HUNTER VALLEY OPERATIONS

CONCEPTUAL FINAL VOID MANAGEMENT PLAN

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1 | INTRODUCTION

1.1 | OVERVIEW AND BACKGROUND

Hunter Valley Operations (HVO) comprises the northern operations (HVO North) and southern operations (HVO South). HVO North and HVO South are separated by the Hunter River and are located approximately 24 kilometres (km) north-west of Singleton in New South Wales (NSW) (refer Figure 1.1). HVO is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd is the appointed manager of the JV.

The current development consent for HVO North (DA 450-10-2003) authorises mining until 12 June 2025. Under Schedule 3, Condition 28 of development consent DA 450-10-2003, development of a final void management plan is required five years prior to cessation of open cut coal extraction.

HVO is currently conducting assessments to inform a development application and accompanying Environmental Impact Statement (EIS) for the HVO Continuation Project which if approved, would extend the mining operation at HVO North to 2050. EMM Consulting Pty Ltd (EMM) understands that HVO has engaged with the NSW Department of Planning, Industry and Environment (DPIE) to defer the requirement of the final void management plan. However, the Planning and Assessment Group of DPIE has advised that a ‘high-level’ final void management plan is required by the end of 2021.

This ‘high-level’ (or conceptual) final void management plan:

- addresses all three voids currently approved;
- is based on the final voids currently approved and discussed in the Mining Operations Plan (MOP; SLR 2021) and reflective of the 2025 mine plan; and
- introduces the final void management plan and outlines a scope of work to come as the mine plan progresses.

The 2025 pit shell (topography) is presented on Figure 1.1.

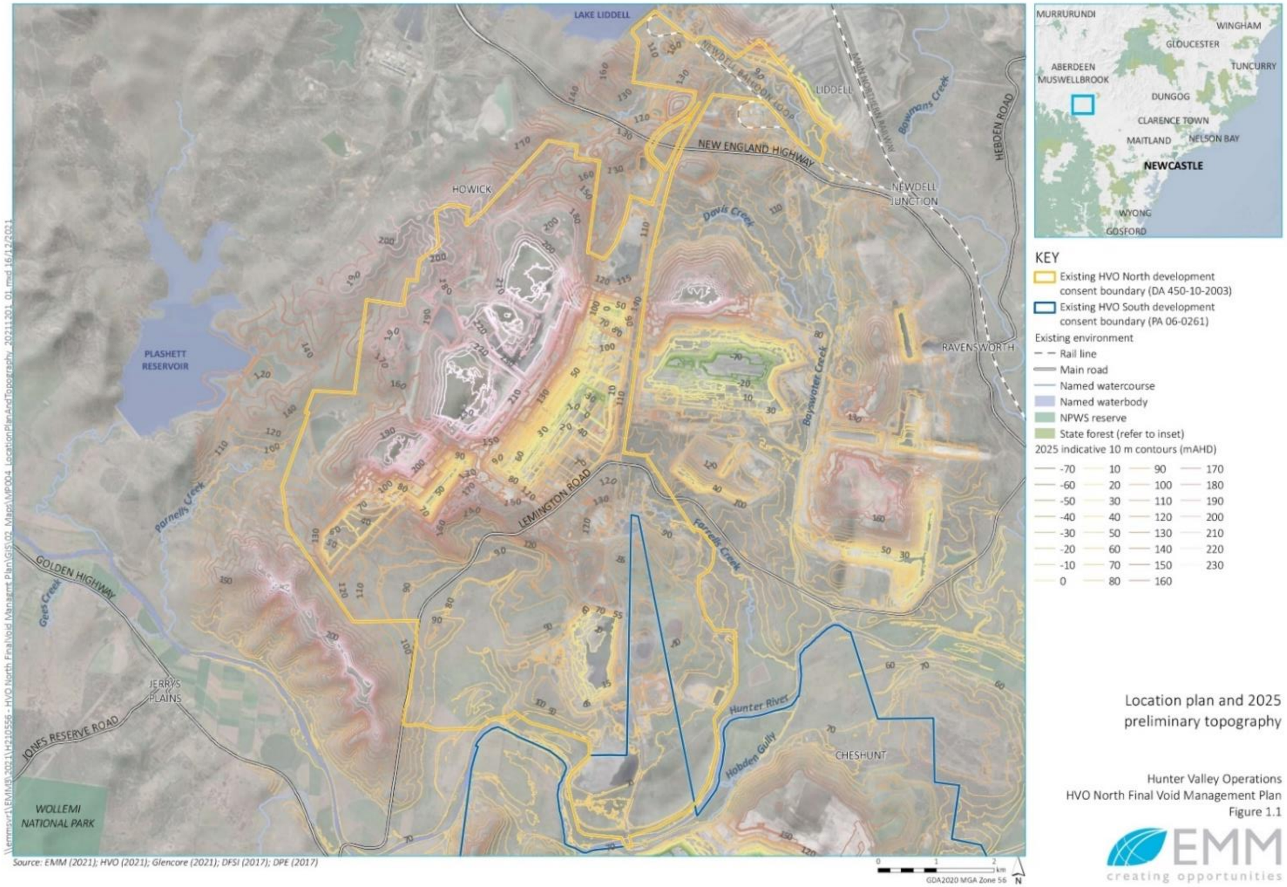


Figure 1.1-Location plan and 2025 Preliminary Topography

1.2 | PURPOSE

The purpose of this conceptual final void management plan is to introduce the concepts of the final void management and provide an overview of the potential short and long-term impacts of the final voids on groundwater resources and associated receptors. In addition, the purpose of this plan is to identify future work scope to develop a detailed plan, in consultation with the NSW Government. As outlined above, this plan is consistent with the approved MOP (SLR 2021) and reflective of the 2025 mine plan.

2 | REGULATORY REQUIREMENTS

HVO North operates under Development Consent DA 450-10-2003, which was issued under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). DA 450-10-2003 has been modified on seven occasions with the most recent modification (Mod 7) approved on 28 July 2017. DA 450-10-2003 approves the extraction of up to 12 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the West Pit and 10 Mtpa of ROM coal from the Carrington Pit. The requirement for a final void management plan is documented in schedule 3, Condition 28 of DA 450-10-2003 and states:

At least 5 years before the cessation of open cut coal extraction that will result in the creation of a final void, or as otherwise agreed with the Secretary, the Applicant must prepare a Final Void Management Plan for each void, in consultation with DRE and DPI Water, and to the satisfaction of the Secretary.

The requirements under Condition 28 are presented in Table 2.1-Final void management plan requirements under DA 450-10-2003

Table 2.1-Final void management plan requirements under DA 450-10-2003

Requirement	Relevant section of management plan
Assess locational, design and future use options	Section **Error! Reference source not found.** and 7
Be integrated with the Water Management Plan and the Rehabilitation Plan	Section **Error! Reference source not found.** and **Error! Reference source not found.**
Assess short-term and long-term groundwater and other impacts associated with each option	Section **Error! Reference source not found.** and **Error! Reference source not found.**
Describe the measures to be implemented to avoid, minimise, manage and monitoring potential adverse impacts of the final void over time	Section **Error! Reference source not found.** and **Error! Reference source not found.**

3 | ENVIRONMENTAL CHARACTERISATION

3.1 | SURFACE WATER

The Hunter River is the largest watercourse in HVO North area. The Hunter River is regulated by releases from Glenbawn Dam located approximately 35 km north of HVO North. The river flows in an easterly direction at the southern boundary of HVO North. Tributaries to the Hunter River in the HVO North area includes:

Parnells Creek to the north-west, which has a highly modified catchment due to historical mining and is frequently dry except following large rainfall events;

Farrells Creek in the east of the consent boundary, which is an ephemeral creek and also has a highly modified catchment in some areas due to historical mining; and

an unnamed tributary in the south of the HVO North consent area, which is ephemeral.

Drainage in the area is shown on Figure 3.1

3.2 | GEOLOGY AND SOILS

HVO North is within the Sydney Basin which was formed via igneous rifting and crustal thinning in the Late Carboniferous – Early Permian. It comprises Permian and Triassic sedimentary sequences. The operation extracts coal from seams within the Permian Jerrys Plain and Vane subgroups.

The HVO North and South area is characterised by two distinct geological units, namely Quaternary alluvium occurring within the Hunter River flood plain (and associated tributaries including Wollombi Brook) and the Permian coal measures that form the bedrock, where coal seams are present.

The Quaternary alluvium, mainly occurring along the Hunter River, contains two main depositional units, surficial fine-grained sediments (clay, silt and sand) overlying a coarser basal material (sand and gravel). An ancient river meander carved into the underlying Permian sediments and infilled with alluvial sediments forms a paleochannel to north of the Hunter River, west of Carrington Pit.

The Permian strata, underlying the Quaternary alluvium, comprise sequences of coal seams separated by overburden and interburden consisting of sandstone, siltstone, tuffs and conglomerate. In the HVO North area, the Permian strata dip gently to the south-east.

In the Hunter Coalfield, a group of smaller thrust faults running parallel to subparallel to the Hunter- (Mooki) thrust and a series of northerly trending folds displaces the Permian sequences. Two prominent folds occur in the Hunter Coalfield near HVO North and South; these are the Muswellbrook Anticline (to the west of HVO North), and the Bayswater Syncline north-west of Singleton (north and east of HVO North).

Historically mined areas at HVO North have been backfilled with spoil and fine rejects. The historical Alluvial Lands mining area has been rehabilitated. The spoil comprises a mix of Permian interburden and overburden material that is generated as waste from the open cut coal mining process.

Figure 3.1 presents the surface geology in the area.

