West Wing Modification (Mackie Environmental Research, 2010) which was part of the supporting documentation for Modification 3 to the HVO North Development Consent (DA 450-10-2003). Modification 3 was approved by the then Department of Planning and Environment in 2013.

In the groundwater assessment for the approved Carrington Pit final void the outcomes were documented as follows for 50 years post closure, i.e. long term:

- Void acts as an evaporative sink.
- Long term steady state free standing water elevation of 40 mAHD.
- Water quality in the final void of around 3,000 to 4,000 mg/L TDS.

HVO is not proposing to change the configuration of the Carrington Pit Void relative to what was previously approved. As such the results for the Amended Project Carrington Pit Void are consistent with the current approved void, as follows:

- Reaches equilibrium levels within one hundred years after the cessation of mining.
- Has a forecast long-term lake water level (100 years post closure) that forms a shallow pit lake with a large freeboard (i.e. a lake depth in the order of 2 m, with a freeboard of 14 m), indicating a negligible risk of spill to HVO North void.
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant, in the order of 9 m.
- All climate change scenarios result in lower lake levels and higher salinity except for the "RCP8.5 Higher" scenario. This indicates that when considering climate change impacts the final pit lake water levels are likely to be lower than the base case assessment.
- Salinity is expected to continue to increase over time in the pit lake with median concentrations of 21,550 mg/L TDS predicted at 100 years after closure. The salinity at 50 years is predicted to be in the order of 10,000 mg/L. It is noted that at the time of the EIS Project Assessment (refer Section 5.3 of the EIS SWIA (Engeny, 2022)), the simplistic mass balance methodology used in the GoldSim model was found to result in TDS forecasts 50% higher than the predictions from the hydrogeochemical modelling methodology used by EGI (2022) for the EIS Project and by Mackie for Modification 3. When the difference in methodology is taken into account, the forecast Carrington Void salinity remains consistent with the previous assessment by Mackie (2010).

5. REFERENCES

EGI. (2022). *Hunter Valley Operations - Continuation Project: Water Quality Predictions for Final Pit Voids.* Environmental Geochemistry International.

EMM. (2025a). *Hunter Valley Operations Continuation Project - Amended Project - Environment Impact Statement.*

EMM. (2025b). *Hunter Valley Operations Continuation Project - Amended Project - Groundwater Modelling Report.*

Engeny. (2022). *HVO Continuation Project - Surface Water Impact Assessment.*

Mackie Environmental Research. (2010). *Carrington West Wing Modification - Groundwater Assessment.*

6. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

  (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

(d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

(e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

(f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

(g) This Report does not provide legal advice.

Attachment C

Regulatory overview

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C.1 Relevant legislation

C.1.1 Water Management Act 2000

i The Act

The WM Act is the primary legislation governing water management and licensing in NSW.

The 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. In addition, 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 WAL holders and provides security for licence holders.

The licensing provisions of the WM Act become effective for any water source once a WSP for that water source commences; it has progressively been enacted across NSW since July 2004.

One of the key components of the WM Act is the separation of the water licence from the land; this facilitates opportunities for licence holders to trade water. The WM Act outlines the requirements for taking and trading water through WALs, water supply works, and water use approvals.

The WM Act is replacing the *Water Act 1912*. This transition occurs for particular water sources when a water sharing plan which applies to those water sources commences. This transition process is largely complete.

ii Water Sharing Plans

WSPs are statutory documents that apply to one or more water source areas. They contain the rules for sharing and managing the water resources within water source areas. WSPs are designed to establish sustainable use and management of water resources and are periodically reviewed (every 10 years).

WSPs describe the basis for water sharing, and document the water available and how it is shared between environmental, extractive, and other uses. The WSPs then outline the water available for extractive uses within different categories, such as local water utilities, domestic and stock, basic rights, and access licences.

C.1.2 NSW Protection of the Environment Operations Act

The POEO Act is the key piece of environment protection legislation administered by the NSW EPA. The POEO Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols, and guidelines.

i Environment Protection Licences

The POEO Act also establishes a licensing regime for pollution generating activities in NSW. Under Section 48, an environment protection licence (EPL) is required for 'scheduled activities'.

Activities that may lead to pollution of waters in NSW are regulated by the EPA under the POEO Act. Where discharge of waters is permitted, it is controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an EPL if the discharge would otherwise constitute a pollution of waters.

ii Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002

Discharges from the HVO Complex are licensed under EPL 640, as well as operating in accordance with the Hunter River Salinity Trading Scheme (HRSTS). The HRSTS is a cap-and-trade system designed to facilitate saline discharges into the Hunter River, without compromising sustainable water quality. The HRSTS is administered under the Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002.

C.1.3 NSW Biodiversity Conservation Act 2016

Under the BC Act, any activities assessed under Part 5 of the EP&A Act must apply the test of significance to determine whether the proposed activity is likely to significantly impact threatened species or ecological communities. If a significant impact is likely, the proponent may choose to opt into the Biodiversity Offsets Scheme (BOS) or undertake a Species Impact Statement (SIS). These are included elsewhere in the Biodiversity Assessment.

C.1.4 NSW Fisheries Management Act 1994

The FM Act is the principal piece of legislation protecting aquatic habitat in NSW. The FM Act aims to conserve fish stocks, key fish habitat, aquatic vegetation, and threatened species, populations and communities. Threatened aquatic species, populations and communities are listed under Schedules 4, 4A and 5 of the FM Act, while key threatening processes are listed under Schedule 6. Any impact to groundwater level or quality needs to be considered under the FM Act for groundwater dependent rivers if it has the potential to reduce streamflow and block fish passage.

