Annexure B

Surface water impact assessment

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Surface Water Impact Assessment

HVO Continuation Project

BNTL00198_002-REP-005-3

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EXECUTIVE SUMMARY

Overview

The Project

Hunter Valley Operations 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) comprising of 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. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV.

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

At HVO South an extension to the life of the mine is proposed to facilitate improved mine sequencing outcomes and reduction in mining rate. The Project proposes a reduced mining footprint at HVO South compared to what is currently approved for extraction by the existing NSW Project Approval 06_0261, with the previously approved coal extraction in the Riverview South East Extension (RSEE) area and South Lemington Pit (SLP) 1 and 2 areas proposed to be removed from the mine plan (and future approvals) for the Project. However, some rehabilitation works will be required to be undertaken in the SLP 1 area, as part of the mine closure process. The approved 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, has also been removed from the Project.

A number of infrastructure upgrades and changes are also required to facilitate the Project (and are included as part of it), including realignment of part of Lemington Road to enable the continuation of mining at HVO North, relocation of transmission and telecommunication lines, an upgrade of the Newdell load point (LP) including construction of a new product stockpile and train loading bin, an upgrade of the Hunter Valley LP (HVLP) product stockpile including an extension to the existing coal stockpile, expansion of the HVO North run-of-mine (ROM) coal stockpile and improvements to Lake James (Dam 15S) and Parnells Dam (Dam 9W).

A detailed description of the HVO North Action is provided in Section 3 of the HVO North Public Environment Report (PER) (EMM, 2026a). A detailed description of the HVO South Action is provided in Section 3 of the HVO South PER (EMM, 2026b). The proposed conceptual layout of the Project inclusive of both HVO North and HVO South Action Areas is provided in Figure 1.3.

At the time of publication of this report, the NSW Department of Planning, Housing and Infrastructure (DPHI) was undertaking its assessment of the Project (as amended).

Assessment Overview

This Surface Water Impact Assessment (SWIA), an annexure to the Water Resources Impact Assessment (WRIA) (EMM, 2026c), forms part of the PERs (EMM, 2026a; EMM, 2026b) and provides an assessment of the potential impacts to surface water as a result of the 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 approach for the assessment of potential impacts with the Project follows the same approach as for the NSW state government approval SWIAs (Engeny, 2022; Engeny, 2025).

The flooding assessment in the Environmental Impact Statement (EIS) SWIA (Engeny, 2022) was peer reviewed by Barry Rodgers (BMT). Barry Rodgers was engaged throughout the development of the Project flood model to provide peer review and to align methodologies and broad outcomes of the Project flood study with concurrent Singleton Council studies.

In addition to the flooding assessment peer review, a peer review of 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.

Updated history-matching of the HVO regional groundwater model (EMM, 2026d) was undertaken following the preparation of the Amendment Project (AP) SWIA (Engeny, 2025).

The Independent Expert Scientific Committee (IESC) completed a review of the WRIA (version 3, dated 16 October 2025) and provided advice (dated 10 December 2025) titled IESC 2025-161: Hunter Valley Operations (HVO) North Open Cut Coal Continuation Project (EPBC 2025/10177) and Hunter Valley Operations (HVO) South Open Cut Coal Continuation Project (EPBC 2025/10176) – Expansion (IESC Advice).

The SWIA and supporting technical reports have been updated to address the IESC Advice. A summary of responses to the IESC Advice is provided at Annexure G of the WRIA (EMM, 2026c).

The 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.

Existing Surface Water Context

The 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.

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 Project is proposed to be in place prior to the commencement of the Project.

The existing 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 HVO North Action 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 Complex 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 runoff 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 (NSW 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 (LCO).

Project Water Management

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

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.

Overflows from water management system are typically limited to overflows from sediment dams (designed in accordance with NSW Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E) (Landcom, 2004) (NSW DECC, 2008d) standards (Landcom, 2004; NSW DECC, 2008d)). In addition, mine water storages are designed and operated to contain the stormwater runoff generated by the 1% Annual Exceedance Probability (AEP) 24 hour design storm event. Therefore, runoff generated from mining areas during rainfall events less than the 1% AEP 24 hour are expected to be contained on site, thereby minimising the risk of impacts to the environment.

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, as well as the Hunter River Salinity Trading Scheme (HRSTS) (refer to Section 4). In addition, there is only minor variation in magnitude and proportion of water management system inflows and outflows between the Approved Operation and the Project.

Climate Change Predictions

Under a Socioeconomic Pathway representing fossil-fuelled development, i.e. SSP5-8.5, climate scenario the Project is expected to maintain sufficient inventory to meet water demands, while relying less on discharges to the HRSTS and more on extraction from the Hunter River. The water balance modelling indicates that HVO holds sufficient WALs to operate in the SSP5-8.5 scenario. Increases in rainfall intensity associated with climate change on the daily timestep rainfall water balance model does not have any significant influence on forecast overflows from the WMS.

Design of the WMS components will consider future increases in rainfall intensities associated with climate change during the detailed design stages. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.

Final Pit Lakes

The final landform for the Project 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 (approximately 100 m freeboard predicted for North Void and South Void).

It is considered that the final void water quality for the Project final voids will be similar to that of the Approved final voids, as both Project and Approved final voids are designed as groundwater sinks and will exist in the same hydrological, hydrogeological and geochemical environments. Salinity is expected to continue to increase over time in the pit lakes until solubility limits (subject to a range of factors including interspecies interactions) are reached (i.e. when precipitation of salts occurs). That is, as time progresses the final voids will reach an “equilibrium” of salt species with inflows and interactions between salt species, such as precipitation, balancing.

Predicted Impacts to Surface Water Resources

Streamflow

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 the Project results in:

- Hunter River – negligible impact, which will be further offset by the regulated nature of the river.
- Wollombi Brook – reduced operational impacts for the Project compared to Approved due to no changes to catchment area and reduced baseflow losses.
- Ungauged Ephemeral Streams – minor changes predicted to streamflows on three watercourses during the Project life relative to the approved operations (UN1, Farrells Creek and Bayswater Creek) with all predicted impacts relative to the approved operations reducing to negligible impacts for Project closure. It should be noted that these three creek systems are already impacted by either current or historical mining operations and approved future mining.

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 Project. The flood modelling was also peer reviewed by BMT and by Torrent Consulting as requested by the NSW DPHI (refer to Section 1.7).

As the 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 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 Project SWIA and has not been re-simulated for the Project.

Design flood events for the 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1% AEP and the Extreme Flood (defined as four times the 1% AEP) were simulated.

The modelling simulated three Project scenarios: Project baseline (existing site forecast at 2025); Project Operations; and Project Closure (refer to Section 6.2 for more detail).

Simultaneously during the development of the flood model and assessment of Project impacts, a separate flood study of the Hunter River has been undertaken by BMT on behalf of Singleton Council (Council). That study was completed subsequent to the flood modelling for this Project. A comparison of the results and methodologies of both studies is included in Attachment C. As mentioned, BMT was engaged throughout the development of the Project flood model to provide a peer review and to ensure aligning methodologies and broad outcomes of this study with the Council study.

Climate Change Predictions

The 0.5% and 0.2% AEP design flood events are typically used as proxies for climate change. These proxies were validated using the Climate Futures Tool (CSIRO, 2015).

A comparison of the flood extents between these events indicates that there is generally little difference in flood extent for the Hunter River in the vicinity of the Project for the climate change scenarios. The design event adopted for Project levees (0.1% AEP) exceeds the magnitude of events shown in the climate change assessment with additional freeboard allowance.

Impacts

The proposed realignment and new Hunter River bridge crossing of Lemington Road as part of the Project will significantly improve the flood immunity of this road adjacent to the Hunter River (refer to Section 6.2.1). With proposed flood immunity exceeding the 10% AEP compared to the existing crossing being less than the 10% AEP (smallest event modelled).

The existing flood ingress risks at the HVO Complex will be reduced with the 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 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 (abbreviated Carrington WW Levee for mapping purposes) in events exceeding the design standard (i.e., exceeding the 0.1% AEP plus freeboard). The final voids will have flood immunity up to and including the Extreme Event.

A conservative approach to the flood impact assessment has been adopted by excluding any incorporation of the approved Carrington West Wing Levee (1% AEP immunity levee in similar location currently approved) or SLP 1 back-fill (to occur at closure under existing approval) from the Project Baseline scenario. As a result, it is emphasised that any flood impact presented in the SWIA is conservative and greater than the incremental impact of the Project in isolation.

The flood modelling for the Project indicates minor impacts to properties not owned by the JV partners. No changes to flooding at privately owned dwellings along the Hunter River is predicted. A small number of properties in the area have a minor flood level change in the range of 20-50 mm but generally less than 30 mm. Relative to baseline conditions these changes are minor (1.7% of the maximum modelled flood depth) and result in negligible changes to flood affected area (maximum of 0.15% of the total property for any individual property). The small predicted change in the flood regime (i.e., flood level or extent) is not considered to have an impact on the use of this agricultural (grazing and cropping) or Crown land.

Velocity changes are generally localised around Project infrastructure (levees, Lemington Road, SLP 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 were predicted 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.

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 overflows from sediment dams will continue to occur at the HVO Complex when rainfall events exceed the design rainfall depths of the sediment dams. With consideration of the WMS design standards and their likely adaption with climate change (refer to Section 3.2.2), it is considered that the likelihood and consequence of sediment dam overflows will continue to be the same as the existing operations and the Approved Operation (refer to Section 6.3), with the likelihood of overflows driven by the NSW design standards (the Blue Book (Landcom, 2004; NSW DECC, 2008d).

Modelling indicates that the impact of discharges from the HVO Complex, under the HRSTS and EPL, on water quality will be negligible (refer to Section 4.6) with the concentrations of key analytes lying within the existing ranges experienced in the Hunter River and below Australian and New Zealand Government (ANZG) toxicity limits for species protection and livestock drinking water.

Mitigation Measures

Detailed environmental studies have been undertaken to inform the 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 Project and a summary of the existing and proposed mitigation measures, including consideration of future climate change, is included in Table 1. It should be emphasised that the majority of the proposed mitigation measures are consistent with the current mitigation measures in place at the HVO Complex. No new mitigation measures are proposed as a result of the 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.

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 Project will maintain and build off these systems.

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 Project, the WMP will be updated in consultation with NSW 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 Project.
- Objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with the Project.
- Details of metering, 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 the HVO Complex. 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 1:, with few additional controls required for the Project.

TABLE 1: SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

Potential Impacts	Existing Measures	Project - Proposed 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. Design of the WMS components will, during the detailed design stages, consider future increases in rainfall intensities associated with climate change. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.
	Comprehensive water quality monitoring systems.	Upgrades to Lake James and Parnells Dam to increase on site water storage and provide upgraded telemetry and release systems.
		Continuation of existing water quality monitoring.
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. Works are in accordance with guidelines from Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volumes 2A, 2C, 2D and 2E (NSW DECC, 2008a; NSW DECC, 2008b; NSW DECC, 2008c; NSW DECC, 2008d) (the Blue Book).	Continuation of existing measures. Extension of existing WMS. Design of the WMS components will, during the detailed design stages, consider future increases in rainfall intensities associated with climate change. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.
	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. • 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.

Potential Impacts	Existing Measures	Project - Proposed Measures
		• Planned works within or near watercourses will have inspections completed as per Ground Disturbance Permit (GDP) (as specified in the WMP).
Capture/import of clean water into WMS	Separation of clean water systems from mine and sediment water systems where practicable.	Continuation of existing measures, including water metering and calculation of take where metering is not possible. Extension of existing WMS including the Mitchell Pit clean water drain (note: this drain diverts upslope runoff away from the mining area and is not a creek diversion).
	Accounting for water take in accordance with the NSW Non-Urban Water Metering Policy (NSW DPIE, 2020).	
Flood immunity	Existing levee systems to protect mine infrastructure, including: • North Carrington Levee 5. • North Pit Levee 3. • North Pit Levee – Alluvial Lands. • North Pit Levee – West. • Barry's Levee and Barry's Levee South. • Hobden Gully Levee.	Extension of existing WMS including the construction of flood levees to provide flood protection to mine workings during operations and final landform. Project levees include: • Carrington West Wing Levee. • Cheshunt Levee. • Riverview Levee. • North Void TSF Levee 2 (South-East levee). • Mitchell East Levee (or final landform shaping) to provide flood immunity for North Void post closure.
	Existing operation flood upgrades including North Void TSF Levee 1 (North-West levee) and SLP 1 ramp regrade.	Realigned Lemington Road with upgraded flood immunity to exceed the 10% AEP event (currently less than 10% AEP immunity).
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.
		Decommissioning of the Carrington West Wing Levee at closure to reinstate floodplain storage.
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.
Flooding impacts on emergency management (Emergency Services / Access)		No proposed changes to emergency services access.
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. No proposed changes to WALs.
	Rehabilitation of overburden emplacement areas with runoff returned to the receiving environment when established and suitable water quality has been demonstrated.	
	Minimisation of catchment contribution to the residual void.	
	Water sharing with adjacent mining operations.	Continued water sharing with adjacent mining operations including tailings storage at LCO.

Potential Impacts	Existing Measures	Project - Proposed Measures
Surplus water on site	Water discharge using HRSTS salt credits via EPL licensed discharge locations.	Continued water discharge using HRSTS salt credits via EPL licensed discharge locations.
Water shortage on site	Water sharing with adjacent mining operations.	Continuation of existing measures. No proposed changes to WALs.
	Water abstraction from Hunter River using regulated river WALs.	
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. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components. Continuation and update as required of existing emergency management system including pollution incident response plan.
Water quality impacts during HRSTS Release	Managed within the requirements of the HRSTS and EPL resulting in discharge water quality considered to be in the natural range of the river. Monitoring of electrical conductivity (EC) continuously during discharge, and pH and total suspended solids (TSS) daily during discharge as per the requirements of the EPL.	Continuation of existing measures. No proposed changes.
Final void extent, water flux and water quality	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 with as much of the catchment directed away from the voids as possible / practical.
	Flood immunity for final voids.	The final landform will be designed with consideration of the risk of long-term climate change impacts on flooding, including construction of the Mitchell East Levee (or incorporation of this area into the final landform), for extreme events.
	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.
	Water quality passively managed with increasing salt concentrations in final voids that will in the future reach an “equilibrium” point.	Consistent with existing approved outcome. As part of closure planning HVO will undertake further detailed analysis and hydrogeochemical modelling (i.e. considering pH and water chemistry using fundamental chemical principles, rather than purely mass-balance or empirical relationships) to estimate the likely final void water quality and any actions that could improve final void water quality (e.g. post mining beneficial uses).

1. INTRODUCTION

1.1 Background

Hunter Valley Operations is a well-established multi-pit open cut coal mining complex (i.e. the HVO Complex), comprising two mine sites (HVO North and HVO South), separated by the Hunter River. 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 separated by the Hunter River, they are operated as one complex with fully integrated environmental management systems. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV. The HVO Complex is illustrated at a local scale in Figure 1.2.

1.2 State Approvals

The HVO Complex operates under separate approvals granted under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act). HVO North operates under Development Consent DA 450-10-2003 (as modified) 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 shown in Figure 1.2, as well as the Hunter Valley Coal Preparation Plant (HVCPP), the Howick Coal Preparation Plant (HCPP), and the Howick and HVO North mine infrastructure areas (MIA). The train loading facilities at the Newdell Load Point (NLP) and Hunter Valley Load Point (HVLP) are also at HVO North, as shown in Figure 1.2.

HVO South operates under Project Approval 06_0261 (as modified) 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 (RSEE) and South Lemington Pits (SLP) 1 and 2, as well as the MIA, and the Lemington CPP (LCPP) and rail loop (both approved but not constructed) as shown in Figure 1.2. Project Approval 06_0261 allows extraction of up to 20 Mtpa of ROM coal at HVO South until 24 March 2030.

Significant coal resources remain across the HVO Complex beyond what is currently approved for extraction under the EP&A Act and *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). HVO has undertaken extensive investigations into a long-term plan for the complex beyond the approved mine life to increase recovery of the remaining coal resources using existing infrastructure, while balancing social, environmental and economic outcomes. Based on the outcomes of these investigations, HVO is seeking the relevant approvals under the EPBC Act (and EP&A Act for the HVO Continuation Project (herein referred to as the Project)).

In December 2022, HVO lodged two State significant development (SSD) applications with the NSW Department of Planning, Housing and Infrastructure (DPHI) under the EP&A Act, as follows:

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

The SSD applications were supported by one environmental impact statement (EIS) titled Hunter Valley Operations Continuation Project, Environmental Impact Statement (EMM, 2022).

To respond to matters raised in submissions on the Project, a Submissions Report (EMM, 2023a) was prepared, along with an Amendment Report (EMM, 2023b) outlining proposed amendments to the HVO North Project (the HVO North Amendment Report).

During the subsequent assessment of the Project, DPHI issued a number of requests for information (RFI) to HVO, who provided responses as required. In March 2024, DPHI requested the NSW Independent Expert Advisory Panel for Mining (IEAPM) conduct an assessment of the Project in respect to water resources and greenhouse gas (GHG) emissions.

The IEAPM advice concluded that:

- In relation to water-related impacts, there is no reason why the Project should not be conditionally approved.
- In relation to GHG emissions, the IEAPM acknowledged that the only fugitive emissions avoidance measure available is changes to the mine plan that restricts the areal extent of mining and that a significant fugitive emissions avoidance measure at HVO would be not to mine Zones 2, 3 and 4 in gas Domain 1.

On 5 July 2024, the DPHI requested that, in light of the correspondence from the Minister and the conclusions of the IEAPM, HVO provided a response that further considered the implications for the Project if all coal extraction from gas Domain 1 at HVO North was avoided and for HVO to have further consideration of the guiding principles of the *NSW Climate Change (Net Zero Future) Act 2023* (the NZF Act).

HVO completed a detailed review of the Project and has amended the SSD applications for the Project, which includes, amongst other things, the removal of coal extraction in gas Domain 1. To document and assess the amendments to the Project, a second Amendment Report (EMM, 2025a) was prepared and submitted to DPHI (the HVO Amendment Report).

At the time of publication of this report, DPHI was undertaking its assessment of the Project.

1.3 Commonwealth Approval

There is one existing approval under the EPBC Act relating to the HVO Complex (EPBC 2016/7640), which allows for the continuation of coal mining operations in areas within the HVO Complex that were previously approved under the EP&A Act after the commencement of the EPBC Act. EPBC 2016/7640 is herein referred to as the HVO EPBC Act Approval.

A second referral (EPBC 2016/7641) was also submitted in 2016 relating to the extension of open cut coal mining operations at HVO South and proposed deeper mining in the Bayswater Seam within the Riverview Pit area. This action was considered not likely to significantly impact on a water resource and was determined as not a controlled action by the Minister on 20 March 2018.

On 16 April 2025, two EPBC referrals for the Project were submitted to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW), being:

- EPBC 2025/10177 – HVO North Project (the HVO North Action).
- EPBC 2025/10176 – HVO South Project (the HVO South Action).

On 27 and 28 October 2025, a delegate of the Minister for the Environment determined that approval is required before the proposed the HVO North Action and HVO South Action can commence as they are likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A).
- Water resource, in relation to unconventional gas development and large coal mining development (sections 24D and 24E).

The delegate also determined that the proposed actions will be assessed by public environment reports (PERs); one for HVO North and one for HVO South. DCCEEW subsequently issued guidelines for the content of the PER (the PER guidelines) on 30 January 2026.

The Independent Expert Scientific Committee (IESC) completed a review of the WRIA (version 3, dated 16 October 2025) and provided advice (dated 10 December 2025) titled IESC 2025-161: Hunter Valley Operations (HVO) North Open Cut Coal Continuation Project (EPBC 2025/10177) and Hunter Valley Operations (HVO) South Open Cut Coal Continuation Project (EPBC 2025/10176) – Expansion (IESC Advice).

The SWIA and supporting technical reports have been updated to address the IESC Advice. A summary of responses to the IESC Advice is provided at Annexure G of the WRIA (EMM, 2026c).

Further details on the Commonwealth approvals for the Project, both existing and proposed, are contained in chapters 1 and 2 of the draft PERs for the HVO North Action (EMM, 2026a) and HVO South Action (EMM, 2026b).

1.4 Project Overview

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

At HVO South an extension to the life of the mine is proposed to facilitate improved mine sequencing outcomes and reduction in mining rate. The Project proposes a reduced mining footprint at HVO South compared to what is currently approved for extraction by the existing NSW Project Approval 06_0261, with the previously approved coal extraction in the RSEE area and SLP 1 and 2 areas proposed to be removed from the mine plan (and future approvals) for the Project. However, some rehabilitation works will be required to be undertaken in the SLP 1 area, as part of the mine closure process. The approved construction and operation of the LCPP and associated rail facilities, which is currently approved (but not constructed) under the HVO South Project Approval, has also been removed from the Project.

A number of infrastructure upgrades and changes are also required to facilitate the Project (and are included as part of it), including realignment of part of Lemington Road to enable the continuation of mining at HVO North, relocation of transmission and telecommunication lines, an upgrade of the Newdell LP including construction of a new product stockpile and train loading bin, an upgrade of the HVLP product stockpile including an extension to the existing coal stockpile, expansion of the HVO North ROM coal stockpile and improvements to Lake James (Dam 15S) and Parnells Dam (Dam 9W).

A detailed description of the HVO North Action is provided in Section 3 of the HVO North PER (EMM, 2026a). A detailed description of the HVO South Action is provided in Section 3 of the HVO South PER (EMM, 2026b). The proposed conceptual layout of the Project inclusive of both HVO North and HVO South Action Areas is provided in Figure 1.3.



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 locality

HVO Continuation Project
Surface Water Impact Assessment
Figure 1.1

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

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

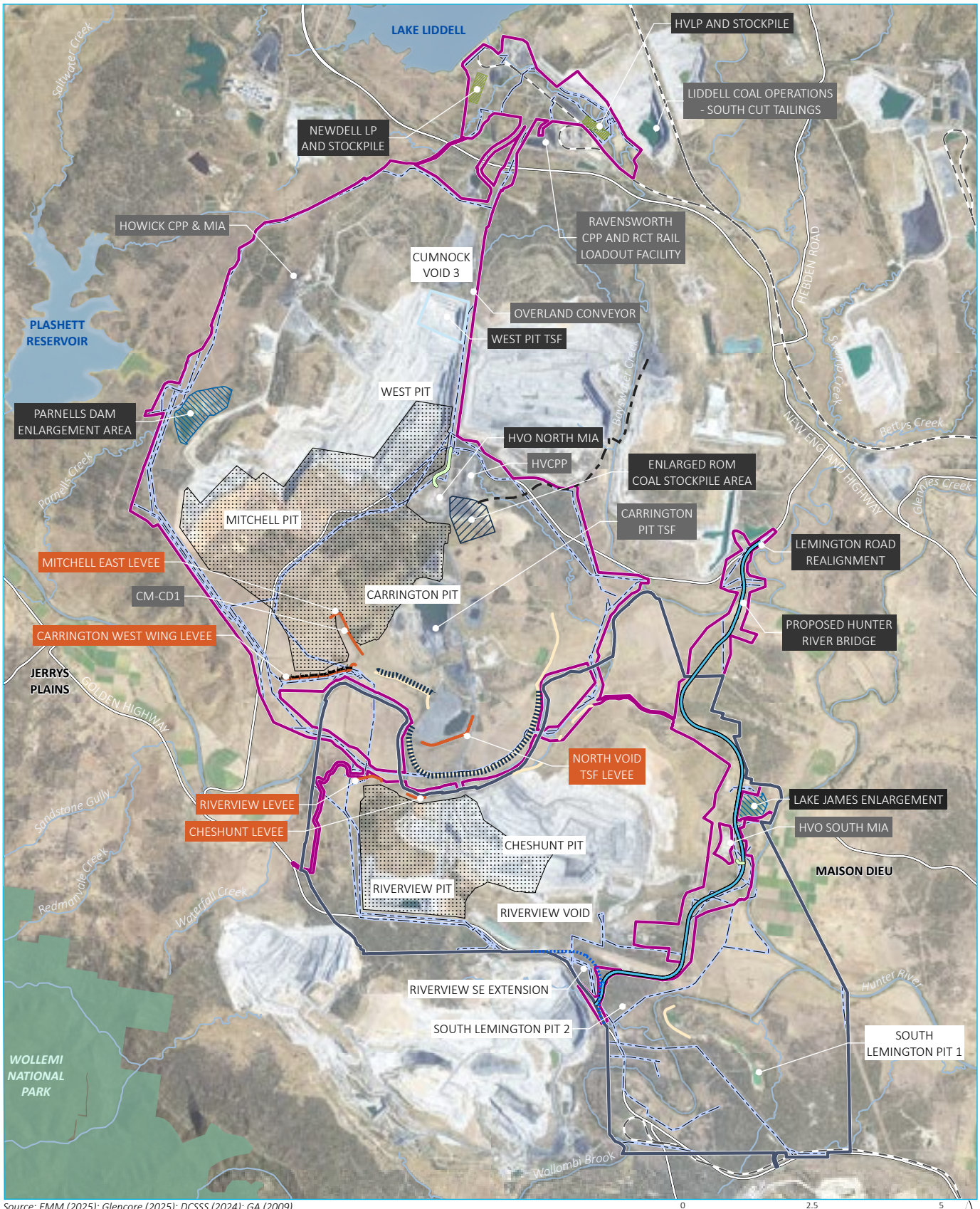
Existing environment

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

Local context

HVO Continuation Project
Surface Water Impact Assessment
Figure 1.2

EMM creating opportunities



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

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KEY

- HVO North Action Area
- HVO South Action Area
- 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 area
- West Pit TSF

Existing environment

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

Label format

- Existing item
- Levee
- Project related item

Project conceptual layout

HVO Continuation Project
Surface Water Impact Assessment
Figure 1.3

EMM creating opportunities

1.5 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 HVO Continuation Project in its entirety, as described in Section 1.4 of this report, encompassing the continuation of the life of the complex, i.e. both HVO North and HVO South, within their respective proposed Action Areas, as illustrated in Figure 1.3. Approval for the Project is sought by:
  - HVO North:
    - SSD-11826681 (under the NSW EP&A Act).
    - EPBC 2025/10177 (under the EPBC Act).
  - HVO South:
    - SSD-11826621 (under the NSW EP&A Act).
    - EPBC 2025/10176 (under the EPBC Act).
  - **EIS Project** – the Project that was submitted as part of NSW SSD applications in 2022.
  - **Amended Project** – the Project assessed in 2025 for the NSW SSD Amendment application, as described in Section 1.2.
- **EIS SWIA** – the SWIA to support the EIS Project.
- **AP SWIA** – the SWIA to support the Amended Project.
- **SWIA** – this current SWIA prepared for the Project as part of the PERs.
- **HVO North Action Area** – Area defined on Figure 1.3. The HVO North Action Area is consistent with the proposed State Development Consent boundary sought under the EP&A Act (SSD-11826681). This is also referred to as the Project boundary.
- **HVO South Action Area** – Area defined on Figure 1.3. The HVO South Action Area is consistent with the proposed State Development Consent boundary sought under the EP&A Act (SSD-11826621). This is also referred to as the Project boundary.
- **Project boundary** – the boundary of the area that is the subject of the two NSW SSD development applications (i.e. the proposed development consent boundary for HVO North and the proposed development consent boundary for HVO South. This is the same area as the combined HVO North Action Area and HVO South Action Area.
- **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 (and in some locations EPBC 2016/7640).
- **Additional disturbance area** – The disturbance proposed by the HVO North Action and HVO South Action and comprises native vegetation and habitat for Matters of National Environmental Significance (MNES) occurring across the three domains requiring assessment (being Domains 2b, 3 and 4).
- **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 and rail loop, the RSEE and SLP 2 mining areas, and the approved temporary crossing across the Hunter River between HVO North and South.
- **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 NSW SSD consents and EPBC Act applications (2025/101777 and 2025/10176).
- **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 areas previously approved by Project Approval 06_0261 including SLP 1, SLP 2, or the RSEE, 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.
- **PER(s)** – the Public Environment Report(s) prepared for 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 approval.

1.6 Regulatory Framework

1.6.1 Commonwealth Legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the Australian Government's central piece of environmental legislation. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places—defined in the EPBC Act as matters of national environmental significance (MNES).

The EPBC Act regulates impacts to MNES, these include consideration of significant impacts from actions on water resources, in relation to a coal seam gas or large coal mining development (the water trigger). As such actions relating to all types of coal developments with potential significant impacts on water resources may need to be referred to the DCCEEW for assessment under the EPBC Act.

On 16 April 2025, two EPBC referrals for the Project were submitted to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW), being:

- EPBC 2025/10177 – HVO North Project (the HVO North Action).
- EPBC 2025/10176 – HVO South Project (the HVO South Action).

On 27 and 28 October 2025, a delegate of the Minister for the Environment determined that approval is required before the proposed the HVO North Action and HVO South Action can commence as they are likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A).
- Water resource, in relation to unconventional gas development and large coal mining development (sections 24D and 24E).

The delegate also determined that the proposed actions will be assessed by PER. DCCEEW subsequently issued guidelines for the content of the PER (the PER guidelines). This SWIA has been prepared in accordance with the HVO North and HVO South PER Guidelines.

This report has been prepared in consideration of the:

- Information guidelines for proponents preparing coal seam gas and large coal mining development proposals (IESC, 2024).
- Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (DCCEEW, 2022).
- IESC Advice titled IESC 2025-161: Hunter Valley Operations (HVO) North Open Cut Coal Continuation Project (EPBC 2025/10177) and Hunter Valley Operations (HVO) South Open Cut Coal Continuation Project (EPBC 2025/10176) – Expansion.

A summary of the assessment against the Significant Impact Guidelines 1.3 (DCCEEW, 2022) is included in Section 6.9.

1.6.2 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 1.6.3.

There is one other key water management legislation 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 1.6.5.

1.6.3 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, 2026c) for further information.

1.6.4 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 (ML/yr). The share components of regulated river (high security entitlements (HSE) and general security entitlements (GSE)), 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 (AWDs) 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, 2025b).

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

1.6.5 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.

1.7 Surface Water Impact Assessment – Background and 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 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 (NSW 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 Project flood model to provide peer review and to align methodologies and broad outcomes of the Project flood study with concurrent Council studies.

In addition to the flooding assessment peer review, a peer review of 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 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 EP&A Act.

Following the exhibition of the EIS (EMM, 2022) the DPHI requested additional information in response to the Flooding Peer Review and a submission from the NSW Biodiversity and Conservation Division (BCD). 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 Project was subsequently amended (refer to Section 1.2) and the Amended Project assessed for the NSW state approvals process. The AP SWIA (Engeny, 2025) was prepared using the same methods as were peer reviewed for the EIS Project.

Updated history-matching of the HVO regional groundwater model (EMM, 2026d) was undertaken following the preparation of the AP SWIA (Engeny, 2025). Additional information regarding the water balance and potential water quality impacts was also requested by the IESC. As such the SWIA for the Project has been reviewed for the PERs (EMM, 2026a; EMM, 2026b). The 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 Project aspects are noted to extend beyond the proposed Action Area boundaries for HVO North and HVO South – this is consistent with the EIS and AP SWIAs.

The approach for the assessment of potential impacts with the Project follows the same approach as for the EIS SWIA and AP SWIA (Engeny, 2022; Engeny, 2025).

TABLE 1.2: SUMMARY OF PROJECT ASPECT, STUDY AREA, POTENTIAL IMPACTS AND SCOPE

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 Action Area boundaries	x		x		
Mining Infrastructure	Mine and sediment water runoff	Proposed Action Area boundaries	x		x		
Mine Water Management System	Mine and sediment water runoff	Proposed Action Area boundaries	x	x	x	x	x
Lemington Road Realignment	Flood behaviour (level, velocity) and access	Proposed Action Area boundaries					x
Clean Catchment Runoff Water Diversions	Clean water separation from mine areas	Proposed Action Area boundaries	x		x	x	
Flood Levees	Flood behaviour (level, velocity) and infrastructure immunity	Proposed Action Area boundaries	x				x
Tailings Emplacement	Sufficient water demands and storage	Proposed Action Area boundaries and disposal at LCO	x	x			
Water Sharing	Maintain existing agreements	Existing water sharing arrangements with nearby mines	x	x			
Water Balance	Manage water inventory, containment, supply and discharge	Proposed Action Area 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		
Risk of Overflows Beyond Design Criteria	Manage water inventory, containment, supply and discharge	Receiving environment in vicinity and downstream of HVO	x	x	x		
Hunter River Flooding	Flood behaviour (level, velocity) and infrastructure immunity	Hunter River in vicinity and downstream of HVO	x	x			x
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 Action Area boundaries	x		x	x	x
Final Void	Lake level, quality and potential for discharge	Proposed Action Area boundaries		x	x		

1.8 Structure of this Report

The key components of the SWIA report for the Project are included in the following sections:

- Surface water context (Section 2), including existing watercourses, catchment context, flow regimes (Attachment A), water quality (Attachment B), flooding (Attachment C), and water users.
- Water Management System; Section 3.
- Water Management System Performance; Section 4 and Attachment I.
- Final Void Hydrology Assessment; Section 5 and Attachment J.
- 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 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.

The 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 the surrounding 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 HVO Complex. In addition, HVO operates two rainfall gauges. These stations are listed in Table 2.1. Typical rainfall and evaporation rates at the HVO Complex 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 long-term rainfall data set for the HVO Complex.

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 the HVO Complex 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 matched well with the data recorded at the Scone SCS Station from 1965 to 2014. On average, daily pan evaporation exceeds daily rainfall at the HVO Complex. 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

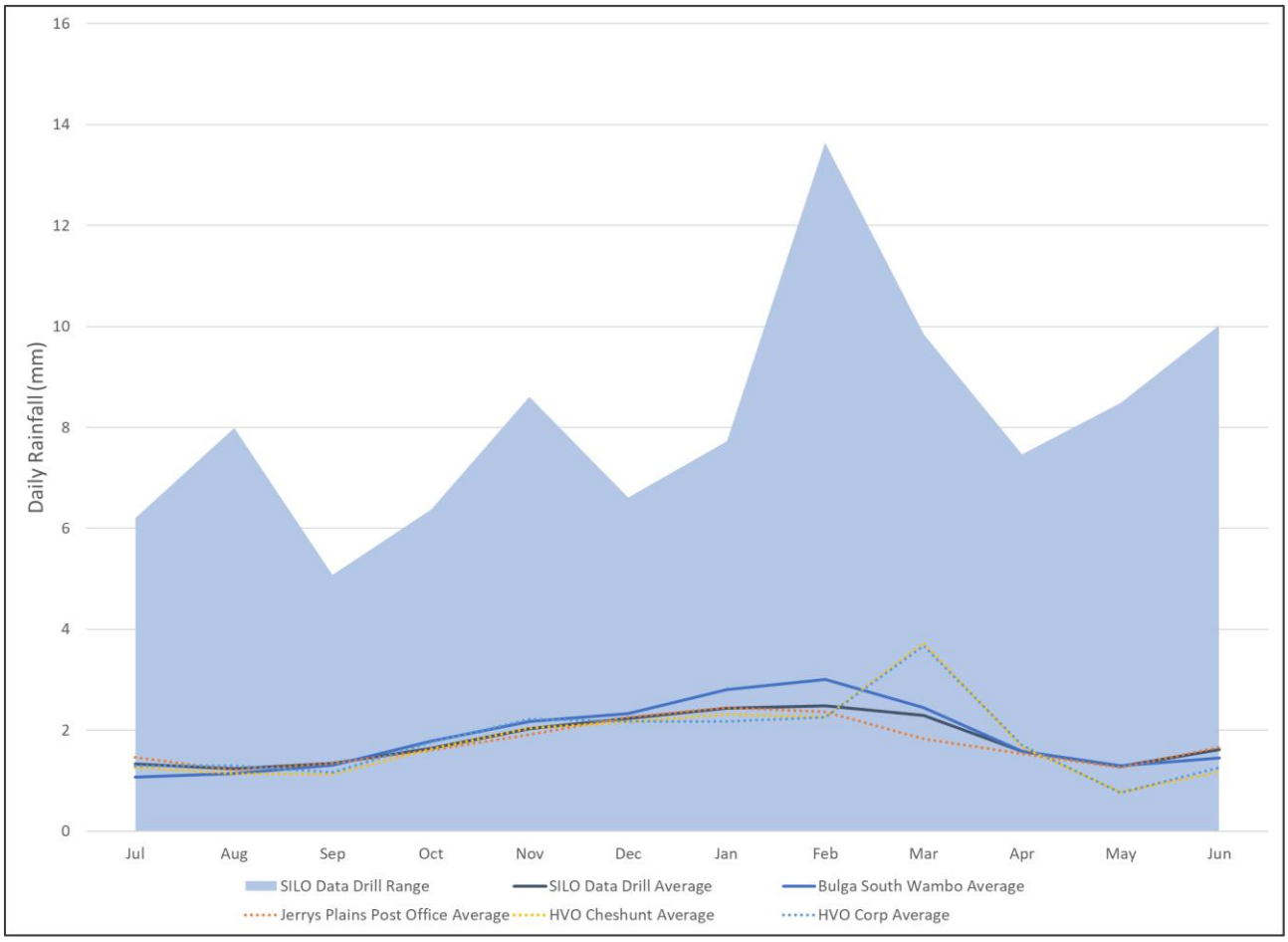


FIGURE 2.1: DAILY RAINFALL COMPARISON (RANGE AND AVERAGE)

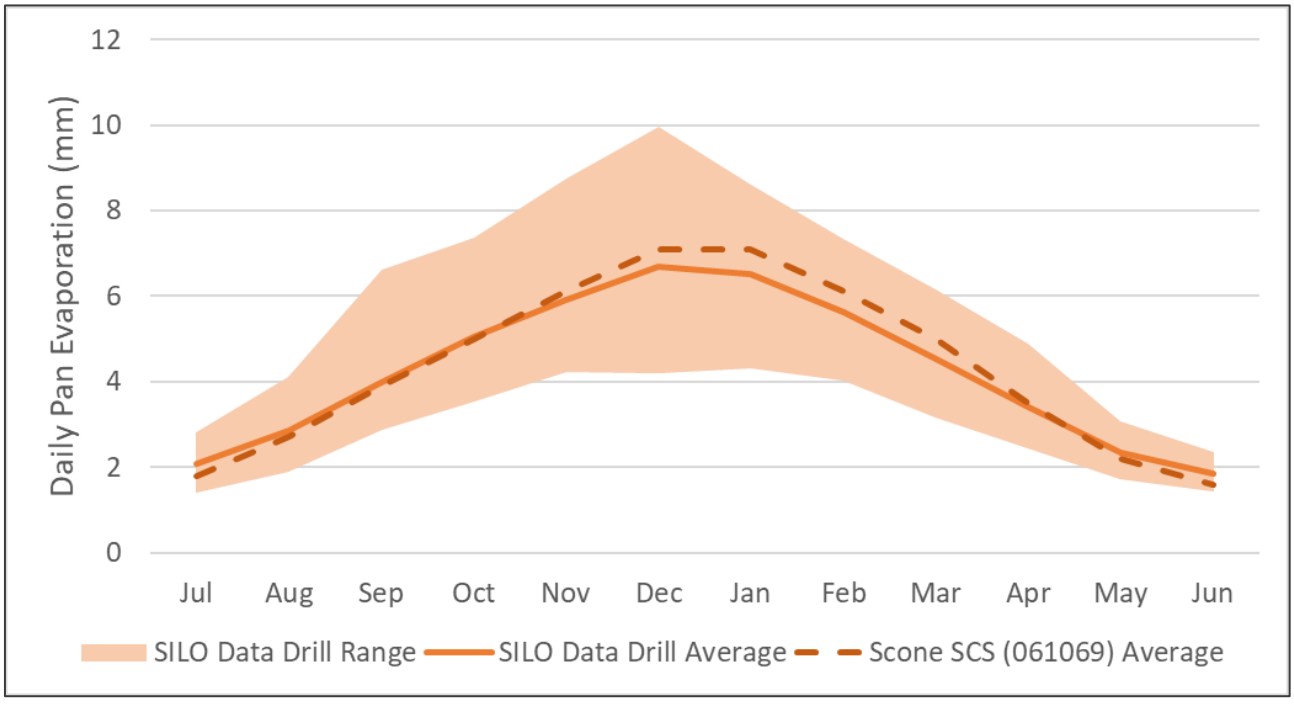


FIGURE 2.2: AVERAGE DAILY EVAPORATION

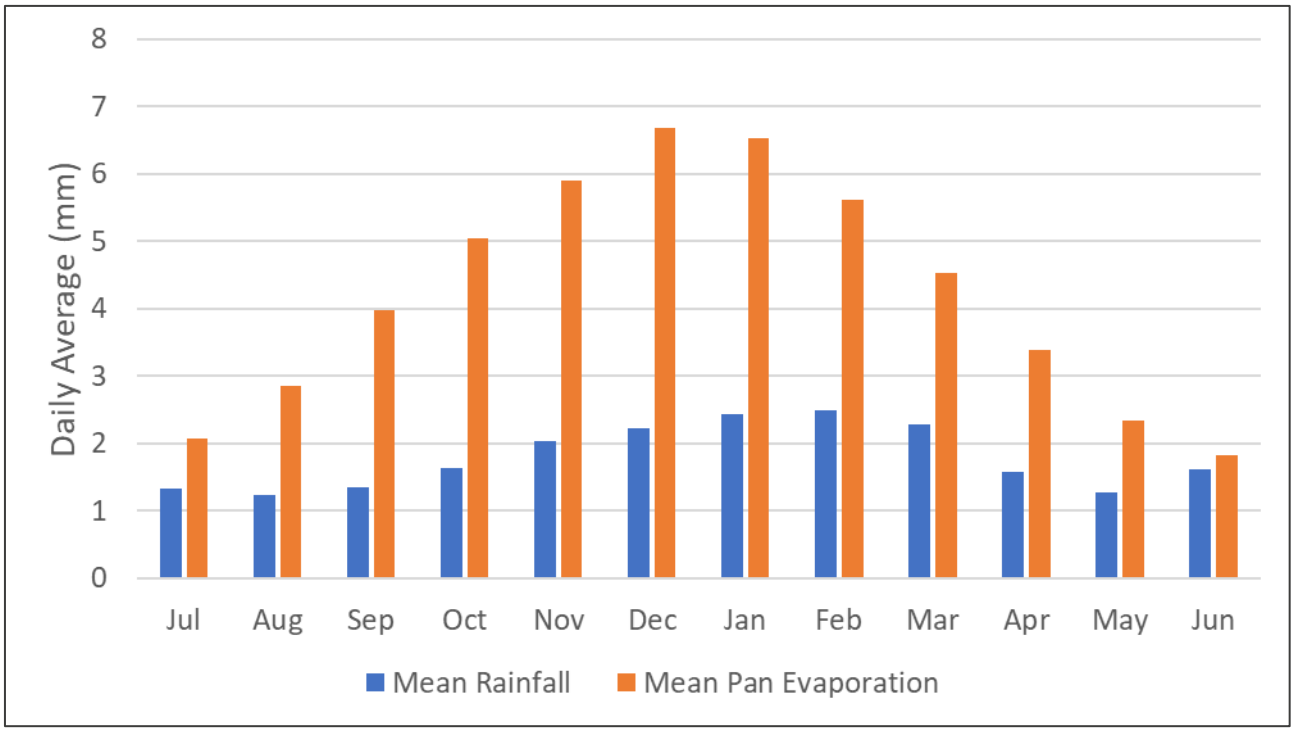


FIGURE 2.3: DAILY MEAN RAINFALL AND EVAPORATION (SILO DATA DRILL)

TABLE 2.2: COMPARISON OF HVO COMPLEX 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 Project is located in the same catchment areas of the Hunter River and its tributaries as the existing HVO Complex. 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 Project. 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 Project. Key findings of the screening process are 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 Project.

The scoping assessment outcomes are presented in Table 2.3 including a description of incremental catchment changes due to the 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 Project Operation[2]	Baseflow Change from Approved due to Project (Operations)[4, 5]	Baseflow Change from Approved due to Project (Final Landform)[4, 5]	Assessed
Hunter River (Mason Dieu 210128)	Yes - Minor changes in upstream tributaries (Parnells Creek, UN1, Pikes Creek and Farrells Creek) (negative impact during operations)	Yes (negative impact)	Yes (negative impact)	Yes
Parnells Creek	Yes - Change due to minor differences associated with mining haul roads and WMS (positive impact)	No	No	Yes
Unnamed Tributary 1 (UN1)	Yes - Change due to increase in mining area with realignment of Lemington Road (negative impact during operations)	No	No	Yes
Unnamed Tributary 2 (UN2)	Yes - Change due to approved rehabilitation area being redirected (positive impact)	No	No	Yes
Hobden Gully	Yes (positive impact after closure)	No	No	Yes[3]
Farrells Creek	Yes - Change due to increase in mining area with realignment of Lemington Road (negative impact during operations)	No	No	Yes
Pikes Creek	Yes - Change due to extension of Newdell Load Point stockpile area (negative impact during operations)	No	No	Yes

Watercourse System[1]	Catchment Change from Approved due to Project Operation[2]	Baseflow Change from Approved due to Project (Operations)[4, 5]	Baseflow Change from Approved due to Project (Final Landform)[4, 5]	Assessed
Bayswater Creek	Yes - Change in upstream tributary (Pikes Creek) (negative impact during operations)	Yes (negative impact)	No	Yes
Unnamed Tributary 3 (UN3)	Yes (positive impact)	No	No	Yes[3]
Wollombi Brook	Yes - Change in upstream tributaries (Unnamed Tributary 5 and 6) (positive impact)	Yes (positive impact)	Yes (positive impact)	Yes
Unnamed Tributary 5 (UN5)	Yes - Change due to removal of Lemington Rail Loop from the Action Area (positive impact)	No	No	Yes
Unnamed Tributary 6 (UN6)	Yes - Change due to removal of Lemington Rail Loop from the Action Area (positive impact)	No	No	Yes

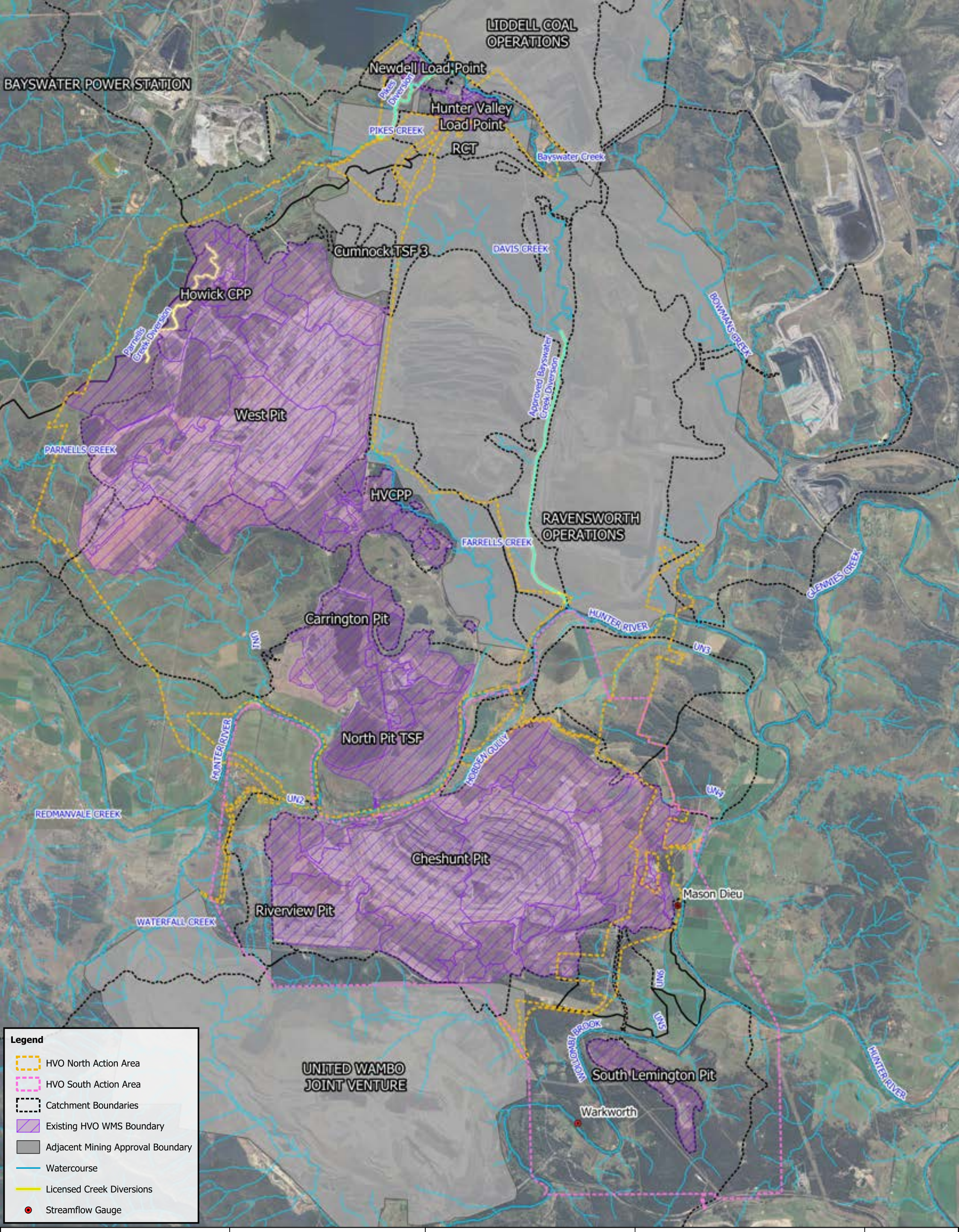
Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed in Water Assessment (EMM, 2026c).

Note 2: Maximum impact associated with the Project during operations. 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, 2026d).

Note 5: Negative impact refers to a predicted reduction in baseflows or catchment, Positive impact refers to a predicted increase in baseflows or catchment.



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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

Figure 2-4:
Surface Water Catchment Context

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 25 /9 /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 are not within the Project disturbance area. The Hunter River is a regulated river (refer to Section 1.6.4) and flows through the Action Areas, 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 channel 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. The Hunter soil landscape, ranges 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 to impact the 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 to the HVO North WMS, has been historically diverted around the WMS with a trapezoidal channel. This diversion channel is licensed under the WM Act (refer to Section 3.1.4). 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. Parnells Creek catchment area includes the Bayswater soil landscape, which 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 3.1.6).



(captured 10th November 2020)

FIGURE 2.6: PARNELLS CREEK – LOOKING DOWNSTREAM (DOWNSTREAM OF THE HVO NORTH ACTION 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 Project (and similar to the existing approved operation), the catchment of UN1 will be partially mined through (including through previously mined areas) with a free-draining landform reinstated as part of the 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.

UN1 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 v 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 HVO NORTH ACTION AREA)

2.2.4 Unnamed Tributary 2

Unnamed Tributary 2 (UN2) is a fourth order ephemeral tributary of the Hunter River, 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 Action 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 Liddell soil landscape covers most of the Farrells Creek catchment. 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 (refer to Section 3.1.4). 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, 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.

UN3 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 ACTION 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 to join the Hunter River near Warkworth (refer to Figure 2.4). Adjacent to the HVO South Action Area, Wollombi Brook meanders east between the HVO South Cheshunt Pit and SLP1 before flowing into the Hunter River. The existing nature of Wollombi Brook downstream of the HVO South Action 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 Action Area, Wollombi Brook is fed by several small, ephemeral tributaries including Redbank Creek, Unnamed Tributary 5 (UN5), Unnamed Tributary 6 (UN6) and Longford Creek (refer to Figure 2.4). The current catchment area of Wollombi Brook is approximately 187,100 ha, with the 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 HVO South Action 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 HVO South Action 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 SLP 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 SLP 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 ephemeral, 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 Project impacts are assessed in Section 6. Key baseline characteristics, i.e. present day (2025), of the watercourses 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 2.5.

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.

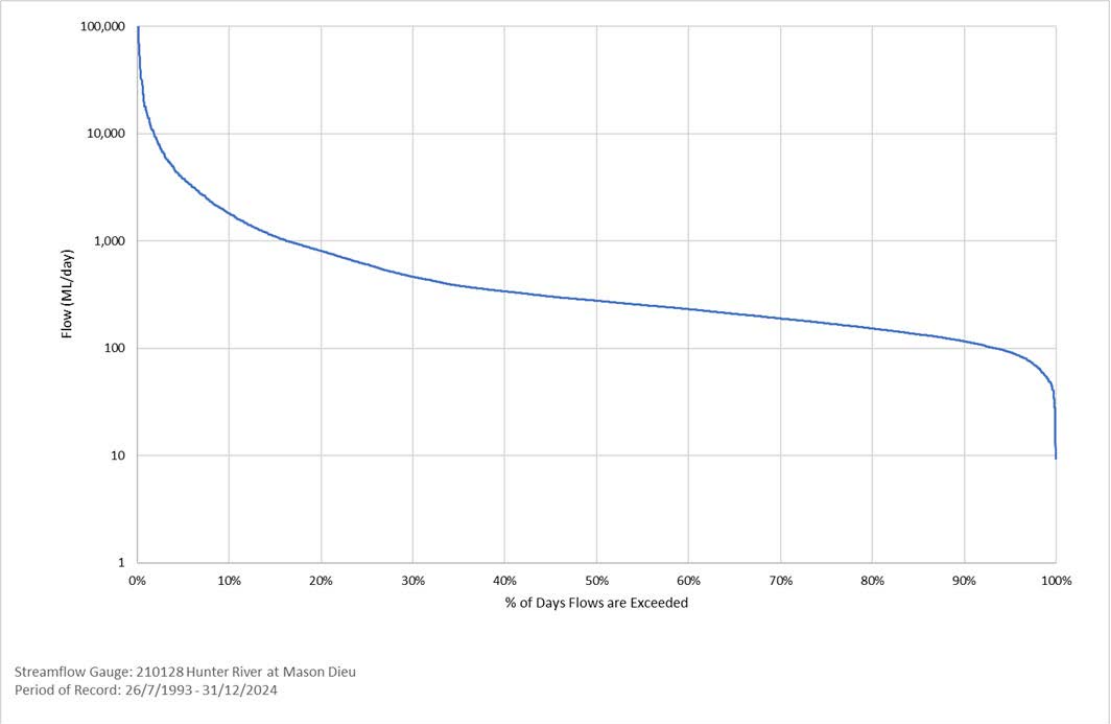


FIGURE 2.21: HISTORICAL FLOW GAUGING DATA – HUNTER RIVER AT MASON DIEU (210128)

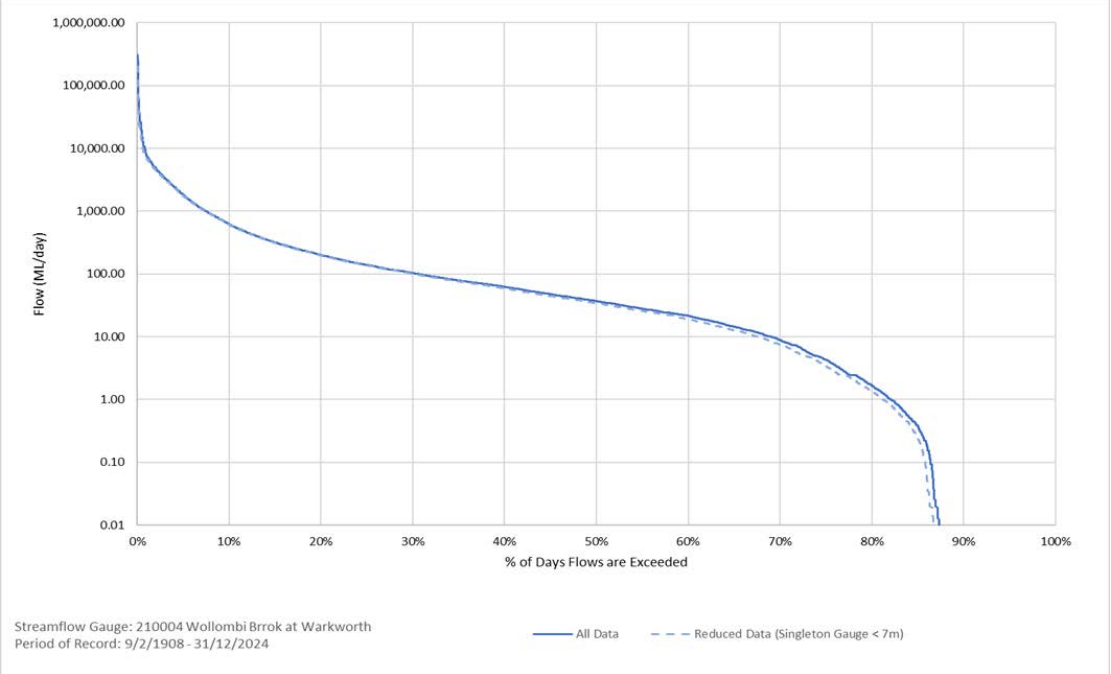


FIGURE 2.22: HISTORICAL FLOW GAUGING DATA – WOLLOMBI BROOK AT WARKWORTH (210004)

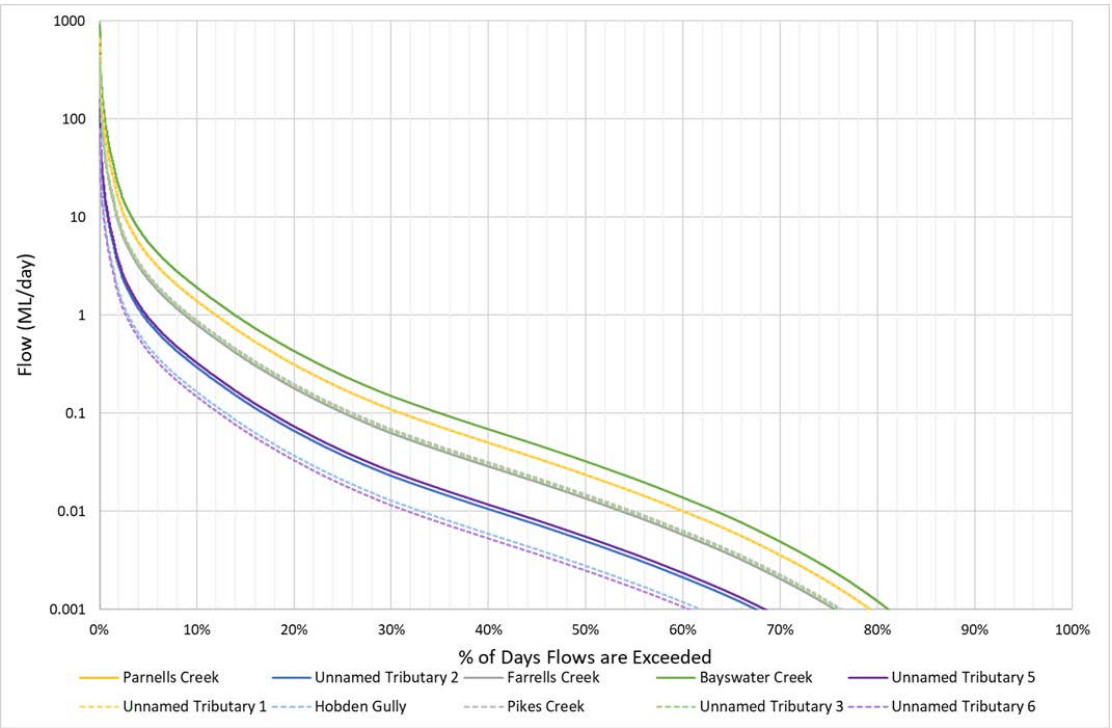


FIGURE 2.23: FLOW DURATION MODELLED RESULTS – EPHEMERAL WATERCOURSES

2.4 Flooding

2.4.1 Baseline Flood Assessment

2.4.1.1 Background

The flood assessment of the Hunter River was prepared during 2020 to support the Environment Impact Statement (EIS) prepared for the NSW government (EMM 2022). As mentioned, the model was peer reviewed by Barry Rodgers (BMT). This included development and calibration of a flood model to define existing flooding conditions and enable assessment of the potential impacts of the Project as per the EIS (i.e. the EIS Project).

Following 2022, the Project subsequently had two amendments; the first being changes to the Lemington Road realignment (these changes are outside of the floodplain areas); and the second including, amongst other things, removal of some areas of coal extraction to reduce greenhouse gas impacts of the Project. The changes to the final landform associated with the mining changes resulted in the Riverview Levee being incorporated into the final landform at closure, as well as further reinstatement of the floodplain adjacent to the location of the Carrington West Wing levee (the levee is only in place during operations), and at closure inclusions of the Mitchell East Levee / final landform to provide flood immunity for North Void.

Simultaneously during the development of the flood model and assessment of Project impacts, a separate flood study of the Hunter River was being undertaken by BMT on behalf of Singleton Council (Council) (BMT, 2022). That study was not complete at the time of the flood modelling for the Project. A comparison of the HVO flood modelling results to the Draft Council Flood Study results (BMT, 2022) was subsequently able to be undertaken and is included in Attachment C.

As discussed in Section 1.7, BMT was engaged by HVO throughout the development of the Project flood model to provide a peer review and to align methodologies and broad outcomes of this study with the Council study. The NSW Department of Planning, Housing and Infrastructure (DPHI) also engaged Torrent Consulting to undertake a peer review of the flood modelling. Further details of the peer reviews are included in the Water Resources Impact Assessment report (EMM, 2026c).

2.4.1.2 Flooding Context and Modelling Approach

The Hunter River has a catchment area of approximately 14,000 km^2 in the vicinity of the HVO Complex and 16,400 km^2 at the nearby town of Singleton. The major tributary inflows between the HVO Complex and Singleton are Bowmans Creek, Glennies Creek and Wollombi Brook, which join the Hunter River downstream of HVO North and in the vicinity of HVO South.

There are two major water storage dams located upstream of Singleton:

- Glenbawn Dam on the upper Hunter River was constructed in 1958 and has a catchment area of approximately 1,295 km^2.
- Glennies Creek Dam on Glennies Creek was constructed in 1983 and has a catchment area of approximately 225 km^2.

Glenbawn Dam accounts for approximately 9% of the catchment of the Hunter River at the HVO Complex and was constructed early in the period of available streamflow records. Glennies Creek Dam represents less than 2% of the catchment area of the Hunter River at the confluence of Glennies Creek (i.e., downstream of the HVO Complex). For these reasons, the impact of these dams and their operations on the design hydrology of the Hunter River at the HVO Complex has been conservatively excluded from the study.

Due to the size of the catchment (>14,000 km^2) and the availability of long-term streamflow records (greater than 50-100 years), it was determined that a Flood Frequency Analysis (FFA) approach for estimating design flows was more appropriate than a rainfall runoff hydrology model. This is consistent with current and previous studies being undertaken for Council. The flood assessment including model development and calibration is detailed in Attachment C. The adopted methodology is summarised as follows:

- Review of previous studies and available stream flow record.
- Conceptual model development including upstream (Liddell) inflow and three tributary inflows (Bowmans Creek, Glennies Creek and Wollombi Brook).
- Peak flow assessment to derive travel times and peak flow scaling relationships.
- FFA undertaken at Singleton (210001) and Liddell (210083) streamflow gauges to determine design flood peaks.
- Determination of Extreme Flood scaling factor.
- Assessment of historical flood hydrographs to develop design hydrograph shapes for the Hunter River and tributary inflows.
- Development and calibration of a TUFLOW hydraulic model.
- Simulation of design flood events for the 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1% Annual Exceedance Probability (AEP) and Extreme Flood (defined as four times the 1% AEP).

As the 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 Project will be no greater than those modelled for the EIS Project and as such the flood modelling has not been updated.

The report prepared for the EIS Project (Engeny, 2022) has been updated to include the details of additional information that was provided to various stakeholders since the EIS Project report was prepared (Attachment C). Detailed mapping of flood conditions including depth, velocity and hazard is provided in Attachment D for the Baseline and Project scenarios. The impacts predicted as a result of the Project are detailed in Section 6.2 with flood impact maps provided in Attachment E. Multi-lot flood impact maps are also provided in Attachment F. The flood mapping (including in Attachments D, E and F of the SWIA are also based on the flood modelling for the EIS Project (Engeny, 2022).

Further information on the following is also included in Attachment C:

- Climate change analysis.
- Sensitivity reviews.
- Comparison of the Project flood study modelling to the Council flood study.
- Modelling limitations.

2.4.2 Flood Planning Information

Specific flood planning information was requested by the NSW government to be included in the flooding assessment for the state approval assessment process. Each of the specific planning tools are listed below along with their definitions as included in the NSW Floodplain Development Manual (NSW DIPNR, 2005) (the Manual). The SWIA also considered the draft release of the Flood Risk Management Manual (NSW DPE, 2022).

- Flood planning area – the area of land below the flood planning level (FPL) and thus subject to flood related development controls. The concept of flood planning area generally supersedes the “flood liable land” concept in the 1986 manual (NSW Government, 1986).
- Flood planning levels (FPL) – are the combinations of flood levels (derived from significant historical flood events or floods of specifics AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated into management plans. FPLs supersede the “standard flood event” in the 1986 manual (NSW Government, 1986).

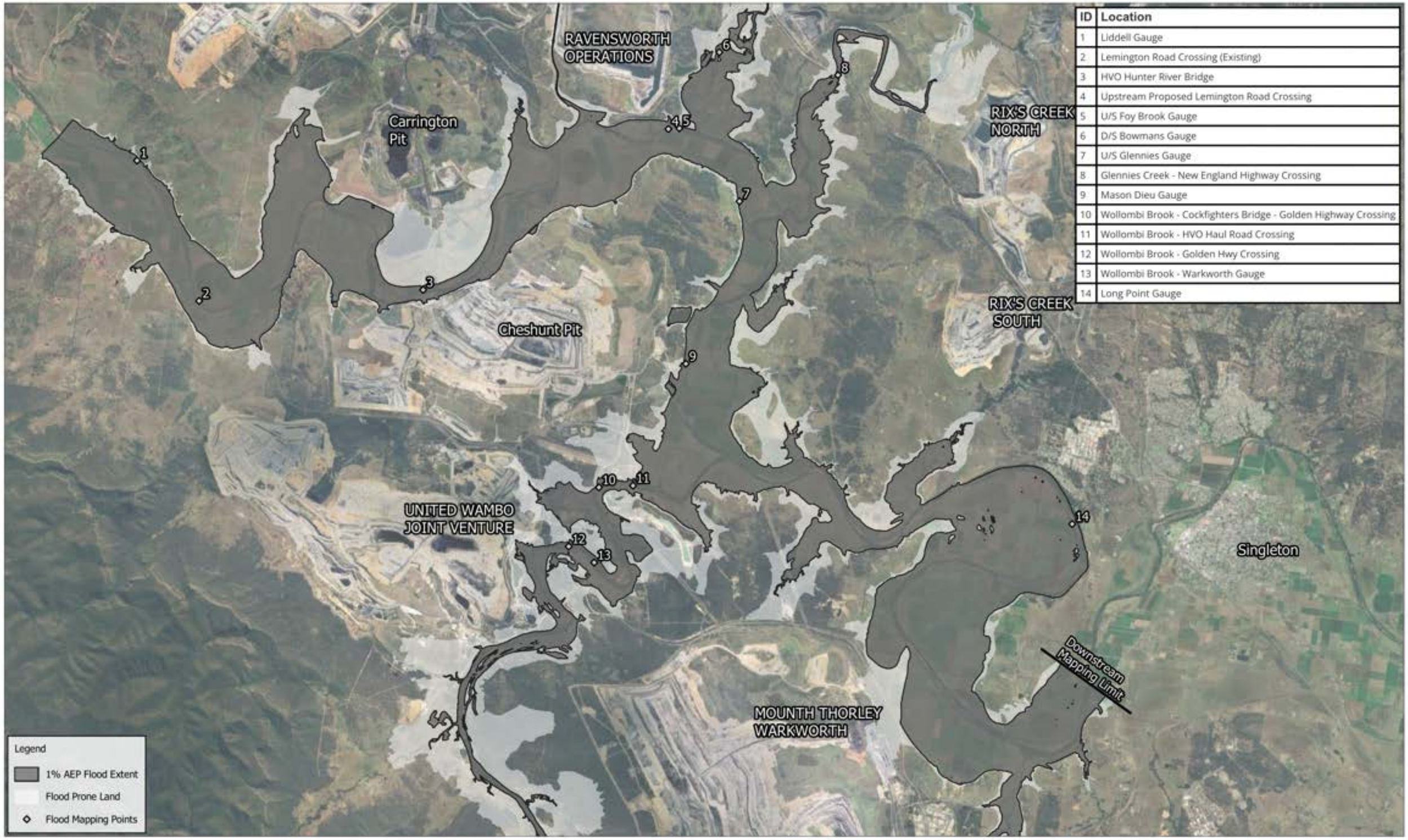
- Flood prone land – land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
- Hydraulic categorisation – hydraulic and hazard categories are used to determine appropriate types of land development in flood-prone areas. As such, the determination of these categories is an essential element in the formulation of a floodplain risk management plan.

The Manual (2005) recognises three hydraulic categories of flood prone land (floodway, flood storage and flood fringe). It should be noted that the NSW Floodplain Development Manual (2005) also states that hydraulic and hazard categories are tools to assist in the preparation of an appropriate floodplain risk management plan (a strategic planning document). They are not to be used for the assessment of development proposals on an isolated or individual basis.

The flood planning information is presented in Figure 2.24 and Figure 2.25.

The *Singleton Local Environmental Plan 2013* defines the flood planning level for property development as follows: flood planning level means the level of a 1:100 ARI (average recurrence interval) flood event plus 0.5 metre freeboard. The 100 year and 1:100 ARI event terminology is interchangeable with the 1% AEP event referred to in this assessment. Further review of Council zoning indicates that the flood extent upstream of the adopted mapping limit is almost exclusively Primary Production (RU1) with some small parcels of Environmental Conservation (C2) as well as zoning for Environmental Living (C4) and Public Recreation (RE1). The Environmental Living lots are generally outside of the 1% AEP flood event (refer to Section 6.2.3.1).

The existing land uses on the floodplain are agricultural (grazing and cropping) and crown land with mines located on the edge and/or outside of the Hunter River floodplain. There is only one road crossing of the Hunter River within the mapping extent. This is located on Lemington Road immediately upstream of the HVO Complex and is a low-level crossing with low existing flood immunity (less than the 10% AEP). Other Hunter River crossings are located downstream of the adopted mapping limit within the urban area of Singleton. The New England Highway and Golden Highway run generally from east to west on the north and south sides of the Hunter River respectively. These roads cross several tributaries of the Hunter River, which are affected by Hunter River backwater but with local tributary flooding expected to be critical. It is noted that the Project does not impact on local flooding of these tributaries.



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

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HUNTER VALLEY OPERATIONS

N

0 2 4 km

Scale in metres (1:75,000 @ A3)

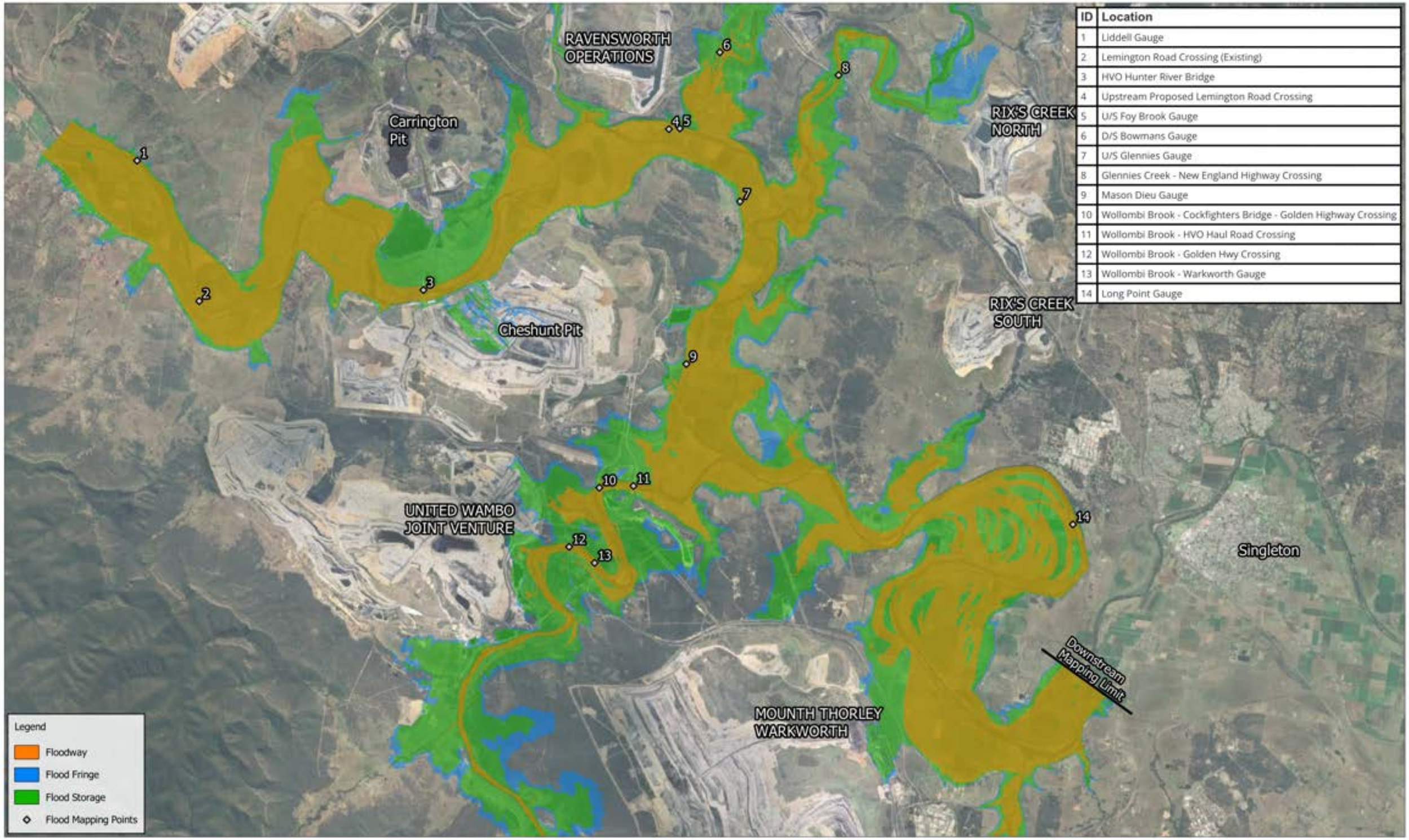
Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 2-24:
Flood Planning Information (NSW 2005)

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Job Number: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 12 /9 /2025



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
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6	D/S Bowmans Gauge
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10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

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N

0 2 4 km

Scale in metres (1:75,000 @ 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 2-25:
Hydraulic Categorisation (NSW 2005)

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Job Number: BNTL00198_0002
Revision: 1
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Checked: LV
Date: 12 /9 /2025

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 three water category areas within the HVO complex: clean, sediment, and mine (including pits and tailings) water systems. The existing surface water quality monitoring locations are shown on Figure 2.26 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.

NEW ENGLAND HIGHWAY
Pikes Diversion
PIKES CREEK
NEW ENGLAND HIGHWAY
PIKES GULLY ROAD
DAVIS CREEK
HEREDEN ROAD
HEREDEN ROAD
BOWMANS CREEK
Parnells Creek Diversion
PARNELLS CREEK
LEMINGTON ROAD
Approved Bayswater Creek Diversion
FARRELLS CREEK
BRUNKERS LANE
GLENNIES CREEK
HUNTER RIVER
UN3
UN1
HUNTER RIVER
HOBDEN GULLY
UN2
UN4
REDMANVALE CREEK
ARCHERFIELD ROAD
WATERFALL CREEK
GOLDEN HIGHWAY
UN5
UN6
WOLLOMBI BROOK
HUNTER RIVER
CULDSVILLE ROAD

Legend

- Existing HVO North Development Consent Boundary (DA_450_10_2003)
- Existing HVO South Project Approval Boundary (PA_06_0261)
- Surface Water Monitoring Location
- Clean Water Dam
- Sediment Dam
- Mine Water Dam
- Tailings Dam
- Existing HVO WMS Boundary
- Watercourse
- Licensed Creek Diversions
- Water Pipelines

Note: Final landform DEM presented for the three final voids and their catchment areas only

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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 2-26:
Surface Water Monitoring Locations

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2.5.2 Review of Surface Water Quality

An assessment of the 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.

Using historical data sets (2011 to 2024) and methods outlined in the ANZECC guidelines (ANZECC, 2000; ANZG, 2018), 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.

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 for the SWIA. A summary of the analyses within each WMS (clean, sediment and mine) is presented in a series of box and whisker plots (Figure 2.27 to Figure 2.30) 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[3]	6.5 – 8.0	125 - 2,200[4]	-
Blue Book (Landcom 2004) value	-	-	50[5]

Note 1: 20th/80th percentile of historical data

Note 2: 80th percentile of historical data

Note 3: ANZECC default guideline values (ANZECC, 2000) *included to assist in the context of the water quality observed adjacent to the HVO Complex.*

Note 4: Table 3.3.3 of Volume 1 of the ANZECC guidelines (ANZECC, 2000) *includes explanatory notes for lowland rivers – "NSW coastal rivers are typically in the range 200 – 300 µS/cm". This is not the case for the reaches of the Hunter River upstream of the HVO Complex.*

Note 5: Not a guideline value but included for context.

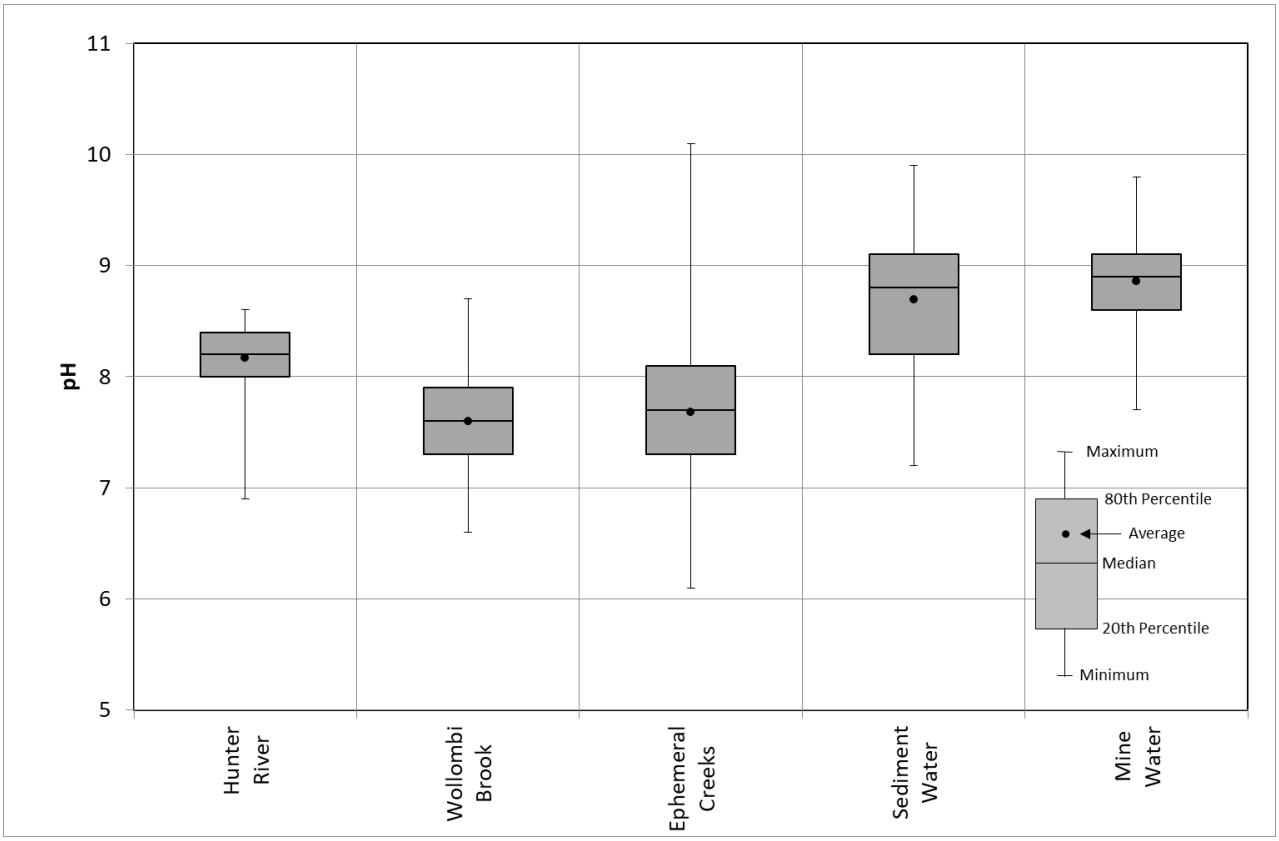


FIGURE 2.27: BOX AND WHISKER STATISTICAL ANALYSIS – PH

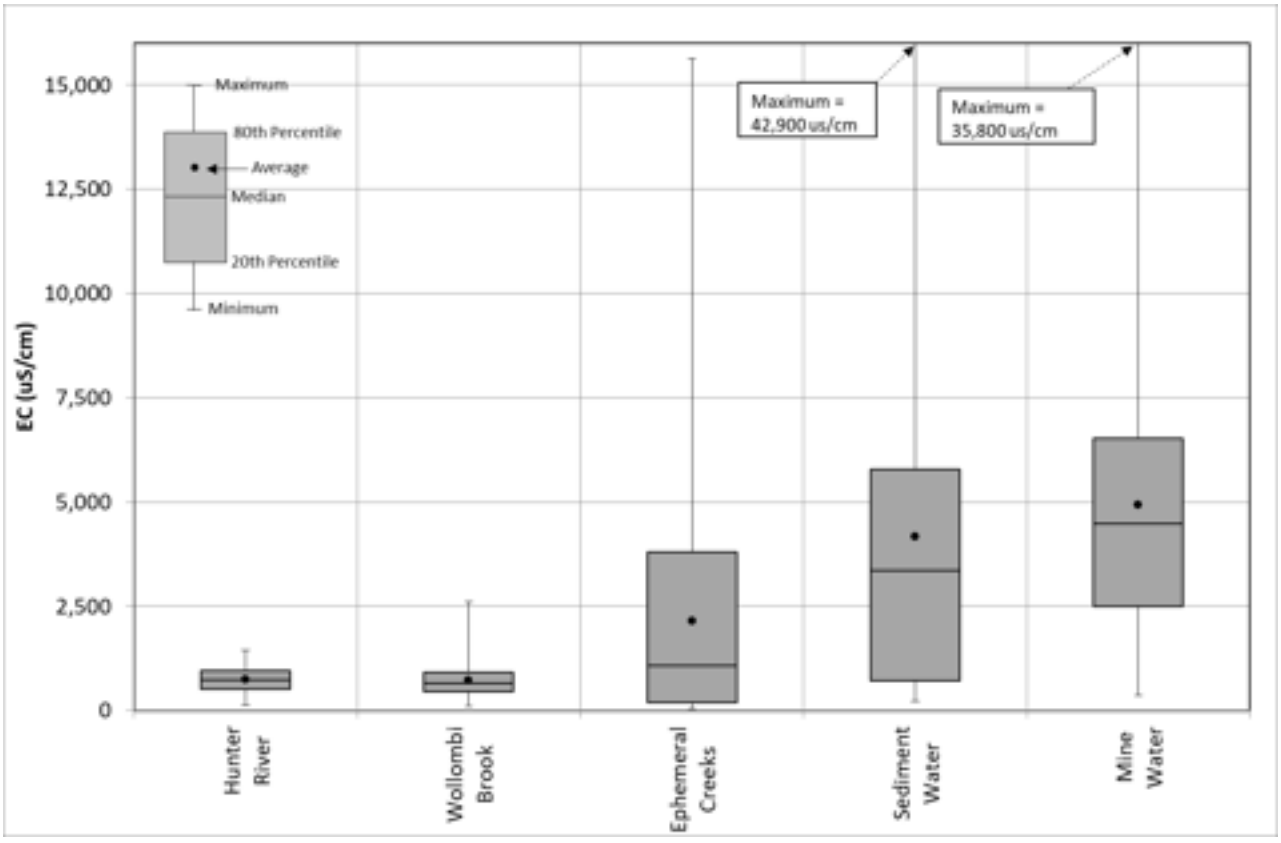


FIGURE 2.28: BOX AND WHISKER STATISTICAL ANALYSIS – EC

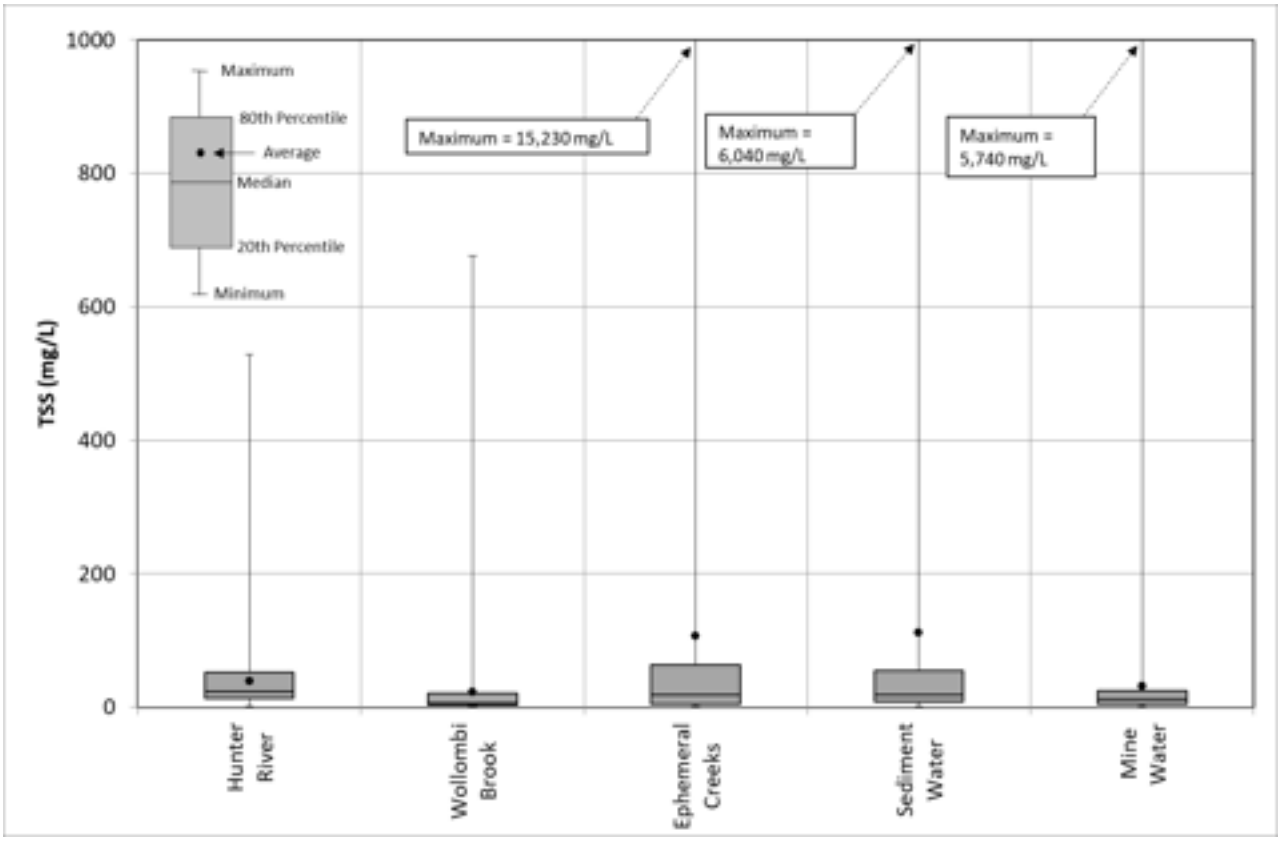


FIGURE 2.29: BOX AND WHISKER STATISTICAL ANALYSIS – TSS

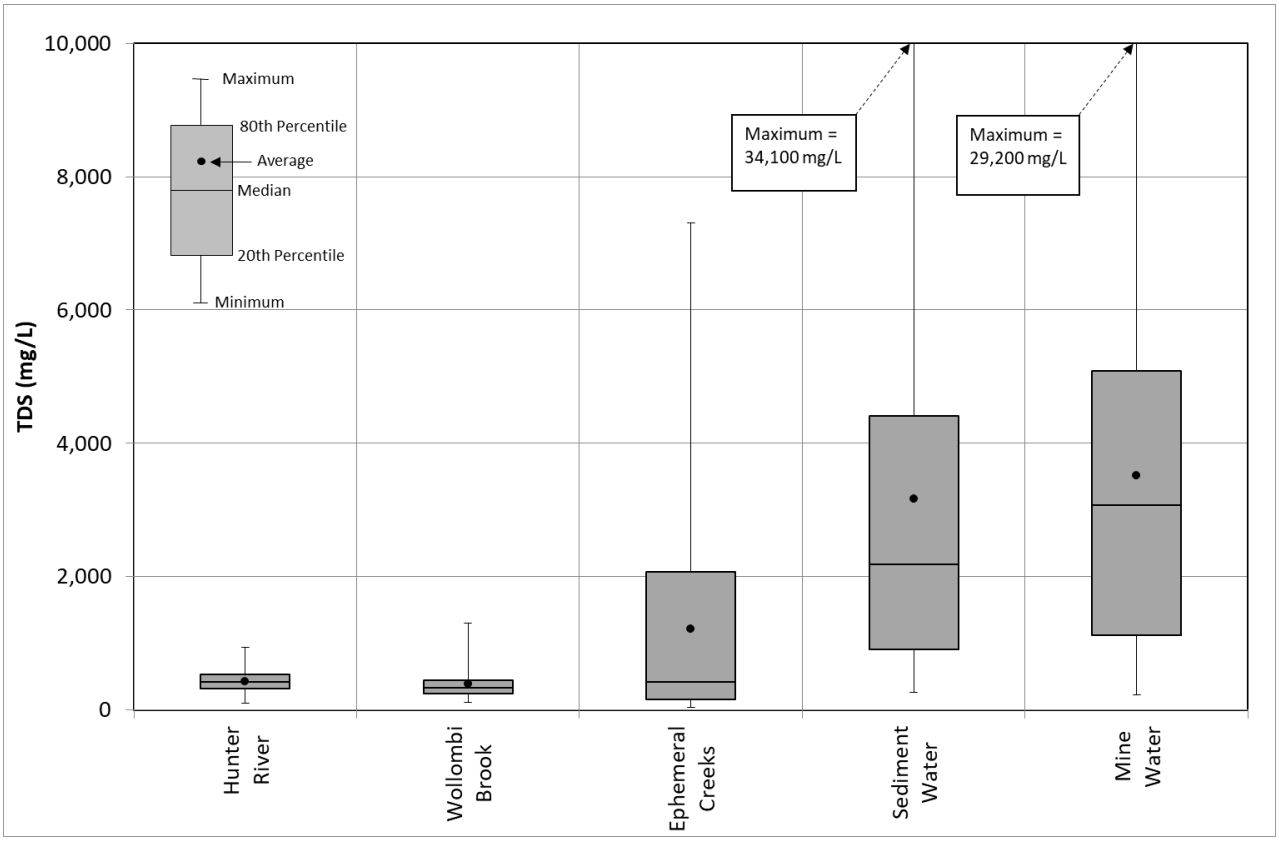


FIGURE 2.30: BOX AND WHISKER STATISTICAL ANALYSIS – TDS

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 to 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. There are no water users downstream of the Project within the ephemeral creek system catchments. There are water users downstream of the Action Areas 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 the HVO Complex are regulated under the *Water Sharing Plan for the Hunter Regulated River Water Source 2016.*

Further details on water licensing are included in the Water Resources Impact Assessment Report (EMM, 2026c).

3. WATER MANAGEMENT SYSTEM

It is proposed to continue to utilise the existing WMS for the Project. That is, the WMS for the Project is generally proposed to maintain and build upon the existing WMS.

The WMS will be constructed and modified as and when required 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 is detailed in the HVO Water Management Plan (HVO, 2018).

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 Project is proposed to be in place prior to the commencement of the 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 1.6).

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 Section 3.1.1).

To assist the reader with the understanding of the proposed WMS for the Project, summaries of the existing WMS are included in Sections 3.1.1 to 3.1.6. The proposed conceptual WMS for the Project is described in Section 3.2.

3.1.1 Water Classification and Target Design Criteria

Water is managed according to type. Water type is determined by catchment source, quality, and use. The main types of water managed at the HVO Complex are summarised in Table 3.1, with their target design criteria, and described in the subsequent sections.

TABLE 3.1: WATER MANAGEMENT SYSTEM CLASSIFICATIONS

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or rehabilitated areas.	Release, where practicable, to downstream environment.
Sediment	Runoff from disturbed areas (does not include water captured in mining pit areas or runoff from mine infrastructure areas where the water has been in contact with coal). Runoff draining away from pits where overburden has been shaped but without established ground cover.	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E) (Landcom, 2004) (NSW DECC, 2008d). Designed to manage runoff from the 5 day, 95th percentile rainfall event (for disturbance >3 years).
Mine	Runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas. Runoff draining into pits from the active / unshaped overburden that forms the low wall.	Contained for events up to and including the 1% AEP 24 hour storm event.

3.1.1.1 Clean Water Drains

The design criteria adopted for clean water drains is summarised in Table 3.2. Selected design criteria are sourced from the Blue Book - Table 6.1 of Volume 2E Mines and Quarries (NSW DECC, 2008d) for the following classification:

- Sensitivity of receiving environment – sensitive (coal mining operation with external stakeholder interest).
- Duration of disturbance - > 3 years.

TABLE 3.2: TYPICAL CLEAN WATER DRAIN DESIGN CRITERIA

Criteria	Adopted Value
Design Flow	Peak flow generated by the 1% AEP, critical duration (t_c) design storm event with 150 mm freeboard
Minimum Base Width	Typically 3.0 m (for constructability)
Minimum Depth (including freeboard)	Typically 0.7 m
Batter Slopes	Typically 1V:3H

3.1.1.2 Sediment Water Drains

The design criteria adopted for sediment water drains is summarised in Table 3.3. Only the placement of major sediment water drains for the WMS are presented in the conceptual design.

Selected design criteria are sourced from the Blue Book - Table 6.1 of Volume 2E Mines and Quarries (NSW DECC, 2008d) for the following classification:

- Sensitivity of receiving environment – sensitive (coal mining operation with external stakeholder interest).
- Duration of disturbance - > 3 years.

TABLE 3.3: TYPICAL SEDIMENT WATER DRAIN DESIGN CRITERIA

Criteria	Adopted Value
Design Flow	Peak flow generated by the 5% AEP, critical duration (tc) design storm event with 150 mm freeboard
Minimum Base Width	Typically, 3.0 m (for constructability)
Minimum Depth (including freeboard)	Typically, 0.7 m
Batter Slopes	Typically, 1V:3H

3.1.1.3 Sediment Dams

All sediment dams have been classified as Type D/F (dispersive/fine) and are sized based on the Landcom Managing Urban Stormwater: Soils and Construction (Blue Book) (Landcom, 2004).

Table 3.4 summarises design criteria adopted in the sediment dam design, in accordance with Blue Book requirements. The typical minimum dimensions have been used for sizing for the conceptual WMS figures.

TABLE 3.4: TYPICAL SEDIMENT DAM DESIGN CRITERIA

Criteria	Adopted Value
Duration of disturbance	> 3 years
Design rainfall	95th percentile, 5 day rainfall depth
95th Percentile, 5 day Rainfall Depth	57.2 mm (Average of Scone and Cessnock)
Soil Hydrological Group	D
Volumetric runoff coefficient (Cv)	0.74
Sediment load	50% of settling zone
Dam Dimensions	• Typical dam side slopes = 1V:4H • Typical minimum settling zone depth = 0.6 m • Typical minimum spillway dry freeboard = 0.3 m

3.1.1.4 Flood Protection Levees

Flood protection levees provide flood protection to the mining pits and final landform. The flood protection levees will be designed and constructed to provide a minimum flood protection up to the 0.1% AEP design flood event plus freeboard during the operational period of the Project.

Levees that remain at closure will generally be incorporated into the final landform with flood protection for the final voids provided up to the Extreme Flood Event (refer to Section 6.7.2).

3.1.2 Overview of Infrastructure

The 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.

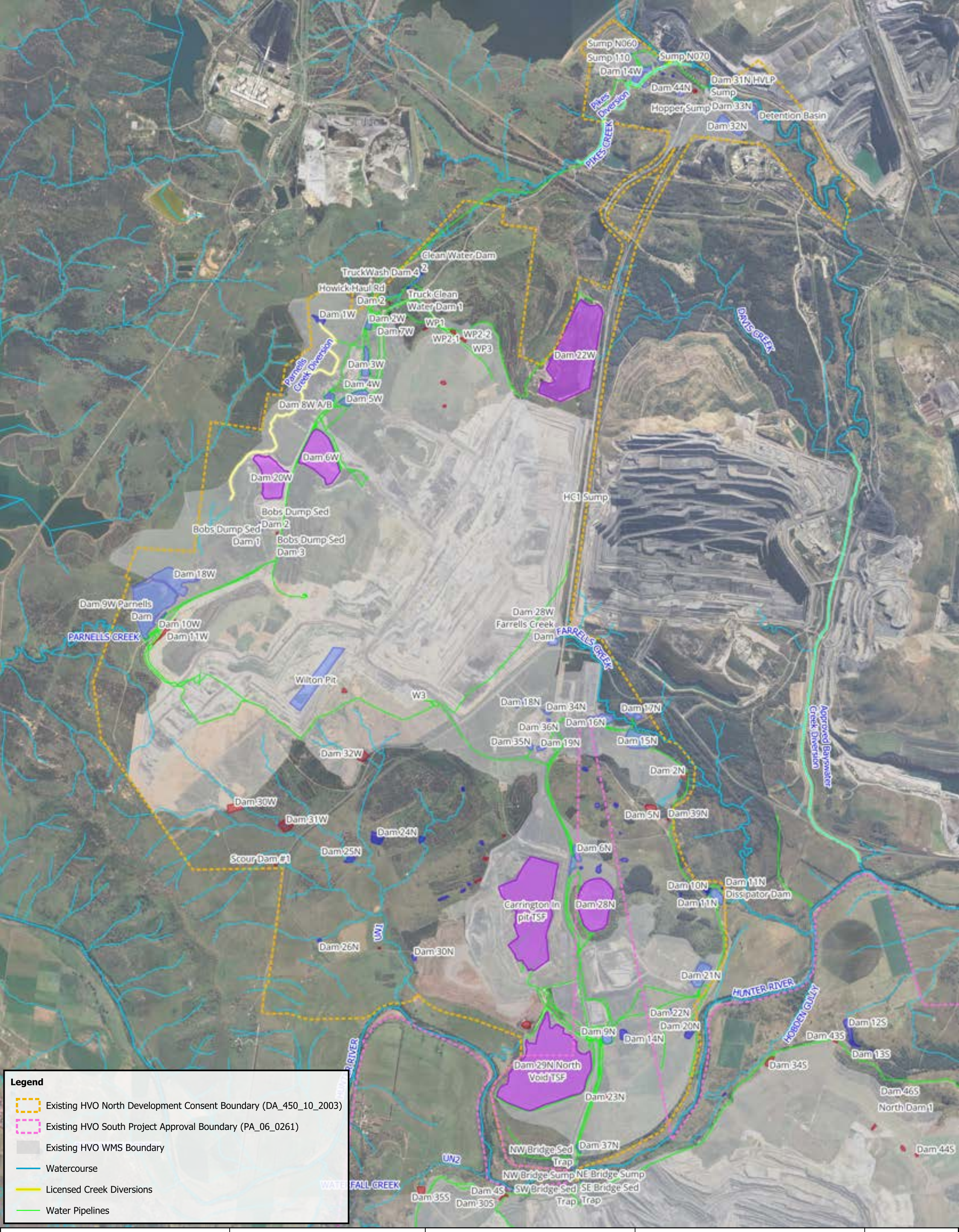
Mine water is pumped to out of pit storage dams or to available in-pit storages using mobile diesel or electric pumps and high-density polyethylene (HDPE) pipelines. Priority is given to water that accumulates in active mining areas, followed by areas to be mined in the short term, and last of all, inactive 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.

3.1.2.1 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.



Legend

- Existing HVO North Development Consent Boundary (DA_450_10_2003)
- Existing HVO South Project Approval Boundary (PA_06_0261)
- Existing HVO WMS Boundary
- Watercourse
- Licensed Creek Diversions
- Water Pipelines

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HUNTER VALLEY OPERATIONS

0 1 2 km

Scale in metres (1:40,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: GDA 2020
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

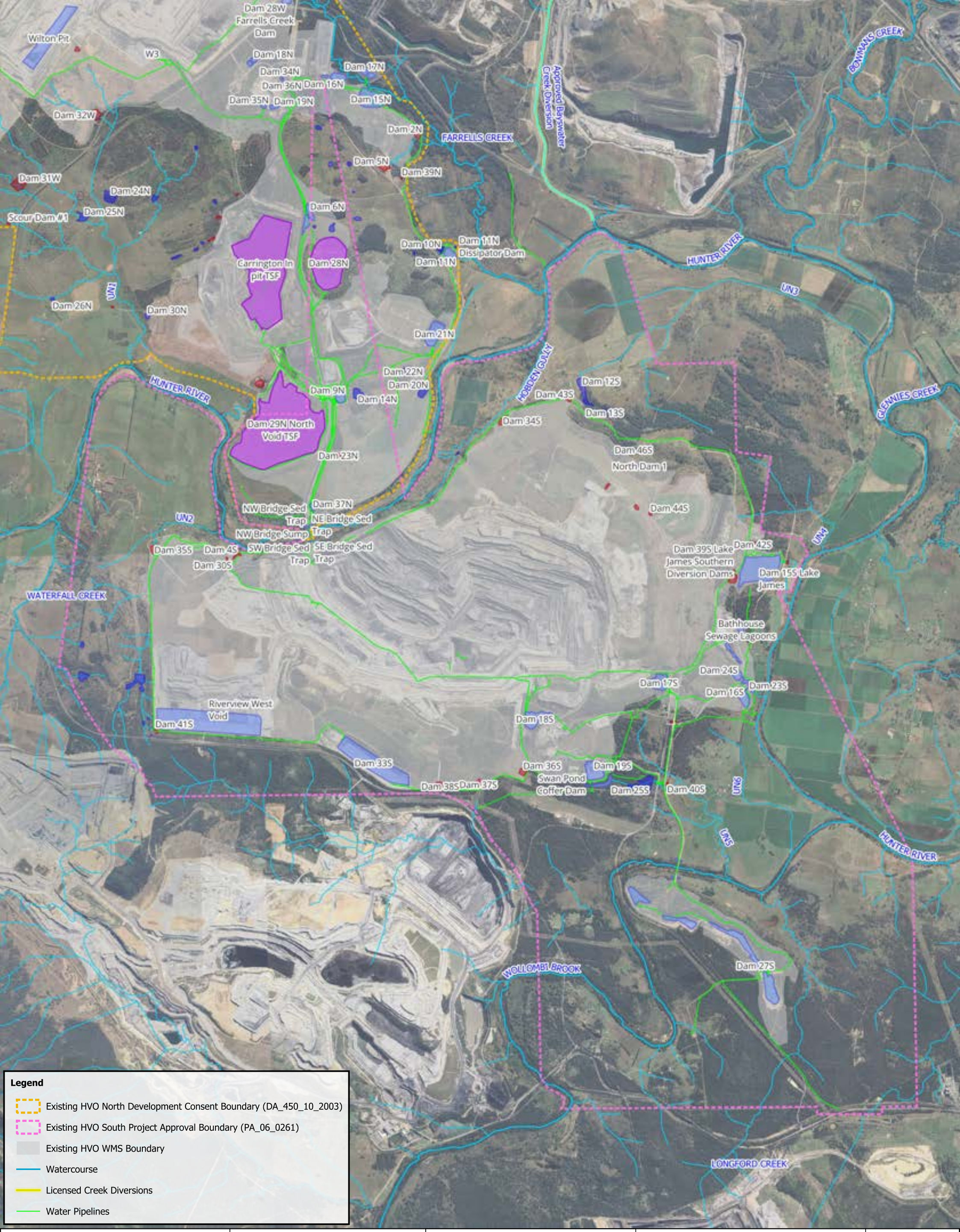
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Figure 3-1:
Existing Water Management System Layout - HVO North

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Date: 29 /9 /2025



Legend

- Existing HVO North Development Consent Boundary (DA_450_10_2003)
- Existing HVO South Project Approval Boundary (PA_06_0261)
- Existing HVO WMS Boundary
- Watercourse
- Licensed Creek Diversions
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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 3-2:
Existing Water Management System Layout - HVO South

N

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Checked: LV
Date: 29 /9 /2025

3.1.2.2 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 3.5. 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 3.5: 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
	Dam 21N	6.8	320
	Total	**50**	**739**
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
	Riverview Void	0	5,640 – 0 (reduction in capacity)
	Dam 17S	4.6	73
	Dam 18S	20.5	166
	Dam 19S	1.0	210
	Dam 27S (South Lemington Void)	N/A	858
	Total	**220**	**7,949 – 3,470**
Newdell and Hunter Valley Load Points	Dam 14W	10	48
	Dam 32N	6.5	152
	Dam 33N	0	40
	Total	**17**	**240**
Total		**491**	**9,643 – 8,830 (enlargements and reductions)**

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.

3.1.2.3 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 the HVO Complex 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 SLP 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 the HVO Complex. There is pump and pipeline infrastructure in place to allow decant water to be returned for use at Howick CPP.

3.1.3 Tailings Water

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.

3.1.4 Clean Water

HVO has licensed flood protection levees and clean water diversion structures to protect the mining areas as well as divert clean runoff water away from the active mining areas and areas of disturbance.

3.1.4.1 Flood Protection Levees

Existing flood mitigation controls in place at the HVO Complex are summarised in Table 3.6, including their respective NSW works approval licence details.

TABLE 3.6: LICENSED LEVEES

Licence Number	Type of Licence	Purpose	Description	Expiry Date
20FW213280	Flood Work Approval	Levee	HVO North Carrington Levee 5	21/09/2027
20FW213278	Flood Work Approval	Levee	HVO North – North Pit Levee 3	21/09/2027
20FW213274	Flood Work Approval	Levee	North Pit Levee – Alluvial Lands	26/08/2028
20FW213278	Flood Work Approval	Levee	North Pit Levee – West	21/09/2027
20FW213281	Flood Work Approval	Levee	Barry's Levee and Barry's Levee South	21/09/2027
20FW213277	Flood Work Approval	Levee	Hobden Gully Levee	21/09/2027

3.1.4.2 Diversions

Clean water diversion structures are employed to divert clean water away from the active pits. HVO has four licensed diversions as summarised in Table 3.7 , including their respective NSW works approval licence details. There are no new creek diversions proposed for the Project.

TABLE 3.7: LICENSED DIVERSIONS

Approval Number	Type of Approval	Purpose	Description	Expiry Date
20WA210991 (see WAL 18307)	Stream Diversion	Stream Diversion	HVO West – Parnells Creek Dam (Diversion Works Bywash)	09/1/2033
20WA211427	Stream Diversion	Cutting (Diversion Drain)	Pikes Gully Creek Stream Diversion	07/09/2033
20WA210985 (see WAL 18327)	Diversion Works	Industrial	HV Loading Point Pump Bayswater Creek	08/09/2032
20WA211428	Stream Diversion	Cutting (Diversion Drain)	HVO North – Carrington Stream Diversion	31/07/2032

3.1.5 River Water

HVO holds both HSE and GSE WALs to abstract water from the Hunter Regulated River. WALs are summarised in Table 1.1. The combined 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.

3.1.6 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 I for further detail). A summary of the current discharge limits under the HRSTS for EPL 640 are outlined in Table 3.8 below.

TABLE 3.8: HRSTS DISCHARGE LIMITS UNDER EPL 640

Release Point	Storage	EPL Maximum Release Rate (ML/day)	Infrastructure Capacity (ML/day)	Storage Capacity (ML)
3	Dam 11N	100	100	84
4	Dam 9W (Parnells Dam)	130	130	634 – 4,300
8	Dam 15S (Lake James)	200	200	739 – 1,900
Total		**430**	**430**	**1,458 – 6,284**

EPL 640 requires monitoring of EC continuously during discharge, and pH and TSS daily during discharge.

3.1.7 Summary Water Balance

A summary of the overall site water balance for 2024 as reported in the Annual Review (HVO, 2025) is provided in Table 3.9. It should be noted that during 2024 a total of 645 mm of rainfall was recorded at the HVO Complex at the HVO Corp Weather Station, compared to the average annual rainfall of approximately 661 mm (refer to Table 2.2). The reported balance, for a close to average rainfall year, shows that the HVO Complex was able to operate with imports of 2 ML from the Hunter River, and 80 ML discharged via the HRSTS. The overall balance indicates that the HVO Complex was able to operate the WMS within the requirements of the EPL.

TABLE 3.9: 2024 SITE WATER BALANCE (HVO, 2025)

Water Stream	Volume (ML)
INPUTS	
Fresh Water (potable)	56
Fresh Water (Hunter River extraction)	2
Groundwater	1,660
Rainfall Runoff	6,307
Recycled to CPP from Tails & Storage	1,266 (not included in total)
Imported (Liddell / Ravensworth (via Cumnock))	4
Water from ROM Coal	1,299
Total Inputs	**9,328**
OUTPUTS	
Dust Suppression	2,101
Evaporation – Mine Water & Tailings Dams	2,257
Entrained in Process Waste	682
Discharged (HRSTS)	80
Vehicle Wash-down	311
Sent to Third Party	6
Miscellaneous Industrial Use	351
Water in Coarse Rejects	396
Water in Product Coal	853
Total Outputs	**7,037**

3.2 Project Water Management System

The Project WMS described in the following sections should be considered a wholistic WMS for both existing approved operations and Project operations rather than as an incremental WMS required solely for the Project.

Consistent with the existing operations, the WMS will be constructed and modified as and when required 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.

It is emphasised that the 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:

- Negligible 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 Project are generally covered by existing approvals.

It is proposed to continue to utilise the existing WMS for the Project. That is, the WMS for the Project is generally proposed to maintain and build upon the existing WMS. 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 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 Project include expansion of the WMS at HVO North and changes to the timing of the WMS at HVO South. There are also some additional changes to levees, drains sediment dams and water storage dams. These aspects are described in the following sections:

- Section 3.2.1 summarises the key considerations of the 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 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 I.

3.2.1 Key Considerations of the 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 the HVO Complex 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 existing HVO Complex 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 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 3.10), new drains and flood protection levees (summarised in Table 3.11) and upgraded water storages (summarised in Table 3.12: Future Water Storages (Approved and Project)

Design of the WMS components will consider future increases in rainfall intensities associated with climate change during the detailed design stages. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.

Current climate change predictions, when considering the SSP5-8.5 scenario for the near future, present the largest seasonal increase to occur during March to May, with a maximum consensus of an increase in rainfall of 6.5%. With consideration of the existing design standards for sediment dams (refer to Section 3.1.1.3) this predicted increase in rainfall can be catered for within the existing design requirements. The design standards for sediment dams at the HVO Complex include a settling zone and a sediment zone. Sediment dams at HVO are conservatively designed with sediment zones equal to 50% of the settling zone. If the Revised Universal Soil Loss Equation (RUSLE) is used for sediment zone sizing (i.e. to estimate the likely volume of sediment entrained in surface runoff and captured by a sediment dam over an 1 year period), the sediment zone size could be reduced to be only 32% of the settling zone. As such, for a 100% disturbed catchment, the existing design standard requires 635 m^3/ha of total storage (settling and sediment zones), compared to a predicted climate change / RUSLE approach of 587 m^3/ha. The conservative approach for the current design standards will also enable adaption of long-term sediment dams to consider changes to rainfall intensities/depths as the Project progresses.

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, 2026c)).

TABLE 3.10: FUTURE WATER STORAGES (APPROVED AND PROJECT)

Storage ID	Classification					Design Volume (ML)
	2029	2032	2038	2041	Closure	
DP2N (Mitchell Dam)	Mine Water Dam	Mine Water Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention	67
DP5N	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam	Decommission	81
DP5Na					Dam / Dry Detention	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	78
DP14N			Sediment Dam	Sediment Dam	Dam / Dry Detention	229 [b]
DP15N					Dam / Dry Detention	355
DP16N					Dam / Dry Detention	71
DP17N					Dam / Dry Detention	78
DP18N					Dam / Dry Detention	40
DP19N					Dam / Dry Detention	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	162
DP5S			Sediment Dam	Clean Water Dam	Decommission	27
DP8S (Cheshunt Pit Stage	Sediment Dam	Sediment Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention	440 [b]
DP9S		Sediment Dam	Sediment Dam	Sediment Dam	Dam / Dry Detention	24
DP10S					Dam / Dry Detention	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.