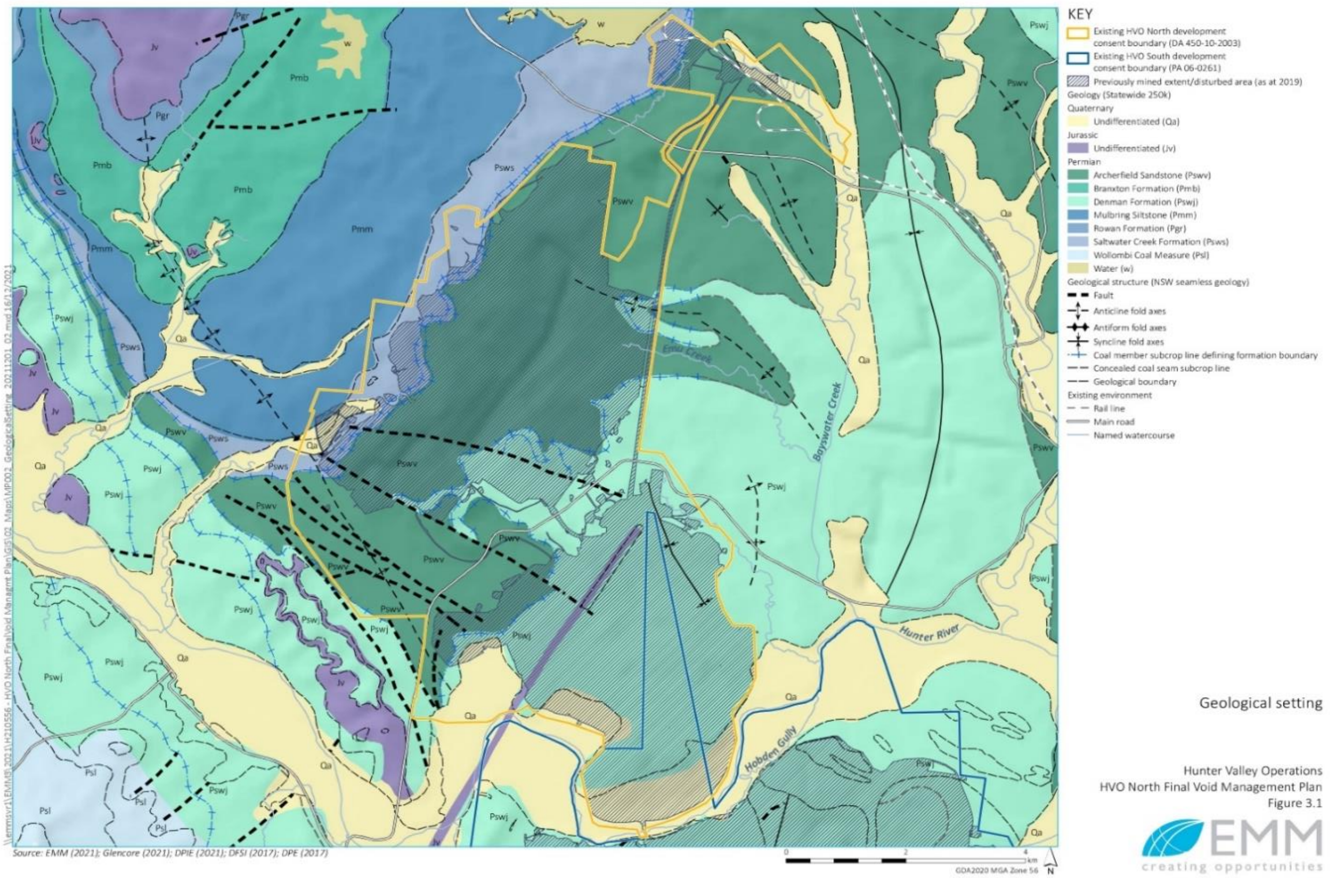


Figure 3.1-Geological setting

3.2.1 | GEOCHEMISTRY OVERVIEW

A geochemical assessment, comprising geochemical testing of the full overburden/interburden sequence mined at HVO North, has been conducted as part of the HVO Continuation Project (EGi 2021). The results indicate the vast majority of overburden/interburden material is likely to be non-acid forming (NAF) with low leachable salinity. Some thin potentially acid forming (PAF) pyritic zones were identified generally closed to the coal seams. The acid rock drainage (ARD) risk for the final voids is considered low.

3.3 | GROUNDWATER

The main hydrostratigraphic units within the HVO North and HVO South area are based on the geological units and their ability to store and transmit water, and include:

- Quaternary alluvium, which forms a relatively thin aquifer system where it occurs along the major creeks and rivers; and
- Permian sediments that can be divided into:
  - thin and variably permeable weathered rock at the surface (regolith). They generally do not form aquifers due to limited saturated thickness;
  - non-coal interburden that forms aquitards; and
  - low to moderately permeable coal seams that act as the most transmissive strata within the coal measures, but still relatively poorly transmissive aquifers.

The Regulated Hunter River is the dominant source of recharge to the Hunter River alluvium. The conceptual understanding is that the Hunter River is in direct connection with the alluvium, maintaining groundwater levels and saturated thickness within the alluvium. Generally, the groundwater flow direction is downward from the alluvium to the Permian, resulting in downward leakage slowly from the alluvium to the Permian.

3.4 | WATER RECEPTORS

3.4.1 | THIRD-PARTY BORES

A search of the National Groundwater Information System (NGIS) database identified 16 registered third-party bores for irrigation and water supply within a search radius of 5 km from Carrington void. Of the 16 registered bores, 6 are functioning and 10 have an unknown status. These groundwater bores are mainly installed within the Hunter River alluvium, suitable for stock and irrigation.

3.4.2 | GROUNDWATER DEPENDENT ECOSYSTEMS (GDES)

Ecosystems that could rely on either the surface or subsurface expression of groundwater within or surrounding the HVO North area are those associated with:

- Creeks where groundwater is interconnected and provides baseflow. This includes the Hunter River and its tributaries.
- Shallow groundwater systems.
- Terrestrial vegetation overlying shallow groundwater (within the vegetation root zone).

Potential aquatic and terrestrial GDE occurrences in the HVO North area are presented in Figure 3.2. The map includes areas of low to high potential GDEs mapped in the National Atlas of Groundwater Dependent Ecosystems (GDE Atlas). The areas of moderate and high potential GDEs are largely associated with the Hunter River and its tributaries.

A site-specific GDE assessment of HVO North and the surrounding area conducted by Ecological Australia (ELA) identified the following potential GDEs (ELA 2021):

- subterranean fauna within aquifer ecosystems (eg stygofauna) of the Hunter River and associated tributary aquifers;
- River Red Gum populations at Carrington Billabong, and along the Hunter River; and
- River Oak Grassy Riparian Woodland of the Hunter River riparian zone.

The Carrington Billabong is an ephemeral freshwater wetland south of Carrington Pit. An existing low permeability barrier wall separates the billabong and Carrington Pit (refer Figure 3.2), resulting in relatively stable groundwater levels supporting the billabong despite the historical mining. The Carrington Billabong, as well as the River Red Gum communities identified elsewhere along the Hunter River, are maintained by flows in the Hunter River, including leakage from the river into the alluvium aquifer(s).

The River Oak Grassy Riparian Woodland, which occurs between HVO North and HVO South next to the Hunter River, has been mapped in the GDE Atlas as having high potential for groundwater dependence.

Stygofauna are known to occur in alluvial sediments in the Hunter Valley area along the Hunter River and its tributaries. They may also occur in the shallow fractured rock up to 60 m depth where they colonise fracture networks of secondary porosity. The presence of stygofauna becomes increasingly uncommon in the deeper, unweathered rock where increasing groundwater salinity, and low dissolved oxygen levels limit their occurrence (ELA 2021).

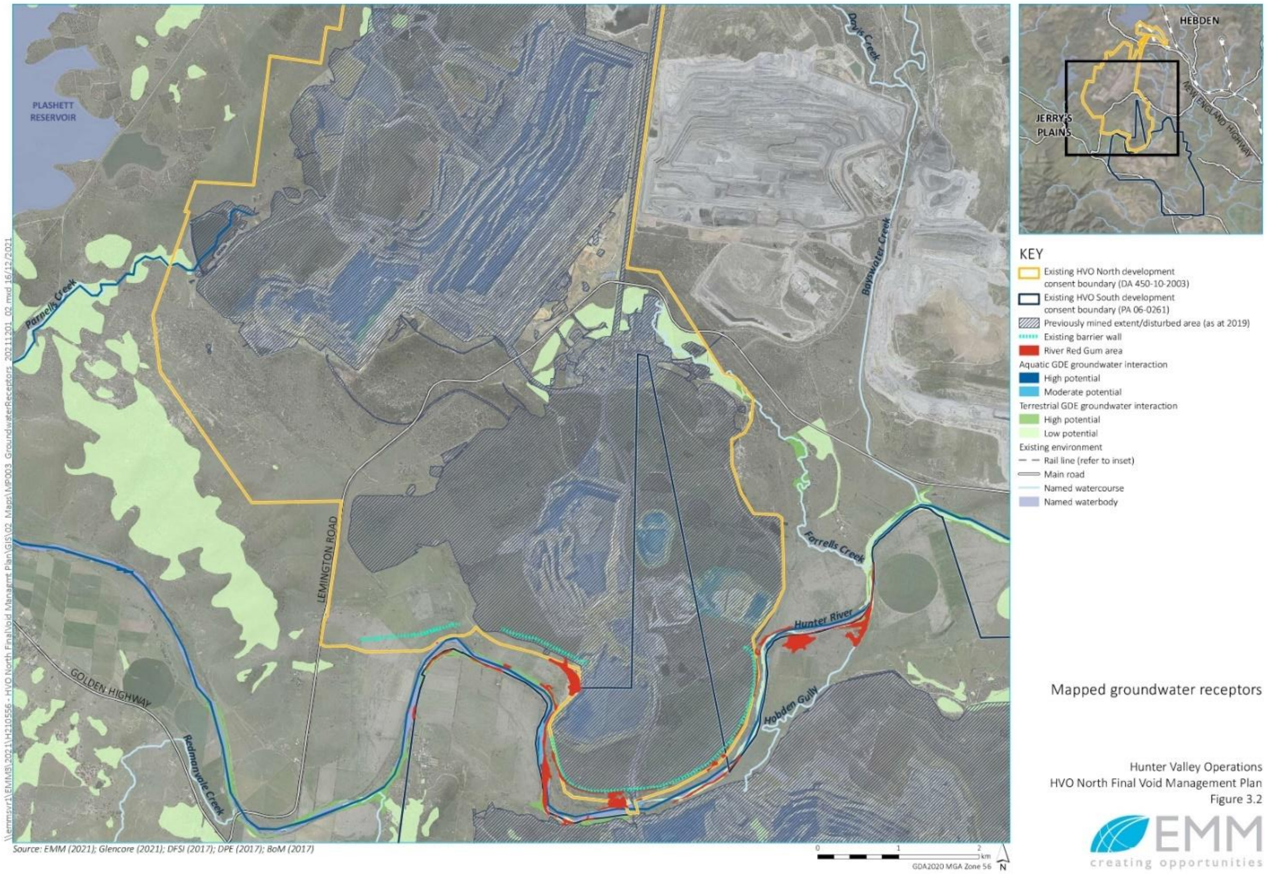


Figure 3.2-Mapped groundwater receptors

4 | FINAL VOID LOCATION AND DESIGN

4.1 | APPROVED POST-MINING LANDFORM (MOP 2021)

