Delta coal	Doc Owner: **Environment and Community Coordinator** Doc No:

CHAIN VALLEY COLLIERY

Water Management Plan

ENVIRONMENTAL MANAGEMENT PLAN

Reviewed	Sally Callander - EMM Consulting
	Chris Armit - EMM Consulting
	Katie Weekes – EMM Consulting
Authorised by:	Chris Armit
	Environment and Community Coordinator
Date:	1 December 2019

Table of contents

1 Introduction

1.1 Purpose

The Water Management Plan (WMP) addresses the requirements for Development Consent SSD-5465 and EPL 1770.

The purpose of the WMP is to:

- guide the management of surface and groundwater resources throughout the operational life of the mine;
- address the relevant conditions of the development consent;
- meet the requirements of EPL 1770, including Pollution Reduction Programs (PRP's) that have been implemented on site;
- address the relevant commitments made within the Surface Water Assessment (SWA) (GSSE, 2013) and Environmental Impact Statement (EIS) (EMM, 2013); and
- address legislative requirements and guidelines relevant to the WMP.

The WMP incorporates the following components as required by SSD-5465:

- a Water Balance;
- a description of Surface Water Management;
- a Surface Water Monitoring Plan;
- a Ground Water Monitoring Plan; and
- a Water Management Review.

1.2 Background

Chain Valley Colliery (CVC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see **Figure 1**). The pit-top is located approximately 1 km south-east of the township of Mannering Park at the southern extent of Lake Macquarie.

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam, commenced with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963.

LakeCoal was formed in 2001 to acquire BHP Billiton's 80% share in the Wallarah Coal Joint Venture (WCJV), the remaining 20% share was owned by Sojitz. In October 2006, Peabody Energy, a US listed company acquired LakeCoal Pty Limited.

In November 2009 LDO Coal Pty Limited purchased LakeCoal Pty Limited. LDO Coal is a consortium consisting of LD Operations, AMCI and private investors. In March 2011 the 20% share in the WCJV which Sojitz held was acquired by LDO Coal shareholders through the entity Fassi Coal Pty Ltd. The WCJV had operated the Wallarah, Moonee and Chain Valley underground coal mines and the Catherine Hill Bay Coal Preparation Plant, all located at the southern end of Lake Macquarie. At the time of LakeCoal's acquisition by LDO Coal, both the Wallarah and Moonee mines were closed.

In 2013 the owners of Mannering Colliery (MC) and CVC entered into an agreement which enabled LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013, with the underground link between CVC and MC completed in October 2017.

LakeCoal was placed into Voluntary Administration on 3 October 2018. The receivers continued operation of the mines in the period 3 October 2018 to 1 April 2019. As of 1 April 2019, Great Southern Energy Pty Ltd (trading as Delta Coal, DC) own and operate the two underground coal mines, CVC and MC. Mining is currently undertaken at CVC, with the coal being transported underground to MC where the coal is crushed and screened and sent directly to VPPS.

1.3 Operations

CVC is an underground coal mine which extracts coal through both first workings and miniwall extraction methods (second workings). ROM coal from both the first and second workings is transported out of the mine via a conveyor system, where it is sized and transported by surface conveyor systems to product bins.

The surface infrastructure comprises limited facilities at the 14 hectare pit top area adjacent to the Vales Point Power Station, off Construction Road at Mannering Park, and another 0.3 hectare area at the ventilation facility situated at Summerland Point. Both the pit top and ventilation facilities have remained largely unchanged since their establishment.

Modification 2 to Development Consent SSD-5465 allowed for minor vegetation clearing/disturbance adjacent to some infrastructure at CVC's pit top and the ventilation fan site at Summerland Point to enable the extension/establishment of asset protection zones (APZs) for bushfire protection purposes.

The above operations have potential impacts which were addressed in the SWA (GSSE, 2013). To address these, the SWA (GSSE, 2013) identified the following key objectives for surface water management at CVC:

- the prevention of the flow of pollutants into watercourses and the sedimentation on receiving waters, being Swindles Creek to the east of the pit top and Lake Macquarie;
- the control of discharges from the site to ensure that all discharges are within the water volume and quality criteria set out in EPL 1770;
- to minimise site potable water usage requirements and maximise runoff water reuse; and
- to ensure there is sufficient water available to meet Chain Valley Colliery's water requirements.

1.4 Consultation

The original WMP (GSSE, 2012) was prepared in consultation with the former NSW Office of Water (NOW), DTIRIS (Division of Resources & Energy (DRE)) and Wyong Shire Council. The previous WMP (GSSE, 2012) was submitted on the 23 August 2012 and approved by the Director-General on the 6 November 2012.

The 2015 revision of the WMP was prepared in consultation with the (former) NOW and the Environment Protection Authority (EPA) and incorporates outcomes of correspondence with EPA in relation to the variation of the EPL. Comments on the WMP were received from NOW on the 5 December 2014 and requested a change to the groundwater drawdown trigger to 2m over a 2 month period, which is consistent with the minimal impact considerations of the NSW Aquifer Interference Policy, this change has been made within the Groundwater Management Plan (**Appendix B**).

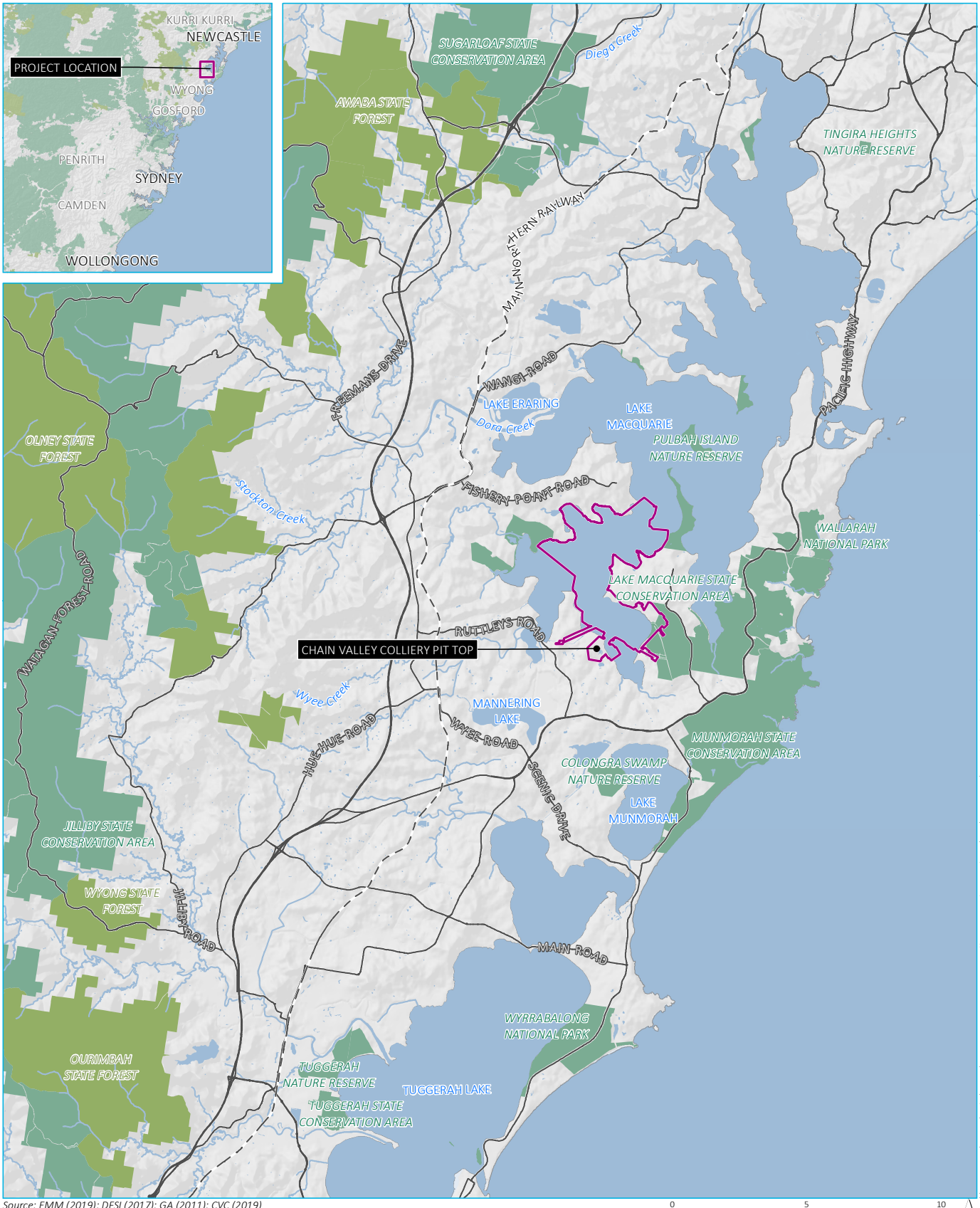
Comments were also sought from the EPA and subsequently requested via email in December 2014. On the 12 June 2015 the EPA responded stating that "The Environment Protection Authority ("EPA") encourages the development of such plans to ensure that proponents have met their statutory obligations and designated environmental objectives. However, EPA does not review these documents as our role is to set environmental objectives for environmental / conservation management, not to be directly involved in the development of strategies to achieve those objectives. The EPA has not reviewed this report and accordingly offers no comments in relation to it".

In accordance with Schedule 3, Condition 18 of development consent SSD-5465 the WMP has been prepared by suitably qualified and experienced persons, Sally Callander (EMM Consulting), Andrew Dawkins (Geoterra) and Chris Armit (EMM Consulting), whose appointment has been endorsed by the Director-General.

A draft revision of the WMP was provided to DPI - Water, EPA and DPIE on 26 November 2019. A summary of the comments received and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**.

Table 1: Consultation Summary

Stakeholder	Comments	Response/Action
NSW DPIE		
NSW EPA		
DPI - Water		



Source: EMM (2019); DFSI (2017); GA (2011); CVC (2019)

0 5 10 km

GDA 1994 MGA Zone 56

N

KEY

- Chain Valley Colliery development consent boundary
- Rail line
- Main road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest

CVC regional context

Chain Valley Colliery
Figure 1

EMM
creating opportunities

\\emmsvr1\EMMJobs\2019\H190358 - Mannering Colliery Mgt Plan Updates\GIS\02_Maps\MCMP001_RegionalLocation_20191021_02.mxd 21/10/2019

2 Summary of the Statutory Approval Requirements

2.1 Key Legislation, Policy and Guidelines

A number of legislative requirements, government policies and guidelines relating to water management are applicable and have been addressed in detail within the SWA (GSSE, 2013). The key items of legislation and the relevant approval documents to this WMP are:

- *Water Act 1912 and Water Management Act 2000* - LakeCoal applied for a 4,443 ML/year groundwater license on the 5th October 2011 under the *Water Act, 1912* to pump water from the underground workings to the sedimentation and pollution control ponds at the pit top. The license (WAL41508) was subsequently granted on the 12 March 2013;
- *Protection of the Environment Operations Act 1997* (POEO Act) - Chain Valley Colliery has an existing EPL 1770 under the POEO Act for the discharge of water from site;
- *Environmental Planning and Assessment Act 1979* (EP&A Act) - On 23rd December 2013 development consent SSD-5465 was issued for the *Chain Valley Extension Project*, which has been modified twice by approval on the 27 November 2014 and 16 December 2015; and
- *Mining Act 1992* – Delta Coal holds numerous mining authorities under the Mining Act 1992, a list of all leases held is contained within the Environmental Management Strategy (OMP-D-16374), the most relevant for the WMP is Mining Purposes Lease 1349 as it pertains to the surface facilities area.

The relevant aspects of these approval documents are addressed further below.

Key policies and guidelines which are relevant to the preparation and implementation of this WMP include:

- Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines), October 2000;
- Department of Environment and Conservation (DEC), Approved Methods for the Sampling and Analysis of Water Pollutants in NSW, March 2004;
- Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008;
- NSW Water Quality and River Flow Objectives, September 1999;
- NSW State Rivers and Estuaries Policy, 1993;
- NSW Groundwater Quality Protection Policy, adopted in 1998;
- The NSW State Groundwater Dependent Ecosystems Policy, adopted in 2002;
- NSW Groundwater Quantity Management Policy;

- Australian Government, Charter: National Water Quality Management Strategy, 2018;
- Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), National Guidelines for Sewerage Systems - Effluent Management, 1997; and
- NSW Department of Environment and Conservation (DEC), Environmental Guidelines: Use of Effluent by Irrigation, 2004.

2.2 Development Consent (SSD-5465)

This plan has been prepared in accordance with Schedule 3, Condition 21 of SSD-5465, which states the requirements of the WMP and what it must address. Surface and groundwater related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

In accordance with Schedule 2, Conditions 2 and 2A, in addition to carrying out the works in accordance with the conditions of SSD-5465, DC will also carry out works generally in accordance with the Environmental Impact Statement (EIS), Statement of Environmental Effects (SEE) (Mod 1), SEE (Mod 2), Project Layout Plans, and Statement of Commitments.

2.3 Mining Leases

MPL 1349, is the most relevant lease to this WMP as MPL 1349 relates to the surface facilities. MPL 1349 contains the following provision with respect to surface water management.

> *2. The proponent shall implement all practical measures to prevent and/or minimise any harm to the environment that may result from the construction, operation or rehabilitation of the development.*
>
> *18. Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosion, unless otherwise authorised by a relevant approval, and in accordance with an accepted Mining Operations Plan. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwater and perform any instructions given by the Director-General in this regard.*

2.4 Environmental Protection License (EPL 1770)

CVC operates under EPL 1770 issued by the Environment Protection Authority (EPA) under the POEO Act. The EPL has been modified a number of times, most recently on the 1 April 2019 for the transfer from Lake Coal Pty Ltd to Great Southern Energy Pty Ltd (trading as Delta Coal). Water related requirements of the EPL, including specific requirements that are to be addressed in this management plan and section references within the WMP are detailed in **Appendix 2**. A 5 year anniversary review of EPL 1770 is being undertaken during the review of this document.

2.5 Maximum Harvestable Right Dam Capacity

Under the NSW *Water Management Act 2000*, landholders are permitted to capture, store and use a portion of the rainfall runoff on their property. The right to harvest rainfall is determined by geographic location and is typically 10% of the total rainfall runoff for the property and storage is calculated under the Maximum Harvestable Right Dam Capacity (MHRDC) provision. Dams that exceed this capacity or are greater than a certain size must be licenced.

Where dams are used to control pollution or effluent, there are exemptions to the licencing requirements. This is the case for the pollution control dams at CVC where the dams are exempt from the MHRDC calculation.

3 Water Balance

A comprehensive site water balance has been prepared for the site and is described in detail within the SWA (GSSE, 2013). This section of the WMP provides a summary of the water balance to enable the key inputs and outputs to be understood along with the water balance results. It also describes the implications of the proposed changes to site water management described in **Section 4.4**.

For more detailed information on the site water balance refer to the SWA (GSSE, 2013).

3.1 Water Balance Model

A detailed 'daily time-step' water balance model was used to represent the Chain Valley Colliery water balance using GoldSim Version 10.50 (GoldSim Technology Group LLC). This software is a graphical, object-oriented system simulation software for completing either static or dynamic systems. GoldSim is commonly used to undertake 'daily time step' water balance simulations for coal mines within NSW due its enhanced modelling capability and flexibility compared to spreadsheet models that have predominately been used in the past. The Chain Valley Colliery water cycle, as simplified and modeled in GoldSim is shown in the schematic water flow diagram as shown on **Figure 2**.

3.2 Data (Model Inputs and Outputs)

3.2.1 Rainfall Runoff

The dataset developed for the water balance used information from the Wyee and Norah Head weather stations. There are other stations in the general vicinity, however these stations were selected due to their proximity to the CVC and length and completeness of the data, which together, provide over 100 years of rainfall data.

The pit top area was segregated into four distinct catchments which were further broken up into eight sub-catchments for the purpose of the CVC water balance.