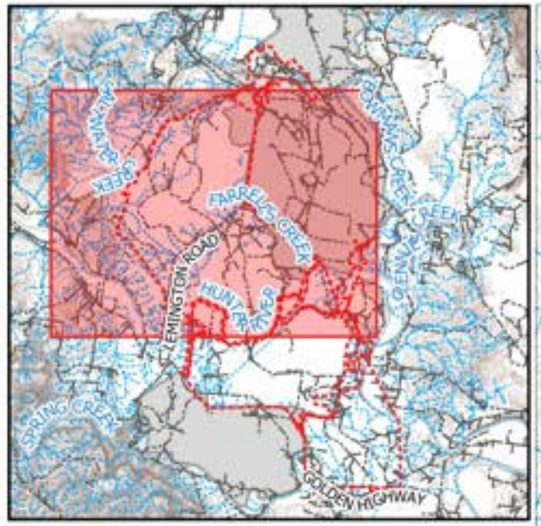
TABLE 3.11: FUTURE DRAINS AND LEVEES / LEVEE UPGRADES (APPROVED AND PROJECT)

Infrastructure ID	Classification				
	2029	2032	2038	2041	Closure
DR01 (Mitchell CWDD)	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Decommission with shaped
DR03	Clean Water Drain	Clean Water Drain	Clean Water Drain	Clean Water Drain	Decommission with shaped
DR04	Mine Water Drain	Mine Water Drain	Sediment Drain	Clean Water Drain	Decommission with shaped
DR05	Sediment Drain	Sediment Drain	Sediment Drain	Clean Water Drain	Decommission with shaped
DR06B	Sediment Drain	Sediment Drain	Sediment Drain	Clean Water Drain	Decommission with shaped
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
DR15			Sediment Drain	Sediment Drain	Decommission
DR16			Sediment Drain	Sediment Drain	Decommission
DR18			Sediment Drain	Sediment Drain	Decommission with shaped
DR23			Sediment Drain	Sediment Drain	Decommission
DR26	Mine Water Drain	Mine Water Drain	Sediment Drain	Clean Water Drain	Decommission with shaped
DR27			Sediment Drain	Sediment Drain	Decommission with shaped
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 3.12: FUTURE WATER STORAGES (APPROVED AND PROJECT)

Storage ID	Classification					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

- HVO North Action Area
- HVO South Action Area
- Adjacent Mining Approvals Boundary
- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment
- 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
- Temporary Stabilisation
- Established Rehabilitation
- Shaping for Final Landform
- Water Storage

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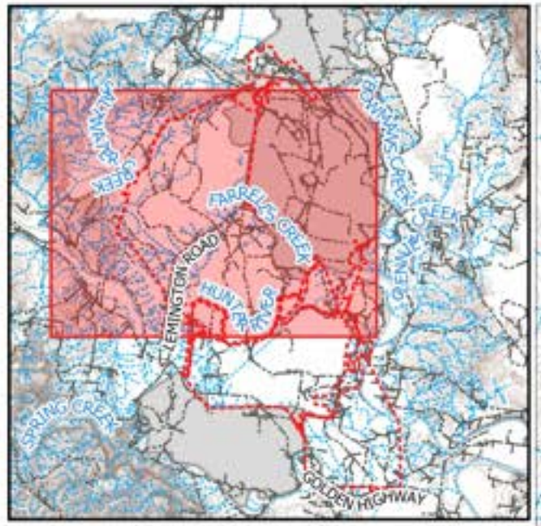
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Figure 3-3 - HVO North Proposed Conceptual WMS - Year 3

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Legend

- HVO North Action Area
- HVO South Action Area
- Adjacent Mining Approvals Boundary
- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment
- Existing Clean Water Drain
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- 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

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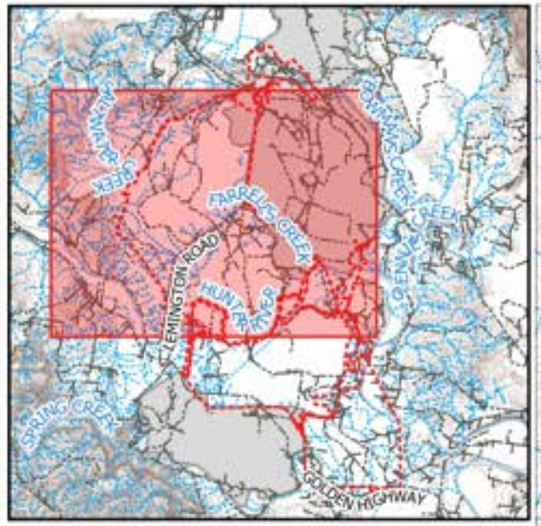
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Figure 3-4 - HVO North Proposed Conceptual WMS - Year 6

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Legend

- HVO North Action Area
- HVO South Action Area
- Adjacent Mining Approvals Boundary
- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment
- 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
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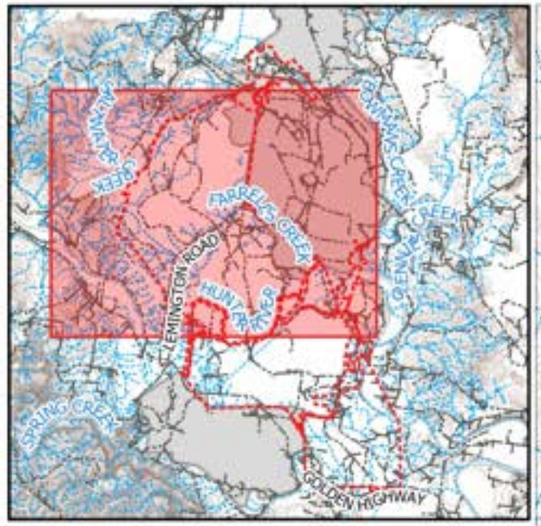
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Figure 3-5 - HVO North Proposed Conceptual WMS - Year 12

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Legend

- HVO North Action Area
- HVO South Action Area
- Adjacent Mining Approvals Boundary
- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment
- 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
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- Inactive Emplacement Area
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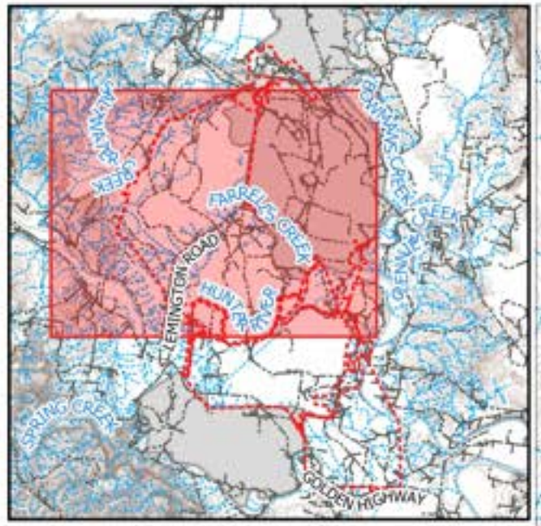
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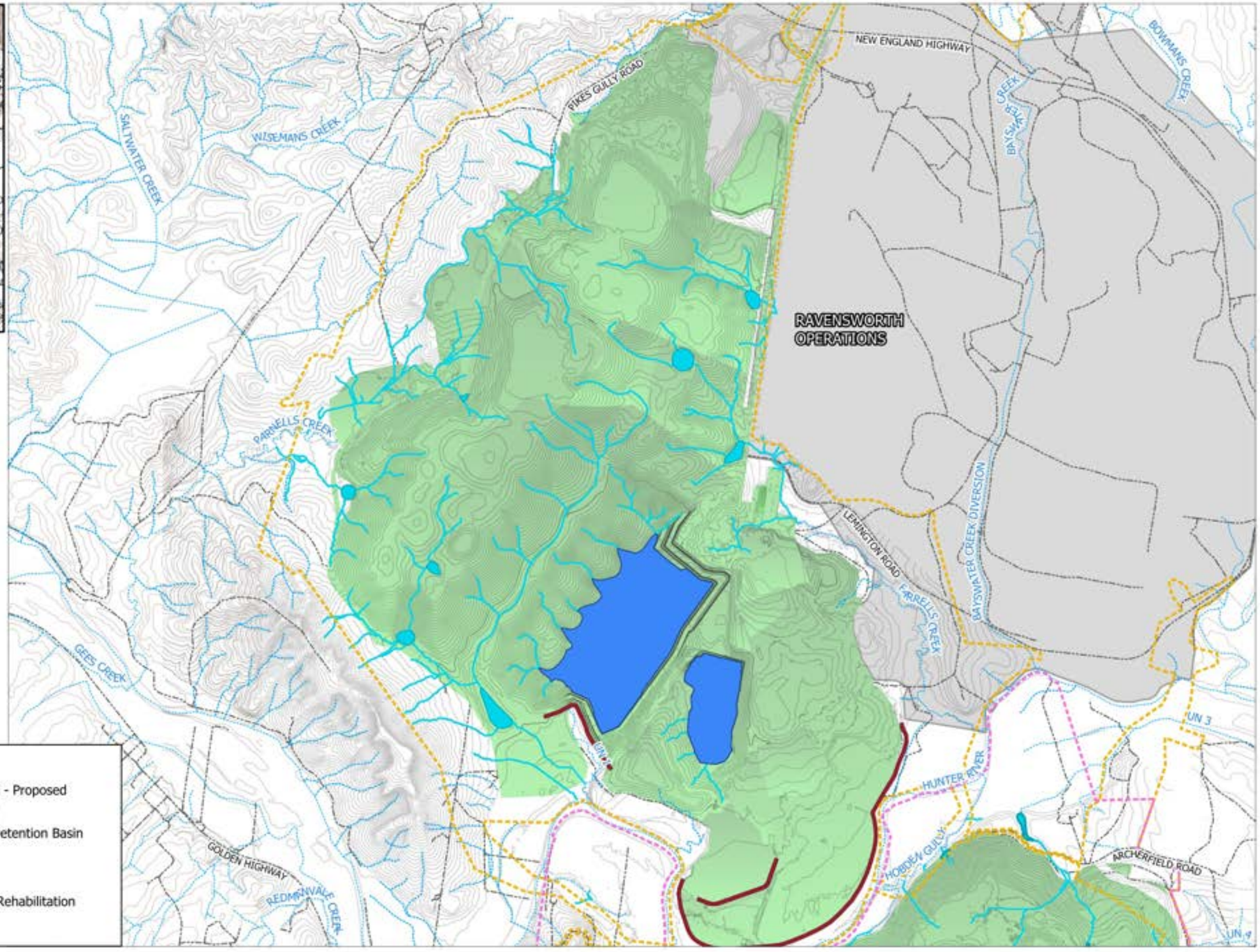
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Figure 3-6 - HVO North Proposed Conceptual WMS - Year 15

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Legend

- HVO North Action Area
- HVO South Action Area
- Adjacent Mining Approvals Boundary
- Road - Existing
- Lemington Road realignment
- Contours
- Watercourse - Existing
- Watercourse - Proposed
- Flood Levee
- Dam / Dry Detention Basin
- Final Void

Land Use

- Established Rehabilitation

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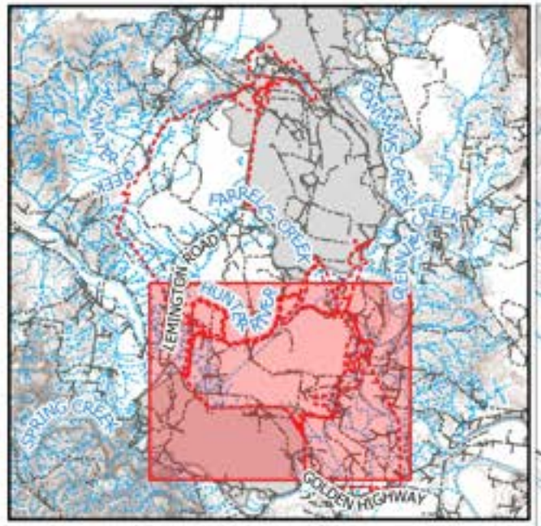
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Figure 3-7 - HVO North Proposed Conceptual WMS - Closure

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NORTH VOID TSF
North Void TSF Levee
Riverview Levee
Cheshunt Levee
DR05
DR06B
DR07
DP1S
DP8S-Staging Dam-1
Dam 45A
Dam 1SS Lake James
CHESHUNT PIT
RIVERVIEW WEST VOID
Riverview Void
DP3S
UNITED WAMBO OPEN CUT OPERATIONS
HUNTER RIVER
LEMINGTON ROAD
HORDEN GULLY
GLENNIES CREEK
WATERFALL CREEK
UN 2
UN 3
UN 4
UN 5
UN 6
ARCHERFIELD ROAD
GOLDEN HIGHWAY
PINEGROVE ROAD
REDBANK CREEK
COMLEROI ROAD
NORTH WAMBO CREEK
WOLLOMBI BROOK
HIGH ROAD

Legend

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- HVO South Action Area
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- Watercourse - Existing
- Road - Existing
- Contours
- Lemington Road realignment
- 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

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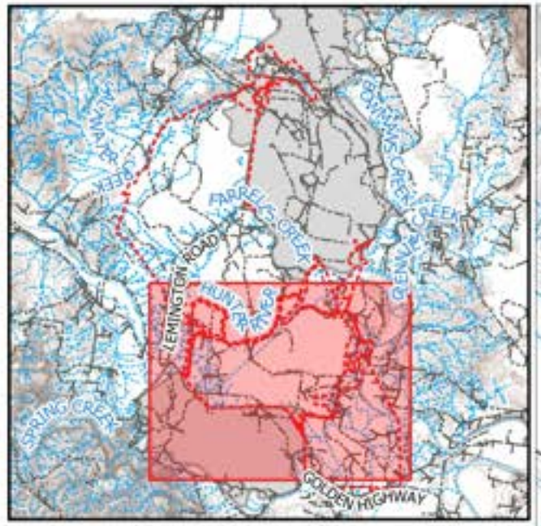
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Figure 3-8 - HVO South Proposed Conceptual WMS - Year 3

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Legend

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- Contours
- Lemington Road realignment
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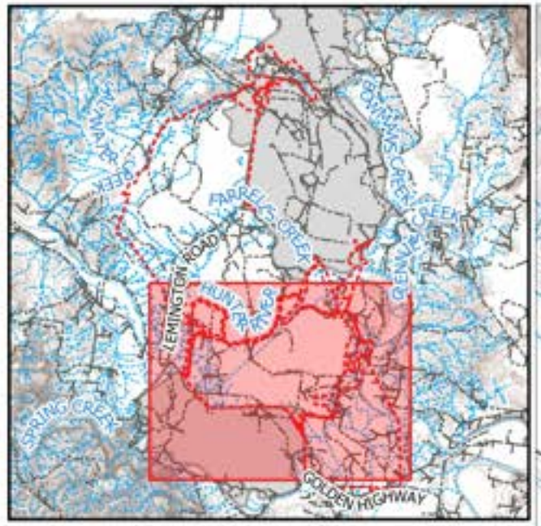
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Figure 3-9 - HVO South Proposed Conceptual WMS - Year 6

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NORTH VOID TSF
North Void TSF Levee
Riverview Levee
Cheshunt Levee
DP9S
DR07
DR05
DR06B
DP1S
Dam 45-A
DP8S-Staging Dam-1
DP8S-Staging Dam-3
CHESHUNT PIT
DP8S-Staging Dam-2
RIVERVIEW WEST VOID
Riverview Void
DP3S
UNITED WAMBO OPEN CUT OPERATIONS
Dam 15S
Lake James
DP5S
DR15
DR16
Unnamed-1
Unnamed-2
DR23
HUNTER RIVER
LEMINGTON ROAD
HORDEN GULLY
GLENNIES CREEK
WATERFALL CREEK
GOLDEN HIGHWAY
PINEGROVE ROAD
REDBANK CREEK
NORTH WAMBO CREEK
COMLEROY ROAD
WOLLOMBI BROOK
HIGH ROAD
ARCHERFIELD ROAD
UN 2
UN 3
UN 5
UN 6
UN 7

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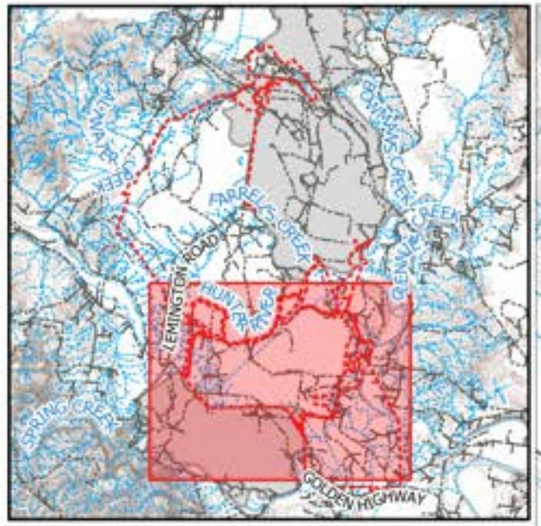
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Figure 3-10 - HVO South Proposed Conceptual WMS - Year 12

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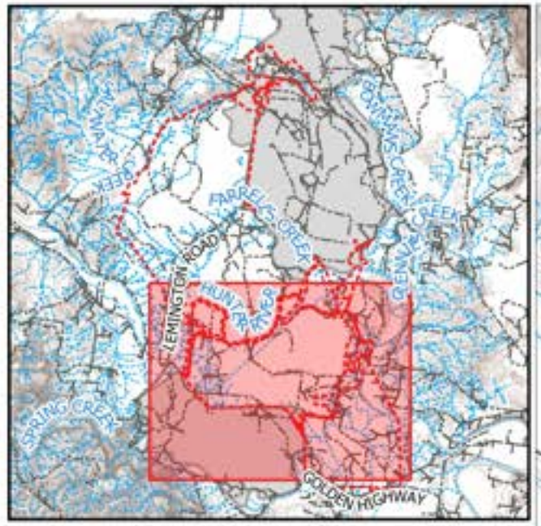
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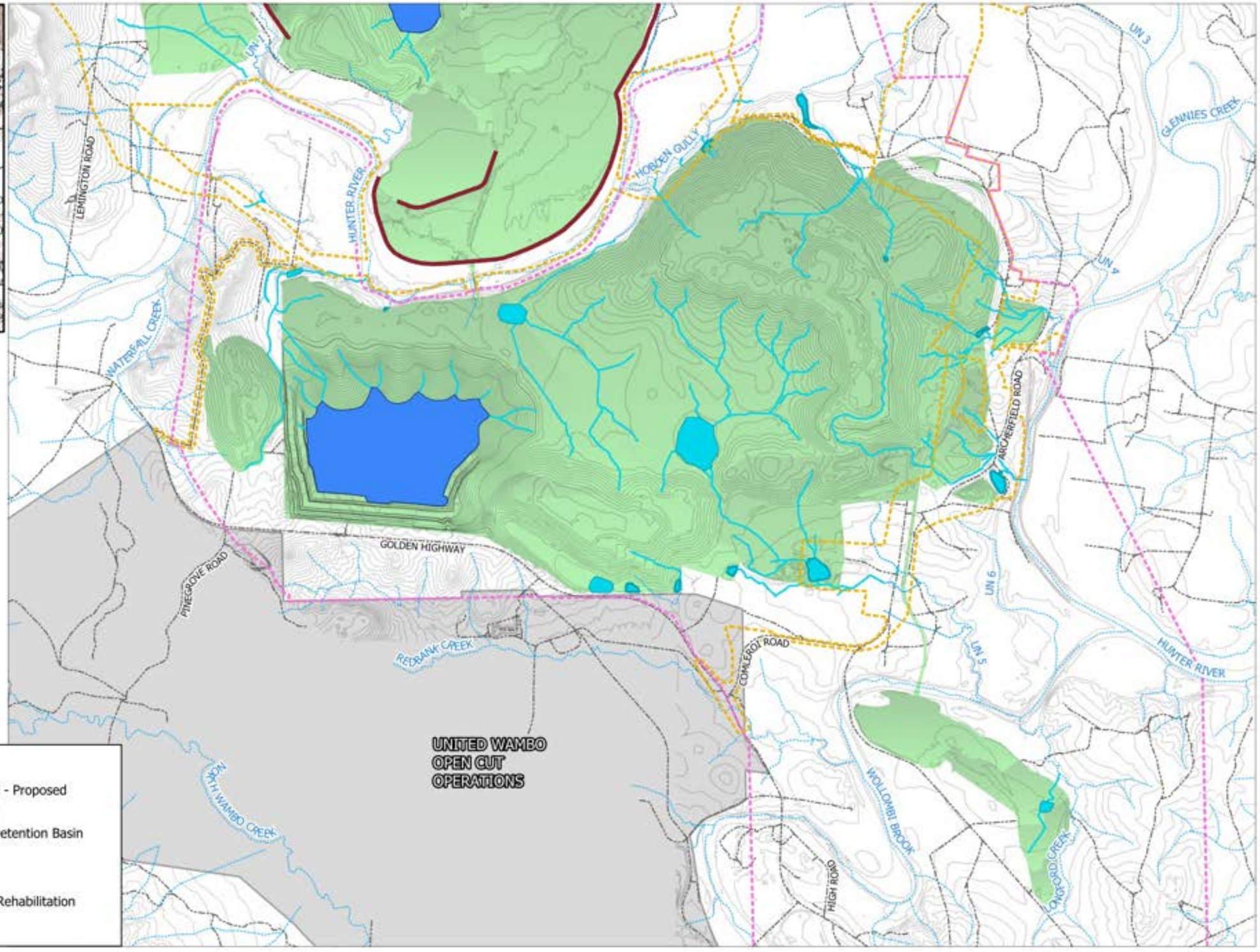
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Figure 3-11 - HVO South Proposed Conceptual WMS - Year 15

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Land Use

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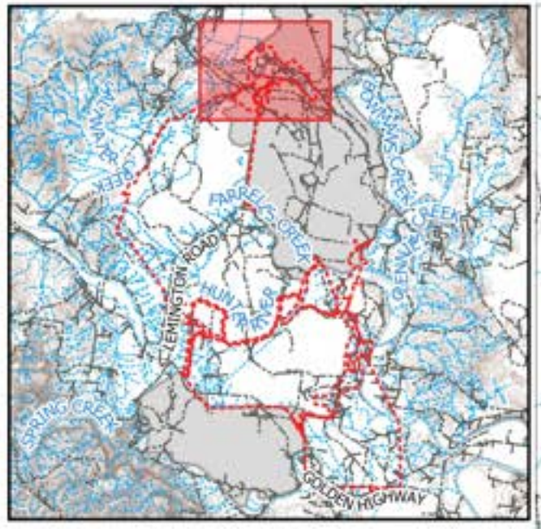
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Figure 3-12 - HVO South Proposed Conceptual WMS - Closure

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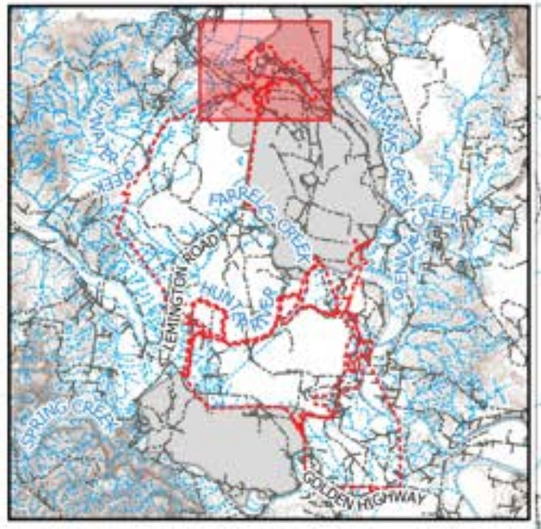
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Figure 3-13 - Newdell Proposed Conceptual WMS - Year 3

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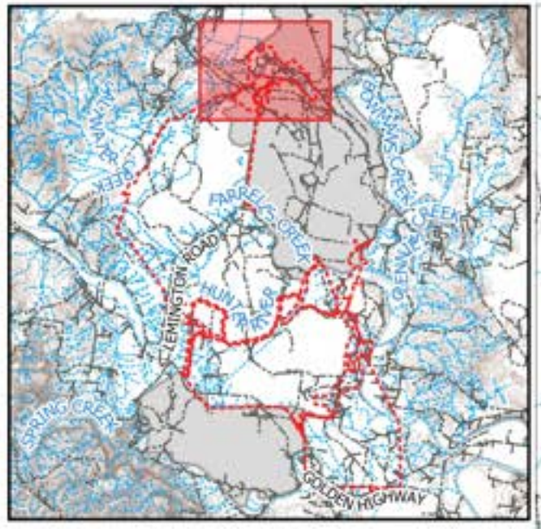
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Figure 3-14 - Newdell Proposed Conceptual WMS - Year 6

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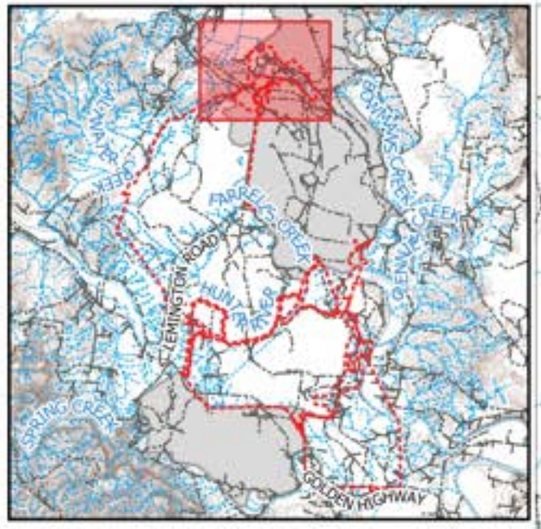
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Figure 3-15 - Newdell Proposed Conceptual WMS - Year 12

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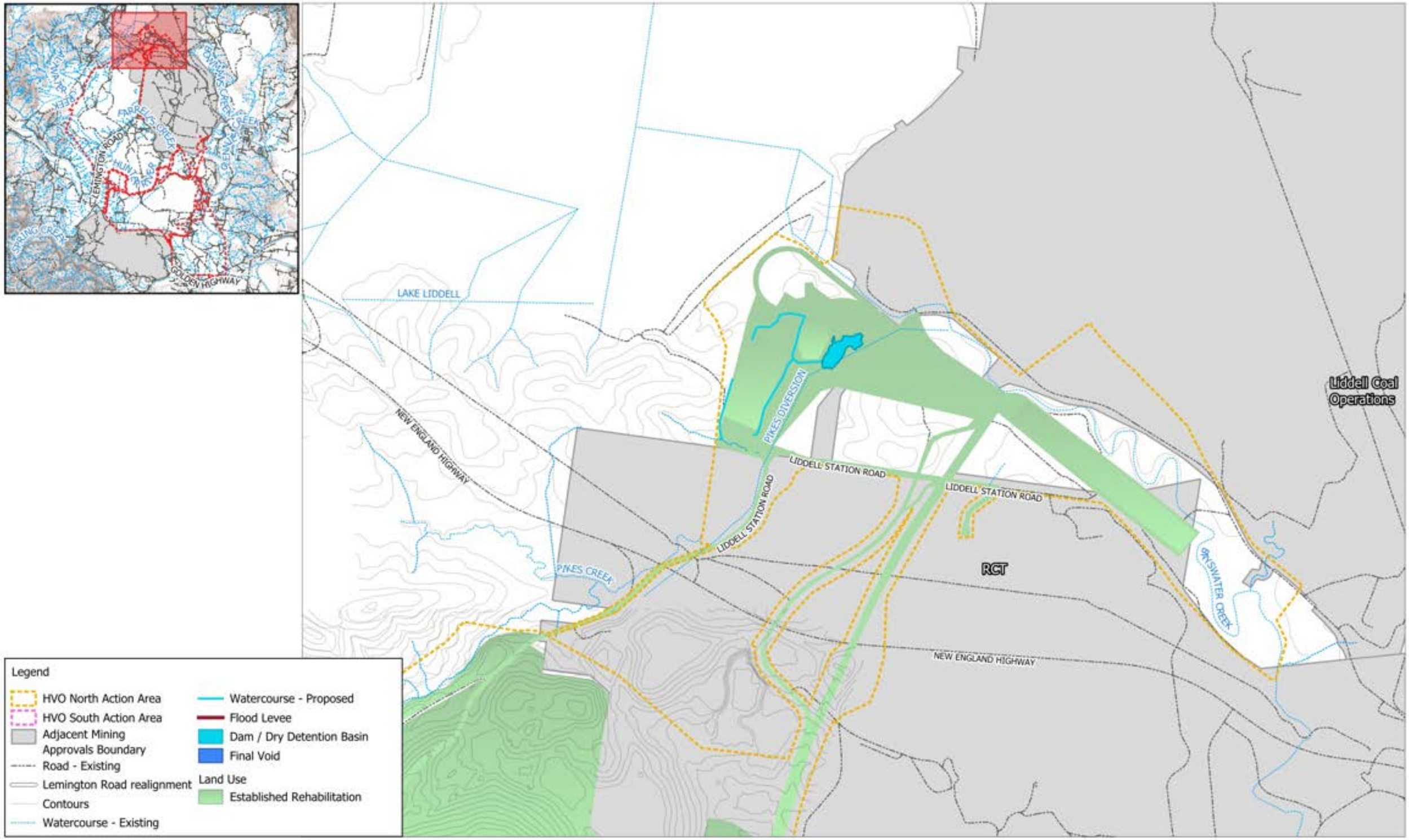
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Figure 3-16 - Newdell Proposed Conceptual WMS - Year 15

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Figure 3-17 - Newdell Proposed Conceptual WMS - Closure

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3.2.2.1 Year 3 (approximately 2029) Water Management Infrastructure (Approved and Project)

At HVO North, 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 TSF.

At HVO South, mining continues in a westerly direction. A new sediment dam (DP1S) and associated 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.

3.2.2.2 Year 6 (approximately 2032) Water Management Infrastructure (Approved and Project)

The progression of mining at HVO North continues to the south-east with no new dams proposed. Tailings disposal will continue at LCO and West Pit TSF.

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.

3.2.2.3 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 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 SLP1 is backfilled with one new sediment dam constructed to contain runoff (DP5S). Shaping around the eastern portion of SLP1 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).

3.2.2.4 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 SLP 1 is filled, and the western portion has sufficiently established rehabilitation for DP5S to transition from a sediment dam to a clean water storage.

3.2.2.5 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, 2025b) (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. By utilising and building upon the existing WMS and upgrades, water for the Project will be able to be managed in accordance with conditions of the current EPL and WALs.

The potential impact of the Project on the site water balance of the HVO WMS has been assessed using a water balance model (WBM) in the GoldSim software. The WBM was developed based on the operational WBM maintained by site and updated to reflect the proposed Project including changes to the WMS as detailed in Section 3.2. The development, calibration and simulation of the WBM is further detailed in Attachment I.

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, 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.

The modelled Project results are also compared to a modelled Approved Operation scenario. The Approved Operation scenario is based on data presented in the 2016 WRM report titled Hunter Valley Operations South Modification 5 Surface Water Assessment (SWA) (WRM, 2016) that formed part of the Project Modification 5 (MOD 5) impact assessment for HVO South. The water balance model inputs for the Approved Operation scenario are included in Appendix A of Attachment I – Water Balance Modelling. The data presented for the Approved Operation is for Stage 4 (2028) of MOD5.

4.1 Climate Inputs

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 NSW government uses the IQQM to provide detailed, time-step data to inform the HRSTS's operation and ensure environmental targets are met. The IQQM data output is an integral component of the HVO WBM used to incorporate 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 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 predicted average annual water balance, for the Project, is shown in Table 4.1 and Figure 4.2. The predicted average annual inflow from the Approved Operation is shown in Figure 4.3. Model results indicate that, on average, rainfall/runoff provides the highest system inflow accounting for 54% 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 Project and reducing to around 1.1 GL near the end of the 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 Project representing 44% to 46% 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 9% to 17% of average outflows over the life of the Project.

Comparison of the inflows and outflows for the Project to the Approved Operation indicates that that there are greater total inflows and total outflows for the Project, primarily due to the larger catchment area compared to the Approved Operation. Figure 4.1 and Figure 4.2 indicate that the proportion of the different inflows and outflows are relatively similar for the Approved Operation and the Project.

TABLE 4.1: AVERAGE ANNUAL WATER BALANCE (ML/YEAR)

Water Stream	Approved Operation	2029	2032	2038	2041
			INFLOWS (ML/year)		
Rainfall	904	901	897	894	890
Runoff	5,773	6,679	7,393	7,914	7,902
Groundwater Inflows[1]	1,240	550	1,050	758	638
Hunter River Extraction[2]	254	2,061	1,260	1,348	1,157
Decant Return	3,204	3,917	4,081	4,559	4,214
Total Inflows	**11,381**	**14,108**	**14,681**	**15,473**	**14,801**
			OUTFLOWS (ML/year)		
Evaporation	1,845	1,719	1,684	1,642	1,623
Pump to CPP	4,643	6,197	6,424	7,216	6,613
Dust Suppression	2,432	3,569	3,566	3,303	3,418
HRSTS Release	1,315	1,256	2,321	2,555	2,578
Overflows	168	381	176	181	200
Washdown	307	263	264	263	263
Misc Industrial Use	329	350	351	350	350
Load Point Sprays[3]	0	142	144	143	144
Total Outflows	**11,408**	**13,877**	**14,930**	**15,653**	**15,189**

Note 1: Adjusted rates to consider pumpable groundwater (refer to Attachment I).

Note 2: High Security Entitlement.

Note 3: Load point spray demands are included in CHPP demands for the Approved Operations water balance.

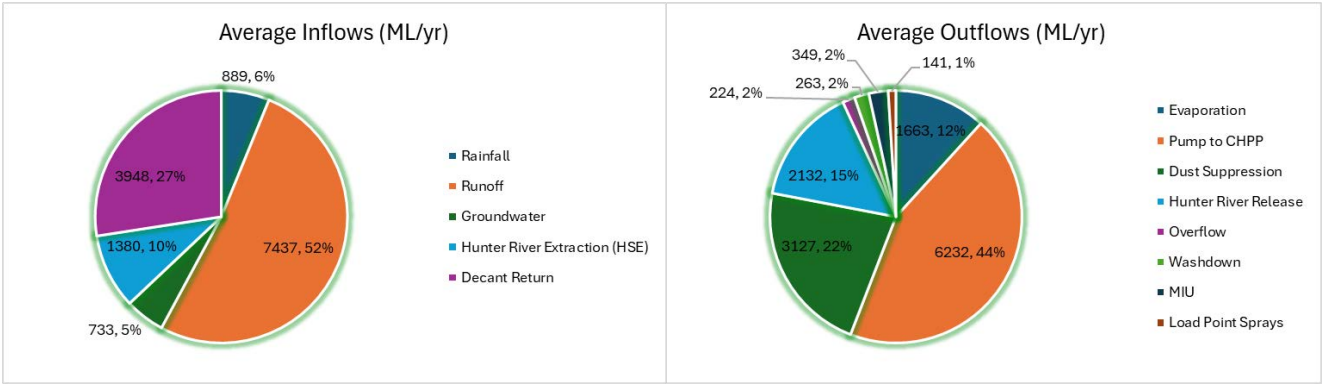


FIGURE 4.1: PROJECT - AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

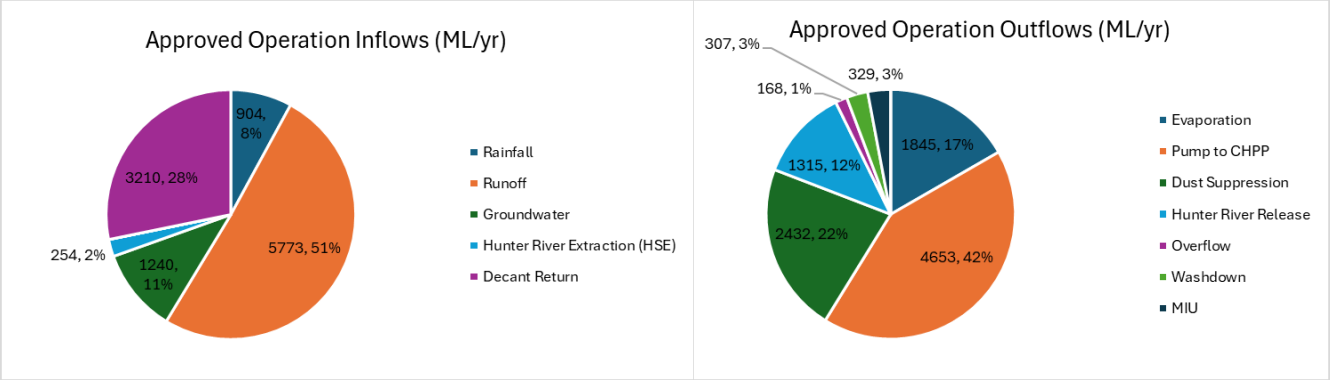


FIGURE 4.2: APPROVED OPERATION - AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

4.3 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 4.3 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 I) – 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 4.3.

The figure indicates that total site inventory remains below the Site Storage Capacity (also known as 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 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 1.5 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 I. Those detailed plots further support the outcomes described above.

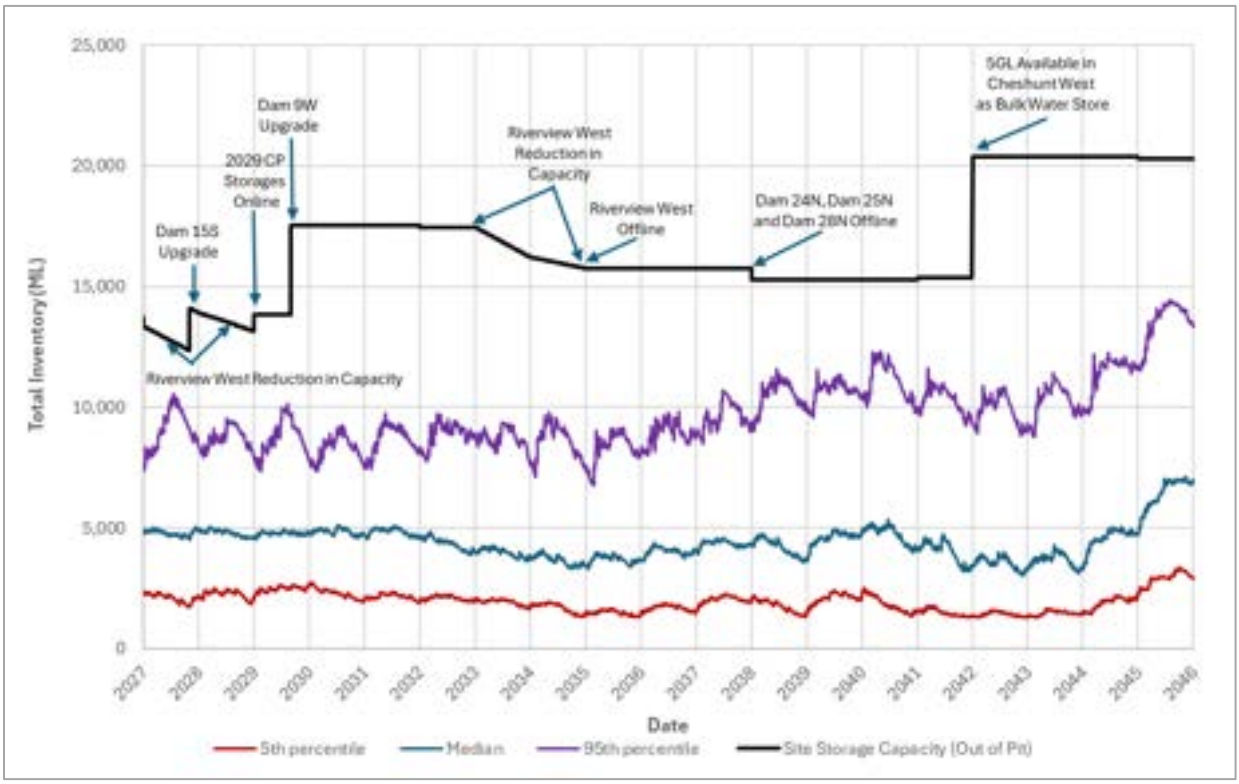


FIGURE 4.3: TOTAL SITE WATER INVENTORY FORECAST

4.4 Climatic Variability

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 4.2.

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).
- Results for the Approved Operation show average inflow and outflow volumes of a similar magnitude to the Project. The most pronounced difference between the two scenarios is the reduced Hunter River extraction for the Approved Operation for the median and 95th percentile result. This is due to more water predicted to be available on site (i.e. groundwater, rainfall and runoff) to meet the water demands for the Approved Operation scenario which are lower than the modelled Project water demands.

TABLE 4.2: 5TH PERCENTILE, MEDIAN AND 95TH PERCENTILE RAINFALL YEAR WATER BALANCE

Water Stream	Approved Operation			2029			2032			2038			2041		
	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile
INFLOWS (ML/year)															
Rainfall	406	828	1,911	406	836	1,414	401	793	1,276	369	821	1,110	371	912	1,202
Runoff	1,670	4,330	11,384	1,828	4,820	10,462	2,051	5,476	11,639	2,190	5,927	12,430	2,104	5,795	12,147
Groundwater Inflows	1,240	1,240	1,240	550	550	550	1,050	1,050	1,050	758	758	758	638	638	638
Hunter River Extraction[1]	1,558	0	0	3,710	2,375	262	2,491	1,197	814	2,831	1,354	1,752	2,787	688	979
Decant Return	3,207	3,196	3,255	3,926	3,926	3,890	4,081	4,081	4,081	4,557	4,560	4,560	4,214	4,214	4,214
Total Inflows	8,081	9,594	17,790	10,419	12,507	16,578	10,075	12,597	18,859	10,705	13,421	20,611	10,114	12,246	19,179
OUTFLOWS (ML/year)															
Evaporation	1,607	1,739	2.629	1,193	1,686	1,862	1,195	1,619	1,654	1,037	1,642	1,433	1,034	1,839	1,541
Pump to CPP	4,440	4,632	4,717	6,211	6,211	6,155	6,424	6,424	6,424	7,212	7,216	7,217	6,613	6,613	6,613
Dust Suppression	2,483	2,484	2,488	2,557	3,653	3,652	2,912	3,732	3,732	2,880	3,345	3,345	2,850	3,504	3,504
HRSTS Release	0	32	7,582	0	0	3,949	0	0	8,933	0	0	10,208	0	104	9,321
Overflows	19	74	317	77	195	435	71	128	194	36	108	246	36	108	246
Washdown	299	306	310	263	263	261	264	264	264	263	263	263	263	263	263
Misc Industrial Use	328	346	350	350	350	349	351	351	351	350	350	350	350	350	350
Load Point Sprays[2]	0	0	0	102	180	196	102	190	201	102	192	198	102	192	198
Total Outflows	9,175	9,612	18,662	10,752	12,538	16,859	11,319	12,708	21,752	11,880	13,116	23,260	11,249	12,974	22,036
Change	**-1,094**	**-19**	**-872**	**-333**	**-31**	**-281**	**-1,245**	**-110**	**-2,893**	**-1,175**	**305**	**-2,649**	**-1,135**	**-728**	**-2,857**

[1] HSE, [2]Load point spray demands are included in CHPP demands for the Approved Operations water balance.

4.5 Water Supply Reliability

There is a very high reliability of water supply with negligible shortfalls over the Project. Any shortfall can 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 Project and reducing to around 1.1 GL near the end of the Project (8% to 15% of total inflows). The modelling indicates that Hunter River extraction via GSE WALs is 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 Project is shown in Figure 4.4 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 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 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 Project is expected to draw on up to 47% of the existing HSE WALs. Compared to the Approved Operation, the Project is predicted to utilise a higher proportion of the existing HSE WALs.

The water licensing strategy is discussed in the Water Assessment (EMM, 2025b).

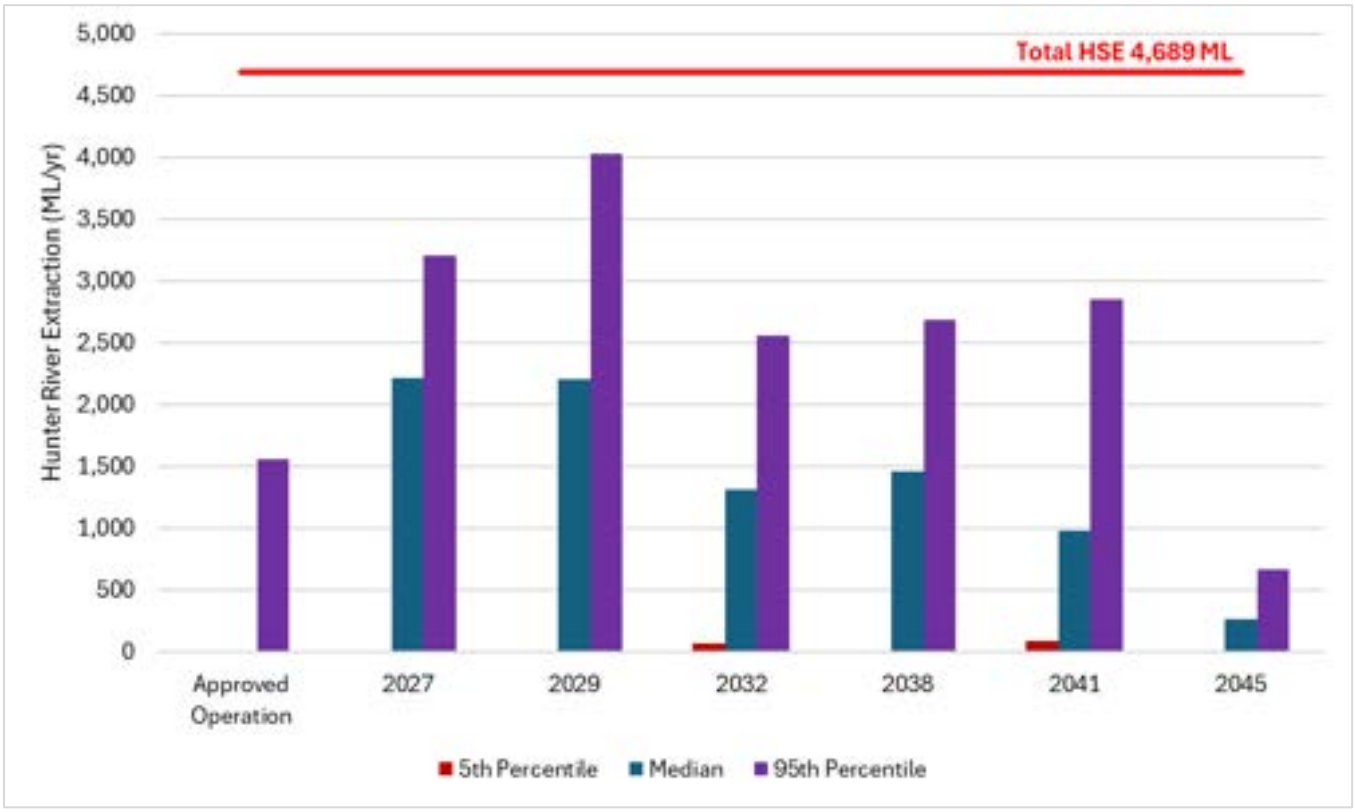


FIGURE 4.4: HUNTER RIVER EXTRACTION (HIGH SECURITY ALLOCATION) – STATISTICAL ANALYSIS

4.6 Controlled Release to HRSTS

As described in Section 4.2, discharge to the Hunter River via HRSTS is forecast to provide approximately 9% to 17% of average outflows for the Project. Discharge to the HRSTS increases to approximately 16% to 17% of average outflows from the middle of the Project (e.g., around Year 6, approximately 2032). It is noted that the 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 4.5. In total, the Project is forecast to utilise on average, 19% to 52% of the average total allowable discharge opportunities. The 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 Project remains well below the release limits (i.e. annual release volumes are higher in wet years). Compared to the Approved Operation, the Project is anticipated to utilise a higher number of release opportunities.

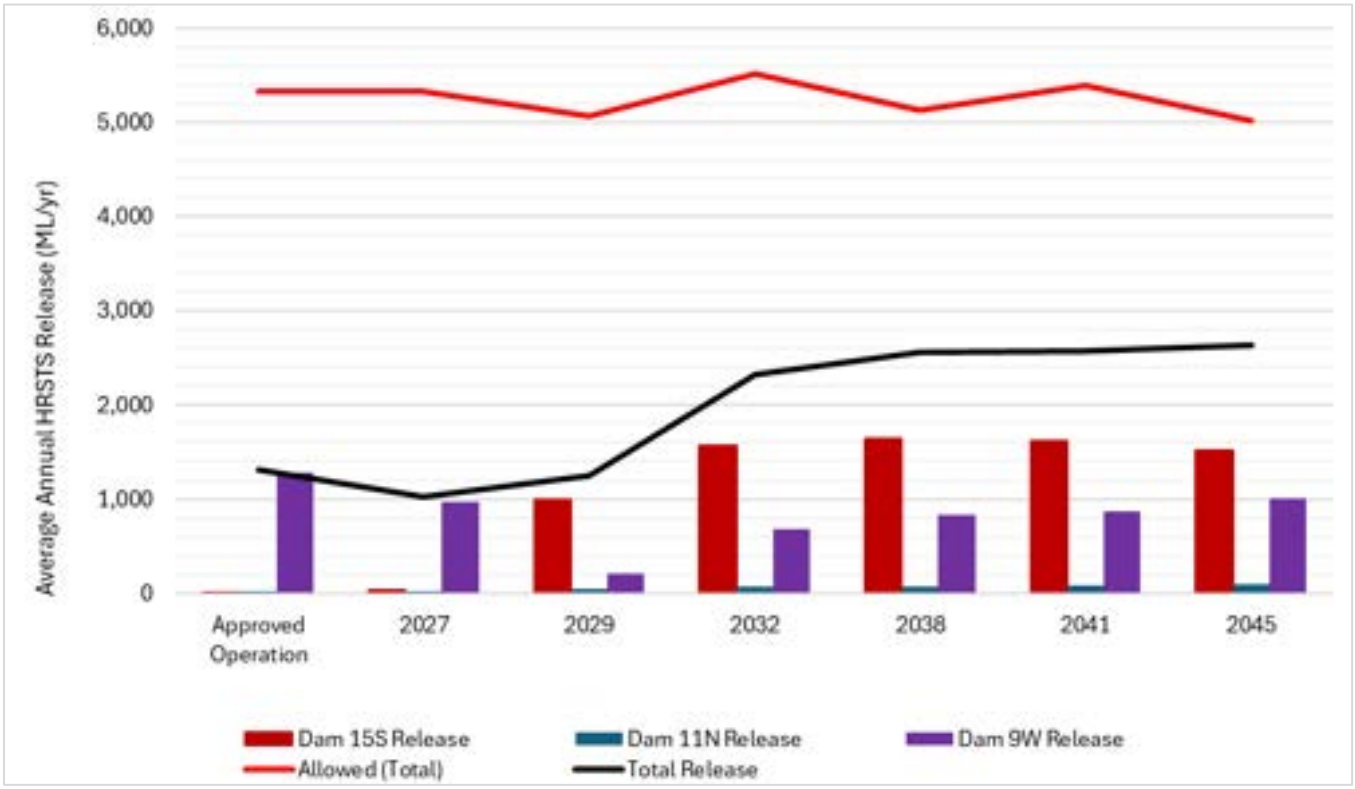


FIGURE 4.5: CONTROLLED RELEASES (HRSTS)

Consistent with the existing operation, the WBM has been set up such that release only occurs within the existing EPL limits and the operation of the HRSTS (refer Attachment I). The exceedance plot in Figure 4.6 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 78% 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.

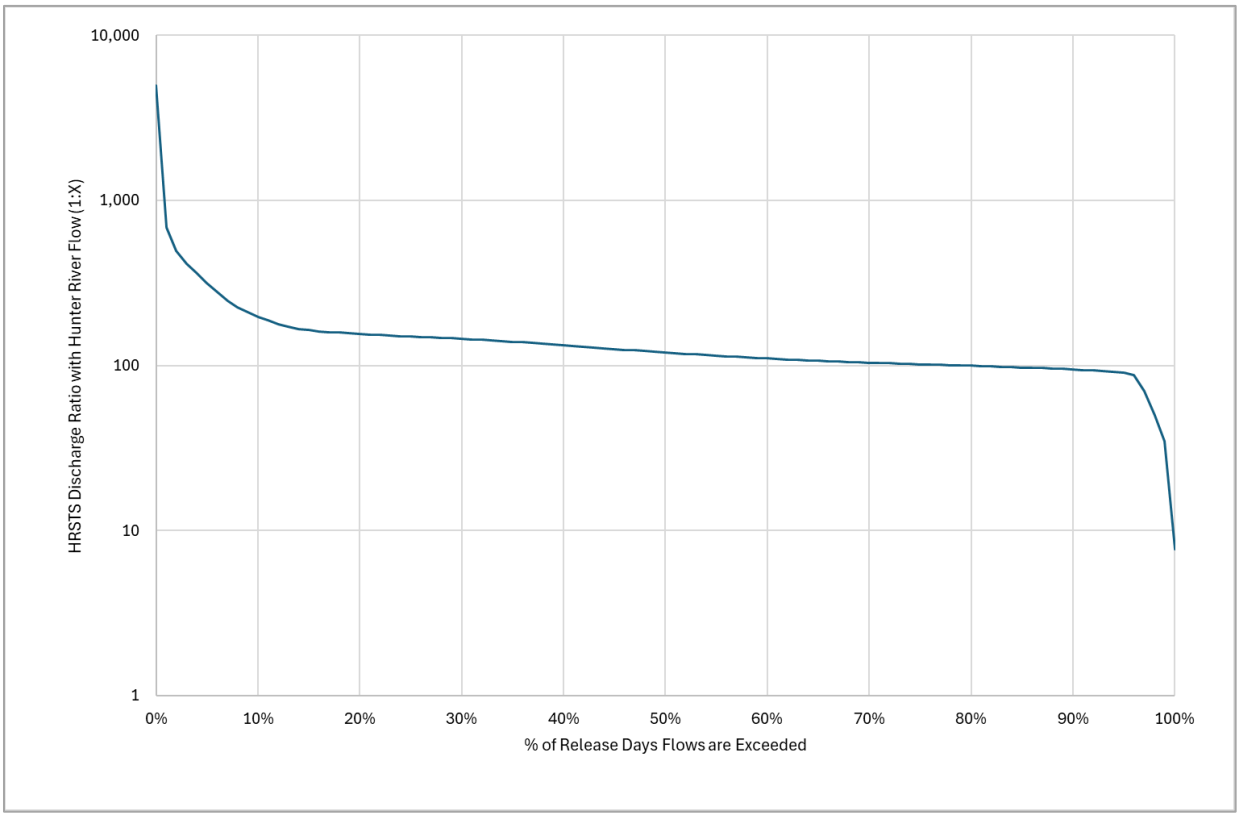


FIGURE 4.6: HRSTS FLOW DILUTION RATIO EXCEEDANCE CURVE

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 following methodology was adopted:

- Release water quality assumed equal to median historical value recorded in release storages (with a sensitivity analysis undertaken for the 80th percentile historical values).
- 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 4.6 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 analysis of metals for the Hunter River upstream monitoring location and in the release dams is included in Table B.2 in Attachment B. All analytes that had a mixed water quality exceeding the 80th percentile background concentration for either the 50th percentile release water or the 80th percentile release water (sensitivity analysis) are presented in Table 4.3. The 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, with the exception of boron (0.0051 mg/L versus 0.0050 mg/L) indicating that the expected water quality is within the existing range experienced in the Hunter River.

The sensitivity analysis (i.e. release discharge water at 80th percentile historical values) indicates no concerns around the mixed water quality relative to published ANZG toxic level of species protection (Tox LOSP) and livestock drinking water default guideline values. A summary of the outcomes of the analysis for each analyte for the sensitivity analysis assessment is included in Table 4.4. Water quality impacts of metals in the Hunter River are expected to be short-term, infrequent and negligible. The analysis considers Tox LOSP which is typically based on chronic toxicity whereas the releases are infrequent short-term discharges and any elevated species concentrations would also be infrequent and short term.

Based on this assessment no significant impact on water quality due to the Project utilising existing HRSTS and EPL discharge conditions is expected. Further discussion of water quality impacts is provided in Section 6.3.

TABLE 4.3: FULLY MIXED HUNTER RIVER WATER QUALITY ASSESSMENT

Analyte	Hunter River Upstream Water Quality		50th Percentile Release Water			80th Percentile Release Water (Sensitivity Analysis)		
			Mixed Concentration	Increase Relative to Hunter River Upstream 80th Percentile		Mixed Concentration	Increase Relative to Hunter River Upstream 80th Percentile	
	80th Percentile (mg/L)	95th Percentile (mg/L)	(mg/L)	(mg/L)	(%)	(mg/L)	(mg/L)	(%)
TDS	531.2	725.5	544.8	13.6	2.6%	571.4	40.2	7.6%
Arsenic (As)	0.0010	0.0010	0.0010	-	-	0.0011	0.0001	11.1%
Boron (B)	0.05	0.05	0.05	-	-	0.051	0.001	1.2%
Potassium (K)	5.0	21.0	5.1	0.1	2.5%	5.3	0.3	6.1%
Magnesium (Mg)	51.4	59.8	51.5	0.1	0.3%	52.0	0.6	1.1%
Sodium (Na)	83.2	101.0	88.2	5.0	6.0%	97.0	13.8	16.6%
Sulfate (SO4)	42.4	59.9	46.3	3.9	9.2%	50.9	8.5	20.1%
Total Alkalinity	259.2	300.0	261.1	1.9	0.7%	268.3	9.1	3.5%
Bicarbonate Alkalinity	259.4	286.6	259.7	0.3	0.1%	263.3	3.9	1.5%
Carbonate Alkalinity	1.0	17.6	1.8	0.8	81.5%	2.6	1.6	162.7%

TABLE 4.4: FULLY MIXED HUNTER RIVER WATER QUALITY – SENSITIVITY ASSESSMENT – OUTCOMES

Analyte	Comments
TDS	<600 mg/L is regarded as good quality drinking water by Australian Drinking Water Guidelines (ADWG) (Chapter 10, 2022) (NHMRC, 2011). It should be noted that TDS is also governed by HRSTS with µS/cm limits.
Arsenic (As)	Mixed is below ANZG Tox LOSP 95% of 0.024 mg/L (ANZG, 2018).
Boron (B)	Mixed is below ANZG Tox LOSP 99% of 0.34 mg/L (ANZG, 2018).
Potassium (K)	No ANZG guideline. Element is not considered a concern for general human population drinking water.
Magnesium (Mg)	No ANZG or other guideline value sourced. Element has no evidence of adverse health effects on humans.
Sodium (Na)	No ANZG or other guideline sourced. Human consumption is typically based on taste.
Sulfate (SO4)	Mixed is below ANZG livestock (poultry) guideline limit of 250 mg/L for poultry (ANZG, 2023).
Total Alkalinity	Buffering capacity of flows remain less than 95th percentile Hunter River water quality.
Bicarbonate Alkalinity	Buffering capacity of flows remain less than 95th percentile Hunter River water quality.
Carbonate Alkalinity	Buffering capacity of flows remain less than 95th percentile Hunter River water quality.

4.7 Overflows

The water balance modelling also forecasts overflows from the WMS. These overflows are typically predicted to occur from sediment dams. The modelling indicates less than 0.2% of forecast overflows for the Project are attributed to mine water for the 5th percentile, median and 95th percentile results for all modelled stages (i.e. the mine water component equates to less than 0.35 ML/year in the above mentioned scenarios). As identified in the Blue Book (Landcom, 2004; NSW DECC, 2008d), overflow from sediment dams will occur during rainfall events above the design criteria specified in the Blue Book. These design criteria have been established by the NSW Government specifically for sediment control at mining operations. The risk of overflows from the mine WMS is limited as freeboard requirements are met by ceasing pumping water to these dams, when surplus water occurs on-site.

As outlined in Sections 3.1.1.3 and 3.2.2, the purpose of the sediment dams within the WMS is to manage runoff from disturbed areas. Sediment dams will be designed in accordance with the Blue Book (Landcom, 2004; NSW DECC, 2008d) to manage runoff from the 5 day, 95th percentile rainfall event. The selected design criteria is in excess of the minimum recommended design criteria for sediment dams as outlined in Volume 2E of the Blue Book (NSW DECC, 2008d), i.e. 90th percentile design storm event. Volume 2E of the Blue Book (NSW DECC, 2008d) indicates that for the 95th percentile design storm event the indicative average annual sediment basin overflow frequency will be 1 to 2 overflow events per year, compared to 2 to 4 overflow events per year for the 90th percentile design storm event.

Mine water is contained within systems designed to a higher design criteria than the sediment water system. The design criteria for mine water is to convey runoff from and to provide sufficient freeboard to contain runoff from the 1% AEP 24 hour storm event within the mine water storage dams. Mine water is stored within the open cut pits as required during large or prolonged rainfall events (refer to Section 4.3).

4.8 Climate Change Assessment

A climate change assessment has been undertaken by applying predicted seasonal change to rainfall and evaporation (%) for a climate change scenario to the base case operational water balance hydrology model. Further details are provided in Section 9 of Attachment I - Water Balance Modelling.

For the assessment, the highest Shared Socio-economic Pathway, SSP5-8.5, was selected. This is consistent with the Groundwater Modelling (EMM, 2026) climate change assessment. SSP5-8.5 is a scenario based on emissions continuing to rise throughout the 21st century with little climate change intervention. SSP5-8.5 is considered a worst-case climate change scenario "Fossil-fuelled Development". For the water balance modelling the "maximum consensus" seasonal projections for the near future (i.e. a 20 year period centred around 2030) climate horizon have been adopted.

The predicted annual inflows and outflows for the Project, at various stages, are presented in Table 4.5. 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.

Compared to the existing baseline climate scenario, the inflows for the climate change scenario (including seasonality predictions) are relatively similar due to the overall balanced increases and decreases throughout the year (i.e. increase rainfall from December to May offset by lower rainfall from June to November).

The modelling also indicates that seasonal increases in rainfall intensity associated with climate change on the daily rainfall model timestep does not have any significant influence on forecast overflows form the WMS. This can be seen in the results presented in Table 4.5, with modelling forecasting negligible increases in average overflows of 1 ML/year for 2032 and 2038 (i.e. ~0.6% increase in volume). Further discussion of design criteria for the WMS and consideration of climate change is included in Sections 3.2 and 4.

Compared to the existing baseline climate scenario, the total site inventory for the climate change scenario is maintained at a higher volume for the 95th percentile result indicative of wet climate conditions due to higher rainfall conditions between December and May (refer to Figure 4.5).

TABLE 4.5: CLIMATE CHANGE SCENARIO AVERAGE ANNUAL INFLOWS AND OUTFLOWS (ML/YEAR)

Water Stream	Approved Operation	2029	2032	2038	2041
			INFLOWS (ML/year)		
Rainfall	906	900	898	894	887
Runoff	5,718	6,613	7,327	7,844	7,829
Groundwater Inflows	1,240	548	1,047	747	630
Hunter River Extraction[1]	260	2,094	1,285	1,364	1,195
Decant Return	3,205	3,910	4,081	4,559	4,213
Total Inflows	11,329	**14,065**	**14,638**	**15,408**	**14,754**
			OUTFLOWS (ML/year)		
Evaporation	1,833	1,701	1,670	1,625	1,601
Pump to CPP	4,646	6,186	6,424	7,216	6,612
Dust Suppression	2,429	3,555	3,558	3,303	3,414
HRSTS Release	1,306	1,270	2,283	2,561	2,557
Overflows	168	377	177	182	196
Washdown	307	262	264	263	263
Misc Industrial Use	328	349	351	350	350
Load Point Sprays[2]	0	140	143	142	143
Total Outflows	11,017	**13,840**	**14,870**	**15,642**	**15,136**

[1] HSE, [2]Load point spray demands are included in CHPP demands for the Approved Operations water balance.

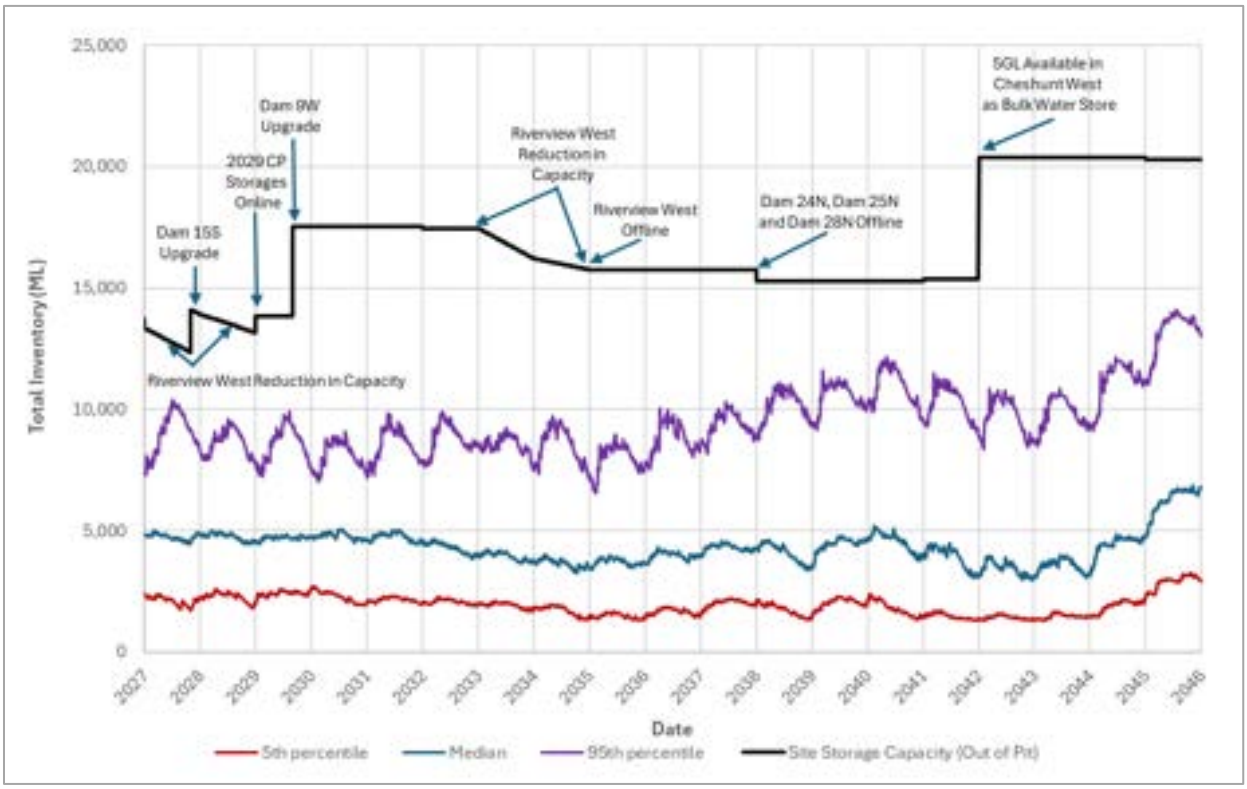


FIGURE 4.7: CLIMATE CHANGE SCENARIO WHOLE OF SITE INVENTORY

4.9 Outcomes

The water balance modelling demonstrates the following outcomes:

- 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).
- Overflows from the WMS are typically limited overflows from sediment dams (designed in accordance with NSW Blue Book standards (Landcom, 2004; NSW DECC, 2008d)). In addition, mine water storages are designed and operated to contain the stormwater runoff generated by the 1% AEP 24 hour design storm event. Therefore, runoff generated from mining areas during rainfall events less than the 1% AEP 24 hour are expected to be contained on site, thereby minimising the risk of impacts to the environment.
- By utilising and building upon the existing WMS and current site upgrades, surface water for the Project will be able to be managed in accordance with conditions of the current EPL and WALs.
- There is only minor variation in magnitude and proportion of WMS inflows and outflows between the modelled Approved Operation and the Project.

In regard to WALs:

- The 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 47% of HSE WALs in median conditions during peak demand years.
- The modelling indicates that the Project has no reliance on GSE allocations.

For HRSTS discharges:

- The Project is expected to utilise, on average, 19% to 52% of the total allowable discharge opportunities to the HRSTS. 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).
- 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.

- Infrequent and short term (e.g. 1 to 2 days) minor increases to metals concentrations in the Hunter River may occur during HRSTS discharges, with concentrations predicted expected to have a negligible impact when considering relevant ANZG guideline values.

Climate change modelling, under an SSP5-8.5 scenario (refer to Attachment I), indicates that:

- The Project is expected to maintain sufficient inventory to meet water demands, while relying less on discharges to the HRSTS and more on extraction from the Hunter River compared to the Approved Operation. The modelling indicates that HVO holds sufficient WALs to operate in the SSP5-8.5 scenario.
- Increases in rainfall intensity associated with climate change on the daily rainfall model timestep does not have any significant influence on forecast overflows from the WMS. The modelling forecasts negligible increases in average overflows of 1 ML/year for 2032 and 2038 (i.e. ~0.6% increase in volume).

5. FINAL VOID HYDROLOGY ASSESSMENT

Final void impacts were assessed for the NSW state approvals process in the AP SWIA (Engeny, 2025). The modelling methodology and the results presented in the AP SWIA are documented in this report. A peer review of the surface water impact assessment was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the surface water impact assessment studies, 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 final landform design (refer to Figure 5.1) includes:

- Two final voids at HVO North (North Void and Carrington Pit Void).
  - 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).
- One final void will remain at HVO South, consistent with the existing HVO South Approval. Some changes to the final void catchment and dimensions due to rescheduling are proposed.

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 relatively 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 is to 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 pit lake levels, recovery timeframes and water quality trends have been assessed through the following methodology:

- Hydrological model:
  - A final void water and salt balance model (that is, a mass 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 predicted from the groundwater modelling (EMM, 2025c). 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.
  - The model development is summarised in Section 5.1 with results provided in Section 5.2. Further details are provided in Attachment J.
- Hydrogeochemical assessment:
  - A Hydrogeochemical assessment was undertaken for the EIS Project final voids, including material characterisation and forecasting of long-term lake chemistry to predict the water qualities of lakes that form within final voids (EGI, 2022b). The hydrogeochemical model developed by EGI is expected to produce more robust predictions of the final pit lake chemistry post closure.
  - The Hydrogeochemical Assessment prepared for the EIS Project is summarised in Section 5.3.

Outcomes for the level, recovery timeframe and quality trends of the final voids are summarised in Section 5.4. 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 Resources Impact Assessment (EMM, 2026c). Closure options and strategies including the final land use are described in the PERs (EMM, 2026a; EMM, 2026b).

5.1 Hydrological Model Methodology

A final void water and salt balance model was set up in the GoldSim software for the EIS Project and remains valid for the Project. The model simulates inflows from rainfall runoff over the residual final void catchment (including direct rainfall), groundwater fluxes (inflow or outflow) from Permian-aged lithology and spoil seepage, as well as outflow due to evaporation on a daily time step. In simulating lake water salinity, the model assumes conservation of mass and fully mixed conditions.

The development of the model is detailed in Attachment J while key inputs and assumptions are summarised as follows:

- Catchment areas of 706 ha, 324 ha and 570 ha for North Void, Carrington Pit Void and South Void respectively.
- Final lake level-volume-area relationships derived from the final landform contour plan.
- A 121 year climatic data set (1889 to 2012) obtained from the SILO Data Drill. The data was looped several times to obtain an extended period with a sufficient length of time to achieve long term water level equilibrium.
- Rainfall runoff from the final void catchments was estimated using the Australian Water Balance Model (AWBM) and the parameters adopted from the calibration of the operational WBM (refer Attachment I).
- Monthly varying pan factors to convert SILO Pan Evaporation to Lake Evaporation ranging from 0.75 to 0.96. A further constant pit lake evaporation reduction factor of 0.8 was adopted to represent the reduced evaporation potential from a deep lake as a result of shading from solar radiation and wind. A sensitivity assessment was undertaken by reducing the evaporation from the pit lake surface by a further 20%.
- A constant pan factor of 0.95 was adopted to convert Lake Evaporation to Evapotranspiration.
- Predicted groundwater fluxes (inflow and outflow) between the pit lake and the surrounding spoil and host rock were determined through the Groundwater Modelling (EMM, 2025c) as a function of lake water level (i.e., level vs flux relationship).
- The adopted salinity of groundwater inflows was informed by the geochemical assessment undertaken (EGI, 2022b) including 4,357 mg/L for host rock inflows and 895 mg/L for spoil seepage.
- The adopted salinity of rainfall runoff included 13 mg/L for direct rainfall and 300 mg/L for runoff from natural or rehabilitated spoil and 2,000 mg/L for runoff from pit.

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 each 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 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 Lake Water Level – Lower Rainfall and Higher Evaporation.
- "worst case" - Higher Lake Water 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. Further detail of the methodology for the climate change sensitivity are provided in Attachment J.

North Void

Carrington Pit Void

HUNTER RIVER

HUNTER RIVER

South Void

Legend

Final Void Catchments

Land Use

Highwall

Rehabilitated

Note: Final landform DEM presented for the three final voids and their catchment areas only

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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

Figure 5-1:
Final Landform - Void Conceptual Overview

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 25 /9 /2025

5.2 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 are 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, which is common for final voids in the Hunter Valley, 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.

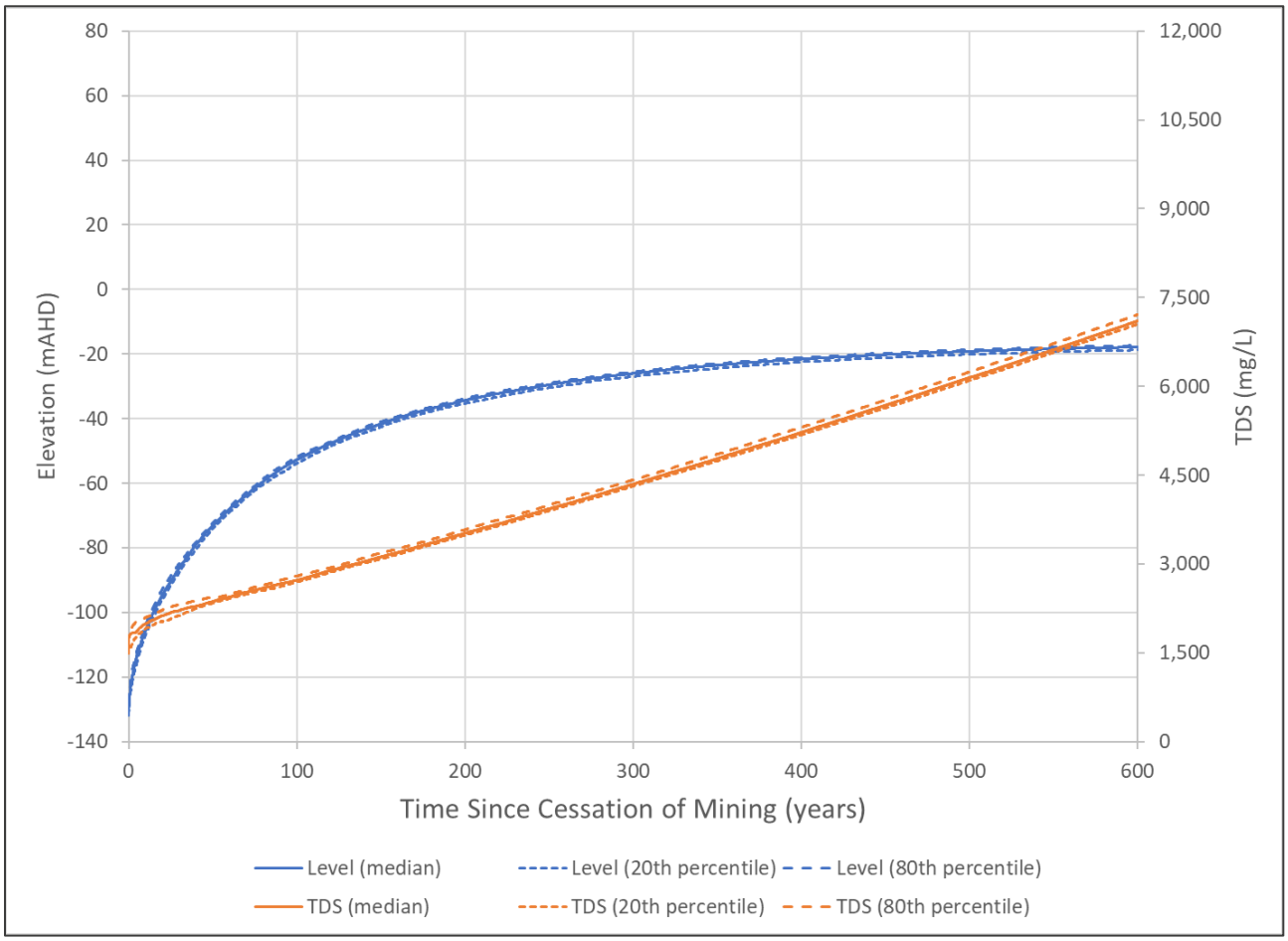


FIGURE 5.2: FINAL VOID WATER LEVELS AND QUALITY (NORTH VOID)

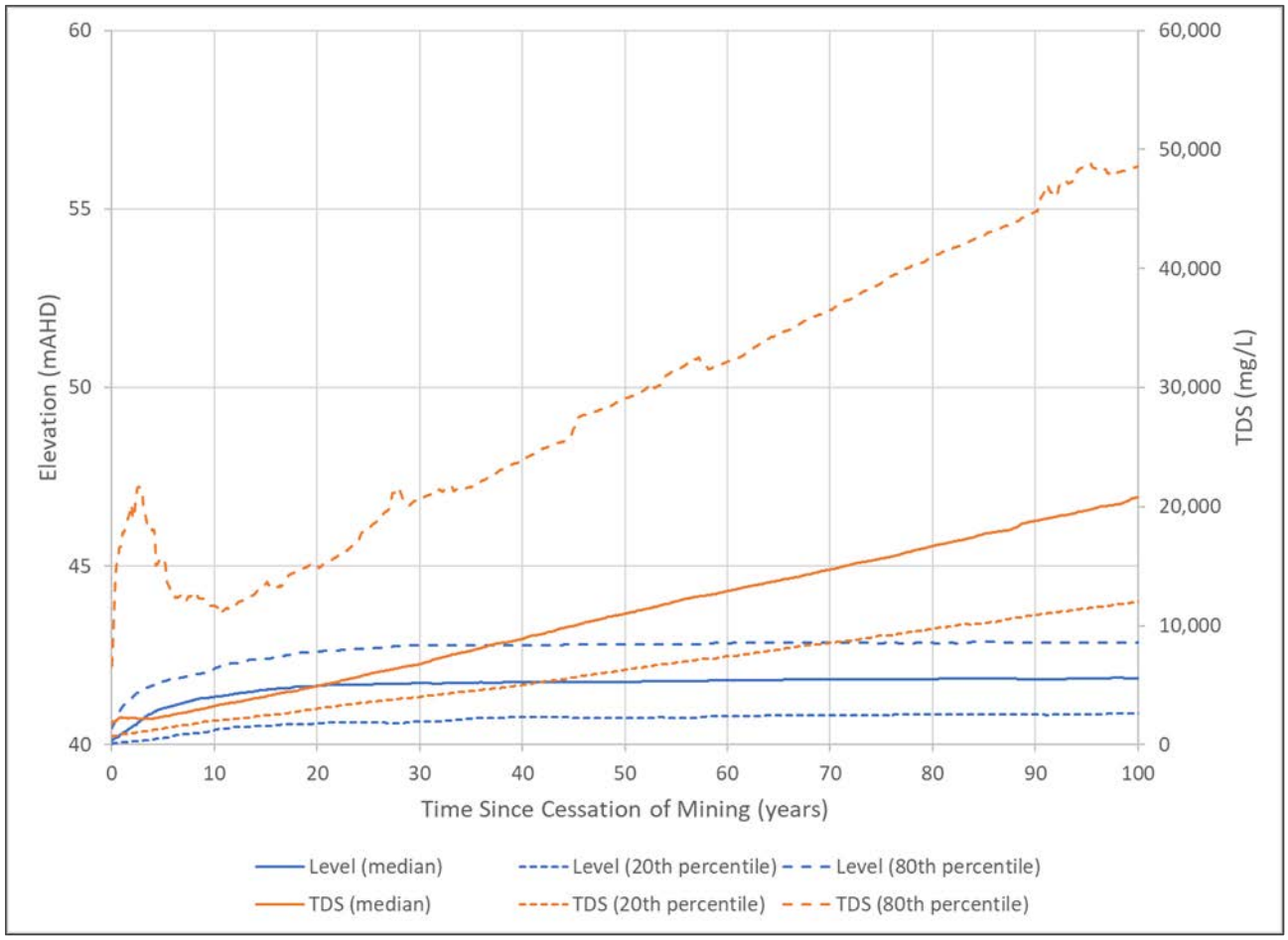


FIGURE 5.3: FINAL VOID WATER LEVELS AND QUALITY (CARRINGTON PIT VOID)

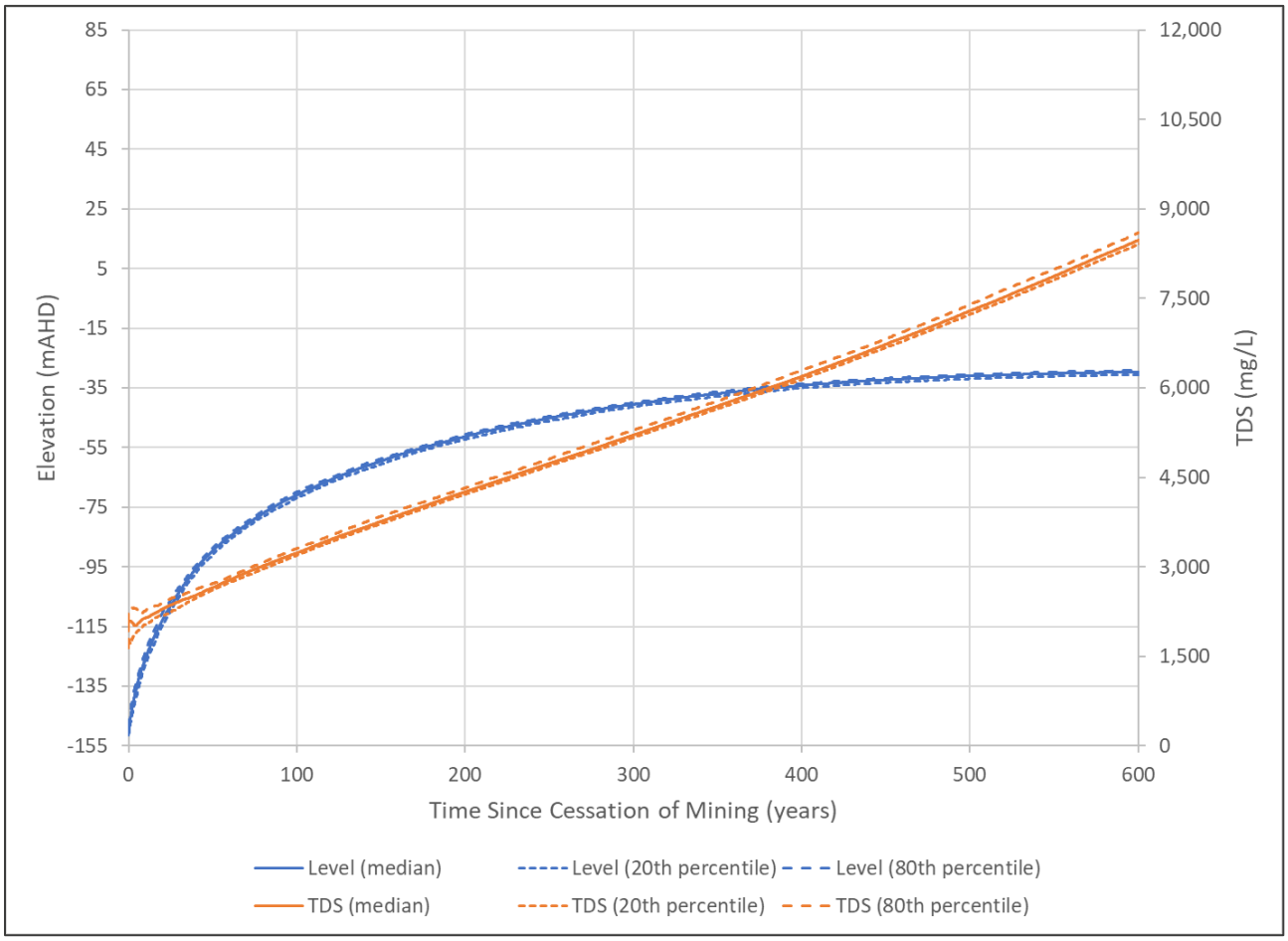


FIGURE 5.4: FINAL VOID WATER LEVELS AND QUALITY (SOUTH VOID)

5.2.1 Sensitivity Assessment

Sensitivity of the predicted final void pit lake outcomes has been undertaken on two climate inputs, groundwater inflows and salinity of inflows :

- 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.
- Groundwater inflows – Predicted increases in groundwater flux rates.
- Salinity of inflows – Higher and lower TDS.

Detailed methodology and results of the sensitivity assessments are provided in Attachment J. 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).
- The sensitivity assessment with increasing groundwater inflows, indicates that the forecast long-term lake water levels continue to have significant freeboard to the spill elevation for North Void and South Void (greater than 65 m). Similarly, the freeboard in Carrington Pit Void exhibits only a minor reduction when compared to the base modelling, i.e. 12 m to 14 m compared to 13 m to 15 m.
- The modelling predicts that the “peak” or “equilibrium” concentration will be reached at different times depending on the actual TDS of each of the inflows (which will likely be a variable combination of the values presented). It should be noted that the upper limit of TDS will depend on a range of factors not considered in the mass balance modelling results presented above (e.g. salt species and interactions between species, etc).

5.3 Hydrogeochemical Final Void Assessment

Environmental Geochemistry International Pty Ltd (EGi) completed a geochemical assessment for the Project. This assessment provides representative water quality data for the EIS 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 ARD and metal leaching.

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 J of this report (i.e., a fully mixed GoldSim model), models TDS 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 5.2) 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. That is, the precipitation of salts and limits to solubility associated with factors such as the various salt species present (e.g. individual species solubility, common ion effect, complex ion formation), temperature and pH are not considered and the modelling assumes all salt inflows remain dissolved. This is not a likely scenario considering the range of anion and cation species present in the final void inflows.

The predictions from the hydrogeochemical model are considered a reliable 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 Project will continue to be overestimated.

It is considered that the final void water quality for the Project final voids will be similar to that of the Approved final voids, as both Project and Approved final voids are designed as groundwater sinks and will exist in the same hydrological, hydrogeological and geochemical environments. That is, as time progresses the final voids will reach an "equilibrium" of salt species with inflows and interactions between salt species, such as precipitation, balancing.

Further data will become available as mining progresses which will assist in understanding the likely long-term chemical composition/speciation of pit water inflows. As part of closure planning HVO will undertake further detailed analysis and hydrogeochemical modelling (i.e. considering pH and water chemistry using fundamental chemical principles, rather than purely mass-balance or empirical relationships) to estimate the likely final void water quality and any actions that could improve final void water quality (e.g. post mining beneficial uses).

5.4 Outcomes

5.4.1 North Void and South Void

The assessment 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 spill level for North Void and South Void of greater than 100 m.

- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant (greater than 60 m).
- While groundwater inflow increases sensitivities result in a higher lake level, the freeboard remains significant (greater than 65 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).

5.4.2 Carrington Pit Void

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 NSW 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, albeit with a change in the catchment area reporting to the final void. As such the results for the 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 at a similar elevation 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 North Void.
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant, in the order of 9 m.
- While groundwater inflow sensitivity results in a 1 m higher lake level, the freeboard remains significant (12 m to 14 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 previous comparisons of TDS forecasts indicate that simplistic mass balance methodology (as used in the GoldSim model) result in predictions that are 50% higher when compared to hydrogeochemical modelling methodology (EGI, 2022b; Mackie Environmental Research, 2010). When the difference in methodology is taken into account, it is considered that 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 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 Project:

- No reduction in approved catchment areas at HVO South. This is consistent with the negligible 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 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 (Project Operations or Project Closure relative to Approved Operations) are predicted.
  - The tabulated results indicate a slight reduction to the long term average number of dry days, however negligible change to the long term average duration of dry periods.
  - The Project Scenarios (Project Operations and Project Closure) are shown to result in reductions to the number of and durations of dry days (average, maximum and minimum) when compared to the Approved Operations scenario for the representative dry year (2006), as discussed below:
    - Average number of dry days within the representative “dry” year (2006) reduced from 38 days to 30 days (21%) during operations and from 38 days to 23 days (39%) during closure as a result of the Project.
    - The number of dry periods within the representative “dry” year (2006) increased from 2 to 4 during operations as a result of the Project. However, the additional dry periods are short (lasting only 2 days) and occur in close succession to the longer dry periods and therefore does not represent a significant change in the overall flow regimes.
    - Average duration of dry periods within the representative “dry” year (2006) reduced from 26 days to 11 days (58%) during operations and from 26 days to 12 days (54%) during closure as a result of the Project.
- 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 average 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 Project Operations), as discussed below:
  - 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 Project.
  - Farrells Creek: Average duration of dry periods within the representative "dry" year (2006) increased from 156 days to 159 days (2%) during operations as a result of the Project.
  - Bayswater Creek: Average duration of dry periods within the representative "dry" year (2006) increased from 144 days to 145 days (1%) during operations as a result of the Project.
- For the 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.

6.2 Flooding

The detailed Hunter River flood modelling that was undertaken to inform the impact assessment is discussed in Section 2.4 (and Attachment C of this report). As discussed in Section 2.4, the flood assessment was prepared during 2020, and included the development and calibration of a flood model to define existing flooding conditions and enable the potential impacts of the Project to be assessed for the New South Wales state approval process (i.e. the EIS Project). The 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 for the Project will be no greater than those modelled for the EIS Project (Engeny, 2022) and has not been re-simulated for the Project.

A summary of the outcomes and impacts is provided in the following sections. The modelled scenarios are summarised as follows and further detailed in Attachment C:

- Project Baseline: Baseline conditions utilising the available topographic data (2016 and 2020) with adjustments for operational changes planned for completion by current operations prior to 2025 including the haul road approach to Cheshunt Pit at Hunter River crossing, construction of the North Void TSF Levee 1 (North-West levee) and construction of the SLP 1 flood protection upgrade at the haul road ramp.
- Project Operation: Construction of Project infrastructure including Carrington West Wing Levee (current approval for a levee in this area up to 1% AEP design flood), North Void TSF Levee 2 (South-East levee), Riverview Levee (proposed), Cheshunt Levee (proposed) and Lake James upgrades as well as construction of the Lemington Road realignment. Also included incorporation of the planned mine progression to select the worst case for potential impact on the floodplain during operations.
- Project Closure: Consistent with Project Operations with the incorporation of the final landform design and decommissioning of the Carrington West Wing Levee.

It is noted that some items captured in the Project Operation scenario are at least partially covered by existing approvals:

- Carrington West Wing Levee: previous approval for a levee in a similar location up to the 1% AEP.
- SLP 1: current approval is for 1% AEP immunity during operations and back-fill at closure.

HVO has determined that a conservative approach to the flood impact assessment should be adopted by excluding any incorporation of the approved Carrington West Wing Levee or SLP 1 back-fill from the Project Baseline scenario. As a result, it is emphasised that any flood impact presented in the SWIA is conservative and greater than the incremental impact of the Project in isolation.

6.2.1 Public Infrastructure Flood Immunity

The flood immunity of Lemington Road (including the existing alignment and proposed realignment) is summarised in Table 6.1. The proposed realignment and new Hunter River bridge crossing of Lemington Road as part of the Project will significantly improve the flood immunity of this road adjacent to the Hunter River. Overall, the Average Annual Time of Closure (AAToC) of the Lemington Road link between the New England Highway and the Golden Highway is estimated to reduce significantly as a result of realignment through the Project. The Baseline AAToC cannot be fully defined as it is overtopped in the smallest flood event simulated (10% AEP), but as a conservatively low estimate it has a minimum AAToC of 2.4 hr (estimated using events from the 10% AEP to the Extreme Event, which is

defined as four times the 1% AEP). By increasing the immunity to exceed the 10% AEP event through the Project, the AAToC improves to 1.4 hr (at least a 42% estimated improvement).

Detailed mapping of Hunter River flooding for the full extent of the Project is provided in Attachment D for Project Baseline, Project Operations and Project Closure scenarios.

TABLE 6.1: SIMULATED EVENT THAT FIRST CAUSES INUNDATION (PUBLIC INFRASTRUCTURE)

Element	Project Baseline	Project Operations	Project Closure
Lemington Road Bridge	Smaller than 10% AEP [1]	5% AEP [2]	5% AEP [2]

Note 1 Existing Lemington Road bridge overtops in the 10% AEP event (smallest event simulated)

Note 2 Realigned Lemington Road bridge immune up to and including 10% AEP event

Further details on the modelling of Lemington Road design flood modelling is included in Attachment H.

6.2.2 Mine Infrastructure Flood Immunity

The immunity of key mine infrastructure is summarised in Table 6.2. Major 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 as detailed in Attachment C) are included. Detailed mapping of Hunter River flooding for the full extent of the Project is provided in Attachment D for Project Baseline, Project Operations and Project Closure scenarios.

The flood mapping for the EIS Project (Engeny, 2022) has been used to determine the mine infrastructure flood immunity for the 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 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 6.2: SIMULATED EVENT THAT FIRST CAUSES INUNDATION (MINE INFRASTRUCTURE)

Element	Project Baseline	Project Operations	Project Closure
SLP 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 SLP 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 inactive with capping in progress in the 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).

6.2.3 Property Impacts

6.2.3.1 Council Zoning

The *Singleton Local Environmental Plan 2013* defines the flood planning level for property development as follows: flood planning level means the level of a 100 year ARI (average recurrence interval) flood event plus 0.5 metre freeboard. The 100 year ARI event terminology is interchangeable with the 1% AEP event referred to in this assessment. The floodplain areas adjacent to the Hunter River upstream of Maison Dieu are all zoned RU1 (primary production) or C2 (environmental conservation) (data sourced in 2024), with the following isolated exceptions:

- Two parcels of Environmental Conservation (C2) near confluence with Bowmans Creek and Glennies Creek.
- The urban area of Maison Dieu and Gowrie on the north bank of the Hunter River at Long Point includes one parcel of Environmental Conservation (C2) as well as zoning for Environmental Living (C4) and Public Recreation (RE1). The Environmental Living lots are generally outside of the 1% AEP flood event.

As noted at the start of Section 6.2, some items captured in the Project Operation scenario are at least partially covered by existing approvals. Consequently, it is emphasised that any flood impact presented in the SWIA is conservative and greater than the incremental impact of the Project in isolation.

There is no land within the flooding extents for the 1% AEP mapped for the SWIA that lie within residential zoning areas (refer to https://maps.singleton.nsw.gov.au/geocortexviewer/?viewer=planning). Figure 6.1 shows that each of the non-JV owned impacted properties (>20 mm) are zoned RU1 (primary production) or SP2 (infrastructure).

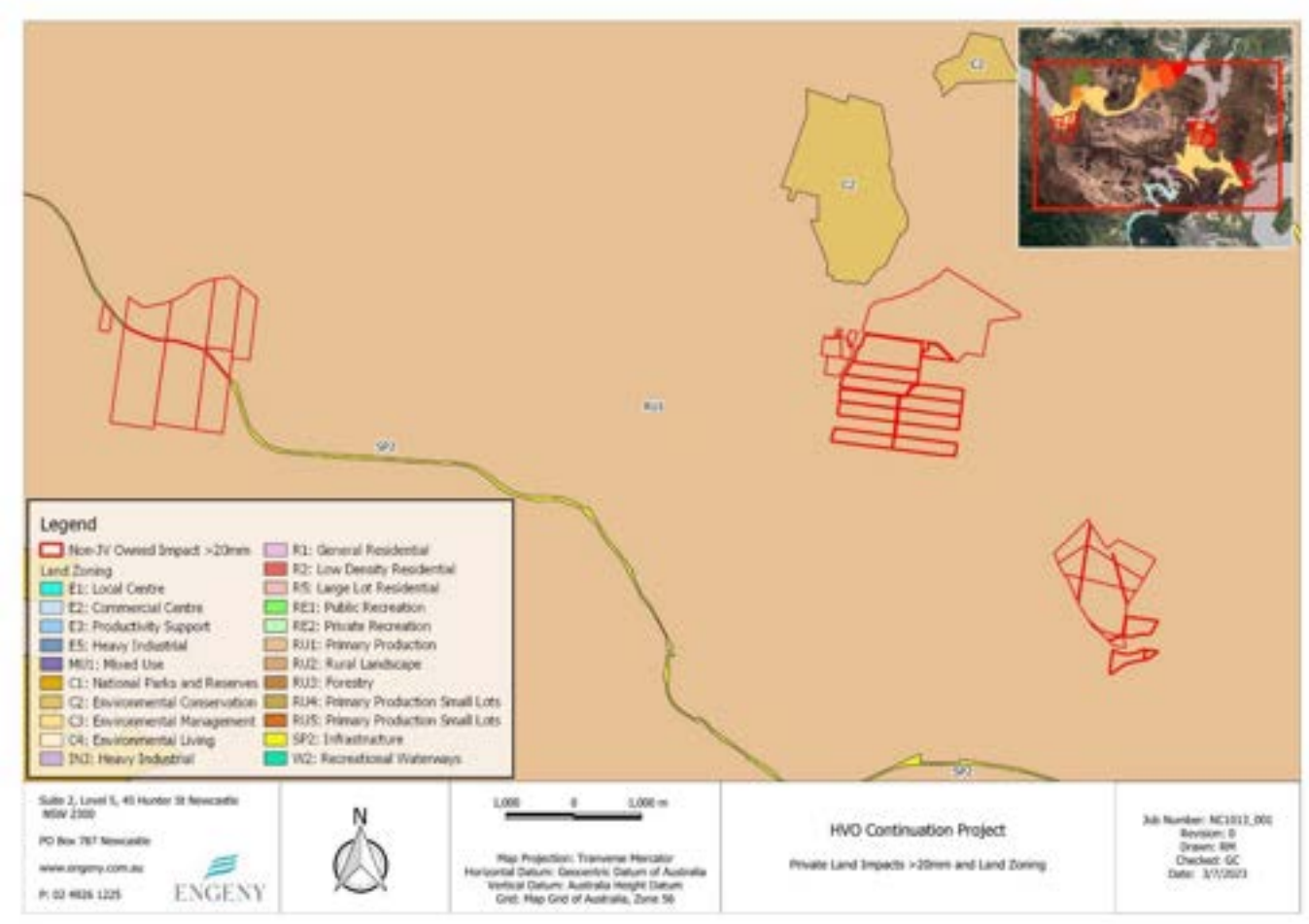


Figure 6.1: Impacted Properties and Council Land Zoning

6.2.3.2 Non-JV Landholding Impacts

Maps of the change in maximum flood level as a result of the Project are provided in Attachment E for a range of events. A spatial database of property not owned by the JV partners has been used to extract maximum baseline flood depths and level impacts in the 1% AEP flood event. All properties owned by HVO or its JV partners (i.e., Yancoal and Glencore) have been excluded. Further, some isolated level changes were initially observed in existing ponding depressions along Hunter River tributaries well upstream of the Hunter River confluences. As the critical flood levels for defining flood planning level in these areas would be local catchment flood events (i.e., not Hunter River flooding), which are not affected by the Project, those properties have been excluded.

Multilot flood mapping is included in Attachment F and shows the 1% AEP event flood level changes overlaying an aerial image and property boundaries. Attachment F includes:

- Sets of 15 maps focused on each of the 15 contiguous land holdings that have 1% AEP flood level impacts greater than 20 mm. This captures 31 properties (lots) as multiple land parcels have the same owner.
- Inclusion of property boundaries and aerial imagery to illustrate the land use and built infrastructure (e.g. dwellings).

- Map sets have been produced showing the change in flood level, velocity and hazard for the 1% AEP event, which is the event used by Singleton Council in defining the Flood Planning Level.
- Tabular summaries have been included to provide a simple numerical summary of the map data. These tables summarise the maximum flood characteristics (level, velocity and hazard) across the relevant landholding in the Project Baseline scenario and the Project Operations scenario, and the maximum flood impacts (changes to flood characteristic) for each landholding.

In the area, 15 landholdings (consisting of 31 individual lots) not owned by the JV partners were found to have maximum flood level changes in the range of 20-50 mm. The maximum change is for any point on the property and does not necessarily mean the entire flooded extent increases by that amount. For the majority of these properties (21) the maximum level change was less than 30 mm. Relative to the maximum baseline flood depth on these properties, these level changes represent a maximum proportional change of 1.7% in existing flood depth. Less than half of these properties (13) had a modelled change in flood affected area with the maximum change being 0.15% of the total property area for any individual property. As can be seen by the multilot flood mapping (refer to Attachment F) there are no dwellings that transition from not flooded to flooded during the 1% AEP event.

Closer inspection of aerial imagery for these properties indicates that all properties with predicted level changes are agricultural land (grazing and cropping) or Crown land and there is no modelled impact to existing dwellings. For this type of land use, the small magnitude changes in flood regime (i.e., flood level or extent) described above are negligible. Consequently, it is considered there is no impact on the use of the land for these properties.

An assessment of the change in time of inundation has been undertaken by extracting flow hydrographs at discrete locations in the vicinity of the relevant properties. These have been extracted using the Plot Output (PO) functionality of TUFLOW and use a 0.5 hr reporting increment. The duration of flows above various thresholds has been extracted and compared for the Project Baseline and Project Operations scenarios. These results are summarised in Figure 6.2 for the locations shown in Figure 6.3 and indicate negligible change in the duration of flood flows (average change across all locations and flow thresholds is less than 1% while the maximum change is generally less than 5%). Consequently, it is evident that there is minimal change in time of inundation on these properties.

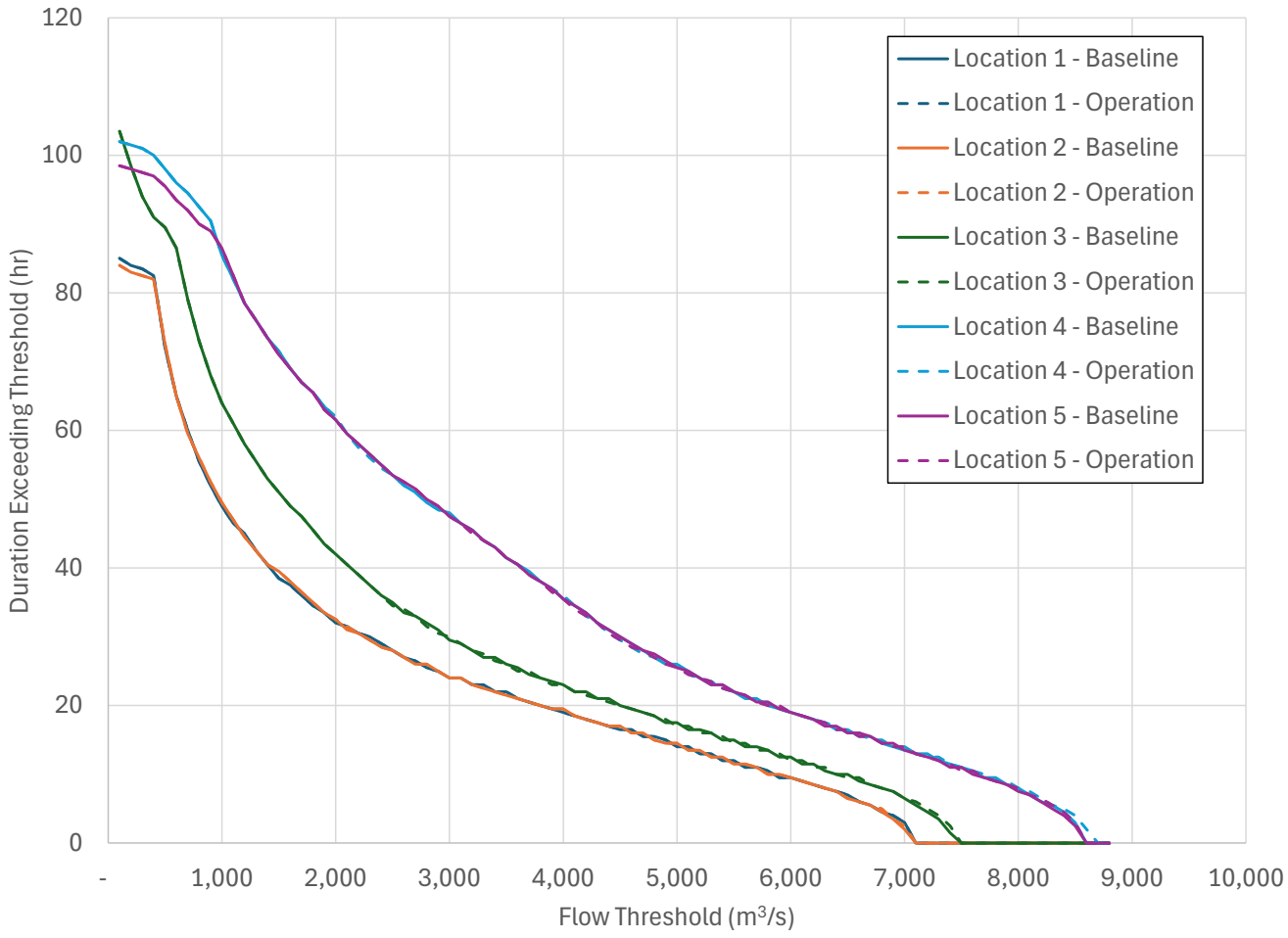


Figure 6.2: Time of Inundation Comparison

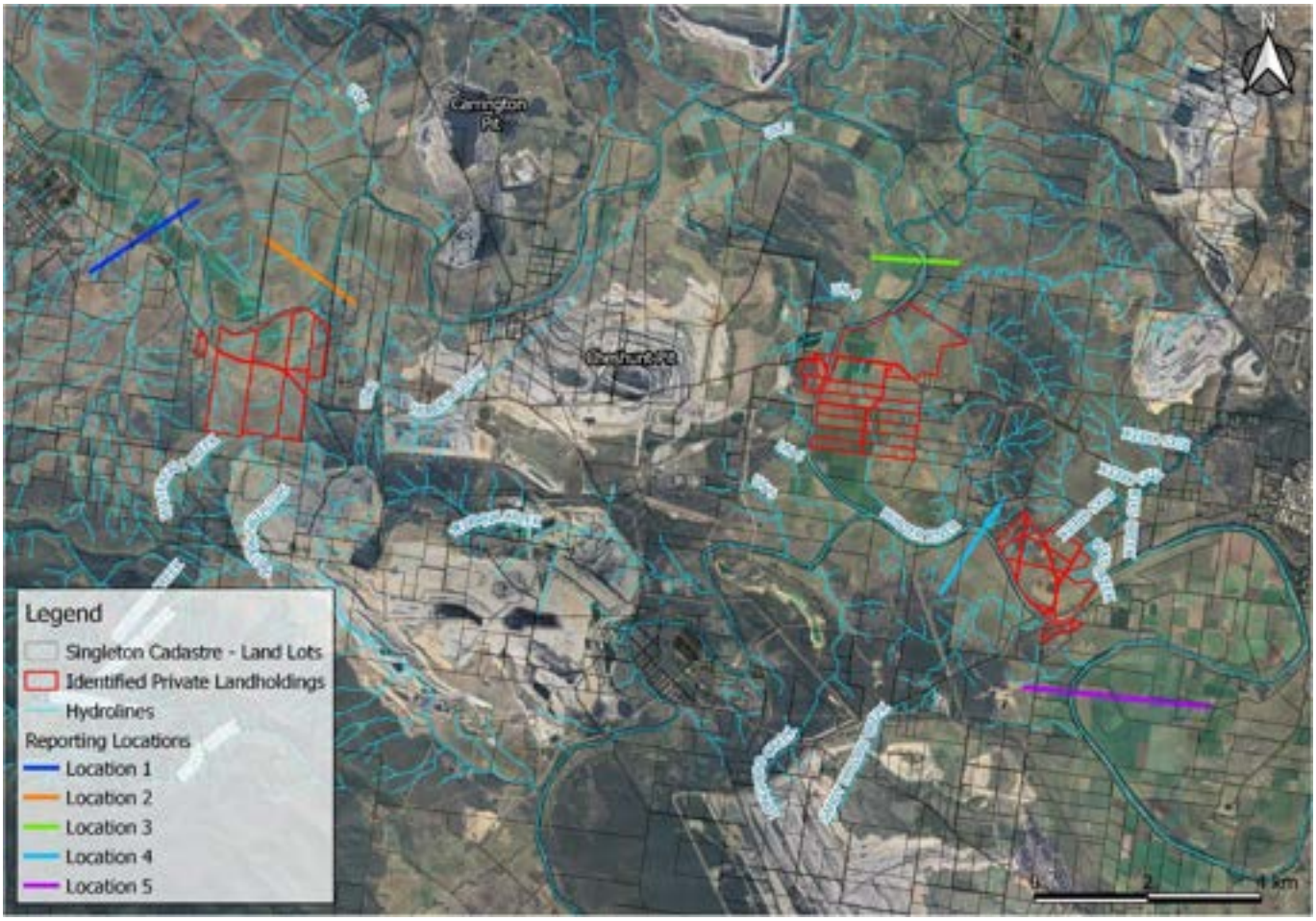


Figure 6.3: Reporting Locations

6.2.4 Risk and Emergency Management

6.2.4.1 Floodplain Risk Management

The Project was assessed during 2022 with consideration of the Singleton Floodplain Risk Management Plan (Paterson Consultants, 2012). Since that time, an updated floodplain risk management plan (BMT, 2023) has been developed. The aims of both plans are the same, with both noting that the prime responsibility for local planning and land management rests with Council. The aims of the current plan are consistent with the plan assessed for the EIS Project (Engeny, 2022), are summarised on the Council website (https://www.singleton.nsw.gov.au/Development/Land-Environment-and-Heritage/Flooding), and include:

- Take an integrated risk management approach to the development of flood prone land, recognising that land should not be unnecessarily restricted and that decisions take into account the flood hazard.
- Provide a framework to manage floodplain risk through cost effective measures that address the flood hazard as identified in local floodplain risk management studies and plans.
- Ensure that the Emergency Services are provided with the most up- to- date flood information so they can include it in their emergency response and recovery planning.

Based on the limited changes to flood behaviour noted throughout this section, the Project is considered to be consistent with the current Floodplain Risk Management Plan.

6.2.4.2 Flood Hazard and Hydraulic Function

The general flood hazard curves and categorisation presented in ARR (Ball, et al., 2019) (Smith, 2014) have been adopted to inform impacts on Emergency Management. Maps of the modelled change in maximum flood hazard category as a result of the Project are provided in Attachment E for a range of events. The impact maps indicate that there are no broad scale changes to flood hazard categories forecast as a result of the Project.

The Project minimises encroachment on the Hunter River floodplain. Where interaction of the Project with the floodplain occurs, it involves raising existing levees or constructing new levees. These levees primarily impact flood storage areas rather than flood conveyance. The Carrington West Wing Levee has the largest encroachment on the floodplain and reduction in flood storage and conveyance.

The location of all levees has been optimised to minimise encroachment. As the residual impacts have been shown to be of small magnitude, the levees are compatible with the hydraulic function of the land. All levees have been designed specifically for management of flooding and are appropriate for the flood hazard of the land.

6.2.4.3 Access and Emergency Management

A detailed assessment of potential impacts to road access has been undertaken with a focus on the primary transport corridors including New England Highway, Golden Highway and Lemington Road. Thirteen road segments were identified to be subject to inundation from Hunter River flooding. The road segments identified are presented in Table 6.3 and illustrated in Figure 6.4.

Model results indicate no change to the maximum flood hazard category on these segments for the range of flood events assessed (10%, 1% and 0.1% AEP and Extreme Event) as a result of the Project. In addition, the potential for impacts on the duration of road closure has been investigated. Road closure has been conservatively defined based on any depth of water over the road (i.e., from first inundation) and the average annual time of closure (AAToC) has been calculated.

The following constraints are noted for the assessment of road closure:

- For crossings that are inundated in the 10% AEP (i.e., the smallest event modelled), the AAToC cannot be fully defined. This applies to three crossings (Crossing 1, 4B and 10). For these crossings, the assessment is based on relative change rather than absolute closure time.
- For crossings that are located on tributaries well upstream of the Hunter River, it is noted that local flooding of that tributary is expected to be the worst case for road closure rather than the regional Hunter River flooding that is the subject of this impact assessment. Local flooding of these tributaries is not impacted by the Project.

The outcomes of the assessment are summarised as follows:

- New England Highway:
  - Crossing 5 has the lowest baseline immunity and is first inundated in the 0.1% AEP event. A slight change in duration for this event (1 hr) results in a small increase (4%) increase in AAToC.
  - As the regional immunity is already very high and the local tributary flooding will be critical, the small changes noted above are not expected to have a material impact on emergency management.
- Golden Highway:
  - The existing regional flood immunity varies with most crossings inundated in the 1% AEP. Crossing 1 and 4B are inundated in events as small as the 10% AEP while crossing 2 is fist inundated in the 0.1% AEP.
  - For crossings 1, 3A and 3B the local tributary flooding will be critical. The Project has no impact on local flooding for these tributaries.
  - No significant change (<1%) to AAToC is forecast for this road link as a result of the Project.
- Lemington Road:
  - The current immunity of this road link is governed by Crossing 10, which is inundated in the smallest event simulated (10% AEP).
  - The AAToC of the Lemington Road link between the New England Highway and the Golden Highway is estimated to reduce significantly as a result of realignment through the Project. The Baseline AAToC cannot be fully defined as it is overtopped in the smallest flood event simulated (10% AEP), but as a conservatively low estimate it has a minimum AAToC of 2.4 hr (estimated using events from the 10% AEP to the Extreme Event). By increasing the immunity to exceed the 10% AEP event through the Project, the AAToC improves to 1.4 hr (at least a 42% estimated improvement).