As approved under DA 450-10-2003 and documented in Section 3.3.6 of the approved MOP (SLR 2021) and shown on Plan 4 of the MOP (represented below in Figure 4.1), the final land uses across the site will include a combination of grazing (generally 70%) and native vegetation and fauna habitat (30%). The unavoidable exception to rehabilitated land will be the loss of land associated with the final voids and evaporative sinks. Plan 4 (represented as Figure 4.1 below) of the MOP represents the conceptual final landform and land use in 2030, five years following cessation of approved mining. The MOP (SLR 2021) presents three final voids across West Pit North, West Pit South and Carrington Pit (Figure 4.1), operating as evaporative sinks and pit lakes. Drainage lines from the final landform will be compatible with the surrounding drainage network.

Final landform slopes will vary according to erosion hazard, stability and drainage requirements. The approved MOP (SLR 2021) and Mod 6 Environmental Assessment (EA) (EMM 2016) commits to maximum external slopes of 10° or less. Internal slopes may be steepened to grades up to 18° (subject to design and approval). Slopes above 10° would typically by covered by woodland or grassland. As documented in the Mod 6 EA (EMM 2016) and MOP (SLR 2021), final landforms at Carrington Pit, Carrington west wing extension (yet to be mined), North Pit and the Alluvial Lands will reflect pre mining landscapes of undulating hills, and flat and gently sloping areas.

The key HVO North rehabilitation objective is to reinstate all mined land to its original land capability class or to a quality and condition suitable to the intended land use (grazing, native vegetation / fauna habitat) (SLR 2021). Pre-mining land capability classes (as defined in the rural land capability classification system; Cunningham et al 1988) range from Class I (10% in the Alluvial Lands area) to VIII (up to 37% in the Carrington west wing extension area). The majority of the land falls within Class IV and is therefore generally unsuitable for long term cultivation, but is suitable for grazing land (SLR 2021).

The following final void objectives are documented in the MOP (SLR 2021):

- highwalls above the pit lake level will be vegetated with woodland vegetation communities, or other vegetation as deemed appropriate through erosion and rehabilitation design;
- overburden emplacements will be designed and constructed to drain away from final voids;
- the final landform will be shaped to minimise the surface water catchment draining to the voids;
- final voids will be safe, profiled for long-term stability, and non-polluting;
- hazardous materials and contaminated materials will be removed;
- risk of coal seam spontaneous combustion will be minimised;
- risk of acid rock drainage will be minimised; and
- final voids will be used for water storage post-mining.

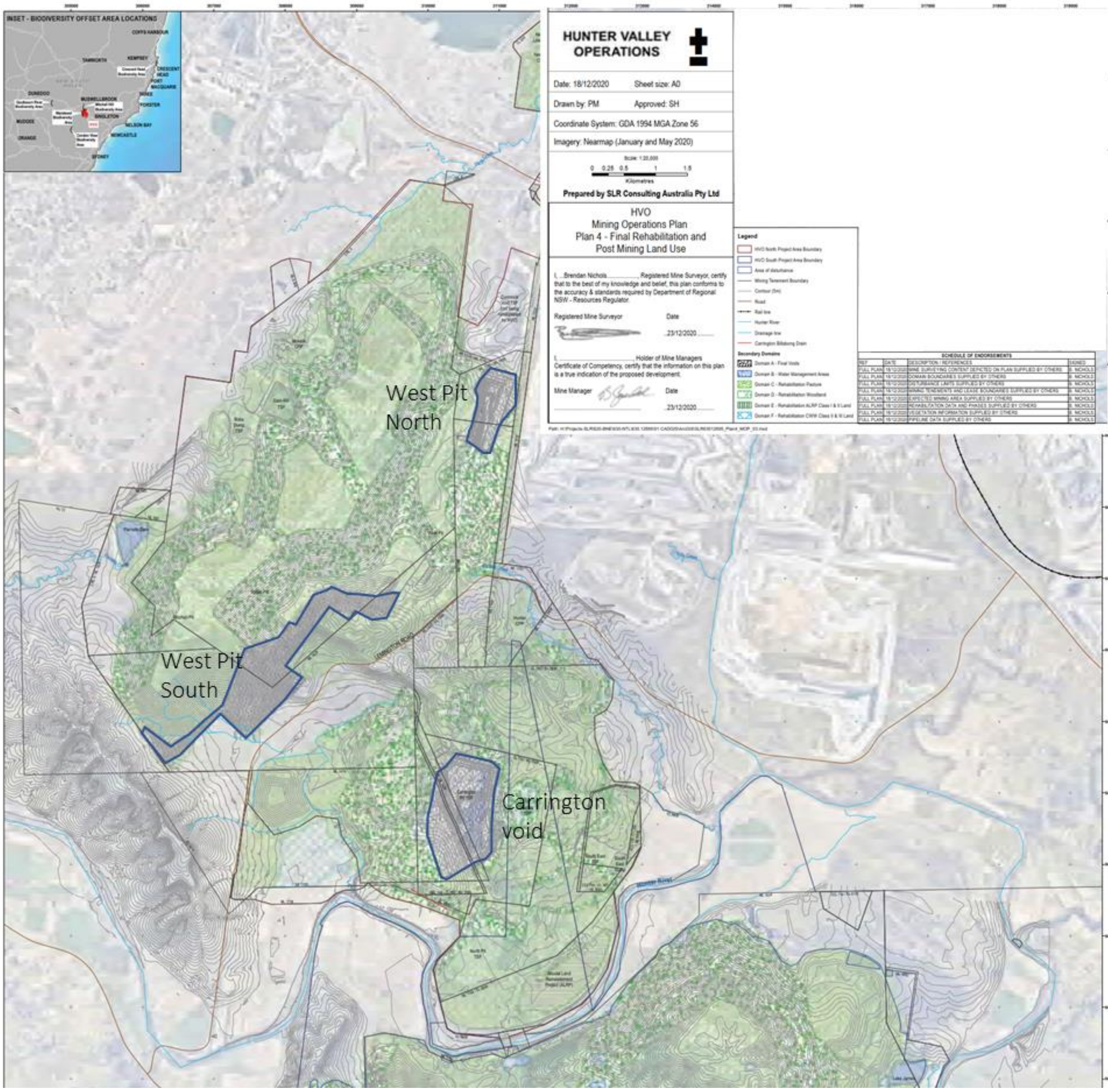


Figure 4.1-HVO MOP Plan 4 – HVO North Final Rehabilitation and Post-mining Land Use (adapted from SLR 2021)

4.2 | PRELIMINARY AND CONCEPTUAL VOID LOCATIONS

Figure 4.2 presents the preliminary and conceptual final void locations based on the current mine plan, as approved by the MOP, if mining were to cease in June 2025. The final voids presented in the approved MOP and development consent represent void locations following mining of the resource within the approved disturbance area. However, as mining is occurring at a slower rate, the void locations presented in Figure 4.2 differ slightly to those shown in Figure 4.1.

Consistent with the MOP (SLR 2021), if mining were to cease in June 2025, the land will be rehabilitated to meet the objectives as defined in the MOP (SLR 2021) and Mod 6 EA, and three main voids will form part of the final landform, with the following potential land uses:

i. Carrington void (consistent with the MOP and Mod 6 EA) – open water storage or a tree planted void;

ii. West Pit South void – open water storage; and

iii. West Pit North void (made up of two sub-voids that are separated by a pillar of spoil) – open water storage.

Surface water will be diverted away from the highwalls to reduce the potential for erosion of the regraded highwall due to concentrated flow. The voids will be designed and rehabilitated to meet the objectives listed in Section 4.1 |and the requirements of the development consent.

The final voids will naturally fill with water and will provide some potential habitat for some fauna. Further discussion on each void is provided in sub-sections below.

Figure 4.3 presents an illustration of a cross section through the West Pit North voids and Carrington in 2025, based on the approved mine plan. It illustrates the difference in mined coal seams and mine depths, as per the development consent. The voids are expected to remain evaporative sinks.

