SURFACE WATER STUDY

Appendix H

Appendix H — SURFACE WATER STUDY

Hunter Valley Operations South Modification 5

Surface Water Assessment

Coal & Allied Operations Pty Limited

0594-06-E8, 17 June 2016

Report Title	Hunter Valley Operations South Modification 5 Surface Water Assessment
Client	Coal & Allied Operations Pty Limited
Report Number	0594-06-E8

Revision Number	Report Date	Report Author	Reviewer
8	17 June 2016	MJB/DN	GR

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List of Abbreviations

Abbreviation	Definition
%	per cent
μs/cm	microSiemens per centimetre
AEP	Annual exceedance probability
AIP	Aquifer Interference Policy
ANZECC	Australia and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AWBM	Australian Water Balance Model
BoM	Bureau of Meteorology
CPP	Coal processing plant
D/S	Downstream
Dams Safety Act	Dams Safety Act, 1978
DECC	Department of Environment and Climate Change
DoE	Department of the Environment
DPI	Department of Primary Industries
DSC	Dam Safety Committee
DSITI	Department of Science, Information Technology and Innovation
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EL	Environmental Licence
EPBC Act	Environment Protection and Biodiversity Conservation Act, 1999
EPL	Environment Protection Licence
ESC	Erosion and Sediment Control
ESD	Ecologically sustainable development
ha	Hectares
HRSTS	Hunter River Salinity Trading Scheme
km	Kilometres
km^2	Square kilometres
L/s	Litres per second
m	Metre
mAHD	Metres above Australian Height Datum
mg/L	Milligrams per litre
MIA	Mine infrastructure area
ML	Mining Lease
ML	Megalitres

ML/day	Megalitres per day
ML/year	Megalitres per year
mm	Millimetre
MNES	Matters of National Environmental Significance
MOV	Maximum operating volumes
Mtpa	Million tonnes per annum
MWD	Mine water dam
NSW	New South Wales
NTU	Nephelometric turbidity units
OEH	NSW Office of Environment and Heritage
OPSIM	Operational Simulation Model
PoEO Act	Protection of the Environment Operations Act, 1997
ROM	Run-of-mine
RWD	Recycled Water Dam
SEARs	Secretary's Environmental Assessment Requirements
SRLUP	Strategic Regional Land Use Plan
TDS	Total Dissolved Solids
the IESC	The Independent Expert Scientific Committee
the proposed modification	The HVO South - Modification 5 proposal
TSS	Total Suspended Solids
U/S	Upstream
w/w	By Weight
Water Act	Water Act, 1912
WM Act	Water Management Act, 2000
WMP	Water Management Plan
WMS	Water Management System
WRM	WRM Water & Environment Pty Ltd
WSP	Water Sharing Plan

1 Introduction

1.1 BACKGROUND

Coal & Allied Operations Pty Limited and HVO Resources Pty Limited own the Hunter Valley Operations (HVO) mining complex, which is managed by HV Operations Pty Ltd (Coal & Allied). Coal & Allied seeks a modification to its current project approval (PA) (PA 06_0261) for its HVO South mine.

WRM Water & Environment Pty Ltd (WRM) in conjunction with HATCH, was engaged by Coal & Allied to undertake a surface water impact assessment for HVO South Modification 5 (the proposed modification).

HVO South is integrated at an operational level with HVO North (together described as 'HVO') and has the ability to move material and associated equipment around HVO including run-of-mine (ROM) coal, product coal, coal rejects, overburden and water as required. As shown in Figure 1.1, the mining and processing activities at HVO are geographically divided by the Hunter River. While HVO is managed as one operation, HVO North and HVO South each have separate planning approvals.

Mining operations first commenced at the now HVO over 65 years ago, in 1949. Since its inception, HVO has been, and will continue to be, an important economic driver in the Hunter Valley economy. It directly employees approximately 1,160 permanent staff, all of which reside in the Hunter region.

HVO South (the project area) operates under Project Approval PA 06_0261, which was granted by the then Minister for Planning on 24 March 2009, under Part 3A of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The original approval has been modified on four occasions, predominately relating to administrative matters. The mine is within the Singleton local government area (LGA).

HVO South comprises the Riverview Pit, Cheshunt Pit and South Lemington Pits 1 and 2, Lemington Coal Preparation Plant (LCPP) and all related mining activities and infrastructure such as overburden and tailings emplacement areas and the approved but yet to be constructed conveyor, rail, or haul road option(s) to transport product coal from LCPP to the Wambo rail spur.

HVO North operates under development consent granted on 12 June 2004 (DA 450-10-2003) (subsequent modifications were approved in August 2005, June 2006 and in March 2013).

HVO North comprises:

- Carrington Pit;
- West Pit;
- Hunter Valley Coal Preparation Plant (HVCPP);
- West Pit (Howick) Coal Preparation Plant (HCPP);
- Hunter Valley Load Point (HVLP); and
- Newdell Loading Point (NLP).

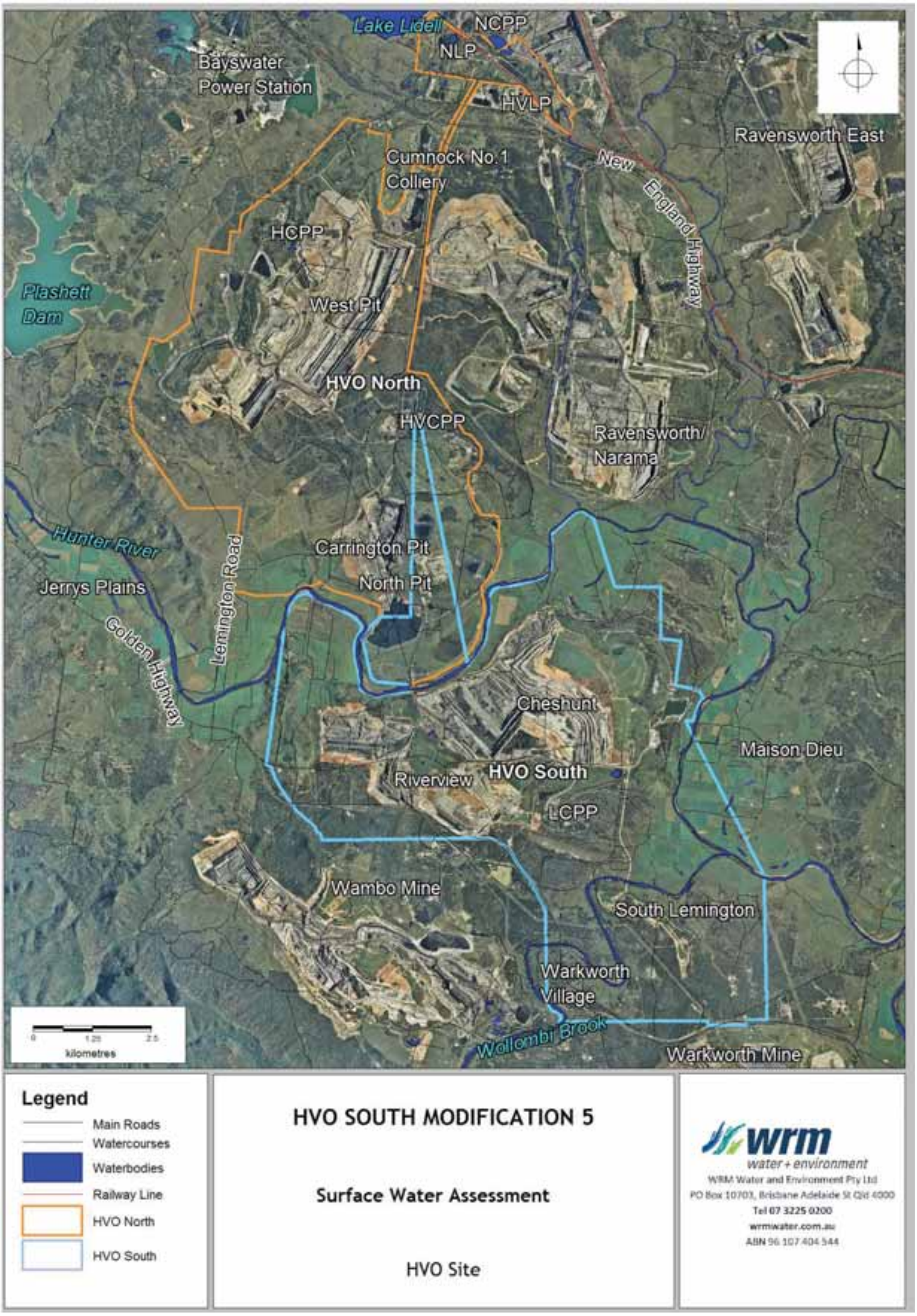

Figure 1.1 – Hunter Valley Operations

1.2 OVERVIEW OF THE PROPOSED MODIFICATION

Modification to the Hunter Valley Operations South (HVO South) project approval PA 06_0261 (PA 06_0261) is required to enable the implementation of an efficient and flexible mine plan to meet market conditions. PA 06_0261 authorises mining in three main areas namely:

- Cheshunt Pit;
- Riverview Pit; and
- South Lemington Pits 1 and 2.

Mine sequencing at HVO South has the Cheshunt and Riverview Pits operating concurrently. The Riverview Pit is designed to extract the seams down to the base of the Bowfield. Cheshunt Pit which is approved to the base of the Bayswater seam is designed to advance through the mined areas in Riverview Pit, stepping up from the deeper Bayswater seam to extract the seams from below the Bowfield seam, including the Vaux seam. South Lemington Pits are mined separately to Cheshunt and Riverview and are approved to mine to the base of the Bowfield seam.

The proposed modification will enable the Cheshunt Pit to continue mining through the Riverview area extracting the deeper Bayswater seam below the Vaux seam. The proposed modification will also enable mining down to the Vaux seam below the Bowfield seam in South Lemington Pit 2. Mining of the deeper seams will occur within the existing approved disturbance footprint.

The mining of the deeper seams will require a revision to HVO South's overburden emplacement strategy. The overburden emplacement strategy requires an increase in dump height in some areas and provides the opportunity to develop a more natural landscape into the post mining landform design using micro-relief design techniques. The change in the mine design also moves the evaporative basin in the void further from the Hunter River.

The proposed modification also seeks to increase the rate of extraction and processing from 16 Million tonnes per annum (Mtpa) to 20 Mtpa of ROM coal during peak production. This will provide HVO South with flexibility for production interactions with HVO North to meet changing market conditions.

The application to modify PA 06_0261 is to allow:

- the progression of mining to the base of the deeper Bayswater seam from Cheshunt Pit into Riverview Pit and mining to the base of the Vaux seam below the Bowfield seam in South Lemington Pit 2;
- a modification to the currently approved overburden emplacement strategy to enable an increase in height in some areas to approximately 230mAHD and incorporation of micro-relief to provide a more natural final landform;
- an increased rate of extraction from 16Mtpa to 20Mtpa ROM coal at peak production and an increased processing rate of coal extracted from HVO South from 16Mtpa to 20Mtpa of ROM coal across HVO coal preparation plants (CPPs); and
- the update of the Statement of Commitments within PA 06_0261 with removal of commitments that are redundant or inconsistent with measures prescribed in approved management plans. This includes the transition from prescriptive blasting conditions and replacement with contemporary outcome based conditions.

The proposed modification will not change the approved footprint of disturbance, mining method, employee numbers, integrated tailings and water management across HVO or extend the project approval period.

The components listed above are taken collectively to form the modification. This is the fifth modification of PA 06_0261 and therefore the proposal is named 'HVO South - Modification 5' which is referred to herein as the 'proposed modification'.

1.3 STUDY METHODOLOGY AND DOCUMENT STRUCTURE

This study has been prepared to assess the potential surface water impacts from the proposed modification and to develop measures that would avoid, minimise and monitor potential impacts.

This report contains a further eight sections:

- Section 2 provides a description of the regulatory framework relevant to this assessment;
- Section 3 provides a description of the existing surface water environment;
- Section 4 provides an overview of the existing site water management system;
- Section 5 provides an overview of the proposed site water management strategy and infrastructure;
- Section 6 presents the results of the assessment of the proposed water management system;
- Section 7 details the proposed management, mitigation and monitoring strategies for the proposed modification; and
- Section 8 summarises the conclusions of the assessment.
- Section 9 is a list of references.

As the proposed modification does not change the approved disturbance footprint and existing flooding regime, the results of previous flooding studies (ERM 2008) are not repeated and remain applicable.

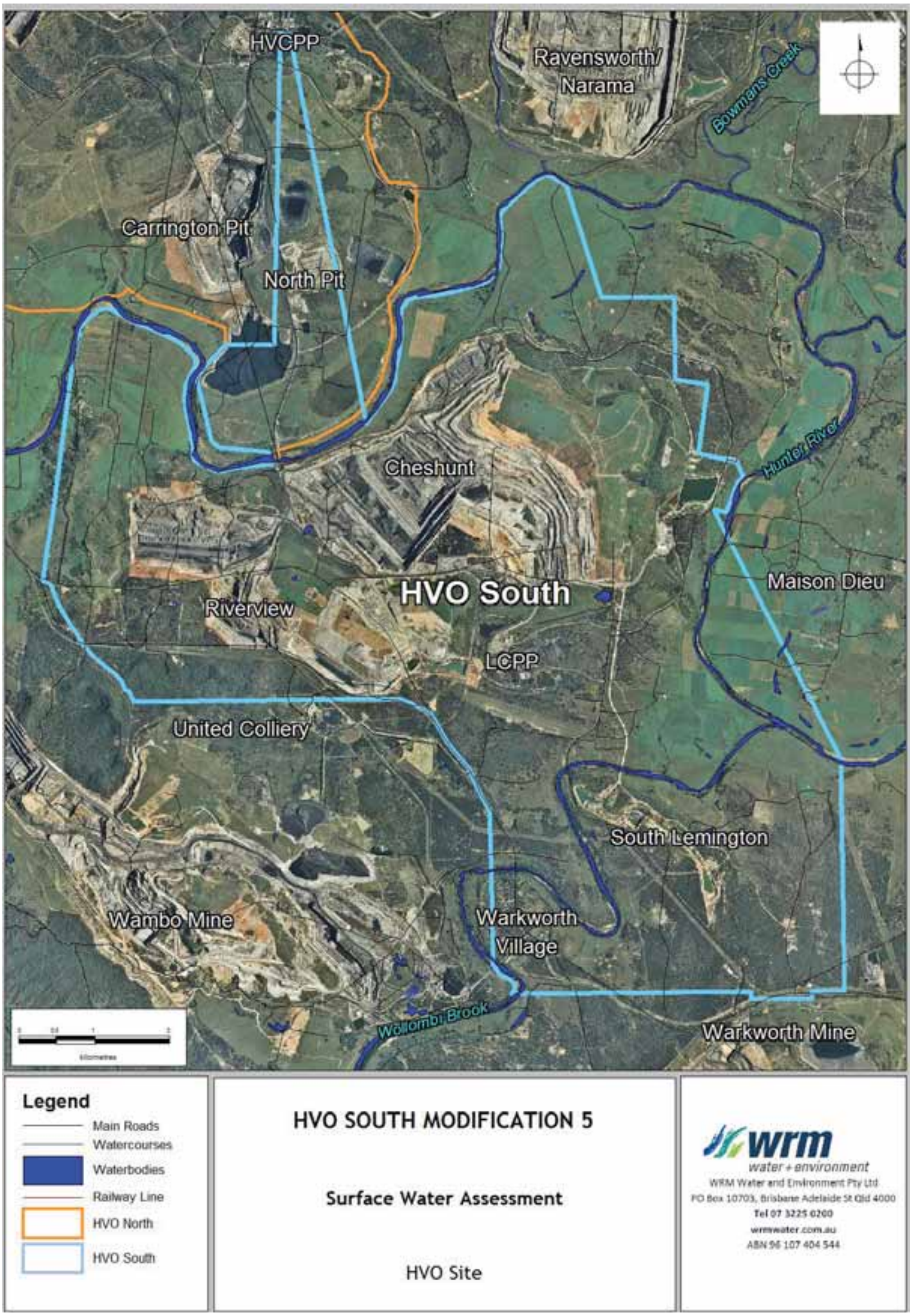

Figure 1.2 – Hunter Valley South Modification 5 project area

2 Assessment requirements and regulatory framework

2.1 OVERVIEW

The following NSW legislation, plans, policies and regulations are potentially relevant to the proposed modification for surface water management:

- Strategic Regional Land Use Policy (SRLUP), which considers potential impacts on agricultural land;
- *Water Management Act 2000 (*WM Act), *Water Act 1912* (Water Act) and associated water sharing plans (WSP), which relate to the sustainable management of water resources;
- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment Conservation Council [ANZECC] and the Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) and the NSW Government Water Quality and River Flow Objectives, which provide information on the environmental values of receiving waters and the definition of protection level based on ecosystem condition;
- *Dams Safety Act 1978* (Dams Safety Act), which relates to the design, construction, monitoring and management requirements of any prescribed dams on the site or in the surrounding area;
- *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries*, (Department of Environment and Climate Change [DECC], 2008) and *Managing Urban Stormwater, Soils and Construction*, (Landcom, 2004), which provide guidelines on suitable management measures for erosion and sediment control; and
- *Protection of the Environment Operations Act 1997* (POEO Act), which relates to the minimisation of pollution from the mine water management systems and discharge criteria.

The design of infrastructure for the proposed modification has considered the requirements of the above legislation, plans, policies and regulations. Further discussion on the regulatory framework with respect to surface water is provided in the following sections.

2.2 STRATEGIC REGIONAL LAND USE POLICY

The SRLUP aims to identify, map and protect valuable residential and agricultural land from the impacts of mining. The proposed modification is located within areas previous disturbed by mining operations and will not affect strategic agricultural land or equine and viticulture critical industry clusters.

2.3 WATER MANAGEMENT ACT 2000 & WATER ACT 1912

The Water Act and WM Act establish licensing regimes for the management of water resources in NSW. The licensing and approvals provisions of the WM Act apply to water sources that are the subject of a WSP. The Water Act continues to apply to water sources that are not the subject of a WSP.

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides for four types of approval:

- water use approval – which authorises the use of water at a specified location for a particular purpose, for up to 10 years;
- water management work approval;
- controlled activity approval; and
- aquifer interference activity approval – which authorises the holder to conduct activities that affect an aquifer such as approval for activities that intersect groundwater, other than water supply bores and may be issued for up to 10 years.

The HVO South operations have been approved under Part 3A of the *Environmental Planning and Assessment Act 1997* (EP&A Act). In accordance with Division 2 of the Water Management (General) Regulation 2011, some water use, water management work and controlled activity approvals are therefore not required.

With respect to the Act, the proposed modification is located within the Hunter Regulated River and Hunter Unregulated Alluvial Water Sources.

2.3.1 Aquifer interference activity approvals

For aquifer interference activities, the WM Act requires that the activities avoid or minimise their impact on the water resource and land degradation, and where possible the land must be rehabilitated. The Aquifer Interference Policy (AIP) (Department of Primary Industries Water [DPI Water], 2012) states that a water licence is required for the aquifer interference activity regardless of whether water is taken directly for consumptive use or incidentally. Activities may induce flow from adjacent groundwater sources or connected surface water. Flows induced from other water sources also constitute take of water. In all cases, separate access licences are required to account for the take from all individual water sources. Further information on the AIP is provided in the Groundwater study (AGE, 2016).

2.3.2 Water Sharing Plan for the Hunter Regulated River Water Source

The Hunter Regulated River Water Source drains an area of approximately 17,500km^2. The river is regulated from Glenbawn Dam to Maitland, a distance of about 250 kilometres. Glennies Creek is regulated by Glennies Creek Dam, which also provides water to the lower reaches of the Hunter River.

HVO has a combined total high security entitlement of 4,665 Units, which is equivalent to 4,665ML per year assuming full allocation. Coal & Allied will ensure that it holds the required licences for the operations.

2.3.3 Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

The Hunter Unregulated and Alluvial Water Sources Sharing Plan (HUAWSP) covers 39 water sources, nine of which are further sub-divided into management zones.

Parts of the project area are contained within the Lower Wollombi Brook and Jerrys Management Zones of the Hunter Extraction Management Unit (EMU).

The total licensed water entitlement within the Jerrys Management Zone has a share component of 10,278ML/year. The majority of this entitlement (76 per cent) is currently categorised for industrial purposes with the remainder used for irrigation purposes.

The total licensed surface water entitlement within the Lower Wollombi Brook Management Zone is 6,663ML/year. The majority of this entitlement (88 per cent) is currently categorised for irrigation purposes, with 10 per cent used for industrial purposes.

2.3.4 Excluded works

Schedule 5 of the Water Management (General) Regulation 2011 provides a number of exemptions for requiring a water access licence for taking water from a water source. Schedule 1 lists a number of exemptions, two of which potentially apply to this proposed modification:

> Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice to prevent the contamination of a water source, that are located on a minor stream.
>
> Dams solely for the control or prevention of soil erosion:
>
> a. from which no water is reticulated (unless, if the dam is fenced off for erosion control purposes, to a stock drinking trough in an adjoining paddock) or pumped, and
> b. the structural size of which is the minimum necessary to fulfil the erosion control function, and
> c. that are located on a minor stream.

All streams potentially diverted by the proposed modification are 2nd order and below. On this basis, all water captured in the site water management system is considered to be exempt from licencing requirements.

Given that the disturbance area for the project area does not extend beyond the existing approved disturbance areas, no additional water entitlements are expected to be required for surface water interception.

2.4 AUSTRALIAN AND NEW ZEALAND GUIDELINES FOR FRESH AND MARINE WATER QUALITY

The ANZECC and ARMCANZ have prepared a guideline for water quality management for use throughout Australia and New Zealand based on the philosophy of ecologically sustainable development (ESD). The guideline is called the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000) and is referred to as the 'ANZECC guideline'.

The former NSW Department of Environment and Climate Change and Water (now the Office of Environment and Heritage [OEH]) published online the *NSW Water Quality and River Flow Objectives* that provide guidance to technical practitioners in applying the ANZECC guidelines in NSW. The guideline defines the 'environmental values' of receiving waters as those values or uses of water that the community believes are important for a healthy ecosystem. The environmental values of the receiving waters of the Hunter River for which water quality objectives are set are regarded as:

> aquatic ecosystem;
>
> visual amenity;

- secondary contact recreation;
- primary contact recreation (assess opportunities to achieve as a longer term objective, 10 years or more);
- livestock water supply;
- irrigation water supply;
- homestead water supply;
- drinking water; and
- aquatic foods (cooked).

The ANZECC guidelines specify three levels of protection, from stringent to flexible, corresponding to whether the condition of the particular ecosystem is:

- of high conservation value;
- slightly to moderately disturbed; or
- highly disturbed.

The receiving waterways adjacent to the study area are regarded as slightly to moderately disturbed.

2.5 DAMS SAFETY ACT 1978

The Dams Safety Act establishes the role of the Dams Safety Committee (DSC) to ensure the safety of dams in NSW, including surveillance of prescribed dams, which are those listed in Schedule 1 of the Dams Safety Act. The DSC is empowered with various enabling functions under the Dams Safety Act and *Mining Act 1992*. The DSC has a general responsibility for the safety of all dams, and a special responsibility for prescribed dams. Determination of whether a dam is a prescribed dam is based on an assessment of its consequence category, which considers potential downstream impacts of dam failure.

The *Dams Safety Act 2015* was assented on 28 September 2015. The *Dams Safety Act 2015*, once fully implemented, will replace the Dams Safety Act and encourage the application of risk management and the principles of cost benefit analysis in relation to dam safety.

Two dams at HVO South (Lake James and Riverview Void) are prescribed dams.

2.6 MANAGING URBAN STORMWATER SOILS AND CONSTRUCTION

Managing Urban Stormwater: Soils and Construction (Landcom, 2004) provides guidance on best practice management measures for erosion and sediment control during construction and other land disturbance activities. *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries* (DECC, 2008) provides specific advice on appropriate measures and design standards for mining operations. The design of erosion and sediment control measures for the proposed modification will be based on the recommended approaches and design criteria from these documents.

2.7 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The POEO Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The POEO Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols and guidelines. The POEO Act also establishes a licensing regime for pollution generating activities in NSW. Under section 48, an environment protection licence (EPL) is required for “scheduled activities”, which includes coal mining. The POEO Act also includes a duty to notify relevant authorities of pollution incidents where material harm to the environment is caused or threatened.

EPL 640 is currently held for the existing HVO activities.

2.8 PROTECTION OF THE ENVIRONMENTAL OPERATIONS (HUNTER RIVER SALINITY TRADING SCHEME) REGULATION 2002

The Hunter River Salinity Trading Scheme (HRSTS) was introduced by the NSW Government to reduce salinity levels in the Hunter River, and operates under the Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002 which is subordinate legislation to the POEO Act.

Releases of mine water to the Hunter River can be made in compliance with the conditions of an EPL and in accordance with credits purchased under the HRSTS. The HRSTS limits the quantity of salt that may be discharged through a cap and trade system that also restricts discharge to periods of high flow.

Under the HRSTS, credit holders are permitted to discharge saline water to the Hunter River on a managed basis. The aim is to maintain river salinity levels below 600µS/cm at Denman and 900µS/cm at Singleton. This is achieved through:

- discharge scheduling that allows discharge only at times when the river flow and salinity level are such that salt can be discharged without breaching the salinity targets; and
- sharing the allowable discharge according to licensed holdings of tradeable salinity credits.

The discharge schedule prohibits discharges during low flow periods. Discharges are regulated in proportion to credit holdings during high flow periods and unlimited discharges are permitted during flood flow periods, subject to tributary protection limits and the overarching requirement to achieve the upper limit salinity levels at Denman and Singleton.

A total of 1,000 credits are available for allocation through the scheme. Consequently, a holding of one credit entitles the owner to discharge 0.1 per cent of the total allowable discharge (TAD) for the period.

If discharge of further excess water to the Hunter River system is required, under the scheme, credits may be obtained on a day to day basis though trade between licensed users, or, for long term use, through public auction.

Under the HRSTS, the Hunter River is separated into three sectors upstream of Singleton: Upper, Middle and Lower. HVO lies in the Middle Sector.

The water in the river is divided into numbered blocks. The scheme operators monitor the flow and salinity in each block, and calculate the TAD of salt to meet the salinity target. Credit holders are notified via a dedicated website of the TAD and the start and end times for each release.

HVO participates in the HRSTS and currently holds 145 credits, allowing it to release up to 14.5 per cent of the TAD salt tonnage during periods of ‘high’ or ‘flood’ flows in accordance within the scheme rules.

3 Existing surface water environment

3.1 REGIONAL DRAINAGE NETWORK

The regional drainage network in the area of interest is shown in Figure 3.1. The project area is located within the Hunter River catchment, approximately 24km north-west of Singleton.

The Hunter River basin has a total catchment area of approximately 22,000km^2. The project area is located to the south of the Hunter River main channel, 40km downstream of the Goulburn River confluence and 5km upstream of the Glennies Creek confluence. The Hunter River has a catchment area of approximately 13,400km^2 to the project area.

The Hunter River catchment upstream of the project area includes Glenbawn Dam (located 22km north of Muswellbrook), which commands a catchment area of 1,300km^2. Glennies Creek Dam (located 25km north of Singleton) commands a catchment area of approximately 233km^2.

Wollombi Brook flows through the project area and joins the Hunter River just downstream of the existing HVO South mining operations. The catchment area of Wollombi Brook at the confluence with the Hunter River is approximately 1,900km^2.

3.2 LOCAL DRAINAGE NETWORK

The local drainage network in the vicinity of HVO South is shown in Figure 3.2.

The local drainage network within the project area has been heavily modified by mine operations. The majority of the local catchment within the project area is captured by the mine water management system. Lake James, located adjacent to the Hunter River on the eastern side of the current mining operations, is a key mine water storage for HVO South. Lake James is the HRSTS release point for HVO South.

The natural catchments on the northern side of HVO South flow overland into the Hunter River. Redbank Creek drains the catchment to the south-west of HVO South in an easterly direction into Wollombi Brook. Comleroi Creek drains the catchment to the north-east of Redbank Creek into Wollombi Brook 2km upstream of the confluence of the Hunter River. Longford Creek drains the catchment at the southern side of the project area in a northerly direction into Wollombi Brook.

Figure 3.1 – Regional drainage overview

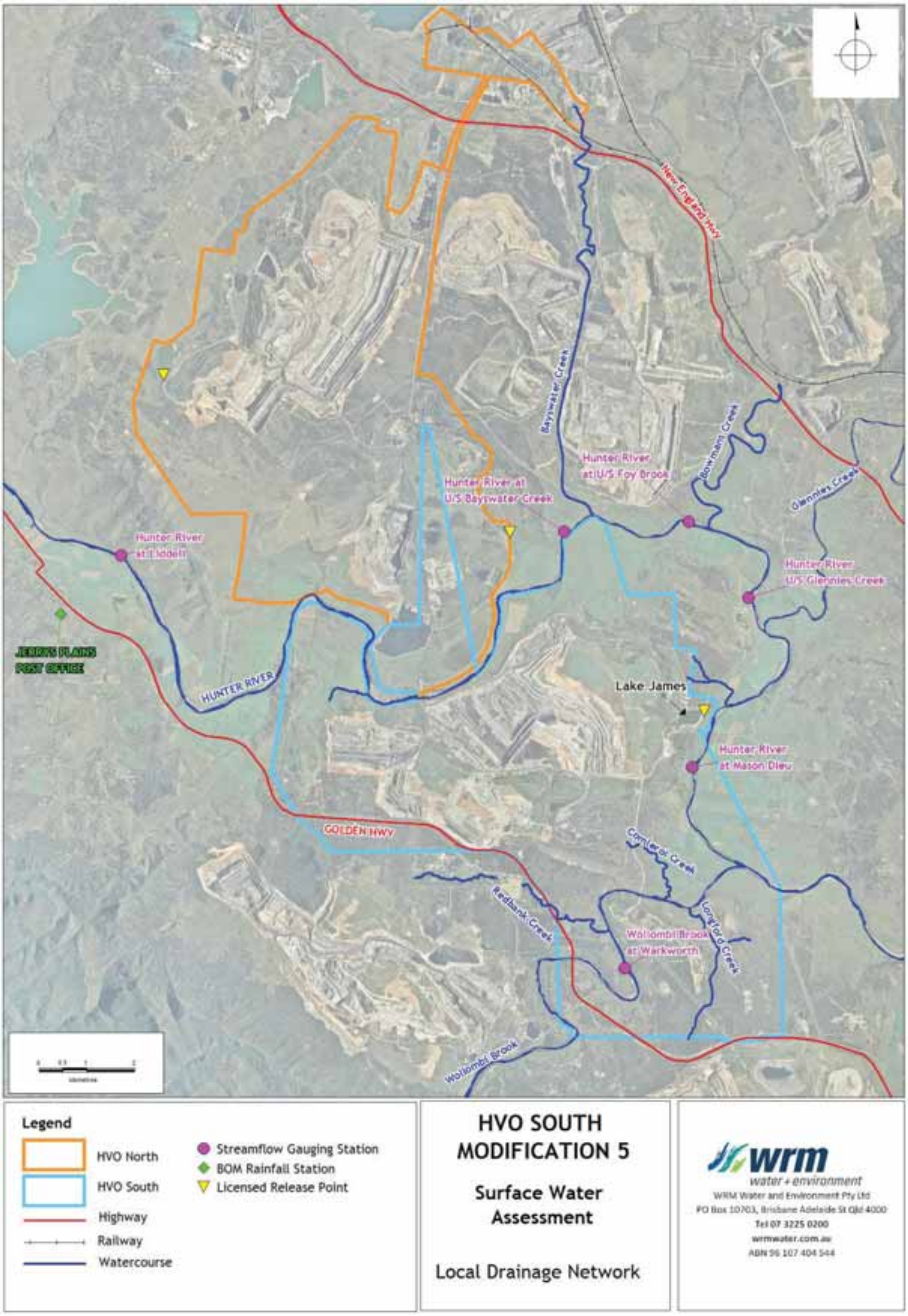

Figure 3.2 – Local drainage network

3.3 RAINFALL AND EVAPORATION

Table 3.1 shows summary details of the Bureau of Meteorology (BOM) rainfall stations. The closest long-term rainfall station is located approximately 7km from the site at Jerrys Plains Post Office (061086). Jerrys Plains Post Office rainfall station was opened in 1884 and closed in 2014. Long-term daily rainfall records are also available at Bulga (South Wambo) station (061191), located 8km from the site.

Pan evaporation has been recorded at Jerrys Plains Post Office station from 1957 to 1972.

Table 3.1 – Rainfall and evaporation station details

Station No.	Station Name	Elevation (m)	Easting (m E)	Northing (m S)	Distance from Site (km)	Opened	Closed
061050	Sedgefield (Bundajon)	73	339,014	6,402,878	23	1903	-
061086	Jerrys Plains Post Office	87	303,649	6,402,216	7	1884	2014
061092	Elderslie	45	343,613	6,392,569	29	1927	-
061130	Doyles Creek (Wood Park)	113	293,000	6,400,707	17	1920	-
061143	Bulga (Down Town)	69	314,407	6,385,352	13	1960	-
061191	Bulga (South Wambo)	80	310,098	6,389,862	8	1959	-
061309	Milbrodale (Hillsdale)	120	309,945	6,381,478	17	1963	-
061397	Singleton STP	45	328,642	6,392,662	15	2002	-
061422	Milbrodale School	88	313,460	6,380,220	18	2010	-

Rainfall statistics for the closest BOM stations are summarised in Table 3.2. Table 3.2 also provides a comparison to rainfalls from the Queensland Department of Science, Information Technology and Innovation's (DSITI's) data drill service. The data drill rainfalls are interpolated between BOM stations to provide a complete data set that eliminates missing data and accumulated daily totals (Jeffrey et al., 2001).

Mean annual rainfall in the data drill dataset is 634mm, similar to the annual average of 645mm and 667mm recorded at Jerrys Plains Post Office and Bulga (South Wambo) rainfall stations.

Annual total rainfall from data drill is plotted in Figure 3.3. Annual rainfall varies significantly from year to year, with annual totals ranging from 295mm in 1980 to 1161mm in 1950.

Table 3.3 compares the annual distribution of average monthly data drill pan evaporation to the Jerrys Plains Post Office monthly average. The two results are generally consistent.

Figure 3.4 shows the data drill monthly average rainfall and evaporation. Rainfall is relatively evenly distributed throughout the year. While average monthly pan evaporation is similar to rainfall in the winter months, it is significantly higher in the summer months (especially in December and January).

Table 3.2 – Rainfall station details

Month	Jerrys Plains Post Office (BoM 061086)	Bulga (South Wambo) (BoM 062032)	Data drill
	Rainfall (mm)	Rainfall (mm)	Rainfall (mm)
Commence	June 1884	Aug 1959	Jan 1889
End	April 2014	Nov 2015	Nov 2015
No. Years	127+	55+	126+
July	43	31	42
August	36	35	36
September	42	39	40
October	52	54	51
November	62	63	60
December	68	73	66
January	77	86	75
February	73	87	71
March	60	64	60
April	44	48	46
May	41	42	40
June	48	44	48
Annual	**646**	**666**	**635**

Source: BOM and SILO (mm = millimetres)

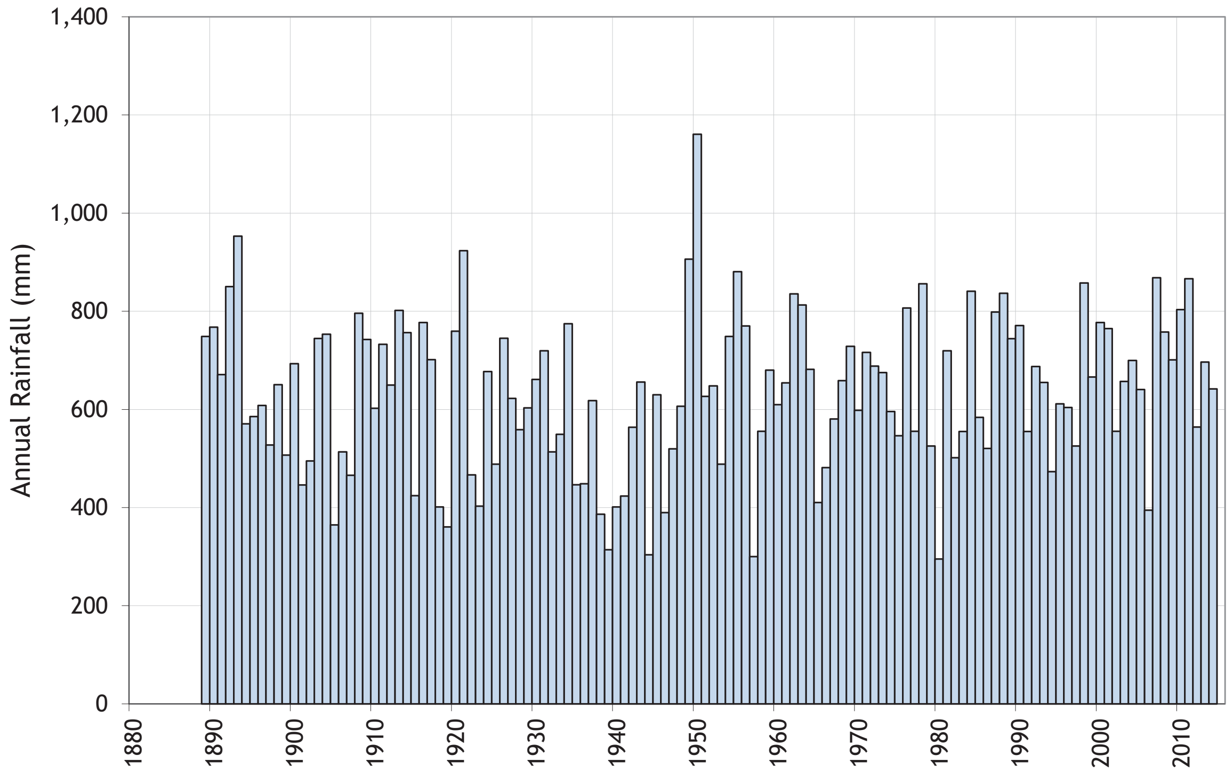

Figure 3.3 – Annual rainfall totals (data drill)

Table 3.3 – Comparison of mean monthly pan evaporation (data drill/Jerrys Plains)

Month	data drill Pan Evap (mm/month)	Jerrys Plains Post Office Pan Evap (mm/month)
July	62	71
August	87	81
September	118	111
October	155	164
November	180	195
December	210	205
January	207	220
February	162	170
March	144	155
April	104	120
May	71	90
June	53	60
Annual	**1,553**	**1,642**

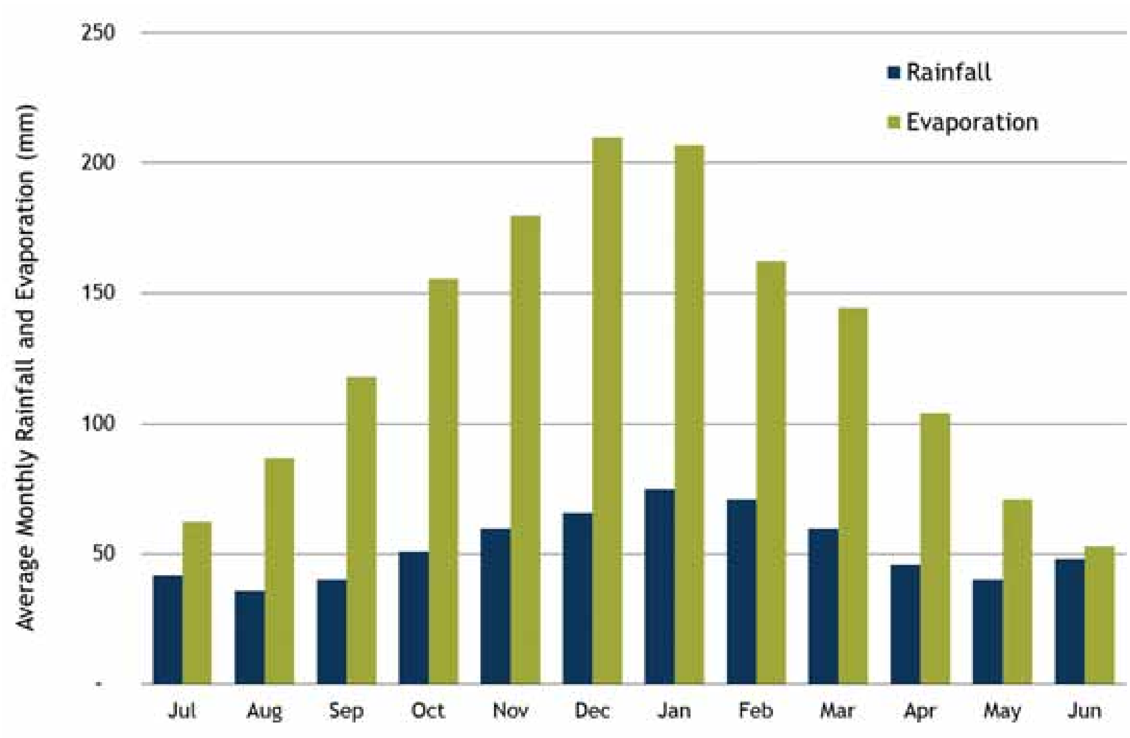

Figure 3.4 – Average monthly rainfall and pan evaporation (data drill)

3.4 STREAMFLOW

Figure 3.2 shows the locations of the DPI Water stream gauging stations in the vicinity of HVO South. Table 3.4 shows the details of these stream gauging stations.

Table 3.4 - Streamflow monitoring site details

Station No.	Station Name	Elevation (m)	Easting (m E)	Northing (m S)	Distance from Site (km)	Opened	Catchment Area (km^2)
210004	Wollombi Brook at Warkworth	59.0	315,355	6,394,850	4	20/02/1908	1,848
210083	Hunter River at Liddell	177.1	304,905	6,403,439	5	05/09/1969	13,400
210125	Hunter River at Upstream Bayswater Creek	67.3	314,103	6,403,924	3	13/04/1994	13,448
210126	Hunter River at Upstream Foy Brook	67.1	316,685	6,404,139	4	28/10/1993	13,589
210127	Hunter River Upstream Glennies Creek	66.0	317,927	6,402,557	3	23/06/1993	13,855
210128	Hunter River at Mason Dieu	58.9	316,756	6,399,030	3	30/07/1993	14,394

3.4.1 Hunter River

The streamflow station Hunter River at Liddell (210083) is located 5km upstream of HVO South. The gauge has been operating since 1969, and has a catchment area of approximately 13,400km^2.

The water levels and streamflow recorded in the Hunter River at Liddell over the period of record are shown in Figure 3.5. The highest recorded water level and discharge at this gauging station are 15.48m in February 1971 and 385,652ML/day in June 2007 respectively.

Figure 3.6 shows the Hunter River at Liddell flow frequency curve. The flow frequency curve shows the percentage of time that a flow exceeds a certain rate. The daily streamflow has exceeded 83ML/day for 90 per cent of the flow record, and median daily flow is over 250ML/day for all years of data. Hunter River flows at this station are regulated by Glenbawn Dam.

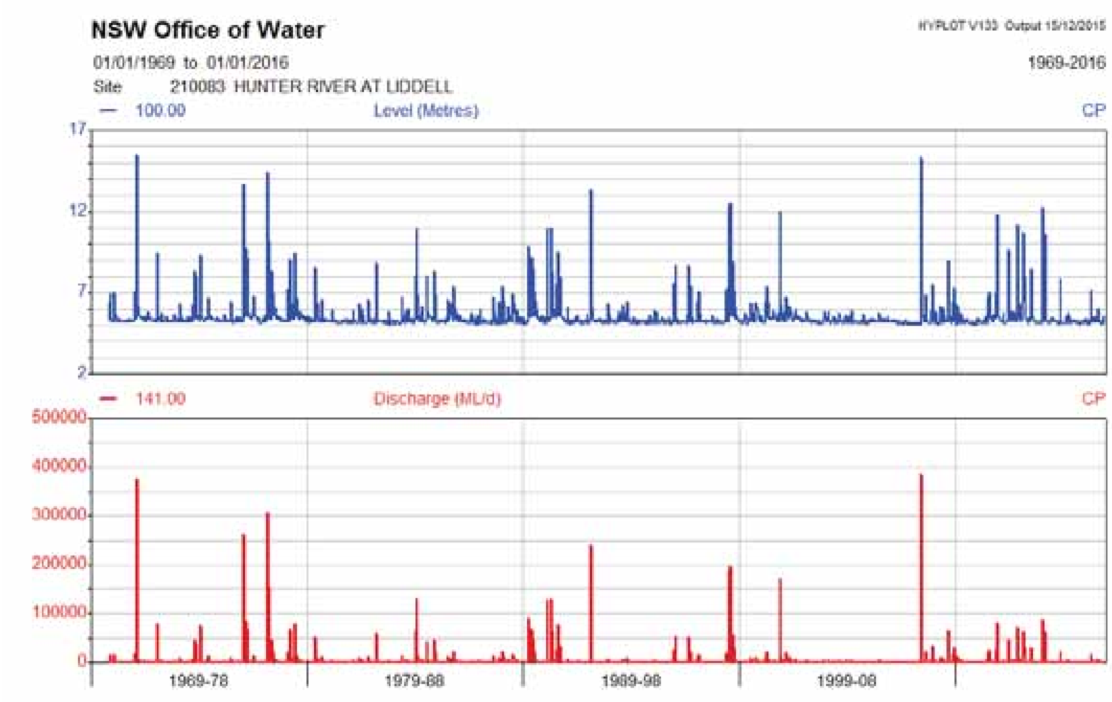

Figure 3.5 – Recorded water levels and streamflow – Hunter River at Liddell (Source: DPI)

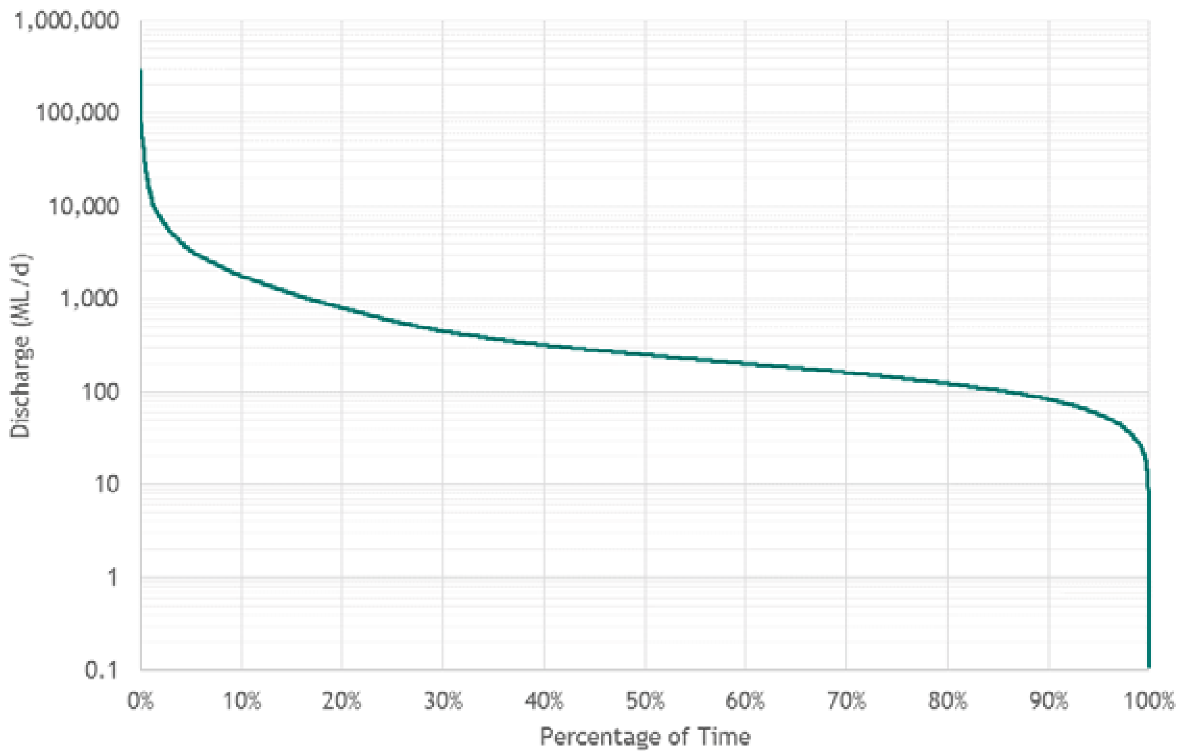

Figure 3.6 – Flow frequency curve – Hunter River at Liddell (210083)

3.4.2 Wollombi Brook

The streamflow station Wollombi Brook at Warkworth (210004) is located near the southern boundary of HVO South and upstream of the confluence of the Hunter River. The gauge has been operating since 1908 and has a catchment area of approximately 1,848km^2.

The water levels and streamflow recorded in the Wollombi Brook at Warkworth are shown in Figure 3.7. The highest recorded water level and discharge at this gauging station occurred in February 1955 at 10.14m and 394,000ML/day.

Figure 3.8 shows the flow frequency curve in Wollombi Brook at Warkworth (210004). The daily streamflow has exceeded 2.5ML/day for 80 per cent of the flow record, and median daily flow is over 38ML/day. Wollombi Brook flows are not regulated.

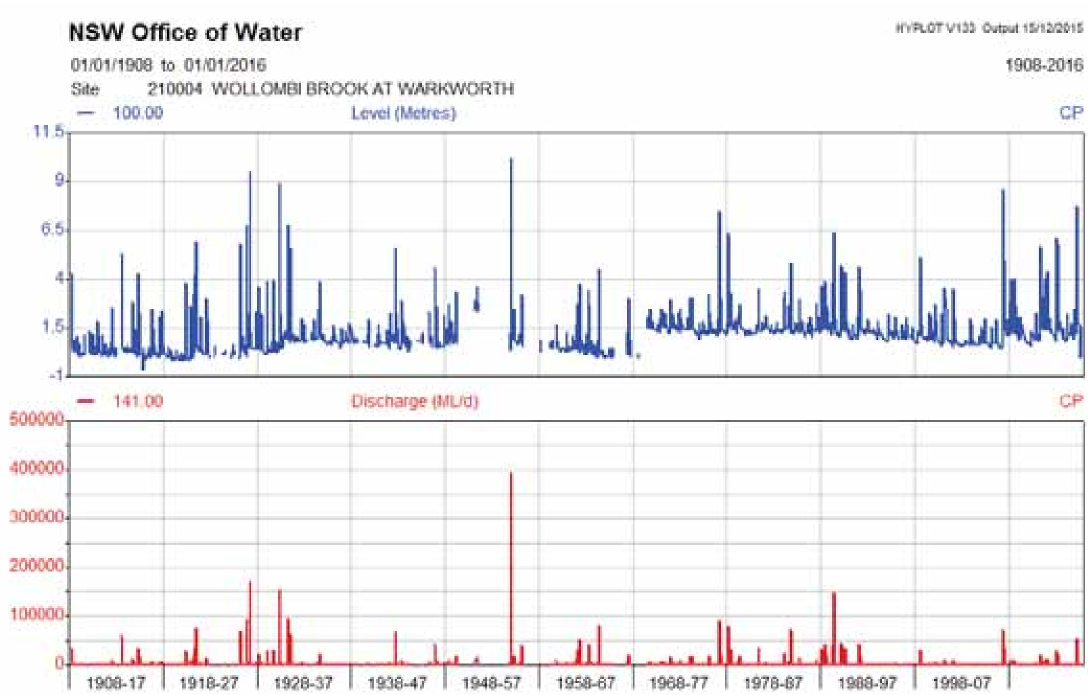

Figure 3.7 – Recorded water levels and streamflow – Wollombi Brook at Warkworth (Source: DPI)

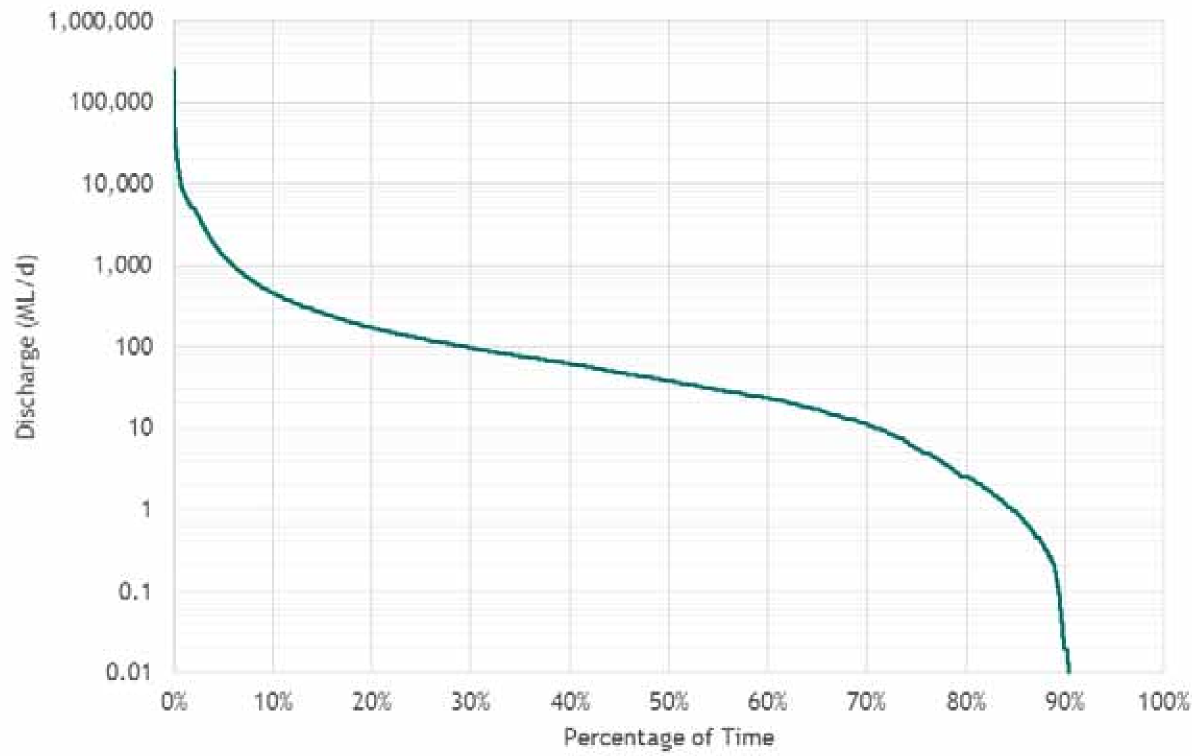

Figure 3.8 – Flow frequency curve – Wollombi Brook at Warkworth (210004)

3.5 SURFACE WATER QUALITY

3.5.1 Overview

A water quality monitoring program has been implemented since 1992 on-site dams and receiving waters at HVO. Figure 3.9 shows the monitoring locations. Water quality statistics for the Hunter River, Wollombi Brook and HVO dams are summarised in the following sections. Water quality statistics for other tributaries at HVO are shown in Appendix A.

For comparison, the tables in the relevant sections also include the NSW water quality objectives for 'Protection of Aquatic Ecosystems' which provides a framework for water quality assessment and management. Exceedances of the guideline water quality objectives (WQOs) can be as a result of natural catchment conditions and/or land use modification (including mining and non-mining related changes).