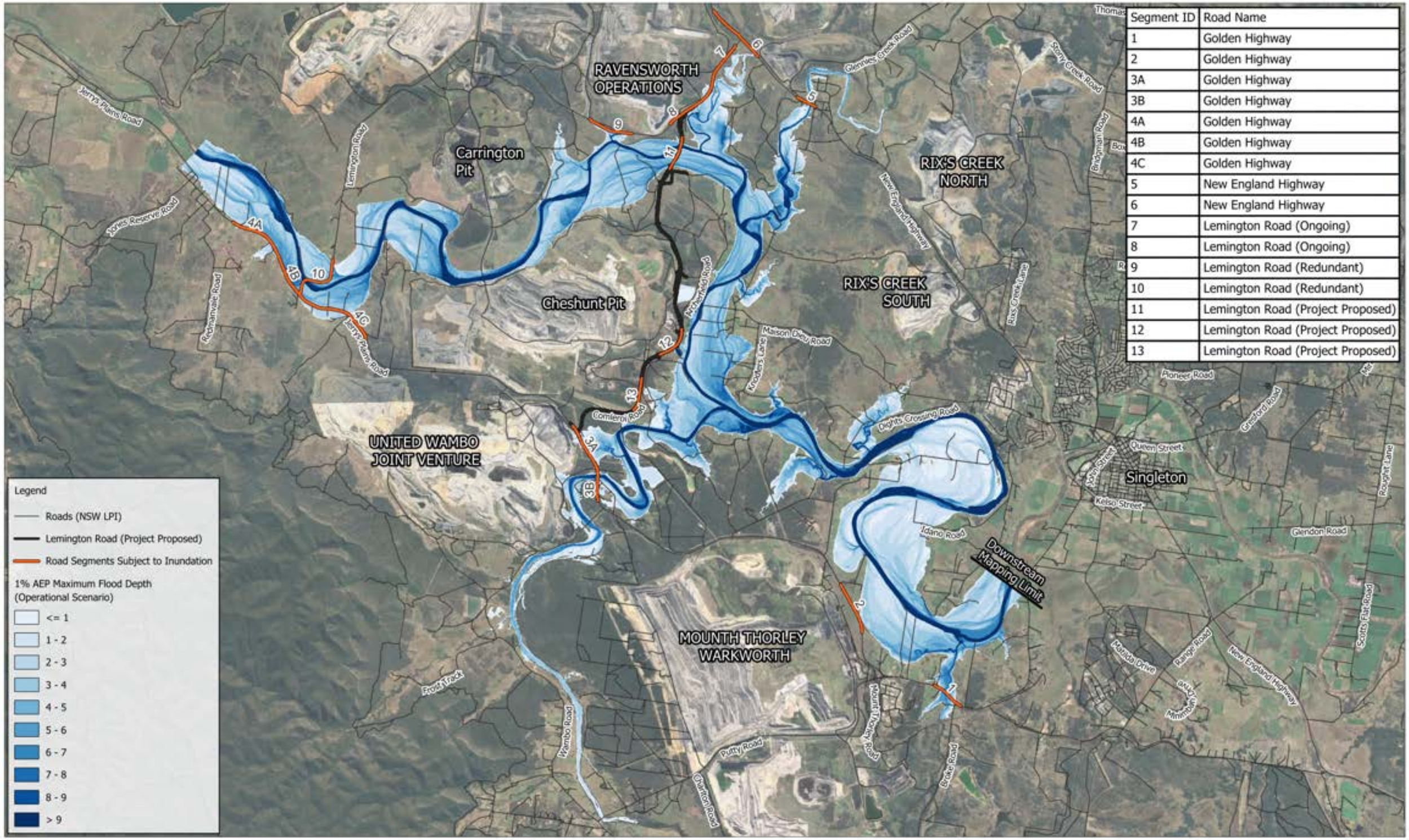
For the land uses in the assessment area (i.e., agricultural and mining) the small changes in road inundation described above are not expected to have an impact on use of the land or public safety. Furthermore, the small changes described are not expected to be material for emergency management. Overall, there is a significant benefit to the local community through improved immunity and access of the realigned Lemington Road.

A sensitivity analysis on the modelled impacts of closure duration was undertaken for greater depth thresholds (150 mm and 300 mm to align with the H1 flood hazard category (Ball, et al., 2019) (Smith, 2014) depth thresholds for still water and 2 m/s velocity flow respectively). Outcomes remained similar to those presented for the more conservative threshold of 0 mm.

TABLE 6.3: ROAD SEGMENTS SUBJECT TO INUNDATION FROM HUNTER RIVER FLOODING

Crossing ID	Road Name	Watercourse Name [1]
1	Golden Highway	Loders Creek
2	Golden Highway	-
3A	Golden Highway	Wollombi Brook
3B	Golden Highway	Wollombi Brook
4A	Golden Highway	-
4B	Golden Highway	-
4C	Golden Highway	-
5	New England Highway	Glennies Creek
6	New England Highway	Bowmans Creek
7	Lemington Road (Ongoing)	Bowmans Creek
8	Lemington Road (Ongoing)	Bowmans Creek
9	Lemington Road (Redundant)	Baywater Creek
10	Lemington Road (Redundant)	Hunter River
11	Lemington Road (Project Proposed)	Hunter River
12	Lemington Road (Project Proposed)	-
13	Lemington Road (Project Proposed)	-

Note 1: Watercourse names are provided for context on crossing location. Flood source is Hunter River flooding.



Segment ID	Road Name
1	Golden Highway
2	Golden Highway
3A	Golden Highway
3B	Golden Highway
4A	Golden Highway
4B	Golden Highway
4C	Golden Highway
5	New England Highway
6	New England Highway
7	Lemington Road (Ongoing)
8	Lemington Road (Ongoing)
9	Lemington Road (Redundant)
10	Lemington Road (Redundant)
11	Lemington Road (Project Proposed)
12	Lemington Road (Project Proposed)
13	Lemington Road (Project Proposed)

Legend

- Roads (NSW LPI)
- Lemington Road (Project Proposed)
- Road Segments Subject to Inundation

1% AEP Maximum Flood Depth (Operational Scenario)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

0 2.5 5 km

Scale in metres (1:95,000 @ 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

Figure 6-4:
Road Segments Subject to Inundation from Hunter River Flooding

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Job Number: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 25 /9 /2025

6.2.5 Channel Stability

Velocity impacts are generally localised around project infrastructure (levees, Lemington Road, SLP 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). 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. Maps of the change in maximum modelled flood velocity as a result of the Project are provided in Attachment E for a range of events. Further discussion on geomorphology is provided in Section 6.4.

6.2.5.1 Hunter River Bank Stabilisation Works

There are a number of old Hunter Valley Flood Mitigation Scheme bank stabilisation works on the Hunter River upstream and downstream of the Project. The potential impacts of the Project on these works was assessed (as described in this section) and found to be negligible.

Velocity results for the 1% and 10% AEP events were assessed for all stabilisation works within the flood modelling area. An ARCGIS layer of the locations of stabilisation works was sourced from NSW Local Land Services (LLS). Figures for these results are presented in Attachment G and summarised below.

The potential for the Project to impact the stabilisation works is considered negligible as modelling indicates only minor changes to peak velocities in these areas. In summary:

- 1% AEP – two stabilisation works locations with modelled decreases of 0.1 m/s and one stabilisation works location with an increase of 0.1 m/s (tabulated below).
- 10% AEP – four stabilisation works locations with modelled decreases in velocity of 0.1 to 0.2 m/s and two stabilisation works locations with modelled increases in velocity of 0.1 m/s.

TABLE 6.4: PEAK VELOCITIES AT STABILISATION WORKS LOCATIONS

Levee Label	Maximum Velocity (m/s) - 1% AEP			Maximum Velocity (m/s) - 10% AEP		
	Baseline	Operational	Change	Baseline	Operational	Change
HR RB 193.6	4.2	4.2	-	2.2	2.2	-
HR LB 191.4	1.7	1.7	-	1.4	1.4	-
HR LB 191.0	1.5	1.5	-	1.3	1.3	-
HR RB 189.8	2.1	2.1	-	2.0	2.0	-
HR 186.2 LB	1.2	1.1	- 0.1			-
HR 184.6 LB	1.7	1.7	-	1.7	1.7	-
HR RB 180.40	3.3	3.3	-	2.0	2.0	-
HR RB 179.80	2.9	2.9	-	2.2	2.2	-
HR LB 179.50	2.5	2.4	- 0.1	1.6	1.6	-
HR LB 179.00	2.6	2.6	-	1.9	1.9	-
HR RB 179.00	1.8	1.8	-	1.6	1.6	-
HR RB 178.90	1.7	1.7	-	1.6	1.6	-
HR RB 178.8	1.8	1.8	-	1.8	1.8	-

Levee Label	Maximum Velocity (m/s) - 1% AEP			Maximum Velocity (m/s) - 10% AEP		
	Baseline	Operational	Change	Baseline	Operational	Change
HR RB 178.5	1.7	1.7	-	1.7	1.7	-
HR RB 177.60	2.2	2.2	-	1.6	1.7	0.1
WB LB 9.1	0.4	0.4	-	0.3	0.3	-
WB RB 5.6	2.0	2.0	-	1.9	1.9	-
WB RB 5.2	2.3	2.3	-	2.0	1.9	- 0.1
WB LB 1.85	2.0	2.0	-	1.4	1.4	-
WB RB 1.4	1.8	1.8	-	1.3	1.3	-
WB LB 0.4	1.3	1.3	-	0.4	0.4	-
HR RB 160.0	2.6	2.6	-	1.8	1.8	-
HR RB 159.8	2.8	2.8	-	1.3	1.4	0.1
HR RB	2.4	2.4	-	2.1	2.1	-
HR LB	1.6	1.6	-	1.4	1.4	-
BC LB 1.8	0.5	0.5	-	0.4	0.4	-
BC LB 0.5	0.7	0.7	-	0.4	0.4	-
HR LB 172.00	2.2	2.2	-	2.3	2.2	- 0.1
HD SR BP 171.00	1.8	1.8	-	1.7	1.7	-
GC0.00RB	1.5	1.5	-	1.5	1.5	-
BoC0.10LB P	1.1	1.1	-	0.6	0.6	-
HR LB 169.2	2.0	2.0	-	1.8	1.8	-
GC2.40LB	1.4	1.4	-	1.3	1.3	-
BoC2.80LB P	1.2	1.2	-	1.0	1.0	-
GC LB 3.6	2.4	2.4	-	1.8	1.8	-
GC RB 4.0	2.2	2.2	-	1.7	1.7	-
GC LB 4.0	1.8	1.8	-	1.2	1.2	-
ARL 6.2 GC	0.3	0.3	-	0.2	0.2	-
GC 6.4 ARL P	0.2	0.2	-	0.1	0.1	-
GC LB 6.60	0.1	0.1	-	0.1	0.1	-
8.6 RB Mesh GC	0.1	0.1	-	Outside flood extent	Outside flood extent	-
BC RB 3.6	1.3	1.3	-	1.1	1.1	-
BC LB 4.3	0.7	0.7	-	0.6	0.6	-
BC RB 4.5	0.5	0.5	-	0.4	0.4	-
ARL 6.2 GC	0.3	0.3	-	0.2	0.2	-

Levee Label	Maximum Velocity (m/s) - 1% AEP			Maximum Velocity (m/s) - 10% AEP		
	Baseline	Operational	Change	Baseline	Operational	Change
GC 6.4 ARL P	0.2	0.2	-	0.1	0.1	-
GC LB 6.60	0.1	0.1	-	0.1	0.1	-
GC 9.8 RB Mesh	0.2	0.3	0.1	Outside flood extent	Outside flood extent	-
BC LB 1.8	0.5	0.5	-	0.4	0.4	-
BC RB 3.1	1.0	1.0	-	0.6	0.4	- 0.2
BC RB 3.6	1.3	1.3	-	1.1	1.1	-
BC LB 4.3	0.7	0.7	-	0.7	0.6	- 0.1
BC RB 4.5	0.5	0.5	-	0.4	0.4	-
HR LB 172.00	2.2	2.2	-	2.3	2.2	- 0.1

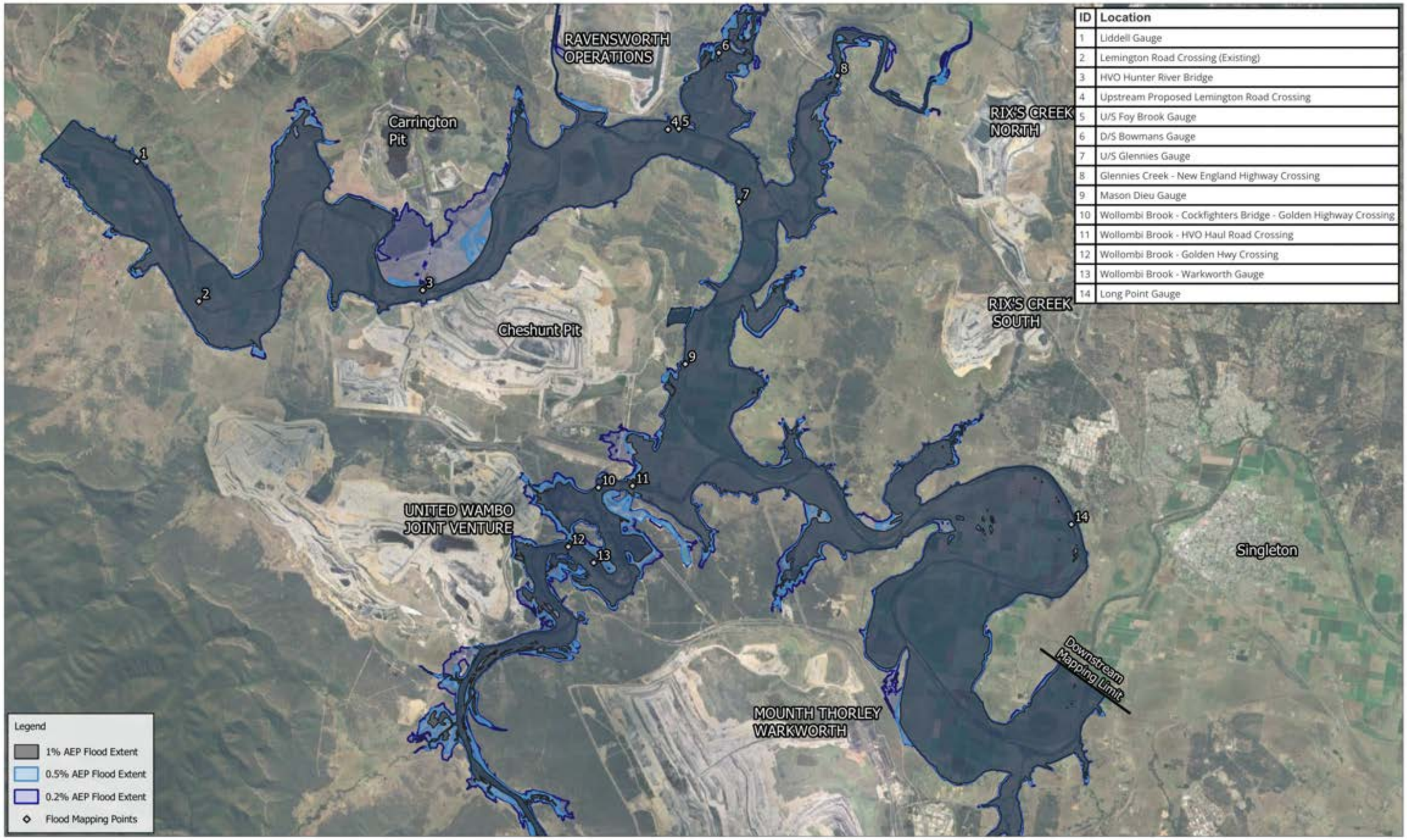
6.2.6 Climate Change Flood Assessment

A climate change sensitivity assessment was undertaken to understand the sensitivity of flooding and flood impacts to climate change. The 0.5% and 0.2% AEP design events are typically used as proxies for climate change. A validation of the suitability of these events is provided in Attachment C and supports the use of the climate change proxy approach. A comparison of the flood extents between these events is presented in Figure 6.5 while further detailed flood mapping for the full range of events is provided in Appendix D.

The figure indicates that there is generally little difference in flood extent for the Hunter River in the vicinity of the Project for the three climate change scenarios assessed. The greatest difference in extent is evident in the vicinity of the alluvial lands on the northern side of the HVO Hunter River Bridge (i.e., at HVO North, refer mapping location 3). This change occurs between the 0.5% AEP and the 0.2% AEP, which represent the more extreme range of climate change impacts. The design event adopted for Project levees (0.1% AEP) exceeds the magnitude of events shown in the climate change assessment with additional freeboard allowance.

An assessment of the change in flood impacts resulting from the Project under the climate change proxy events (0.5% and 0.2% AEP) has also been undertaken and is summarised as follows:

- As noted at the start of Section 6.2, some items captured in the Project Operation scenario are at least partially covered by existing approvals. Consequently, it is emphasised that any flood impact presented in the SWIA is conservative and greater than the incremental impact of the Project in isolation.
- The difference in flood depth for climate change proxies (0.5% and 0.2% AEP) relative to the 1% AEP is greater than the 0.5 m freeboard adopted by Council in setting current flood planning levels. This indicates that a climate change scenario would result in the future flood planning reference event (1% AEP plus climate change) exceeding the current flood planning level (existing 1% AEP plus 0.5 m freeboard).
- The magnitude and extent of flood level changes increase for proxy events with the greatest change evident in the 0.2% AEP event. Consequently, the number of properties not owned by the JV partners with level changes exceeding the 20 mm threshold would increase. However, from a review of these changes upstream of the flood mapping limit, the following is noted:
  - Level changes are up to 100 mm, which remains small relative to baseline flood depths on these properties and is within the 0.5 m freeboard set by Council. Furthermore, this is a small change in the context of the much larger flood level change resulting directly from climate change alone (the 0.2% AEP flood levels are approximately 1.5 m higher than the 1% AEP flood levels in this area).
  - The incremental change in flood extent resulting from the Project is small (isolated model cells or groups of model cells on the edge of the floodplain).
  - This change in depth and extent does not tend to result in inundation of additional buildings. One potential exception was noted within the mapping limit where a residential dwelling is near the 0.5% AEP flood extent. Detailed floor survey would be required to verify if the small, predicted level change from the Project in this climate change scenario (0.5% AEP) resulted in inundation. The residence is already fully within the flood extent of the 0.2% AEP event in the Project Baseline.
  - The small change in flood regime (i.e., flood level or extent) for this agricultural land (grazing and cropping) or Crown land is not considered to have a resulting impact on the use of the land under a climate change scenario.



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

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HUNTER VALLEY OPERATIONS

N

0 2 4 km

Scale in metres (1:75,000 @ 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

Figure 6-5:
Climate Change Assessment

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 12 /9 /2025

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).

Overflows from sediment dams will occur when rainfall exceeds the design criteria of the dams. The design criteria, discussed in detail in Section 4.7, is set by NSW Government standards and has an indicative average annual sediment basin overflow frequency of 1 to 2 overflow events per year. It should be noted that historical overflows from sediment dams from the HVO Complex have occurred in the past with all being reported to the relevant NSW government agency at the time. The details of these overflows are included in the Annual Environmental Reports (refer to Section 7.2), with the outcomes review for this assessment (2018 to 2024 inclusive) indicating for each of the six overflow events no environmental harm was caused. The overflows of sediment dams have all been due to rainfall events exceeding the design rainfall event depths that the sediment dams have been designed to contain. With consideration of the WMS design standards and their likely adaption with climate change (refer to Section 3.2.2), it is considered that the likelihood and consequence of sediment dam overflows will continue to be the same as the existing operations and the Approved Operation.

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) 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 6.1, the predicted changes to streamflow volumes and the occurrence of dry days due to the 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 Project are not expected to result in any significant changes to the geomorphology or hydrological values of the downstream waterways.

Although exempt from requiring a separate Controlled Activity Approval (CAA) under the *Water Management Act 2000*, HVO proposes to undertake any works within waterfront land in accordance with the CAA guidelines (NSW Government, 2025).

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 (NSW DECC, 2008a; NSW DECC, 2008b; NSW DECC, 2008c; NSW DECC, 2008d) (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, SLP 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 Project is expected as a result of the Project, this includes all identified Hunter Valley Flood Mitigation Scheme bank stabilisation works (refer to Section 6.2.5.1).

6.4.1 Carrington West Wing Levee

A focus of the geomorphic assessment 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 Project proposing to increase this to 0.1% AEP immunity plus freeboard. As noted at the start of Section 6.2, that approved levee has been conservatively excluded from the Baseline scenario and therefore it is emphasised that any flood impact presented in the SWIA is conservative and greater than the incremental impact of the Project in isolation.

The flood model results demonstrate that the 10% AEP design flood event just starts to break out of the Hunter River channel in this area. It is the 5% AEP event that first causes extensive inundation of the floodplain adjoining the levee. As the most frequent event causing flood flows on these lands, the 5% AEP event was adopted for assessing potential geomorphic impacts.

The peak velocity distribution in the vicinity of the Carrington West Wing Levee for the Project Operations scenario is shown in Figure 6.6. The change between the Project Baseline to Project Operations was calculated by subtracting the velocity distributions for the two scenarios and is shown in Figure 6.7. In Figure 6.7, areas where there is a reduction or negligible increase (<0.1 m/s) in velocity are not shaded. The results indicate that changes are concentrated between the river channel and the downstream (eastern) half of the levee and are generally of small magnitude (<0.5 m/s increase shown in blue and green). The maximum velocity increase of approximately 1 m/s occurs at the toe of the levee.

Results presented in Figure 6.6 indicate that despite the velocity changes noted above, the resulting velocities generally remain less than 1 m/s on the floodplain. This is consistent with the velocities in the area under baseline conditions. Review of aerial imagery indicates that this is agricultural land with good vegetation cover. There is no sign of geomorphic instability under current conditions. The changes described above would not be expected to change the existing geomorphic regime.

Adjacent to the levee the maximum velocity is approximately 1.5 m/s. This velocity can be readily managed through incorporation of scour protection in the detailed design of the levee.

The area should be monitored during the operational life of the 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 Project.



FIGURE 6.6: PEAK VELOCITY WITH THE PROJECT (5% AEP EVENT) AT CARRINGTON WEST WING LEVEE



FIGURE 6.7: PEAK VELOCITY INCREASE WITH THE PROJECT (5% AEP EVENT) AT CARRINGTON WEST WING LEVEE

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 Project, especially as the 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). The aquatic ecology and GDE assessment undertaken for the Project indicates no significant impacts on associated receptors due to these changes (ELA, 2025). The 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 Project within the ephemeral watercourse catchments. There are water users downstream of the Action Areas 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. The Project is therefore not expected to impact any water users.

6.7 Final Void

6.7.1 Streamflow Impacts

The catchment areas for the Project final voids are presented in Table 6.5 along with the current approved void catchments. The 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 6.5: FINAL VOID CATCHMENT AREAS

Mining Area	Approved Void	Current Approved Void Catchment (ha)	Project Proposed Void Catchment (ha)
HVO North	West Pit	497 [1]	706 North Void, 324 Carrington Pit Void
	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 to 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 with no flood ingress predicted. It should be noted that all of the flood levees and final landforms incorporate freeboard into the design requirements.

HVO North Void and Carrington Pit Void are shown on Figure 3.7, with construction of the Mitchell East Levee (or associated landform works) to achieve flood immunity outcomes.

HVO South Void is shown on Figure 3.12 with the flood protection of the void being the final landform and no separate long-term flood levee being proposed. The Riverview Levee and Cheshunt Levee, which are shown on the WMS figures to be present during Project Operations are incorporated into the final landform.

The final landform will be designed with consideration of the risk of long-term climate change impacts on flooding, including construction of the Mitchell East Levee (or incorporation of this area into the final landform).

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 Void 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 until solubility limits (subject to a range of factors including interspecies interactions) are reached (i.e. when precipitation of salts occurs). 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.

It is considered that the final void water quality for the Project final voids will be similar to that of the Approved final voids, as both Project and Approved final voids are designed as groundwater sinks and will exist in the same hydrological, hydrogeological and geochemical environments. That is, as time progresses the final voids will reach an “equilibrium” of salt species with inflows and interactions between salt species, such as precipitation, balancing.

6.8 Cumulative Impacts

The potential for cumulative impacts has been considered as presented in Table 6.6. The impacts associated with cumulative baseflow and river leakage were identified as requiring further assessment and are presented in the following section.

TABLE 6.6: 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, 2026d).	
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 information from the regional groundwater model (EMM, 2026d). The groundwater model predicted cumulative baseflow and river leakage changes for both operations and closure and are presented in Attachment A. To determine whether further assessment of surface water impacts is required, two criteria have been considered:

- The Project is forecast to have an impact on baseflow and river leakage at closure (defined as 1 ML/year or more), and
- 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, two 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 A. Key cumulative impact outcomes are:

- The average annual flow in the Hunter River is increased by 0.3% or less (from 409,600 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 PERs (EMM, 2026a; EMM, 2026b) for assessment of the impact of these changes to streamflow on aquatic ecology.

6.9 Commonwealth Significant Impact Guidelines

A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (DoE 2013) is included in Table 6.7.

TABLE 6.7: SUMMARY OF ASSESSMENT AGAINST SIGNIFICANT IMPACT GUIDELINES: COAL SEAM GAS AND LARGE COAL MINING DEVELOPMENTS – IMPACTS ON WATER RESOURCES

Aspect	Impact
Flow Regimes (volume, timing, duration and frequency of surface water flows)	The SWIA assessed the impacts to of the Project on streamflow and flooding for a range of climatic conditions inclusive of potential variations in rainfall and evaporation associated with climate change. The Project results in negligible impacts to flows in the Hunter River, of which these potential negligible impacts will be further offset by the regulated nature of the river. For Wollombi Brook the assessment indicates reduced operational impacts for the Project compared to Approved Operations (refer to Section 6.1). In the ungauged ephemeral watercourses there are minor predicted changes to flows on three watercourses during the Project operational phase relative to the approved operations with all predicted impacts relative to the Approved Operations reducing to negligible impacts for Project closure. It should be noted that these three creek systems are already impacted by either current or historical mining operations and approved future mining.
Recharge Rates; Aquifer Pressure or Pressure Relationships Between Aquifers; Groundwater Table Levels	Refer to Groundwater Modelling Report (EMM, 2026d).
Groundwater-Surface Water Interactions	Impacts of the Project on surface baseflows through leakage to groundwater are predicted to be minimal, and generally consistent with the existing approved mining operations. The average annual flow in the Hunter River is predicted to increase by 0.3% or less (from 409,600 ML/year to 411,000 ML/year) as a consequence of the Project. Despite a negative cumulative impact to baseflow and river leakage, the increase in surface water catchment draining to the Hunter River results in an overall net increase in flows. 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. Further discussion on groundwater-surface water interactions is included in Section 6.1 and 6.8.1 and in the Water Resources Impact Assessment (EMM, 2026c).
River-Floodplain Connectivity	The Project has been assessed to have negligible impacts on river-floodplain connectivity as no extension to mining is proposed in floodplain areas. The detailed assessment of flood behaviour and potential impacts on flooding regimes, including impacts on river-floodplain connectivity is included in Sections 6.2, 6.4 and 6.5. Consideration of local floodplain risk management planning is discussed in Section 6.2.4.1, and concludes that based on the limited changes to flood behaviour, the Project is considered to be consistent with the current Floodplain Risk Management Plan (BMT, 2023).
Inter-aquifer Connectivity	Refer to Groundwater Modelling Report (EMM, 2026d).
Coastal Processes	No impacts on coastal process are predicted as a result of the Project being located over 80 km from the coast.
Impact on Water Users	The assessment of impacts on water users indicates that there will be negligible impact on surface water users. All water take associated with the Project will be licensed in accordance with the *NSW Water Management Act 2000*. The *NSW Water Management Act 2000* licensing arrangements have been designed to provide for sustainable take from NSW water sources. Water licensing for the Project is assessed for the NSW state approvals process in the Water Assessment (EMM, 2025b).
State Water Resource Plans	The Project is not located within the Murray-Darling Basin and as such no Water Resource Plan has been developed for the area. The surface water sources within and adjacent to the Project are managed under WSPs that are governed under the *NSW Water Management Act 2000*. The NSW Government WSPs provide a regional water balance for these water sources and consider cumulative water use (refer to Section 1.6.2). The Hunter Unregulated and Alluvial Water Sources WSP applies to watercourses and alluvial groundwater (greater than 40 m from the riverbanks) in the vicinity of the HVO Complex, with the exception of the Hunter River. The 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). Water take for the HVO Complex will continue to comply with the above listed WSPs and *NSW Water Management Act 2000* which are designed to provide for the sustainable use of NSW's water resources.

Aspect	Impact
Water Quality	Surface infrastructure for the Project will be designed and constructed to include erosion and sediment controls in accordance with relevant NSW government guidelines and standards to minimise potential impacts on downstream water quality by managing water that has the potential to cause environmental harm. Operational and rehabilitation phases of the Project will include water quality control measures in accordance with the relevant NSW government standards will be implemented to minimise potential impacts on water quality. With consideration of the WMS design standards and their likely adaption with climate change (refer to Section 3.2.2), it is considered that the likelihood and consequence of sediment dam overflows will continue to be the same as the existing operations and the Approved Operation. 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) 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. Predicted velocity changes in the Hunter River during flood events are generally localised around Project infrastructure (levees, Lemington Road, SLP 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) and mobilising increased quantities of sediment. No significant change to flood velocities were predicted on property not owned by the JV partners

7. MITIGATION, MONITORING AND MANAGEMENT MEASURES

7.1 Summary of Impacts and Mitigation Measures

Detailed environmental studies have been undertaken to inform the 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 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. 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 Project.

TABLE 7.1: SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

Potential Impacts	Existing Measures	Project - Proposed 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. Design of the WMS components will, during the detailed design stages, consider future increases in rainfall intensities associated with climate change. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.
	Comprehensive water quality monitoring systems.	Upgrades to Lake James and Parnells Dam to increase on site water storage and provide upgraded telemetry and release systems.
		Continuation of existing water quality monitoring.
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. Works are in accordance with guidelines from the Blue Book (Landcom, 2004; NSW DECC, 2008a; NSW DECC, 2008b; NSW DECC, 2008c; NSW DECC, 2008d).	Continuation of existing measures. Extension of existing WMS. Designs of the WMS components will, during the detailed design stages, consider future increases in rainfall intensities associated with climate change. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components.
	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. • 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.

Potential Impacts	Existing Measures	Project - Proposed Measures
		• 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/import of clean water into WMS	Separation of clean water systems from mine and sediment water systems where practicable.	Continuation of existing measures, including water metering and calculation of take where metering is not possible. Extension of existing WMS including the Mitchell Pit clean water drain (note: this drain diverts upslope runoff away from the mining area and is not a creek diversion).
	Accounting for water take in accordance with the NSW Non-Urban Water Metering Policy (NSW DPIE, 2020).	
Flood immunity	Existing levee systems to protect mine infrastructure, including: • North Carrington Levee 5. • North Pit Levee 3. • North Pit Levee – Alluvial Lands. • North Pit Levee – West. • Barry's Levee and Barry's Levee South. • Hobden Gully Levee.	Extension of existing WMS including the construction of flood levees to provide flood protection to mine workings during operations and final landform. Project levees include: • Carrington West Wing Levee. • Cheshunt Levee. • Riverview Levee. • North Void TSF Levee 2 (South-East levee). • Mitchell East Levee (or final landform shaping) to provide flood immunity for North Void post closure.
	Existing operation flood upgrades including North Void TSF Levee 1 (North-West levee) and SLP 1 ramp regrade.	Realigned Lemington Road with upgraded flood immunity to exceed the 10% AEP event (currently less than 10% AEP immunity).
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.
		Decommissioning of the Carrington West Wing Levee at closure to reinstate floodplain storage.
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.
Flooding impacts on emergency management (Emergency Services / Access)		No proposed changes to emergency services access.
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. No proposed changes to WALs.
	Rehabilitation of overburden emplacement areas with runoff returned to the receiving environment when	

Potential Impacts	Existing Measures	Project - Proposed Measures
	established and suitable water quality has been demonstrated.	
	Minimisation of catchment contribution to the residual void.	
Surplus water on site	Water sharing with adjacent mining operations.	Continued water sharing with adjacent mining operations including tailings storage at LCO.
	Water discharge using HRSTS salt credits via EPL licensed discharge locations.	Continued water discharge using HRSTS salt credits via EPL licensed discharge locations.
Water shortage on site	Water sharing with adjacent mining operations.	Continuation of existing measures. No proposed changes to WALs.
	Water abstraction from Hunter River using regulated river WALs.	
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. Changes to government guidance, for example the Blue Book design rainfall depths, and/or ARR rainfall depths, will be incorporated, as required, into detail designs for construction of new WMS components and augmentation/management changes for existing WMS components. Continuation and update as required of existing emergency management system including pollution incident response plan.
Water quality impacts during HRSTS Release	Managed within the requirements of the HRSTS and EPL resulting in discharge water quality considered to be in the natural range of the river. Monitoring of EC continuously during discharge, and pH and TSS daily during discharge as per the requirements of the EPL.	Continuation of existing measures. No proposed changes.
Final void extent, water flux and water quality	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 with as much of the catchment directed away from the voids as possible / practical.
	Flood immunity for final voids.	The final landform will be designed with consideration of the risk of long-term climate change impacts on flooding, including construction of the Mitchell East Levee (or incorporation of this area into the final landform), for extreme events.
	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.
	Water quality passively managed with increasing salt concentrations in final voids that will in the future reach an “equilibrium” point.	Consistent with existing approved outcome. As part of closure planning HVO will undertake further detailed analysis and hydrogeochemical modelling (i.e. considering pH and water chemistry using fundamental chemical principles, rather than purely mass-balance or empirical relationships) to estimate the likely final void water quality and any actions that could improve final void water quality (e.g. post mining beneficial uses).

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 Project will maintain and build off these systems.

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 Project, HVO will update the existing WMP in consultation with relevant agencies to reflect the changes to water management associated with the Project. The updated WMP will address any specific development consent or licence conditions and will include:

- Proposed mitigation and management measures for the Project. The range of additional mitigation measures are summarised in Table 7.1, with few additional controls required.
- Objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with the 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.
- Include analysis of total and dissolved metals, as well as, dissolved organic carbon (DOC) in the comprehensive analysis.

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 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 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 Public Environment Reports (EMM, 2026a; EMM, 2026b) and associated Water Resources Impact Assessment (EMM, 2026c) and provides an assessment of the potential impacts to surface water as a result of the 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 existing operation has a well-established existing WMS in place to minimise surface water impacts. The Project proposes to continue to utilise the existing WMS by maintaining and building upon the existing WMS including new dams, pipelines, pumps, drains and flood levees (new and raising existing).

The predicted impacts of the 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 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 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 Project will be no greater than those modelled for the EIS Project and has not been re-simulated for the 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 changes 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, SLP 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 Water Assessment (EMM, 2026c) for assessment of the impact of these changes to streamflow on aquatic ecology and GDEs.

The range of potential impacts resulting from the 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 the HVO Complex. This is appropriate and to be expected given the generally small incremental impact due to the small additional disturbance associated with the 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 Project will maintain and build off these systems. In summary, it is expected that integration of the Project into this established management system will adequately mitigate the potential surface water impacts associated with the Project.

9. REFERENCES

ANZECC. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council.

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Canberra ACT: Australian and New Zealand Governments and Australian state and territory governments.

ANZG. (2023). *Livestock Drinking Water Guidelines.* Australian and New Zealand Governments and Australian state and territory governments.

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

BMT. (2022). *Singleton Floodplain Risk Management Study and Plan - Draft.*

BMT. (2023). *Singleton Floodplain Risk Management Study and Plan.*

CSIRO. (2015). *Climate Change in Australia Technical Report.*

DAWE. (2019). *Hunter Subregion Bioregional Assessment.* Commonwealth Government Department of Agriculture Water and the Environment.

DCCEEW. (2022). *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources.* Department of Climate Change, Energy, the Environment and Water, Canberra. CC BY 4.0.

DoE. (2013). *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources.*

EGI. (2022a). *HVO Continuation Project EIS - Geochemical Assessment.*

EGI. (2022b). *Hunter Valley Operations - Continuation Project:, Water Quality Predictions for Final Pit Voids.*

ELA. (2022). *Hunter Valley Operations Continuation Project - aquatic ecology and groundwater dependent ecosystem assessment.* Eco-Logical Australia.

ELA. (2025). *Hunter Valley Operations Continuation Project - aquatic ecology and groundwater dependent ecosystem assessment.*

EMM. (2022). *Hunter Valley Operations Continuation Project Environmental Impact Statement.*

EMM. (2023a). *Hunter Valley Operations Continuation Project Submissions Report.*

EMM. (2023b). *Hunter Valley Operations Continuation Project - Amendment Report.*

EMM. (2025a). *Hunter Valley Operations Continuation Project - Amendment Report.*

EMM. (2025b). *HVO Continuation Project Amendment - Water Assessment.*

EMM. (2025c). *Hunter Valley Operations Continuation Project - Amendment, Groundwater Modelling.*

EMM. (2026a). *HVO North Open Cut Continuation Project (EPBC 2025/10177) - Public Environment Report.*

EMM. (2026b). *HVO South Open Cut Continuation Project (EPBC 2025/10176) - Public Environment Report.*

EMM. (2026c). *HVO Continuation Project - Water resources impact assessment.*

EMM. (2026d). *HVO Continuation Project - Groundwater modelling.*

Engeny. (2018). *HVO Environmental Constraints Surface Water Management and Water Balance.*

Engeny. (2022). *HVO Continuation Project - Surface Water Impact Assessment.*

Engeny. (2025). *HVO Continued Operations - Amended Project - Surface Water Impact Assessment.*

HVO. (2018). *Hunter Valley Operations Water Management Plan.*

HVO. (2022). *Hunter Valley Operations Water Management Plan.*

HVO. (2023). *Hunter Valley Operations 2023 Annual Environmental Review.*

HVO. (2025). *Hunter Valley Operations 2024 Annual Review.*

IESC. (2024). *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals.* Commonwealth of Australia.

Kovac, M., & Lawrie, J. W. (1991). *Soil Landscapes of the Singleton 1:250 000 Map Sheet.* Sydney: Department of Land and Water Conservation of NSW.

Landcom. (2004). *Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition.*

Mackie Environmental Research. (2010). *Carrington West Wing Modification - Groundwater Assessment.*

NHMRC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy.* National Health and Medical Research Counci.

NSW DECC. (2008a). *Managing Urban Stormwater - Soils and Construction Volume 2A Installation of services.* Sydney: Department of Environment and Climate Change NSW.

NSW DECC. (2008b). *Managing Urban Stormwater: Soils and Construction - Volume 2C Unsealed roads.* Sydney: Department of Environment and Climate Change NSW.

NSW DECC. (2008c). *Managing Urban Stormwater: Soils and Construction - Volume 2D Main road construction.* Sydney: Department of Environment and Climate Change NSW.

NSW DECC. (2008d). *Managing Urban Stormwater - Soils and Construction, Volume 2E Mines and Quarries.*

NSW DIPNR. (2005). *Floodplain Development Manual.* NSW Department of Infrastructure, Planning and Natural Resources.

NSW DPE. (2022). *Flood Risk Management Manual.* NSW Department of Planning and Environment.

NSW DPIE. (2020). *NSW Non-Urban Water Metering Policy.* NSW Department of Planning, Industry and the Environment.

NSW Government. (1986). *Floodplain Development Manual.*

NSW Government. (2025). *Guidelines for Controlled Activity Approvals*. Retrieved from https://www.dpie.nsw.gov.au/water/our-work/licensing-and-approvals/controlled-activity-approvals#guidelines-for-controlled-activity-approvals

Paterson Consultants. (2012). *Singleton Floodplain Risk Management Plan.* Paterson Consultants Pty Ltd.

Smith, G. D. (2014). *Flood Hazard UNSW Australia Water Research Laboratory Technical Report 2014/07.*

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

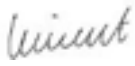
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26 SEPTEMBER 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	9/09/2025	Client Issue	Laura Vincent	Susan Shield	Susan Shield	Sean Frazer
1	17/09/2025	Client Issue	Laura Vincent	Susan Shield	Susan Shield	Sean Frazer
2	26/9/2025	Client Issue	Laura Vincent	Susan Shield	Susan Shield	Chris Bonomini
Signatures:						

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1. INTRODUCTION

Hunter Valley Operations 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) comprising of 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. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV.

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

A peer review of the streamflow assessment approach and methodologies was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the surface water impact assessment, 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.

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. Water licensing for the Project was assessed for the NSW state approvals process in the Water Assessment (EMM, 2025c). The Streamflow Assessment for the Project follows the same methodology that was peer reviewed by Ian Rowbottom.

2. ASSESSMENT SCOPE

A screening process was undertaken to determine the required extent of the assessment for the 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). It should be noted that the maximum impacts on baseflow associated with the Approved Operations (refer to Section 1 and 4.1) 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 Project are presented in Table 2.1 and illustrated in Figure 2.1. No new catchment areas are proposed to be intersected by the Project when compared to 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 Project Operation[2]	Baseflow Change from Approved due to Project (Operations)[4, 5]	Baseflow Change from Approved due to Project (Final Landform)[4, 5]	Assessed
Hunter River (Mason Dieu 210128)	Yes - Minor changes in upstream tributaries (Parnells Creek, UN1, Pikes Creek and Farrells Creek) (negative impact during operations)	Yes (negative impact)	Yes (negative impact)	Yes
Parnells Creek	Yes - Change due to minor differences associated with mining haul roads and WMS (positive impact)	No	No	Yes
Unnamed Tributary 1 (UN1)	Yes - Change due to increase in mining area with realignment of Lemington Road (negative impact during operations)	No	No	Yes
Unnamed Tributary 2 (UN2)	Yes - Change due to approved rehabilitation area being redirected (positive impact)	No	No	Yes
Hobden Gully	Yes (positive impact after closure)	No	No	Yes[3]
Farrells Creek	Yes - Change due to increase in mining area with realignment of Lemington Road (negative impact during operations)	No	No	Yes
Pikes Creek	Yes - Change due to extension of Newdell Load Point stockpile area (negative impact during operations)	No	No	Yes
Bayswater Creek	Yes - Change in upstream tributary (Pikes Creek) (negative impact during operations)	Yes (negative impact)	No	Yes
Unnamed Tributary 3 (UN3)	Yes (positive impact)	No	No	Yes[3]
Wollombi Brook	Yes - Change in upstream tributaries (Unnamed Tributary 5 and 6) (positive impact)	Yes (positive impact)	Yes (positive impact)	Yes

Watercourse System[1]	Catchment Change from Approved due to Project Operation[2]	Baseflow Change from Approved due to Project (Operations)[4, 5]	Baseflow Change from Approved due to Project (Final Landform)[4, 5]	Assessed
Unnamed Tributary 5 (UN5)	Yes - Change due to removal of Lemington Rail Loop from the Action Area (positive impact)	No	No	Yes
Unnamed Tributary 6 (UN6)	Yes - Change due to removal of Lemington Rail Loop from the Action Area (positive impact)	No	No	Yes

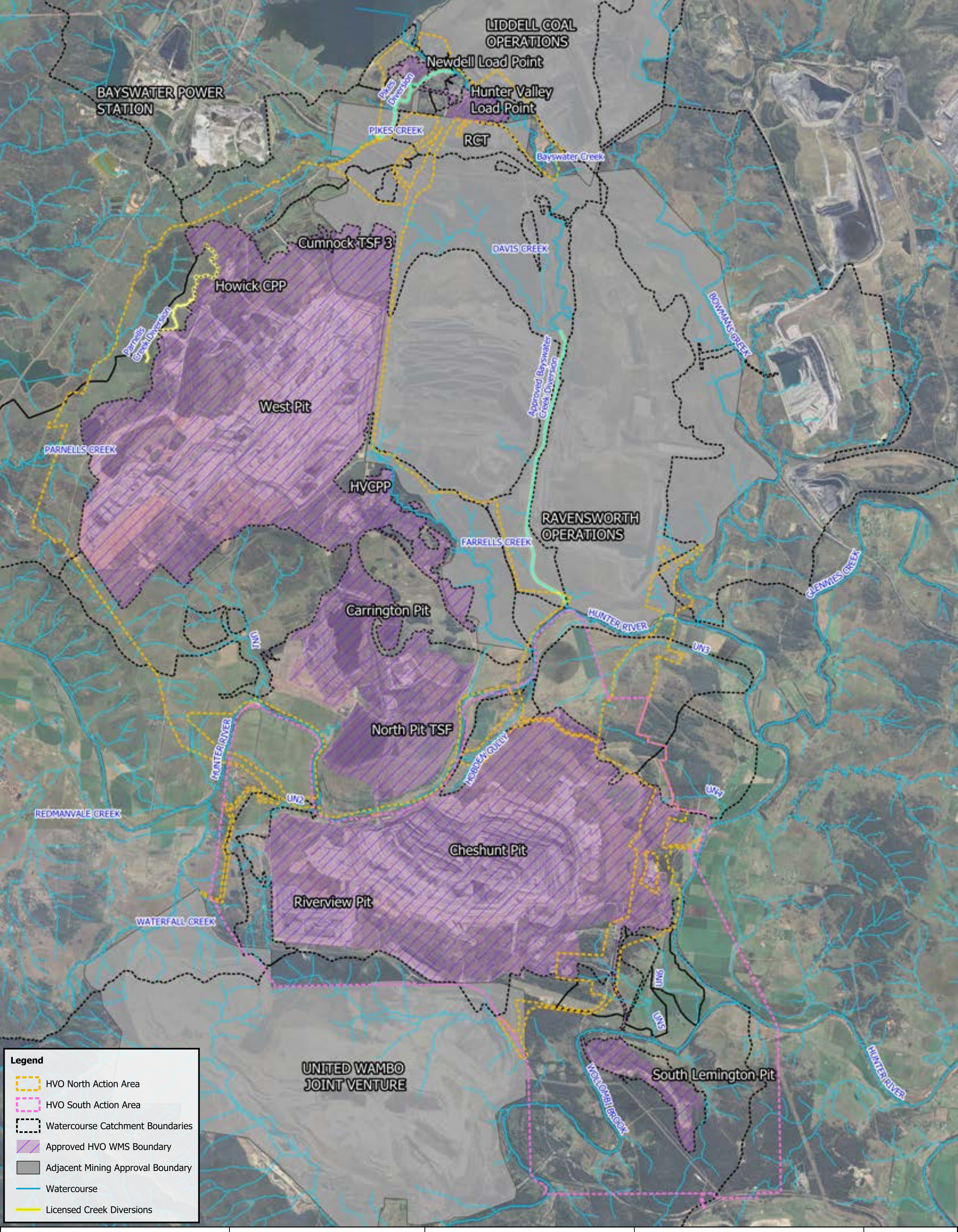
Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed in Water Assessment (EMM, 2025b).

Note 2: Maximum impact associated with the Project during operations. 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 or catchment, Positive impact refers to a predicted increase in baseflows or catchment.



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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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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.

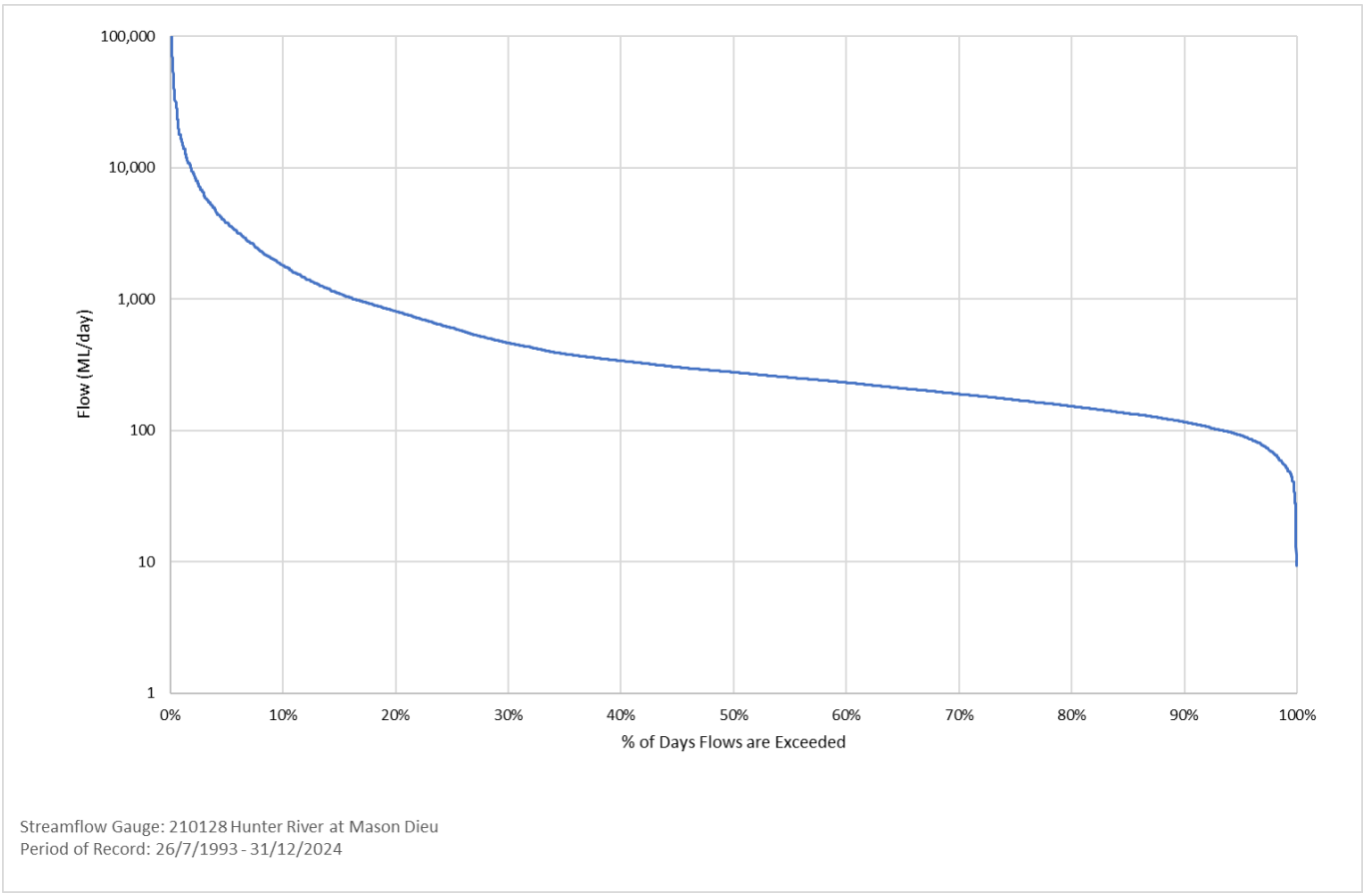


Figure 3.1: Historical Flow Gauging Data – Hunter River at Mason Dieu (210128) Flow Gauge

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).

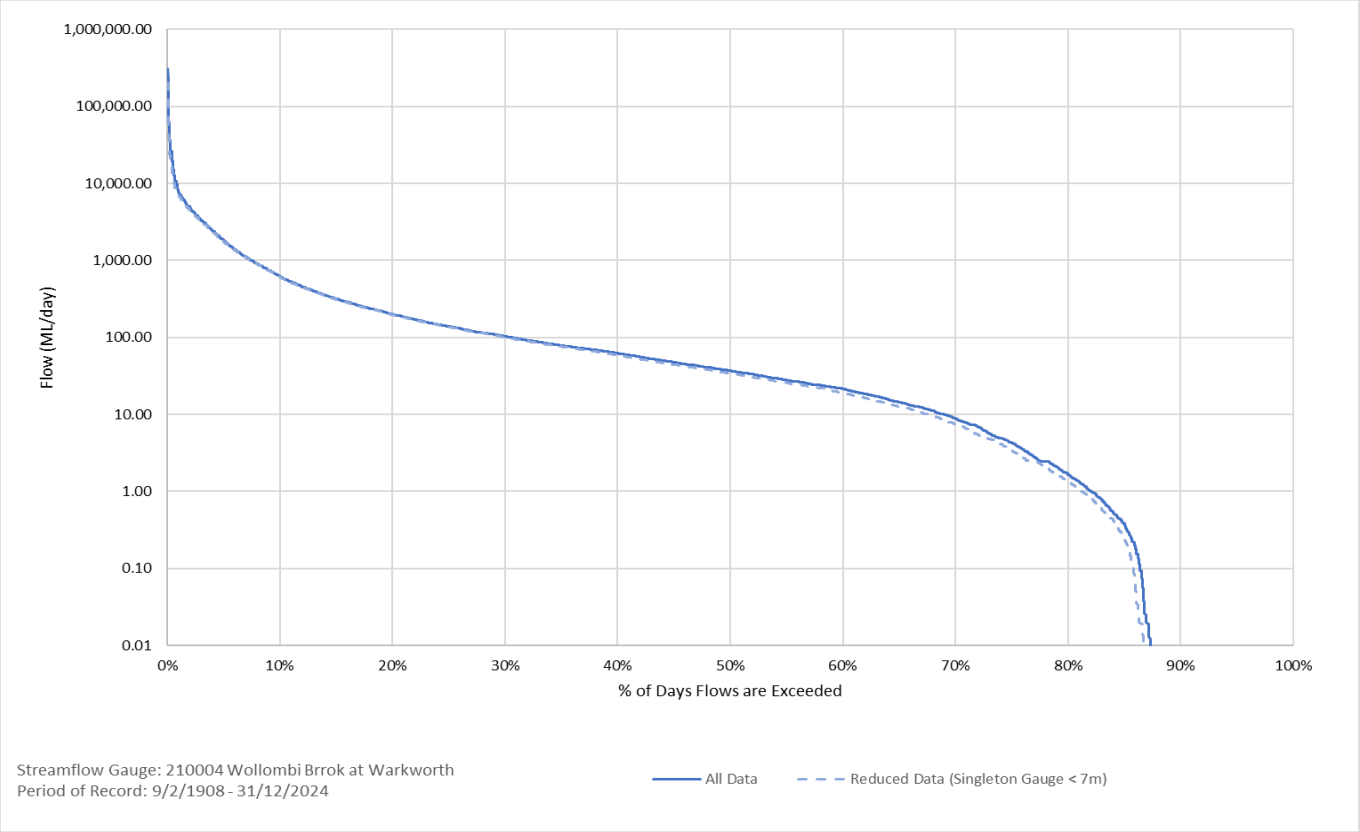


Figure 3.2: Historical Flow Gauging Data – Wollombi Brook at Warkworth (210004)

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.

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.

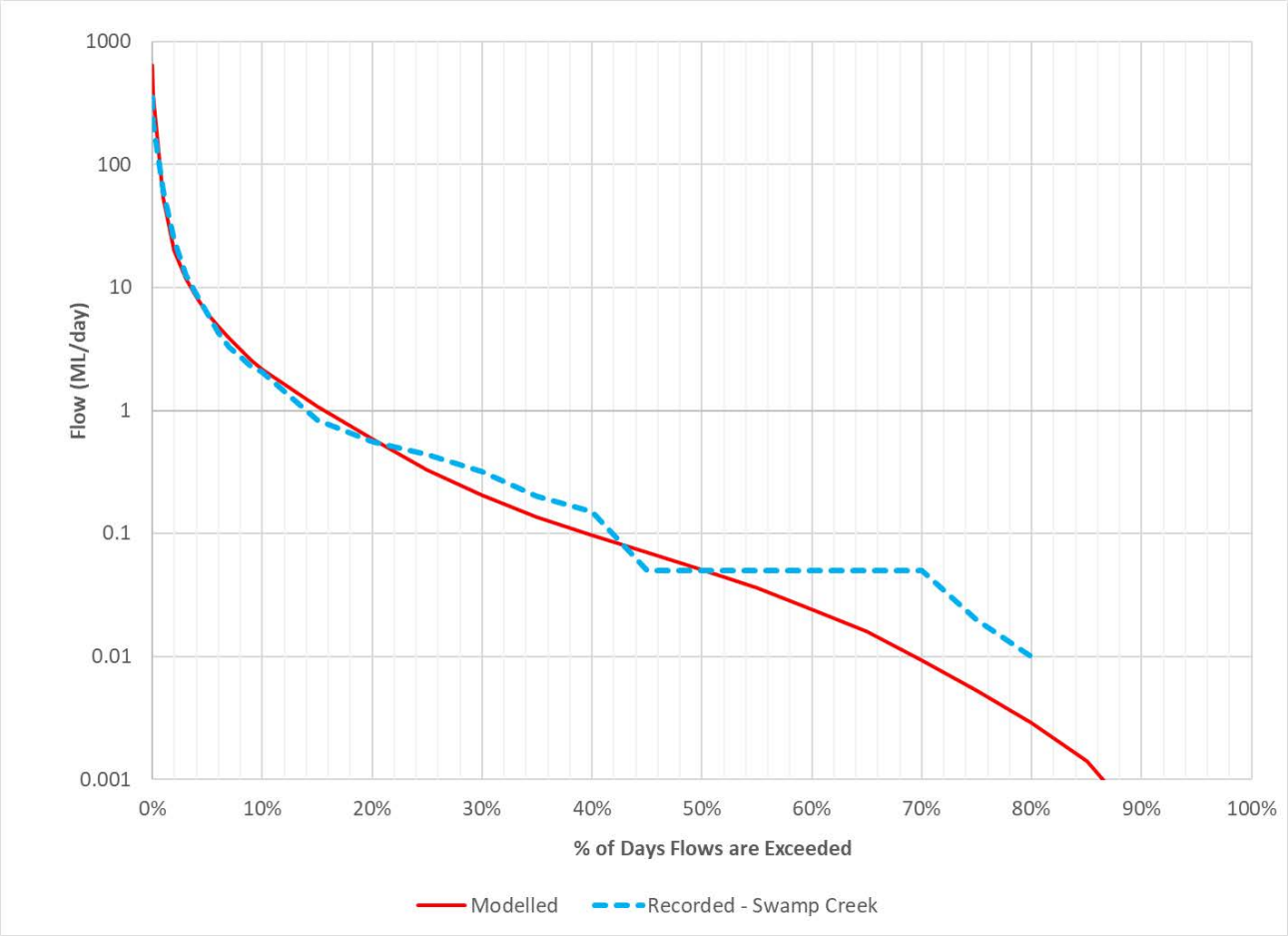


Figure 3.3: Calibration – AWBM Catchment Model – Flow Duration Curve

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.

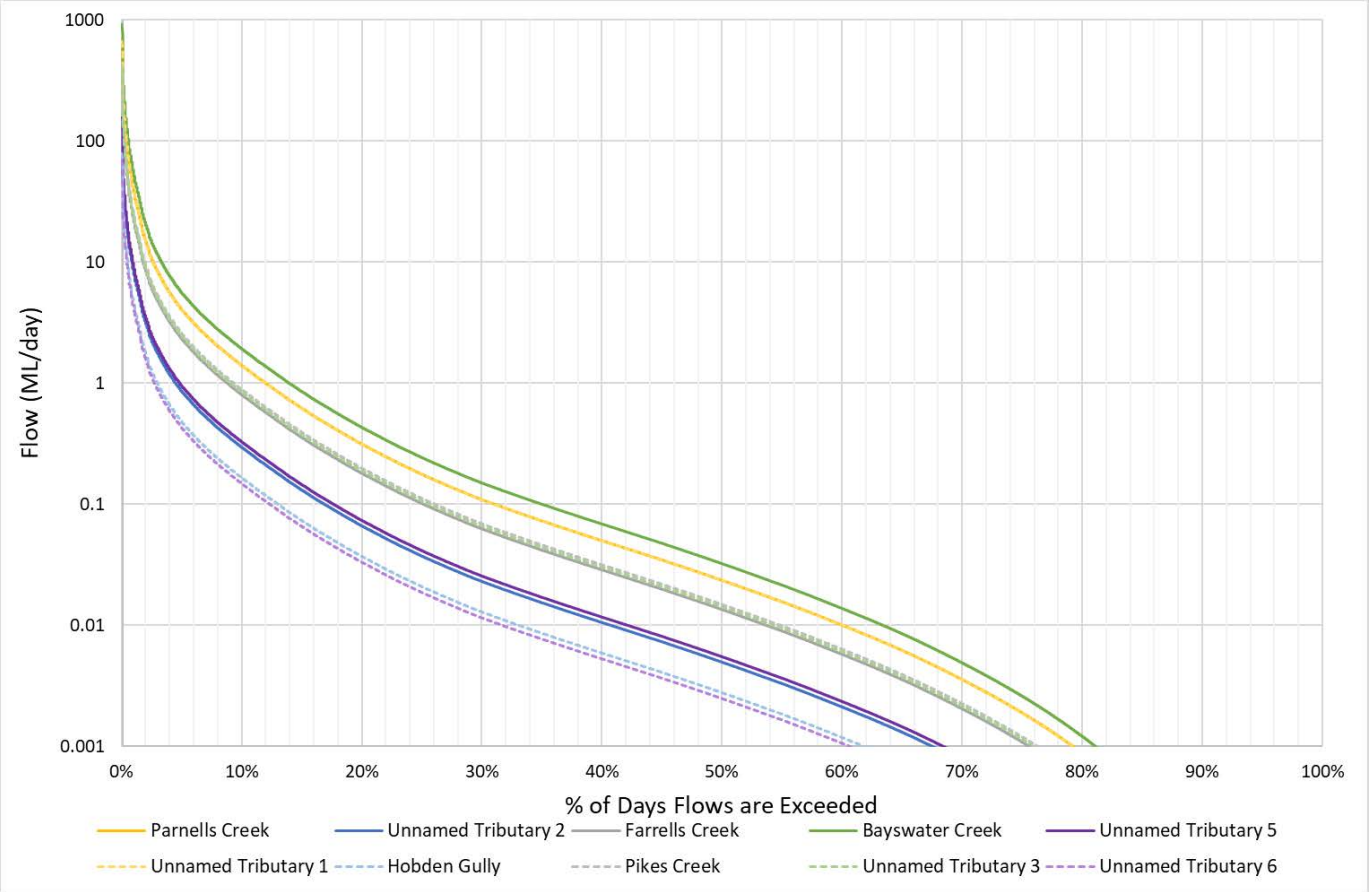


Figure 3.4: Existing (2025) Flow Duration Modelled Results – Ephemeral Creeks

4. IMPACT ASSESSMENT

The additional disturbance associated with the 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 (2025 – 2030).
- Project Operations: maximum impact to watercourse catchments under proposed conditions determined from stage plans (2027 – 2045).
- Project Closure: Final Landform (2046 onward).

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 (NSW DPIE, 2020). Catchment areas for the minor watercourses within and surrounding the Project were delineated using from digital elevation data (LiDAR). These catchments were then adjusted to align with the Approved Operations, Project Operations and Project Closure WMS extents.

Compared to the Approved Operations, the proposed 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. For some of these catchment areas, the Project will improve catchment impacts, compared to the Approved Operations.

TABLE 4.1: PREDICTED CATCHMENT AREAS (HA)

Watercourse System	Approved Operations	Project Operations	Project Closure	Comments (Approved Operations versus 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.
UN1	765	225	1,080	Change due to increase in mining area with realignment of Lemington Road.
UN2	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.

Watercourse System	Approved Operations	Project Operations	Project Closure	Comments (Approved Operations versus Project Operations)
Bayswater Creek[1]	2,045	2,025	2,630	Change in upstream tributary (Pikes Creek).
UN3	615	615	870	-
Wollombi Brook[1]	187,300	187,400	188,100	Change in upstream tributaries (Unnamed Tributary 5 and 6).
UN5	150	175	875	Change due to removal of Lemington Rail Loop from the Project.
UN6	85	105	105	Change due to removal of Lemington Rail Loop from the Project.

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 derived as part of the Project Groundwater Modelling (EMM, 2025a). These flows are defined as follows:

- **Baseflow:** Groundwater discharge to surface water.
- **River Leakage:** Surface water leakage to groundwater.

Consistent with the peer reviewed methodology, 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 groundwater 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 (2025) for the Approved Operations (2025 – 2030), Project Operations (2027 – 2045), Project Closure which represents cumulative effects (i.e., effects of all mining activities simulated in the groundwater model (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 Operations	Project Operations	Project Closure
Hunter River (Mason Dieu 210128)	199	344	110
Parnells Creek	0	0	0
UN [1]	0	0	0
UN [2]	0	0	0
Hobden Gully	0	0	0

Watercourse System [1]	Approved Operations	Project Operations	Project Closure
Farrells Creek	0	0	0
Pikes Creek	0	0	0
Bayswater Creek	1.2	1.7	0
UN3	0	0	0
Wollombi Brook	36	20	-29.1[2]
UN [5]	0	0	0
UN [6]	0	0	0

Note 1: Redmanvale Creek, Bowmans Creek, Glennies Creek and Saltwater Creek assessed in the Water Assessment (EMM, 2025b).

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 peer reviewed by Ian Rowbottom, as follows:

- Gauged Streams:
  - Linear scaling of the daily streamflow based on the ratio of catchment area to the existing (2025) case.
  - 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.
  - 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.
- Project Operations: maximum impact to watercourse catchments and baseflows under proposed conditions determined from stage plans and Groundwater Modelling (EMM, 2025a).
- 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 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.

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	Project Operations	Project Closure	Approved Operations	Project Operations	Project Closure	Approved Operations	Project Operations	Project Closure
Gauged Streams	Hunter River	100	409,600	409,300	411,000	24	25	24	5	5	5
	Wollombi Brook	0.1	172,200	172,300	173,000	54	53	52	32	32	32
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	630	640	1,220	252	252	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	870	870	1,230	239	240	221	63	63	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)	
			Project Operations vs Approved Operations	Project Closure vs Approved Operations	Project Operations vs Approved Operations	Project Closure vs Approved Operations	Project Operations vs Approved Operations	Project Closure vs Approved Operations
Gauged Streams	Hunter River	100	-0.1%	0.3%	4%	0%	0%	0%
	Wollombi Brook	0.1	0%	0%	-2%	-4%	0%	0%
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	2%	94%	0%	-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%	41%	0%	-8%	0%	0%
	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	Project Operations	Project Closure	Approved Operations	Project Operations	Project Closure
Gauged Streams	Hunter River	100	42	43	40	10	11	10
	Wollombi Brook	0.1	38	30	23	2	4	2
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	325	325	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	315	315	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	Project Operations	Project Closure	Approved Operations	Project Operations	Project Closure	Approved Operations	Project Operations	Project Closure
Gauged Streams	Hunter River	100	4	4	4	18	18	18	1	1	1
	Wollombi Brook	0.1	26	11	12	35	26	22	17	2	1
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	150	150	137	272	272	259	27	27	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	145	137	266	267	259	22	22	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	
			Project Operations vs Approved Operations	Project Closure vs Approved Operations	Project Operations vs Approved Operations	Project Closure vs Approved Operations	Project Operations vs Approved Operations	Project Closure vs Approved Operations	Project Operations vs Approved Operations	Project Closure vs Approved Operations
Gauged Streams	Hunter River	100	2%	-5%	0%	0%	0%	0%	0%	0%
	Wollombi Brook	0.1	-21%	-39%	-58%	-54%	-26%	-37%	-88%	-94%
Ungauged Ephemeral Streams (AWBM)	Parnells Creek	0.1	0%	-8%	0%	-9%	0%	-5%	0%	-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%	-5%	1%	-5%	0%	-3%	0%	-36%
	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

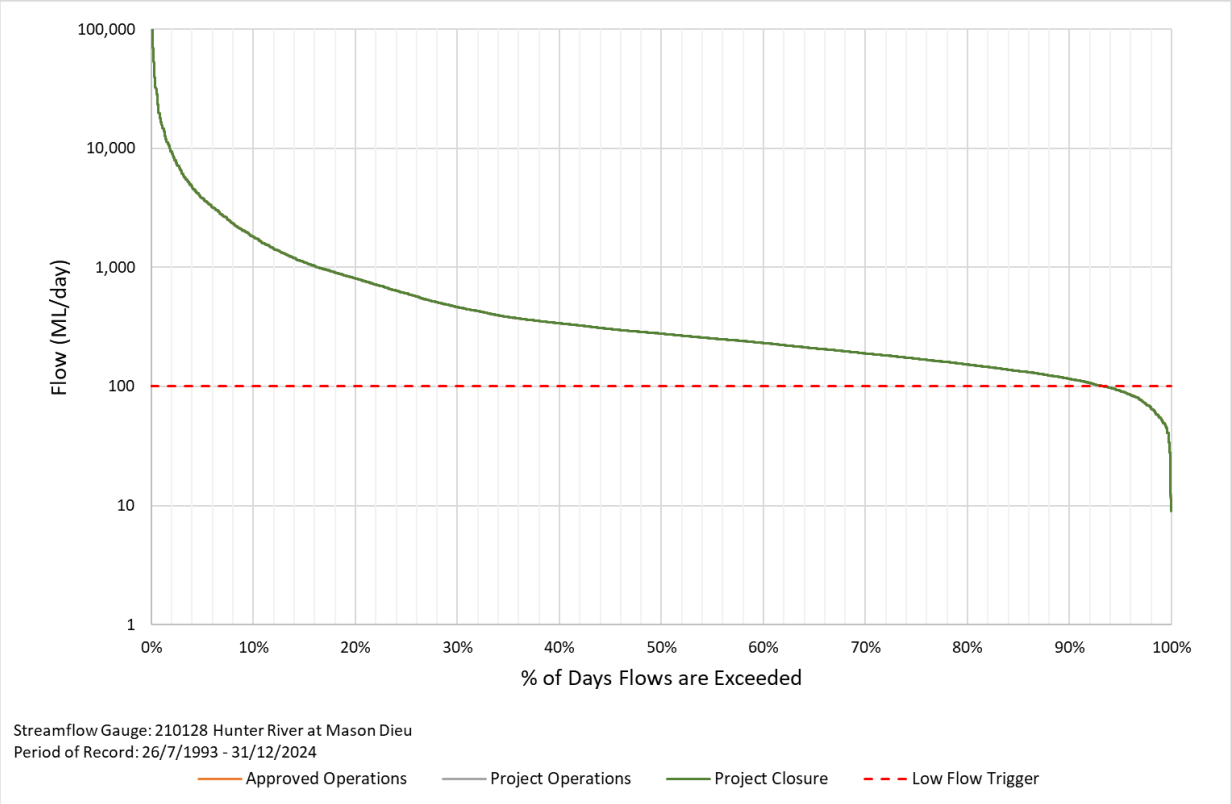


Figure 5.1: Flow Duration – Hunter River

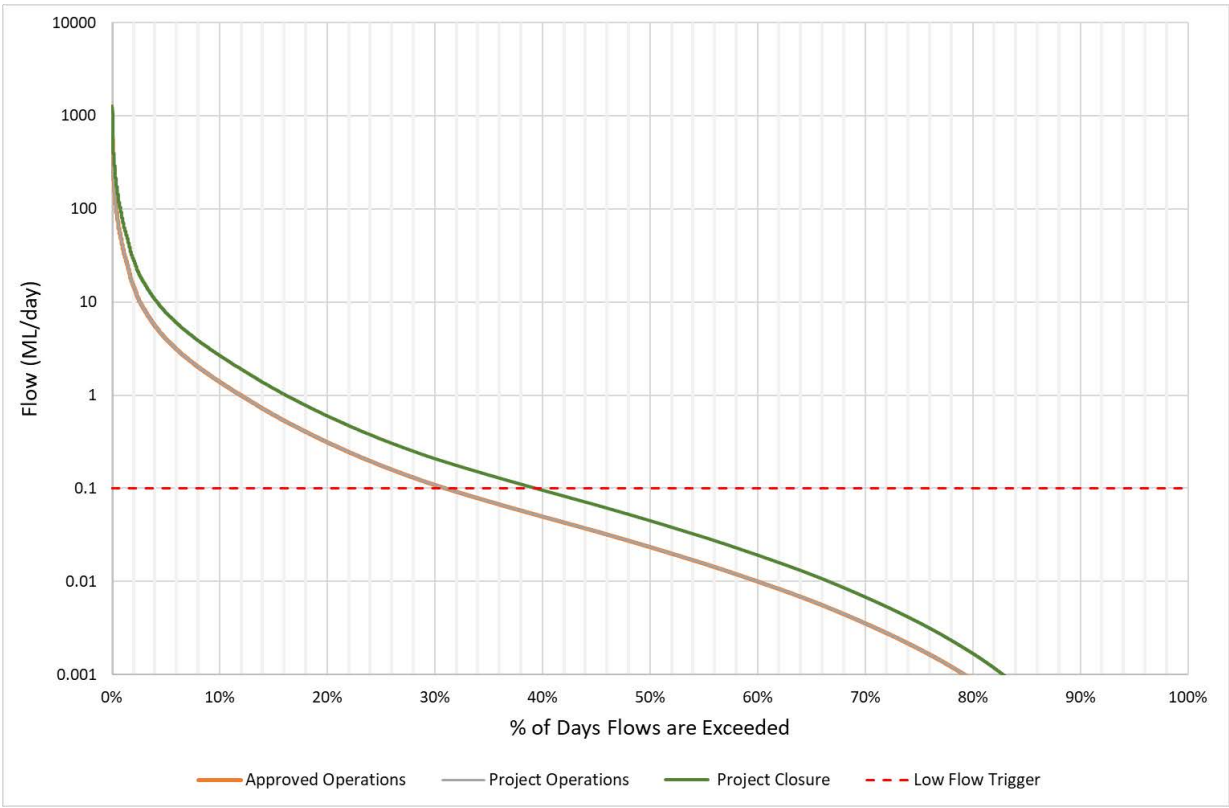


Figure 5.2: Flow Duration – Parnells Creek

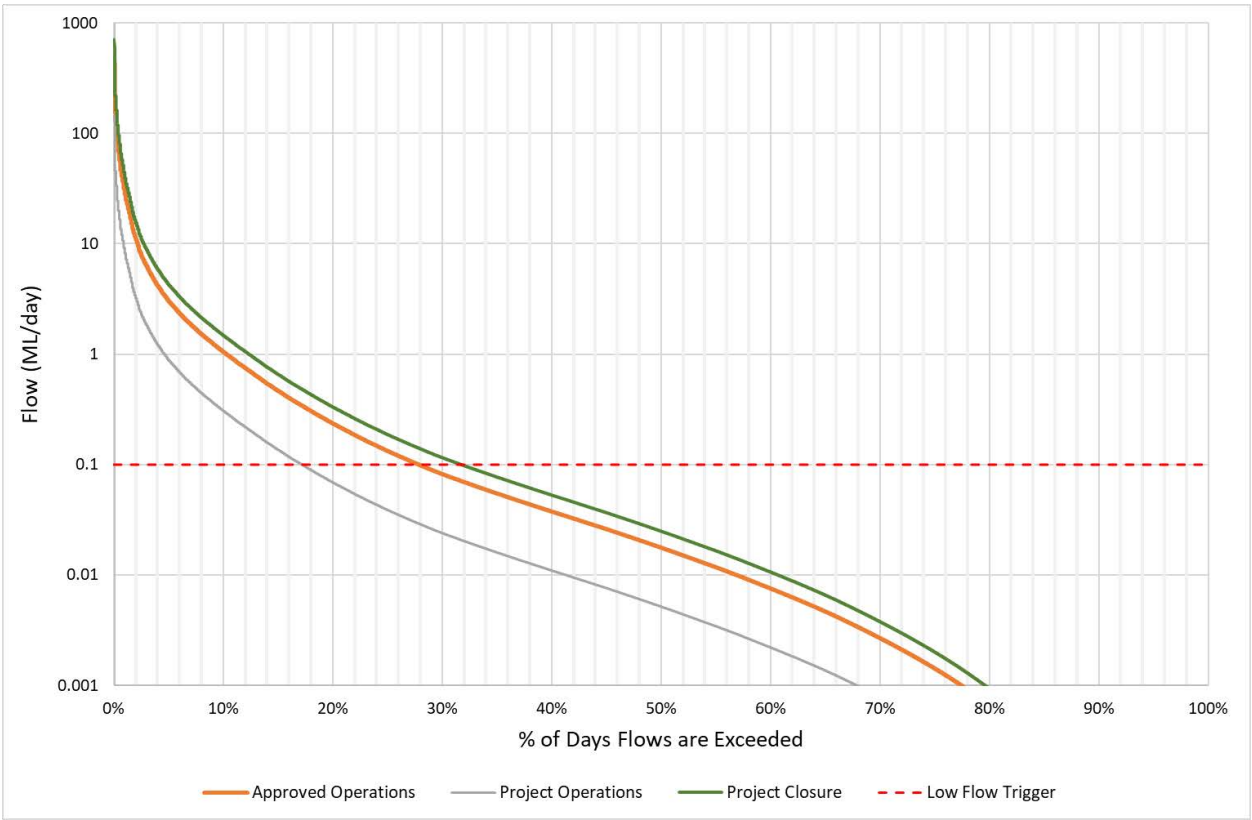


Figure 5.3: Flow Duration – Unnamed Tributary 1

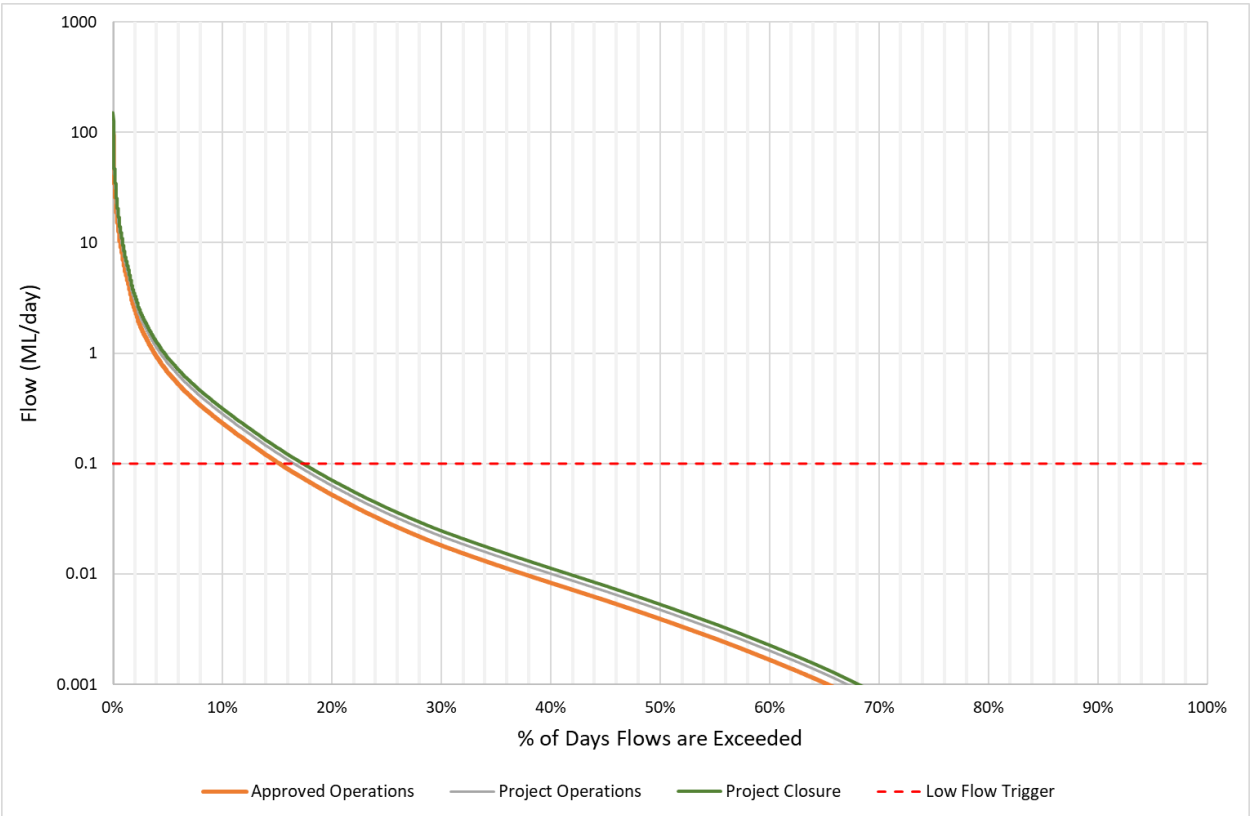


Figure 5.4: Flow Duration – Unnamed Tributary 2

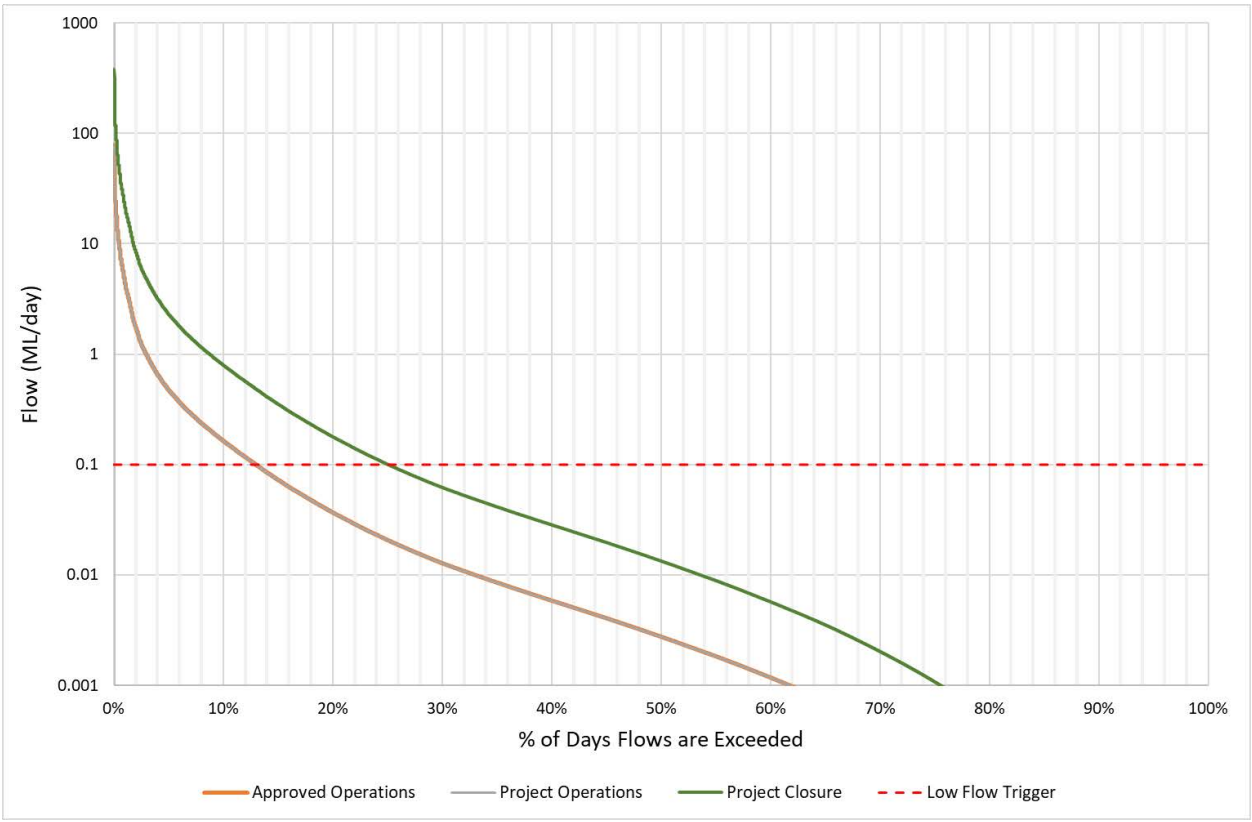


Figure 5.5: Flow Duration – Hobden Gully

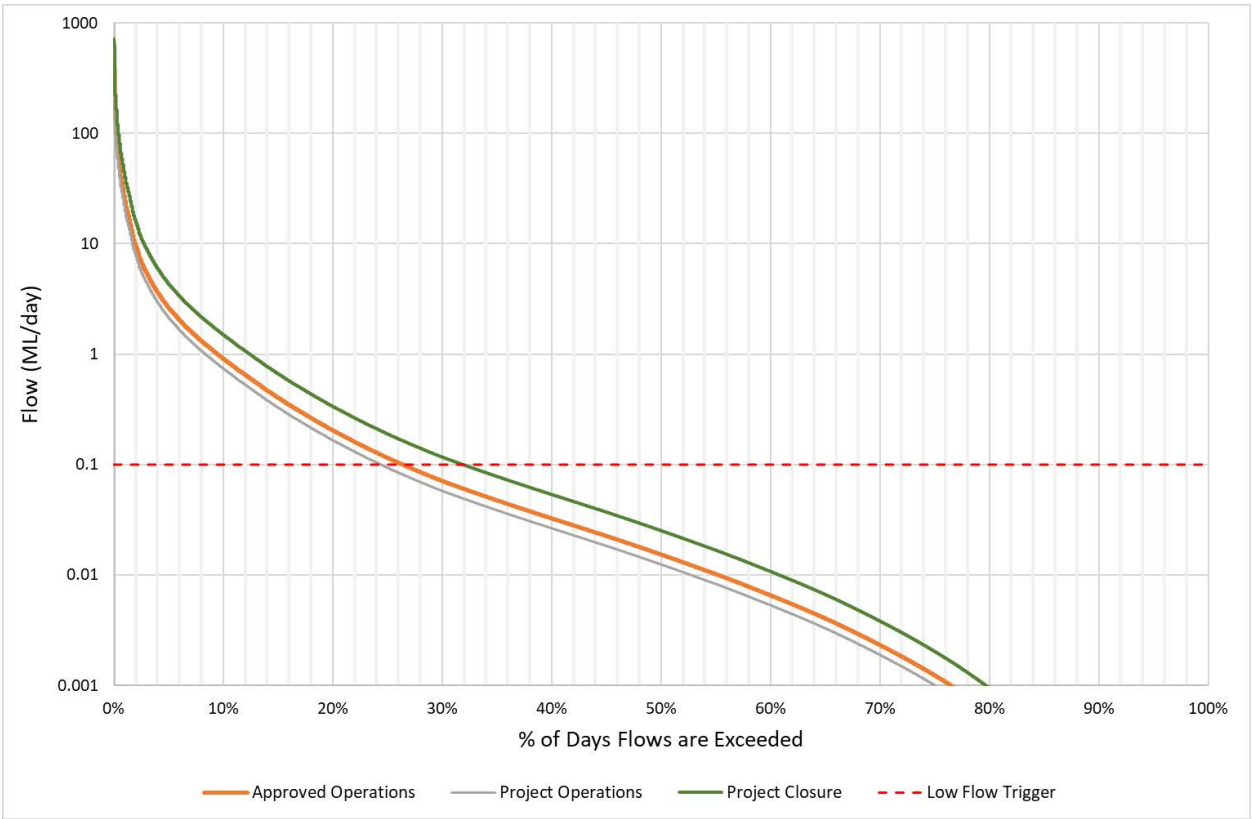


Figure 5.6: Flow Duration – Farrells Creek

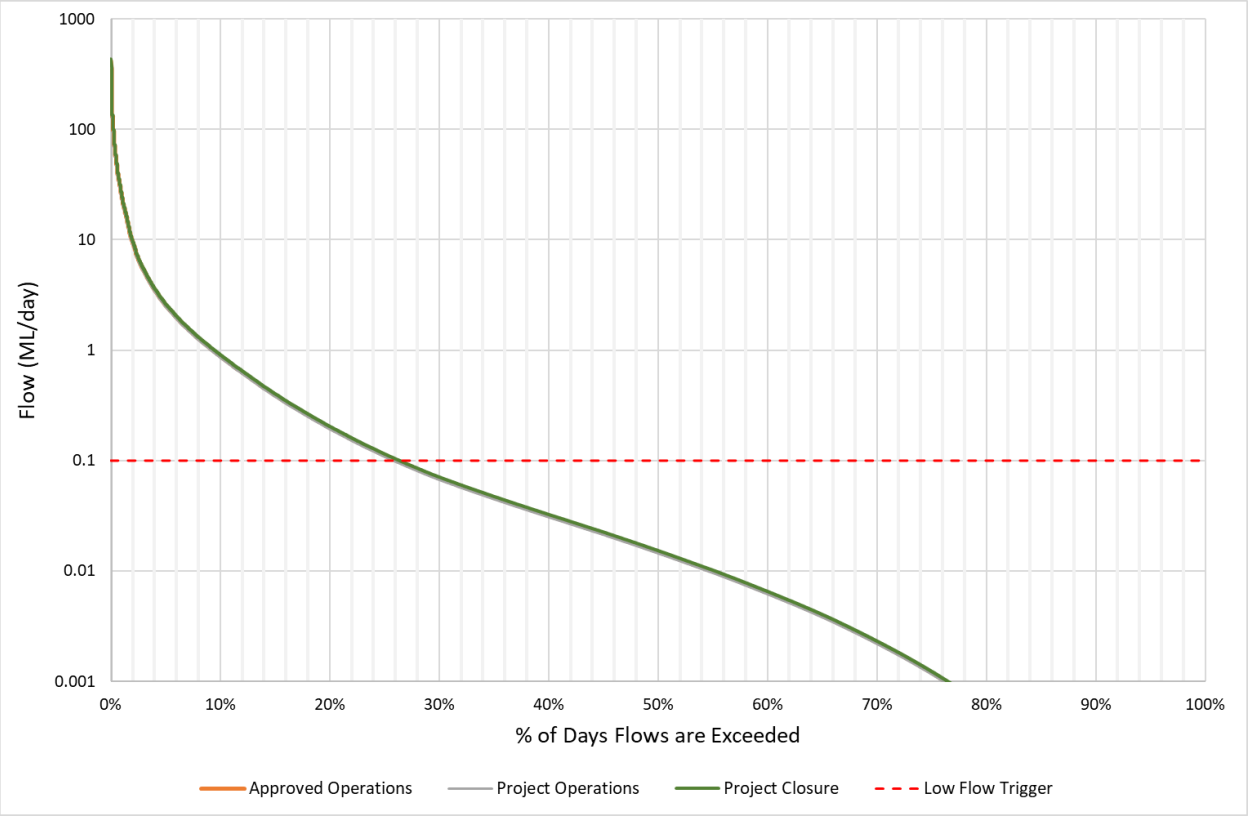


Figure 5.7: Flow Duration – Pikes Creek

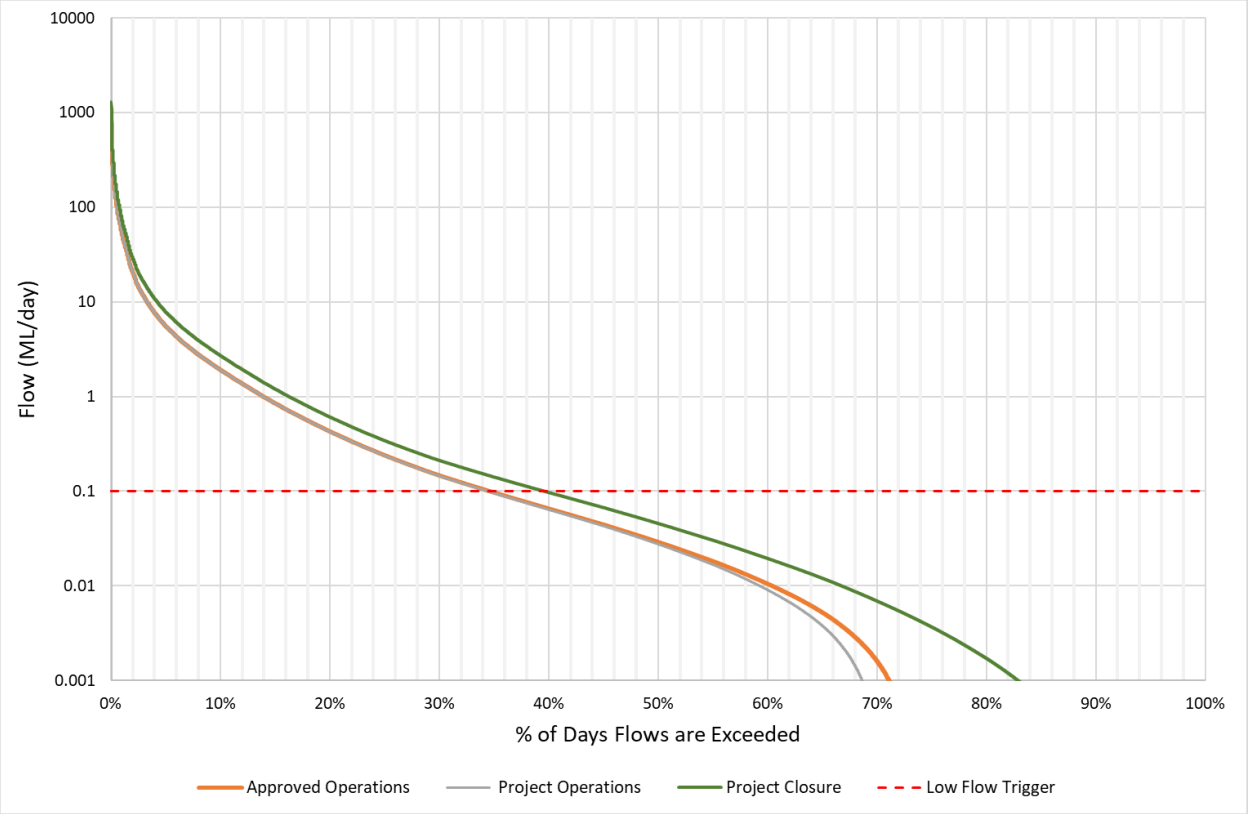


Figure 5.8: Flow Duration – Bayswater Creek

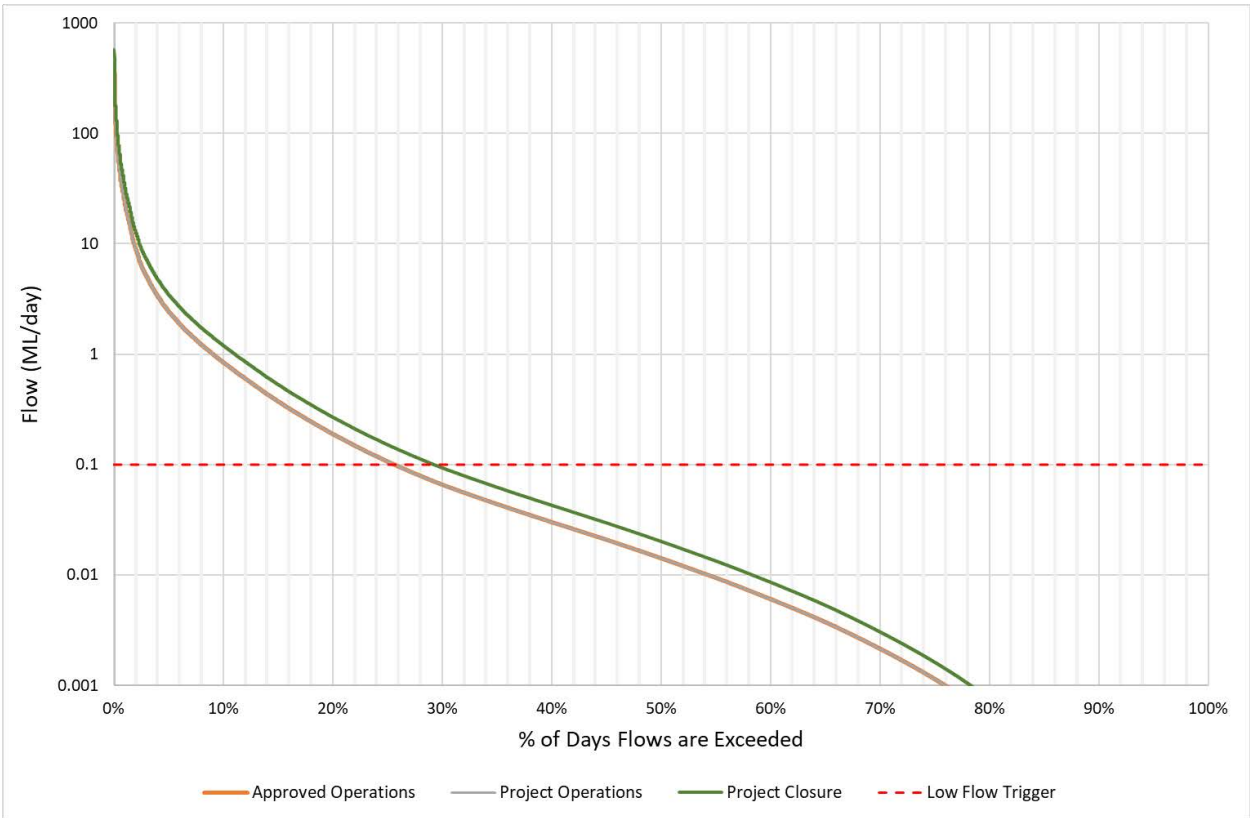


Figure 5.9: Flow Duration – Unnamed Tributary 3

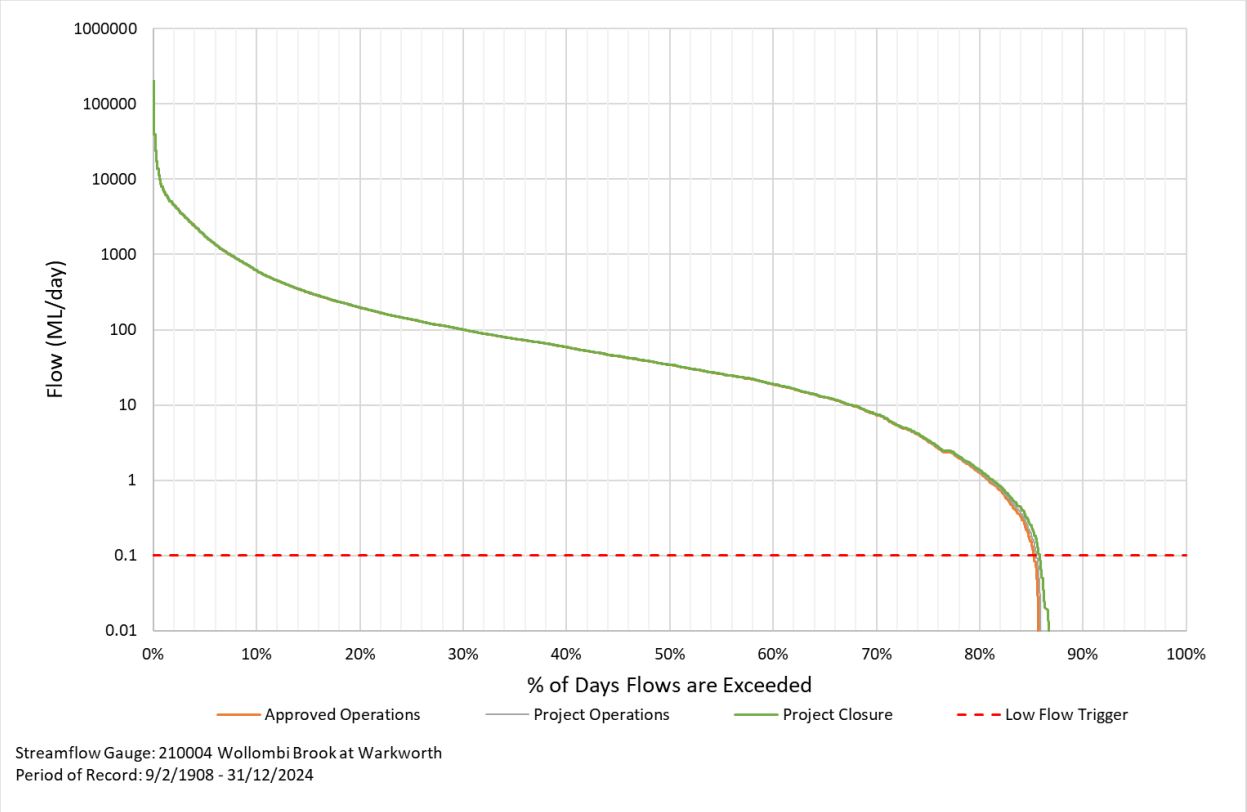


Figure 5.10: Flow Duration – Wollombi Brook

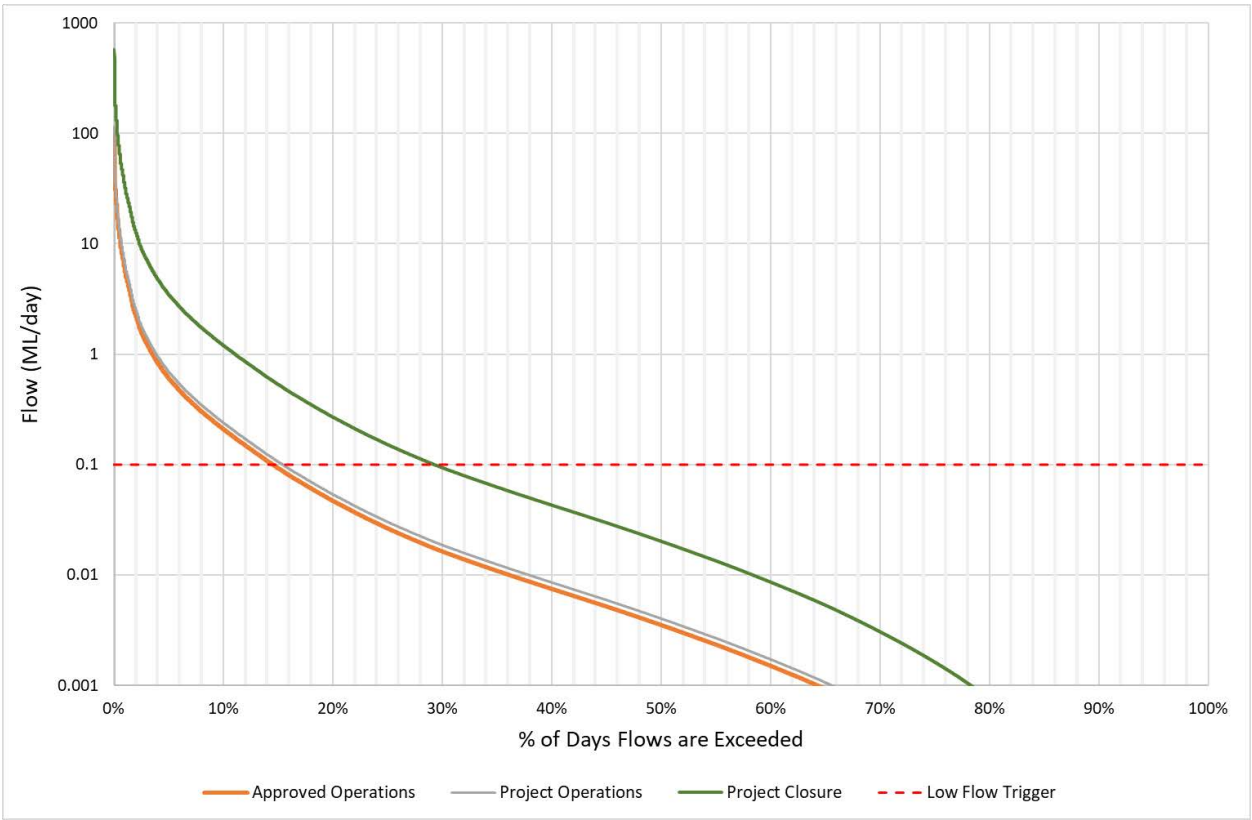


Figure 5.11: Flow Duration – Unnamed Tributary 5

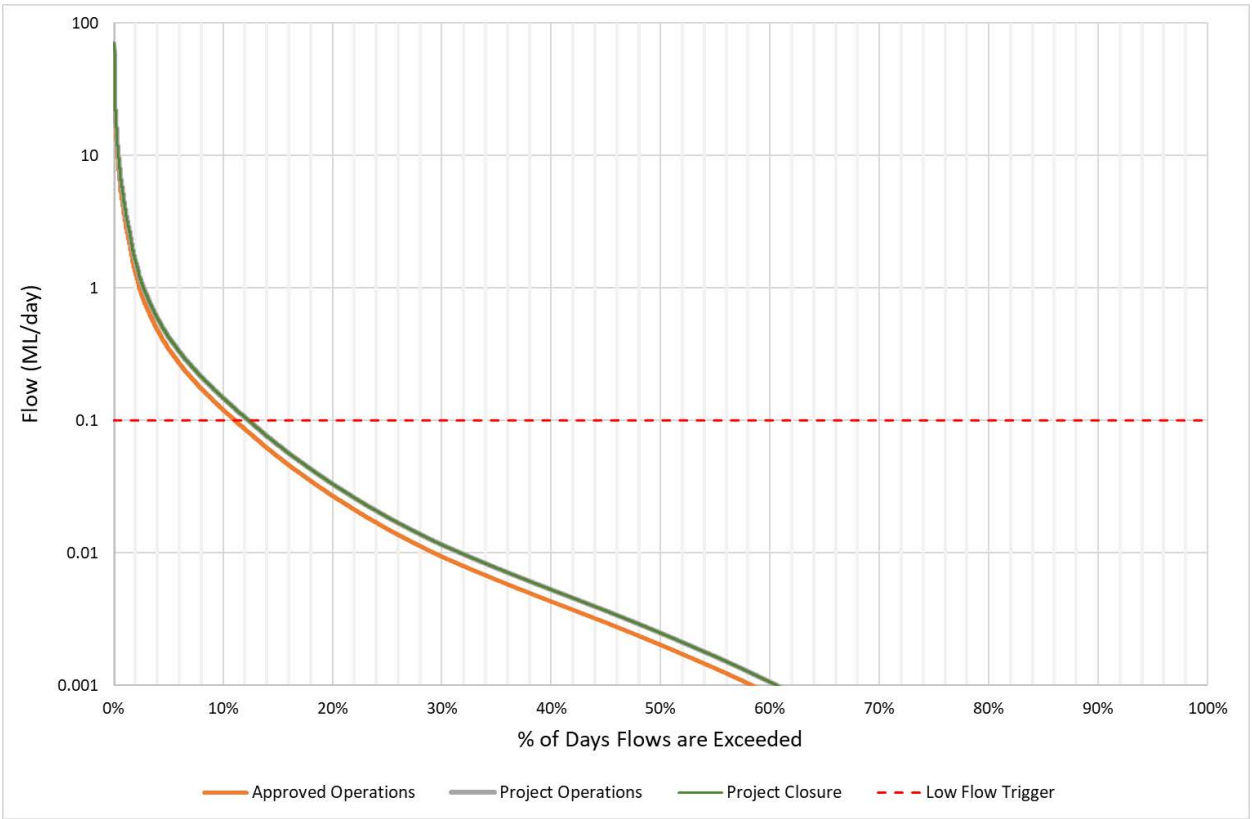


Figure 5.12: Flow Duration – Unnamed Tributary 6

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 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 (Project Operations or Project Closure relative to Approved Operations) are predicted.
  - The tabulated results indicate a slight reduction to the long term average number of dry days, however negligible change to the long term average duration of dry periods.
  - The Project Scenarios (Project Operations and Project Closure) are shown to result in reductions to the number of and durations of dry days (average, maximum and minimum) when compared to the Approved Operations scenario for the representative dry year (2006), as discussed below:
    - Average number of dry days within the representative “dry” year (2006) reduced from 38 days to 30 days (21%) during operations and from 38 days to 23 days (39%) during closure as a result of the Project.
    - The number of dry periods within the representative “dry” year (2006) increased from 2 to 4 during operations as a result of the Project. However, the additional dry periods are short (lasting only 2 days) and occur in close succession to the longer dry periods and therefore does not represent a significant change in the overall flow regimes.
    - Average duration of dry periods within the representative “dry” year (2006) reduced from 26 days to 11 days (58%) during operations and from 26 days to 12 days (54%) during closure as a result of the Project.
- 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 average 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 Project Operations), as discussed below:
    - 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 Project.
    - Farrells Creek: Average duration of dry periods within the representative “dry” year (2006) increased from 156 days to 159 days (2%) during operations as a result of the Project.
    - Bayswater Creek: Average duration of dry periods within the representative “dry” year (2006) increased from 144 days to 145 days (1%) during operations as a result of the Project.
  - For the 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.

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.

(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.

8. REFERENCES

EMM. (2025a). *Hunter Valley Operations Continuation Project, Groundwater Modelling.*

EMM. (2025b). *Hunter Valley Operations Continuation Project, Water Assessment.*

EMM. (2025c). *Hunter Valley Operations Continuation Project - Amendment, Water Assessment.*

Engeny. (2018). *Mount Owen Continued Operations Modification 2 Surface Water Impact Assessment.*

Nittim, R. (1996). *Flooding in Wollombi Brook.* University of New South Wales Water Research Laboratory.