C.2 Relevant policies

C.2.1 Aquifer Interference Policy

i Overview

The AIP was released by the NSW Government in September 2012. The purpose of the AIP is to explain the water licensing and assessment processes for aquifer interference activities under the WM Act and other relevant legislative frameworks.

The dictionary to the WM Act (under section 91) defines an ‘aquifer interference activity’ as an activity involving any of the following:

- penetration of an aquifer
- interference with water in an aquifer
- obstruction of the flow of water in an aquifer
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, or
- disposal of water taken from an aquifer in the course of carrying our mining or any other activity prescribed in the regulations.

The AIP clarifies the requirements for obtaining water licences for aquifer interference activities and defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The AIP defines water sources as being either 'highly productive' or 'less productive' based on levels of salinity and average yields from bores. The AIP then further defines water sources by their lithological character, being one of: alluvium, coastal sand, porous rock, or fractured rock.

The key requirements of the AIP are to:

- Account for, or prevent, the take of water. Where a proposed activity will take water from an aquifer or connected surface water source, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to enable this to be estimated to a suitable level of accuracy, and to ensure necessary WALs are obtained and held.

- Address the 'minimal impact considerations'. Aquifer interference activities can adversely impact groundwater and connected surface water sources by decreasing groundwater pressure and/or lowering the watertable; deteriorating groundwater and surface water quality either due to pollution or increases in salinity; by affecting the health or viability of a groundwater dependent ecosystem; or impacting on a culturally significant site. The AIP provides objective, measurable thresholds for considering the degree of impact an activity may have on the watertable, groundwater pressure and water quality changes. The assessment criteria differ between aquifer types (for example alluvial, porous, fractured) and whether the aquifer is deemed 'highly' or 'less' productive on the basis of natural water quality and extraction yields.

- Propose remedial actions. Where impacts are greater than those that were predicted as part of the relevant approval, proposed remedial actions shall be specified to manage those impacts.

ii AIP assessment process

As part of the NSW Government's role in water management, including assessing development proposals and providing advice to the DPE Planning and Assessment Group, DPE Water's approach is based on the principles of "account for, mitigate, avoid/ prevent, and remediate".

The Aquifer Interference Assessment Framework is a step-by-step guide that DPE Water use to assess project proposals against the AIP. The framework has been considered in this assessment and is provided in Attachment D.

a Minimal impact considerations

The WM Act includes the concept of ensuring "no more than minimal harm" for both the granting of WALs and the granting of approvals.

The minimal impact considerations have been developed for impacts on groundwater sources, connected water sources, and their dependent ecosystems, culturally significant site and water users. The AIP minimal impact considerations process is shown in Figure 6.1 in Section 6.3.

b Make good provisions

AIP Fact Sheet 4 outlines how a minimal impact is to be considered. It describes how the minimal impact criteria are applied to both a water supply work and a groundwater dependent ecosystem or culturally significant site defined in a WSP.

iii Licensing

The WM Act requires water users or landholders to hold:

- a WAL to take water from a river, lake, dam or groundwater for irrigation, industrial, or commercial purposes

- a water supply work approval to construct and use a water supply work, such as a pump, dam, channel or bore
- a water use approval for a specific purpose at a particular location
- a flood work approval for works on floodplain that diver floodwaters
- a controlled activity approval to carry out work in a watercourse or within 40 m of the bank of a river, lake of estuary, such as extracting material from a river bed, constructing a creek crossing or residential developments.

However, under Clause 4.41(1)(g) of the EP&A Act, SSD projects are exempt from requiring:

- a water use approval under section 89 of the WM Act
- a water management work approval under section 90 of the WM Act, or
- an activity approval (other than an aquifer interference approval) under section 91 of the WM Act.

As the amended Project is an SSD, there is no requirement to obtain approvals under the WM Act.