The daily step GoldSim model was used to estimate the surface water runoff from different sub catchments at the pit top area. The runoff coefficients adopted are considered conservative but reflect the large impermeable area in the catchment which includes laydown areas, compacted roads and coal stockpile areas. The free water surfaces of the pollution control dams and the roofed areas were modelled as completely impervious areas, capturing all precipitation.

Catchment areas as modeled within the GoldSim model are provided in **Table 2**.

Table 2: Pit Top Catchment Areas

Major Catchment Name	Sub-Catchment Name	Catchment Area (ha)
Carpark (Catchment 1)	Carpark (not modelled)	NA
Storage Yard (Catchment 2)	Oil Water Separator	0.15
	Workshop (Roof)	0.24
	Old Bath House (Roof)	0.11
	Pit Top Storage Yard	3.03
Stockpile (Catchment 3)	CHP Stockpile	5.34
Pollution Control Dams (Catchment 4)	Dams D1 to D6	0.41
	Dams D7 to D13	1.97
Total catchment reporting to pollution control dams (excluding carpark)		**11.25**

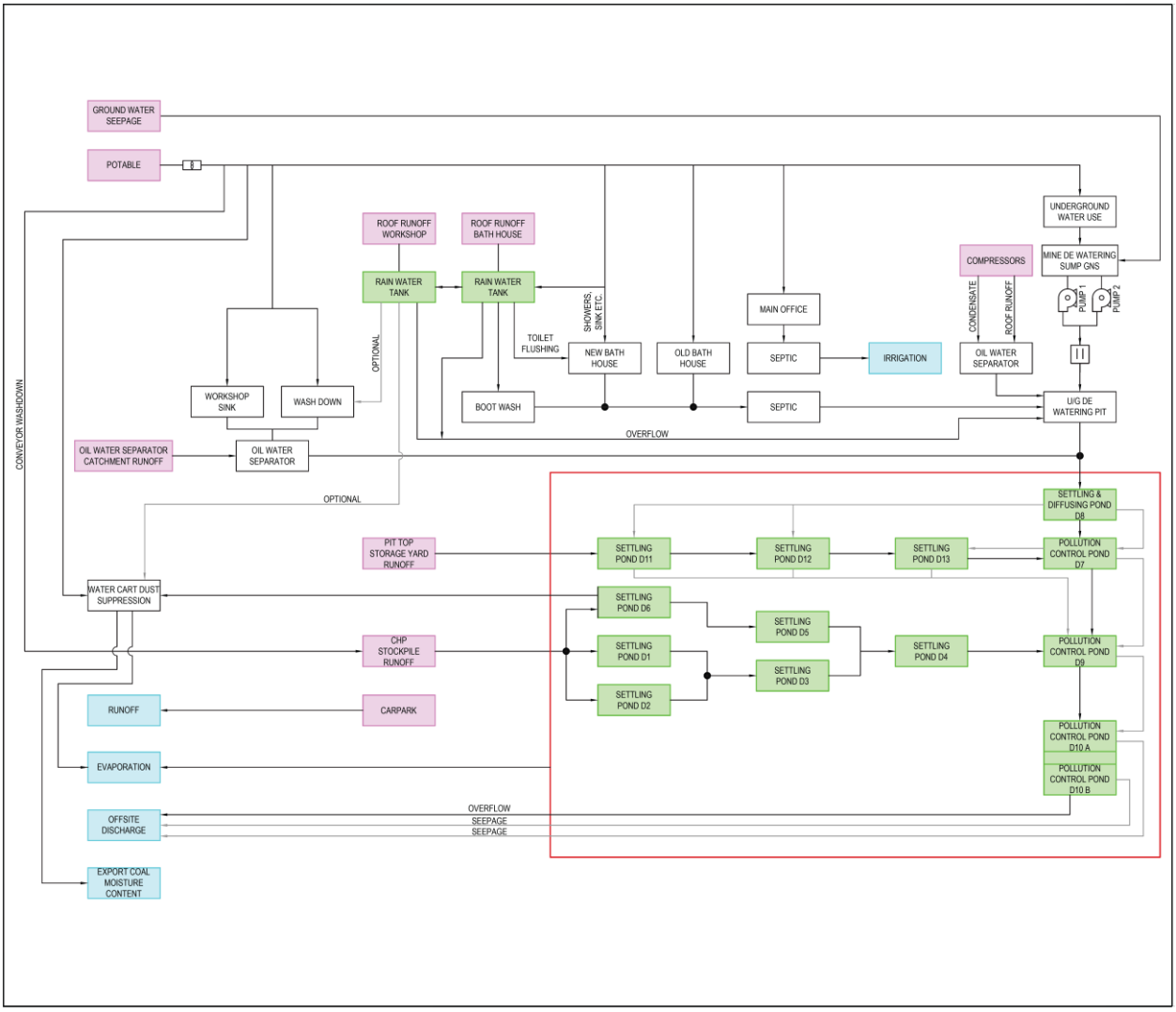


Figure 2: GoldSim schematic water flow diagram

3.2.2 Evaporation

Evaporation data was obtained from the Peats Ridge weather station on Waratah Road (station number 61351), approximately 33km south-west of the site. This was the closest meteorological weather station to the CVC with over 25 years of evaporation information. Evaporation data from this weather station was adjusted for the change in site conditions from the measuring site to the sedimentation dams by multiplying the average monthly rates by a pan coefficient of 0.7.

Evaporation from the pollution control dams was calculated using a daily step within the GoldSim model similar to the runoff model calculations. This model used the evaporation rate, modified by the pan coefficient, and the surface area of the dams, which was calculated using survey data.

3.2.3 Underground Water Extraction

The Groundwater Assessment (Geoterra, 2013) predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day. This estimated pumping rate is an average value and therefore pumped flow rates may exceed this value on occasions. It should be noted however, that this average daily volume was calculated as an 'end of mining' estimate and can be considered a 'worst case' prediction of groundwater inflow rates. It is not expected to occur for the majority of the project life.

The annual groundwater make from the mine is estimated at approximately at 1,817 ML/yr, or 4.98 ML/day (Geoterra, 2019).

Pump rate information provided by LakeCoal indicates that the two existing underground dewatering pumps from the Great Northern Seam sump have a maximum pumping rate of 75 L/sec and 75 L/sec respectively. This equates to a total maximum pumping rate from underground of approximately 12.96 ML/day.

However, within the EIS (EMM, 2013) LakeCoal committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day (equivalent to the predicted average daily volume that will need to be pumped from the coal face during the later stages of the project). This limit was put in place during September 2014, using the site Citect system to automatically stop the one of the underground pumps when 9.5 ML has been pumped and stopping the second pump if a total of 10.5 ML in any day has been pumped. The pumps are only able to be restarted the following day. This limit can however be temporarily disabled by authorised persons in the event of unacceptable risk (e.g. flooding and risk to employee health and safety), which was a requirement of the site risk assessment completed.

When not pumping, water accumulates underground in a number of storages that exist within both the Great Northern and Wallarah Seams, these are discussed in **Section 4.3**.

3.2.4 Pollution Control Dam Characteristics

Information pertaining to the GoldSim modelling of the sedimentation dams was obtained from survey data. This information is shown in **Table 3**. It should be noted that the volume of dam D6 was not available and was estimated based on a 1 m depth, the measured surface area and standard stage/storage relationships. Dams D1 to D6 and D7 to D13 were each modelled as single storages to simplify the water balance processes at the site.

Table 3: Pollution Control Dam Capacities (as modelled in GoldSim)

Dam	Volume (m^3)
D1	80
D2	51
D3	284
D4	547
D5	770
D6	568
Total dams D1 to D6	**2300**
D7	3856
D8	2933
D9	3796
D10	4802
D11	297
D12	229
D13	168
Total dams D7 to D13	**16081**

3.2.5 Loss of Water through Coal Export

During mining and conveying, the moisture content in the coal increases due to the use of water sprays at the coal face and at transfer points along the conveyor system. A review of the CVC coal analysis data indicates that the inherent (air dried) moisture content of the coal from underground is approximately 2.7%.

This same data indicates that the total moisture of the CVC coal that is exported is approximately 7.3%, which means that around 4.6% of this total moisture content is added to the coal prior to export. This equates to 69,000 tonnes of additional water at the proposed maximum rate of production of 1.5 Mtpa. Therefore, approximately 69.0 ML of water is exported from the CVC every year, or 188.9 kL/day.

3.2.6 Additional Data

A limited amount of water usage and flow monitoring data at CVC was available for the water balance investigation. However, where historic information was lacking, data and operational information was made available to best derive estimates of the respective water balance parameters (flow rates, water usage, etc.). Additional data, as used in the water balance model, is shown in **Table 4**, as well as comments/assumptions on how this data was derived.

Table 4: CVC Supplied and Derived Data

Parameter	Value	Comments/Assumptions
Potable Water: Underground (includes increase of 25% to account for any additional underground potable water demand)	139.583 ML/yr	Average of underground potable water from monitored water use with an additional 25% to account for increased potable water used underground.
Potable Water: Main Office	211 L/day	Includes shower, sink and toilet facilities. Shower (26 L/day): Assumes 9 L/min, 10 min/person, 2 showers per week. Toilet (154 L/day): Assumes 12 employees, employees at work 5 days/week, 6 L/toilet flush, average employee flushes 3 times/day (at work). Sink (31 L/day): Assumes 12 employees, 1.2 L/wash, employees at work 5 days/week, employees use sink 3 times/day.
Potable Water: Workshop	3724 L/day	Includes equipment washdown and sink use. Equipment Washdown (3712 L/day): Assumes 1-hour wash/day, 1.031 L/sec flow rate. Sink (12 L/day): Assumes 1.2 L/wash, 1 sink used 10 times per day.
Potable Water: Old Bath House	24 L/day	Includes sinks facilities. Sinks (24 L/day): Assumes 1.2 L/wash, 2 sinks each used 10 times per day.
Potable Water: New Bath House (Showers, Sink)	8519 L/day	Includes shower and sink facilities (assumes rainwater tank water used for toilets flushing). Shower (8190 L/day): Assumes 9L/min, 10 min/person, average of 91 shift ends / day (calculated from shift information provided by DC). Sink (329 L/day): Assumes 160 employees, 1.2 L/wash, employees at work 4 days/week, employees use sink 3 times/day.

Potable Water: Conveyor Washdown	11.135 kL/day	Assumes it is used 3 hrs/day, 1.031 L/s flow rate.
Bootwash Water Demand	273 L/day	Assumes it is used 3 L/person/shift, average of 91 shift ends / day (calculated from shift information provided by DC).
New Bath House Toilet Flushing Demand	1097 L/day	Assumes 160 employees, employees at work 4 days/week, 4 L/toilet flush (reduced for urinals), average employee flushes 3 times/day (at work).
Dust Suppression Demand	11.28 ML/yr	Calculated from available water cart records (3/01/2012 to 11/05/2012).
Combined Rainwater Tank Capacity	30 kL	Estimated rainwater tank capacity.

3.3 Water Balance Results

3.3.1 Expected Discharge from Chain Valley Colliery

As noted in **Section 3.2.3**, DC limits the main underground pumps to a maximum pump out rate of 10.5 ML/day. As such, the GoldSim model was run (using a deterministic simulation) assuming that the pumps from the Great Northern Seam sump were constantly pumping at this 10.5 ML/day rate. This scenario assumes that adequate capacity is available in the underground workings to effectively store water during periods when the groundwater inflow rate exceeds the underground dewatering rate. This is further discussed in **Section 4.3**. It should be noted that assuming a constant underground pump rate of 10.5 ML/day is a 'worst case' scenario and is only predicted to occur, on occasions, near the end of the project life.

Key statistics from the GoldSim modelling, assuming a constant discharge from underground of 10.5 ML/day, include:

- daily average discharge through the LDP1 of 10.716 ML/day;
- maximum discharge through LDP1 of 35.124 ML/day; and
- likelihood of LDP1 volumetric limit exceedance on any given day of 4% (or approximately 15 times per year).

The prediction that rainfall events will regularly result in discharges above the EPL LDP limit of 12.161 ML/day is further discussed in **Section** Error! Reference source not found.. During the period 2016 to 2019, there have been 3 discharges above the LDP volumetric limit of 12.161 ML/day. Two occurred during 2016 and one in August 2019. All were reported to the EPA and DPIE.

3.3.2 Potable Water Use

The total amount of potable water used at the CVC was investigated in the GoldSim model, with and without the committed water savings measures (as described in **Sections 4.7**) in order to quantify how much potable water these measures are likely to save at the site. GoldSim modelling estimates that the potable water used in the pit top area will be reduced from 55.9 kL/day to 23.7 kL/day with an overall saving of 32.3 kL/day (11.8 ML/year) as a result of water saving measures being implemented.

This equates to an approximate reduction in total potable water of 8.9% (for current levels of potable water use) and 7.4% (allowing for a 25% increase in the underground potable water use as a result of the proposed future mining works).

3.4 Water Supply and Security

All water required for operational activity has historically been sourced from the single potable water supply connection from the Central Coast Council town-water system. This connection is considered a secure source of water as it is only a small portion of the total water consumed annually by the Central Coast and no viable alternative sources have been identified. Further discussion on water savings and alternative water supply is contained in **Section 4.7**.

No water is obtained from unregulated water sources listed in the *Water Sharing Plan for the Central Coast Unregulated Water Sources 2009*.

4 Surface Water Management

4.1 Overview of Water Management System

The water management at the CVC pit top is primarily focused on erosion and sediment control, however there are a number of water management components including the underground de-watering, oil water separator system, the effluent management train and the operation of the pollution control dams.

All water required for operational activity is sourced from the single potable water supply connection from the Central Coast Council town-water system. All excess water from the underground workings is pumped to the Great Northern Seam sump. This water is then pumped to the surface and discharged into the site's pollution control dams.

A combination of surface slope and earth diversion drains on the eastern and northern boundaries results in the majority of the site draining east towards the pollution control dams. A small catchment (i.e. carpark and access road) discharges off-site to the west and north. Other than the carpark catchment, the site's pollution control dams receive all rainfall runoff from the pit top, amenities water and underground mine water, as well as workshop and wash down water after treatment by an oil separator. A system of 13 pollution control dams have been constructed from a mixture of earth, crushed rock, recycled brick and stone. The dams are interconnected through a series of overflow pipes and spillways which allows water to circulate through each dam before reaching the site discharge point. The dams provide improvement to the site wastewater and runoff quality prior to discharge to Lake Macquarie (via Swindles Creek).

4.2 Potable water

All water used for underground mining purposes by CVC is potable water and used in equipment, for cleaning, and dust control. To quantify the estimated volume of water consumed underground a flow/volume meter is installed on the underground water line.

Water is made available throughout the underground workings to satisfy statutory obligations for the production of underground coal. Water is consumed mainly by the following processes.

- when cutting coal at the coal face - to reduce respirable dust and propensity for frictional ignition of coal dust and methane gas;
- when transferring coal along the underground conveyor system and at transfer points - to reduce dust make;
- for use in cleaning;
- for use in equipment; and
- for emergency firefighting purposes.

Water used in the pit top operations is consumed by amenities, dust suppression and wash down.

4.3 Underground Water

In addition to the potable water, naturally saline groundwater migrates into the underground workings of the mine. This water is pumped to or collects in a sump within the Great Northern Seam, from there it is pumped to the pollution control dams on the surface. This water is not used for operational purposes due to its high salinity and subsequent potential effects on mine machinery and equipment.

As mentioned in **Section 3.2.3**, DC has limited the main underground pumps to a maximum pump out rate of 10.5 ML/day. To facilitate restrictions to pumping rates, underground water can be stored within both the Great Northern and Wallarah Seams. The underground storage volumes have been assessed and estimated at the following capacities:

- Great Northern Seam – North East Sump, ~ 100 ML;
- Great Northern Seam - Shaft Headings Sump, ~ 200 ML;
- Great Northern Seam - Sump Headings, ~ 5 ML; and
- Wallarah Seam – Wallarah Sump/Storage Location, 150 to 200 ML.

Details on groundwater management are contained in the Groundwater Management Plan (GwMP) (GeoTerra, 2019) which is in **Appendix 3**.