NSW DPIE. (2020). *Water Sharing Plan - Unregulated River Water Sources-Spatial Dataset.* Retrieved from SEED: The Central Resource for Sharing and Enabling Environmental Data in NSW: https://datasets.seed.nsw.gov.au/dataset/water-sharing-plan-unregulated-river-water-sources-spatial-dataset

ATTACHMENT B: WATER QUALITY ASSESSMENT

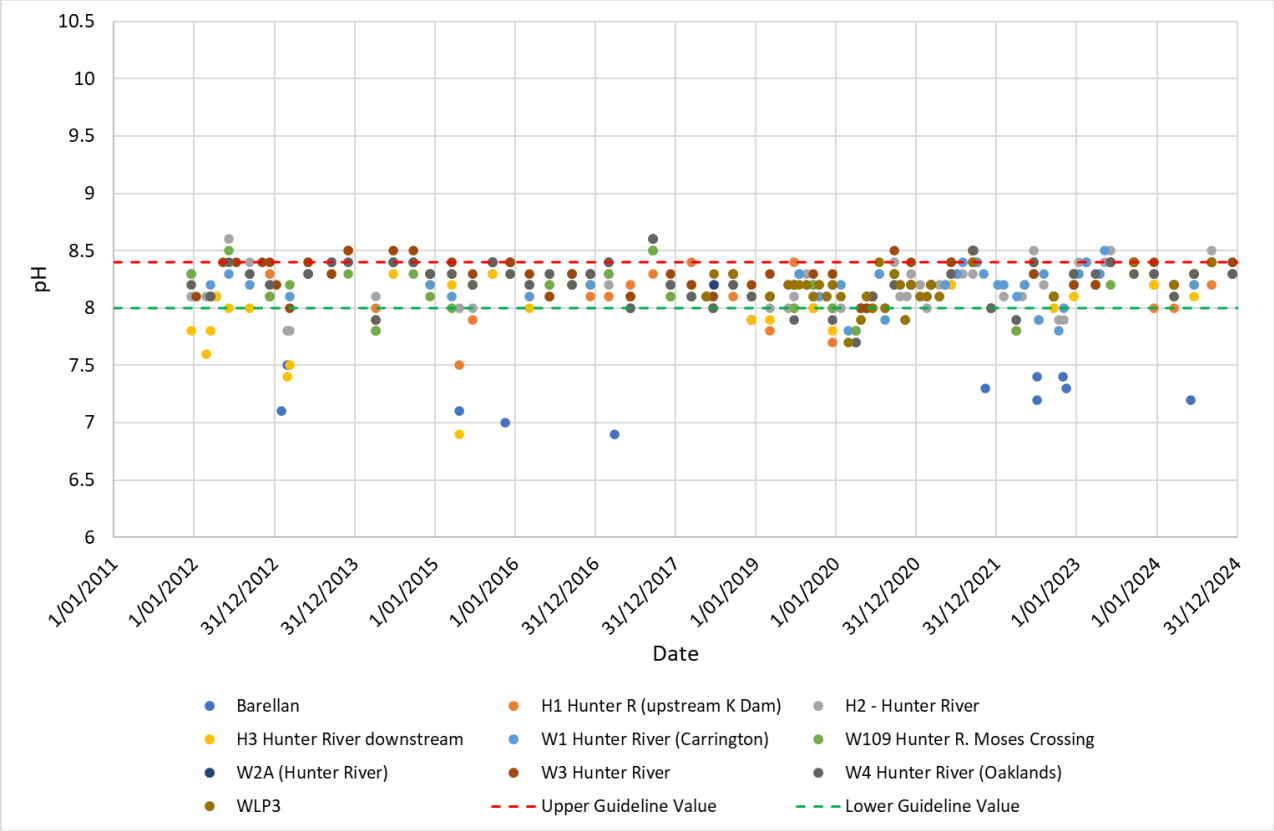


Figure B.1: Hunter River

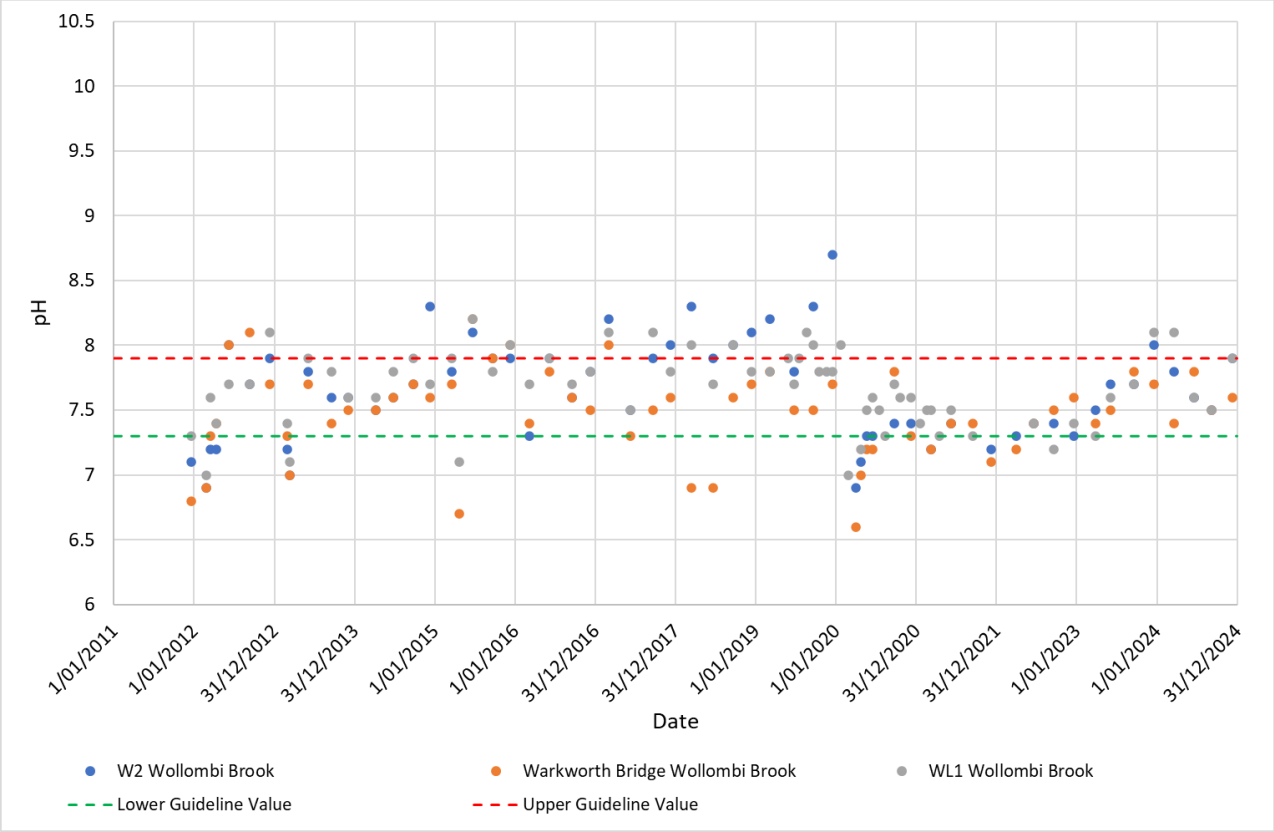


Figure B.2: Wollombi Brook – pH

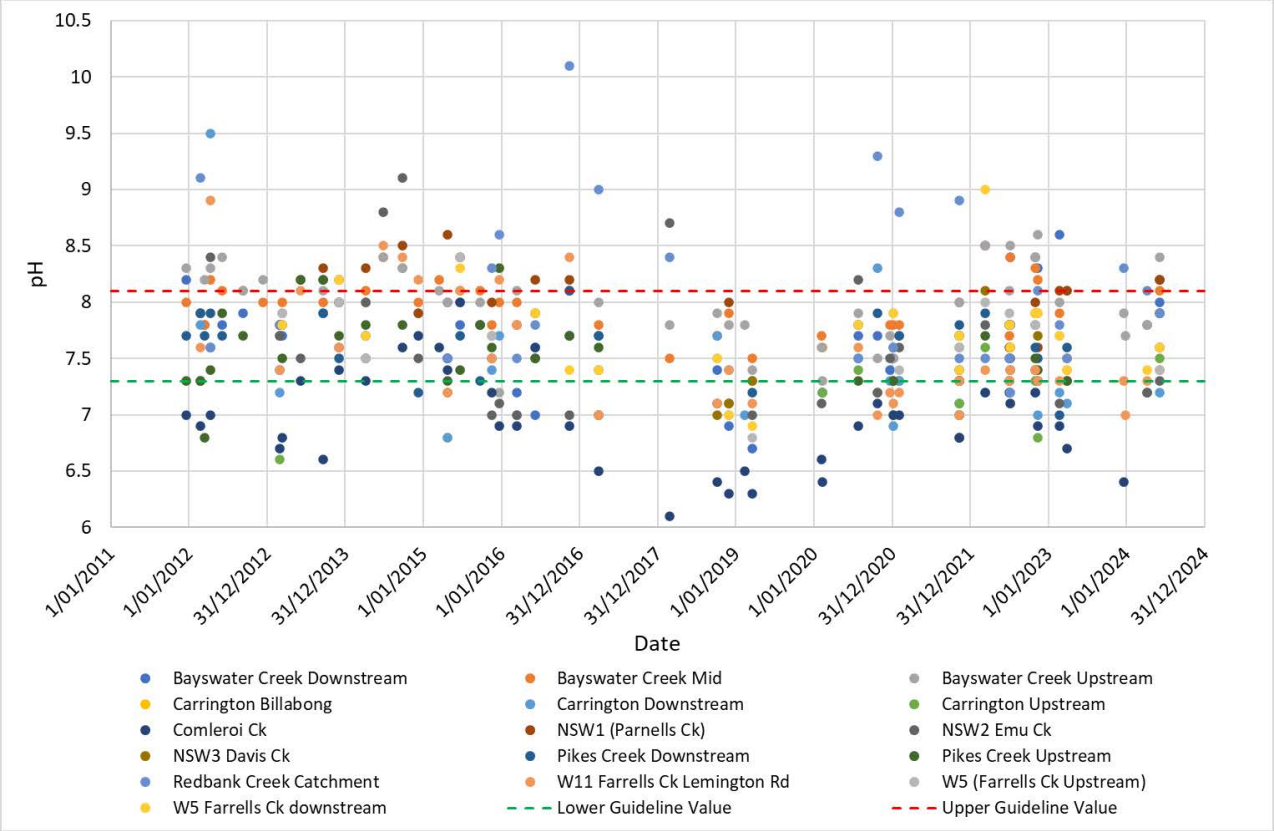


Figure B.3: Ephemeral Creeks – pH

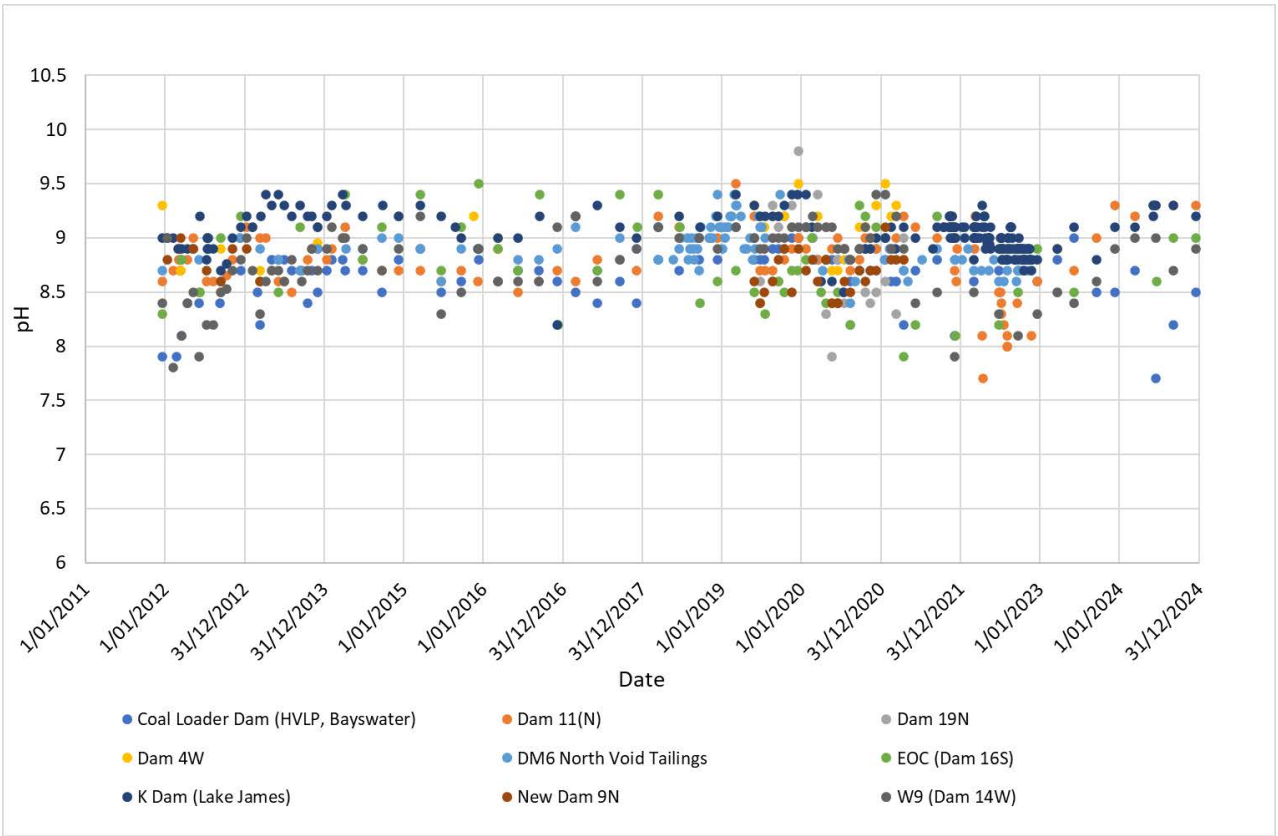


Figure B.4: Mine Water System – pH

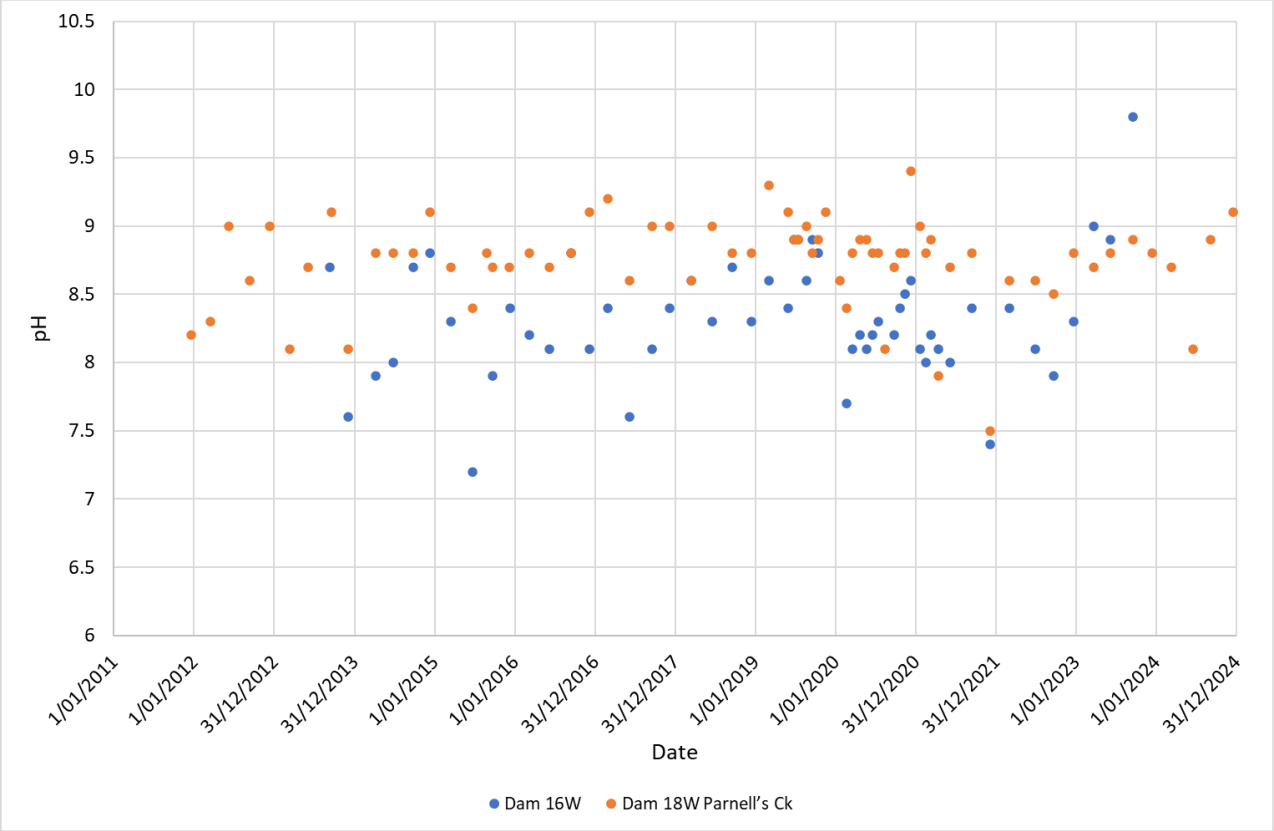


Figure B.5: Sediment Water System – pH

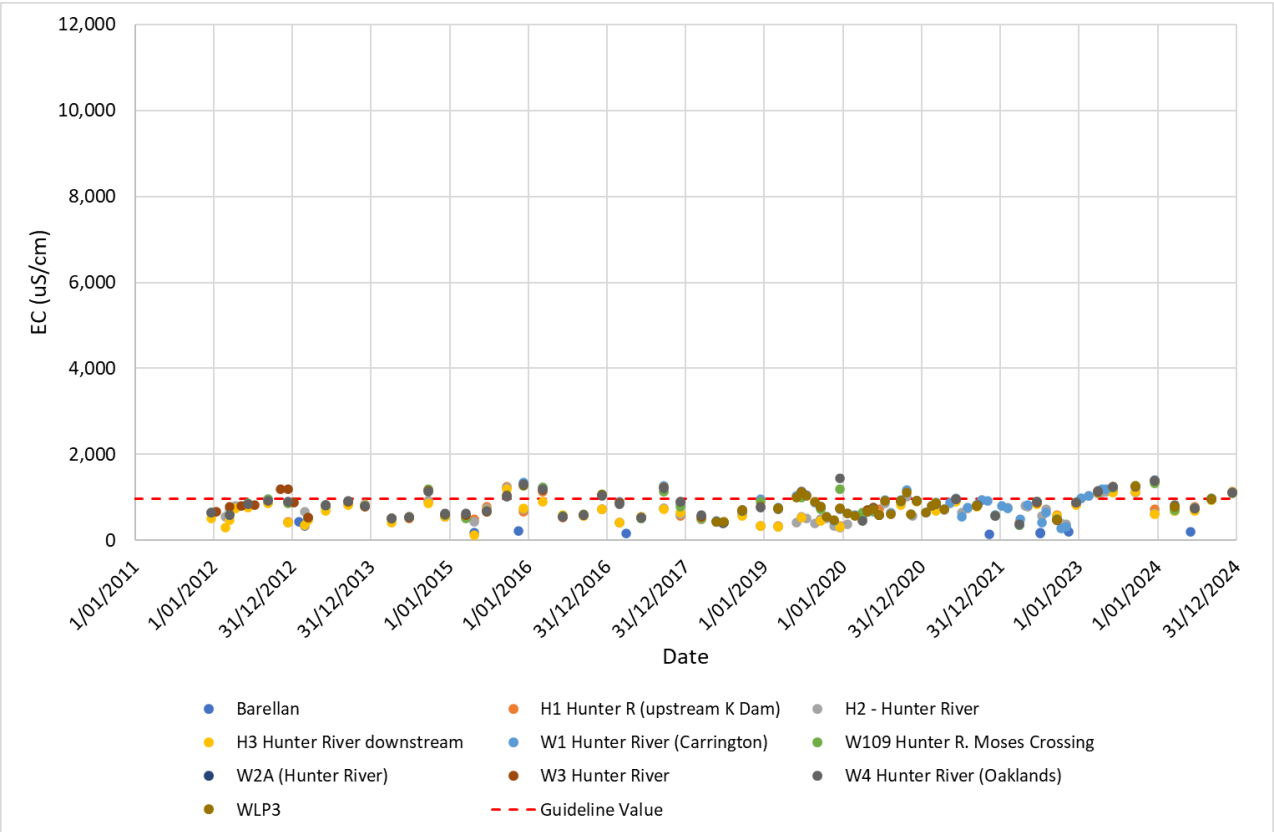


Figure B.6: Hunter River – EC

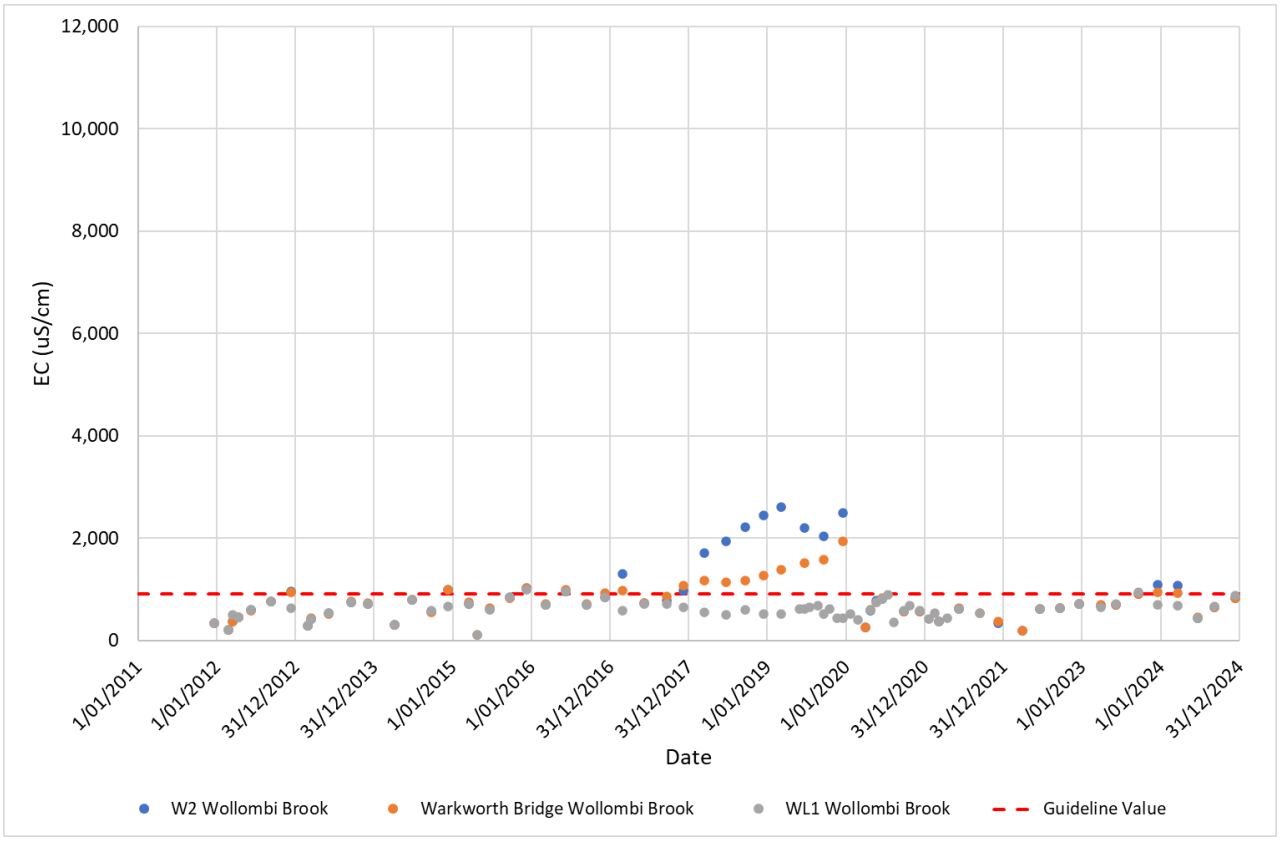


Figure B.7: Wollombi Brook – EC

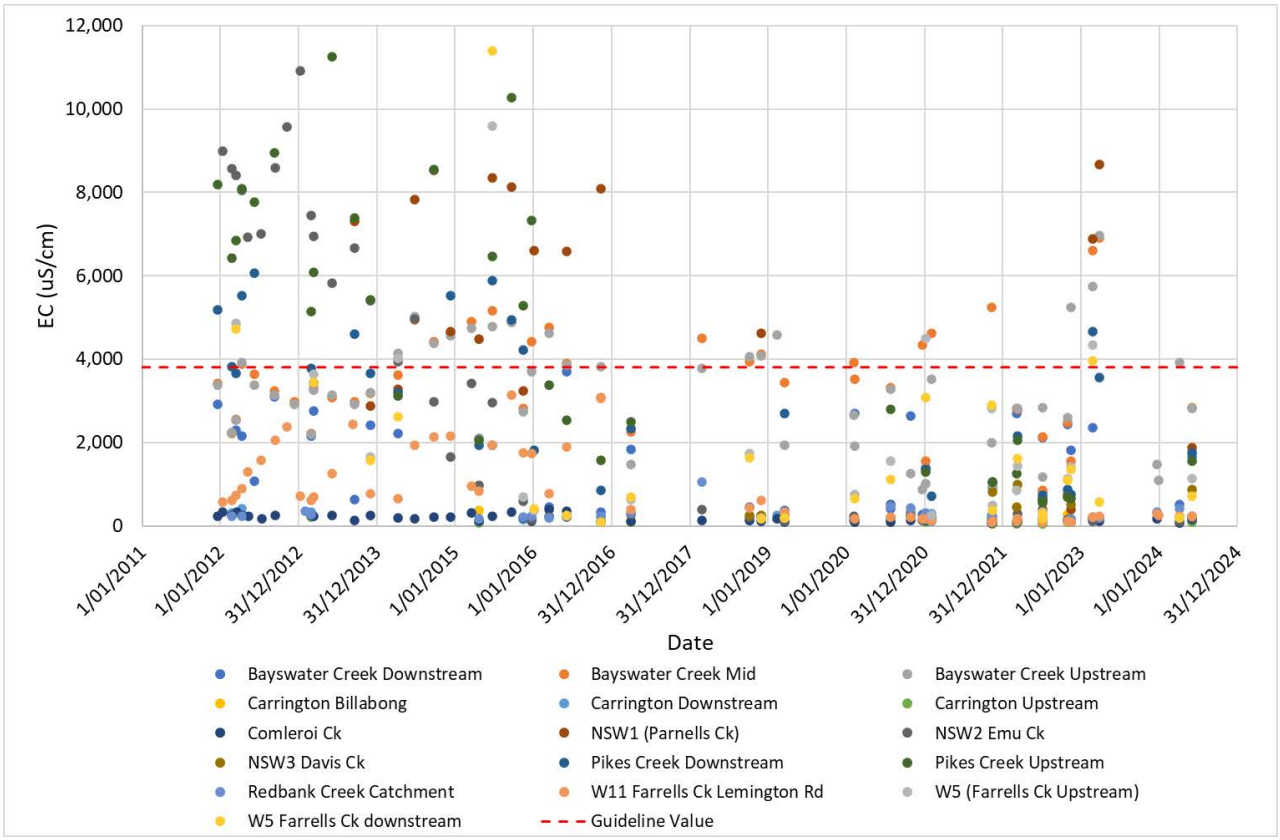


Figure B.8: Ephemeral Creek - EC

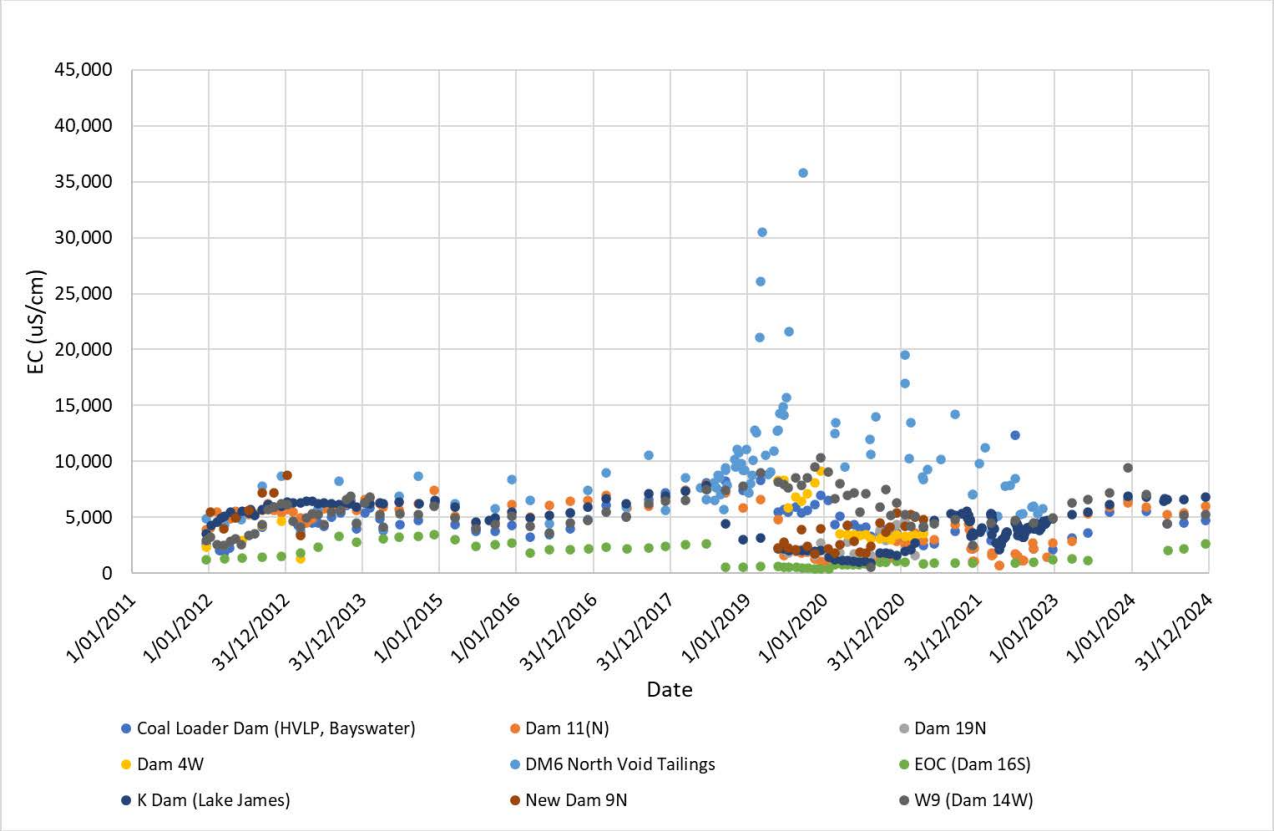


Figure B.9: Mine Water System - EC

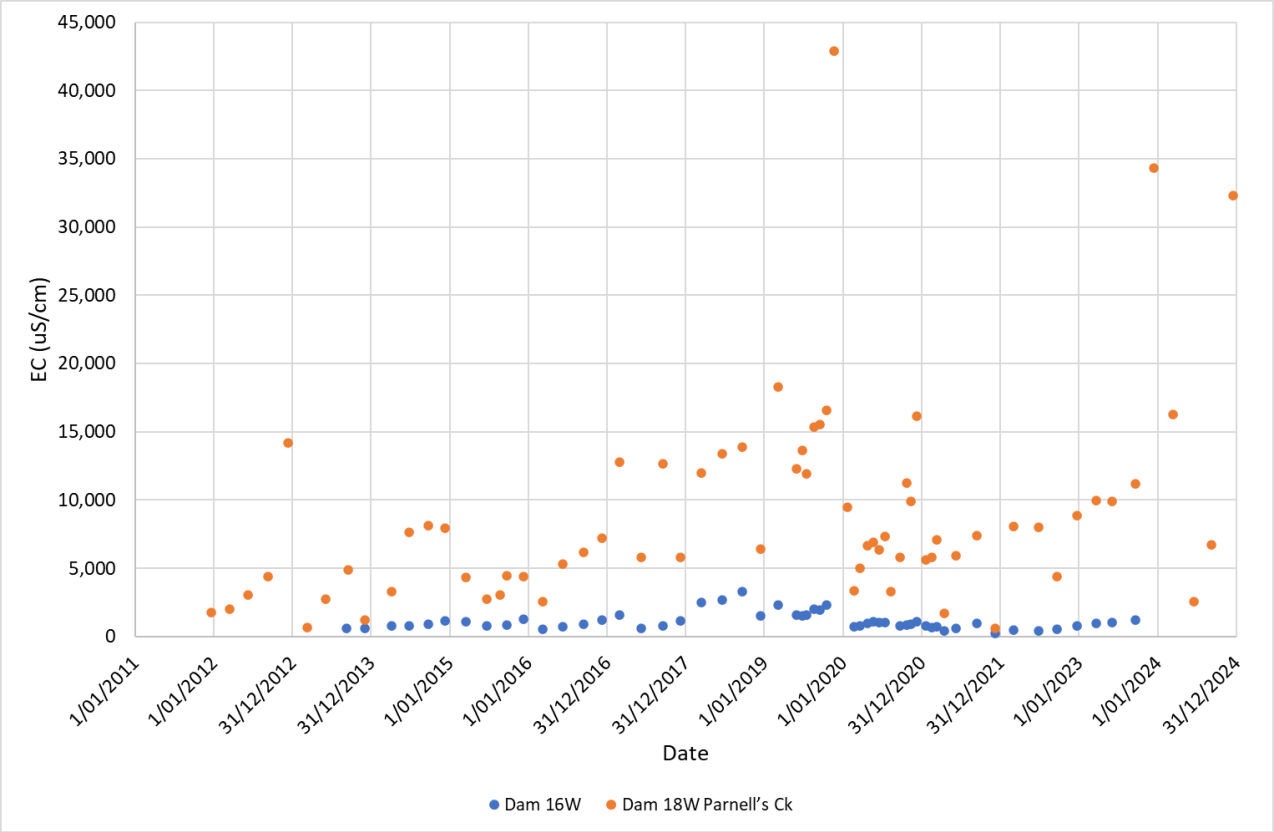


Figure B.10: Sediment Water System – EC

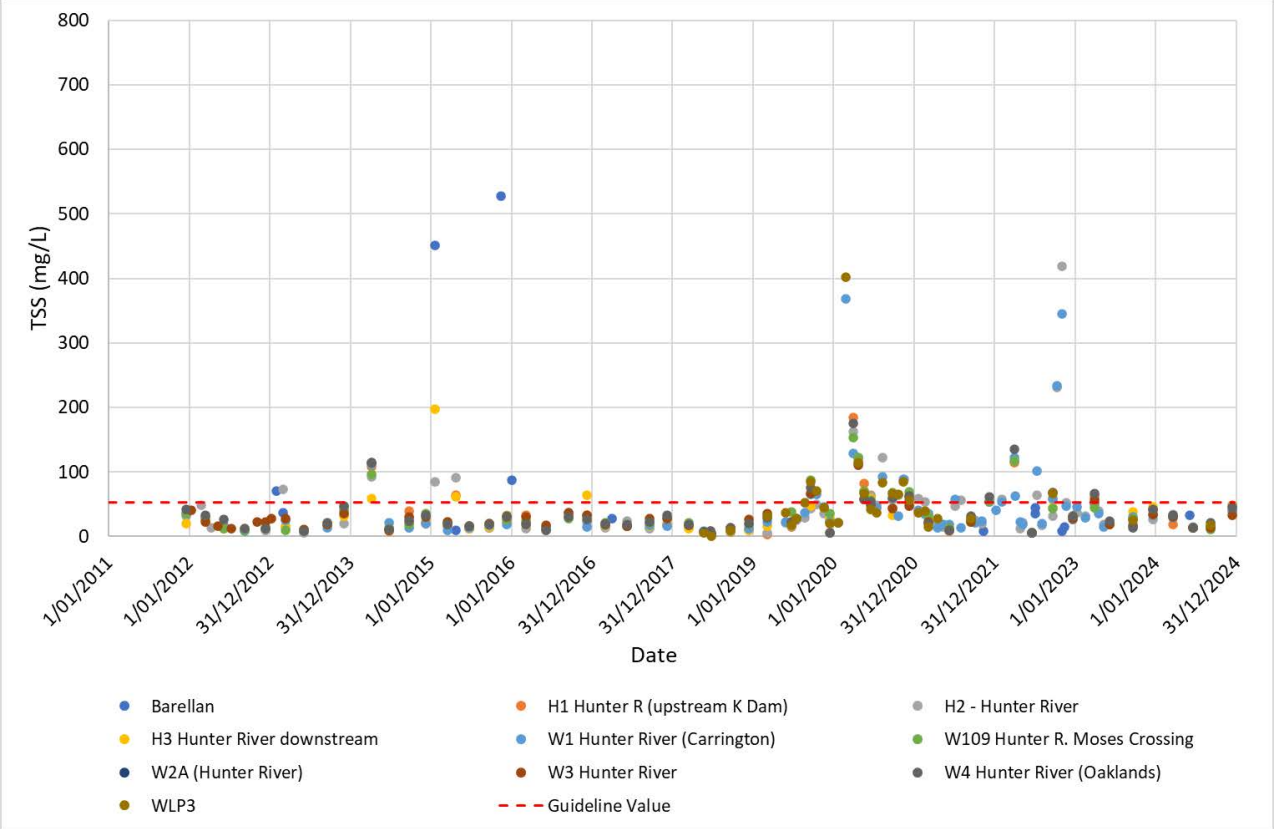


Figure B.11: Hunter River – TSS

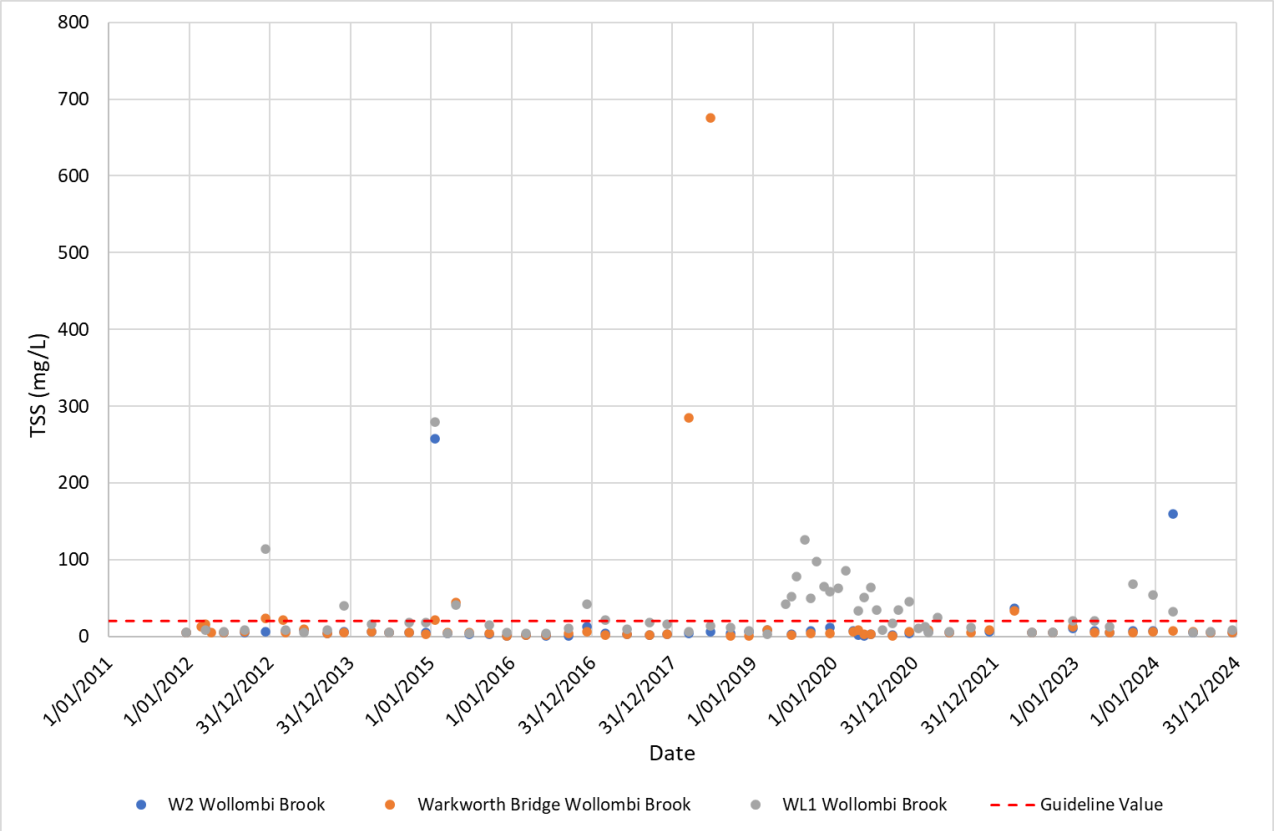


Figure B.12: Wollombi Brook – TSS

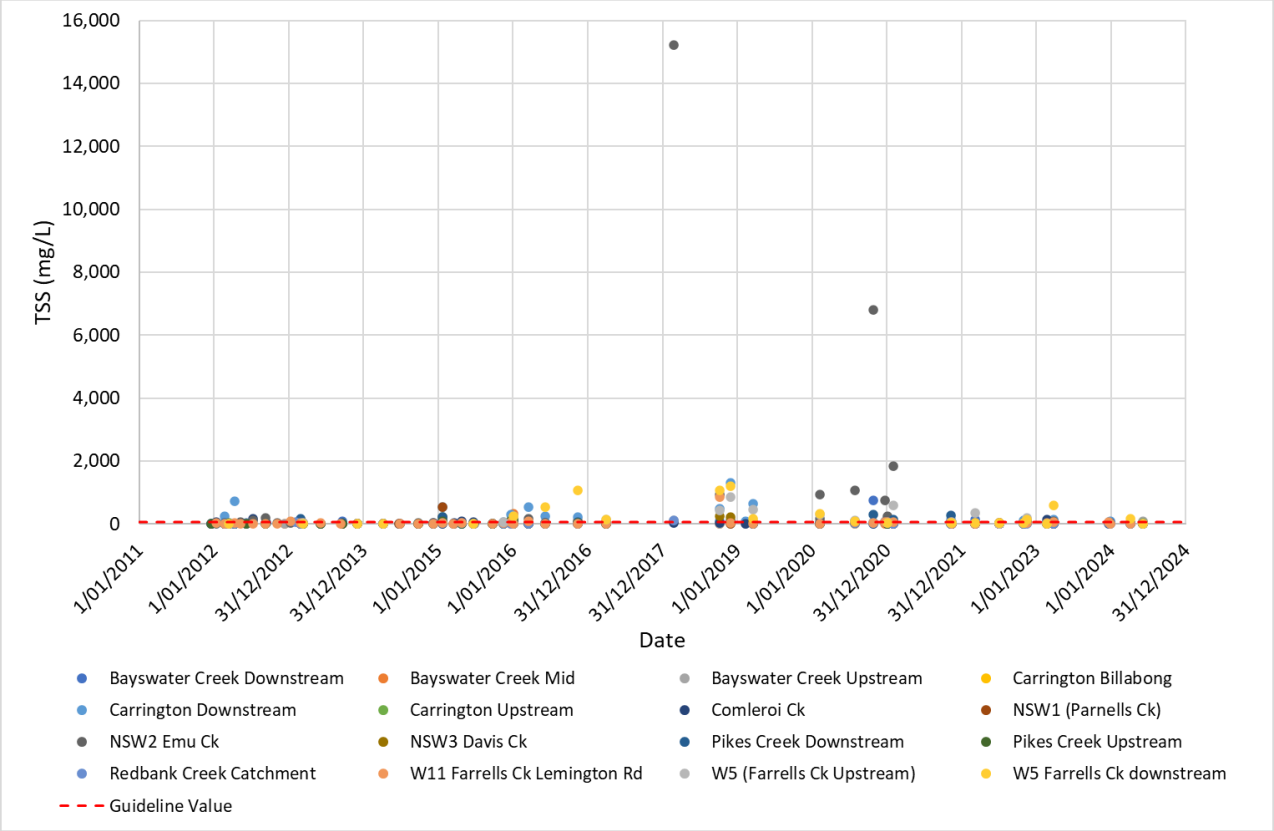


Figure B.13: Ephemeral Creeks – TSS

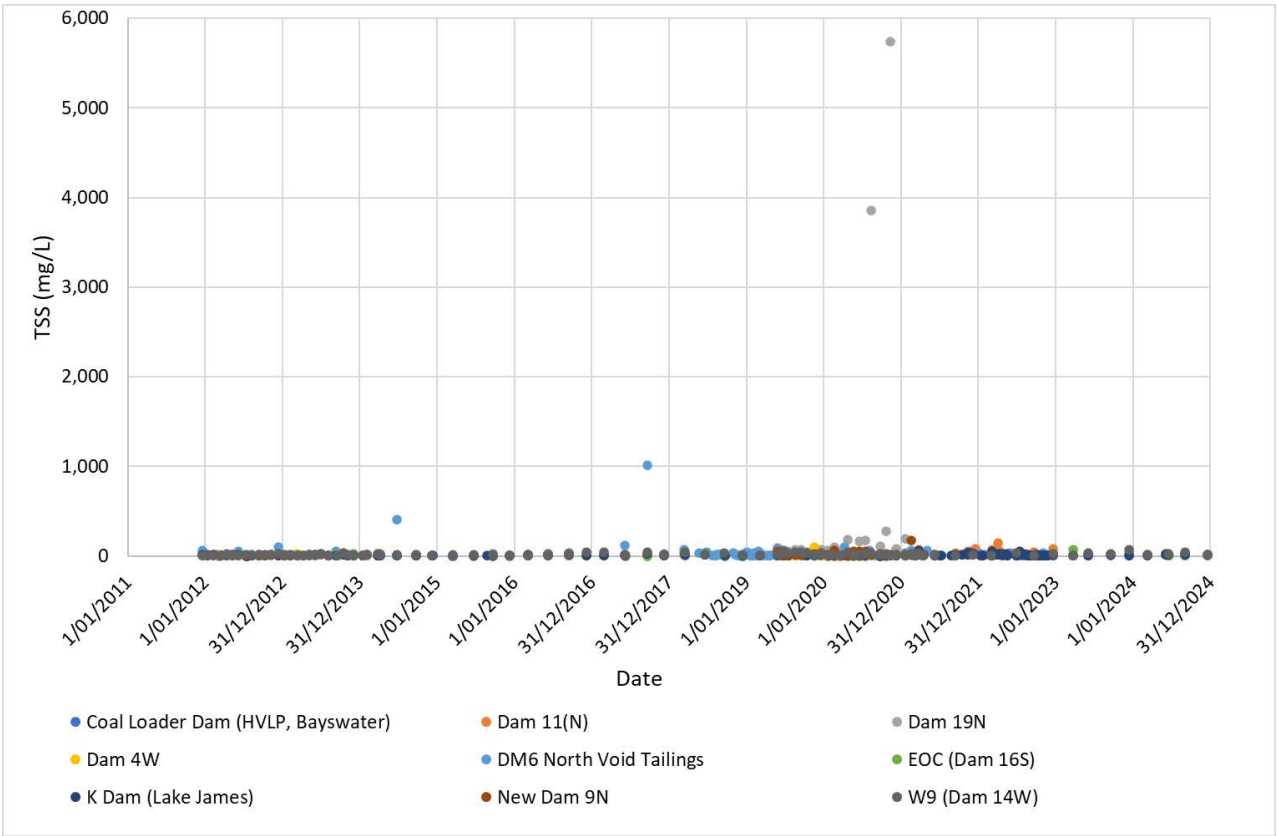


Figure B.14: Mine Water System – TSS

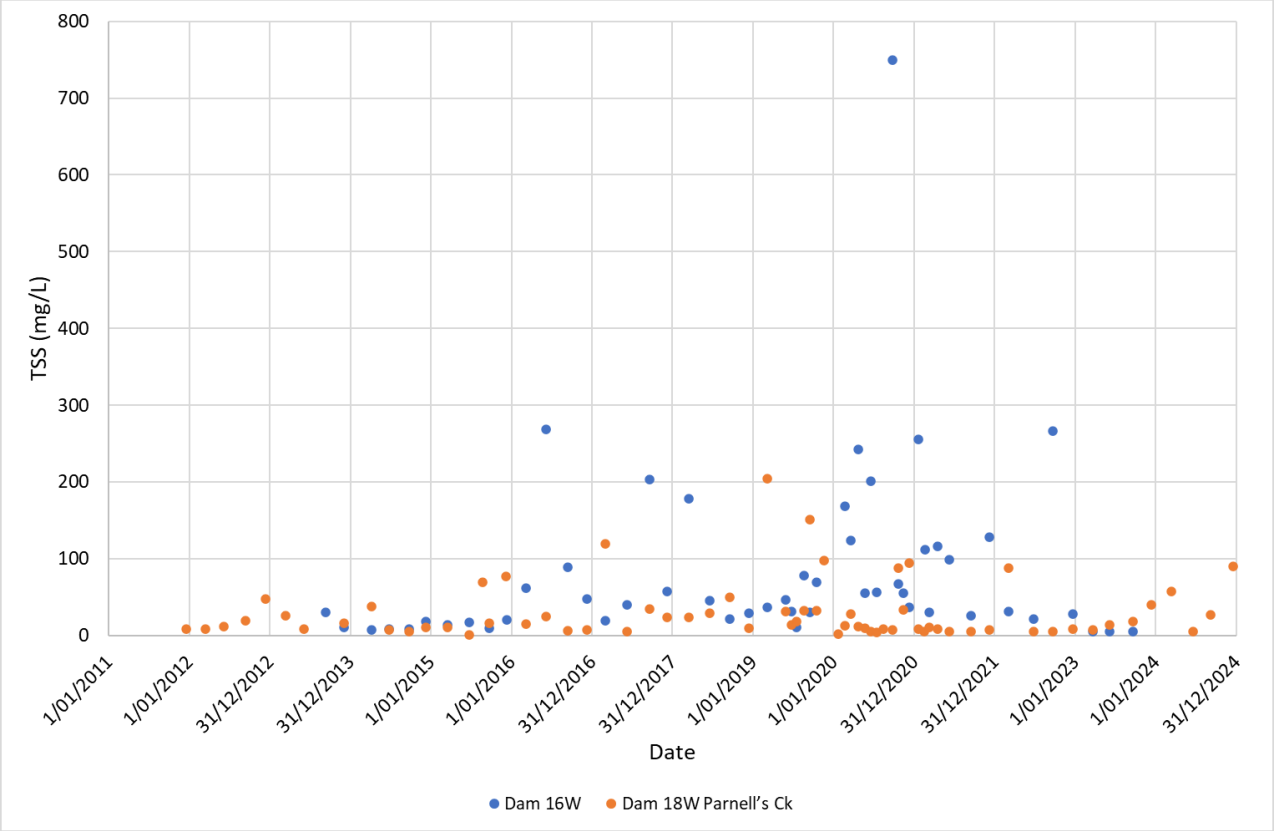


Figure B.15: Sediment Water System – TSS

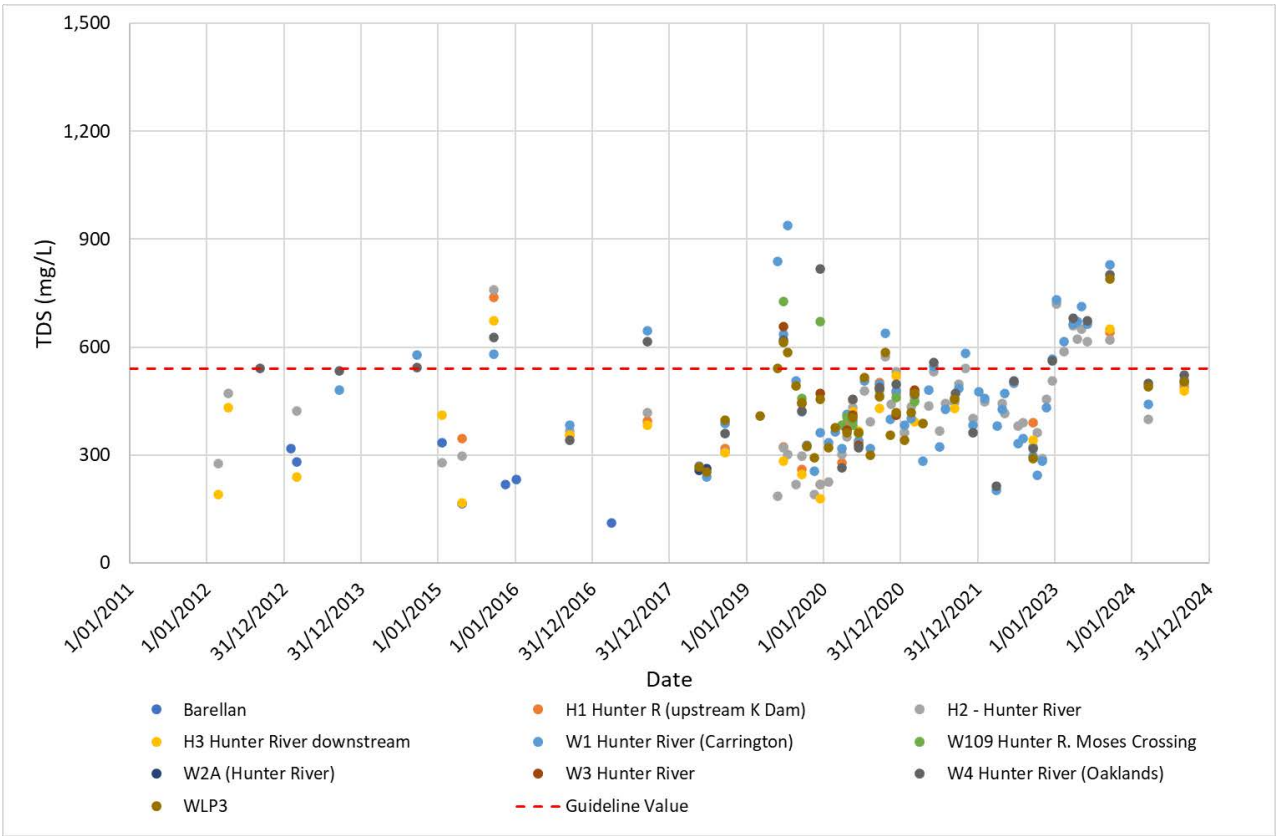


Figure B.16: Hunter River – TDS

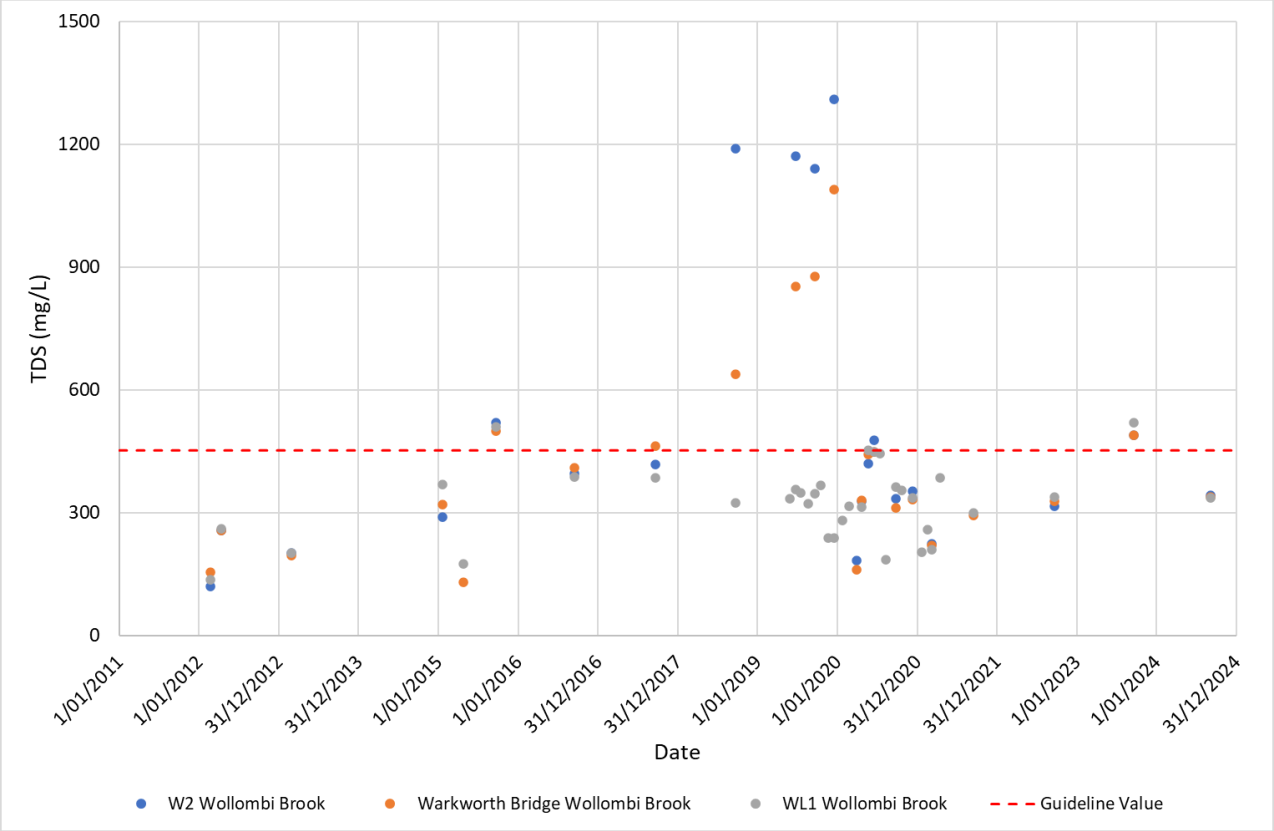


Figure B.17: Wollombi Brook – TDS

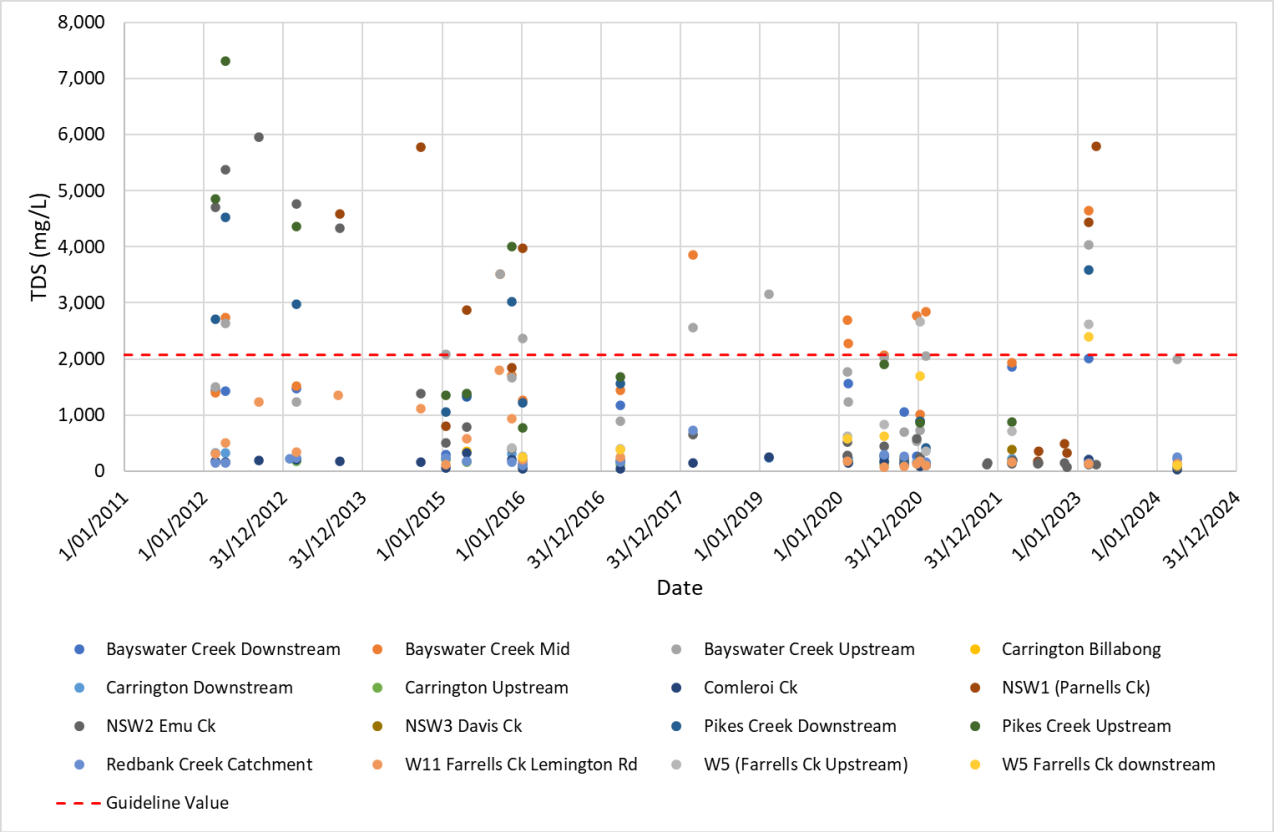


Figure B.18: Ephemeral Creeks – TDS

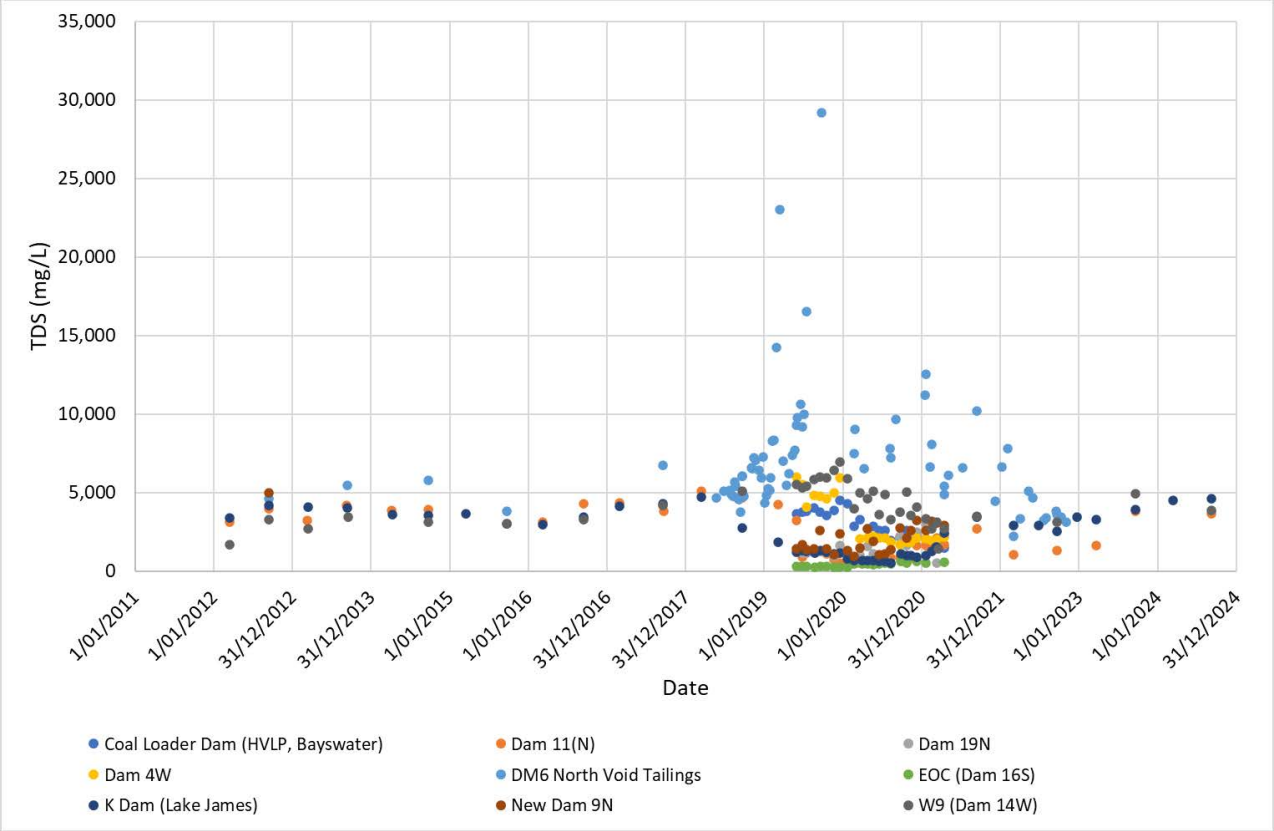


Figure B.19: Mine Water System – TDS

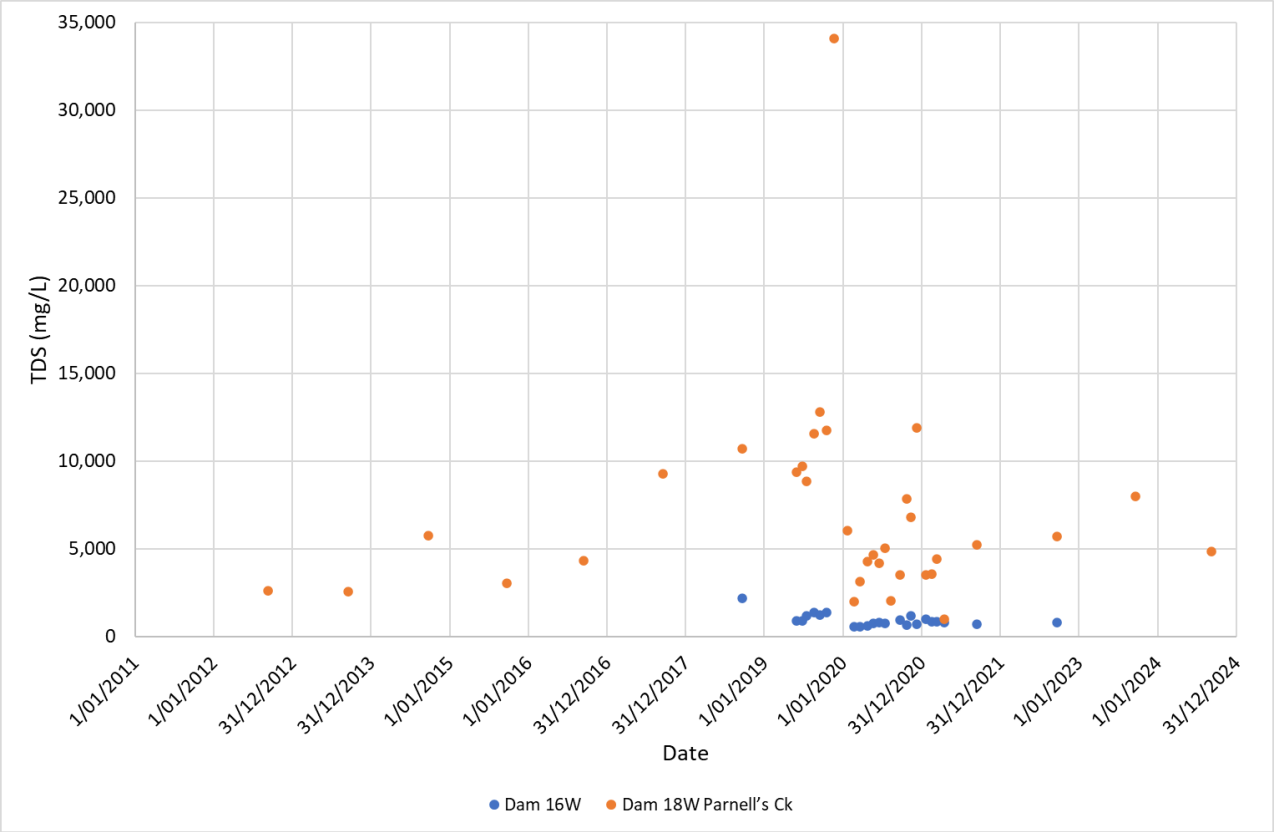


Figure B.20: Sediment Water System – TDS

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

TABLE B2: SUMMARY OF WATER QUALITY DATA FOR HUNTER RIVER RELEASES

Location	Aspect	Statistic	Aluminium (Al)	Arsenic (As)	Boron (B)	Barium (Ba)	Calcium (Ca)	Cadmium (Cd)	Chlorine (Cl)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Mercury (Hg)	Potassium (K)	Magnesium (Mg)	Manganese (Mn)	Sodium (Na)	Nickel (Ni)	Selenium (Se)	Sulfate (SO4)	Zinc (Zn)
U/S Hunter River	Total	Number of samples	49	50	56	36	41	34	34	26	34	26	34	34	55	7	28	55	34	53	56	50
		Minimum (mg/L)	0.210	0.001	0.02	0.022	0.1	0.0001	25.0	0.001	0.001	0.05	0.001	0.0001	1.60	13.0	0.050	2.8	0.001	0.001	1.0	0.005
		20th%ile(mg/L)	0.360	0.001	0.05	0.030	31.0	0.0001	55.8	0.001	0.001	1.35	0.001	0.0001	2.00	25.6	0.080	27.8	0.001	0.002	18.0	0.005
		Median (mg/L)	1.190	0.001	0.05	0.040	39.0	0.0001	77.5	0.001	0.001	2.09	0.001	0.0001	4.00	28.0	0.105	56.0	0.001	0.010	30.0	0.005
		80th%ile(mg/L)	3.364	0.001	0.05	0.046	50.0	0.0001	140.0	0.001	0.001	3.61	0.001	0.0001	5.20	33.4	0.146	80.4	0.010	0.010	40.0	0.010
		Maximum (mg/L)	13.000	0.001	31.00	0.090	63.0	0.0001	212.0	0.010	0.010	12.00	1.890	0.0001	29.00	34.0	0.440	140.0	0.030	1.000	90.0	0.060
		Average (mg/L)	2.122	0.001	1.12	0.039	39.0	0.0001	93.4	0.001	0.002	2.68	0.057	0.0001	5.67	27.6	0.132	55.9	0.004	0.045	30.3	0.010
		Standard Deviation	2.632	0.000	5.61	0.012	13.8	0.0000	50.2	0.002	0.002	2.42	0.324	0.0000	6.26	7.2	0.094	28.5	0.006	0.191	16.4	0.011
		Skew	2.697	1.031	5.15	2.263	0.9	1.047	0.6	5.005	3.714	2.60	5.831	1.047	2.478	1.567	2.195	0.165	2.791	4.991	1.0	3.207
		CV	20%	0.0%	18%	13%	22%	0.0%	24%	18%	22%	20%	17%	0.0%	22%	21%	21%	20%	20%	19%	18%	18%
		IQR (mg/L)	2.140	0.000	0.00	0.010	14.0	0.000	78.3	0.000	0.000	2.01	0.000	0.000	1.450	6.000	0.060	39.500	0.008	0.000	19.3	0.005
HRSTS Release Dams	Total	Number of samples	95	95	94	60	78	72	72	56	71	50	72	72	89	24	70	89	69	92	93	95
		Minimum (mg/L)	0.010	0.001	0.027	0.015	0.10	0.000	120.0	0.001	0.001	0.030	0.000	0.000	3.00	36.0	0.001	106.0	0.001	0.002	50.0	0.000
		20th%ile (mg/L)	0.020	0.001	0.050	0.020	9.64	0.000	207.4	0.001	0.001	0.050	0.001	0.000	6.00	47.0	0.001	193.4	0.001	0.009	136.6	0.005
		Median (mg/L)	0.050	0.002	0.050	0.030	20.50	0.000	338.5	0.001	0.001	0.060	0.001	0.000	15.00	62.0	0.010	485.0	0.001	0.010	357.0	0.005
		80th%ile	0.132	0.010	0.100	0.040	28.40	0.000	586.8	0.001	0.001	0.120	0.001	0.000	29.80	99.2	0.014	1200.0	0.005	0.010	733.4	0.005
		Maximum (mg/L)	1.060	0.020	0.140	0.070	47.00	0.001	1270.0	0.001	0.003	0.510	0.001	706.000	59.00	135.0	0.124	1600.0	0.020	0.020	1400.0	0.050
		Average (mg/L)	0.104	0.005	0.070	0.032	19.75	0.000	418.6	0.001	0.001	0.102	0.001	9.806	19.15	71.8	0.012	672.0	0.003	0.009	450.2	0.006
		Standard Deviation	0.165	0.005	0.029	0.012	11.72	0.000	263.9	0.000	0.000	0.094	0.000	83.203	14.14	29.9	0.016	471.1	0.003	0.003	342.1	0.005
		Skew	4.46	1.18	0.98	1.04	0.10	1.68	1.3	2.20	3.32	2.59	3.57	8.49	0.95	0.8	5.18	0.4	2.70	0.24	0.86	7.37
		CV	158%	97%	41%	36%	59%	133%	63%	7%	37%	92%	23%	849%	74%	42%	140%	70%	113%	36%	76%	80%
		IQR (mg/L)	0.09	0.01	0.04	0.02	12.0	0.00	300.0	0.00	0.00	0.06	0.00	0.00	20.00	45.25	0.01	848.0	0.00	0.00	481	0.00
	Dissolved	Number of samples	23	23	23	21	32			23	23	35	23	1	40	40	23	40	23	2		5
		Average (mg/L)	47	4.59	110.48	25.81	27.59			1.01	1.53	28.92	0.93	0.01	15	74.5	8.77	680	3.03	5.70		5.20
		Dissolved (%)	40%	97%	97%	92%	100%			100%	89%	63%	51%	0%	100%	100%	32%	100%	90%	100%		90%
		CV	81%	7%	7%	6%	0%			0%	24%	53%	113%	0%	0%	0%	93%	0%	17%	0%		15%
	Seasonal Count (total)	DFJ	15	15	14	12	15	15	15	12	15	12	15	15	14	6	12	14	15	14	15	15
		MAM	34	34	34	18	24	22	22	14	22	14	22	22	31	11	18	31	19	34	32	34
		JJA	13	13	13	12	13	13	13	12	13	12	13	13	13	1	12	13	13	13	13	13
		SON	33	33	33	18	26	22	22	18	21	12	22	22	31	6	28	31	22	31	33	33
ANZECC	Tox LOSP (mg/L)	99%	0.027	0.001	0.340			0.000			0.001	0.140	0.001	0.000			1.200			0.005		0.002
		95%	0.055	0.024	0.940			0.000			0.001	0.280	0.003	0.001			1.900			0.011		0.008
		90%	0.080	0.094	1.500			0.000			0.002	0.430	0.006	0.002			2.500			0.018		0.015
		80%	0.150	0.360	2.500			0.001			0.003	0.730	0.009	0.005			3.600			0.034		0.031
	Primary Industries - poultry (mg/L)																				250	

ATTACHMENT C: FLOOD ASSESSMENT TECHNICAL REPORT

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Hunter River Flood Assessment

HVO Continuation Project

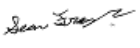
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26 SEPTEMBER 2025

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	3/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
1	12/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
2	26/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Chris Bonomini
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1. INTRODUCTION

Hunter Valley Operations 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) comprising of 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. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV.

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

The Project is in the catchment areas of the Hunter River and its tributaries. 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 the Hunter River floodplain through construction of levees and haul road bridge crossings in addition to mining landforms (i.e., open cut pits and overburden emplacement areas).

This report summarises the development and calibration of the Hunter River flood model used to define baseline flooding conditions as well as Project flooding conditions and associated impacts and forms an attachment to the Surface Water Impact Assessment (SWIA). Further background, including timing of the study and assessment is discussed in Section 1.1.

The flood model has been developed for Hunter River flooding (not flooding of local tributaries) and is focused on flooding conditions in the vicinity of the HVO Complex and potential Project impacts. The model defines existing flooding conditions and allows assessment of the impact of the Project.

Simultaneously during the development of the flood model and assessment of Project impacts, a separate flood study of the Hunter River was being undertaken by BMT on behalf of Singleton Council (Council) (BMT, 2022). That study was not complete at the time of the flood modelling for the Project. A comparison of the HVO flood modelling results to the Draft Council Flood Study results (BMT, 2022) was subsequently able to be undertaken and is included in Section 6.

BMT was engaged by HVO throughout the development of the Project flood model to provide a peer review and to align methodologies and broad outcomes of this study with the Council study. The NSW Department of Planning, Housing and Infrastructure (DPHI) also engaged Torrent Consulting to undertake a peer review of the flood modelling. Further details of the peer reviews are included in the Water resources impact assessment (EMM, 2025).

1.1 Background

The flood assessment of the Hunter River was prepared during 2020 to support the Environment Impact Statement (EIS) prepared for the NSW government (EMM, 2022). As mentioned, the model was peer reviewed by Barry Rodgers (BMT). This included development and calibration of a flood model to define existing flooding conditions and enable the potential impacts of the Project as per the EIS (i.e. the EIS Project).

Following 2022, the Project subsequently had two amendments; the first being changes to the Lemington Road realignment (these changes are outside of the floodplain areas); and the second including, amongst other things, removal of some areas of coal extraction to reduce greenhouse gas impacts of the Project. The changes to the final landform associated with the mining changes resulted in the Riverview Levee being incorporated into the final landform at closure, as well as further reinstatement of the floodplain adjacent to the location of the Carrington West Wing levee (the levee is only in place during operations), and at closure inclusions of the Mitchell East Levee / final landform to provide flood immunity for North Void.

As the Project, as amended for NSW government, does not encroach onto the floodplain further than the EIS Project or further reduce floodplain storage it is considered that the impacts from the Project will be no greater than those modelled for the EIS Project and as such the flood modelling has not been updated.

The report prepared for the EIS Project (Engeny, 2022) has been updated, i.e. this report, to include the details of additional information that was provided to various stakeholders since the EIS Project report was prepared. The flood mapping (including in Attachments D, E and F of the SWIA are also based on the flood modelling for the EIS Project (Engeny, 2022).

1.2 Flood Modelling Approach

The following approach was undertaken:

- Review of previous studies and available streamflow record (refer to Sections 2.1 and 2.2).
- Conceptual model development including upstream (Liddell) inflow and three tributary inflows (Bowmans Creek, Glennies Creek and Wollombi Brook) (refer to Section 2.3).
- Peak flow assessment to derive travel times and peak flow scaling relationships (refer to Section 2.4).
- Flood Frequency Analysis (FFA) undertaken at Singleton (210001) and Liddell (210083) streamflow gauges to determine design flood peaks (refer to Section 2.5).
- Determination of Extreme Flood scaling factor (refer to Section 2.6).
- Assessment of historical flood hydrographs to develop design hydrograph shapes for the Hunter River (refer to Section 2.7) and tributary inflows (refer to Section 2.8).
- Development and calibration of a TUFLOW hydraulic model (refer to Sections 3.1 and 3.2).
- Simulation of three project scenarios (refer to Section 3.3) for the range of design flood events (10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1% Annual Exceedance Probability (AEP) and Extreme Flood) (refer to Section 3.4).
- Preparation of flood mapping (refer to Section 4).

Information is also included on the following aspects of the study:

- Climate change analysis (refer to Section 2.9).
- Sensitivity reviews (refer to Section 5).
- Comparison of the Project flood study modelling to the Council flood study (refer to Section 6).
- Modelling limitations (refer to Section 7).

2. HYDROLOGY

The Hunter River has a catchment area of approximately 14,000 km^2 in the vicinity of the HVO Complex and 16,400 km^2 at the nearby town of Singleton. The major tributary inflows between the HVO Complex and Singleton are Bowmans Creek, Glennies Creek and Wollombi Brook, which join the Hunter River downstream of HVO North and in the vicinity of HVO South.

There are two major water storage dams located upstream of Singleton:

- Glenbawn Dam on the upper Hunter River was constructed in 1958 and has a catchment area of approximately 1,295 km^2.
- Glennies Creek Dam on Glennies Creek was constructed in 1983 and has a catchment area of approximately 225 km^2.

Glenbawn Dam accounts for approximately 9% of the catchment of the Hunter River at the HVO Complex and was constructed early in the period of available streamflow records (as detailed in Section 2.2). Glennies Creek Dam represents less than 2% of the catchment area of the Hunter River at the confluence of Glennies Creek (i.e., downstream of the HVO Complex). For these reasons, the impact of these dams and their operations on the design hydrology of the Hunter River at the HVO Complex has been conservatively excluded from the study.

The land use within the Hunter River catchment is predominantly a mixture of farming, grazing and mining.

2.1 Previous Studies

At the time of model development, the most recent flood study of the Hunter River in the vicinity of the HVO Complex was the Singleton Flood Study (2007) undertaken by WBM on behalf of Council. The methodology for that study included:

- A FFA at the Singleton streamflow gauge (210001).
- Design hydrographs determined by averaging hydrographs from the 1949, 1955, 1971, 1976 and 1977 events.
- A TUFLOW hydraulic model with an upstream boundary approximately 8 km upstream of the Dunnolly Ford Bridge in Singleton and a downstream boundary located at Lower Belford (downstream of Singleton).

Following the completion of the Draft BMT Flood Study in 2022 (subsequently finalised in 2023) a comparison out the outcomes of the HVO study to the BMT flood study was undertaken. This comparison is included in Section 6.

2.2 Streamflow Record

The Hunter River catchment is well gauged with a total of seven gauges along the river from Liddell (located immediately upstream of the HVO Complex) to Singleton. There are an additional four gauges located on the three main tributaries. The period of record and location of these gauges in relation to the HVO Complex is summarised in Table 2.1 and illustrated in Figure 2.1.

TABLE 2.1: SUMMARY OF STREAMFLOW GAUGES

Gauge Number	Gauge Name	Watercourse	Length of Record (years)
210083	Liddell	Hunter River	50
210126	U/S Foy Brook	Hunter River	26
210127	U/S Glennies Ck	Hunter River	26
210128	Mason Dieu	Hunter River	26
210134	Long Point	Hunter River	26
210129	U/S Singleton	Hunter River	26
210001	Singleton	Hunter River	106
210130	D/S Bowmans	Bowmans Creek	26
210004	Warkworth	Wollombi Brook	111
210028	Bulga	Wollombi Brook	70
210044	Middle Falbrook	Glennies Creek	63

Two of the Hunter River streamflow gauges have considerably long periods of record and have had streamflow gauging undertaken for significant flows:

- The Singleton (210001) streamflow gauge (hereinafter referred to as Singleton (210001)) has 106 years of record. The maximum gauging was undertaken on 1/02/1971 to a level of 41.64 mAHD with a corresponding flow estimate of approximately 5,300 m^3/s, which corresponds to a design flow between the 5% and 2% AEP.
- The streamflow gauge at Liddell (210083) (hereinafter referred to as Liddell (210083)) has 50 years of record. The maximum gauging was undertaken on 5/12/2010 to a level of 72.801 mAHD with a corresponding flow estimate of approximately 920 m^3/s, which corresponds to a design flow below the 10% AEP.

The remainder of the Hunter River streamflow gauges have a relatively short period of record and are poorly gauged. The tributary gauges have variable periods of record with several of them being impacted by backwater from the Hunter River.



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HUNTER VALLEY OPERATIONS

N

2,500 0 2,500 m

Scale in metres (1:100,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

HVO Continuaton Project Flood Assessment

Figure 2-1 - Site Locality and Location of Streamflow Gauges

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 7 /9 /2022

2.3 Conceptual Model Development

Following the review of previous studies and the available streamflow record, a conceptual flood model was developed for the Hunter River in the vicinity of the HVO Complex. The conceptual model is illustrated in Figure 2.2 below and summarised as follows:

- Due to the size of the catchment (>14,000 km^2) and the availability of long-term streamflow records (greater than 50-100 years), it was determined that a FFA approach to determining design flows was more appropriate than a rainfall runoff hydrology model. This is consistent with current and previous studies being undertaken for Council.
- Development of a two-dimensional hydraulic model of the Hunter River and its floodplain from upstream of HVO (in the vicinity of the Liddell streamflow gauge) to the town of Singleton.
- Determination of design flood inflow hydrographs at the upstream boundary. It is noted that the Liddell streamflow gauge accounts for approximately 96% of the contributing catchment at the HVO Complex and approximately 82% of the contributing catchment area at Singleton. The Hunter River design inflow hydrographs were derived directly from available streamflow gauging data at the long-term streamflow gauges at Singleton (210001) and Liddell (210083) using the following process:
  - Determination of a peak flow scaling relationship between the gauge locations.
  - FFA undertaken at each gauge and determination of adopted design flood peaks.
  - Determination of a design hydrograph shape at each gauge based on averaging of gauged historical flood hydrographs.
- Determination of design flood inflow hydrographs at the three major tributaries. It is noted that these tributaries enter the Hunter River downstream of HVO North but influence flooding characteristics in the vicinity of HVO South. The residual catchment between Liddell (210083) and Singleton (210001) is approximately 18% of the catchment area at Singleton. Tributary design inflow hydrographs were derived from the adopted design Hunter River hydrographs using the following process:
  - Calculation of the residual flow hydrograph between Liddell (210083) and Singleton (210001).
  - Separation of the residual flow hydrograph for the three primary tributaries proportional to catchment area.
  - Application of a timing adjustment based on measured stream distance to the inflow location and the adopted travel time based on average historical flood peak travel times in the Hunter River.

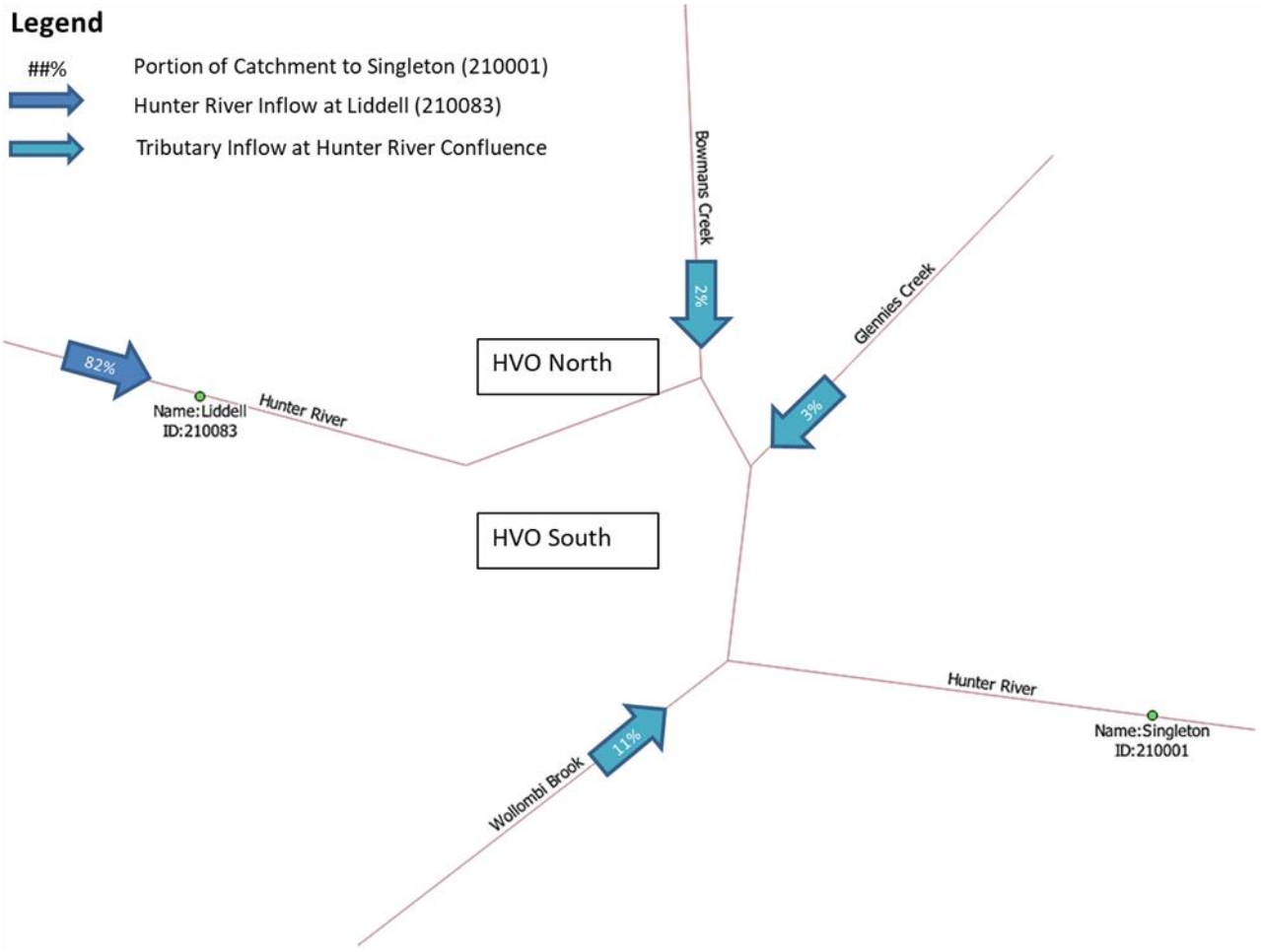


Figure 2.2: HVO Conceptual Flood Model

2.4 Peak Flow Assessment

2.4.1 Peak Flow Relationship

The relationship between peak flows at Liddell (210083) and Singleton (210001) was assessed for the periods of coincident record (i.e., 1979 onwards). The assessment included investigation of an appropriate flow threshold (0 m^3/s, 500 m^3/s, 1,000 m^3/s and 1,500 m^3/s) and location to adopt (i.e., either at Liddell or Singleton) to ensure that the resulting peak flow relationship was representative of the large floods of interest for this study. A threshold of 1,000 m^3/s at Singleton (210001) has been adopted as the cut-off based on the following findings:

- Adopted peaks at Liddell are slightly more conservative and flows more consistent with the Liddell FFA.
- Resulting design flows similar to using 500 m^3/s threshold at Liddell.
- Visual fit of the trend to the data set.
- Liddell: Singleton peak flow ratio is 82% for the 0.1% AEP, which is consistent with catchment area ratio of 82%. The 0.1% AEP event is of particular interest as the adopted design standard for operational pit flood immunity.

The resulting peak flow relationship is presented in Figure 2.3 along with the linear trend line. The relationship has a high degree of correlation (R^2 = 0.89) and a scaling factor of 0.81 between Liddell and Singleton peak flood flows.

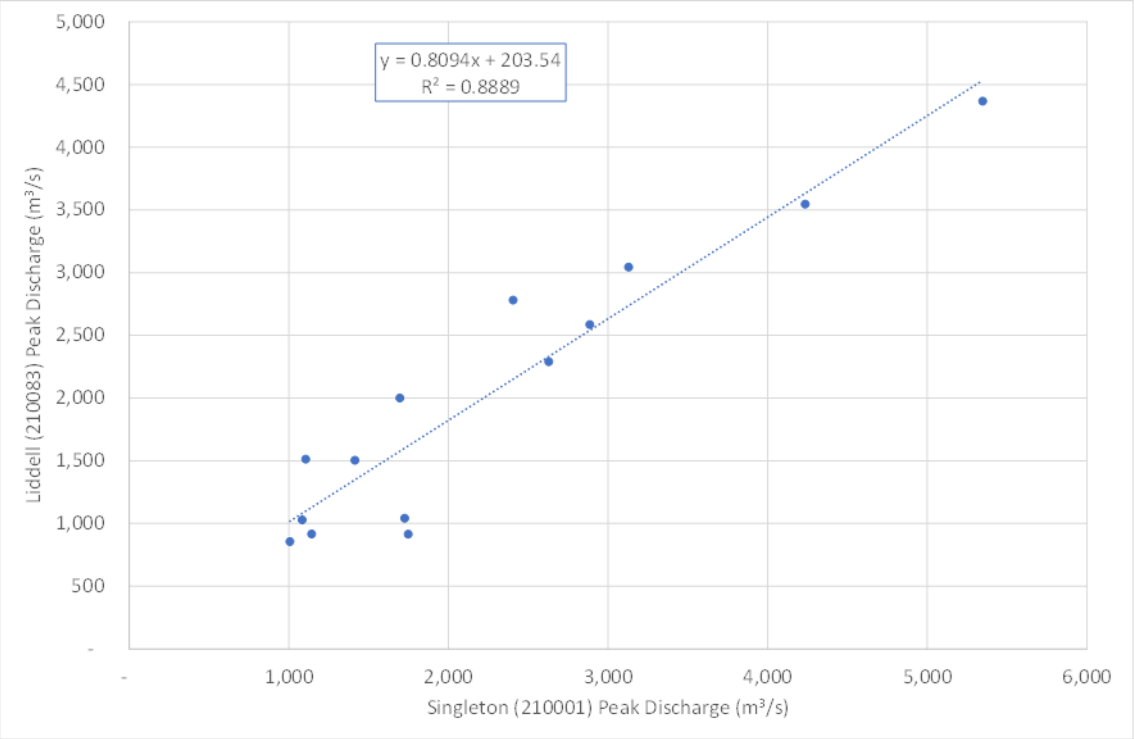


Figure 2.3: Peak Flow Relationship Liddell (210083) vs Singleton (210001)

2.4.2 Travel Time Assessment

An assessment of peak flow travel times along the Hunter River has been undertaken based on several major flood events that occurred during the period of coincident gauging record at Liddell (210083) and Singleton (210001). The results are presented in Table 2.2. The average velocity of flood peaks of 1.4 m/s has been adopted for use in translating design inflow residual hydrographs for the tributary reaches.

TABLE 2.2: HISTORICAL FLOOD PEAK TRAVEL TIMES

Flood Event	Travel Time from Liddell to Singleton (hr)	Average Velocity (m/s)
1976	14.7	1.2
1977	13.1	1.4
1998	10.3	1.7
2007	10.5	1.7
Average	12.1	1.4

2.5 Flood Frequency Analysis

A FFA was undertaken at Liddell (210083) and Singleton (210001) using the methodologies defined in Australian Rainfall and Runoff (ARR) (Ball, et al., 2019) and the industry standard FLIKE software.

Historical flow estimates were obtained from the WaterNSW website, and an annual flow series was derived for each streamflow gauge. Annual flows were defined on a calendar year basis (i.e. water year starting in January). Of the range of probability distributions assessed, the Log Pearson Type III (LP3) distribution was found to give the best fit to the recorded data. This finding is consistent with the previous study (WBM, 2007). The adopted FFA for Liddell (210083) and Singleton (210001) are presented in Figure 2.4 and Figure 2.5.

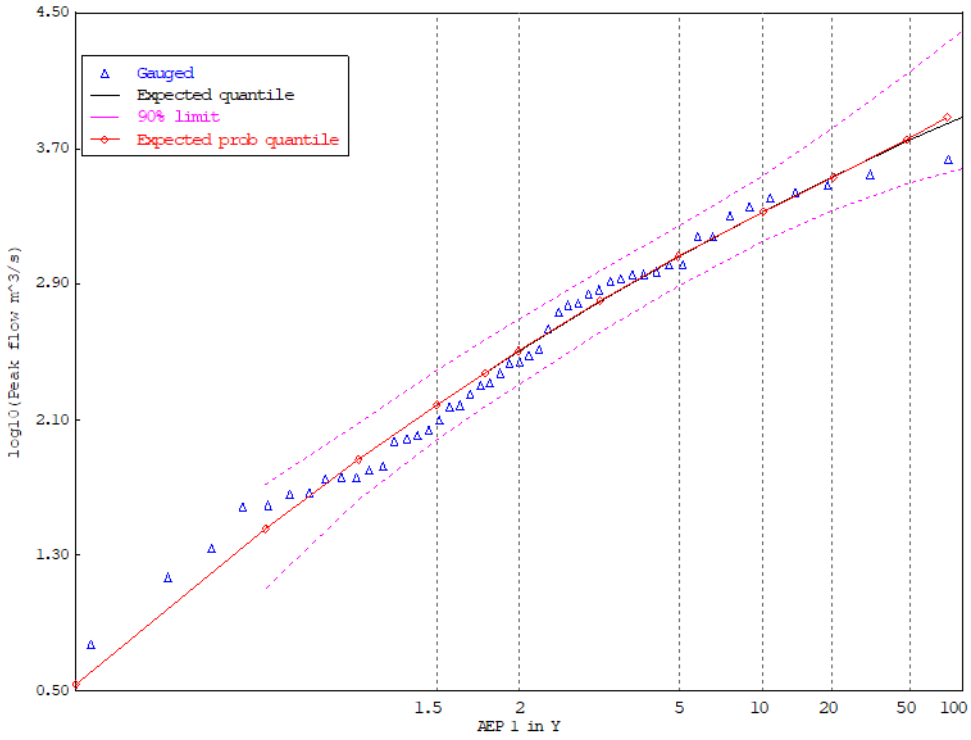


Figure 2.4: Liddell (210083) FFA LP3

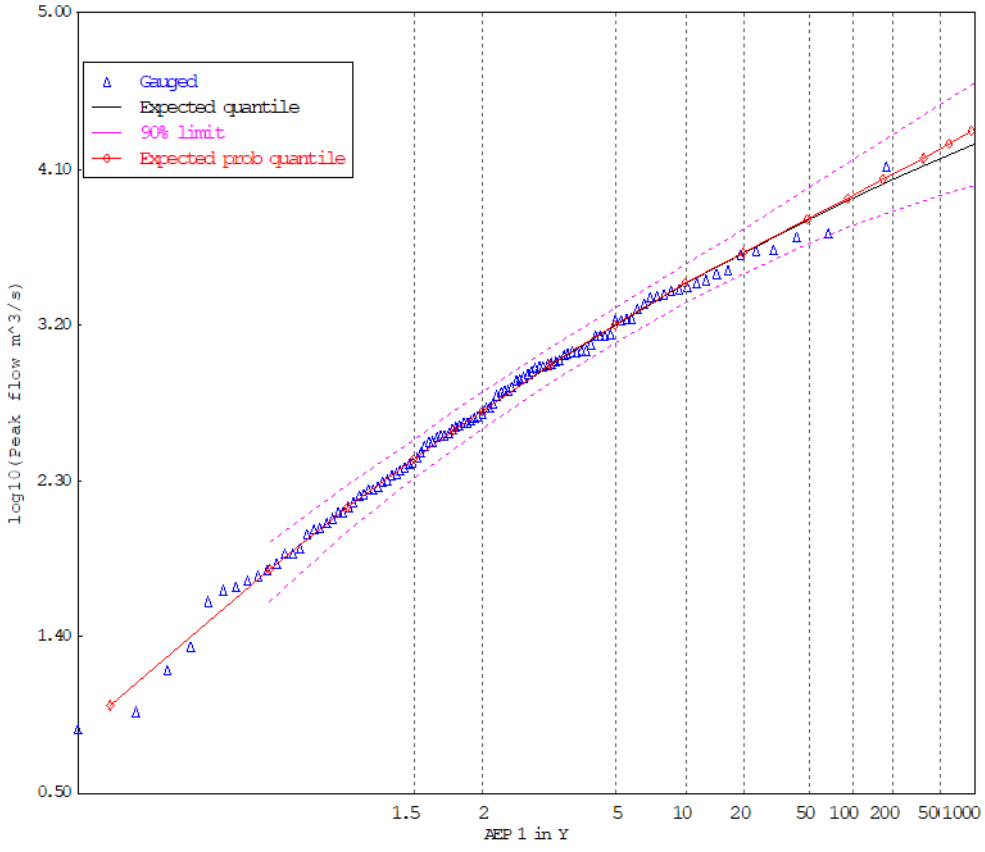


Figure 2.5: Singleton (210001) FFA LP3

The peak design flows at both Liddell (210083) and Singleton (210001) determined from the FFA are presented in Table 2.3 along with the Singleton (210001) results from the previous Council study (BMT, 2022). The results indicate a reduction of approximately 10% in design flows at Singleton compared to the previous Council study. This is consistent with the dry conditions experienced during the additional 19 years of recorded data since that study.

TABLE 2.3: SUMMARY OF FFA AT SINGLETON (210001) AND LIDDELL (210083)

Annual Exceedance Probability	Singleton (210001) (WBM, 2007) (m^3/s)	Singleton (210001) (Engeny) (m^3/s)	Liddell (210083) (Engeny) (m^3/s)
10%	2,950	2,739	2,147
5%	4,480	4,169	3,435
2%	7,035	6,500	5,630
1%	9,390	8,599	7,670
0.5%	12,135	10,984	10,041
0.2%	16,381	14,570	13,680
0.1%	20,145	17,604	16,810

A sensitivity analysis of the FFA was undertaken and is described in Section 5.

The design flows derived at Singleton (210001) have been scaled to a consistent location as Liddell (210083) using the peak flow relationship derived Section 2.4 and are presented in Table 2.4 along with the results of the Liddell (210083) FFA.

TABLE 2.4: SUMMARY OF LIDDELL DESIGN FLOOD ESTIMATES

Annual Exceedance Probability	Liddell FFA		Scaled Singleton FFA		
	Flow (m^3/s)	Percent of Singleton FFA	Flow (m^3/s)	Percent of Singleton FFA	Percent of Liddell FFA
10%	2,147	78%	2,420	88%	113%
5%	3,435	82%	3,578	86%	104%
2%	5,630	87%	5,465	84%	97%
1%	7,670	89%	7,164	83%	93%
0.5%	10,041	91%	9,094	83%	91%
0.2%	13,680	94%	11,996	82%	88%
0.1%	16,810	95%	14,452	82%	86%

The scaled Singleton results were found to give a slightly lower estimate of the design flood peaks compared to the FFA undertaken at Liddell (210083) for the events of interest to this study (refer to Appendix A of this report for further details). However, the comparison is very similar especially when considered within the range of the Liddell FFA confidence limits. Further, the Liddell: Singleton peak flow ratio is consistent with the catchment area ratio of 82% for the larger flood events of interest for this study.

It was concluded that the difference in design flows between the Liddell FFA and the scaled Singleton FFA is a result of the quality of the underlying streamflow estimates available at the gauges. The FFA derived for Singleton (210001) is more accurate due to the longer period of record, tighter confidence bounds and larger gauged flows than Liddell (210083). Consequently, it was determined to adopt the design flow estimates derived by scaling the Singleton FFA to the Liddell gauge location. The adopted design flow estimates at the upstream boundary of the flood model are presented in Table 2.5.

TABLE 2.5: ADOPTED DESIGN FLOOD PEAKS AT UPSTREAM MODEL BOUNDARY

Annual Exceedance Probability	Peak Flow (m^3/s)
10%	2,420
5%	3,578
2%	5,465
1%	7,164
0.5%	9,094
0.2%	11,996
0.1%	14,452

2.6 Extreme Flood Assessment

Due to the adopted methodology using FFA rather than a rainfall runoff model, it was not possible to estimate the Probable Maximum Flood (PMF) using Probable Maximum Precipitation (PMP) methodology. An alternative approach was adopted to estimate an Extreme Flood deemed to be the maximum flood likely to occur by scaling the 1% AEP design flood. This approach is consistent with other studies in the area including the Singleton Flood Study (WBM Oceanics Australia, 2007) and Wollombi Brook Flood Study (BMT WBM, 2016). Each of these studies defined the Extreme Flood by multiplying the 1% AEP flow by a factor of 3.

A review of publicly available flood studies across the Hunter River Basin was undertaken in 2020 to benchmark the scaling factor against estimates of the PMF from rainfall runoff models. The available studies that included the required flood estimates (i.e., both a 1% AEP and PMF estimate) were:

- Upgrading of Lower Hunter Flood Model at Hexham - Final Report Phase 4 prepared for Newcastle City Council (DHI, 2008).
- Flood Assessment - Wollombi Brook prepared for United Collieries (Umwelt, 2016).
- Ashton Coal Southeast Open Cut Project Surface Water Assessment prepared for Ashton Coal Operations (WorleyParsons, 2009).

The Council study (BMT, 2022) defined the Extreme Flood by multiplying the 1% AEP flow by a factor of 3.

The reported design flows are summarised in Table 2.6 and indicate that the ratio of the PMF to the 1% AEP varies from 2.8 to 4.4. The catchment of the Hunter River at the HVO Complex is approximately 14,000 km^2, which is most comparable to the Hexham study. A ratio of 4.0 has been conservatively adopted to define the Extreme Flood at the HVO Complex. This results in a flow of approximately 28,700 m^3/s.

TABLE 2.6: ASSESSMENT OF PMF: 1% AEP RATIO FOR HUNTER RIVER BASIN

Location	Catchment (km^2)	1% AEP Peak Flow (m^3/s)	PMF Peak Flow (m^3/s)	PMF:1% AEP Ratio
Hunter River at Hexham	20,320	6,104	24,000	3.9
Wollombi Brook at Warkworth	1,848	1,695	7,452	4.4
Glennies Creek	515	834	2,319	2.8

2.7 Hunter River Hydrograph

A design hydrograph shape has been derived at both Liddell (210083) and Singleton (210001) streamflow gauges based on averaging of the five largest floods on record in the period of common record. The historical hydrographs were scaled to a consistent unit flow (i.e., 1 m^3/s) and plotted with consistent timing of peaks. The resulting "unit hydrographs" were averaged and minor adjustments were made to smooth smaller peaks occurring either before or after the main flood peak.

The resulting design hydrograph shapes are presented in Figure 2.6 and Figure 2.7 for Liddell (210083) and Singleton (210001) respectively.

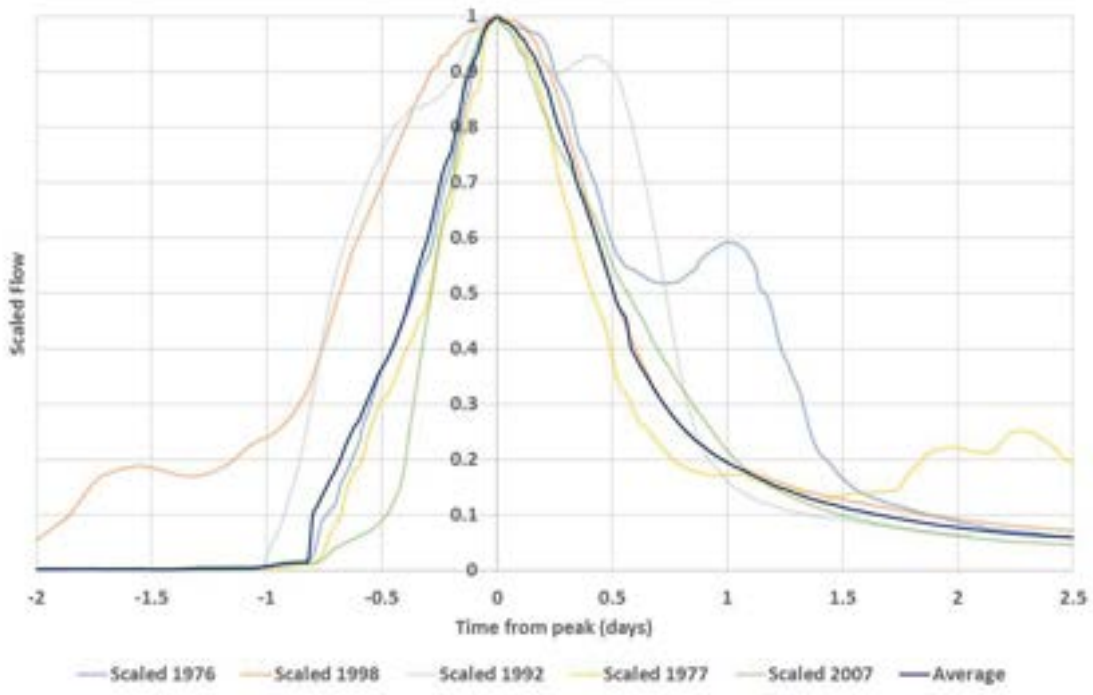


Figure 2.6: Hydrograph Shape at Liddell (210083)

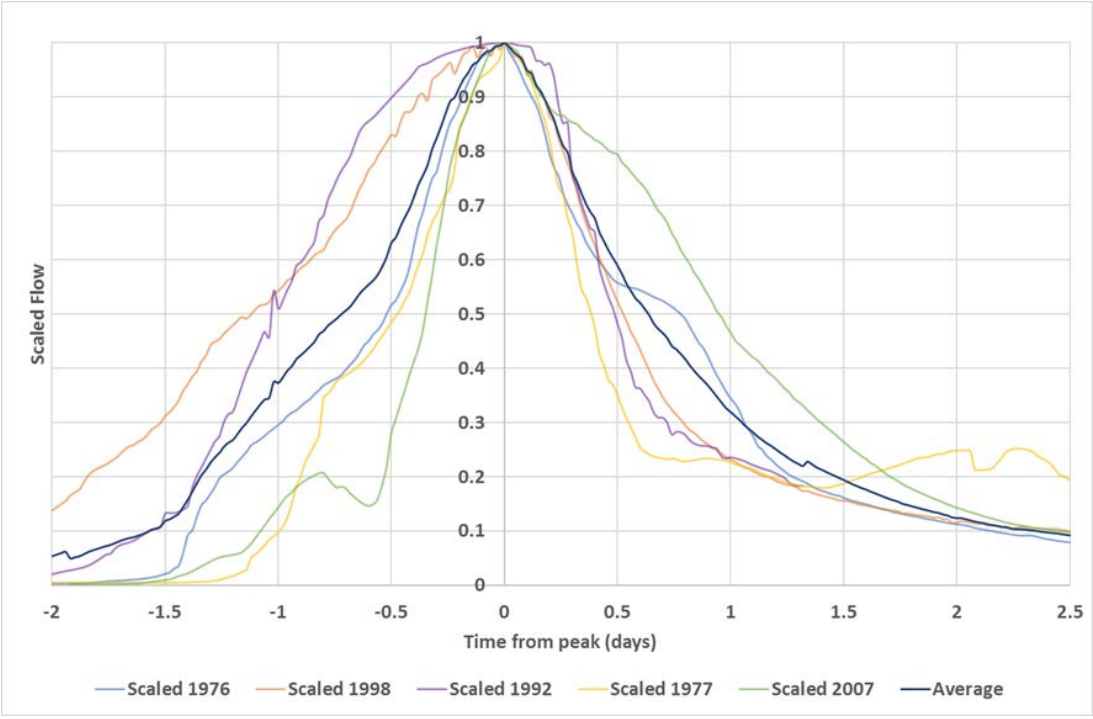


Figure 2.7: Hydrograph Shape at Singleton (210001)

The adopted design hydrograph shape was scaled to the adopted design flood peaks (refer to Table 2.5). The resulting inflow hydrographs for the upstream boundary of the flood model (i.e., vicinity of Liddell) are presented in Figure 2.8.

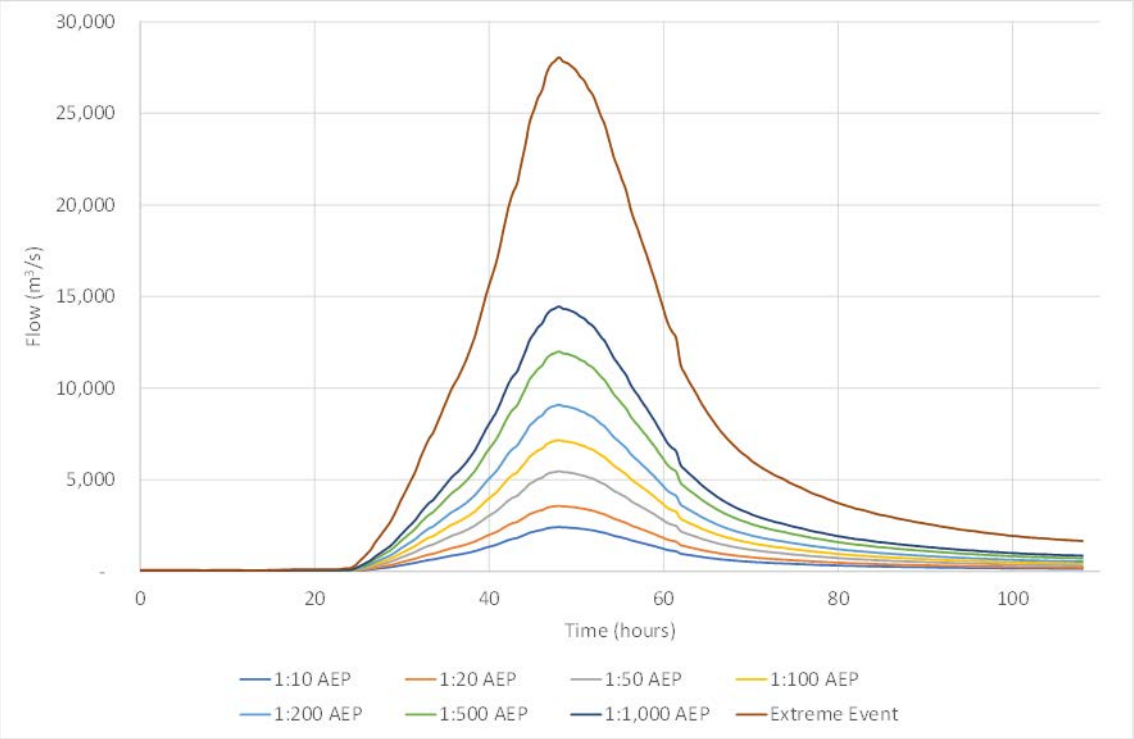


Figure 2.8: Adopted Design Inflow Hydrographs for Hunter River

2.8 Tributary Hydrographs

Design hydrographs for the tributaries have been calculated by determining the residual hydrograph between the Liddell and Singleton adopted design hydrographs. The resulting residual hydrograph has been applied to the three tributaries proportional to catchment area and translated in time based on the average historical flood peak travel time described in Section 2.4. The resulting design inflows to the flood model are presented in Figure 2.9 to Figure 2.11.

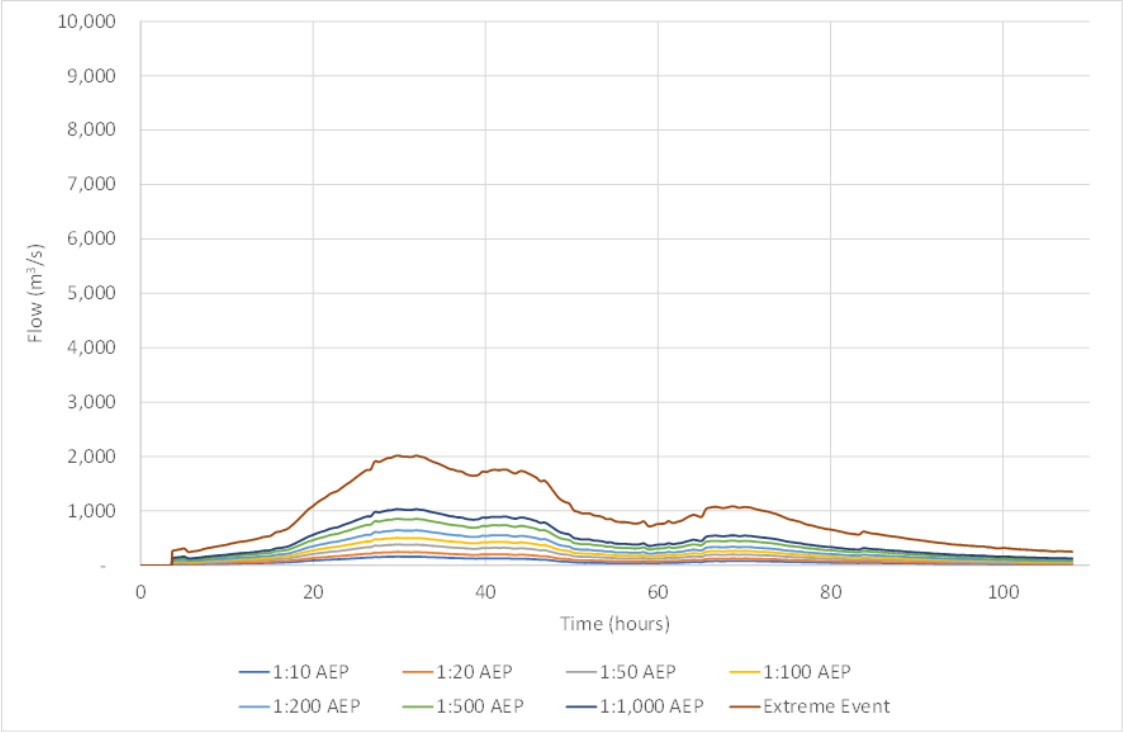


Figure 2.9: Bowmans Creek Design Hydrographs

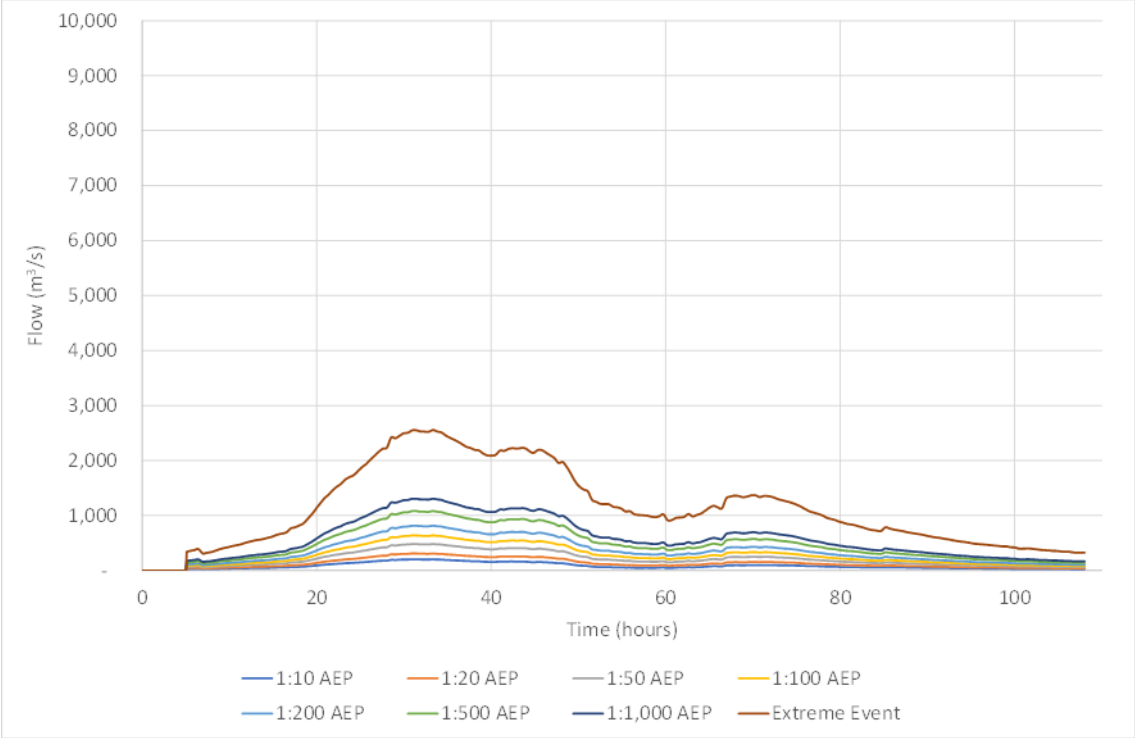


Figure 2.10: Glennies Creek Design Hydrographs

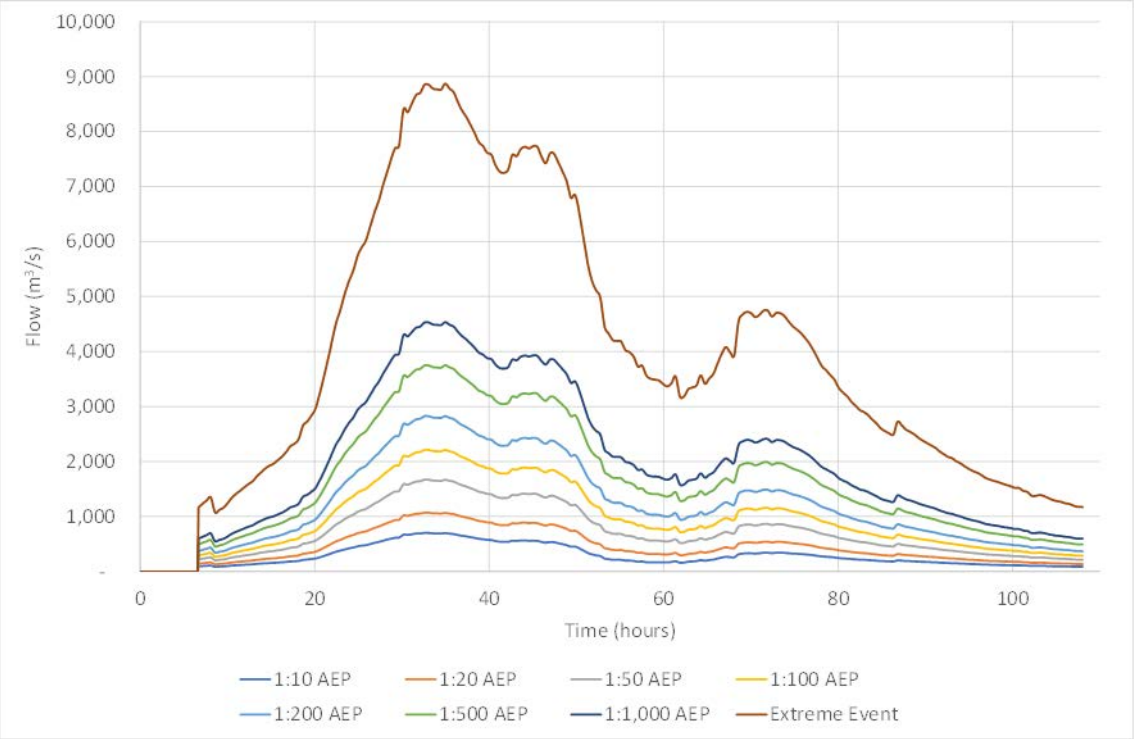


Figure 2.11: Wollombi Brook Design Hydrographs

2.9 Climate Change Assessment

In NSW, the 0.5% and 0.2% AEP design rainfall intensities are typically used as proxies for climate change. A climate change sensitivity assessment was undertaken to validate this approach at the HVO Complex.