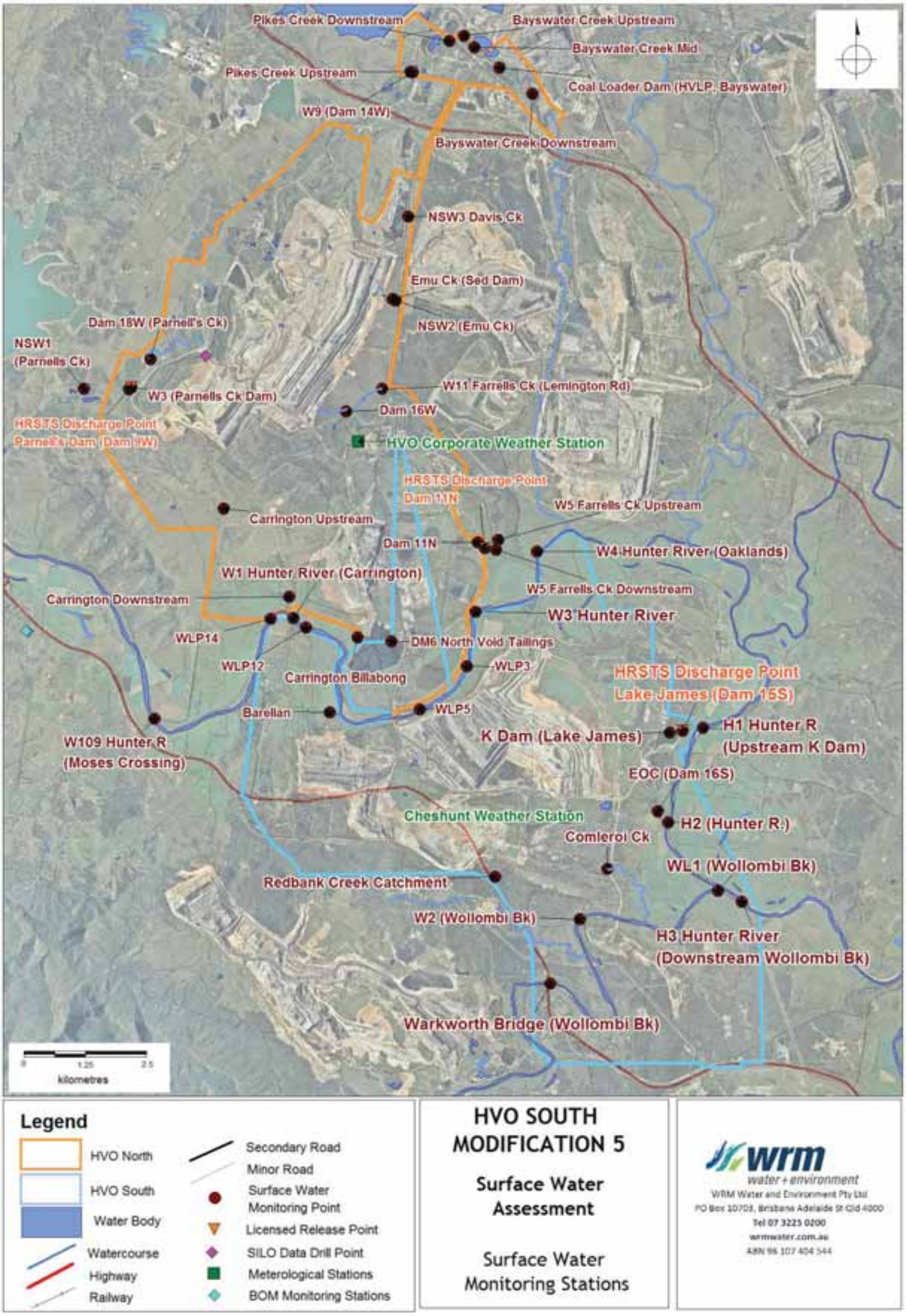

Figure 3.9 – Surface water monitoring stations

3.5.2 Hunter River

The Hunter River flows between HVO North and HVO South. Since 2001, water quality samples have been collected at seven locations (shown in Figure 3.9) from upstream of HVO (W109) to downstream of Wollombi Brook (H3).

The graphs below show the 20th percentile, median and 80th percentile water quality results for key parameters along the reach of the Hunter River adjacent to the project area. Controlled releases from HVO South are discharged from Lake James to the river between H1 and H2. Wollombi Brook joins the Hunter River between H2 and H3.

As shown in Figure 3.10, median pH values along the Hunter River are relatively similar (8.2 to 8.3) with a slight reduction in pH (median of 8.0) observed downstream of Wollombi Brook.

A plot of electrical conductivity (EC) along the Hunter River adjacent to the project area (Figure 3.11) indicates no adverse impact from HVO South releases to the river. Downstream EC values are slightly lower than EC further upstream. Similarly for sulphate (Figure 3.12) and TSS (Figure 3.13), the water quality data indicates no adverse impact on water quality, with downstream values similar to or lower than upstream values.

A summary of water quality data from the two nearest monitoring locations upstream and downstream of the HVO South discharge point is shown in Table 3.5. The pH value has the same median of 8.2 both upstream and downstream. The sulphate and total suspended solids (TSS) 80th percentile values decrease slightly downstream of the discharge point. Impacts on EC are very small, with an increase of less than 2 per cent.

Table 3.5 - Hunter River water quality upstream and downstream of HVO South discharge point

Location	Value	EC Field (µS/cm)	pH Field	Sulphate (mg/L)	TSS (mg/L)
H1 (Upstream of discharge point)	Min	310	5.5	36	282
	Max	1,180	9.1	60	666
	20%ile	486	7.9	36	2912
	Median	630	8.2	37	459
	80%ile	782	8.4	51	638
	No. of Samples	80	80	3	4
H2 (Downstream of discharge point)	Min	320	7.2	12	240
	Max	1,200	8.8	80	671
	20%ile	498	7.9	25	277
	Median	640	8.2	33	374
	80%ile	800	8.4	40	633
	No. of Samples	100	99	15	6
NSW WQO for lowland rivers		125 - 2,200	6.5 - 8.5		

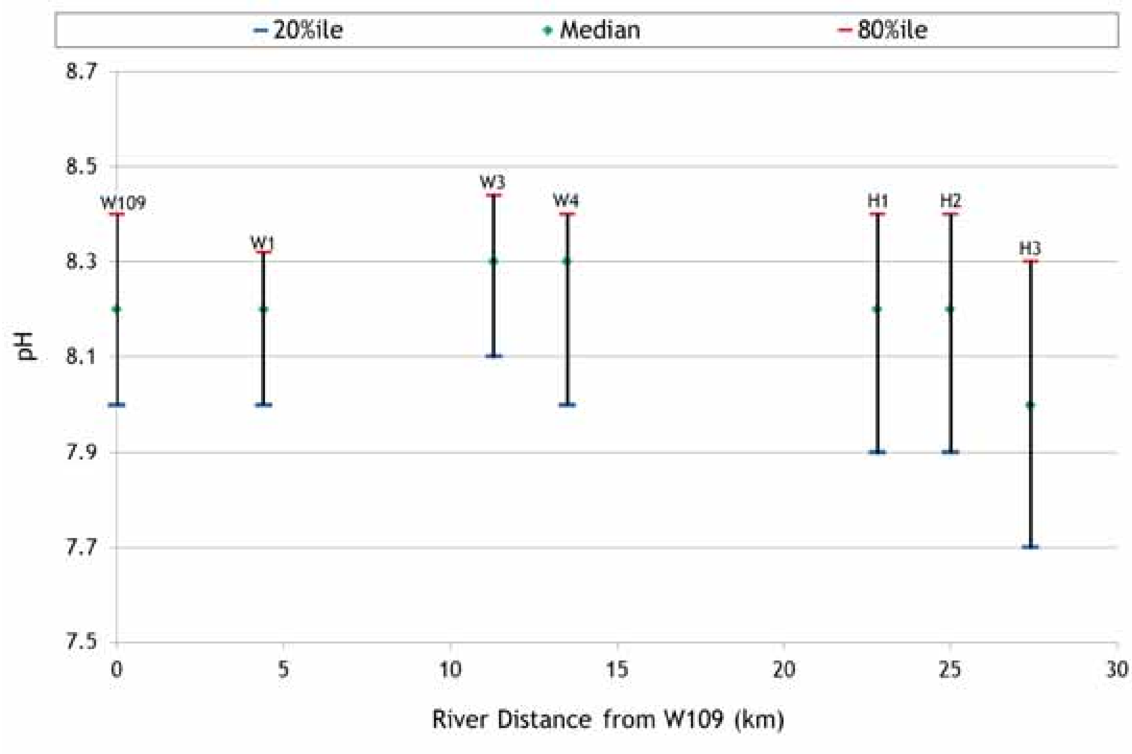

Figure 3.10 – pH along Hunter River

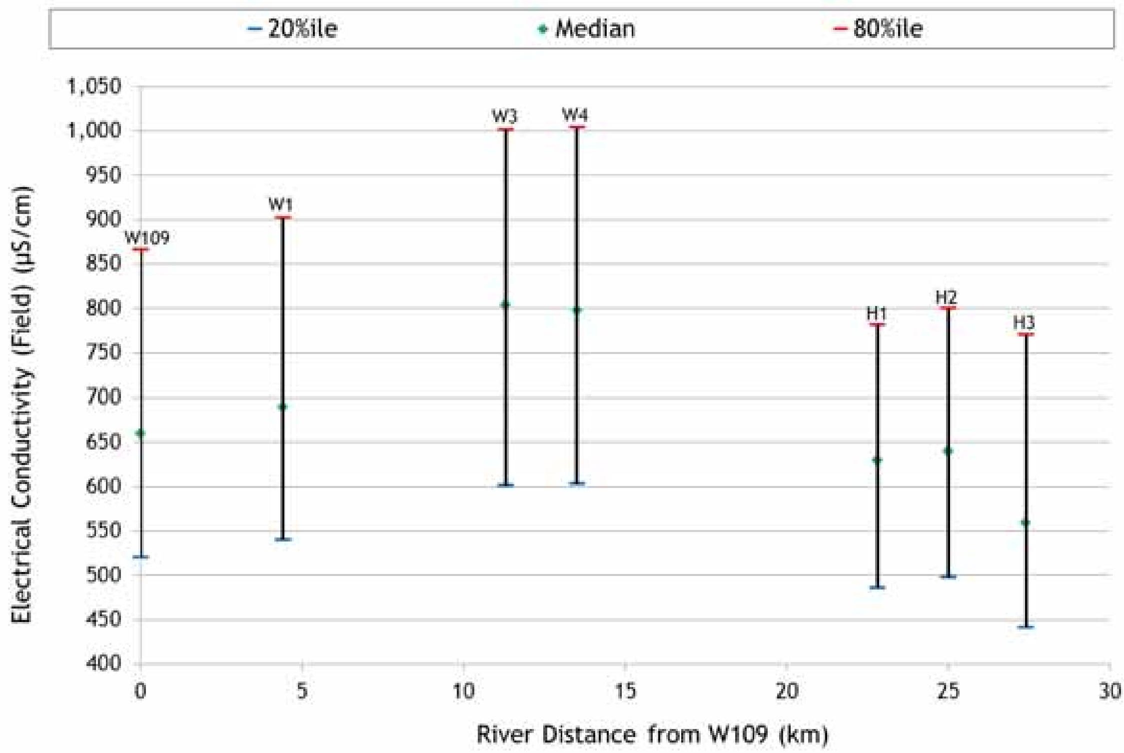

Figure 3.11 – EC along Hunter River

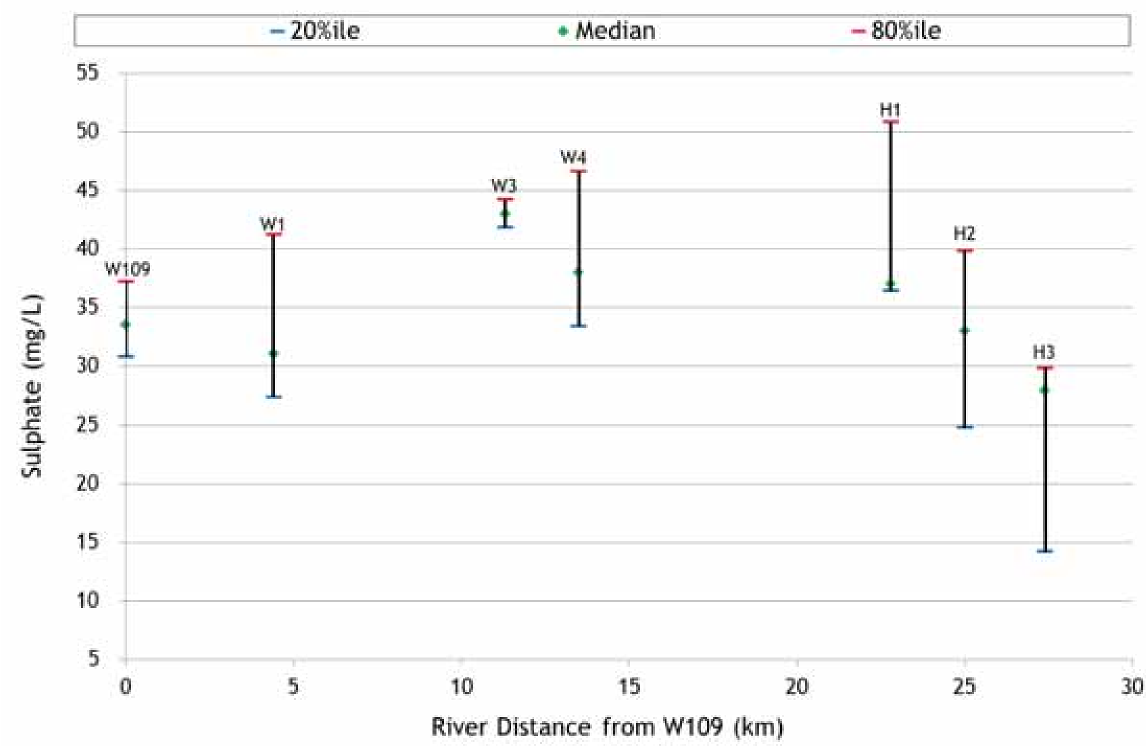

Figure 3.12 – Sulphate along Hunter River

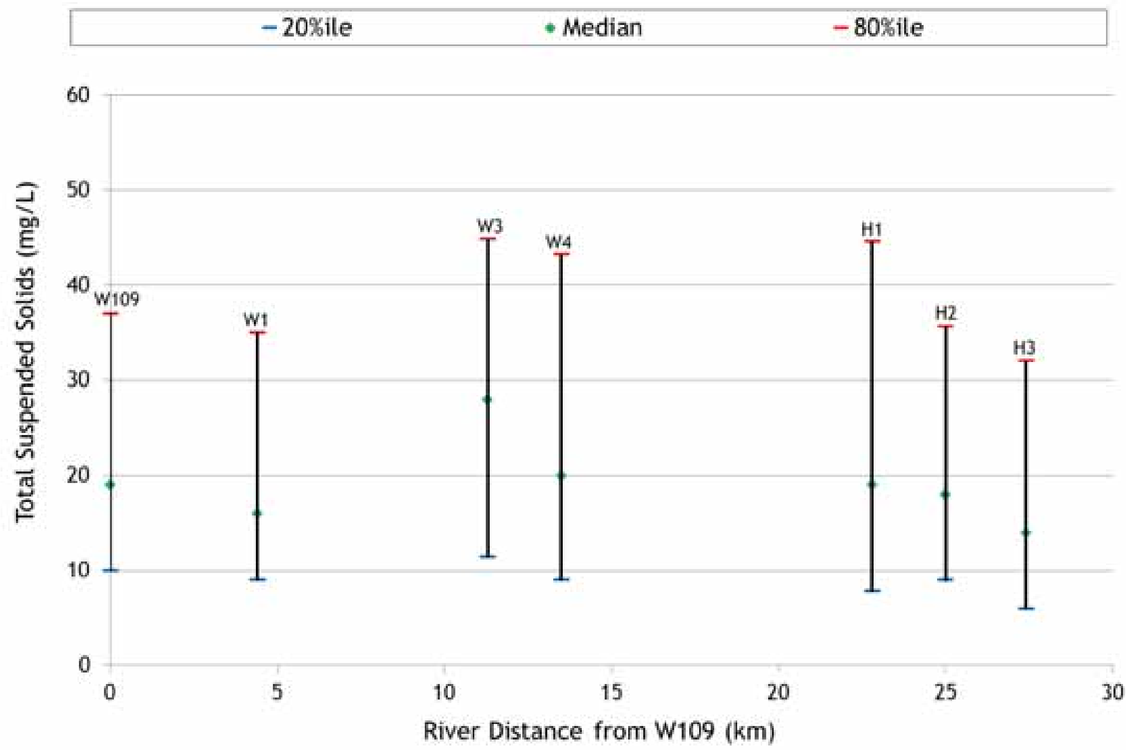

Figure 3.13 – TSS along Hunter River

Figure 3.14, Figure 3.15 and Figure 3.16 show a time series of recorded data for pH, EC and TSS respectively.

pH is typically within the range of the NSW WQOs.

EC is less than the WQO of 2,200µS/cm at all monitoring locations and less than the HRSTS salinity target of 900µS/cm most of the time.

The 80th percentile TSS varies between 32mg/L and 45mg/L at the different monitoring locations, with the highest occurring at W3 and the lowest at H3.

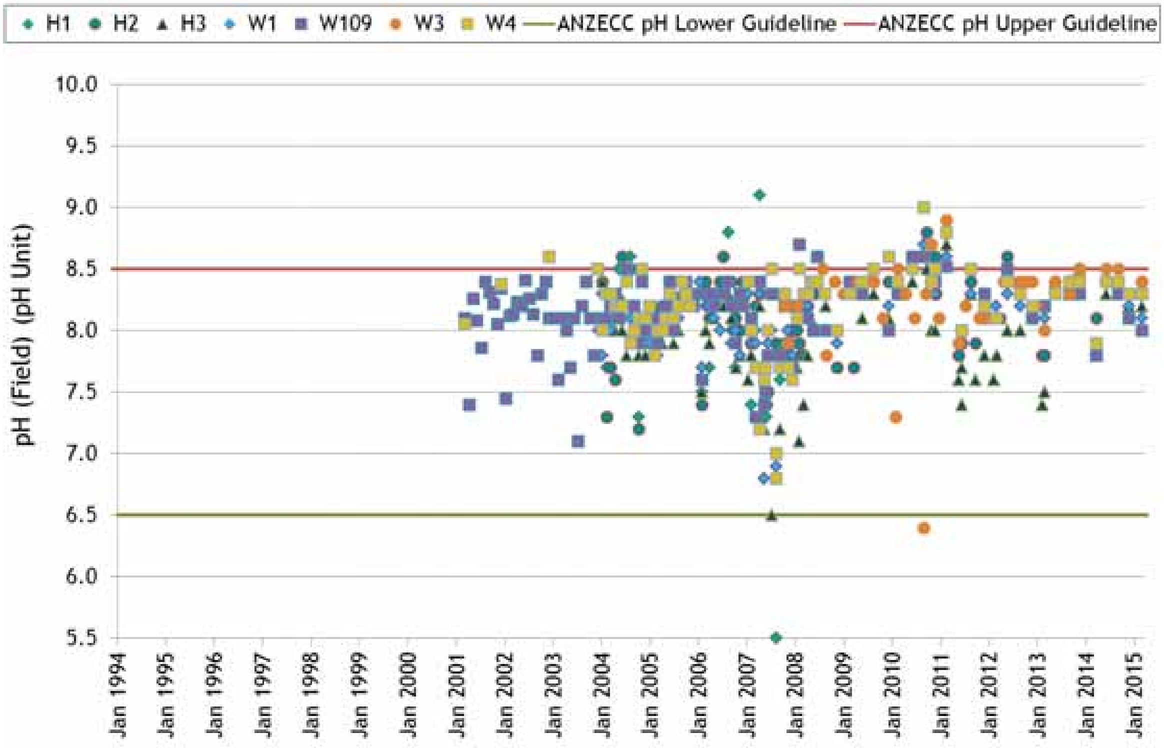

Figure 3.14 – pH - Hunter River

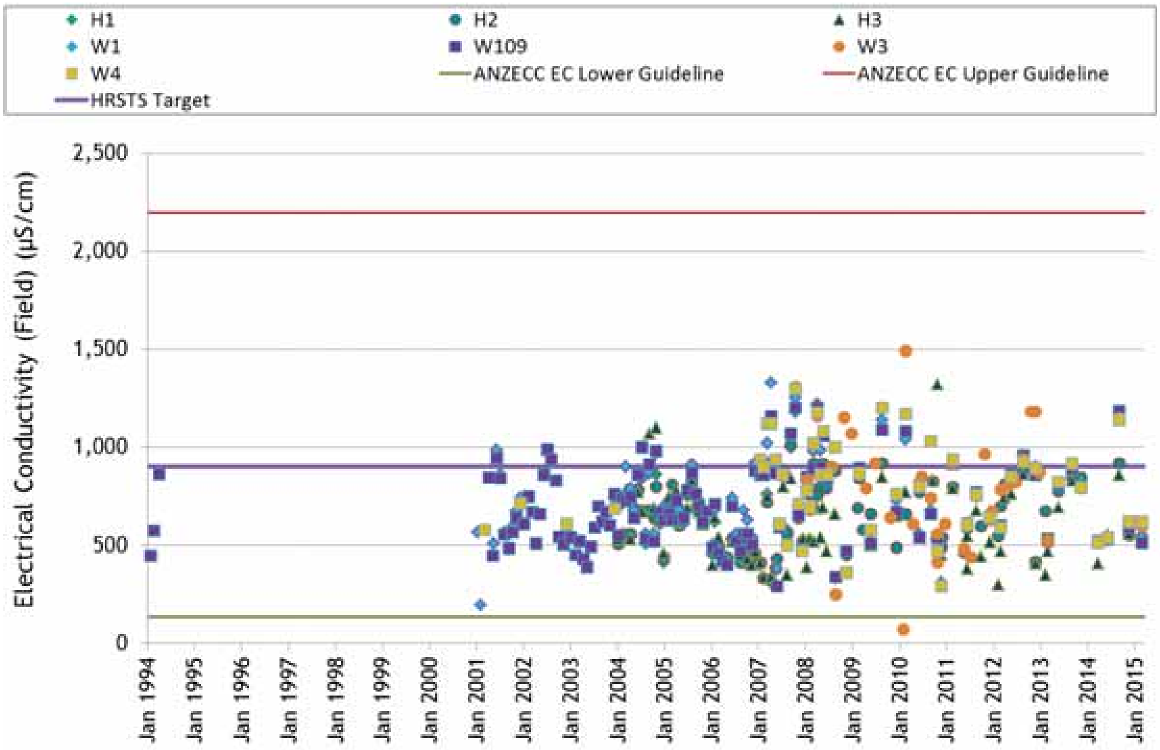

Figure 3.15 – EC - Hunter River

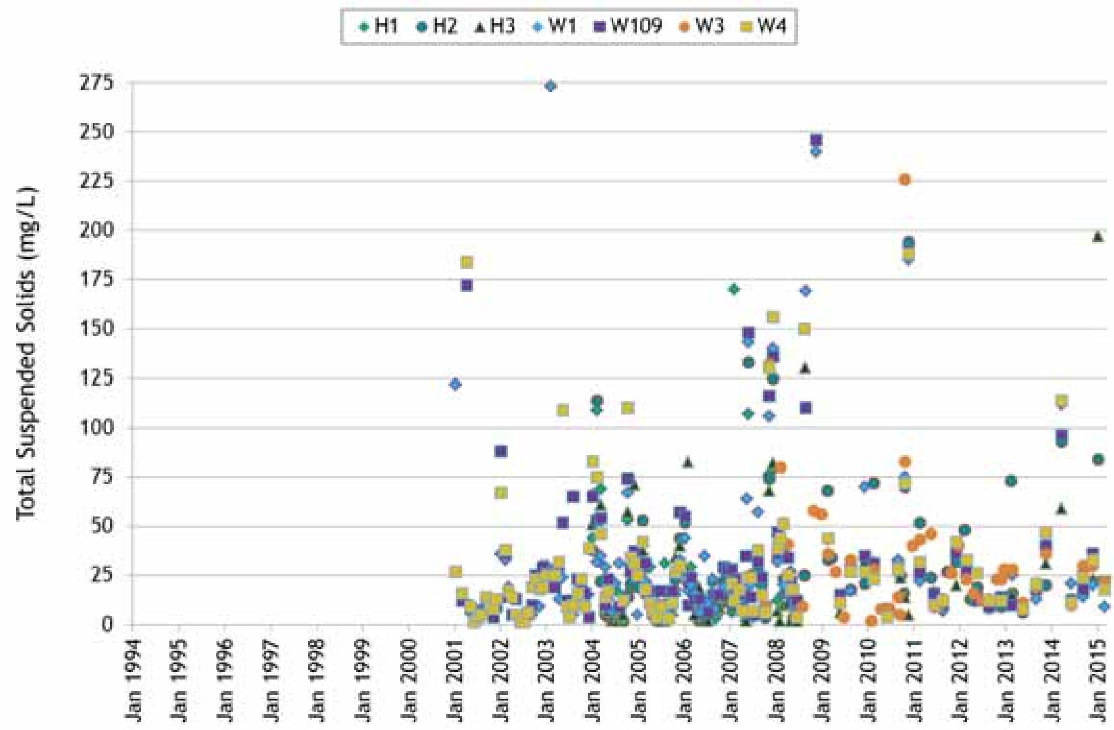

Figure 3.16 – TSS - Hunter River

3.5.3 Wollombi Brook

Table 3.6 shows the statistics of water quality samples collected in Wollombi Brook since 2004. Runoff from minor local catchments along the southern side of HVO South enters Wollombi Brook between the upstream and downstream monitoring locations. Time series of key water quality parameters are plotted in Figure 3.17, Figure 3.18, and Figure 3.19.

The Wollombi Brook water quality data indicates no significant deterioration in water quality along the monitored reach.

Table 3.6 – Wollombi Brook water quality data

Monitoring Site	Value	EC Field (µS/cm)	pH Field	Sulphate (mg/L)	TSS (mg/L)
Upstream (W2 and Warkworth Bridge)	Min	105	6.4	6	2
	Max	2,610	8.4	128	258
	20%ile	374	7.2	8	3
	Median	640	7.6	12	5
	80%ile	1,132	8.0	23	13
	No. of Samples	74	74	17	55
Downstream (W1)	Min	107	6.8	6	2
	Max	2,480	8.5	32	280
	20%ile	426	7.5	8	4
	Median	588	7.8	15	9
	80%ile	813	8.1	23	22
	No. of Samples	80	80	9	71
NSW WQO for lowland rivers		125 – 2,200	6.5 - 8.5		

NTU = Nephelmetric Turbidity Units and mg/L = milligrams per litre

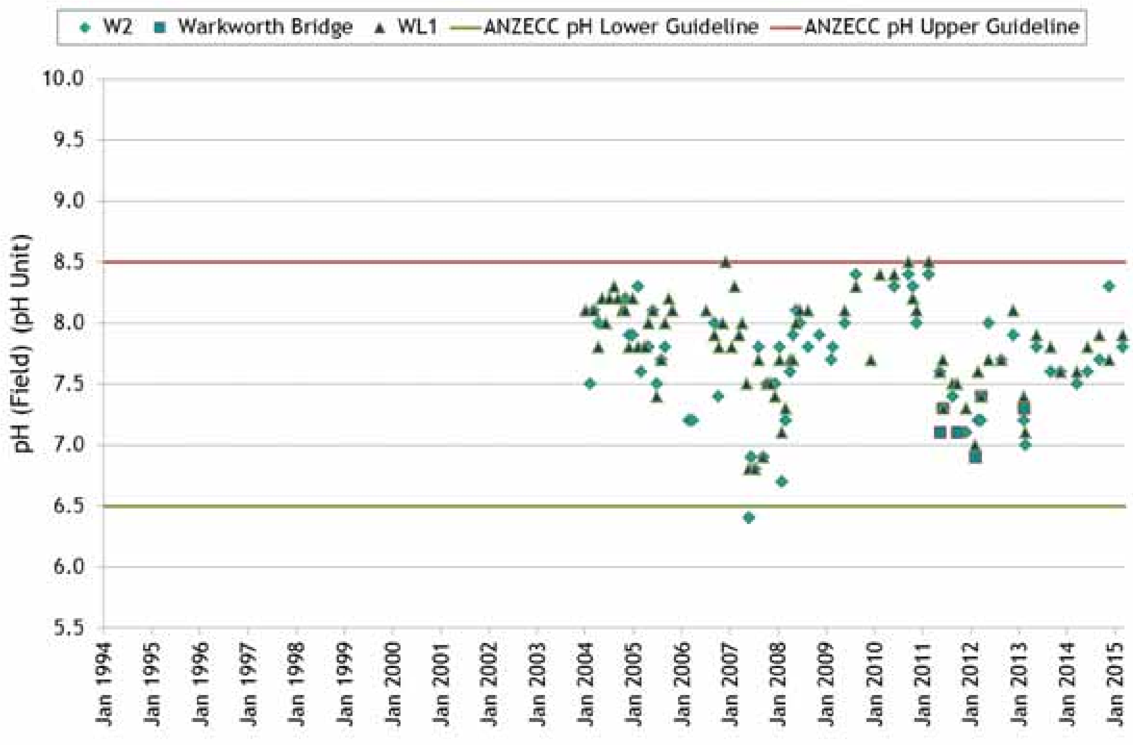

Figure 3.17 – pH – Wollombi Brook

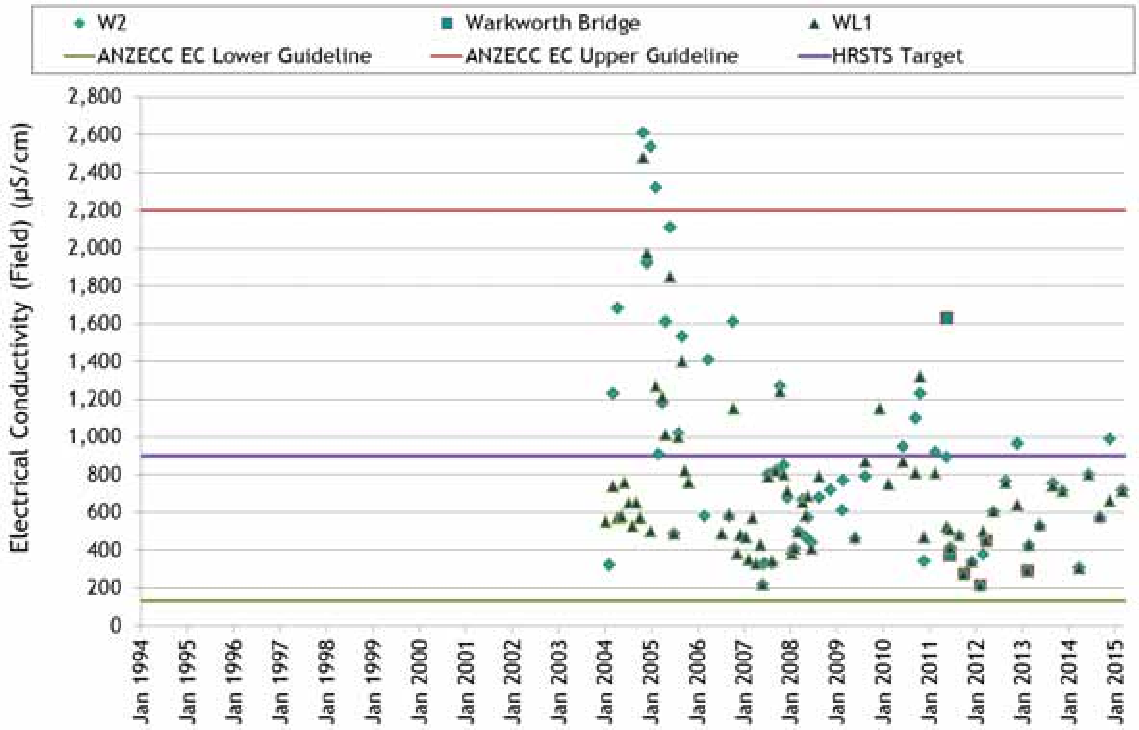

Figure 3.18 – EC – Wollombi Brook

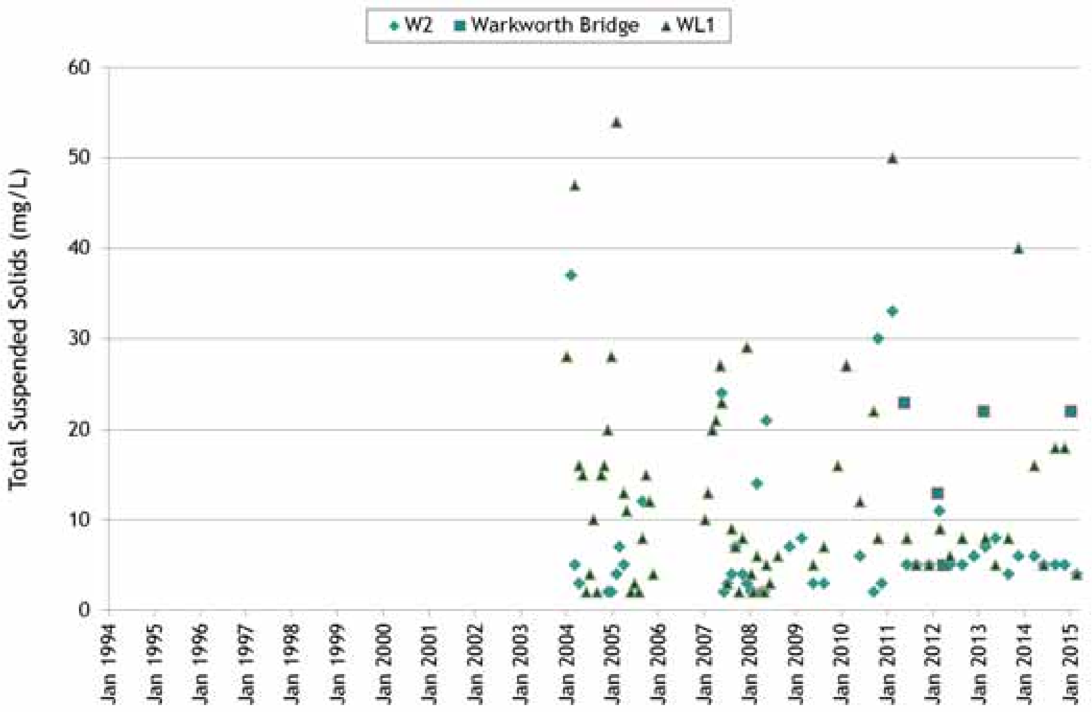

Figure 3.19 – TSS – Wollombi Brook

3.5.4 Comparison of Hunter River and Wollombi Brook water quality

Table 3.7 shows a comparison of water quality at the downstream end of Wollombi Brook and in the Hunter River just downstream of the Wollombi Brook confluence. The data shows similar water quality in both streams.

Table 3.7 – Comparison of water quality for downstream of Hunter River and Wollombi Brook

Monitoring Site	Value	EC Field (µS/cm)	pH Field	TSS (mg/L)	Sulphate (mg/L)
Downstream end of Wollombi Brook (WL1)	Min	107	6.8	2	5.5
	Max	2,480	8.5	197	32
	20%ile	426	7.5	6	8.2
	Median	588	7.8	14	15
	80%ile	813	8.1	32	23
	No. of Samples	80	80	81	9
Hunter River downstream of Wollombi Brook (H3)	Min	124	6.5		8.2
	Max	1,320	8.7		33
	20%ile	441	7.7		14
	Median	560	8.0		28
	80%ile	770	8.3		30
	No. of Samples	86	85		9

3.5.5 On-site dams

Water quality data for on-site dams is summarised in Appendix A and the graphs showing the results of all samples are shown in Figure 3.20, Figure 3.21 and Figure 3.22.

Table 3.8 shows a summary of water quality data for Lake James, the licensed release point for HVO South. Median EC for Lake James is 5,200µS/cm. However, the median EC of discharges is significantly less (3,140µS/cm) likely due to dilution from freshwater inflows during wet periods that result in the need to discharge. pH of releases (9) is typically higher than background pH in the Hunter River (typically in the range 8.0 to 8.5).

Table 3.8 – Water quality at Lake James discharge point

Monitoring Site	Value	EC Field (µS/cm)	pH Field	Sulphate (mg/L)	Turbidity (NTU)	TSS (mg/L)
K Dam (Lake James)	Min	1,240	7.9	344	1.1	2.0
	Max	36,000	10.0	4,700	82	406
	20%ile	3,172	8.9	524	2.1	8.0
	Median	5,200	9.1	609	4.2	16
	80%ile	6,234	9.3	689	13	47
	Count	115	117	13	46	117
K Dam (Lake James) Discharge Samples	Min	333	7.0		45	1.0
	Max	5,730	9.8		465	382
	20%ile	2,340	8.9		50	3.0
	Median	3,140	9.0		61	10
	80%ile	5,240	9.1		328	36
	Count	57	61		6	61

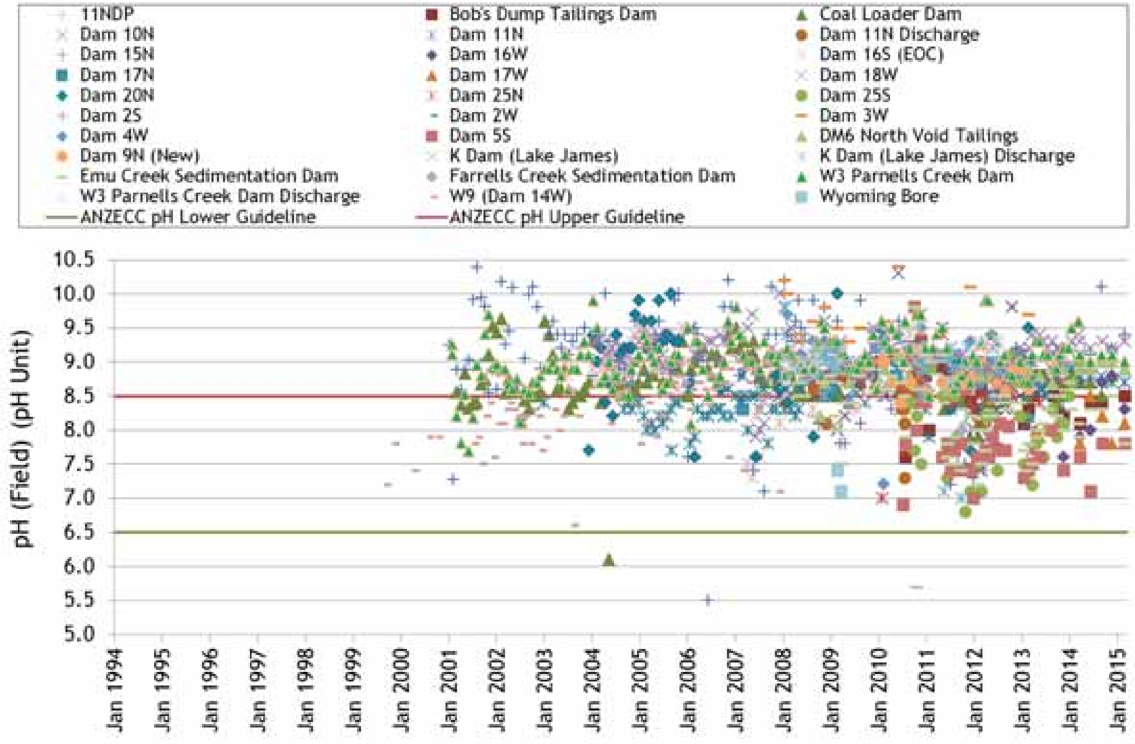

Figure 3.20 – pH – HVO on-site dams

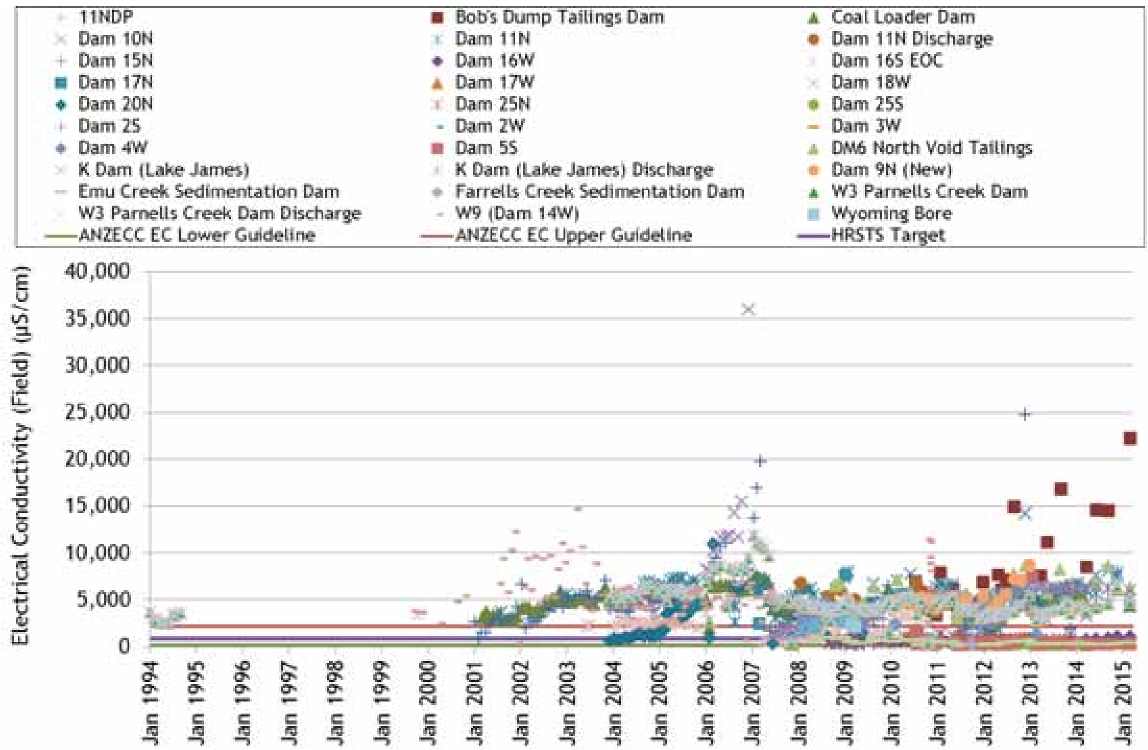

Figure 3.21 – EC – HVO on-site dams

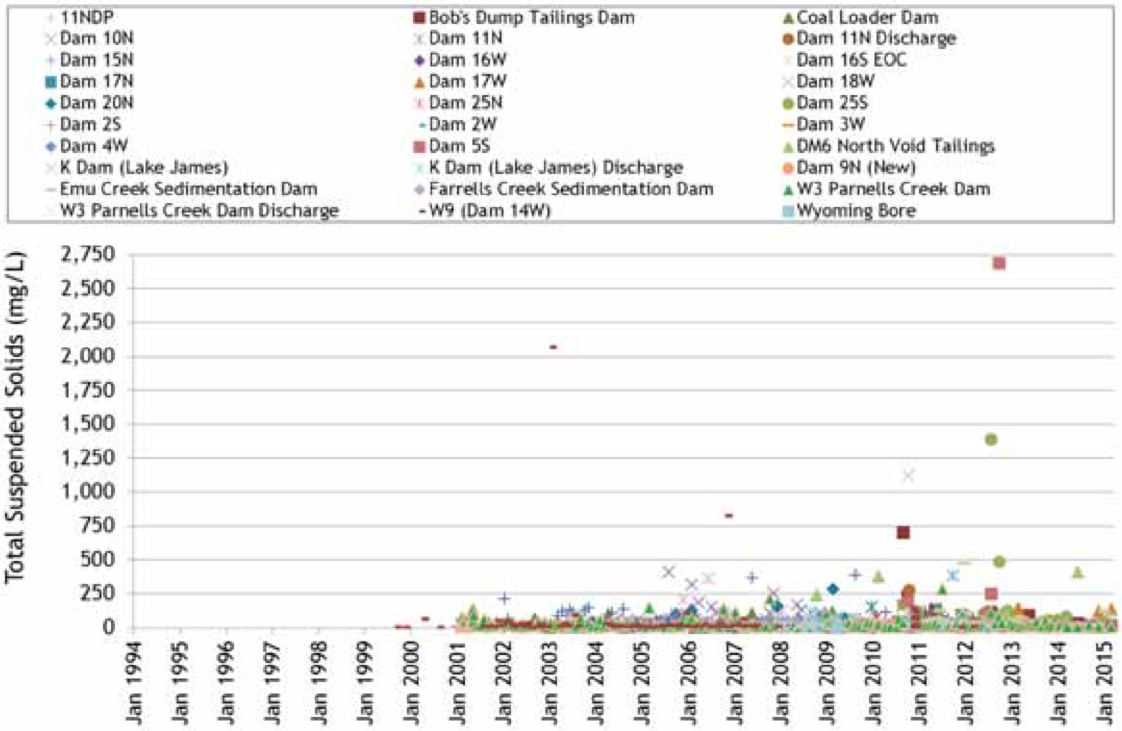

Figure 3.22 – TSS – HVO on-site dams

4 Existing water management strategy and infrastructure

4.1 OVERVIEW

This section describes the objectives of the HVO water management system (WMS), and provides details of the existing water management infrastructure.

The HVO EPL 640, project approval for HVO South (PA 06_0261) and development consent for HVO North (DA 450-10-2003) require the development and approval of a range of environmental plans. A water management plan (WMP) for HVO, prepared in consultation with the now DPI Water and EPA, was approved in May 2014 and updated in July 2015. This plan fulfils the requirements of these approvals together with commitments made in the respective environmental assessments, environmental impact statements and relevant legislation, standards and guidelines.

The WMP describes procedures required to achieve compliance with conditions of the approvals relating to potential water impacts. It also provides a mechanism for assessing water quality and quantity monitoring results.

4.2 CURRENT MINING ACTIVITIES

HVO's mining activities are shown in Figure 1.1. Activities north of the Hunter River comprise:

- four coal mining areas, including the West Pit, Mitchell Pit, Carrington Pit and North Pit;
- use of the HCPP and HVCPP;
- use of the NLP and the HVLP train loading facilities;
- use of two administration areas including bathhouses, one adjacent to the HVCPP and one adjacent to the HCPP;
- two workshops, one adjacent to the HVCPP and one adjacent to the HCPP; and
- use of numerous internal haul roads and conveyors.

HVO's mining activities south of the Hunter River comprise:

- open-cut and highwall mining of coal reserves in Cheshunt Pit and Riverview Pit;
- mining by a combination of draglines, shovels, excavators and associated haul trucks;
- use of numerous internal haul roads;
- use of one administration area, including a bathhouse; and
- use of infrastructure to facilitate transfer of product coal (a rail spur and loop, overland conveyor or trucks, or any combination).

4.3 TYPES OF WATER GENERATED ON SITE

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including coal stockpiles, etc.) may have increased concentrations of salts and other pollutants when compared to natural runoff. The strategy for the management of surface water at HVO is based on the separation of water from different sources based on observed and anticipated water quality.

Water at HVO is managed according to type. Water type is determined by catchment source, quality and use. The main types of water managed at HVO are described below:

Mine water - water used in coal production at HVO is predominantly saline due to interaction with saline groundwater within coal seams and contact with saline mine spoils. Saline water cannot be released from site except for opportunistic discharges as regulated by the HRSTS. There are three main sources of saline water managed at HVO. These sources become so thoroughly intermixed as to be indistinguishable, but are described as follows:

- **pit water** - consisting of rainfall-runoff, groundwater seepage, spoils seepage and tailings dam seepage that accumulates at low points in the open cut pits;
- **coal processing plant (CPP) water supply** - The HVCPP and the HCPP are the main consumers of water at HVO; and
- **tailings water**.

Runoff water - runoff waters vary in quality depending on the characteristics of the catchment area. Runoff water is captured or diverted away from the mine water system dependent on quality, climatic conditions and production requirements. Broadly, runoff water can be split into four types based on catchment characteristics:

- **clean catchment non-mined and ancillary catchment** - clean water diversion structures are employed to divert clean water away from the active pits. Diversion structures are currently employed for West Pit, North Pit and South Pit at HVO North. Clean catchment which has been disturbed by ancillary mining activities (eg road construction or car-parks) has the potential to produce degraded water. Prior to release from site this water is managed to minimise sediment load. Sediment control structures are implemented generally in accordance with "Managing Urban Stormwater Volume: 2E mines and Quarries";
- **unconsolidated mine spoil** - unconsolidated mine spoil contributes the largest volume of rainfall runoff into active pits. In addition, due to the high porosity of mine spoil a large proportion of incident rainfall actually reaches the pit as seepage through the mine spoil, accumulating salt as it flows. Most water reaches the active pit in a matter of hours or days, however amongst block tipped spoil, heterogeneous layering can delay breakthrough of seepage for longer periods;
- **rehabilitated mine spoil -** the fate of runoff from rehabilitated mine spoil will be determined by commitments in the HVO South Mine Operations Plan (MOP) and the HVO South Rehabilitation and Landscape Management Plan. Sediment laden runoff will be managed in the same way as disturbed clean catchment until groundcover is established; and
- **active mining areas**.

4.4 WATER MANAGEMENT SYSTEM OBJECTIVES AND STRATEGY

The objectives of the HVO WMS are to:

- minimise fresh water usage;
- minimise impacts on the environment and HVO neighbours; and
- minimise interference to mining production.

This is achieved by:

- minimising freshwater use 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 quality where practical;
- recycling on-site water;
- ongoing maintenance and review of the system; and
- disposing of water to the environment in accordance with statutes and regulations.

4.5 HVO WATER MANAGEMENT SYSTEM

4.5.1 Components and layout

For the purposes of this assessment, the water management system has been assessed against a baseline scenario representing the existing approved operation for 2016. The key components of the existing HVO WMS are as follows:

- Active pit not used for water storage:
  - HVO North – Carrington Pit, West Pit North & South, Wilton Pit;
  - HVO South – Cheshunt Pit, Riverview Central Pit, Riverview East Pits, South Lemington Pit 2.
- Water storages (used for storing mine-affected water. Comprises surface ponds/dams and inactive mining pits. Also includes sediment dams which overflow into mine-affected water storages):
  - HVO North – Dam 11N, Dam 21N, Dam 9W;
  - HVO South – Riverview Void, Dam 15S (Lake James), Dam 16S.
- Tailings facilities (dams or repurposed open cut mining pits used to store tailings waste).
  - Dam 29N (HVO North - tailings from HVCPP);
  - Dam 6W (HVO North - tailings from HCPP) will be replaced by Cumnock void from 2016.
- Other infrastructure
  - Coal Preparation Plants:
    - HVO North – HVCPP and HCPP.
  - HRSTS releases:
    - HVO South - Dam 15S (Lake James);
    - HVO North - Dam 9W, Dam 11N (not operational).

- Transfer pipeline between Mount Thorley Warkworth (MTW) and HVO South (Riverview Void) as allowed in project approvals/development consents for both HVO South and MTW.
- Externally draining sediment ponds: sediment management structures designed to intercept sediments from non-mine affected runoff prior to discharging off-site.

A plan showing the locations of all existing HVO WMS components is provided in Figure 4.1, and the storage and catchment details of the key WMS infrastructure are listed in Table 4.1. Numerous water management dams have been constructed across the combined HVO WMS. Some dams shown in Figure 4.1 for completeness, are not listed in Table 4.1 because they do not play a significant role in the WMS.

The total capacity of the HVO WMS is 6,450ML. The largest storage, Riverview Void is an inactive open cut pit used to store up to 4,000ML of mine water (more than half the total HVO WMS mine water storage capacity).

Full details of the existing water management system are provided in the HVO South Modification 5 - Water Balance Modelling Report (HATCH 2016) provided in Appendix B, extracts of which are provided in the following sections. Figure 4.4 shows the locations and landuse in the catchments of the existing HVO WMS. Details of the catchments of these key water storages and pits, including catchment land use classifications are provided in Appendix B.

4.5.2 Overall operating strategy

Key water storages are linked by pipelines to allow water to be transferred around the HVO WMS. The general operating strategy of the water management system is outlined below. Full details are included in the HVO South Modification 5 - Water Balance Modelling Report in Appendix B (HATCH 2016).

Pits are dewatered as follows:

HVO North Pits are dewatered to Dam 9N and Dam 9W;

HVO South Pits are dewatered to Riverview Void.

Process water makeup demands are supplied as follows:

HVCPP – is supplied from HVCPP Hosedown Tank which in turn is supplied from Dam 15N and Dam 9N (and from Dam 16N, 17N, and 18N if required);

HCPP – is supplied from HCPP Hosedown Tank which in turn is supplied from Dam 9W, 8W and 2W;

Industrial water demands are supplied as follows:

HVO South dust suppression is supplied via Dam 15S, which sources water from nearby dams and pits, and Riverview Void;

HVO North demands are supplied by:

- Dam 9N, which sources water from Dam 29N Tailings, Dam 21N Carrington Pit, and Riverview Void; and
- Dam 9W, which sources water from Dam 6W Tailings, nearby pits.

Excess water in HVO South is stored in Riverview Void. Infrastructure is being developed to integrate the HVO and MTW water management systems. While Warkworth Mine and Hunter Valley Operations have different ownership, both are managed by Coal & Allied, and interactions between the operations are approved through the Hunter Valley Operations South Project Approval 06_0261. A pump and pipeline with a capacity of 11ML/day would connect the two operations in 2016, with the system pumping direct to Riverview Void.