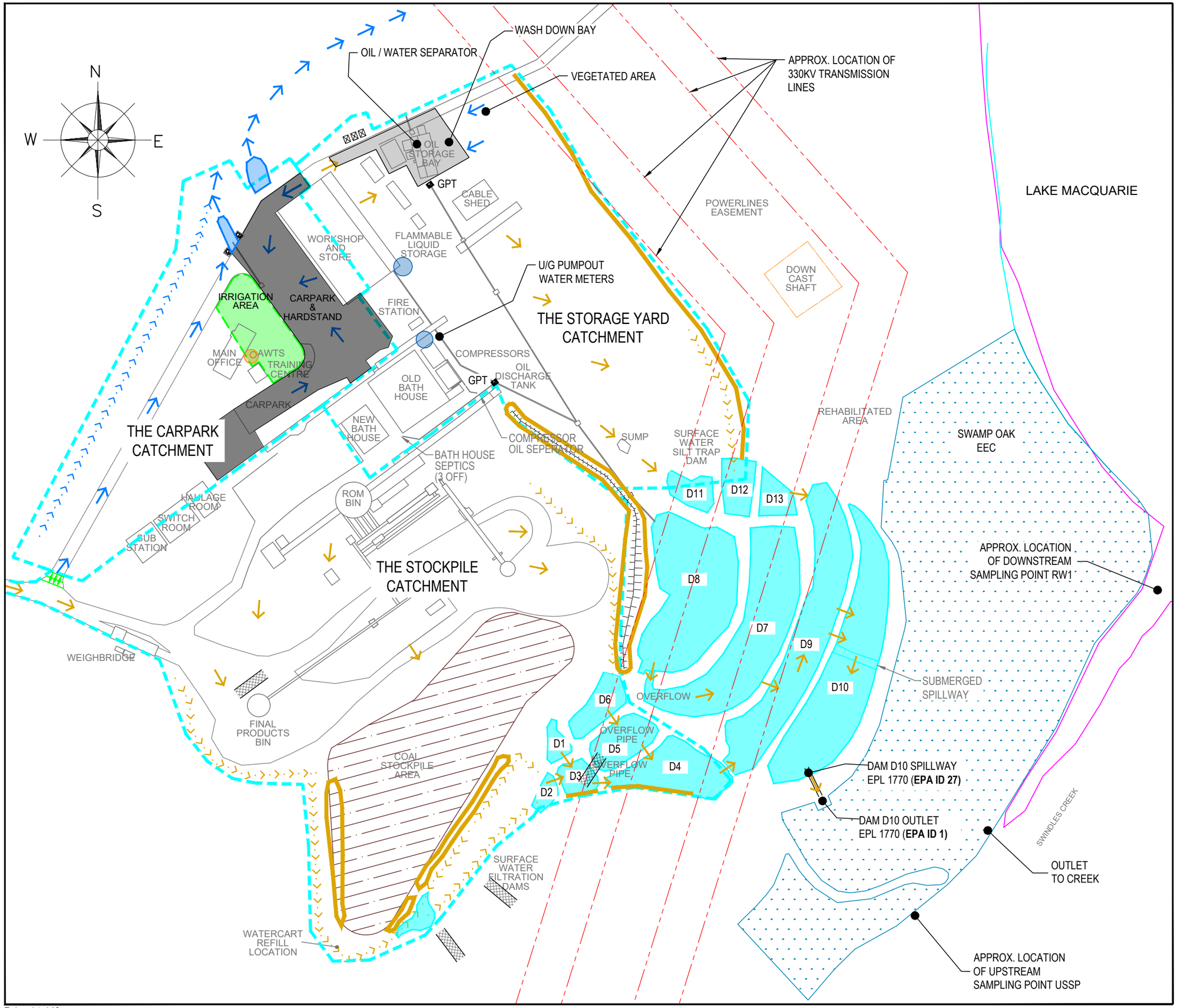
4.4 Surface Water Catchments and Controls

For the purpose of the WMP runoff from the pit top area is managed as 4 catchment areas including:

- Catchment 1 (Carpark) – carpark, office building and partial runoff from the workshop roof;
- Catchment 2 (Storage Yard) – rear storage yard and oil water separator;
- Catchment 3 (Stockpile) – stockpile, entry road and bathhouse form the third catchment; and
- Catchment 4 (Sedimentation Dams) – pollution control dams.

The above catchments and the major drainage structures are shown on **Figure 3.**

Figure 3: Water Management Structures



LEGEND:

- STOCKPILE AREA
- EXISTING BUND LOCATION
- TEMPORY BUND LOCATION
- CLEAN WATER DIVERSION CHANNEL
- DIRTY WATER DIVERSION CHANNEL
- CLEAN WATER FLOW ARROWS
- DIRTY WATER FLOW ARROWS
- BUND/CHANNEL CATCHMENT SEPARATION
- CATCHMENT BOUNDARIES
- POWER LINES
- WATER BASIN
- PROTECTED WETLAND AREA
- SURFACE MAINTENANCE STRATEGY AREA
- IRRIGATED TREATED WASTE WATER AREA
- RAINWATER TANKS
- AERATED WASTE TREATMENT SYSTEM (AWTS)

0 50 100m

Scale 1:2000

FIGURE 3

WATER MANAGEMENT STRUCTURES

CHAIN VALLEY COLLIERY
WATER MANAGEMENT PLAN

Dwg: C1W0008_rev3 Water Management Plan - Figure 3

Date: 29 November 2019

Drawn: RT

Checked: KW

Delta coal

To be printed A3
P:\plans\Surface\C1W0008_rev3 Water Management Plan - Figure 3.dwg

4.4.1 Catchment 1

Catchment 1 (carpark catchment) is a relatively clean catchment as a large portion of this area is vegetated, and there are areas of offices and sealed roads. However, the carpark is unsealed (gravel hardstand) and some sediments accumulate on the surface.

The key control methods implemented in Catchment 1 include:

- clean water diversion channel runs down the north-western perimeter of the pit top to divert any off-site run-on into the natural drainage channel. This is the only major clean water diversion channel required on-site with the remaining topography such that small bunds are sufficient to prevent overland flows entering the site;
- a concrete spoon drain at the intersection with the main site entry road directs dirty runoff from the entry road toward the weighbridge within the storage yard catchment and prevents it from entering this catchment;
- regular sweeping of the carpark surface to remove accumulated sediment;
- kerb and guttering on the access road provides the perimeter drainage directing runoff to the sediment treatment basins within this catchment; and
- utilisation of two small basins, the first is in line with main drainage outlet of the carpark and the second is beside the workshop adjacent to the carpark. Both basins allow coarse sediment to be removed prior to discharge into the natural drainage channel and are shown on **Figure 3**.

4.4.2 Catchment 2

Catchment 2 (storage yard catchment) includes the main storage yard, the majority of which is gravelled hardstand for equipment storage. This area also includes the vehicle wash down bay and bunded areas which drain to the oil water separator within this catchment.

The key control methods implemented in Catchment 2 include:

- there is no off-site water flowing into this catchment and subsequently clean water diversion is not required;
- an earth bund is installed along the eastern perimeter of the catchment which contains all dirty water runoff; and
- a large portion of this storage yard area drains south-east via overland flow into the pollution control dams D11, D12 and D13 which function as primary settling dams before discharging into the main mine water treatment system (i.e. dams D7 to D10);

- the remainder of the catchment (e.g. bathhouse, workshop and treated water) enters various inlet pits and drains south-east via the pit and pipe network into the main mine water treatment system via dams D8; and
- an oil water separator to treat runoff from the bunded hydrocarbon storage areas and vehicle wash down bay (see **Section 4.10**).

4.4.3 Catchment 3

Catchment 3 (stockpile catchment) includes the main entry/haul road, weighbridge (no longer in use), coal handling (including ROM bin) and coal stockpiles (also no longer in use).

The key control methods implemented in Catchment 3 include:

- perimeter bunding along south-west perimeter to prevent clean water entering this area and dirty water leaving the site;
- bunding and surface grading around the water cart fill location to directed runoff to a stockpile catch drain;
- bunding and drainage around the weigh bridge to directed runoff to a stockpile catch drain;
- runoff is contained by two main stockpile catch drains that surround the stockpile. Runoff from this area contains a significant amount of coal fines and there are in-line sumps within the catch drains to trap coarse material before it enters the series of pollution control dams below the stockpile; and
- runoff from this catchment area reports to the pollution control dams D1 to D6 which function as primary settling dams before discharging into the main mine water treatment system (i.e. dams D7 to D10).

4.4.4 Catchment 4

This catchment contains all the pollution control dams (i.e. D1 to D13) which receive runoff from the storage yard area, the stockpile area, pumping of water from underground, and rainfall directly into the dams. The management of this catchment is described in **Section 4.5**.

4.5 Management of Pollution Control Dams

Effective management of surface water runoff relies heavily on the use of pollution control dams for the detention of dirty water as well as mine water. All surface water runoff potentially containing sediment, septic treated bathhouse wastewater, treated water from the oil water separator and underground mine water is captured by the site's pollution control dams prior to discharge under EPL 1770. These dams have been constructed with a mixture of earth, crushed rock, crushed recycled brick and stone and are interconnected through a series of overflow pipes and spillways. The dams discharge through the LDP into native vegetation

and flow to Swindles Creek prior to draining into Lake Macquarie on the western shoreline of Chain Valley Bay.

Water is directed through the treatment dams from a number of main inlet locations. Runoff from the stockpile area and the storage yard enters the pollution control dams as described above for those catchments. The underground mine water is pumped to a pit adjacent the compressor house and is combined with the septic treated wastewater from the bathhouse, the treated compressor condensate water and some surface runoff.

From this pit the water is piped to D8 for settling and diffusion. Water within D8 enters D7 via a spillway at the southern end of D8. However, due to the imperfect nature of the dam's construction an unknown amount of water diffuses through the dam wall. The water in D7 flows into D9 in a similar manner, in D9 the underground water is combined with the runoff from other areas on site. The primary spill from D9 to D10 is at the northern end of D9. Once in D10 the water flows over a shallow buffer spillway to the main discharge spillway and offsite at the LDP. A real time monitoring system on the final spillway was installed in February 2015, with monitoring data sent every 30 minutes via 3G to an online database where data can then be viewed or downloaded.

The dams provide improvement to the site wastewater and runoff quality through the settlement of fines and suspended solids and prevention of off-site discharge of hydrocarbon spills prior to discharge to Lake Macquarie. Based on the volume of the dams and the average daily discharge, the estimated residence time of the water in the pollution control dams is 1 – 2 days. The storage capacity of these dams is provided in **Section 3.2.4**.

4.6 Erosion and Sediment Control / Ground Disturbance

Erosion and sediment control are predominately managed through the implementation of the primary controls described above within the surface water management systems. In addition to these controls, temporary erosion and sediment controls are implemented for any construction disturbance that is not contained with the surface water management system. The primary objective is to ensure that appropriate procedures and programs of work are in place to meet the requirements of Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008).

4.6.1 Soils

CVC surface facilities are situated at the southern end of Lake Macquarie. This area is principally comprised of the Doyalson soil landscape with small parts on the Wyong soil landscape. The Doyalson soil landscape is characterised by gently undulating rises on Munmorah Conglomerate with broad crests, ridges and long gently inclined slopes.

Local relief is up to 30 metres and slope gradient is less than 10%. Doyalson soils are strongly acidic soils of low fertility with slight to high erodibility. The Wyong soil landscape is characterised by broad, poorly drained deltaic floodplains and alluvial flats of Quaternary sediments. Local relief is less than 10 metres and slope gradient is less than 3%. Wyong soils are strongly acidic, poorly drained, impermeable soils of very low fertility with saline subsoils.

There is also the potential for acid sulfate soils (ASS) to be present, with probability of occurrence increasing with proximity to the shoreline of Lake Macquarie (see **Section 4.8**).

4.6.2 Potential Impacts

As there is expected to be very little disturbance to ground surfaces and generally restricted to limited construction activities associated with the mines pit top, erosion impacts will be minimal. Construction activities would typically be in areas of relatively flat land at the pit top, with mitigation measures to be put in place to control mobilisation of disturbed soils at the time of, and immediately following, the construction activity.

The greatest potential for soil exposure and movement of soil would occur during any construction activities within areas outside of the pit top water management system (such as at the ventilation shaft site). Exposed soil may be mobilised, leading to erosion, fugitive dust emissions and potential sedimentation of Lake Macquarie. The following sections provide control measures to prevent adverse impacts on surrounding catchment areas and receiving waters.

4.6.3 Standard Erosion and Sediment Controls

Erosion and sediment controls are to be implemented across the CVC for all phases of the operation including construction, operation and maintenance activities to mitigate impacts on watercourses and the surrounding environment. Where activities are contained with the pit top surface water management system, erosion and sediment control will be achieved through the controls described in the previous section.

Where soil disturbance activities are outside of these controls, standard erosion and sediment control techniques and management principles are used in accordance with the requirements of Managing Urban Stormwater: Soils and Construction Vol. 1 and Vol. 2E - Mines and Quarries (referred to as the Blue Book in this Plan) (Landcom, 2004 and DECC, 2008).

For activities at CVC, a 'Permit to Clear or Disturb Land' is required prior to disturbance. This permit includes requirements to have water management and erosion controls in place prior to disturbance.

4.6.4 Construction Erosion Management Plan

Where soil disturbance activities are outside of the surface water management system, erosion and sedimentation shall be effectively controlled through the development of a Construction Erosion Management Plan (CEMP) prior to undertaking large scale disturbances (i.e. greater than 2,500 m^2). The CEMP shall be consistent with the Blue Book (Landcom, 2004 and DECC, 2008) and would include the following key principles:

- conducting best practice land clearing procedures for all proposed disturbance areas including:
    - coordinating construction activities to minimise exposure of disturbed soils to the elements; and
    - topsoil stripping procedures to reduce deterioration in topsoil quality and dust generation.
- appropriate storage of topsoil stockpiles in areas away from roadways and other drainage lines;
- appropriate design of access tracks;
- use of diversion structures to separate 'clean' water runoff from disturbed areas runoff, to minimise volumes of sediment-laden and mine water for management;
- ensuring sediment-laden runoff is treated via designated sediment control devices;
- topsoiling, reshaping and revegetation of disturbed areas as soon as possible following the completion of construction activities;
- temporary erosion and sediment controls to be in place prior to any construction activity outside of an existing dirty water management system; and
- implementing an effective maintenance program for the site.

The above principles are addressed in further detail in **Appendix 4**.

4.7 Water Savings

CVC seeks continual improvement in relation to water consumption, potential improvements in water efficiency, alternative water sources and options for recycling and reuse. The following measures are implemented on site:

- use of a road sweeper to clean roads (as opposed to more frequent washing of roads with a water cart);
- rainwater tank installed on the workshop;
- repair works to aging pipelines to reduce losses from leakage; and
- trial use of chemical dust suppressant to reduce water cart usage.

The primary use of potable water is to supply underground activities. The water storage within the dirty water dams is not suitable for supply to underground machinery.

4.8 Acid Sulfate Soils

The ASS risk map for coastal NSW shows a high probability of occurrence of ASS below the pollution control dams, and down to the shoreline of Lake Macquarie.

Disturbance of ASS would be avoided wherever practicable. Where ASS has the potential to be disturbed, an ASS management plan would be prepared. Any ASS disturbed would be tested and handled in accordance with the ASS management plan and would be treated or disposed of to an appropriately licensed facility. For activities at CVC, a 'Permit to Clear or Disturb Land' is required prior to disturbance which includes requirements to manage the disturbance of ASS.

4.9 Sewerage Disposal and Management

There are two sources of domestic wastewater located at the pit top facilities. The first source is generated in the administration office building and the second is generated in the bathhouse and operations area. Both wastewater streams are treated by separate treatment systems. The administration office treatment system is an aerated wastewater treatment system (AWTS) while the bathhouse system is a traditional 3 part septic.

Following treatment, the office wastewater is sprayed onto the grass surrounding the office building via a spray irrigation system. The bathhouse wastewater is discharged to the pollution control dams. Both systems have a quarterly monitoring and maintenance schedule in place that is undertaken by an external wastewater treatment system service contractor.