At the time of the modelling, that is 2020, ARR (Ball, et al., 2019) design rainfall depths did not include potential climate change effects. At that time, the recommended process for assessing the impacts of climate change in accordance with Book 1, Chapter 6 of the ARR Guidelines was to increase the rainfall (intensity or depth) by 5% per °C of predicted local warming (i.e., a temperature-scaling approach).

At the time of the modelling, 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.

Climate projections for the Project were obtained using the Climate Futures Tool provided on the Climate Change in Australia website and applied using methodologies outlined in Climate Change in Australia Technical Report (CSIRO, 2015).

Projected changes to the storm rainfall intensity were obtained for the RCP 2.6 (now known as SSP1-2.6), RCP 4.5 (now known as SSP2-4.5) and RCP 8.5 (SSP5-8.5) emissions scenarios. RCP 2.6 (SSP1-2.6) represents the most ambitious mitigation scenario, with emissions expected to rapidly decline from around 2020 due to stringent intervention to reducing greenhouse gas and aerosol emissions from all emitters and is indicative of achieving the Paris Agreement goals. RCP 8.5 (SSP5-8.5) represents a high emissions scenario resulting from a future with little to no intervention of emissions, while RCP 4.5 (SSP2-4.5) is an intermediate emission scenario, and hence considered the most realistic.

The projected changes to annual rainfall for the 2050 and 2090 projection years are provided in Table 2.7, which also summarises the equivalent rainfall depth AEP associated with the change in rainfall for each emissions scenario. The projection years of 2050 and 2090 were adopted to align with the end of the Project and the longest available forecast horizon respectively.

TABLE 2.7: PROJECTED MEAN CHANGES IN RAINFALL USING THE CLIMATE FUTURES TOOL

Representative Concentration Pathway	Projection Year	Change in Mean Surface Temperature	Increase in Rainfall	Equivalent Rainfall AEP
RCP 2.6	2050	1°C	5%	Between 1% AEP and 0.5% AEP
	2090	1°C	5%	Between 1% AEP and 0.5% AEP
RCP 4.5	2050	1°C	5%	Between 1% AEP and 0.5% AEP
	2090	2.25°C	12%	~0.5% AEP
RCP 8.5	2050	2.25°C	12%	~0.5% AEP
	2090	4.1°C	22%	Between 0.5% AEP and 0.2% AEP

The adjusted 1% AEP design rainfall intensities were applied to a single node rainfall runoff model using the Runoff Analysis and Flow Training System (XP-RAFTS) software to determine the expected change in peak flow at Singleton for each emissions scenario. The changes in peak flow for the 1% AEP design event are summarised in Table 2.8 along with the equivalent AEPs resulting from each emissions scenario at the HVO Complex. The findings support the use of the climate change proxy (0.5% and 0.2% AEP) approach with these events within the range of emissions pathways assessed. This assessment provides additional context to be able to relate these proxy events to approximate emissions scenarios.

TABLE 2.8: CHANGE IN 1% AEP PEAK FLOW

Emissions Scenario	1% AEP Peak Flow (m^3/s)			Equivalent AEP
	Singleton Base Case	Singleton Climate Change	Percent Increase	
5% Rainfall Increase (RCP 2.6 2050/2090, RCP 4.5 2050)	8,619	9,512	10%	Between 1% AEP and 0.5% AEP
12% Rainfall Increase (RCP 4.5 2090, RCP 8.5 2050)	8,619	10,804	25%	~0.5% AEP
22% Rainfall Increase (RCP 8.5 2090)	8,619	13,019	51%	Between 0.5% AEP and 0.2% AEP

3. HYDRAULIC MODEL

3.1 Model Development

A two-dimensional hydraulic model has been developed using the TUFLOW modelling package. Key aspects of the hydraulic model development are summarised in Table 3.1. A description of the model layout is provided in Section 3.3 along with illustrative figures.

TABLE 3.1: HYDRAULIC MODEL DEVELOPMENT AND PARAMETERS

Model Parameter	Details
Grid Size	HVO Complex area sourced form LiDAR data provided by site captured in May 2020 and in 2016 NSW LPI LiDAR used beyond extent of site LiDAR (downstream of the Long Point gauge)
DEM	4 seconds
Timestep	A normal depth boundary was applied across the floodplain approximately 3 km downstream of Singleton
Downstream Boundary	Inflow boundaries have been applied as flow versus time boundaries at the following locations: • Hunter River – Approximately 2 km upstream of the Liddell gauge. • Bowmans Creek – At the confluence of Bowmans Creek and the Hunter River. • Glennies Creek – Approximately 5 km upstream of the confluence with the Hunter River. Wollombi Brook – In the vicinity of the Warkworth Gauge, approximately 6.5 km upstream of the confluence with the Hunter River
Inflow Boundaries	Used to delineate land use categories Provided by HVO, dated 28/10/2018
Aerial Photography	Refer to Table 3.2
Manning's 'n' Roughness	2020-01-AB with HPC Solver
Model Build and Solver	HVO Complex area sourced form LiDAR data provided by site captured in May 2020 and in 2016 NSW LPI LiDAR used beyond extent of site LiDAR (downstream of the Long Point gauge)

Several hydraulic structures were incorporated into the model and represented as layered flow constrictions based on design drawings (where available) or visual observations. All structures in the model are drowned out in the larger modelled design events. The existing structures in the vicinity of the Project have low immunity and do not have a significant impact on the flood behaviour for the large floods of interest to this study.

Roughness has been represented using Manning's 'n' values delineated based on the provided aerial. Calibration of roughness parameters is further detailed Section 3.2, with a sensitivity review of the roughness parameters discussed in Section 5.2.2. The adopted roughness values for each defined land use category are summarised in Table 3.2.

TABLE 3.2: MANNING'S 'N' ROUGHNESS VALUES

Land Use	Manning's 'N'
Channel	0.035
Channel (Low Roughness)	0.025
Riparian	0.08
Grazing / Grassland	0.05
Wooded	0.09
Irrigation	0.04
Mine Pits / Roads	0.045
Low Density Urban	0.10
Medium Density Urban	0.25

3.2 Model Calibration

Four historical events (January 1976, March 1977, August 1998 and June 2007) were initially adopted for calibration of the model with the addition of the February 1955 event as a validation as the largest flood on record. However, calibration to events prior to June 2007 was determined not to be practical due to a significant change in the WaterNSW rating curve applied for flows since June 2007. The change in rating curve was determined to be due to a significant change in the hydraulic characteristics of the channel at Liddell (e.g. change in cross section due to ongoing geomorphology of the channel and/or floodplain, changes in landuse and associated roughness). Consequently, calibrating a hydraulic model for events prior to 2007 was determined to not be practical without obtaining the corresponding bathymetry/topography of the river channel and floodplain. Further detail on the Liddell rating curve has been provided in Section 3.2.1.

As a result, the calibration process was revised to include:

- Calibration of the hydraulic model to the gauged portion of the rating table for the Liddell (210083).
- Calibration to recorded flood levels along the Hunter River for the June 2007 event.
- Validation of the ability of the HVO flood model (hydrology methodology and hydraulic model) to replicate historical flows at Singleton using the February 1955 event.

Each component of the calibration process is described in the following sections.

While it is acknowledged that further calibration is constrained by limitations in the availability and quality of data, the calibration has made the best use of available data and is appropriate for the study. Furthermore, the calibration has been reviewed and refined through the BMT peer review process, as well as being reviewed through the DPHI peer review process, with no further actions identified outstanding.

3.2.1 Liddell Rating Curve Calibration and Constraints

3.2.1.1 Gaugings and Latest Ratings

The streamflow gauge at Liddell (210083) has a 50 year period of record and has been well gauged (255 gaugings since September 1969) with a maximum gauged level of 72.801 mAHD, which corresponds to a peak flow below the 10% AEP design flood. The historical gaugings and resulting rating curve derived by WaterNSW are presented in Figure 3.1.

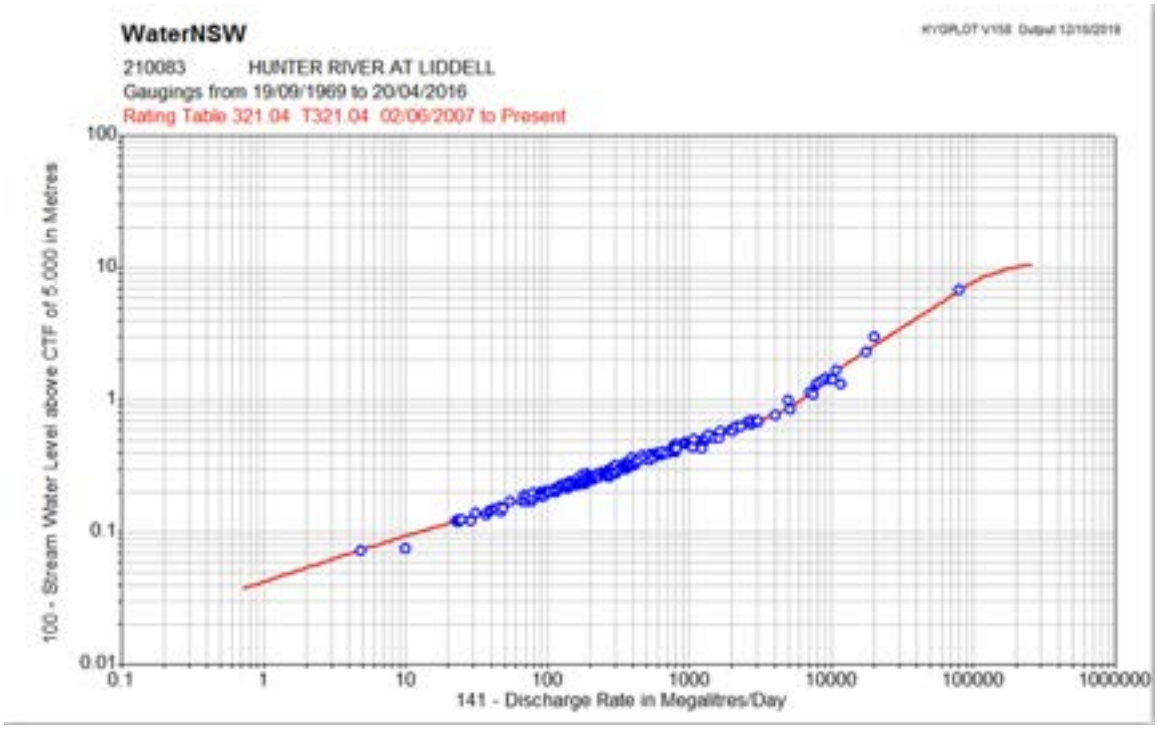


Figure 3.1: Liddell (210083) Rating Curve and Historical Gaugings (WaterNSW)

3.2.1.2 Historical Variation in Liddell Rating Curve

A review of historical flood levels and WaterNSW flow estimates at Liddell (210083) indicates that a significant change occurred to the rating curve between the 1998 and 2007 events. Whereas there are minimal changes between the 1976, 1977 and 1998 rating curves.

The maximum gauging, which is considerably larger than any previous gauging (refer to Section 3.2.1.3), occurred in December 2010, with the latest rating curve (2/6/2007) having been applied for flows since June 2007. If the current rating curve was used, the peak flow in the 1976, 1977 and 1998 events would be approximately half of the flow reported by WaterNSW for these events (refer to Figure 3.2).

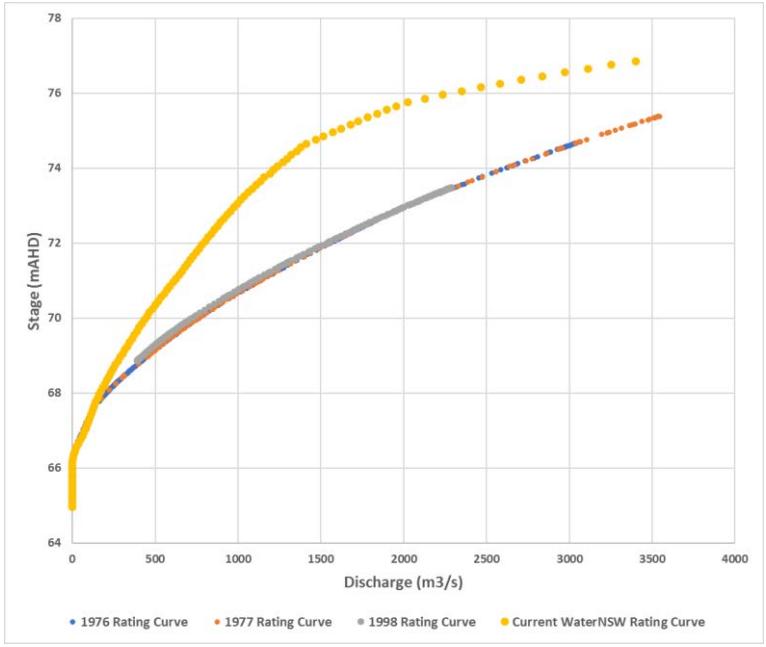


Figure 3.2: Liddell (210083) Historical Rating Curves

3.2.1.3 Adopted Liddell Rating Curve

It is noted that the maximum gauging at Liddell (210083) occurred in December 2010 and is significantly higher than all other gauged flow events. The December 2010 event resulted in an update of the WaterNSW rating curve, with the updated rating curve applied to historical flows recorded since June 2007. Due to the significant change in the rating curve at this date, an assessment was undertaken to determine whether it would be appropriate to apply this rating curve to earlier events.

A comparison of peak flows at Liddell (210083) and Singleton (210001) was undertaken using the WaterNSW estimates (i.e. the flows directly extracted from WaterNSW) and the revised flows (i.e. using the recorded levels and the latest WaterNSW rating curve).

The WaterNSW flow estimates provide the best fit for the relationship of peak flows between Liddell (210083) and Singleton (210001) (refer to Figure 3.3). In addition, adoption of the revised flows would suggest that only 42% of the peak flow at Singleton passes Liddell. This is considered unrealistic as the catchment upstream of Liddell accounts for 82% of the catchment upstream of Singleton.

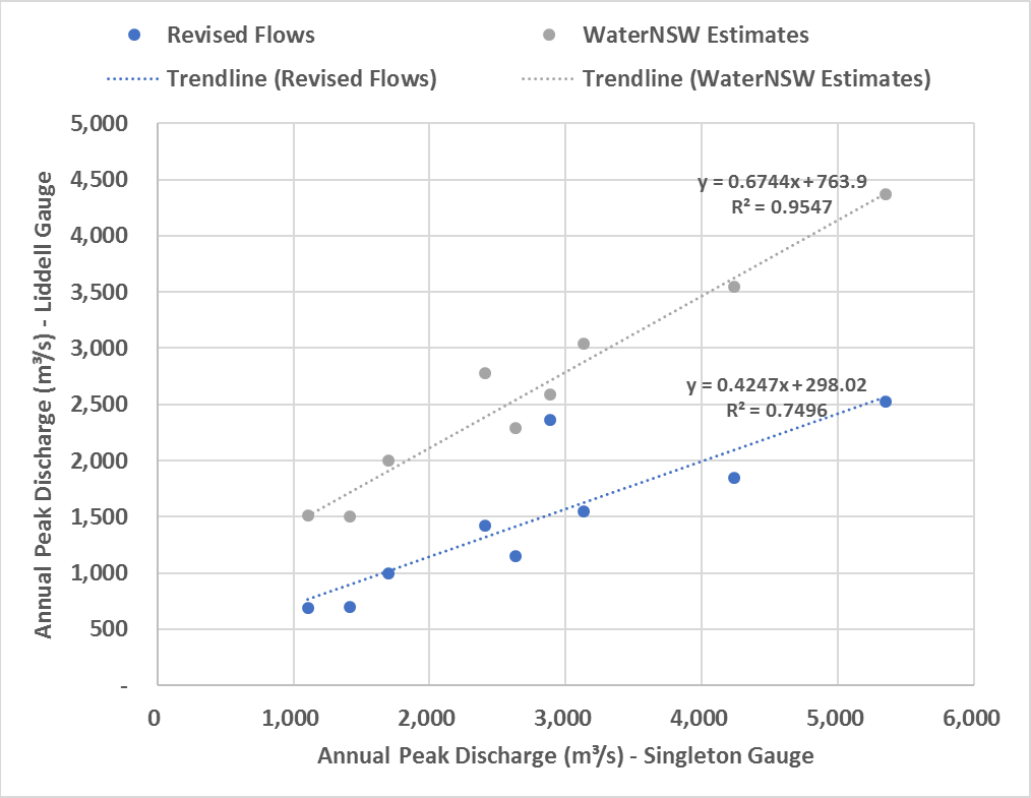


Figure 3.3: Peak Flow Comparison – WaterNSW Estimates versus Revised Flows

As such, it was concluded that:

- The WaterNSW flow estimates as reported are the best estimate of historical flows.
- The change in the rating curve is due to a significant change in the hydraulic characteristics of the channel at Liddell (e.g. change in cross section due to ongoing geomorphology of the channel and/or floodplain, changes in landuse and associated roughness).
- It was not appropriate to amend earlier flow estimates provided by WaterNSW.
- Calibrating a hydraulic model for events prior to 2007 is not practical without obtaining the corresponding bathymetry/topography of the floodplain.

3.2.1.4 Calibration to Liddell Rating Curve

The Liddell (210083) rating curve and associated gaugings (255 gaugings between 1969 and 2019, up to a maximum level of 72.801 mAHD which is approximately 950 m³/s (between a 20% and 10% AEP event)), were determined to be the best available data for calibration of the flood model in the vicinity of the HVO Complex.

The roughness values in the TUFLOW hydraulic model were adjusted to achieve a satisfactory fit to WaterNSW rating curve. The adopted roughness values (Manning's 'n') are included in Table 3.2).

The comparison of the modelled and WaterNSW rating curves is presented in Figure 3.4 and indicates a good level of agreement. The fit to the low end is limited by the lack of bathymetric survey of the river channel; however, the slope of the curve is consistent. At the higher end of the curve (i.e., in the range of flows of interest to this study), the shape of the rating curves compares well up to the maximum gauged level.

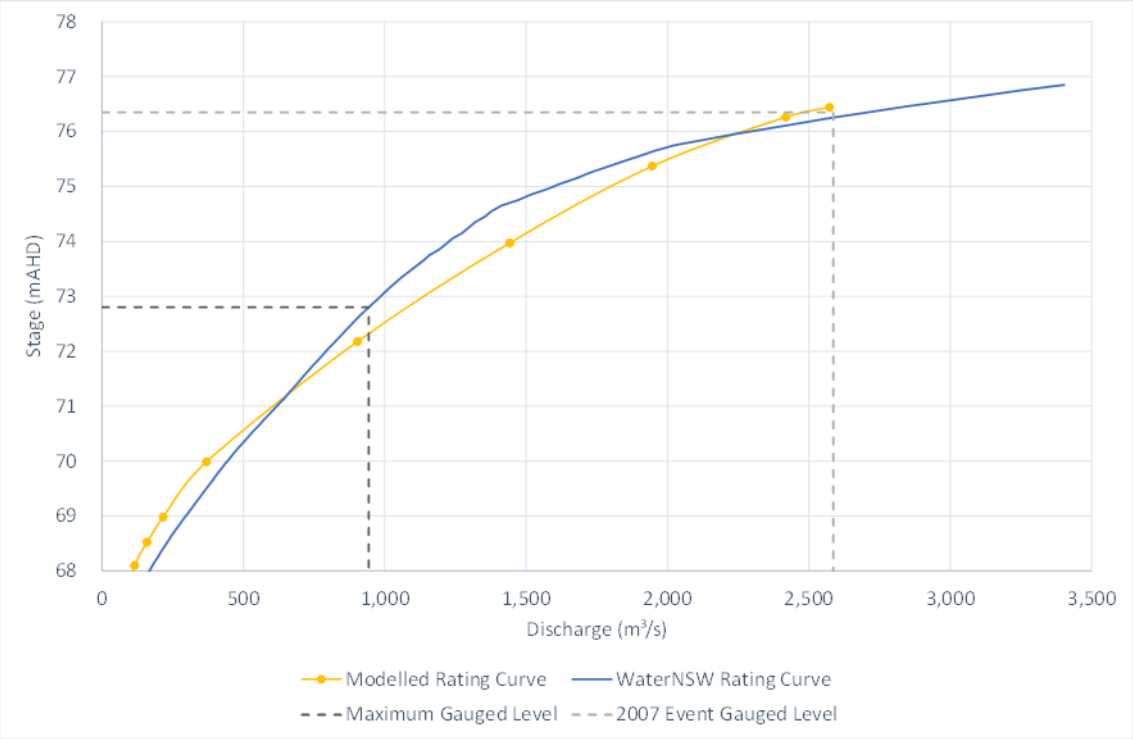


Figure 3.4: Comparison of WaterNSW and Modelled Rating Curves

3.2.2 2007 Event Calibration

Once a suitable calibration was achieved at Liddell (210083), the June 2007 event was simulated to assess the level of calibration along the Hunter River at the seven available streamflow gauges. As noted above (refer to Section 3.2.1.3), it was determined to be impractical to calibrate the hydraulic model to events prior to June 2007 unless the corresponding historical bathymetry and land use could be defined.

Simulation of the 2007 event involved application of a gauged hydrograph from Liddell (210083) at the upstream model boundary. Additional hydrographs for the three major tributaries were derived and apportioned as per the method described in Section 2.8.

The comparisons of modelled and recorded levels at the seven gauge locations are presented in Table 3.3. The model is shown to provide a high level of correlation with the observed flood levels (i.e. within approximately 300 mm of the recorded values and a mixture of over and under estimation). The average of the absolute value of differences for the June 2007 event is 170 mm.

The model is considered to provide a good calibration and has been adopted for use as the Project flood model.

TABLE 3.3: COMPARISON OF MODELLED AND RECORDED LEVELS (JUNE 2007)

Gauge Location	Recorded Level (mAHD)	Modelled Level (mAHD)	Difference (m)	Difference (% of observed depth)
Liddell	76.26	76.44	0.19	1.2%
US Foy Brook	62.00	61.71	-0.29	-2.3%
US Glennies	60.08	59.74	-0.34	-2.5%
Mason Dieu	55.91	56.01	0.10	0.8%
Long Point	48.98	48.98	0.00	0.0%
US Singleton	42.70	42.48	-0.22	-1.7%
Singleton	41.77	41.84	0.07	0.5%

3.2.3 1955 Event Validation

The 1955 event is the largest event within the available streamflow record; however, the only gauge in operation at that time was Singleton (210001). Due to its magnitude, the 1955 event has been used as a validation event to confirm that the hydrology methodology and calibrated hydraulic model can replicate flow events at Singleton. The gauged Singleton hydrograph has been scaled to the upstream model boundary and tributary hydrographs calculated in accordance with the design event methodology described in Sections 2.7 and 2.8.

Figure 3.5 presents the comparison between modelled and observed/recorded flows upstream of Singleton (i.e., prior to break out flows across the floodplain at Glenridding). The model was considered to provide a suitable comparison to the timing, shape and flow peak of the 1955 event.

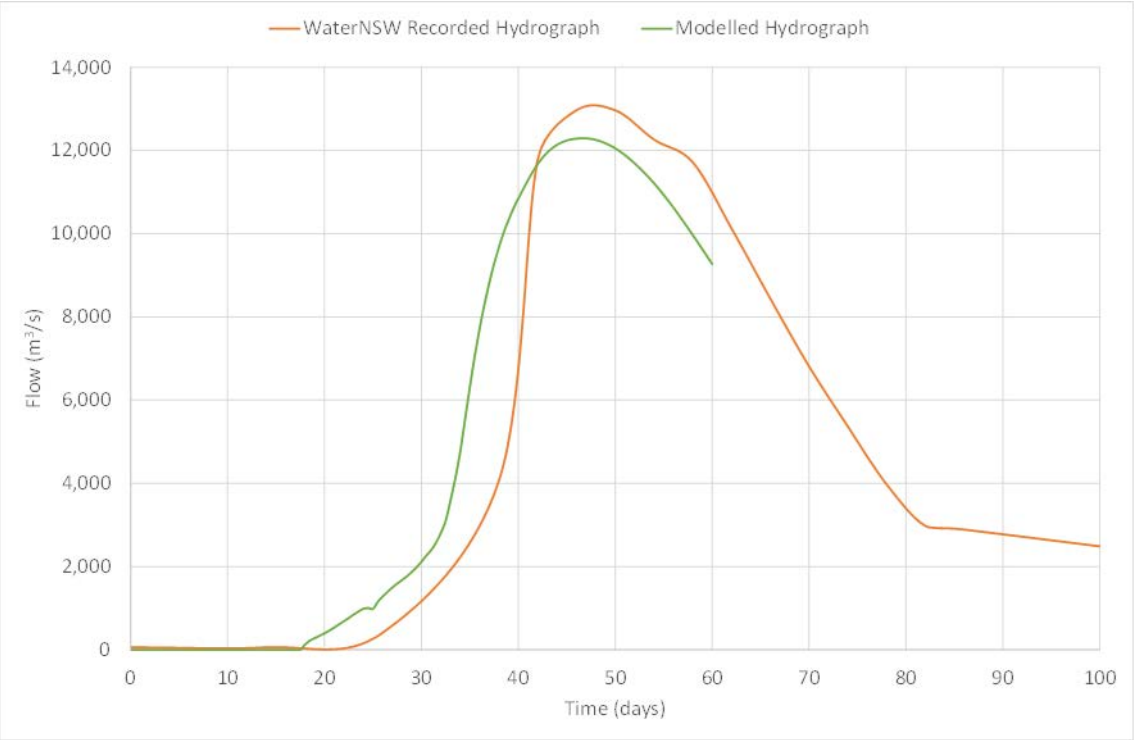


Figure 3.5: Comparison of Modelled and Recorded Flows at Singleton (February 1955)

3.3 Model Scenarios

The hydraulic model has been set up to reflect three Project scenarios. The model layout for each scenario is provided in Figure 3.6 to Figure 3.8 with key changes summarised as follows:

- Project Baseline:
  - Apply topographic update for upgrade to Cheshunt Pit Hunter River flood protection at approach to haul road crossing (to be completed by existing operations prior to the Project).
  - Construction of the North Void Tailings Storage Facility (TSF) Levee 1 (North-West levee) represented through application of the levee design surface.
  - Construction of the South Lemington Pit (SLP) 1 flood protection upgrade at the haul road ramp (to be completed by existing operations prior to the Project) represented through application of the concept design earthworks.
- Project Operations – consistent with Project Baseline with the following adjustments:
  - Construction of the Carrington West Wing Levee (abbreviated Carrington WW Levee for mapping purposes), North Void TSF Levee 2 (South-East levee), Riverview Levee, Cheshunt Levee and Lake James upgrade.
  - Construction of the Lemington Road realignment through the Hunter River floodplain, including two bridge crossings of the main Hunter River channel. Note: this is the Lemington Road alignment (outside of the floodplain) that was assessed for the EIS Project.

- Incorporation of the planned mine progression as per the 2044 stage plan. This stage is the worst case for potential impacts on the floodplain during operations and includes SLP 1 back-fill, North Void TSF capping and progression of the HVO North and HVO South open cut pits and overburden emplacement areas.

- Project Closure – consistent with Project Operations with the following adjustments:
  - Decommissioning of the Carrington West Wing Levee applied in the model as per the final landform design for this area.
  - Incorporation of the final landform including the open cut pit voids and rehabilitated overburden emplacement areas.
  - The Riverview Levee will remain at closure and continues to provide a flood protection function. This levee has been retained in the Project Closure model.

In regard to the Project Closure scenario, it should be noted, as discussed in Section 1.1, that the current Project continues to include the Riverview Levee at closure, in the same location, as was modelled in 2020. However, the Riverview Levee will now be incorporated into the final landform at closure. In addition, at closure, the Mitchell East Levee / final landform will provide flood immunity for North Void.

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Liddell
Carrington Pit
North Void Levee 1
RAVENSWORTH OPERATIONS
North Bridge
South Bridge
Bowmans
Glennies
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Cheshunt Pit
Lemington Road Existing Crossing
HVO Haul Rd Hunter
UNITED WAMBO JOINT VENTURE
HVO Haul Rd Wollombi
Wollombi
MOUNTH THORLEY WARKWORTH
New England Hwy Singleton
Rail Singleton
Singleton
Dunolly Bridge
Downstream Mapping Limit
DS Boundary Condition

Legend

- Model Extent
- Downstream Boundary
- Inflow Boundary
- Residual Catchment Inflow Boundary
- Model Hydraulic Structures

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuaton Project Flood Assessment

Figure 3-6 - Flood Model Layout - Project Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 25 /9 /2025

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Liddell
Carrington WW Levee
Carrington Pit
North Void Levee 1
North Void Levee 2
RAVENSWORTH OPERATIONS
North Bridge
RIX'S CREEK NORTH
Glennies
South Bridge
Bowmans
Lake James
Lemington Road Realignment
Riverview Levee
Cheshunt Levee
Cheshunt Pit
Lemington Road Existing Crossing
HVO Haul Rd Hunter
RIX'S CREEK SOUTH
New England Hwy Singleton
Rail Singleton
UNITED WAMBO JOINT VENTURE
HVO Haul Rd Wollombi
Singleton
Dunolly Bridge
Wollombi
Downstream Mapping Limit
DS Boundary Condition
MOUNTH THORLEY WARKWORTH

Legend

- Proposed Infrastructure
- Model Extent
- Downstream Boundary
- Inflow Boundary
- Residual Catchment Inflow Boundary
- Model Hydraulic Structures

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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HVO Continuaton Project Flood Assessment

Figure 3-7 - Flood Model Layout - Project Operations

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Revision: 0
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Checked: SF
Date: 25 /9 /2025

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
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6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Liddell
Carrington Pit
RAVENSWORTH OPERATIONS
North Bridge
Glennies
RIX'S CREEK NORTH
South Bridge
Bowmans
Lemington Road Realignment
Riverview Levee
Cheshunt Pit
RIX'S CREEK SOUTH
Lemington Road Existing Crossing
HVO Haul Rd Hunter
New England Hwy Singleton
Rail Singleton
UNITED WAMBO JOINT VENTURE
HVO Haul Rd Wollombi
Singleton
Dunolly Bridge
Wollombi
Downstream Mapping Limit
DS Boundary Condition
MOUNTH THORLEY WARKWORTH

Legend

- Proposed Infrastructure
- Model Extent
- Downstream Boundary
- Inflow Boundary
- Residual Catchment Inflow Boundary
- Model Hydraulic Structures

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuaton Project Flood Assessment

Figure 3-8 - Flood Model Layout - Project Closure

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Revision: 0
Drawn: MW
Checked: SF
Date: 25 /9 /2025

3.4 Design Events

The model was simulated for the range of design events including the 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1% AEP and Extreme Event Flood. The range of events has been determined to meet the NSW Planning Secretary's Environmental Assessment Requirements (SEARs) as well as the operational requirements of HVO.

The Project Baseline and Project Operations scenarios have been simulated for the full range of design events. The Project Closure scenario has been simulated for the Extreme Event only to confirm the flood immunity of the final landform.

4. FLOOD MAPPING

Flooding mapping illustrating peak flood depth, velocity and hazard is provided as attachments to the SWIA, while the outcomes of the flood impact assessment are detailed in the Section 6.2 of the SWIA:

- Attachment D – Design Flood Maps.
- Attachment E – Flood Impact Maps.
- Attachment G – Multilot Flood Maps.

4.1 Flood Mapping and Impact Mapping Limit

The model has been established to include a large extent downstream of the HVO Complex. The downstream boundary is approximately 36 km downstream of the Wollombi Brook confluence and 3 km downstream of the town of Singleton. The adopted extent ensures that sufficient flood results are available to assess the potential impacts of the Project while also ensuring that there are no boundary impacts on design flood levels in the vicinity of the Project. However, presentation of flood mapping in Singleton is not considered to be appropriate for the following reasons:

- Singleton is well downstream of the Project and area of interest.
- The model intentionally lacks resolution in town (e.g., levees, cross drainage structures, detailed delineation of roughness) as it is well beyond the expected area of interest.
- Avoidance of duplication with previous and ongoing Singleton Council flood study models. It is not preferred to have multiple sources of flood mapping results (flood levels and extents) in populated areas.
- Comparison to the Council study (WMB, 2007) indicates that the Project flood model extents in town are more extensive. In other words, design flood levels estimated by the Project flood model are overly conservative in Singleton relative to the Council study (WMB, 2007).

Furthermore, presentation of flood impacts in Singleton were determined not to be required. Flood level impacts in the 1% AEP event are less than 20 mm well upstream of town. Limiting flood level mapping to events up to the 1% AEP is consistent with flood planning methodologies while assessment of larger events focuses on emergency management (i.e., access and hazard).

The flood impact mapping for the SWIA shows impacts to a 20 mm threshold, which is considered sufficient based on:

- Almost all of the modelled and impacted area is rural (Primary Production RU1) (refer to Section 6.2 of SWIA).
- The environmental assessment of the Singleton Bypass project applied a 20 mm threshold for impact mapping (NSW Roads and Maritime Services, 2019). The Project assessment is consistent with this.
- A recent guideline by Austroads (Guide to Road Design Part 5: Drainage – General and Hydrology Considerations, 2023) assumes a 25 mm change in peak level at residential buildings is generally acceptable with greater tolerance for non-residential uses.

A mapping limit has been adopted approximately 3 km upstream of town where the flood extent remains confined. A comparison of the flow hydrographs extracted from the hydraulic model at this location are provided in Figure 4.1 while the peak flows are tabulated in Table 4.1. The results indicate that there is negligible difference in peak flow for the range of events including a 0.5% difference for the flood planning event (1% AEP). There is little discernible change to the hydrographs except for the Extreme Event during Project Operations due to flood ingress to North Pit via overtopping of the Carrington West Wing Levee in events that exceed the levee design event (0.1% AEP).

The flood mapping and impact mapping limits were supported by the BMT Peer Reviewer (refer to Peer Review Reports included in the Water resources impact assessment (EMM, 2025)).

TABLE 4.1: PEAK FLOW COMPARISON AT MAPPING LIMIT

	Extreme Event	1% AEP	10% AEP
Project Baseline (m^3/s)	33,800	8,500	2,500
Project Operations (m^3/s)	31,200	8,600	2,500
Difference to Baseline (m^3/s)	-2,600	<100	<100
Difference (%)	-8%	0.5%	0.1%
Project Closure (m^3/s)	34,000	-	-
Difference to Baseline (m^3/s)	200	-	-
Difference (%)	0.6%	-	-

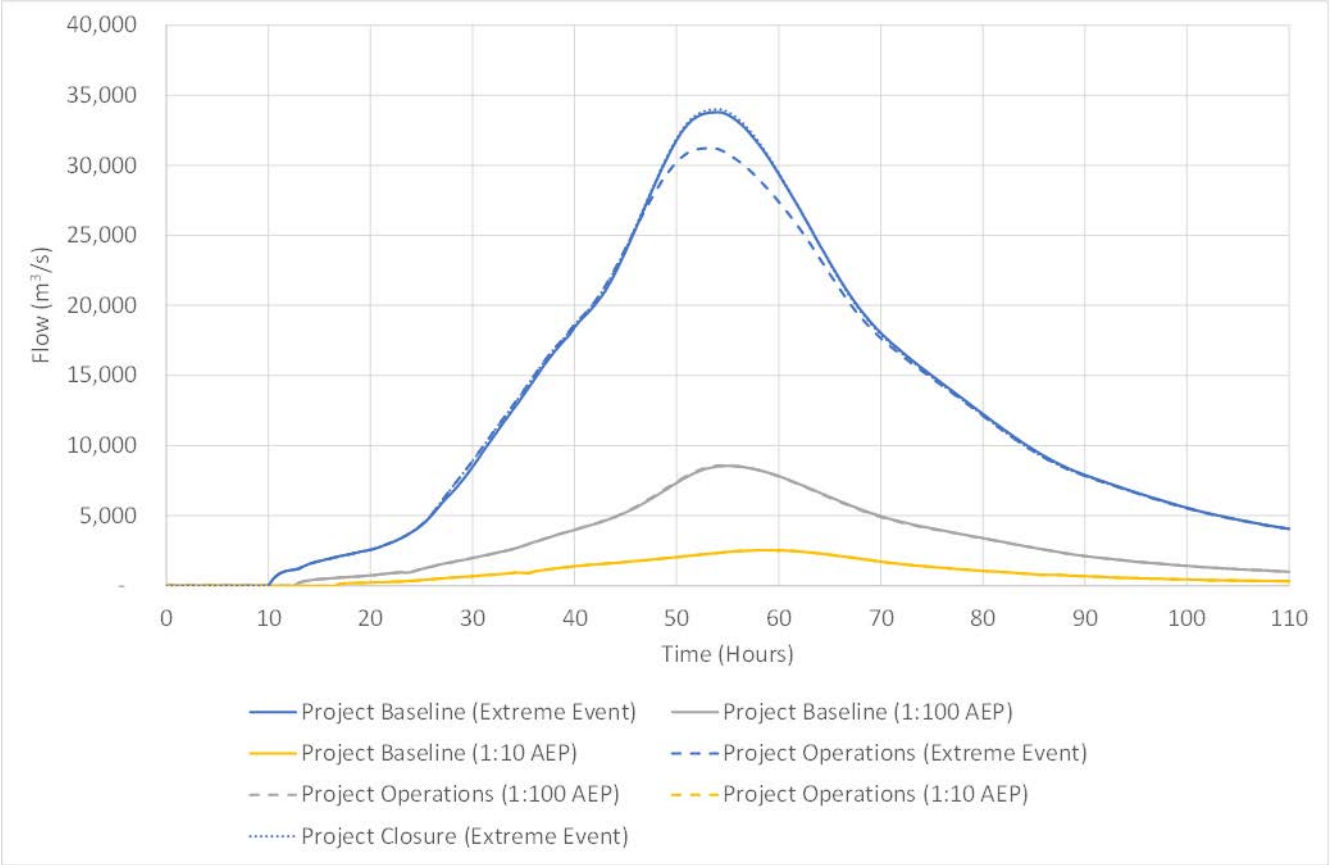


Figure 4.1: Flow Hydrograph Comparison at Mapping Limit

5. SENSITIVITY REVIEWS

5.1 FFA Analysis

Sensitivity analysis/review of the FFA was undertaken to consider the impacts on removing low flow outliers, use of calendar versus water year, and consideration of the period of record.

The results of the analysis/review are described below with further information provided in Appendix A of this report.

- **Removal of low flow outliers:** A low flow threshold of 25 m^3/s was assessed resulting in removal of the four smallest flows from the 107 year annual series. The small magnitude of the difference in the low flows and the reduced accuracy of the resulting FFA fitted distribution does not justify removing low flows. The full data set has been maintained for the adopted FFA.
- **Water year:** The occurrence of flood events is reasonably well distributed throughout the year. Differences resulting from a water year commencing in July or October instead of January were found to be negligible within the confidence limits of the FFA. It is understood that the previous Council study (WBM 2007) adopted a January – December water year. A January – December water year has been maintained for this study.
- **Period of Record for Liddell Flow Comparison:** Peak flow estimates at Liddell derived from the Liddell FFA have been compared against estimates derived by scaling the Singleton FFA peak flows using the relationship derived in Section 2.4.1. This comparison is described further below. A sensitivity has been undertaken by applying a consistent period of record for the FFA between Singleton and Liddell. This determined that the full Singleton record was the most appropriate to adopt in the context of scaling flow estimates to Liddell.

5.2 Hydraulic Scenarios

Sensitivity analysis was undertaken early in the flood model development and included sensitivity assessment of both the adopted flood frequency analysis peak flow and the Manning's roughness. The associated impact on flood levels was quantified at seven points along the river in the vicinity of the HVO Complex as illustrated in Figure 5.1.



Figure 5.1: Sensitivity Analysis Reporting Locations

5.2.1 Scenario 1 – Liddell FFA Design Peak Flows

This scenario assessed the impact of adopting the Liddell FFA rather than the scaled Singleton FFA to define the design inflows at the upstream model boundary. This scenario was assessed for the 0.1% AEP and corresponds to a 40% increase in flow at the upstream boundary. The sensitivity results are presented in Table 5.1 and indicate significant variation in design flood levels upstream of the tributary inflows (0.6 to 1.7 m).

TABLE 5.1: SCENARIO 1 – LIDDELL FFA DESIGN PEAK FLOWS

Reporting Point	Peak Flood Level – Base Case (mAHD)	Peak Flood Level – Scenario 1 (mAHD)	Difference (m)
1	81.31	83.01	1.70
2	76.31	77.27	0.96
3	73.79	74.38	0.59
4	70.23	71.90	1.67
5	69.33	70.99	1.66
6	64.55	64.97	0.42
7	64.24	64.57	0.32

5.2.2 Scenario 2 - Manning's 'n' Roughness

A sensitivity analysis was undertaken on the adopted Manning's 'n' roughness values by applying a global increase of 30% across all land use types. The results of the sensitivity analysis are presented in Table 5.2 and indicate increased levels of 0.3 to 1.12 m.

TABLE 5.2: SCENARIO 2 – MANNING'S 'N' ROUGHNESS

Reporting Point	Peak Flood Level – Base Case (mAHD)	Peak Flood Level – Scenario 2 (mAHD)	Difference (m)
1	81.31	82.24	0.93
2	76.31	76.72	0.41
3	73.79	74.13	0.34
4	70.23	71.26	1.03
5	69.33	70.41	1.08
6	64.55	65.69	1.15
7	64.24	65.36	1.12

5.3 Consideration of Sensitivity Outcomes

The Manning's roughness sensitivity assessment applied a global increase of 30% across all land use types and was undertaken for a peak flow at Liddell of approximately 11,900 m^3/s, which is comparable to the 0.2% AEP design flood. It is noted that a 30% increase in Manning's roughness is conservatively high considering the baseline grazing/grassland parameter of 0.08 adopted in the hydraulic model. The increased Manning's roughness values for this event resulted in increased flood levels of up to approximately 1 m throughout the model domain, although the differences were considerably smaller (0.3 - 0.4 m) in the vicinity of Project levees, which is less than the available freeboard. This is understood to be due to the hydraulic structures in the vicinity of the Project levees having a greater control on nearby flood levels. In particular, the Alluvial Lands levee begins to overtop in the 0.5% AEP flood event, which limits the impact of increased floodplain roughness in the upstream areas for events exceeding the 0.5% AEP (including the adopted levee design flood event). It is noted that overtopping of the Alluvial Lands levee is not high consequence as the area behind the levee has been backfilled and rehabilitated (i.e. no active mine pit or infrastructure).

The sensitivity assessment was presented to the BMT Peer Reviewer and no further sensitivity assessment was requested.

Further details with reference to adopted design flood levels and vegetation at the Carrington Billabong are included in Section 5.3.2.

5.3.1 Adopted Design Flood Levels

As stated in the SWIA (Engeny, 2025):

- The flood protection levees will be designed and constructed to provide a minimum flood protection up to the 0.1% AEP design flood event plus freeboard during the operational period of the Project.
- Levees that remain at closure will generally be incorporated into the final landform with flood protection for the final voids provided up to the Extreme Flood Event.

The adopted flood protection standards meet or exceed previous HVO approvals where most levees have had 1% AEP immunity (e.g. Carrington West Wing Levee and SLP 1). Consequently, the Project improves pit flood immunity relative to the Project Baseline scenario.

In the vicinity of the Project levees, there is an average difference of approximately 3.2 m between the 1% and 0.1% AEP flood level and 2.4 m between the 0.1% AEP and Extreme Event flood level. The adoption of higher design flood events for setting levee crests results in greater conservatism in design level than would be indicated from the Manning's roughness sensitivity (refer to Section 5.2.2). Detailed design of the flood levees will use the flood model results from the Project approvals.

5.3.2 Increased Vegetation at the Carrington Billabong

It has been identified that the Carrington Billabong has both recent and planned vegetation establishment near the Hunter River, and as such these changes were identified as having potential to impact the flood modelling assessment.

An inspection of the flood mapping for this area illustrates that the Carrington Billabong is located in an area of low velocity floodplain storage (refer to Figure 5.2) with velocities in this area less than 1 m/s in the 0.1% AEP flood event. The potential impacts of vegetation in this area is considered to be low, as areas of low velocity floodplain storage have lower sensitivity to increases in roughness through vegetation establishment.

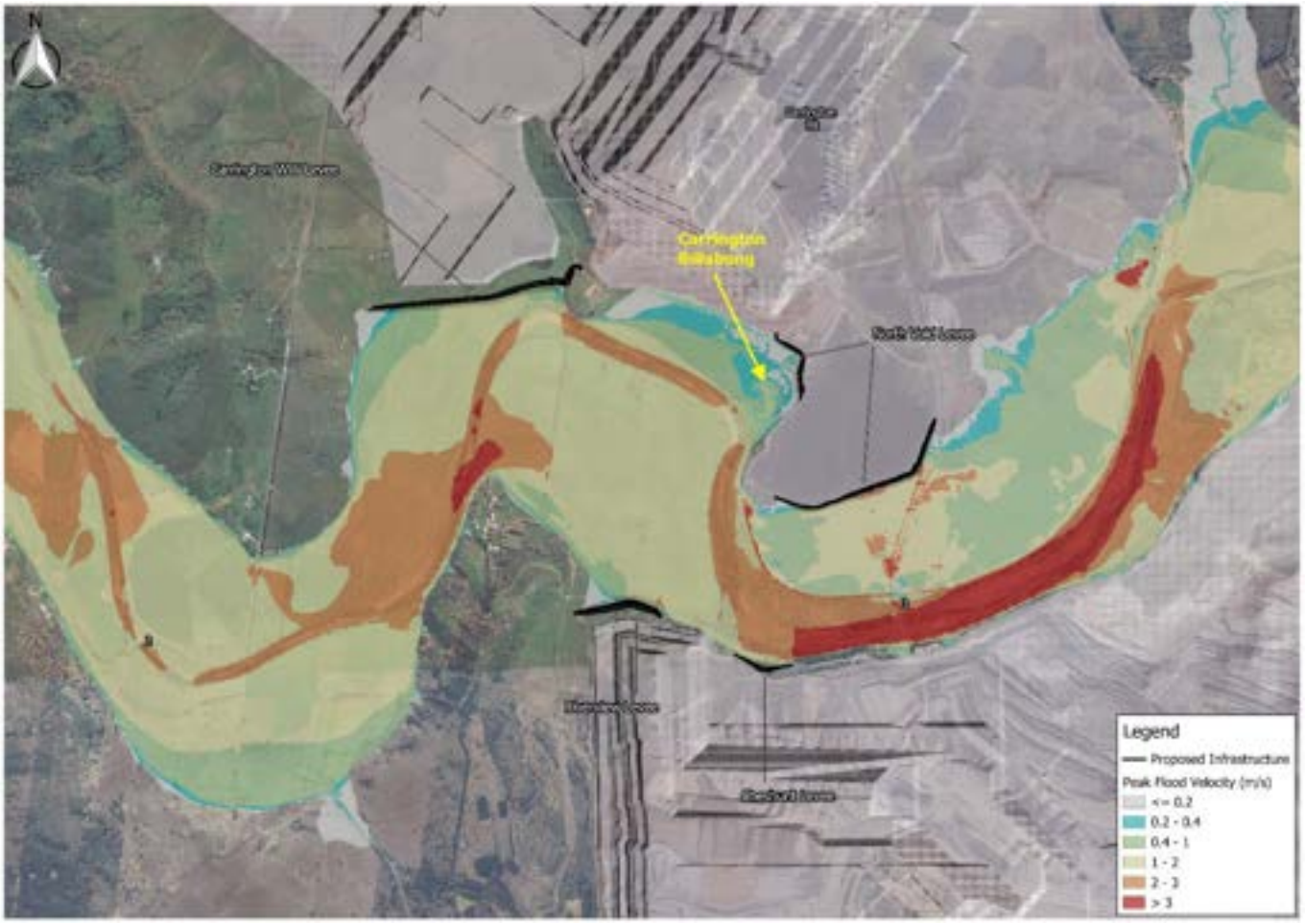


Figure 5.2: Carrington Billabong 0.1% AEP Velocity

6. COMPARISON TO BMT RESULTS

In addition to the calibration process described in Section 3.2, the Project flood model was compared to the flood modelling documented in the Draft Singleton Floodplain Risk Management Study and Plan (BMT, 2022) developed on behalf of Singleton Council. Since the comparison was undertaken the Council Study has been finalised (BMT, 2023). Comparison to the Council study indicates that the two studies had a broadly similar methodology with some notable differences:

- Both prioritise statistical models for Hunter River flow estimation (i.e. FFA).
- The Council study used hydrology model for residual catchment inflow (downstream of Jerrys Plains) while the Project study used a residual hydrograph method.
- The Council study used a factor of 3 x 1% AEP to define the Extreme Event, whereas the Project study used a factor of 4 x 1% AEP.
- Both studies use the TUFLOW hydraulic software. Differences are evident in the level of detail, extent and Manning's roughness values adopted.
- Both prioritise calibration to the 2007 event with validation to the 1955 event.
- Focal area differed:
  - The Project study focused on the area near the mine and extent of expected impacts. Greater emphasis on calibration to Liddell and nearby level gauges.
  - The Council study covers the full LGA but with greatest emphasis on urban area of Singleton. Greater emphasis on calibration to Singleton flows and levels.

Differences in the study outcomes include:

- Peak flows adopted by the Council study are higher than those adopted by the Project study (refer to Table 6.1).
- Due to lower floodplain roughness, resulting flood levels are higher for the Project study. The main difference in Manning's roughness between the studies is that while the Council study adopted a floodplain roughness of 0.04, the Project study adopted a value of 0.05.
- A comparison of flood levels for the 1% AEP design event (i.e. the Defined Flood Event (DFE) for Singleton Council) is illustrated in Figure 6.1 and Figure 6.2. The figures show:
  - Georeferenced images of the PDF draft flood maps provided by Council.
  - Project 1% AEP Flood Extent (blue line).
  - Six locations where the Council figures show specific levels (i.e. at contour colour band changes) are listed in Table 6.2 and compared to the Project flood data.
- The data comparison indicates that the Project flood levels range between 0.1 to 1.0 m above the Council flood levels. The difference is approximately 1 m in the lower reaches (Long Point to the mapping limit) and 0.2 to 0.5 m in the vicinity of the Project levees (i.e. location A and B).
- In particular, it is noted that the Project flood levels are conservative (i.e. higher) relative to the Council study for the 1% AEP.

TABLE 6.1: COMPARISON OF PEAK FLOW ESTIMATES AT LIDDELL (COUNCIL VS PROJECT)

AEP	Council (modelled)	Singleton Council (FFA)	Project
10% (1:10)	2,614	1,970	2,420
5% (1:20)	3,973	3,380	3,578
2% (1:50)	6,450	6,160	5,465
1% (1:100)	8,311	9,140	7,164
0.5% (1:200)	11,012	13,090	9,094
0.2% (1:500)	15,154	20,120	11,996
Extreme Event	25,070		28,656

TABLE 6.2: 1% AEP FLOOD LEVEL COMPARISON (COUNCIL VS PROJECT)

Location	Council (mAHD)	**Project** (mAHD)	Level Difference (m)
A	75	75.4 to 75.5	0.4 to 0.5
B	70	70.2 to 70.3	0.2 to 0.3
C	65	65.1 to 65.2	0.1 to 0.2
D	60	60.5	0.5
E	55	55.9 to 56.0	0.9 to 1.0

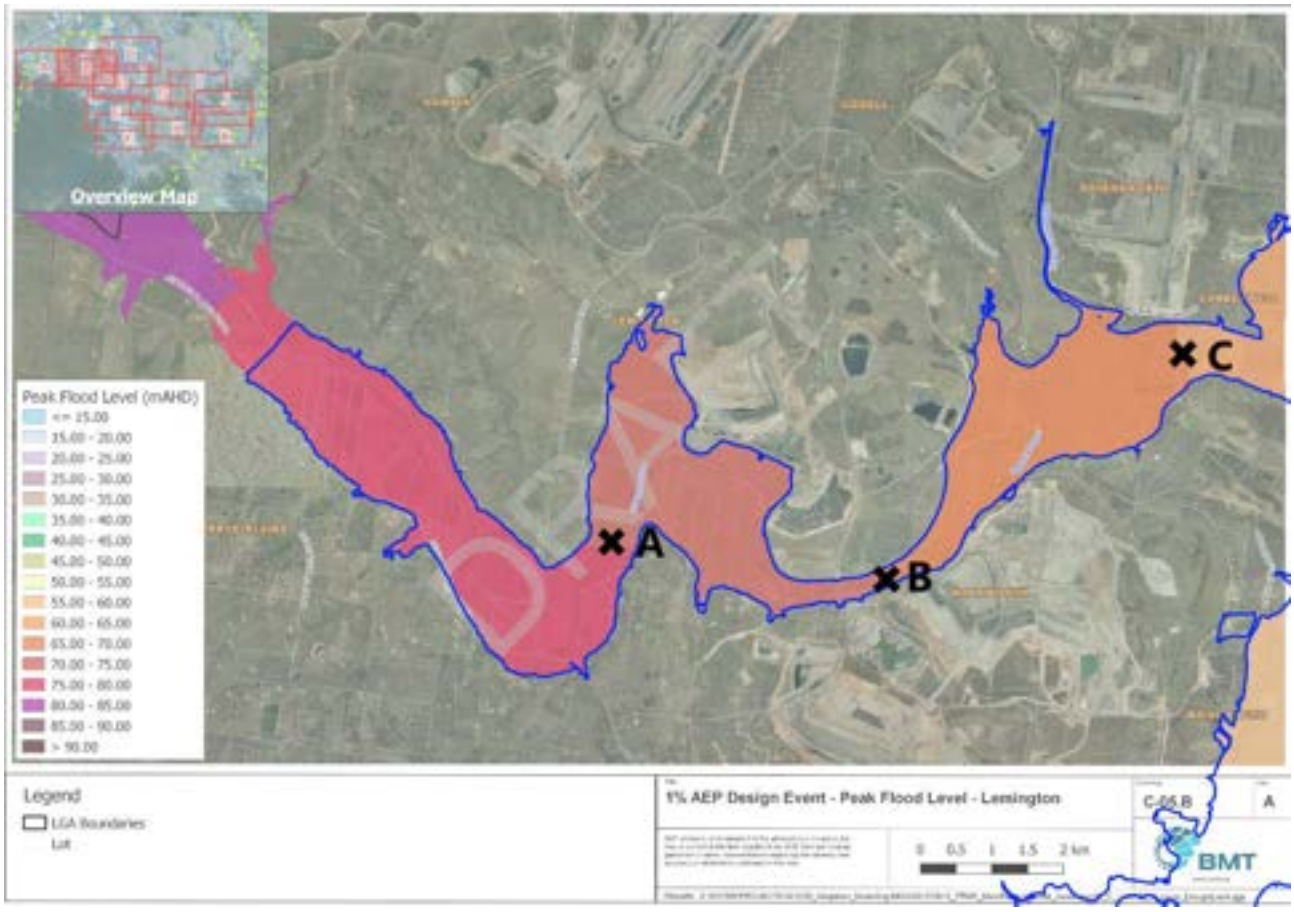


Figure 6.1: Comparison Points, Project Flood Extent (Blue Outline) and Singleton Council Draft 1% AEP Flood Map - Lemington

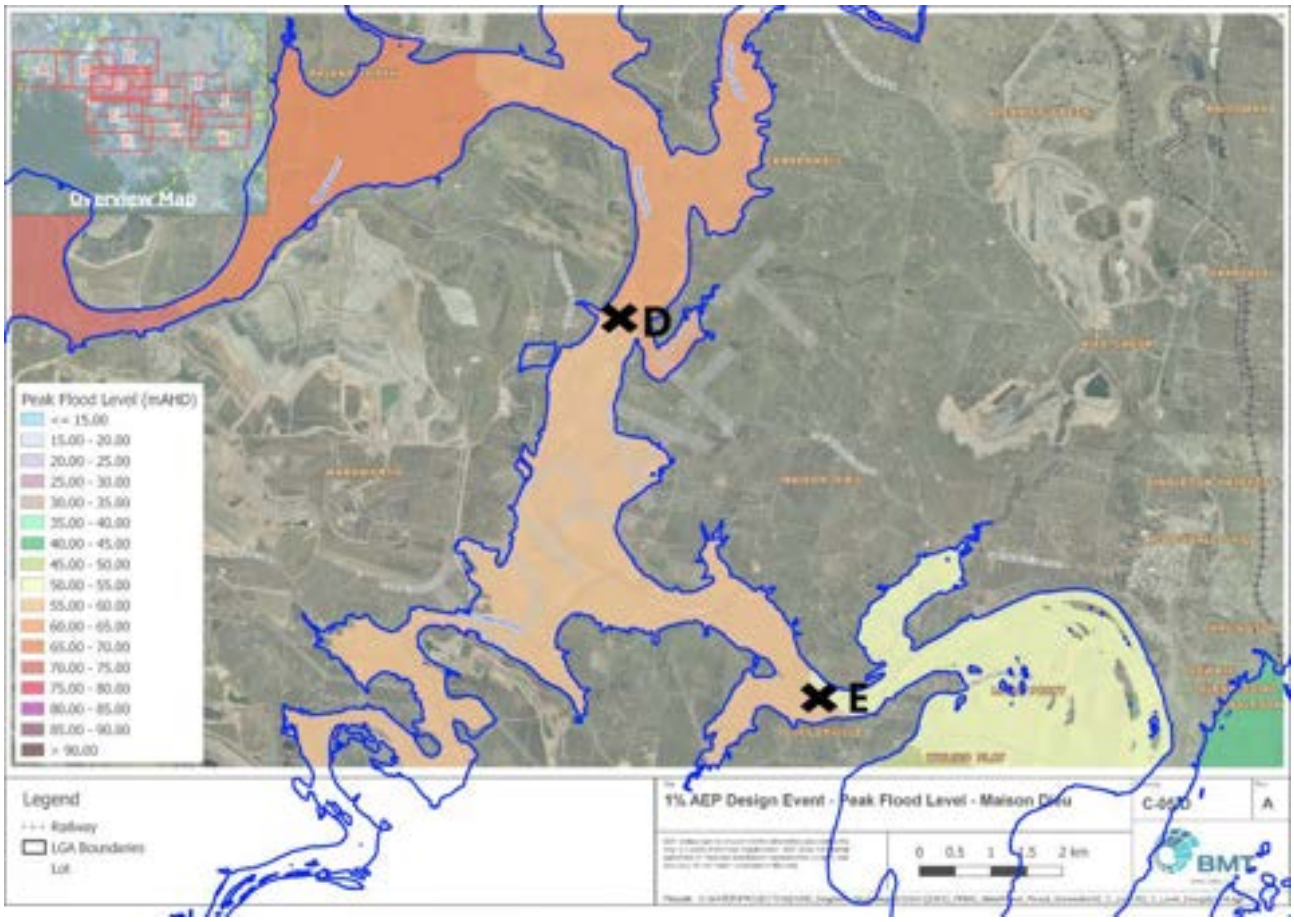


Figure 6.2: Comparison Points, Project Flood Extent (Blue Outline) and Singleton Council Draft 1% AEP Flood Map – Maison Dieu

7. LIMITATIONS

An additional peer review process was undertaken by Torrent at the request of NSW DHPI (refer to Section 1). The review was generally supportive of the assessment. Two limitations were identified as key limitations of the assessment undertaken. These are potentially underestimated flows, and topographic modifications. Both these limitations are discussed in further detail in Sections 7.1 and 7.2.

7.1 Potentially Underestimated Flows

It is acknowledged that there is considerable uncertainty in design flood hydrology in general due to limitations in the accuracy and duration of the historical record as well as the accuracy of stage-discharge rating curve relationships and the influence of upstream development (e.g. construction of large water storage dams) over time. Further comparison of outcomes between the Project flood assessment and the latest Council flood study (BMT, 2022) was undertaken. Comparison of peak flows between the studies is provided in Table 6.1 and indicates the Project flows are typically within 10% to 15% of the Council flood study flows, which is commonly considered to be a reasonable level of consistency for similar hydrology studies.

While design flow estimates are lower for the Project study compared to the Council flood study, the resulting flood levels for the Project study are higher throughout the model domain (refer Table 6.2, Figure 6.1 and Figure 6.2). On further investigation, it is evident that this is due to the lower floodplain Manning's roughness value adopted in the Council flood study. Further adjustment of Project design flood hydrographs should not be undertaken without consideration of other model parameters (e.g. Manning's roughness) and any calibration and/or validation undertaken.

It was concluded that design flood level outcomes of the Project study are more conservative relative to the Council flood study and are suitable for informing design levels and infrastructure immunity for the Project. Furthermore, as noted by the NSW DPHI peer review, "it is not expected that inflow refinement would change the overall findings of the impact assessment, being a relative condition" (refer to Peer Review Reports included in the Water resources impact assessment (EMM, 2025).

7.2 Topographic Modifications

It is acknowledged that given the 8 m cell size of the TUFLOW model, direct import of design DEMs may have resulted in some underestimation of crest levels for certain Project infrastructure (e.g. flood protection levees and the Lemington Road realignment). Further review has been undertaken to consider potential implications for the assessment.

7.2.1 General considerations

As noted by the NSW DPHI peer reviewer, "the adopted model grid resolution of 8 m may not explicitly define the contiguous crest levels of narrow linear features such as levees and road embankment where they are read into the model directly via a DEM surface (1 or 2 m resolution) and have not been reinforced by other 2d_zhape layers." This may result in the modelled terrain underestimating the design crest levels in places where the model cells do not fall directly on the crests of relevant infrastructure. By enforcing these elements, the crest of the modelled terrain would be increased. Consequently, enforcing levee and dam crests would improve modelled flood immunity for these Project elements and could only impact flood outcomes for events that are currently shown to overtop these topographic features.

7.2.2 Carrington West Wing Levee

A review of the TUFLOW model indicates that on average the as-modelled levee crest is approximately 300 mm lower than the design levee crest (design crest width of 4 m) due to the 8 m cell size. During Project operations, the design flood level in the Extreme Event is approximately 900 mm above the as-modelled levee crest (600 mm above the design crest). Further, it is estimated that approximately 140 GL of flood water spills into the pit in this scenario, which is approximately 5% of the total flood volume for the Extreme Event. As a result of these findings, it is evident that enforcing the levee crest in the flood model would reduce the volume of flood ingress to the Carrington West Wing Extension mining area but not achieve flood immunity in the Extreme Event.

Furthermore, the as-modelled results indicate a reduction in downstream flood levels and hazard under the Project Operation scenario as a result of flood ingress to the Carrington West Wing Extension mining area in the Extreme Event. By enforcing the Carrington West Wing Levee and reducing the flood ingress, there would be less reduction in flood levels and hazard relative to the Project Baseline. It is noted that the Project Closure scenario, which incorporates the final landform design (including an emplacement area landform providing flood immunity to North Pit void) and decommissioning of the Carrington West Wing Levee represents a worst-case flood behaviour for the Project. For the Extreme Event, maximum flood levels for the Project Closure scenario are up to 130 mm higher than the Baseline scenario; however, flood immunity of other nearby mine infrastructure (e.g. Riverview Levee) remains as documented in Table 6.2 of the SWIA (Engeny, 2025).

7.2.3 Realigned Lemington Road

Review of model results indicates that the Lemington Road realignment interacts with the Hunter River floodplain at the Hunter River crossing and in some backwater areas on the edge of the flood extent along Wollombi Brook. Small changes in the road crest level within these backwater areas would not materially change flood behaviour and have not been considered further. The primary location of consideration has been the Hunter River crossing.

The Hunter River crossing is formed by two bridge structures with an intermediate section of elevated road causeway. Previous results indicate that the road is immune to flooding in the 10% AEP event and results for the 10% AEP would therefore not be impacted by enforcing the road crest.

Review of the design road cross section indicates that it has a 12 m wide crest with a one-way crossfall through the causeway. While an 8 m cell size may be sufficient to generally capture the road crest, it does not capture the variation in level due to the one-way crossfall. Further review of the model indicates that on average the as-modelled road crest is approximately 170 mm lower than the maximum design road crest as a result of the 8 m cell size.

The portion of the Hunter River flow that overtops the causeway is presented in Table 7.1 for events up to and including the 1% AEP (i.e. the event adopted by Council for setting the Flood Planning Level). In addition, the estimated cross-sectional flow area over the as-modelled road crest and the design road crest (assuming no change in upstream water level) have been compared in Table 7.2. The tables indicates that most of the flow is conveyed through the bridge openings, particularly in smaller overtopping events. The potential impact of enforcing the road crest on the portion of flow over the causeway can be inferred by the reduction in cross-sectional flow area from the as-modelled road crest to the design crest. The results indicate that as the portion of flow over the causeway increases in progressively larger floods, the impact on flow area over the causeway becomes progressively smaller.

As a result of this finding, it is expected that enforcing the causeway crest would not materially change the flood impact assessment.

TABLE 7.1: FLOW OVER REALIGNED LEMINGTON ROAD COMPARED TO TOTAL FLOW

AEP	Total Flow (m^3/s)	Flow over road (m^3/s)	Flow over road (%)
5% (1:20)	3,498	48	1%
2% (1:50)	5,349	743	14%
1% (1:100)	7,016	1,809	26%

TABLE 7.2: CROSS SECTIONAL FLOW AREA FOR REALIGNED LEMINGTON ROAD OVERTOPPING FLOW

AEP	As-modelled flow area (m^2)	Design flow area (m^2)	Reduction
5%	59	32	-47%
2%	420	345	-18%
1%	736	656	-11%

7.2.4 Conclusions

Based on the further consideration undertaken, it is concluded that while enforcing the crest level of narrow topographic features (levees, dams, roads) would provide a more accurate representation in the flood model, it is not expected to materially change the flood assessment results and findings. This is consistent with the findings of the NSW DPHI peer review, which notes "any refinement in this regard is not expected to fundamentally change the flood assessment, but confirm local conditions."

8. 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:

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  (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.

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(g) This Report does not provide legal advice.

9. REFERENCES

Austroads. (2023). *Guide to Road Design Part 5: Drainage – General and Hydrology Considerations.*

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

BMT. (2022). *Singleton Floodplain Risk Management Study and Plan - Draft.*

BMT. (2023). *Singleton Floodplain Risk Management Study and Plan.*

BMT WBM. (2016). *Wollombi Brook Flood Study. Report to Singleton Shire Council.*

CSIRO. (2015). *Climate Change in Australia Technical Report.*

DHI. (2008). *Upgrading of Lower Hunter Flood Model at Hexham - Final Report Phase 4. Report to Newcastle City Council.*

EMM. (2022). *Hunter Valley Operations Continuation Project Environmental Impact Statement.*

EMM. (2025). *HVO Continuation Project - Water resources impact assessment.*

Engeny. (2022). *HVO Continuation Project - Surface Water Impact Assessment.*

Engeny. (2025). *Hunter Valley Operations Continuation Project, Surface Water Impact Assessment.*

NSW Roads and Maritime Services. (2019). *Singleton Bypass – Technical Working Paper: Surface and Groundwater Assessment.*

Umwelt. (2016). *Flood Assessment - Wollombi Brook. Report to United Collieries.*

WBM Oceanics Australia. (2007). *Singleton Flood Study Final Report. Report to Singleton Shire Council.*

WorleyParsons. (2009). *Ashton Coal Southeast Open Cut Project Surface Water Assessment. Report to Ashton Coal Operations.*

APPENDIX A: FFA SENSITIVITY ASSESSMENT

A.1 Singleton (21001) FFA Sensitivity – Outliers

- Assessed impact of removing low flow outliers with an adopted minimum flow threshold of 25 m^3/s. This resulted in exclusion of the four smallest flows from the 107-year annual series.
- Removal of these low flow outliers resulted in an increase in design flows (refer to Table A1), with the greatest impact for larger flood magnitudes.
- The fitted LP3 distribution was found to get worse for large events due to a change in the inflection of the curve (refer Figure to A1).
- As shown in Figure A2, the low outlier sensitivity flows are within the confidence limits of the base case distribution.
- The magnitude of the difference in the low flows and the reduced accuracy of the fitted distribution does not justify removing low flows.
- The full data set has been maintained for the adopted flood frequency analysis.

TABLE A1: SINGLETON (210001) FFA SENSITIVITY - OUTLIERS

AEP	Design Flows – All Data (m^3/s)	Design Flows – Low Outliers Removed (m^3/s)	Percentage Difference
10%	2,739	2,763	0.9%
5%	4,169	4,387	5.2%
2%	6,501	7,369	13.4%
1%	8,599	10,403	21.0%
0.5%	10,984	14,254	29.8%
0.2%	14,570	20,862	43.2%
0.1%	17,605	27,237	54.7%

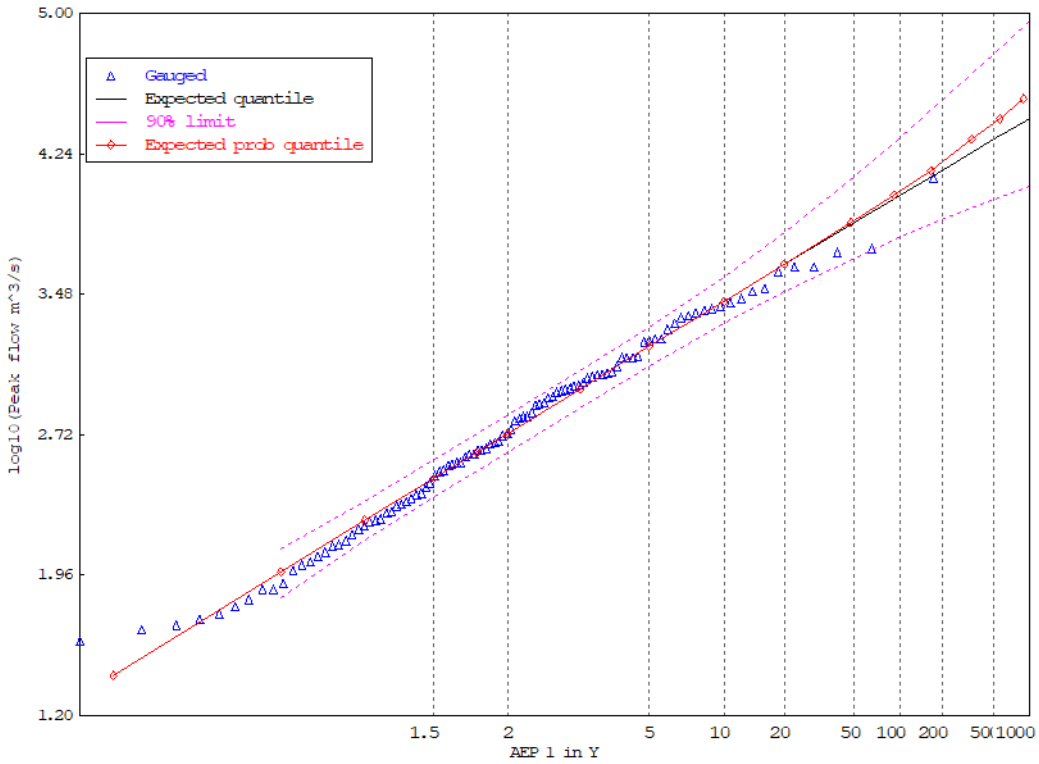


FIGURE A1: SINGLETON (210001) FFA SENSITIVITY – OUTLIERS

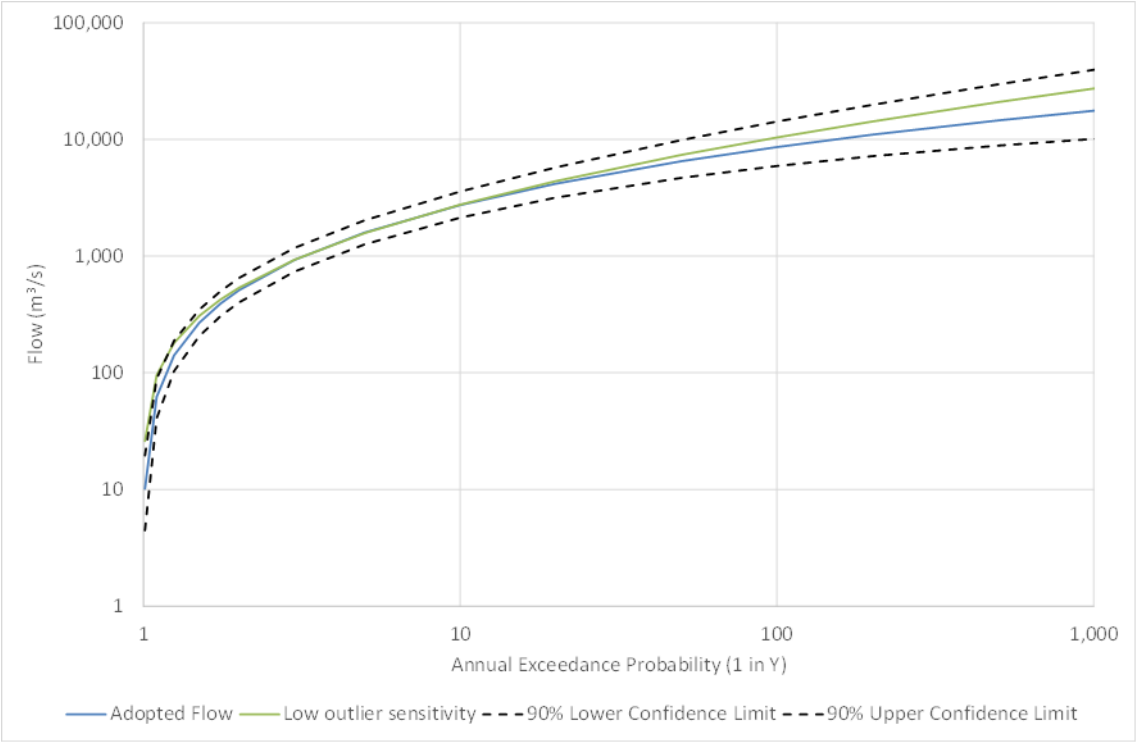


FIGURE A2: SINGLETON (210001) FFA WITH CONFIDENCE BOUNDS AND OUTLIER SENSITIVITY

A.2 Singleton (210001) FFA Sensitivity – Water Year

- The occurrence of flood events is reasonably well distributed throughout the year. A sensitivity analysis has been undertaken on the start of the water year (July, January and October) (refer Table A2).
- The differences are negligible within the plotted confidence limits (refer Figure A3).
- It is understood that the previous Singleton Council study (WBM 2007) adopted a January – December water year.
- A January – December water year has been maintained.

TABLE A2: SINGLETON (210001) FFA SENSITIVITY – WATER YEAR SENSITIVITY

AEP	Jan – Dec (Adopted) (m^3/s)	Jul - Jun (m^3/s)	Oct - Sep (m^3/s)
10%	2,739	2,746	2,655
5%	4,169	4,129	4,075
2%	6,501	6,317	6,439
1%	8,599	8,226	8,612
0.5%	10,984	10,338	11,128
0.2%	14,570	13,416	14,998
0.1%	17,605	15,941	18,345

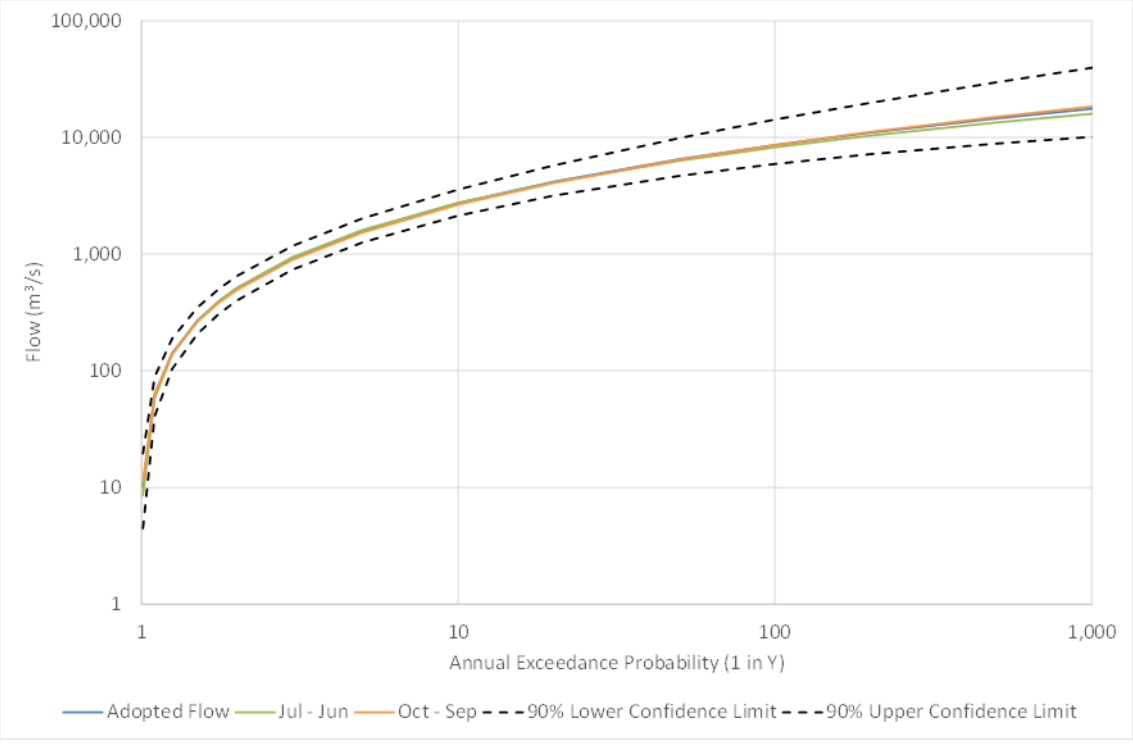


FIGURE A3: SINGLETON (210001) FFA WITH CONFIDENCE BOUNDS AND WATER YEAR SENSITIVITY

A.3 Liddell Flow Comparison and Singleton Period of Record Sensitivity

- Singleton FFA results scaled to Liddell using the peak flow relationship derived in 2.4.1 give a lower design flow estimate compared to the Liddell FFA (refer Table A3).
- A comparison has been undertaken using a consistent period of record (i.e., the 50 years of overlap with Liddell) to check consistency of this trend. As shown in Table A3, using a consistent period of record results in even lower estimates for the events of interest for this study.
- The three sets of design flow estimates at Liddell are plotted along with the Liddell FFA confidence limits in Figure A4. The flow estimates for the scaled Singleton FFA using the full record compare well to the Liddell FFA.
- The FFA derived for Singleton (210001) is more accurate due to the longer period of record, tighter confidence bounds and larger gauged flows than Liddell (210083).
- The design flow estimates derived by scaling the full flow record from Singleton to Liddell have been adopted for this study.

TABLE A3: LIDDELL FLOW COMPARISON AND SINGLETON PERIOD OF RECORD SENSITIVITY

AEP	Liddell FFA (m^3/s)	Singleton (Full) FFA Scaled to Liddell (m^3/s)	Singleton (consistent 50yr record) FFA scaled to Liddell (m^3/s)
10%	2,147	2,420	2,221
5%	3,435	3,578	3,122
2%	5,630	5,465	4,395
1%	7,670	7,164	5,383
0.5%	10,041	9,094	6,370
0.2%	13,681	11,997	7,646
0.1%	16,810	14,453	8,574

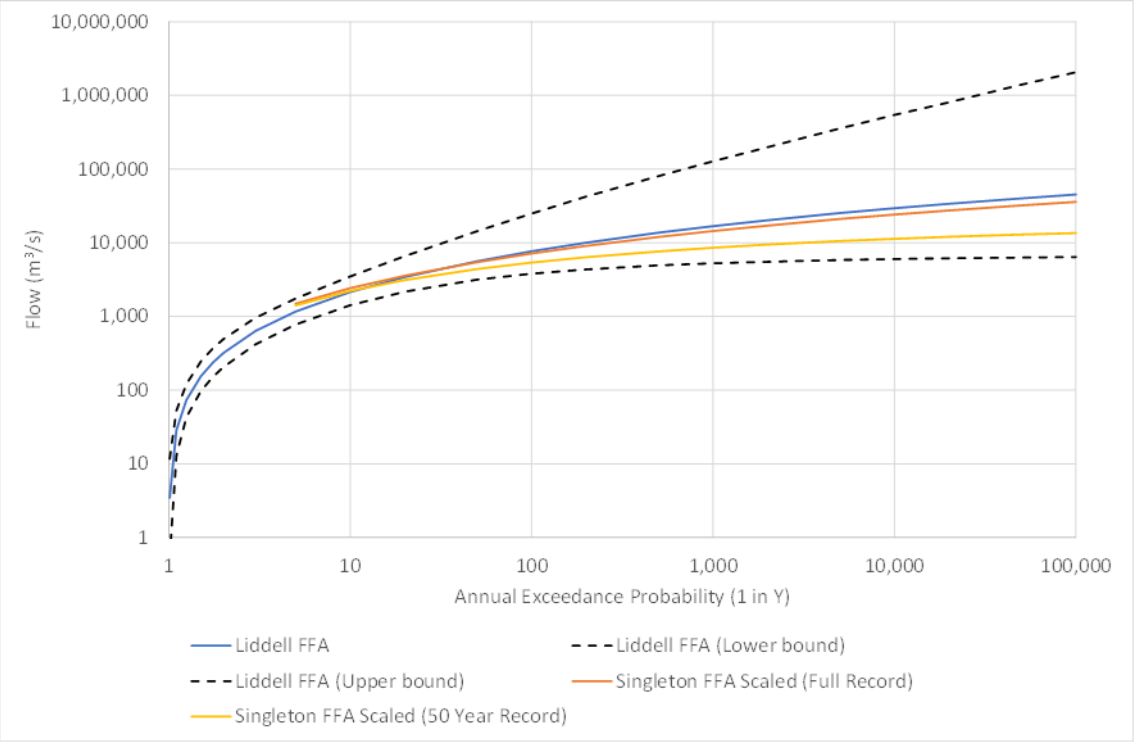


FIGURE A4: LIDDELL (210083) FFA WITH CONFIDENCE BOUNDS AND SCALED SINGLETON FLOW ESTIMATES

ATTACHMENT D: DESIGN FLOOD MAPS

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D1 - 10% AEP - Flood Depth - Baseline

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Revision: 0
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Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
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5	U/S Foy Brook Gauge
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14	Long Point Gauge

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Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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Scale in metres (1:72,000@ A3)

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Figure D2 - 5% AEP - Flood Depth - Baseline

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UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Depth (m)

- <= 1
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Map Projection: Tranverse Mercator
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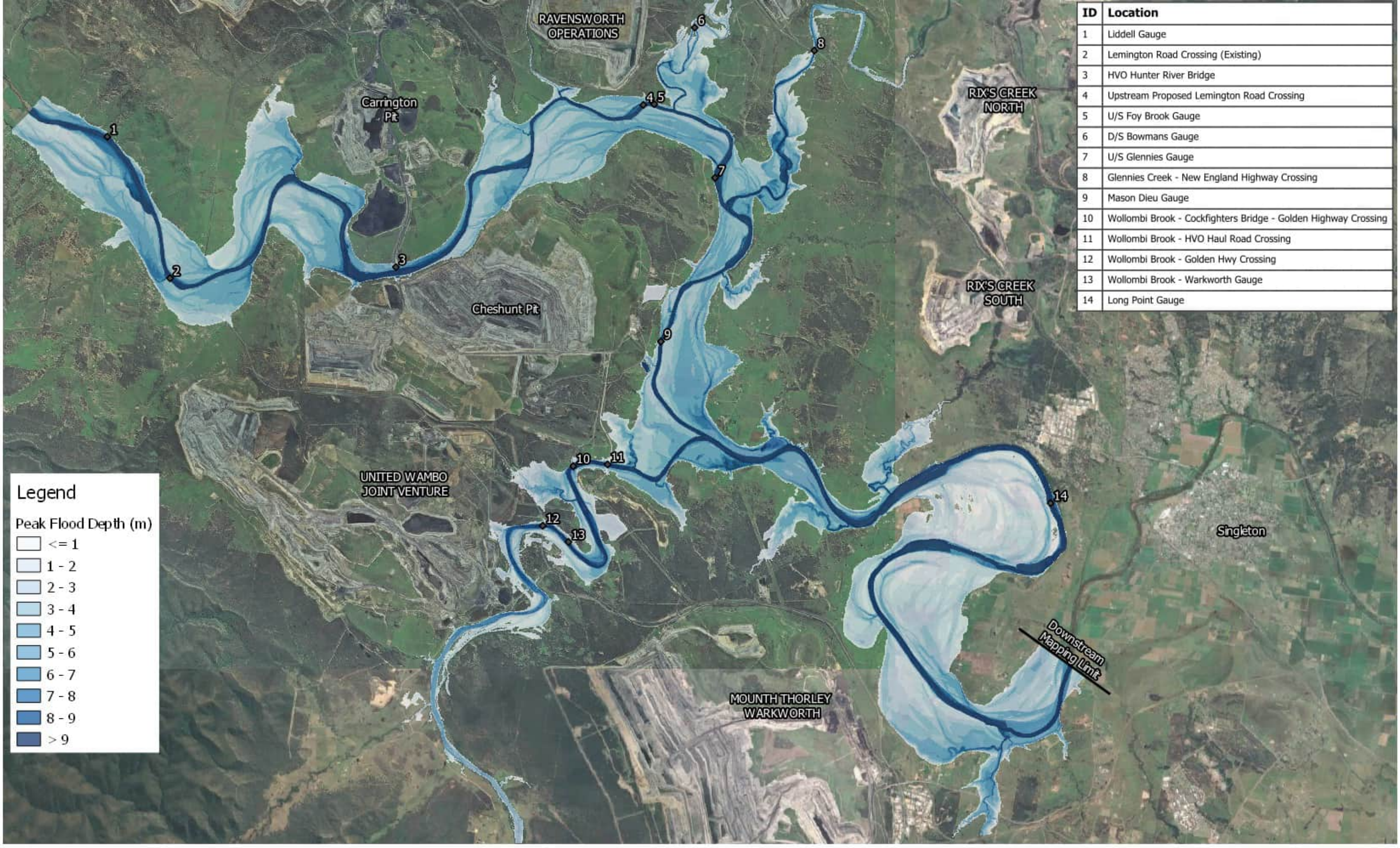
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Figure D3 - 2% AEP - Flood Depth - Baseline

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Scale in metres (1:72,000@ A3)

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Figure D4 - 1% AEP - Flood Depth - Baseline

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Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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Figure D5 - 0.5% AEP - Flood Depth - Baseline

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Cheshunt Pit
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
Singleton
Downstream Mapping Limit
MOUNTH THORLEY WARKWORTH

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D6 - 0.2% AEP - Flood Depth - Baseline

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
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Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
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- 8 - 9
- > 9

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N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D7 - 0.1% AEP - Flood Depth - Baseline

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Revision: 0
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ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
RIX'S CREEK NORTH
Cheshunt Pit
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
Singleton
Downstream Mapping Limit
MOUNTH THORLEY WARKWORTH

Legend

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D8 - Extreme Event - Flood Depth - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D9 - 10% AEP - Flood Velocity - Baseline

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D10 - 5% AEP - Flood Velocity - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D11 - 2% AEP - Flood Velocity - Baseline

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D12 - 1% AEP - Flood Velocity - Baseline

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D13 - 0.5% AEP - Flood Velocity - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
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4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D14 - 0.2% AEP - Flood Velocity - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

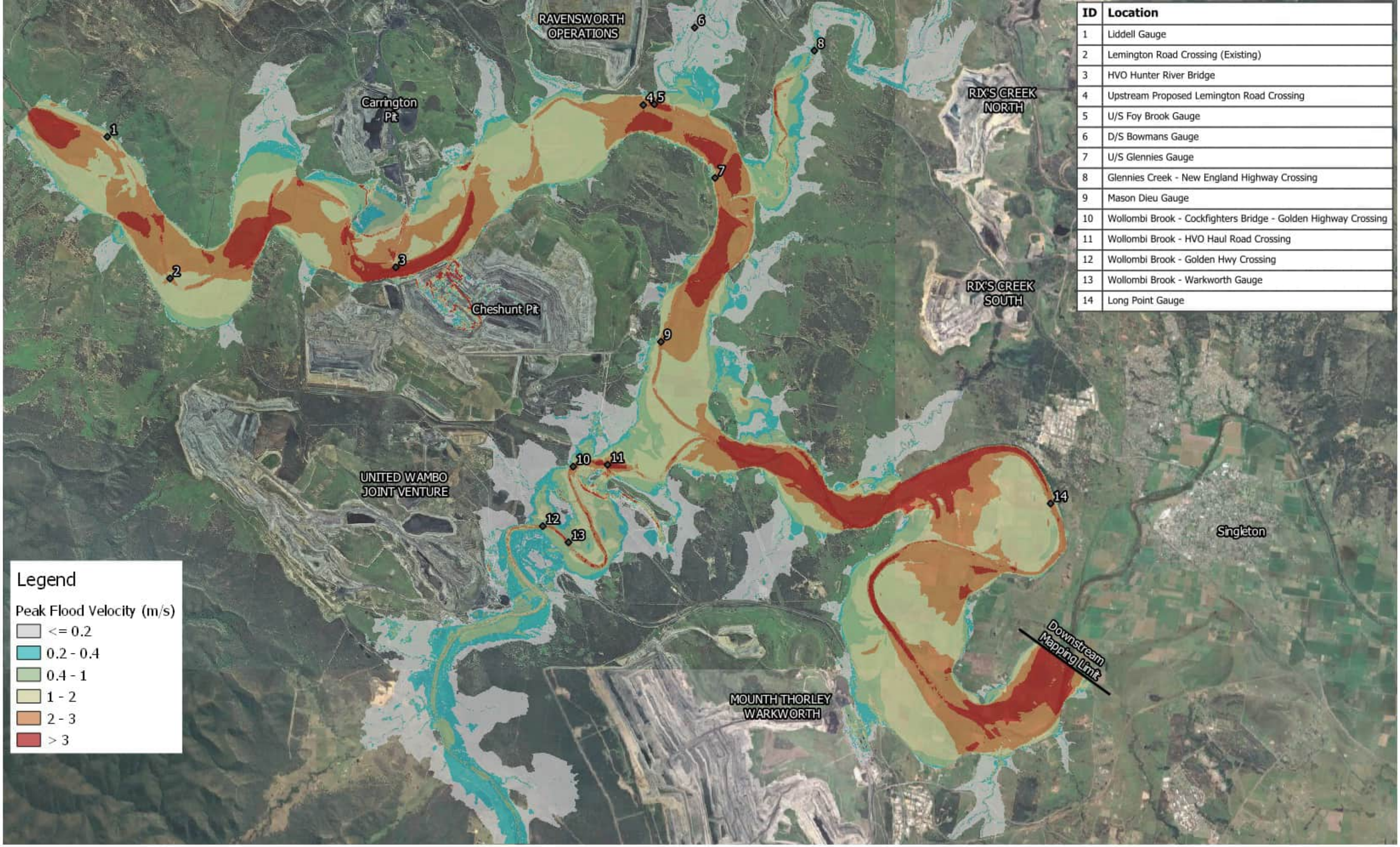
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Figure D15 - 0.1% AEP - Flood Velocity - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D16 - Extreme Event - Flood Velocity - Baseline

Engeny does not give any warranty nor accept any liability in relation to the correctness or accuracy of the maps, which may be inherently reliant upon the correctness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Singleton
MOUNTH THORLEY WARKWORTH
Downstream Mapping Limit

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D17 - 10% AEP - Flood Hazard - Baseline

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
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4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D18 - 5% AEP - Flood Hazard - Baseline

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
RIX'S CREEK NORTH
Cheshunt Pit
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
Singleton
Downstream Mapping Limit
MOUNTH THORLEY WARKWORTH

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D19 - 2% AEP - Flood Hazard - Baseline

Engeny does not give any warranty nor accept any liability in relation to the correctness or accuracy of the maps, which may be inherently reliant upon the correctness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Singleton
MOUNTH THORLEY WARKWORTH
Downstream Mapping Limit

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D20 - 1% AEP - Flood Hazard - Baseline

Engeny does not give any warranty nor accept any liability in relation to the correctness or accuracy of the maps, which may be inherently reliant upon the correctness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Singleton
MOUNTH THORLEY WARKWORTH
Downstream Mapping Limit

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D21 - 0.5% AEP - Flood Hazard - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
RIX'S CREEK NORTH
Cheshunt Pit
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
Singleton
Downstream Mapping Limit
MOUNTH THORLEY WARKWORTH

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D22 - 0.2% AEP - Flood Hazard - Baseline

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
RIX'S CREEK NORTH
Cheshunt Pit
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
Singleton
Downstream Mapping Limit
MOUNTH THORLEY WARKWORTH

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D23 - 0.1% AEP - Flood Hazard - Baseline

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

AEM Flood Hazard Rating
- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D24 - Extreme Event - Flood Hazard - Baseline

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
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8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

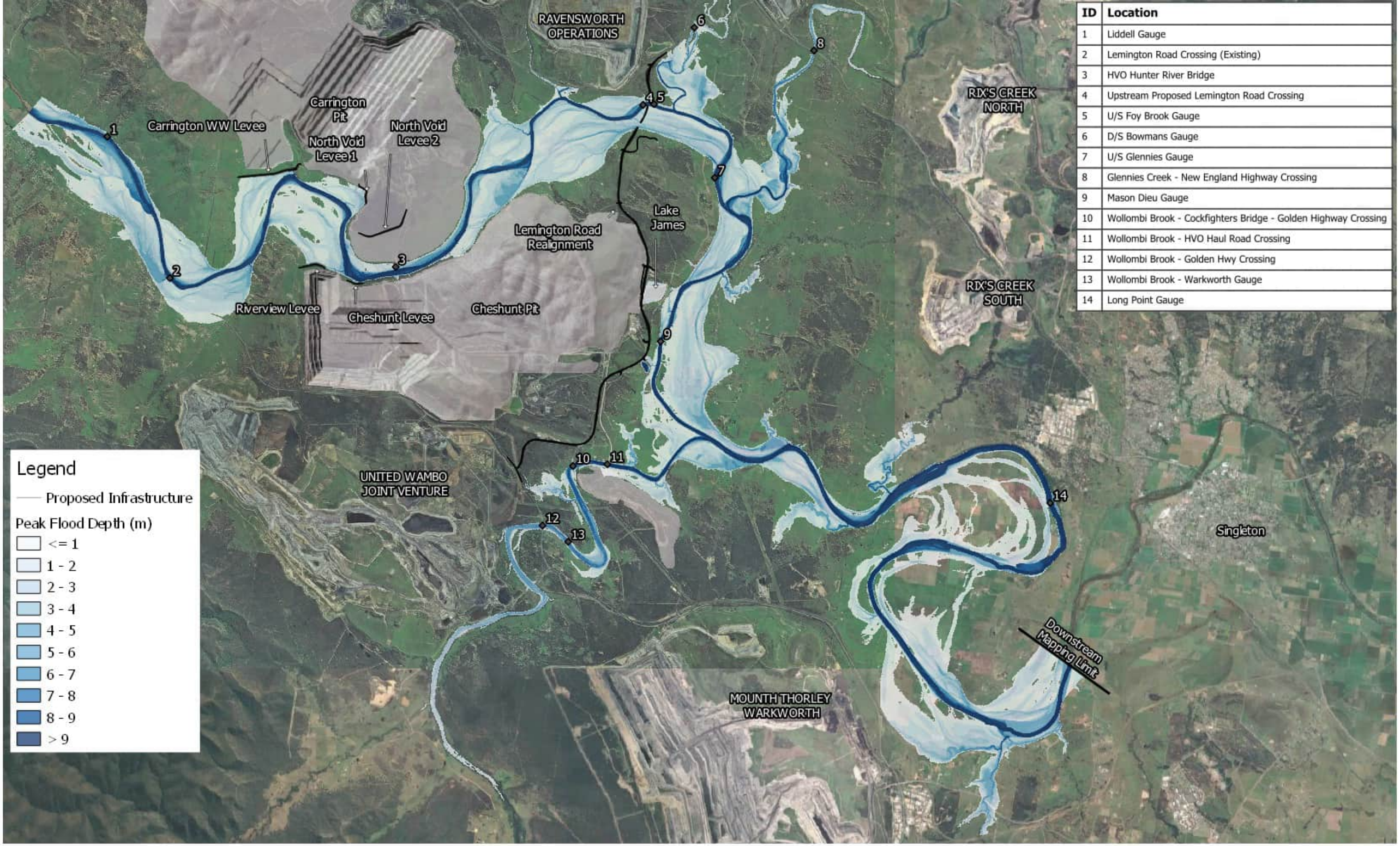
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Figure D25 - 10% AEP - Flood Depth - Project (Operations)

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
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5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

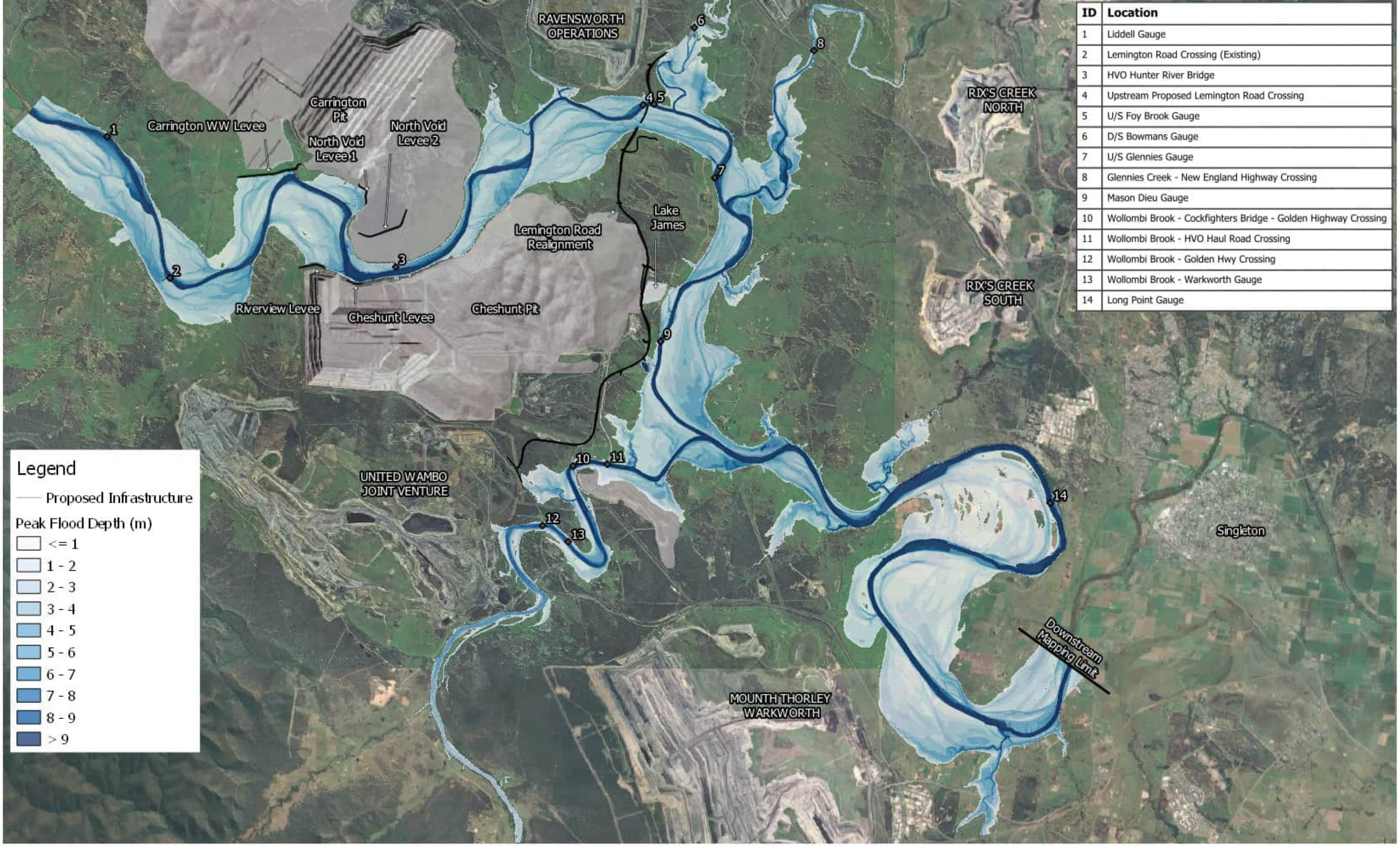
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Figure D26 - 5% AEP - Flood Depth - Project (Operations)

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
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8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

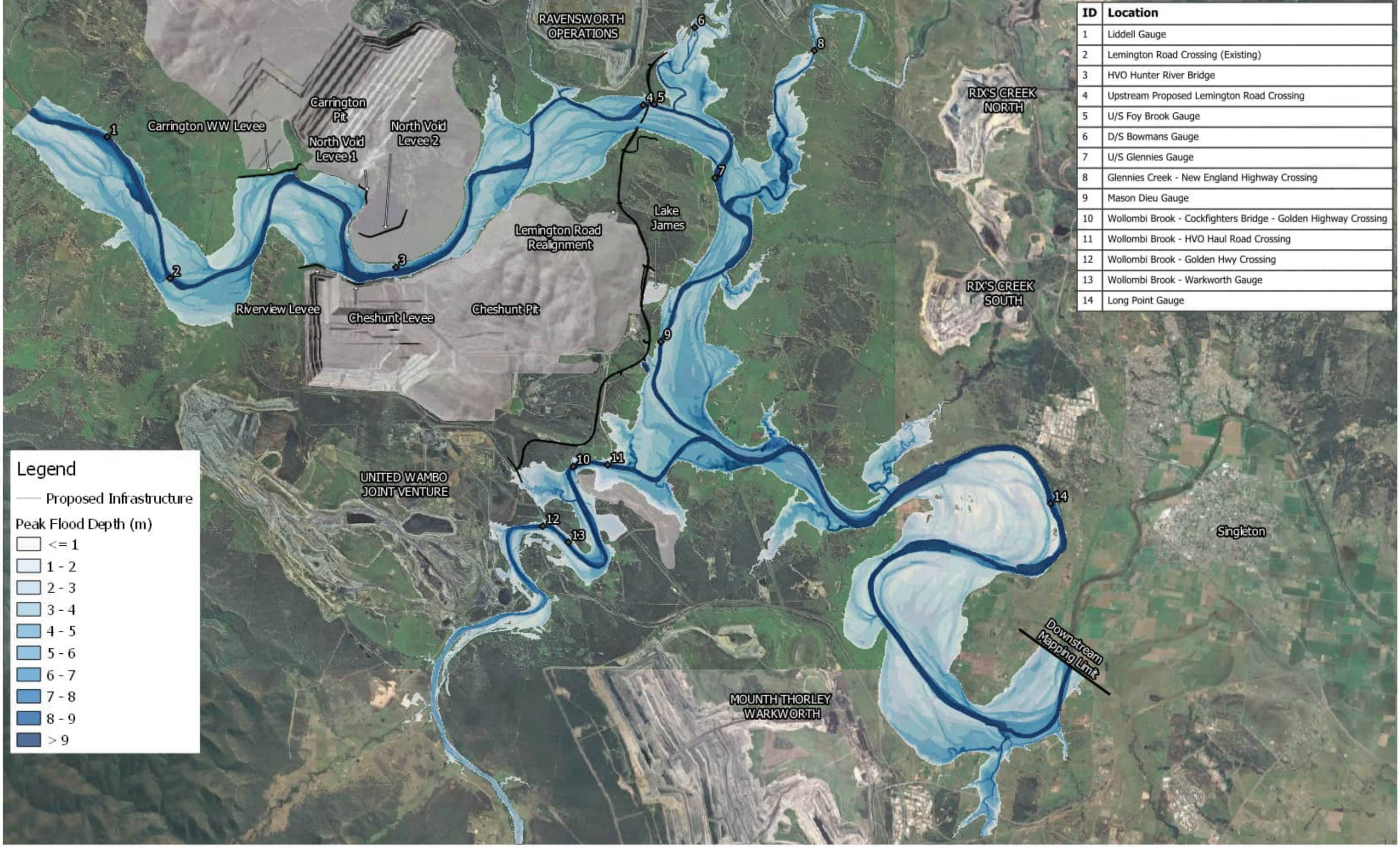
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Figure D27 - 2% AEP - Flood Depth - Project (Operations)

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Revision: 0
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Checked: SF
Date: 18 /11 /2022



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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

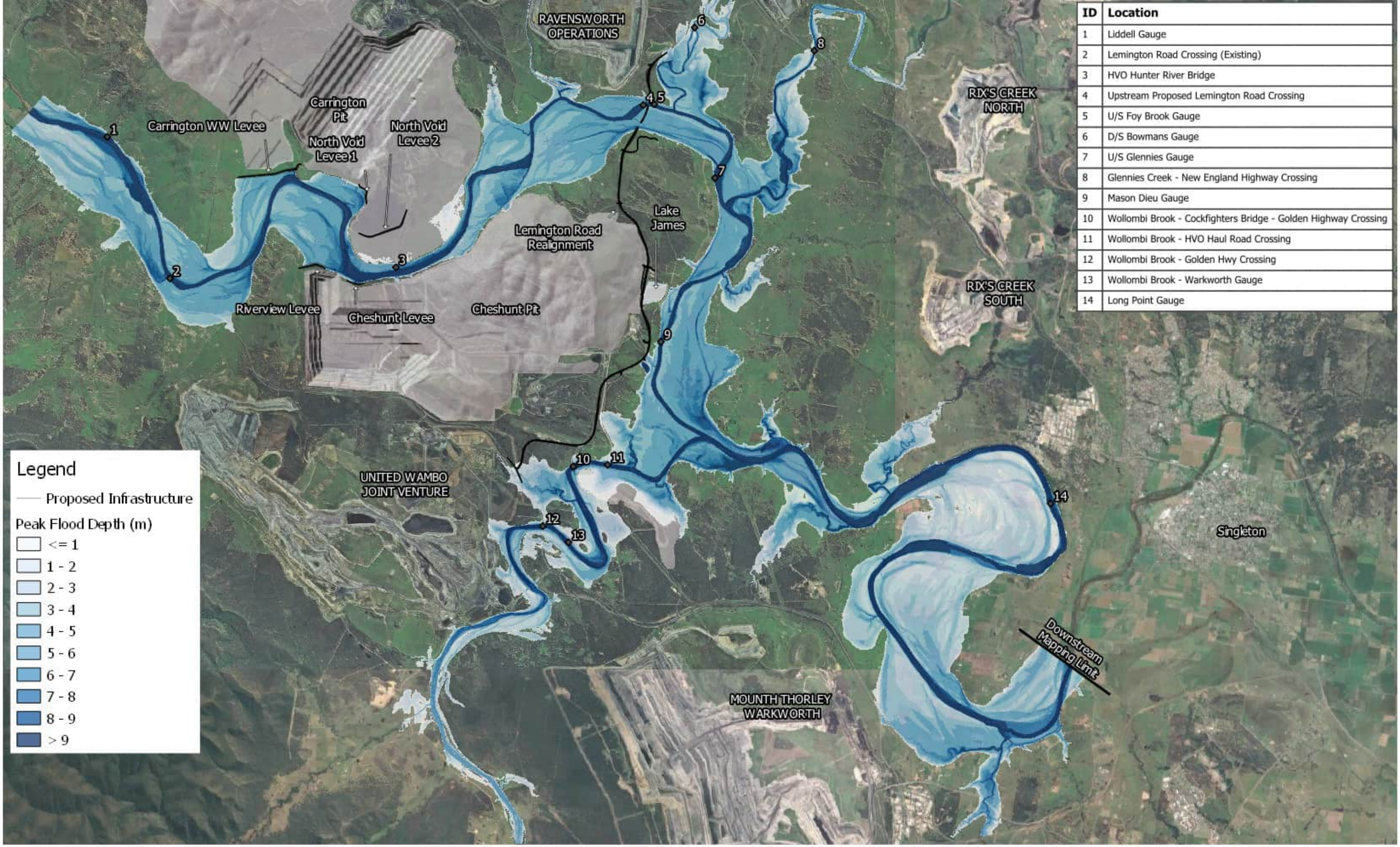
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Figure D28 - 1% AEP - Flood Depth - Project (Operations)

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10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D29 - 0.5% AEP - Flood Depth - Project (Operations)

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Revision: 0
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Checked: SF
Date: 18 /11 /2022

ID	Location
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9	Mason Dieu Gauge
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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D30 - 0.2% AEP - Flood Depth - Project (Operations)

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6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lake James
Lemington Road Realignment
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

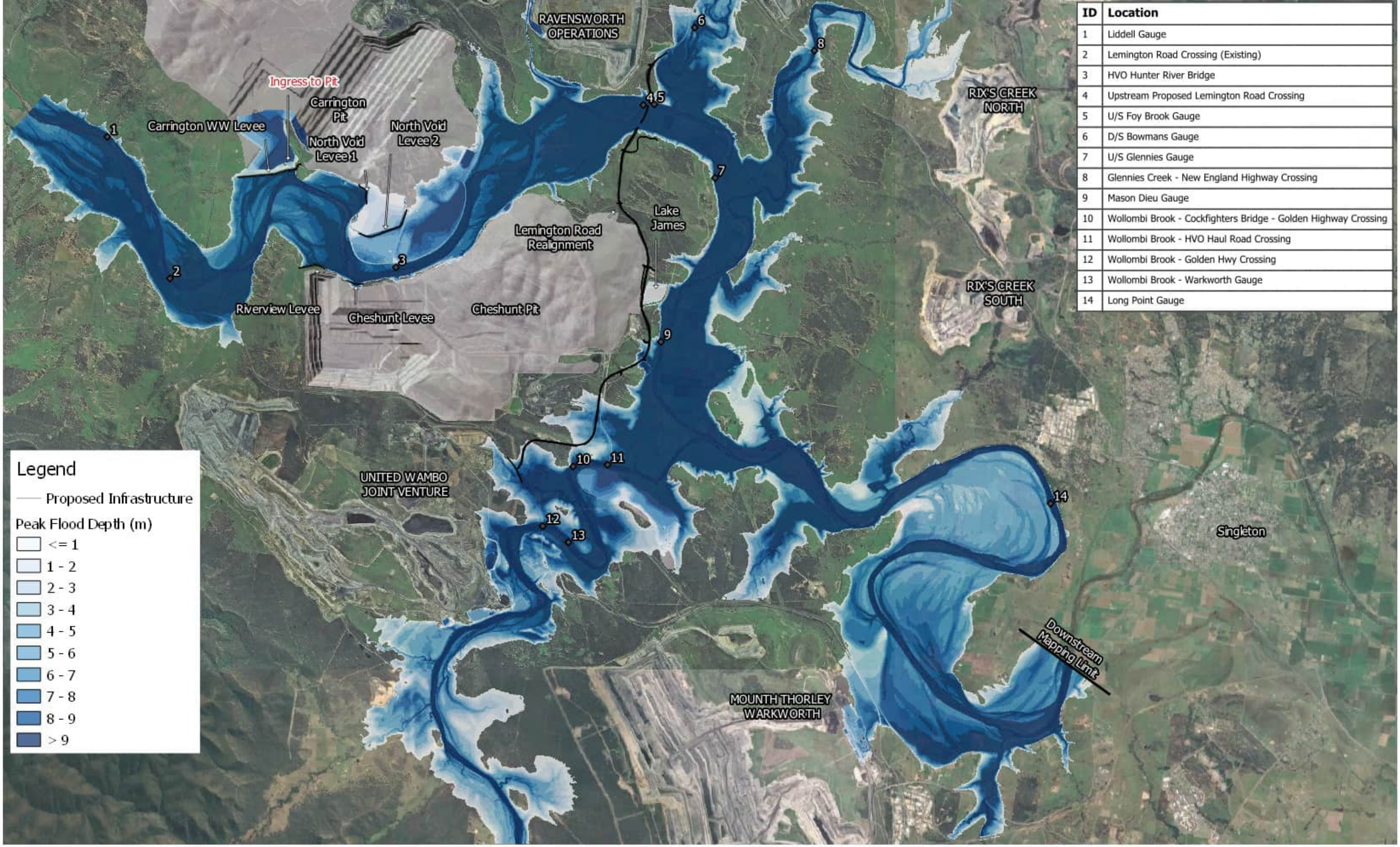
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Figure D31 - 0.1% AEP - Flood Depth - Project (Operations)

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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D32 - Extreme Event - Flood Depth - Project (Operations)

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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Lemington Road Realignment
Riverview Levee
Cheshunt Pit
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Depth (m)

- <= 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9

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ENGENY
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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D33 - Extreme Event - Flood Depth - Project (Closure)

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8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D34 - 10% AEP - Flood Velocity - Project (Operations)

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Revision: 0
Drawn: MW
Checked: SF
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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D35 - 5% AEP - Flood Velocity - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D36 - 2% AEP - Flood Velocity - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