Table 4.1 – Key water storage/pit characteristics - existing WMS

Storage/pit name	Full supply volume (ML)	Catchment area (ha)
Pits		
HVO North		
Carrington Pit		205.2
GRS Pit		11.9
Wilton Pit		234
West Pit (North)		277.6
West Pit (South)		517.2
HVO South		
Cheshunt Pit 1 &2		695.7
Riverview Central		81.7
Riverview West (South)		176.9
Riverview West (North)		39.5
South Lemington Pit 2		82.2
Dams/voids		
HVO North		
Dam 9N	80	3.3
Dam 11N	75	3.9
Dam 21N	450	40.5
Dam 9W (Parnell's Dam)	870	31.2
HVO South		
Riverview Void	4,000	94.1
Dam 15S (Lake James)	715	224.4
Dam 16S	280	123.9

ML = megalitres

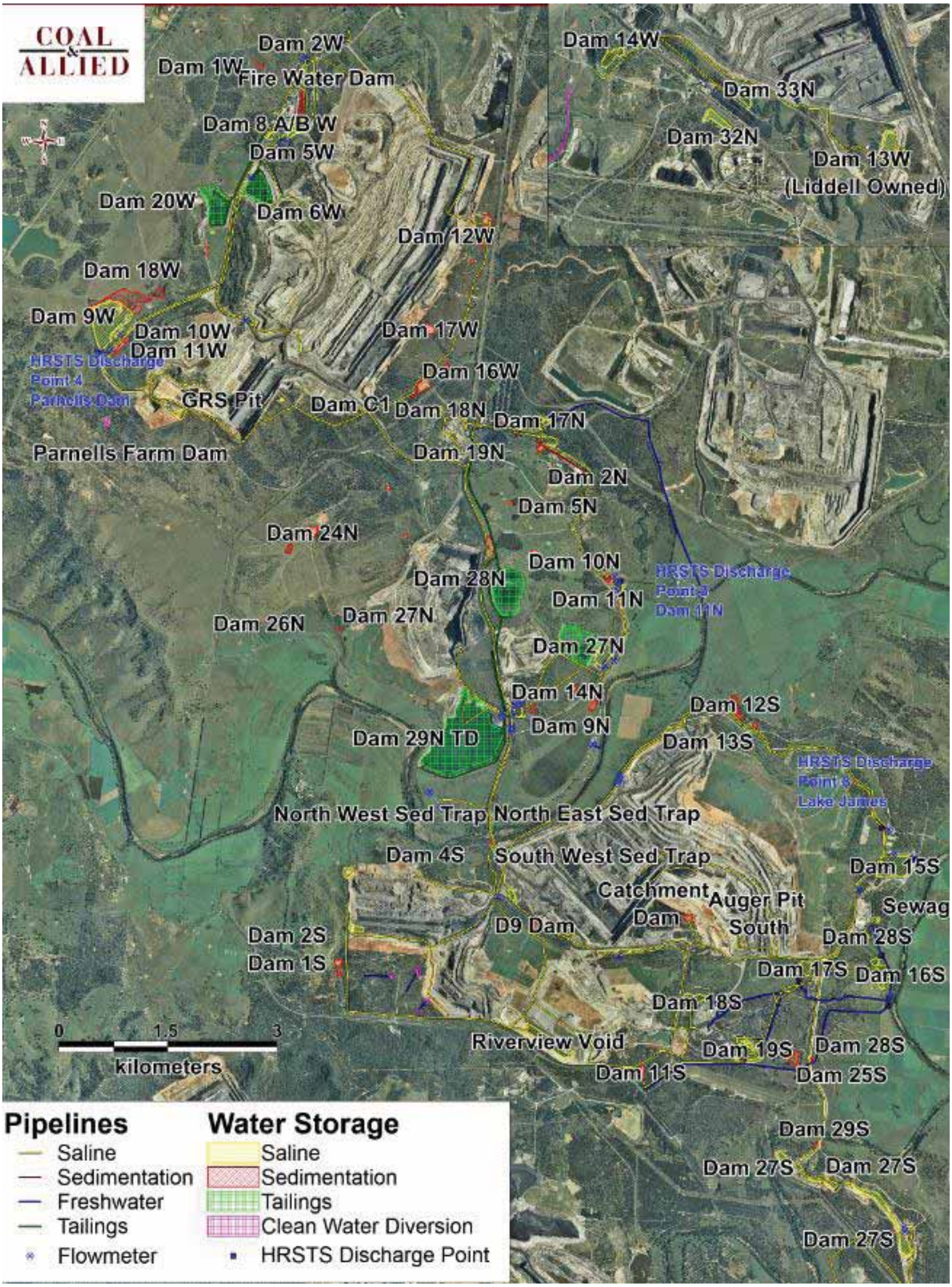

Figure 4.1 - Water storages and pipelines in the HVO WMS

(figure extracted from Coal & Allied mapping)

4.5.3 Site water use

4.5.3.1 Coal processing plants

Coal processing plants consume makeup water to offset losses of moisture within the product, coarse reject and tailings material streams.

Tailings from the HVCPP are currently actively managed in North Pit Tailings Dam (Dam 29N in HVO North). Tailings from the HCPP are currently managed in Dam 6W and will be pumped to Cumnock void from 2016. Other tailings facilities (Dam 27N and Dam 28N at HVO North) and Dam 20W (Bob's Dump Tailings Dam) are currently inactive.

Some water entrained in the tailings material stream is recovered and recycled to the processing plant. Water decanted from the tailings generated by the HVCPP are estimated to have a return rate of 75 per cent from Dam 29N.

Return rates from Dam 6W to HCPP are estimated to be 50 per cent. However once tailings are sent to Cumnock void from 2016, negligible moisture return is expected.

The existing residual process water makeup requirements have been estimated based on HVO's CPP operational parameters summarised in Table 4.2. The resultant estimates of moisture flow and residual CPP demand are summarised in Table 4.3.

Table 4.2 – HVO's CPP operational parameters

Parameter	Units	HVCPP	HCPP	Total
Plant feed (wet ROM)	Mtpa	15.4	3.6	**19.0**
Plant yield (wet)	%	77.5	71.5	
Saleable product (wet)	Mtpa	11.9	2.6	**14.5**
Proportion of coarse rejects	%	80	60	
Proportion of fine rejects	%	20	40	
Feed moisture content	%	7.5	7.5	
Product moisture content	%	9.6	9.8	
Coarse reject moisture content	%	15.0	15.0	
Tailings moisture content	%	80	75	

Table 4.3 – HVO's CPP moisture flows and process water makeup demand

Parameter	Units	HVCPP	HCPP	Total
ROM moisture	ML/year	1,155	270	1,425
Product coal moisture	ML/year	1,140	255	1,395
Coarse reject moisture	ML/year	495	105	600
Tailings moisture	ML/year	2,800	1,200	4,000
Total process water makeup	**ML/year**	**3,280**	**1,290**	**4,570**
Tailings moisture recycled	ML/year	2,100	0*	2,100
Residual water demand	**ML/year**	**1,180**	**1,290**	**2,470**

*expected nil return rate from Cumnock void. Existing return rate from Dam 6W is estimated as 50%

4.5.4 Haul road dust suppression

Water usage for haul road dust suppression varies with prevailing weather conditions. Dust suppression usage is metered across HVO, and in the 2014-15 financial year, totalled 2,465ML, approximately half of which was used at HVO South.

4.5.5 Miscellaneous industrial demand and vehicle washdown

Minor industrial and vehicle washdown water demands totalling approximately 1.8ML/day (660ML/year) are extracted from Dam 19N, Dam 5W, Dam 17S, and the HVCPP and HCPP Hosedown tanks.

4.5.6 Groundwater

Groundwater inflows to HVO are described in the Groundwater Assessment Report (AGE 2016). The report indicates (after allowance for evaporative/coal moisture removal) existing groundwater inflows to the HVO North Carrington Pit are very small (approximately 0.3ML/day) while flows to the HVO South Cheshunt Pit and Riverview Pit are approximately 1.6ML/day and 0.9ML/day respectively. This is consistent with validation of the site water balance model against observed total water inventory, which indicated the total groundwater inflow to the combined water management system was approximately 3.0ML/day between 2012 and 2014.

4.5.7 Releases from the site water management system

HVO participates in the HRSTS (as described in 2.8) and currently holds 145 credits, allowing it to release up to 14.5 per cent of the TAD salt tonnage during periods of 'high' or 'flood' flows in accordance within the scheme rules.

HVO's EPL 640 authorises HRSTS discharges from the following release points (shown in Figure 4.2):

Release Point 3 - Dam 11N (to Farrells Creek) (middle sector) – 100ML/day;

Release Point 4 - Dam 9W (to Parnells Creek) (middle sector) – 130ML/day;

Release Point 8 - HVO South Dam 15S (Lake James) (lower sector) – 120ML/day.

Release Point 3 is not currently operational, and the capacity of infrastructure at Release Point 4 limits potential releases to a rate of only 40ML/day.

The WMS is currently operated such that releases may be made under the HRSTS if the combined inventory is greater than 4GL. Figure 4.3 shows historical discharges made by HVO under the HRSTS between 2007 and 2015. Table 4.4 shows details of the releases since 2009.

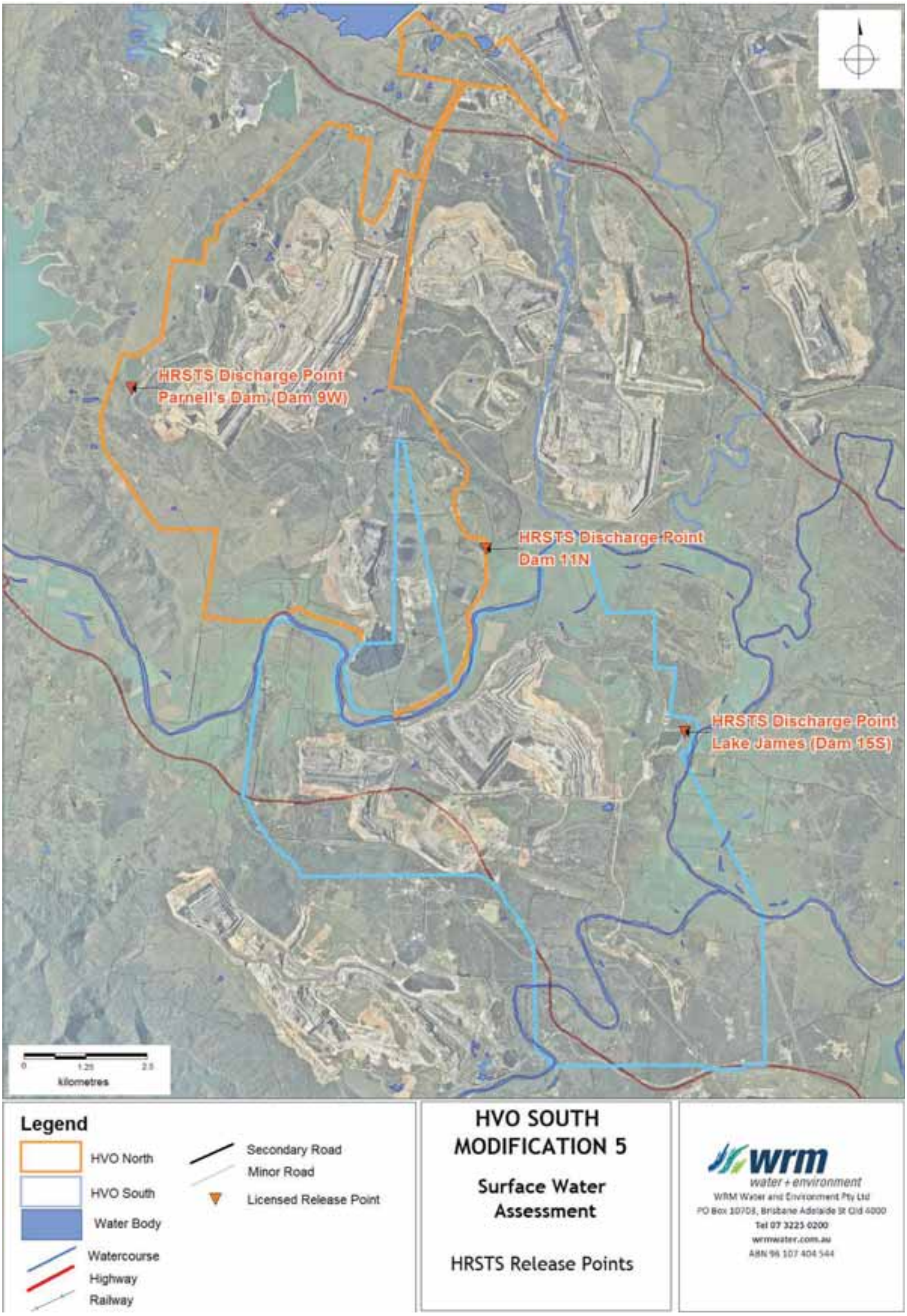

Figure 4.2 – HRSTS release points

Table 4.4 – Historical HRSTS releases from HVO

Year	Volume (ML)	Location		Recorded Discharge Time	Number of Discharge Blocks	Allowable Discharge (tonnes)	Total Salt Load Discharged (tonnes)
2009	192	Release Point 4	Dam 9W	16 Feb 2009 - 15 Apr 2009	6	18,778	351
2010	680	Release Point 3	Dam 11N	16 Jul 2010 - 11 Dec 2010	23	80,455	1,898
		Release Point 8	Dam 15S	16 Dec 2010 - 31 Dec 2010	3	3,035	322
2011	1857	Release Point 4	Dam 9W	24 Jul 2011 - 29 Nov 2011	9	30,945	932
		Release Point 3	Dam 11N	26 Nov 2011 - 7 Mar 2012	6	40,883	452
		Release Point 8	Dam 15S	25 Jul 2011 - 23 Feb 2012	19	61,417	3,547
2012	468	Release Point 4	Dam 9W	19 Jul 2012 - 20 Jul 2012	2	1,225	102
		Release Point 8	Dam 15S	14 Jul 2012 - 18 Jul 2012	5	17,225	1,437
2013	0	-	-	-	-	-	-
2014	0	-	-	-	-	-	-
2015	497	Release Point 4	Dam 9W	22 Apr 2015 - 25 Apr 2015	4	18,110	545
		Release Point 8	Dam 15S	22 Apr 2015 - 27 Apr 2015	5	39,019	1,014

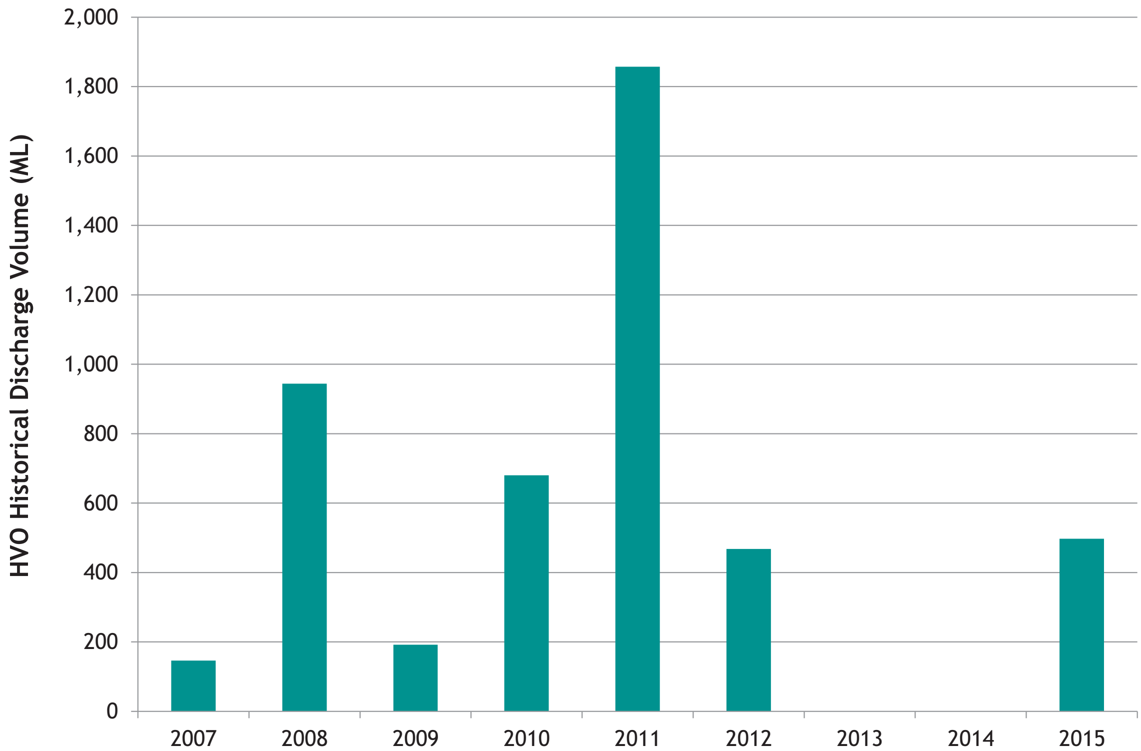

Figure 4.3 – Historical HRSTS discharges

4.5.8 Water supply

Following prolonged periods of drought, HVO may need to supplement site water supplied from an external source. Imported water requirements can be provided from a number of sources, including:

- On-site groundwater resources (eg North Void spoil at HVO);
- Lemington Underground Bore (LUG Bore – licensed extraction of up to 1,800ML/year). This allocation is shared with the MTW mine as HVO does not require additional external supply. Should HVO require external water supply in the future, it would take advantage of its full entitlement;
- External mine water sources through water sharing agreements with neighbouring mines (including Coal and Allied's MTW, Peabody's Wambo and Glencore's Liddell mines);
- Hunter River extraction (including inter-site transfer from HVO, MTW, Bengalla, Mount Pleasant).

HVO holds both High and General Security Water Access Licences to extract water from the Hunter River. Should HVO require more water, entitlements can be traded to this licence to increase output through the scheme.

The currently licensed high security water extraction volume of 4,665ML/year is adequate for both HVO North and HVO South requirements provided internal water use continues to be actively managed, and provided high security water licence allocations are maintained at the current levels. Note that groundwater seepage from the alluvial groundwater source and from the Hunter River regulated surface water source is also currently accounted for under these entitlements.

4.5.9 Sewage disposal

HVO currently has 19 on-site packaged sewerage management systems. Six are located in pit, a further six are associated with CPP's and the remaining seven systems are located at infrastructure associated with mining and administration. Two of the 19 systems are large scale systems that service up to four sub-systems.

The sewage treatment and disposal facilities consist of sewage treatment plants which treat, disinfect and re-use the treated effluent on-site. The remaining effluent from some septic systems that can't be treated on site is sent to approved facilities for disposal.

4.6 PROJECT AREA WATER MANAGEMENT INFRASTRUCTURE

Details of the water storages and mine pits within the project area are listed in Table 4.5. Their locations are shown in Figure 4.4.

Table 4.5 - Project area water storages

Storage	Baseline Catchment Area	Full Storage Capacity		Functional Description
	(ha)	(mRL)	(ML)	
Water Storages				
Dam 15S	224.4	65	715	HRSTS Release Point 8 (Lake James). Primary dust suppression fill point for southern mining area.
Dam 16S Group	123.9	54.4	285	Surface water dams located along south-east edge of mining area.
Dam 17S	44	83.6	65	Dams capture runoff and supply Dam 15S, and Lemington workshop industrial water demands.
Dam 18S	42	81.5	175	
Dam 19S	100	67.8	210	
D9 Dam	55.8	82.9	25	Water storages located upstream of, or within Cheshunt Pit watershed.
Saline Dam	44.9	78.6	40	Used to supply local dust suppression water demands.
C2 Sed Dam	32.8	91.1	5	Not used to store excess water.
Auger South	34.7	13.4	675	
Riverview Void	94.1	80	TBC	Bulk water storage. Maximum storage volume set at 4,000 ML, equivalent to 75.6 mRL.
Mining Pits				
Cheshunt Pit 1 & 2	695.7	n/a	n/a	Active Mining Pits.
Riverview Central	81.7	n/a	n/a	
Riverview West (South)	176.9	n/a	n/a	
Riverview West (North)	39.5	n/a	n/a	
South Lemington Pit 2	82.2	n/a	n/a	
Ext. Draining Sediment Dams				
Dam 4S	38.5	68	12	Sediment management structures. Intercept runoff from natural/rehabilitated areas prior to draining off-lease.
Dam 5S	14.9	67	3	
Riverview Sed. Dams	55.6 45.2	n/a n/a	25*	

	16.6	n/a	
	3.8	n/a	
	31.8	n/a	
Dam 11S	86.5	70	25
Dam12S & 13S	228	n/a	53*
Dam 25S	105.3	n/a	5*
Dam 28S	76.6	n/a	3*

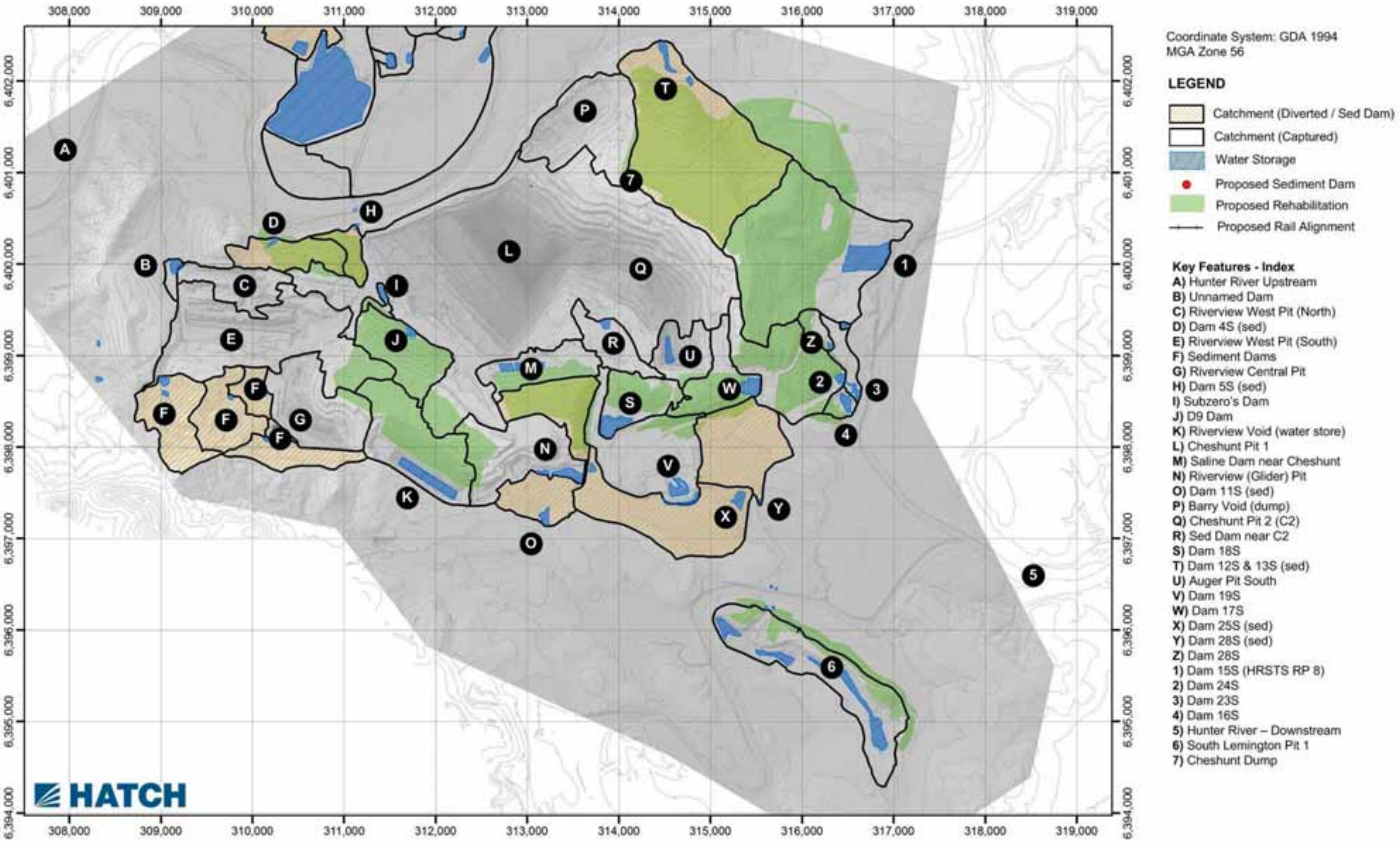

Figure 4.4 – Baseline project area water management system – Year 2016

4.7 MITIGATION, MANAGEMENT AND MONITORING

The existing documents used to document and guide on site water management are described below.

4.7.1 Water Management Plan

The WMP describes the HVO WMS and the site water balance, erosion and sediment controls, water monitoring.

The WMP describes the water management protocols and response procedures for the HVO WMS. The water management protocols in the WMP (to avoid overflows or releases from contained water storages) are described in Sections 4.4 and 4.5.

4.7.2 Site water balance

The site water balance model is updated on a regular basis to record the status of inflows (water capture), storage and consumption (eg CPP usage, return water from co-disposal areas, dust suppression and HRSTS discharges) and to optimise water management performance.

The results of site water balance reviews are reported in the Annual Review as required in the project approval.

4.7.3 Erosion and Sediment Control Plan

The Erosion and Sediment Control Plan identifies activities that could cause soil erosion and generate sediment and describe the specific controls (including locations, function and structure capacities) to minimise the potential for soil erosion and transport of sediment off-site.

4.7.4 Surface water management and monitoring plan

The HVO Surface Water Management and Monitoring Plan of the WMP outlines how monitoring is undertaken for the project in accordance with the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC and ARMCANZ, 2000) and Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004).

5 Proposed water management strategy and infrastructure

5.1 OVERVIEW

In accordance with normal operational management procedures, adjustments will be made to the WMS through the remainder of the project approval period to accommodate mine plans associated with the proposed modification. Anticipated changes to the WMS, the associated impacts on surface water and proposed management or mitigation measures are described in this chapter. The proposed changes are scheduled to commence in 2017 (subject to approval of the proposed modification), with mining occurring under existing approvals up until that time. The proposed modification will not change the approved footprint of disturbance or the management of tailings.

The key aspects of the proposed modification which will bring about anticipated operational changes to the management of surface water across HVO are:

- mining of the deeper Bayswater seam from Cheshunt Pit into Riverview Pit, and the associated backfilling of the existing Riverview Void water storage;
- mining the Vaux seam below the Bowfield seam in South Lemington Pit 2;
- changes to the currently approved overburden emplacement strategy and post mining landform design;
- an increased peak rate of extraction and coal processing from 16Mtpa to 20Mtpa ROM coal across all HVO coal preparation plants.

The four stages shown in Table 5.1 have been chosen to represent the development of the mine through the life of the proposed modification The base case, which represents the HVO as it is will be operated in 2016 is described in section 4.5.

Figure 5.1 to Figure 5.4, which are reproduced from the HVO South Modification 5 - Water Balance Modelling Report in Appendix B (HATCH 2016), shows the progression of mining and the indicative locations of the proposed water management infrastructure throughout the life of the proposed modification (as described in Table 5.1).

Table 5.1 - Proposed modification indicative mine plan stages

	Stage	Applied Mine Plan Snapshot
Base case		2016
Proposed modification	1	2019
	2	2022
	3	2025
	4	2028

The relevant changes to the HVO WMS are described in the following sections. Full details of the WMS and the proposed changes are given in Appendix B.

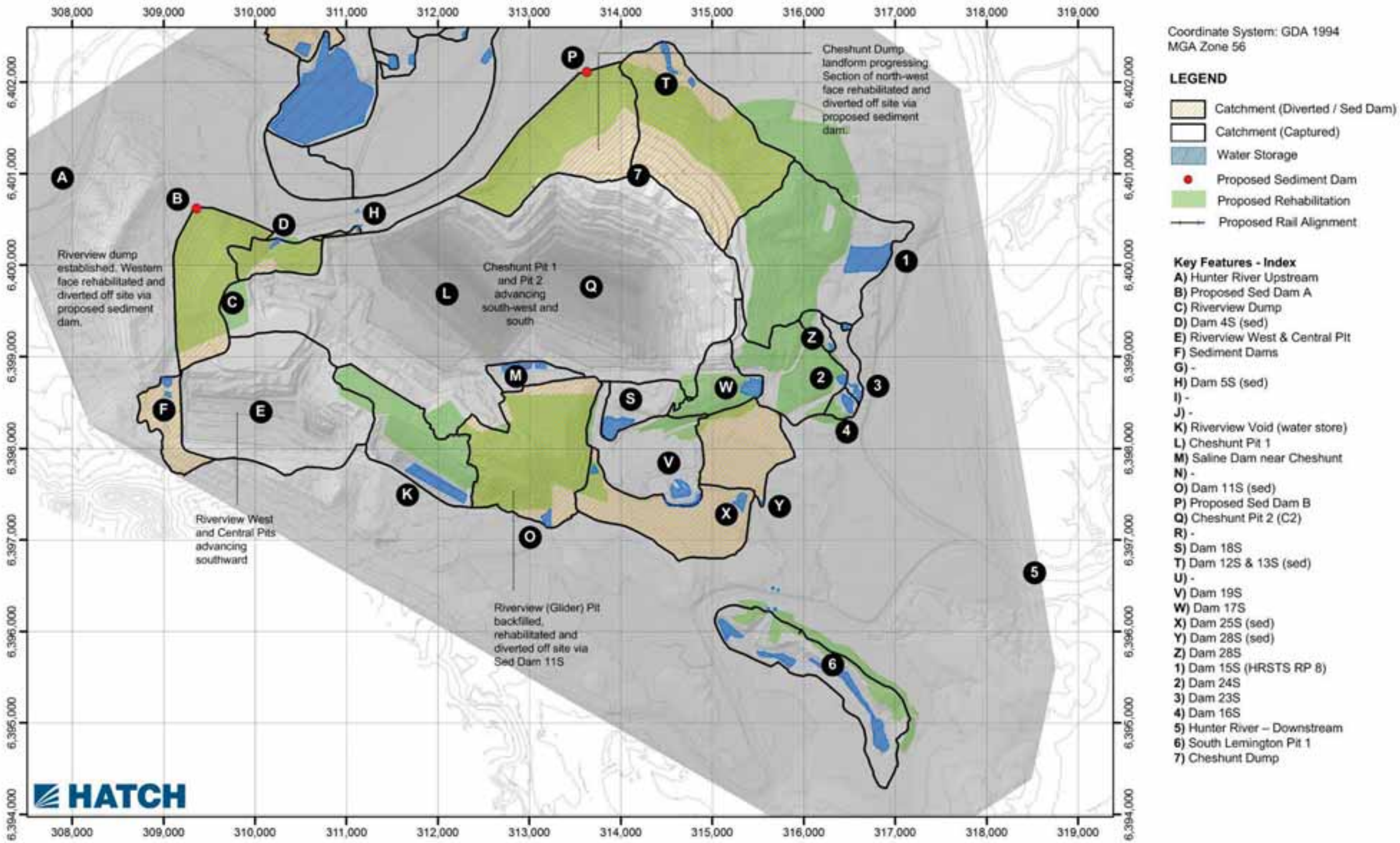

Figure 5.1 – Proposed water management system – Year 2019 (Stage 1)

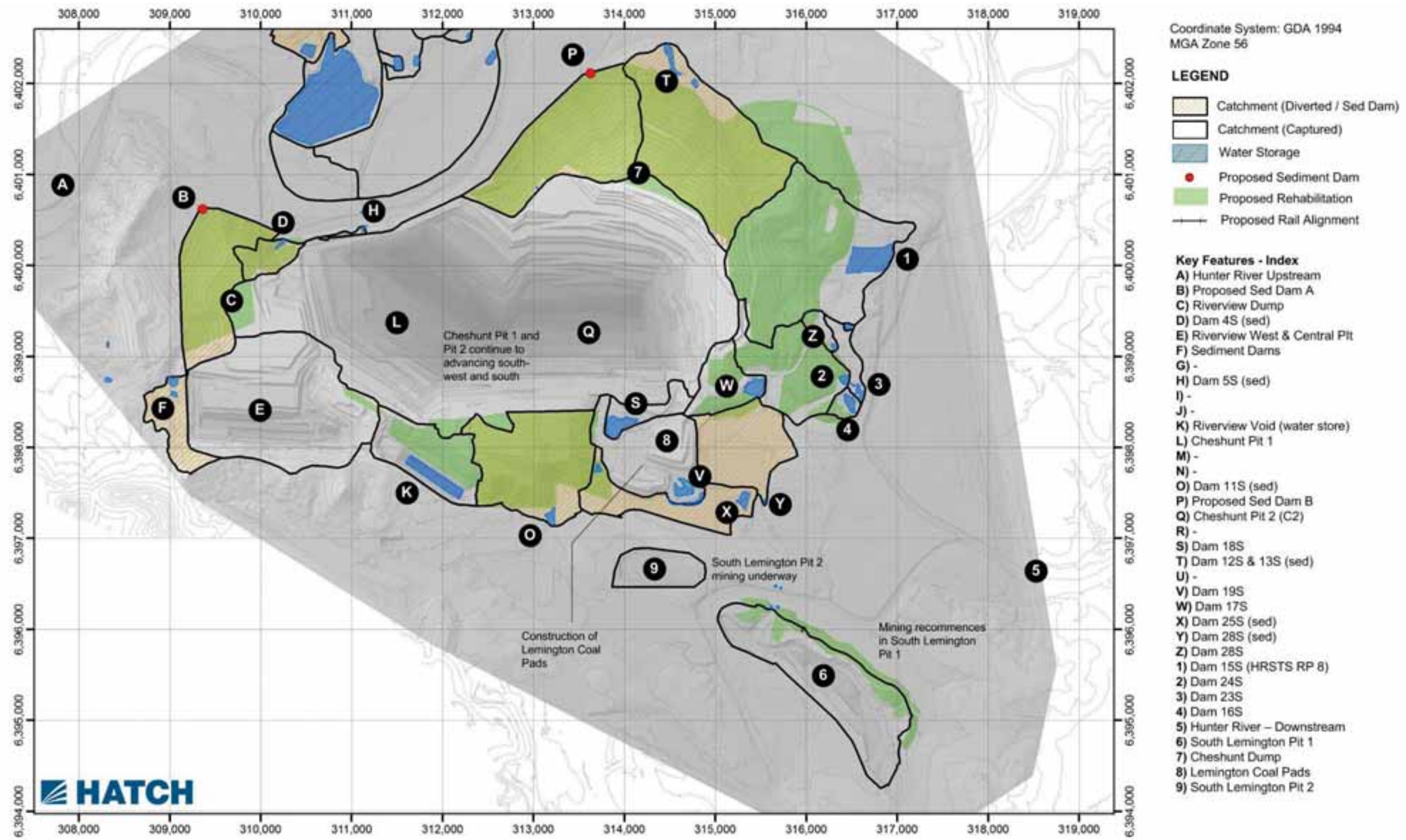

Figure 5.2 – Proposed water management system – Year 2022 (Stage 2)

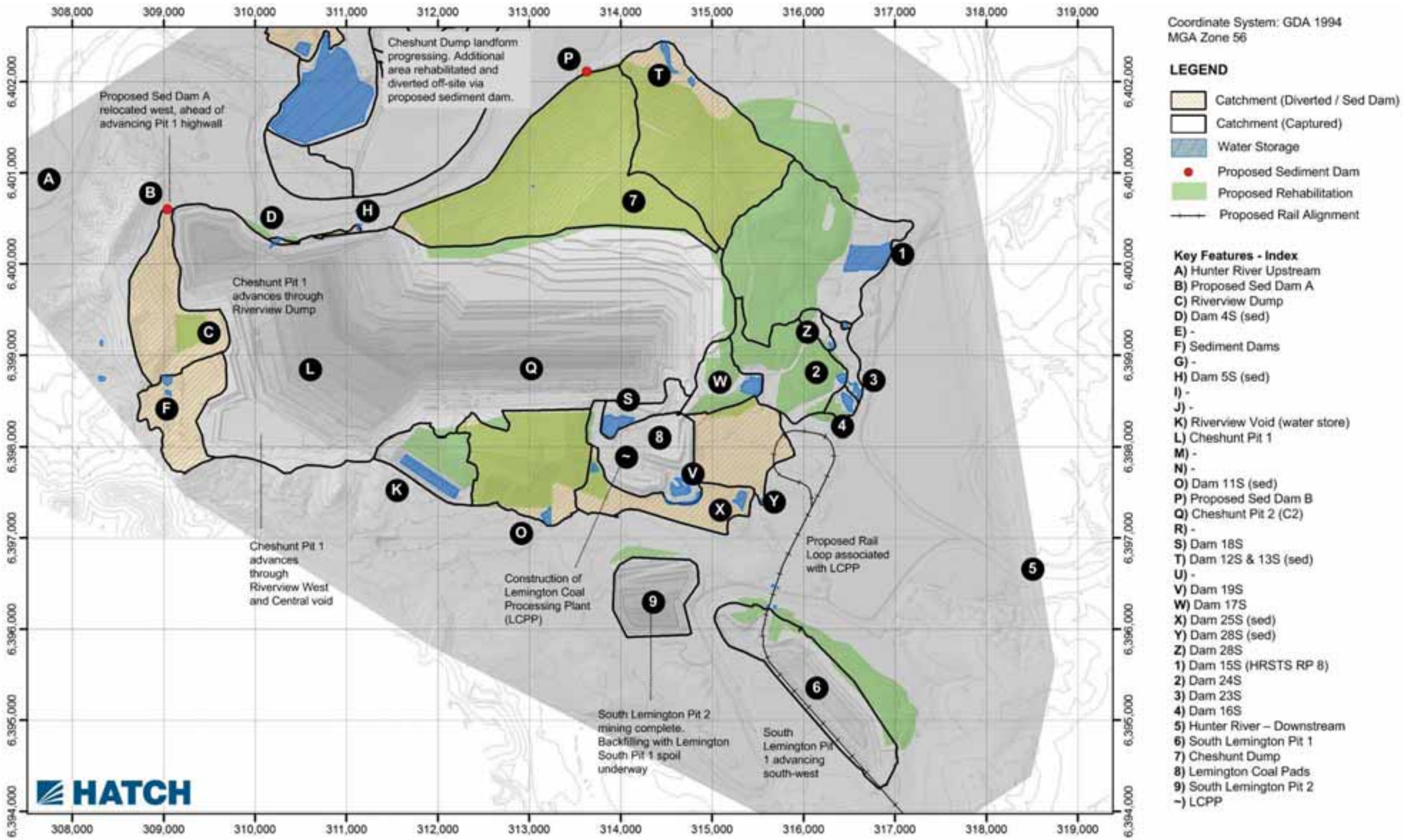

Figure 5.3 – Proposed water management system – Year 2025 (Stage 3)

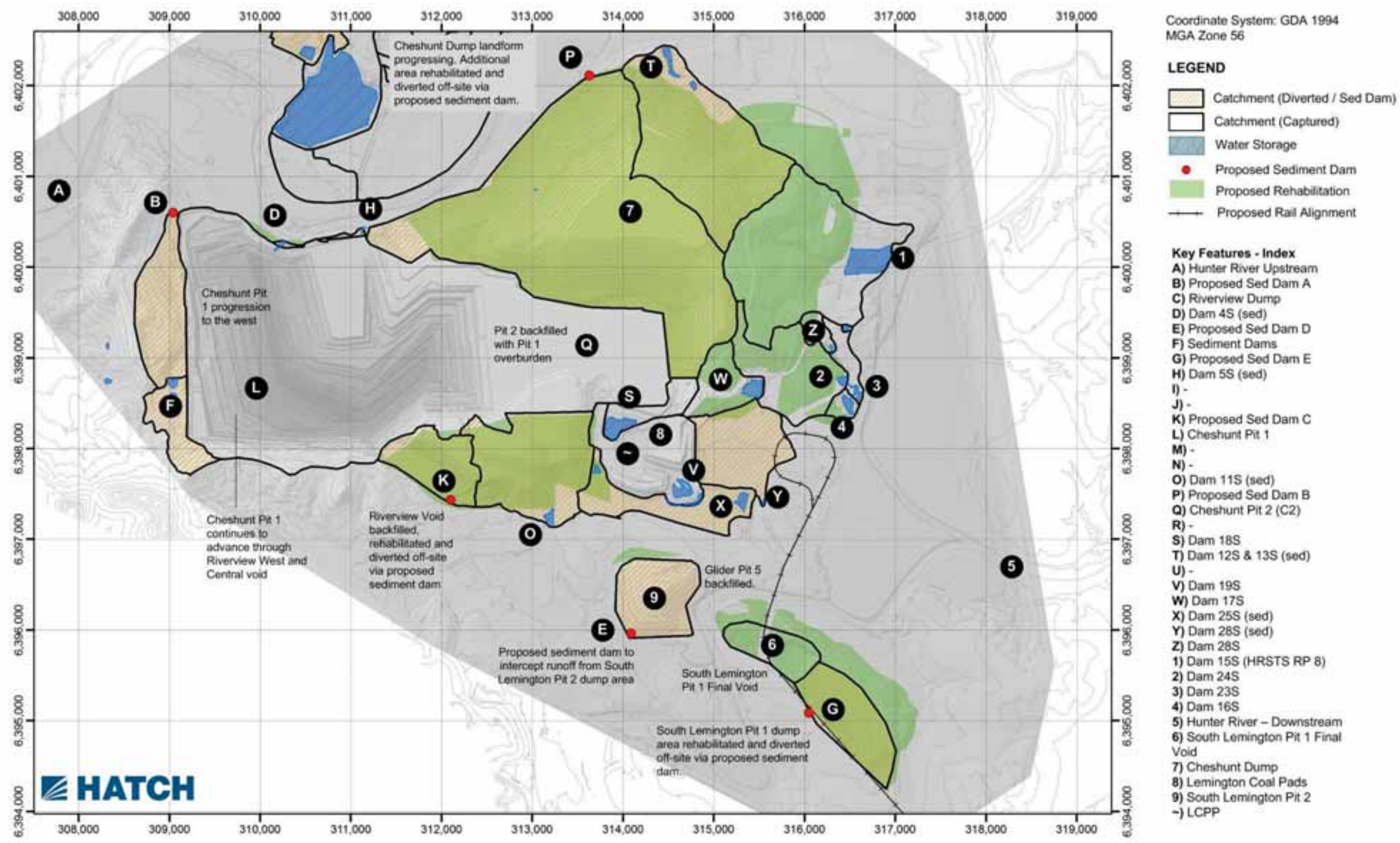

Figure 5.4 – Proposed water management system – Year 2028 (Stage 4)

5.2 CHANGES TO WMS AS A RESULT OF THE PROPOSED MODIFICATION

The WMS infrastructure will be progressively developed over of the life of the proposed modification to meet the water management objectives given in Section 4.4. The primary changes to components of water-related infrastructure for the proposed modification are consistent with this progressive development of the WMS to accommodate mining operations. Examples of the changes in the proposed WMS are:

- the removal of some existing mine water dams and to collect runoff from the CPP and coal stockpile area;
- the addition of sediment dams to collect and treat runoff from overburden emplacement areas.

These changes would be subject to detailed design based on the mining sequence documented in the relevant MOP.

In addition, the commissioning of the LCPP at HVO South in Stage 3 will result in changes to the way water is recycled for CPP process water make-up supplies. LCPP will be supplied from the local surface water dam - Dam 19S (which in turn will supplied from Dams 17S, 18S, 15S and 16S). Riverview Void has also been nominated as a potential site for LCPP tailings deposition after Stage 3, and is scheduled to be backfilled and rehabilitated in Stage 4.

5.2.1 Mine water management storages

No new mine water dams are proposed as part of the proposed modification. Mine water will continue to be managed in the existing WMS dams described in Section 4.5. However, a number of mine storages associated with Cheshunt Pit will be removed by the proposed modification, including:

- D9 Dam;
- Saline Water Dam;
- Sediment Dam;
- Subzero's Dam.

The removal of these storages will not materially impact the performance of the HVO WMS.

Riverview Void is scheduled to be backfilled and rehabilitated in Stage 4. This will result in a significant reduction in out-of-pit mine water storage capacity. A comparable in-pit storage at HVO North has been identified as an option for future excess water storage from Stage 4. The HVO pump and pipeline network will be modified if required to enable transfer between HVO and MTW to continue after Riverview Void has been backfilled.

5.2.2 Sediment dams

There are likely to be changes to the number of sediment dams to collect and treat runoff from overburden emplacement areas due to the proposed modification. The number, location and size of these dams may be modified as the design and staging of overburden emplacement area rehabilitation is refined and finalised. Based on the indicative mine plans, a total of five new sediment dams are proposed over the remaining life of the current approval for HVO South. The locations and sizes of these dams may be modified as the design and staging of overburden dump rehabilitation is refined and finalised:

- Sediment Dam A is proposed to the west of Riverview dump in Stage 1;
- Sediment Dam B is proposed to the north of Cheshunt dump, near the current Barry Void in Stage 1;

- Sediment Dam C is proposed downstream of the current Riverview Void in Stage 4 after Riverview Void is backfilled, and its catchment rehabilitated and diverted off-site;
- Sediment Dam D is proposed downstream of the proposed South Lemington Pit 2 dump during Stage 4;
- Sediment Dam E is proposed downstream of the rehabilitated area of the South Lemington pit dump in Stage 4.

The sediment dams will be sized in accordance with recommended design standards in the following guidelines:

- Managing Urban Stormwater, Soils and Construction (Landcom, 2004); and
- Managing Urban Stormwater, Soils and Construction, Mines and Quarries (DECC, 2008).

The sediment dam volumes will be based on the following design standards and methodology:

- "Type F" sediment basins consistent with SD 6-4 (page 6-19, Landcom 2004);
- total sediment basin volume = settling zone volume + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone is the minimum required free storage capacity that must be restored within 5 days after a runoff event;
- sediment basin settling zone volume based on 90^{th} percentile 5-day duration rainfall at Scone (35.9mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.64; and
- sediment storage volume = 50 per cent of settling zone volume.

The adopted design standard does not provide 100 per cent containment for runoff from disturbed areas. Hence, it is possible that overflows will occur from sediment dams if rainfall exceeds the design standard.

5.3 CHANGES TO OTHER WMS COMPONENTS

As the operations progress, the HVO WMS will develop in accordance with existing approvals not directly related to the proposed modification. The assumptions regarding changes to the design and operation of these components are detailed in the HVO South Modification 5 - Water Balance Modelling Report in Appendix B (HATCH 2016).

6 Water management system assessment

6.1 OVERVIEW

HVO has developed and maintains an operational water balance model for the site using the OPSIM software platform. The OPSIM software is a general purpose simulation model for water resource systems. It is industry accepted, and primarily used for mine site water management applications throughout Australia.

The model simulates the operation of all major components of the water management system, including: catchment runoff, water inventory fluctuation and overflow, pump and gravity transfers, industrial water extraction and return, climatic influence, groundwater inflow, open cut mine dewatering, tailings hydrology and opportunistic controlled release of mine-affected water to the Hunter River under HRSTS.

The model has been updated and used to assess the performance of the HVO WMS during the operation of the proposed modification by HATCH (2016). Details of the model, including validation against metered data collected between January 2014 and June 2015, are included in Appendix B, and the results of the assessment are summarised in the following section, with respect to the following key performance indicators:

- mine water inventory – the risk of accumulation (or reduction) of the overall mine water inventory at HVO, and the associated water volumes;
- external water supply requirements – the risk of requiring imported external water to supplement on-site mine water supplies;
- off-site water discharges – the risk of controlled and uncontrolled discharges from the site storages to receiving waters; and
- overall site water balance.

The performance of the HVO WMS has been assessed through long-term historical simulation, on the basis of 123 years of daily climate data. Combined site volume has been set at 2 GL at the start of the simulation.

6.2 WATER BALANCE MODEL CONFIGURATION AND CALIBRATION

The HVO water balance model is comprised of a collection of inter-connected nodes incorporating two sub models of HVO North and HVO South. The MTW model is also partially included to properly simulate site transfers. Nodes represent key components of the WMS such as dams, CPPs and pits. The water balance model schematisation of the project area is shown in Figure 6.1. The schematisations of the other areas across HVO are given in Appendix A.

The model uses the Australian Water Balance Model (AWBM) to simulate the runoff characteristics from the various landuses across the mine site using daily rainfall and catchment evapotranspiration. The AWBM parameters have been calibrated to historical on-site inventory over the period January 2014 to June 2015. The calibration showed that the model simulated both the performance of the overall site water balance and the sub model water balance reasonably well and that the adopted parameters were suitable for the purposes of high level water balance modelling. Further details of the model configuration and calibration are given in Appendix B.

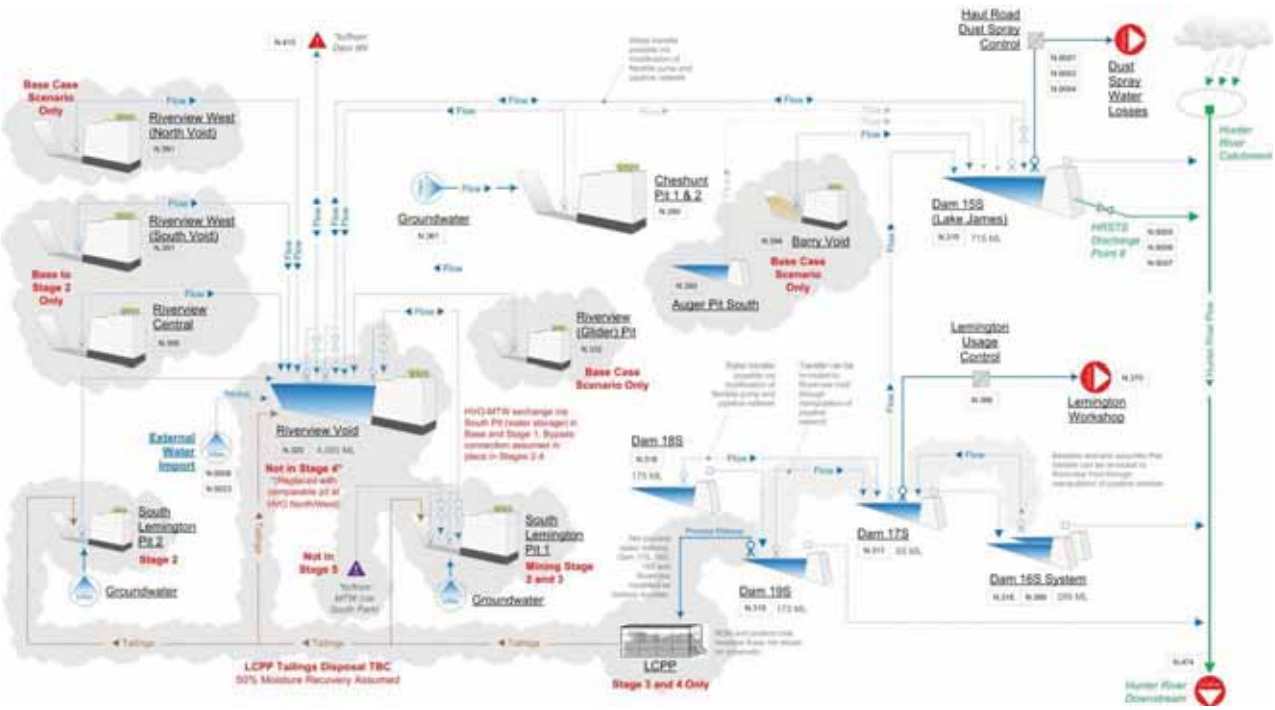

Figure 6.1 - Water Balance Model Schematic – HVO South

6.3 MODEL CHANGES

6.3.1 Areas captured and diverted by HVO WMS

The proposed modification is wholly within the existing approved disturbance footprint, and therefore the total area captured is not expected to be greater than for the approved operations. However, the total catchment area captured or diverted by the WMS will change during the development of the proposed modification compared to the existing operations.

Table 6.1 summarises the changes for both the proposed modification (HVO South) as well as for the approved areas of HVO North. The total HVO South area captured by the HVO WMS will peak in Stage 2 at 2,067ha, an increase of approximately 10 per cent over existing conditions. At the end of Stage 4, the rehabilitation and diversion of parts of the proposed dumps will result in a 17 per cent reduction in the area captured compared to existing conditions.

Table 6.1 – Areas captured and diverted by the HVO WMS incorporating the proposed modification

	Catchment Area (ha)				
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HVO South					
Captured catchment area	1,876.6	1,840.7	2,067.1	1,995.8	1,566.7
Diverted catchment area	702.5	899.6	818.6	989.3	1,416.2
Total	***2,579.1***	***2,740.3***	***2,885.7***	***2,985.1***	***2,982.9***
HVO North					
Captured catchment area	2,636.1	3,070.5	3,096.7	3,200.6	3,200.6
Diverted catchment area	804.5	711.7	765.7	797.7	797.7
Total	***3,440.6***	***3,782.2***	***3,862.4***	***3,998.3***	***3,998.3***
Combined HVO					
Captured catchment area	4,512.7	4,911.2	5,163.8	5,196.4	4,767.3
Diverted catchment area	1,507.0	1,611.3	1,584.3	1,787.0	2,213.9
Total	***6,019.7***	***6,522.5***	***6,748.1***	***6,983.4***	***6,981.2***

6.3.2 Site water demands

6.3.2.1 Coal processing plants

Residual process water makeup requirements were calculated at each stage of the indicative mine plan, and are summarised in Table 6.2

Initially tailings disposal from HVCPP and HCPP would be to the baseline facilities (Dam 29N and Cumnock Void), before transitioning to a proposed out-of-pit TSF to be constructed near the Carrington Pit at HVO North from Stage 2. The adopted tailings return water rates reflect these changes, with the return rate from the Carrington Out-of-Pit TSF assumed to be 75 per cent, and the LCPP tailings moisture return assumed to be 50 per cent.

Table 6.2 – Projected CPP water demand

Parameter	Units	Base case	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HCPP						
Plant feed (wet ROM)	Mtpa	3.6	6	6	6	6
Plant yield (wet)	%	71.5	71.5	71.5	71.5	71.5
Saleable product (wet)	Mtpa	2.6	4.3	4.3	4.3	4.3
Moisture Flows						
ROM moisture	ML/year	270	450	450	450	450
Product coal moisture	ML/year	255	420	420	420	420
Coarse reject moisture	ML/year	105	180	180	180	180
Tailings moisture	ML/year	1,200	2,020	2,020	2,020	2,020
Process water makeup	ML/year	1,290	2,165	2,165	2,165	2,165
	ML/day	3.5	5.9	5.9	5.9	5.9
HVCPP						
Plant feed (wet ROM)	Mtpa	15.4	17.4	20	20	20
Plant yield (wet)	%	77.5	77.5	77.5	77.5	77.5
Saleable product (wet)	Mtpa	11.9	13.5	15.5	15.5	15.5
Moisture Flows						
ROM moisture	ML/year	1,155	1,305	1,500	1,500	1,500
Product coal moisture	ML/year	1,140	1,295	1,490	1,490	1,490
Coarse reject moisture	ML/year	495	550	635	635	635
Tailings moisture	ML/year	2,800	3,125	3,590	3,590	3,590
Process water makeup	ML/year	3,280	3,665	4,210	4,210	4,210
	ML/day	8.9	10	11.5	11.5	11.5
LCPP						
Plant feed (wet ROM)	Mtpa	-	-	-	4	4
Plant yield (wet)	%	-	-	-	75	75
Saleable product (wet)	Mtpa	-	-	-	3	3
Moisture Flows						
ROM moisture	ML/year	-	-	-	300	300
Product coal moisture	ML/year	-	-	-	295	295
Coarse reject moisture	ML/year	-	-	-	140	140
Tailings moisture	ML/year	-	-	-	795	795
Process water makeup	ML/year	-	-	-	930	930
	ML/day	-	-	-	2.5	2.5
Total process water makeup	ML/year	4,570	5,830	6,375	7,305	7,305
Tailings moisture recycled	ML/year	2,100	2,345	4,205	4,605	4,605
Residual water demand	ML/year	2,465	3,490	2,170	2,705	2,705

6.3.2.2 Haul road dust suppression

Haul road dust suppression watering rates will vary over the life of the proposed modification, with changing haul road lengths. Haul road footprints were calculated from the mine plans for each mine stage. Dust suppression rates were calculated from the historical climate record taking into account the proposed length of coal and waste haulage routes in the project area and by making minor adjustments to historical application rates in the other areas. Estimates of haul road dust suppression requirements at each mine stage are presented in Table 6.3. Demands are supplied from fill points at Dam 15S (Lake James), Dam 9N, Dam 9W.

Table 6.3 - Haul road dust suppression demands

Item	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Maximum	3,155	3,775	4,255	4,240	3,020
90th Percentile	2,840	3,400	3,830	3,820	2,720
Median	2,600	3,110	3,505	3,495	2,490
10th Percentile	2,410	2,885	3,250	3,240	2,310
Minimum	2,255	2,700	3,040	3,030	2,160

6.3.3 Groundwater inflows

Groundwater inflows to the open cut mining areas over the life of the proposed modification were provided by AGE (2016). The estimates for the open cut pit inflows have been corrected for evaporation from pit walls.

The adopted groundwater inflow rates for water balance modelling are the average for each indicative mine plan stage, as shown in Table 6.4.

Table 6.4 - Groundwater inflows

Open-Cut Pit	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Cheshunt/Riverview	915	675	800	960	1,180
Carrington	60	60	60	60	60
Carrington West	-	280	-	-	-
South Lemington Pit 1	0	0	0	80	-
South Lemington Pit 2	-	-	-	530	-
Total	975	1,015	860	1,630	1,240

6.4 MODEL RESULTS

6.4.1 Mine water inventory

Figure 6.2 shows the simulated annual maximum water inventory (presented as a ranked plot against percentage of years exceeded) for the main HVO mine water dams and pits given in Table 4.1 for the base case and the four mine stages. The following is of note:

- The simulated results are generally comparable between scenarios. Annual maxima in future stages are generally within 10 to 20 per cent of baseline results.
- All future stages predict higher maximum volumes than the baseline scenario, with the exception of Stage 1.
- The annual probability of exceeding the combined storage capacity of 6,450ML is 10 to 25 per cent for all stages (except Stage 4 when the Riverview Void is removed). The annual probability of exceeding the combined storage capacity of 2,400ML is approximately 70 per cent in Stage 4.
- Using the 10 per cent AEP as a point of reference, the out of pit storage capacity is simulated to be exceeded for 100 days (1 GL excess) under baseline conditions, holding constant through Stage 1, and increasing to 150 days (1.4GL excess) and 200 days (1.8 GL excess) in Stage 2 and Stage 3 respectively. Results for Stage 4 are dominated by the loss of Riverview Void storage capacity. AEP of exceeding capacity increases to 70 per cent and excess volumes are nominally 4 GL higher than those predicted for other stages.