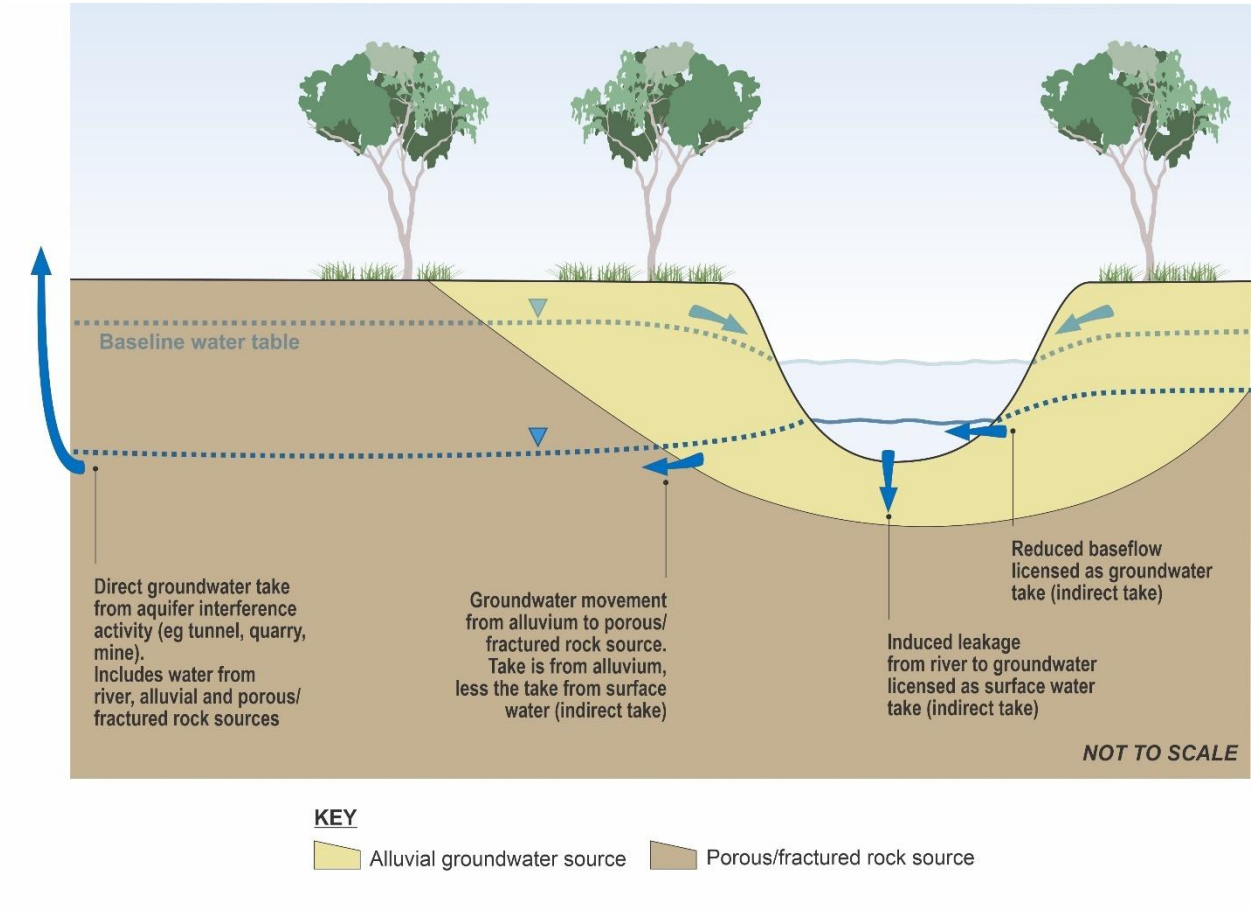
AIP Fact Sheet 3 and the DPE Water (2022b) guidelines provides guidance regarding licensing and accounting for water. Water can be taken directly from a groundwater or surface water source, usually via a pump (in a river or an excavated area) or bore. It can also be taken indirectly when an aquifer interference activity causes water to flow from another connected groundwater or surface water source. Flows induced from other water sources also constitute take of water. In all cases, separate WALs are required to account for the take from all individual water sources.

Take of water is licensed by the source from where the water is taken.

For example, where an aquifer interference activity is taking water from a groundwater source, and this take is causing the movement of water from a connected surface water source into the groundwater source, then an access licence in the regulated or unregulated river water source is required to account for the take of water from that water source and another access licence in the groundwater source is required for the remainder of the take. This is illustrated in Figure C.1.

The DPE Water (2022b) guidelines note the total volume of water to be taken from each water source as a result of an aquifer interference activity needs to be estimated before project approval can be granted. A proponent is not required to hold sufficient entitlement prior to project approval; however, the proponent is required to demonstrate the licensing pathway to secure sufficient entitlement for the peak take (including documenting the proposed mechanisms to secure the entitlement, for example trade or controlled allocation orders). A proponent is required to hold sufficient entitlement prior to the take occurring (DPE Water 2022b).

Once the activity commences, the take must be measured and reported (DPE Water 2022b).



Source: DPE Water (2022b)

Figure C.1 Licensing requirements by source (surface water vs groundwater)

iv NSW State Groundwater Dependent Ecosystems Policy

This policy aims to protect the ecological processes and biodiversity of ecosystems that depend on groundwater. The GDE policy was developed in 2002, and outlines the following principles for managing GDEs:

- the scientific, ecological, aesthetic and economic values of GDEs, and how threats to them may be avoided, should be identified and action taken to ensure the most vulnerable and valuable ecosystems are protected
- groundwater extractions should be managed sustainably so that ecological processes and biodiversity are maintained and/or restored
- priority should be given to ensuring enough groundwater of a suitable quality is available when needed for:
  - protecting ecosystems which are known to be, or most likely to be, groundwater dependent
  - GDEs which are under immediate or high degree of threat from groundwater-related activities
- where scientific knowledge is lacking, the precautionary principle should be applied to protect GDEs
- planning, approval and management should aim to minimise adverse impacts on GDEs by:
  - maintaining natural patterns of groundwater flow and not disrupting groundwater levels that are critical for ecosystems

- not polluting or causing adverse changes in groundwater quality
- rehabilitating degraded groundwater systems where practical.

v Strategic Regional Land Use Policy 2012

The NSW Strategic Regional Land Use Policy applies to the Hunter Valley in which the HVO Complex resides. Biophysical Strategic Agricultural Land (BSAL) is land considered to have high quality soil and water resources capable of sustaining high levels of productivity. BSAL occurs within the amended Project area, along the Hunter River floodplain.

vi State Rivers and Estuary Policy

The NSW State Rivers and Estuary Policy (1993) encourages sustainable management of the state's rivers, estuaries, and wetlands to halt or reduce:

- declining water quality
- loss of riparian vegetation
- damage to river banks and channels
- declining natural productivity
- loss of biological diversity
- declining natural flood mitigation.