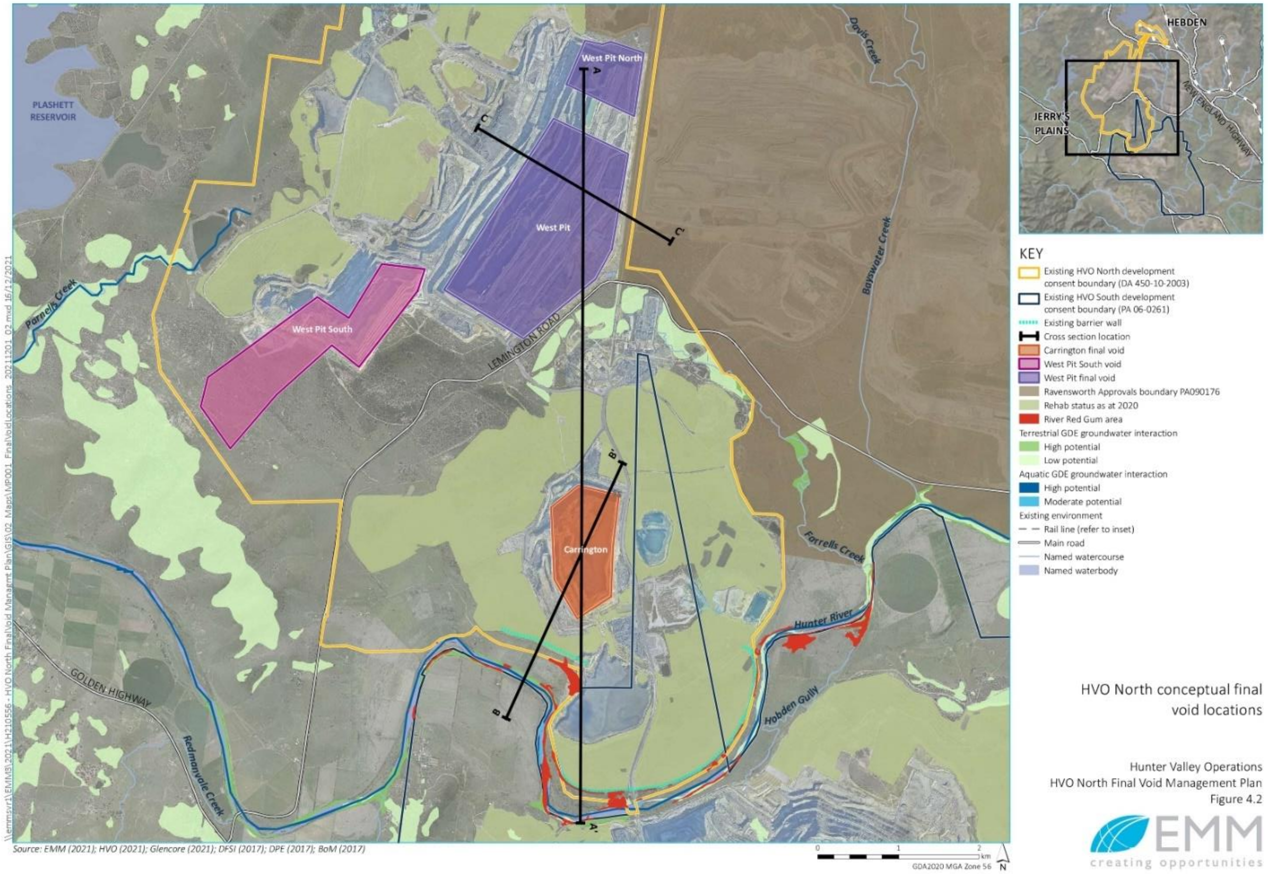


Figure 4.2-HVO North conceptual final void locations

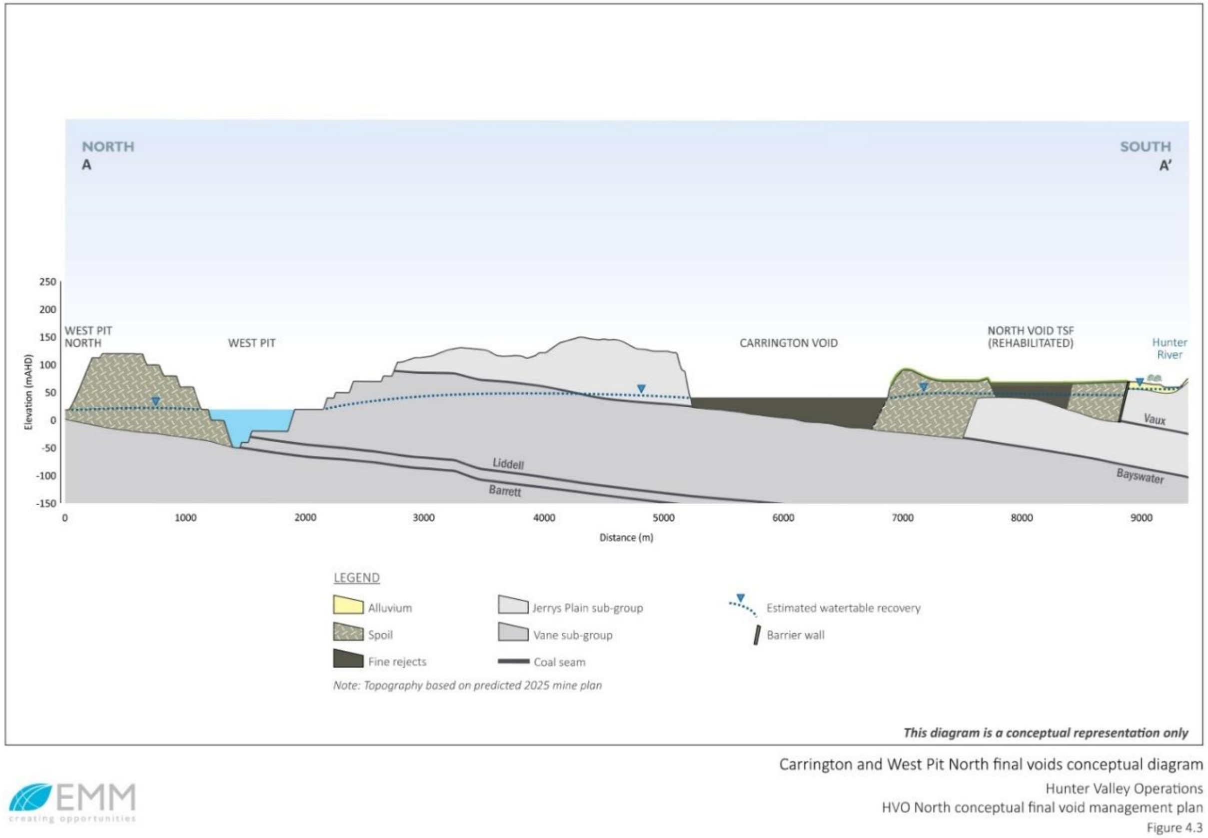


Figure 4.3-Carrington and West Pit North final voids conceptual diagram

4.2.1 | CARRINGTON VOID

In 2017, a modification to development consent DA 450-10-2003 (Mod 6) was approved for fine reject emplacement within Carrington Pit. In 2019, emplacement of tailings in-pit commenced at Carrington Pit. As per the EA (EMM 2016) and development consent, the Carrington void will be reshaped with a final void of approximately 100 ha and water levels in the void will recover with time.

Two options are approved for the post-mining use of the Carrington final void: an open water void and a tree planted void (refer to Sections 4.2.1 |(i) and 4.2.1 | (ii) below). The Director-General's Assessment Report for the Carrington Pit Extended SEE (ERM 2005) identified the tree planted void as the preferred option. Regardless of the option, the final void has been designed and approved to be an evaporative sink to manage groundwater post-mining. Each option is discussed further below.

As part of rehabilitation, the fine rejects will be capped and rehabilitated to promote evaporation. Prior to capping, water will be decanted from the area until the surface is dry and stable, and reaches sufficient strength. This will be confirmed by monitoring. At least 2 m of capping (using inert material sourced from surrounding stockpiles) will be place at the northern end (near the deposition points) and up to 6 m at the southern extent.

The evaporative sink would maintain the hydraulic gradient towards the open void, ensuring water within the spoil preferentially drains towards the final void, rather than interacting with the Hunter River alluvium.

An indicative cross section of the Carrington in-pit TSF area during operation, capping and rehabilitation was presented in the Mod 6 EA and represented as Figure 4.4 below.