Should the stored site inventory exceed the available out of pit storage volume of 6,450ML over the remaining life of the existing HVO South approval, an existing active pit will be temporarily used to store the excess water. Alternatively, additional out of pit water storage infrastructure will be investigated.

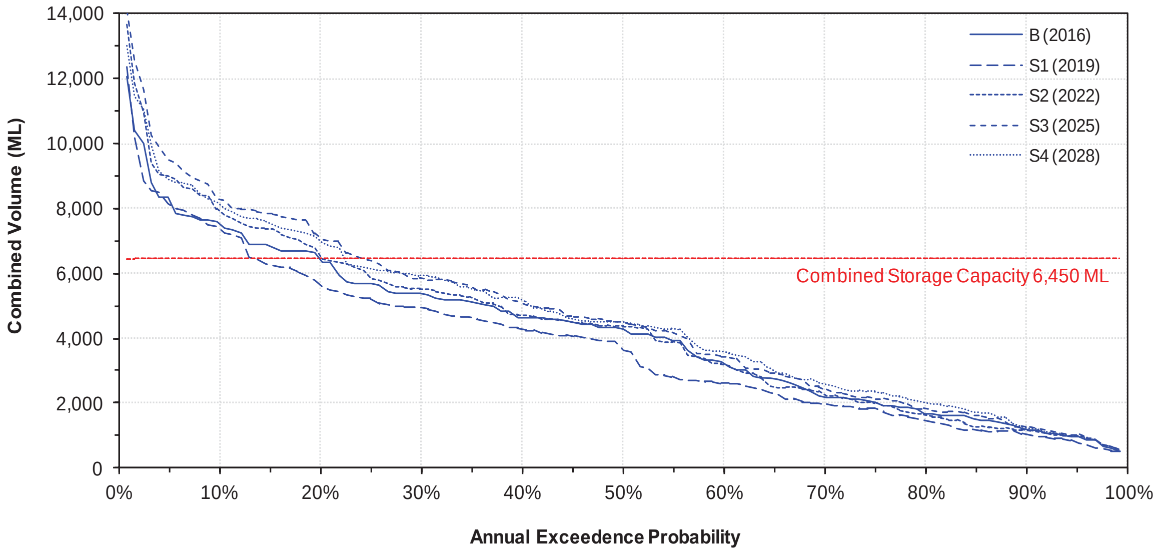

Figure 6.2 - Combined HVO inventory – maximum simulated volume vs AEP – all scenarios

6.4.2 External water supply requirement

Figure 6.3 shows the simulated annual external water supply requirements for the base case and the four indicative mine plan stages (presented as a ranked plot against percentage of years exceeded). These results are compared against the combined Hunter River allocations as well as the LUG Bore extraction allocations shared with MTW. Note however that these entitlements need to be offset to account for passive groundwater take from the Hunter River (via groundwater) and LUG Bore entitlement shared with MTW. Potential water import volumes from neighbouring mines (Wambo, Liddell etc), which are not fixed quantities are also not plotted. The results show the following:

The annual probability of requiring imported water is 45 to 55 per cent in all scenarios except Stage 1.

The highest water import requirements are simulated in Stage 1, primarily associated with increasing CPP water usage (with no moisture return from HCPP tailings) and increasing dust suppression usage, with comparatively little change in groundwater and catchment to offset. The AEP of requiring imported water in this stage is 70 per cent and the annual volumes of imported water are typically around 1.8GL higher than baseline results.

Existing water supply entitlements should be adequate to provide the mine with reliable water supply under all but very severe dry periods over the project life. Coal & Allied will ensure that it holds the required licences for the operations.

Should very extreme dry conditions occur, options such as maximising the return of water from the Cumnock void or the use of dust suppressant agents will be investigated.

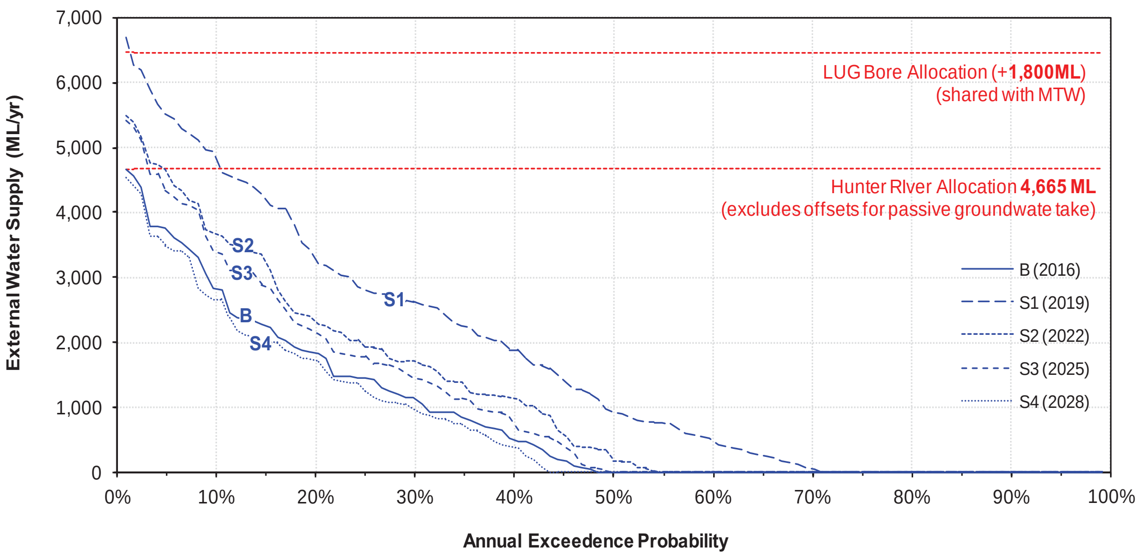

Figure 6.3 - Simulated external water supply requirements vs AEP

6.4.3 Off-site water discharges

Figure 6.4 shows the simulated annual controlled releases made under the HRSTS (presented as a ranked plot against percentage of years exceeded).

There is an annual probability of approximately 50 per cent of discharging water to the Hunter River under the HRSTS in all scenarios except for Stage 1, in which probability reduces to 40 per cent.

The annual probability of discharging greater than 2,000 ML/year under the HRSTS is approximately 10 per cent in all scenarios.

Other than discharges from the HRSTS dams, the modelling predicts no overflows from the MWD. The simulated annual discharge volumes to the environment from sediment dams steadily increase with each indicative mine plan stage, consistent with the increases in diverted catchment area. Increase in discharge volume between Stage 4 and the base case scenario is approximately 25 per cent.

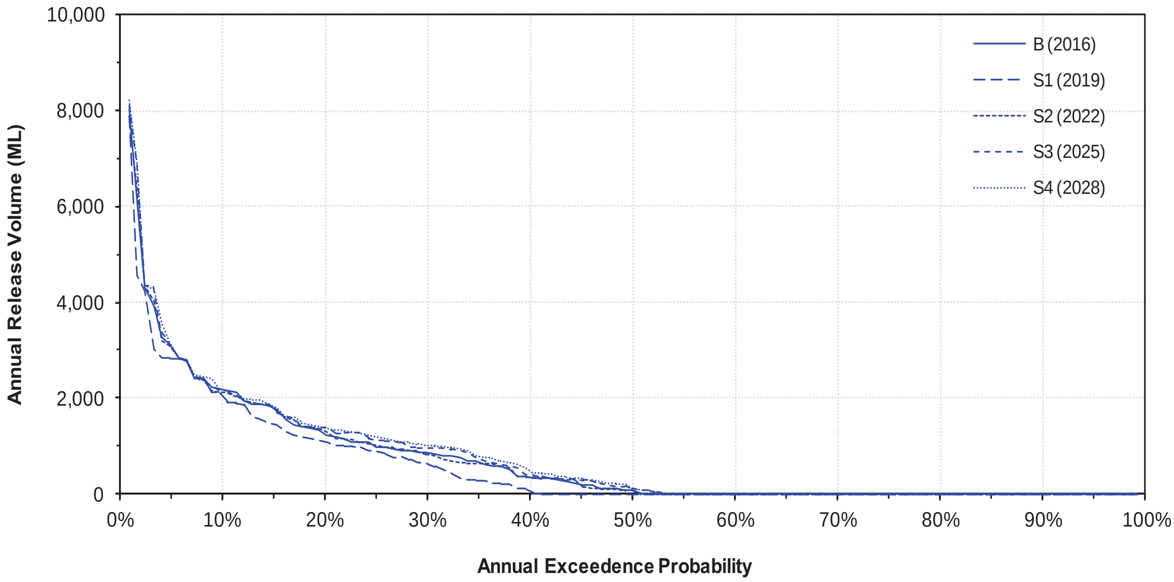

Figure 6.4 - Simulated annual HRSTS releases – all release points

6.4.4 Discussion of results

The results of the water balance modelling indicate that under the current model assumptions and configuration, there are no uncontrolled spills of mine-affected water. Therefore the HVO WMS is sufficient to prevent adverse impacts on the environmental values of the receiving waters.

Water will continue to be released to the Hunter River in accordance with the EPL and the HRSTS.

With the implementation of management measures in the existing WMP, the potential adverse impacts of the proposal on downstream water quality would be too small to measure.

The surface water salt load to the receiving environment could potentially be impacted in two ways:

- an increase in salt load due to overflows from dams containing salts accumulated from saline overburden and groundwater inflows; and
- a reduction in salt loads due to the capture of salt in catchment runoff intercepted by the water management system.

The water model balance results show that the untreated mine water is unlikely to flow into the receiving environment. It is therefore likely that salt will accumulate within the HVO WMS, and the total salt load released from the proposed modification to the receiving environment during operations will be less than that released by pre-mine conditions.

Sediment dams would only discharge following periods of rainfall that generate runoff in adjacent catchments. It is likely that the quality of water collected in sediment dams would be improved by fresh surface runoff inflows, and the total impact on downstream salinity will be small.

Some overflow of water from sediment dams may occur during wet periods that exceed the design standard of the sediment control system. In some cases these overflows would report to the pit and in others, depending on the status of mining and rehabilitation in the area, these overflows would flow to the surrounding environment. Overflows would only occur during significant rainfall events which will also generate runoff from surrounding undisturbed catchments. Hence, it is unlikely that sediment dam overflows will have a measurable impact on receiving water quality.

Runoff from rehabilitated areas would continue to be captured by sediment dams until water quality is within the range of water quality recorded from analogue sites and does not pose a threat to downstream water quality. Therefore, the total salt load released from the proposed final conceptual landform to the receiving environment would be generally consistent with pre-mine conditions.

6.5 WATER BALANCE

The average annual water balance for each modelled stage is presented in Table 6.5.

Table 6.5 - Average annual water balance

Item	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Inflows					
Rainfall and Runoff	7,045	7,550	7,565	7,725	7,545
Groundwater	975	1,010	860	1,625	1,240
ROM moisture	1,425	1,755	1,950	2,250	2,250
Pumped from MTW	440	530	430	380	395
External water supply	830	1,715	1,195	1,030	750
Sub-total	***10,715***	***12,560***	***12,000***	***13,010***	***12,180***
Outflows					
Evaporation	1,755	1,715	1,780	1,775	1,815
Tailings moisture retention	1,825	2,830	1,410	1,870	1,870
Haul road dust suppression	2,610	3,135	3,520	3,520	2,485
Misc. demands & vehicle wash	605	605	605	620	620
Pumped to MTW	305	250	270	275	315
Product coal moisture	1,410	1,685	1,880	2,160	2,160
Coarse reject moisture	555	730	810	950	950
HRSTS discharges	710	590	710	760	780
Mine-water dam discharges	0	0	0	0	0
Sediment dam discharges	940	1,020	1,015	1,080	1,185
Sub-total	***10,715***	***12,560***	***12,000***	***13,010***	***12,180***

6.7 PROPOSED FINAL CONCEPTUAL LANDFORM

At the completion of mining, a single final void will be retained at Riverview Pit. Figure 6.5 shows the location of the proposed Riverview Pit void.

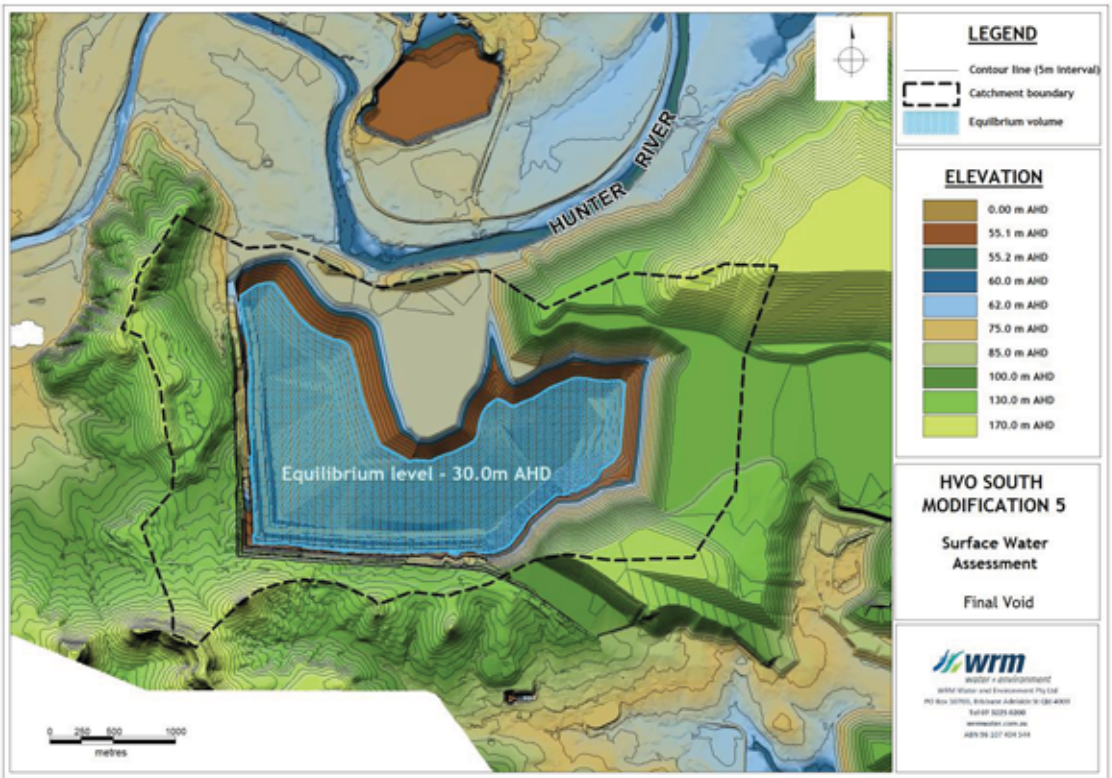

Figure 6.5 – Location and arrangement of proposed Riverview Pit final void

The landform will be shaped to minimise the surface water catchment draining to the void. The previous approval also requires the void to be protected from flooding in events up to and including the 1% annual exceedance probability design flood. However, the accumulation of surface runoff combined with groundwater inflows will result in the formation of a pond of water which will rise until the average rate of inflow is balanced by evaporation from its surface. This pond of water is referred to as the evaporative basin. As the final equilibrium void water level is expected to be 20m to 30m below the pre-mining groundwater level, the void will act as an evaporative sink with no escape of void water (AGE, 2016).

The geometry of the proposed void and its catchment are very similar to the approved void which is shown in Figure 6.6. Key characteristics of the proposed and approved voids are compared in Table 6.6.

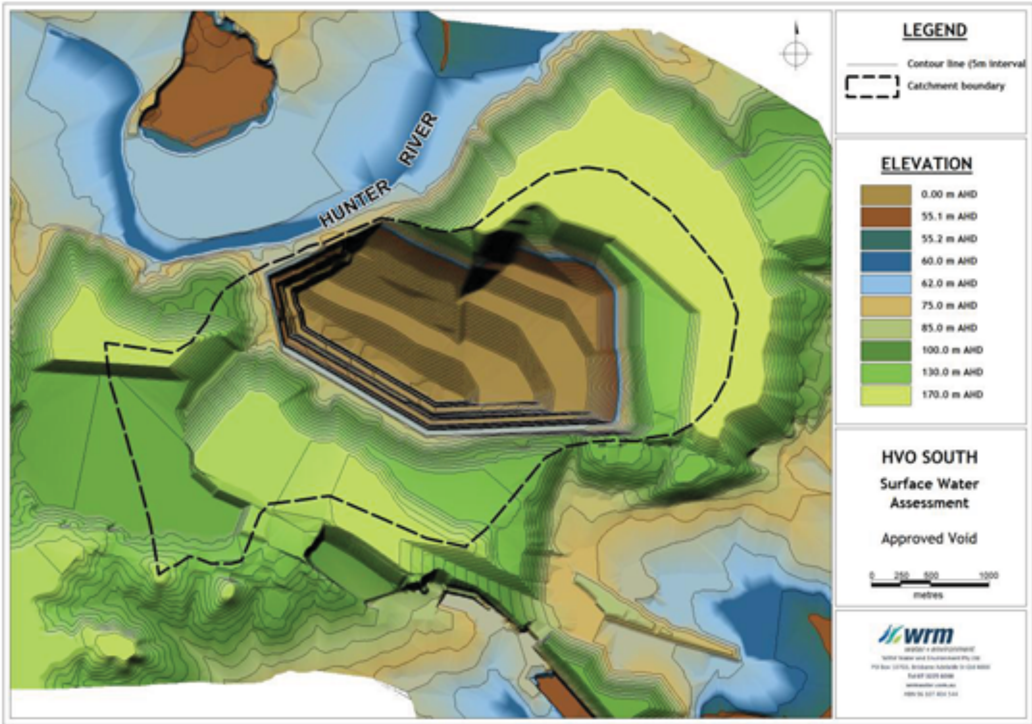

Figure 6.6 – Location and arrangement of approved Cheshunt Pit final void

Table 6.6 -Approved and proposed final void characteristics

Characteristic	Approved	Proposed
Catchment area (ha)	1,190	1,145
Minimum floor elevation (m AHD)	-135	-150
Spill level (m AHD)	72.5	72.5
Storage capacity at spill level (GL)	378	390
Equilibrium evaporative basin surface level (m AHD)	32	30
Depth to equilibrium evaporative basin surface below spill level (m)	40.5	42.5
Storage capacity at equilibrium level (GL)	216	212
Evaporative basin surface area at equilibrium level (ha)	340	337

The long-term behaviour of the void was simulated using the OPSIM software assuming floodwaters are excluded. Catchment runoff and evaporation were calculated from historical climate data on a daily time step from the catchment area and daily water surface area.

The equilibrium evaporative basin level is relatively sensitive to changes in long-term inflow rates (due to there being a relatively small increase in surface area with water depth). However, significant changes in water level influence the groundwater pressure differentials driving pit inflows, and result in changes to the rate of groundwater inflow.

Groundwater inflows and outflows were therefore modelled using storage level vs flow relationships developed through groundwater modelling (AGE, 2016).

The results of the simulation presented in Figure 6.7 and Table 6.7 show that evaporative basin levels are expected to reach equilibrium within approximately 300 years (the simulation period was extended by looping the Data Drill rainfall and evaporation data) at a stored volume near 212GL. The simulated water level reaches equilibrium with water levels fluctuating within 3m of 30mAHD. This is 42.5m below the crest of the void.

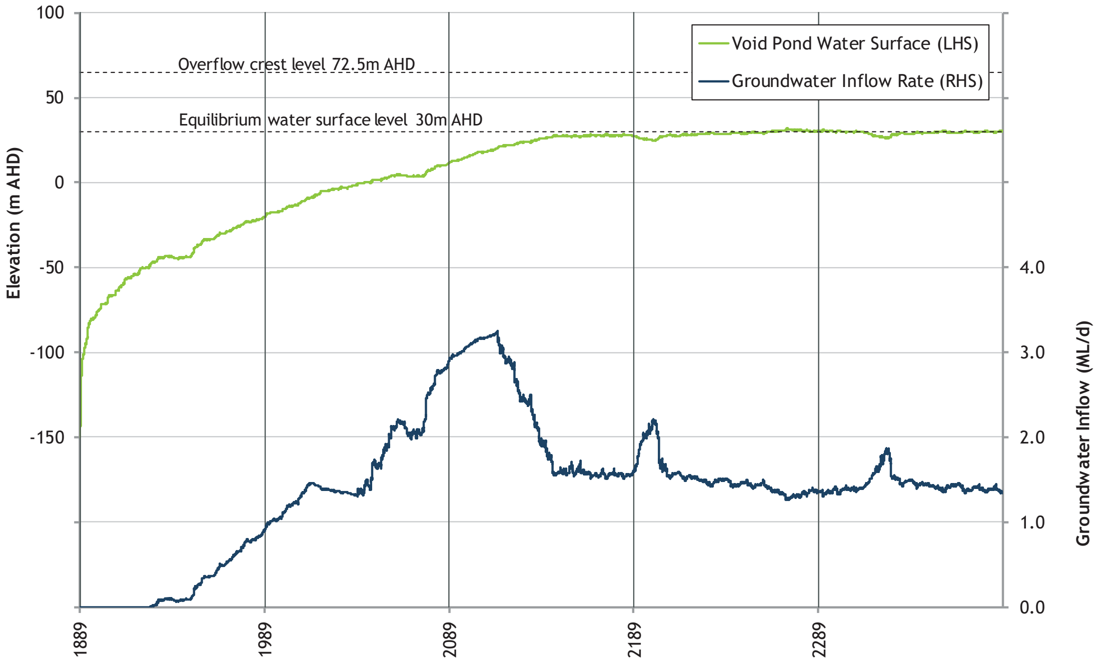

Figure 6.7 – Modelled final void evaporative basin water level and groundwater inflows

Table 6.7 – Equilibrium water balance of proposed Riverview pit final void (last 200 years of simulation)

Item	Inflow ML/a	Outflow ML/a
Catchment Runoff	621	0
Direct Runoff	2,113	0
Groundwater Inflow	541	0
Evaporation	0	3,223
Change in storage	0	52
Sum	**3,275**	**3,275**

As shown in Table 6.6, the equilibrium conditions are similar to those predicted by modelling of the approved void using similar methodology. For this analysis, groundwater inflows were also provided by AGE. The groundwater assessment report (AGE, 2016) states the following with respect to estimated inflows to the approved final void:

"The approved final void is located within Cheshunt Pit, up groundwater gradient of the proposed final void and closer to the Hunter River than the proposed final void. Given the location of the approved final void, it is considered likely that the recovered groundwater levels would be higher than the proposed modification. In order to be conservative, it was assumed that the approved final void would follow a similar recovery pattern to the proposed final void, with a final pit lake elevation of 35mAHD. This was remodelled by applying a series of constant heads over time, as per the recovery model for the proposed modification."

The results of the groundwater assessment are consistent with the results of the surface water modelling of the void for the range of modelled groundwater inflows.

In previous groundwater studies (ERM 2008), on the basis of spreadsheet modelling, the equilibrium water level of the approved evaporative basin was predicted to be significantly lower (0mAHD). The information presented in that report does not clearly state the groundwater inflow at equilibrium, and appears to significantly overestimate the surface area of the approved void. This is illustrated in Figure 6.7, which compares the surface area vs elevation relationships for the proposed and approved voids with the relationship described in the previous study.

The present study includes a more rigorous representation of the void geometry, as well as catchment and water storage response to historical daily climate conditions. It is therefore considered to be more likely to be representative of long-term behaviour given the predicted groundwater inflows.

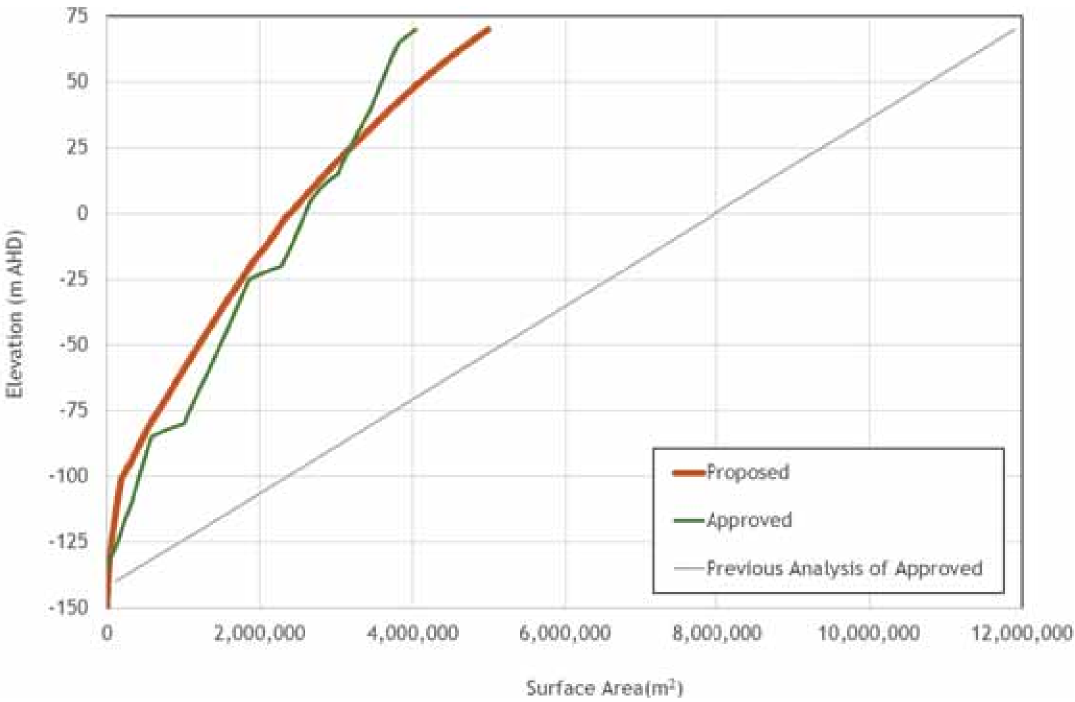

Figure 6.7 – Surface area – elevation relationships for proposed and approved voids

Surface and groundwater inflows will also bring salt into the voids over the long term. The salinity of the evaporative basin will gradually increase over time – and eventually reach levels exceeding 20,000µS/cm.

6.8 CUMULATIVE SURFACE WATER IMPACTS

The cumulative surface water impacts of coal mining in the Hunter Valley include the potential for impacts on both surface water quality and quantity.

A number of other coal mines are located in the immediate vicinity of the HVO site. Nearby operations include the Wambo, Mount Thorley, Warkworth and Bulga Mines, and the Redbank Power Station.

Cumulative impacts on salinity, a key potential impact of coal mining, are managed at a whole-of-catchment scale through the HRSTS (see Section 2.8). HVO South currently participates in the HRSTS and from time to time makes releases of water from the site in accordance with the scheme rules. As demonstrated by analysis of historical surface water quality data (see Section 3.5) to date HVO South has not resulted in a measurable adverse impact on water quality in the Hunter River.

The proposed modification will not affect the successful operation of the HVO WMS. Hence, there are not expected to be any additional water quality impacts associated with the proposed modification.

The proposed modification can potentially contribute to impacts on water quantity through capture of surface runoff for recycling at HVO and use of external water supplies to supplement water collected. The proposed modification will not result in an increase in the amount of captured catchment area at HVO. Hence, there will be no additional contribution to cumulative impacts by the proposed modification.

Any water taken from the Hunter River Regulated Water Source is taken under a Water Access Licence (WAL - see Section 2.3.2). WALs are allocated by considering water availability and community water use requirements across the entire catchment. The use of water allocated under a WAL will not adversely affect the opportunity of other licence holders to access their licenced water entitlement (subject to water availability as determined by climatic conditions).

7 Mitigation, management and monitoring

7.1 OVERVIEW

The assessment in Section 6 demonstrates that impacts of the proposed modification on surface water resources can be managed and mitigated by implementing the existing water management strategy as described in the WMP (2015) and summarised in Section 0.

The existing documents used to manage water on site will be updated to incorporate the proposed modification. These changes are described below.

7.1.1 Water Management Plan

The existing WMP would be reviewed and revised to incorporate the proposed modification. The WMP includes provisions for review of the site water balance, erosion and sediment controls, water monitoring and management.

The WMP would describe the water management protocols and response procedures for the HVO WMS that would be adhered to throughout the operation of the proposed modification.

7.1.2 Site water balance

Review and progressive refinement of the site water balance model would continue to be undertaken on a regular basis.

7.1.3 Erosion and Sediment Control Plan

The Erosion and Sediment Control Plan would be reviewed and updated for the proposed modification.

7.1.4 Surface water management and monitoring plan

The existing surface water monitoring program, which is included in the HVO Surface Water Management and Monitoring Plan of the WMP, is considered sufficient for the purposes of monitoring potential impacts associated with the proposed modification. The disturbance footprint remains within the existing approved disturbance area and as such monitoring of additional areas is not required.

8 Conclusions

The outcomes of this surface water assessment are summarised below.

The potential impacts of the proposed modification on surface water resources can be managed and mitigated by the updating and implementing the existing water management strategy. The WMP and associated existing documents would be reviewed and updated to incorporate the proposed modification. The existing surface water monitoring program is sufficient for the purposes of monitoring potential impacts associated with the proposal.

In conjunction with WALs for extraction from the Hunter River Regulated Water Source, the proposed revisions to the HVO WMS provide a sufficiently reliable water supply over the life of the proposed modification. The proposed modification will not result in an increase in the amount of captured catchment area at HVO, and therefore it will not cause additional impacts on downstream flows.

Controlled release of excess mine water to the Hunter River would continue to be made in accordance with the HRSTS. The water balance modelling results show that the proposed modification would not significantly change the frequency and magnitude of releases under the HRSTS.

The water balance modelling results demonstrate the proposed modification's water management strategy would result in no uncontrolled releases of mine water to the receiving environment under historical climate conditions.

Saline water will accumulate in the final void. The proposed final void and catchment configuration is expected to result in a ponded water surface which will reach an equilibrium level (where runoff and groundwater inflows match evaporative losses) after several hundred years at an elevation approximately 35m below the crest of the void. That is, the final void would not overflow into the Hunter River.

9 References

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Appendix A Water quality

A1 Receiving water quality

Table A.1 - Other tributaries water quality summary

Monitoring Site	Value	EC Field (µS/cm)	EC Lab (µS/cm)	pH Field	pH Lab	Sulphate (mg/L)	Turbidity (NTU)
W5 (Farrells Ck Downstream)	Min	850	1,160	7.1	7.1	143	4.1
	Max	11,390	6,140	8.9	8.7	943	4.1
	20%ile	1,248	3,650	7.7	7.7	303	4.1
	Median	4,660	5,715	8.4	7.9	543	4.1
	80%ile	5,352	5,990	8.6	8.2	783	4.1
	No. of Samples	74	16	83	5	2	2
W5 (Farrells Ck Upstream)	Min	310	355	6.5	6.7	173	2.1
	Max	18,160	2,420	8.8	8.2	173	6.4
	20%ile	990	1,220	7.5	7.4	173	3.0
	Median	1,245	1,885	7.8	7.8	173	4.3
	80%ile	2,336	2,310	8.1	8.2	173	5.5
	No. of Samples	92	6	96	6	1	2
Bayswater Creek Downstream	Min	643	125	7.5	6.9	16	1.0
	Max	3330	125	8.2	6.9	768	4.9
	20%ile	2,026	125	7.7	6.9	426	1.8
	Median	2,220	125	7.8	6.9	506	3.1
	80%ile	2,820	125	7.9	6.9	572	4.3
	No. of Samples	14	1	14	1	6	4
Bayswater Creek Mid	Min	2,210		7.8		553	1.8
	Max	5,160		8.4		809	28
	20%ile	2,976		8,0		562	2.1
	Median	3,420		8.1		682	2.9
	80%ile	4,508		8.2		801	13
	No. of Samples	19		19		4	4
Bayswater Creek	Min	2,080	3,220	7.8	7.8	510	1.4
	Max	5,020	3,220	8.4	7.8	771	2.8

Upstream	20%ile	2,834	3,220	8.0	7.8	544	1.4
	Median	3,315	3,220	8.1	7.8	586	1.4
	80%ile	4,416	3,220	8.3	7.8	683	2.2
	No. of Samples	20	1	20	1	6	3
NSW 2 (Emu Ck)	Min	100	264	7.3	7.1	156	0.4
	Max	10,910	264	9.3	7.1	871	350
	20%ile	912	264	7.5	7.1	396	3.1
	Median	5,185	264	7.9	7.1	670	6.3
	80%ile	8,572	264	8.4	7.1	819	70
	No. of Samples	48	1	48	1	4	32
NSW1 (Parnells Ck)	Min	520	1,350	7.9	7.9	150	1.4
	Max	8,530	1,350	9.6	7.9	1,180	31
	20%ile	2,680	1,350	8.3	7.9	570	3.3
	Median	3,960	1,350	8.5	7.9	950	13
	80%ile	7,716	1,350	8.9	7.9	1,102	25
	No. of Samples	12	1	12	1	4	4
Carrington Billabong	Min	379		6.8		27	
	Max	900		8.2		27	
	20%ile	428		7.0		27	
	Median	520		7.9		27	
	80%ile	644		8.1		27	
	No. of Samples	5		5		1	
Carrington Downstream	Min	121	89	6.7	7.1	1	4
	Max	405	89	9.5	7.1	25	406
	20%ile	223	89	6.9	7.1	5	104
	Median	318	89	7.7	7.1	6	251
	80%ile	360	89	8.0	7.1	20	401
	No. of Samples	7	1	7	1	8	6
Carrington Upstream	Min	79	75	6.6	6.8	1	30
	Max	223	75	7.2	6.8	13	213
	20%ile	108	75	6.7	6.8	1	39
	Median	130	75	6.8	6.8	5	64
	80%ile	221	75	7.1	6.8	7	135
	No. of Samples	5	1	5	1	6	4

NSW3 Davis Ck	Min	230		7.2			48
	Max	230		7.2			48
	20%ile	230		7.2			48
	Median	230		7.2			48
	80%ile	230		7.2			48
	No. of Samples	1		1			1
Pikes Creek Downstream	Min	1,940	1,555	7.2	7.4	440	0.4
	Max	6,070	1,555	8.1	7.4	1,840	35
	20%ile	3,670	1,555	7.5	7.4	832	1.8
	Median	4,215	1,555	7.7	7.4	1,230	2.3
	80%ile	5,390	1,555	7.9	7.4	1,390	4.4
	No. of Samples	18	1	17	1	9	8
Pikes Creek Upstream	Min	2,060	1,933	6.8	7.2	550	1.4
	Max	11,250	1,933	8.2	7.2	3,390	27
	20%ile	5,372	1,933	7.4	7.2	1,240	3
	Median	6,515	1,933	7.7	7.2	2,090	6.4
	80%ile	8,226	1,933	7.8	7.2	2,442	1
	No. of Samples	20	1	20	1	9	8
Redbank Creek Catchment - Special Sampling	Min	177	333	7.1	8.3	2	4.5
	Max	353	333	9.1	8.3	23	124
	20%ile	212	333	7.5	8.3	5	13
	Median	253	333	7.6	8.3	10	37
	80%ile	304	333	7.8	8.3	17	85
	No. of Samples	9	1	9	1	10	8
Comleroi Ck	Min	90	47	6.4	6.5	1	12
	Max	1,230	1,510	8.7	8.9	73	320
	20%ile	192	314	6.9	7.2	2	17.8
	Median	300	562	7.3	7.6	9	30
	80%ile	532	1,042	7.9	7.8	23	59
	No. of Samples	85	44	85	44	15	24
Barellan	Min	185	104	7.1	6.6	1	27
	Max	606	104	8.4	6.6	54	1,350
	20%ile	260	104	7.1	6.6	6	60
	Median	312	104	7.5	6.6	14	217

	80%ile	428	104	8.3	6.6	35	651
	No. of Samples	6	1	6	1	6	5
W11 (Farrells Ck Lemington Rd)	Min	200	122	7.2	7.1	42	5
	Max	2,430	122	8.9	7.1	67	193
	20%ile	622	122	7.5	7.1	51	16
	Median	770	122	7.9	7.1	59	44
	80%ile	1939	122	8.4	7.1	63	117
	No. of Samples	28	1	28	1	4	18

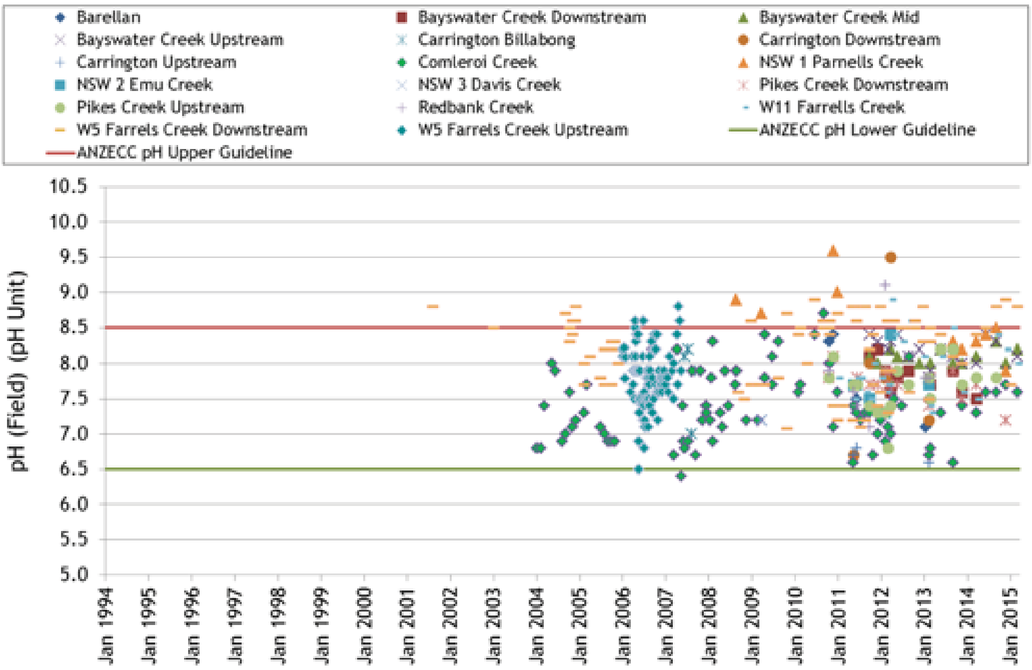

Figure A.1 - pH - Other tributaries

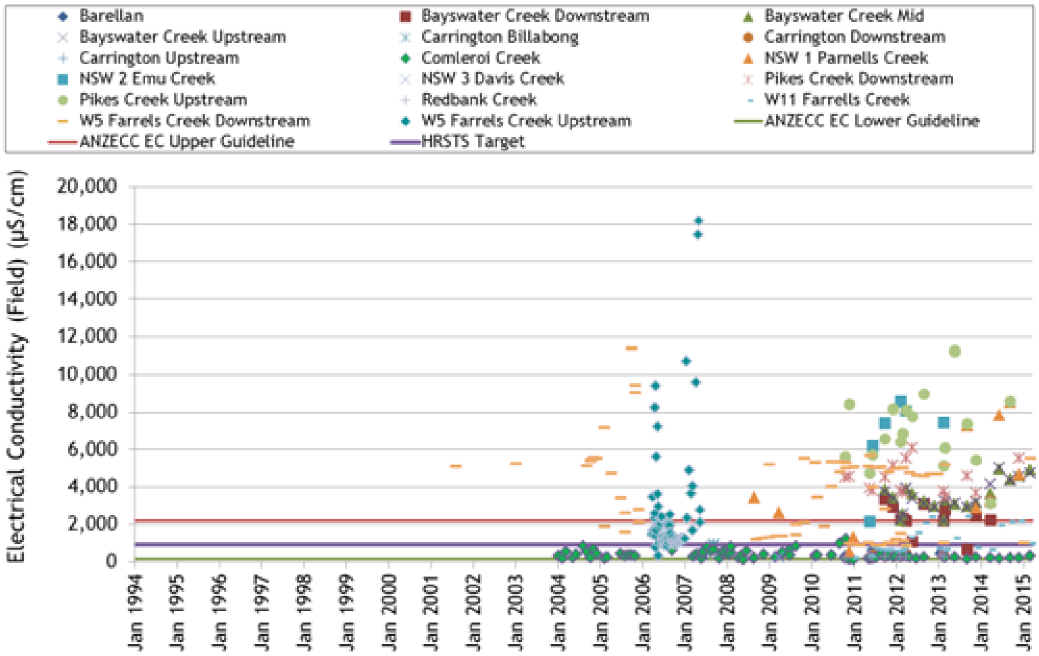

Figure A.2 – EC – Other tributaries

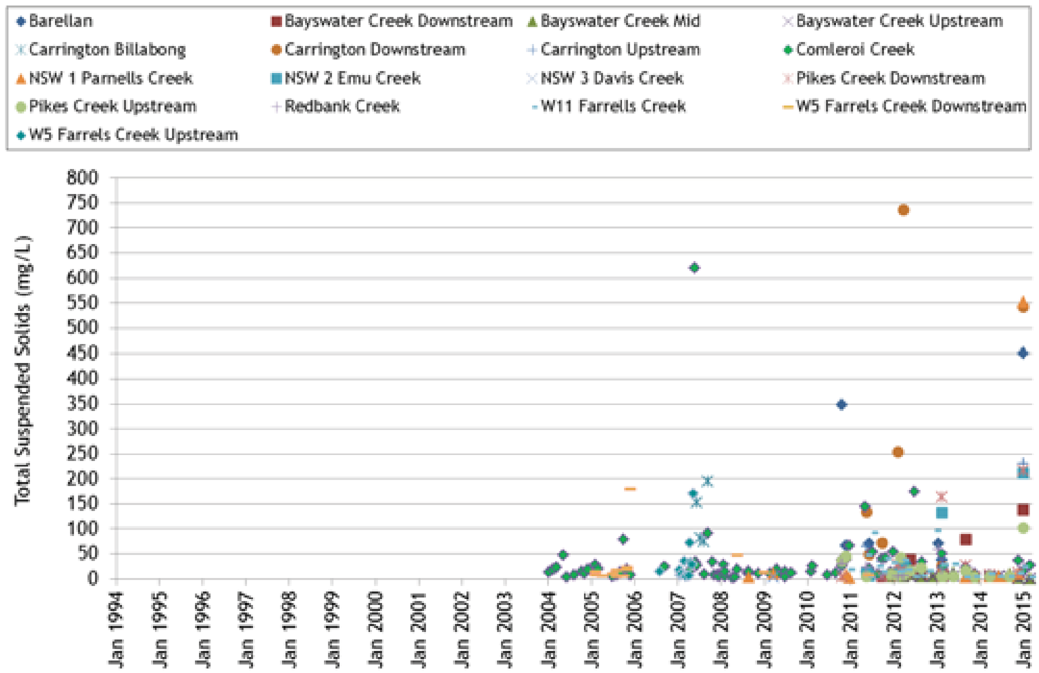

Figure A.3 – TSS – Other tributaries

A2 Site water quality

Table A.2 - Site dams water quality summary

Monitoring Site	Value	EC Field (µS/cm)	EC Lab (µS/cm)	pH Field	pH Lab	Sulphate (mg/L)	Turbidity (NTU)
11NDP	Min		7,340		8.4		1.1
	Max		7,340		8.4		27
	20%ile		7,340		8.4		2.1
	Median		7,340		8.4		4.3
	80%ile		7,340		8.4		7.5
	No. of Samples		1		1		65
Dam 10N	Min	163		7.4			
	Max	4,820		9.8			
	20%ile	204		8.2			
	Median	305		8.5			
	80%ile	512		8.9			
	No. of Samples	24		25			
Dam 11(N)	Min	800	885	7.7	5.1	455	0.6
	Max	8,020	7,120	9.4	8.8	1,875	370
	20%ile	4,594	2,964	8.3	6.7	811	1.6
	Median	5,580	4,415	8.6	7.1	938	2.8
	80%ile	6,420	5,800	8.9	7.7	1,122	7.0
	No. of Samples	123	130	129	129	14	65
Dam 11N (Discharge)	Min	4,630	5,480	7.3			5.6
	Max	6,980	5,700	9.0			5.6
	20%ile	5,006	5,510	8.4			5.6
	Median	5,270	5,560	8.7			5.6
	80%ile	5,604	5,634	8.8			5.6
	No. of Samples	55	4	62			1
Dam 15(N)	Min	820	1,710	5.5	7.6	1	2.8
	Max	24,700	31,320	10.4	1,002	874	490
	20%ile	2,430	2,096	8.8	9.4	264	8.5
	Median	4,250	2,210	9.2	9.9	475	16
	80%ile	5,480	2,576	9.6	10	719	73

	No. of Samples	119	17	120	16	12	23
Dam 16W	Min	583		7.2			
	Max	1,134		8.8			
	20%ile	679		7.7			
	Median	802		8.2			
	80%ile	1,031		8.7			
	No. of Samples	8		8			
Dam 17N	Min	2,430	2,400	8.3	8.6		4.4
	Max	7,680	2,400	8.8	8.6		5.0
	20%ile	3,698	2,400	8.4	8.6		4.5
	Median	5,600	2,400	8.6	8.6		4.7
	80%ile	6,848	2,400	8.7	8.6		4.9
	No. of Samples	3	1	3	1		2
Dam 17W	Min	227		7.5			
	Max	580		8.9			
	20%ile	262		7.8			
	Median	310		8.0			
	80%ile	365		8.3			
	No. of Samples	10		10			
Dam 18W Parnell's Ck	Min	676	1,980	8.1		320	1.2
	Max	14,180	1,980	10.0		1,730	78
	20%ile	2,344	1,980	8.4		491	2.0
	Median	3,910	1,980	8.8		750	6.0
	80%ile	6,970	1,980	9.1		991	14
	No. of Samples	27	1	28		6	18
Dam 20N Final Dam	Min	310	3,600	7.6	9.4	78	
	Max	11,000	4,600	10	9.6	78	
	20%ile	759	3,800	8.4	9.4	78	
	Median	1,210	4,100	9.2	9.5	78	
	80%ile	3,580	4,400	9.4	9.6	78	
	No. of Samples	40	2	40	2	1	
Dam 25N	Min	250	5,920	7.0		6.0	1.9

	Max	5,920	5,920	9.4		794	78
	20%ile	622	5,920	8.4		7.0	6.3
	Median	707	5,920	8.7		12.5	11
	80%ile	839	5,920	8.8		30	27
	No. of Samples	40	1	41		6	27
Dam 25S	Min	158	410	6.8	7.6	2	5
	Max	1,420	485	9.1	7.6	25	371
	20%ile	208	425	7.5	7.6	5.8	20
	Median	248	448	8.0	7.6	14	49
	80%ile	350	470	8.5	7.6	19	109
	No. of Samples	43	2	43	1	8	31
Dam 2S	Min	210		7.2			
	Max	640		9.3			
	20%ile	280		7.5			
	Median	329		8.1			
	80%ile	390		8.6			
	No. of Samples	18		19			
Dam 2W	Min	1,140	3,050	8.2	8.8	469	1.9
	Max	5,470	4,090	9.3	8.9	966	26
	20%ile	2,862	3,128	8.8	8.8	683	6.4
	Median	3,930	3,515	8.9	8.8	741	9.4
	80%ile	4,744	3,946	9.1	8.8	822	18
	No. of Samples	24	4	24	4	5	20
Dam 3W	Min	2,180	2,800	8.4	9.1		1.8
	Max	7,150	3,220	10	9.6		93
	20%ile	2,744	2,884	9.1	9.2		2.8
	Median	3,140	2,985	9.4	9.3		9.0
	80%ile	4,192	3,106	9.8	9.4		15
	No. of Samples	23	4	23	4		22
Dam 4W	Min	1,326	2,100	7.2	7.3		2.6
	Max	4,890	3,650	9.7	9.6		88
	20%ile	2,542	2,686	8.9	8.6		5.1
	Median	3,400	3,110	9.1	9.2		9.1

	80%ile	4,582	3,288	9.3	9.2		19
	No. of Samples	27	9	26	9		24
Dam 5S	Min	225	770	6.9		3	0.9
	Max	7,390	770	9.8		96	1,720
	20%ile	291.2	770	7.4		4.6	2.08
	Median	358	770	7.7		9	4.4
	80%ile	486	770	8.1		26.8	40.36
	No. of Samples	35	1	36		7	27
DM6 North Void Tailings	Min	3,050		8.2		854	6.2
	Max	8,680		9.1		1,780	250
	20%ile	4,412		8.7		920	55
	Median	5,750		8.8		1,215	128
	80%ile	6,952		8.9		1,360	201
	No. of Samples	25		25		6	2
New Dam (9N)	Min	3,420		8.4		773	2.3
	Max	8,740		9.2		1,170	20
	20%ile	4,440		8.7		785	4.1
	Median	5,100		8.7		802	6.5
	80%ile	5,534		8.9		1,023	8.5
	Count	18		19		3	18
Wyoming Bore	Min	2,100		7.1			
	Max	2,380		7.4			
	20%ile	2,156		7.2			
	Median	2,240		7.3			
	80%ile	2,324		7.3			
	Count	2		2			
Coal Loader Dam	Min	315	3,050	6.1	8.6	625	1
	Max	7,600	5,110	9.6	9.1	1275	60
	20%ile	3,364	3,098	8.5	8.7	682	2.8
	Median	4,610	3,170	8.7	8.8	912	6.7
	80%ile	5,732	4,334	9.0	9.0	965	18
	Count	139	3	140	2	8	33
EOC	Min	570	930	7.3	8.5		
	Max	5,490	6,360	9.5	9.5		

	20%ile	1,102	2,680	8.5	8.9		
	Median	2,140	3,450	9.0	9.1		
	80%ile	2,714	3,780	9.2	9.3		
	Count	67	59	66	59		
K Dam (Lake James)	Min	1,240	329	7.9	7.8	344	1.1
	Max	36,000	78,400	10	9.5	4,700	82
	20%ile	3,172	2,502	8.9	8.9	524	2.1
	Median	5,200	2,860	9.1	9.1	609	4.2
	80%ile	6,234	4,562	9.3	9.2	689	13
	Count	115	77	117	74	13	46
Emu Creek Sed Dam	Min	152	397	5.7	8.2	10	6
	Max	1,060	925	9.8	8.4	174	1,800
	20%ile	256	503	7.8	8.2	24	14
	Median	420	661	8.3	8.3	46	90
	80%ile	639	819	8.7	8.4	111	370
	No. of Samples	78	2	78	2	8	55
W9 (Dam 14W)	Min	345	2,230	6.6	6.7	725	1.5
	Max	14,640	11,500	9.2	9.0	2,250	130
	20%ile	3,718	4,670	7.9	7.5	800	2.5
	Median	5,325	7,150	8.3	7.9	1,124	6.3
	80%ile	8,882	9,640	8.7	8.2	1,280	13
	Count	84	16	75	33	8	34
K Dam (Lake James) Non Routine Discharge Samples	Min	333	1,720	7	8.5		45
	Max	5,730	3,330	9.8	9.8		465
	20%ile	2,340	1,816	8.9	8.8		50
	Median	3,140	2,500	9.0	9.4		61
	80%ile	5,240	3,242	9.1	9.7		328
	Count	57	5	61	4		6
Farrells Ck Sed Dam	Min	242		8			
	Max	242		8			
	20%ile	242		8			
	Median	242		8			
	80%ile	242		8			
	No. of Samples	1		1			
Bob's Dump	Min	440		7.6		805	0.9

Tailings Dam (20W)	Max	22,200		9.3		4,400	85
	20%ile	3,880		8.3		926	3.2
	Median	5,590		8.5		1,210	7.8
	80%ile	8,510		8.8		4,348	24
	Count	36		37		8	27
W3 (Parnells Ck Dam)	Min	490	2,050	7.7	7.3	429	0.3
	Max	11,840	9,470	9.9	9.9	1,650	231
	20%ile	3,600	2,540	8.8	8.0	709	3.2
	Median	4,390	2,670	9.0	8.5	871	6.4
	80%ile	5,850	3,494	9.3	9.3	995	17
	No. of Samples	141	149	166	148	16	60
W3 (Parnells Creek Dam) Non Routine Discharge Sampling	Min	2,530	4,560	8.7	8.9		
	Max	5,130	5,000	9.5	9.0		
	20%ile	3,900	4,596	8.9	8.9		
	Median	4,030	4,640	9.0	8.9		
	80%ile	4,300	4,796	9.2	8.9		
	No. of Samples	36	4	38	4		

Appendix B HVO South Modification - Water Balance Modelling Report (HATCH 2016)

Report

HVO South Modification - Water Balance Modelling

H350150-00000-228-230-0001

			[signature]	[signature]	[signature]	
2016-05-16	2	Approved for Use	G. Rootsey	J. Heaslop	J. Heaslop	Not required
DATE	REV.	STATUS	PREPARED BY	CHECKED BY	APPROVED BY	APPROVED BY
				Discipline Lead	Functional Manager	Client

Executive Summary

Hunter Valley Operations (HVO) is an existing open cut coal mine located approximately 24 kilometres (km) north-west of Singleton, New South Wales. The mine is managed by Rio Tinto Coal Australia (RTCA) on behalf of Coal & Allied Industries Pty Ltd (Coal & Allied). Mining activities at HVO are geographically divided by the Hunter River into HVO North and HVO South. While HVO is managed as a single integrated operation, HVO North and HVO South each have separate planning approvals.

Modification to the HVO South approval (PA 06_0261) is required to enable the implementation of an efficient and flexible mine plan to meet market conditions. The proposed modification (HVO South Modification 5) will enable the mining of deeper coal seams within the existing approved disturbance footprint. Mining of deeper seams also requires revisions to the mines overburden emplacement strategy and final landform. The proposed modification also seeks to increase the rate of extraction and processing from 16 Million tonnes per annum (Mtpa) to 20 Mtpa of run of mine (ROM) coal during peak production.

EMM Consulting Pty Limited (EMM) has been engaged by Coal & Allied as the lead consultant for the preparation of environmental studies associated with the proposed modification, including a detailed Environmental Assessment (EA). Hatch has been engaged to undertake surface water balance modelling components for the proposed modification EA.