The amended Project has been assessed against this policy and component policies and each of the above listed objectives has been specifically considered. In summary, the SWIA has concluded that:

- the amended Project's water quality effects will be negligible
- there will be no loss of riparian vegetation or damage to natural river banks and channels
- surface water resources in the amended Project area will not decline in their natural level of productivity
- there will be no loss of biological diversity
- flooding effects will be negligible and a full flood study for the amended Project has been conducted.

vii Floodplain Development Manual and Flood Prone Land Policy

The Floodplain Development Manual and Flood Prone Land Policy (DIPNR 2005) were developed to provide guidance to local councils during the development and implementation of detailed local floodplain risk management plans. The manual clearly sets out the floodplain risk management process to be used by local councils.

The flood assessment for the original Project has considered flooding changes with regard to the above-mentioned manual (Engeny 2022). Further discussion on the flood assessment is included in Attachment B.

C.3 Relevant guidelines

C.3.1 Groundwater Assessment Toolbox for Major Projects in NSW

DPE Water has developed a Groundwater Assessment Toolbox for Major Projects in NSW (Groundwater Assessment Toolbox) (DPE Water 2022a), which aims to create a collaborative, transparent and enabling environment for the preparation and review of groundwater assessments for major projects in NSW. The documents provide a framework to investigate, assess the impacts on, manage and monitor groundwater resources and their interaction with surface water resources within the footprint of a major project.

The Groundwater Assessment Toolbox is a complementary guidance document that comprises the following documents:

- *Guidelines for Groundwater Documentation for SSD/SSI Projects* (DPE Water 2022b)
- *Minimum Requirements for Groundwater Modelling* (DPE Water 2022c)
- *Cumulative Groundwater Impact Assessment Approaches* (DPE Water 2022d).

These documents denote the role of the NSW Government in project assessment, and the continuation of guidance on and review of post-approvals monitoring and management plans, and compliance reporting.

The GIA and Water Assessment has been prepared in accordance with the above guidance documentation.

C.3.2 Australian Groundwater Modelling Guidelines

The Australian Groundwater Modelling Guideline (Barnett et al. 2012) provide a consistent and sound approach for the development of groundwater flow models in Australia. The guidelines 'propose a point of reference and not a rigid standard' and provide direction on scope and approaches while acknowledging that techniques are continually evolving, and innovation is to be encouraged.

The guidelines provide information on the data requirements for models (depending on complexity and level of potential risk and scale), such as spatial distribution of bores and temporal groundwater level data.

The numerical groundwater model for the amended Project has been prepared in accordance with the Australian Groundwater Modelling Guidelines and peer reviewed using the structure of the 'review checklist' as per the guidelines.

C.3.3 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) provides guidance on monitoring, assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. The guidelines provide a framework for:

- establishing water quality objectives
- assessing and managing water quality for environmental values
- establishing protection levels, water quality indicators and trigger values.

C.3.4 Information guidelines for assessing groundwater dependent ecosystems

The IESC developed an explanatory note in 2019 on assessing GDEs (Doody et al 2019). It outlines a framework for undertaking an assessment and suggests some tools and techniques that may be useful during an impact assessment.

The explanatory note also highlights the intent of the 'water trigger' is that potential impacts from coal seam gas and coal mines on all GDE should be assessed, not only listed protected or threatened ecological communities.

The aquatic ecology and GDE assessment considered the recommendations of this explanatory note (refer Appendix L of the Amendment Report for further discussion).

C.3.5 Risk assessment guidelines for groundwater dependent ecosystems

The Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Serov et al 2012) (GDE Risk Assessment Guidelines) are the NSW requirements for assessment and management of GDEs under the WM Act.

The GDE Risk Assessment Guidelines provide that GDEs:

> explicitly include any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition.

An ecosystem's dependence on groundwater can be variable, ranging from partial and infrequent dependence, i.e. seasonal or episodic (facultative), to total continual dependence (entire/obligate) (refer to Figure C.2).

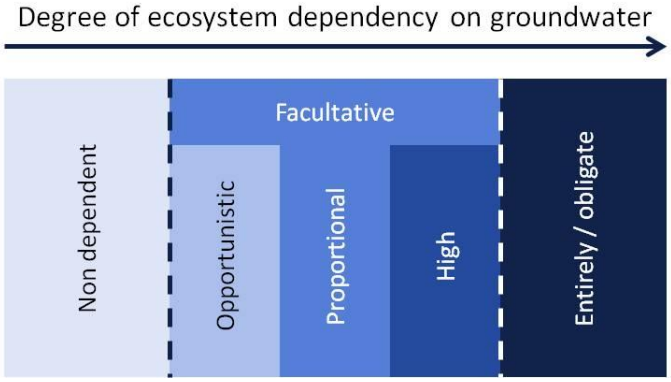


Figure C.2 Groundwater dependent ecosystem level of dependence on groundwater

A GDE assessment has been conducted for the amended Project, which considered variations in available water and ecosystem types with assessment methods based on the GDE Risk Assessment guidelines.