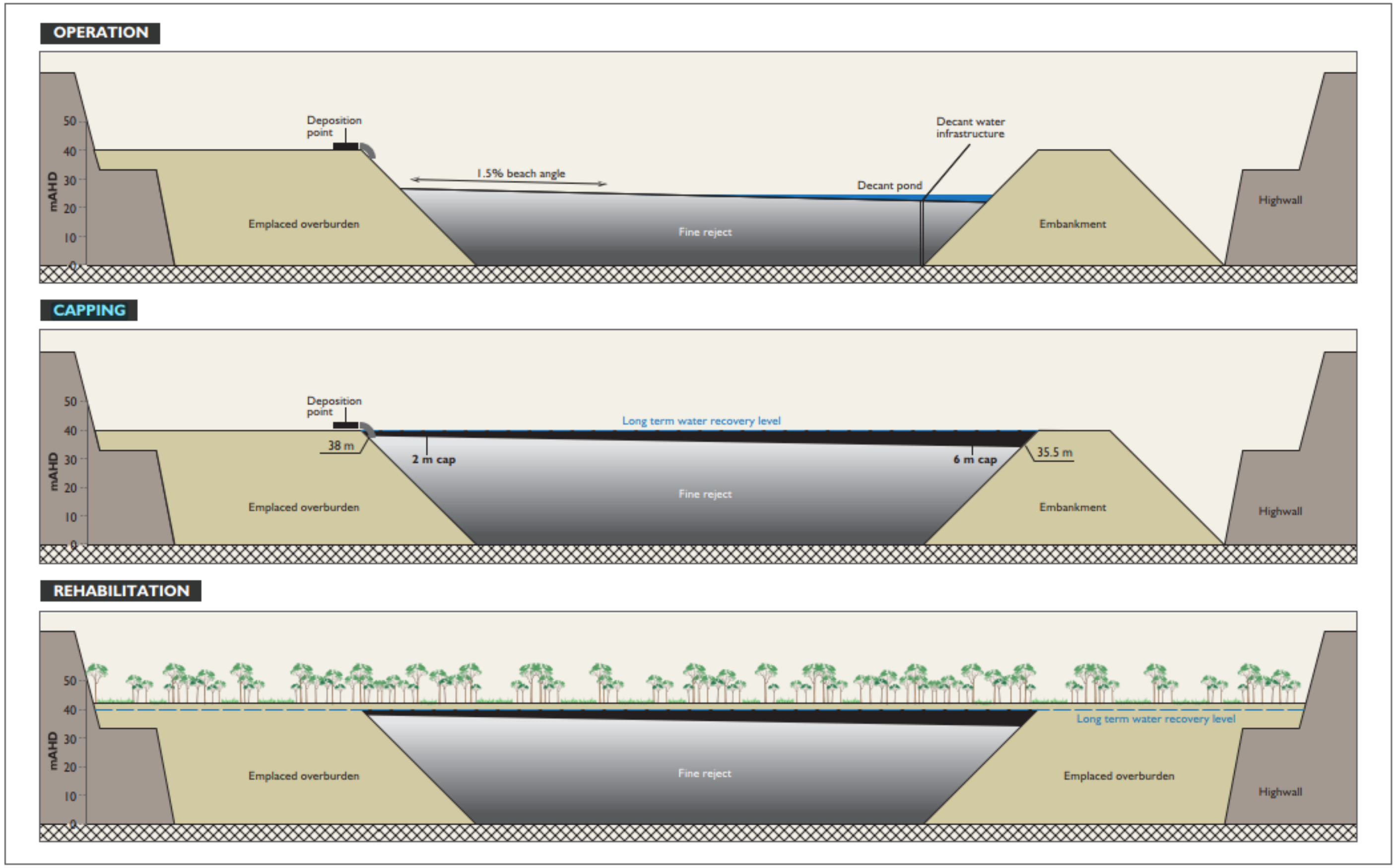


Figure 4.4-Carrington void-conceptual section of proposed fine reject emplacement during operation, capping and rehabilitation (treed void option) (EMM 2016)

4.2.1.1 | OPTION 1 – OPEN WATER VOID

Previous groundwater assessments (MER 2010) predict a long-term pit lake water level of around 40 mAHD, which is above the planned fine rejects emplacement level (38 mAHD).

The long-term pit lake recovery level is expected to be approximately 25 m below the crest of the barrier walls and approximately 20 m below the average Hunter River level (58-60 mAHD).

Salinity of the pit lake is expected to increase with time due to evapoconcentration; however, the concentration would be dependent on rainfall runoff contribution, evaporation and groundwater inflow rates.

4.2.1.2 | OPTION 2 – TREED VOID

For the treed void design, rehabilitation of the Carrington void would include placement of capping, a capillary break and sufficient topsoil to establish vegetation (trees) within the void. Tree planting would use species with high transpiration rates to maintain the void water level below ground level. As there is the potential for the void water level to rise into the root zone, the selected tree species would need to be tolerant to temporary inundation.

Capping material would be sourced from overburden and previous sampling and analysis demonstrates the soil has low natural salinity (electrical conductivity ranging from 0.05 to 0.92 dS/m in the West Pit area and 0.05 to 1.1 dS/m in the Carrington Pit area) (EMM 2016).

The long-term water level in the treed void is expected to recover to a similar level as the open water void option.

4.2.2 | WEST PIT VOID – NORTH AND SOUTH

The conceptual West Pit North voids (based on the 2025 mine plan) presented in Figure 4.2 differ in size and location to the proposed void presented in the MOP (SLR 2021) due to the predicted advance of the mine. Should mining cease in 2025, the West Pit North voids would include a larger void (approximately 340 ha) north of Lemington Road and a smaller void to the north, consistent with that presented in the MOP (SLR 2021).

The West Pit voids will be open water voids and are expected to be evaporative sinks. The West Pit North void is identified for tailings deposition in the Fine Reject Management Strategy (ATC 2018), subject to planning approval.

4.3 | RELATIONSHIP WITH OTHER PLANS

The final void management plan will form part of the rehabilitation and closure plan for HVO North, and will be integrated with the water management plan for the operation.

5 | RISK ASSESSMENT AND POTENTIAL IMPACTS

A conceptual impact assessment was conducted to identify the potential impacts of the final voids on groundwater, surface water and water receptors. The identified impacts were qualitatively assessed using a risk assessment approach (refer Section 6 |).

5.1 | POTENTIAL IMPACTS

The three final voids, Carrington void, West Pit North and West Pit South, are predicted to remain evaporative sinks, drawing groundwater towards the voids and would be designed to facilitate evaporative losses at a greater rate than the accumulation of groundwater, rainfall runoff and infiltration from the backfilled (spoil) areas.

The main impacts that could result from the final voids relate to changes in groundwater levels, groundwater quality and slope stability. Section 5.1 | describes the potential impacts specific to Carrington void and West Pit voids.

5.1.1 | CARRINGTON VOID

As described in Section 4 |, two options have been approved for the Carrington final void design: an open water void option and a tree planted void option. Figure 5.1 and Figure 5.2 present conceptual diagrams of the Carrington open water void option and tree planted option (based on the 2025 mine plan), and the main processes influencing groundwater regimes (short-term and long-term).

The conceptual assessment has been informed by previous assessments, including groundwater modelling completed by MER in 2005 and 2010, as well as the long-term established groundwater monitoring network at HVO North and South.

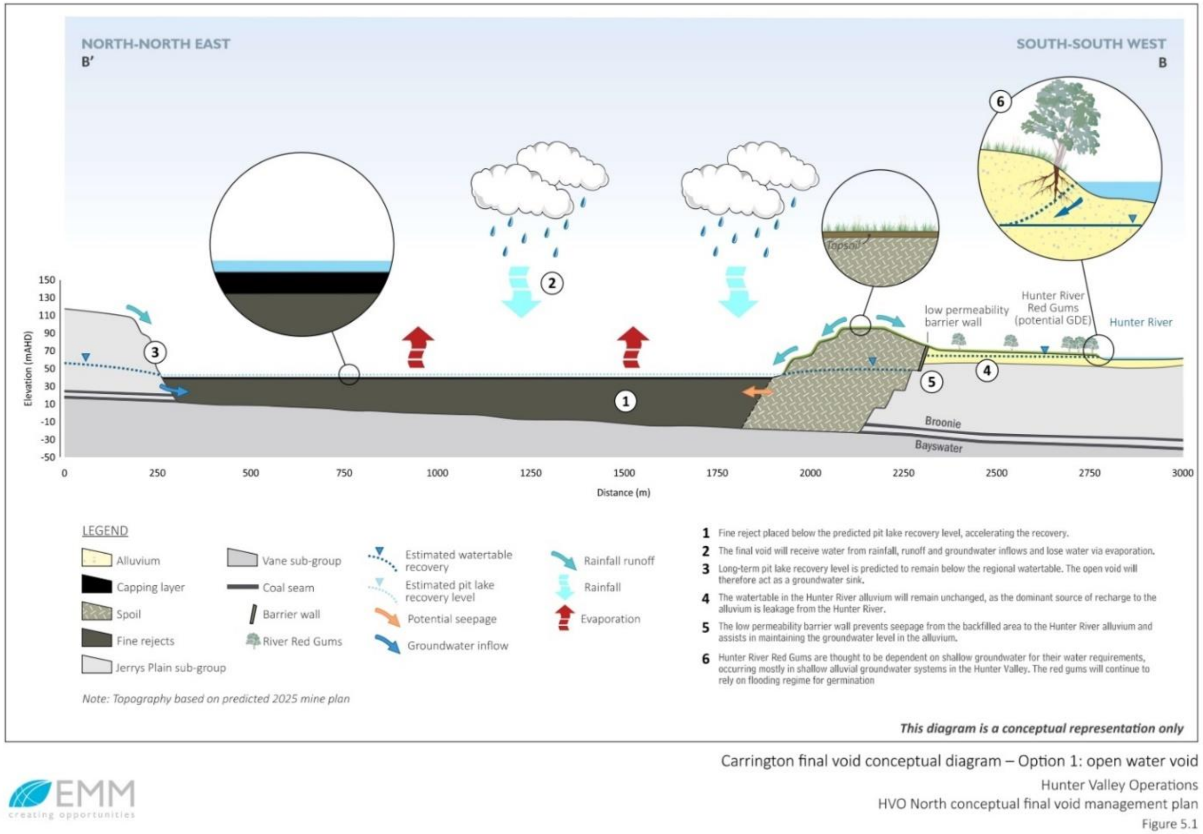
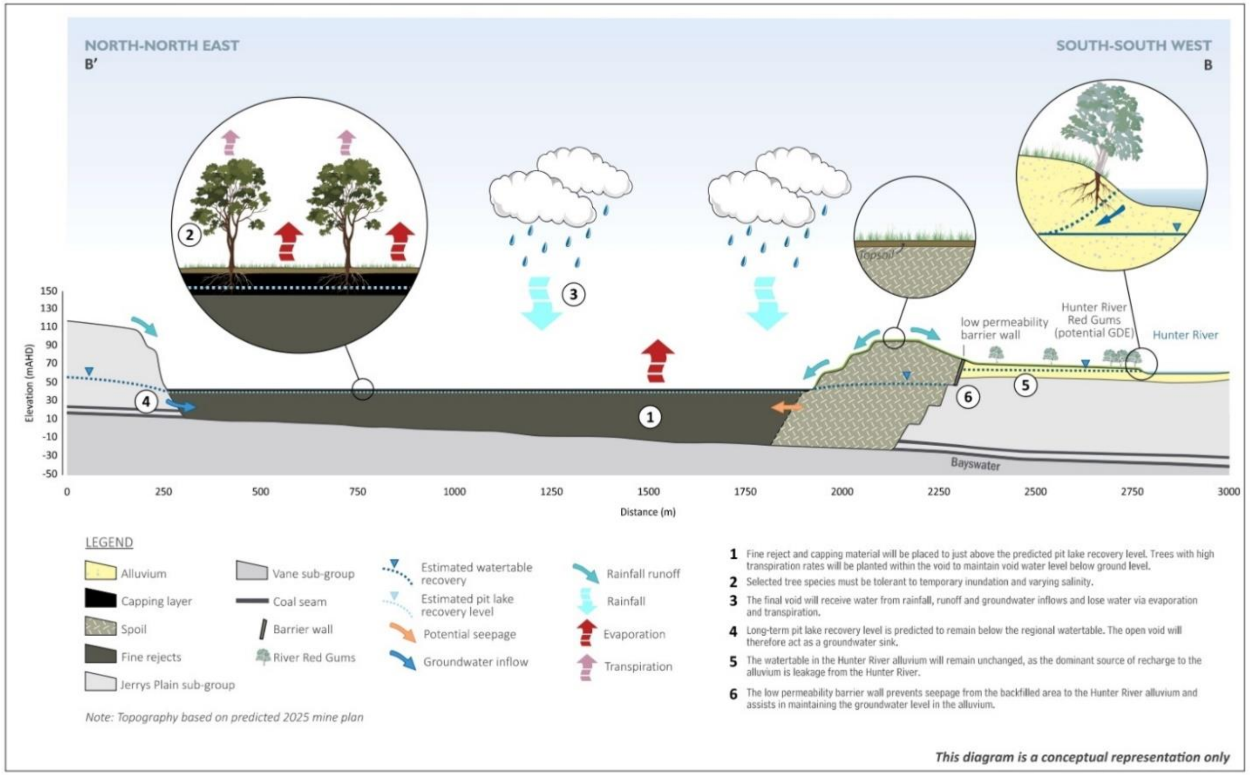