Investigations have included documentation of the existing water management system (WMS) and review of mine planning information to define proposed WMS changes under future conditions. Proposed changes to the existing HVO South WMS identified as part of this study include:

- Changes to catchment areas reporting to various water storages and open cut pits, and changes in catchment land use composition as mining progressing
- Removal of several minor water storages within the existing Cheshunt Pit catchment
- Progressive rehabilitation of disturbed catchment areas, and diversion of clean catchment runoff off-lease via sediment dams. Investigations have identified five nominal locations where sediment dams are proposed for construction.
- Changes in water usage practices, including increased haul road dust suppression water use, and water supply to the approved Lemington Coal Processing Plant (LCPP) following its construction, and pumped return of tailings recovered LCPP tailings moisture
- Backfilling of Riverview Void mine water storage nominally two years from the end of mining
- Modifications to the pump and pipeline network to meet operational requirements

Investigations have also included development of an operational water balance computer model for the integrated HVO South and HVO North operations. The base case model has been developed and calibrated using monitoring data collected by Coal & Allied during 2014 and 2015. Design model scenarios for four future scenarios have also been developed based on mine planning information. Long-term historical rainfall and evaporation data for the project site are used as climate input to the model; the input time-series includes the wettest and driest historical climate sequences observed in the past 123 years. The model has been used to assess the performance of the HVO WMS under current and expected future conditions. Key outcomes of the assessment include:

Safety • Quality • Sustainability • Innovation

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- There are no new mine water storage proposed for construction at HVO South. Under all scenarios, there is a 10-25 per cent probability that the combined water storage capacity of the site will be exceeded in a given year, resulting in temporary storage of water in-pit. Any potential impacts on production or safety are operational risks that will be managed by the mine, and are not considered to pose any material risk to the environment. Note that outcomes are based on the assumption that an inactive mining pit at HVO North will be temporarily converted to a dedicated water storage nominally in 2028, to replace Riverview Void which is scheduled to be backfilled.
- Existing water supply allocations held by the mine are expected to be adequate to supply future operational water requirements, in all modelled scenarios. Provisions for external water supply include extraction entitlements from the Hunter River and LUG Bore, and water sharing arrangements with neighboring mines.
- Hunter River Salinity Trading Scheme (HRSTS) licensed discharges are required in all future scenarios. Assuming existing operating rules remain constant in future scenarios, the annual probability of requiring HRSTS release is simulated at 40 to 50 per cent.
- There are no simulated non-HRSTS discharges from any mine water dams to the environment reported in any of the scenarios considered.
- Simulated annual discharge volumes to the environment from sediment dams steadily increase with each scenario, consistent with increases in diverted catchment area. Increases in annual discharge volume between the base case and the last design scenario (nominally 2028) are approximately 25 per cent.

The HVO water balance model developed by Hatch and documented in this report is considered to be suitable for assessing the performance of the HVO WMS. Investigations have been undertaken to a level of detail sufficient to maintain a fair and reasonable appreciation of the hydrological characteristics of the HVO WMS under current and proposed future site conditions, as best as can be determined based on available information.

Potential impacts on operational performance have been identified as part of the surface water balance assessment (e.g. temporary storage of mine water in-pit); however operational risks will be managed by Coal & Allied, and are not expected to result in any material change in risk to the surrounding environment relative to current conditions. This is a key overall outcome of the current assessment.

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Safety ● Quality ● Sustainability ● Innovation

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1. Introduction

HVO South is integrated at an operational level with HVO North (together described as 'HVO') and has the ability to move material and associated equipment around HVO including run-of-mine (ROM) coal, product coal, coal rejects, overburden and water as required. HVO is an existing open cut coal mine approximately 24 kilometres (km) north-west of Singleton, NSW. The mining activities at HVO are geographically divided by the Hunter River into HVO North and HVO South. While HVO is managed as one operation, HVO North and HVO South each have separate planning approvals.

Mining operations first commenced at the now HVO over 65 years ago, in 1949. Since its inception, HVO has been, and will continue to be, an important economic driver in the Hunter Valley economy. It directly employees approximately 1,160 permanent staff, all of which reside in the Hunter region.

HVO South operates under PA 06_0261, which was granted by the then Minister for Planning on 24 March 2009, under Part 3A of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The original approval has been modified on four occasions, predominately relating to administrative matters. The mine is within the Singleton local government area (LGA).

HVO South comprises the Riverview Pit, Cheshunt Pit and South Lemington Pits 1 and 2, Lemington Coal Preparation Plant (LCPP) and all related mining activities and infrastructure such as overburden and tailings emplacement areas and the approved but yet to be constructed conveyor, rail, or haul road option(s) to transport product coal from LCPP to the Wambo rail spur.

Modification to the Hunter Valley Operations South (HVO South) project approval PA 06_0261 (PA 06_0261) is required to enable the implementation of an efficient and flexible mine plan to meet market conditions. PA 06_0261 authorises mining in three main areas namely:

- Cheshunt Pit;
- Riverview Pit; and
- South Lemington Pits 1 and 2.

Mine sequencing at HVO South has the Cheshunt and Riverview Pits operating concurrently. The Riverview Pit is designed to extract the seams down to the base of the Bowfield. Cheshunt Pit which is approved to the base of the Bayswater seam is designed to advance through the mined areas in Riverview Pit, stepping up from the deeper Bayswater seam to extract the seams from below the Bowfield seam, including the Vaux seam. South Lemington Pits are mined separately to Cheshunt and Riverview and are approved to mine to the base of the Bowfield seam.

The proposed modification will enable the Cheshunt Pit to continue mining through the Riverview area extracting the deeper Bayswater seam below the Vaux seam. The proposed modification will also enable mining down to the Vaux seam below the Bowfield seam in South Lemington Pit 2. Mining of the deeper seams will occur within the existing approved disturbance footprint.

The mining of the deeper seams will require a revision to HVO South's overburden emplacement strategy. The overburden emplacement strategy requires an increase in dump height in some areas and provides the opportunity to develop a more natural landscape into the post mining landform design using micro-relief design techniques. The change in the mine design also moves the evaporative basin in the void further from the Hunter River.

The proposed modification also seeks to increase the rate of extraction and processing from 16 Million tonnes per annum (Mtpa) to 20 Mtpa of ROM coal during peak production. This will provide HVO South with flexibility for production interactions with HVO North to meet changing market conditions.

In summary, Coal & Allied is seeking to modify PA 06_0261 to allow:

- the progression of mining of the deeper Bayswater seam from Cheshunt Pit into Riverview Pit and mining the Vaux seam below the Bowfield seam in South Lemington Pit 2;
- a modification to the currently approved overburden emplacement strategy resulting in, amongst other changes, the relocation and shape of the evaporative basin in the void and the inclusion of more natural landform with micro-relief design into the post mining landform design;
- an increased rate of extraction from 16 Mtpa to 20 Mtpa ROM coal at peak production and an increased processing rate of coal extracted from HVO South from 16 Mtpa to 20 Mtpa of ROM coal across HVO coal preparation plants; and
- the removal of redundant prescriptive blasting conditions and replacement with contemporary outcome based conditions.

The proposed modification will not change the approved footprint of disturbance, mining method, employee numbers, integrated tailings and water management across HVO or extend the project approval period. The components listed above are taken collectively to form the 'HVO South Modification 5' which is referred to herein as the 'proposed modification'.

EMM Consulting Pty Limited (EMM) has been engaged by Coal & Allied as the lead consultant for the preparation of environmental studies associated with the proposed modification, including a detailed Environmental Assessment (EA).

Hatch has been engaged to undertake surface water balance modelling components of the proposed modification. This report documents the HVO water balance model developed and applied for the purposes of the EA, and outlines modelling results which describe expected future performance of the water management system under proposed conditions.

The following investigations have been completed:

- Definition of existing water management system
- Review of mine planning information and definition of water management system under proposed future conditions
- Development of an operational water balance model

- Application of model to determine proposed water management system performance with respect to inventory management, water supply security, and off site water discharge potential
- Preparation of documentation (this report)

Investigations have built upon the baseline HVO water balance model developed and calibrated as part of a recent project completed by Hatch for RTCA in 2015[A]. The earlier baseline study is frequently referred to throughout this report as the 2015 model update.

Key personnel involved in this project have comprised:

Coal & Allied, Rio Tinto Coal Australia

- Trudie Larnach, Specialist – Project Approvals
- Chris New, Environmental Specialist – Operations
- Scott Diggles, Principal Advisor – Water – HSEC

EMM

- Duncan Peake, Associate Director – Executive Leader
- Luke Stewart, Managing Director

Hatch Pty Ltd

- Gavin Rootsey, Water Engineer
- Jim Heaslop, Senior Water Engineer

[A] Hatch Pty Ltd, October 2015. *HVO Water Balance Model – Baseline Scenario*. Document H349794-00000-228-230-0001 (Rev 1).

2. Naming Conventions

Differences in terminology used between the main EA and this report have been outlined in the following sub-sections.

2.1 Mining Areas

The integrated HVO mine comprises two main areas HVO South and HVO North, which are geographically divided by the Hunter River, and covered by separate approvals: HVO South (PA 06_0261) and HVO North (DA 450-10-2003). Mining areas are described with respect to these main two areas in the main EA (and also in the general overview provided in Section 1 of this report).

Infrastructure comprising the HVO water management system (WMS) is divided between three distinct operational areas, defined as: HVO South, HVO North and HVO West. WMS infrastructure is generally named based on position within one of these areas (for example, dams within HVO South are labelled with the suffix S: Dam 15S etc). Mining area naming convention used in this report is consistent with that used to define and operate the HVO WMS, unless otherwise stated.

When reading this report in the context of the main EA, please note the following:

- Definition of the HVO South mining area is consistent between this report and the main EA, specifically referring to areas covered by PA 06_0261.
- HVO North and HVO West referred to in this report are collectively referred to as HVO North in the main EA. These sub-areas are both covered by approval DA 450-10-2003. Spatial extents are as follows:
    - HVO North as defined in this report refers to areas in the vicinity of Carrington Pit and the Hunter Valley Coal Processing Plant (HVCPP).
    - HVO West as defined in this report refers to areas in the vicinity of West Pit and the Howick Coal Processing Plant (HCPP).

The location of the HVO South, HVO North and HVO West mining areas has been marked on Figure 2-1.

2.2 Open Cut Pits

For the purposes of describing and assessing the performance of the HVO WMS, this report has made use of a more detailed open cut pit naming system, compared to that used in the main EA. Voids have been described at a catchment scale. This report also refers to several open cut pits outside the HVO South mining area, which are generally not discussed in the main EA. For reference, a figure has been prepared showing the location and adopted naming convention of all pits referred to in this report – please refer to Figure 2-1.

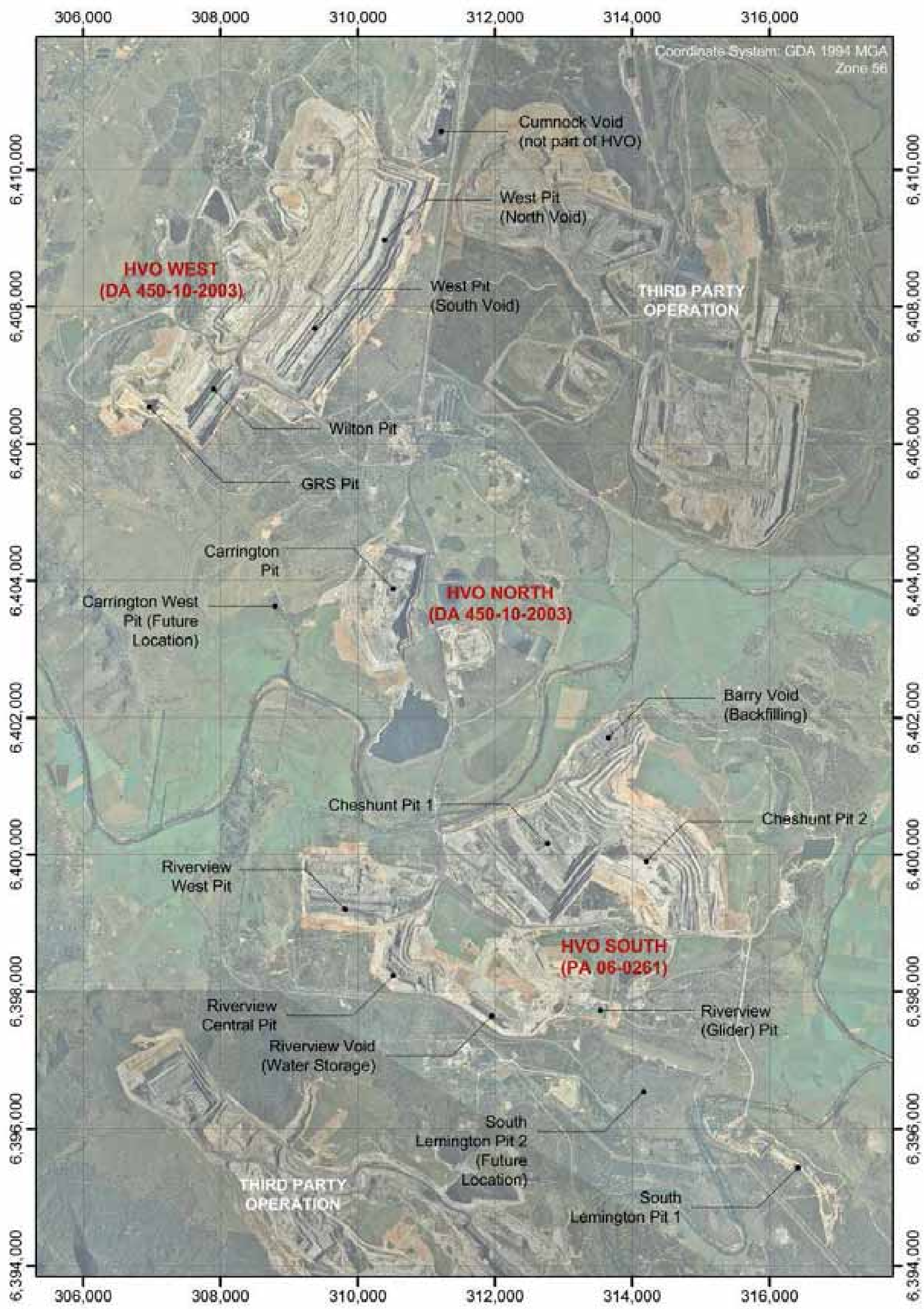

Figure 2-1: Pit Naming Convention used in this Report

3. Water Management System

3.1 Overview of Existing System

The existing HVO WMS is complex, and comprises an extensive network of surface water storage ponds, inactive mining pits (providing bulk water storage), interconnecting water transfer infrastructure (pumps and pipelines, etc.) sediment ponds and drainage. The general layout of key water management infrastructure is shown in Figure 3-1. It is important to note that whilst HVO South and HVO North[B] operate under separate planning approvals, water management infrastructure servicing the two areas is interconnected, and operated as a single integrated system.

A key function of the HVO WMS is the capture and storage of water that has come into contact with mine affected catchment or coal handling and processing activities. This has been defined as 'mine-affected water'. 'Non mine-affected water' includes: raw water (pipeline), treated (or potable), and clean water (natural catchment runoff).

It is also important to distinguish mine-affected water from 'disturbed' catchment runoff, which may require sediment treatment to settle out suspended material, but is otherwise absent of any significant contaminants that would preclude release to the receiving environment under an approved erosion and sediment control plan. A second function of the HVO WMS is the application of mine-affected water reserves to perform industrial tasks (e.g. washing coal, dust suppression).

Primary water inputs to the HVO WMS include rainfall, catchment runoff, and groundwater. Water losses are primarily associated with evaporation from wetted areas and dust suppression activities, and entrainment within product coal exports and tailings waste products. Site water reserves may be supplemented with externally sourced (e.g. Hunter River) water during times of drought to ensure continued supply to industrial demands. During wet periods, excess surface water inventory may be opportunistically discharged to the Hunter River in accordance with the Hunter River Salinity Trading Scheme (HRSTS).

HVO surface water storage dams, tailings storage facilities (TSFs) and open cut pits are operated in accordance with the conditions outlined in the HVO Environment Protection Licence (EPL) 640 and approvals for HVO South (PA 06_0261) and HVO North (DA 450-10-2003).

The following sub-sections summarise the physical characteristics of the HVO WMS, including water storage specifications and function, catchment and land use classification breakdown, and key transfer infrastructure specifications as incorporated in the model.

[B] Mining areas covered by approval DA 450-10-2003. HVO North and HVO West per definitions outlined in Section 2.1 of this report.

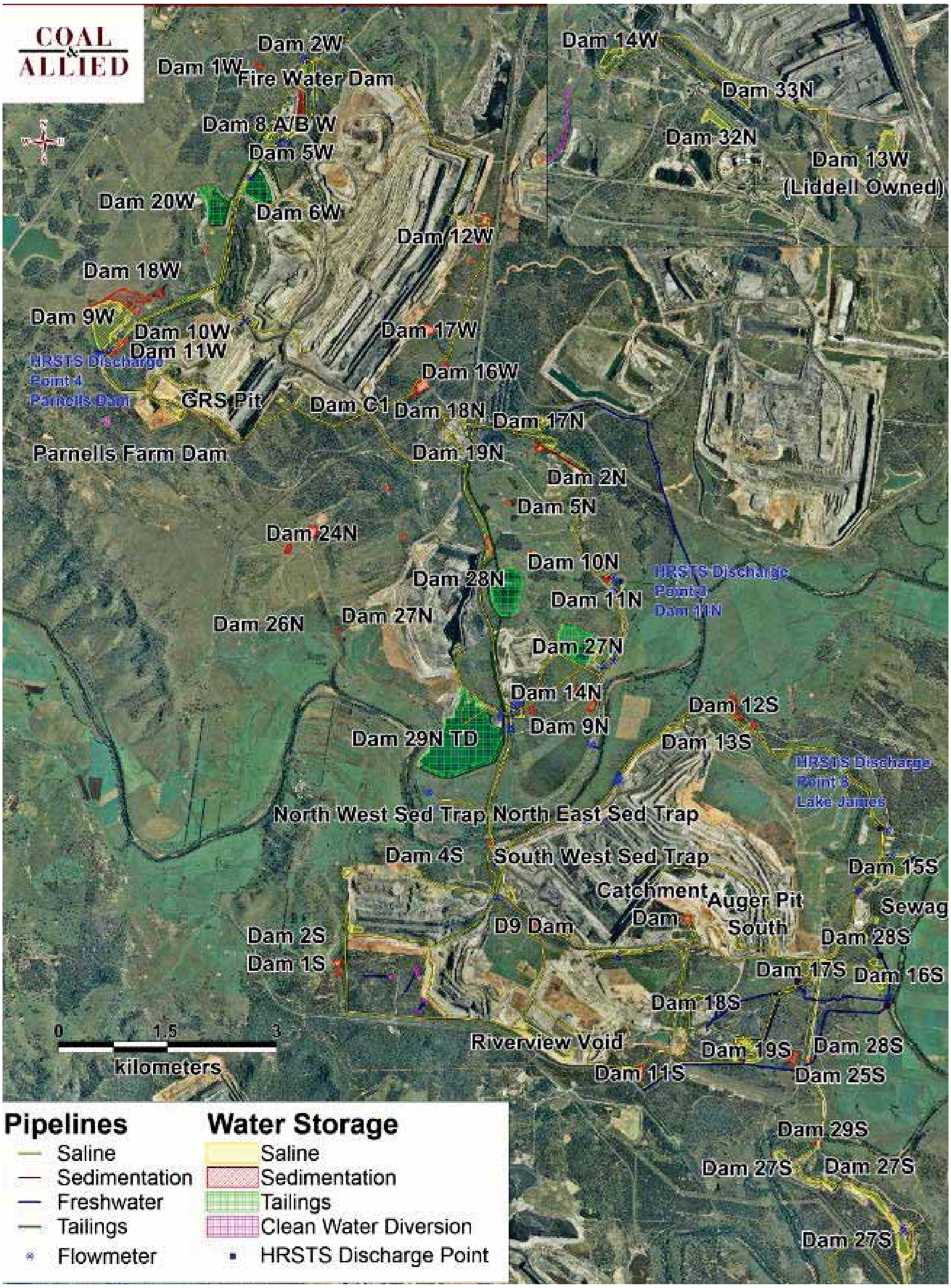

Figure 3-1: Water Storages and Pipelines – Existing HVO Site

(Figure above extracted from Coal & Allied mapping)

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3.1.1 Water Storage Infrastructure and Voids

3.1.1.1 Function and Specifications

Brief functional descriptions and general specifications for key water storages and voids within the HVO WMS have been summarised in Table 3-1. Summary data includes location, full storage capacity level and volume, operating levels and catchment areas.

Infrastructure has been grouped by mining area, and sub-grouped based on function as one of the following:

- Water Storages: infrastructure used for storing mine-affected water. Comprises surface ponds/dams and inactive mining pits used for bulk water storage. Also includes sediment dams which overflow into mine-affected water storages.
- Tailings: dams or repurposed open cut mining pits used to store tailings waste. Note that tailings storage capacities have not been listed in the following tabulation, as available air space is not used for water storage.
- Externally draining sediment ponds: sediment management structures designed to intercept sediments from non-mine affected runoff prior to discharging off-site.
- Mining Pits: open cut voids currently subject to active mining. Not used for water storage.

Table 3-1: Existing Water Storage Infrastructure and Voids – Specifications and Function

Storage	Location GDA94		Catch-ment Area (ha)	Full Storage Capacity		Functional Description
	Lat	Long		(mRL)	(ML)	
HVO South						
Water Storages						
Dam 15S	-32.521	151.048	224.4	65.0	715	HRSTS Release Point 8 (Lake James). Primary dust suppression fill point for southern mining area.
Dam 16S Group[C]	-32.535	151.046	123.9	54.4	285	Surface water dams located along south-east edge of mining area. Dams capture runoff and supply Dam 15S, and Lemington workshop industrial water demands.
Dam 17S	-32.534	151.035	44.0	83.6	65	
Dam 18S	-32.538	151.018	42.0	81.5	175	
Dam 19S	-32.544	151.026	100.0	67.8	210	
D9 Dam	-32.528	150.995	55.8	82.9	25	Water storages located upstream of, or within Cheshunt Pit watershed. Used to supply local dust suppression water demands. Not used to store excess water.
Saline Dam (Name TBC)	-32.532	151.006	44.9	78.6	40	
C2 Sed Dam (Name TBC)	-32.528	151.018	32.8	91.1	5	
Auger South	-32.530	151.025	34.7	13.4	675	
Riverview Void	-32.542	150.997	94.1	80.0	TBC	Bulk water storage. Maximum storage volume set at 4,000 ML, equivalent to 75.6 mRL.
Mining Pits						
Cheshunt Pit 1 & 2	-32.520	151.004	695.7	n/a	n/a	Active Mining Pits.
Riverview Central	-32.537	150.982	81.7	n/a	n/a	
Riverview West (South)	-32.528	150.976	176.9	n/a	n/a	
Riverview West (North)	-32.523	150.975	39.5	n/a	n/a	
Riverview (Glider)	-32.542	151.011	82.2	n/a	n/a	

[C] Includes Dam 23S, 24S, 28S and Sewage Lagoons.

Storage	Location GDA94		Catch-ment Area (ha)	Full Storage Capacity		Functional Description
	Lat	Long		(mRL)	(ML)	
Ext. Draining Sed. Dams						
Dam 4S	-32.519	150.980	38.5	68.0	12	Sediment management structures. Intercept runoff from natural/rehabilitated areas prior to draining off-lease.
Dam 5S	-32.518	150.989	14.9	67.0	3	
Riverview Sed. Dams	-32.533	150.967	55.6	n/a	25*	
	-32.534	150.974	45.2	n/a		
	-32.534	150.978	16.6	n/a		
	-32.537	150.979	3.8	n/a		
	-32.539	150.978	31.8	n/a		
Dam 11S	-32.547	151.01	86.5	70.0	25	
Dam12S & 13S	-32.501	151.026	228.0	n/a	53*	
Dam 25S	-32.545	151.033	105.3	n/a	5*	
Dam 28S	-32.546	151.036	76.6	n/a	3*	
HVO North						
Water Storages						
Dam 9N	-32.501	150.994	3.3	77.0	80	Hub mine water storage. Supplies local dust suppression water demands. Receives Hunter Valley Coal Processing Plant (HVCPP) tailings decant water and returns to industrial area for re-use. Primary point of exchange between west, north and south mining areas.
Dam 11N	-32.486	150.009	3.9	70.5	75	HRSTS Release Point 3 (not actively used). Transfer dam between Dam 9N area and industrial area.
Dam 15N	-32.468	150.999	67.2	84.2	80	Runoff capture from HVCPP industrial area and stockpiles. Supplies process water makeup to HVCPP.
Dam 16N	-32.466	150.995	28.2	89.8	64	
Dam 19N	-32.469	150.986	14.6	103.0	10	
Dam 33N & 34N	-32.466	150.987	8.9	105.0	6	
Dam 35N	-32.469	150.984	10.5	111.1	5	
Dam 17N	-32.465	150.998	1.8	90.0	36	Supplies water to HVCPP area water demands. Freshwater pipeline discharges into this dam.
Dam 18N	-32.464	150.983	1.1	TBC	27	Water supply dam for HVCPP area.
Dam 20N	-32.501	151.005	207.1	62.0	43	Captures runoff from area behind Dam 30N area levee. May be used as water supply source if required.
Dam 21N	-32.495	151.006	40.5	64.8	910	Transfer dam between Dam 9N area and industrial area.
Carrington Highwall Dam	-32.482	150.990	65.2	102.6	7	Captures runoff from area north-east of Carrington Pit.
Tailings Storage						
Dam 27N	-32.494	151.004	62.7	71.5	360	Former TSF. Currently inactive.
Dam 28N	-32.487	150.992	21.6	116.3	525	
Dam 29N (North Void)	-32.505	150.986	140.0	69.0	TBC	Current TSF for HVCPP.
Mining Pits						
Carrington Pit	-32.486	150.986	205.2	n/a	n/a	Currently inactive. Preference is to keep pit empty so mining can re-commence.

Storage	Location GDA94		Catch-ment Area (ha)	Full Storage Capacity		Functional Description
	Lat	Long		(mRL)	(ML)	
Ext. Draining Sed. Dams						
Dam 1N	-32.469	150.998	26.9	87.1	16	Sediment management structures. Intercept runoff from natural/rehabilitated areas prior to draining off-lease.
Dam 2N	-32.472	151.005	10.5	n/a	10*	
Dam 5N	-32.476	151.000	116.9	n/a	17*	
Dam 10N	-32.485	151.007	151.4	n/a	9*	
Dam 24N	-32.479	150.964	22.1	n/a	25*	
Dam 25N	-32.481	150.961	31.8	n/a	18*	
Dam 27N (Name TBC)	-32.491	151.968	53.7	n/a	3*	
Sed Dam (Name TBC)	-32.479	150.969	9.3	n/a	6*	
Sed Dam (Name TBC)	-32.473	150.975	31.7	n/a	4*	
Sed Dam (Name TBC)	-32.479	150.978	44.5	n/a	6*	
HVO West						
Water Storages						
Dam 1W	-32.421	150.958	30.3	185.0	9	Captures natural runoff from hillside above Howick Coal Processing Plan (HCPP) area. Overflows to Dam 3W.
Dam 2W	-32.421	150.964	10.8	180.7	27	Water storage/supply dams in HCPP industrial area.
Dam 3W	-32.426	150.963	47.3	165.0	70	
Dam 4W & 5W	-32.43	150.961	91.3	TBC	40	
Dam 8W	-32.429	150.958	32.9	164.0	16	
Dam 9W	-32.452	150.934	31.2	113.4	870	HRSTS Release Point 4 (Parnell's Dam). Hub mine water storage for western mining area. Supplies makeup water to HCPP area. Primary fill point for western mining area. Primary point of exchange between western and northern mining areas.
Dam 18W	-32.449	150.937	342.1	113.6	105	Sediment capture dam upstream of Dam 9W. Supplies Dam 9W during drought, otherwise functions as sediment dam and discharges off lease.
Tailings Storage						
Dam 6W	-32.436	150.957	103.0	179.6	TBC	Former TSF. Inactive during baseline scenario while Cumnock TSF being used.
Dam 20W	-32.438	150.951	24.0	TBC	TBC	
Mining Pits						
GRS Pit	-32.463	150.942	11.9	n/a	n/a	Active Mining Pits
Wilton Pit	-32.461	150.954	234.0	n/a	n/a	
West Pit (North)	-32.442	150.983	277.6	n/a	n/a	
West Pit (South)	-32.454	150.971	517.2	n/a	n/a	
Ext. Draining Sed. Dams						
Dam 11W	-32.455	150.937	81.3	124.0	15	Sediment management structures. Intercept runoff from natural/rehabilitated areas prior to draining off-lease.
Dam 12W	-32.441	150.990	17.9	n/a	32*	
Dam 16W	-32.461	150.981	129.0	n/a	43*	
Sed Dam (Name TBC)	-32.458	150.984	59.5	n/a	10*	
Dam 17W	-32.454	150.982	17.9	n/a	4*	

Note: * sediment dam storage capacities assumed based on wetted surface area and an assumed depth.

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3.3.1.1 Storage Characteristics

Coal & Allied provided feature survey and LIDAR topographic data as part of the 2015 water balance model update (data assumed current December 2014). This information was processed and used to update level-area-volume characteristics for key storages within the HVO WMS.

3.3.1.2 Catchment and Land Use Classification

Catchment boundaries for water storages within the existing HVO mine were delineated based on the most recent available topographic data at the time of the 2015 model update. Existing system catchment areas have been summarised in Table 3-1. Catchment maps and a breakdown of catchment areas by land use have been provided in Figure 3-2, Figure 3-3 and Figure 3-4 for the South, North and West mining areas respectively.

Satellite imagery provided by Coal & Allied and current as at December 2014 was used to classify land use within the HVO mine catchment. Land use has been classified as one of the following categories:

- *Natural / undisturbed* – no disturbance, typically grass or brush.
- *Cleared / prestrip* – exposed and loosened earth typically ahead of an advancing open-cut pit.
- *Roads / industrial / hardstand* – sealed or unsealed road or track, cleared and compacted earth or concrete (layout areas etc.).
- *Mining Pit* – open-cut void, classification typically refers to runoff properties for exposed coal face.
- *Spoil / overburden* – unrehabilitated dumps, clear of vegetation, typically uncompacted.
- *Rehabilitated overburden* – dump areas that have been shaped and re-vegetated.
- *Stockpile* – ROM or coal stockpile areas.
- *Tailings Area* – beach and other exposed tailings reject areas.

Land use data has been used to calculate catchment yield within the water balance model. Different land use classifications generally correspond with a unique catchment runoff model parameter set. Catchment yield is discussed further in Section 4.3.

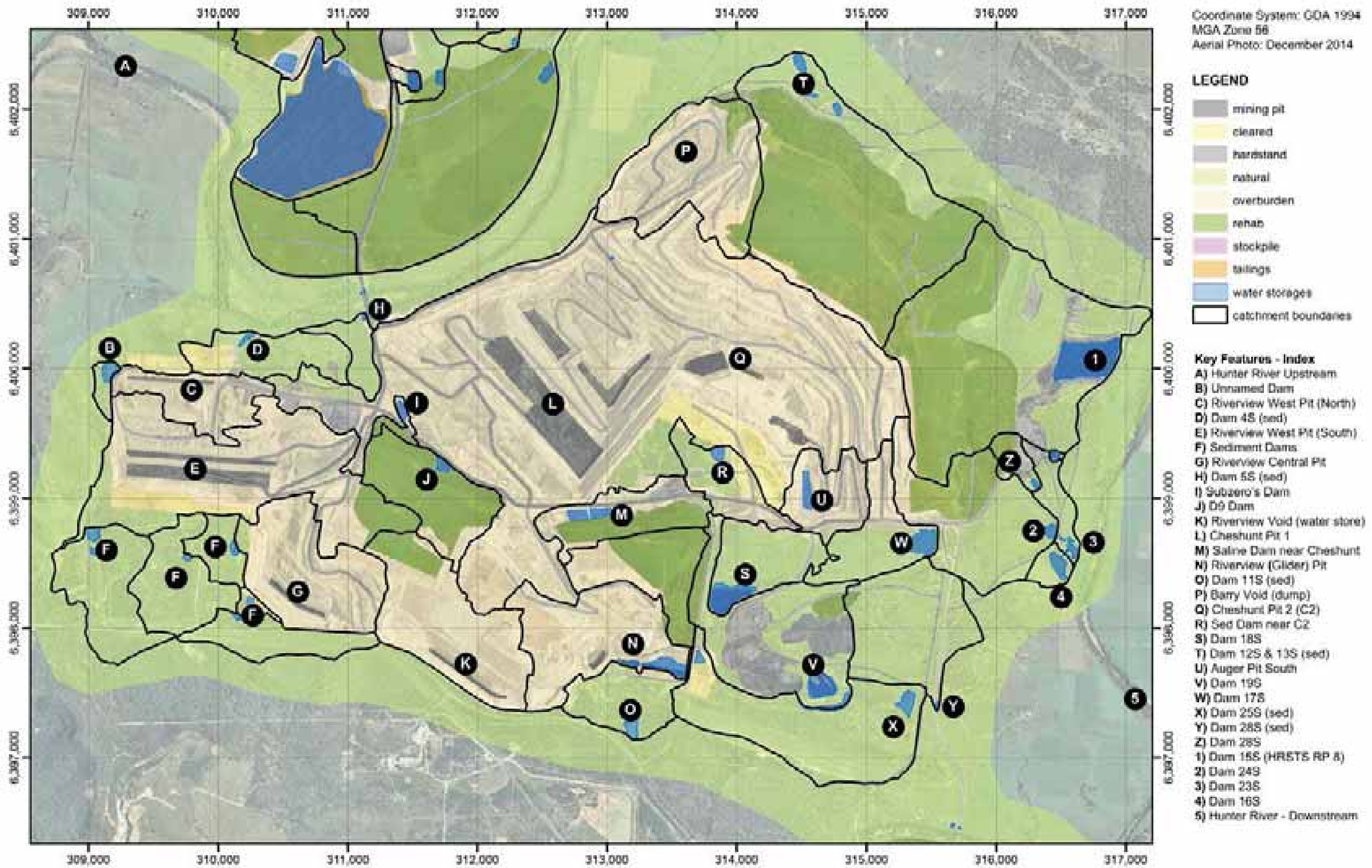

Figure 3-2: Catchment and Land Use Plan – Existing System – HVO South Mining Area

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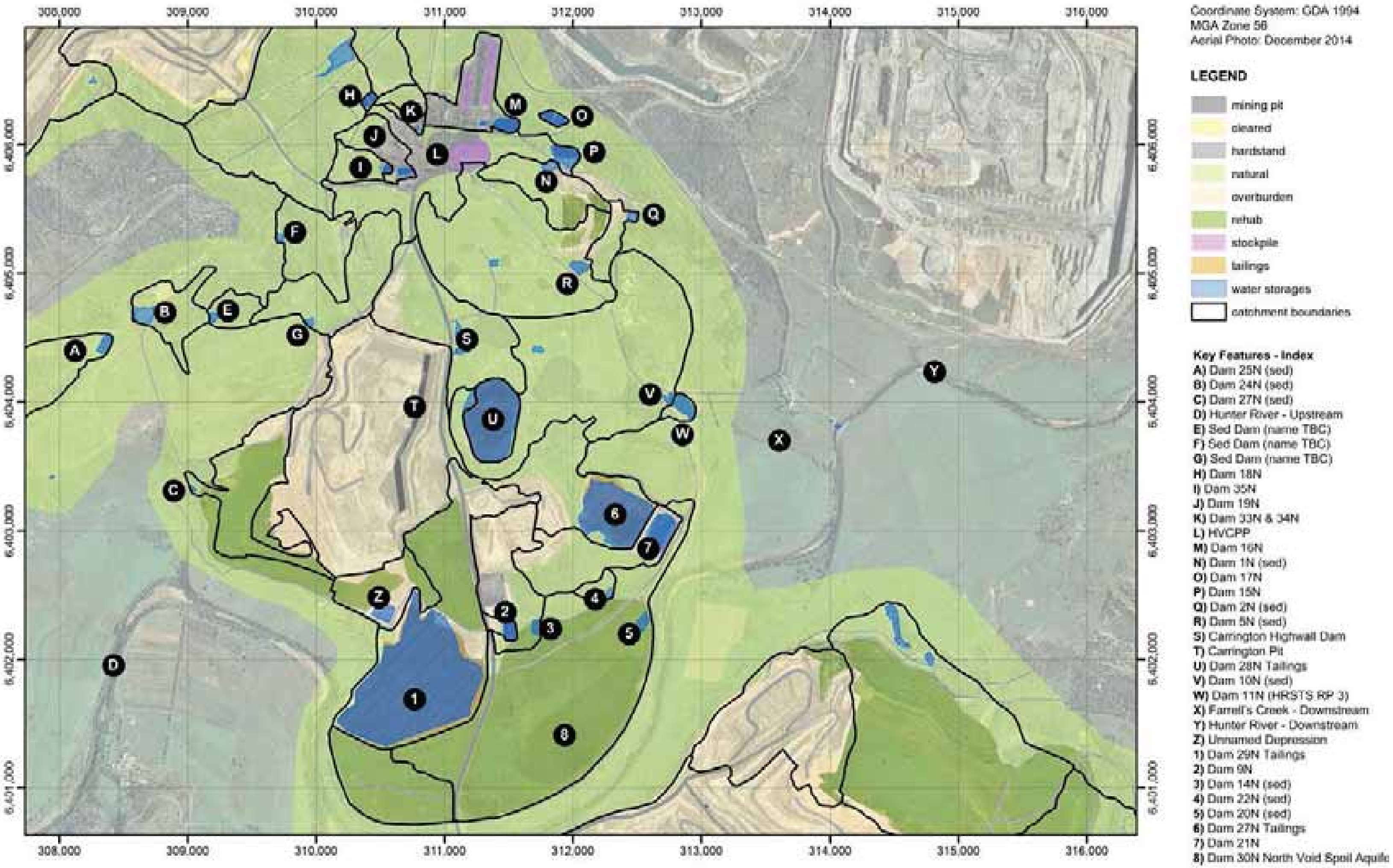

Figure 3-3: Catchment and Land Use Plan – Existing System – HVO North Mining Area

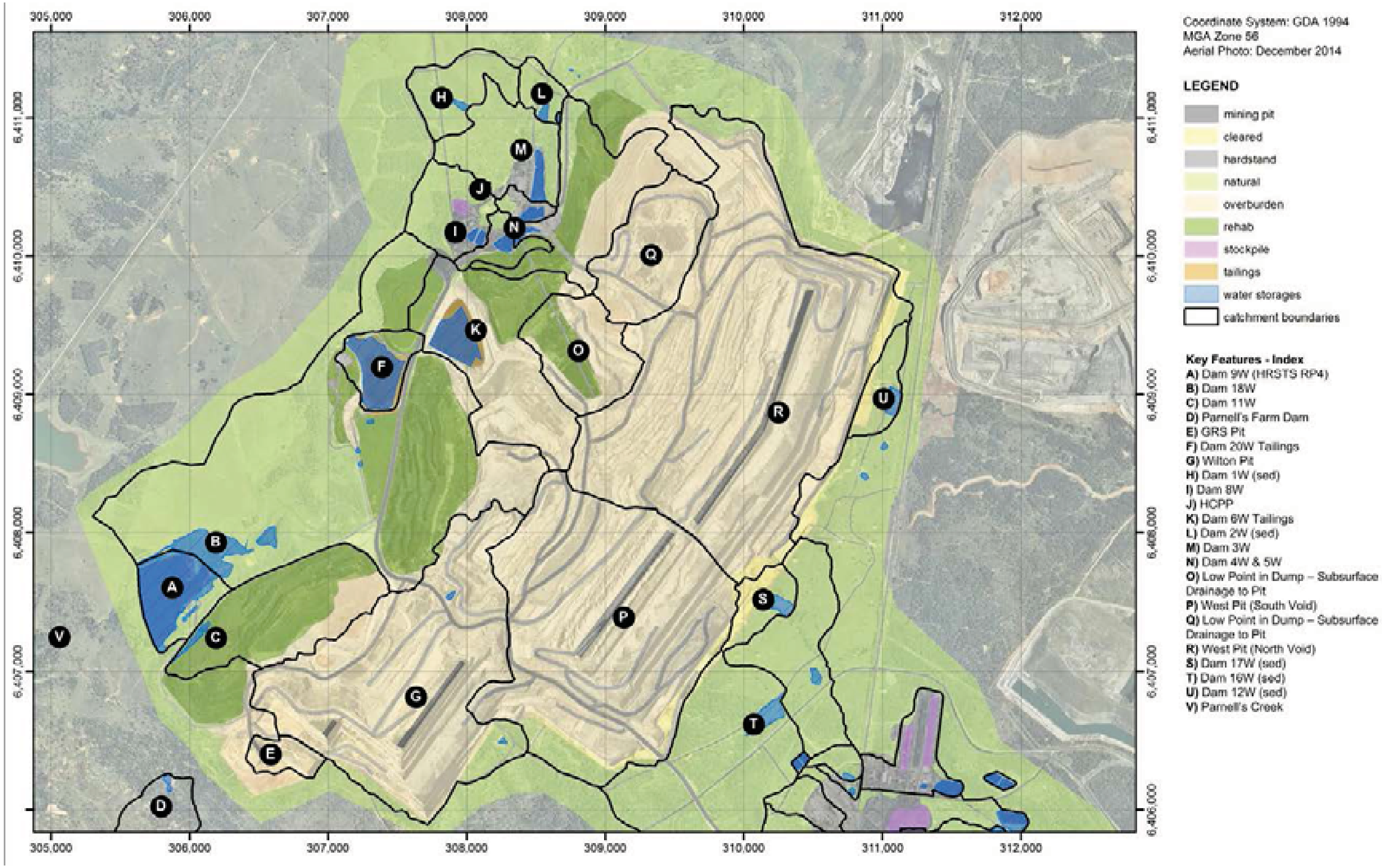

Figure 3-4: Catchment and Land Use Plan – Existing System – HVO West Mining Area

3.3.2 Water Transfer Infrastructure

Adopted specifications for key water transfers have been summarised in Table 3-2. Information was collated as part of the 2015 model update in consultation with Coal & Allied.

Table 3-2: Water Transfer Infrastructure – Modelled Capacities

Connection Points		Flow Capacity		Comment
Point A	**Point B**	**L/s**	**ML/d**	
MTW Mine	Riverview Void	130	11.2	Construction underway. Commissioning planned for Dec-15.
Riverview West Pit	Riverview Void or Dam 15S	120	10.4	Operational advice
Riverview Central		120	10.4	Operational advice
Riverview (Glider)		50	4.3	Operational advice
Cheshunt Pit		130	11.2	Operational advice
Auger Pit South		90	7.8	Operational advice
Barry Void		35	3.0	Per 2014 model update
Riverview Void	Dam 15S	100	8.6	Nominal rate. No permanent connection currently in place. Temporary connection would be provided as required via rearrangement of pump and pipeline network.
Dam 17S*		50	4.3	Operational advice
Dam 18S	Dam 17S	50	4.3	Nominal rate. No permanent connection currently in place. Temporary connection would be provided as required via rearrangement of pump and pipeline network.
Dam 19S*		50	4.3	Operational advice
Dam 16S*		50	4.3	Operational advice
Riverview Void	Dam 9N	220	19.0	Operational advice
Dam 21N		80	6.9	Operational advice
Carrington Pit		100	8.6	Operational advice
Dam 9W		70	6.0	Operational advice
Dam 21N	Dam 11N	100	8.6	Operational advice
Dam 11N	Dam 15N	70	6.0	Per 2014 model update
Carrington Pit		150	13.0	Functional transfer rate assumed to be in place as part of 2016 baseline scenario. Rate sized to achieve Dam 15N spill frequency consistent with design specification. Transfer may not be direct (e.g may be through HVCPP). Also assumes Dam 1N clean catchment overflows will be diverted away from Dam 15N.
Dam 18W	Dam 9W	50	4.3	Gravity transfer
GRS Pit		70	6.0	Operational advice
Wilton Pit		80	6.9	Operational advice
West Pit North		70	6.0	Operational advice
West Pit South		80	6.9	Operational advice
HCPP Area Dams		80	6.9	Operational advice

Note: * Modelling has assumed that Dam 16S, Dam17S and Dam 19S pumping can be re-routed to Riverview Void via manipulation of the HVO South pipeline network under emergency conditions. Redirection occurs to prevent unauthorised discharge to the environment and only if the first preference receiving storage is full to capacity.

3.4 Proposed Water Management System

The following sub-sections outline proposed changes to the HVO mine landform and WMS as mining progresses towards completion. Descriptions have been provided for the base case and four indicative mine plans for the proposed modification, based on review of the following information provided by Coal & Allied:

- HVO South Mine Plans and associated digital topographic data (design contours, land management polygons)
- HVO North yearly pit progress polygons (outlines only – no design landform contour data)
- HVO Tailings disposal strategy

Please note that some of the planned system changes and activities described in the following sections are currently approved under the existing project approval. Descriptions have not differentiated between approved vs proposed modifications. Mine progression, layout and catchment plans have been provided for each stage of mining in Figure 3-5 to Figure 3-9 immediately following the stage descriptions. Detailed plans focus on HVO South. An overview of HVO North & West pit progress has also been presented in Figure 3-10.

3.4.1 Base case Scenario

The base case scenario is consistent with current (2015-2016) conditions. System configuration is as described in Section 3.1 of this report. Mine landform, layout and catchment areas are presented in Figure 3-5.

3.4.2 Stage 1 (2019)

Stage 1 is representative of expected conditions in nominally 2019. Mine landform, layout and catchment areas are presented in Figure 3-6. Changes to the mine landform include:

- Progression of Cheshunt Pits 1 and 2.
- Expansion of the Cheshunt Dump and associated increase in dump height.
- Progression of Riverview West and Riverview Central Pits, with these pits linking up to form a single void. Riverview dumps (north of advancing Riverview West Pit) have been completed and partially rehabilitated.
- Backfill and rehabilitation of Riverview (Glider) Pit.

Modifications to HVO South infrastructure include:

- Changes to catchment areas associated with pit and dump landform progression.
- Several minor water storages within Cheshunt Pit catchment mined through by Cheshunt Pit. These storages are not functionally significant and their removal will not have a material impact on the performance of the WMS.
- Construction of sediment dams (proposed) to intercept runoff from rehabilitated and diverted sections of the Riverview and Cheshunt Dumps. Location and functional sizing of proposed dams to be confirmed as part of future studies.

- Diversion of rehabilitated Riverview (Glider) Pit catchment off site via existing Sediment Dam 11S.

System changes external to HVO South are understood to include:

- Continued mining of West, Wilton and GRS Pits at HVO West. Pit progression mines through sediment dams 12W and 17W and cuts into Dam 16W catchment.
- Mining of Carrington West Pit.

3.4.3 Stage 2 (2022)

Stage 2 is representative of expected conditions in nominally 2022. Mine landform, layout and catchment areas are presented in Figure 3-7. Changes to the mine landform include:

- Continued development of Cheshunt Pits 1 and 2, and Cheshunt Dump.
- Continued progression of combined Riverview West and Riverview Central Pit.
- Commencement of South Lemington Pit 2 mining.
- Re-commencement of mining in South Lemington Pit 1.
- Construction of the Lemington Coal Pad Dumps (out of pit dump).

Modifications to HVO South infrastructure are limited to changes to catchment areas associated with pit and dump landform progression.

System changes external to HVO South are understood to include:

- Continued mining of West, Wilton and GRS Pits at HVO West.
- Continued mining of Carrington West Pit. Backfilling and dump formation progressing. Part of dump landform assumed to have been rehabilitated and diverted off-site via sediment dam.
- Carrington Out-of-Pit TSF operational and receiving tailings from both HVCPP and HCPP plants.

3.4.4 Stage 3 (2025)

Stage 3 is representative of expected conditions in nominally 2025. Mine landform, layout and catchment areas are presented in Figure 3-8. Changes to the mine landform include:

- Continued development of Cheshunt Pits 1 and 2, and Cheshunt Dump. Cheshunt Pit 2 final stages of mining.
- Riverview West and Central Pit, and dumps being mined through by Cheshunt Pit 1.
- South Lemington Pit 2 mining complete and in the process of being backfilled with waste material from South Lemington Pit 1 (and possibly Lemington Coal Processing Plant (LCPP) tailings).
- Continued mining of South Lemington Pit 1.
- LCPP and Rail Loop constructed.

Modifications to HVO South infrastructure include:

- Changes to catchment areas associated with pit and dump landform progression.
- Provision of additional dewatering capacity in Dam 19S to manage increased runoff from additional hardstand/impervious area associated with construction of the LCPP.
- Changes in water usage characteristics associated with new LCPP, including tailings disposal and moisture recovery from areas within Glider 5 and South Lemington Pit (details TBC).
- Potential relocation of proposed Riverview Dump sediment dam to the west, away from the advancing Cheshunt Pit 1 highwall.
- Additional rehabilitation and diversion of Cheshunt Dump area. Associated increase in flows reporting to proposed Sediment Dam described in Stage 1.

System changes external to HVO South are understood to include:

- Continued mining of West, Wilton and GRS Pits at HVO West.
- Carrington West Pit backfilled, rehabilitated and diverted off-site via sediment dam.

3.4.5 Stage 4 (2028)

Stage 4 is representative of expected conditions in nominally 2028, nominally two years from the end of mining. Mine landform, layout and catchment areas are presented in Figure 3-9. Changes to the mine landform include:

- Continued development of Cheshunt Pit 1.
- Reshaping of the Cheshunt Dump, including rehabilitation and diversion of additional area off-site via a proposed sediment dam.
- Backfilling of Cheshunt Pit 2, South Lemington Pit 2 and South Lemington Pit 1 (small final void remains).
- Backfilling of the Riverview Void water storage.
- Rehabilitation and diversion of South Lemington Pit 2 Dump.

Modifications to HVO South infrastructure include:

- Changes to catchment areas associated with pit and dump landform progression.
- Construction of proposed sediment dams to intercept runoff from rehabilitated and diverted Riverview Void, South Lemington Pit 1 and 2 catchments.
- Backfilling Riverview Void and associated loss of 4GL water storage capacity.

System changes external to HVO South are understood to be limited to progressive rehabilitation of dump areas. Note that investigations have conservatively assumed that no diversion of rehabilitated catchment will have occurred by this stage.