EPL 1770 also has a limit for faecal coliforms of 200 CFU/100 mL at the LDP. This is monitored for and reported on monthly. In addition, effluent stream monitoring is undertaken quarterly (monitoring parameters are detailed in **Section 5.3**) and annual soil sampling of the effluent irrigation area is undertaken, as per **Section 5.6**.

4.10 The Oil Water Separator

Water that is likely to be contaminated with oil and grease, such as runoff from the oil storage facilities, diesel tank storage, workshop / maintenance areas and wash bay is directed to and treated by an oil water separator.

The system includes a packed bed oil separation system where solids are removed in the grit trap and oily water is drawn from the sump through a floating skimmer, into the packed bed oil separator by a non-emulsifying pump. The system has a capacity of 2000 L/hr of through flow. The waste oil is collected in a container and the treated water flows by gravity to the pollution control dams.

A separate oil water separation system is installed on the condensate drain from the compressors on site. This system consists of an in-ground tank where water is passed through and under over a weir arrangement and then discharged to the pollution control dams.

Inspections and maintenance of the separation systems occurs regularly, in addition to water quality monitoring and analysis for total oil and grease at all monitoring points as per **Section 5.3**.

5 Monitoring

To ensure the continued functionality of the surface water management system and to assist CVC identify any potential issues with the system, an on-going water monitoring program is implemented, inclusive of water quality and stream health monitoring.

5.1 Baseline Water Quality Monitoring Data

CVC collates and maintains an up to date database of surface water quality monitoring data for all sampling at the mine. A summary of the baseline water quality data available for the site is presented in Section 3.5.2 of the SWA (GSSE, 2013).

5.2 Impact Assessment Criteria and Trigger Levels

5.2.1 Surface Waters

Table 5 provides water quality parameters and relevant limits to be measured at the LDP as per EPL 1770.

Table 5: Water Quality Monitoring Limits for Chain Valley Colliery

Parameter	Trigger Value	Source
Faecal coliform	200 colony forming units per 100 millilitres	EPL 1770
pH	6.5-8.5	EPL 1770
TSS	50 mg/L	EPL 1770

5.2.2 Underground Water

Groundwater monitoring is described within the GwMP provided in **Appendix 3.**

5.3 Surface Water Monitoring and Frequency

DC will continue to monitor as required by the EPL and also undertake monitoring beyond the requirements of the EPL. The monitoring locations, parameters to be monitored and the required frequency are detailed in **Table 6** with the position of these monitoring locations shown on **Figure 4**. Surface water quality monitoring summary plots for LDP1 for the period from January 2012 to December 2018 are presented in **Appendix 5**.

Table 6: Surface Water Quality Monitoring Locations and Frequency

Identification	Type of Monitoring Point	Parameter	Frequency	Sampling Method
Outlet to Creek (OTC)	Operational (where discharged water enters Swindles creek)	pH Total suspended solids Biochemical Oxygen Demand Faecal Coliforms Enterococci Total oil and grease Electrical Conductivity Total Nitrogen Total Phosphorus Anionic Surfactants	Monthly (min 4 weeks)	Grab sample
Dam 10 Outlet LDP1 and LDP27	EPL 1770 Licensed Discharge Points 1 (Dam piped discharge) and 27 (Dam spillway)			
USSP	Baseline Data (Swindles Creek Upstream of Site)			
RW1	Baseline Data (Swindles Creek Downstream of Site)			

All monitoring of waters should be undertaken in accordance with Approved Methods for Sampling and Analysis of Water Pollutants in NSW (DECCW, March 2004). Additionally, pollutant concentration measurements shall be determined in micrograms per litre and within ANZECC concentration limits unless noted otherwise.

Figure 4: CVC Surface Water Monitoring Locations

5.4 Stream Health Channel Flow and Riparian Vegetation Monitoring

A program to monitor creek line channel stability and health of riparian vegetation within Swindles Creek is undertaken along a short length of the downstream watercourse. Observations of stream health and stability are undertaken quarterly and recorded on the CVC *'Creek Stability Inspection'* form.

Monitoring of Swindles Creek, as per the creek stability form, includes multiple photographic points at representative locations. Photos are taken over multiple inspections in a repeatable manner, with the inspection specifically including:

- general observations of water quantity and quality;
- documenting locations and dimensions of significant erosive or depositional features;
- documenting evidence of erosion and exposed soils;
- noting general indicators of stream health, including abundance of flora and fauna; and
- a review and comparison of results to previous inspections.

Where degradation or adverse erosion is occurring, additional investigations will be undertaken to assess whether the impacts may be associated with the operation of the mine and ameliorative actions undertaken as required. In addition, further riparian vegetation monitoring will be undertaken in accordance with the Biodiversity Management Plan.

5.5 Groundwater Monitoring Program

Details of the groundwater monitoring program is contained in the GwMP in **Appendix 3**, which includes monitoring of mine inflows and private bore water levels.

5.6 Effluent Monitoring

In accordance with *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004), quarterly monitoring of the irrigated effluent from the AWTS at the administration building is undertaken. The parameters that are monitored are identified in **Table 7**.

Soil monitoring (of the surface soil and soil profile adjacent to the administration building) is also undertaken in accordance with *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004). Soil monitoring is undertaken annually using hand auger to assess soils within the irrigation area. The parameters monitored and frequency of monitoring is identified in **Table 8**, which is more frequent than the recommended sampling frequency.

Table 7: Monitoring of CVC AWTS Effluent Stream

Identification	Type of Monitoring Point	Parameter	Frequency	Sampling Method
AWTS	Effluent from AWTS	pH Electrical Conductivity Sodium Adsorption Ratio Total Dissolved Solids Total Suspended Solids Total Phosphorus Total Nitrogen Faecal Coliforms Enterococci Total Oil and Grease Biochemical Oxygen Demand	Quarterly	Grab sample

Table 8: Soil Monitoring at CVC

Monitoring Location	Parameter	Frequency of Sampling	
		Surface Soil	Soil Profile
Effluent Irrigation Area	pH	Annually	Annually
	Electrical Conductivity (EC) (dS/m)	Annually	Annually
	Nitrate-N	Annually	Annually
	Total N	Annually	Annually
	Available P	Annually	N/A
	Total P	Annually	Annually
	Exchangeable Sodium Percentage	Annually	Annually
	Heavy Metals & Pesticides	Annually	N/A
	P sorption	Annually	Annually

5.7 Additional Operational Monitoring

In addition to the other monitoring described above, DC also undertakes periodic surface water quality monitoring for dams within the site. This additional monitoring allows the performance of the surface water management system to be assessed for various areas around the site. CVC is also committed to monitoring water usage onsite. Water usage is currently monitored through the following:

- metering of the potable supply to site;
- monitoring of the volume of water pumped from the Great Northern Seam sump to the surface and
- maintaining records of the water cart operation, including fill times.
-

5.8 Inspections and Maintenance

All water management structures will be inspected regularly. **Table 9** contains the inspection schedule used to ensure the water management structures are functioning effectively throughout CVC. The inspections will also determine the scheduling of maintenance required for the structures.

Table 9: Inspection Schedule for Water Management Structures

To Be Inspected	Frequency
All water management structures	Monthly
Works In Progress (including temporary erosion and sediment control structures)	Weekly

In addition to these inspections, regular water quality monitoring is undertaken as described above. The results of this monitoring with regards to total suspended solids will assist in assessing the effectiveness of the water management system, along with highlighting any possible areas that need to have additional controls added or improve the function of existing controls.

All water management structures will be maintained in a functioning condition. Where controls are observed to be not functioning correctly, the controls will be restored to meet the required standard. The maintenance and monitoring of specific features of the site are described in the sections below.

5.8.1 Sediment Dams

Visual inspections of the sediment dams are undertaken to determine the clarity of the water and if any maintenance is required. The inspections also enable correct scheduling of de-silting works and prompt repairs and/or replacement of damaged works. When required, the silt from dams is removed and stored so that it is not able to be washed back into the dam. Documented inspections of the above are part of the Monthly Environmental Inspection which is scheduled via a work order (part of the CVC maintenance management system).

De-silting of dams is scheduled to occur annually. However, the schedule may be amended based on the above inspections and identified requirements.

5.8.2 Drainage Channels

For clean water diversions, any signs of erosion along the length of the drains should be noted and remedial works undertaken as required. Where significant erosion is observed, additional erosion controls are constructed e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock-armouring or erosion blanket) of the channel surface.

Where dirty water drainage channels contain in-line sumps, these will be cleaned on a regular basis depending on the accumulation of material within the sumps.

5.8.3 Temporary ESC Structures

Regular visual checks will be made of any temporary erosion and sediment controls (ESC) such as sediment filter fences, sandbag weirs etc. to ensure that they are functioning adequately. Structures will be repaired where required.

5.8.4 Roads and Hard Stand Areas

A water cart will be used around the site to ensure dust is kept to a minimum. This will be undertaken on an as needs basis, with more regular use during the warner months. The use of chemical dust suppressant is also being trialed to reduce water usage.

5.8.5 Washbay Oil Water Separator

The packed bed oil separator system is designed to minimise maintenance and servicing. As oil separator systems are critical for the reliable prevention of oil contamination, regular inspections/servicing are important. It is critical that the mechanisms be regularly checked for operation to prevent environmental contamination. Preventative maintenance may also prevent failures before they occur by detecting trends in functionality.

This system has specific weekly and monthly work orders that ensure the system is serviced and maintained.

All accumulated waste oils and solid material shall be disposed of periodically by a licensed operator. The weekly waste management inspection will determine waste oil levels and disposal requirements.

5.8.6 Compressor Condensate Oil Water Separator

Excess oil from the compressors and surrounds is contained, piped to a collection tank which is inspected weekly to ensure the system is serviced and maintained.

Any accumulated waste oil is then removed for recycling by licensed and approved waste management contractors.

5.8.7 Carpark

The carpark hardstand area shall be regularly maintained to minimise the generation of sediment. The maintenance strategy shall include the immediate removal or shaping of material that might result in concentrated flow paths by maintaining a smoothly graded surface. A water cart will be used around the site (as required) to ensure dust is kept to a minimum. A street sweeper is used a monthly basis to sweep the sealed entrance roads.

5.8.8 Underground Flow Monitoring Devices

Water flow monitoring appliances have been installed in the mine to measure pumped water volumes to and from the mine workings. These appliances shall be maintained in good working order, and if required, the mine will supply a test certificate to certify the current accuracy of the appliances furnished by the manufacturer or by some duly qualified person or organisation.

5.9 Data Recording and Publication

Recording of monitoring data will be undertaken in accordance with the requirements outlined in EPL 1770. DC will collate and maintain an up-to-date database of surface water quality monitoring data for all sampling at the mine. Monitoring results will be interpreted as they are received in order to ensure water quality is maintained within the desired parameters.

A summary of results, including daily volumetric discharge and water quality results, will be prepared monthly and made publicly available on the DC website (www.deltacoal.com.au) in accordance with the requirements of *Protection of the Environment Operations Act, 1997*.

The results will also be compared to relevant site operations and meteorological conditions to further interpret the results. This comparison between samples, sampling periods and against other factors will assist in identifying whether the activities on the site are in fact affecting the water quality of the local catchment.

Results of surface water quality monitoring will be reported in the Annual Review. The results will also be made available to the Community Consultative Committee members on a regular basis as part of the Environmental Monitoring and Reporting process, as well as to the Central Coast Council and Lake Macquarie City Council (LMCC).

6 Reporting

6.1 Regular Reporting

The water monitoring results will be reviewed on a monthly basis to confirm compliance with the conditions specified in **Section 5** or ensure corrective action is taken where results or trends indicate non-compliance or risk of future non-compliance.

A summary of monthly environmental monitoring results will be published on the DC website.

6.2 Annual Review

The water monitoring results will be reviewed on a monthly basis to confirm compliance with the conditions specified in **Section 5** or ensure corrective action is taken where results or trends indicate non-compliance or risk of future non-compliance.

The results will also be included in the Annual Review. The Annual Review will include:

- a summary of monitoring results,
- comparison against the water quality criteria;
- summary of previous years monitoring results;
- comparison against predictions in the Environmental Impact Statement (EIS);
- identify any trends in water quality/quantity;
- identify any non-conformances over the year; and
- describe any actions currently implemented or planned to ensure compliance with the water quality impact criteria.

The Annual Review will be forwarded to the relevant authorities including the DPIE, EPA and WaterNSW. The Annual Review will also be forwarded to members of the Community Consultative Committee and local Councils (Central Coast and Lake Macquarie) and will also be placed on the CVC website.

The EPA will be provided with an annual return, including monitoring details, as required by EPL 1770.

6.3 Incident or Non-Compliance Response and Reporting

Following detection or notification of an incident, site personnel at CVC will immediately focus on the mitigation of any potential environmental harm. Should potential or actual harm to the environment be identified, the appropriate regulatory authority shall be immediately notified, and remediation measures applied. Where ameliorative actions may reduce the threat or harm to the environment, action will be undertaken immediately to mitigate or rectify the issue. These actions will be followed by an investigation into the cause of the incident.

If monitoring reveals that, as a direct result of CVC operations, levels have exceeded the relevant criteria outlined in **Section 5,** DC will conduct an investigation into the source of the non-compliance. As detailed in Condition 7, Schedule 6 of SSD-5465, relevant agencies will be notified by phone or email at the earliest opportunity of an incident that causes or threatens to cause material harm to the environment. For all other incidents, relevant agencies will be notified by phone or email as soon as practicable.

An investigation will consider any activities and plant operation or other factors that may have caused or contributed to the incident or non-compliance. This will include a review of rainfall data, an investigation regarding the water source, and an inspection of all relevant pollution control structures to ensure they are functioning correctly. Aspects to be inspected include:

- integrity of all structures to capture/convey flows as designed;
- level of sediment in pollution control dams and drains;
- amount of vegetation (reeds) in pollution control dams, which may affect the pH of the water;
- the location of the water source; and
- the presence of any hydrocarbon spills underground or on the surface in the vicinity of pollution control structures.

The written report will be provided to any affected landowner and/or existing tenants, including tenants of mine owned properties, to the DPIE, EPA and any other relevant stakeholders within 7 days of the date of the incident or being made aware of the incident (such as receiving monitoring data). The report will:

- describe the date, time and nature of the observation;
- identify the cause (or likely cause) of the damage;
- describe what action has been taken to date; and
- describe the proposed measures to address the impacts and prevent further such occurrences.

DC will implement the recommendations of the investigation in order to address any future non-compliance issues. Additional details of the incident reporting process are provided in the Environmental Management Strategy.

The GwMP in **Appendix 3** contains the assessment triggers and ameliorative measures relevant to the groundwater monitoring.

Any incidents or complaints will be recorded and fully investigated to find root causes and corrective actions implemented where necessary. Additionally, the following measures will be undertaken:

- a review of management practices to systematically identify and implement options to modify site practices so as to ensure effective water management and erosion and sediment control activities in order to achieve the goals stated in this plan; and
- additional water quality monitoring may be conducted at a complainant's request at an appropriate frequency.

7 Stakeholder Management, Response and Training

7.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 115 277) for members of the public to lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters. All complaints are recorded and responded to.

The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or if no action was taken, the reason why; and
- follow up contact with the complainant.

7.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review

7.3 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environment and Community Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager together with the Environment and Community Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in Schedule 5 of SSD-5465.

7.4 Training, Awareness and Competence

Training is an essential component of the implementation phase of this WMP. The Environment and Community Coordinator will ensure that training and awareness processes are implemented to manage, identify and minimise potential impacts of CVC and to ensure personnel are aware of their roles and responsibilities in terms of water quality management and erosion and sediment control.

Generally training at CVC consists of induction training for new starters and contractors along with environmental awareness training at two-year intervals and ongoing “toolbox” training for all permanent employees as required. Site inductions also specifically identify that no unauthorised clearing is to occur.