Figure 5.1-Carrington final void conceptual diagram – Option 1:open water void



EMM creating opportunities

Carrington final void conceptual diagram – Option 2: tree planted void
Hunter Valley Operations
HVO North conceptual final void management plan
Figure 5.2

Figure 5.2-Carrington final void conceptual diagram – Option 2: tree planted void

5.1.1.1 | GROUNDWATER LEVELS

Mining activities in the region, including at HVO North and South, has resulted in reduced groundwater levels in the Permian groundwater systems, and downward leakage from the alluvium to the underlying Permian bedrock. Following closure, groundwater levels in the Permian will recover slowly, and the final void (under both options) is predicted to remain an evaporative sink, drawing groundwater from the bedrock and spoil areas to the void.

MER (2010) predicted the long-term pit lake level in the Carrington void would be approximately 40 mAHD, which is approximately 25 m below the crest of the barrier walls and approximately 20 m below the average Hunter River level (58-60 mAHD).

The hydraulic gradient in the alluvium south of Carrington void is relatively flat, with a slight gradient towards the low permeability barrier wall (refer Figure 5.1). This is due to connection between the Hunter River and alluvium, and the regulated flows in the Hunter River maintaining the main source of recharge to the alluvium. The barrier wall will remain in place following closure, continuing to limit leakage from the alluvium into the HVO North area, and thereby limiting potential drawdown in the alluvium.

It is expected that there will be long-term minor indirect take from the Hunter River and the alluvium associated with the void (acting as a groundwater sink). HVO hold sufficient water access licences (WALs) in the Water Sharing Plan (WSP) for the Hunter Regulated River Water Source 2016 and the Water Sharing Plan for the Hunter Unregulated River and Alluvial Water Sources 2009 for the short-term and long-term indirect take. HVO also hold sufficient entitlement in the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016 for the groundwater take associated with the voids.

5.1.1.2 | WATER QUALITY

The final void at Carrington is currently being used to store fine rejects, which will be placed to below the predicted pit lake recovery level to avoid oxidation and acidification due to air exposure. The maximum fine rejects elevation is 38 mAHD. As described in Section 4 |, a layer of capping material (eg overburden) will cover the fine rejects once the surface crust is of sufficient strength.

In the open water void option, MER (2010) predicted the water quality in the fine rejects and final void would be moderately saline (ranging from 1,000 to 4,000 mg/L total dissolved solids) and sulphate dominant. Salinisation of the void water is not predicted to pose a risk to the surrounding groundwater regime as the final void will remain a permanent sink, preventing the potential movement of void water to the surrounding groundwater systems.

In the tree planted option, the void water level is expected to remain below the ground level with capping to be placed above the predicted recovery level. The trees will generate transpiration losses, thereby preventing water accumulating in the final void. This option would therefore result in lower salinisation and promote beneficial use of the final void.

The void water pH is expected to range from pH 7.5 to 9.5 (EMM 2016).

5.1.1.3 | IMPACTS TO WATER RECEPTORS

Groundwater receptors have been identified in the vicinity of Carrington void (Carrington Billabong, other River Red Gum communities and stygofauna). These receptors access water in the Hunter River alluvium, which is recharged by the regulated Hunter River. Groundwater monitoring and assessments for HVO North and South has demonstrated that the low permeability barrier wall is effective at limiting leakage from the alluvium into the Carrington pit area and also limiting potential seepage from Carrington void towards the Hunter River and associated alluvium (HVO 2021).

The barrier wall will remain in place following closure, continuing to limit these potential impacts. In addition, the void lake recovery level is also expected to remain well below the base of the alluvium, further limiting the risk of seepage from the spoil to the alluvium.

Therefore, receptors in the area are not expected to be adversely affected by the Carrington final void. As the regulated Hunter River is the dominant source of recharge to the alluvium, the vegetation communities (including those associated with the Carrington Billabong) and stygofauna in the alluvium in the HVO North area will continue to have access to water post-mining.

5.1.2 | WEST PIT VOIDS

Based on the 2025 mine plan, the conceptual West Pit voids would consist of three void areas: West Pit South, West Pit and Pit North. If mining were to cease in 2025, these voids would be designed as open water voids and would act as groundwater sinks.

Figure 5.3 presents a conceptual diagram of West Pit North void (based on the 2025 mine plan), the hydrogeological setting and the main processes influencing long-term groundwater regimes.

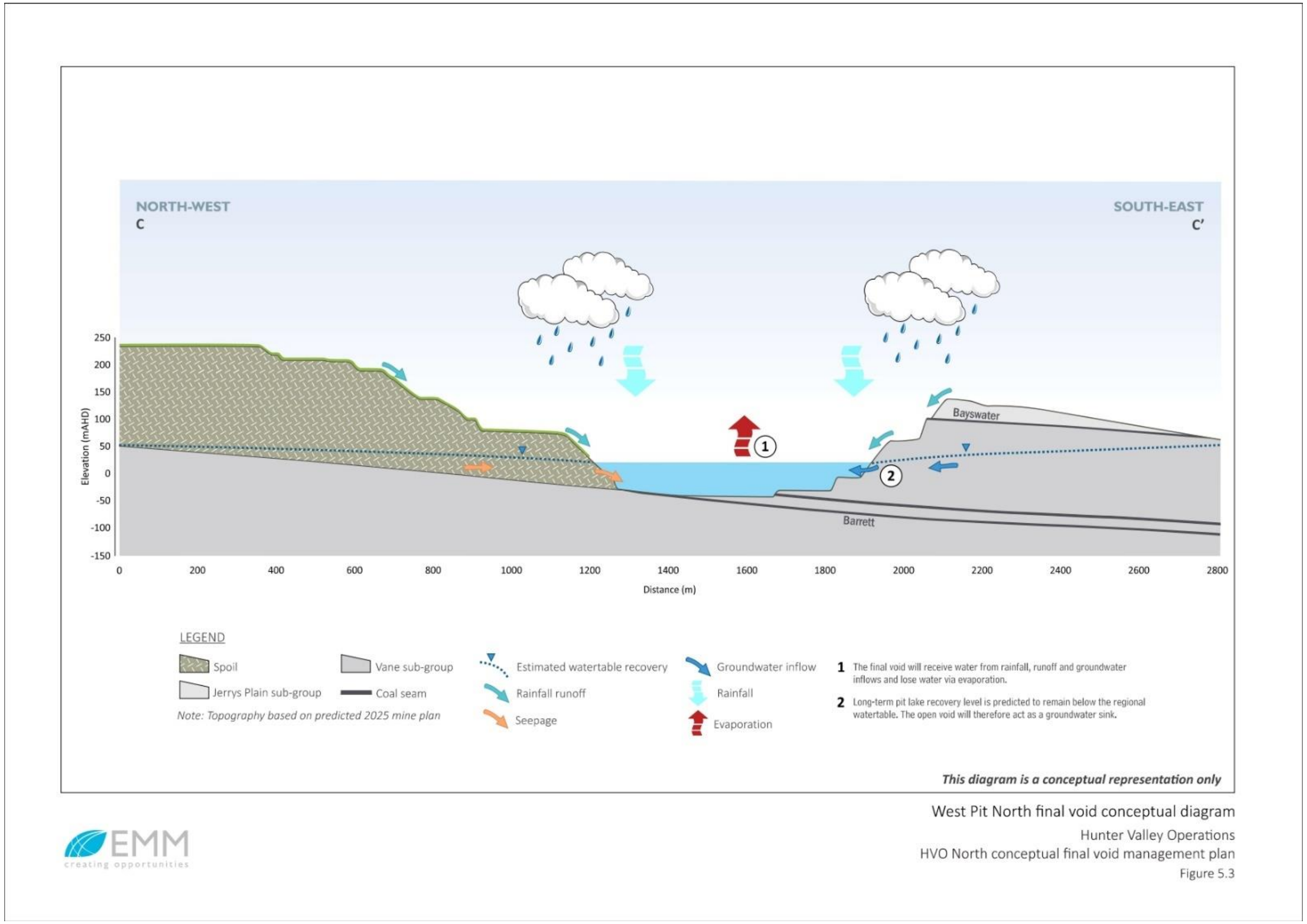


Figure 5.3-West Pit North final void conceptual diagram

5.1.2.1 | GROUNDWATER LEVELS

The West Pit extension EIS (ERM 2003) reported a long-term pit lake recovery level below 50 mAHD. Although, this assessment was based on smaller void areas in comparison to the conceptual voids based on the 2025 mine plan, the pit lake recovery level is expected to remain well below 50 mAHD due to higher evaporation losses from the lake.