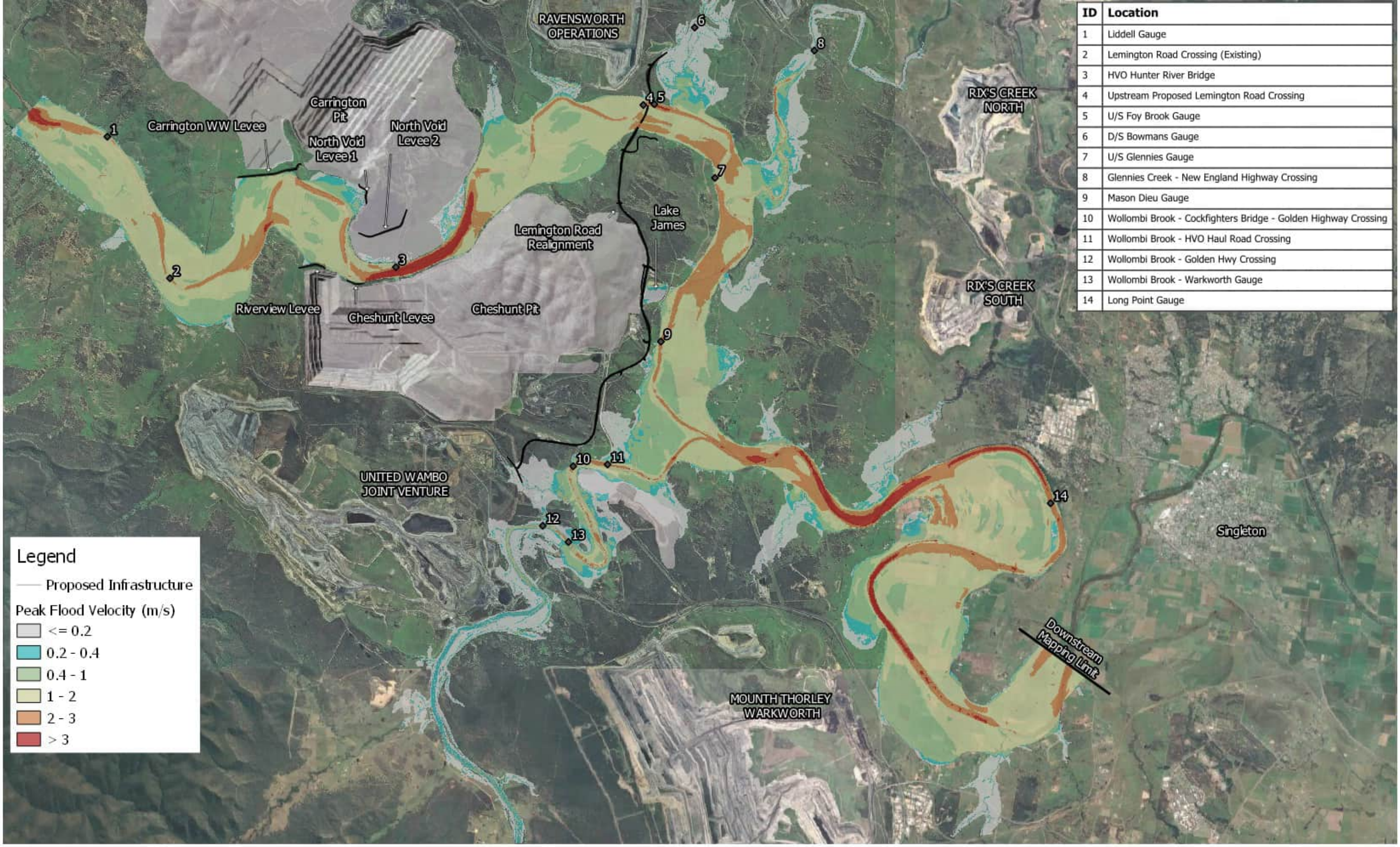
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Figure D37 - 1% AEP - Flood Velocity - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D38 - 0.5% AEP - Flood Velocity - Project (Operations)

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D39 - 0.2% AEP - Flood Velocity - Project (Operations)

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D40 - 0.1% AEP - Flood Velocity - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS

RIX'S CREEK NORTH

RIX'S CREEK SOUTH

Ingress to Pit

Carrington Pit

Carrington WW Levee

North Void Levee 1

North Void Levee 2

Lemington Road Realignment

Lake James

Riverview Levee

Cheshunt Levee

Cheshunt Pit

UNITED WAMBO JOINT VENTURE

MOUNTH THORLEY WARKWORTH

Singleton

Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D41 - Extreme Event - Flood Velocity - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
Carrington Pit
Lemington Road Realignment
Riverview Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Singleton
MOUNTH THORLEY WARKWORTH
Downstream Mapping Limit

Legend

Proposed Infrastructure

Peak Flood Velocity (m/s)

- <= 0.2
- 0.2 - 0.4
- 0.4 - 1
- 1 - 2
- 2 - 3
- > 3

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

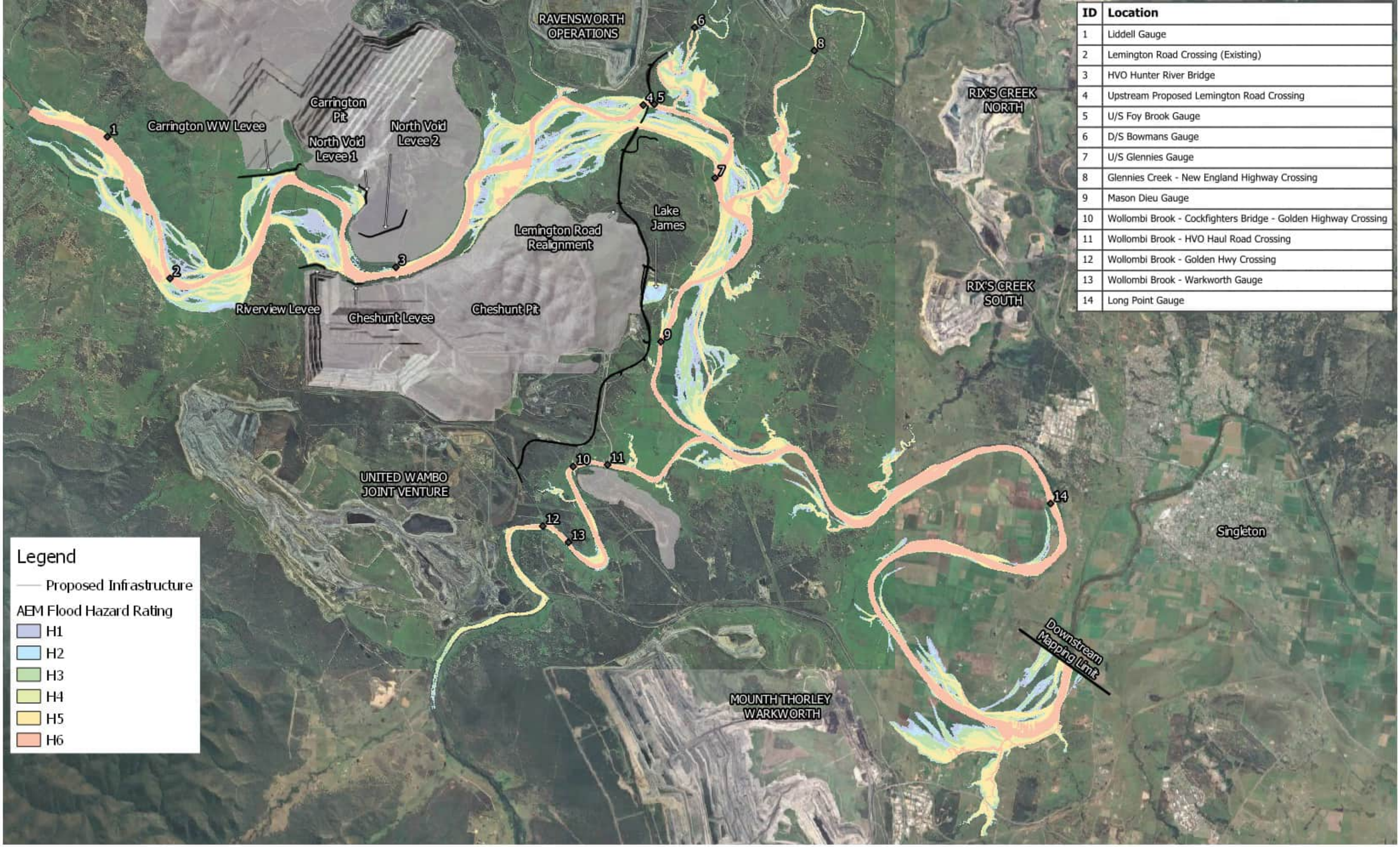
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Figure D42 - Extreme Event - Flood Velocity - Project (Closure)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

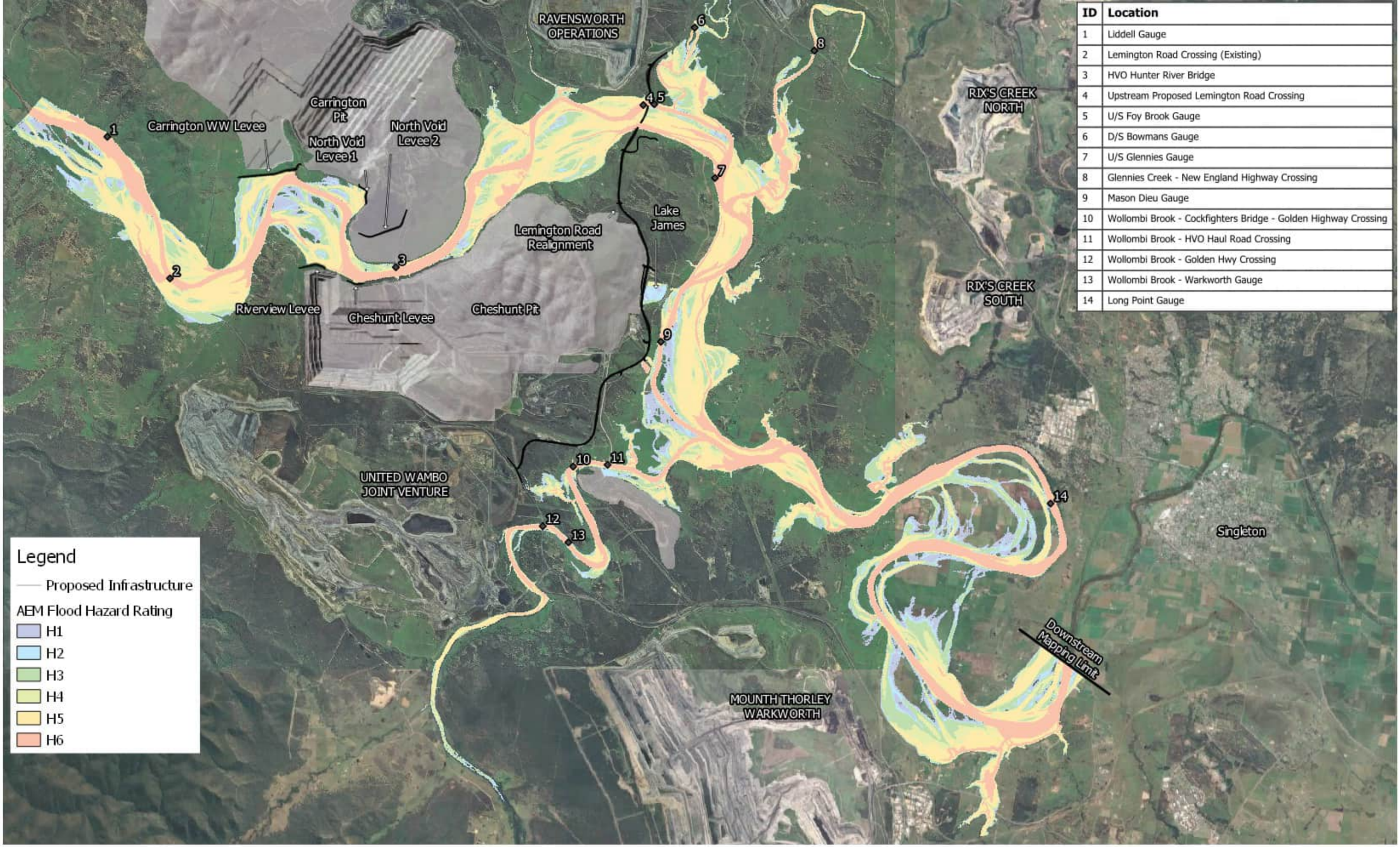
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Figure D43 - 10% AEP - Flood Hazard - Project (Operations)

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Job Number: N1000_067
Revision: 0
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Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
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4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

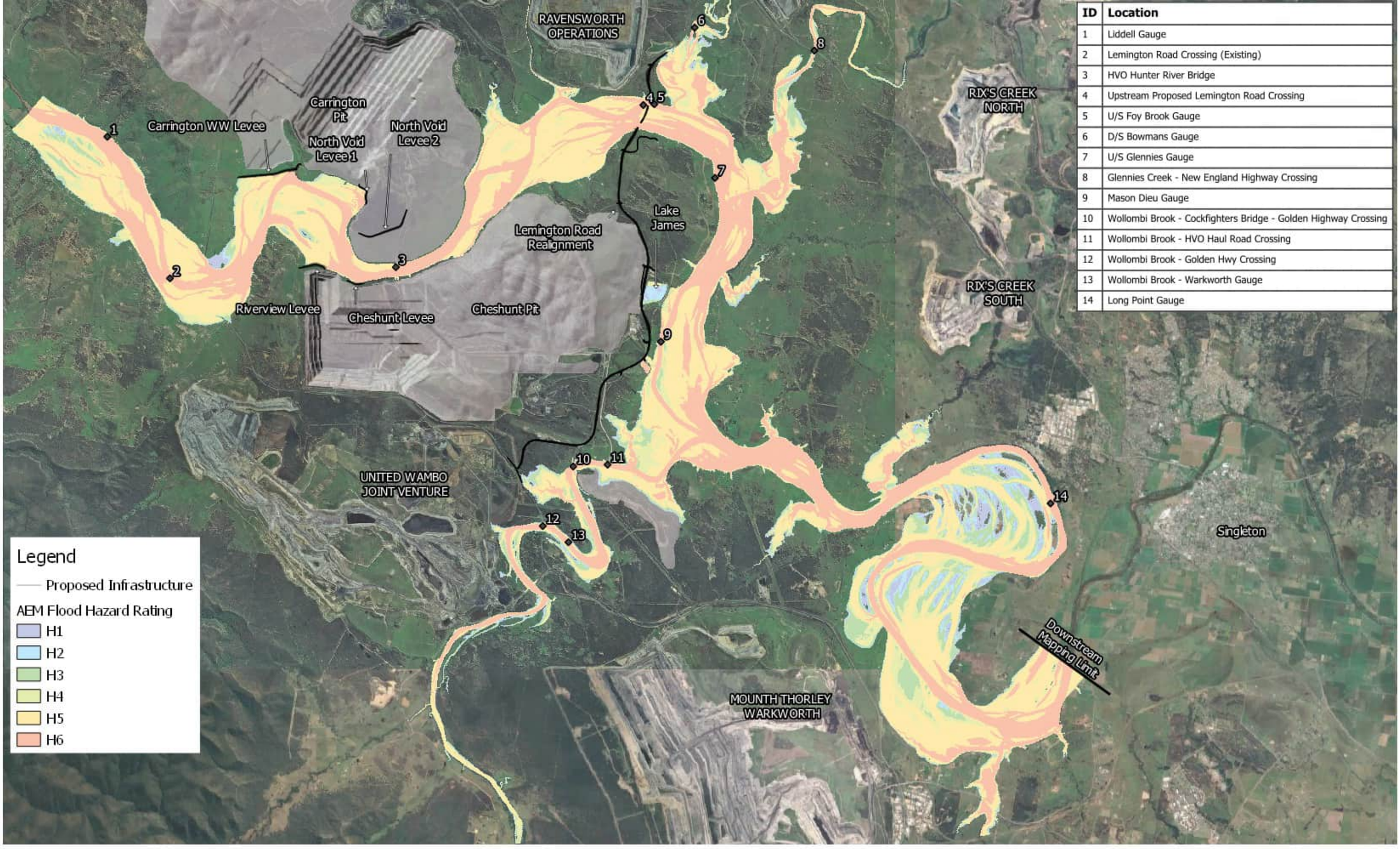
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Figure D44 - 5% AEP - Flood Hazard - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D45 - 2% AEP - Flood Hazard - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D46 - 1% AEP - Flood Hazard - Project (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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Newcastle NSW 2300
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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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HVO Continuation Project

Figure D47 - 0.5% AEP - Flood Hazard - Project (Operations)

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

HVO Continuation Project

Figure D48 - 0.2% AEP - Flood Hazard - Project (Operations)

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

RAVENSWORTH OPERATIONS
RIX'S CREEK NORTH
RIX'S CREEK SOUTH
Carrington Pit
Carrington WW Levee
North Void Levee 1
North Void Levee 2
Lemington Road Realignment
Lake James
Riverview Levee
Cheshunt Levee
Cheshunt Pit
UNITED WAMBO JOINT VENTURE
MOUNTH THORLEY WARKWORTH
Singleton
Downstream Mapping Limit

Legend

Proposed Infrastructure

AEM Flood Hazard Rating

- H1
- H2
- H3
- H4
- H5
- H6

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HV Operations Pty Ltd

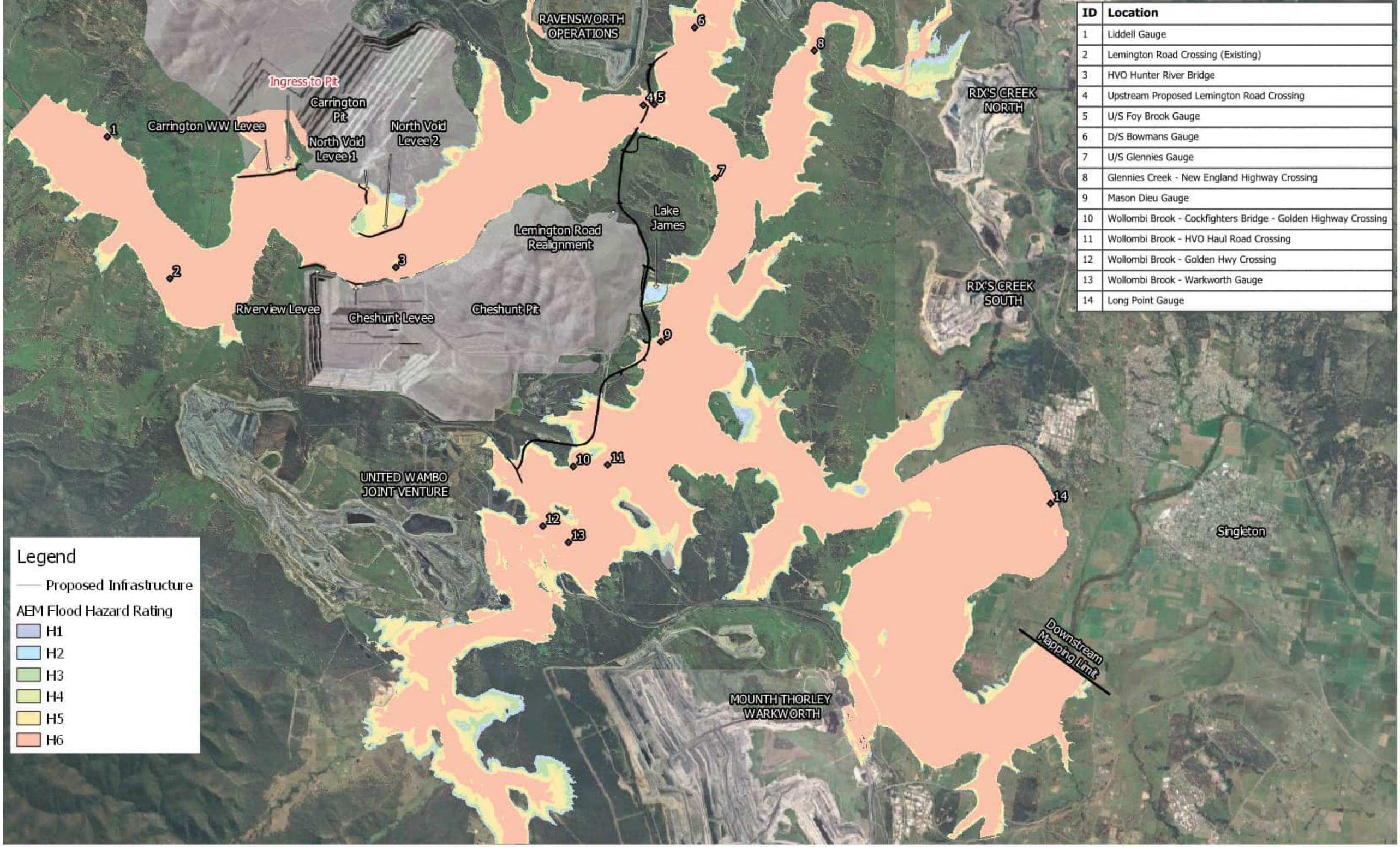
HVO Continuation Project

Figure D49 - 0.1% AEP - Flood Hazard - Project (Operations)

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Revision: 0
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ID	Location
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12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge



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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

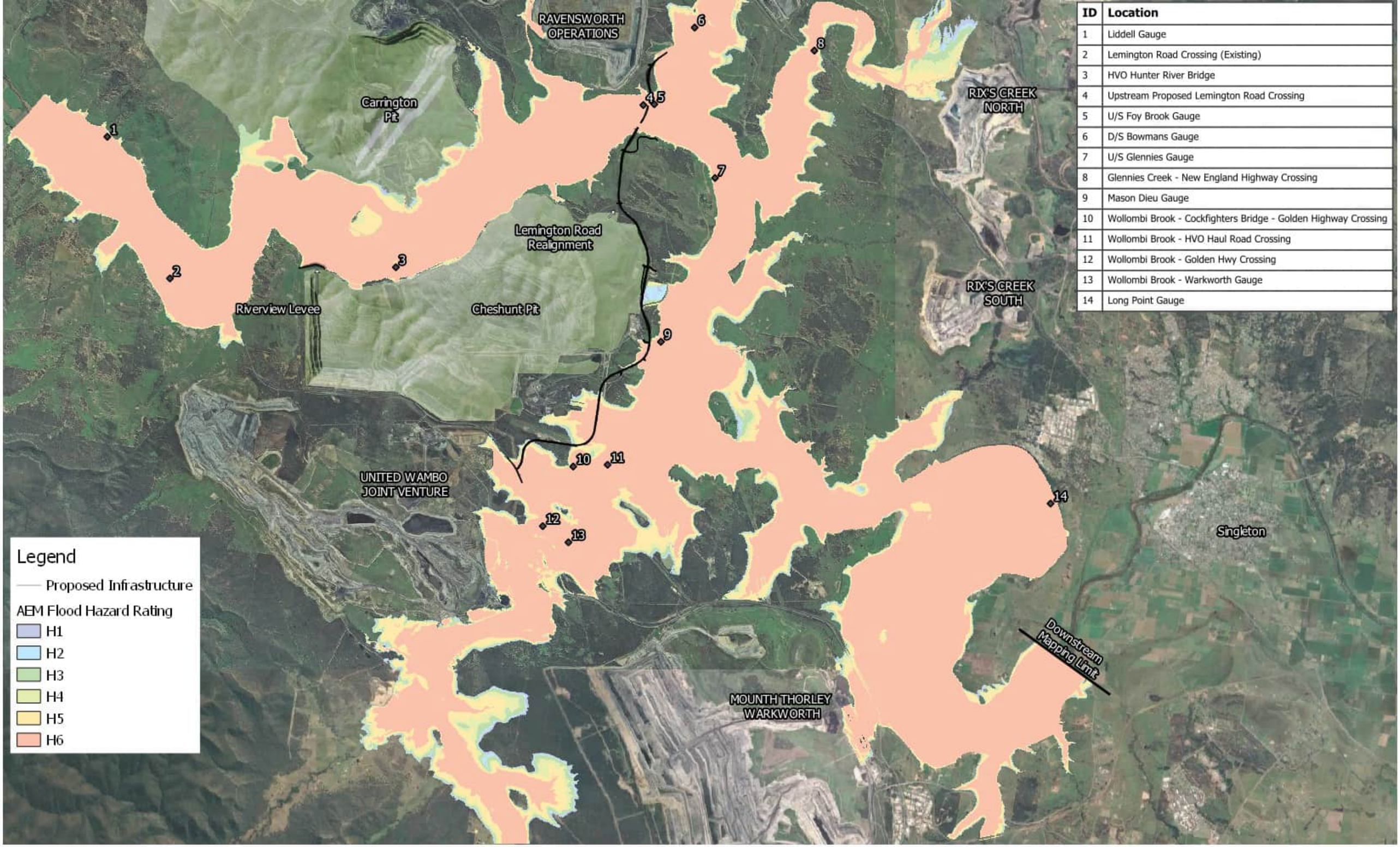
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HVO Continuation Project

Figure D50 - Extreme Event - Flood Hazard - Project (Operations)

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Revision: 0
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Checked: SF
Date: 18 /11 /2022



ID	Location
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6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure D51 - Extreme Event - Flood Hazard - Project (Closure)

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Job Number: N1000_067
Revision: 0
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Checked: SF
Date: 18 /11 /2022

ATTACHMENT E: FLOOD IMPACT MAPS



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

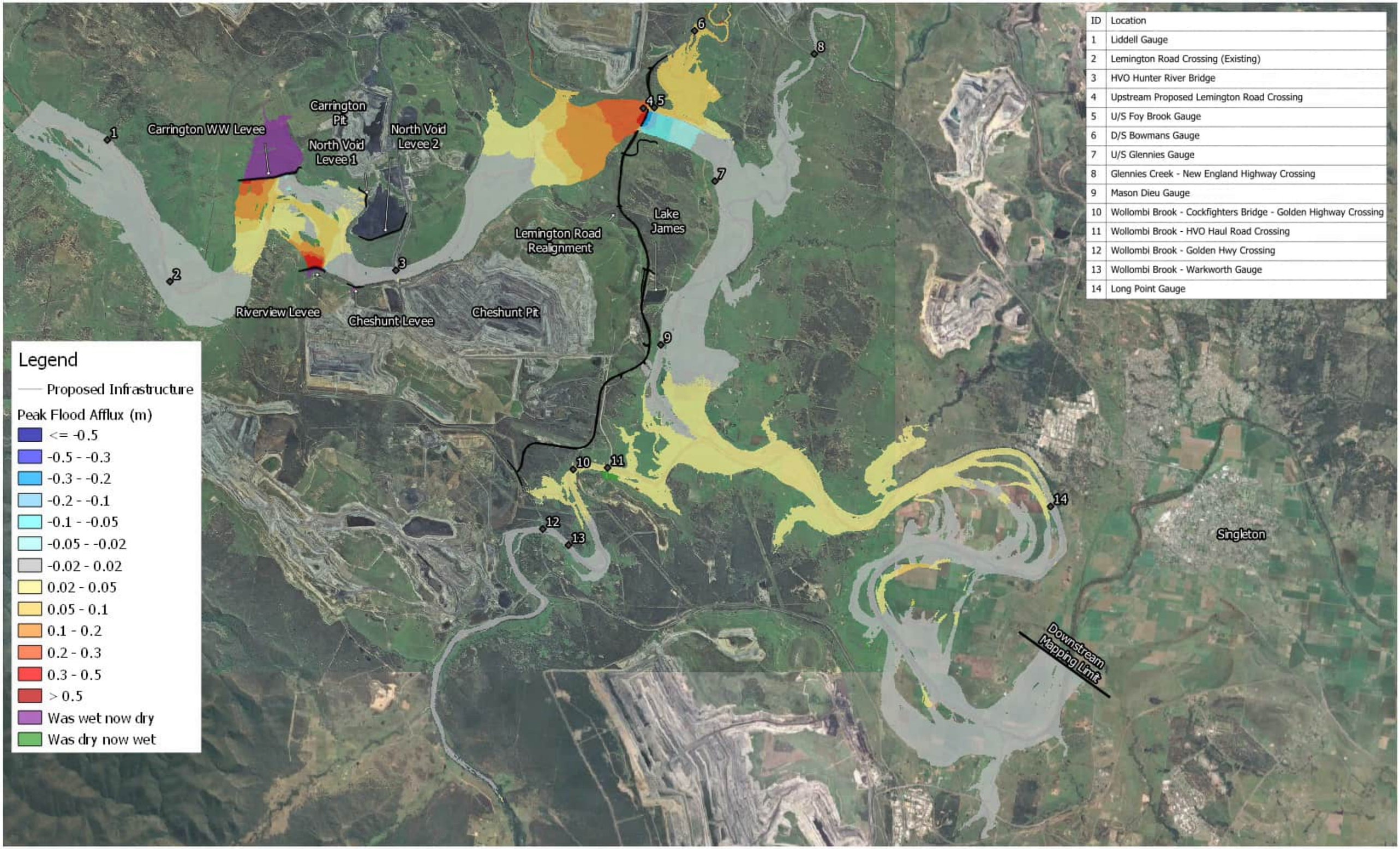
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HVO Continuation Project

Figure E1 - 10% AEP - Flood Level - Project Impact

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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

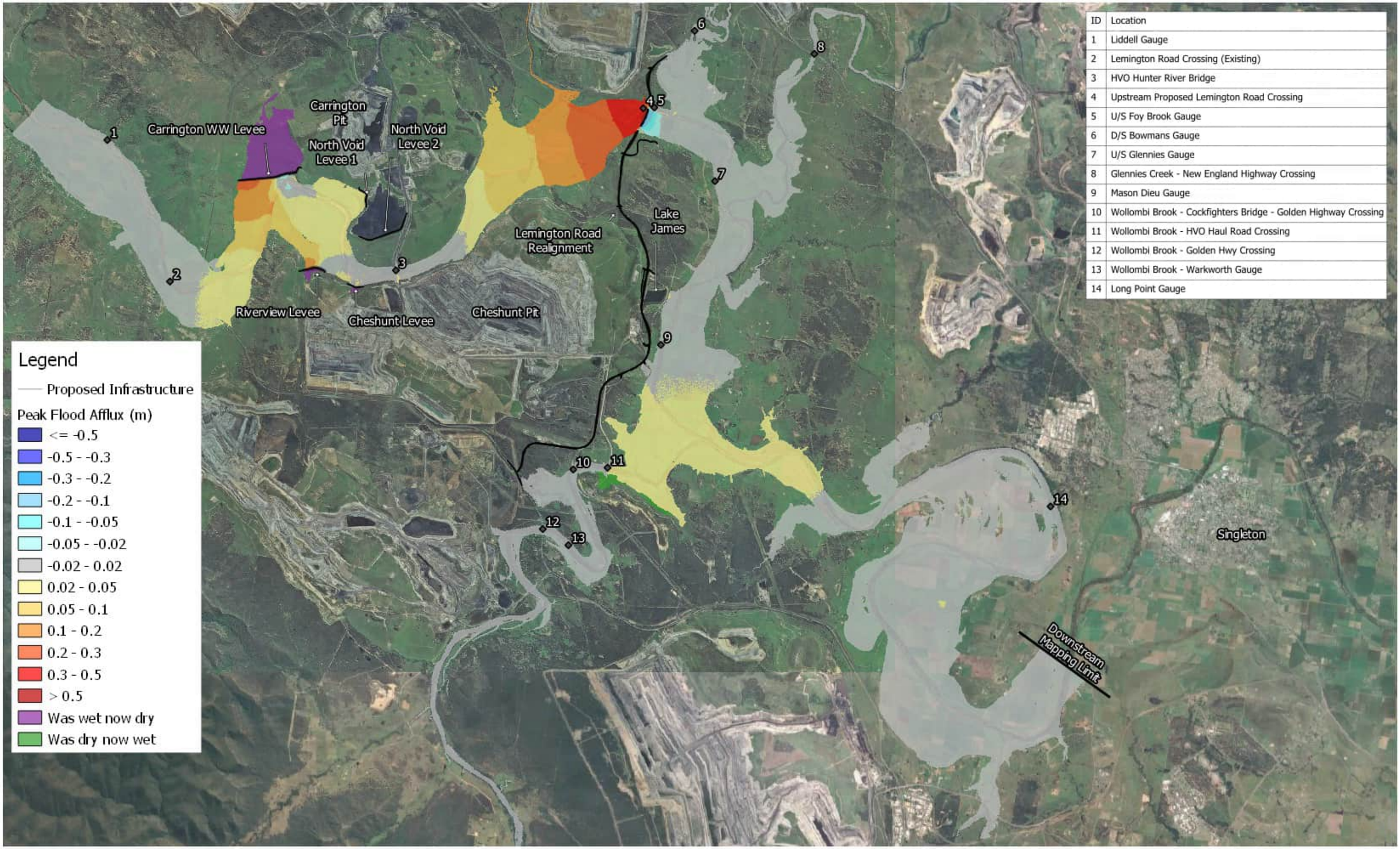
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Figure E2 - 5% AEP - Flood Level - Project Impact

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ID	Location
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10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

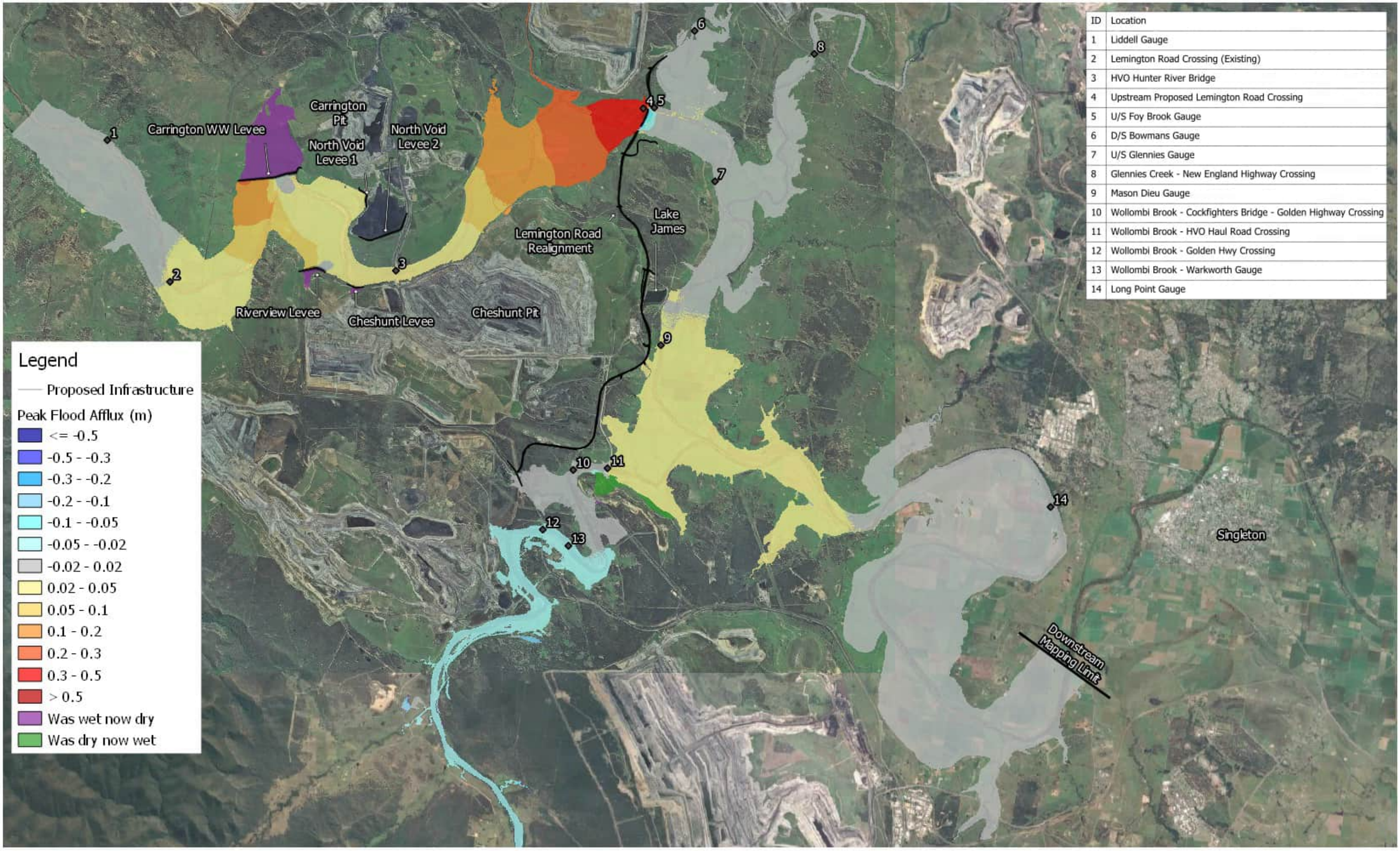
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Figure E3 - 2% AEP - Flood Level - Project Impact

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Revision: 0
Drawn: MW
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ID	Location
1	Liddell Gauge
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9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Peak Flood Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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Newcastle NSW 2300

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

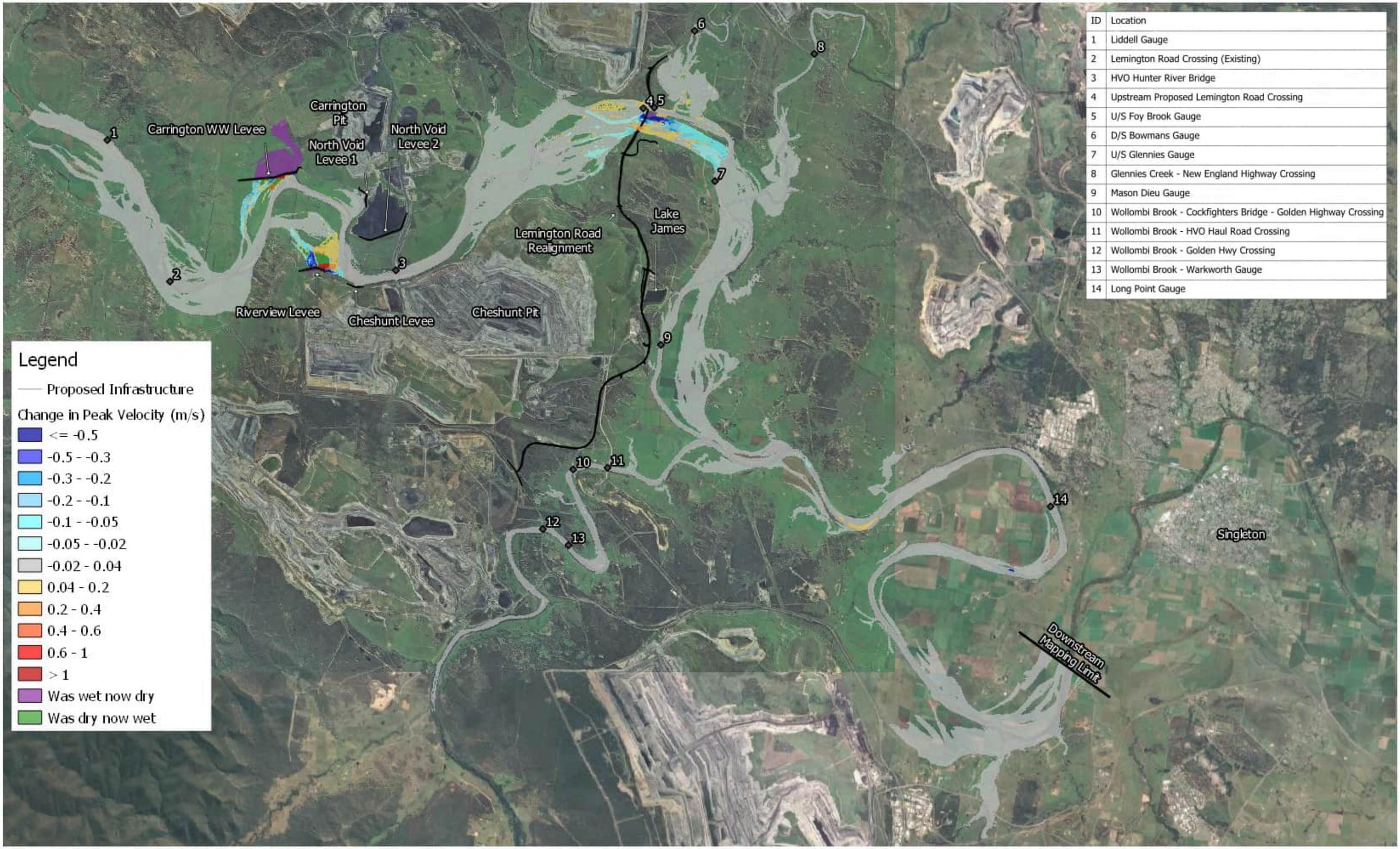
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Figure E4 - 1% AEP - Flood Level - Project Impact

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Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
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7	U/S Glennies Gauge
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9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in Peak Velocity (m/s)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.04
- 0.04 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 1
- > 1
- Was wet now dry
- Was dry now wet

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

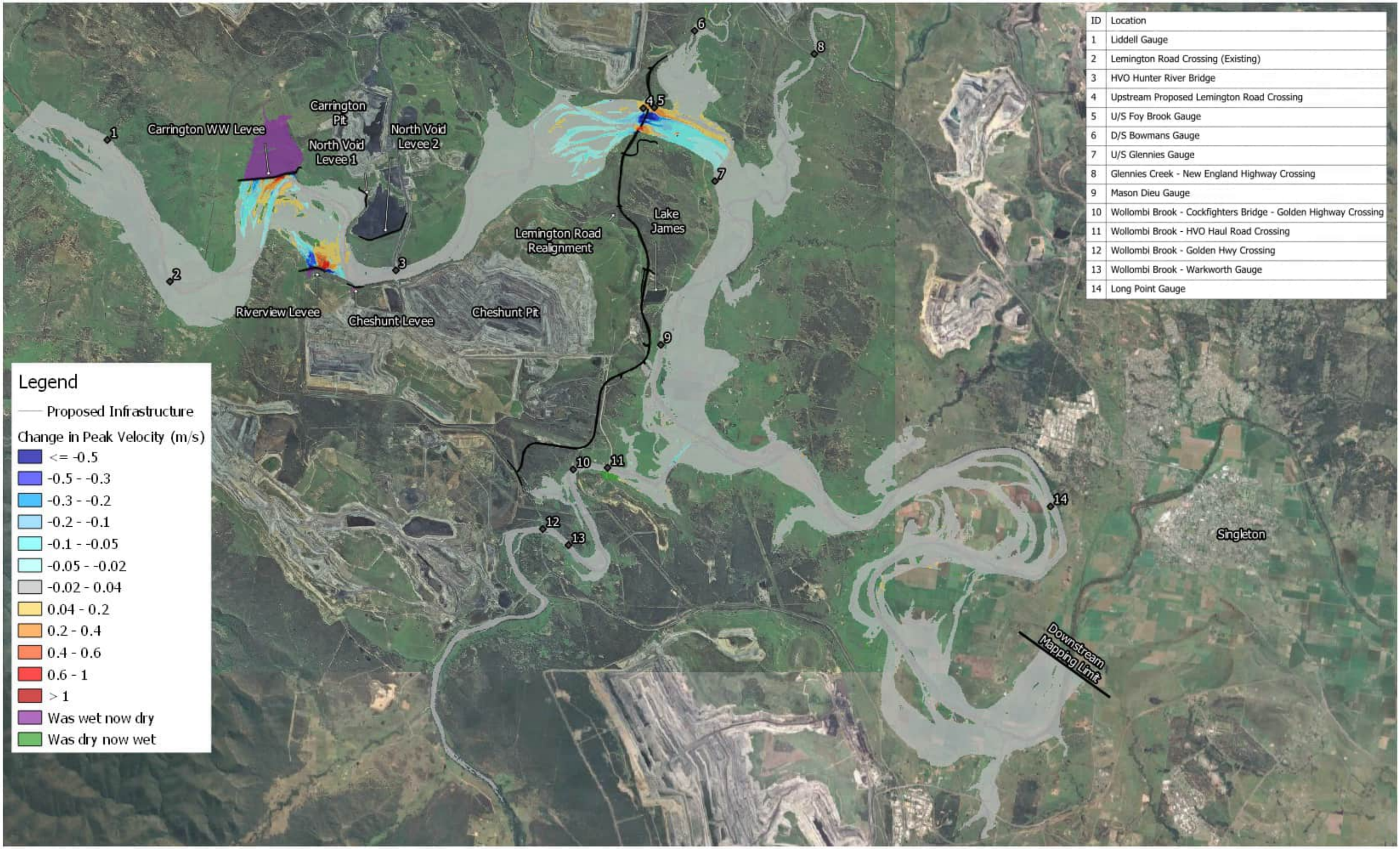
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Figure E5 - 10% AEP - Flood Velocity - Project Impact

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9	Mason Dieu Gauge
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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in Peak Velocity (m/s)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.04
- 0.04 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 1
- > 1
- Was wet now dry
- Was dry now wet

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

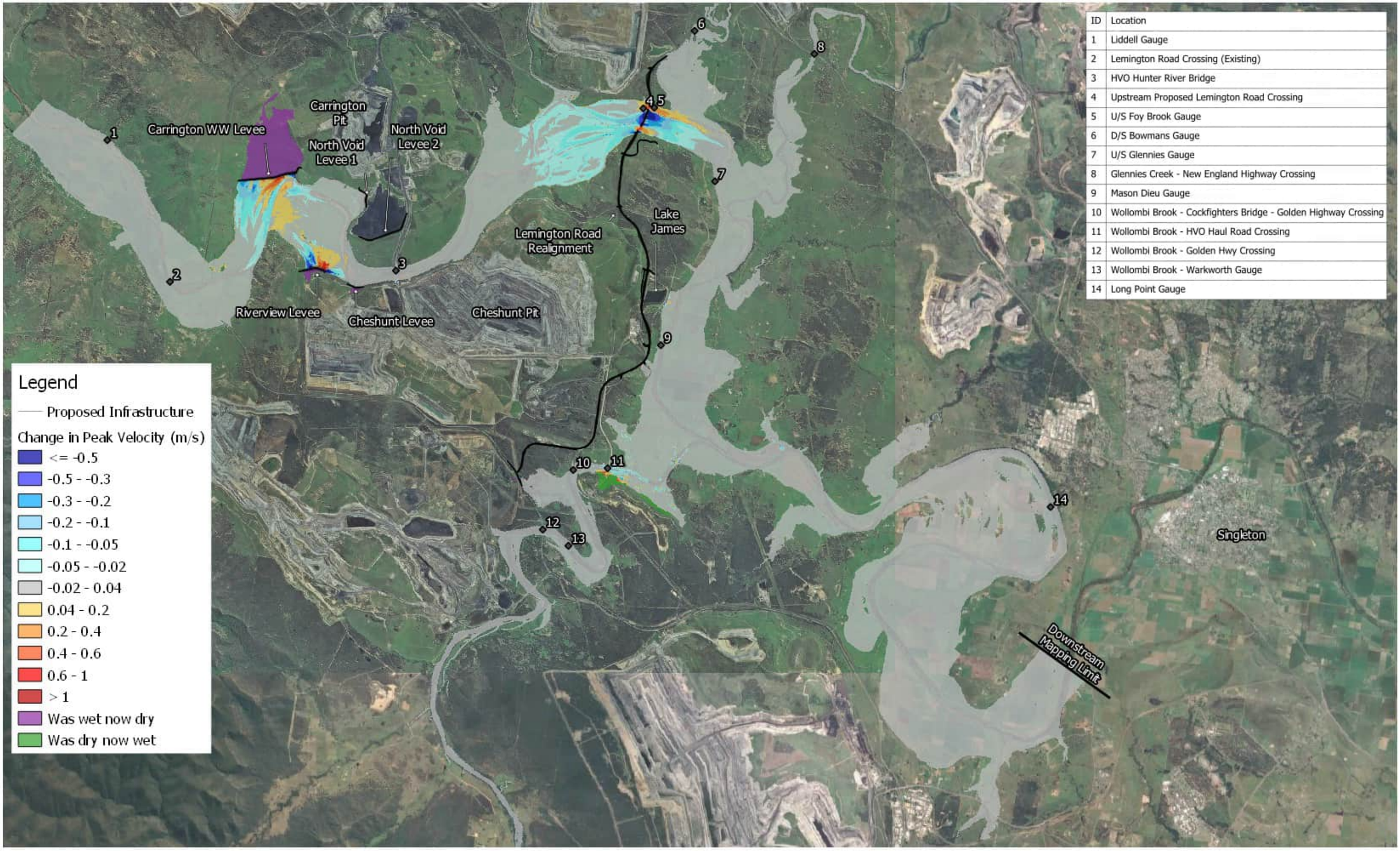
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HVO Continuation Project

Figure E6 - 5% AEP - Flood Velocity - Project Impact

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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in Peak Velocity (m/s)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.04
- 0.04 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 1
- > 1
- Was wet now dry
- Was dry now wet

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

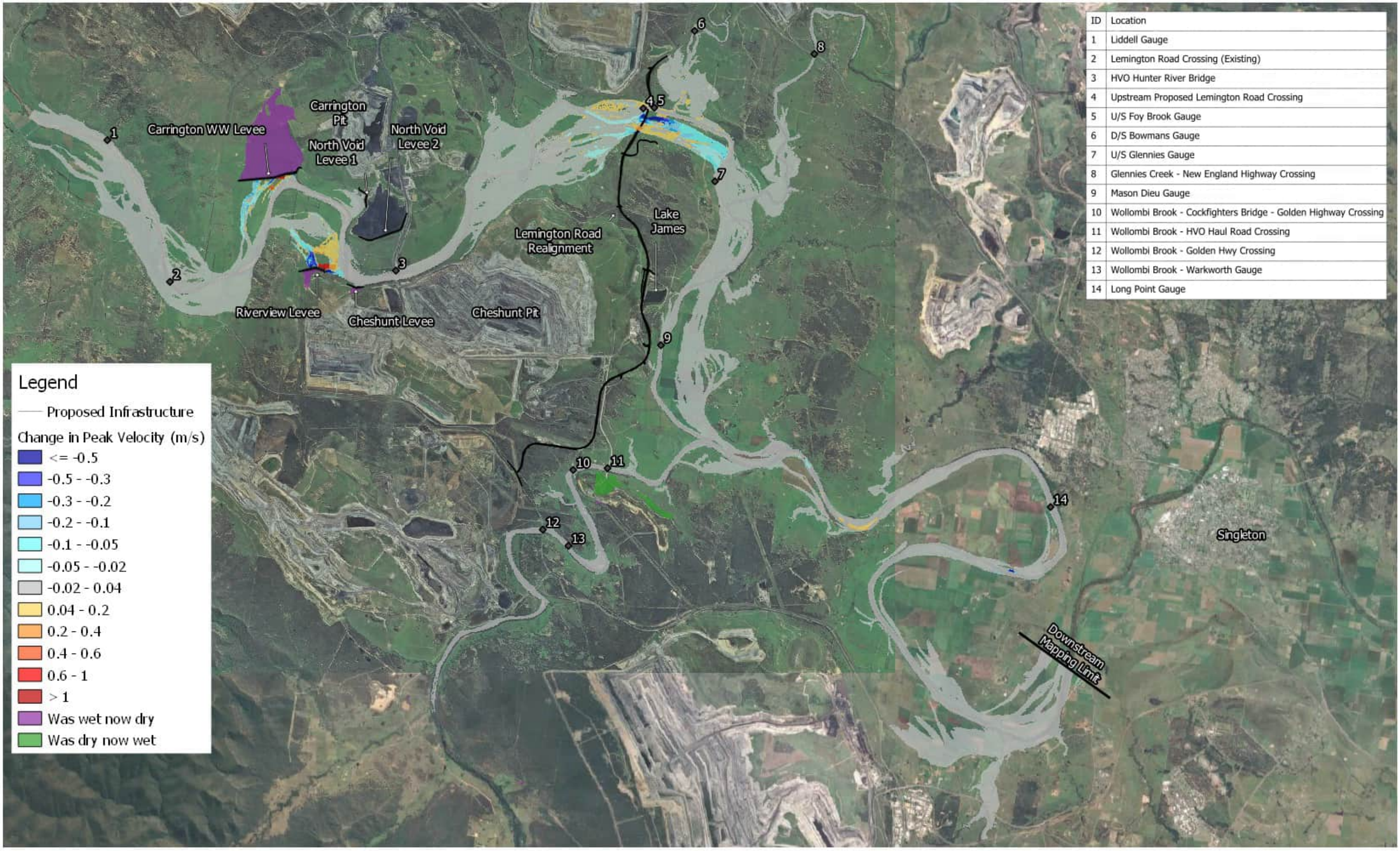
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HVO Continuation Project

Figure E7 - 2% AEP - Flood Velocity - Project Impact

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11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in Peak Velocity (m/s)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.04
- 0.04 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 1
- > 1
- Was wet now dry
- Was dry now wet

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

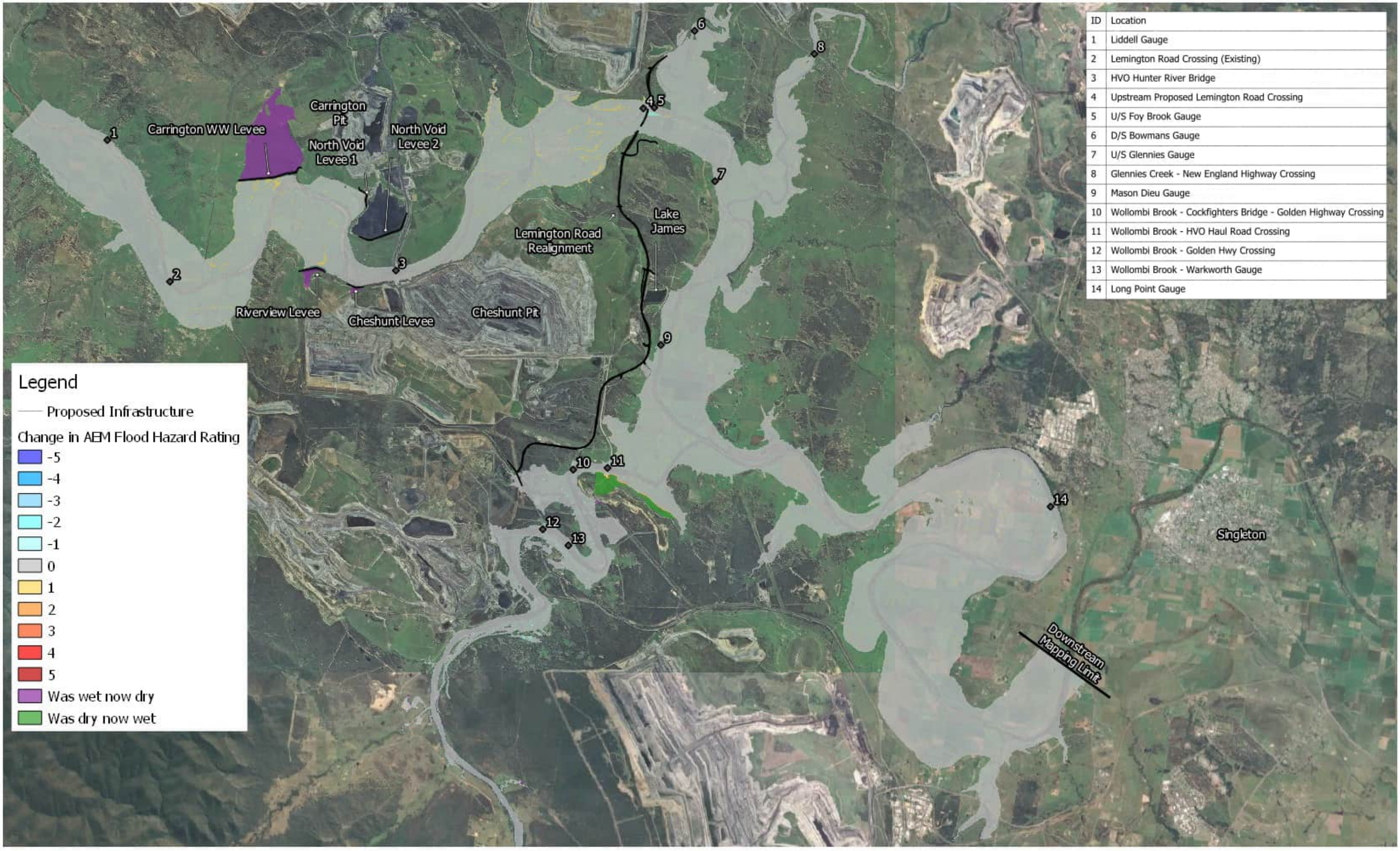
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HVO Continuation Project

Figure E8 - 1% AEP - Flood Velocity - Project Impact

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7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in AEM Flood Hazard Rating

- -5
- -4
- -3
- -2
- -1
- 0
- 1
- 2
- 3
- 4
- 5
- Was wet now dry
- Was dry now wet

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

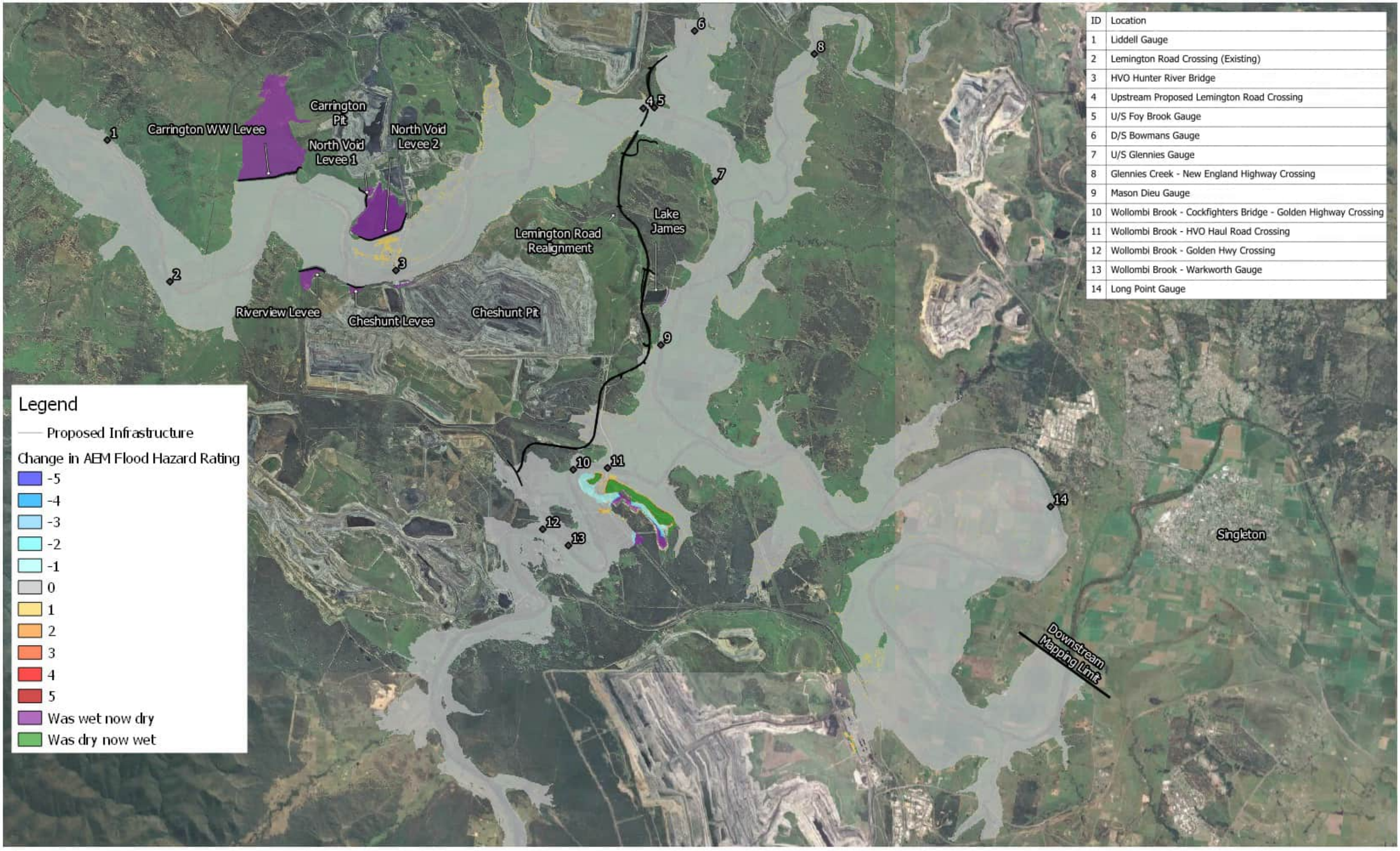
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Figure E9 - 1% AEP - Flood Hazard - Project Impact

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in AEM Flood Hazard Rating

- -5
- -4
- -3
- -2
- -1
- 0
- 1
- 2
- 3
- 4
- 5
- Was wet now dry
- Was dry now wet

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HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

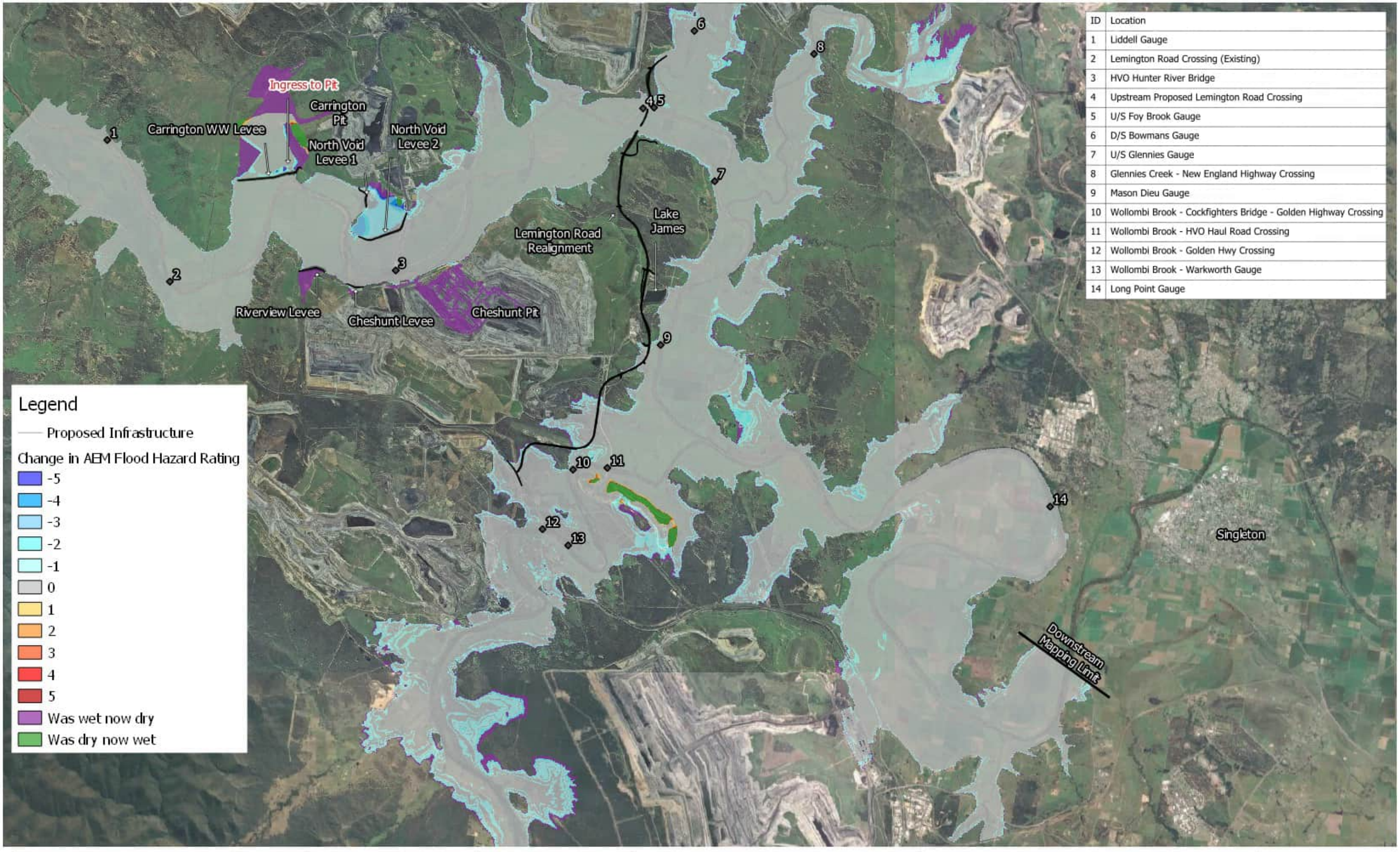
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Figure E10 - 0.1% AEP - Flood Hazard - Project Impact

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

- Proposed Infrastructure

Change in AEM Flood Hazard Rating

- -5
- -4
- -3
- -2
- -1
- 0
- 1
- 2
- 3
- 4
- 5
- Was wet now dry
- Was dry now wet

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ENGENY WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

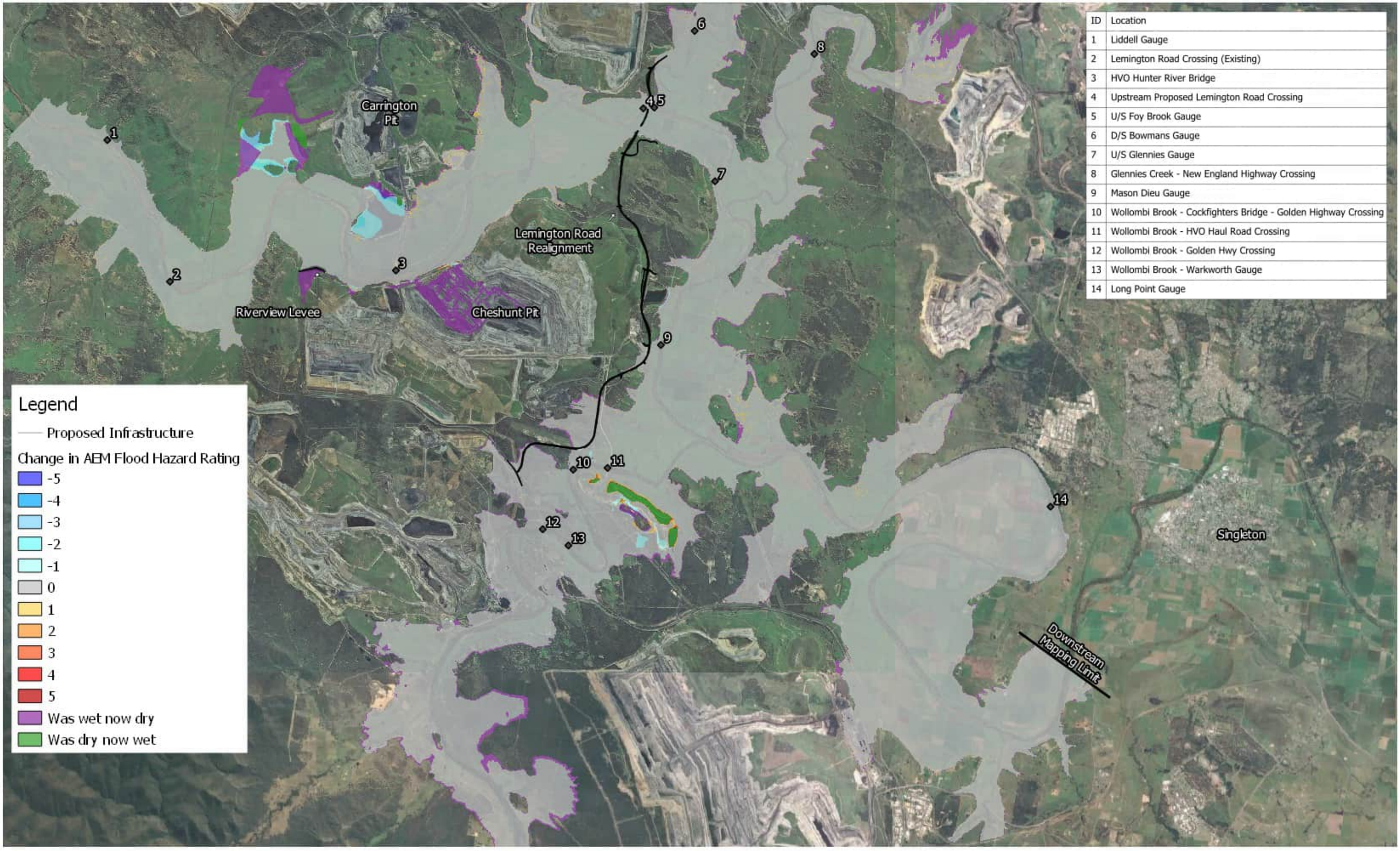
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Figure E11 - Extreme Event - Flood Hazard - Project Impact (Operations)

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Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022



ID	Location
1	Liddell Gauge
2	Lemington Road Crossing (Existing)
3	HVO Hunter River Bridge
4	Upstream Proposed Lemington Road Crossing
5	U/S Foy Brook Gauge
6	D/S Bowmans Gauge
7	U/S Glennies Gauge
8	Glennies Creek - New England Highway Crossing
9	Mason Dieu Gauge
10	Wollombi Brook - Cockfighters Bridge - Golden Highway Crossing
11	Wollombi Brook - HVO Haul Road Crossing
12	Wollombi Brook - Golden Hwy Crossing
13	Wollombi Brook - Warkworth Gauge
14	Long Point Gauge

Legend

Proposed Infrastructure

Change in AEM Flood Hazard Rating

- -5
- -4
- -3
- -2
- -1
- 0
- 1
- 2
- 3
- 4
- 5
- Was wet now dry
- Was dry now wet

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WATER MANAGEMENT

HUNTER VALLEY OPERATIONS

N

1,800 0 1,800 m

Scale in metres (1:72,000@ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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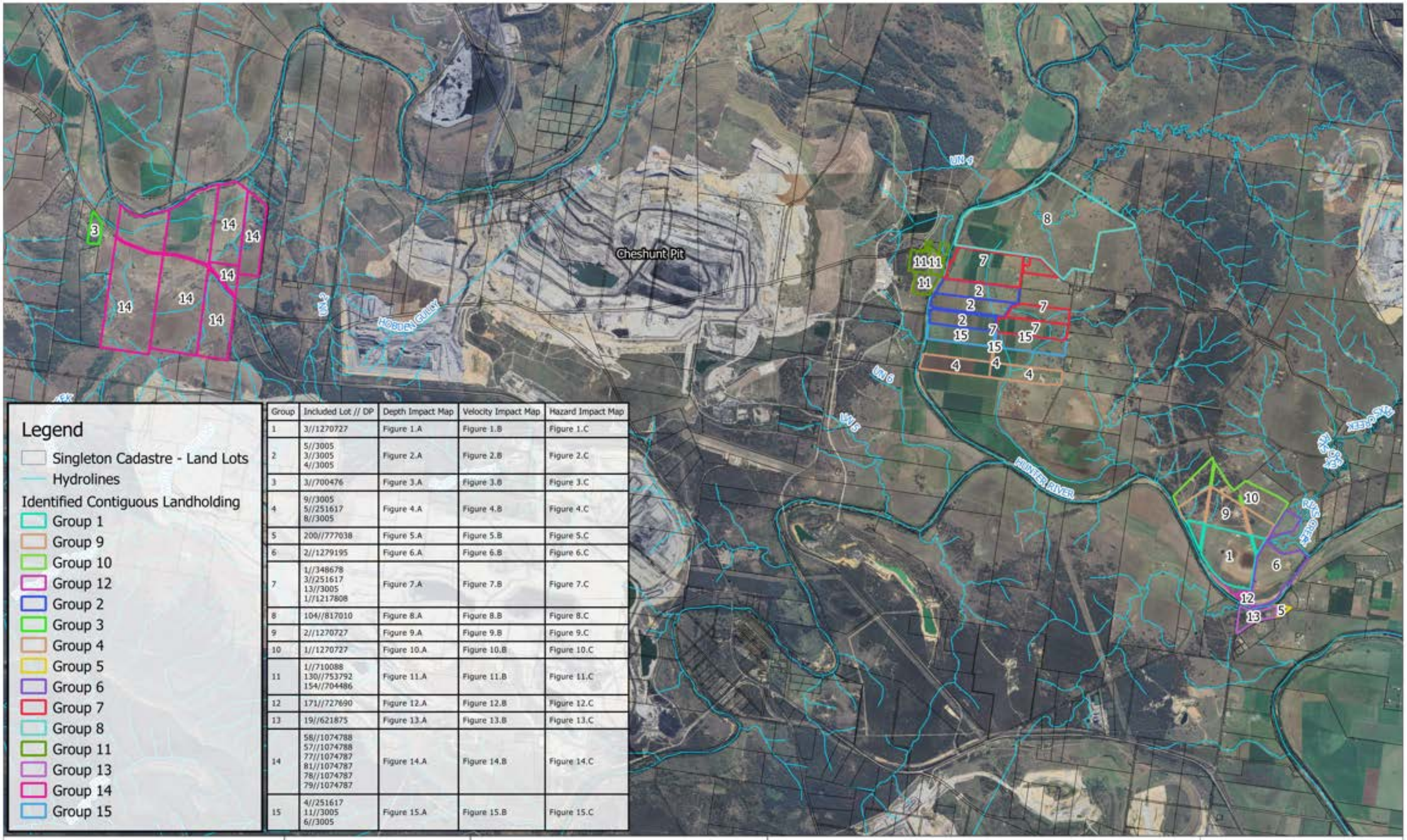
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Figure E12 - Extreme Event - Flood Hazard - Project Impact (Closure)

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: N1000_067
Revision: 0
Drawn: MW
Checked: SF
Date: 18 /11 /2022

ATTACHMENT F: MULTILOT FLOOD MAPS



Legend

- Singleton Cadastre - Land Lots
- Hydrolines

Identified Contiguous Landholding

- Group 1
- Group 9
- Group 10
- Group 12
- Group 2
- Group 3
- Group 4
- Group 5
- Group 6
- Group 7
- Group 8
- Group 11
- Group 13
- Group 14
- Group 15

Group	Included Lot // DP	Depth Impact Map	Velocity Impact Map	Hazard Impact Map
1	3//1270727	Figure 1.A	Figure 1.B	Figure 1.C
2	5//3005 3//3005 4//3005	Figure 2.A	Figure 2.B	Figure 2.C
3	3//700476	Figure 3.A	Figure 3.B	Figure 3.C
4	9//3005 5//251617 8//3005	Figure 4.A	Figure 4.B	Figure 4.C
5	200//777038	Figure 5.A	Figure 5.B	Figure 5.C
6	2//1279195	Figure 6.A	Figure 6.B	Figure 6.C
7	1//348678 3//251617 13//3005 1//1217808	Figure 7.A	Figure 7.B	Figure 7.C
8	104//817010	Figure 8.A	Figure 8.B	Figure 8.C
9	2//1270727	Figure 9.A	Figure 9.B	Figure 9.C
10	1//1270727	Figure 10.A	Figure 10.B	Figure 10.C
11	1//710088 130//753792 154//704486	Figure 11.A	Figure 11.B	Figure 11.C
12	171//727690	Figure 12.A	Figure 12.B	Figure 12.C
13	19//621875	Figure 13.A	Figure 13.B	Figure 13.C
14	58//1074788 57//1074788 77//1074787 81//1074787 78//1074787 79//1074787	Figure 14.A	Figure 14.B	Figure 14.C
15	4//251617 11//3005 6//3005	Figure 15.A	Figure 15.B	Figure 15.C

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N

1,000 0 1,000 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 0: Private Land Impacts - Overview

Job Number: N1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273
12	171//727690	0.023	15.052	15.074

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

90 0 90 m

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Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
9	2//1270727	<0.1	3.4	3.4
10	1//1270727	<0.1	3.4	3.4
12	171//727690	<0.1	3.6	3.6

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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ENGENY

N

90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
1	3//1270727	1	6	6
9	2//1270727	1	6	6
10	1//1270727	1	6	6
12	171//727690	0	6	6

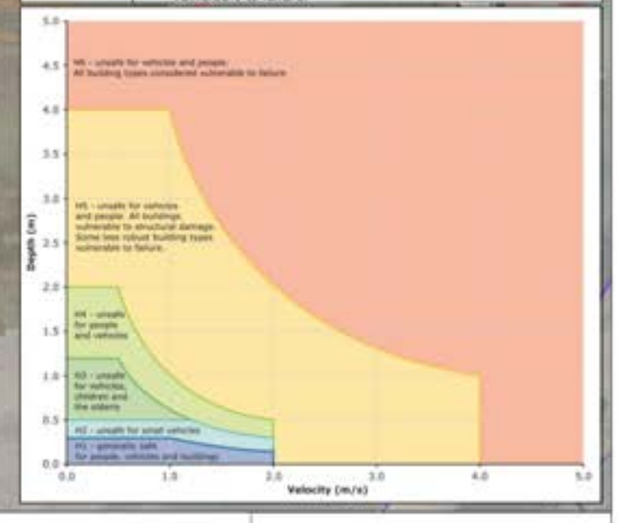
Lot: 2//1270727

Lot: 3//1270727

Lot: 171//727690

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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ENGENY

N

90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
2	4//3005	0.025	15.555	15.577
2	5//3005	0.024	15.769	15.791
7	13//3005	0.024	5.339	5.362
7	3//251617	0.024	5.87	5.894
7	1//348678	0.024	6.468	6.491
7	1//1217808	0.029	15.706	15.727

Lot: 130//753792
Lot: 154//704486
Lot: 1//710088
Lot: 1//12178
Lot: 3//3005
Lot: 4//3005
Lot: 13//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
2	5//3005	<0.1	2.4	2.4
3	3//700476	<0.1	1.0	1.0
4	8//3005	<0.1	2.3	2.3
4	9//3005	<0.1	1.2	1.2

Lot: 130//753792
Lot: 154//704486
Lot: 1//12
Lot: 1//710088
Lot: 3//3005
Lot: 4//3005
Lot: 13//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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ENGENY

N

90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.B: 1% AEP Velocity Afflux - Private Land Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Afflux	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
2	5//3005	1	6	6
7	13//3005	1	6	6
7	3//251617	0	6	6

Lot: 154//704486

Lot: 1//710088

Lot: 1//1217808

Lot: 3//3005

Lot: 4//3005

Lot: 5//3005

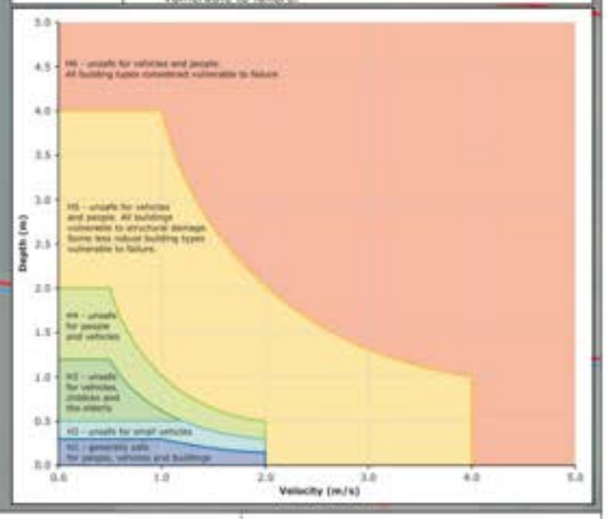
Lot: 3//251617

Lot: 6//3005

Lot: 4//251617

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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ENGENY

N

90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.C: 1% AEP Hazard Afflux - Private Land Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
3	3//700476	0.023	2.771	2.793
14	58//1074788	0.029	15.299	15.325

Lot: 3//700476

Lot: 58//1074788

Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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ENGENY

N

40 0 40 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 3.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 3 DP 700476 (Group 3)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
3	3//700476	<0.1	1.0	1.0
14	58//1074788	<0.1	2.9	2.9

Lot: 3//700476

Lot: 58//1074788

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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ENGENY

N

40 0 40 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 3.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 3 DP 700476 (Group 3)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

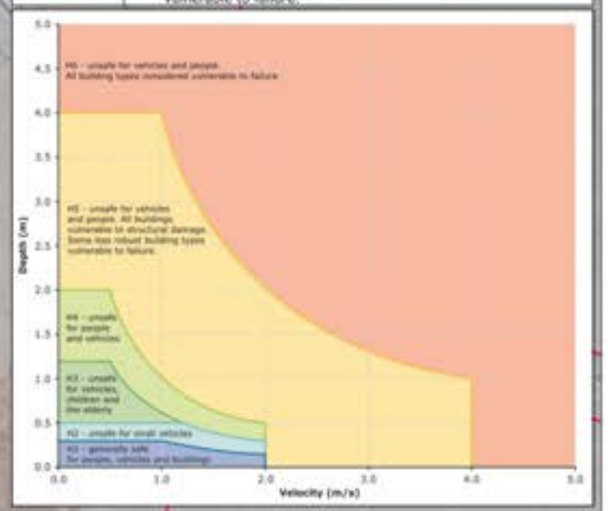
Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
3	3//700476	1	5	5
14	58//1074788	1	6	6

Lot: 3//700476

Lot: 58//1074788

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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ENGENY

N

40 0 40 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 3.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 3 DP 700476 (Group 3)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	5//3005	0.024	15.769	15.791
4	8//3005	0.025	8.733	8.757
4	9//3005	0.026	8.808	8.832
4	5//251617	0.025	5.697	5.722
7	3//251617	0.024	5.87	5.894
7	1//348678	0.024	6.468	6.491
15	6//3005	0.024	15.413	15.436
15	11//3005	0.024	6.728	6.752
15	4//251617	0.024	4.577	4.601

Lot: 5//3005;1617
Lot: 6//3005
Lot: 4//251617
Lot: 5//251617
Lot: 8//3005
Lot: 9//3005

Legend
- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)
- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 4.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	5//3005	<0.1	2.4	2.4
4	8//3005	<0.1	2.3	2.3
4	9//3005	<0.1	1.2	1.2
4	5//251617	<0.1	1.0	1.0
7	3//251617	<0.1	1.4	1.4
7	1//348678	<0.1	1.5	1.5
15	6//3005	<0.1	2.5	2.5
15	4//251617	<0.1	1.0	1.0
15	11//3005	<0.1	1.7	1.7

Lot: 5//3005;1617
Lot: 6//3005
Lot: 4//251617
Lot: 5//251617
Lot: 8//3005
Lot: 9//3005

Legend
- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)
- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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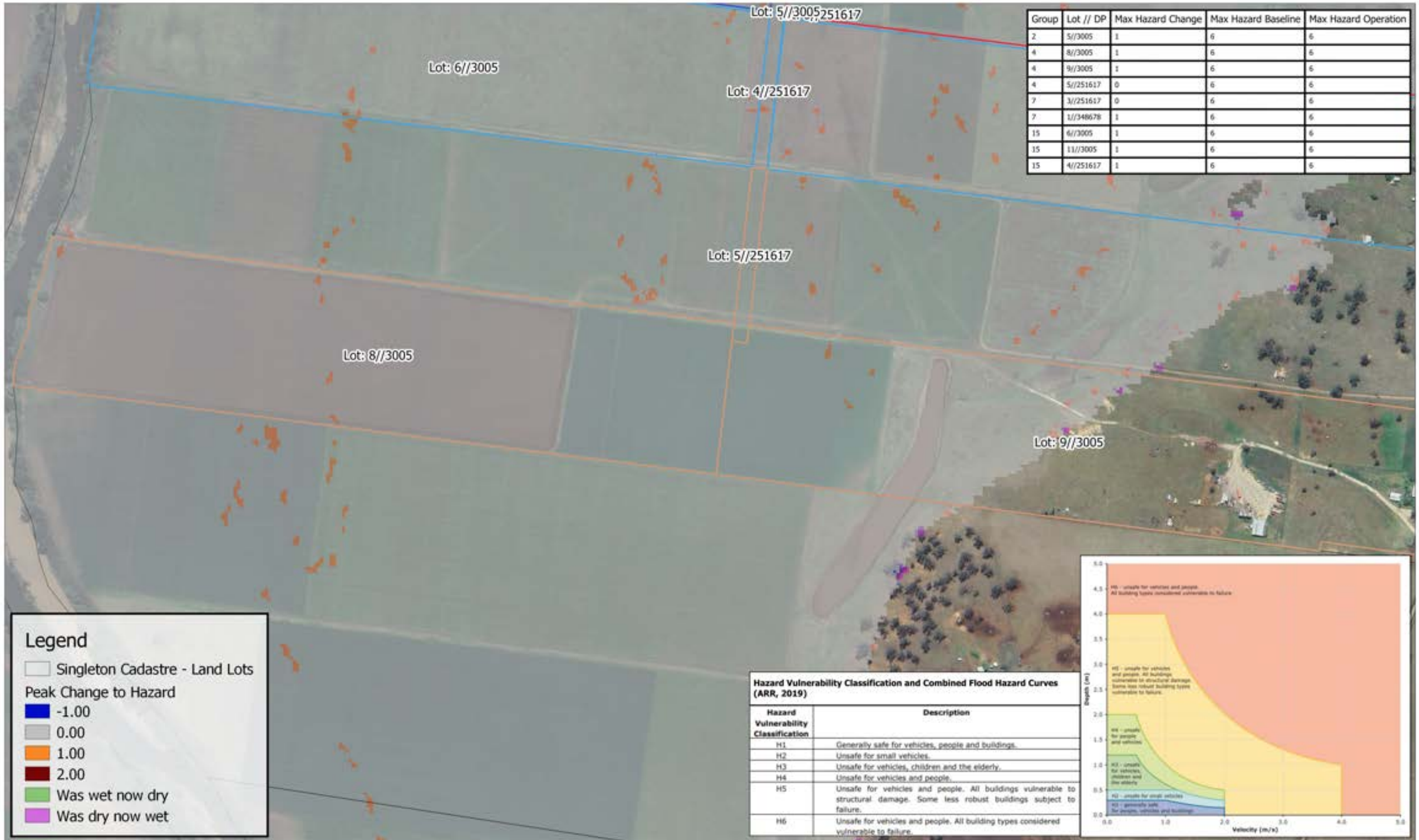
100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 4.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024



Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	5//3005	1	6	6
4	8//3005	1	6	6
4	9//3005	1	6	6
4	5//251617	0	6	6
7	3//251617	0	6	6
7	1//348678	1	6	6
15	6//3005	1	6	6
15	11//3005	1	6	6
15	4//251617	1	6	6

Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

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Figure 4.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
5	200//777038	0.022	12.868	12.888
13	19//621875	0.024	10.875	10.896
6	2//1279195	0.021	15.316	15.329

Lot: 2//1279195

Lot: 200//777038

Lot 19//621875

Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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25 0 25 m

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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 5.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 200 DP 777038
(Group 5)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
6	2//1279195	0.2	4.1	4.2
5	200//777038	<0.1	2.4	2.4
13	19//621875	<0.1	2.3	2.3

Lot: 2//1279195

Lot: 200//777038

Lot: 19//621875

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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N

25 0 25 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 5.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 200 DP 777038
(Group 5)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
5	200//777038	1	6	6
13	19//621875	0	6	6

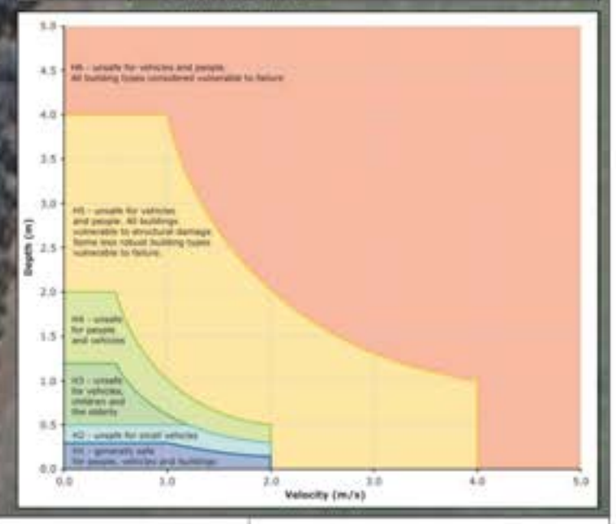
Lot: 2//1279195

Lot: 200//777038

Lot: 19//621875

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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25 0 25 m

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Grid: Map Grid of Australia, Zone 56

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Figure 5.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 200 DP 777038
(Group 5)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
5	200//777038	0.022	12.868	12.888
13	19//621875	0.024	10.875	10.896
6	2//1279195	0.021	15.316	15.329

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Lot: 19//621875//777038

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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130 0 130 m

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Figure 6.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
6	2//1279195	0.2	4.1	4.2
5	200//777038	<0.1	2.4	2.4
13	19//621875	<0.1	2.3	2.3

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Lot: 19//621875//777038

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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130 0 130 m

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Figure 6.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
5	200//777038	1	6	6
6	2//1279195	1	6	6
13	19//621875	0	6	6

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

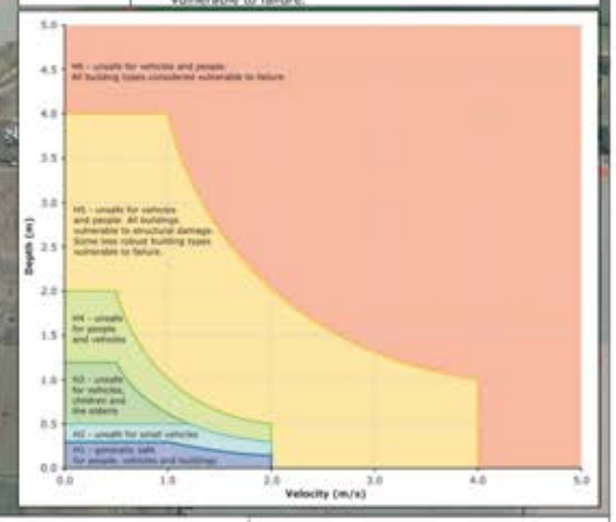
Lot: 2//1279195

Lot: 171//727690

Lot: 19//621875//777038

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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130 0 130 m

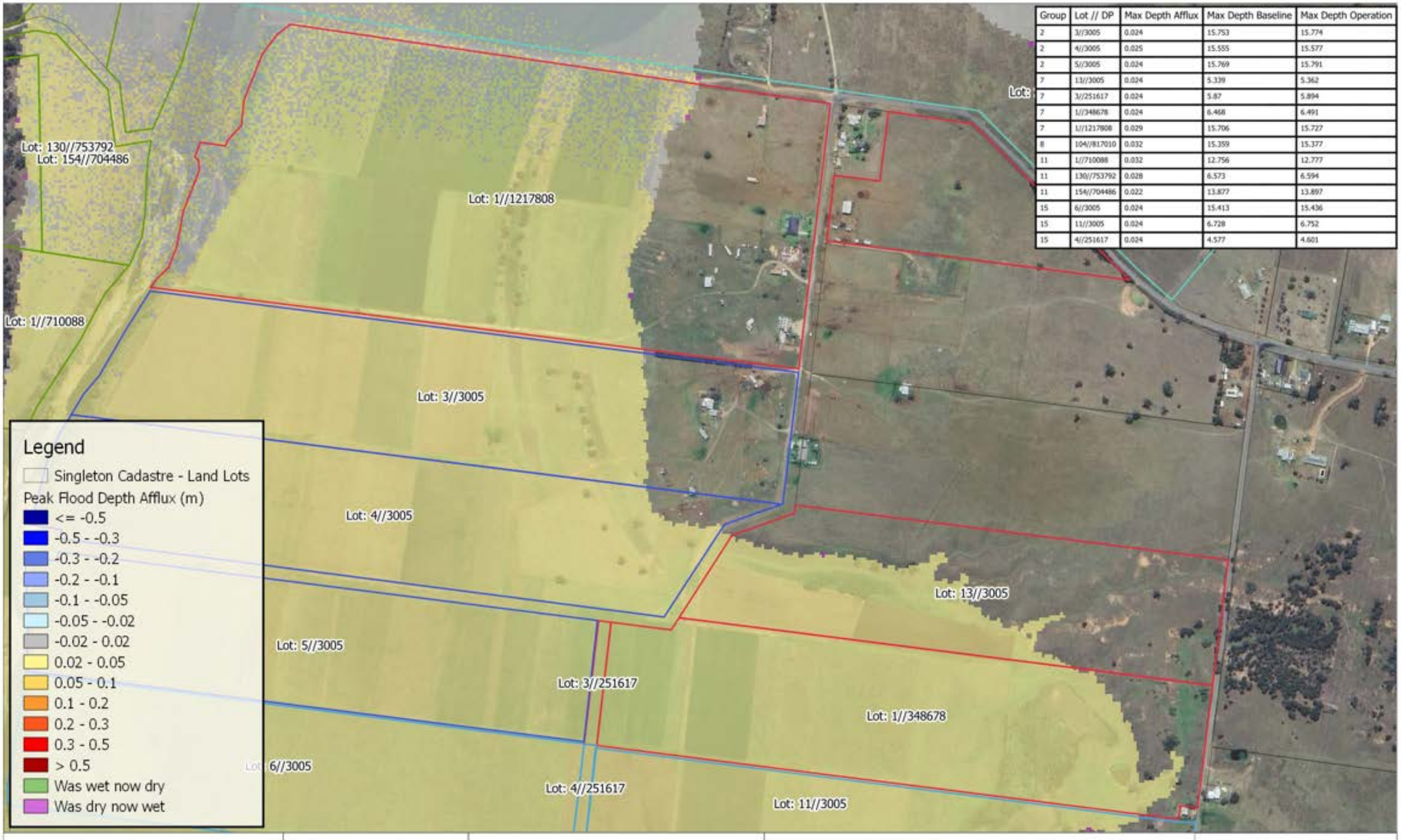
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 6.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
2	4//3005	0.025	15.555	15.577
2	5//3005	0.024	15.769	15.791
7	13//3005	0.024	5.339	5.362
7	3//251617	0.024	5.87	5.894
7	1//348678	0.024	6.468	6.491
7	1//1217808	0.029	15.706	15.727
8	104//817010	0.032	15.359	15.377
11	1//710088	0.032	12.756	12.777
11	130//753792	0.028	6.573	6.594
11	154//704486	0.022	13.877	13.897
15	6//3005	0.024	15.413	15.436
15	11//3005	0.024	6.728	6.752
15	4//251617	0.024	4.577	4.601



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Grid: Map Grid of Australia, Zone 56

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Figure 7.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 1 DP 348678, Lot 3 DP 251617, Lot 13 DP 3005 and Lot 1 DP 1217808 (Group 7)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
2	5//3005	<0.1	2.4	2.4
7	3//251617	<0.1	1.4	1.4
7	1//348678	<0.1	1.5	1.5
7	13//3005	<0.1	1.2	1.2
7	1//1217808	<0.1	2.6	2.6
8	104//817010	<0.1	2.9	2.9

Lot: 130//753792
Lot: 154//704486
Lot: 1//1217808
Lot: 1//710088
Lot: 3//3005
Lot: 4//3005
Lot: 13//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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130 0 130 m

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Grid: Map Grid of Australia, Zone 56

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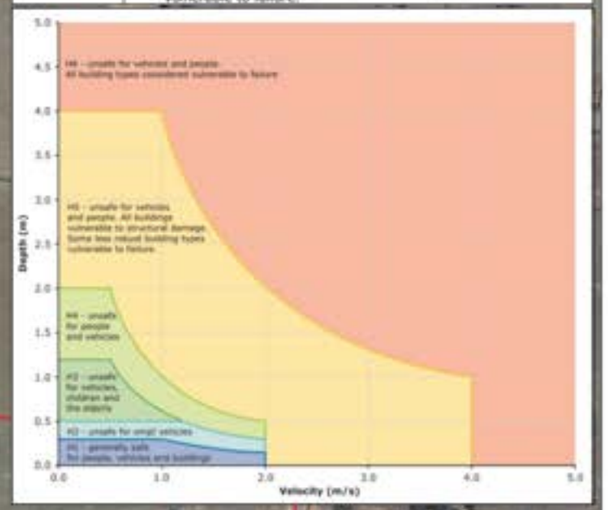
Figure 7.B: 1% AEP Velocity Afflux - Private Land Impacts Lot 1 DP 348678, Lot 3 DP 251617, Lot 13 DP 3005 and Lot 1 DP 1217808
(Group 7)

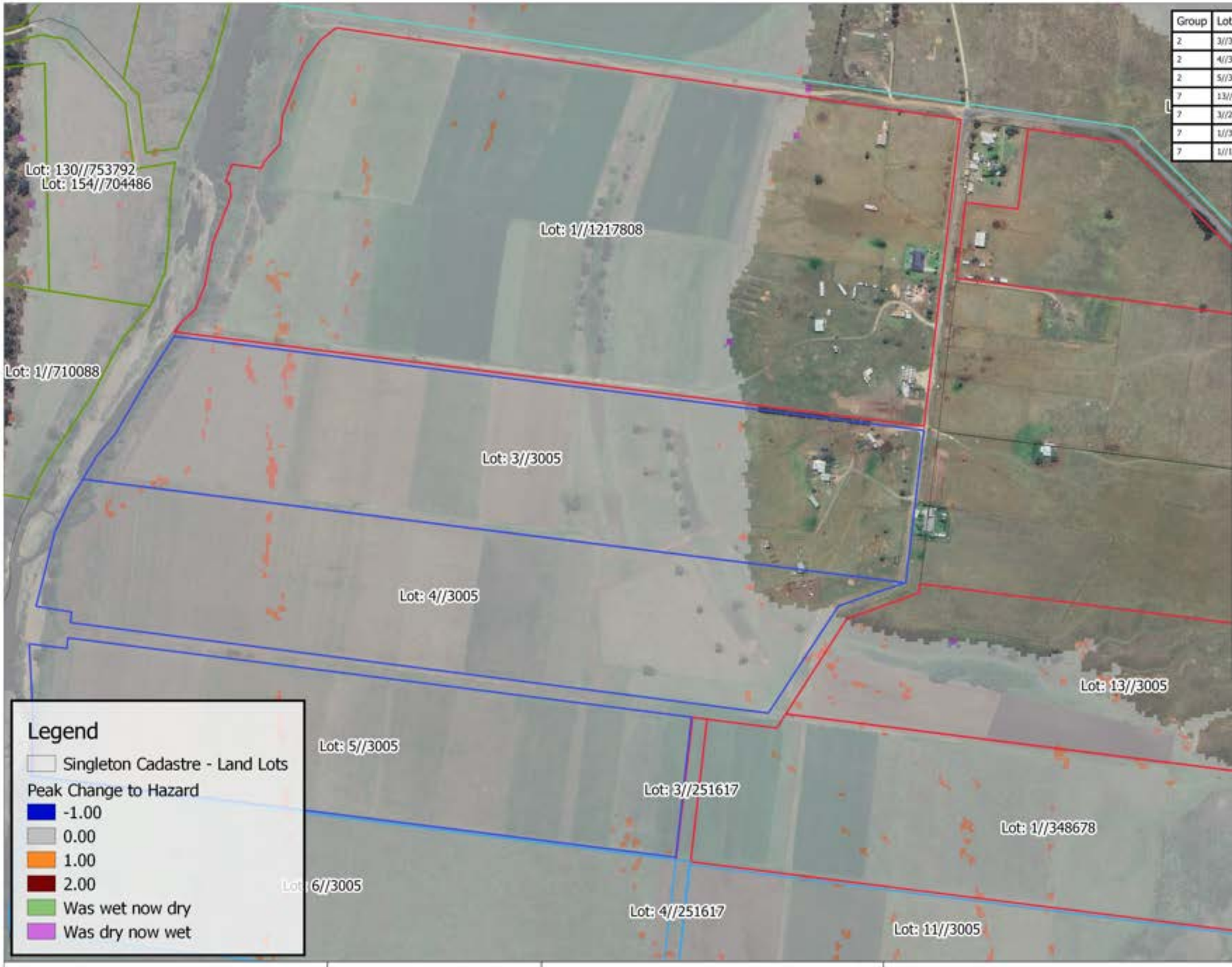
Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
2	5//3005	1	6	6
7	13//3005	1	6	6
7	3//251617	0	6	6
7	1//348678	1	6	6
7	1//1217808	1	6	6

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.





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130 0 130 m

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Grid: Map Grid of Australia, Zone 56

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Figure 7.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 1 DP 348678, Lot 3 DP 251617, Lot 13 DP 3005 and Lot 1 DP 1217808
(Group 7)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
7	1//1217808	0.029	15.706	15.727
8	104//817010	0.032	15.359	15.377
11	1//710088	0.032	12.756	12.777
11	130//753792	0.028	6.573	6.594
11	154//704486	0.022	13.877	13.897

Lot: 104//817010

Lot: 1//1217808

Lot: 3//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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160 0 160 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 8.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
7	1//1217808	<0.1	2.6	2.6
8	104//817010	<0.1	2.9	2.9
11	1//710088	<0.1	2.3	2.3
11	130//753792	<0.1	1.0	1.0
11	154//704486	<0.1	2.6	2.6

Lot: 104//817010

Lot: 1//1217808

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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160 0 160 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 8.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
7	1//1217808	1	6	6
8	104//817010	1	6	6
11	1//710088	1	6	6
11	154//704486	1	6	6

Lot: 104//817010

Lot: 1//1217808

Lot: 3//3005

Legend

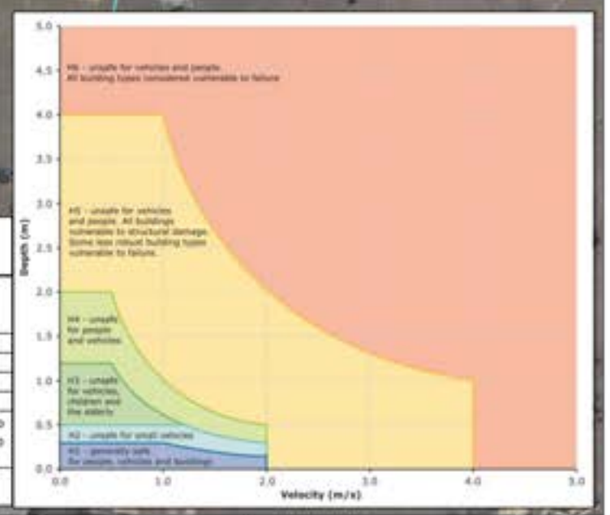
- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



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N

160 0 160 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 8.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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80 0 80 m

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Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 9.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 2 DP 1270727 (Group 9)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
9	2//1270727	<0.1	3.4	3.4
10	1//1270727	<0.1	3.4	3.4

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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80 0 80 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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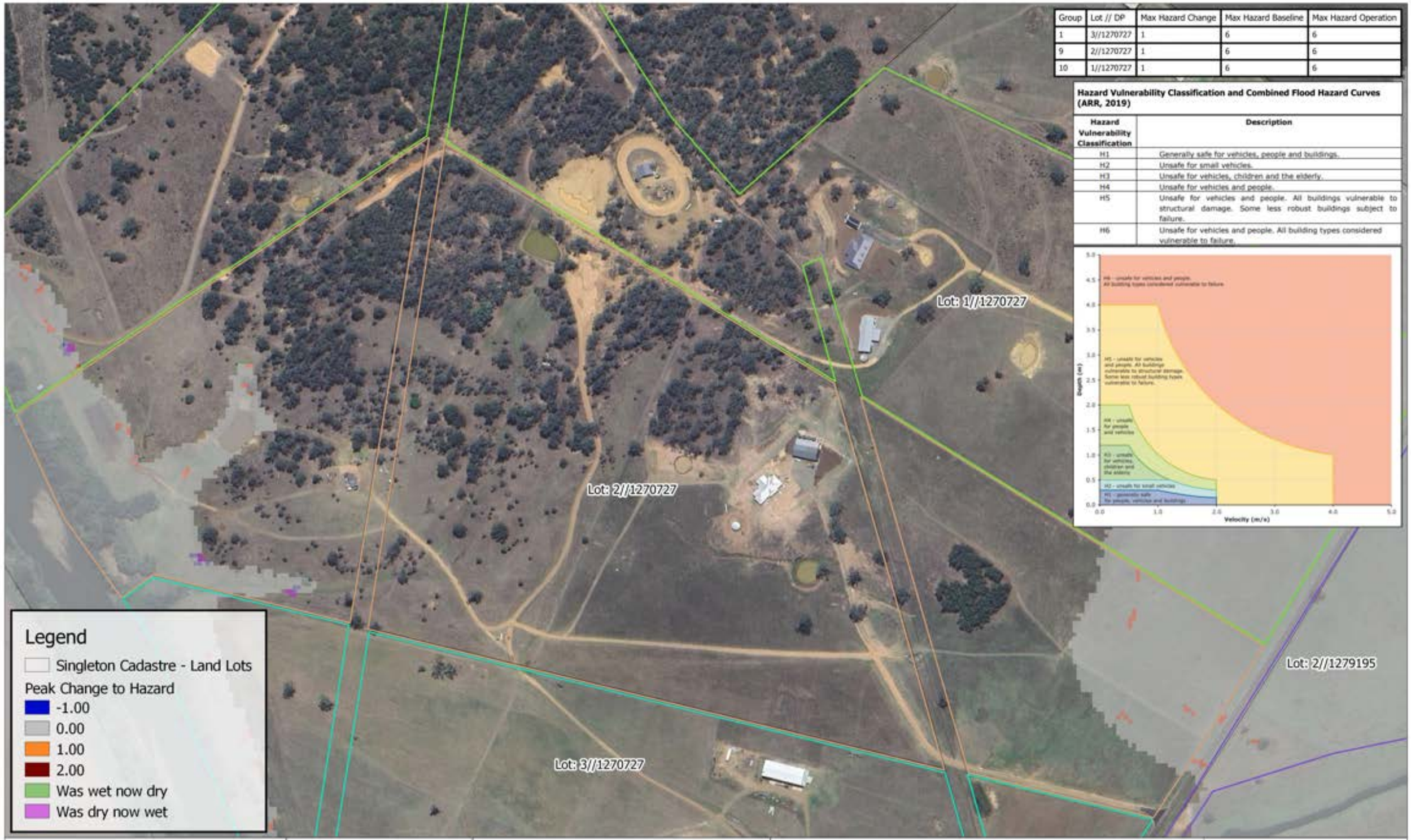
Figure 9.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 2 DP 1270727 (Group 9)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
1	3//1270727	1	6	6
9	2//1270727	1	6	6
10	1//1270727	1	6	6

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



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80 0 80 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 9.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 2 DP 1270727 (Group 9)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273



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100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 10.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 1 DP 1270727 (Group 10)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
9	2//1270727	<0.1	3.4	3.4
10	1//1270727	<0.1	3.4	3.4

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

Lot: 1//1270727

Lot: 2//1270727

Lot: 3//1270727

Lot: 2//1279195

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100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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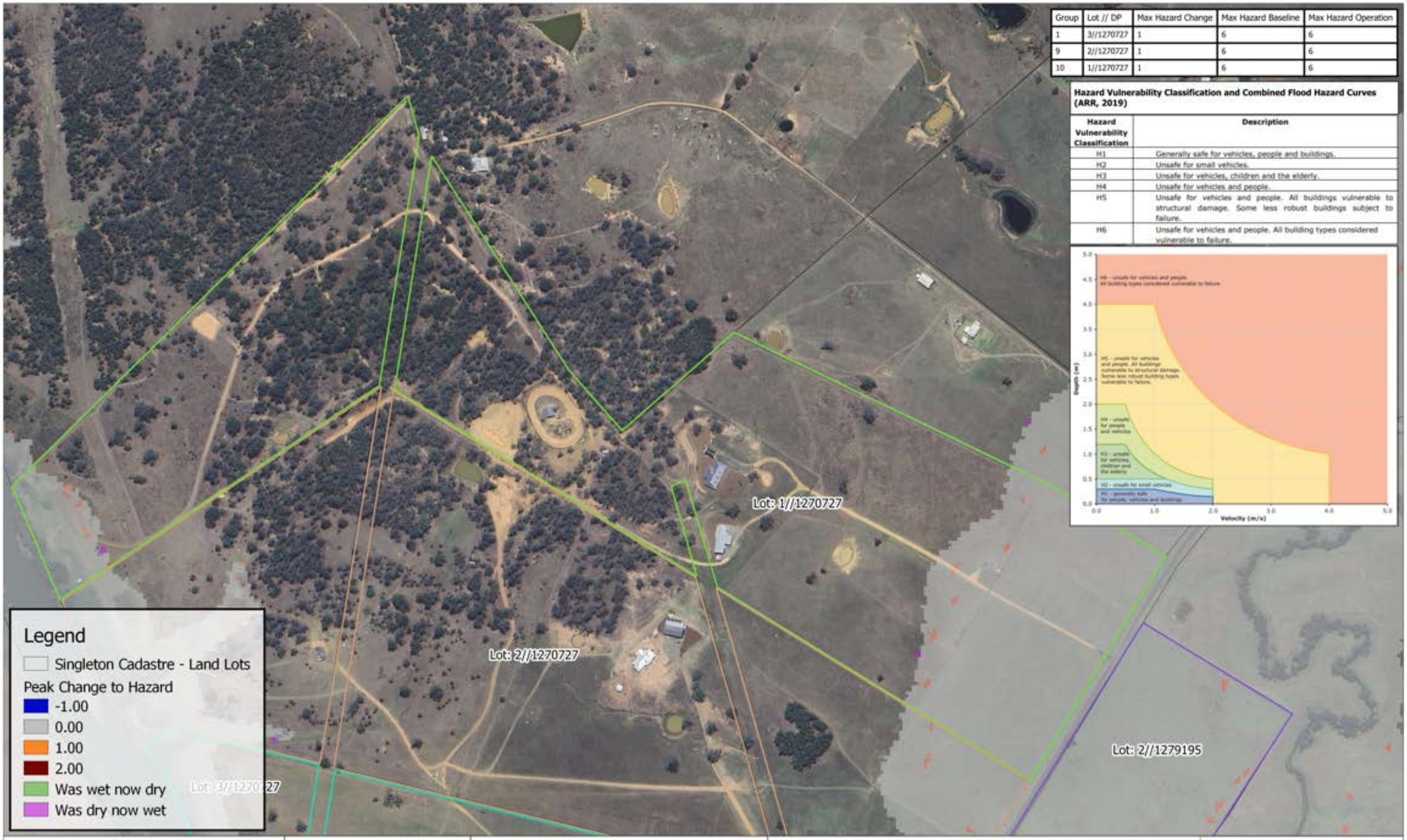
Figure 10.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 1 DP 1270727 (Group 10)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
1	3//1270727	1	6	6
9	2//1270727	1	6	6
10	1//1270727	1	6	6

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



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N

100 0 100 m

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Figure 10.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 1 DP 1270727 (Group 10)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
2	4//3005	0.025	15.555	15.577
7	1//1217808	0.029	15.706	15.727
8	104//817010	0.032	15.359	15.377
11	1//710088	0.032	12.756	12.777
11	130//753792	0.028	6.573	6.594
11	154//704486	0.022	13.877	13.897

Lot: 130//753792

Lot: 154//704486

Lot: 1//1217808

Lot: 1//710088

Lot: 3//3005

Lot: 4//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

70 0 70 m

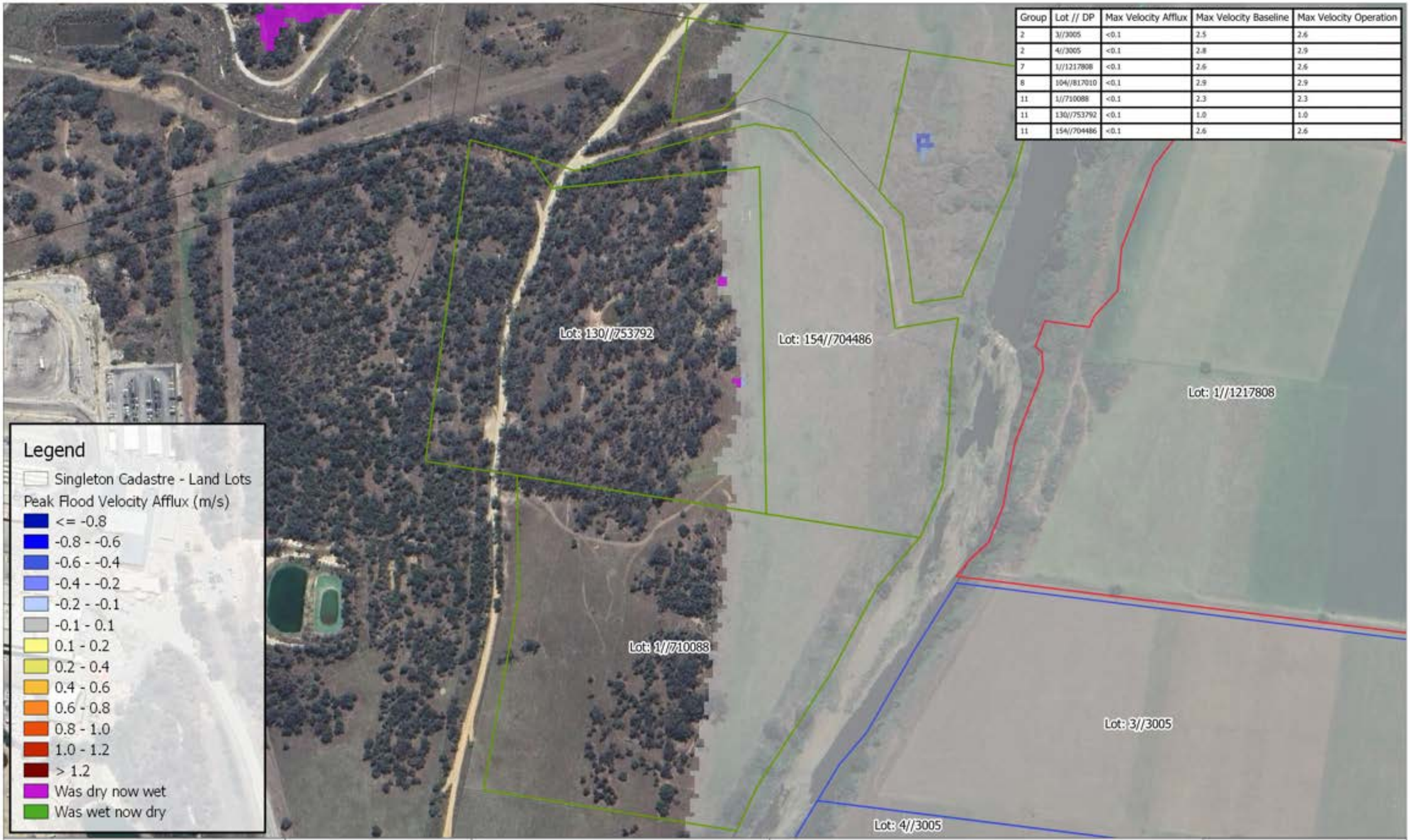
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 11.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 1 DP 710088, Lot 130 DP 753792 and Lot 154 DP 704486 (Group 11)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
7	1//1217808	<0.1	2.6	2.6
8	104//817010	<0.1	2.9	2.9
11	1//710088	<0.1	2.3	2.3
11	130//753792	<0.1	1.0	1.0
11	154//704486	<0.1	2.6	2.6



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70 0 70 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 11.B: 1% AEP Velocity Afflux - Private Land Impacts Lot 1 DP 710088, Lot 130 DP 753792 and Lot 154 DP 704486 (Group 11)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
7	1//1217808	1	6	6
8	104//817010	1	6	6
11	1//710088	1	6	6
11	130//753792	1	6	6
11	154//704486	1	6	6

Lot: 130//753792

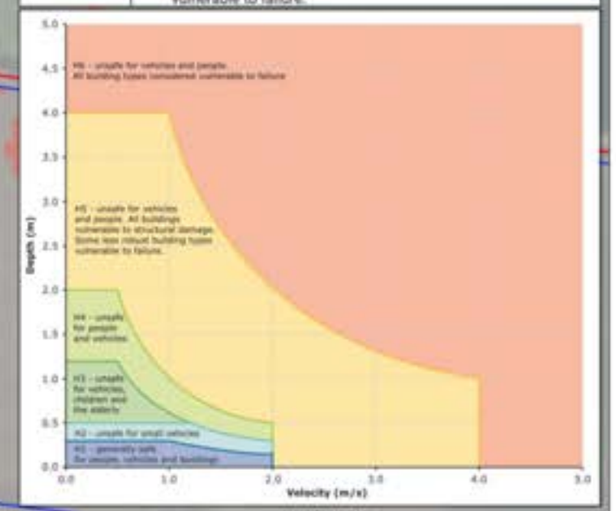
Lot: 154//704486

Lot: 1//710088

Lot: 4//3005

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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N

70 0 70 m

Map Projection: Tranverse Mercator
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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 11.C: 1% AEP Hazard Afflux - Private Land Impacts Lot 1 DP 710088, Lot 130 DP 753792 and Lot 154 DP 704486 (Group 11)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
12	171//727690	0.023	15.052	15.074

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Lot: 19//621875

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

50 0 50 m

Map Projection: Tranverse Mercator
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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 12.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 171 DP 727690 (Group 12)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
12	171//727690	<0.1	3.6	3.6

Lot: 3//1270727

Lot: 2//1279195

Lot: 171//727690

Lot: 19//621875

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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N

50 0 50 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 12.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 171 DP 727690 (Group 12)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
1	3//1270727	1	6	6
12	171//727690	0	6	6

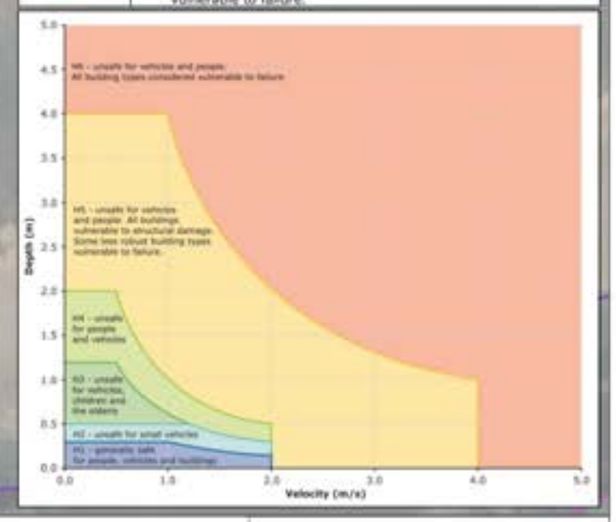
Lot: 3//1270727

Lot: 171//727690

Lot: 19//621875

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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50 0 50 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 12.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 171 DP 727690 (Group 12)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
5	200//777038	0.022	12.868	12.888
13	19//621875	0.024	10.875	10.896
6	2//1279195	0.021	15.316	15.329



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40 0 40 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 13.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
6	2//1279195	0.2	4.1	4.2
5	200//777038	<0.1	2.4	2.4
13	19//621875	<0.1	2.3	2.3



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40 0 40 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 13.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
5	200//777038	1	6	6
13	19//621875	0	6	6

Lot: 171//727690

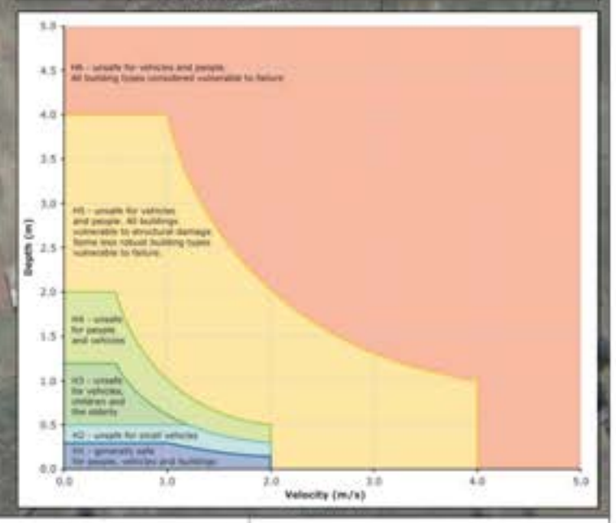
Lot: 2//1279195

Lot: 200//777038

Lot: 19//621875

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



Legend

- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

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N

40 0 40 m

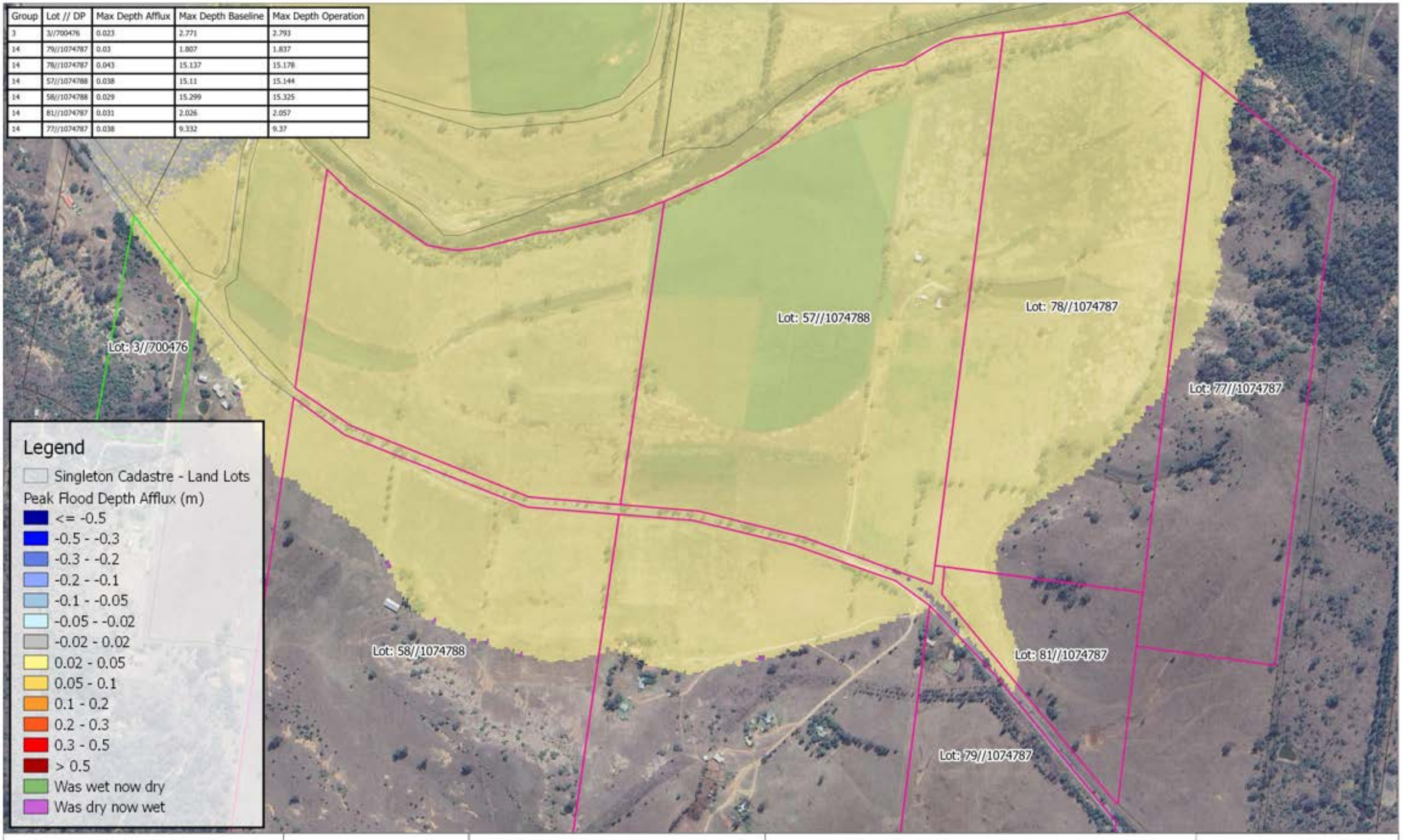
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 13.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
3	3//700476	0.023	2.771	2.793
14	79//1074787	0.03	1.807	1.837
14	78//1074787	0.043	15.137	15.178
14	57//1074788	0.038	15.11	15.144
14	58//1074788	0.029	15.299	15.325
14	81//1074787	0.031	2.026	2.057
14	77//1074787	0.038	9.332	9.37



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N

160 0 160 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 14.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 58 and 57 DP 1074788, Lot 77, 78, 79 and 81 DP 1074787 (Group 14)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
3	3//700476	<0.1	1.0	1.0
14	78//1074787	<0.1	2.4	2.4
14	58//1074788	<0.1	2.9	2.9
14	81//1074787	<0.1	0.6	0.6
14	77//1074787	<0.1	1.6	1.6
14	79//1074787	<0.1	0.4	0.4
14	57//1074788	<0.1	2.6	2.6



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160 0 160 m

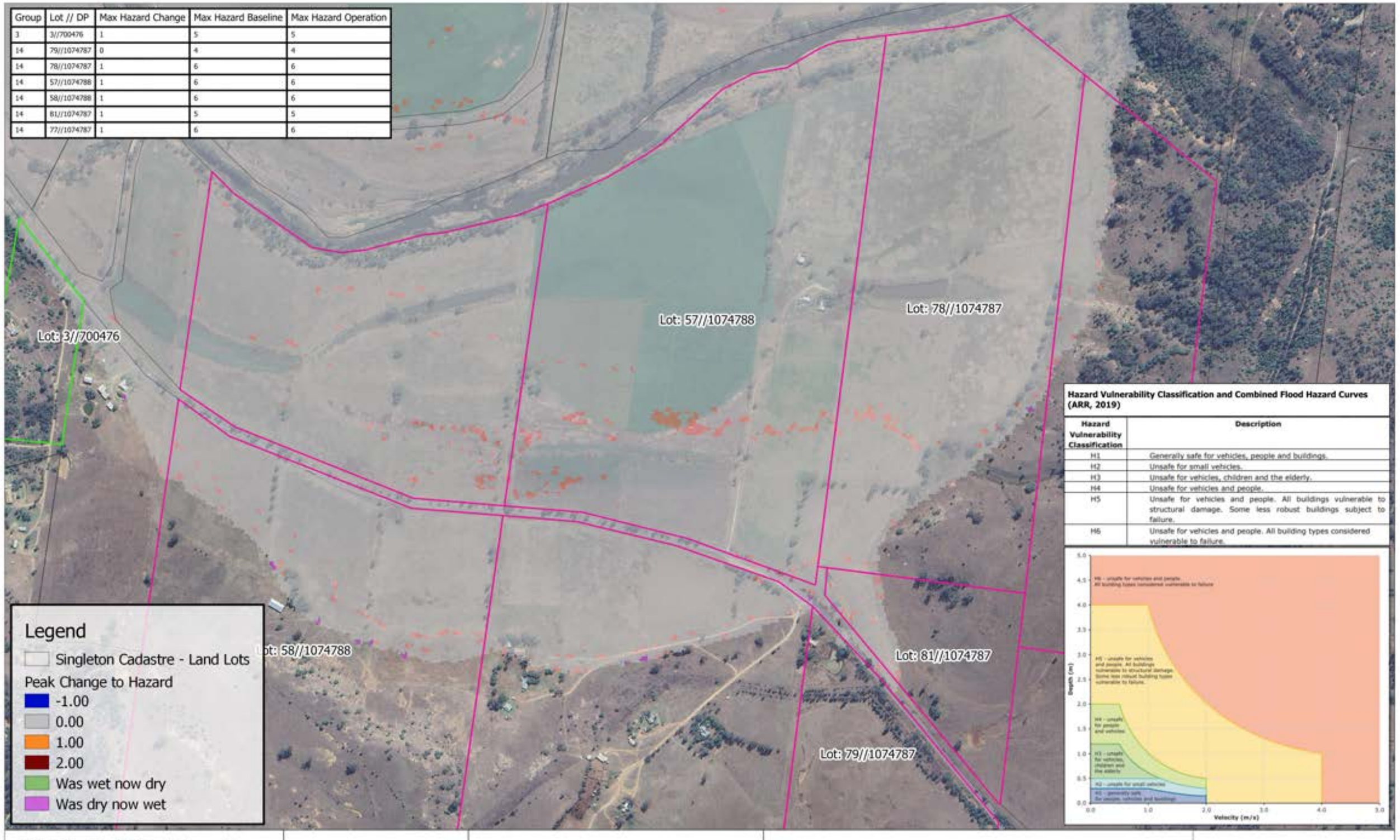
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 14.B: 1% AEP Velocity Afflux - Private Land Impacts Lot 58 and 57 DP 1074788, Lot 77, 78, 79 and 81 DP 1074787 (Group 14)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
3	3//700476	1	5	5
14	79//1074787	0	4	4
14	78//1074787	1	6	6
14	57//1074788	1	6	6
14	58//1074788	1	6	6
14	81//1074787	1	5	5
14	77//1074787	1	6	6



Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

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Figure 14.C: 1% AEP Hazard Afflux - Private Land Impacts Lot 58 and 57 DP 1074788, Lot 77, 78, 79 and 81 DP 1074787 (Group 14)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
2	4//3005	0.025	15.555	15.577
2	5//3005	0.024	15.769	15.791
4	8//3005	0.025	8.733	8.757
4	9//3005	0.026	8.808	8.832
4	5//251617	0.025	5.697	5.722
7	13//3005	0.024	5.339	5.362
7	3//251617	0.024	5.87	5.894
7	1//348678	0.024	6.468	6.491
15	6//3005	0.024	15.413	15.436
15	11//3005	0.024	6.728	6.752
15	4//251617	0.024	4.577	4.601

Lot: 4//3005
Lot: 3//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005
Lot: 5//251617
Lot: 8//3005
Lot: 9//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- -0.5 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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N

100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Grid: Map Grid of Australia, Zone 56

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Figure 15.A: 1% AEP Flood Depth Afflux - Private Land Impacts
Lot 4 DP 251617 and Lots 6 and 11 DP 3005 (Group 15)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
2	5//3005	<0.1	2.4	2.4
4	8//3005	<0.1	2.3	2.3
4	9//3005	<0.1	1.2	1.2
4	5//251617	<0.1	1.0	1.0
7	3//251617	<0.1	1.4	1.4
7	1//348678	<0.1	1.5	1.5
7	13//3005	<0.1	1.2	1.2
15	6//3005	<0.1	2.5	2.5
15	4//251617	<0.1	1.0	1.0
15	11//3005	<0.1	1.7	1.7

Lot: 3//3005
Lot: 4//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005
Lot: 5//251617
Lot: 8//3005
Lot: 9//3005

Legend

- Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- -0.8 - -0.6
- -0.6 - -0.4
- -0.4 - -0.2
- -0.2 - -0.1
- -0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

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N

100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 15.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 4 DP 251617 and Lots 6 and 11 DP 3005 (Group 15)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
2	5//3005	1	6	6
4	8//3005	1	6	6
4	9//3005	1	6	6
4	5//251617	0	6	6
7	13//3005	1	6	6
7	3//251617	0	6	6
7	1//348678	1	6	6
15	6//3005	1	6	6
15	11//3005	1	6	6
15	4//251617	1	6	6

Lot: 3//3005
Lot: 4//3005
Lot: 5//3005
Lot: 3//251617
Lot: 1//348678
Lot: 6//3005
Lot: 4//251617
Lot: 11//3005
Lot: 5//251617
Lot: 8//3005

Legend

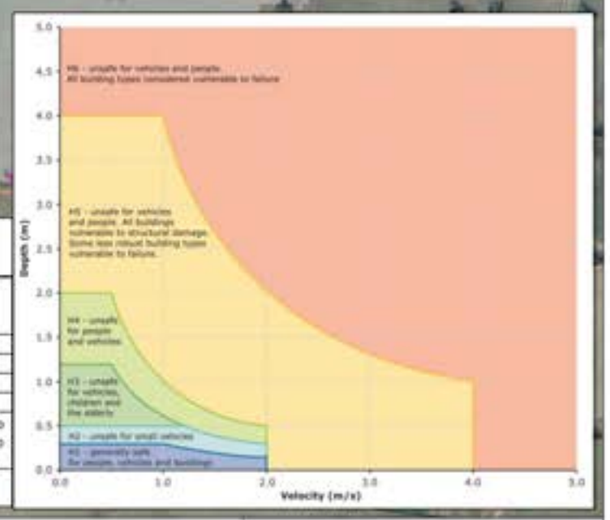
- Singleton Cadastre - Land Lots

Peak Change to Hazard

- -1.00
- 0.00
- 1.00
- 2.00
- Was wet now dry
- Was dry now wet

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.