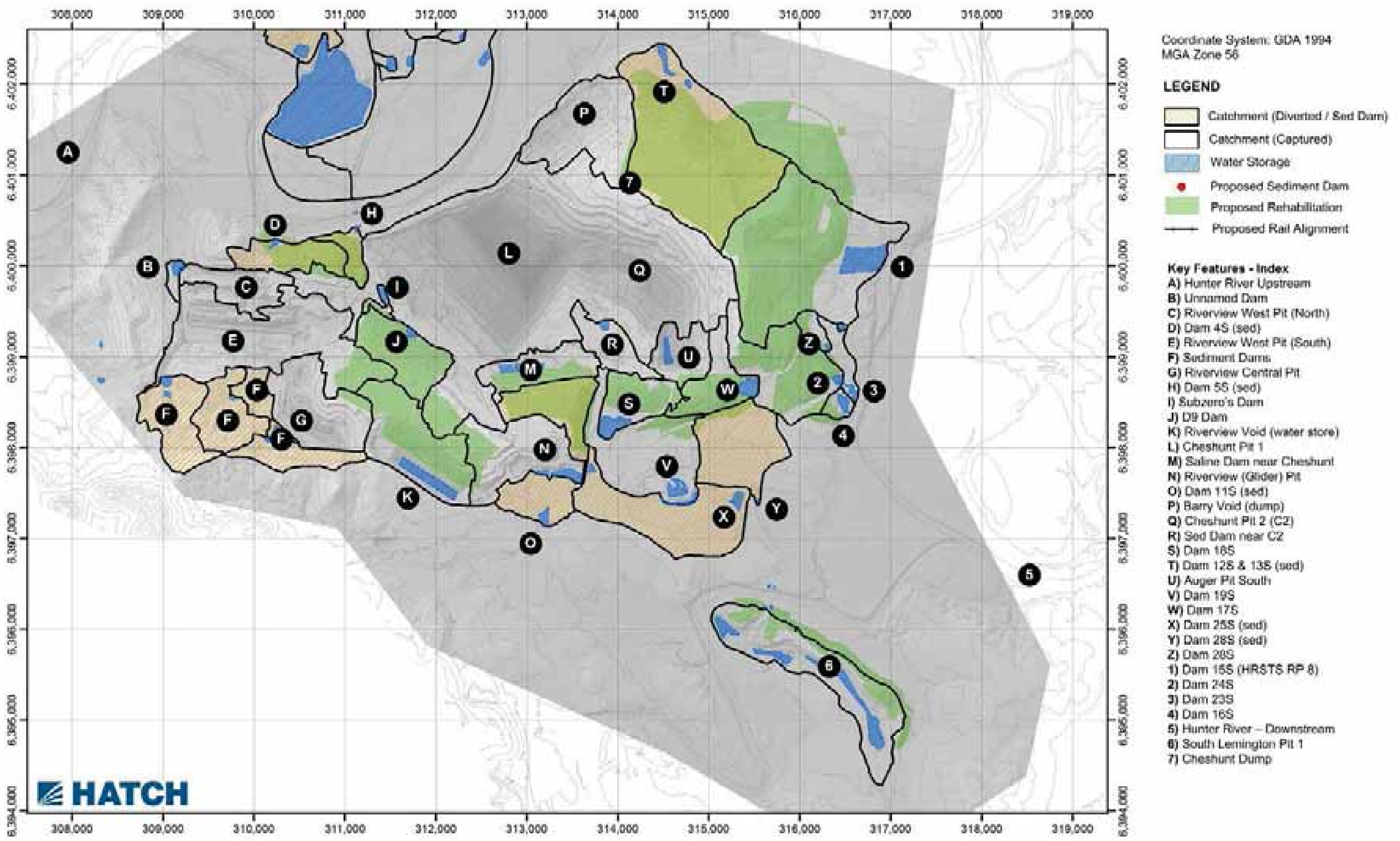

Figure 3-5: Mine Progression and Catchment Plan – Base case Scenario

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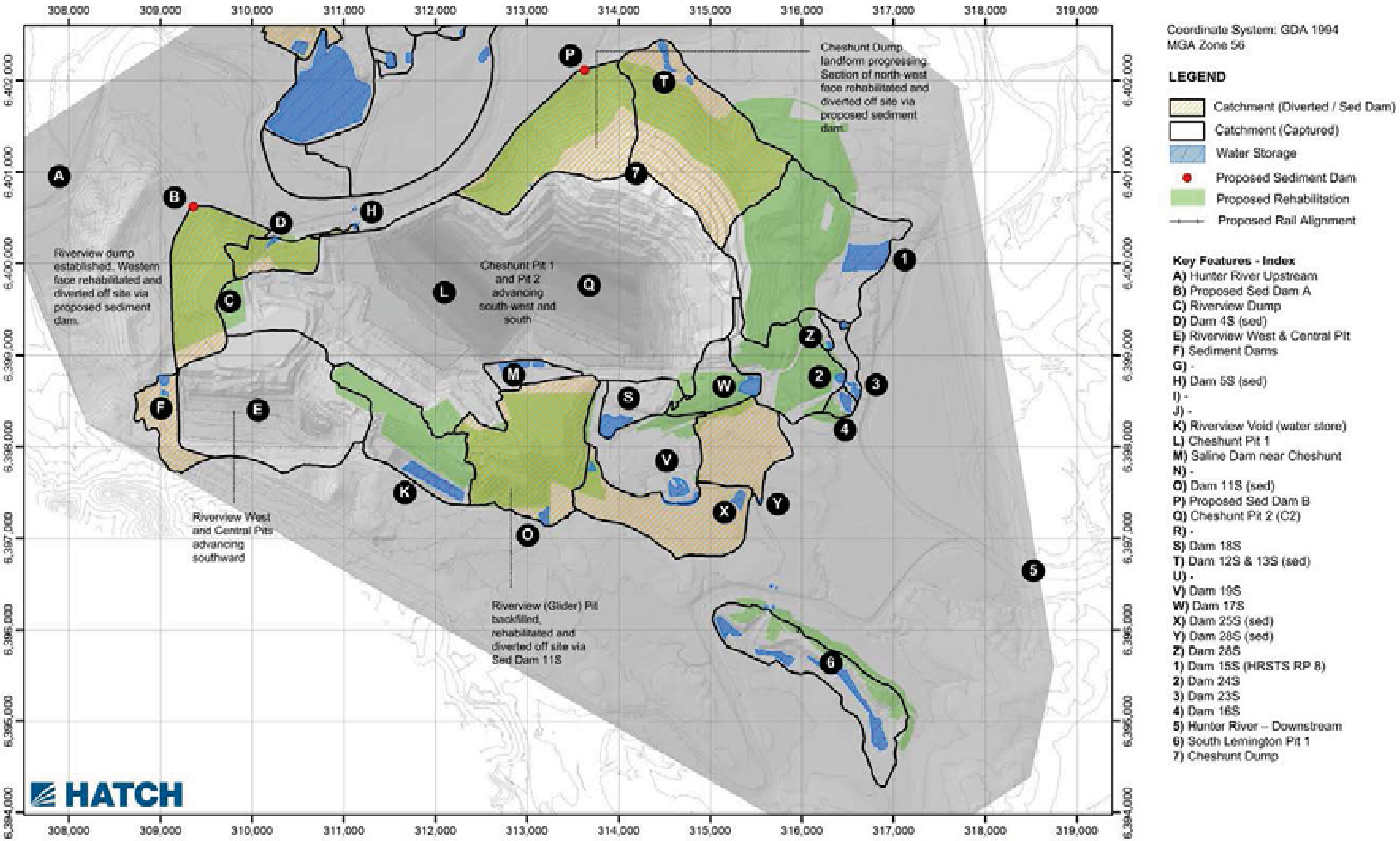

Figure 3-6: Mine Progression and Catchment Plan – Stage 1 (2019)

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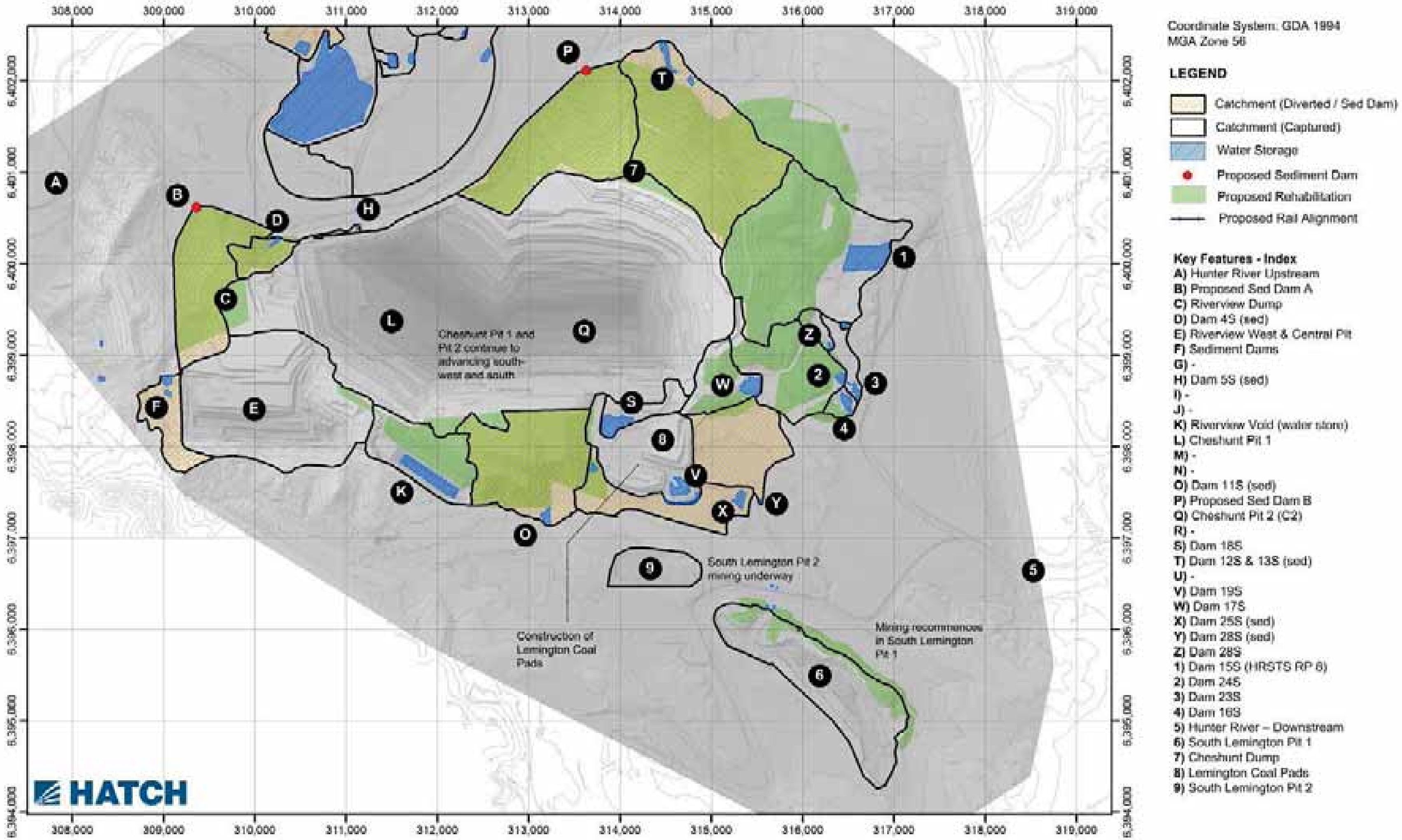

Figure 3-7: Mine Progression and Catchment Plan – Stage 2 (2022)

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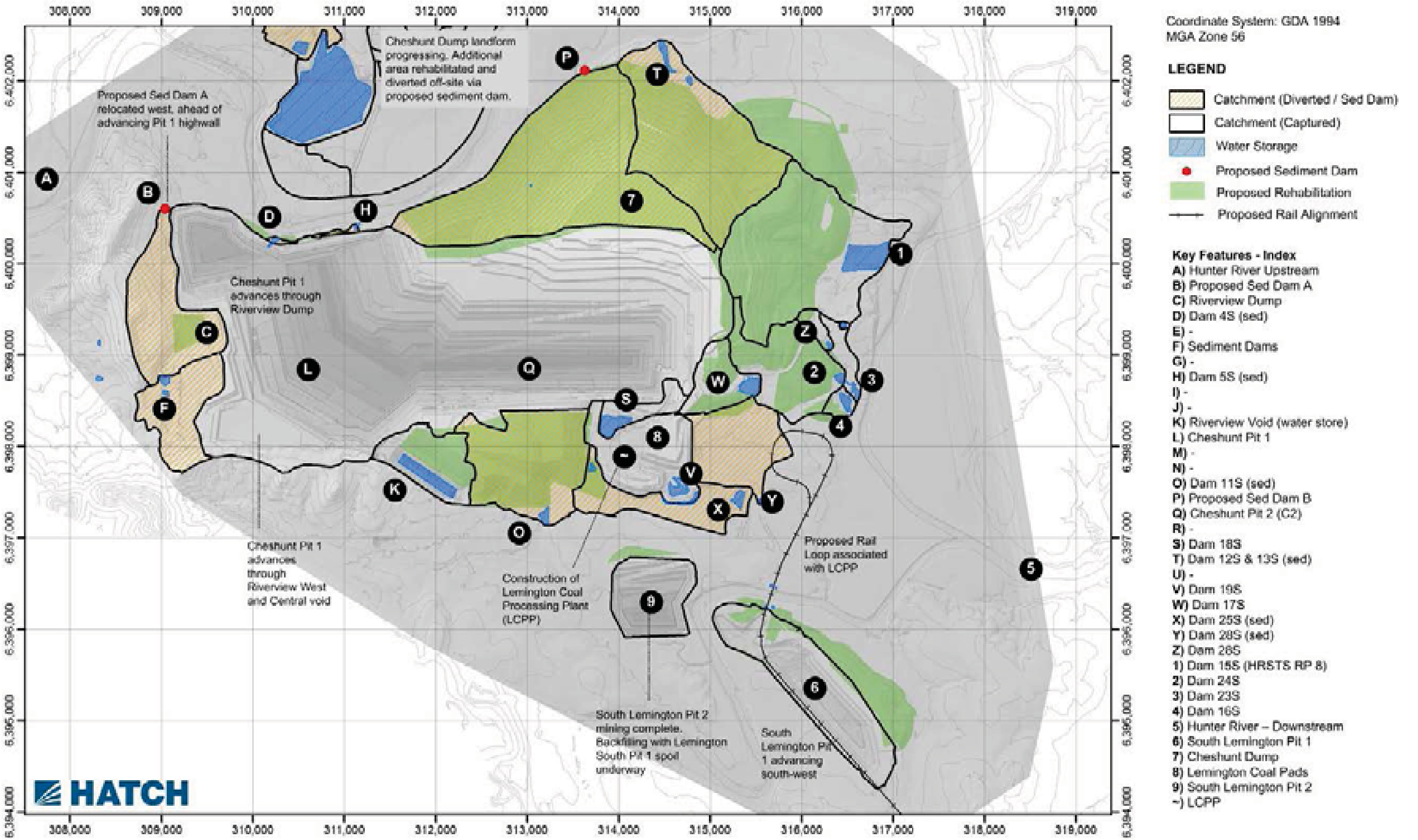

Figure 3-8: Mine Progression and Catchment Plan – Stage 3 (2025)

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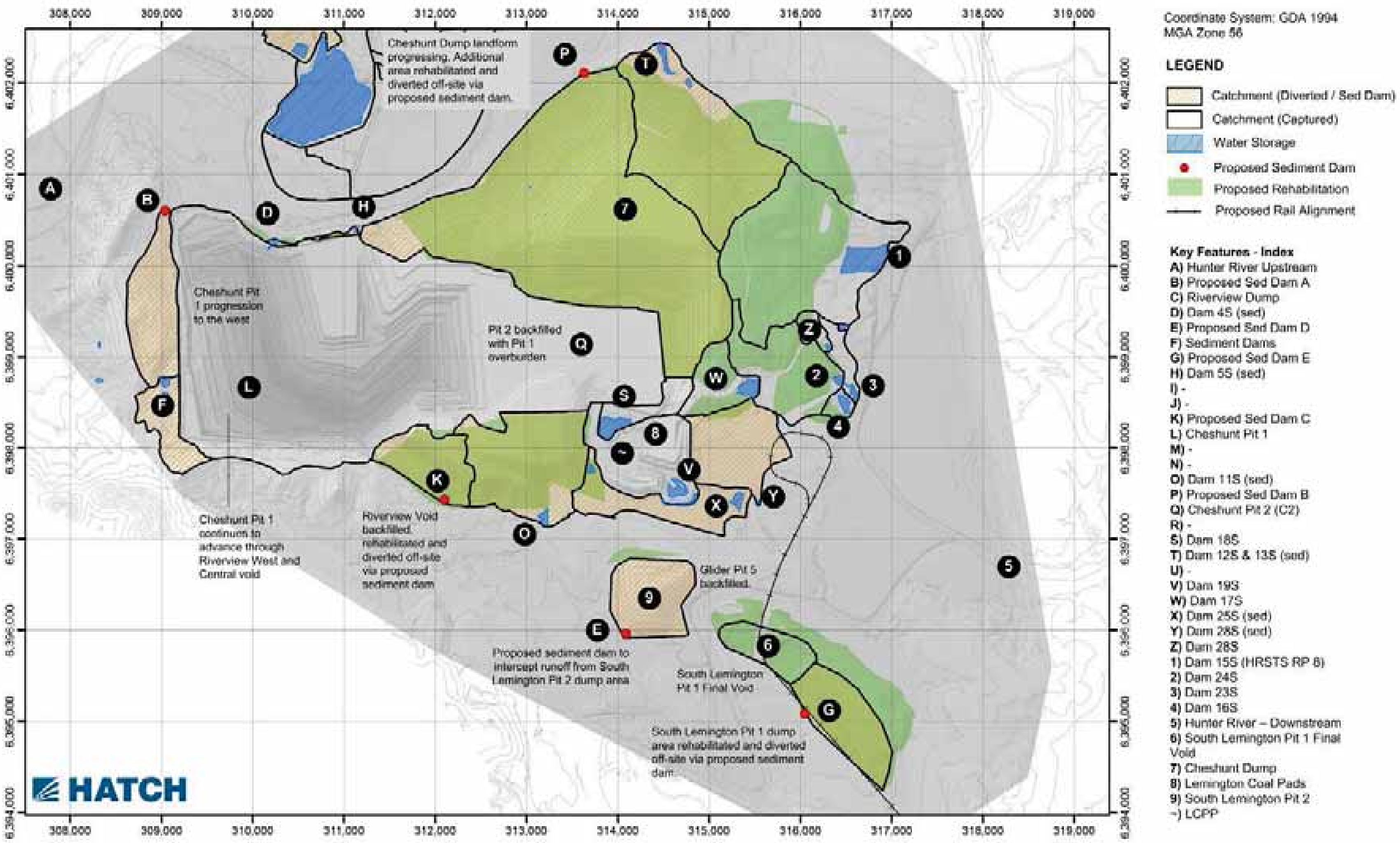

Figure 3-9: Mine Progression and Catchment Plan – Stage 4 (2028)

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3.4.6 *HVO North Pit Progression*

Approved HVO North pit progression has been outlined in Figure 3-10. Note that reviewed planning information shows no further mining footprint progression between Stage 3 and Stage 4.

It has been conservatively assumed that no diversion of rehabilitated West Pit catchment will occur prior to Stage 4 (diversion understood to require backfilling of West Pit, and construction of drainage pathways across the backfilled void to access natural watercourses to the south-east, downstream of existing Dam 16W and 17W).

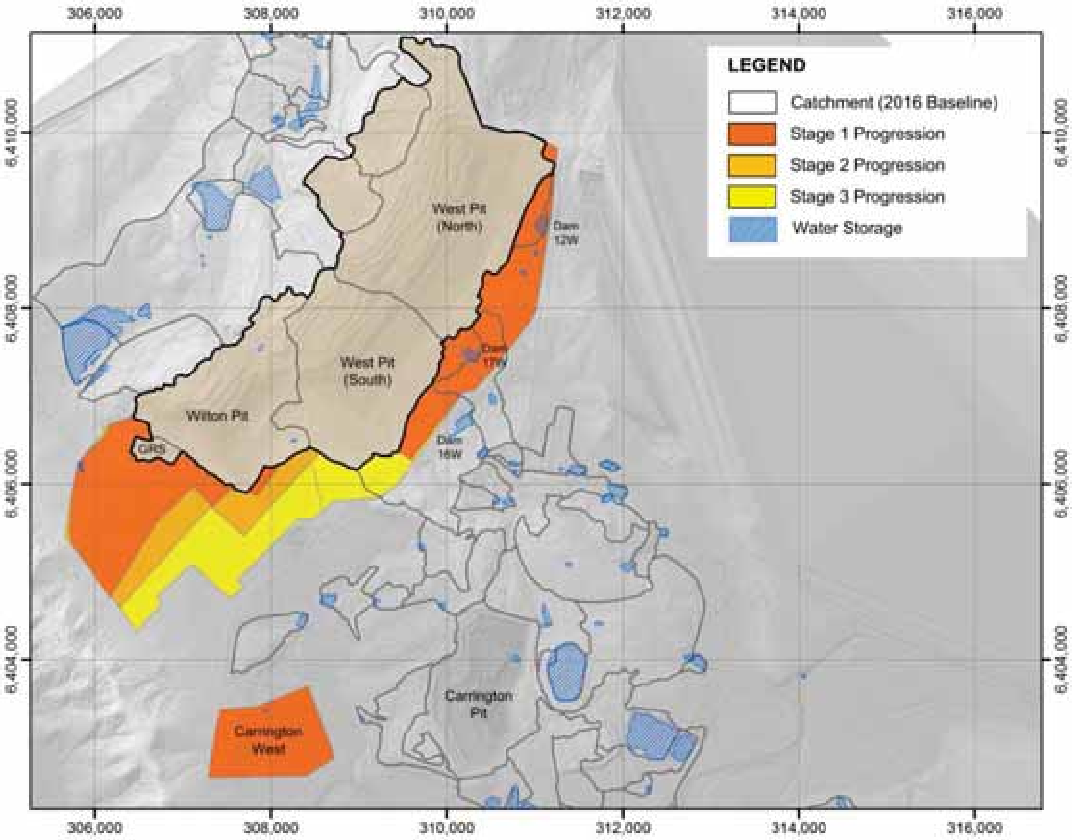


Figure 3-10: HVO North and West – Proposed Pit Progression

3.4.7 *Summary of Changes to Water Storages*

3.4.7.1 *Water Storages to be Removed*

The following water storages will be mined out or decommissioned in the indicative mine plan stages:

- Minor water storages within the existing Cheshunt Pit catchment: D9 Dam, Saline Water Dam, Sediment Dam, Subzero's Dam. These storages are not functionally significant and their removal will not have a material impact on the performance of the water management system. Dams are removed nominally in Stage 1.
- Sediment dams ahead of West Pit: Dam 17W and Dam 12W. Dams mined through by advancing West Pit highwall in Stage 1.

3.4.7.2 Water Storages to be Constructed

There are no new mine water dams proposed at HVO South in the indicative mine plan stages.

Replacement of Riverview Void with a comparable in-pit storage at HVO North or HVO West has been identified as an option for inclusion in future mining planning. Refer to Section 3.4.10.1.

There are several proposed sediment dams to be constructed at HVO South that will intercept runoff from rehabilitated areas prior to discharging off-site. Indicative details are summarised below.

- **Proposed Sediment Dam A**. Indicative location (-32.516, 150.969) west of Riverview Dump. Proposed for construction in Stage 1. May need to be relocated to the west in Stage 3 away from the advancing Cheshunt Pit 1 highwall. Storage capacity will be commensurate to need and subject to detailed design.
- **Proposed Sediment Dam B**. Indicative location (-32.503, 151.015) north of the Cheshunt Dump, near the current Barry Void. Proposed for construction in Stage 1. Storage capacity will be commensurate to need and subject to detailed design. Catchment expands as additional areas of Cheshunt Dump are rehabilitated and diverted.
- **Proposed Sediment Dam C**. Indicative location (-32.545, 150.959) above or downstream of the current Riverview Void. May be constructed in Stage 4 after Riverview Void is backfilled, and its catchment rehabilitated and diverted off-site. Storage capacity will be commensurate to need and subject to detailed design. Dam may not be required if Riverview Void catchment is diverted into Cheshunt Final void.
- **Proposed Sediment Dam D**. Indicative location (-32.558, 151.02) downstream of the proposed South Lemington Pit 2 dump. Proposed construction in Stage 4 after dump landform is established. Storage capacity will be commensurate to need and subject to detailed design.
- **Proposed Sediment Dam E**. Indicative location (-32.567, 151.04) downstream of the rehabilitated area of the South Lemington Pit 1 dump diverted off-site. Proposed construction in Stage 4 after dump landform is established. Storage capacity will be commensurate to need and subject to detailed design.

Location and storage capacity of proposed sediment dams will be confirmed as part of future detailed design investigations.

Additional storages identified for construction but not detailed in this report include sediment dam(s) associated with the Carrington West Pit, and the Carrington Out-of-Pit tailings storage, and any sediment control works associated with the LCPP rail loop (Stage 3).

3.4.8 Proposed Catchment Progression

3.4.8.1 Catchment Areas – All Storages

Catchment areas for HVO South water storages have been delineated based on design landform contours provided by Coal & Allied for each indicative mine plan stage. Areas for HVO North and West have been assumed based on pit progress polygons provided by Coal & Allied. Mine progression, layout and catchment plans have been provided for each stage of mining in Figure 3-5 to Figure 3-9. An overview of HVO North & West pit progress is also presented in Figure 3-10.

Proposed catchment areas for all existing and proposed water storages, voids, TSFs and sediment dams have been summarised in Table 3-3.

Note that proposed storages are highlighted with blue fill; storages that have been removed (mined out, backfilled etc) have been marked with red text; and catchments that do not change between stages have been marked with grey text.

Table 3-3: Proposed Catchment Area Progression by indicative mine plan stage

Storage	Catchment Area (ha)					Notes
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4(2028)	
HVO South						
Water Storages						
Dam 15S	224.4	224.4	230.7	230.7	230.7	Minor changes in catchment area associated with development of Cheshunt dump landform
Dam 16S Group[D]	123.9	121.9	121.9	121.9	121.9	
Dam 17S	44.1	42.1	40.6	40.6	40.6	
Dam 18S	41.9	37.5	24.2	23.8	27.5	
Dam 19S	99.6	97.8	90.0	90.0	90.0	Catchment land use changes include coal pads present from Stage 2, and LCPP area present from Stage 3
D9 Dam	55.8	x	x	x	x	Mined through in Stage 1
Saline Dam (Name TBC)	44.9	21.5	x	x	x	Mined through in Stage 2
C2 Sed Dam (Name TBC)	32.8	x	x	x	x	Mined through in Stage 1
Auger South	34.7	x	x	x	x	Mined through in Stage 1
Riverview Void	94.1	98.1	74.0	60.2	x	Catchment reduces as Cheshunt Pit progresses through Riverview dumps. Approximately 50 per cent of catchment rehabilitated in Stage 1, and 80 per cent in Stage 3. Storage used for tailings disposal then subsequently capped and rehabilitated between Stage 3 and 4. Rehabilitated catchment diverted off-site via sediment dam
Mining Pits						
Cheshunt Pit 1 & 2	700.1	953.9	1,054.9	1,221.4	1,018.0	Pit expands in each stage of mining. Expansion is offset by progressive catchment rehabilitation and diversion off-site via sediment dam
Riverview Central + West	298.1	243.5	243.5	x	x	Mined out by Cheshunt in Stage 3

[D] Includes Dam 23S, 24S, 28S and Sewage Lagoons.

Storage	Catchment Area (ha)					Notes
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4(2028)	
Riverview (Glider)	82.2	x	x	x	x	Backfilled and rehabilitated by Stage 1. Catchment diverted to Dam 11S (sediment dam)
South Lemington Pit 2	x	x	37.6	69.3	x	Mining commences Stage 2. Backfilled and used for LCPP tailings disposal in Stage 3. Catchment assumed to be rehabilitated and diverted off site via sediment dam in Stage 4
South Lemington Pit 1	N/A	N/A	149.7	137.9	38.0	Not mined in prior to Stage 2 – during this time, void is used by adjacent MTW for excess water storage. Mining recommences in Stage 2 and continues through Stage 3. Part of catchment rehabilitated and diverted off site via sediment dam; some catchment reports to final void
Ext. Draining Sed. Dams						
Dam 4S	38.5	34.3	21.2	1.5	1.5	Reduction in catchment due to Cheshunt Pit progression
Dam 5S	14.9	2.2	2.2	2.2	2.2	
Riverview Sed. Dams	153.0	36.9	36.9	69.2	39.3	Reduction in catchment due to Riverview Pit progression
Dam 11S	86.5	168.6	136.6	136.6	136.6	Expansion in catchment area in Stage 1 due to backfill, rehabilitation and diversion of Riverview (Glider) Pit. Stage 2 reductions due to Cheshunt Pit expansion
Dam12S & 13S	228.0	212.6	212.6	212.6	212.6	Minor adjustment to catchment area in Stage 1 associated with Cheshunt Dump landform development
Dam 25S	105.0	105.0	63.2	63.2	63.2	Stage 2 reduction due to Lemington Coal Pad construction.
Dam 28S	76.6	76.6	82.5	82.5	82.5	Modifications due to LCPP and rail loop construction
Proposed Sed Dam A	x	103.6	103.6	105.8	79.0	Intercepts runoff from rehabilitated Riverview West Dump. Relocated west in Stage 3
Proposed Sed Dam B	x	159.8	159.8	315.7	578.2	Intercepts runoff from rehabilitated Cheshunt Dump (Barry Void area). Baseflow assumed to report to Cheshunt Pit via underlying spoil aquifer
Proposed Sed Dam C	x	x	x	x	79.0	Dams intercept runoff from backfilled and rehabilitated Riverview Void, South Lemington Pit 2 and South Lemington Pit 1 respectively. Dams not required until Stage 4
Proposed Sed Dam D	x	x	x	x	69.3	
Proposed Sed Dam E	x	x	x	x	72.8	
HVO North						
Water Storages						
Dam 9N	3.3	3.3	3.3	3.3	3.3	-
Dam 11N	4.0	4.0	4.0	4.0	4.0	-
Dam 15N	67.2	67.2	67.2	67.2	67.2	-
Dam 16N	28.1	28.1	28.1	28.1	28.1	-
Dam 19N (+35N)	25.1	25.1	25.1	25.1	25.1	-
Dam 33N & 34N	8.9	8.9	8.9	8.9	8.9	-

Storage	Catchment Area (ha)					Notes
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4(2028)	
Dam 17N	1.8	1.8	1.8	1.8	1.8	-
Dam 18N	1.1	1.1	1.1	1.1	1.1	-
Dam 20N	207.1	207.1	207.1	207.1	207.1	-
Dam 21N	40.5	40.5	40.5	40.5	40.5	-
Carrington Highwall Dam	65.4	65.4	65.4	65.4	65.4	-
Tailings Storage						
Dam 27N	62.7	62.7	62.7	62.7	62.7	-
Dam 28N	21.7	21.7	21.7	21.7	21.7	-
Dam 29N (North Void)	140.0	140.0	140.0	140.0	140.0	-
Carrington Out-of-Pit	x	x	N/A	N/A	N/A	Functionally modelled as continuation of Dam 29N TSF. Proposed TSF will be constructed within the existing footprint of the mine
Mining Pits						
Carrington Pit	205.2	205.2	205.2	205.2	205.2	-
Carrington West Pit	x	108.0	54.0	x	x	Mining in Stage 1. Backfilling and rehabilitation in progress Stage 2 .50 per cent of catchment assumed diverted off site via sediment dam in Stage 2, and 100 per cent in Stage 3.
Ext. Draining Sed. Dams						
Dam 1N	26.9	26.9	26.9	26.9	26.9	-
Dam 2N (+ 5N)	127.4	127.4	127.4	127.4	127.4	-
Dam 10N	151.4	151.4	151.4	151.4	151.4	-
Dam 24N	22.2	22.2	22.2	22.2	22.2	-
Dam 25N	31.8	31.8	31.8	31.8	31.8	-
Dam 27N (Name TBC)	53.7	53.7	53.7	53.7	53.7	-
Sed Dam (Name TBC)	9.3	9.3	9.3	9.3	9.3	-
Sed Dam (Name TBC)	31.7	31.7	31.7	31.7	31.7	-
Sed Dam (Name TBC)	44.5	44.5	44.5	44.5	44.5	-
Carrington West Sed Dam	x	x	54.0	108.0	108.0	50 per cent of Carrington West catchment assumed diverted off site via sediment dam in Stage 2, and 100 per cent in Stage 3.
HVO West						
Water Storages						
Dam 1W	30.3	30.3	30.3	30.3	30.3	-
Dam 2W	10.8	10.8	10.8	10.8	10.8	-
Dam 3W	47.3	47.3	47.3	47.3	47.3	-
Dam 4W & 5W	91.4	91.4	91.4	91.4	91.4	-
Dam 8W	33.0	33.0	33.0	33.0	33.0	-
Dam 9W	31.2	31.2	31.2	31.2	31.2	-
Dam 18W	342.2	342.2	342.2	342.2	342.2	-
Tailings Storage						
Dam 6W	103.0	103.0	103.0	103.0	103.0	-
Dam 20W	24.0	24.0	24.0	24.0	24.0	-
Mining Pits						

Storage	Catchment Area (ha)					Notes
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4(2028)	
GRS Pit + Wilton Pit	246.0	419.1	499.3	612.1	612.1	Catchment progression based on pit footprint polygons provided by Coal & Allied. Rehabilitation land use changes have been allowed for based on provided planning information. Investigations have assumed no diversion of rehabilitated catchment will occur prior to Stage 4 (2028)
West Pit (North)	517.2	624.8	624.8	624.8	624.8	
West Pit (South)	277.6	323.3	323.3	368.4	368.4	
Ext. Draining Sed. Dams						
Dam 11W	81.3	81.3	81.3	81.3	81.3	-
Dam 12W	17.9	x	x	x	x	Mined out by West Pit progression
Dam 16W	129.0	103.0	103.0	81.0	81.0	Catchment reduced by advancing West Pit highwall
Sed Dam (d/s from 16W)	59.5	28.5	28.5	28.5	28.5	
Dam 17W	17.9	x	x	x	x	Mined out by West Pit progression

3.4.8.1 *Catchment Areas – Overview*

The following table summarises total catchment type by mining area and stage of mine development. Areas have been reported as one of the following:

- Captured catchment: area reporting to a storage or void forming part of the HVO WMS. Runoff from these areas is captured, stored and beneficially reused over time, or released under HRSTS.
- Diverted catchment: generally rehabilitated or undisturbed areas reporting to sediment control structures prior to off-site release.

Table 3-4: Overview of Catchment Type by Mining Area and Stage

Storage	Catchment Area (ha)				
	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HVO South					
Captured catchment area	1,876.6	1,840.7	2,067.1	1,995.8	1,566.7
Diverted catchment area	702.5	899.6	818.6	989.3	1416.2
Total	*2,579.1*	*2,740.3*	*2,885.7*	*2,985.1*	*2,982.9*
HVO North					
Captured catchment area	882.1	990.1	936.1	882.1	882.1
Diverted catchment area	498.9	498.9	552.9	606.9	606.9
Total	*1,381.0*	*1,489.0*	*1,489.0*	*1,489.0*	*1,489.0*
HVO West					
Captured catchment area	1,754.0	2,080.4	2,160.6	2,318.5	2,318.5
Diverted catchment area	305.6	212.8	212.8	190.8	190.8
Total	*2,059.6*	*2,293.2*	*2,373.4*	*2,509.3*	*2,509.3*
Combined HVO Site					
Captured catchment area	4,512.7	4,911.2	5,163.8	5,196.4	4,767.3
Diverted catchment area	1,507.0	1,611.3	1,584.3	1,787.0	2,213.9
Total	*6,019.7*	*6,522.5*	*6748.1*	*6,983.4*	*6,981.2*

3.4.8.2 Allowances for Land Use Changes

Land use classifications remain as per the baseline (refer Figure 3-2 to Figure 3-4) in all stages, for all storages where catchment areas do not change.

For advancing mining pits, baseline land use areas have been held constant, and any change in total catchment area has been applied to the spoil / overburden land use type.

For new mining pits, investigations have allowed for a nominal strip of mining pit land use with the balance defined as spoil/overburden.

Exceptions have been based on rehabilitation footprints provided with the HVO South indicative mine plan stages and also in HVO North development plans. HVO South proposed rehabilitation has been shown in Figure 3-5 to Figure 3-9. Rehabilitation allowances:

- Riverview void catchment defined as 50 per cent rehabilitated land use in Stage 1-2, 80 per cent in Stage 3 and 100 per cent in Stage 4 (post backfilling).
- Dam 11S catchment defined as rehabilitated land use from Stage 1 onward (predominantly associated with Riverview (Glider) Pit backfilling and rehabilitation).
- Proposed HVO South sediment dam catchments are defined as 100 per cent rehabilitated land use, except for the proposed South Lemington Pit 2 sediment dam (Sed Dam D), which has been assumed to be spoil/overburden.
- Approximately 25 per cent combined West Pit (North and South) catchment defined as rehabilitated land use in Stage 2, increasing to 35 per cent in Stage 3 and 50 per cent in Stage 4.

Dam 19S catchment has been assumed to be predominantly hardstand land use from Stage 3 onward, to account for additional impervious area associated with the LCPP and rail construction.

3.4.9 Proposed Water Transfer Infrastructure

Water transfer infrastructure generally remains as described in Section 3.3.2 with the exception of the following:

- Provision of pump and pipeline connections to supply LCPP process water makeup from mine water dams south of Cheshunt Pit (e.g. Dams 17S, 18S, 19S). Required from Stage 3 onward. Assumed this infrastructure will be designed with the LCPP.
- Upgrades to Dam 19S dewatering pump and pipeline infrastructure to enable dewatering at up to 100 L/s to prevent overtopping during significant rainfall events. Upgrade is required to manage catchment runoff from additional hardstand areas associated with the LCPP.

- Provision of pump and pipeline connection to transfer excess water from South Lemington Pit 2 back to the water management system (most likely Riverview Void). The same pipeline may later be used to return excess LCPP tailings moisture if some or all of the South Lemington Pit 2 void is converted into a TSF.
- Modifications to pump and pipeline infrastructure around South Lemington Pit 1 that enable exchange of water between HVO and MTW to accommodate proposed recommencement of mining in this pit. That is, pipework to enable direct transfer to Riverview Void rather than transferring into and out of South Lemington Pit 1.
- Following the backfill of the Riverview void in Stage 4, modifications to the HVO pump and pipeline network that will enable transfer of water between MTW and the replacement in-pit water storage is assumed to be provided at HVO North or HVO West.

3.4.10 Other Notes and Basis

3.4.10.1 Riverview Void

Riverview Void is an inactive open cut pit which has been repurposed to store up to 4 GL of mine water. The void is scheduled to be backfilled and rehabilitated in Stage 4. Riverview Void may be used for tailings disposal from LCPP in the future between Stage 3 and Stage 4.

Given that Stage 4 represents the final stage of mining (nominally two years from completion) it is likely not feasible to construct a replacement out-of-pit water storage for Riverview Void. A preferable option will likely involve the temporary use of an inactive pit at HVO North or HVO West for water storage until HVO mining is complete.

Modelling has assumed that an inactive pit at HVO North or HVO West will be temporarily converted to a dedicated water storage in Stage 4. The storage capacity of the replacement pit is assumed to be comparable to that of Riverview Void.

3.4.10.2 South Lemington Pit 1

South Lemington Pit 1 is currently used by MTW for excess water storage. The mining of South Lemington Pit 1 by HVO in Stage 2 and Stage 3 will take precedent over any water storage or transfer requirements requested by MTW

Investigations have assumed that MTW will provide a comparable storage within the footprint of their own operation when HVO resumes mining this pit in Stage 2. There will be no material change in the storage capacity of MTW, or volume triggers governing the exchange of water between HVO and MTW.

Transfer of water between HVO and MTW is currently via South Lemington Pit 1. It is assumed that pump and pipeline infrastructure will be modified so that exchanges are not affected by HVO recommencing mining this pit in Stage 2.

4. Climate

Climatic influence on the HVO WMS is principally via catchment rainfall–runoff and evaporation (from wetted areas) and evapotranspiration[E] (from catchments). The HVO water balance model has been configured to simulate system performance on the basis of long-term historical climate data.

Historical data has been directly applied, based on the assumption that climatic conditions observed in the past, and captured in the data, are indicative of persistent local climatic trends. Historical data is therefore assumed to represent the range of potential conditions likely to be observed in the near future.

Climatic data for the HVO site[F] has been sourced through the SILO Data Drill service[G]. The Data Drill service accesses grids of climate data interpolated from point observations by the Bureau of Meteorology (BoM), for any point in Australia. Sourced information includes daily resolution rainfall and evaporation data, for the 127 year period 1889 to present. This information has been processed and summarised in the following sub-sections.

4.1 Rainfall

4.1.1 Annual Rainfall (Data Drill)

Annual rainfall totals (water year: October to September) have been presented in Figure 4-1 on a percentile basis. Review of this information shows that annual rainfall varies between 300 mm and 1,200 mm (900 mm spread), with a median of 645 mm ± 155 mm. Approximately 65 per cent of the data set falls within 1 standard deviation of the median – with a slight wet bias. Also shown for reference is the October to September rainfall totals for the five most recent years.

[E] Evapotranspiration is the combined effect of two separate processes acting on a plant-soil system to convert liquid water to water vapour; it comprises evaporative losses from the exposed soil surfaces, and transpiration from the plant canopy.

[F] Reference coordinates -32.45 S, 150.95 E.

[G] SILO Data Drill service hosted by the State of Queensland (Department of Science, Information Technology and Innovation).

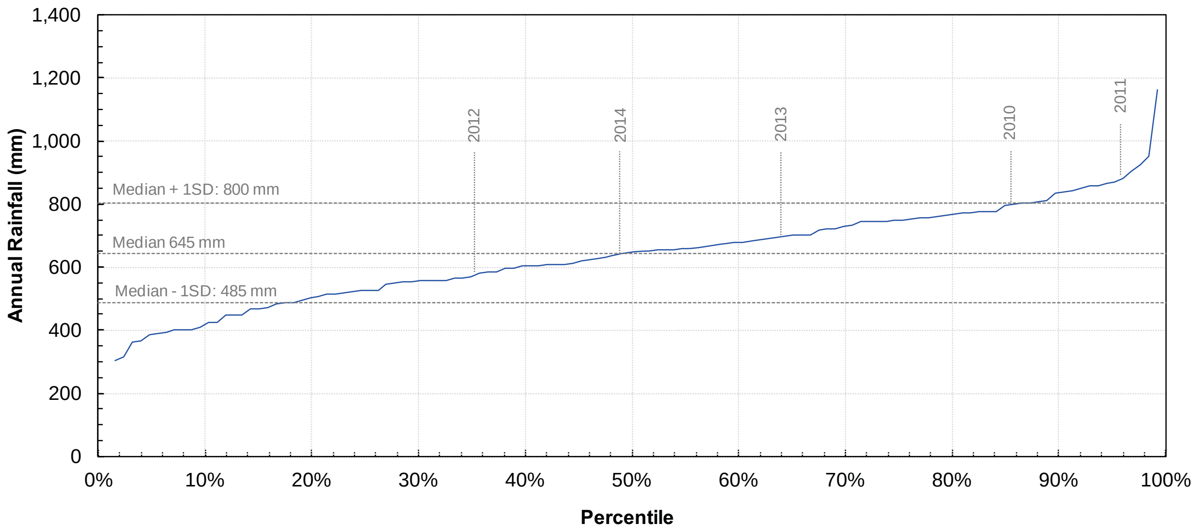


Figure 4-1: Annual Rainfall Percentiles (October-September) – Data Drill 127 years

4.1.2 Rainfall Statistics (Data Drill)

The statistics for the long term Data Drill rainfall data are summarised in Table 4-1. Annual totals are for a calendar year January to December.

Table 4-1: Long Term Monthly Total Rainfall Statistics (mm)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	222	355	270	196	284	288	209	211	152	176	199	185	1,161
90^{th} %	160	165	122	102	90	101	87	64	78	95	126	125	824
Median	66	47	48	34	25	30	35	31	31	45	50	56	645
10^{th} %	22	8	11	6	6	10	7	8	10	9	11	18	417
Min	1	0	1	0	0	0	0	0	0	1	1	3	295
Mean	75	71	60	46	40	48	42	36	40	51	60	66	633
Std Dev	50	66	52	41	41	49	35	30	30	36	45	41	156
Count	127	127	127	127	127	127	127	127	126	126	126	126	126

4.2 Evaporation

Long term daily evaporation data for HVO has been sourced from the SILO Data Drill service and includes:

- Morton lake (M_{lake}) evaporation which has been used to estimate evaporation from the wet surface areas of surface storages.[H]
- Morton wet (M_{wet}) evaporation which has been used to model evapotranspiration losses from catchment areas.[I]

The water balance model uses M_{lake} evaporation as the primary data input, with evapotranspiration calculated by factoring the M_{lake} daily values by the average ratio of M_{lake} to M_{wet}, which was calculated at 0.95.

The statistics for the long term Data Drill M_{lake} evaporation data are summarised in Table 4-2.

Table 4-2: Long Term Monthly Total M_{lake} Evaporation Statistics (mm)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	224	186	158	109	71	48	59	90	130	170	202	227	1,527
90^{th} %	208	168	150	101	65	44	53	81	117	158	182	208	1,468
Median	191	153	135	91	59	40	48	73	104	143	168	191	1,390
10^{th} %	166	136	124	84	54	36	43	66	94	131	148	173	1,326
Min	146	121	104	68	46	33	36	61	79	110	136	152	1,263
Mean	188	152	136	92	59	40	48	73	104	144	167	191	1,393
Std Dev	16	13	10	7	4	3	4	6	9	11	13	14	57
Count	127	127	127	127	127	127	127	126	126	126	126	126	126

4.3 Catchment Yield

Accurate estimation of catchment yield hydrology is an important component of water management investigations. Catchment yield within the HVO water balance model is simulated using the Australian Water Balance Model (AWBM). The AWBM is a saturation overland flow model which uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a water balance approach. The AWBM is a widely accepted and commonly used within Australia[J].

Adopted AWBM parameters are listed in Table 4-3 and were calibrated as part of the 2015 model update.

[H] Evaporation from shallow water lakes is calculated by Data Drill, on the basis of daily meteorological data (temperature, humidity, vapour pressure, etc.) as per procedures proposed by Morton (1983). Rates are typically lower than comparative Class A Pan evaporation, and are generally considered to be more appropriate for estimating losses from surface water storages.

[I] Evapotranspiration from wet environment areas is calculated by Data Drill, on the basis of daily meteorological data (temperature, humidity, vapour pressure, etc.) as per procedures proposed by Morton (1983). Rates are typically lower than comparative Class A Pan evaporation, and are generally considered to be more appropriate for estimating losses from catchment areas.

[J] Refer to '*A Hydrograph-based Model for Estimating the Water Yield of Ungauged Catchments*' (Boughton, 1993) for further information.

Table 4-3: HVO AWBM Parameters

Land Use Classification	AWBM Parameters									
	Partial Area			Soil Storage			K_s	Baseflow		S_{avg}
	A_1	A_2	A_3	S_1	S_2	S_3		K_b	BFI	
Natural / Undisturbed	0.134	0.433	0.433	20	75	150	0.50	0.86	0.22	100
Roads / Industrial / Hardstand	0.100	0.900	-	2	7	-	0.00	-	0.00	6
Mining Pit	0.100	0.900	-	2	7	-	0.00	-	0.00	6
Spoil / Overburden	0.150	0.350	0.500	5	30	120	0.20	0.85	0.30	71
Rehabilitated overburden	0.134	0.433	0.433	5	55	140	0.20	0.85	0.30	85
Cleared / Prestrip	0.100	0.900	-	1	11	-	0.00	-	0.00	10
Stockpile	0.100	0.900	-	1	11	-	0.00	-	0.00	10
Tailings Area	0.100	0.900	-	1	11	-	0.00	-	0.00	10

A breakdown of AWBM calculated runoff coefficients are provided in Table 4-4 on a monthly and annual basis.

Table 4-4: Percent Runoff by AWBM Land Use (Average 127 yr Long Term Simulation)

Item	Monthly average runoff co-efficient (%)												Annual average (%)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Natural	5.7	10.6	11.0	8.4	11.4	19.0	16.0	8.0	3.2	3.0	3.4	3.7	8.3
Cleared (set)[1]	38.2	46.4	43.1	44.4	49.8	54.5	47.7	36.2	31.4	30.3	32.3	32.8	40.4
Hardstand (set)[2]	44.0	51.6	48.9	50.4	55.8	59.6	53.8	42.7	38.4	36.9	38.2	38.8	46.3
Spoil	14.1	20.7	20.8	18.7	21.6	30.0	25.5	16.1	10.6	10.2	11.2	11.3	17.3
Rehab Spoil	10.3	15.8	15.9	13.9	16.8	24.4	20.8	12.3	7.2	6.7	7.5	7.7	13.0

Note: [1] Cleared / Pre-strip, Stockpiles and Tailings share a common AWBM parameter set.
[2] Hardstand / Roads and Mining Pit share a common AWBM parameter set

5. Water Usage

Water stored within the HVO WMS is beneficially re-used to supply various industrial water demands including: CPP process water makeup, haul road dust suppression, vehicle washdown and miscellaneous industrial area water usage (workshops, cleaning, etc.). The following sub-sections describe industrial water usage as incorporated into the HVO water balance model.

5.1 Coal Processing Plants

5.1.1 Overview

Significant quantities of water are required to mechanically separate saleable coal from run-of-mine impurities. In a typical wash plant, water is used in the following applications: float separation of lighter coal particles from heavier impurities, dust suppression during crushing and conveyor handling, machinery wash-down, and as a hydraulic medium for the pumped disposal of suspended tailings reject material.

The majority of water used in these applications is typically captured and re-circulated through the CPP(s) or returned to the mine water system via drains, or recovered through the tailings decant circuits. Actual consumption of water is primarily via product coal moisture export and tailings moisture losses (i.e. retention, evaporation).

There are currently two active CPPs at HVO: the Hunter Valley CPP (HVCPP) (20 Mtpa capacity) is located in the northern mining area, and the Howick CPP (HCPP) (6 Mtpa capacity) is located in the western mining area. The majority of saleable coal is produced via the HVCPP. Coal & Allied plans to construct a third (approved) plant; the LCPP at HVO South between stages 3 and 4 of the indicative mine plan.

5.1.2 Operational Parameters

Operational parameters used to define the solids and water balance of the two existing wash plants and approved but not yet constructed LCPP have been summarised in Table 5-1. Parameters for the HVCPP and HCPP plants are as per the 2015 model update. LCPP parameters have been assumed to be comparable to the two existing CPPs.

Table 5-1: Summary CHPP Operational Parameters

Parameter	HVCPP	HCPP	LCPP
Moisture Contents (% by mass)			
ROM	7.5	7.5	7.5
Product Coal (all streams)	9.6	9.8	9.6
Coarse Rejects	15.0	15.0	15.0
Tailings	80.0	75.0	80.0
Product Yield (%)			
Yield (wet basis)	77.5	71.5	75.0
Reject Material Split (% dry basis)			
Percent as coarse reject	80.0	60.0	80.0
Percent as fine tailings	20.0	40.0	20.0

5.1.3 Throughput - Feed Rates

Feed rates to each CPP have been modelled as follows:

- Base case scenario feed rates remain as per the 2015 model update, at 3.6 Mtpa and 15.4 Mtpa ROM (wet basis) for the HCPP and HVCPP respectively (based on mine production forecasts).
- Stage 1 HVCPP ROM feed rate has been set at 17.4 Mtpa – based on production forecast data (same source as baseline feed rates).
- Feed rates have been set at plant capacity from Stage 1 for the HCPP (6 Mtpa), Stage 2 for the HVCPP (20 Mtpa) and Stage 3 for the LCPP (4 Mtpa) per the indicative mine plans.

5.1.4 Summary Plant Specifications

5.1.4.1 HVCPP

Summary plant specifications for the HVCPP have been presented in Table 5-2. Specifications have been derived based on operational parameters listed in Table 5-1 and adopted ROM feed rates listed in Section 5.1.3.

Table 5-2: HVCPP Summary Specifications per Stage

Parameter	Units	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Plant feed (wet ROM)	Mtpa	15.4	17.4	20.0	20.0	20.0
Plant yield (wet)	%	77.5	77.5	77.5	77.5	77.5
Saleable product (wet)	Mtpa	11.9	13.5	15.5	15.5	15.5
Moisture Flows						
ROM moisture	ML/yr	1,155	1,305	1,500	1,500	1,500
Product coal moisture	ML/yr	1,140	1,295	1,490	1,490	1,490
Coarse reject moisture	ML/yr	495	550	635	635	635
Tailings moisture	ML/yr	2,800	3,125	3,590	3,590	3,590
Process water makeup	ML/yr	3,280	3,665	4,210	4,210	4,210
	ML/d	8.9	10.0	11.5	11.5	11.5

5.1.4.2 HCPP

Summary plant specifications for the HCPP have been presented in Table 5-3. Specifications have been derived based on operational parameters listed in Table 5-1 and adopted ROM feed rates listed in Section 5.1.3.

Table 5-3: HCPP Summary Specifications per indicative mine plan stage

Parameter	Units	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Plant feed (wet ROM)	Mtpa	3.6	6.0	6.0	6.0	6.0
Plant yield (wet)	%	71.5	71.5	71.5	71.5	71.5
Saleable product (wet)	Mtpa	2.6	4.3	4.3	4.3	4.3
Moisture Flows						
ROM moisture	ML/yr	270	450	450	450	450
Product coal moisture	ML/yr	255	420	420	420	420
Coarse reject moisture	ML/yr	105	180	180	180	180
Tailings moisture	ML/yr	1,200	2,020	2,020	2,020	2,020
Process water makeup	ML/yr	1,290	2,165	2,165	2,165	2,165
	ML/d	3.5	5.9	5.9	5.9	5.9

5.1.4.3 LCPP

Summary plant specifications for the LCPP have been presented in Table 5-4. Specifications have been derived based on operational parameters listed in Table 5-1 and adopted ROM feed rates listed in Section 5.1.3.

Table 5-4: LCPP Summary Specifications per Stage

Parameter	Units	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Plant feed (wet ROM)	Mtpa	-	-	-	4.0	4.0
Plant yield (wet)	%	-	-	-	75.0	75.0
Saleable product (wet)	Mtpa	-	-	-	3.0	3.0
Moisture Flows						
ROM moisture	ML/yr	-	-	-	300	300
Product coal moisture	ML/yr	-	-	-	295	295
Coarse reject moisture	ML/yr	-	-	-	140	140
Tailings moisture	ML/yr	-	-	-	795	795
Process water makeup	ML/yr	-	-	-	930	930
	ML/d	-	-	-	2.5	2.5

5.1.5 Process Water Makeup

Process water makeup has been calculated for each plant at each stage of the mine plan, as summarised in the previous sub-section. Makeup is required to offset water entrained in the product, coarse reject and tailings material streams. In practice, some water entrained in the tailings material stream is recovered and recycled in the wash plant. The net influence of each wash plant on the HVO water management system is the residual process water makeup demand after tailings moisture recovery has been accounted for.

Estimated residual process water makeup demands have been summarised in Table 5-5 based on nominal moisture recovery percentages based on the tailings deposition strategy employed in each stage of the indicative mine plan (for additional information regarding tailings please refer to Section 6).

Table 5-5: Estimated Residual Process Water Demands (ML/year)

Parameter	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Total process water makeup [A]	4,565	5,830	6,377	7,305	7,305
Tailings moisture recycled	2,100 [B]	2,345 [B]	4,205 [C]	4,605 [D]	4,605 [D]
Residual water demand [E]	2,465	3,490	2,170	2,705	2,705

Note: [A] Sum of process water makeup listed in HVCPP, HCPP and LCPP summary specification tables
[B] HVCPP moisture return nominally 75 per cent (Dam 29N TSF), HCPP return 0 per cent (Cumnock Void TSF)
[C] HVCPP and HCPP moisture returns nominally 75 per cent (Carrington Out-of-Pit modeled as Dam 29N TSF).
[D] HVCPP and HCPP per Stage 2. LCPP tailings moisture return assumed to be nominally 50 per cent.
[E] Total process water makeup minus tailings moisture recycled.

Review of Table 5-5 shows that the maximum net demand on the HVO WMS occurs in Stage 1 – based on adopted parameters, feed rates and tailings disposal strategy.

5.2 Haul Road Dust Suppression

5.2.1 Overview

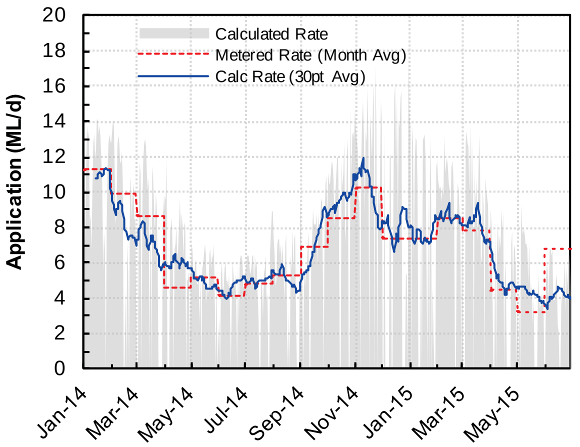
Water is extracted from the HVO WMS and applied over haul roads to prevent or minimise dust lift-off. As part of the 2015 model update, Coal & Allied provided monthly metered dust suppression volumes, review of which yielded the following observations:

- Net monthly dust suppression varied considerably throughout each year, with a degree of seasonality (usage tends to peak in warmer summer months, and trough during winter).
- Water usage appeared to be influenced by rainfall.
- The majority of dust suppression water usage occured at HVO South, accounting for approximately 49% of total site usage in 2014-2015. HVO west accounted for approximately 37% of site usage, with the balancing 14% used at HVO North.
- 2014 calendar year net water usage was 2,630 ML. 2014-2015 financial year water usage was 2,465 ML. January 2014 to June 2015 total usage was 3,785 ML.

A sub-model was developed to dynamically calculate haul road dust suppression water usage in the 2015 model, based on 2014-2015 metered data. The dust suppression sub-model takes into account the observed seasonal variation in usage and sensitivity to rainfall.

Daily water application is calculated in the model as a function of wetted haul road area, evaporation, and rainfall. Water is applied to offset daily evaporation from the wetted area. Evaporation rates are subject to monthly adjustment factors. Application is cancelled if rainfall exceeds a nominated minimum threshold (1.5 mm/d). Monthly evaporation factors and the rainfall threshold have been adjusted to reproduce 2014-2015 metered water usage.

Predicted versus metered dust suppression usage has been presented in Figure 5-1. Review of this figure shows consistency between the predicted and metered water usage rates.



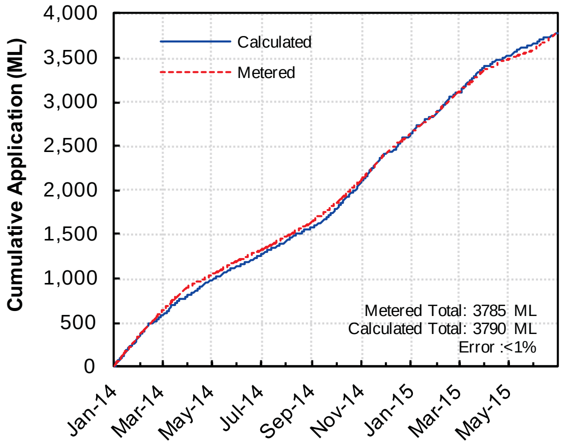


Figure 5-1: Dust Suppression – Predicted versus Metered Usage (2014-2015)

5.2.2 Predicted Usage Rates (Base case Scenario)

Water usage rates have been predicted using the dust suppression sub-model and 123 years of SILO data drill climate[K]. Usage statistics are summarised for reference in Table 5-6.

Table 5-6: Predicted Total Dust Suppression Usage Statistics (ML/month) – Base case Scenario

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	343	325	341	275	197	161	204	261	272	353	401	456	3,156
90th %	317	279	308	244	175	146	176	223	229	310	355	403	2,841
Median	**263**	**230**	**253**	**205**	**152**	**126**	**148**	**192**	**190**	**251**	**282**	**326**	**2,600**
10th %	201	169	204	165	122	97	122	150	157	207	228	259	2,409
Min	162	111	144	96	92	48	86	107	97	150	147	181	2,255
Mean	262	225	254	204	150	123	149	188	192	255	287	328	2,619
Std Dev	43	44	42	32	21	20	22	30	29	40	51	53	182
Count	123	123	123	123	123	123	123	123	122	122	122	122	122

[K] Climate time series has been truncated. Sequence starts in 1893 to align with HRSTS release flow time series, which has been constructed based on IQQM flood modelling. Refer Section 9.3.

5.2.3 Predicted Usage Rate – Future Scenarios

Baseline scenario haul road dust suppression water usage rates have been adjusted for future scenarios according to the following basis:

- HVO South demands have been pro-rated based on the proposed length of coal and waste haulage routes presented in each stage of the proposed modification's indicative mine plans, relative to lengths shown for the Base case Scenario.
- HVO North demands have been assumed to remain constant in all stages with the exception of Stage 1, which assumed a temporary 20 per cent increase in usage to account for mining of the Carrington West pit.
- HVO West demands have been assumed to increase by 5 per cent per stage until Stage 4 to account for the expanding West Pit footprint and expected increases in associated haulage lengths. Usage is assumed to reduce by 5 per cent in Stage 4 to reflect an expected decrease in haulage given there is no pit progression between Stage 3 and Stage 4.