C.3.6 Water quality and river flow objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provide agreed environmental values and long-term targets for water quality and river flow in each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities associated with waterways.

Water quality objectives have been agreed for fresh and estuarine surface waters and are consistent with the national framework for assessing water quality provided in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018). River flow objectives are the agreed high-level goals for surface water flow management that identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

This is discussed further in Section 4.3.4 of the main report.

C.3.7 Australian Rainfall and Runoff: a Guide to Estimation

The *Australian Rainfall and Runoff – a Guide to Estimation* (Ball et al 2019) is the national guideline to estimate design flood characteristics in Australia. It provides robust estimates of flood risks to avoid development in high risk areas and sound design of infrastructure in flood-prone areas, and has been referenced as part of the flood modelling conducted for the amended Project (refer Attachment B).

C.3.8 Erosion and sediment control guidelines

Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) outlines the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters.

Additional guidelines on specific aspects of development and the application of erosion and sediment controls are also available. *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries* (DECC 2008) provide specific guidelines, principles and minimum design standards for good management practice in erosion and sediment control during the construction and operation of mines and quarries.

Attachment D

Supporting assessment requirements

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D.1 AIP assessment framework

Department of Primary Industries
Office of Water

AQUIFER INTERFERENCE ASSESSMENT FRAMEWORK

Assessing a proposal against the NSW Aquifer Interference Policy – step by step guide

Note for proponents

This is the basic framework which the NSW Office of Water uses to assess project proposals against the **NSW Aquifer Interference Policy (AIP).**

The NSW Aquifer Interference Policy can be downloaded from the NSW Office of Water website (www.water.nsw.gov.au under Water management > Law and policy > Key policies > Aquifer interference).

While you are not required to use this framework, you may find it a useful tool to aid the development of a proposal or an **Environmental Impact Statement (EIS).**

We suggest that you summarise your response to each AIP requirement in the tables following and provide a reference to the section of your EIS that addresses that particular requirement. Using this tool can help to ensure that all necessary factors are considered, and will help you understand the requirements of the AIP.

Table 1. Does the activity require detailed assessment under the AIP?

	Consideration	Response
1	Is the activity defined as an aquifer interference activity?	If **NO,** then no assessment is required under the AIP. If **YES,** continue to Question 2.
2	Is the activity a defined minimal impact aquifer interference activity according to section 3.3 of the AIP?	If **YES**, then no further assessment against this policy is required. Volumetric licensing still required for any water taken, unless exempt. If **NO**, then continue on for a full assessment of the activity.

Note for proponents

Section 3.2 of the AIP defines the framework for assessing impacts. These are addressed here under the following headings:

1. Accounting for or preventing the take of water
2. Addressing the minimal impact considerations
3. Proposed remedial actions where impacts are greater than predicted.

1. Accounting for, or preventing the take of water

Where a proposed activity will take water, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to ensure that the necessary licences are held. These requirements are detailed in Section 2 of the AIP, with the specific considerations in Section 2.1 addressed systematically below.

Where a proponent is unable to demonstrate that they will be able to meet the requirements for the licensing of the take of water, consideration should be given to modification of the proposal to prevent the take of water.

Table 2. Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Described the water source(s) the activity will take water from?	See Section 3, 4 and 11 Sydney Basin North Coast Groundwater Source Hunter Unregulated River (surface water and alluvium from various water sources) Hunter Regulated River Alluvial Water Source Hunter Regulated River Water Source	
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	See Section 11	
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	See Section 11.3.2	
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Yes, see Section 11	
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	See Section 11	
6	Described how any licence exemptions might apply?	See Section 11	
7	Described the characteristics of the water requirements?	See Section 7.2, 11 and the Surface Water Impact Assessment (Annexure B to the Water Assessment report)	

	AIP requirement	Proponent response	NSW Office of Water comment
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	Yes, see Section 11	
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Yes, see Section 11	
10	Determined how it will obtain the required water?	See Section 7.2, 11 and the Surface Water Impact Assessment (Annexure B to the Water Assessment report)	
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	There is adequate water entitlement in the water source for approved activities. During the recent drought, there was still sufficient entitlement made available by the water determinations.	
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	See Section 7, 10 and the Surface Water Impact Assessment (Annexure B to the Water Assessment report)	
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Section 11	
Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? If **YES,** items 14-16 must be addressed.			
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?		
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?		

	AIP requirement	Proponent response	NSW Office of Water comment
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?		

Table 3. Determining water predictions in accordance with Section 3.2.3 (complete one row only – consider both during and following completion of activity)

	AIP requirement	Proponent response	NSW Office of Water comment
1	**For the Gateway process**, is the estimate based on a simple modelling platform, using suitable baseline data, that is, fit-for-purpose?		
2	**For State Significant Development or mining or coal seam gas production**, is the estimate based on a complex modelling platform that is: • Calibrated against suitable baseline data, and in the case of a **reliable water source,** over at least two years? • Consistent with the Australian Modelling Guidelines? • Independently reviewed, robust and reliable, and deemed fit-for-purpose?	Yes. Considerable data available from the existing operation and surrounding areas has been used to develop and update a regional groundwater model that is based on groundwater monitoring data going back to 1995. The modelling is consistent with the Australian Groundwater Modelling Guidelines and has been peer reviewed by Dr Doug Weatherill. Appendix A to the Water Assessment report contains the Groundwater Impact Assessment by AGE (2022), which describes the groundwater modelling. The peer review report is provided as Appendix F to the Water Assessment report	
3	In all other processes, estimate based on a desk-top analysis that is: • Developed using the available baseline data that has been collected at an appropriate frequency and scale; and • Fit-for-purpose?		