Following closure, groundwater levels in the Permian will recover slowly, and the final voids are expected to remain evaporative sinks, drawing groundwater from the bedrock and spoil areas to the void.

The predicted final void equilibrated water levels at West Pit voids are predicted to remain below the regional watertable. Therefore, the voids are expected to act as evaporative sinks, drawing groundwater from the bedrock and spoil areas to the void.

5.1.2.2 | WATER QUALITY

The pit lakes associated with the voids is expected to exhibit salinity higher than existing pit water due to leaching of salts from spoil areas and evaporative processes. As the final voids are expected to act as groundwater sinks maintaining inward hydraulic gradients, void water quality is expected to remain largely isolated from the regional coal measures and surficial aquifers, limiting the risk of saline water seepage.

The void water quality is expected to have high salinity (ranging from 15,000 to 23,000 mg/L total dissolved solids) and sodium bicarbonate type. The pH is expected to range from 7.5 to 8.5 (ERM 2003).

5.1.2.3 | IMPACTS TO WATER RECEPTORS

Potential groundwater receptors have not been identified in the vicinity of West Pit voids (refer Figure 3.2).

As there are no receptors in the void areas and as the conceptual voids are expected to form evaporative sinks, the potential for impacts on receptors, as a result of the West Pit voids is unlikely. At the operation scale, the voids will result in the HVO North area forming a low point in the Permian groundwater system, acting as a groundwater sink.

6 | RISK ASSESSMENT AND CONTROLS

A risk assessment was undertaken on the conceptual void locations, based on the 2025 mine plan. The risk assessment has been used to identify knowledge gaps and prepare a future work scope for the final void management plan.

6.1.1 | METHODOLOGY

The risk assessment considers the potential consequence or severity of a potential impact / outcome and the potential likelihood of the outcome occurring.

Table 6.1 lists the consequence definitions that were applied.

Table 6.1-Risk assessment consequence definitions

Consequence	Health and Safety	Environment
1 – Negligible	• First Aid Injury (FAI) or illness (not considered disease or disorder)	• Near source and confined • No lasting environmental damage or effect (typically <day) • Requires minor or no remediation
2 – Minor	• Medical Treatment Injury (MTI) • Medical Treatment Disease (MTD) • Restricted Work Injury (RWI) • Restricted Work Disease (RWD)	• Near source • Short-term impact (typically <week) • Requires minor remediation
3 – Moderate	• Lost Time Injury (LTI) • Lost Time Disease (LTD) • Permanent Disabling Injury (PDI) • Permanent Disabling Disease (PDD) • Single incident that results in multiple medical treatments	• Medium-term (<2 years) impact (typically within a year) • Requires moderate remediation
4 – Major	• Single incident resulting in: Less than 5 Fatalities • Permanent Damage Injury or Disease that results in a permanent disability- less than 5 cases in a single incident	• Long-term (2 to 10 years) impact • Requires significant remediation
5 - Catastrophic	• Multiple fatalities (5 or more fatalities in a single incident) • Multiple cases (5 or more) of Permanent Damage Injuries or Diseases that result in permanent disabilities in a single incident	• Unconfined and widespread • Environmental damage or effect (permanent; >10 years) • Requires major remediation

The following likelihood definitions were applied:

- **Rare:** unlikely to occur during a lifetime or very unlikely to occur;
- **Unlikely:** Could occur about once during a lifetime or more likely not to occur than to occur;
- **Possible:** Could occur more than once during a lifetime or as likely to occur as not to occur;
- **Likely:** May occur about once per year or more likely to occur than not occur; and
- **Almost Certain**: May occur several times per year or expected to occur.

Table 6.2 presents the risk matrix used to identify environmental and health and safety risks associated with the conceptual final voids

Table 6.2 Risk assessment matrix

Basis of Rating	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)

6.1.2 | RISK RATINGS

The results of the risk assessment are provided in Table 6.3 and Table 6.4. The results present unmitigated risks, proposed mitigations /controls or studies, and a residual risk rating.

Table 6.3-Risk assessment – West Voids and Carrington void option 1

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Significant impact on Hunter River alluvium and associated receptors (quantity)	Groundwater inflows to the final voids from the Permian and alluvium; voids acting as sinks. Post-mining catchments and drainage lines not compatible with the surrounding drainage network and pre-mining catchments.	Significant impact on Hunter River alluvium and associated receptors (quantity). Regulated Hunter River is the source of recharge to the alluvium and associated receptors.	5-Low	Existing barrier walls Landform design (including water management) to direct as much of the catchment towards the Hunter River. Hydrological modelling to predict surface water captured by the void and other permanent structures. Groundwater modelling and assessment to predict long-term indirect take and potential impact Hydrology modelling (pit lake recovery) Existing water licences held by HVO (considerable) for associate direct and indirect take	1-Low

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Final voids differ to predicted (no longer sinks)	Final void water overtopping due to a difference in predicted and actual water balance, or water management measures differing to assumptions (inability to divert catchments away from void, incl Hunter River flooding)	Previous modelling suggests the potential for this is very unlikely, however additional modelling would need to be done to develop a final landform (representative of the current mine plan)	6-Low	Landform design (including water management), rehabilitation planning Groundwater modelling and assessments Hydrology modelling (pit lake recovery) Closure planning process	3-Low
Long-term water quality (surface & groundwater) in the voids, altering future use of final voids	Unexpected water quality ((salinity/ acidity) compared to previous predictions) in voids post-closure resulting in additional costs for water treatment and constraints to post-mining land use. Evapoconcentration of salts resulting in pit lake not suitable for native fauna	Previous assessment suggests salinity up to 10,000 mg/L TDS after 500 years. However additional modelling would need to be done to develop a final landform (representative of the current mine plan).	8-Medium	Landform modelling, rehabilitation planning (limiting the size of the voids) Groundwater modelling and assessments Hydrology modelling (pit lake recovery) Pit lake water quality modelling Closure planning process	5-Low
	Acid mine drainage	Selective handling of PAF material (minimal volumes). Previous geochemical assessments (neutralising capacity of interburden, etc) suggests the potential is unlikely (ARD risk is low)	5-Low	Erosion modelling as part of landform design. Geotechnical stability assessment. Final void will be designed according to erosion hazard, stability and drainage requirements. Landform design, closure and rehab planning Integration with water management plan	3-Low

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Impact on Hunter River and associated alluvium due to seepage from historical tailings areas (Carrington)	Tailings areas left uncapped / unrehabilitated and lateral connection from tailings areas to alluvium	Existing commitments and operating measures (MOP) to store tailings below alluvium. Existing barrier walls limiting potential seepage.	5-Low	Closure and rehab planning Landform design (incl water management) Existing barrier walls remain in place Tailings to be stored below equilibrated watertable (ie sink and below alluvium)	3-Low
Risk of coal seam spontaneous combustion on void walls	Areas with potential for spontaneous combustion not identified or managed as part of rehabilitation and closure	Coarse rejects and overburden have low potential for spontaneous combustion. Existing commitments and operating measures (Spontaneous Combustion Principal Hazard Management Plan). Potential to occur in West Pit area (midway up the highwall)	8-Medium	Updated geochemistry assessment Void modelling to understand risk better Management plans Closure and rehabilitation planning	5-Low
Safety and long-term stability of final voids, erosion	Final void slopes inadequate for void stability and not consistent with final land use (highwall)	Maximum external slopes will be less than 10°. Internal slopes may be steepened to grades up to 18°. Slopes above 10° would typically by covered by woodland or grassland	5-Low	Erosion modelling as part of landform design. Geotechnical stability assessment. Final void will be designed according to erosion hazard, stability and drainage requirements. Landform design, closure and rehabiltation planning Integration with water management plan	3-Low

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Safety and long-term stability of final voids, water management	Long term stability and functioning of contour banks and drop structures, leading to slope instability (related to water directed to the void)	Landform design and water management systems will minimise catchment of water directed to the voids. Existing commitments and operating measures in place (MOP)	5-Low	Final void will be designed according to erosion hazard, stability and drainage requirements. Landform design (incl water management) to direct as much of the catchment towards the Hunter River. Closure and rehab planning	3-Low
Public safety	Site not secure, bunding etc not in place to prevent interaction with voids	Unsecure site may result in public entering the void area	9-Medium	Restrict access, using techniques such as bunding and fencing to restrict access in the high wall area. Geotechnical stability assessment Closure planning	3-Low

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Sustainability of vegetation in the Carrington final void (quality)	Groundwater in the final void expected to become saline	Mod 6 (EMM 2016): Selected tree species to be resistant to saline water	8-Medium	Landform design (incl water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery and WQ modelling) Ecological assessments for species tolerance assessment	5-Low
	Recovered watertable / pit lake level is higher than predicted	A higher than predicted void water level could result in increased salinisation and leachate to surrounding formation Use of vegetation with high transpiration rates	8-Medium	Landform design (including water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery and water quality modelling) Capping design (2 to 6m, as per Mod 6 EA) to limit upward migration of salts and use of capillary break Ecological assessments for species tolerance assessment	5-Low

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Sustainability of vegetation in the Carrington final void (inundation)	High rainfall may lead to flooding of final void. Extended periods of inundation and elevated pit lake level could adversely affect trees (and associated fauna) in final void	Mod 6 (EMM 2016): Selected tree species to be resistant to inundation. Use of trees with high transpiration rates Limited catchment to report to the voids	13-Medium	Landform design (including water management aspects) Hydrology modelling (pit lake recovery) Ecological assessments for species tolerance for inundation and/or flooding	5-Low
	Recovered watertable / pit lake level is higher or lower than predicted	Capping to be undertaken just above the predicted water recovery level. Previously assessed predicted water recovery level (MER 2003, 2005, 2010)	8-Medium	Landform design (incl water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery) to inform design	5-Low