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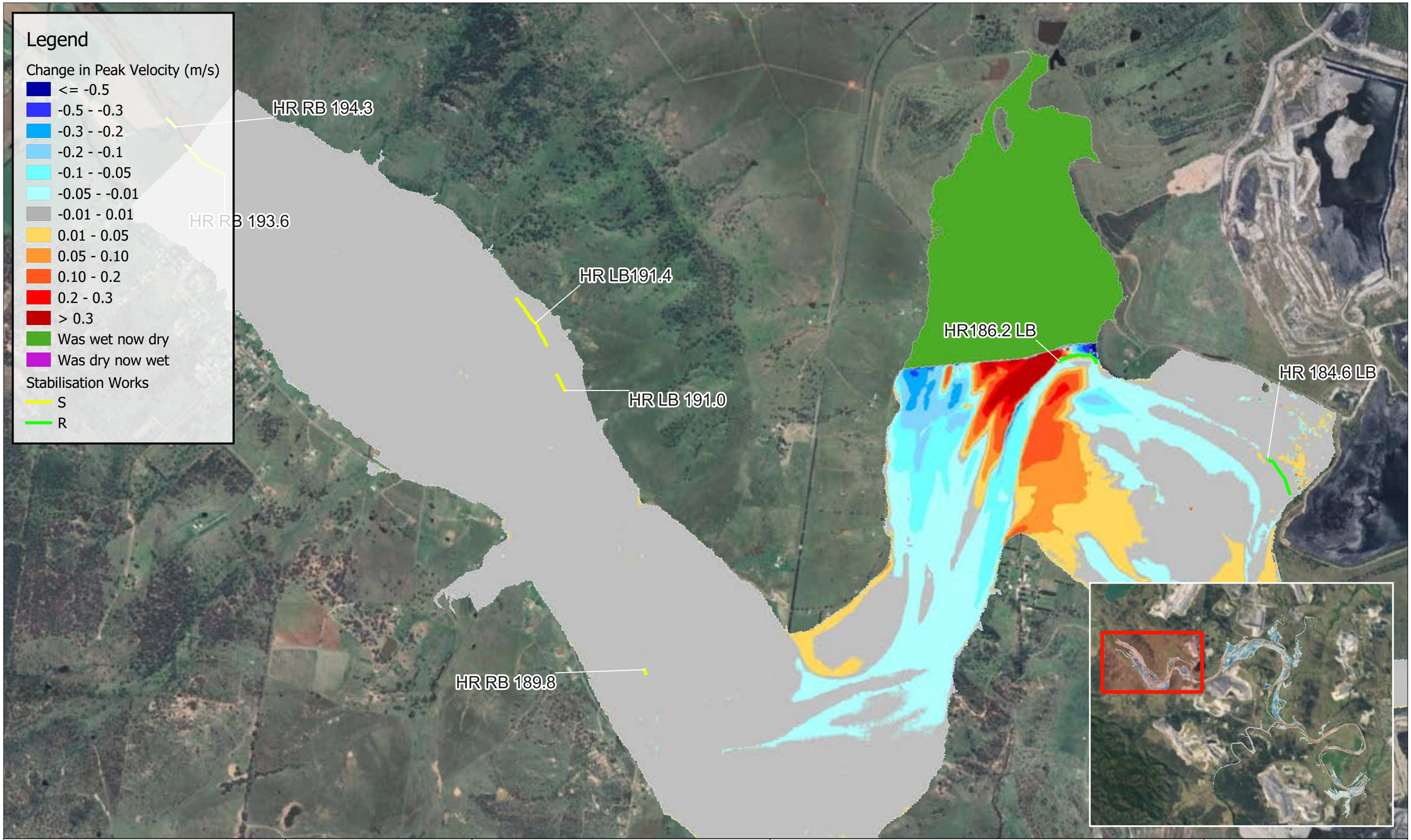
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Figure 15.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 4 DP 251617 and Lots 6 and 11 DP 3005 (Group 15)

Job Number: NC1013_001
Revision: 0
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ATTACHMENT G: HUNTER RIVER FLOOD MITIGATION SCHEME BANK STABILISATION WORKS FIGURES



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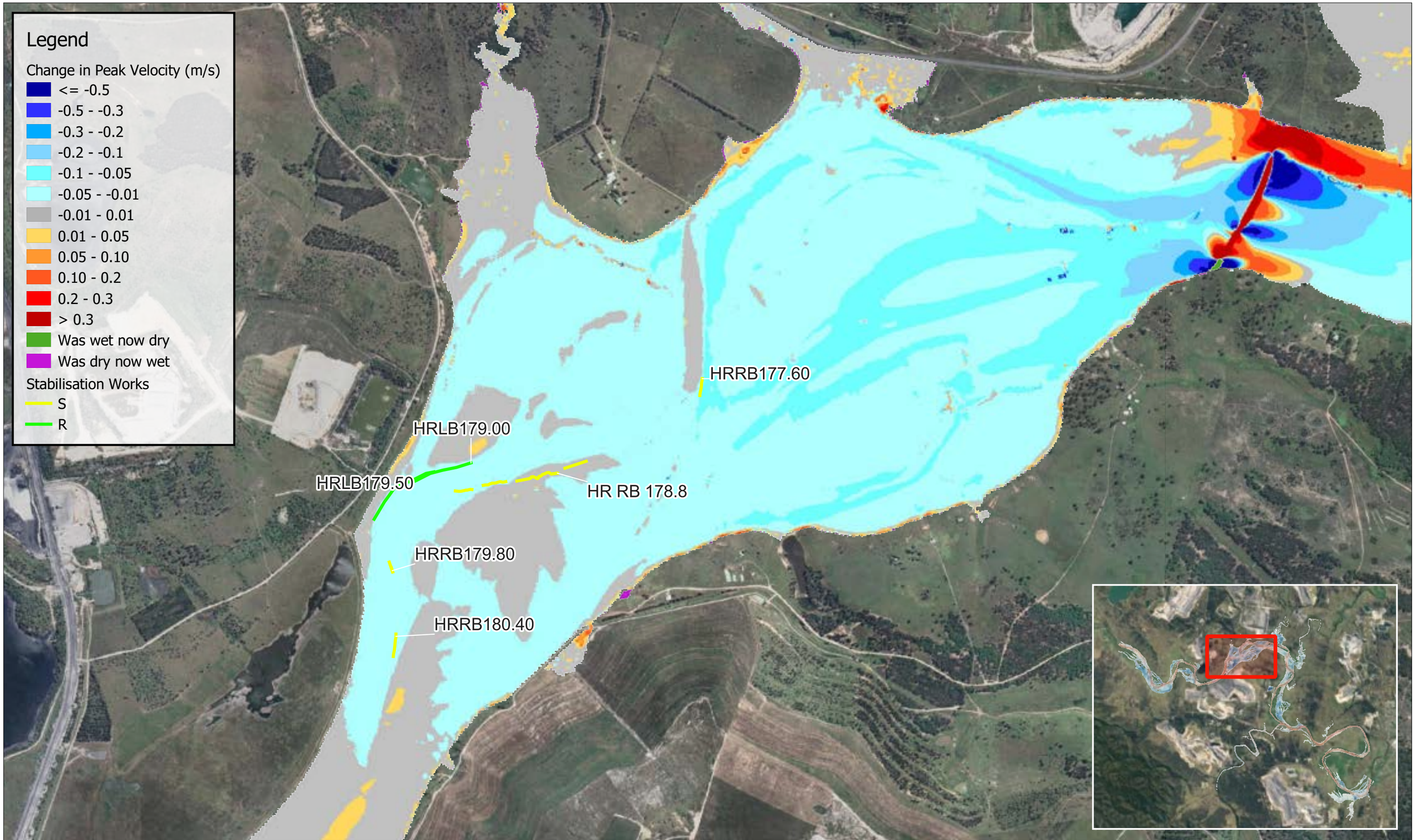
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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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1% AEP Afflux - Levee Impacts 1

Job Number: NC1013_001
Revision: 0
Drawn: RM
Checked: GC
Date: 20/6/2023



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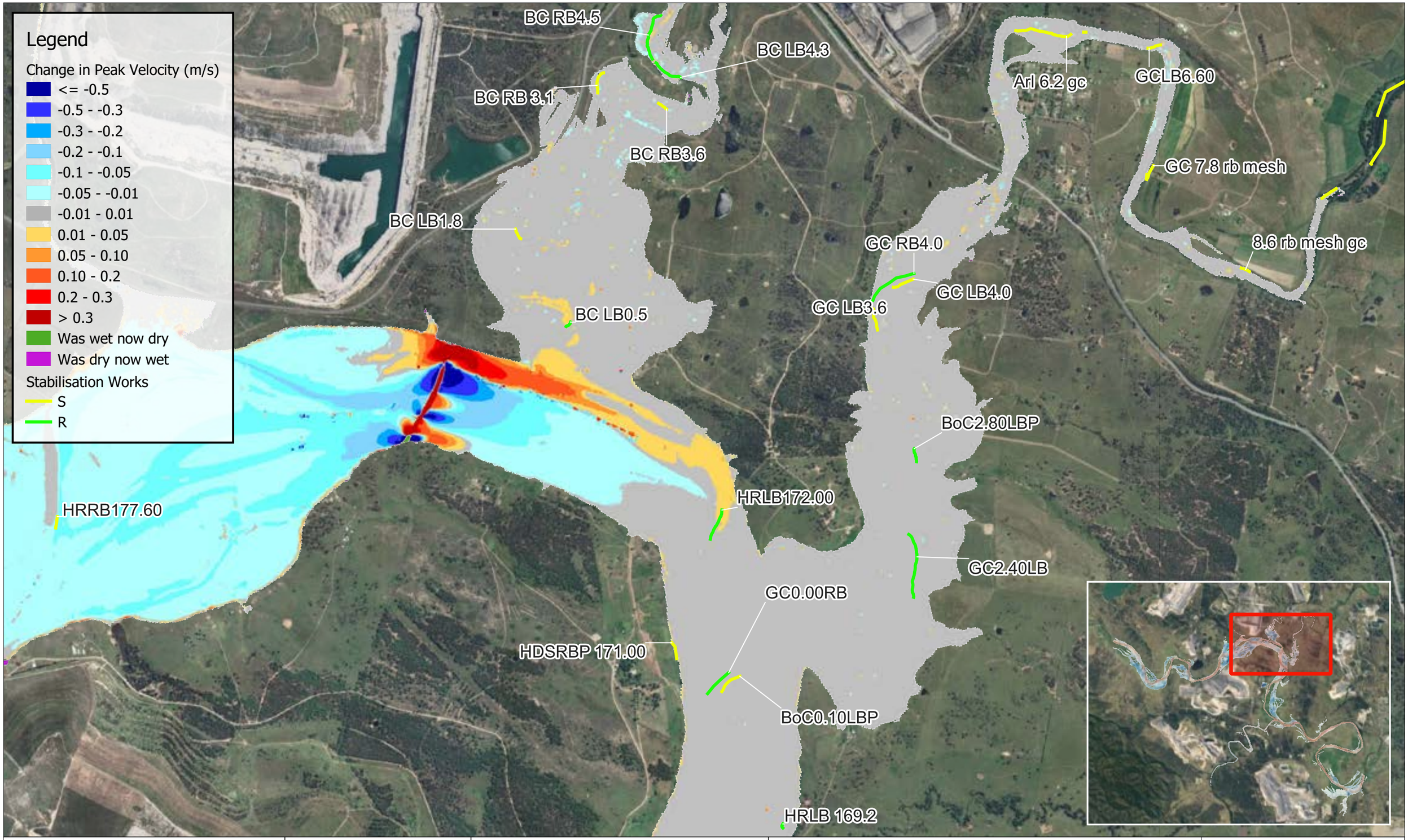
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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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1% AEP Afflux - Levee Impacts 2

Job Number: NC1013_001
Revision: 0
Drawn: RM
Checked: GC
Date: 20/6/2023



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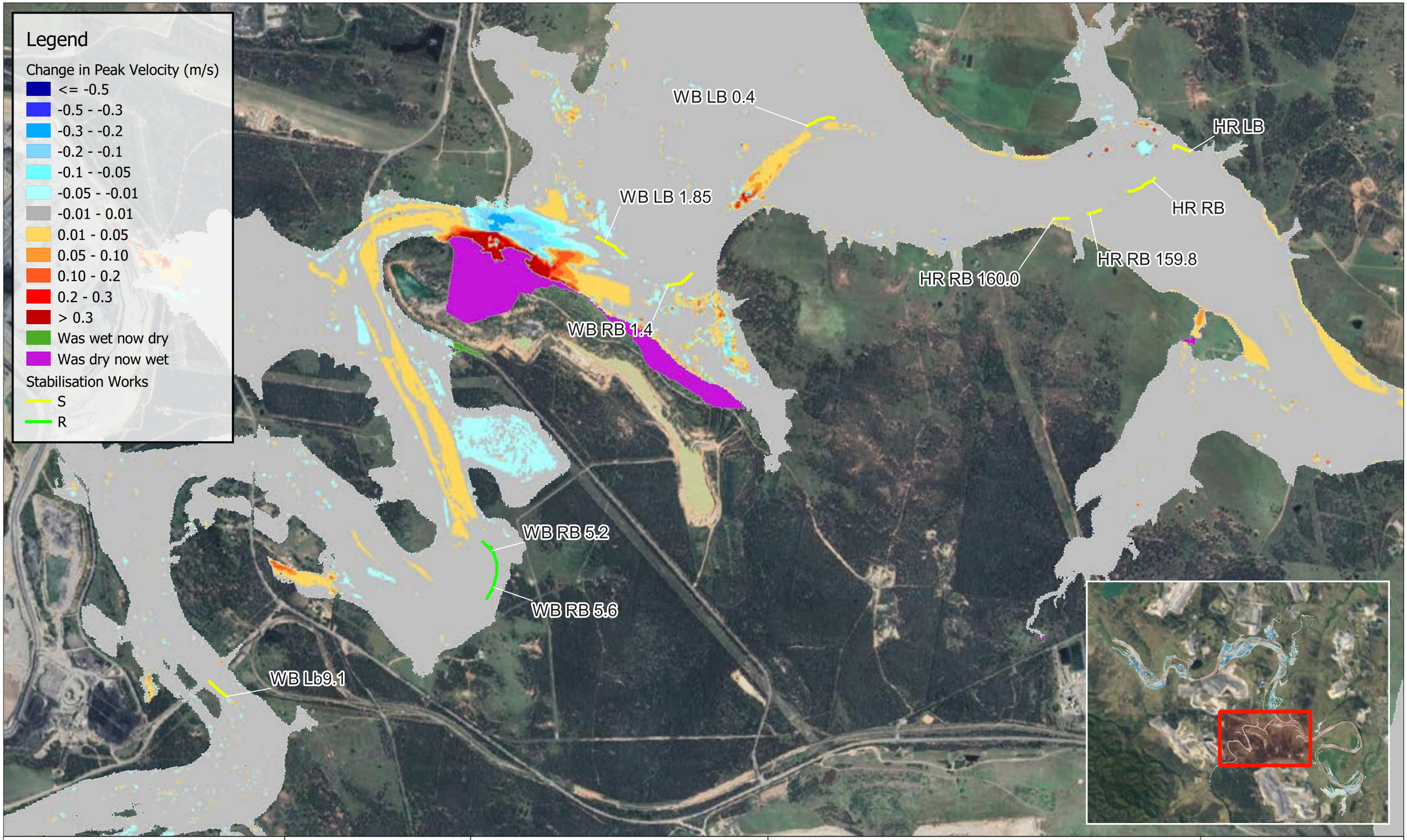
500 0 500 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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1% AEP Afflux - Levee Impacts 3

Job Number: NC1013_001
Revision: 0
Drawn: RM
Checked: GC
Date: 20/6/2023



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400 0 400 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

1% AEP Afflux - Levee Impacts 4

Job Number: NC1013_001
Revision: 0
Drawn: RM
Checked: GC
Date: 20/6/2023

ATTACHMENT H: LEMINGTON ROAD REALIGNMENT

MEMORANDUM

Project:	NC1013_001	Date:	26 October 2023
To:	EMM	From:	Susan Shield
ATT:	Kate Holder	CC:	
Subject:	HVO CP RTS – Lemington Road		

SUMMARY

As discussed in the Surface Water Impact Assessment (SWIA) (Engeny, 2022) detailed flood modelling of the Hunter River was undertaken as part of the SWIA. The modelling was undertaken in accordance with the methods recommended in Australian Rainfall and Runoff 2019 (Ball, et al., 2019). Design flood events for the 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1% Annual Exceedance Probability (AEP) and the Extreme Flood (defined as four times the 1% AEP) were simulated.

The modelling simulated three Project scenarios: Project baseline (existing site forecast at 2025); Project Operations; and Project Closure. Both the Project Operations and the Project Closure modelling scenarios included the proposed realignment and new Hunter River bridge crossing of Lemington Road.

The assessment indicated that the proposed realignment and new Hunter River bridge crossing of Lemington Road will significantly improve the flood immunity of this road adjacent to the Hunter River. With proposed flood immunity exceeding the 10% AEP compared to the existing crossing being less than the 10% AEP (smallest event modelled).

The assessment indicated that the Average Annual Time of Closure (AAToC) of the Lemington Road link between the New England Highway and the Golden Highway is estimated to reduce significantly as a result of realignment as part of the Project (i.e. will have a shorter average annual time period closed due to flooding). The Baseline AAToC was conservatively estimated to be 2.4 hr, with the assessment indicating that with the increased immunity (i.e. above the 10% AEP event) the AAToC improves to 1.4 hr (at least a 42% estimated improvement).

FLOOD ATTENUATION AND VELOCITIES

The Project Operations and Project Closure scenarios included modelling of two bridges and the new/raised road realignment over the Hunter River and associated floodplain (Figures within this document show this location). The northern bridge crossing over the Hunter River consists of four spans with three sets of four approximately 900 mm diameter concrete piers between the two outside bridge abutments. The southern bridge is a lower structure over an existing flood breakout channel from the primary Hunter River channel to the west (i.e., upstream) of the bridge and consists of five spans with four sets of four approximately 900 mm diameter concrete piers between the two outside bridge abutments.

The area around the southern bridge experiences the largest changes in flood depths and velocities. This is primarily due to water attenuation behind the proposed realigned Lemington Road, which directs additional flows from the primary channel towards the flood breakout channel. Attenuation of water (i.e. increased depth of water at the flood peak) will occur behind (i.e., upstream of) the two bridges and the realigned Lemington Road, with a maximum water depth of approximately 1.59 m at this location in the Project Operation and Project Closure scenario, compared to 1.17 m in the Project Baseline scenario in the 10% AEP event (i.e., a 0.42 m increase).

Table 1 and Table 2 below provide a summary of peak flood levels and velocities directly upstream, at the centre, and downstream of each of the bridges associated with the realigned Lemington Road. Results were extracted from the approximate channel/flow centre point (see Figure 1 for reference locations).

The impacts are relatively localised and do not extend downstream to beyond about 2 kilometres in this flood event (see Figure 3 and Figure 5). The greater magnitude of flood impacts are observed upstream, with flood attenuation behind the road embankment and bridges.

TABLE 1: SUMMARY OF FLOOD VELOCITIES – WITHIN THE VICINITY OF BRIDGES ASSOCIATED WITH REALIGNED LEMINGTON ROAD

Location	Peak Flood Velocities (m/s) – 10% AEP		
	Baseline	Operations	Difference
North Bridge – Upstream	1.85	1.87	0.01
North Bridge - Centre	1.90	1.96	0.01
North Bridge – Downstream	2.01	2.01	<0.01
South Bridge - Upstream	1.48	2.03	0.55
South Bridge - Centre	1.52	1.96	0.44
South Bridge – Downstream	1.60	1.87	0.26

TABLE 2: SUMMARY OF FLOOD DEPTHS – WITHIN THE VICINITY OF BRIDGES ASSOCIATED WITH REALIGNED LEMINGTON ROAD

Location	Peak Flood Depths (m) – 10% AEP		
	Baseline	Operations	Difference
North Bridge – Upstream	11.83	11.94	0.11
North Bridge - Centre	11.58	11.67	0.10
North Bridge – Downstream	12.25	12.32	0.08
South Bridge - Upstream	5.27	5.32	0.05
South Bridge - Centre	5.26	5.28	0.02
South Bridge – Downstream	5.07	5.12	0.04



Figure 1: Approximate Locations of Depth and Velocity Results Summary

CHANNEL STABILITY AND GEOMORPHOLOGY

As discussed in Section 6.2.5 of the SWIA (Engeny, 2022) 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). Further detailed design of localised scour protection will be included in the design of Project infrastructure.

No significant change to modelled flood velocities was observed on property not owned by the JV partners. Maps of the change in maximum modelled flood velocity as a result of the Project around the proposed realignment of Lemington Road in the 10% AEP event are shown below (refer Figure 4 and Figure 5).

The land within the area of predicted flood depth increase downstream of the proposed realignment of Lemington Road in the 10% AEP event is mine owned land. The majority of the land upstream is also mine owned land, with a small area that is privately owned by a pastoral company. The predicted increases in flood depths over the privately owned land is in the order of 100 mm to 200 mm for the 10% AEP event in an area that is already flooded by the 10% AEP event.

FIGURES

The below figures provide an overview of the flood depth and velocity changes between the baseline and operational scenarios for the Project for the 10% AEP event.

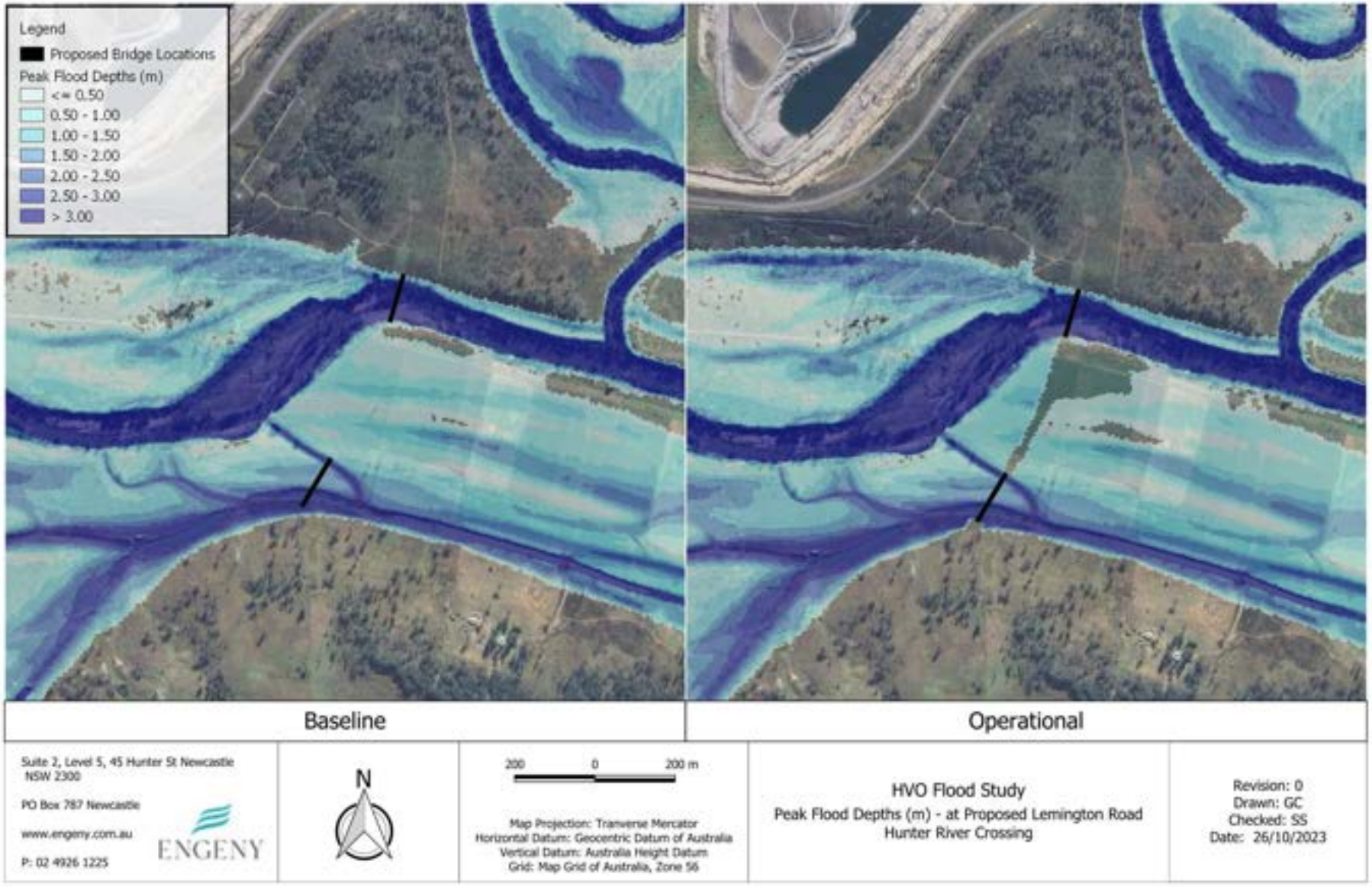


Figure 2: Flood Depth Comparison

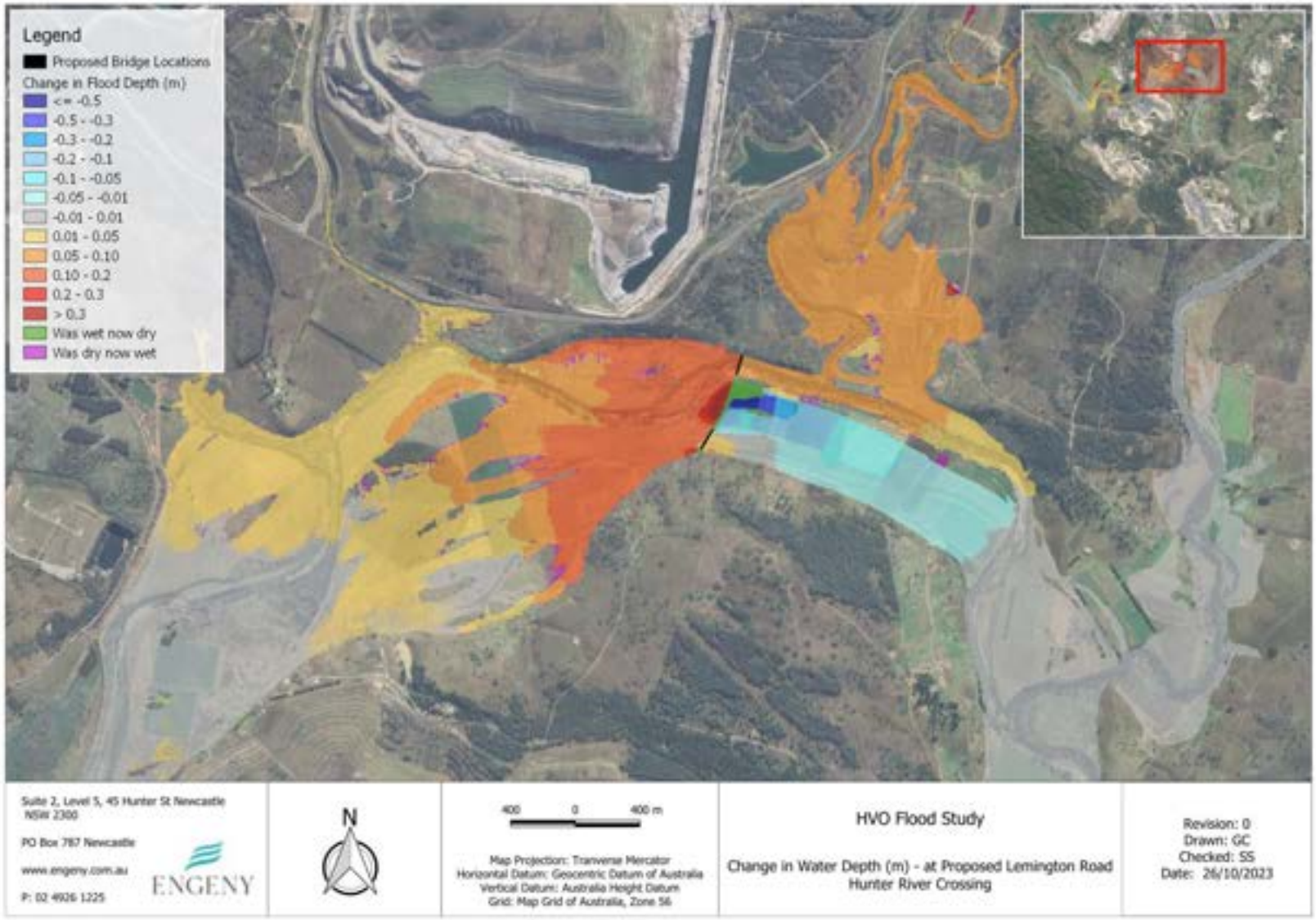


Figure 3: Change in Flood Depths

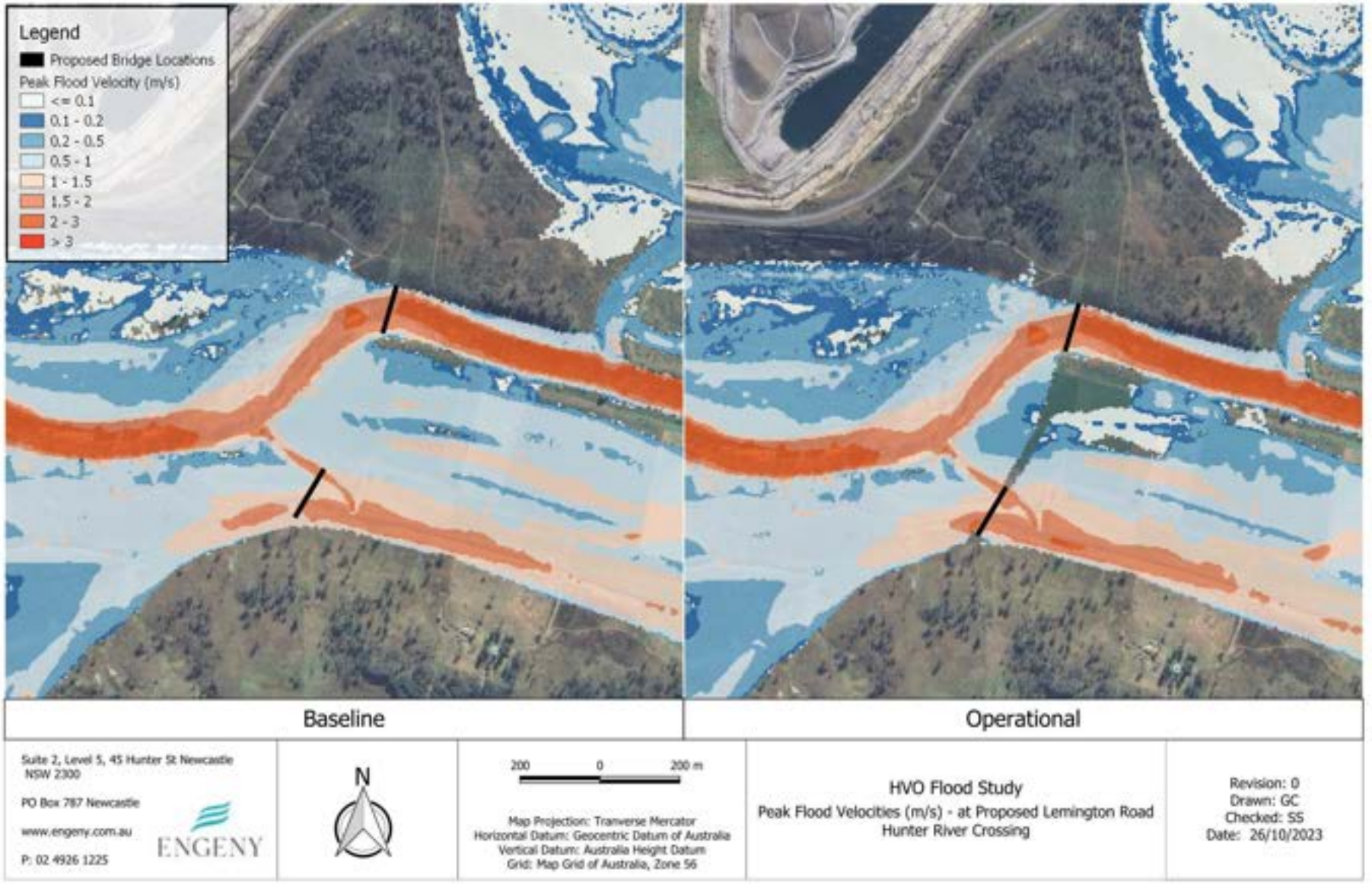


Figure 4: Flood Velocity Comparison

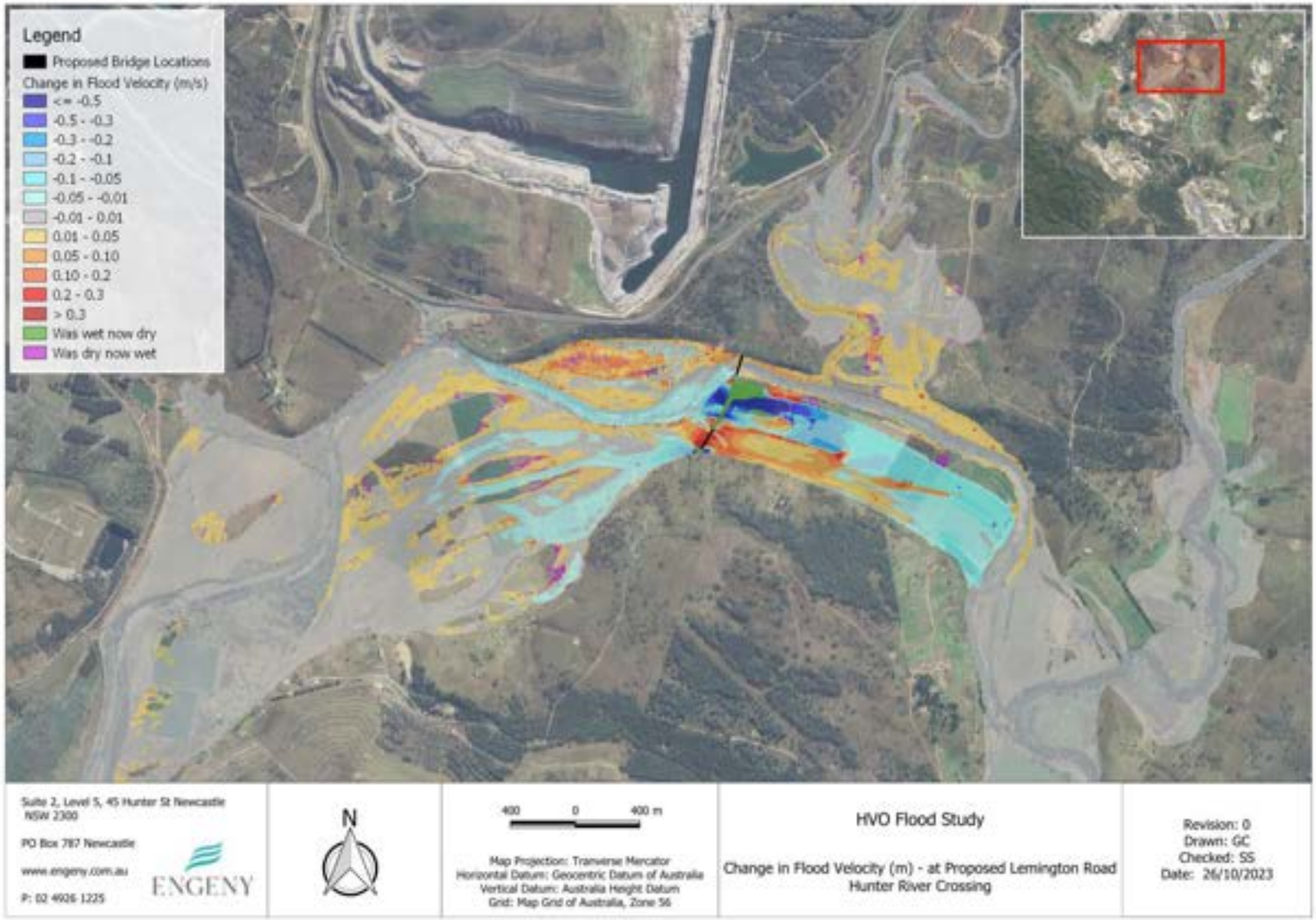


Figure 5: Change in Flood Velocity

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ATTACHMENT I: WATER BALANCE MODELLING

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egis GROUP

HV OPERATIONS PTY LTD

Water Balance Modelling

HVO Continuation Project

BNTL00198_002-REP-007-4

6 MARCH 2026

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	28/08/2025	Client Issue	Sarah Green Goldberg	Susan Shield	Susan Shield	Sean Frazer
1	12/09/2025	Client Issue	Sarah Green Goldberg	Susan Shield	Susan Shield	Sean Frazer
2	26/09/2025	Client Issue	Sarah Green Goldberg	Susan Shield	Susan Shield	Chris Bonomini
3	19/02/2026	Client Issue	Sarah Green Goldberg	Susan Shield	Susan Shield	Chris Bonomini
4	6/03/2026	Client Issue	Sarah Green Goldberg	Susan Shield	Susan Shield	Chris Bonomini
Signatures:						

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1. INTRODUCTION

1.1 Background

Hunter Valley Operations 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) comprising of 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. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV.

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

A peer review of the water balance modelling approach and methodologies was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the development of the surface water impact assessment (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 water balance modelling for the Project, documented in this report, follows the same methodology that was peer reviewed by Ian Rowbottom.

1.2 Overview

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 2012 to generate historical river flow data to simulate future opportunities for controlled release.

The purpose of the WBM was to assess the performance of the proposed WMS over the life of the Project. Key performance indicators of the WBM 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 prior to the commencement of the Project in 2027. As such this report shows the input data to the model for 2025 to 2045 (inclusive) and the Project modelling results for 2027 to the end 2045 (inclusive).

The Project water balance is compared to key results for a water balance of the Approved Operation (refer to Section 8). A climate change scenario model was also assessed for the Project water balance and is documented in Section 9.

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
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 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.

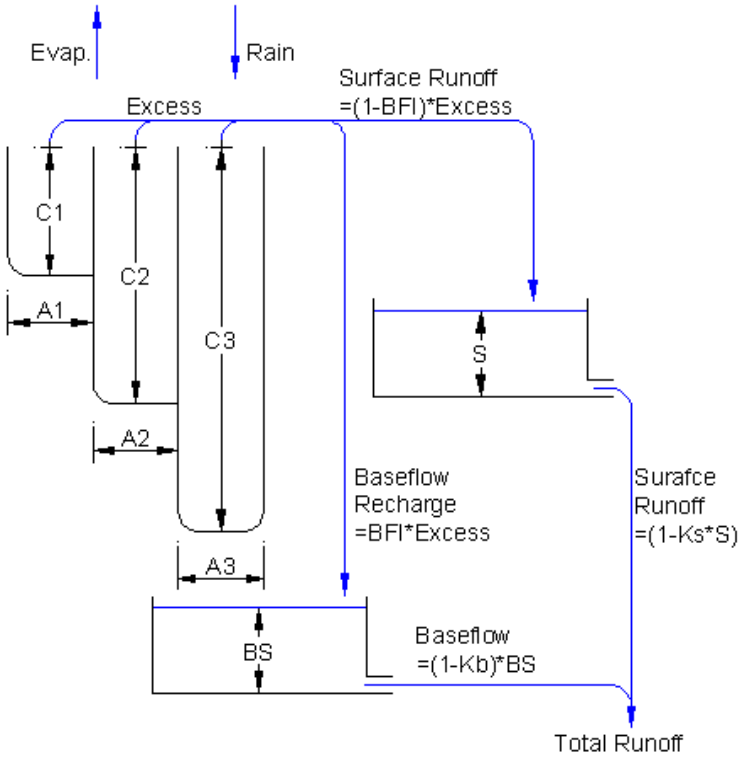


FIGURE 3.1: AWBM SCHEMATIC

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 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 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, 2026).

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**

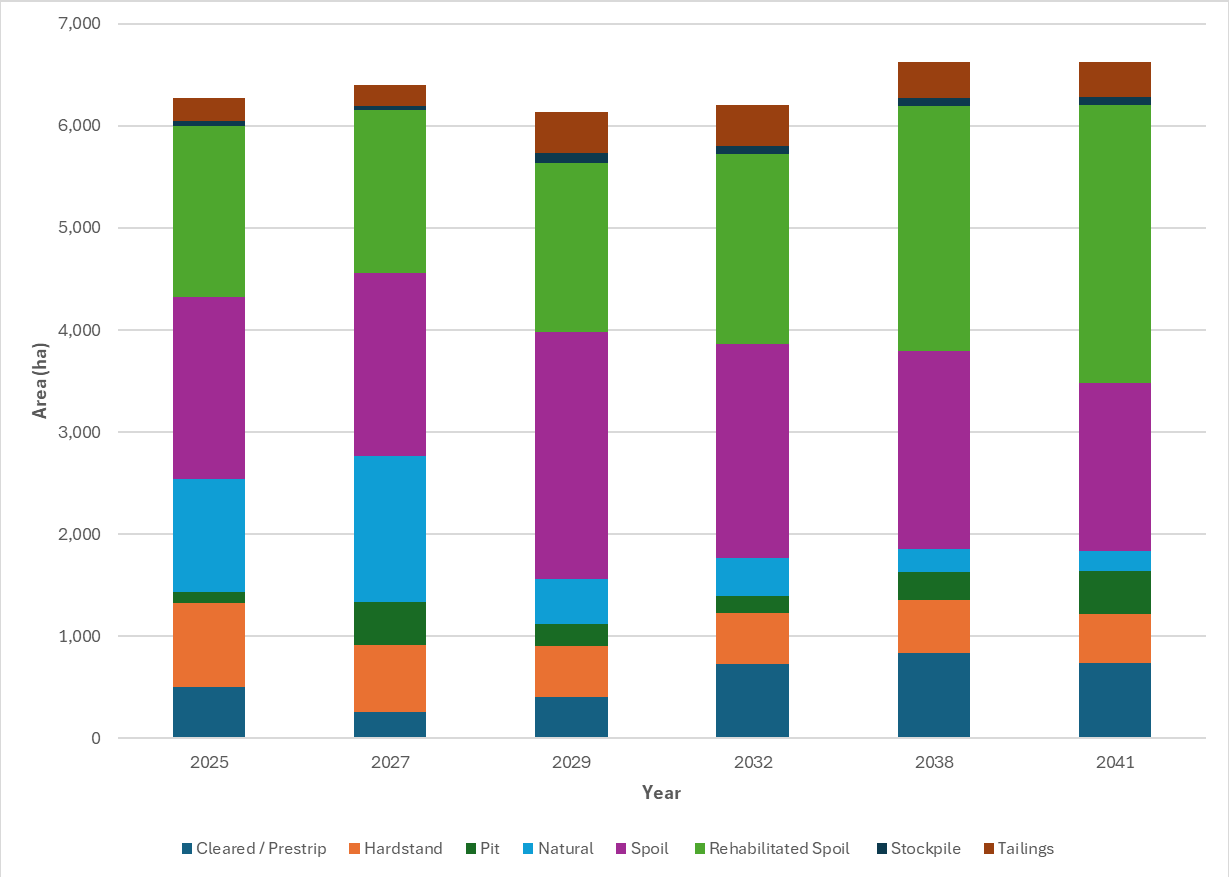


FIGURE 3.2: CONTRIBUTING CATCHMENT AREA

3.3 Groundwater Inflows

Groundwater ingress into open cut pits uses outputs from the regional groundwater model for the Project (EMM, 2026). The groundwater model provides a prediction of all groundwater intercepted by mining 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 during mining that does not flow to in-pit sumps.

The following adjustments have been made to estimate the pumpable groundwater volumes:

- 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.

This methodology was established with (AGE, 2022) and has been adopted for this assessment for consistency the approach that was peer reviewed by Ian Rowbottom. 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
2027	61	186
2029	120	430
2032	444	607
2038	537	221
2041	514	124
2045	831	6

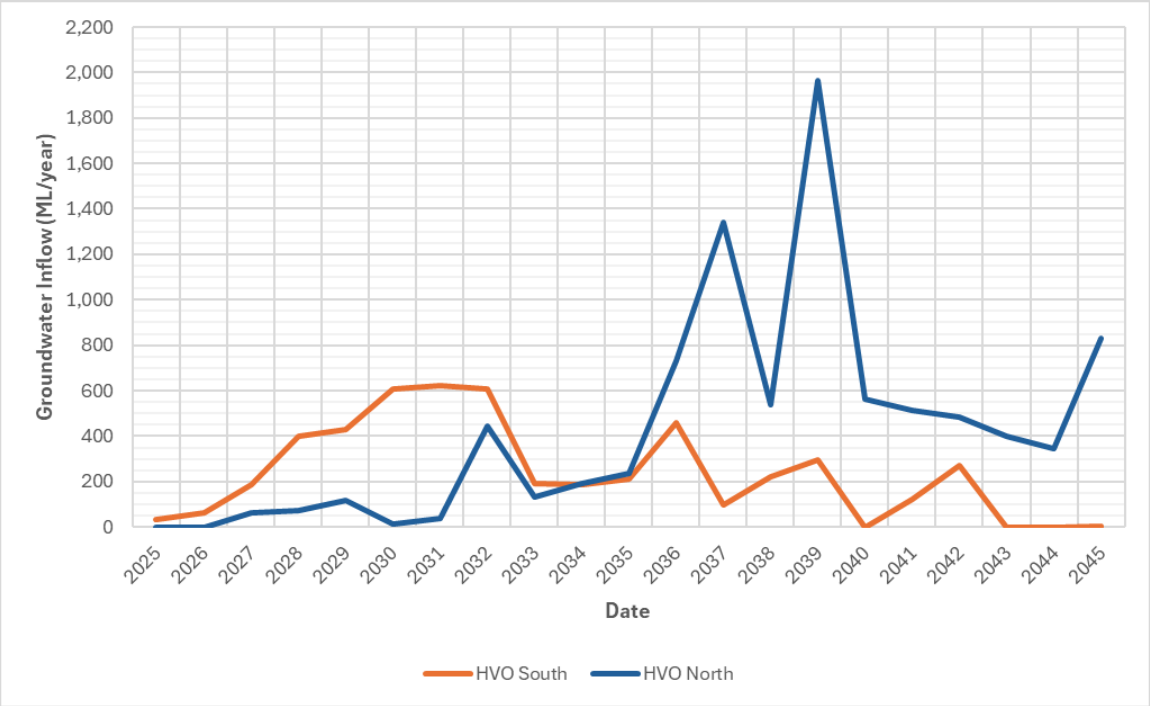


FIGURE 3.3: OPEN CUT PIT GROUNDWATER INGRESS (PUMPABLE GROUNDWATER)

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).

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 CPP at HVO (Howick CPP and Hunter Valley CPP). 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 Project. The forecast ROM coal production schedule associated with the Project is presented in Figure 4.1.

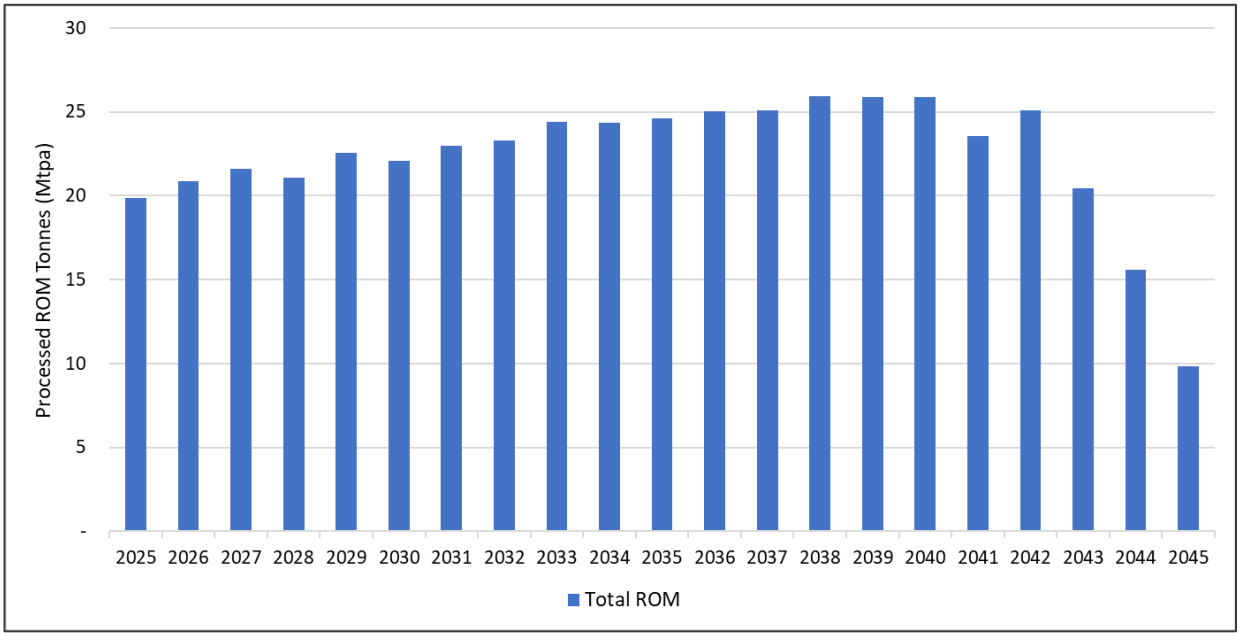


FIGURE 4.1: ROM PRODUCTION SCHEDULE

4.2 Tailings Strategy

The Project proposes tailings disposal strategy is described below:

- Tailings emplacement in the Carrington Pit TSF and Cumnock Void 3 TSF will occur during the early stages of the Project.
- Tailings from the Hunter Valley and Howick CPPs are stored in a TSF that will be established in the northern extent of West Pit and Liddell Coal Operations (LCO).
- Tailings from the Ravensworth Operations CPP are sent to LCO.
- Tailings decant water from LCO are sent back to the HVO Complex.

An overview of the current operations and Project tailings schedule is shown in Figure 4.2. Most of the Project tailings are proposed to be deposited at the LCO tailings facilities with some tailings storage within the West Pit TSF.

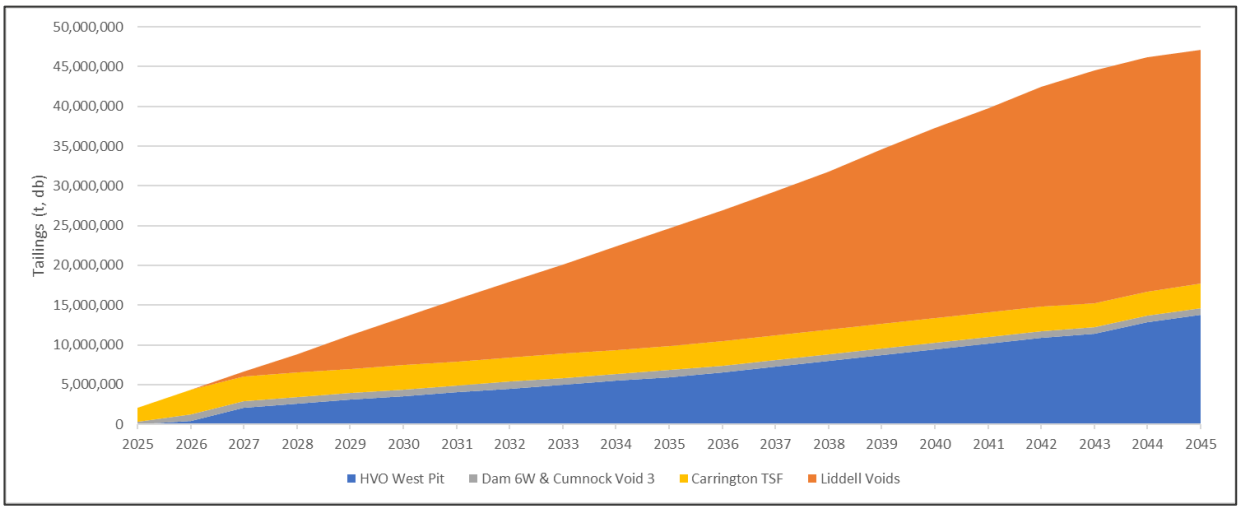


FIGURE 4.2: CUMULATIVE TAILINGS DEPOSITION

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.

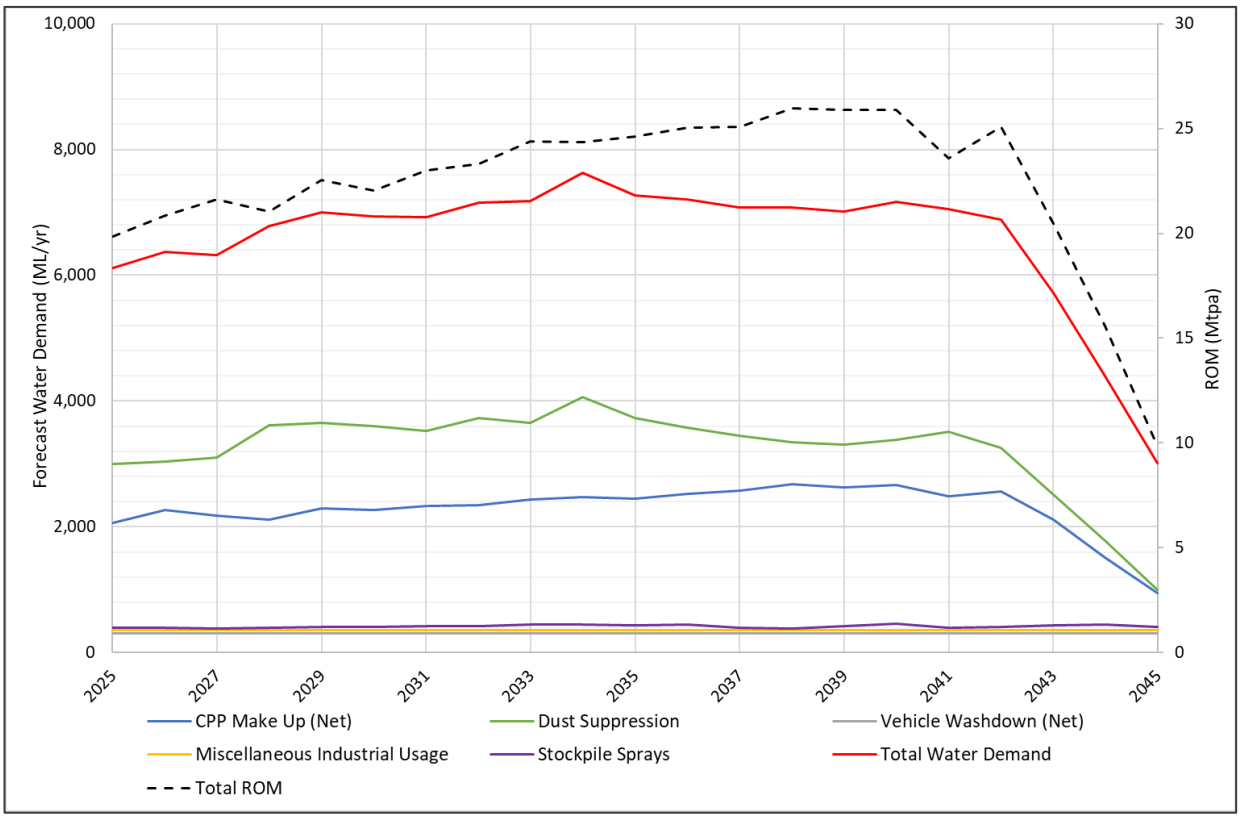


FIGURE 4.3: FORECAST SITE WATER DEMANDS

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 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 TSF 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 TSF (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 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). 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 Project. Figure 4.3 shows the total forecast water cart demands.

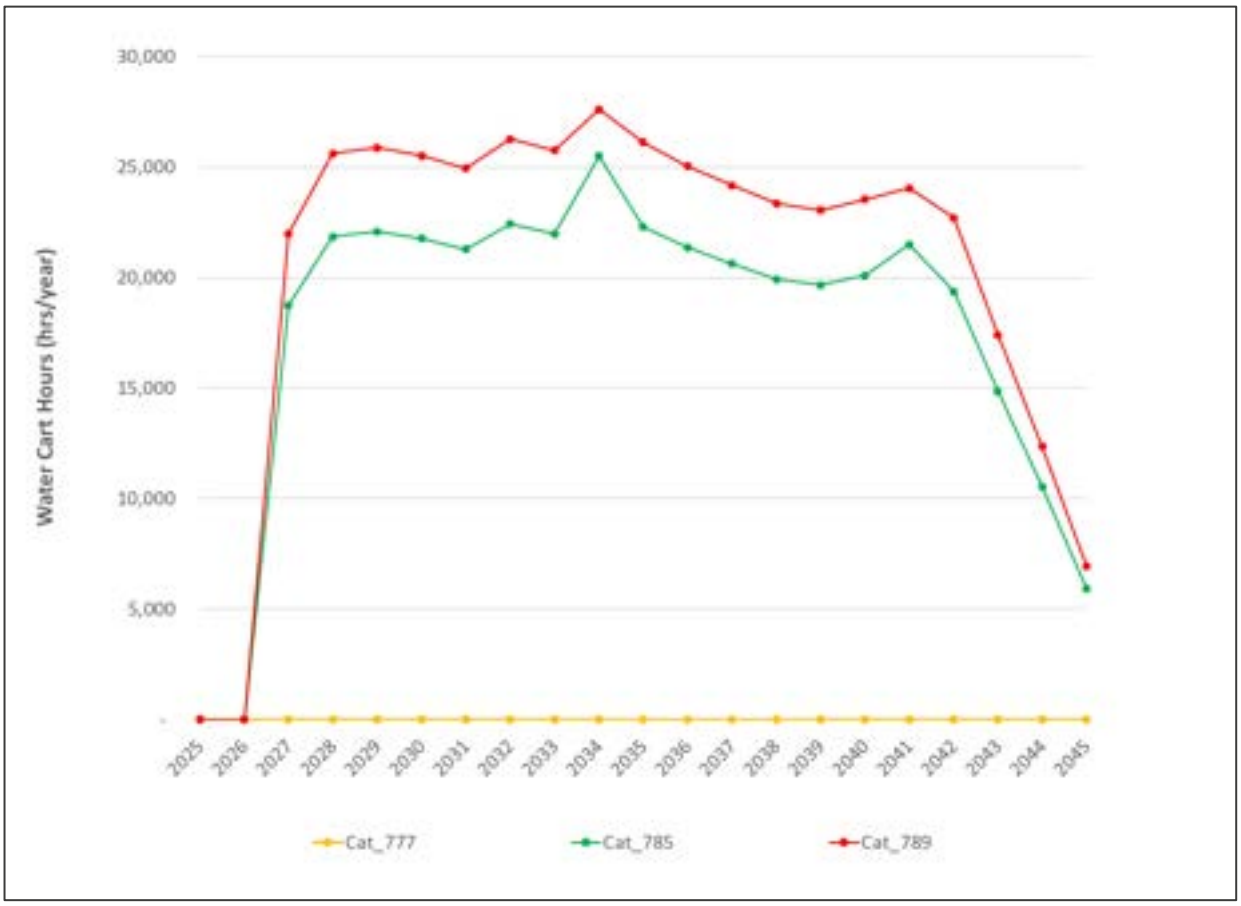


FIGURE 4.4: WATER CART ANNUAL OPERATING HOURS

4.6 Load Point Demands

Forecast load point demands (primarily for stockpile sprays) for the Project were estimated 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 LCO. The current agreement is due to expire in 2032 and is proposed to be extended.

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 Project and are based on values reported on in the Annual Environmental Reports (AERs) for 2017 to 2024.

- 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 (refer to Section 6). 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, 2026).

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 the HVO Complex 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 logic). The HRSTS release is modelled to occur only when the mine water inventory exceeds specified volumes (refer to Section 7).

6. WATER BALANCE VALIDATION

The HVO Complex WBM was originally calibrated in 2015 by Hatch by comparing modelled and observed inventory. In the time since, the WBM has undergone a series of validations with updates to the calibration made as required. The most recent validation of the WBM was completed by Engeny as part of the 2024 update of the *HVO Water Accounting Framework* (Engeny, 2024). This revision extended the WBM validation to the historical period January 2018 to December 2023. 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 dewatering volumes are not accurately recorded or measured (as the pits are largely dry) and therefore groundwater inflow estimates from the regional groundwater model have been adopted in the validation model (AGE, 2022).
- 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 observation or 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.

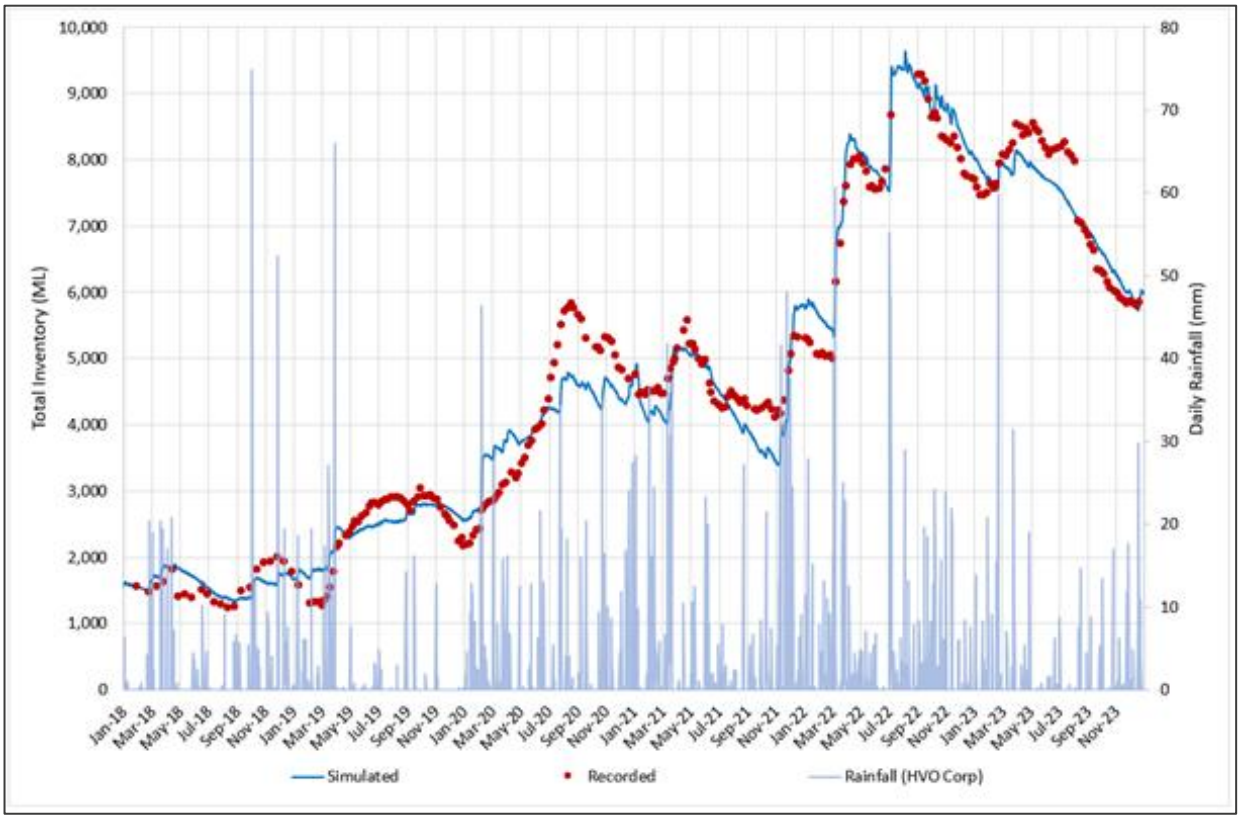


FIGURE 6.1: SIMULATED VERSUS HISTORICAL SITE INVENTORY

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, 2026)). The key aspects of the conceptual operating strategy include:

- Enlargement of Lake James (Dam 15S) at the commencement of the 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 in the 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 the likelihood of in pit water accumulation, 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) until it is backfilled in 2041.
- 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 21N	320	
	Dam 11N	84	
HVO West[1]	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.
	Dam 17S	73	

Area	Storage	Full Supply Volume (ML)	Comment
	Dam 18S	166	
	Dam 19S	210	
	Riverview Void	5,640	Reducing to 0 ML.
	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[2]	Proposed Infrastructure

1. HVO West is a sub area of HVO North.

2. Capacity excludes sediment storage capacity.

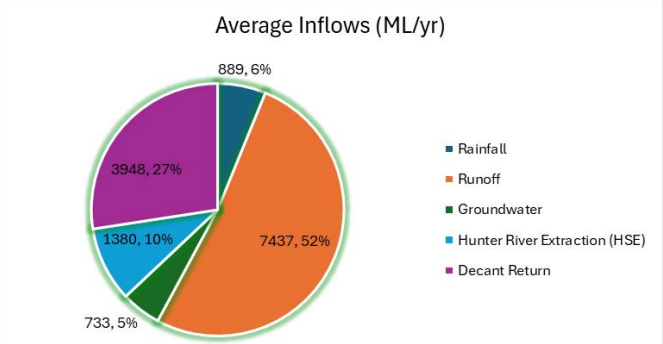
8. WATER BALANCE MODEL RESULTS

8.1 Introduction

Water balance model results for the Project are presented in subsequent sections. The modelled Project is also compared to modelled Approved Operation. The water balance model inputs for the Approved Operation scenario are provided in Appendix A.

8.2 Average Annual Inflow and Outflow Volumes

The predicted annual inflows and outflows for the Project, at various stages, is presented in Table 8.1. The average inflows and outflows for the Project are shown in Figure 8.1. The Approved Operation inflows and outflows are shown in Figure 8.2.



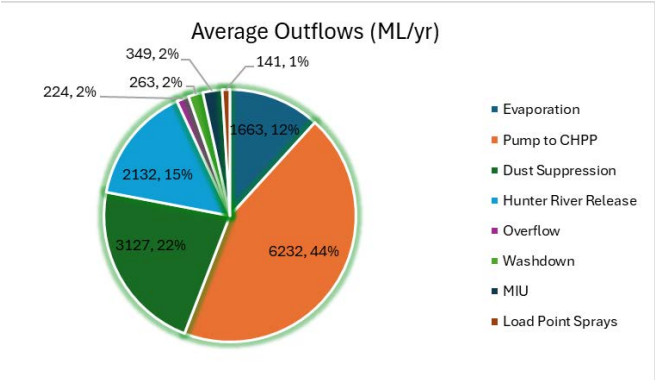


Figure 8.1. The Approved Operation inflows and outflows are shown in Figure 8.2.

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 1.1.

Comparison of the inflows and outflows for the Project to the Approved Operation indicates that that there are greater total inflows and total outflows for the Project, primarily due to the larger catchment area compared to the Approved Operation.

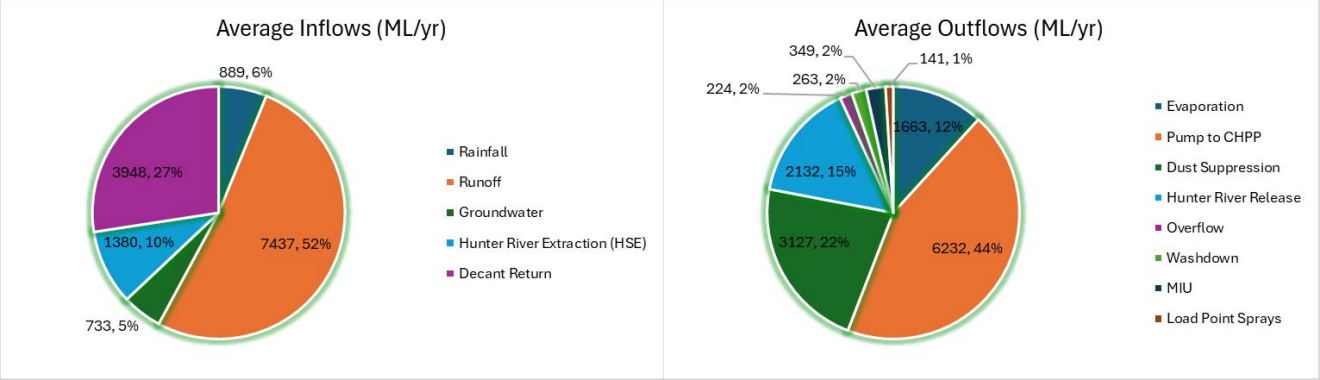


Figure 8.1 and Figure 8.2 indicate that the proportion of the different inflows and outflows are relatively similar for the Approved Operation and the Project.

TABLE 8.1: AVERAGE ANNUAL INFLOWS AND OUTFLOWS (ML/YEAR)

Water Stream	Approved Operation	2029	2032	2038	2041
		INFLOWS (ML/year)			
Rainfall	904	901	897	894	890
Runoff	5,773	6,679	7,393	7,914	7,902
Groundwater Inflows	1,240	550	1,050	758	638
Hunter River Extraction[1]	254	2,061	1,260	1,348	1,157
Decant Return	3,204	3,917	4,081	4,559	4,214
Total Inflows	**11,381**	**14,108**	**14,681**	**15,473**	**14,800**
		OUTFLOWS (ML/year)			
Evaporation	1,845	1,719	1,684	1,642	1,623
Pump to CPP	4,643	6,197	6,424	7,216	6,613
Dust Suppression	2,432	3,569	3,566	3,303	3,418
HRSTS Release	1,315	1,256	2,321	2,555	2,578
Overflows	168	381	176	181	200
Washdown	307	263	264	263	263
Misc Industrial Use	329	350	351	350	350
Load Point Sprays[2]	0	142	144	143	144
Total Outflows	**11,408**	**13,875**	**14,930**	**15,652**	**15,188**

[1] HSE, [2]Load point spray demands are included in CHPP demands for the Approved Operations water balance.

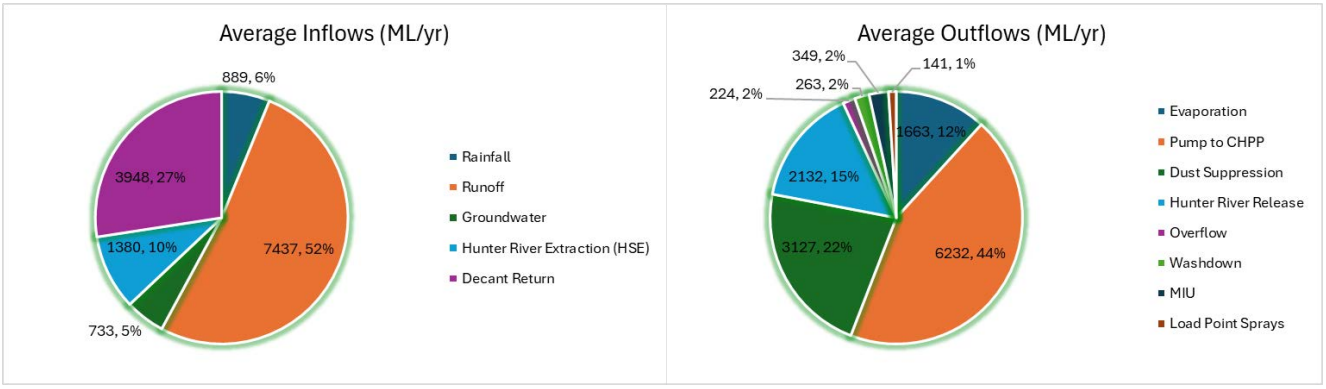


FIGURE 8.1: PROJECT - AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

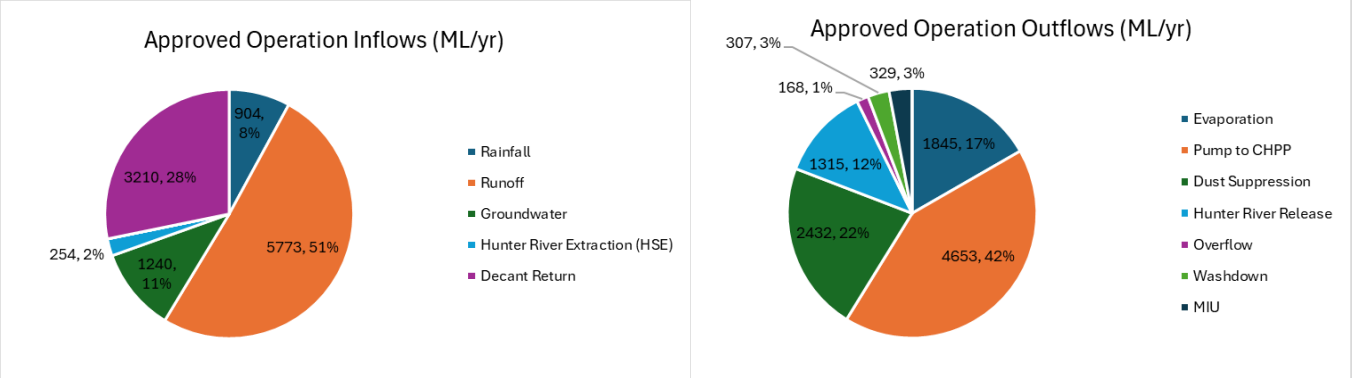


FIGURE 8.2: APPROVED OPERATION – AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

8.3 Climatic Variability

Water balance data for a range of climatic scenarios is included 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).

Results for the Approved Operation show average inflow and outflow volumes of a similar magnitude to the Project. The most pronounced difference between the two scenarios is the reduced Hunter River extraction for the Approved Operation for the median and 95th percentile result. This is due to more water predicted to be available on site (i.e. groundwater, rainfall and runoff) to meet the water demands for the Approved Operation scenario which are lower than the modelled Project water demands.

TABLE 8.2: 5TH PERCENTILE, MEDIAN AND 95TH PERCENTILE RAINFALL YEAR WATER BALANCE

Water Stream	Approved Operation			2029			2032			2038			2041		
	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile
INFLOWS (ML/year)															
Rainfall	406	828	1,911	406	836	1,414	401	793	1,276	369	821	1,110	371	912	1,202
Runoff	1,670	4,330	11,384	1,828	4,820	10,462	2,051	5,476	11,639	2,190	5,927	12,430	2,104	5,795	12,147
Groundwater Inflows	1,240	1,240	1,240	550	550	550	1,050	1,050	1,050	758	758	758	638	638	638
Hunter River Extraction[1]	1,558	0	0	3,710	2,375	262	2,491	1,197	814	2,831	1,354	1,752	2,787	688	979
Decant Return	3,207	3,196	3,255	3,926	3,926	3,890	4,081	4,081	4,081	4,557	4,560	4,560	4,214	4,214	4,214
Total Inflows	8,081	9,594	17,790	10,419	12,507	16,578	10,075	12,597	18,859	10,705	13,421	20,611	10,114	12,246	19,179
OUTFLOWS (ML/year)															
Evaporation	1,607	1,739	2.629	1,193	1,686	1,862	1,195	1,619	1,654	1,037	1,642	1,433	1,034	1,839	1,541
Pump to CPP	4,440	4,632	4,717	6,211	6,211	6,155	6,424	6,424	6,424	7,212	7,216	7,217	6,613	6,613	6,613
Dust Suppression	2,483	2,484	2,488	2,557	3,653	3,652	2,912	3,732	3,732	2,880	3,345	3,345	2,850	3,504	3,504
HRSTS Release	0	32	7,582	0	0	3,949	0	0	8,933	0	0	10,208	0	104	9,321
Overflows	19	74	317	77	195	435	71	128	194	36	108	246	36	108	246
Washdown	299	306	310	263	263	261	264	264	264	263	263	263	263	263	263
Misc Industrial Use	328	346	350	350	350	349	351	351	351	350	350	350	350	350	350
Load Point Sprays[2]	0	0	0	102	180	196	102	190	201	102	192	198	102	192	198
Total Outflows	9,175	9,612	18,662	10,752	12,538	16,859	11,319	12,708	21,752	11,880	13,116	23,260	11,249	12,974	22,036
Change	**-1,094**	**-19**	**-872**	**-333**	**-31**	**-281**	**-1,245**	**-110**	**-2,893**	**-1,175**	**305**	**-2,649**	**-1,135**	**-728**	**-2,857**

[1] HSE, [2]Load point spray demands are included in CHPP demands for the Approved Operations water balance.

8.4 Mine Water Accumulation in Dedicated Storages

8.4.1 Site Water Inventory

The predicted total site water inventory (all storages, including any water in open cut pits) is shown in Figure 8.3 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 8.3.

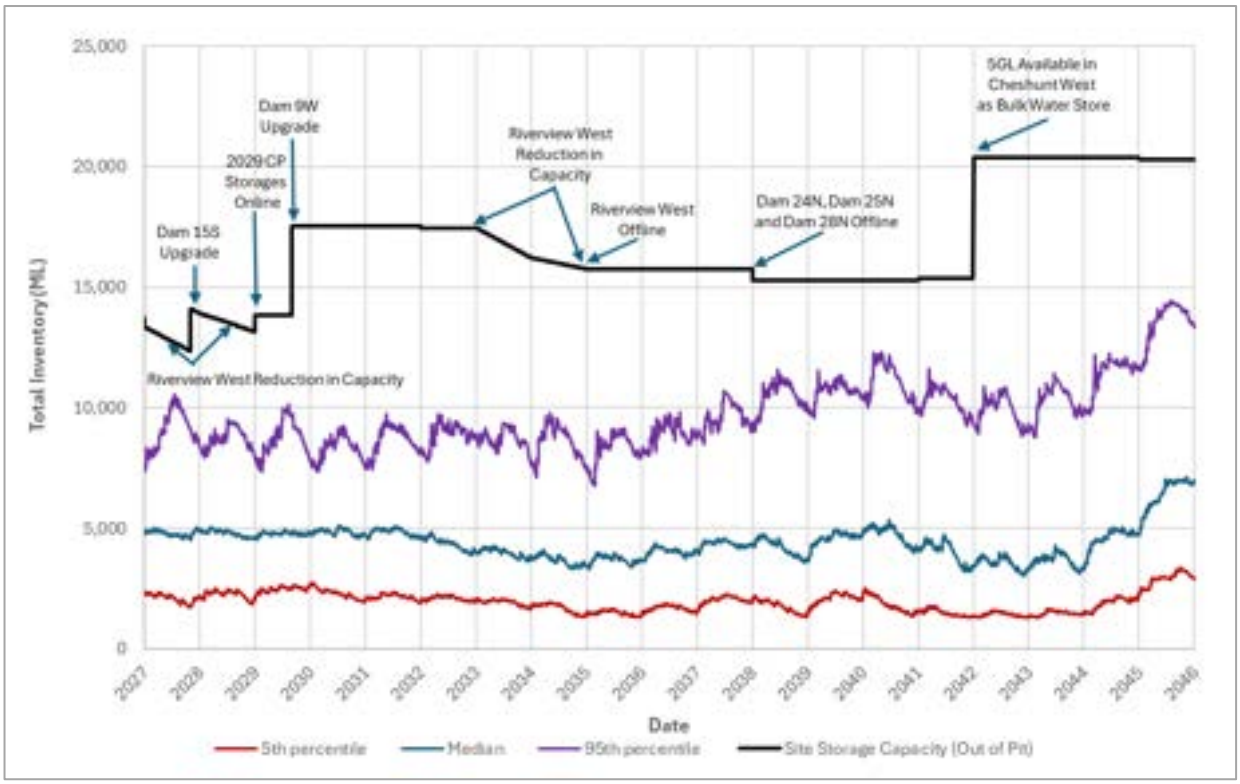


FIGURE 8.3: WHOLE OF SITE INVENTORY

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 8.4 to Figure 8.16.

8.4.2 HVO West Inventory

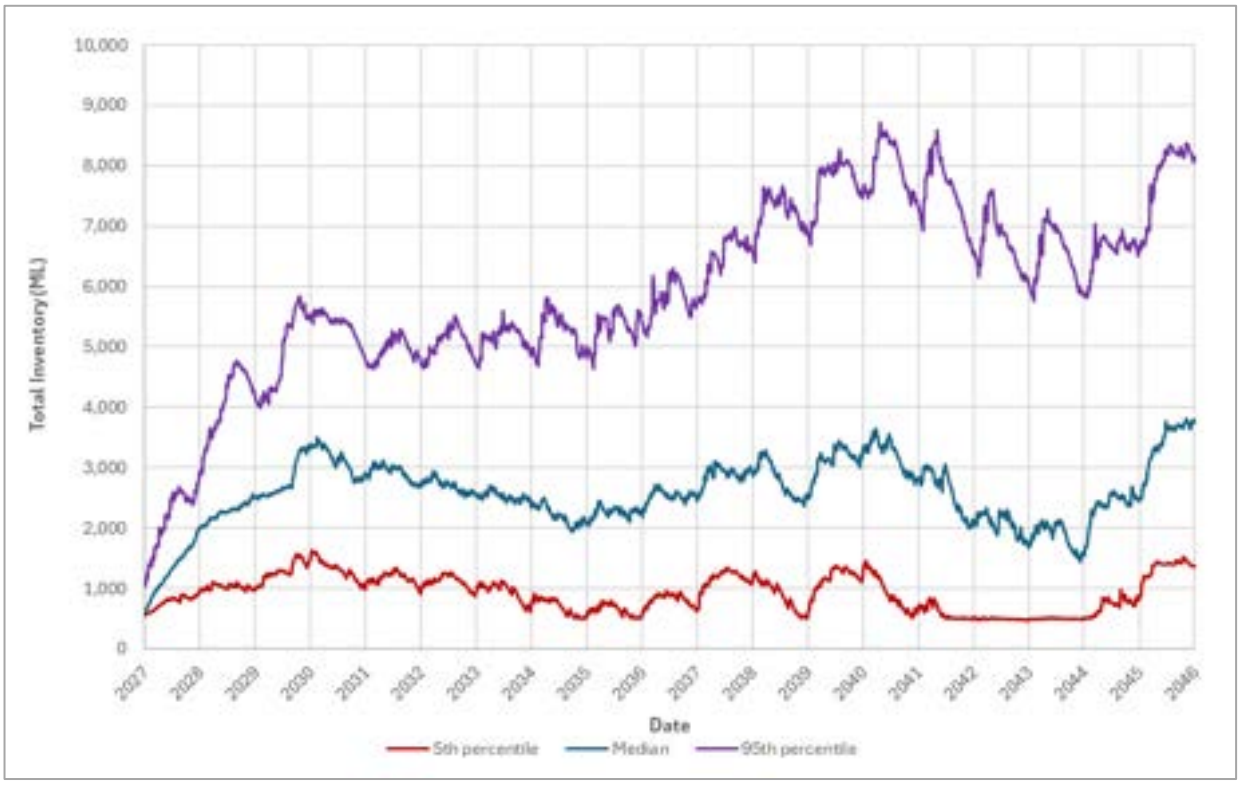


FIGURE 8.4: HVO WEST WATER INVENTORY FORECAST

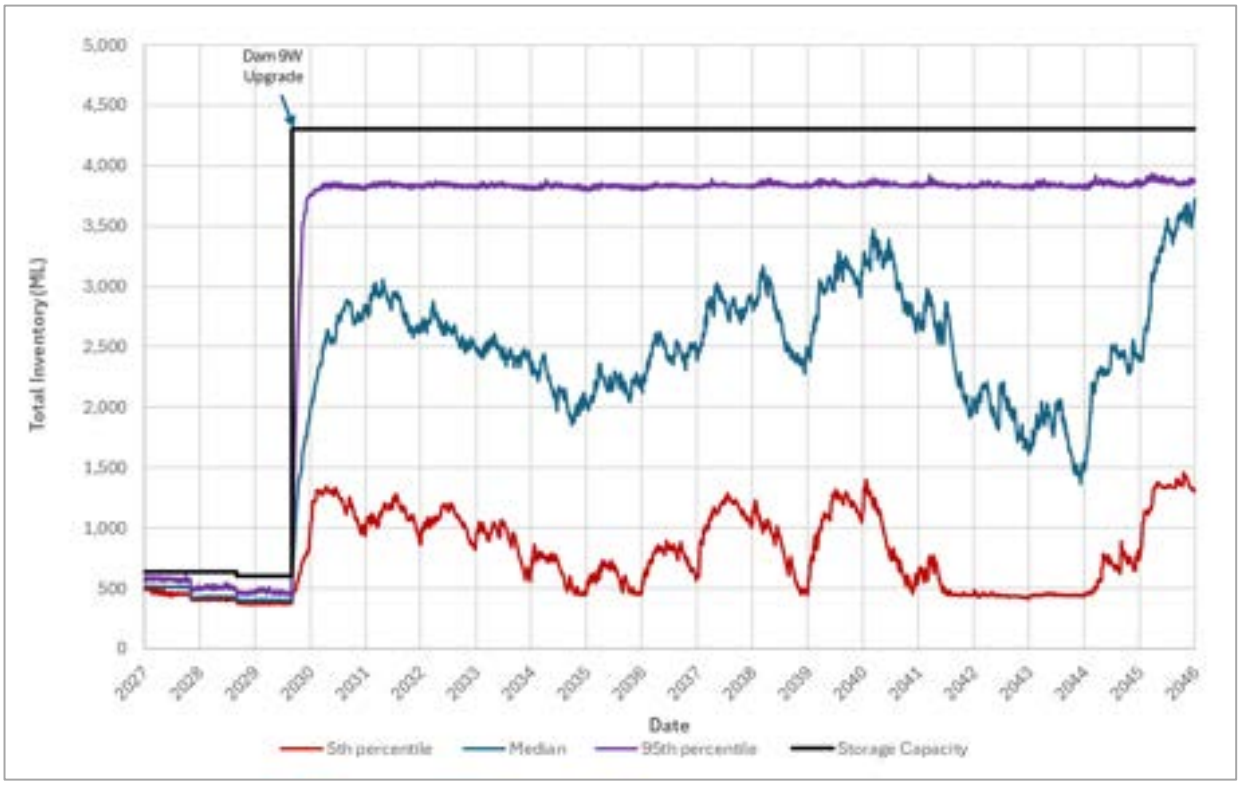


FIGURE 8.5: DAM 9W (PARNELLS DAM) WATER INVENTORY FORECAST

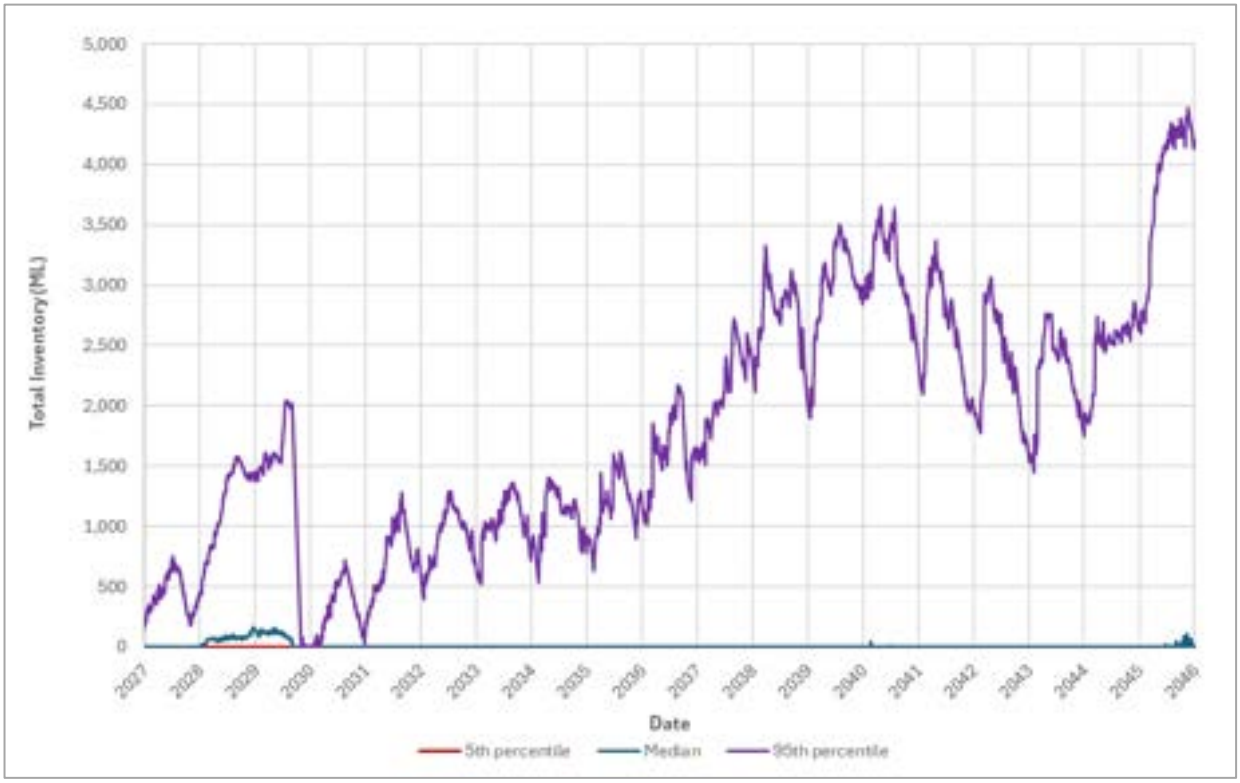


FIGURE 8.6: WEST PIT WATER INVENTORY FORECAST

8.4.3 HVO North Inventory

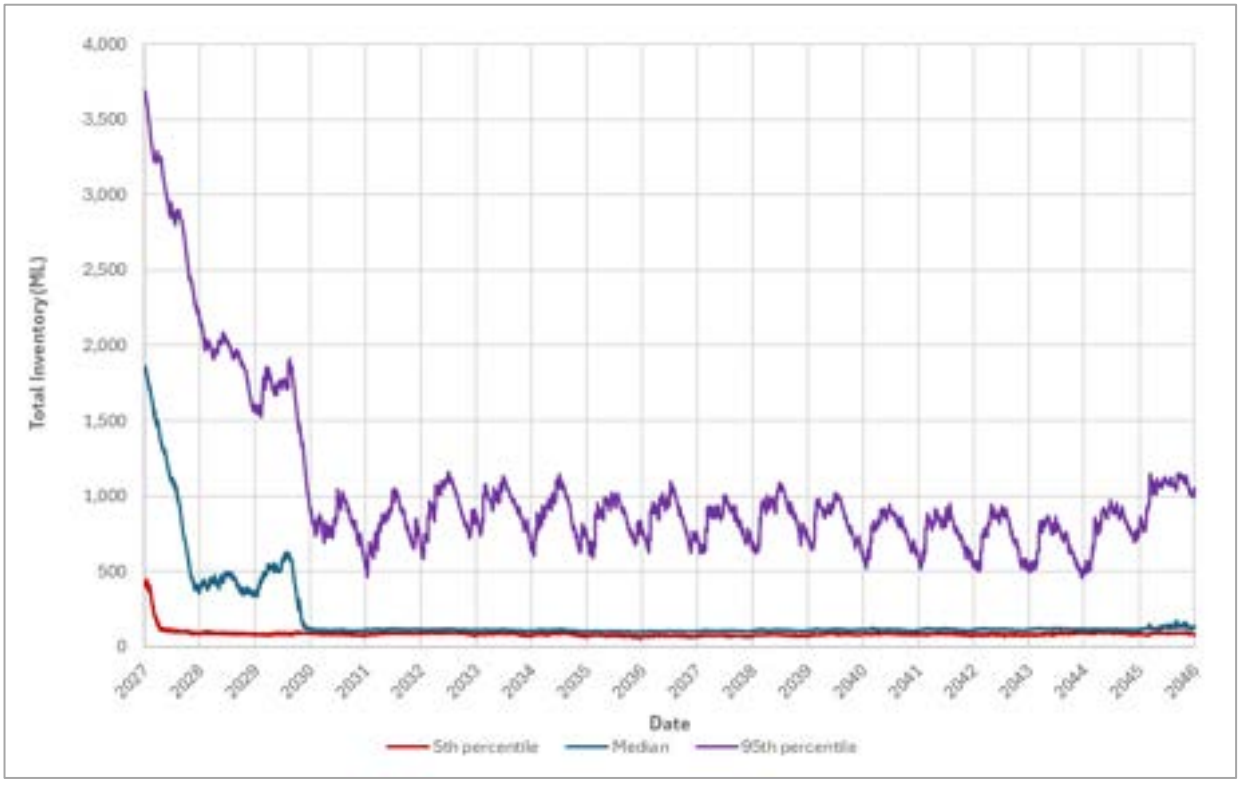


FIGURE 8.7: HVO NORTH WATER INVENTORY FORECAST

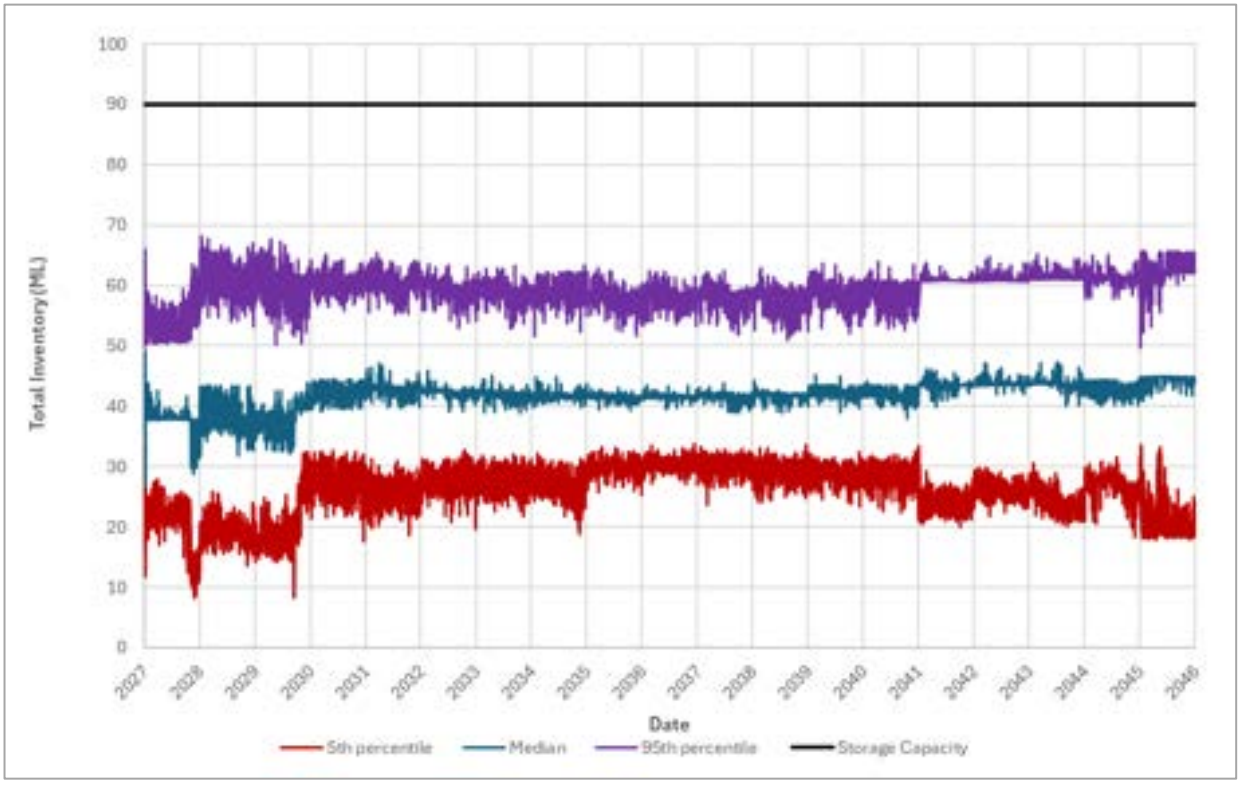


FIGURE 8.8: DAM 9N WATER INVENTORY FORECAST

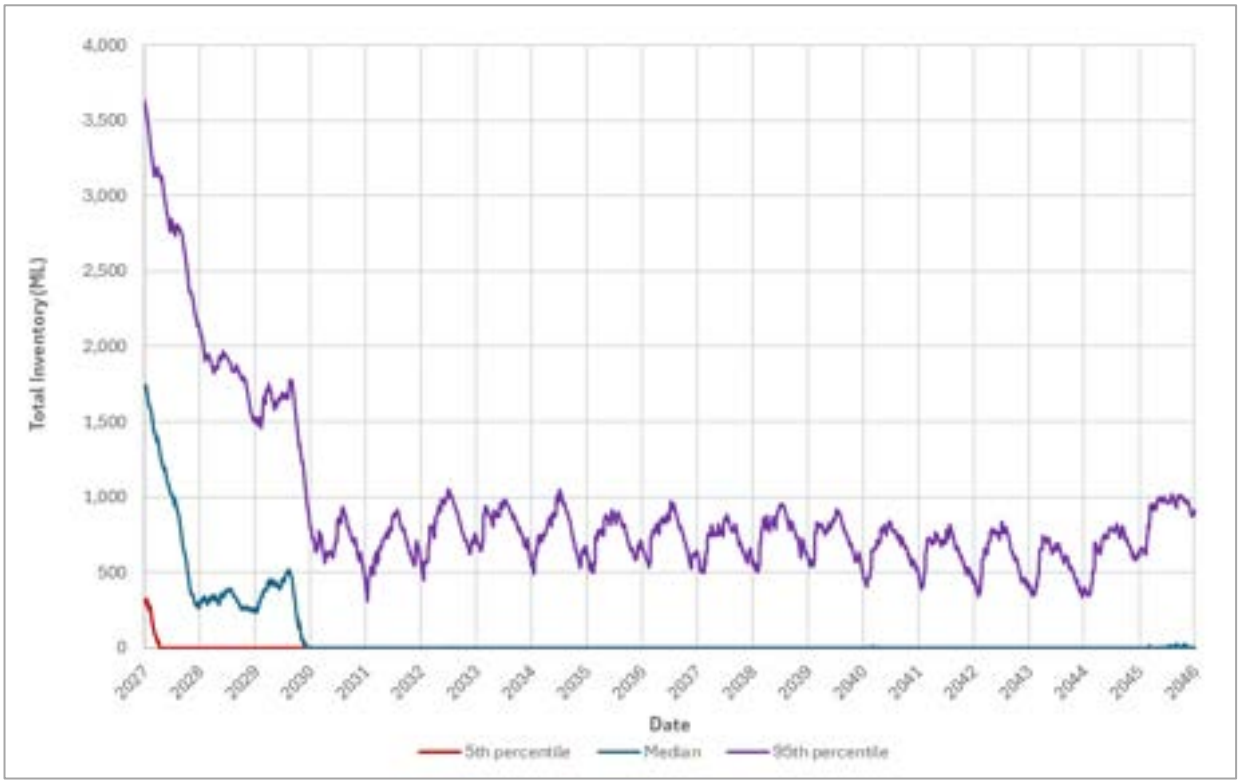


FIGURE 8.9: CARRINGTON PIT WATER INVENTORY FORECAST

8.4.4 HVO South Inventory

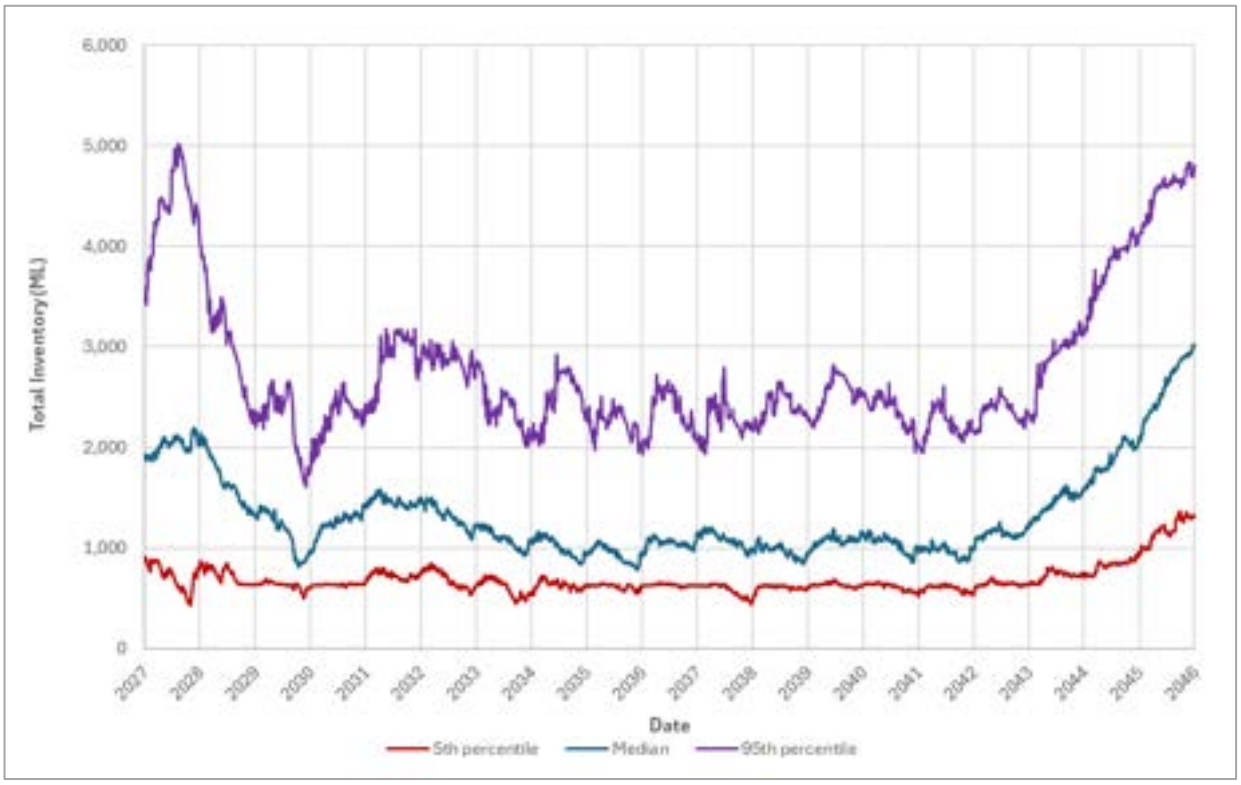


FIGURE 8.10: HVO SOUTH WATER INVENTORY FORECAST

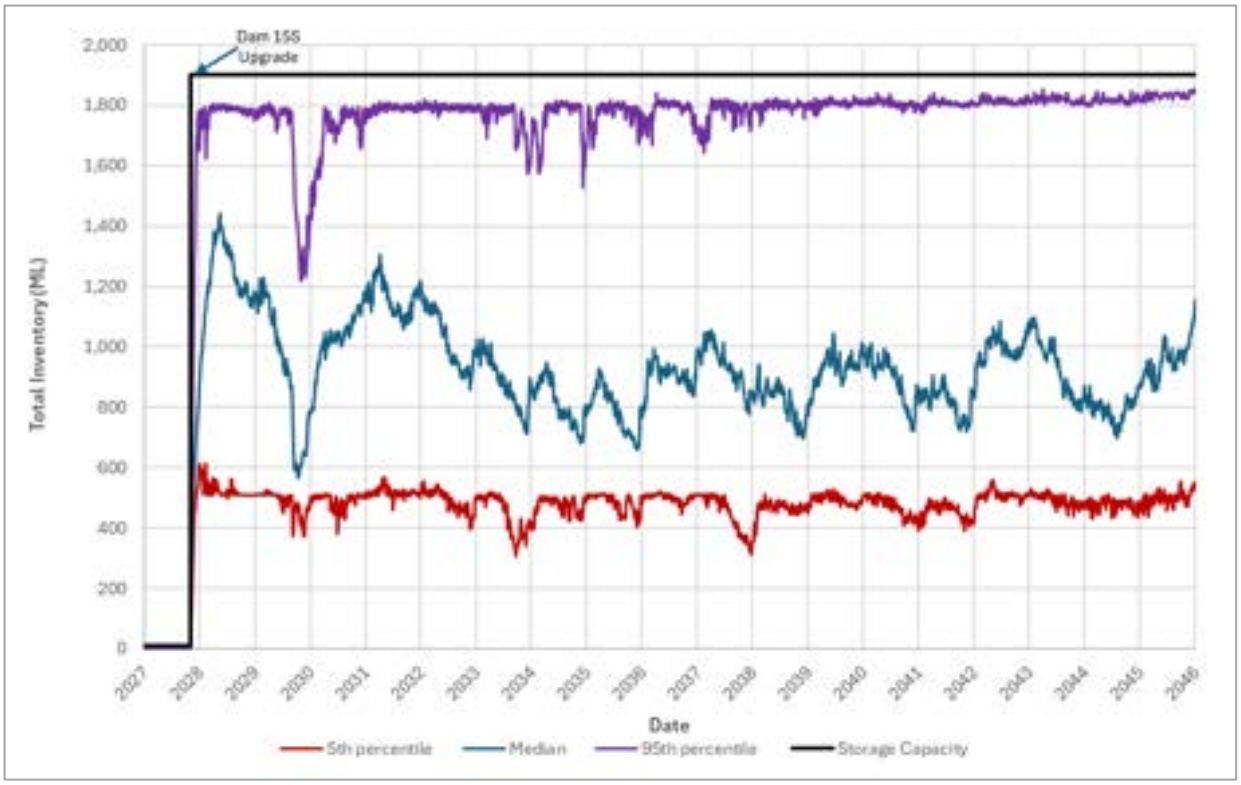


FIGURE 8.11: DAM 15S (LAKE JAMES) WATER INVENTORY FORECAST

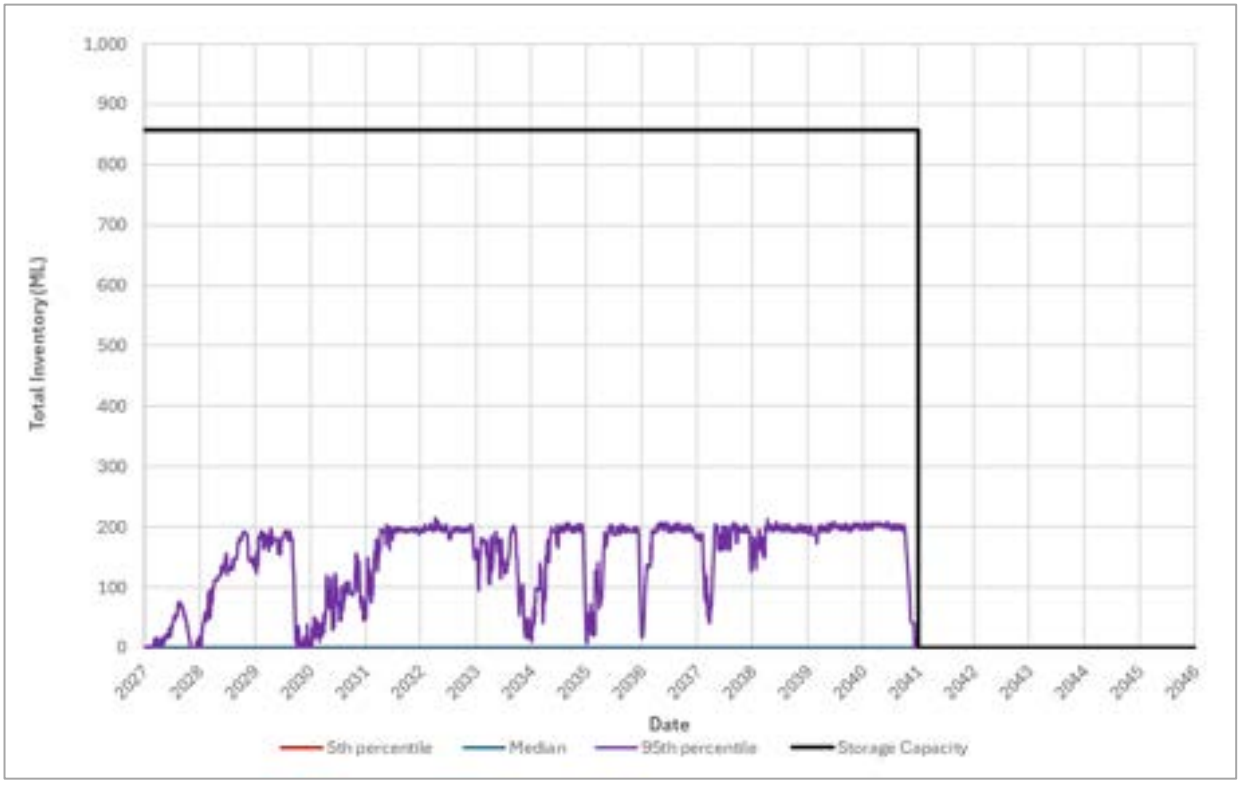


FIGURE 8.12: DAM 27S (SOUTH LEMINGTON VOID) WATER INVENTORY FORECAST

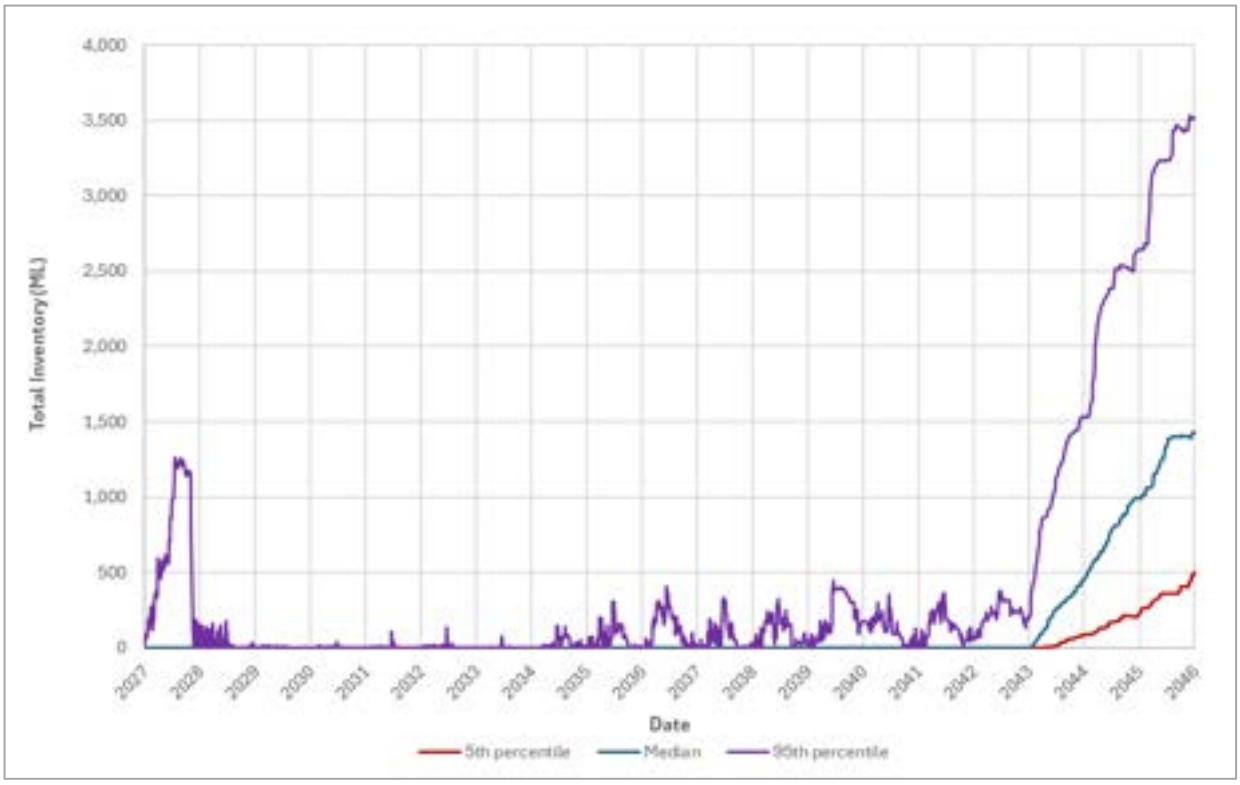


FIGURE 8.13: CHESHUNT PIT WATER INVENTORY FORECAST

8.5 External Supply - Hunter River Licensed Extraction

The total water predicted to be extracted from the Hunter River for the Project, using the sites HSE allocations is shown in Figure 8.14. 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 not required to meet water supply demands during the forecast period.