Adopted scaling factors per stage have been summarised in Table 5-7.

Table 5-7: Dust Suppression Demand Scaling per Stage (%)

Mining Area	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HVO South	100	130	165	160	85
HVO North	100	120	100	100	100
HVO West	100	105	110	115	110

Per the 2015 model update, the breakdown of total HVO dust suppression usage is nominally 49 per cent for HVO South, 14 per cent for HVO North, and 37 per cent for HVO West. These weightings have been applied to the scaling factors listed in Table 5-7. The sum of the adjusted weightings is the adjusted total site dust suppression usage; results are listed in Table 5-8. Review of this table shows that maximum usage occurs in indicative mine plan stages 2 and 3, approximately 35 per cent higher than baseline rates.

Table 5-8: Factored Baseline Usage Distribution (%)

Mining Area	Base case* (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HVO South	49	64	80	78	41
HVO North	14	17	14	14	14
HVO West	37	39	41	43	41
Total	100	120	135	134	96

Annual dust suppression demand statistics predicted by the sub-model have been listed in Table 5-9.

Table 5-9: Predicted Annual Dust Suppression Demand Statistics – All Areas (ML)

Item	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Maximum	3,155	3,775	4,255	4,240	3,020
90^{th} Percentile	2,840	3,400	3,830	3,820	2,720
Median	2,600	3,110	3,505	3,495	2,490
10^{th} Percentile	2,410	2,885	3,250	3,240	2,310
Minimum	2,255	2,700	3,040	3,030	2,160

5.2.4 Fill Points

Dust suppression demands for the HVO South, HVO North and HVO West mining areas are modelled as being supplied from fill points at Dam 15S (Lake James), Dam 9N, and Dam 9W (Parnell's Dam) respectively. Supply sources remain consistent with the 2015 model update.

5.3 Miscellaneous Industrial Demands and Vehicle Washdown

The HVO water balance model has been configured to supply vehicle washdown and miscellaneous industrial area usage demands from the mine water management system. Modelled usage rates are listed below.

Usage rates for existing demand streams are consistent with the 2015 model update, and are assumed to remain constant in all stages of mine development. An additional 50 kL/d miscellaneous industrial area demand has been modelled in indicative mine plan stages 3 and 4 associated with the LCPP.

Vehicle Washdown:

- Dam 19N 775 kL/d
- Dam 5W 50 kL/d

Miscellaneous Industrial Usage

- HVCPP Hosedown Tank 450 kL/d
- HCPP Hosedown Tank 50 kL/d
- Dam 17S 450 kL/d (Lemington workshop)
- Dam 17S 50 kL/d (LCPP - Stage 3 and 4 only)

Modelled return rates are as follows:

- 15 per cent of vehicle washdown water usage is assumed to return to the source dam.
- No return from industrial usage modelled.

6. Tailings

6.1 Base case Scenario

The 2015 model updated defined indicative operating protocols and parameters for the following TSFs:

- Dam 29N TSF (located at HVO North)
- Dam 6W TSF (located at HVO West)
- Cumnock Void (external to mine)

The HVO water balance model was configured to simulate the following processes within the Dam 29N and Dam 6W facilities, when operational:

- Percentage loss applied to all in-bound tailing slurry accounting for matrix moisture retention and transmission losses. Residual moisture reports to the free water body of the TSF.
  - Dam 29N TSF 22 per cent loss
  - Dam 6W TSF 50 per cent loss
- Climatic influence on the wetted surface area of each TSF (rainfall and evaporation).
- Rainfall over dry (non-submerged) areas of the TSF is subject to moisture losses that vary depending on antecedent conditions. Excess runoff drains to the free water body.
- Additional water loss from free water body based on wetted area:
  - Dam 29N TSF 2 mm/d depth loss (average 440 kL/d)
  - Dam 6W TSF 4 mm/d depth loss (average 200 kL/d)
- Excess water is pumped to the mine water management system for re-use.

Based on this approach, average moisture returns over the long-term is approximately 75 per cent for the Dam 29N TSF, and approximately 50 per cent for the Dam 6W TSF. Moisture recovery from the Cumnock TSF is understood to be negligible.

6.2 Proposed modification indicative mine plan stages

Tailings slurry disposal from the HVCPP, HCPP and LCPP for the proposed modification has been modelled in accordance with mine planning information provided by Coal & Allied.

Indicative mine plans propose continued use of existing storages in Stage 1, transitioning to an approved out-of-pit TSF to be constructed near the Carrington Pit at HVO North, operational from Stage 2.

Investigations have modelled the Carrington Out-of-Pit TSF as a continuation of the Dam 29N TSF, based on the following assumptions:

- Operational characteristics (losses, moisture returns, etc) will be comparable to the existing Dam 29N TSF.

- The TSF will be constructed within the existing mine catchment (no net change in overall mine catchment area).
- Increased runoff capture from changed land use associated with the new TSF will be offset by rehabilitation and catchment diversion in the Carrington Pit area and at HVO West (conservatively excluded from current modelling).

Tailings produced at the LCPP in HVO South are approved and scheduled for disposal in the South Lemington Pit 1, South Lemington Pit 2 or Riverview Void. Sequencing and method of disposal remain subject to confirmation. Note the LCPP is online from Stage 3. Modelling has assumed the following:

- **Stage 3**: LCPP tailings assumed directed to South Lemington Pit 2 (which will be in the process of being backfilled) and possibly also to South Lemington Pit 1 (to partitioned sections of the pit where mining has been completed). 50 per cent of tailings moisture is assumed to be recovered and pumped back to mine water system for re-use (same return rate as Dam 6W TSF). No tailings pumped to Riverview Void.
- **Stage 4**: Riverview void assumed to have been used for tailings storage between indicative mine plan stages 3 and 4 while being backfilled. Both Riverview Void and South Lemington Pit 2 would be backfilled and rehabilitated in Stage 4. LCPP tailings disposal assumed directed to South Lemington Pit 1 with 50 per cent moisture recovery.

6.3 Summary

The following tabulation lists which TSF is being used by each CPP in each stage of the indicative mine plans. Note that Dam 29N TSF has been abbreviated as ‘29N’, Cumnock Void as ‘Cumnock’, Carrington Out-of-Pit as ‘C Ex-Pit’, South Lemington Pit 1 ‘SL1’, and South Lemington Pit 2 as ‘SL2’.

Table 6-1: Tailings Disposal by Plant and by Stage

Plant	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
HVCPP	29N	29N	C Ex-Pit	C Ex-Pit	C Ex-Pit
HCPP	Cumnock	Cumnock	C Ex-Pit	C Ex-Pit	C Ex-Pit
LCPP	n/a	n/a	n/a	SL1, SL2	SL1

7. Groundwater

Groundwater inflow rates to open cut mining pits have been modelled in accordance with predictive modelling results provided by Australian Groundwater & Environmental Consultants (AGE). Modelled inflow rates have been summarised in Table 7-1, listed by pit and by stage. Listed inflow rates are pumpable flows, after allowances for evaporation and coal moisture uptake.

Table 7-1: Modelled Groundwater Inflow Rates (ML/y)

Open-Cut Pit	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Cheshunt or Riverview	915	675	800	960	1,180
Carrington	60	60	60	60	60
Carrington West	-	280	-	-	-
South Lemington Pit 1	0	0	0	80	-
South Lemington Pit 2	-	-	-	530	-
Total	975	1,015	860	1,630	1,240

Spoil Aquifer Inflows

AGE modelling results also included predicted time-series inflows from spoil aquifers in the vicinity of each open cut pit. Spoil aquifer inflow rates are over and above the predicted 'pumpable' flows from undisturbed aquifers (listed in table above), and are predicted in all years of mining of the proposed modification. Undisturbed aquifer inflows alone are considered more appropriate for water balance modelling, given the following:

- The water balance model already accounts for sub-surface runoff from spoil dump areas, calculated after each rainfall event.
- The water balance model was validated against historical inventory data collected in 2014-2015 as part of the 2015 model update. The outcomes were consistent with historical inventory fluctuations without including any additional spoil aquifer discharge. This suggests that the spoil aquifer inflow stream is already inherently accounted for in the model, either via AWBM baseflow runoff calculations or some other mechanism.
- Baseflow from diverted sections of the Cheshunt Dump have been assumed to report to the Cheshunt Pit.

Despite the above, water balance modelling has tested a set of sensitivity scenarios that include the additional spoil aquifer inflows to determine what effect they would have on the performance of the water management system. Results included reduced external water supply requirements, an increased frequency of in-pit water storage, increased HRSTS discharge volumes, and no increase in non-HRSTS discharge from mine water dams (note results not plotted in this report).

8. External Water Supply

Following prolonged periods of drought the mine may need to supplement site inventory reserves by sourcing water from an external supply source, to ensure continued supply to site water demands. Available water sources include, but are not limited to:

- LUG Bore
- Water sharing with neighbouring mines (including Coal & Allied's MTW, Peabody's Wambo and Glencore's Liddell mines).
- Extraction from the Hunter River.

Site water demands do not require high quality water, and are routinely supplied with water from the HVO WMS. HVO would seek to import water of comparable quality prior to accessing high quality river water.

8.1 Available Allocation

Total available allocation is made up the following sources:

- Licensed extraction for HVO from the LUG Bore is 1,800 ML/year. Note that this allocation is currently shared with the neighbouring MTW mine as HVO does not require additional external supply. Should HVO require the external water supply in the future it would take advantage of the full entitlement requiring MTW to seek other external water supply to meet their needs.
- The volume of water that could be sourced from neighbouring mines depends on whether excess volume is available. Water sharing would be negotiated between mine operators on a case by case basis. It is noted that water exchange between HVO and MTW is already accounted for in the water balance model (refer Section 10).
- HVO holds both High and General Security WALs to withdraw water from the Hunter River as a contingency, should sufficient quantities of poorer quality water be unavailable. HVO has a combined total entitlement of 4,665 units, which is equivalent to 4,665 ML per year assuming full allocation. Coal & Allied will ensure that it holds the required licenses for the operations. Note that passive groundwater inflows from the Hunter River into the HVO WMS via near surface aquifers are counted toward the licensed extraction volume. For context, the 2014 passive inflow was estimated at approximately 915 ML, leaving a residual allocation of 3,750 ML for pumped extraction. 2

8.2 Model Approach

The HVO water balance model has been configured to source water from an external source to sustain site water demands during times of drought. Water is imported to Dam 17N at HVO North, Riverview Void or Dam 15S at HVO South, and Dam 9W at HVO West. Annual import has not been constrained in order to quantify what additional supply may be required in the event that current allocations are exceeded.

9. HRSTS Releases

9.1 Overview

HVO is a participant in the HRSTS, managed by the NSW Environment Protection Authority. The HRSTS is designed to manage salinity in the Hunter River by restricting discharge of saline water to periods of river flow. Release opportunity occurs during periods of 'high flow' or 'flood flow', which correspond to specific flow rates in different reaches of the Hunter River.

When the river is in high flow, release opportunity is governed by the total allowable discharge (TAD), which is calculated by the scheme operators based on ambient river flow and salinity. The TAD is a net salt mass, which if added to the river would result in an electrical conductivity of no greater than 900 µS/cm.

Participants in the HRSTS hold a number of 'credits' of which there are 1,000 available; credits are bought at auction but can be traded. The number of credits held dictates what percentage of the TAD can be used on any particular high flow day. HVO currently holds 145 credits, and as such may release up to 14.5 per cent of the declared TAD salt tonnage during a high flow event.

When the river is in flood flow, participants in the scheme may discharge at high rate of flow, provided the salt concentration in the river does not exceed 900 µ S/cm.

9.2 Release Points

The HVO EPL lists the following authorised HRSTS release points – and maximum release rates (per condition L3.1):

- Release Point 3 (Dam 11N) 100 ML/d
- Release Point 4 (Dam 9W) 130 ML/d
- Release Point 8 (Dam 15S) 120 ML/d

Release points 3 and 4 are within the middle sector of the Hunter River. Release point 8 is in the lower sector. The lower sector typically experiences a higher frequency of flood flow than the middle sector, due to additional catchment area.

9.3 Model Configuration

9.3.1 Release Opportunity

The HVO water balance model has been configured to simulate the release of saline water to the Hunter River in accordance with the calculation flow described in Figure 9-1. Model inputs are annotated on the schematic:

- Inputs that do not change over time are listed in red text.
- Inputs that vary over time are listed in blue text.

Key parameters governing the release of saline water to the Hunter River include the following:

- The combined volume of water currently stored within the HVO WMS. Operating protocols seek to maintain a minimum quantity of water on site to sustain demands through periods of low rainfall. Releases will only occur if this minimum buffer volume is exceeded.
- Hunter River flow regime and TAD.
- Current HRSTS credit holding.
- Salinity of water to be released.
- Infrastructure constraints.
- Efficiency or availability adjustments (accounting for operator delay, accessibility, decision making, safety margins, etc.).

All of these items are modeled as static parameters with the exception of the TAD/flow-regime time series, which is described in the following sub-section. Adopted parameters are summarised in Section 9.3.3.

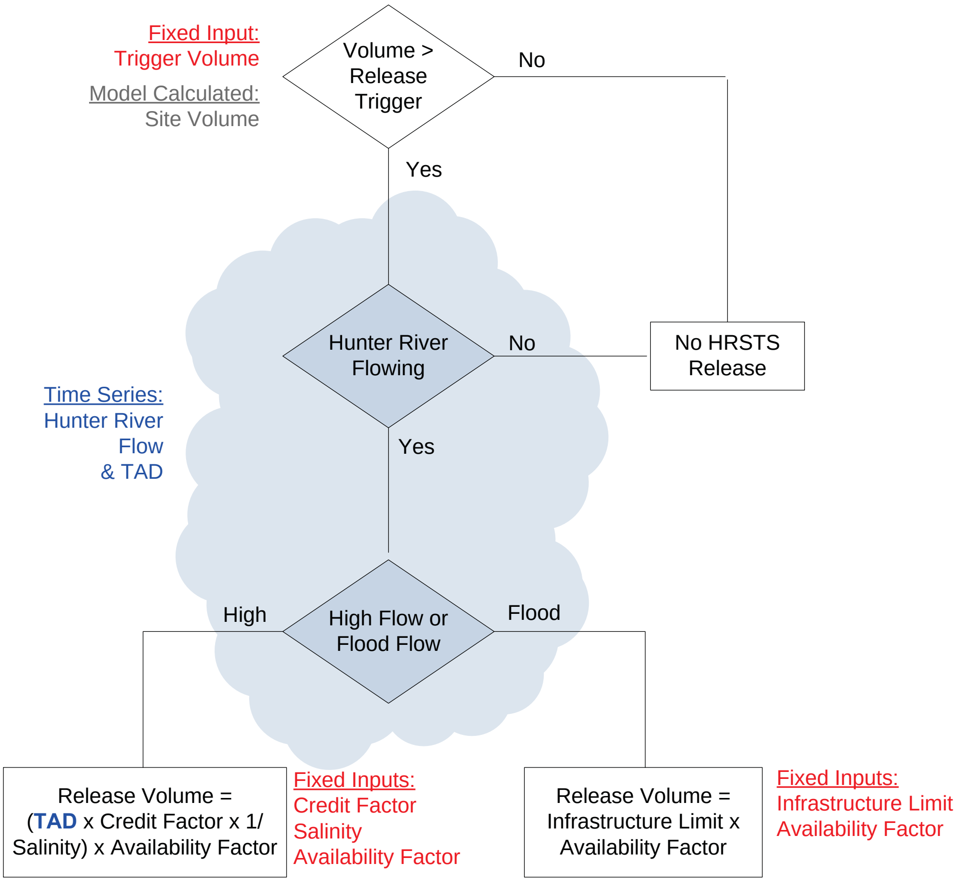


Figure 9-1: HRSTS Release Protocols

9.3.2 Flow and TAD Time Series

9.3.2.1 Overview

HRSTS releases are calculated based on the declared TAD during high flow conditions, and based on release infrastructure during flood flow.

The HVO water balance model simulates system performance using a long-term climate time series (1889 – 2013) as the main probabilistic input. The model requires a TAD and flow regime time series of equal length in order to estimate HRSTS releases.

A long term TAD/flow-regime time series was developed as part of the 2015 model updated based on a composite of: **1)** actual declared TAD and **2)** synthetic TAD based on predictive flood modelling and ambient salinity monitoring data. Associated documentation from the previous report has been reproduced in the following sub-sections.

9.3.2.2 Data Inputs

The following information was used to develop the long-term TAD and flow-regime time series:

- **REF1)** Declared TAD and flow regime for the period 2000 to 2015 sourced from the HRSTS river register. For conservatism – reference TAD and flow-regime data were based on middle sector data (which typically experiences a lower frequency of flood flow days than the lower sector).
- **REF2)** Hunter River streamflow time series: simulated streamflow data for Singleton from the Department of Primary Industries, Water (DPI Water) (formerly NSW Office of Water) IQQM model (full development case with 2004 water sharing plan rules) for the period September 1892 to June 2007.
- **REF3)** Hunter River Streamflow time series: measured flow upstream of Singleton at Station 210001 for the period 2007 to 2011.
- **REF4)** Salinity: recorded salinity data for the Hunter River at Denman (#210055) from the PINEENA database, covering the period February 1993 to October 2010.
- **REF5)** Algorithm to predict Hunter River salinity as a function of stream flow, developed as part of a previous model update (WRM, 2014[L]).

$$S = -75.89 \ln(Q) + 1186.4 \qquad \text{(EQ1)}$$

Where: S is electrical conductivity in µS/cm
Q is stream flow in ML/d

9.3.2.3 Methodology

The long-term synthetic TAD and flow-regime file was developed using the following methodology:

[L] WRM Water & Environment, March 2014. *Hunter Valley Operations – Water Balance Model Update 2014.* Document 0969-02-C1. Revision 1.

- REF5 – EQ1 was validated through comparison of REF2 and REF3 streamflow data and REF4 salinity data.
- REF3 streamflow data was reviewed. Data quality post 2010 appeared to be questionable and was omitted.
- REF2 long-term stream flow file was extended with data from REF3 to extend the period of overlap with REF1. The extended long-term flow file comprised daily flow rates between September 1892 and December 2009.
- Hunter River salinity was calculated for the 1892-2009 time series using EQ1.
- The additional mass of salt required to increase salinity in the Hunter River to 900 µS/cm EC was calculated, to produce an uncalibrated estimate of the TAD.
- The long-term predicted TAD and streamflow file overlapped with the REF1 historical data between 2000 and 2009. The following parameters were adjusted to align the predicted data with the historical data:
  - High and flood flow thresholds were adjusted to match predicted high and flood flow day frequency.
  - TAD adjustment factor: adjusted to match the predicted TAD with declared TAD for high flow days only (flood flow days excluded).
- The final TAD and flow-regime file was constructed by using predicted values prior to 2000, and historical data between 2000 and 2015.

Cumulative predicted vs actual TAD and flow day frequency results have been reproduced in Figure 9-2 for reference. Review shows that cumulative TAD agreement is within 1 per cent between 2000 and 2009[M]. Cumulative flow day frequency agreement is within 3 per cent for the same period (high flow: 109 predicted vs. 106 actual; flood flow: 18 predicted vs. 18 actual)[N].

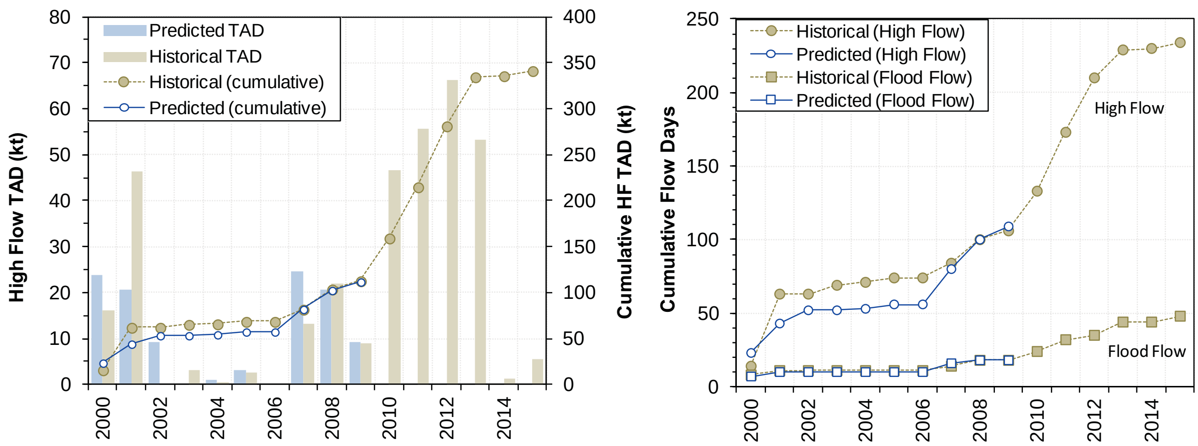


Figure 9-2: Predicted vs Historic TAD (left) and Flow Day Frequency (right)

[M] Cumulative TAD agreement is within 0.5 per cent between 2000 and 2007 (excludes REF3 extension of REF2)
[N] Cumulative flow day frequency is within 2 per cent between 2000 and 2007 (excludes REF3 extension of REF2)

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9.3.3 Potential HRSTS Release Flows

The composite TAD and flow-regime time series described in Section 9.3.2 was used to calculate a long-term potential HRSTS release volume time-series. Potential release volumes are calculated per the protocols outlined in Figure 9-1, based on the parameters listed in Table 9-1. Note that parameters remain consistent with those derived in consultation with Coal & Allied as part of the 2015 model update. Parameters and HRSTS release protocols are assumed to remain current in all future stages of modelling.

The potential release volume time-series is imported into the water balance model. Simulated releases occur if the combined site inventory exceeds the adopted minimum threshold volume of 4 GL. Releases occur from Dam 15S and/or Dam 9W at up to 120 ML/d or 40 ML/d respectively, but the net daily release is constrained to the volume in the potential flow time-series (current settings limit release to 96 ML/d). Note the maximum rate of release from Dam 9W has been modelled at a reduced rate consistent with the 2015 model update. Releases from Dam 11N have also not been modelled consistent with the earlier model update.

Conservative assumptions include the 60 per cent availability factor, reduced Dam 9W maximum release rate, no releases from Dam 11N, and the composite TAD time-series based on middle sector flows (RP8, the primary release point, is located in the lower sector, which experiences higher flow).

Table 9-1: HRSTS Release Assumptions (All Scenarios)

Parameter	Value	Basis
High Flow Events		
TAD (tonnes)	varies	Declared TAD - 2000 to 2015 Calculated TAD - 1892 to 1999 - per Section 9.3.2.
Credit Factor	0.145	Based on current HVO holding of 145 credits (out of 1,000 available).
Release Water EC	4,100 µS/cm	Assumed EC - per discussions with Coal & Allied and RTCA.
EC to TDS conversion	0.67	Typical conversion factor
Availability Factor	0.60	Nominal allowance - per discussions with Coal & Allied and RTCA.
Release Volume (ML)	Q_{HF} = TAD x 0.145 x (4100 x 0.67)$^{-1}$ x 1000 x 0.6	
Flood Flow Events		
Release Rate		Per Coal & Allied advice
RP3 (Dam 11N)	0 ML/d	*RP3 not used per 2015 model update*
RP4 (Dam 9W)	40 ML/d	*Adopted limit per 2015 model update*
RP8 (Dam 15S)	120 ML/d	*Limit specified in EPL640*
Availability Factor	0.60	Same factor as adopted for high flow.
Release Volume (ML)	Q_{FF} = (0 + 40 + 120) x 0.6 = 96 ML/d MAX	

Maximum annual release volumes adopted for the HVO baseline model are presented in Figure 9-3. Volumes have been calculated based on the composite TAD time series and the assumptions listed in Table 9-1.

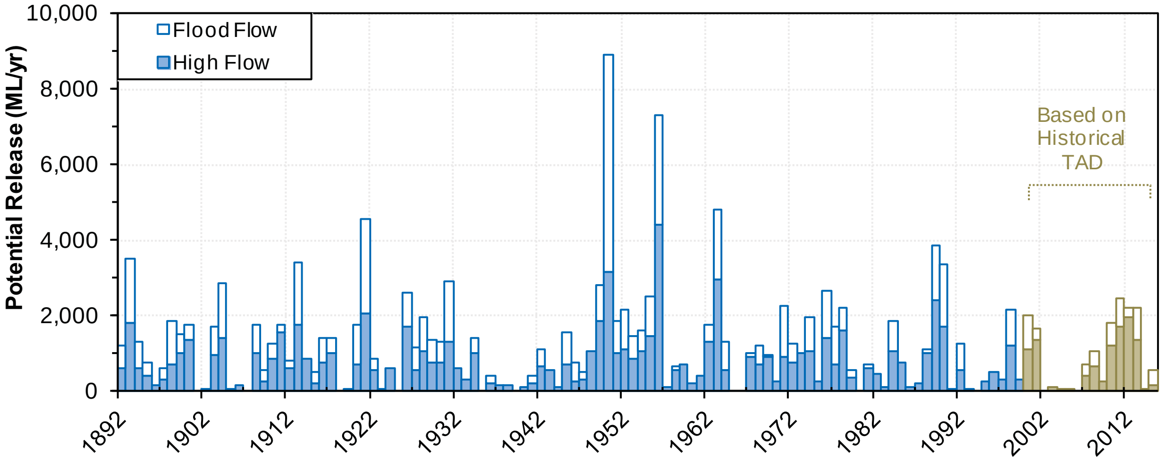

Figure 9-3: Annual Potential HRSTS Release Volumes – Model Input

10. Exchanges with MTW Mine

Water transfers between HVO and MTW form part of each operation's approved activities. Transfers are via the South Lemington Pit 1, which each operation is capable of pumping to/from at a rate of 11 ML/d. Protocols governing the transfer of water between the two sites remain subject to finalisation, but in general, transfers will be undertaken to benefit MTW without materially worsening the HVO risk position with respect to mine water storage and/or water supply security.

For the purposes of modelling, nominal transfer rules have been set in consultation with Coal & Allied. Adopted modelling rules generally seek to maintain HVO inventory between 2.5 GL and 4 GL, and MTW inventory between 2.5 GL and 2.0 GL.

To enable these transfers to be simulated, functionality has been included in the HVO water balance model to track inventory at MTW. Inflows and outflows to the MTW sub-model have been calculated using the MTW water balance model developed as part of the 2015 HVO/MTW WMS integration project, and re-calibrated as part of this project. Documentation of MTW model components and basis has not been included in this report. Modelling has assumed MTW system configuration remains constant in all future scenarios (assumed no significant change in water generation or water consumption).

Exchanges between HVO and MTW are simulated in all scenarios. It has been assumed that infrastructure will be modified to allow pumping directly to Riverview Void in indicative mine plan stages 2 and 3 when mining resumes in South Lemington Pit 1. It has also been assumed that the HVO pump and pipeline network will be modified, if required, to enable transfers between HVO and MTW to continue in Stage 4, after Riverview Void has been backfilled.

11. Water Balance Model

11.1 Overview

HVO has developed and maintain an operational water balance model for the site using the OPSIM software platform. The OPSIM software is a general purpose simulation model for water resource systems. It is industry accepted, and primarily used for mine site water management applications throughout Australia.

The HVO water balance model was last updated by Hatch in 2015[O], and validated against metered data collected between January 2014 and June 2015. Model validation outcomes from the previous report have been reproduced in this report to support modelling outcomes (refer Section 11.3).

The HVO water balance model has been designed to simulate the operation of all major components of the WMS, including catchment runoff, water inventory fluctuation and overflow, pump and gravity transfers, industrial water extraction and return, climatic influence, groundwater inflow, open cut mine dewatering, tailings hydrology and opportunistic controlled release of mine-affected water to the Hunter River under HRSTS.

Key components of the HVO WMS are generally described in the preceding report sections.

11.2 Model Schematisation

A representative schematic of the HVO water balance model has been provided in Figure 11-1 to Figure 11-3. Review of these figures shows the model is comprised of a collection of inter-connected nodes. Nodes represent key components of the WMS (dams, CPPs, pits, etc.). Functional specifications for various node types can be provided upon request.

[O] Hatch Pty Ltd, October 2015. *HVO Water Balance Model – Baseline Scenario*. Document H349794-00000-228-230-0001 (Rev 0 – dated 29/10/2015).

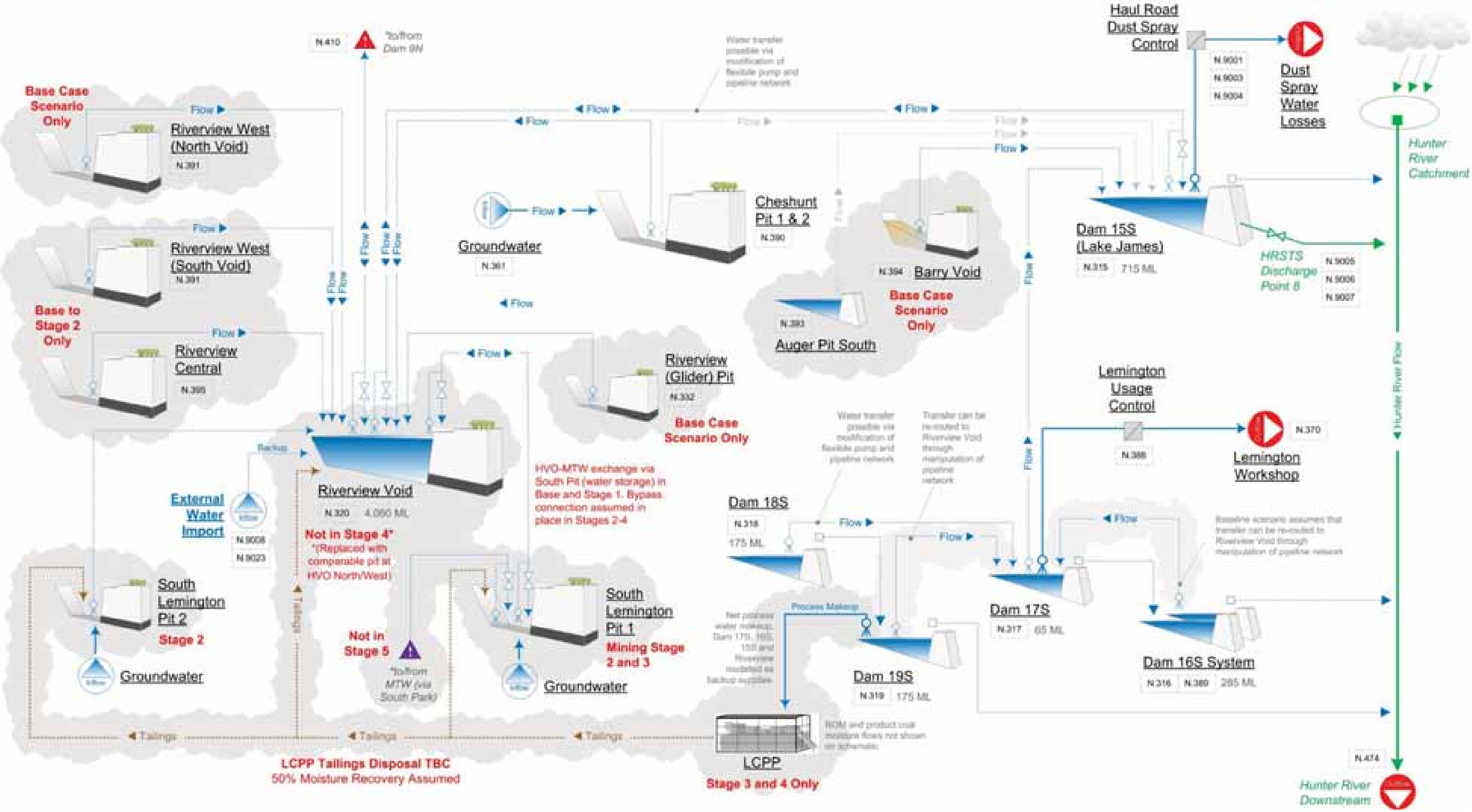

Figure 11-1: Water Balance Model Schematic – HVO South

Safety • Quality • Sustainability • Innovation

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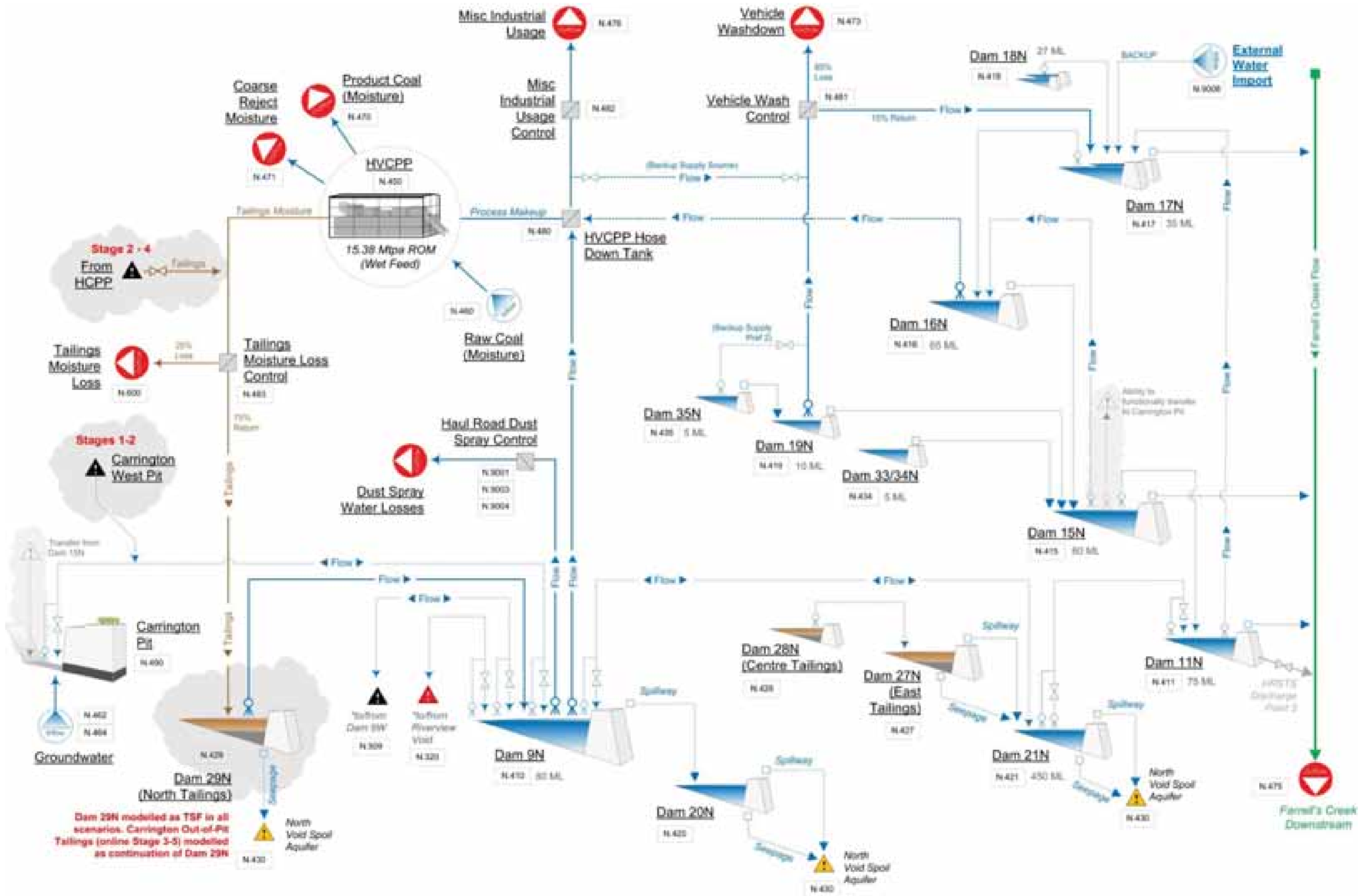

Figure 11-2: Water Balance Model Schematic – HVO North

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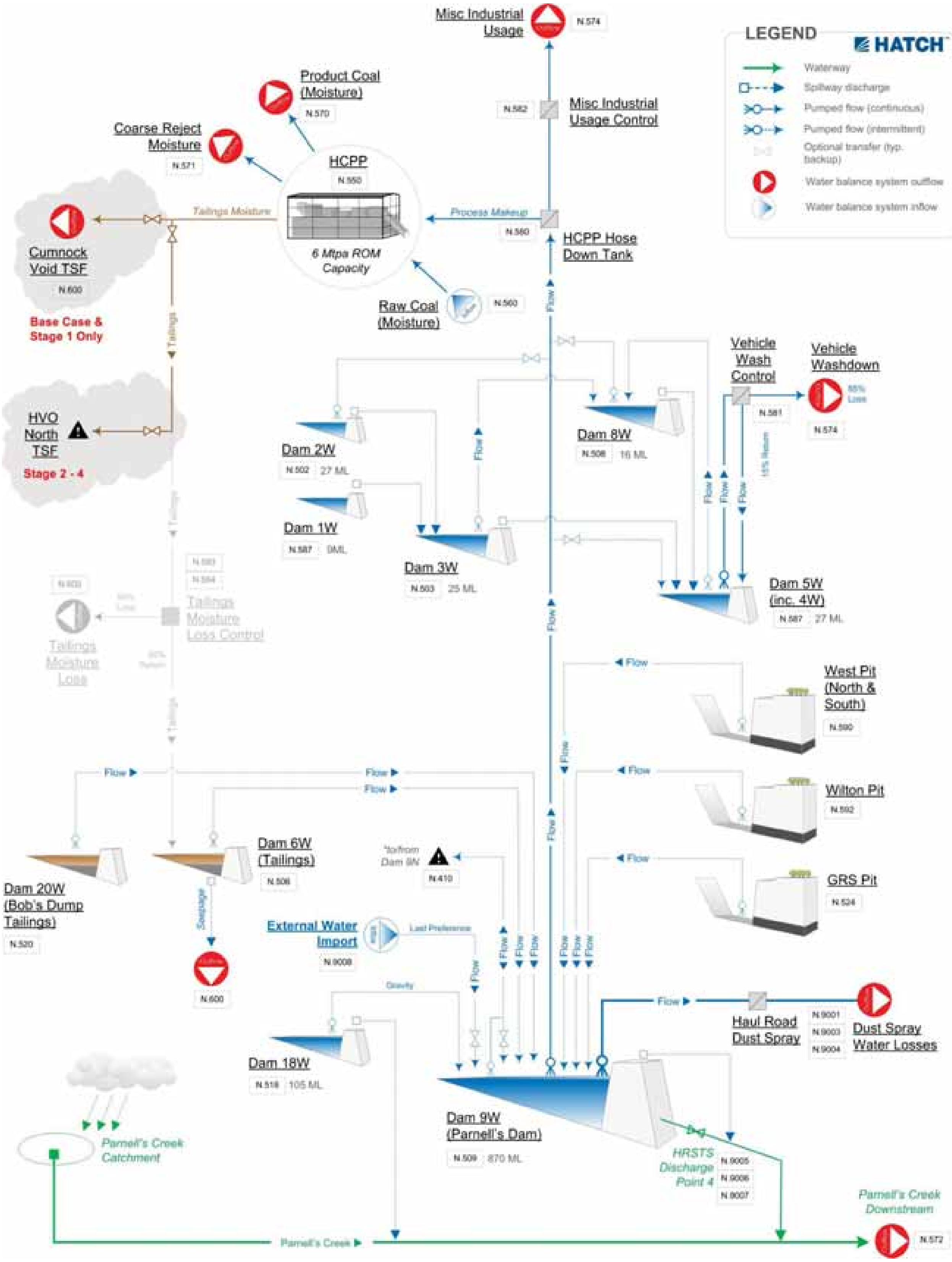

Figure 11-3: Water Balance Model Schematic – HVO West

11.3 Model Calibration

11.3.1 Overview

As part of the 2015 model update, Coal & Allied provided historical inventory data for a period including January 2014 to June 2015. This information was used to validate the HVO water balance model. Documentation associated with the validation process has been reproduced in this report to support current modelling.

Model calibration focused specifically on reproducing the combined historical volume within the overall HVO WMS, and also within the following sub-groupings:

- HVO South, comprising: Riverview void, Dam 15S (Lake James), Dam 16S, Barry Void, Cheshunt Pit, Riverview Central Pit, Riverview West Pits and Riverview (Glider) Pit.
- HVO North: comprising Dam 11N, Dam 21N and Carrington Pit.
- HVO West: comprising Dam 9W, West Pit North & South, and Wilton Pit.

The following process inflows and outflows were hard-coded into the model as time series data:

- HVCPP and HCPP process water makeup.
- HVCPP and HCPP tailings moisture flow to Dam 29N and Dam 6W TSFs.
- Haul road dust suppression water usage by fill point.
- HRSTS releases from Dam 15S and Dam 9W.

The following processes were simulated:

- Climatic influence: evaporation, evapotranspiration, direct rainfall and catchment runoff using site recorded rainfall data (daily depths – HVO Corporate AWS) and Data Drill evaporation data (M_{lake} daily resolution).
- Transfer of water between storages, pit dewatering, etc.
- Extraction of water and return from miscellaneous industrial and vehicle washdown demands.

The following parameters were adjusted to improve agreement between simulated and historical inventory:

- AWBM catchment yield parameters.
- Evaporation rates and reduction factors.
- Groundwater inflows.
- Tailings circuit moisture losses.

11.3.2 Calibration Performance

11.3.2.1 HVO South Sub-Model

Simulated versus historical inventory within the HVO South mining area has been presented in Figure 11-4. Note the starting inventory included a minor offset to mitigate a period of uncertainty in April and May 2014.

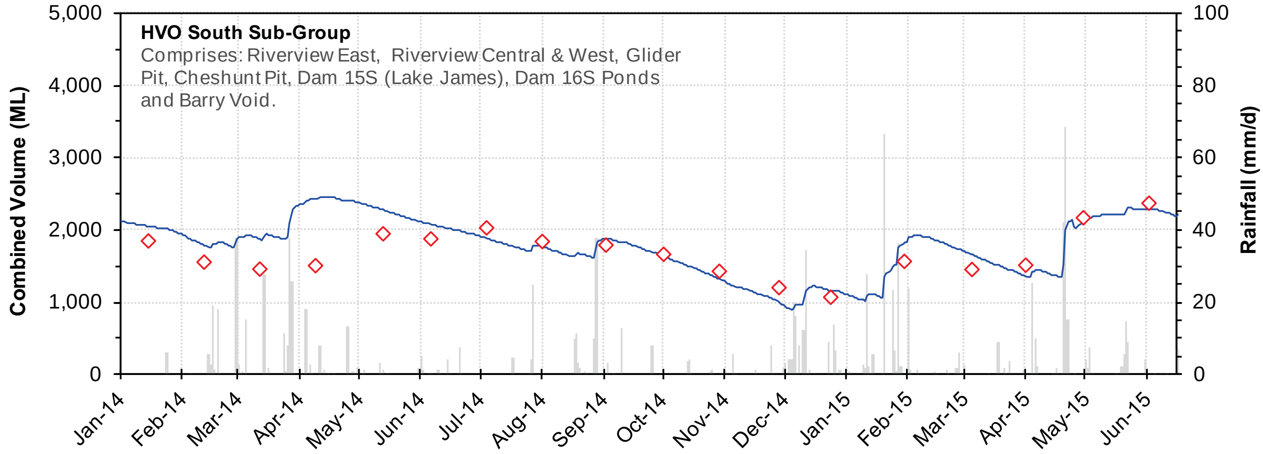

Figure 11-4: Simulated vs Historical Volumes – HVO South

Review of Figure 11-4 gives the following:

- Simulated inventory was consistent with observed inventory between July 2014 and June 2015. Drawdown rates and catchment responses appeared to be well represented.
- There was an unresolved inconsistency between simulated and observed inventory between May 2014 and June 2014. Observed inventory held steady at 2 GL whilst the model predicted a steady draw down. It was noted that rainfall across HVO is highly variable, and that nearby gauges reported higher depths than the HVO corporate gauge at this time.
- The inventory drawdown and plateau observed between January 2014 and March 2014 was reproduced by the model (allowing for the offset starting inventory).

An additional 0.8 ML/d inflow was applied to improve the consistency between simulated inventory and observed inventory. Without detailed flow meter data it was difficult to determine the nature of the inflow, and as an interim measure, modelling assumed the additional flow was evenly split between HVO South groundwater and the HVO North tailings circuit. Additional groundwater was apportioned to the Cheshunt Area pits (0.4 ML/d above the 2.1 ML/d inflow predicted by groundwater modelling current at the time).

Note that additional groundwater inflows have not been applied through future scenarios as revised groundwater modelling inflow rates for the baseline scenario have been adjusted to 2.5 ML/d (refer Table 7-1 Cheshunt Pit).

11.3.2.2 HVO North Sub-Model

Simulated versus historical inventory within the HVO North mining area has been presented in Figure 11-5.

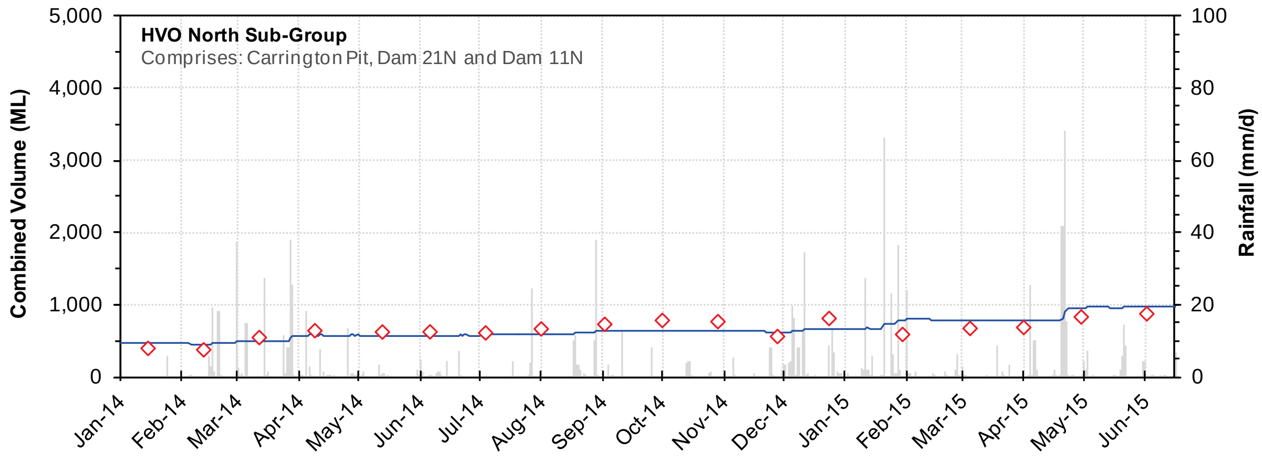

Figure 11-5: Simulated vs Historical Volumes – HVO North Area

Review of Figure 11-5 shows consistency between simulated and observed inventory within the HVO North mining area was achieved. Groundwater inflow rates and evaporation factors appeared to be reasonable.

11.3.2.3 HVO West Sub-Model

Simulated versus observed inventory within the HVO West mining area has been presented in Figure 11-6.

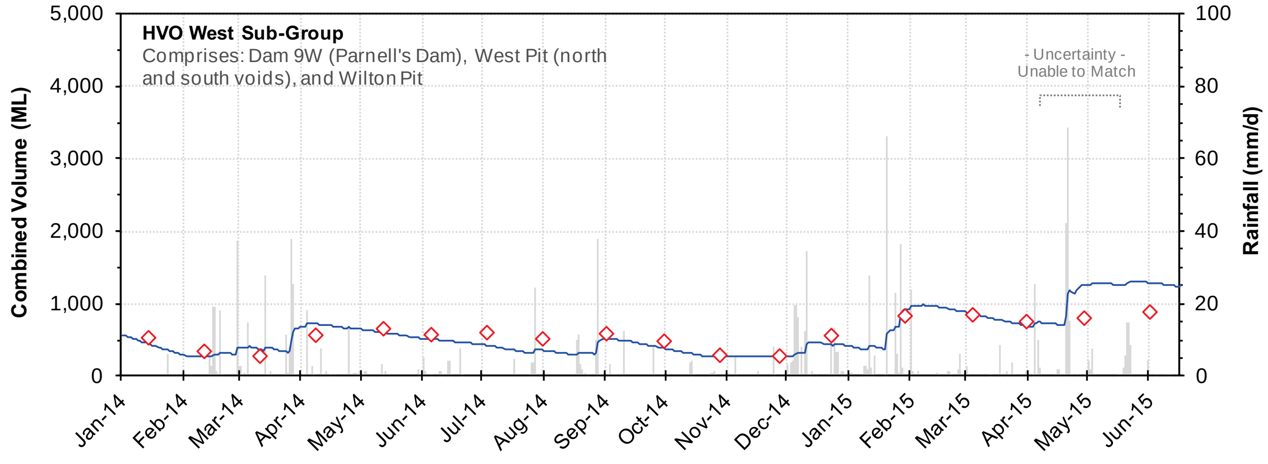

Figure 11-6: Simulated vs Historical Volumes – HVO West Area

Review of Figure 11-6 gives the following:

- Simulated inventory was generally consistent with observed inventory within the HVO West sub-model grouping.

- Drawdown rates appeared to be well reproduced, suggesting that groundwater inflows (nil), evaporation rates, and tailings circuit moisture losses are reasonable.
- Catchment responses appeared to be well reproduced throughout the simulation period, with the exception of the late April 2015 rainfall event which was over-estimated in the model. The observed minimal response to approximately 150 mm of rainfall was noted; it was speculated that observed volumes may have been under-estimated, or that the April 2015 storm cell did not pass over the bulk of the HVO West catchment.

11.3.2.4 Combined HVO Site

Simulated versus observed combined HVO site volume is presented in Figure 11-7.

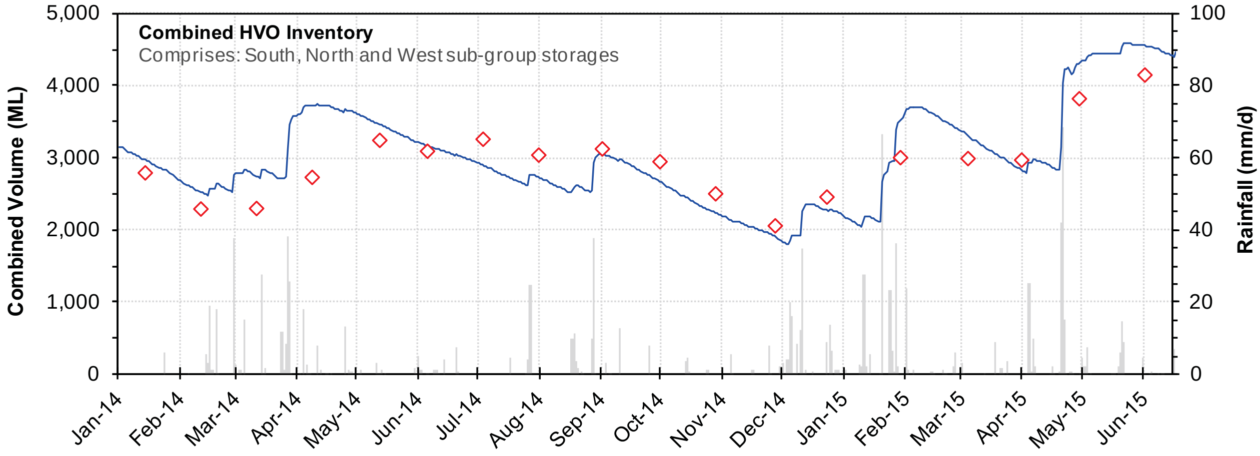

Figure 11-7: Simulated vs Historical Volumes – Combined HVO Site

Review of Figure 11-7 gives the following:

- Despite isolated periods of inconsistency, the overall profile of the observed site inventory was well reproduced by the water balance model.
  - Inconsistency in early 2014 was associated with an unresolved discrepancy at HVO South in April to May 2014, and an offset starting volume to compensate (see Figure 11-4 commentary).
  - Inconsistency at simulation end was due to an isolated event at HVO West (refer to Figure 11-6 commentary).
- Drawdown rates in 2014 Q1 and the second half of 2014 were well reproduced, suggesting that adopted groundwater inflow rates, evaporation factors and tailings circuit moisture losses were reasonable. Historical volume capture frequency was considered to be too coarse to determine whether drawdown rates in 2015 were well represented.

11.3.3 Outcomes

Outcomes of the model calibration exercise undertaken as part of the 2015 model update included the following:

- Revised AWBM catchment yield parameters (refer Section 4.3).
- Pit evaporation factors were set to 1.0.
- Additional 0.8 ML/d inflow was inferred, and distributed as follows:
  - 50 per cent modelled as additional groundwater to Cheshunt Pit.
  - 50 per cent modelled as additional moisture return from Dam 29N TSF.

Overall, the HVO water balance model was considered to be calibrated and suitable for the purposes of high level water balance modelling.

Note that additional groundwater inflows have not been applied in future scenarios as revised groundwater modelling inflow rates for the baseline scenario have been adjusted to 2.5 ML/d (refer Table 7-1 Cheshunt Pit).

11.4 Model Operating Rules

Indicative rules governing the operation of the HVO water balance model were developed as part of the 2015 model update in consultation with Coal & Allied. These operating rules have been modified as required in future scenarios. Adopted operating rules have been summarised in Table 11-1.