As the document owner, the Environment and Community Coordinator is the contact point for any person that does not understand this document or their specific requirements and will provide guidance and training to any person that requires additional training regarding this management plan.

8 Audit and Review

8.1 Overview

This document shall be reviewed, and if necessary revised, annually or within 3 months of the following;

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the development consent or EPL.

8.2 Audits

Internal and external audits of this document and all other Environmental Management System documents are to be undertaken every three years. Improvements from the audit are to be incorporated in the site action database to ensure the actions are assigned to the relevant people and completed.

Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

External audits will be conducted utilising external specialists and will consider this document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished.

An Independent Environmental Audit (IEA) was undertaken during June 2019. In accordance with SSD-5465 Schedule 6, Condition 9, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

9 Records and Document Control

9.1 Records

Generally, the Environment and Community Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data and equipment calibration;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

9.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environment and Community Coordinator. Details on document revisions are provided in **Table 10**.

Table 10: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	23/08/2012	Revision 1	LakeCoal	GSS Environmental Chris Ellis
2	21/07/2015	Revision 2	LakeCoal	Niche Environment and Heritage Chris Ellis
3	30/11/2019	Updated to Delta Coal format	Delta Coal EMM Consulting	Sally Callander Chris Armit Katie Weekes

10 Roles and Responsibilities

10.1 Responsibilities

All employees and contractors of Chain Valley Colliery are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this WMP are identified in **Table 11**.

Table 11: Water Management Roles and Responsibilities

Role	Responsibilities
General Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the WMP.
Manager of Mining Engineering	• Overall responsibility for environmental compliance with Mining Lease, EPL, Development Consent and other mining approvals as they pertain to water management.
Environment and Community Coordinator	• Implementing the forward works program; • Planning for adequate resources to implement this site WMP. • Approving revised versions of this site WMP; • Co-ordination of external audits, corporate reporting and management; • Co-ordinate environmental monitoring, reporting, inspections, environmental training, authority liaison, maintaining complaints register and community liaison; • Allocation of resources within area of responsibility and budget; • The implementation and adherence to this site WMP; • Providing adequate training to employees and contractors regarding their requirements under this site WMP; • Contractor management; and • Delegating tasks associated with this site WMP when responsible personnel are absent.
Employees and contractors	• Comply with the requirements of this WMP.

11 References & Associated Documents

Documents used in the preparation of this management plan are detailed in **Table 12**.

Table 12: References and Associated Documents

Reference Type	Document
Australian standards	AS/NZS ISO 14001:2004 *Environmental management systems – Requirements with guidance for use* AS/NZS ISO 14004:2004 *Environmental management systems – General guidelines on principles, systems and support techniques*
Legislation and regulations	NSW EPA, EPL 1770 *Environment Protection License 1770* Development Consent SSD-5465 (Modification 2) dated 16 December 2015 for the Mining Extension 1 Project *Environmental Planning and Assessment Act 1979* *Mining Act 1992* *Protection of the Environment Operations Act, 1997* *Water Act 1912* *Water Management Act 2000*
Delta Coal documents	EMS 001 Mannering Colliery - Environmental Management Strategy. LakeCoal, 2017. Chain Valley Colliery Annual Review 2016. Doc No. REP 00025, 28 April 2017. LakeCoal, 2018. Chain Valley Colliery Annual Review 2017. Doc No. REP 00040, 30 March 2018. LakeCoal, 2019. Chain Valley Colliery Annual Review 2018. Doc No. REP 00058, 16 May 2019.
External documents	Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), National Guidelines for Sewerage Systems - Effluent Management, 1997. Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC

	Guidelines), October 2000. Australian Government, Charter: National Water Quality Management Strategy, 2018. DECCW, March 2004. Approved Methods for Sampling and Analysis of Water Pollutants in NSW. GEOTERRA, 2019, Groundwater Management Plan, Chain Valley Colliery. GEOTERRA, 2014, Groundwater Management Plan, Chain Valley Colliery. GEOTERRA, March 2013, Chain Valley Colliery Mining Extension 1 Groundwater Assessment. GSS Environmental, March 2013, Chain Valley Mining Extension 1 Project Surface Water Assessment. Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008. Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries. NSW Water Quality and River Flow Objectives, September 1999. NSW State Rivers and Estuaries Policy, 1993. NSW Groundwater Quality Protection Policy, adopted in 1998. NSW Groundwater Quantity Management Policy. NSW Department of Environment and Conservation (DEC), Environmental Guidelines: Use of Effluent by Irrigation, 2004. The NSW State Groundwater Dependent Ecosystems Policy, adopted in 2002.

12 Definitions

ANZECC Australia New Zealand Environment Conservation Council

AWTS Aerated Waste Water Treatment System

DECCW Former NSW Department of Environment, Climate Change and Water

DP&E NSW Department of Planning and Environment (former)

DPIE NSW Department of Planning, Industry and Environment

DoI - Water NSW Department of Industry (Water)

DRE Division of Resources and Energy (within the Department of Trade and Investment, Regional Infrastructure and Services)

EPA Environment Protection Authority

EP&A Act Environmental Planning and Assessment Act 1979

EPL Environment Protection License

GwMP Groundwater Management Plan

LDP Licensed Discharge Point

LMCC Lake Macquarie City Council

MPL Mining Purposes Lease

Mt Million Tonnes

NOW NSW Office of Water (former)

OEH Office of Environment and Heritage

POEO Act *Protection of the Environment Operations Act 1997*

ROM Run of Mine

Secretary Secretary of the Department of Planning and Environment, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

TARP Trigger Action Response Plan

TSS Total Suspended Solids

WMP Water Management Plan

WSC Wyong Shire Council (now part of Central Coast Council)

Appendix 1: Consultation

Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

This WMP has been prepared in accordance to Schedule 3, Condition 21 of SSD-5465, which states the requirements of the WMP and what it must address. **Table A1** outlines the requirements of the WMP and where this document addresses these requirements.

Table A1: Requirements from Chain Valley Colliery Development consent SSD-5465

Condition No.	Requirement	Relevant section of this document
	Schedule 2 Administrative Conditions	
18	***Updating and Staging Strategies, Plans or Programs*** *The Applicant must regularly review the strategies, plans and programs required under this consent and ensure that these documents are updated to incorporate measures to improve the environmental performance of the development and reflect current best practice in the mining industry. To facilitate these updates, the Applicant may at any time submit revised strategies, plans or programs for the approval of the Secretary.* *With the agreement of the Secretary, the Applicant may also submit any strategy, plan or program required by this consent on a staged basis. With the agreement of the Secretary, the Applicant may prepare a revision or stage of any strategy, plan or program required under this consent without undertaking consultation with all parties nominated under the applicable condition in this consent.* *Notes:* • *While any strategy, plan or program may be submitted on a staged basis, the Applicant must ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* • *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*	**Section 8**
	Schedule 3 Specific Environmental Conditions	
18	*The Applicant shall prepare and implement a Water Management Plan for the surface facilities sites to the satisfaction of the Secretary.* *This plan must be prepared in consultation with DPI Water and EPA, by*	**Section 1.4**

	suitably qualified and experienced persons whose appointment has been endorsed by the Secretary and submitted to the Secretary for approval within 6 months of the date of this consent. *This plan must include:*	
	(a) a comprehensive water balance for the development that includes details of: • *sources and security of water supply;* • *water make in the underground workings;* • *water transfers from the underground operations to the surface;* • *water use; and* • *any water discharges;*	**Section 3**
	(b) management plans for the surface facilities sites, that include: • *a detailed description of water management systems for each site, including:* – *clean water diversion systems;* – *erosion and sediment controls; and* – *any water storages;* • *measures to minimise potable water use and to reuse and recycle water;* • *measures to manage acid sulfate soils, if encountered;* • *activities that would involve ground disturbance at the site; and* • *monitoring and reporting procedures.*	**Section 4**
	(c) a Surface Water Management Plan which: • *includes baseline data on surface water flows and quality of Swindles Creek;* • *details surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on surface water resources or surface water quality;* • *provides a program to monitor:* – *surface water discharges;* – *surface water flows and quality; and* – *channel stability;*	**Section 5**
	(d) a Ground Water Monitoring Program which includes a program to: • *monitor and report groundwater inflows to underground workings;* • *predict, manage and monitor impacts to nearby groundwater bores on privately-owned land that may be impacted by the development; and*	**Appendix A**
	(e) a detailed review of surface water management at the site, with particular reference to the water storages within the dirty water management system, to: • *determine whether the capacity, integrity, retention time and management of the dirty water storages (particularly the final Pollution Control Dam) are sufficient to ensure that water*	**Appendix C**

	discharged from the site meets the EPL limits and surface water impact assessment criteria within the Surface Water Management Plan; and • *propose any appropriate changes to the surface water management system.*	
	The Applicant shall implement the approved management plan as approved from time to time by the Secretary. *NOTE: The Secretary may require the Applicant to implement upgrades and other changes identified under paragraph (e), in accordance with condition 4 of schedule 2.*	**This document**
	Statement of Commitments	
	Groundwater *In addition to the management and mitigation measures undertaken at the Colliery for groundwater as described in the WMP, the following commitments specific to the Proposal will be undertaken. Some commitments are already undertaken under the WMP. Delta Coal will:* • *assess whether abnormal or significant groundwater inflow changes occur in the active panels;* • *maintain the water flow monitoring appliances used to measure pumped water volumes to and from the Colliery in good working order;* • *maintain and plot records of daily total Colliery water pumping and annually communicate an interpretation of the findings within the Annual Review. A copy of the Annual Review will be supplied to DPI Water;* • *measure water levels and quality within private bores, where access is possible, in relevant areas to assess if any adverse effects occur due to subsidence from the Proposal; and* • *develop groundwater assessment criteria and triggers, response protocols and contingency measures.*	**GwMP in Appendix A**
	Although it is not anticipated that private bore yields would be impacted due to subsidence, should such a situation arise, Delta Coal would provide an alternative water supply until the impacted bore recovers.	**GwMP in Appendix A**
	Any monitored or reported adverse impacts on the yield, saturated thickness or quality of a private registered bore will be investigated by Delta Coal. In the event of a groundwater level drop of over 2 m for a period of two months or more, a notable increase in iron hydroxide, or an adverse change in salinity as a consequence of subsidence, Delta Coal will enter into negotiations with the affected landowners and the Mine Subsidence Board with the intent of formulating an agreement which provides for one, or a combination of: • *re-establishment of saturated thickness in the affected bore(s) through bore deepening;* • *establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;*	**GwMP in Appendix A**

	• *provision of access to alternative sources of water; and/or* • *compensation to reflect increased water extraction costs (e.g., due to lowering pumps or installation of additional or alternative pumping equipment).*	
	Surface Water *Management and monitoring of surface water will continue to be undertaken in accordance with the Colliery's WMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will:*	**This document**
	update the WMP to include any changes as a result of the proposed modification;	**This document**
	limit the main underground pumps to a maximum pump out rate of 10.5 ML/day within 12 months of approval;	**Section 3.2.3**
	request an amendment of EPL 1770 to include a condition on the daily discharge volume limit stating that "Exceedence of the volume limit for Point 1 is permitted only if the discharge from Point 1 occurs solely as a result of rainfall at the premises exceeding 10 mm during the 24 hours immediately prior to commencement of the discharge";	**Section 1.1**
	undertake daily measurements of discharge volumes and report publically on a monthly basis via Delta Coal's website;	**Section 5.9**
	continue collection of baseline water quality data to aid in the development of appropriate discharge water quality trigger values;	**Section 5.3**
	engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and provide this assessment to the EPA by 31 December 2013;	**Section 2.4**
	investigate water saving measures to minimise the amount of potable water required from WSC for Colliery operations;	**Section 4.7**
	quantify the groundwater storage capacity in the Great Northern and Wallarah Seams;	**Section 4.3**
	continue effluent monitoring regime of receiving soils from the AWTS in accordance with the parameters and testing frequencies identified in the Colliery's WMP. The results of this monitoring program will be reviewed by a suitably qualified expert and used to determine the appropriateness of the existing irrigation area to receive this effluent;	**Section 5.6**
	develop a program to monitor creek line channel stability and the health of riparian vegetation within Swindles Creek. Monitoring will be undertaken in accordance with Section 8.5.2 of the Surface Water Impact Assessment (EIS Appendix E) and incorporated into the Colliery's WMP or Biodiversity Management Plan; and	**Section 5.4**
	record monitoring data in accordance with the Colliery's WMP and EPL 1770. Monitoring data will be interpreted as it is received to ensure	**Section 5.9**

	appropriate operational guidance on monitoring water quality within desired parameters. Results of water quality monitoring will be reported in the Annual Review and made available to the CCC, as well as Wyong and Lake Macquarie Councils.	

CVC operates under EPL 1770 issued by the NSW EPA under the POEO Act. The EPL has been modified a number of times, most recently on the 2 April 2019. CVC has two Licensed Discharge Points (LDP) under EPL 1770. The main discharge point is defined in the EPL as Point 1 and referred to herein as Licensed Discharge Point 1 (LDP1). Licenced Discharge Point 27 is the spillway which rarely discharges.

Relevant sections of EPL 1770 detail water related requirements and are reproduced in **Table A2** below along with identification of where the requirements are addressed in this document.

Table A2: Environment Protection Licence 191 Water Quality Requirements

<table>
<tr><th>Condition No.</th><th>Requirements</th><th>Relevant section of this document</th></tr>
<tr><td>2</td><td>Discharges to Air and Water and Applications to Land</td><td></td></tr>
<tr><td>P1</td><td>Location of monitoring/discharge points and areas</td><td></td></tr>
<tr><td>P1.2</td><td>The following points referred to in the table below are identified in this licence for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.</td><td>Noted</td></tr>
<tr><td>P1.3</td><td>The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.
Water and land
<table>
<tr><th>EPA Identi-fication no.</th><th>Type of Monitoring Point</th><th>Type of Discharge Point</th><th>Location Description</th></tr>
<tr><td>1</td><td>Discharge to waters Discharge quality and volume monitoring</td><td>Discharge to waters Discharge quality and volume monitoring</td><td>Discharge to waters and monitoring from final settlement pond via low level discharge identifed as EPA 1 on plan of the premises titled "EPL premises Plan Fig 1 Project Extents, Monitoring and Compliance Locations dated 12 March 2015 DOC15/83810.</td></tr>
<tr><td>27</td><td>Discharge to waters Discharge quality and volume monitoring</td><td>Discharge to waters Discharge quality and volume monitoring</td><td>Discharge to waters via concrete high level spillway from final settlement pond adjacent to EPA 1 on plan of the premises titled "EPL premises Plan Fig 1 Project extents, Monitoring and Compliance Locations" dated 12 March 2015 DOC15/83810.</td></tr>
</table></td><td>Section 5</td></tr>
<tr><td>3</td><td>Limit Conditions</td><td></td></tr>
<tr><td>L1</td><td>Pollution of Waters</td><td></td></tr>
<tr><td>L1.1</td><td>Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.</td><td>Section 2</td></tr>
</table>

<table>
<tr><td>L2</td><td>Concentration Limits</td><td></td></tr>
<tr><td>L2.1</td><td>For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.</td><td>Section 5</td></tr>
<tr><td>L2.2</td><td>Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.</td><td>Section 5</td></tr>
<tr><td>L2.3</td><td>To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.</td><td>Noted</td></tr>
<tr><td>L2.4</td><td>Water and/or Land Concentration Limits
Point 1, 27
<table>
<tr><th>Pollutant</th><th>Units of Measure</th><th>50 percentile concentration limit</th><th>90 percentile concentration limit</th><th>3DGM concentration limit</th><th>100 percentile concentration limit</th></tr>
<tr><td>Faecal Coliforms</td><td>colony forming units per 100 millilitres</td><td></td><td></td><td></td><td>200</td></tr>
<tr><td>pH</td><td>pH</td><td></td><td></td><td></td><td>6.5-8.5</td></tr>
<tr><td>Total suspended solids</td><td>milligrams per litre</td><td></td><td></td><td></td><td>50</td></tr>
</table></td><td>Section 5</td></tr>
<tr><td>L3</td><td>Volume and mass limits</td><td></td></tr>
<tr><td>L3.1</td><td>For each discharge point or utilisation area specified below (by a point number), the volume/mass of:
a) liquids discharged to water; or;
b) solids or liquids applied to the area;
must not exceed the volume/mass limit specified for that discharge point or area.
<table>
<tr><th>Point</th><th>Unit of Measure</th><th>Volume/Mass Limit</th></tr>
<tr><td>1</td><td>kilolitres per day</td><td>12161</td></tr>
<tr><td>27</td><td>kilolitres per day</td><td>12161</td></tr>
</table></td><td>Section 5</td></tr>
<tr><td>L3.2</td><td>The volumetric daily discharge limit for the premises is the combined discharge measured at EPA discharge points 1 and 27 and must not exceed 12161 kilolitres per day.</td><td>Section 5</td></tr>
<tr><td>M2</td><td>Requirement to monitor concentration of pollutants discharged</td><td></td></tr>
<tr><td>M2.3</td><td>Water and/ or Land Monitoring Requirements</td><td>Section 5</td></tr>
</table>