Other requirements to be reported on under Section 3.2.3

Table 4. Has the proponent provided details on:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Establishment of baseline groundwater conditions?	See Section 4 and the Groundwater Impact Assessment in Appendix A of the Water Assessment	
2	A strategy for complying with any water access rules?		
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	See Section 7 and 8, no impacts predicted	
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	See Section 7 and 8, no impacts predicted	
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	See Section 8 and 9, no long-term impact on the viability of the ecosystem	
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	See Section 8 and 10 - groundwater modelling presented in Appendix A of the Water Assessment assessed potential for seepage from the backfilled emplacement areas to the Hunter River and associated alluvium and shows the pit and final voids will be strong sinks and risk of seepage is negligible for the approved or proposed operation	
7	Potential to cause or enhance hydraulic connection between aquifers?	No applicable due to mining method. Refer Section 6 for assessment approach and considerations	
8	Potential for river bank instability, or high wall instability or failure to occur?	Considered as part of project design. The project will not result in a change in the mining extent into the Hunter River alluvium and has a reduced alluvial impact at HVO South due to removing South Lemington Pit 1 and 2 from the mine plan	
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	Not applicable	

2. Addressing the minimal impact considerations

Note for proponents

Section 3.2.1 of the AIP describes how aquifer impact assessment should be undertaken.

1. Identify all water sources that will be impacted, referring to the water sources defined in the relevant water sharing plan(s). Assessment against the minimal impact considerations of the AIP should be undertaken for each ground water source.
2. Determine if each water source is defined as 'highly productive' or 'less productive'. If the water source is named in then it is defined as highly productive, all other water sources are defined as less productive.
3. With reference to pages 13-14 of the Aquifer Interference Policy, determine the sub-grouping of each water source (eg alluvial, porous rock, fractured rock, coastal sands).
4. Determine whether the predicted impacts fall within Level 1 or Level 2 of the minimal impact considerations defined in Table 1 of the AIP, for each water source, for each of water table, water pressure, and water quality attributes. The tables below may assist with the assessment. There is a separate table for each sub-grouping of water source – only use the tables that apply to the water source(s) you are assessing, and delete the others.
5. If unable to determine any of these impacts, identify what further information will be required to make this assessment.
6. Where the assessment determines that the impacts fall within the Level 1 impacts, the assessment should be 'Level 1 – Acceptable'
7. Where the assessment falls outside the Level 1 impacts, the assessment should be 'Level 2'. The assessment should further note the reasons the assessment is Level 2, and any additional requirements that are triggered by falling into Level 2.
8. If water table or water pressure assessment is not applicable due to the nature of the water source, the assessment should be recorded as 'N/A – reason for N/A'.

Table 5. Minimal impact considerations – *example tables*

Aquifer	**Alluvial aquifer**
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Considered in the assessment (see Section 6.3.2) and results presented in Section 8 and 9. The conservative cumulative predictions exceed the Level 1 minimal impact consideration however the aquatic ecology and GDE assessment, conducted by Eco Logical Australia (2022) shows the Project will not affect the long-term viability of the identified GDEs. See Figure 14.1 in the report. No predicted drawdown at a water supply work.
Water pressure A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work. **OR**, for the Lower Murrumbidgee Deep Groundwater Source: A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the top of the relevant aquifer to a maximum of a 3 metre decline, at any water supply work.	Not applicable as the alluvial aquifer is unconfined.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 metres laterally from the top of high bank and 100 metres vertically beneath a highly connected surface water source that is defined as a reliable water supply.	See Section 7.4, 8.5 and 10.5. The Project is not predicted to adversely impact groundwater or surface water quality or change the beneficial use category.

Aquifer	**Alluvial aquifer**
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Aquifer	**Coastal sands**
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Not applicable
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Not applicable

Aquifer	Porous Rock – except Great Artesian Basin
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Not applicable
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Not applicable

Aquifer	Porous Rock – Great Artesian Basin – Eastern Recharge and Southern Recharge
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Not applicable
Water pressure Less than 0.2 metre cumulative variation in the groundwater pressure, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. A cumulative pressure level decline of not more than 15 metres, allowing for typical climatic 'post-water sharing plan' variations. The cumulative pressure level decline of no more than 10% of the 2008 pressure level above ground surface at the NSW State border, as agreed between NSW and Queensland.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Not applicable

Aquifer	Porous Rock – Great Artesian Basin – Surat, Warrego and Central
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table NOT APPLICABLE	
Water pressure Less than 0.2 metre cumulative variation in the groundwater pressure, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. A cumulative pressure level decline of not more than 30 metres, allowing for typical climatic 'post-water sharing plan' variations. The cumulative pressure level decline of no more than 10% of the 2008 pressure level above ground surface at the NSW State border, as agreed between NSW and Queensland.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Not applicable

Aquifer	Fractured Rock
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem; or • high priority culturally significant site; listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Not applicable
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Not applicable

Aquifer	Alluvial
Category	Less productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work unless make good provisions apply	Not applicable
Water pressure A cumulative pressure head decline of not more than 40% of the 'post-water sharing plan' pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work.	Not applicable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a 'reliable water supply'.	Not applicable

Aquifer	Porous rock or fractured rock
Category	Less productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Not applicable as the Sydney Basin North Coast Groundwater Source is confined in this area
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Groundwater modelling shows no drawdown at privately-owned bores. Refer Section 8 and Appendix A of the Water Assessment report
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Refer Section 8.5 and 10.5. There is no predicted change to the beneficial use category of the groundwater source. The final voids will act as strong sinks.