The 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 Project is expected to use up to 47% of the existing HSE WALs. Compared to the Approved Operation, the Project is predicted to utilise a higher proportion of the existing HSE WALs.

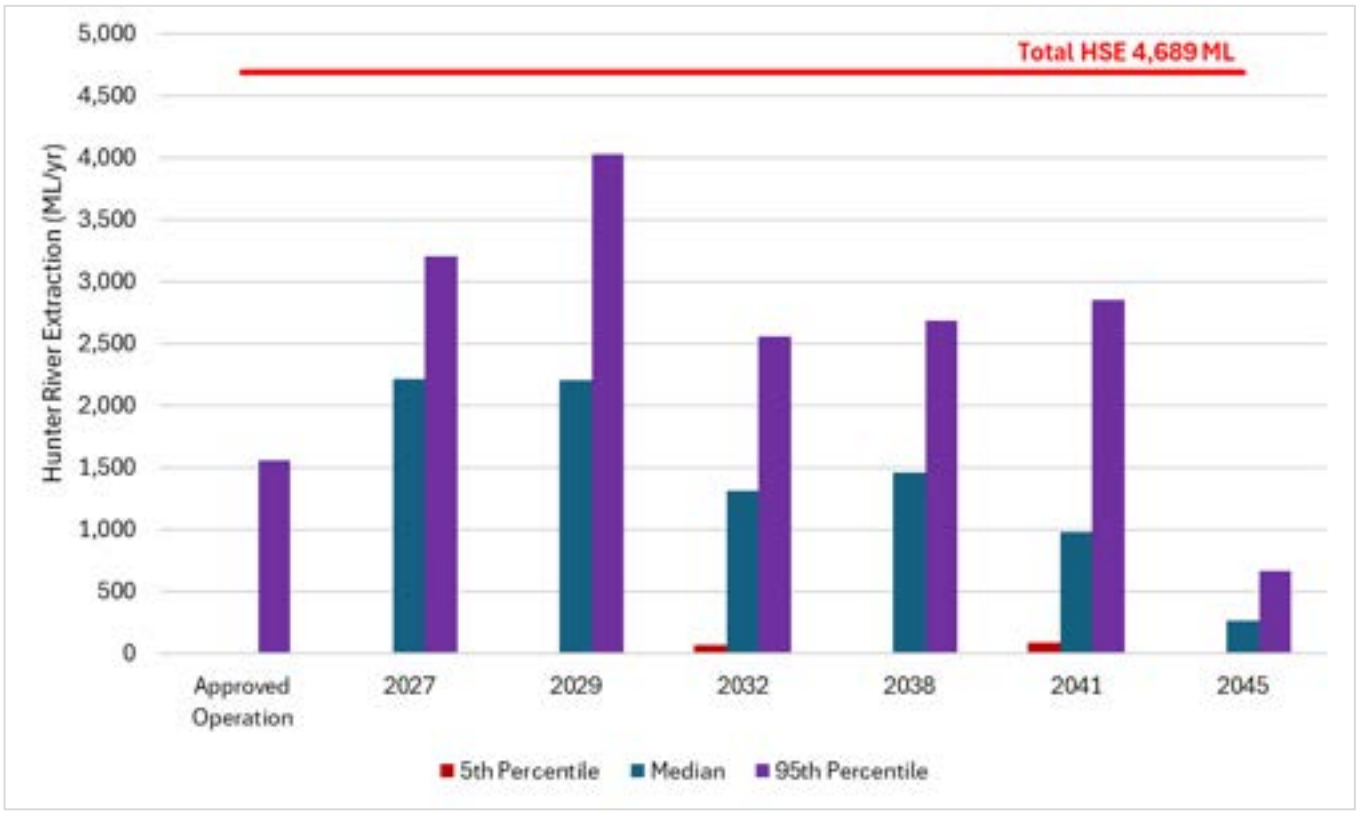


FIGURE 8.14: HUNTER RIVER EXTRACTION (HIGH SECURITY ALLOCATION)

8.6 Controlled Releases (HRSTS)

The predicted average annual total controlled releases to the Hunter River via the HRSTS, and release storage is shown in Figure 8.15. In total, the Project is forecast to utilise on average, 19% to 52% of the average total allowable discharge opportunities. The 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) (refer to Figure 8.15) the Project remains well below the release limits (i.e. annual release volumes are higher in wet years). Compared to the Approved Operation, the Project is anticipated to utilise a higher number of release opportunities.

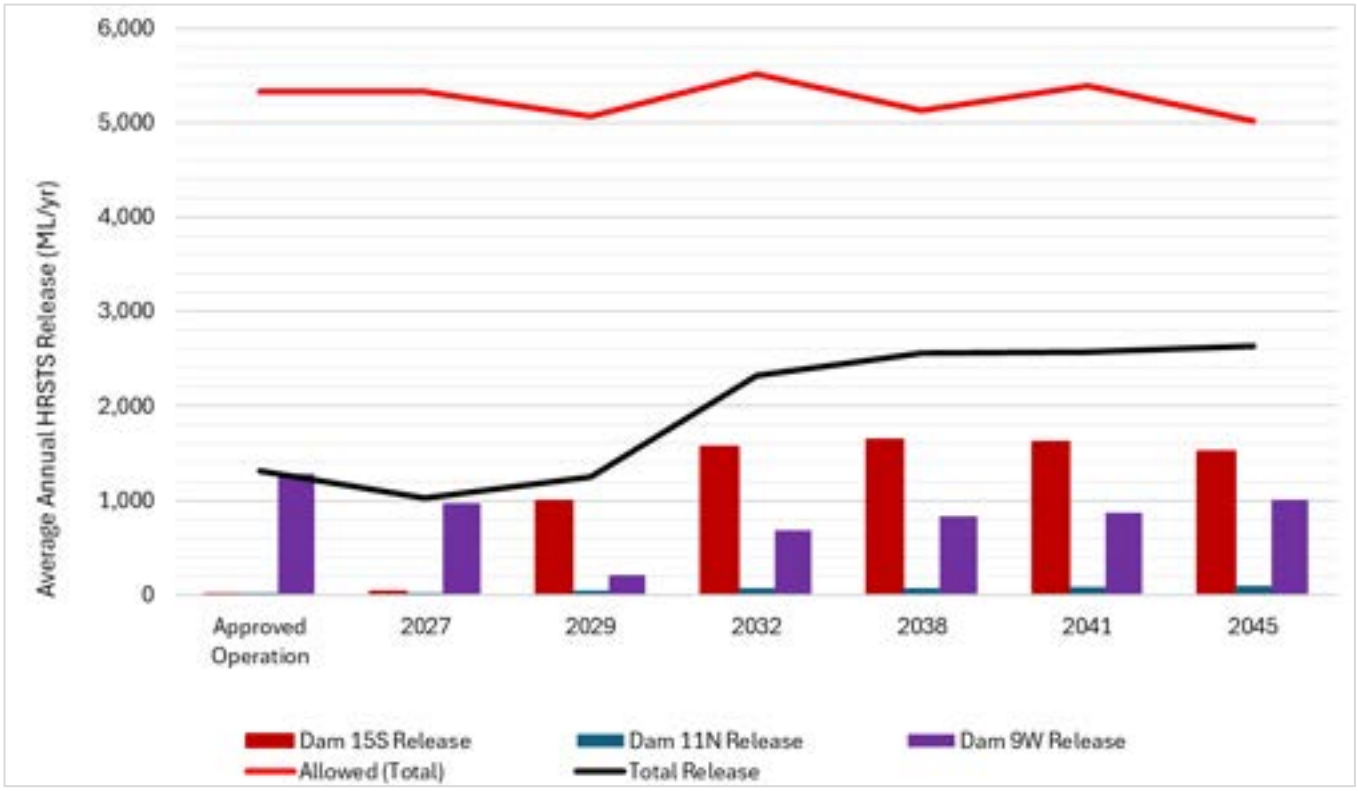


FIGURE 8.15**: CONTROLLED RELEASES (HRSTS) FLOW DILUTION RATIO**

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 8.16 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 78% 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.

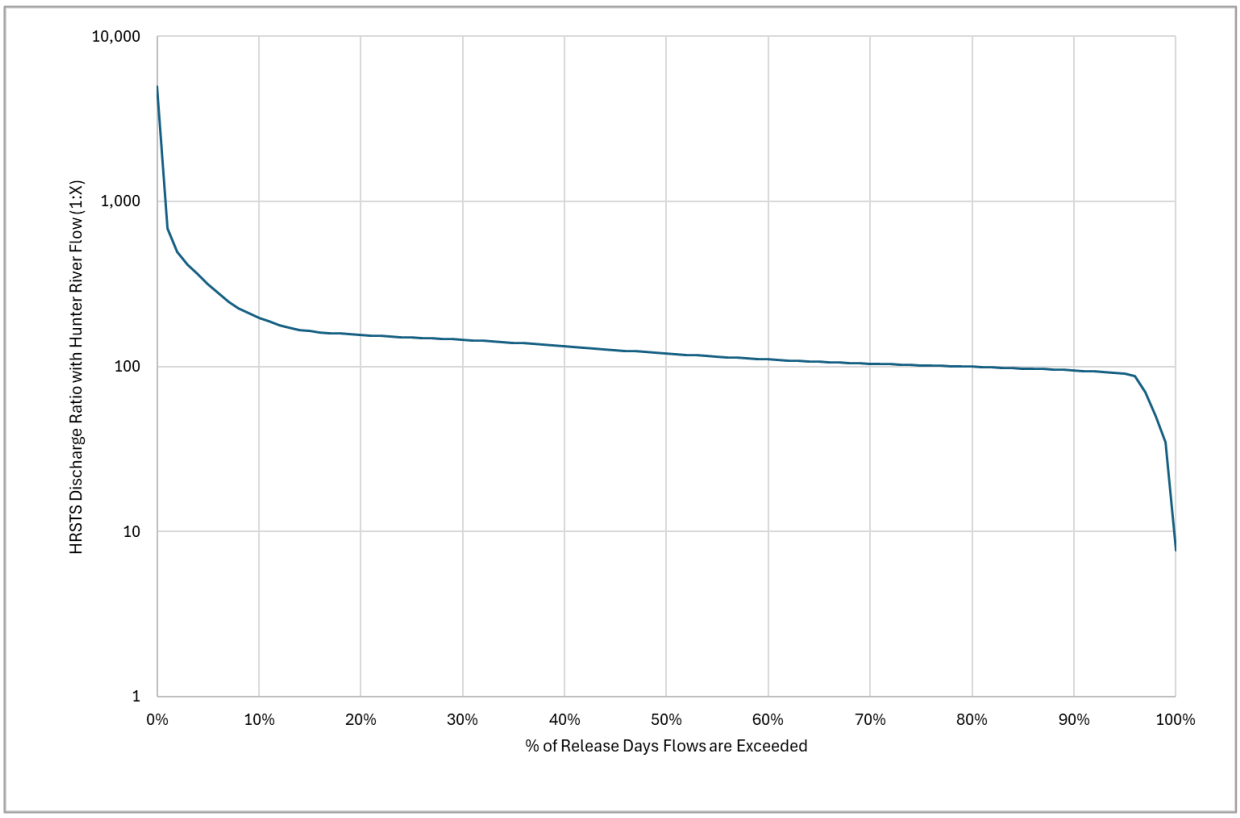


FIGURE 8.16: HRSTS FLOW DILUTION RATIO EXCEEDANCE CURVES

8.7 Overflows

The water balance modelling also forecasts overflows from the WMS. These overflows are typically predicted to occur from sediment dams. The modelling indicates less than 0.2% of forecast overflows for the Project are attributed to mine water for the 5th percentile, median and 95th percentile results for all modelled stages (i.e. the mine water component equates to less than 0.35 ML/year in the above mentioned scenarios). As identified in the Blue Book (Landcom, 2004; NSW DECC, 2008d), overflow from sediment dams will occur during rainfall events above the design criteria specified in the Blue Book. These design criteria have been established by the NSW Government specifically for sediment control at mining operations. The risk of overflows from the mine WMS is limited as freeboard requirements are met by ceasing pumping water to these dams, when surplus water occurs on-site.

As outlined in the SWIA (Sections 3.1.1.3 and 3.2.2), the purpose of the sediment dams within the WMS is to manage runoff from disturbed areas. Sediment dams will be designed in accordance with the Blue Book (Landcom, 2004; NSW DECC, 2008d) to manage runoff from the 5 day, 95th percentile rainfall event. The selected design criteria is in excess of the minimum recommended design criteria for sediment dams as outlined in Volume 2E of the Blue Book (NSW DECC, 2008d), i.e. 90th percentile design storm event. Volume 2E of the Blue Book (NSW DECC, 2008d) indicates that for the 95th percentile design storm event the indicative average annual sediment basin overflow frequency will be 1 to 2 overflow events per year, compared to 2 to 4 overflow events per year for the 90th percentile design storm event.

Mine water is contained within systems designed to a higher design criteria than the sediment water system. The design criteria for mine water is to convey runoff from and to provide sufficient freeboard to contain runoff from the 1% AEP 24 hour storm event within the mine water storage dams. Mine water is stored within the open cut pits as required during large or prolonged rainfall events (refer to SWIA – Section 4.3).

8.8 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 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. CLIMATE CHANGE ASSESSMENT

9.1 Modelled Climate Change Scenario

A climate change assessment has been undertaken by applying predicted seasonal changes to rainfall and evaporation (%) for a climate change scenario, to the base case operational water balance hydrology model.

For the assessment, the highest Shared Socio-economic Pathway, SSP5-8.5, was selected. This is consistent with the Groundwater Modelling (EMM, 2026) climate change assessment. SSP5-8.5 is a scenario based on emissions continuing to rise throughout the 21st century with little climate change intervention. SSP5-8.5 is considered a worst-case climate change scenario "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 the water balance modelling the "maximum consensus" seasonal projections for the near future (i.e. a 20 year period centred around 2030) climate horizon have been adopted. The predicted seasonal changes to rainfall and evaporation for this scenario are presented in Table 9.1.

TABLE 9.1: CLIMATE CHANGE SCENARIO VARIABLES

Scenario		Projections		
		Model	Rainfall	Evaporation
SSP5-8.5	Maximum Consensus	CESM1-CAM5	June - August: -3.8% September - November: -0.8% December - February: +0.8% March - May: +6.5%	June - August: +5.4% September - November: +5.9% December - February: +4.7% March - May: +5.7%

9.2 Water Balance Model Results

9.2.1 Average Annual Inflow and Outflow Volumes

The predicted annual inflows and outflows for the Project, at various stages, are presented in Table 9.2. The average inflows and outflows are shown in Figure 9.1.

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.

Compared to the existing baseline climate scenario, the inflows for the climate change scenario (including seasonality predictions) are relatively similar due to the overall balanced increases and decreases throughout the year (i.e. increase rainfall from December to May offset by lower rainfall from June to November).

The modelling also indicates that seasonal increases in rainfall intensity associated with climate change on the daily rainfall model timestep does not have any significant influence on forecast overflows form the WMS. This can be seen in the results presented in Table 8.1 and Table 9.2, with modelling forecasting negligible increases in average overflows of 1 ML/year for 2032 and 2038 (i.e. ~0.6% increase in volume). Further discussion of design criteria for the WMS and consideration of climate change is included in Sections 3.2 and 4 of the SWIA.

TABLE 9.2: CLIMATE CHANGE SCENARIO AVERAGE ANNUAL INFLOWS AND OUTFLOWS (ML/YEAR)

Water Stream	Approved Operation	2029	2032	2038	2041
			INFLOWS (ML/year)		
Rainfall	906	900	898	894	887
Runoff	5,718	6,613	7,327	7,844	7,829
Groundwater Inflows	1,240	548	1,047	747	630
Hunter River Extraction[1]	260	2,094	1,285	1,364	1,195
Decant Return	3,205	3,910	4,081	4,559	4,213
Total Inflows	11,329	**14,065**	**14,638**	**15,408**	**14,754**
			OUTFLOWS (ML/year)		
Evaporation	1,833	1,701	1,670	1,625	1,601
Pump to CPP	4,646	6,186	6,424	7,216	6,612
Dust Suppression	2,429	3,555	3,558	3,303	3,414
HRSTS Release	1,306	1,270	2,283	2,561	2,557
Overflows	168	377	177	182	196
Washdown	307	262	264	263	263
Misc Industrial Use	328	349	351	350	350
Load Point Sprays[2]	0	140	143	142	143
Total Outflows	11,017	**13,840**	**14,870**	**15,642**	**15,136**

[1] HSE, [2]Load point spray demands are included in CHPP demands for the Approved Operations water balance.

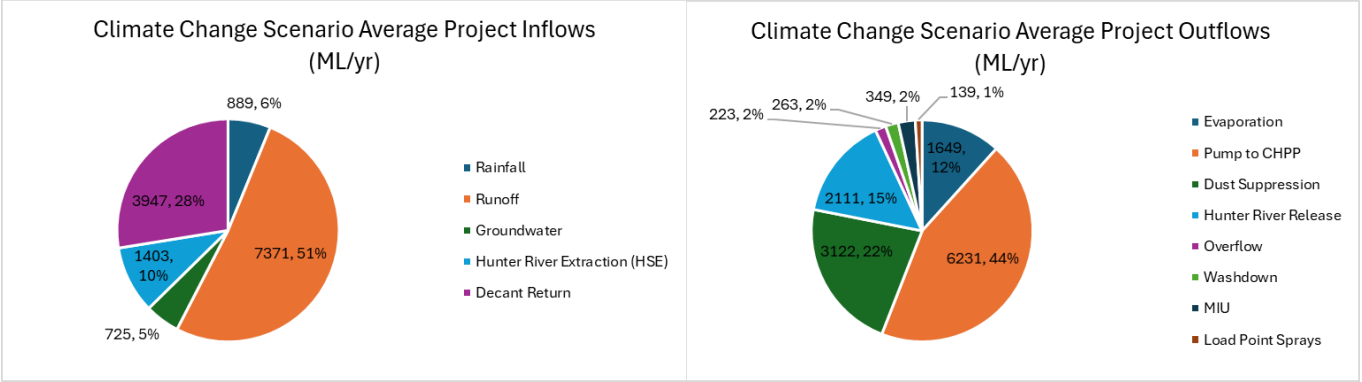


FIGURE 9.1: CLIMATE CHANGE SCENARIO AVERAGE PREDICTED ANNUAL INFLOWS AND OUTFLOWS

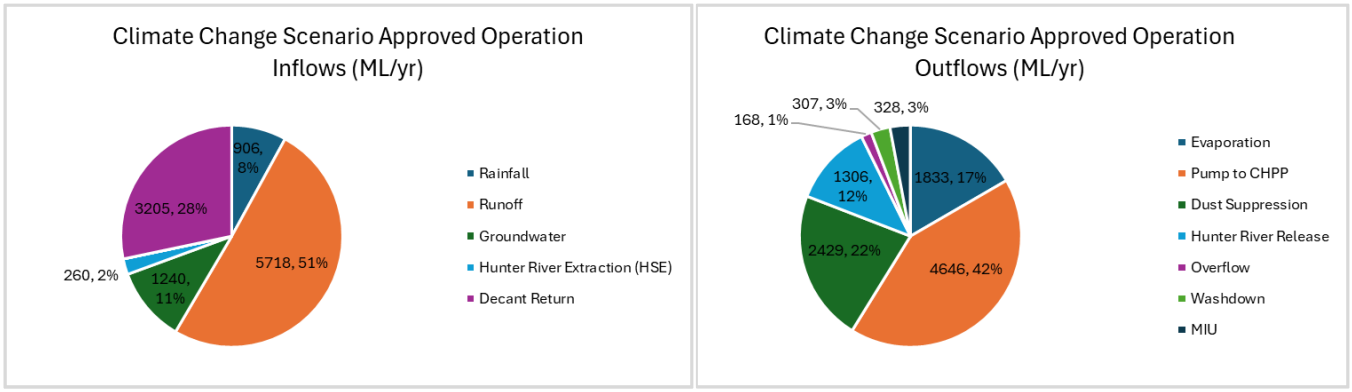


FIGURE 9.2: CLIMATE CHANGE SCENARIO APPROVED OPERATION INFLOWS AND OUTFLOWS

9.2.2 Site Water Inventory

The predicted total site water inventory (all storages, including any water in open cut pits) is shown in Figure 9.3 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 9.3.

Compared to the existing baseline climate scenario, the total site inventory for the climate change scenario is maintained at a higher volume for the 95th percentile result indicative of wet climate conditions due to higher rainfall conditions between December and May.

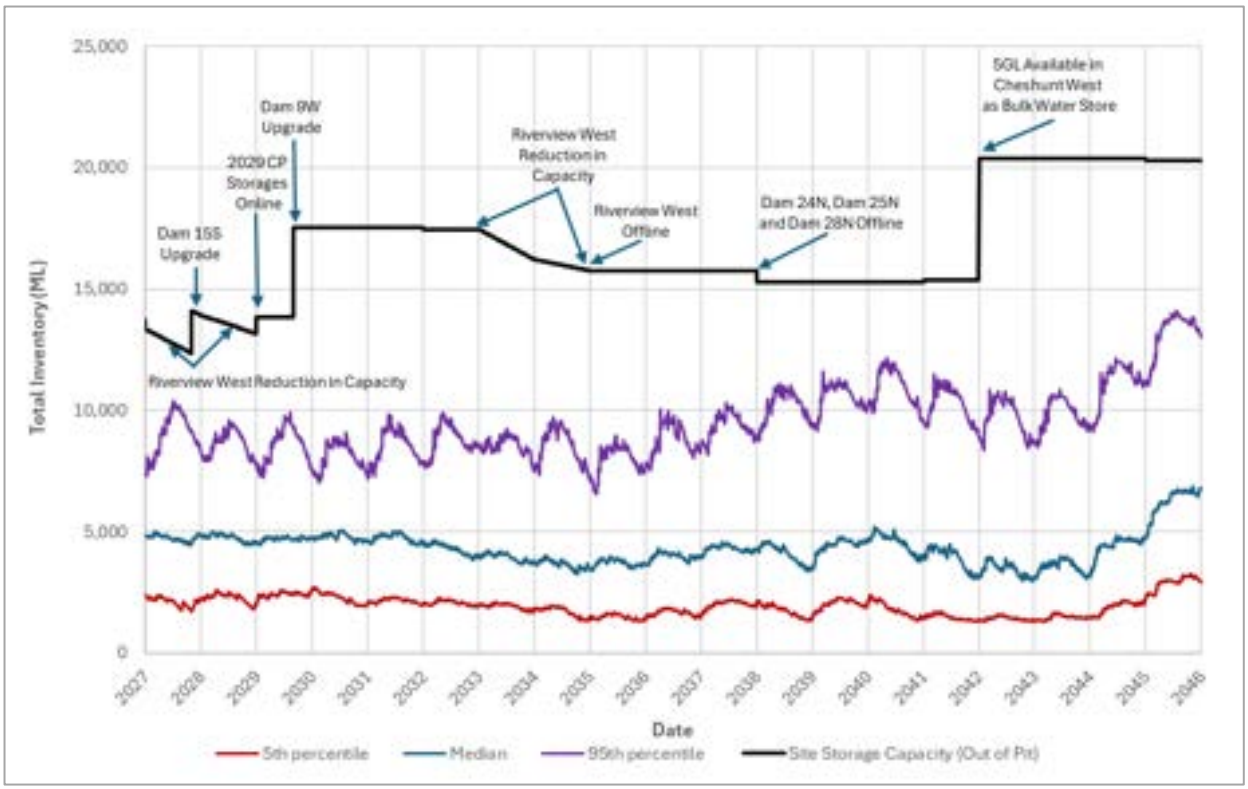


FIGURE 9.3: CLIMATE CHANGE SCENARIO WHOLE OF SITE INVENTORY

9.2.3 External Supply - Hunter River Licensed Extraction

The total water predicted to be extracted from the Hunter River for the Project, using the sites HSE allocations is shown in Figure 9.4. The 95th percentile is indicative of dry conditions. No results are presented for the GSE allocations as the model results indicate that the GSE allocation are not required to meet water supply demands during the forecast period.

The Project is predicted to use up to 84% (compared to 86% for the baseline climate scenario) of the existing 4,689 ML HSE WALs to maintain water supply in dry conditions (the 95th percentile). In the median forecast, the Project is predicted to use up to 48% of the existing HSE WALs

(compared to 47% for the baseline climate scenario). In the baseline climate scenario, the Project is predicted to use no WALs for the majority of the forecast period in wet conditions (the 5th percentile). In dry conditions for the climate change scenario, the Project is predicted to use up to 2% of the existing HSE WALs as a result of lower rainfall.

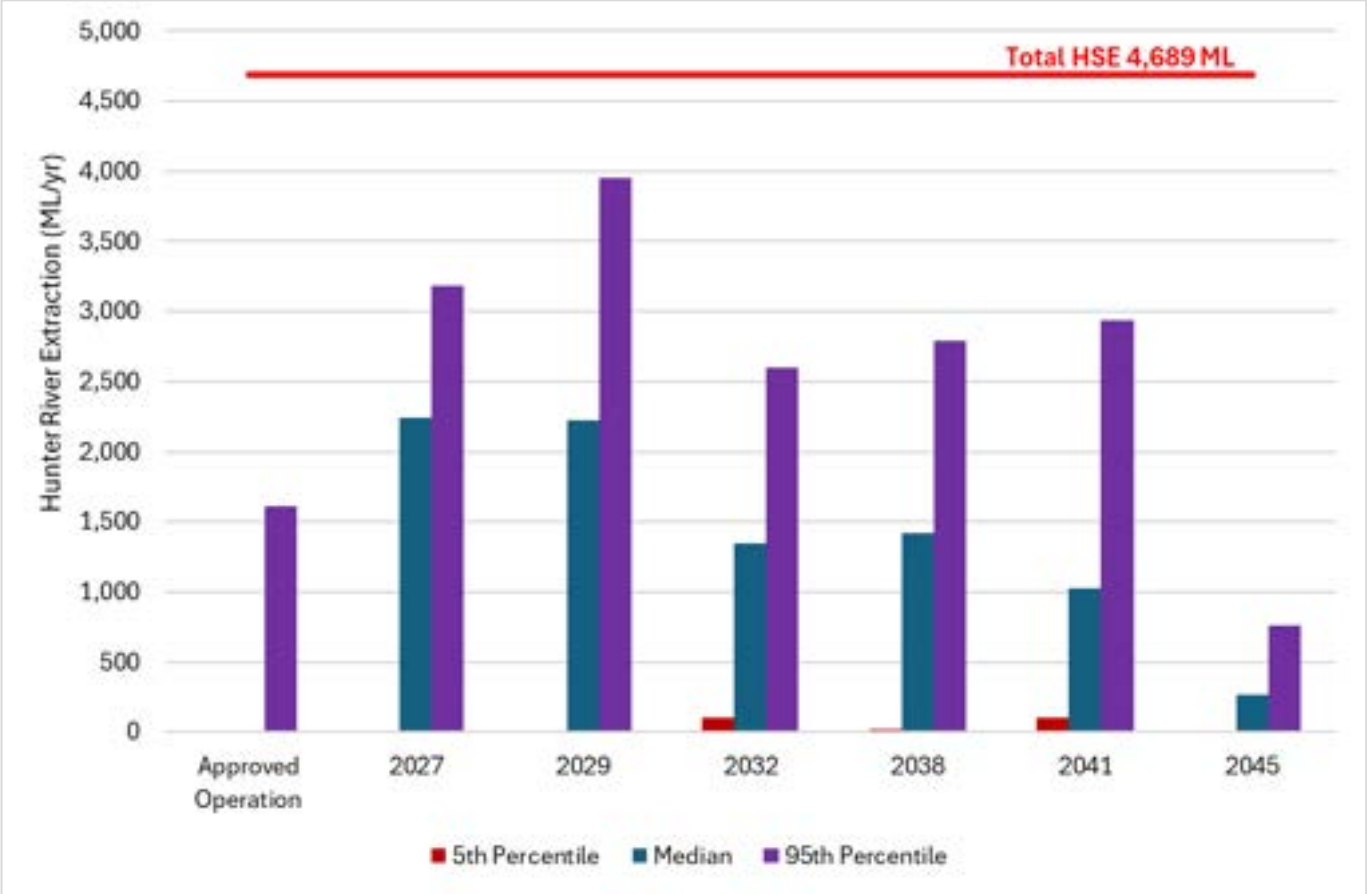


FIGURE 9.4: CLIMATE CHANGE SCENARIO HUNTER RIVER EXTRACTION (HIGH SECURITY ALLOCATION) CONTROLLED RELEASES (HRSTS)

The predicted average annual total controlled releases to the Hunter River via the HRSTS, and release storage is shown in Figure 9.5. In total, the Project is forecast to utilise on average, 3% to 34% of the average total allowable discharge opportunities (compared to 19% to 52% for the baseline climate scenario). The 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 Project utilises more than the average allowable discharge potential (i.e., annual release volumes are skewed towards wet years).

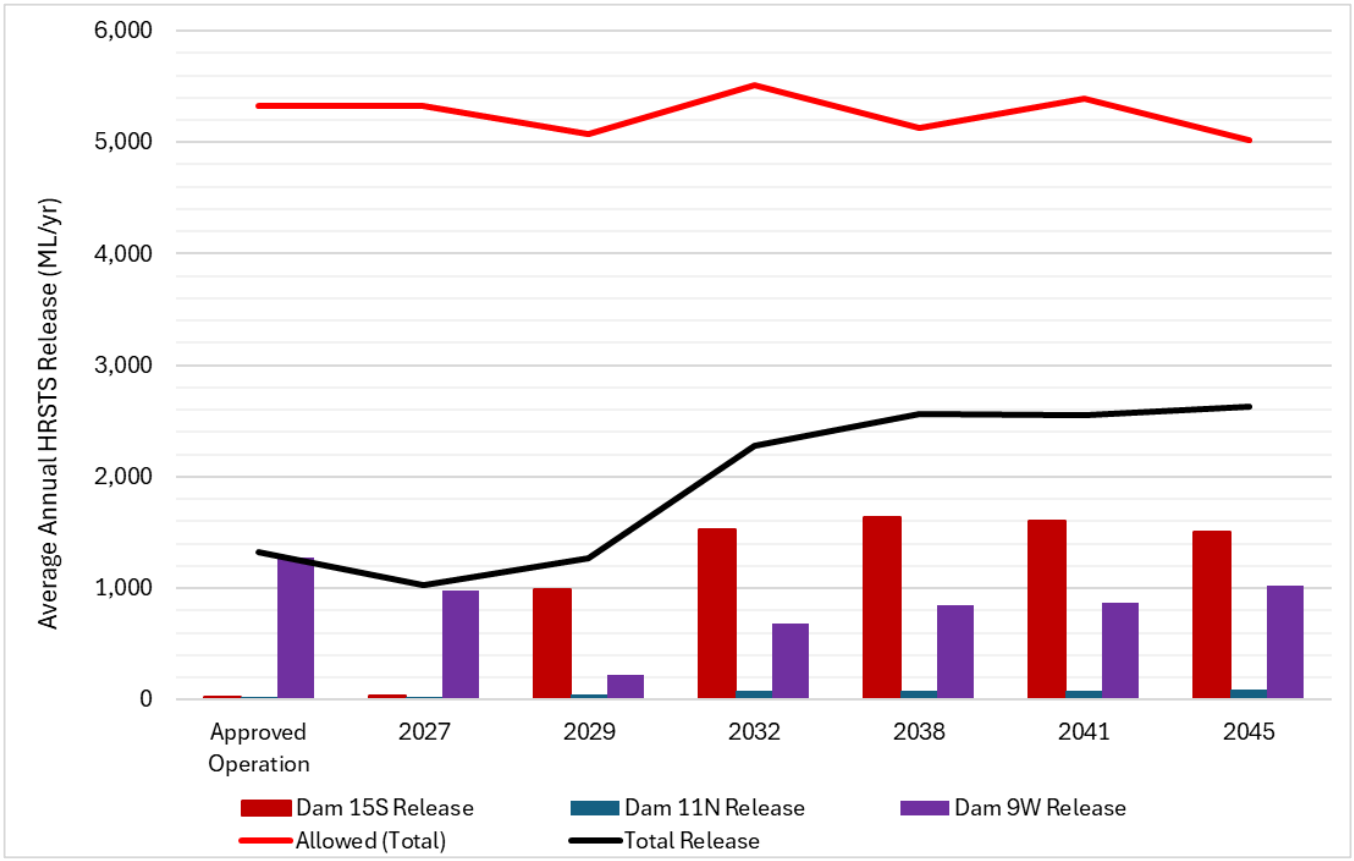


FIGURE 9.5: CLIMATE CHANGE SCENARIO CONTROLLED RELEASES (HRSTS)

9.2.4 Flow Dilution Ratio

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 9.6 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 78% 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. This is consistent with the baseline climate scenario.

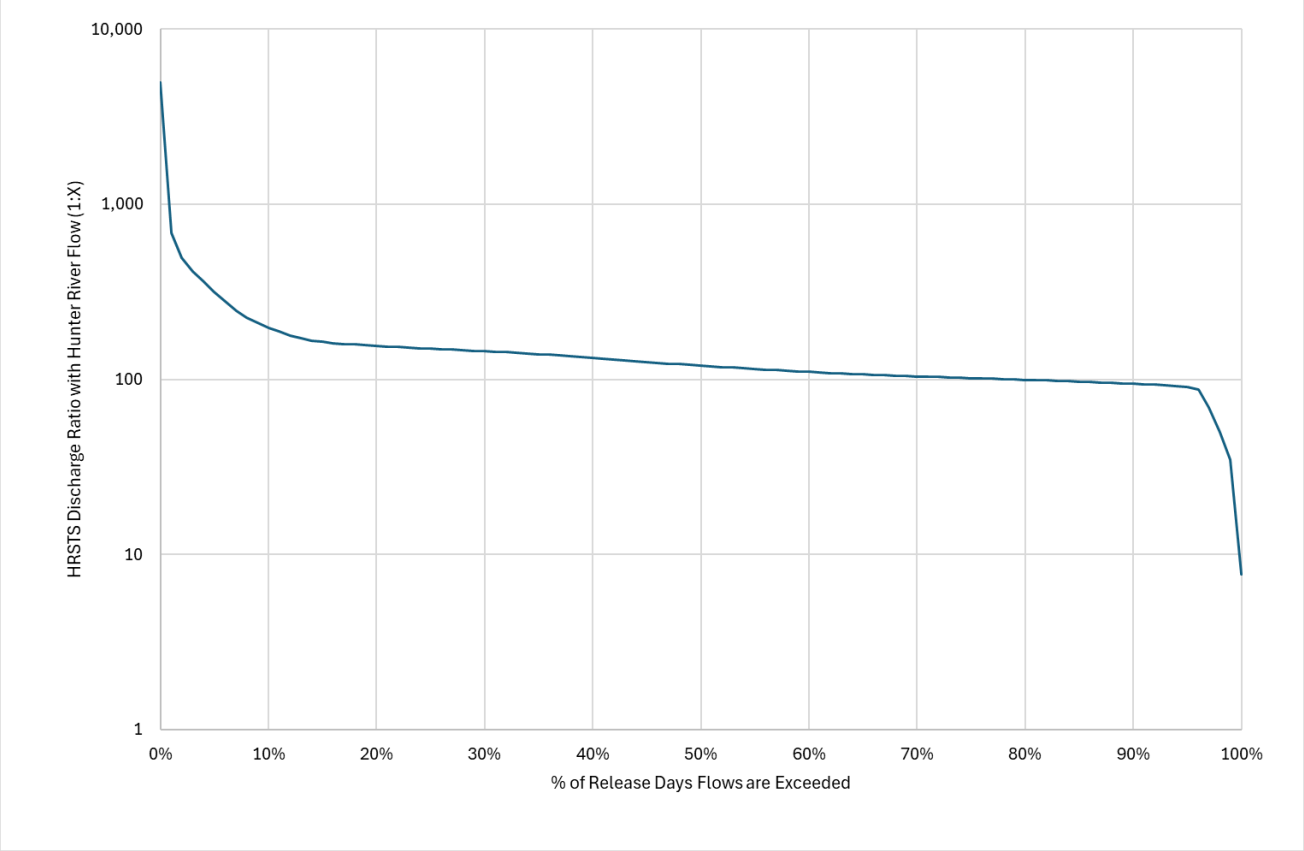


FIGURE 9.6: CLIMATE CHANGE SCENARIO HRSTS FLOW DILUTION RATIO EXCEEDANCE CURVES

9.2.5 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 for the climate change scenario, even under the 5th percentile dry climate scenario. This is consistent with the baseline climate scenario. As presented in Figure 9.1, the annual inflow and outflow volumes indicate that water supplies will be met for the 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.

10. CONCLUSIONS

The water balance modelling demonstrates the following outcomes:

- 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).
- Overflows from water management system are typically limited overflows from sediment dams (designed in accordance with NSW Blue Book standards (Landcom, 2004; NSW DECC, 2008d)). In addition, mine water storages are designed and operated to contain the stormwater runoff generated by the 1% Annual Exceedance Probability (AEP) 24 hour design storm event. Therefore, runoff generated from mining areas during rainfall events less than the 1% AEP 24 hour are expected to be contained on site, thereby minimising the risk of impacts to the environment.
- By utilising and building upon the existing WMS and current site upgrades, surface water for the Project will be able to be managed in accordance with conditions of the current EPL and WALs.
- There is only minor variation in magnitude and proportion of WMS inflows and outflows between the modelled Approved Operation and the Project.

In regard to WALs:

- The 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 47% of HSE WALs in median conditions during peak demand years.
- The modelling indicates that the Project has no reliance on GSE allocations.

For HRSTS discharges:

- The Project is expected to utilise, on average, 19% to 52% of the total allowable discharge opportunities to the HRSTS. 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 the 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.

Climate change modelling, under an SSP5-8.5 seasonal prediction scenario, indicates that:

- The Project is expected to maintain sufficient inventory to meet water demands, while relying less on discharges to the HRSTS and more on extraction from the Hunter River. The modelling indicates that HVO holds sufficient WALs to operate in the SSP5-8.5 scenario.
- Seasonal increases in rainfall intensity associated with climate change on the daily rainfall model timestep do not have any significant influence on forecast overflows from the WMS. The modelling forecasts negligible increases in average overflows of 1 ML/year for 2032 and 2038 (i.e. ~0.6% increase in volume).

11. REFERENCES

AGE. (2022). *Hunter Valley Continuation Project - Groundwater Impact Assessment. Australasian Groundwater & Environmental Consultants.*

EMM. (2026). *HVO Continuation Project - Groundwater modelling.*

Engeny. (2024). *HVO Water Accounting Framework.*

Engeny. (2026). *Hunter Valley Operations Continuation Project, Surface Water Impact Assessment.*

HATCH. (2015). *HVO Water Balance Model - Baseline Scenario.*

Landcom. (2004). *Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition.*

NSW DECC. (2008d). *Managing Urban Stormwater - Soils and Construction, Volume 2E Mines and Quarries.*

WRM. (2016). *Hunter Valley Operations South Modification 5 - Surface Water Assessment.*

12. 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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APPENDIX A: APPROVED OPERATION WATER BALANCE MODEL INPUTS

A.1 Overview

The existing calibrated HVO water balance model (as described in Section 6) was updated to represent the Approved Operation. Updates made to the water balance model to represent the Approved Operation are based on data presented in the 2016 WRM report titled Hunter Valley Operations South Modification 5 Surface Water Assessment (SWA) (WRM, 2016) that formed part of the Project Modification 5 (MOD 5) impact assessment for HVO South. The model assumptions and input data are provided below and represent Stage 4 (2028) for MOD5.

A.2 Input Data

The following components of the water balance model were updated to represent the Approved Operation:

- Catchment areas.
- Dust suppression demands.
- Processing demands.
- Groundwater inflows.

The values adopted for these parameters are provided in Table A.1. The values adopted are based on the values presented for Stage 4 (2028) horizon of the SWA (WRM, 2016).

TABLE A.1: APPROVED OPERATION WATER BALANCE MODEL INPUTS

Item	Adopted Value
Catchment Areas	<table><tr><th>Site Area</th><th>Total Area (ha)</th></tr><tr><td>**HVO North** (inclusive of HVO West)</td><td>3,201</td></tr><tr><td>**HVO South**</td><td>1,567</td></tr><tr><td>**Total (Excluding Load Point Area)**</td><td>4,767</td></tr></table>
Dust Suppression	2,490 ML/year
Processing Demand	Net demand of 2,700 ML/year. Comprised of 7,305 ML/year demand and 2,700 ML/year decant return.
Groundwater Inflows	1,180 ML/year

A.3 Assumptions

The representation of the Approved Operation in the water balance model assumes that:

- All planned rehabilitation and catchment diversion would proceed as per the time schedule presented in the SWA (WRM, 2016), that is a smaller WMS catchment area compared to the current WMS at the HVO Complex, and the proposed WMS for the Project.
- The areas removed from the current WMS catchment at the HVO Complex would be areas classified as rehabilitated or natural land use.
- The distribution of dust suppression demand in the different areas of the HVO Complex would be consistent with the Project modelling for the 2027 stage (i.e. 13% of the total dust suppression demand distributed to HVO North, 34% to HVO West and 53% to HVO South).
- The miscellaneous demands and seepage losses are consistent with the water balance model for the Project (which is consistent with the current operational HVO Complex water balance model).
- Load point water demands are included in the CPP demands.

ATTACHMENT J: FINAL VOID ASSESSMENT

ENGENY

HV OPERATIONS PTY LTD

Final Void Assessment

HVO Continuation Project

BNTL00198_002-REP-008-4

6 MARCH 2026

DISCLAIMER

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	2/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
1	15/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Sean Frazer
2	29/09/2025	Client Issue	Susan Shield	Sean Frazer	Susan Shield	Chris Bonomini
3	11/02/2026	Client Issue	Susan Shield	Chris Bonomini	Susan Shield	Chris Bonomini
4	6/03/2026	Client Issue	Susan Shield	Chris Bonomini	Susan Shield	Chris Bonomini
Signatures:						

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1. INTRODUCTION

Hunter Valley Operations 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) comprising of 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. The HVO Complex is owned by subsidiary companies of Yancoal and Glencore, as participants in the unincorporated HVO Joint Venture (JV). HV Operations Pty Ltd (HVO) is the appointed manager of the JV.

The Project broadly comprises the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 31 December 2026 and 24 March 2030 respectively, to 31 December 2045 at HVO North and 31 December 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 (excluding Carrington West Wing extension area where mining depth is proposed to occur as approved).

Final void impacts were assessed for the NSW state approvals process in the Amended Project Surface Water Impact Assessment (AP SWIA) (Engeny, 2025). The modelling methodology and the results presented in the AP SWIA are documented in this report. A peer review of the surface water impact assessment was conducted by Ian Rowbottom (EMM). Ian Rowbottom was involved throughout the surface water impact assessment studies, 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 final landform design includes:

- Two final voids at HVO North (North Void and Carrington Pit Void):
  - 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).
- One final void will remain at HVO South, consistent with the existing HVO South Approval. Some changes to the final void catchment and dimensions due to rescheduling are proposed.

The pit low wall dumps will be regraded and free draining, and the upstream catchments areas will be diverted around the final voids. The proposed 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 relatively 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 is to 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 Project final void characteristics is included in .

TABLE 1.1: SUMMARY OF PROJECT FINAL VOIDS

Void ID	Description	Catchment Area (ha)	Floor Level (m AHD)	Spill Level (m AHD)	Storage Volume (GL)
North 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	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	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

1.1 Approved Final Voids

The current approved final voids are described in Table 1.2. The approved final voids include three voids at HVO North and one void at HVO South.

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 Project.

TABLE 1.2: FINAL VOID CATCHMENT AREAS

Mining Area	Approved Void	Current Approved Void Catchment (ha)	Project Proposed Void Catchment (ha)
HVO North	West Pit	497 [1]	706
	Mitchell Pit	154 [2]	
	Carrington Pit	120 [3]	324
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 (EMM, 2025a)

Note 3: HVO North Mod 3 (Carrington West Wing) (MER 2010)

Note 4: HVO South MOD5 EA (EMM, 2016)

North Void

Carrington Pit Void

HUNTER RIVER

HUNTER RIVER

South Void

Legend

Final Void Catchments

Land Use

Highwall

Rehabilitated

Note: Final landform DEM presented for the three final voids and their catchment areas only

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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

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HVO Continuaton Project

Figure 1-1:
Final Landform - Void Conceptual Overview

N

Job: BNTL00198_0002
Revision: 1
Drawn: AH
Checked: LV
Date: 29 /9 /2025

2. MODELLING METHODOLOGY

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 and AP SWIA (Engeny, 2025).

The final void water and salt balance model has been set up in the GoldSim software using calibrated hydrology inputs from the HVO operational water balance model (WBM) (refer to Attachment I of the SWIA). The model is a mass balance model and simulates inflows from rainfall runoff over the residual final void catchment (including direct rainfall), groundwater fluxes (inflow or outflow) from hardrock 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.

The following sections outline the modelling methodology and inputs, model results and sensitivity assessment.

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 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	Highwall (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 Attachment H 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 estimated using groundwater modelling (EMM, 2025b). The groundwater inflow/outflow relationships applied to the final void models are shown in Figure 2.2.
  - It is noted that a updated history-matching of the HVO regional groundwater model (EMM, 2026) was undertaken following the preparation of the AP SWIA (Engeny, 2025). A sensitivity analysis to consider the potential influence of groundwater inflows on the final void recovery was undertaken and is presented in Section 3.1.3.
- 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, 2022b):
    - 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.

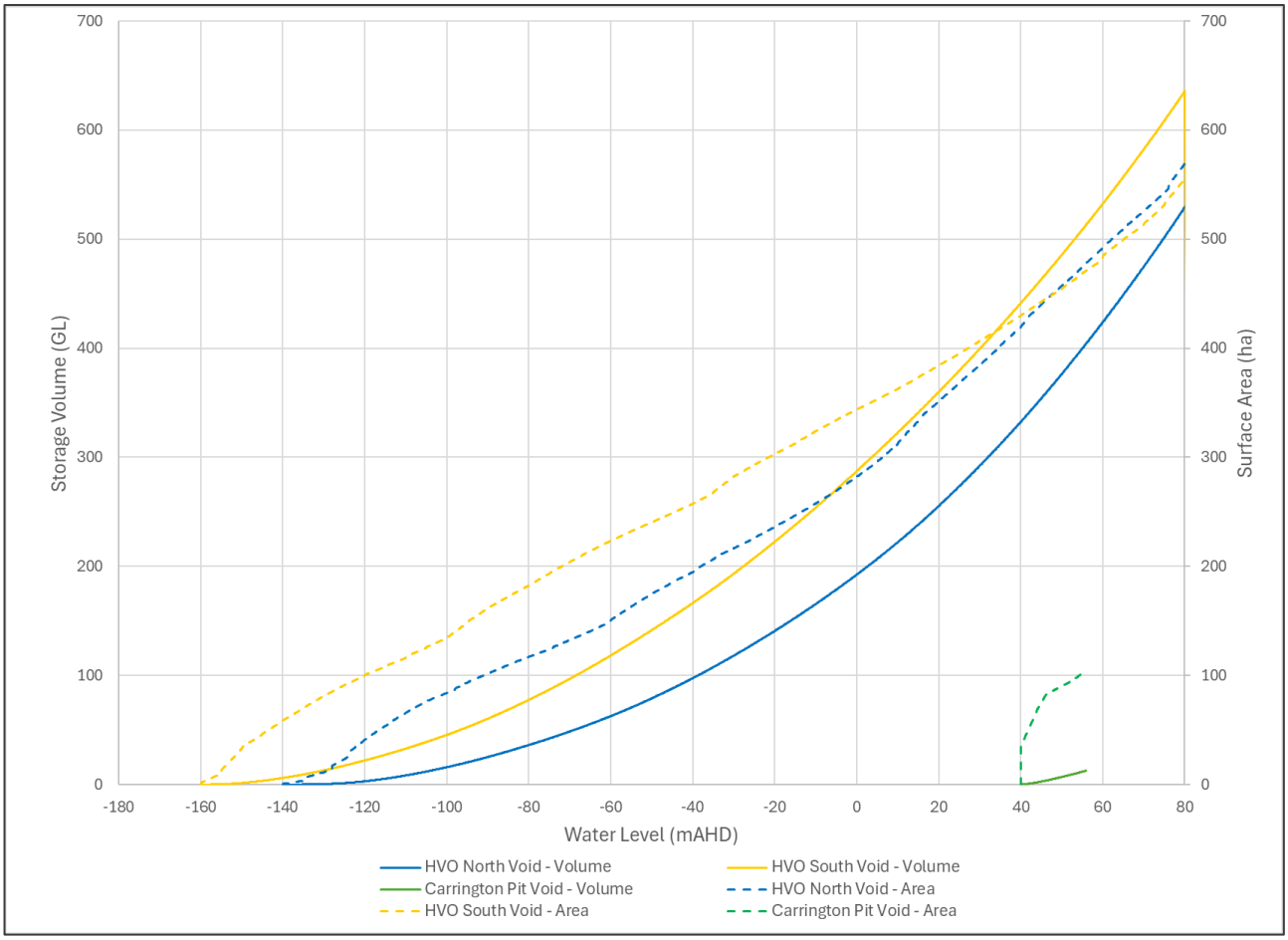


FIGURE 2.1: FINAL VOID STORAGE CHARACTERISTICS

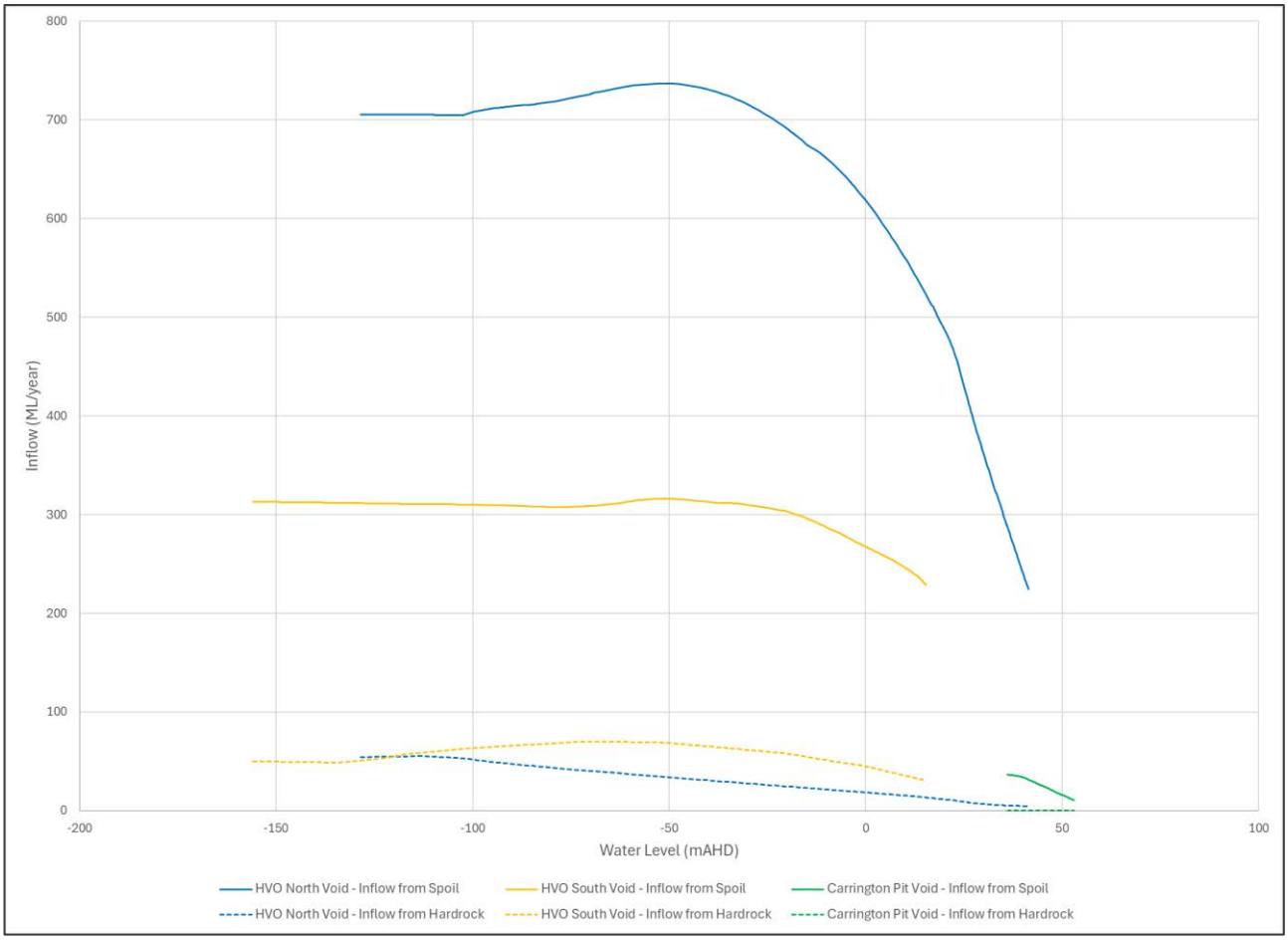


FIGURE 2.2: GROUNDWATER INFLOW RELATIONSHIPS (EMM, 2025B)

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)[1]	600	600	600	600
Water quality at 600 years post closure, TDS (mg/L)	7,130	7,050	7,100	7,200

Note 1. Approximate, continues to slowly rise

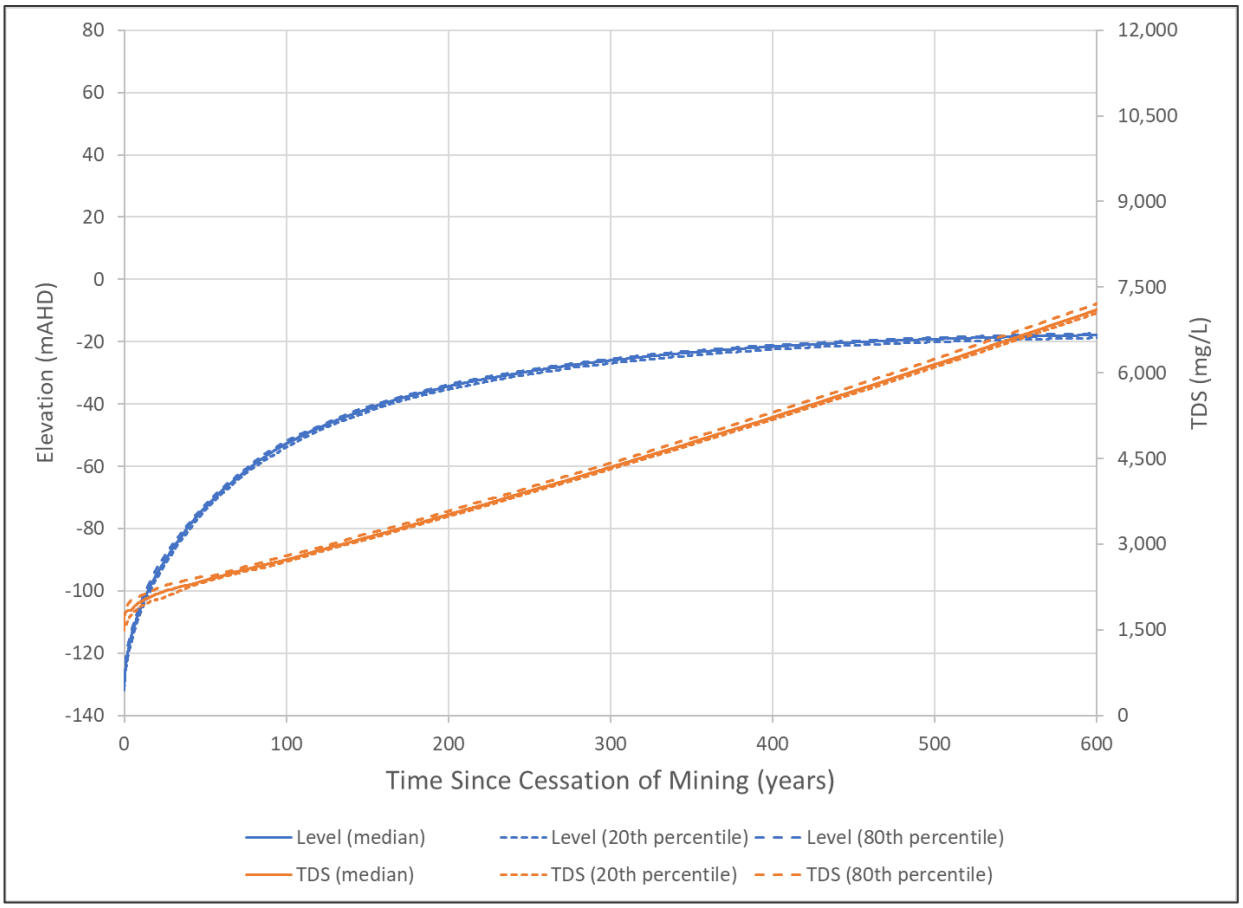


FIGURE 3.1: PREDICTED FINAL VOID WATER LEVELS AND QUALITY (NORTH VOID)

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 when there is a smaller water volume combined with a large surface area.

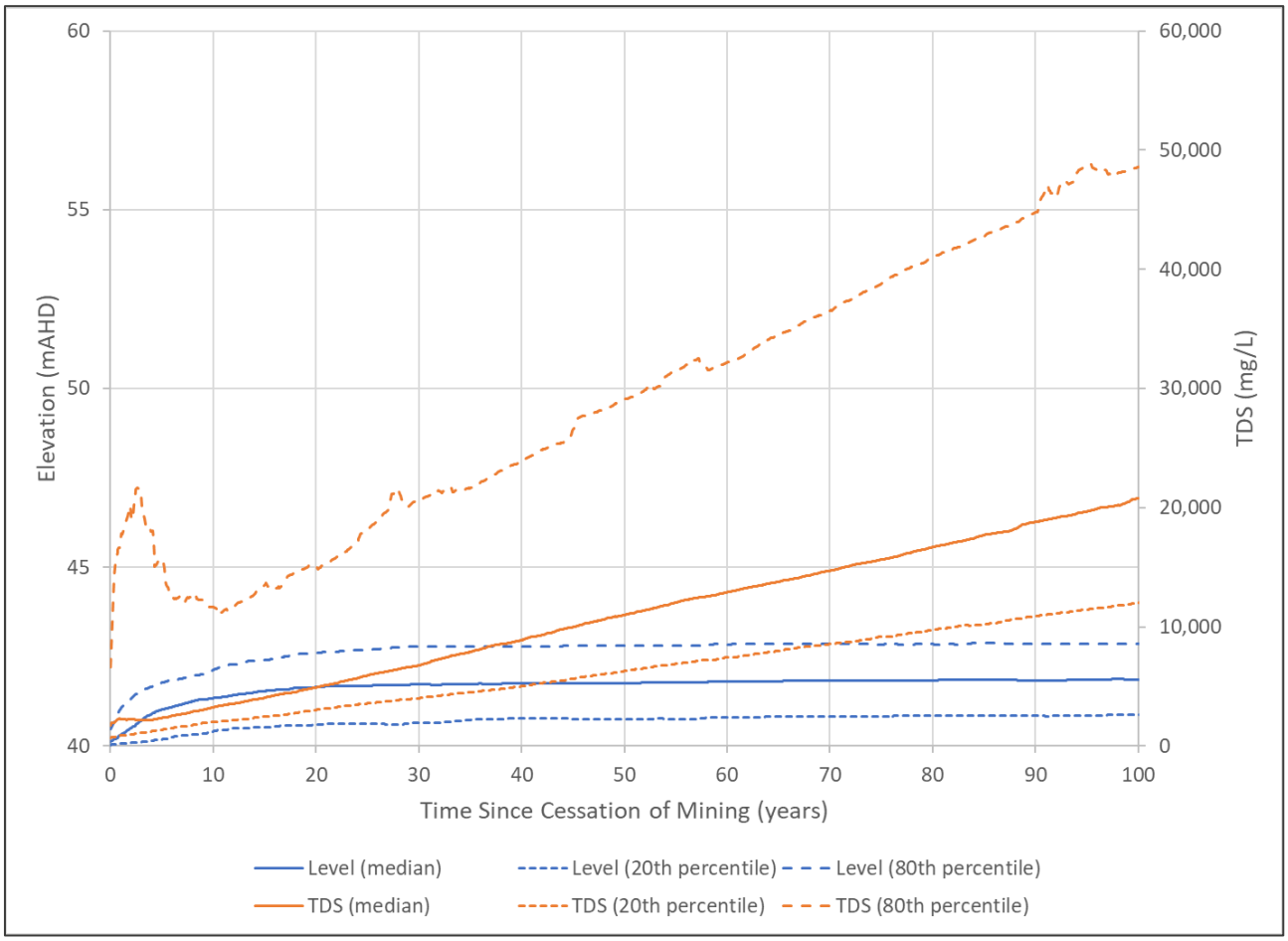


FIGURE 3.2: PREDICTED FINAL VOID WATER LEVELS AND QUALITY (CARRINGTON PIT VOID)

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)[1]	600	600	600	600
Water quality at 600 years post closure, TDS (mg/L)	8,510	8,400	8,480	8,600

Note 1. Approximate, continues to slowly rise

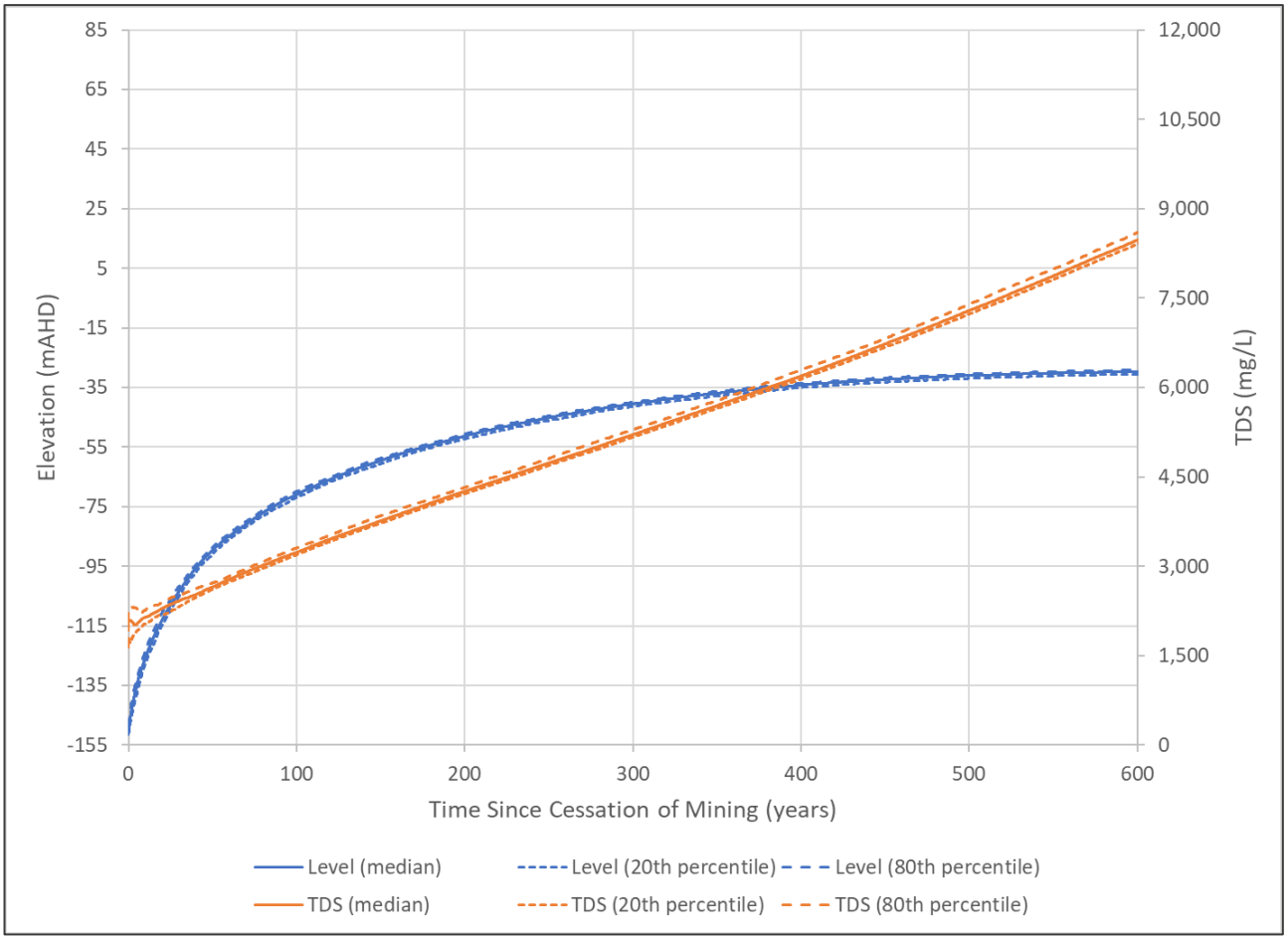


FIGURE 3.3: PREDICTED FINAL VOID WATER LEVELS AND QUALITY (HVO SOUTH VOID)

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	1,180	1,261	1,430
Runoff	356	321	577	452
Groundwater Inflow – Hardrock	61	62	61	62
Groundwater Inflow - Spoil Seepage	310	310	310	310
Evaporation	1,768	1,864	1,683	1,748
Groundwater Outflow	0	0	0	0
Spoil Seepage Outflow	0	0	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 which is common for final voids in the Hunter Valley. 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

A sensitivity assessment of the predicted final void pit lake outcomes has been undertaken on two climate inputs, groundwater inflows and salinity of inflows:

- 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.
- Groundwater inflows – Predicted increases in groundwater flux rates.
- Salinity of inflows – Higher and lower TDS.

Evaporation is the largest flux (i.e. inflow or 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.

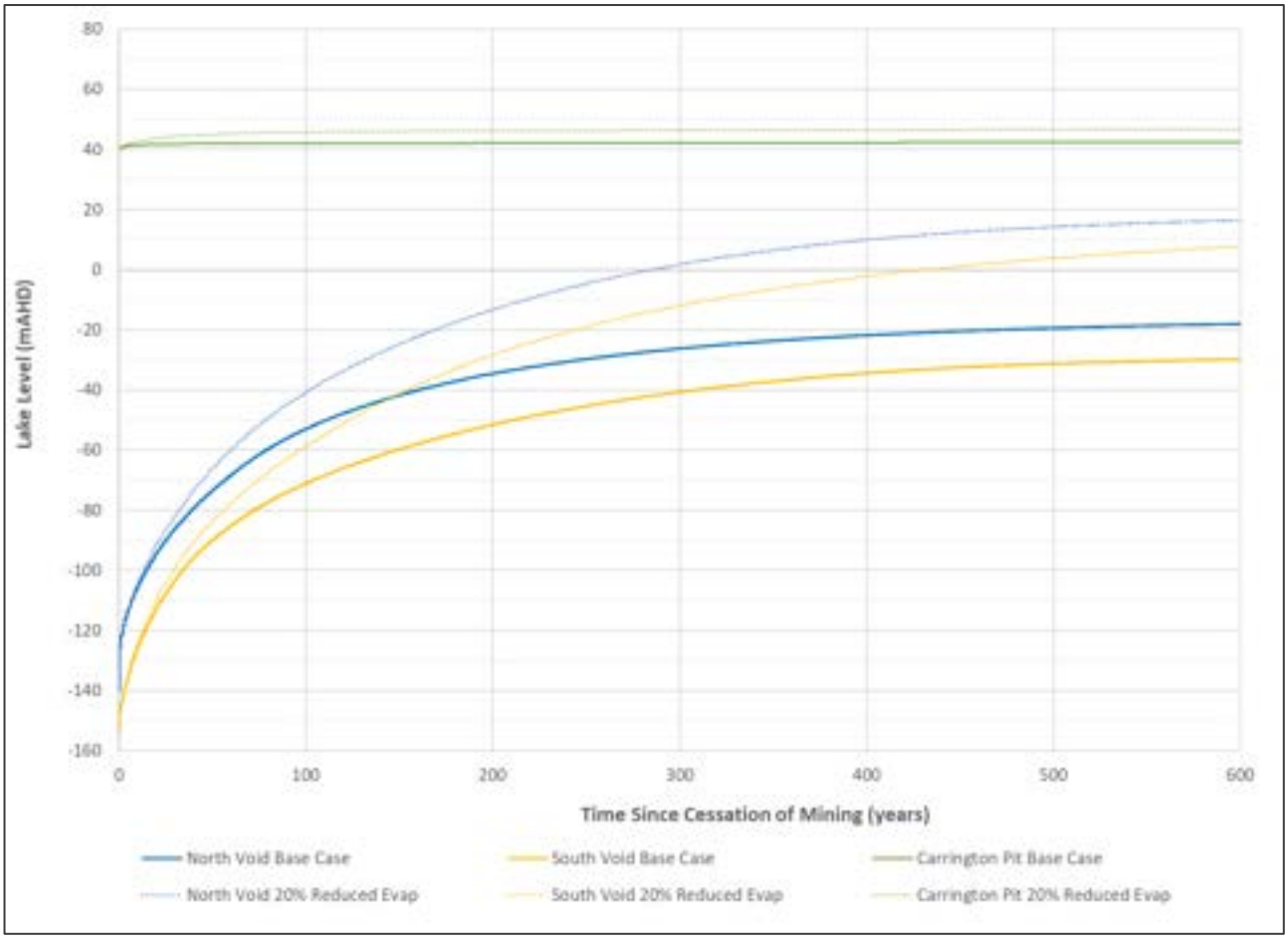


FIGURE 3.4: PIT LAKE EVAPORATION SENSITIVITY (20% REDUCTION) ON FINAL PIT LAKE WATER LEVELS

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 commencement of the final void modelling (2020), 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. Three RCPs were assessed and 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 spill level).

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	-52.2	40.4	-76.4	8,910	278,670	12,250
	'Worst Case' Higher Lake Level	-27.5	41.4	-40.6	5,670	83,350	6,730
	Maximum Consensus	-41.7	40.7	-62.3	7,340	179,560	9,520
RCP4.5	'Best Case' Lower Lake Level	-57.2	40.3	-82.7	9,920	322,210	13,970
	'Worst Case' Higher Lake Level	-22.0	41.8	-32.8	5,240	51,560	6,120
	Maximum Consensus	-47.3	40.6	-69.3	8,270	220,340	10,950
RCP8.5	'Best Case' Lower Lake Level	-83.5	40.1	-105.4	19,010	485,500	23,380
	'Worst Case' Higher Lake Level	-3.9	43.9	-13.0	4,010	13,160	4,720
	Maximum Consensus	-62.0	40.3	-87.3	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.

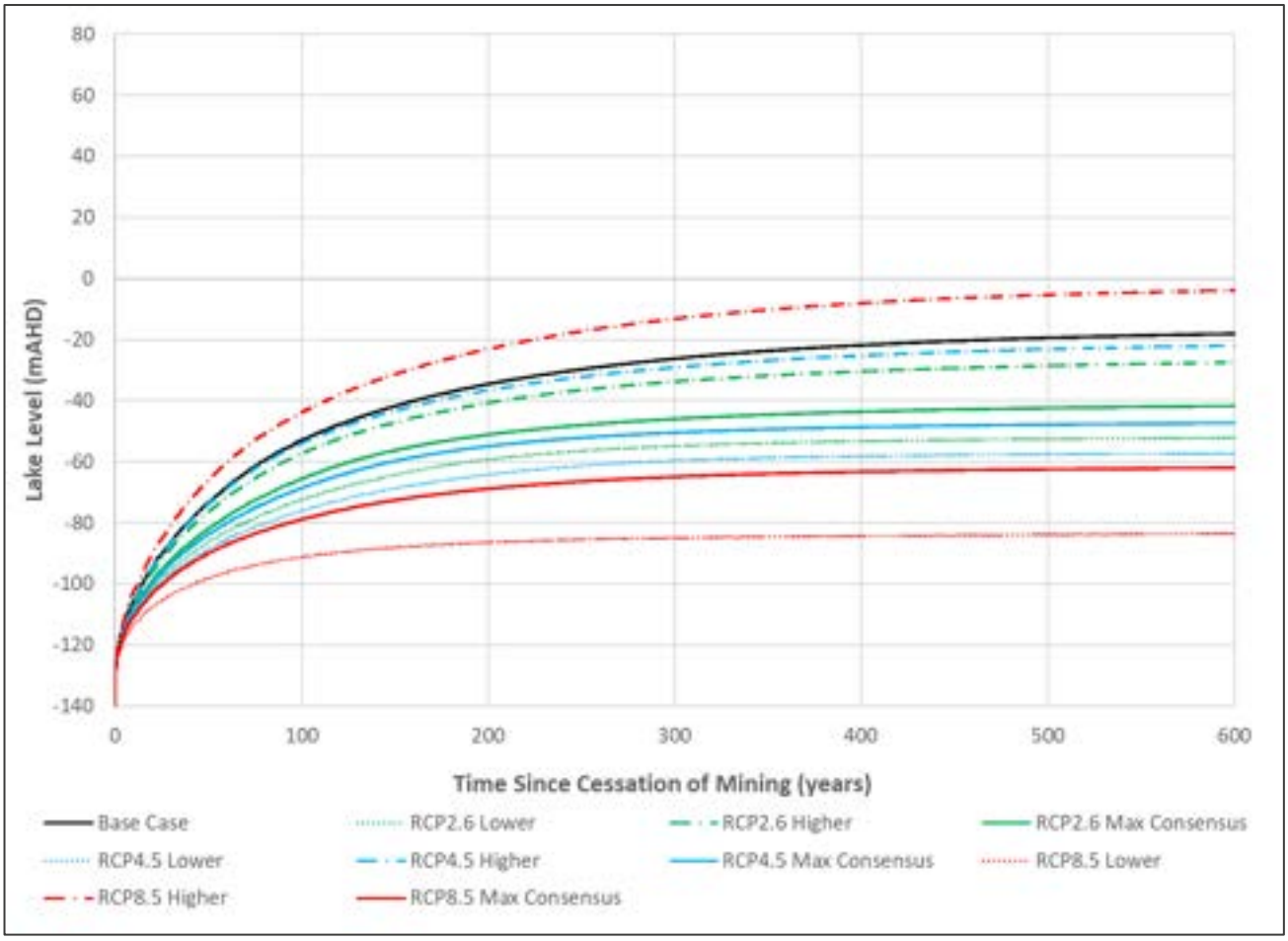


FIGURE 3.5: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (NORTH VOID)

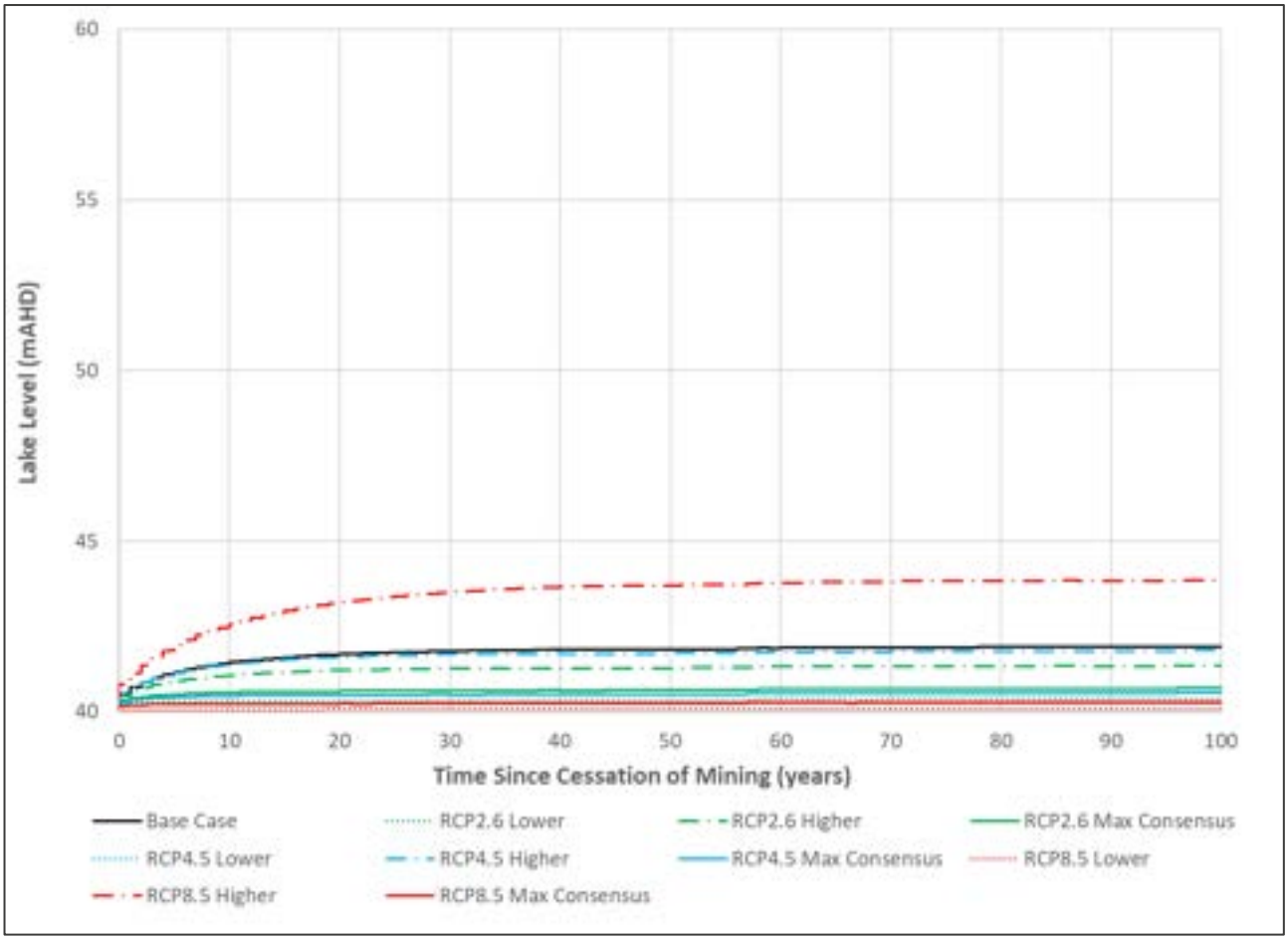


FIGURE 3.6: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (CARRINGTON PIT VOID)

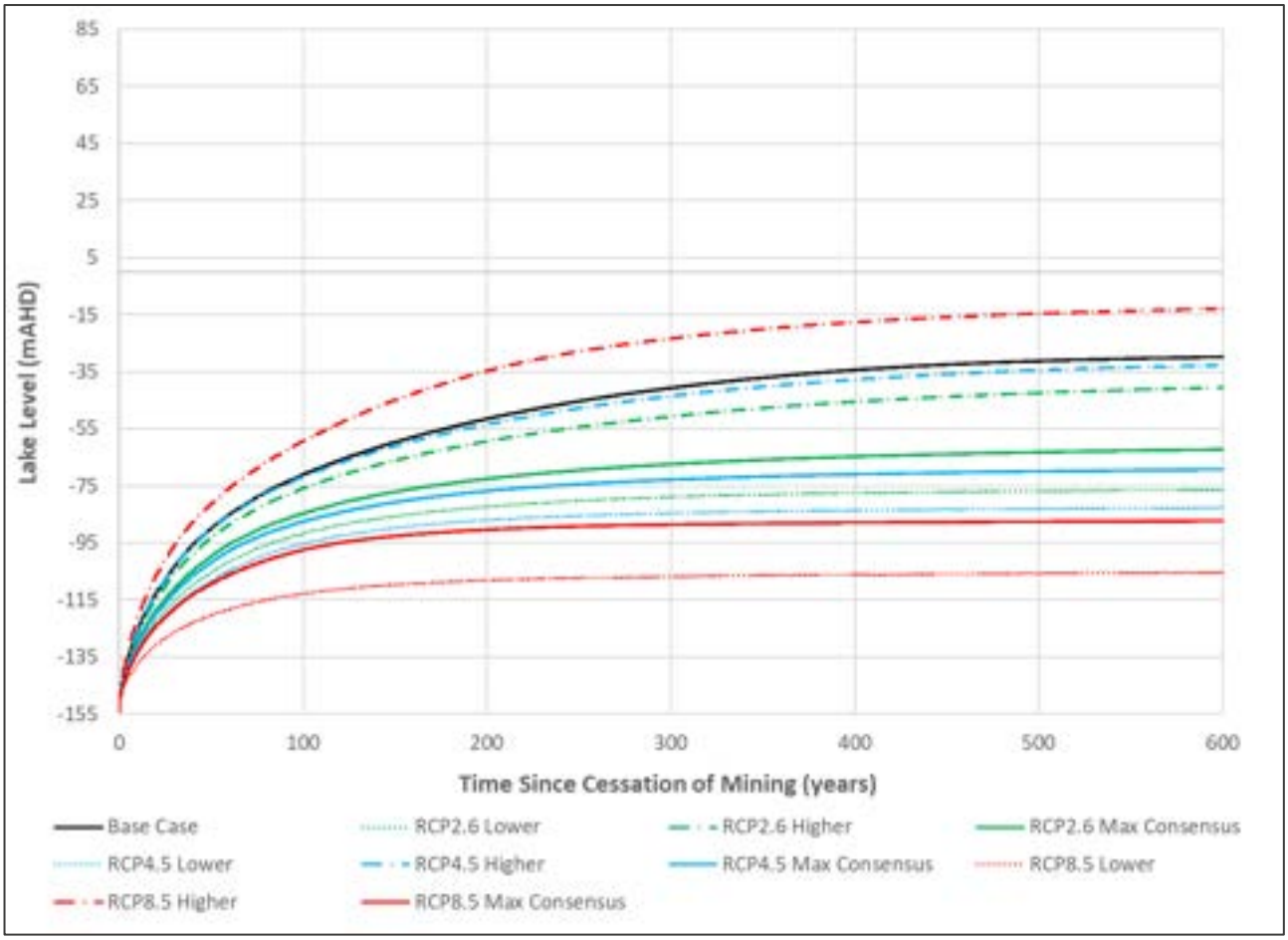


FIGURE 3.7: CLIMATE CHANGE SENSITIVITY ON FINAL PIT LAKE WATER LEVELS (SOUTH VOID)

3.1.3 Groundwater Inflow

As indicated in Section 2, the HVO groundwater model underwent updated history-matching following submission of the AP SWIA (Engeny, 2025) (prepared for the NSW state approvals process). The potential changes to the final void assessment have been considered by using a sensitivity assessment for groundwater inflows to the final voids.

A review of groundwater inflow data during the Project operations indicates that pumpable groundwater inflows assessed for the Project water balance (refer to Attachment I of the SWIA) compared to the AP SWIA water balance model (Engeny, 2025) are as follows:

- HVO North – Project pumpable groundwater is 1.46 times AP SWIA pumpable groundwater during 2045, ranging between 0.02 times and 1.46 times over the Project operational period.
- HVO South – Project pumpable groundwater is 0.03 times AP SWIA pumpable groundwater during 2045, ranging between zero pumpable groundwater and 1.27 times over the Project operational period.

To consider how changes in updated groundwater model (i.e. post AP SWIA) could influence the final void recovery water levels, a sensitivity model was run with the groundwater inflow/outflow relationship modified to double the groundwater rates used in the modelling (for both spoil and hardrock (host)). Doubling the groundwater inflow rates is a conservative sensitivity case when considering the predicted pumpable groundwater inflow rate changes (maximum of 146%).

The modelling results, presented in Table 3.9, indicate that the forecast long-term lake water levels continue to have significant freeboard to the spill elevation for North Void and South Void (greater than 65 m). Similarly, the freeboard in Carrington Pit Void exhibits only a minor reduction when compared to the base modelling, i.e. 12 m to 14 m compared to 13 m to 15 m.

TABLE 3.9: LONG-TERM PIT[1] LAKE LEVELS (AND FREEBOARD) FOR GROUNDWATER INFLOW SENSITIVITY MODELLING

Area	Average	20th Percentile	Median	80th Percentile
North Void	11.9 mAHD (69.6 m)	11.4 mAHD (70.2 m)	12.2 mAHD (69.3 m)	12.6 mAHD (68.9 m)
Carrington Pit Void	42.4 mAHD (13.6 m)	41.6 mAHD (14.4 m)	42.4 mAHD (13.6 m)	43.3 mAHD (12.7 mAHD)
South Void	-1.9 mAHD (81.9 m)	-2.5 mAHD (82.5 m)	-1.6 mAHD (81.6 m)	-1.2 mAHD (81.2 m)

Note 1: 600 years post closure for HVO North and HVO South, 100 years post closure for Carrington Pit

3.1.4 Salinity of Inflows

The potential ranges in salinity of inflows to the final voids and how these may influence the water quality of the pit lakes in the final voids has been considered by modelling lower and higher sets of inflow TDS concentrations. These concentrations are included in Table 3.10.

TABLE 3.10: SALINITY SENSITIVITY MODELLING – TDS INPUTS

Input	Base Case (mg/L)	Lower Salinity (mg/L)	Higher Salinity (mg/L)	Notes
Rainfall	13	13	13	Project is 80 to 100 km from the coast (DERM, 2011)
Groundwater – host rock	4,357	872	7,383	Estimated 20th percentile and 80th percentile values based on host rock water quality data (AGE, 2022)
Groundwater – spoil seepage	895	620	2,475	Estimated 20th percentile and 80th percentile values based on water leach data (EGI, 2022a)
Rehabilitated and natural land use rainfall runoff	300	250	350	Estimated 20th percentile and 80th percentile values based on historical on-site water quality data
Pit land use rainfall runoff	2,000	780	2,740	Estimated 20th percentile and 80th percentile values based on historical on-site water quality data

The outcomes of the modelling indicate various timeframes for the final voids to reach higher salinity levels. It should be noted that the modelling results presented here are based on mass balance calculations. That is, the precipitation of salts and limits to solubility associated with factors such as the various salt species present (e.g. individual species solubility, common ion effect, complex ion formation), temperature and pH are not considered and the modelling assumes all salt inflows remain dissolved. This is not a likely scenario considering the range of anion and cation species present in the final void inflows.

The modelling predicts that the "peak" or "equilibrium" concentration will be reached at different times depending on the actual TDS of each of the inflows (which will likely be a variable combination the values presented in Table 3.10). It should be noted that the upper limit of TDS will depend on a range of factors not considered in the mass balance modelling results presented above (e.g. salt species and interactions between species, etc).

Further discussion of the results and potential trends in salinity of the final voids is presented in Section 5.3 of the SWIA.

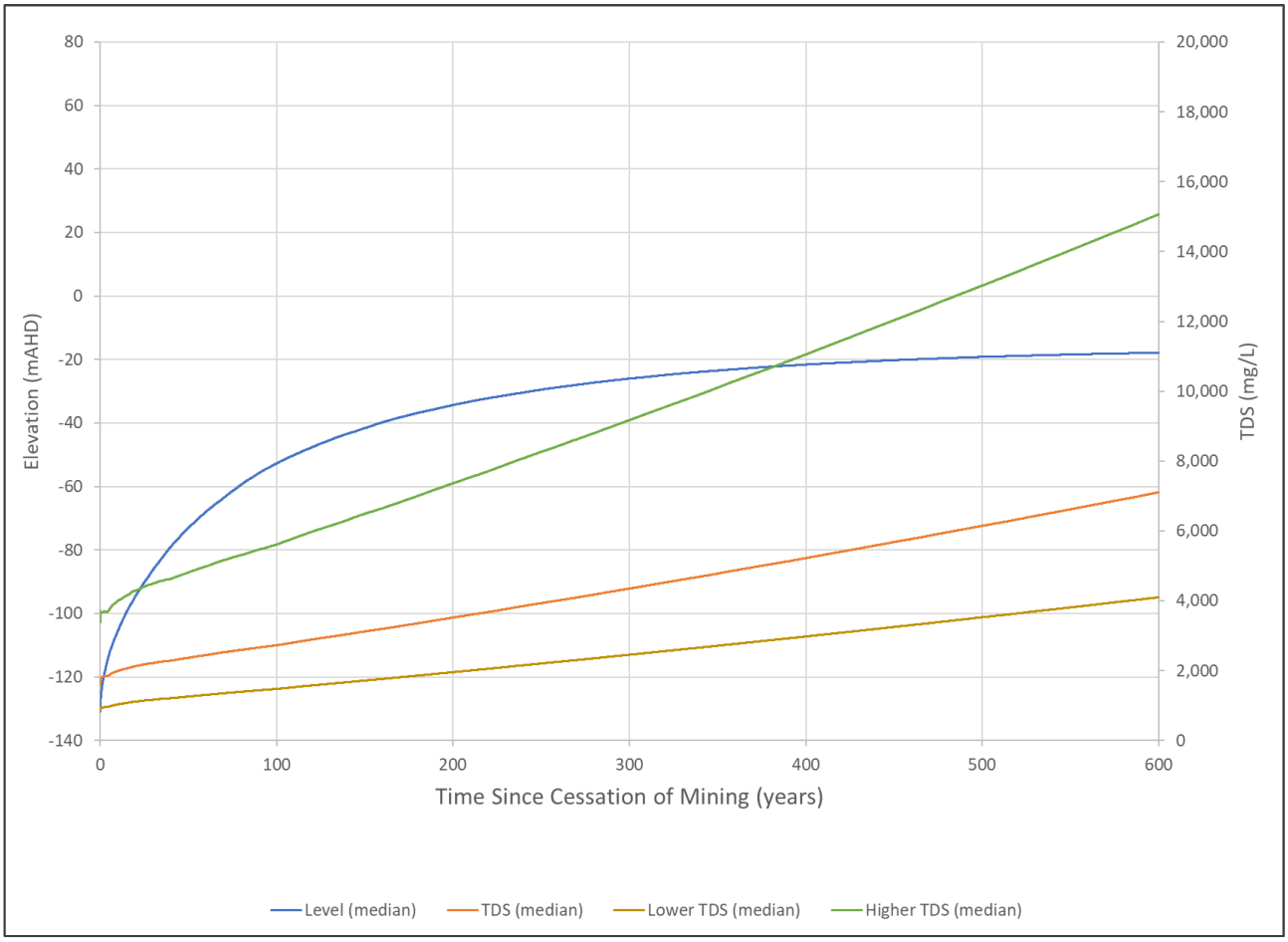


FIGURE 3.8: SALINITY OF INFLOWS SENSITIVITY ON FINAL PIT WATER QUALITY (HVO NORTH VOID)

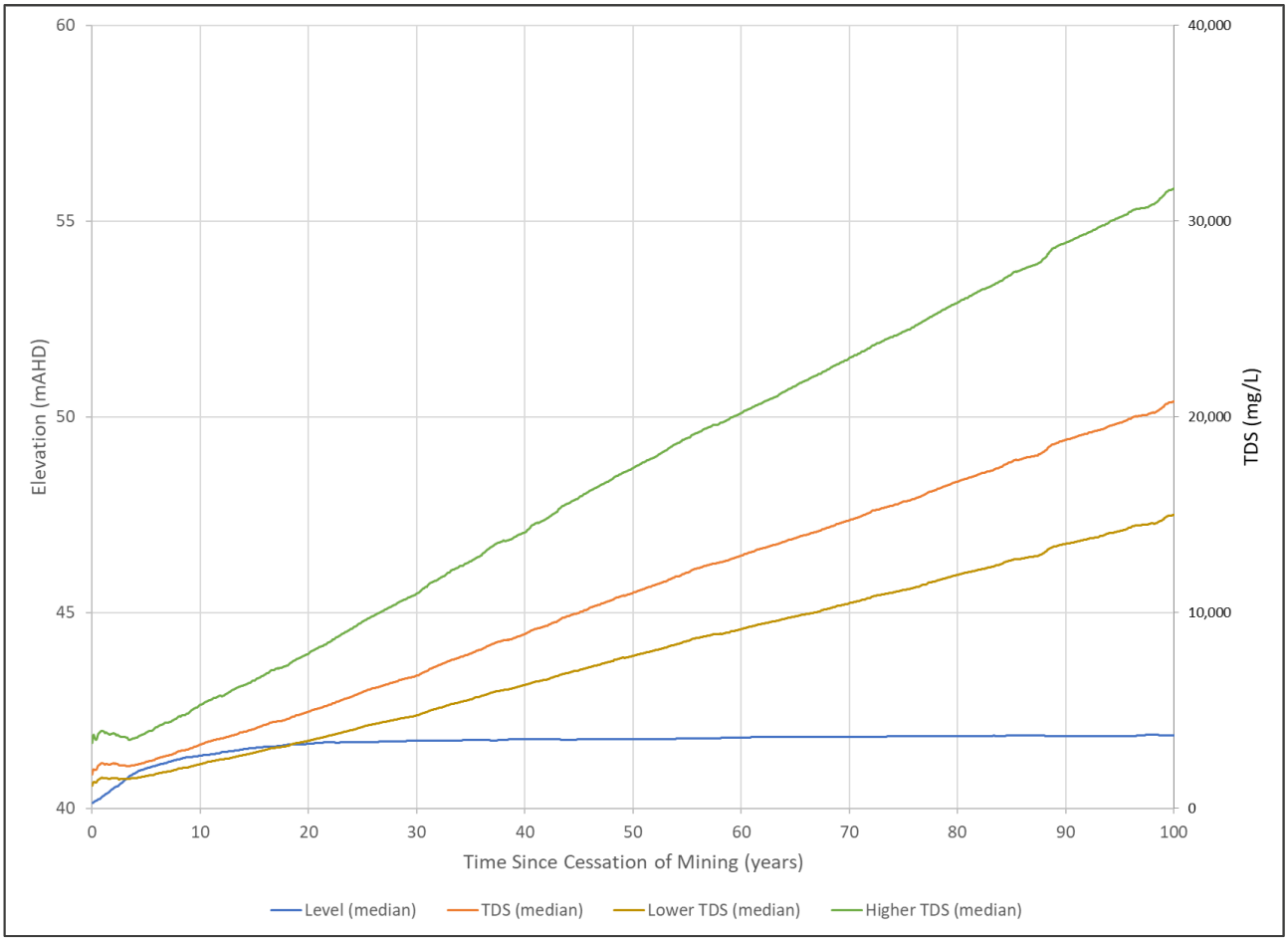


FIGURE 3.9: SALINITY OF INFLOWS SENSITIVITY ON FINAL PIT WATER QUALITY (CARRINGTON PIT VOID)

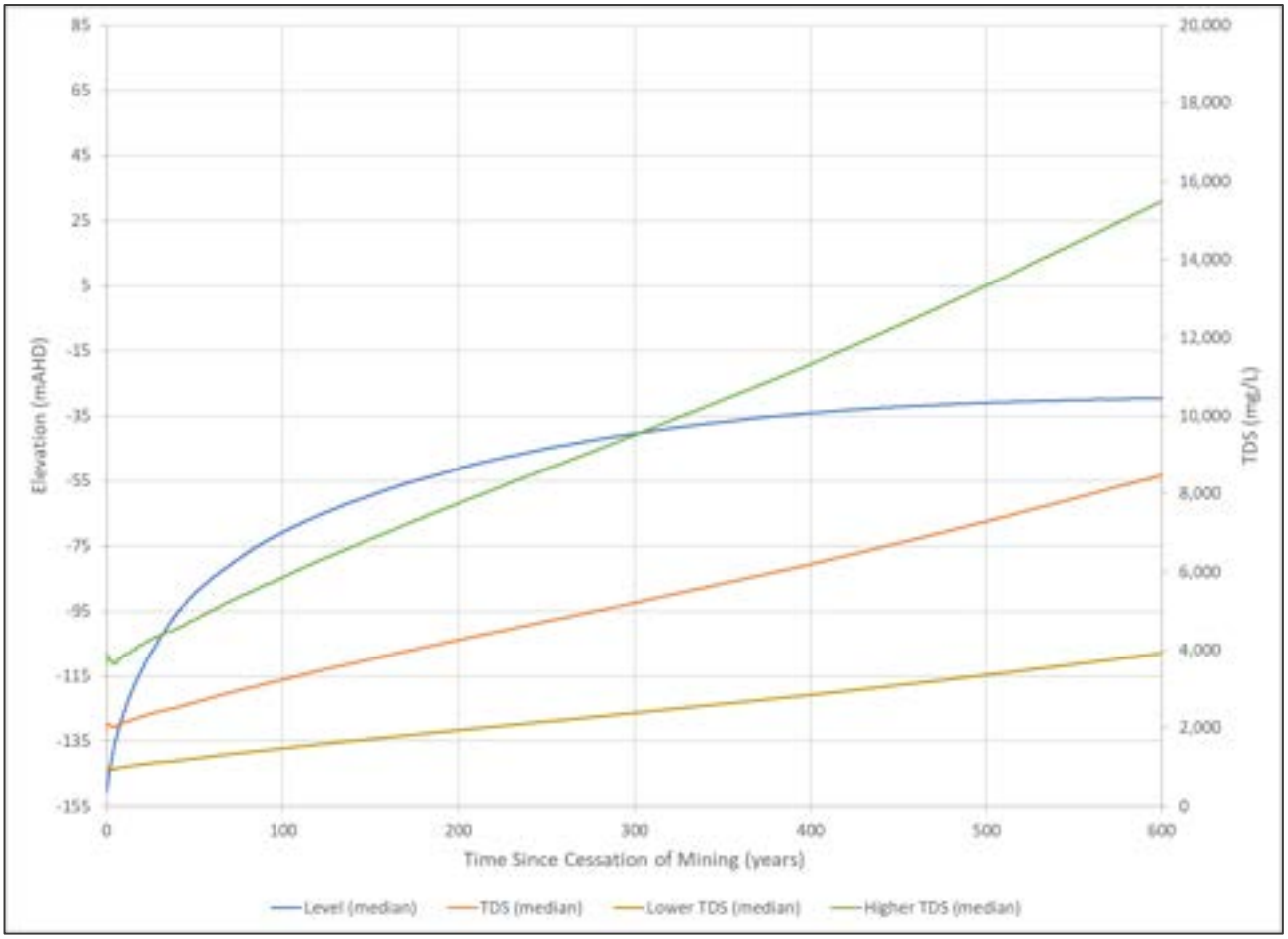


FIGURE 3.10: SALINITY OF INFLOWS SENSITIVITY ON FINAL PIT WATER QUALITY (HVO SOUTH VOID)

4. OUTCOMES

4.1 North Void and South Void

Final void modelling for the Project indicates that for North Void and South Void:

- Filling of the pit 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 spill level for North Void and South Void.
- 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.
- While groundwater inflow increase sensitivities result in a higher lake level, the freeboard remains significant (greater than 65 m).
- 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.
- Salinity of inflow sensitivities indicate various timeframes for the final voids to reach higher salinity levels.
- 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 Carrington Void

4.2.1 Overview

Final void modelling for the Project indicates that for the Carrington Pit Void:

- The equilibrium level will be reached within one hundred years after the cessation of mining.
- A long-term post closure (100 years) water depth of approximately 2 m will be reached giving a freeboard of approximately 14 m, making the risk of potential spill to the North Void negligible.
- While evaporation reduction sensitivities result in a higher lake level, the freeboard remains significant (10 m).
- While groundwater inflow increase sensitivity results in a 1 m higher lake level, the freeboard remains significant (12 m to 14 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 with TDS concentrations of approximately 21,550 mg/L at 100 years after closure.
- Salinity of inflow sensitivity indicates various timeframes for the final void to reach higher salinity levels.

4.2.2 Comparison of Results to Approved Void - Carrington Pit Void

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., albeit with a change in the catchment area reporting to the final void. As such the results for the 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 at a similar elevation, 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 10 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 previous comparisons of TDS forecasts indicate that simplistic mass balance methodology (as used in the GoldSim model) result in predictions that are 50% higher when compared to hydrogeochemical modelling methodology ((EGI, 2022b; Mackie Environmental Research, 2010). When the difference in methodology is taken into account, it is considered that the forecast Carrington Void salinity remains consistent with the previous assessment by Mackie (2010).

5. REFERENCES

AGE. (2022). *Hunter Valley Continuation Project - Groundwater Impact Assessment. Australasian Groundwater & Environmental Consultants.*

DERM. (2011). *Salinity Management Handbook 2nd edition.* QLD Department of Environment and Resource Management.

EGI. (2022a). *HVO Continuation Project EIS - Geochemical Assessment.*

EGI. (2022b). *Hunter Valley Operations - Continuation Project:, Water Quality Predictions for Final Pit Voids.*

EMM. (2025a). *HVO North Open Cut Continuation Project (EPBC 2025/10177) - Public Environment Report.*

EMM. (2025b). *Hunter Valley Operations Continuation Project - Amended Project - Groundwater Modelling Report.*

EMM. (2026). *HVO Continuation Project - Groundwater modelling.*

Engeny. (2025). *Hunter Valley Operations Continuation Project - Amended Project - Surface Water Impact Assessment.*

Mackie Environmental Research. (2010). *Carrington West Wing Modification - Groundwater Assessment.*

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