Point 1

Pollutant	Units of measure	Frequency	Sampling Method
Biochemical oxygen demand	milligrams per litre	Once a month (min. of 4 weeks)	Grab sample
Enterococci	colony forming units per 100 millilitres	Once a month (min. of 4 weeks)	Grab sample
Faecal Coliforms	colony forming units per 100 millilitres	Once a month (min. of 4 weeks)	Grab sample
pH	pH	Once a month (min. of 4 weeks)	Grab sample
Total suspended solids	milligrams per litre	Once a month (min. of 4 weeks)	Grab sample

Point 27

Pollutant	Units of measure	Frequency	Sampling Method
Enterococci	colony forming units per 100 millilitres	Daily during any discharge	Grab sample
Faecal Coliforms	colony forming units per 100 millilitres	Daily during any discharge	Grab sample
pH	pH	Daily during any discharge	Grab sample
Total suspended solids	milligrams per litre	Daily during any discharge	Grab sample

M3.2	Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.	**Section 5**
M8	**Requirement to monitor volume or mass**	
M8.1	For each discharge point or utilisation area specified below, the licensee must monitor: a) the volume of liquids discharged to water or applied to the area; b) the mass of solids applied to the area; c) the mass of pollutants emitted to the air; at the frequency and using the method and units of measure, specified below.	**Section 5**

Point 1

Frequency	Unit of Measure	Sampling Method
Continuous during discharge	kilolitres per day	In line instrumentation

Point 27

Frequency	Unit of Measure	Sampling Method
Continuous during discharge	kilolitres per day	In line instrumentation

<table>
<tr><td>G2</td><td>Other general conditions</td><td></td></tr>
<tr><td>G2.1</td><td>Completed programs
<table>
<tr><th>Program</th><th>Description</th><th>Completed Date</th></tr>
<tr><td>Coal Mine Particulate Matter Control Best Practice</td><td>Requires licensee to conduct a site specific Best Management Practice (BMP) determination to identify ways to reduce particle emissions</td><td>28-September-2012</td></tr>
<tr><td>Assessment of Potential Impacts of Metals in wastewater</td><td>The licensee must conduct an assessment of metals detected in wastewater discharges from the mine in accordance with the ANZECC water quality guidelines.. To obtain a greater understanding of the type and concentration of metals discharged in mine water and entering the receiving waters. To limit the concentration of metals discharged in mine water within ANZECC guidelines.</td><td>23-October-2013</td></tr>
<tr><td>Air Quality Monitoring</td><td>The licensee must evaluate best locations and install monitoring devices as defined in Project Approval MP10_0161 under the Environent Planning & Assessment Act 1979.</td><td>31-December-2013</td></tr>
<tr><td>PRP4 - Upgrade to Clean and Dirty Water Management System</td><td>The licensee must review and upgrade separation of the Clean and Dirty Water Management System and review and upgrade bunding.</td><td>14-August-2015</td></tr>
<tr><td>PRP5 - Remediation of Dam Wall and Spillway formalisation</td><td>The licensee must design and remediate the dam wall on the final control pond and formalise a spillway to prevent dam seepage and to ensure that volumetric discharge can be monitored</td><td>27-February-2015</td></tr>
<tr><td>PRP 6 Upgrade to Sewage Treatment Systems</td><td>Assessment of options for improved disinfection of effluent from STP on licenced premises.</td><td>06-January-2015</td></tr>
<tr><td>PRP7 Sewage Treatment System Concept Design</td><td>Provide the EPA with a Concept Design and Timetable for Implementation of Upgrade to the Sewage Treatment System</td><td>19-February-2016</td></tr>
</table></td><td>Noted</td></tr>
</table>

Appendix 3: Groundwater Management Plan (GwMP)

GeoTerra

DELTA COAL PTY LTD

CHAIN VALLEY COLLIERY
GROUNDWATER MANAGEMENT PLAN

CVC3-R3A
30 September 2019

GeoTerra Pty Ltd **ABN 82 117 674 941**

PO Box 220 Canterbury NSW 2193

Phone: 02 9787 9137 Fax: 02 9787 1874 Mobile 0417 003 502 Email: geoterra@iinet.net.au

Authorised on behalf of GeoTerra Pty Ltd:	
Name:	Andrew Dawkins
Signature:	
Position:	Principal Hydrogeologist

Date	Rev.	Comments
09.09.2019		Initial Draft
30.09.2019	A	Incorporate review comments

TABLE OF CONTENTS

FIGURES

TABLES

1. INTRODUCTION

This revised Groundwater Monitoring Program (GwMP) has been prepared in compliance with Schedule 3 (Condition 18D) of the Delta Coal Pty Ltd (DC) Chain Valley Colliery Extension Project Approval SSD 5465 for the addition of Miniwall S4.

This report is to be read in conjunction with the Water Management Plan prepared for Chain Valley Colliery (Delta Coal, 2019).

This GwMP includes:

- a groundwater water quality and quantity monitoring program;
- trigger levels for mining impacts on groundwater systems;
- procedures to be followed in the event that monitoring of groundwater indicates an exceedance of trigger levels;
- measures to mitigate, remediate and/or compensate for identified impacts;
- a protocol for the notification of trigger level exceedances, and;
- a contingency plan where, in the event of adverse effects on groundwater quality and/or quantity due to mining impacts, Chain Valley Colliery will provide an equivalent supply until the affected supply is restored, or as agreed with the landowner and the NSW Department of Industry - Water (DIW).

Groundwater related operations at Chain Valley Colliery include the:

- historic Great Northern and Wallarah seams bord and pillar workings;
- current Fassifern Seam development as well as miniwall workings; and
- water storage and management facilities owned and operated by Chain Valley Colliery.

Operation of the GwMP needs a high level of management input to operate Chain Valley Colliery within the relevant requirements and various water licences, particularly to ensure compliance with the water discharges authorised by Environment Protection Licence (EPL) 1770.

An essential part of the plan is monitoring of all groundwater inflows and extraction into and out of the underground with reliable flow meters, as well as monitoring of groundwater levels and water quality in private bores.

This information is necessary for periodical reviews of the groundwater management system and to support any updates/changes to licences.

The proposed mitigation measures minimise and manage the impacts of any potential adverse effects on local aquifers within the GwMP area.

The proposed mitigation measures minimise, where possible, the impacts of the proposed mining on the various groundwater sources, aquifers or groundwater dependent ecosystems that may be present in the Project Area.

1.1 Objectives

The objective of the GwMP is to operate Chain Valley Colliery so that the subsurface mining operations will be conducted in a manner which minimises the potential impacts on groundwater flow and quality, aquifer integrity, groundwater dependent ecosystems and other off-site groundwater related impacts.

In order to achieve this goal, the GwMP will be used to establish procedures to:

- measure, control, mitigate and repair potential impacts that could, or do, occur to the groundwater system overlying Chain Valley Colliery; and
- identify, measure, minimise or where possible, avoid potential significant adverse impacts that can result from mining and subsidence on the groundwater systems within the Project Area.

In addition, the GwMP will be used to:

- monitor groundwater system changes in relation to the leaseholder's mining activities;
- assess the pre and post-mining condition of groundwater systems in the lease area;
- ensure all relevant groundwater criteria are met;
- minimise and manage any impacts on the availability of groundwater to potentially impacted residents, landholders or other groundwater users;
- minimise adverse changes on groundwater dependent ecosystems, where present;
- provide a forum to record and discuss mining impacts; and
- provide an annual report on the monitoring, observations and actions conducted within the preceding 12 months to DIW.

These objectives will be met by:

- monitoring groundwater seepage and groundwater quality in the workings during mining within the mine lease area;
- installation of water monitoring appliance(s) to measure pumped water volumes to and from the mine workings. These appliances will be maintained in good working order. If required the mine will supply a test certificate to certify the current accuracy of the appliance(s) furnished by the manufacturer or by some duly qualified person or organisation. The mine water pumping records will be maintained and supplied to DIW at the end of the water year;
- ensuring that any tailwater drainage will not be allowed to discharge onto adjoining roads, crown land or other lands, or into any unauthorised stream, or any aquifer, by surface or subsurface drains or pipes or any other means without appropriate approval;
- ensuring that any groundwater extracted from the works will not be discharged into any watercourse or source of groundwater except in compliance with the Protection of the Environment Operations Act (1997);
- any works used for the purpose of conveying, distributing or storing groundwater from the works will not be constructed or installed so as to obstruct the free passage of floodwaters flowing in, to or from a river or lake;
- all groundwater extracted from the works will be used or applied only on such land, and for such purposes, as approved by DIW, and;
- providing a forum to report, discuss and record impacts to the groundwater system that involves the Chain Valley Colliery, stakeholders and DIW, as required.

1.2 Scope

The GwMP is to be used to protect, monitor and manage the condition of the groundwater system within the Chain Valley Colliery lease area that may potentially be impacted due to coal mining and mine subsidence.

The GwMP also applies to persons employed or engaged by Chain Valley Colliery when carrying out activities described by this plan.

This GwMP is to be read in conjunction with the current version of the Water Management Plan (WMP) which outlines the monitoring and management of specific factors relating to surface water and groundwater issues due to the predicted subsidence.

All other water management components not directly related to the GwMP are contained as part of the WMP.

The GwMP covers mining until completion of Domains 1 and 2, although the plan may be used beyond that benchmark with appropriate modification.

1.3 Definitions

For the purpose of this document, the area addressed in the GwMP is defined as the groundwater systems within the Chain Valley Colliery project approval area. The main features in the GwMP area shown in **Figure 1** include the:

- current Chain Valley Colliery workings in the Fassifern Seam;
- the proposed extraction within Domains 1 and 2; and
- the proposed extraction of Miniwalls S2, S3 and S4.

1.4 Limitations

This GwMP is based on current monitoring data and the proposed and approved operational aspects relating to Chain Valley Colliery. The relevant groundwater features have been identified from:

- existing studies;
- data supplied by Chain Valley Colliery representatives; and
- associated consultant's reports in the Lake Macquarie area.

The impacts of mining on the groundwater system have been assessed in previous studies (see references). However, it is recognised that prediction and assessment of changes to, and effects from, operation of the Colliery on the groundwater system can be relied upon only to a certain extent.

The groundwater study prepared for the Chain Valley Colliery Mining Extension 1 Groundwater Assessment (GeoTerra, 2013) determined there is a low potential for the mine's impacts on the groundwater system to exceed the predictions and assessments. However, the possibility of impacts above predictions has been considered in this plan.

The GwMP will not necessarily prevent impacts from the proposed mining, but does identify appropriate procedures to manage the impacts within tolerable limits and identifies procedures that can be followed should evidence of increased impacts and unacceptable risk emerge.

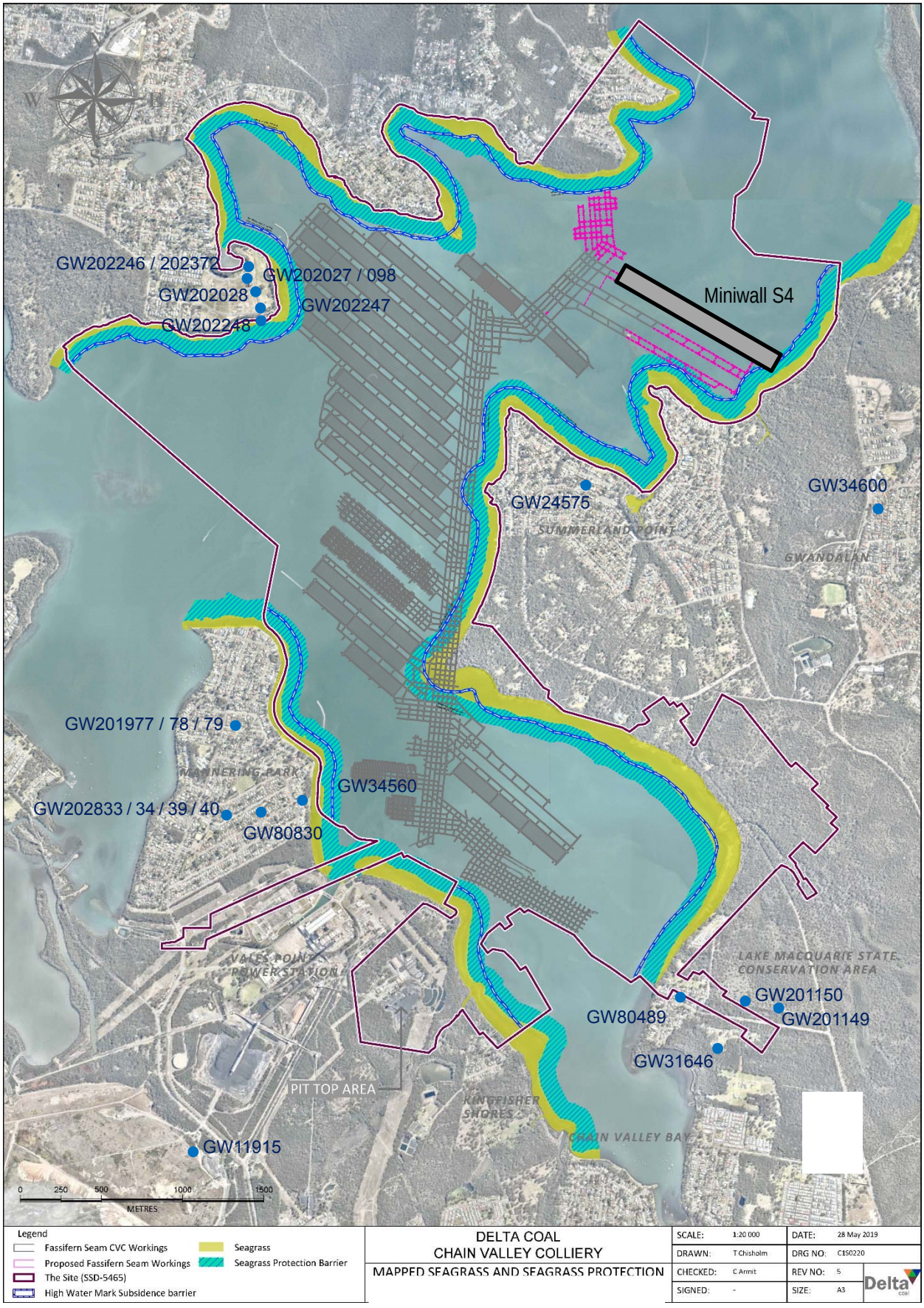


Figure 1 Chain Valley Colliery Project Approval Area and Groundwater Bores

2. LEGISLATION

The following sub-sections outline NSW statutory requirements that apply to the mining operation with respect to groundwater.

2.1 Water Management Act 2000

The key legislation for the management of water in the project area is the *Water Management Act 2000* (the Act), which regulates water use for rivers and aquifers where water sharing plans have commenced.

Under the Act, DIW has prepared a range of statutory water management plans covering aspects such as water sharing, water use, drainage management and floodplain management. In NSW, 36 water sharing plans have commenced, covering 80 percent of water currently extracted. The plans cover most of the regulated river systems (those controlled by major dams for rural water supplies), a number of unregulated river systems and the major inland alluvial aquifers.