3. Proposed remedial actions where impacts are greater than predicted.

Note for proponents

Point 3 of section 3.2 of the AIP provides a basic framework for considerations to consider when assessing a proponent's proposed remedial actions.

Table 6. Has the proponent:

AIP requirement		Proponent response	NSW Office of Water comment
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?	Yes, see Section 6 and results presented in Section 8 and Appendix A of the Water Assessment report (the Groundwater Impact Assessment included uncertainty analysis)	
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?	Yes, see Section 10 and Appendix A of the Water Assessment report	
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?	See Section 6.2 - under the Project, HVO will no longer mine in the South Lemington Pit 1 and 2 and Riverview South East Extension. Also, the approved Carrington West Wing barrier wall will be constructed prior to backfilling in that area.	
4	Proposed remedial actions should the risk minimization strategies fail?	Trigger action response plans will be updated and developed for the Project, including preparation of a Low Permeability Barrier Monitoring and Management Plan, as per the existing consent requirements for HVO North. See Section 12 and 13	
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?	See Section 12 and 13	
6	Considered what conditions might be appropriate?	See commitments listed in Section 13 and the EIS	

4. Other considerations

Note for proponents

These considerations are not included in the assessment framework outlined within the AIP, however are discussed elsewhere in the document and are useful considerations when assessing a proposal.

Table 7: Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)	See Section 13.4 and approved WMP	
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)	Conducted as part of annual reporting, as per the requirements of the development consents and approved WMP	

More information

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Disclaimer:

This is a draft document produced as a guide for discussion, and to aid interpretation and application of the NSW Aquifer Interference Policy (2012). All information in this document is drawn from that policy, and where there is any inconsistency, the policy prevails over anything contained in this document.
Any omissions from this framework do not remove the need to meet any other requirements listed under the Policy.

The information contained in this publication is based on knowledge and understanding at the time of writing (July 2025). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the users independent adviser.

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Reference 12279

D.2 NSW Groundwater Guidelines (DPE 2022)

Project setting (If any 'no' answers are recorded, then proponent to provide explanation)	
Scope of the project described (including construction, operation and closure)? Section 1.2 and 2	☒ Yes ☐ No
Location of project clearly identified (address and real property description, and/or lot and plan information)? Section 1 and EIS	☒ Yes ☐ No
Environmental setting described (including topography, climate, the location of surface water features, biodiversity values and land use)? Section 4	☒ Yes ☐ No
Appreciation of regional and local geological setting clearly stated? Section 4.4 and Attachment A	☒ Yes ☐ No
Geological structural features potentially affecting groundwater behaviour identified? Section 4.4 and Attachment A	☒ Yes ☐ No
Will any project related excavation remain above the water table? No	☒ Yes ☐ No
Have baseline groundwater field investigations been conducted and report provided? Groundwater monitoring network described in Section 4.5 and Attachment A. Monitoring has been conducted at HVO for several years in accordance with the approved WMP	☒ Yes ☐ No
Have the relevant Water Sharing Plans and relevant water sources been identified? Section 3.2.2	☒ Yes ☐ No
Has the proponent consulted with the local community, local Aboriginal community, council, DCCEEW, EPA, WaterNSW and Environment, Energy and Science group within DCCEEW (where relevant) to establish cultural and environmental values of the water sources? Social, environmental and cultural values discussed in Section 4. Consultation summarised in the EIS	☒ Yes ☐ No
Receptors (If any 'no' answers are recorded, then proponent to provide explanation)	
Have mapped high priority groundwater dependent ecosystems, listed in the relevant Water Sharing Plans, been identified? There is limited information provided in the updated Hunter Unregulated and Alluvial Water Sources WSP (2022) regarding high priority GDEs; however a thorough GDE assessment has been conducted for the amended Project (refer Appendix L of the EIS). The SEED portal was accessed	☒ Yes ☐ No

Has the proponent reviewed the GDE Atlas to identify any other mapped potential groundwater dependent ecosystems in the project area? Yes; however, the GDE Atlas is inaccurate in some areas, such as within the currently disturbed area at Ravensworth open cut and between West Pit and Mitchell Pit, where depressurisation of the Permian has occurred (and no alluvium is present).	☒ Yes ☐ No
Has the proponent identified other potential groundwater dependent ecosystems out of other technical specialist analysis? Have the technical specialists used outputs from the GIA for their ecological assessment? See Appendix L to the Amendment Report and Section 9	☒ Yes ☐ No
Have considered and identified potential culturally significant sites listed in the relevant Water Sharing Plans been identified? None are listed in the WSPs	☐ Yes ☐ No
Has the proponent identified third-party users in the vicinity that might be impacted identified (Registered/unregistered)? See Section 4.7.1 and 4.7.2	☒ Yes ☐ No
Groundwater investigations and groundwater impact assessment (If any 'no' answers are recorded, then proponent to provide explanation)	
Groundwater elevation and flow	
Are monitoring bore locations and depths provided and appropriate based on depth and scale of proposed development? Refer Section 4.5.2 and Attachment A, and additional monitoring bores proposed as discussed in Section 13.2.	☒ Yes ☐ No
Are measurements recorded at a frequency suitable to detect potential changes (EIS or post-approval)? Refer Attachment A, HVO WMP and Annual Reviews	☒ Yes ☐ No
Has a bore census of existing third-party bores in the project area been completed? Not required as the adjacent landholdings are predominantly mine-owned and incremental drawdown is predicted to be localised and of short duration	☐ Yes ☒ No
Is the groundwater baseline provided sufficient (AIP requires 2 years)? Section 4.5 and Attachment A.	☒ Yes ☐ No
Has the proponent assessed vertical gradients between overlying water sources? Section 4.5 and Attachment A	☒ Yes ☐ No