Table 6.4-Risk assessment – Carrington void option 2

Risk title	Trigger/cause	Background / rationale	Risk rating	Mitigation actions / controls	Residual risk rating
Sustainability of vegetation in the Carrington final void (quality)	Groundwater in the final void expected to become saline	Mod 6 (EMM 2016): Selected tree species to be resistant to saline water	8-Medium	Landform design (incl water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery and WQ modelling) Ecological assessments for species tolerance assessment	5-Low
	Recovered watertable / pit lake level is higher than predicted	A higher than predicted void water level could result in increased salinisation and leachate to surrounding formation Use of vegetation with high transpiration rates	8-Medium	Landform design (including water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery and water quality modelling) Capping design (2 to 6m, as per Mod 6 EA) to limit upward migration of salts and use of capillary break Ecological assessments for species tolerance assessment	5-Low
Sustainability of vegetation in the Carrington final void (inundation)	High rainfall may lead to flooding of final void. Extended periods of inundation and elevated pit lake level could adversely affect trees (and associated fauna) in final void	Mod 6 (EMM 2016): Selected tree species to be resistant to inundation. Use of trees with high transpiration rates Limited catchment to report to the voids	13-Medium	Landform design (including water management aspects) Hydrology modelling (pit lake recovery) Ecological assessments for species tolerance for inundation and/or flooding	5-Low
	Recovered watertable / pit lake level is higher or lower than predicted	Capping to be undertaken just above the predicted water recovery level. Previously assessed predicted water recovery level (MER 2003, 2005, 2010)	8-Medium	Landform design (incl water management aspects) Groundwater modelling Hydrology modelling (pit lake recovery) to inform design	5-Low

6.2 | MONITORING

The existing groundwater monitoring network is shown on Figure 6.1. The network includes monitoring bores installed within the alluvium, regolith, spoil and coal seams. Monitoring is conducted in accordance with the approved water management plan.

As part of the detailed final void management plan and closure planning, the monitoring network will be reviewed to ensure it meets the closure objectives. This would include identifying bores to be decommissioned as part of closure.

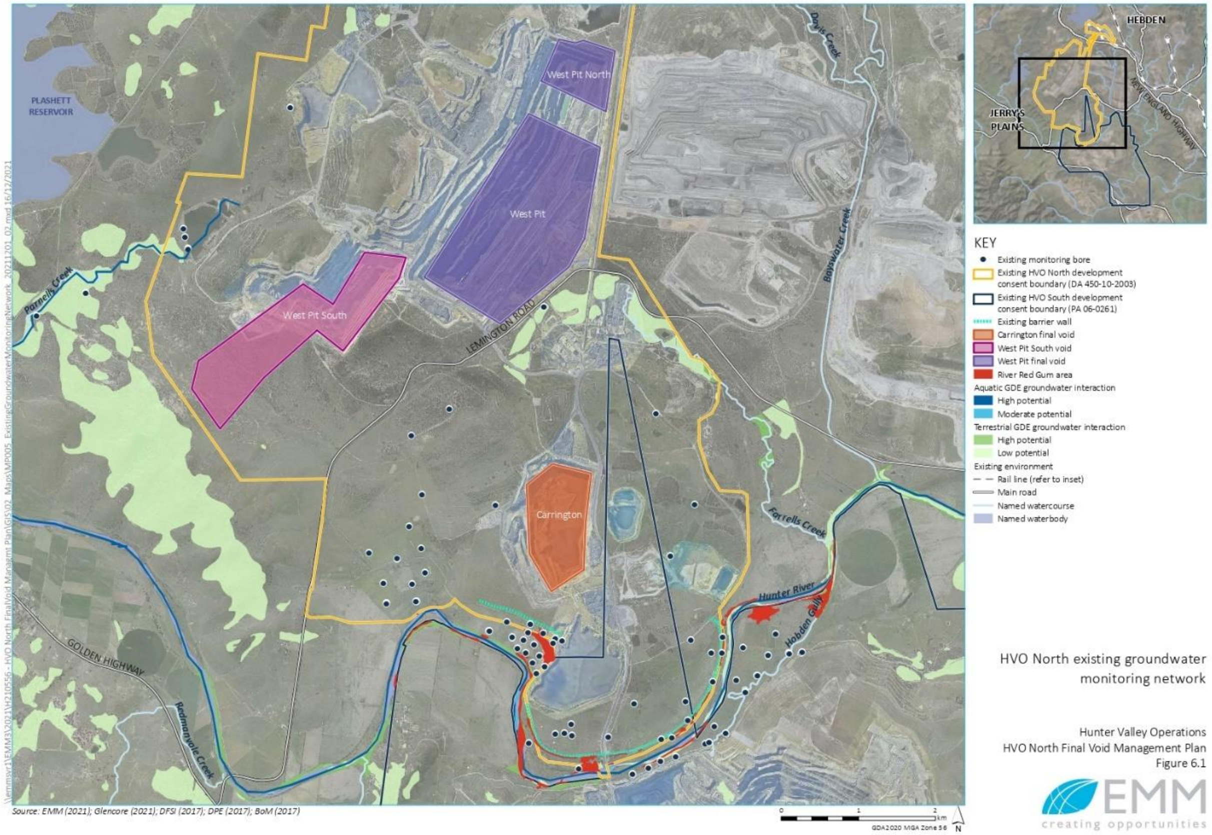


Figure 6.1-HVO North existing groundwater monitoring network

7 | FUTURE WORK PLAN

The following work will be conducted to prepare a detailed final void management plan, as part of closure planning. As discussed in the document, the location and function of the voids in 2025 are different to that outlined in the North Pit Development Consent due to the slower rate of mining. They are substantially different to the final voids proposed for the HVO Continuation Project. The HVO South operation relies on the availability of the Carrington Void for tailings storage until 2030 and one of the West Pit voids is identified for tailings deposition (subject to further planning approval). For these reasons, it is proposed to undertake detailed assessments once the location and function of the final voids is confirmed.

The trigger for undertaking this work would be either:

- the HVO Continuation Project not proceeding to approval; or
- a modification to extend the life of the North Development Consent (to extract current approved coal resources under that Consent) not proceeding to approval.

The scope and timing of the work will be conducted in consultation with the NSW Government and comprise:

- final landform design and rehabilitation and erosion modelling, based on the 2025 mine plan
- further consideration of future use options for the voids
- hydrological modelling to inform the landform design and post-closure water management system (ie directing catchment away from the voids);
- hydrological modelling to predict pit lake recovery (duration and elevation), as well as pit lake salinity;
- groundwater modelling and assessment to reflect the closure after 2025 and predict groundwater level

responses and recovery post-mining, including potential groundwater level effects on identified receptors;

- pit lake water quality modelling;
- pit slope stability modelling and assessment by geotechnical specialists; and
- ecological assessment to determine vegetation species appropriate for the Carrington tree planted void option (tolerance to inundation and changes in salinity).

8 | SUMMARY

This conceptual final void management provides:

- A high-level assessment of locational, design and future use options for the final voids, reflective of the 2025 mine plan. Three voids are discussed:
  - Carrington void (two options)
  - West Pit North voids
  - West Pit South void
- A commitment for future work to integrate the final void management plan with the water management plan and the rehabilitation plan.
- A qualitative assessment of short-term and long-term groundwater and other potential impacts associated with each option. The voids are predicted to form evaporative sinks, maintaining a depressed groundwater elevation in the Permian groundwater system. Water held within the spoil areas will preferentially flow towards the voids, limiting the potential for interaction with identified receptors. In addition, the existing low permeability barrier walls will remain in place post-mining, further limiting the potential for interaction between spoil areas and the alluvium. Receptors in the area are not expected to be adversely affected by the final voids. As the regulated Hunter River is the dominant source of recharge to the alluvium, the vegetation communities (including those associated with the Carrington Billabong) and stygofauna in the alluvium in the HVO North area will continue to have access to water post-mining.
- The detailed final landform and void design will meet the objectives outlined in the MOP and development consent, including ensuring the void is safe, profiled for long-term stability, and non-polluting. In addition, it will be designed to minimise the surface water catchment draining to the voids. Additional assessment and design will be conducted to further inform the final void management plan.

9 | REFERENCES

Cunningham GM, Higginson FR, Riddler AMH and Emery KA 1998, *Systems Used to Classify Rural Lands in New South Wales.*

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EMM Consulting Ltd (EMM) 2016, Hunter Valley Operations North – Modification 6 *Environmental Assessment*. Prepared for Coal & Allied Operations Pty Limited, November 2016. Reference J15014RP1.

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10 | DOCUMENT INFORMATION

Relevant legislation, standards and other reference information must be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

10.1 | RELATED DOCUMENTS

Related documents, listed in Table below, are documents directly related to or referenced from within this document.

NUMBER	TITLE

10.2 | REFERENCE INFORMATION

Reference information, listed in Table below, is information that is directly referred to for the development of this document

REFERENCE	TITLE

10.3 | CHANGE INFORMATION

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in table below. Example detail shown below.

VERSION	DATE	CHANGE DETAILS
1.0	17/12/21	New document prepared by EMM
1.1	16/09/2024	Transfer to new HVO template

APPENDIX A APPROVAL

NSW GOVERNMENT

Mr Andrew Speechly
HV OPERATIONS PTY LTD
1011 Lemington Road
Lemington NSW 2330

16/05/2022

Dear Mr Speechly

Hunter Valley Operations North Coal Project (DA 450-10-2003)
Conceptual Final Void Management Plan

I refer to the conceptual Final Void Management Plan which was submitted in accordance with condition 28 of Schedule 2 of the development consent for Hunter Valley Operations (HVO) North Coal Project (DA 450-10-2003).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of DA 450-10-2003 noting that a detailed Final Void Management Plan is required to be lodged by 30 June 2022.

The Department also considers that the detailed Final Void Management Plan should be prepared in consultation with the NSW Resources Regulator and DPE Water as required by condition 28 of Schedule 2 of DA 450-10-2003.

Accordingly, the Secretary has approved the conceptual Final Void Management Plan (dated December 2021). Please ensure that the approved plan is placed on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Joe Fittell on (02) 4908 6896.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Secretary

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