The project area is located in the *South Lake Macquarie Water Source* section of the Water Sharing Plan - Hunter unregulated water sources.

The object of the Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The Act provides 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 approvals – authorise the use of water at a specified location for a particular purpose, for up to ten years;
- water management work approvals;
- controlled activity approvals; and
- aquifer interference activity approvals – authorise the holder to conduct activities that affect the aquifer. This approval is for activities that intersect groundwater, other than water supply bores and may be issued for up to ten years.

For controlled activities and aquifer interference activities, the Act requires that the activities avoid or minimise impacts on the water resource and land degradation, and where possible the land must be rehabilitated.

2.2 State Groundwater Policy

The *NSW State Groundwater Policy* (Framework Document) was adopted in 1997 and aims to manage the State's groundwater resources to sustain their environmental, social and economic uses. The policy has three component parts:

- The *NSW Groundwater Quality Protection Policy*, adopted in December 1998;
- The *NSW State Groundwater Dependent Ecosystems Policy*, adopted in 2002; and
- The *NSW Groundwater Quantity Management Policy*.

2.2.1 Groundwater Quality Protection

The *NSW Groundwater Quality Protection Policy* (Department of Land and Water Conservation, 1998), states that the objectives of the policy will be achieved by applying the management principles listed below.

- all groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained;
- town water supplies should be afforded special protection against contamination;
- groundwater pollution should be prevented so that future remediation is not required;

- for new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource;
- a groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwater that is incompatible with soil, vegetation and receiving waters;
- groundwater dependent ecosystems will be afforded protection;
- groundwater quality protection should be integrated with the management of groundwater quality;
- the cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource; and
- where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.

2.2.2 Groundwater Dependent Ecosystems

The *NSW State Groundwater Dependent Ecosystems Policy* (Department of Land and Water Conservation, 2002) is specifically designed to protect valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored for the benefit of present and future generations. The policy defines Groundwater Dependent Ecosystems (GDEs), as *"communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater".*

Five management principles establish a framework by which groundwater is managed in ways that ensure, whenever possible, that ecological processes in dependent ecosystems are maintained or restored. A summary of the principles follows:

- GDEs can have important values. Threats should be identified and action taken to protect them;
- groundwater extractions should be managed within the sustainable yield of aquifers;
- priority should be given to ensure that sufficient groundwater is available at all time to identified GDEs;
- where scientific knowledge is lacking, the precautionary principle should be applied to protect GDEs; and
- planning, approval and management of developments should aim to minimise adverse effects on groundwater by maintaining natural patterns, not polluting or causing changes to groundwater quality and rehabilitating degraded groundwater systems.

2.2.3 Groundwater Quantity Protection

The objectives of managing groundwater quantity in NSW are to:

- achieve the efficient, equitable and sustainable use of the State's groundwater;
- prevent, halt and reverse degradation of the State's groundwater and/or its dependent ecosystems;
- provide opportunities for development which generate the most cultural, social and economic benefits to the community, region, state and nation, within the context of environmental sustainability; and
- involve the community in the management of groundwater resources.

3. CURRENT AND PROPOSED OPERATIONS

Chain Valley Colliery is an underground coal mine operated by Delta Coal Pty Ltd (Delta Coal).

The Colliery is located in the Newcastle Coalfields at the southern end of Lake Macquarie in NSW, and is approximately 60 kilometres south of Newcastle, within the Swansea-North Entrance Mine Subsidence District.

The project area incorporates the relatively flat pit top area, existing ventilation shaft and fan site on Summerland Point, as well as foreshore areas and Lake Macquarie.

The terrestrial land within the GwMP area is gently undulating and drains to Lake Macquarie.

Chain Valley Colliery commenced operation in the 1960's extracting coal from the Wallarah seam, the Great Northern Seam and the Fassifern Seam, and currently conducts mining within leases ML 1051, CCL 721 and ML 1632.

The current Fassifern Seam Miniwalls are located underneath Lake Macquarie, within and to the north of Chain Valley Bay.

The mine has completed extraction of Miniwalls 1 to 12 (MW1 to MW12) and has an approved Extraction Plan for Miniwalls N1 and S1, S2 and S3 in the Fassifern Seam. At the time of writing, the Chain Valley Colliery has completed MWS1 and N1.

No current or proposed secondary extraction underlies any terrestrial based surface water catchments, with all secondary extraction proposed to be underneath the saline, tidal region of Lake Macquarie.

Chain Valley Colliery currently has Development Consent (SSD-5465 – as modified) for:

- extraction of up to a maximum of 2.1 million tonnes per annum until 31 December 2027 through continued mining via first workings and miniwall methods within the Fassifern Seam;
- continued coal transport for the surface facilities site;
- continued use of the existing surface facilities, and;
- continuation of passive underground activities within the old workings of the Wallarah seam, Great Northern seam and the Fassifern Seam.

The approved mining area is approximately 200m below the sediments of Lake Macquarie, within a boundary set to exclude secondary extraction within the High Water Mark Subsidence Barrier or the Seagrass Protection Barrier**.**

Bord and pillar mining was commenced in the Fassifern Seam in 2006 and secondary extraction in the form of miniwall mining method in the Fassifern Seam commenced in 2011.

The S2 miniwall panel is being mined at 97m wide (rib to rib) with a 40m wide inter-panel pillar, whilst the proposed miniwall panels S3 and S4 will have the same width. These panel widths being significantly less than those previously proposed for Chain Valley and adjacent mines – for example, at Wyee Colliery Longwalls 17 to 21 were up to 150m wide, and were extracted between 150m and 180m below surface.

The Development Consent (SSD-5465 – as modified) was approved on 23 December 2013 which permitted the above activities.

Historically, Chain Valley Colliery has mined within the Wallarah and Great Northern seams to the east with via bord and pillar methods, while to the south west and west Wyee State Mine (now named Mannering Colliery) has mined the Great Northern and Fassifern seams using bord and pillar and longwall extraction.

Mining within the Wallarah and Great Northern Seams will not be undertaken as part of the

Project.

The maximum water depth within the proposed mining areas is greater than 5m, whilst sediment on the bottom of the lake varies from 9 – 23m deep over MWS2, 3 and 4.

Overburden above the Fassifern Seam over Miniwalls S2 and S3, including the lake sediments, ranges from 160 – 171m with a rock cover thickness of 138 – 158m (Strata^2, 2019).

The maximum height of connective fracturing is predicted to be between 94 and 96m for Miniwall S4 (Strata^2, 2019).

3.1 Adjacent Workings

Chain Valley Colliery is entirely surrounded by the existing Mannering, Myuna and Wallarah Collieries as well as by the historic Newvale and Moonee Collieries.

Mannering Colliery (formerly the Wyee State Mine), has conducted longwall mining in the Great Northern and Fassifern seams since the 1960s. Extraction continued until 2002, when mining became uneconomic. The mine was temporarily shut down until 2004 when it was reopened by Centennial Coal. Since 2004, mining progressed in the Fassifern Seam using bord and pillar methods.

The Myuna Colliery commenced operation in 1981 and is currently mining the Fassifern Seam via bord and pillar techniques.

Wallarah Colliery operated from 1979 until 2002, when it was placed under care and maintenance.

Munmorah, Mandalong and Cooranbong Collieries are also nearby, but are not immediately adjacent to the Chain Valley Colliery holding boundary.

3.2 Predicted Subsidence

The maximum subsidence after completion of mining will be located under Lake Macquarie, with the 20mm subsidence line to be contained within the lake high water mark (Strata^2, 2019).

The maximum predicted subsidence, tilts and strains over the proposed workings (assuming a 170m depth of cover) are summarised in **Table 1**.

TABLE 1 Maximum Predicted Subsidence

Parameter	After Extraction of Miniwall S4
Vertical subsidence	296 mm
Tilt	4 mm/m
Strain (Compressive and Tensile)	2 mm/m

To date, the maximum subsidence has been observed as summarised in **Table 2**.

TABLE 2 Maximum Observed Subsidence

Location	Maximum Subsidence (m)
MW1	0.20
MW2	0.40
MW3	0.70
MW4	0.22
MW5	0.46
MW6	0.80
MW7	0.90
MW8	1.00
MW9	1.20
MW10	0.90
MW11	0.60
MW12	0.30
CVB1	0.45
MW S1	<0.1
MW N1	<0.1

It is predicted there will be no observable subsidence at the lake foreshore, lake high water mark, or the sea grass beds (Strata^2, 2019).

3.3 Rainfall and Evaporation

Analysis of climate data from the Bureau of Meteorology (BoM) weather station at Peats Ridge indicates the following rainfall data as shown in **Table 3**.

TABLE 3 Rainfall and Evaporation Summary Data

	Rainfall (mm/year)	Evaporation (mm/year)
Maximum	2186	1420
90th Percentile	1685	1247
75th Percentile	1418	1210
Median	1226	1170
20th Percentile	902	1090
Minimum	567	410

4. LOCAL GROUNDWATER SYSTEM

For management purposes, groundwater within the GwMP area has been divided into the following classes:

- **(Mine water**) groundwater and town water that is pumped into or out of the underground workings;
- (**Groundwater**) water contained within strata overlying the mine workings; and
- (**Seeps and springs**) groundwater that discharges to surface water catchments within the project area.

Groundwater flows from the "terrestrial" recharge areas, outside of Lake Macquarie, as well as from the saline waters of Lake Macquarie into the overburden under a regional hydraulic gradient, with dominantly horizontal confined flow along discrete discontinuities and fractures within bedding planes, and / or above fine grained, relatively impermeable strata within the overburden sequence.

The overburden generally contains low yielding aquifers with low hydraulic conductivities. A schematic of the stratigraphic sequence is shown in **Figure 2.**

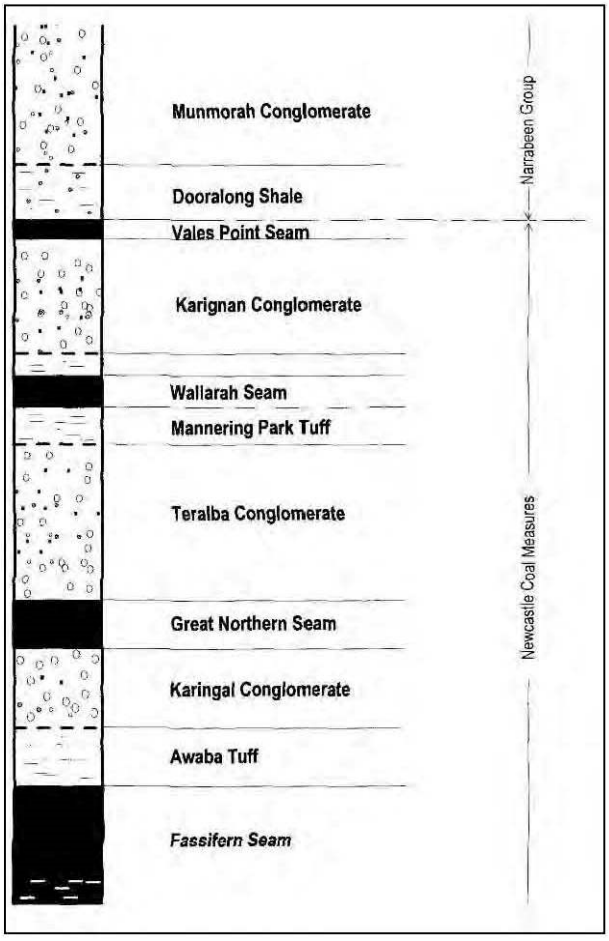


Figure 2 Local Area Stratigraphy

4.1 Alluvial Aquifers

Quaternary to recent alluvial terrestrial sediments comprising sand, gravel, clay and silt are associated with creeks and drainage channels in the local area, to the east, west and south on the shores of Lake Macquarie.

Alluvium in the vicinity of the project area is likely to be present associated with the drainage lines which discharge to Lake Macquarie.

No data is available for the thickness or lithology of alluvium within the project area. However, it is anticipated, if present, to be thin, with limited aerial extent, and no significant water storage or transmitting capacity.

Alluvial sediments within the "terrestrial" areas, outside of the project area, are generally too shallow and limited in extent to be used for groundwater supply.

4.2 Lake Macquarie Sediments

Sediments in the vicinity of MWS2, S3 and S4 within Lake Macquarie consist of unconsolidated sands, clays, silts and gravels from 5 - 23m thick.

4.3 Shallow Bedrock

The shallow bedrock comprises weathered bedrock which potentially contains discontinuous perched aquifers. These have developed at the interface between the soil and bedrock and along zones of locally increased permeabilities caused by weathering of bedrock and faulting.

The depth and permeability of any aquifers is likely to be dependent on the depth of weathering and the extent and frequency of any permeable fracture systems.

Recharge to the shallow bedrock aquifer is primarily through rainfall infiltration, with some infiltration into the underlying basement through fractures, joints and faults.

4.4 Deep Bedrock

The Newcastle Coal Measures are overlain by the Munmorah Conglomerate and the Dooralong Shale of the Triassic Narrabeen Group which comprise the majority of the overburden.

The Munmorah Conglomerate extends to a depth of approximately 120m in the vicinity of the project area and comprises mostly quartz-lithic sandstone interbedded with pebble conglomerate.

The Dooralong Shale is up 20m thick and comprises cross-bedded sandstone intercalated with siltstone and claystone (Forster and Enever, 1992).

Fractured bedrock aquifers would be present within the Narrabeen Group and the Newcastle Coal Measures with discrete water yielding horizons associated with zones of increased permeability i.e. faults and the coal seams.

The overburden and interburden is a low yielding sequence of essentially dry conglomerates and shales.

Joints and fractures associated with fractured bedrock systems tend to be laterally and vertically discontinuous, resulting in poor hydraulic connection and low groundwater yields.

Forster and Enever (1992) state that "*neither the Narrabeen Group nor the Newcastle Coal Measures contain any significant quantities of groundwater and their permeabilities are known to be generally low (<10-7 m/s).*

Any permeable zones which do occur are usually due to jointing, faulting and shearing on bedding planes.

Because of the extremely low permeability of the rock substance, groundwater flow through the overburden strata is almost exclusively by interconnecting defects such as joints and bedding.

For this reason, coal seams with their interconnecting cleat and joint patterns are often found to be 'aquifers' relative to the surrounding strata. Despite this, most underground coal mines on the Central Coast are quite dry, and rarely have any major groundwater problems."

Groundwater in the deep bedrock aquifer is of poor quality with salinity levels ranging from 3000 to 16,000 µS/cm.

Recharge to the deep bedrock aquifer is generally from infiltration of rainfall from overlying aquifers and the flow direction is expected to reflect the local topography.

4.5 Coal Seams

The coal deposits historically or currently mined in the area include the Wallarah, Great Northern and Fassifern seams of the Newcastle Coal Measures which are generally interbedded with tuffaceous claystone.

The coal seams generally have a low primary or inter-granular porosity and permeability, with bedding planes, joints, fractures and cleating imparting an enhanced secondary permeability.

The 4.5 – 5.5m thick Fassifern Seam underlies the Wallarah and Great Northern seams within the project area, and lies between 185m and 220m below surface, with a proposed mining height of up to 3.5m.

4.6 Structure and Intrusions

The overburden dips at approximately two degrees to the south-west.

Superimposed on the regional dip is the Macquarie Syncline, with an axis that runs through the Chain Valley Colliery holding, along with associated faulting and igneous intrusions.

Mapped and inferred geological structures in the project area indicate that MW S4 may be extracted through an approximately 2m wide normal fault dipping at 60^{o} to the north-east over the inbye two-thirds of the panel. The fault plane will almost certainly extend upwards through the Fractured and Constrained Zones. However, given that:

- voussoir beam analysis suggests that such a feature would not appreciably impact on the spanning ability of the Teralba Conglomerate; and
- the favourable experiences from previous extraction panels with much greater exposure to major structures,

this fault is considered to be of no material consequence.