Has the proponent provided water table elevation and potentiometric surface contour plans for water sources pre-development (including consideration of wet/winter and summer/dry seasonal variations), supported by points labelled with measured groundwater elevation? As the site is not a greenfields site, pre-mining data is not available, however data to illustrate the existing situation is presented in Section 4.5 and Attachment A (including modelled outputs).	☒ Yes ☐ No
Has the proponent provided evidence of spatial and temporal assessment of groundwater elevation and flow (that is, vertical and lateral with time and seasons)? Section 4.5 and Attachment A	☒ Yes ☐ No
Hydraulic properties	
Has the proponent conducted hydraulic tests at various locations across the project area? For example, slug tests, pumping tests, packer tests, core tests. Pumping tests are limited due to the low permeability Permian sediments. Testing has been conducted as part of historical investigations and documented in Attachment A	☒ Yes ☐ No
Has the proponent conducted a literature review of potential hydraulic properties for the water sources in the project area? For example, other projects in the area or textbook values. Attachment A	☒ Yes ☐ No
Groundwater quality	
Has the proponent included sufficient spatial & temporal variation in groundwater quality data? Section 4.5.4 and Attachment A	☒ Yes ☐ No
Was the potential for cross contamination of aquifers assessed sufficiently? Section 8.5	☒ Yes ☐ No
Is the baseline groundwater quality defined and described sufficiently with respect to the cultural and environmental values and the development? EIS Water Assessment (EMM 2022b)	☒ Yes ☐ No
Is quality assurance data provided? Available as part of the Annual Reviews, available on HVO's website (https://insite.hvo.com.au/)	☒ Yes ☐ No
Conceptual hydrogeological model	
Has the proponent described the hydrostratigraphic units in the project area? Section 4.6 and Attachment A	☒ Yes ☐ No
Has the proponent assessed and described potential surface water-groundwater interaction? Section 4 and 5, and Attachment A	☒ Yes ☐ No
Has the proponent considered existing water use in the area? Section 4.7 and Attachment A	☒ Yes ☐ No

Has the proponent provided a graphical representation of the conceptual hydrogeological model (cross section or three dimensional block model) to show hydrostratigraphy and other groundwater processes described above? Section 5 and Figure 5.1, Figure 5.2 and Attachment A	☒ Yes ☐ No
Has the proponent provided a graphical representation of potential groundwater dependence of GDEs within the project area? Section 4.7.3	☒ Yes ☐ No
Impact assessment (If any 'no' answers are recorded, then proponent to provide explanation)	
Is the assessment methodology commensurate with the risk and as agreed with DCCEEW? For example, analytical model versus simple numerical model vs complex numerical model? Numerical groundwater model used that has been informed by historical monitoring and modelling in the area. Consultation has occurred with DPE Water during the EIS assessment phase. Attachment A	☒ Yes ☐ No
Has the proponent completed the Aquifer Interference Assessment Framework form? Refer Annexure D.1	☒ Yes ☐ No
Has the proponent assessed the predicted impacts against the Aquifer Interference Policy "minimal impact considerations"? Section 8 and Attachment A	☒ Yes ☐ No
Has the proponent assessed the predicted impacts during construction, operations and post-development? Section 8 and Attachment A	☒ Yes ☐ No
Have the potential impacts from changes in water quality, water quantity, aquifer integrity and biological integrity of groundwater dependent ecosystems been identified and quantified? Section 8, 9 and Attachment A, and Appendix L of the Amendment Report	☒ Yes ☐ No
Has the proponent assessed the potential presence of acid sulfate soils? Considered but not applicable. Refer Section 6.3	☒ Yes ☐ No
Has the proponent assessed the potential for generation of acid metalliferous drainage? Section 4.6, 8.5 and EMM (2022b)	☒ Yes ☐ No
Has the proponent documented the predicted annual water take (per water source) on an annual basis? Section 11	☒ Yes ☐ No
Has the proponent documented the licensing pathway proposed to secure the required water entitlement for water access licence(s) for the predicted take? Section 11	☒ Yes ☐ No

Has the proponent assessed impacts on the groundwater dependent ecosystems and culturally significant sists in accordance with the Aquifer Interference Policy considerations? Section 9, Attachment A, and Appendix L of the EIS	☒ Yes ☐ No
Management and mitigation measures (If any 'no' answers are recorded, then proponent to provide explanation)	
Are the documented management and mitigation measures practical and measurable? Section 13	☒ Yes ☐ No
Has the proponent documented the approach to the proposed monitoring program during construction and operations? Section 13.2	☒ Yes ☐ No

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