Table 11-1: HVO OPSIM Operating Rules

Item	Description	Operating Rules	Node
1.0	**External Water Supply**		
1.1	External Water Supply	▪ Backup water supply – used to sustain mine water demands during prolonged drought periods. ▪ Last priority water supply source for the following dams: ○ HVO South (Riverview Void). ○ Dam 17N. ○ Dam 9W. ▪ Supply rate not constrained.	9008
2.0	**Supply to Demands**		
2.1	HVCPP	▪ Operational in all scenarios. ▪ ROM Feed rate and process water makeup varies by scenario (refer Section 5.1). ▪ Process water makeup sourced from the HVCPP Hosedown Tank. ▪ Tailings slurry pumped to Dam 29N TSF in all scenarios. Transition t the Carrington Out-of-Pit TSF has been modelled as a continuation of Dam 29N.	450

Item	Description	Operating Rules	Node
2.2	HCPP	▪ Operational in all scenarios. ▪ ROM Feed rate and process water makeup varies by scenario (refer Section 5.1). ▪ Process water makeup sourced from the HCPP Hosedown Tank. ▪ Tailings slurry pumped to Cumnock Void TSF (external to HVO mine) with no moisture return in the base case and Stage 1 scenarios. Tailings pumped to Dam 29N TSF from Stage 2 (functionally represents the Carrington Out-of-Pit TSF – see above).	550
2.3	LCPP	▪ Online in Stage 3, continuing through Stage 4. ▪ ROM Feed rate modelled as 4Mtpa. ▪ Process water makeup sourced from local surface water dams (e.g. Dam 19S first priority, then 17S, 18S, 15S, 16S), with Riverview Void as backup supply. ▪ Tailings slurry pumped to inactive pits at HVO South. Tailings solids accumulation not modelled. Assumed that 50 per cent of tailings moisture is recovered and pumped back to the mine water system (via Riverview Void).	900
2.4	Dust Suppression	▪ Water usage calculated daily in model as a function of climate and application area. (Refer to Section 5.2). ▪ Usage and distribution varies by scenario (refer Table 5-9). ▪ No dust suppression if rainfall exceeds 1.5 mm/d. ▪ No return from demand modelled.	9001 9003 9004
2.5	Vehicle Washdown	▪ HVO North vehicle washdown demand of 775 kL/d sourced from the following locations (in order of priority): o Dam 19N. o Dam 35N. o HVCPP Hosedown Tank. ▪ 15 per cent of HVO North vehicle washdown usage returned to Dam 17N. ▪ HVO West vehicle washdown demand of 50 kL/d sourced from Dam 4W/5W. 15 per cent of usage returned to source dam ▪ Demands constant in all scenarios.	473/481 574/581
2.6	Misc Industrial Area	▪ Miscellaneous industrial area water demands supplied from the following storages at the listed rates, with no return: o Dam 17S – 450 kL/d (Lemington Workshop). o HVCPP Hosedown Tank – 450 kL/d. o HCPP Hosedown Tank – 50 kL/d. o LCPP Misc Usage – 50 kL/d (Stage 3 and Stage 4 only).	370/386 476/482 574/582

Item	Description	Operating Rules	Node
2.7	HVCPP Hose Down Tank	▪ Supplies HVCPP process water makeup and HVO North misc industrial area demands. Backup water supply for HVO North vehicle washdown. ▪ Makeup water sourced from the following storages: o Dam 15N (50 per cent of demand). o Dam 9N (50 per cent of demand). o Dam 16N (backup). o Dam 17N (backup). o Dam 18N (backup).	480
2.8	HCPP Hose Down Tank	▪ Supplies HCPP process water makeup and HVO West misc industrial area demands. ▪ Makeup water sourced from the following storages: o Dam 9W (60 per cent of demand). o Dam 8W (30 per cent of demand). o Dam 2W (10 per cent of demand).	580
3.0	**Operation of Key Storages**		
3.1	HVO South Mining Area		
	Water Storages		
3.1.1	Dam 15S (Lake James)	▪ Key mine water storage for HVO South mining area. ▪ Primary water source for HVO South dust suppression. ▪ Water supply source for LCPP (Stages 3 and 4). ▪ Sources makeup water from the following locations if water level falls below 62 mRL (315 ML): o Dam 17S. o Auger South. o Cheshunt Pit. o Riverview Void. ▪ HRSTS Release Point 8. Maximum release rate 120 ML/d. During HRSTS opportunity: releases initiated if water level greater than 63.7 mRL (530 ML), ceasing at 63 mRL (435 ML). ▪ Receives pumped dewatering from Dam 17S and Riverview Void. ▪ HVO South dewatering directed to Dam 15S if combined HVO volume exceeds 4 GL, to maximise HRSTS release opportunity. ▪ All inbound pumping is cancelled if Dam 15S inventory reaches 64.2 mRL (600 ML). ▪ Attempts to pump back to Riverview Void if water level reaches 64.75 mRL (680 ML). ▪ Spillway overflow to Hunter River at 65 mRL (full storage volume 715 ML).	315

Item	Description	Operating Rules	Node
3.1.2	Dam 16S Group	▪ Supplies makeup water to Dam 17S. ▪ Water supply source for LCPP (Stages 3 and 4). ▪ Sources makeup water from the following locations to maintain water level at 46.0 mRL (120 ML): ○ Dam 19S. ○ Riverview Void (backup). ▪ Pumps to Dam 17S at 4,320 kL/d if water level exceeds 48.0 mRL (150 ML). Conditional upon Dam 17S inventory. ▪ Pumping re-routed to Riverview Void at 4,320 kL/d if water level exceeds 50.0 mRL (185 ML). ▪ Spillway overflow to Hunter River at 54.4 mRL (full storage volume 285 ML). ▪ Nominal 30ML of upstream buffer storage modelled. Accounts for dams upstream of Dam 16S. ▪ Receives spillway overflow from Dam 17S.	316/389
3.1.3	Dam 17S	▪ Supplies makeup water to Dam 15S. ▪ Water supply source for LCPP (Stages 3 and 4). ▪ Supplies Lemington workshop industrial water demands. ▪ Sources makeup water from the following locations to maintain water level at 82.5 mRL (40 ML): ○ Dam 19S (50 per cent). ○ Dam 18S (50 per cent). ○ Dam 16S (backup). ▪ Dewatering pumping re-routed from Dam 15S to Riverview Void at 4,320 kL/d if water level exceeds 83.1 mRL (55 ML). ▪ All in-bound transfers restricted if water level exceeds 83 mRL (52 ML). ▪ Spillway overflow to Dam 16S at 83.6 mRL (full storage volume 65 ML).	317
3.1.4	Dam 18S	▪ Supplies makeup water to Dam 17S (if required). ▪ Water supply source for LCPP (Stages 3 and4). ▪ Spillway overflow to Dam 19S at 81.5 mRL (full storage volume 175 ML).	318
3.1.5	Dam 19S	▪ Supplies makeup water to Dam 17S and Dam 16S. ▪ Primary water supply source for LCPP (Stages 3 and 4). ▪ Base case to Stage 2: Pumps to Dam 17S at 4,320 kL/d if water level exceeds 66.25 mRL (130 ML). Transfer conditional upon adequate spare capacity in receiving storage. Pumping re-routed to Riverview Void at 4,320 kL/d if water level exceeds 67.25 mRL (180 ML). ▪ Stages 3 and 4: Pumps to Dam 17S at 4,320 kL/d if water level exceeds 65.6 mRL (100 ML). Pumping re-routed to Riverview Void at 8,640 kL/d (increased rate) if water exceeds 65.7 mRL (110 ML). ▪ Spillway overflow to Hunter River at 67.75 mRL (full storage volume 210 ML).	319
3.1.6	D9 Dam	▪ Storages within Cheshunt Pit catchment.	346

Item	Description	Operating Rules	Node
3.1.7	Saline Dam (TBC)	▪ Storages receive catchment runoff, fill and overflow to Cheshunt Pit in wet weather. ▪ Inventory used to supply HVO south dust suppression via Dam 15S. ▪ Auger South dewaters to Cheshunt Pit if volume exceeds 200 ML. ▪ All storages removed in Stage 1 (Saline Dam removed in Stage 3) – mined out by advancing Cheshunt Pit.	347
3.1.8	C2 Sediment Dam (TBC)		348
3.1.9	Auger South Pit		393
3.1.10	Riverview Void	▪ Primary bulk water storage for HVO mine. ▪ Receives dewatering from active HVO South mining pits. Also receives excess water from HVO South surface water dams to prevent non-compliant discharge to environment. ▪ Receives pumped transfers from MTW mine if combined HVO volume is less than 4 GL. Supplies makeup water to MTW as required, if combined HVO volume is greater than 2.5 GL. ▪ Pumps to Dam 15S if combined site volume is greater than 4 GL to maximise HRSTS release opportunity. Transfer conditional upon adequate spare capacity in receiving storage. ▪ Pumps to HVO North (Carrington Pit via Dam 9N) at 19,000 kL/d if water level exceeds 68.1 mRL (3 GL) ▪ Maximum storage level set at 75.6 mRL (4 GL). Inbound transfers cancelled if level exceeded. ▪ Receives water from supply source external to mine during drought conditions. Inflow rate modelled at 11,000 kL/d. Transfer initiated if combined inventory in Riverview Void and Dam 15S is less than 100 ML. ▪ Receives pumped dewatering from South Lemington Pit 2 and South Lemington Pit 1 during active mining (Stages 2 and 3). ▪ Receives recovered LCPP tailings moisture (Stage 4). ▪ **General note applying to all references to Riverview Void in this table, specifically regarding Stage 4:** Riverview Void backfilled and not present in Stage 4 of indicative mine plans. It has been assumed that Riverview Void will be replaced by temporarily converting an inactive pit at HVO North or HVO West to store water. It has been assumed that any connections into Riverview Void would be diverted to the replacement storage or areas of the mine water management system with spare capacity (or temporarily into an inactive or active pit) either with new transfer infrastructure, or more likely, transferred indirectly via manipulation of the existing pump and pipeline network. Riverview Void catchment inflows have been directed through the proposed Sediment Dam C. Climate influence on the free water surface has been modelled, assuming that these effects would be comparable wherever the water is held.	320 / 9023
3.1.11	Barry Void	▪ Former bulk water storage. Function transferred to Riverview void in early 2014. Now in the process of being filled with overburden from Cheshunt Pit development. ▪ All water transferred to Riverview Void or Dam 15S (if in need of water). ▪ Not present from Stage 1 onward.	

Item	Description	Operating Rules	Node
	Tailings Storage Facilities		
3.1.12	Various	▪ No tailings storages at HVO South prior to Stage 3. ▪ Indicative mine plans specify that tailings from the LCPP will be disposed of in either South Lemington Pit 1 or 2, or Riverview Void. Timing and details of the strategy are yet to be confirmed. ▪ Modelling has not included simulation of tailings solids accumulation in any of these voids. It is assumed that disposal strategies will be designed to avoid impacting on whatever pit access is required in each stage. ▪ Modelling has assumed 50 per cent of tailings moisture will be recovered and pumped back to Riverview Void.	-
	Mining Pits		
3.1.13	Cheshunt Pit 1 & 2	▪ Active mining pit in all scenarios. ▪ Dewaters to Riverview Void at 11,200 kL/d if volume exceeds 100 ML, or to empty if Riverview Void is low. No dewatering if Riverview Void exceeds 4 GL. ▪ Groundwater inflow varies by stage (refer Table 7-1).	390
3.1.14	Riverview Central	▪ Active mining pit in Base case, Stage 1 and 2 scenarios. Mined through by Cheshunt Pit in Stage 4. ▪ When operational: dewaters to Riverview Void at 10,400 kL/d until empty. No dewatering if Riverview Void exceeds 4 GL.	395
3.1.15	Riverview West North & South	▪ Active mining pit in Base case, Stages 1 and 2 scenarios. Mined through by Cheshunt Pit in Stage 3. ▪ When operational: dewaters to Riverview Void at 10,400 kL/d until empty. No dewatering if Riverview Void exceeds 4 GL.	391
3.1.16	Riverview (Glider) Pit	▪ Active mining pit in base case scenario only. ▪ Backfilled and rehabilitated in Stage 1. Catchment diverted off-site via Dam 11S (sediment dam). ▪ When operational: dewaters to Riverview Void at 4,320 kL/d until empty. No dewatering if Riverview Void exceeds 4 GL.	332
3.1.17	South Lemington Pit 2	▪ Active mining pit in Stage 2. ▪ Backfilling underway in Stage 3 with South Lemington Pit 1 material, and possible LCPP tailings solids. ▪ Groundwater inflow varies by stage (refer Table 7-1). ▪ When active: dewaters to Riverview Void with no restriction.	Integrated to 320

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Item	Description	Operating Rules	Node
3.1.18	South Lemington Pit 1	▪ Currently an inactive pit, used as a water storage by the neighbouring MTW mine. Function remains this way in the base case and Stage 1 scenarios. ▪ Mining recommences in Stage 2, continuing through Stage 3. ▪ When active: groundwater inflow varies by stage (refer Table 7-1). ▪ When active: dewaters to Riverview Void with no restriction. ▪ Backfilled and rehabilitated in Stage 4 (small final void remains). ▪ Possible disposal point for LCPP tailings solids (Stages 3 and 4). ▪ Exchange of water between HVO and MTW mines is currently via South Lemington Pit 1 (water storage). Infrastructure assumed to be modified in Stage 2 (still in place in Stage 3) to allow transfer between HVO and MTW bypassing this pit. ▪ Assumed that loss of water storage provided by this pit to MTW will be compensated for at MTW.	Integrated to 320
3.2	HVO North Mining Area		
	Water Storages		
3.2.1	Dam 1N	▪ Sediment Dam upstream of Dam 15N. Receives clean catchment runoff. ▪ No pumped inflows or outflows modelled. ▪ Spillway overflow to Farrell's Creek at 87.1 mRL (16 ML). *Note: currently spills to Dam 15N, but assumes diversion of outlet works will be undertaken as part of baseline scenario.*	401
3.2.1	Dam 9N	▪ Key mine water storage for HVO North mining area. ▪ Supplies makeup water to the following locations as required: ○ HVO North Dust Suppression (first preference). ○ HVCPP Hose Down Tank (equal first preference). ○ Dam 9W (emergency). ○ Dam 21N. ▪ Sources makeup water from the following locations if water level falls below 73.0 mRL (35 ML) – listed in order of priority: ○ Dam 29N Tailings. ○ Carrington Pit. ○ Dam 21N. ○ Riverview Void. ▪ Receives pumped inflow from Riverview Void and Dam 21N. ▪ Pumped transfer to Carrington Pit at 74.5 mRL (55 ML) Effectively a re-routing of Riverview Void dewatering. ▪ Spillway overflow to Dam 20N at 77.0 mRL (full storage volume 80 ML).	410

Item	Description	Operating Rules	Node
3.2.2	Dam 11N	▪ HRSTS Release Point 3. Releases not modelled. ▪ Receives pumped dewatering from Dam 15N. ▪ Supplies makeup water to HVCPP area via Dam 17N. ▪ Pumping to/from Dam 21N at 8,640 kL/d to manage water level between 68.2 mRL and 69.5 mRL (30 ML to 50 ML). ▪ Inbound pumping is cancelled if inventory reaches 70 mRL (60 ML). ▪ Spillway overflow to Farrell's Creek at 70.5 mRL (full storage volume 75 ML).	411
3.2.3	Dam 15N	▪ Mine affected dam. Intercepts runoff from HVCPP area catchment. ▪ Excess water transferred to HVCPP Hose Down Tank (via Dam 16N) for beneficial re-use. ▪ Receives spillway overflows from the following storages: ○ Dam 1N. ○ Dam 33N/34N. ○ Dam 19N. ○ Dam 16N. ▪ Pumped transfer to Dam 11N at 6,048 kL/d if water level exceeds 80.9 mRL (10 ML). ▪ Emergency pumped transfers initiated at 81.5 mRL (20 ML) to prevent non-compliant release to environment. Pump rate 10,370 kL/d. Destination modelled as Carrington Pit. Actual mechanics of transfer to be confirmed. Assumed to be in-place as part of baseline scenario. ▪ Spillway overflow to Farrell's Creek at 84.2 mRL (full storage volume 80 ML).	415
3.2.4	Dam 16N	▪ Backup water supply for HVCPP Hose Down Tank. ▪ Receives pumped inflows from Dam 17N. ▪ Pumped dewatering to Dam 29N at 89.0 mRL (50 ML). ▪ Spillway overflow to Dam 15N at 89.75 mRL (full storage volume 65 ML).	416
3.2.5	Dam 19N	▪ Primary water supply for HVO North vehicle washdown. ▪ Receives spillway overflow from Dam 35N. ▪ Spillway overflow to Dam 15N at 103.0 mRL (full storage volume 10 ML).	419
3.2.6	Dam 33/34N	▪ Mine affected runoff capture dams. Two dams constructed in series. ▪ Spillway overflow to Dam 15N at 105.0 mRL (full storage volume 5 ML).	434
3.2.7	Dam 35N	▪ Backup water source for HVO North vehicle washdown. ▪ Spillway overflow to Dam 19N at 111.1 mRL (full storage volume 5 ML).	435

Item	Description	Operating Rules	Node
3.2.8	Dam 17N	▪ Turkey's Nest water storage. ▪ Hunter River raw water extraction pipeline water discharges into this dam. ▪ Backup water supply source for HVCPP Hose Down Tank. ▪ Sources makeup water from the following locations to maintain inventory at 88.0 mRL (16 ML) – in order of priority: o Dam 11N. o Dam 18N. o External Water Supply Source. ▪ Pumps to Dam 16N if water level exceeds 88.5 mRL (21 ML). ▪ Pumps to Dam 15N if water level exceeds 89.5 mRL (30 ML). ▪ Spillway overflow to Farrell's Creek at 90.0 mRL (full storage volume 35 ML).	417
3.2.9	Dam 18N	▪ Supplies makeup water to Dam 17N and HVCPP Hosedown Tank. ▪ Spillway overflow to Dam 15N - full storage volume 27 ML.	418
3.2.10	Dam 20N	▪ Water storage dam constructed in the gully formed behind the north void spoil levee. Receives catchment runoff from local area. ▪ Seepage to underlying Dam 30N spoil aquifer at 1,000 kL/d. ▪ Standing water may be extracted to make up Dam 21N.	420
3.2.11	Dam 21N	▪ Water storage constructed in an old mining void. ▪ Utilised as water storage, and also as an intermediate storage between Dam 9N and the HVCPP area dams. ▪ Sources makeup water from Dam 9N or Dam 20N (if water available) to maintain water level at 55.2 mRL (400 ML). ▪ Balancing transfer to Dam 9N at 8,640 kL/d to maintain water level at 56.1 mRL (450 ML). ▪ Receives seepage and overflow from Dan 27N (Old Tailings). ▪ Supplies makeup water to Dam 11N. ▪ Receives pumped inflows from Dam 11N. Transfer cancelled if Dam 21N water level exceeds 57.55 mRL (500 ML). ▪ Overflow to north void spoil aquifer modelled at 64.8 mRL (910 ML).	421
3.2.12	Carrington Highwall Dam	▪ Minor water storage located north east of Carrington Pit. Receives catchment runoff from local area. ▪ Overflows to Carrington Pit at 102.64 mRL (8 ML).	491
	Tailings Storage Facilities		
3.2.13	Dam 27N	▪ Old tailings storage facility. ▪ Receives local catchment runoff and excess dewatering from Dam 28N (Old Tailings). ▪ No pumped outflows. ▪ Seepage to Dam 21N at 4 mm/d (applied to wetted area). ▪ Overflows to Carrington Pit at 71.5 mRL (365 ML).	427

Item	Description	Operating Rules	Node
3.2.14	Dam 28N	▪ Old TSF. ▪ Receives local catchment runoff. No pumped inflows. ▪ Excess water pumped to Dam 27N (Old Tailings) at 4,320 kL/d if water level exceeds 114.0 mRL (free water 165 ML). ▪ Overflows to Dam 29N Tailings at 116.2 mRL (525 ML).	428
3.2.15	Dam 29N	▪ Currently active TSF. ▪ Receives tailings slurry moisture from HVCPP in all scenarios. Nominal 22% moisture loss applied to incoming water prior to entering free water body. ▪ Receives tailings slurry moisture from HCPP from Stage 2. ▪ Supplies makeup water to Dam 9N as required. ▪ Pumped dewatering to Dam 9N if free water level reaches 60.12 mRL (free water 300 ML) – equivalent to 1.0 m water storage depth. ▪ Seepage to north void spoil aquifer at 2.1 mm/d (applied to wetted area). ▪ Solids accumulation not modelled. ▪ No spillway overflow modelled. ▪ Transition t the Carrington Out-of-Pit TSF in Stage 2 has been modelled as a continuation of Dam 29N. Refer Section 6.2.	429
3.2.16	Carrington Out-of-Pit TSF	▪ Proposed online from Stage 2, receiving tailings from HVCPP and HCPP. ▪ Not modelled. Functionally modelled as continuation of Dam 29N TSF. Refer Section 6.2.	N/A
	Mining Pits		
3.2.17	Carrington Pit	▪ Not scheduled for active mining in base case scenario ▪ Operational intent is to keep pit free of water, so that mining can commence in the future (beyond 2016). ▪ Dewaters to Dam 9N as required to sustain demand. ▪ May receive pumping from Riverview Void (via Dam 9N) during prolonged wet conditions. Excess water will be temporarily stored in-pit. ▪ Receives groundwater inflow of 165 kL/d in all scenarios.	490
3.2.18	Carrington West Pit	▪ Active mining in Stage 1. ▪ Backfilling, dump shaping, rehabilitation and diversion assumed 50% complete in Stage 3 and 100% in Stage 3. ▪ When active: receives groundwater inflows (refer Table 7-1). ▪ When active: dewaters to Carrington Pit without restriction.	Integrated to 490

Item	Description	Operating Rules	Node
3.3	HVO West Mining Area		
	Water Storages		
3.3.1	Dam 1W	▪ Sediment dam. ▪ Overflows to Dam 3W at 185.0 mRL (full storage volume 9 ML).	587
3.3.2	Dam 2W	▪ Sediment dam. ▪ Supplies water to HCPP Hose Down Tank as required. ▪ Overflows to Dam 3W at 180.7 mRL (full storage volume 27 ML).	502
3.3.3	Dam 3W	▪ Receives spillway overflow from Dam 1W and Dam 2W. ▪ Supplies makeup water to Dam 8W (CHPP Dam). ▪ Overflows to Dam 3W at 164.55 mRL (full storage volume 57 ML).	503
3.3.4	Dam 4W & 5W	▪ Receives spillway overflow from Dam 3W and Dam 8W. ▪ Supplies makeup water to Dam 8W (CPP Dam). ▪ Supplies makeup water to HVO West vehicle wash demand. ▪ Functional transfer to West Pit modelled. Transfers at unrestricted rate if water level exceeds modelled full storage depth of 2.5 m (40 ML). Represents temporary switching of HCPP process water makeup demand to Dam 4W/5W.	587
3.3.5	Dam 8W	▪ Supplies makeup water to HCPP Hose Down Tank ▪ Sources makeup water from Dam 3W and Dam 4W/5W with equal priority to maintain water level at 163.0 mRL (9 ML). ▪ Overflows to Dam 4W/5W at 164.0 mRL (full storage volume 16 ML)	508

3.3.6	Dam 9W
	(Parnell's Dam)
		▪ Key mine water storage for HVO West mining area.
		▪ Primary water source for HVO West dust suppression.
		▪ Supplies makeup water to Dam 4W/5W.
		▪ Receives pumped dewatering from HVO West mining pits, Dam 6W Tailings and Dam 20W (old tailings).
		▪ Sources makeup water from the following locations if water level falls below 111.1 mRL (280 ML):
		  o Dam 6W Tailings (Priority 1 – P1).
		  o West Pit North & South (equal P2).
		  o Wilton Pit (equal P2).
		  o GRS Pit (equal P2).
		  o Dam 18W (P3).
		  o Dam 9N (P4).
		  o External Water Source (Last Priority).
		▪ Pumping to Riverview Void (via Dam 9N) initiated at 6,000 kL/d if water level exceeds 112.5 mRL (615 ML); continues until water level below 112.2 mRL (540 ML). Transfer cancelled if Riverview Void inventory exceeds 4 GL.
		▪ HRSTS Release Point 4. Maximum release rate 40 ML/d. During HRSTS opportunity: releases initiated if water level greater than 112.8 mRL (700 ML), ceasing at 112.5 mRL (615 ML).
			509

Item	Description	Operating Rules	Node
		▪ All incoming pumped transfers cancelled if water level reaches 113.1 mRL (780 ML). ▪ Spillway overflow to Parnell's Creek at 113.4 mRL (full storage volume 870 ML).	
3.3.7	Dam 18W	▪ Sediment dam. ▪ Supplies makeup water to Dam 9W as required. ▪ Overflows to Dam 3W at 113.6 mRL (full storage volume 105 ML).	518
	Tailings Storage Facilities		
3.3.8	Dam 6W	▪ Active tailings storage during model calibration period (2014-2015). Not used in any scenario (temporarily used *between* Stages 1 and 2). ▪ Supplies makeup water to Dam 9W as required ▪ Pumped dewatering to Dam 9W if free water level reaches 167.0 mRL (free water 75 ML) – equivalent to approximately 3.0 m water storage depth. Transfer conditional upon receiving capacity in Dam 9W. ▪ Seepage to north void spoil aquifer at 5 mm/d (applied to wetted area). ▪ Solids accumulation not modelled. ▪ No spillway overflow modelled.	506
3.3.9	Dam 20W	▪ Old TSF ▪ Receives local catchment runoff. No pumped inflows. ▪ Excess water pumped to Dam 9W at 2,000 kL/d if water level exceeds 170.8 mRL (free water 5 ML). Transfer conditional upon receiving capacity in Dam 9W. ▪ Overflows to Dam 18W at 175.0 mRL (3,505 ML).	520
3.3.10	Cumnock Void	▪ Modelled as a sink. No moisture return. ▪ Receives HCPP tailings moisture in Baseline and Stage 2 scenarios.	9022
	Mining Pits		
3.3.11	GRS Pit	▪ Active mining pit in all scenarios. ▪ Dewaters to Dam 9W at 6,000 kL/d until empty. No pumping if receiving storage is at or above upper operating volume.	524
3.3.12	Wilton Pit	▪ Active mining pit in all scenarios. ▪ Dewaters to Dam 9W at 6,900 kL/d until empty. No pumping if receiving storage is at or above upper operating volume.	592
3.3.13	West Pit North & South	▪ Active mining pit in all scenarios ▪ Dewaters to Dam 9W at 12,900 kL/d until empty. No pumping if receiving storage is at or above upper operating volume.	590

Item	Description	Operating Rules	Node
4.0	**General**		
4.1	HRSTS Controlled Releases	▪ Controlled releases undertaken from Dam 15S and Dam 9W. See operating rules for respective dams (Item 3.1.1 and Item 3.3.6). ▪ Releases undertaken if site water inventory exceeds 4 GL. ▪ HRSTS release opportunity modelled per Section 9.3 of this report.	9005 9006 9007
4.2	Externally Draining Sediment Dams	▪ Sediment Dams that do not overflow, pump to, or receive pumping from the HVO mine water management system have not been included in the water balance model. ▪ Dams assigned to this category have been listed in Table 3-1 of this document. ▪ These storages receive runoff from clean or rehabilitated (i.e. non-mine affected) catchments, and overflow off lease as part of normal operation. Overflows are not classified as mine affected water.	-
4.3	Climate	▪ All water storages receive catchment runoff and lose water to evaporation.	-

11.5 Model Limitations

Climatic data (rainfall and evaporation), supply, demand and transfer volumes have been modelled as daily totals. The model assumes that daily data can be distributed over 24 hours. The model does not accurately represent events with durations less than 24 hours. For example, storm runoff events with durations less than 24 hours cannot be accurately accounted for using the HVO water balance model.

12. Performance Assessment

12.1 Overview

The water balance model has been used to assess the expected performance of the HVO water management system under current and expected future conditions, specifically in regard to the following key areas:

- Mine water inventory management:
  - Combined site mine water inventory versus combined site water storage capacity. Measure of systems ability to store excess mine water inventory without impacting ROM coal extraction.
- Annual water supply requirements (external water supply to site).
- HRSTS release volumes.
- Non-HRSTS releases volumes (spillway discharges from mine water dams and sediment dams).
- Average annual water balance

The performance of the water management system has been assessed through long-term historical simulation, on the basis of 123 years of daily climate data[P]. Combined site volume has been set at 2 GL at the start of the simulation.

12.2 Combined Site Inventory

The HVO baseline model has been used to simulate the range of combined site inventory volumes that may be experienced under baseline system conditions. Combined site volume has been compared against the combined site water storage capacity to identify potential risks to production and/or environmental license compliance.

12.2.1 Storages Included

Site inventory is the sum of all major water storages routinely tracked as part of the RTCA Water Inventory Management Report:

- *HVO South*: Riverview Void, Riverview Central & West Pits, Riverview (Glider) Pit, Cheshunt Pit, Dam 15S (Lake James), and the Dam 16S Ponds
- *HVO North*: Carrington Pit, Dam 11N, Dam 21N
- *HVO West*: Dam 9W (Parnell's Dam), Wilton Pit, West Pit (North and South).

12.2.2 Water Storage Capacity

The combined mine water management system storage capacity of 6,450 ML has been superimposed on the volume plot.

Note that current mine plans show that Riverview Void will be backfilled in Stage 4. Modelling has assumed that an inactive pit at HVO North or HVO West will be temporarily converted to a dedicated water storage in Stage 4. The storage capacity of the replacement pit is assumed to be comparable to that of Riverview Void, and as such, the combined HVO storage capacity is assumed to remain at 6,450 ML in Stage 4.

The combined bulk storage capacity at HVO comprises the following water storages (per RTCA Inventory Water Management Reporting):

- Riverview Void 4,060 ML (replaced in Stage 4)
- Dam 15S 715 ML
- Dam 16S 280 ML
- Dam 11N 75 ML
- Dam 21N 450 ML
- Dam 9W 870 ML

[P] Climate time series has been truncated. Sequence starts in 1893 to align with HRSTS release flow time series, which has been constructed based on IQQM flood modelling. Refer Section 9.3.

12.2.3 Other Mine Water Dams

Minor surface water dams are not included in the simulated volume or the combined storage capacity. Excess water from these storages is transferred back into the primary water storage group to manage risk of non-HRSTS discharge, and as such, their influence is inherently accounted for.

12.2.4 Simulated Mine Water Volume

Combined HVO mine water inventory results have been presented in Figure 12-1 and Figure 12-2. Figures present maximum and minimum simulated volumes respectively for all scenarios, on an annual exceedence probability basis (AEP).

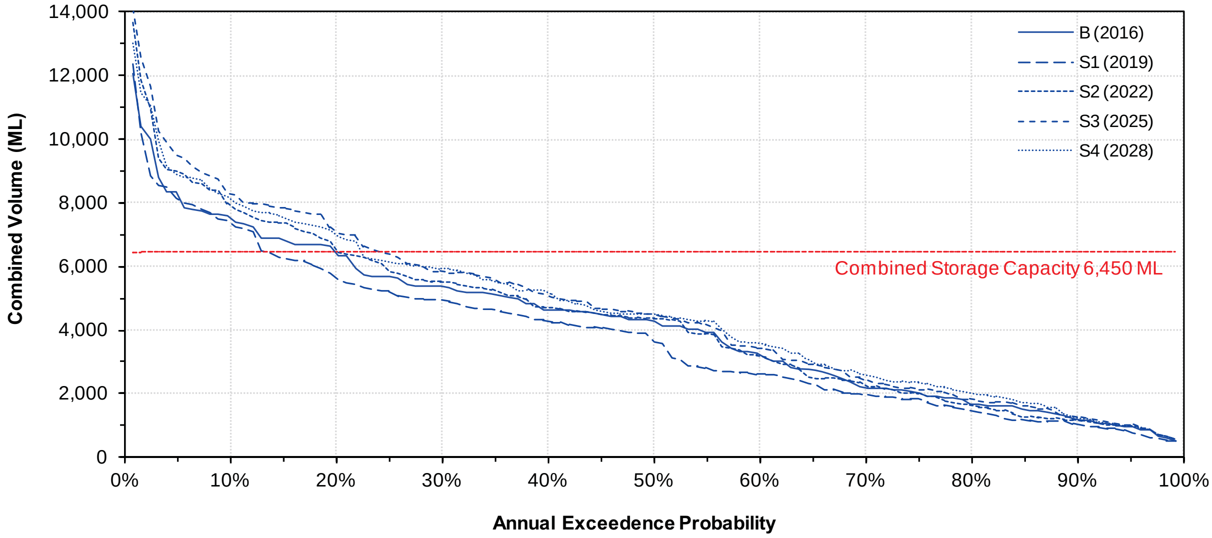

Figure 12-1: Combined Site Inventory – Maximum Simulated Volume vs AEP – All Scenarios

Review of Figure 12-1 gives the following:

- Simulated results are generally comparable between scenarios. Annual maxima in future scenarios are generally within 10-20 per cent of baseline results.
- All future results predict higher maximum volumes than the baseline scenario, with the exception of Stage 1.
- Annual probability of exceeding the combined storage capacity of 6,450 ML is 10 to 25 per cent for all scenarios.
- Additional results regarding storage capacity exceedence have been presented in Section 12.3.

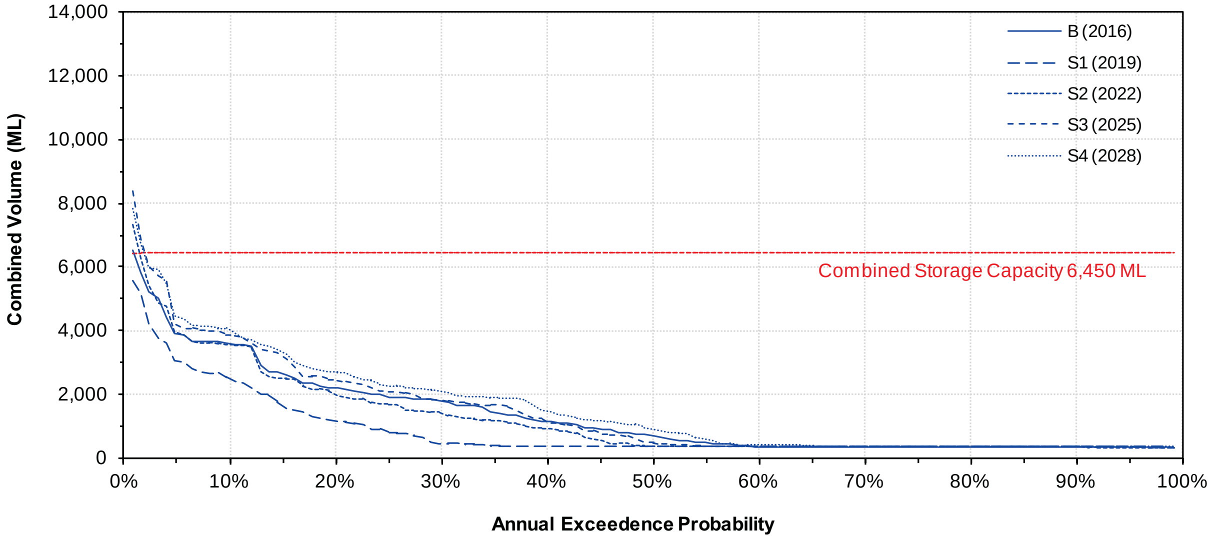

Figure 12-2: Combined Site Inventory – Minimum Simulated Volume vs AEP – All Scenarios

Review of Figure 12-2 gives the following:

- The annual probability of the minimum annual inventory exceeding the combined storage capacity is 2 to 3 per cent in all scenarios. This indicates that the system is capable of recovering relatively quickly following historically wet conditions.
- In all scenarios except Stage 1, there is an annual probability of 45 to 55 per cent that the combined site inventory will be depleted to the point that external import of water will be required to sustain site water demands.
- The annual probability of requiring external import of water to sustain site water demands increases to approximately 70 per cent in Stage 1 (30 per cent of not requiring import).
- Additional results regarding external water import requirements are presented in Section 12.4.

12.3 Storage Capacity Exceedence

Figure 12-3 presents simulated days per calendar year where the combined site water inventory exceeds the storage capacity in each scenario. Figure 12-4 presents the maximum simulated volume that the storage capacity is exceeded by. All results are presented on an AEP basis.

Based on the modelled operating strategy, these results nominally represents the period of time where excess water would be temporarily stored in-pit. This practice may or may not represent a risk to production depending on which pits are active at the time, the duration of exceedence and the quantity of excess water to be stored.

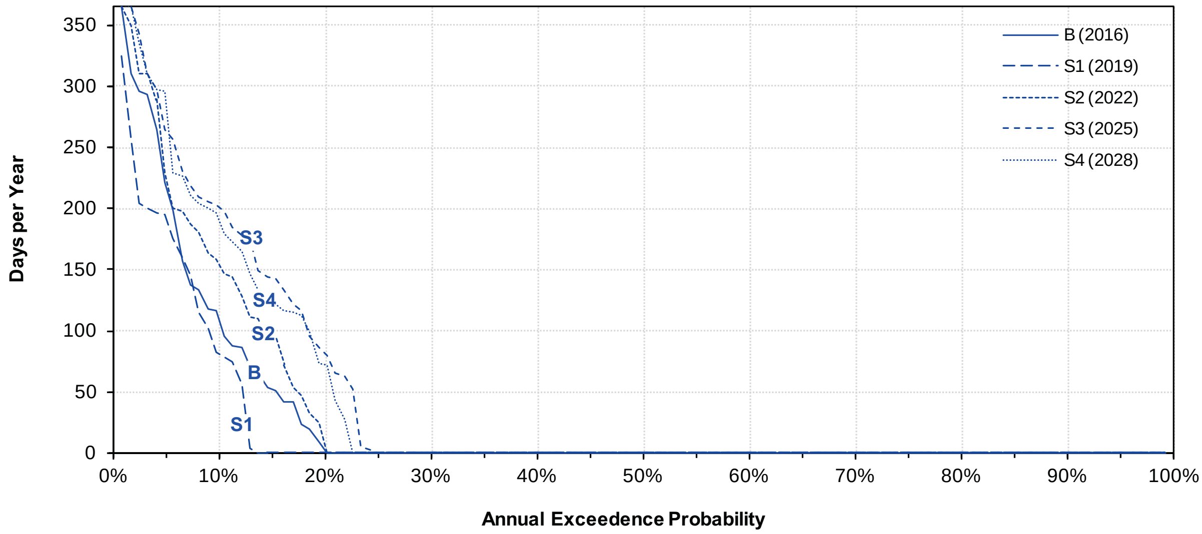

Figure 12-3: Annual Days of Exceeded Storage Capacity vs AEP

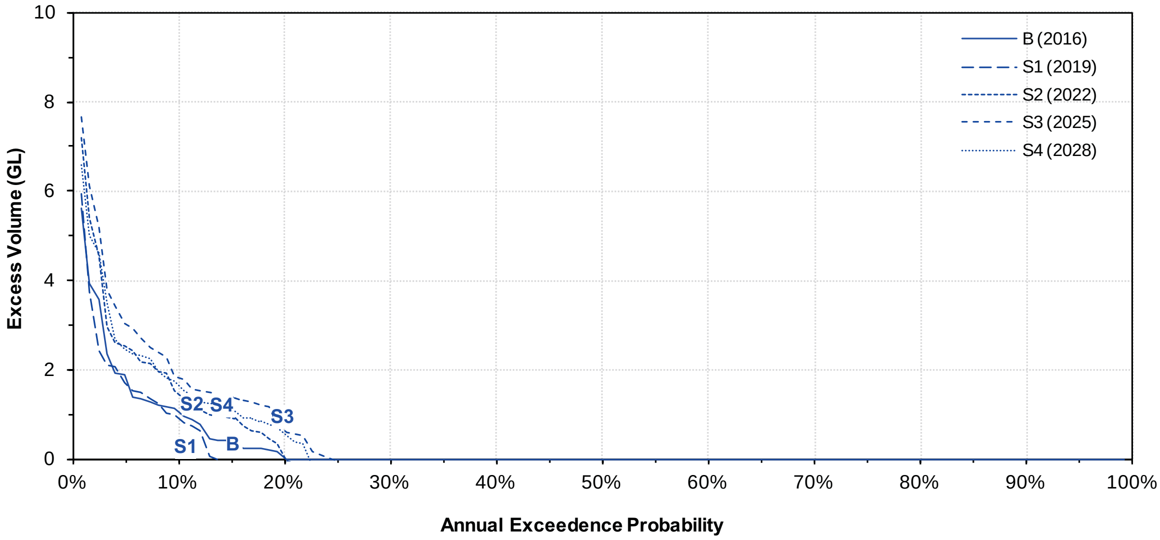

Figure 12-4: Maximum Excess Inventory vs AEP

Review of Figure 12-3 and Figure 12-4 gives the following:

- The simulated annual probability of exceeding the combined storage capacity of 6,450 ML is approximately 10 to 25 per cent for all scenarios.
- Using the 10% AEP as a point of reference: storage capacity is simulated to be exceeded for 100 days (1 GL excess) under baseline conditions, holding constant through Stage 1, increasing to 150 days (1.4 GL excess) in Stage 2, and increasing again to approximately 200 days (1.8 GL excess) in Stage 3 and Stage 4.

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Exceedence of storage capacity and associated requirement for temporary in-pit water storage is considered to represent an operational risk rather than an environmental risk. Increases in frequency and magnitude of excess predicted in Stages 2 to 4 may not be of concern if the excess volume can be temporarily stored in other areas of the mine (inactive pits, active pits, etc.) without impacting on production or safety. Operational risks may be managed by providing additional storage capacity through temporary conversion of an inactive mining pit at HVO North to an in-pit water storage. Note that modelling has assumed this approach will be employed to replace Riverview Void storage capacity in Stage 4.

Increasing HRSTS discharge potential by increasing utilisation of the Dam 11N release point, or by increasing the HVO credit holding are alternative options that may be explored to improve system performance if required.

12.4 Water Supply Reliability

Total annual external water supply to HVO has been presented in Figure 12-5 on an AEP basis for all scenarios.

Hunter River and LUG Bore extraction allocations have been superimposed for context. Note however that River extraction entitlements need to be offset to account for passive groundwater take from the Hunter River (via groundwater).

Potential water import volumes from neighbouring mines (Wambo, Lidell etc) are not fixed quantities and have not been plotted; but would counter some of the offset mentioned above.

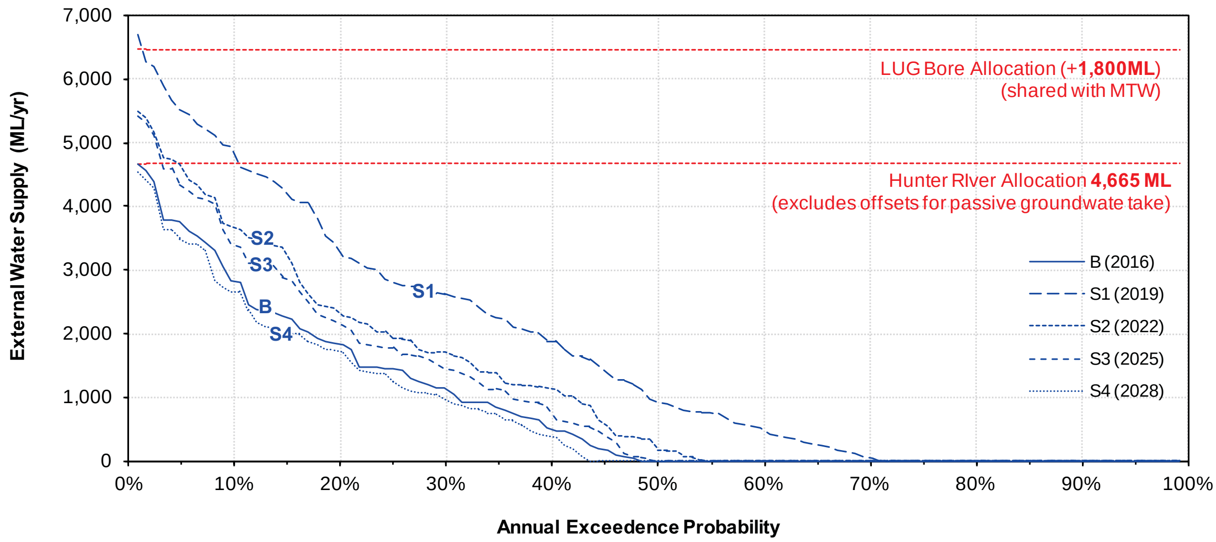

Figure 12-5: Simulated External Water Supply Requirements vs AEP

Review of Figure 12-5 shows the following:

- The annual probability of requiring import of water from an external source is 45 -55 per cent in all scenarios except Stage 1.

- The highest water import requirements are simulated in Stage 1, primarily associated with increasing CPP water usage (with no moisture return from HCPP tailings) and increasing dust suppression usage, with comparatively little change in groundwater and catchment to offset. The AEP of requiring import in this scenario is 70 per cent. Annual volumes are typically around 1.8 GL higher than baseline results.
- Existing water supply entitlements should be adequate to provide the mine with reliable water supply under normal climatic conditions. The AEP 10 per cent volumes are well below the combined LUG Bore and Hunter River allocations. Although allocations may be reduced for reasons outlined above, they may also be supplemented with water sourced from neighboring mines (e.g. Wambo, Liddell).

Stage 1 external water import requirements may be reduced if moisture returns from the Cumnock Void TSF are possible in future.

12.5 Off-site Discharges

12.5.1 HRSTS Discharges

Simulated annual HRSTS release volumes have been presented in Figure 12-6 on an AEP basis. Annual volumes comprise releases from both Dam 15S and Dam 9W. Additional information regarding the HRSTS and adopted modelling protocols and assumptions can be found in Section 9.

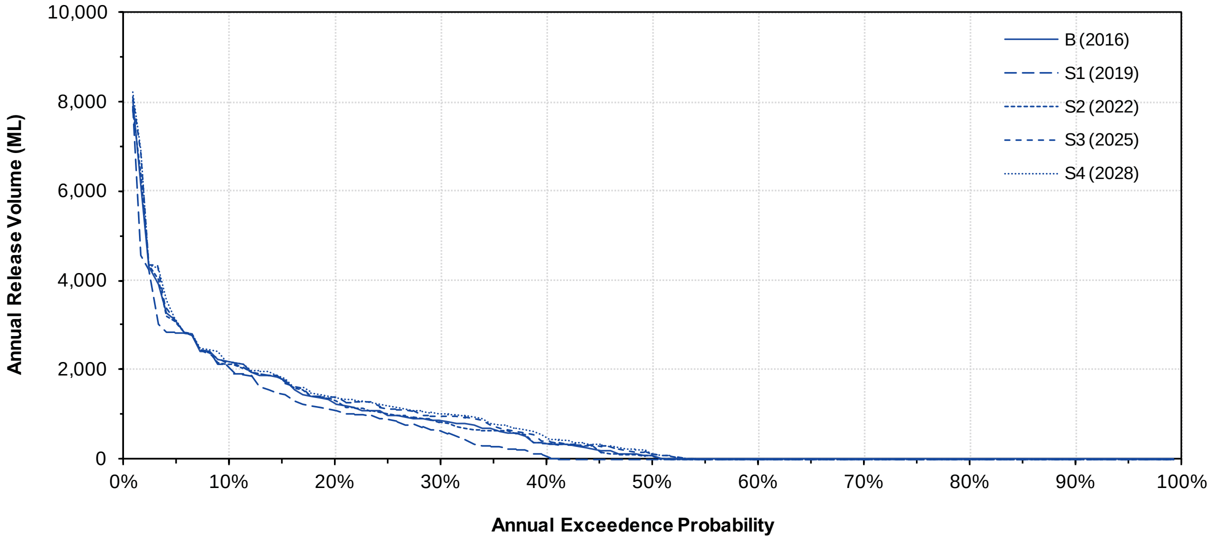

Figure 12-6: Simulated Annual HRSTS Releases – All Release Points

Review of Figure 12-6 shows the following:

- There is an annual probability of approximately 50 per cent of discharging water to the Hunter River under the HRSTS in all scenarios except for Stage 1, in which probability reduces to 40 per cent.
- The annual probability of discharging greater than 2,000 ML/year under the HRSTS is approximately 10 per cent in all scenarios.

12.5.2 Mine Water Dams

There are no simulated non-HRSTS discharges from any mine water dams to the environment reported in any of the scenarios considered.

12.5.3 Sediment Dams

Simulated annual discharge volumes to the environment from sediment dams have been presented in Figure 12-7 on an AEP basis, for all scenarios. Review of this figure shows that annual discharge volumes steadily increase with each scenario, consistent with the increases in diverted catchment area. Increase in discharge volume between Stage 4 and the base case scenario is approximately 25 per cent.

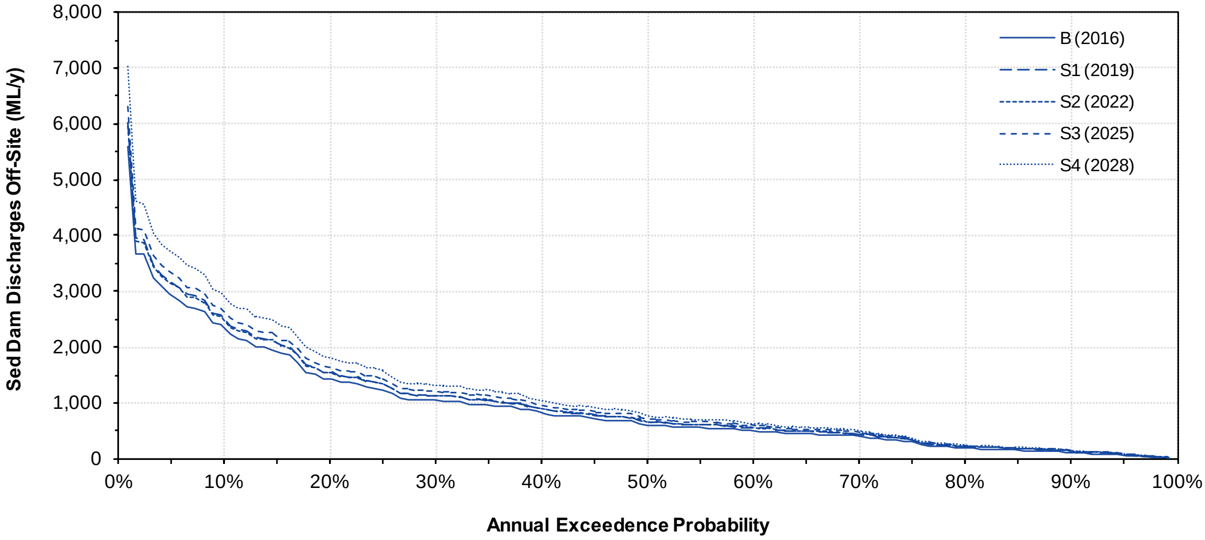

Figure 12-7: Simulated Annual Sediment Dam Discharges vs AEP – All Dams

12.6 Average Annual Water Balance

Long term model results have been processed to derive an average annual water balance for each scenario. Results have been summarised in Table 12-1.

Table 12-1: Indicative Average Annual Water Balance (ML/yr)

Item	Base case (2016)	Stage 1 (2019)	Stage 2 (2022)	Stage 3 (2025)	Stage 4 (2028)
Inflows					
Rainfall Runoff	7,045	7,550	7,565	7,725	7,545
Groundwater	975	1,010	860	1,625	1,240
ROM Moisture	1,425	1,755	1,950	2,250	2,250
Pumped from MTW	440	530	430	380	395
External Water Supply	830	1,715	1,195	1,030	750
Sub-total	*10,715*	*12,560*	*12,000*	*13,010*	*12,180*
Outflows					
Evaporation	1,755	1,715	1,780	1,775	1,815
Tailings Moisture Retention	1,825	2,830	1,410	1,870	1,870
Haul Road Dust Suppression	2,610	3,135	3,520	3,520	2,485
Misc Demands & Veh. Wash	605	605	606	620	620
Pumped to MTW	305	250	270	275	315
Product Coal Moisture	1,410	1,685	1,880	2,160	2,160
Coarse Reject Moisture	555	730	810	950	950
HRSTS Discharges	710	590	710	760	780
Mine-Water Dam Discharges	0	0	0	0	0
Sediment Dam Discharges	940	1,020	1,015	1,080	1,185
Sub-total	*10,715*	*12,560*	*12,000*	*13,010*	*12,180*

13. Conclusions

Investigations have been undertaken to a level of detail sufficient to maintain a fair and reasonable appreciation of the hydrological characteristics of the HVO WMS under proposed future site conditions, as best as can be determined based on available information.

The project has included review and documentation of the existing HVO WMS, and proposed modifications under future conditions. Investigations have identified the following modifications to water management infrastructure:

- The following water storages will be mined out or decommissioned under the proposed modification's indicative mine plan stages:
    - Minor water storages within the existing Cheshunt Pit catchment: D9 Dam, Saline Water Dam, Sediment Dam, Subzero's Dam. Note that storages are not functionally significant and their removal will not have a material impact on the performance of the water management system. Dams removed nominally in Stage 1.
    - Sediment dams ahead of West Pit: Dam 17W and Dam 12W. Dams mined through by advancing West Pit highwall in Stage 1.
- There are no new mine water dams proposed for construction at HVO South in future scenarios.
- Modelling has assumed that an inactive mining pit at HVO North or HVO West will be temporarily converted to a dedicated water storage in Stage 4, to replace Riverview Void which is scheduled to be backfilled (refer to Section 3.4.10.1 for further details).
- There are several proposed sediment dams to be constructed at HVO South that will intercept runoff from rehabilitated areas prior to discharging off-site. Indicative details are summarised in Section 3.4.7.2. Location and storage capacity of proposed sediment dams will be confirmed as part of future design investigations.
- Additional storages identified for construction but not detailed in this report include sediment dam(s) associated with the Carrington West Pit, and the Carrington Out-of-Pit tailings storage, and any sediment control works associated with the proposed rail loop (Stage 3).
- Provision of pump and pipeline connections to supply LCPP process water makeup from mine water dams south of Cheshunt Pit (e.g. Dams 17S, 18S, 19S). Required from Stage 3 onward. Assumed Tthis infrastructure will be designed with the LCPP.
- Upgrades to Dam 19S dewatering pump and pipeline infrastructure to enable dewatering at up to 100L/s to prevent overtopping during significant rainfall events. Upgrade is required to manage catchment runoff from additional hardstand areas associated with the LCPP.
- Provision of pump and pipeline connection to transfer excess water from South Lemington Pit 2 back to the water management system (most likely Riverview Void). The same pipeline may later be used to return excess LCPP tailings moisture if some or all of the South Lemington Pit 2 void is converted into a TSF.

- Modifications to pump and pipeline infrastructure around South Lemington Pit 1 that enable exchange of water between HVO and MTW to accommodate proposed recommencement of mining in this pit.
- Following the backfill of the Riverview void in Stage 4, modifications to the HVO pump and pipeline network that will enable transfer of water between MTW and the replacement in-pit water storage is assumed to be provided at HVO North or HVO West.

The project has also included developed of an operational water balance model. Key outcomes of a water management system performance assessment undertaken using the developed model include:

- With respect to inventory management:
  - The simulated annual probability of exceeding the combined storage capacity of 6,450 ML is approximately 10-25 per cent for all scenarios.
  - Exceedence of storage capacity and associated requirement for temporary in-pit water storage is considered to represent an operational risk rather than an environmental risk. Increases in frequency and magnitude of excess predicted in Stage 2 to Stage 4 may not be of concern if the excess volume can be temporarily stored in other areas of the mine (inactive pits, active pits, etc.) without impacting on production or safety.
  - Increasing HRSTS discharge potential by increasing utilisation of the Dam 11N release point, or by increasing the HVO credit holding are alternative options that may be explored to improve system performance if required. These are expected to be more realistic options for Stages 2 or 3 rather than Stage 4.
- With respect to water supply availability:
  - The annual probability of requiring import of water from an external source is 45 to 55 per cent in all scenarios except Stage 2.
  - The highest water import requirements are simulated in Stage 1, primarily associated with increasing CPP water usage (with no moisture return from HCPP tailings) and increasing dust suppression usage, with comparatively little change in groundwater and catchment to offset. The AEP of requiring import in this scenario is 70 per cent. Annual volumes are typically around 1.8 GL higher than baseline results.
  - Existing water supply entitlements should be adequate to provide the mine with reliable water supply under normal climatic conditions. The AEP 10 per cent volumes are well below combined LUG Bore and Hunter River allocations. Although allocations need to be offset to account for passive groundwater take from the Hunter River (via groundwater) and LUG Bore entitlement shared with MTW, they may also be supplemented with water sourced from neighbouring mines (e.g. Wambo, Liddell).

- With respect to off-site water discharges:
  - There is an annual probability of approximately 50 per cent of discharging water to the Hunter River under the HRSTS in all scenarios except for Stage 2, in which probability reduces to 40 per cent. The annual probability of discharging greater than 2,000 ML/yr under the HRSTS is approximately 10 per cent in all scenarios.
  - There are no simulated non-HRSTS discharges from any mine water dams to the environment reported in any of the scenarios considered.
  - Simulated annual discharge volumes to the environment from sediment dams steadily increase with each scenario, consistent with the increases in diverted catchment area. Increase in discharge volume between Stage 4 and the baseline scenario is approximately 25 per cent.

The HVO water balance model developed by Hatch and documented in this report is considered to be suitable for assessing the performance of the HVO WMS.

Potential impacts on operational performance have been identified as part of the surface water balance assessment (e.g. temporary storage of mine water in-pit). Operational risks will be managed by Coal & Allied, and are not expected to result in any material change in risk to the surrounding environment relative to current conditions. This is a key overall outcome of the current assessment.