Figure 3 shows the major structural features, based on in-seam drilling, mapping in adjacent areas / seams and exploration drilling results. The MW S2 to S4 panels are orientated at 119^{o}, rather than the 134^{o} of earlier CVC panels which is more favourable with respect to the dominant 131^{o} structural direction.

Overall, the structural environment is considered to have no significant adverse implications for S4 panel subsidence and sub-surface fracturing.

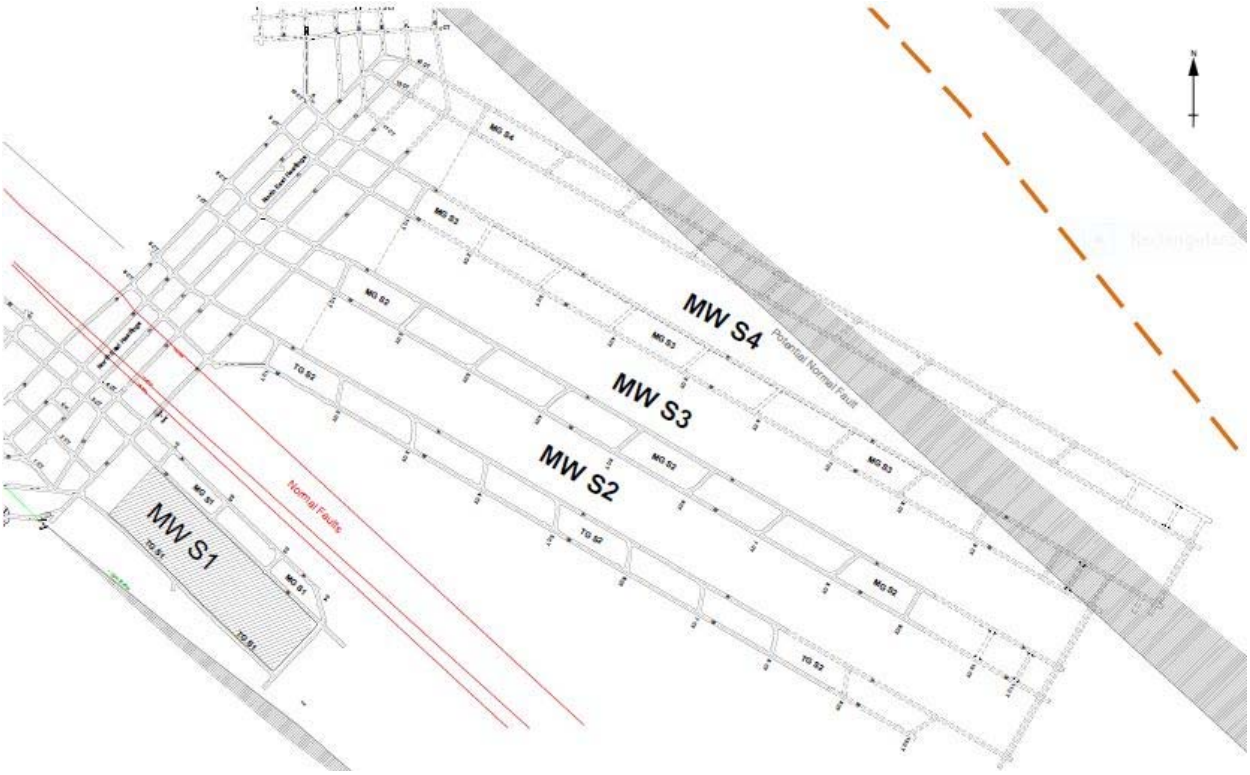


Figure 3 Faulting in the Vicinity of MWS4

4.7 Private Bores Within or Adjacent to the Proposed Mining Area

Twenty three DIW registered bores are (or were) located within or near the GwMP area as shown in **Figure 1** and **Table 4**.

From the available data, the majority of bores are completed in shallow (<18.3) meters below ground level (mbgl) sandy alluvium with one coal exploration bore converted for use as a domestic water supply (GW31646).

Many shallow (<7 mbgl) deep test bores are present in the area, along with some shallow (<7.2 mbgl) monitoring bores.

Most of the deeper remnant private bores in the GwMP area are potentially used for domestic garden or limited irrigation water supply.

Where the data is available from the DIW records, groundwater has been obtained from the shallow sandy alluvial / colluvial aquifers with low to moderate yields ranging from 0.13 L/sec to 1.50 L/sec.

TABLE 4 Registered Local Private Bores

GW	E	N	Drilled	Depth (m)	SWL (m)	Aquifer (mbgl)	YIELD (L/s)	Purpose	Bore Currency
11915	363007	6329604	-	5.4	-	-	-	Poultry	no response
24575	365969	6332788	1965	15.2	-	-	-	Domestic	no response
31646	366742	6329317	1960	277.5	3.0	3.0 – 10.6	0.13	Dom. / Coal Explore	not present
34560	364130	6330883	1970	18.3	5.5	5.5	-	Domestic	not present
34600	367678	6332873	1971	61.0	5.7	18.2	0.06	Waste disposal	-
80489	366441	6329674	2003	-	-	-	-	Domestic	no internal access
80830	363757	6330850	2004	-	-	-	-	Test bore	capped / covered
201149	367104	6329608	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201150	366840	6329640	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201977	363730	6331388	2008	7.1	6.0	6.0 – 7.0	-	Monitoring	-
201978	363712	6331391	2008	7.1	6.0	6.0 – 7.0	-	Monitoring	-
201979	363704	6331405	2008	7.2	6.0	6.0 – 7.0	-	Monitoring	-
202027	363829	6334141	2007	3.7	-	-	-	Test bore	not present
202028	363872	6334034	2007	5.5	1.6	-	-	Test bore	not present
202098	363829	6334141	2007	4.0	0.8	-	-	Test bore	not present
202246	363834	6334174	2007	3.5	1.2	0.6 – 3.5	-	Test bore	not present
202247	363899	6333964	2007	5.0	3.6	2.0 – 5.1	-	Test bore	not present
202248	363918	6333881	2007	5.0	-	2.0 – 5.0	-	Test bore	not present
202372	363834	6334174	2007	4.0	-	-	-	Test bore	not present
202833	363568	6330876	2013	6.5	2.50	2.5 – 3.5	-	Monitoring bore	-
202834	363563	6330861	2013	6.5	2.50	2.5 – 3.5	-	Monitoring bore	-
202839	363574	6330883	2013	7.2	2.5	2.5 - 3.5	-	Monitoring bore	-
202840	363573	6330859	2013	5	2.0	2.0 – 3.0	-	Monitoring bore	-

Note: - no data available SWL = standing water level

4.8 Regional Groundwater Use

Registered bores in the vicinity of the GwMP area are generally installed into the Munmorah Conglomerate to a maximum depth of 61m, with the majority of bores installed to less than 30m.

Groundwater yields are generally less than 1 L/s, with one bore reporting a yield of 5 L/s.

The authorised uses of the bores include:

- stock watering;
- poultry;
- industrial;
- domestic; and
- waste disposal.

While it is recognised that not all existing bores are likely to be registered, the database gives an indication of groundwater usage in the area.

Overall, it is concluded that the importance and reliance on groundwater by local landowners and residents is limited.

5. GROUNDWATER IMPACTS FROM PREVIOUS MINING

The Chain Valley Mine is surrounded by other collieries which have been extracting coal from as early as the 1940s using both longwall and bord and pillar methods.

Historical and current mining operations have resulted in extensive dewatering and depressurisation within and overlying the extracted coal seams.

Water is pumped out of the mines which results in a lowering of the potentiometric surface within the overlying aquifers.

Due to the extent of mining in the region, the subsidence effects would have partly depressurised the overburden.

5.1 Wyee State Mine

An extensive study by Forster and Enever (1992) at the adjacent Wyee State Mine (now called Mannering Colliery) assessed the impact of 150 m wide longwall mining on the hydrogeological properties of the overburden.

The study assessed that longwall mining of the Great Northern Seam resulted in measurable changes in the hydrogeological properties over a large proportion of the overburden as a result of the redistribution of stresses. The changes reported for the overburden were:

- **Upper Strata** (more than 115 m above the Great Northern Seam) –the hydrogeological properties of the strata after mining were generally similar to those measured prior to mining. Some strata reported a temporary drop in piezometric pressure which recovered soon after the completion of mining in that area.
- **Intermediate Strata** (65 to 115 m above the Great Northern Seam) – experienced significant permanent piezometric pressure increases after mining. The cause of the increase in pressure was uncertain, however it was concluded that *"since the intermediate strata have not lost piezometric pressure, it is certain that significant vertical drainage has not occurred from these strata and they have formed an effective barrier against vertical hydraulic connection between the surface and the mine."*
- **Lower Strata** (less than 65 m above the Great Northern Seam) – showed significant increased permeability and permanent decreases in piezometric pressure which indicated that significant cracking has occurred and allowed partial drainage into the workings.

Although measured changes in the lower strata indicate hydraulic connection was generated and groundwater seepage to the workings had occurred, the changes in the intermediate and upper strata was not significant, and were due to minor strata movements and the formation of fractures that were vertically discontinuous.

It was assessed that the intermediate and upper strata would form a barrier to vertical drainage and that aquifers from 65 – 115 m above the workings should not be hydraulically vertically connected to the workings, and should not be drained as a result of subsidence.

Aquifers greater than 115 m above the mine workings should not be impacted at all.

It should be noted that the subsidence studied over the Wyee State Mine related to 150 m wide longwalls, whilst the maximum width of the proposed Chain Valley miniwalls is 97 m, with 30.6 m wide pillars. As a result, the predicted subsidence and the height of fracturing over the proposed workings will be significantly less than was observed over the Wyee State Mine longwalls.

5.2 Private Bores

No adverse changes to bore yields, pumping flow duration or groundwater quality have been observed or reported in private bores within the GwMP area.

5.3 Potable Mine Water Supply

The mine has a potable water supply connection from the Wyong Council town-water system.

Historically, a range of 132 – 162 ML/year of potable water is supplied to Chain Valley Colliery, of which approximately 15% is used for pit top operations and 85% is used for dust suppression in the underground.

As required by Schedule 3, Condition 18(b) of SSD-5465, practical measures to minimise potable water consumption and maximise recycled water use have been implemented and continue to be investigated by Delta Coal, as discussed in the associated WMP. However, the use of non-potable water in all operational activities is not possible due to its quality, work health and safety and equipment requirements.

5.4 Licensed Mine Water Discharges

The discharge of mine water from the sedimentation and pollution control ponds is licensed under the *Protection of the Environment Operations Act* 1997 by the Environment Protection Authority (EPA).

Under EPL No. 1770 there is a single licensed discharge point for Chain Valley Colliery (LDP1), which has a maximum discharge volume of 12,161 kL/day.

The Colliery obtained a 4,443 ML/year groundwater licence (20BL173107) on the 12th March 2013 under the *Water Act, 1912* to enable water to be pumped from the underground workings to the sedimentation and pollution control ponds at the pit top.

5.5 Mine Water Pumping and Mine Groundwater Inflow

Historic data indicates that 1,914 – 2,536.4 ML/year of mine water has been extracted via two pumps in the Great Northern Seam workings sump, with a reduction in extraction volumes being evident over the last 3 years as shown in **Figure 4**.

The net groundwater seepage into the workings is estimated from the difference between the annual potable water intake and the annual water volume extracted from the underground workings.

The latest annual groundwater make from the mine is estimated at 1,817 ML/yr, or 4.98 ML/day.

Temporary increases in groundwater inflows to the mine have been reported in the vicinity of faults and associated fractures. The increases in inflow are usually short lived as the structures associated with fractured bedrock systems tend to be laterally and vertically discontinuous, resulting in poor hydraulic connection and have low groundwater yields (GeoTerra, 2013).

In general, the Fassifern Seam has to date been the driest seam, whilst mining of the overlying Wallarah Seam has been conducted without major adverse impacts to the overlying aquifers or inflow of water from Lake Macquarie (GeoTerra, 2013).

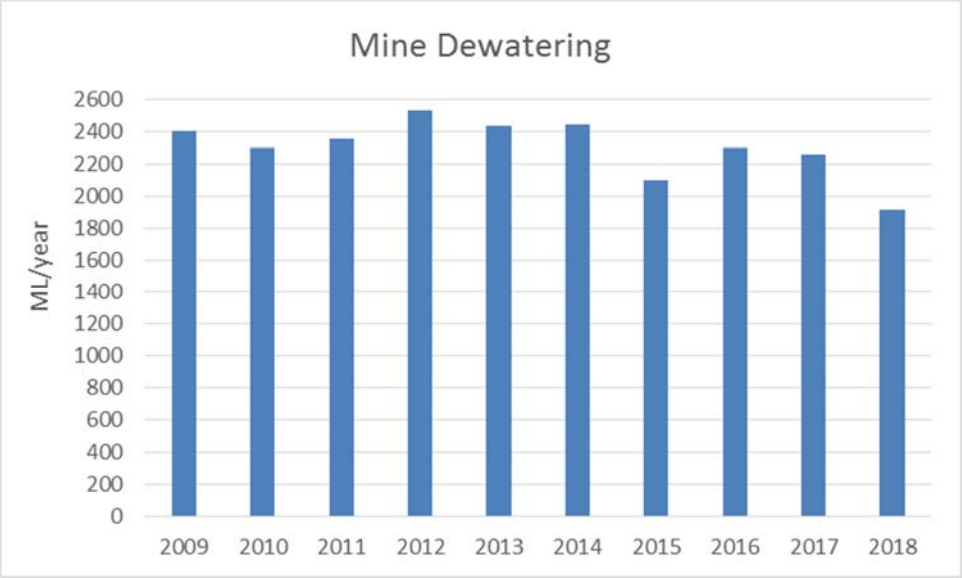


Figure 4 Annual Mine Dewatering Volumes

5.6 Mine Groundwater Quality

Groundwater monitored within the current and historic underground mining areas in the Chain Valley Colliery indicates the inflow water is brackish to relatively saline in subsided areas over the Great Northern Seam workings (11,800 – 28,200 mg/L) with a circum-neutral to mildly alkaline pH (7.30 – 7.76).

Groundwater seepage from a dyke at the northern end of the current Fassifern Seam workings, over the unsubsided main headings, had a brackish salinity of 2,390 mg/L and an alkaline pH of 8.63 as shown in **Tables 5** and **6**.

The data indicates that groundwater within the underground is significantly above the ANZECC (2000) water quality criteria (the default trigger values for physical & chemical stressors in SE Austtralian lowland rivers and 95% protection of freshwater species) for:

- pH (Fassifern dyke);
- electrolytical conductivity (all samples);
- total nitrogen (all samples);
- total phosphorous (Fassifern dyke); as well as,
- filterable copper (Great Northern Seam sump , Fassifern dyke); and
- filterable zinc (all samples except GNS2).

The exceedance in the mine water seepage depends on the guideline applied for the end use of the water.

The groundwater seepage is not generally suitable for potable, livestock or irrigation use, but is suitable for discharge under EPL 1770.

TABLE 5 Water Chemistry - Major Ions

	pH	EC (uS/cm)	TDS	Na	Ca	K	Mg	Cl	F	HCO3	SO4	Total P	Total N	DOC
ANZECC 2000	6.5 -8.0	2,200	-	-	-	-	-	-	-	-	-	0.05	0.5	-
Karignan Ck	6.93	185	100	29	2.2	2.3	3.5	54	0.10	10	6	**0.15**	**0.6**	17
Chain Valley Bay	7.64	47,300	36,100	10500	470	470	1100	19400	1.3	125	2200	**0.06**	0.4	<1
GNS SUMP	7.48	35,600	23,200	7640	590	125	690	13600	0.25	360	1200	0.04	**2.3**	2
GNS1 (roof)	7.30	40,400	28,200	7980	730	80	840	15600	0.47	435	1320	<0.01	**3.4**	<1
GNS2 (pond)	7.76	19,500	11,800	3950	140	38	230	6730	0.57	385	250	0.02	**0.6**	3
Fassifern dyke	**8.63**	3,500	2,390	925	1.9	9.1	2.1	310	5.6	2040	7	**0.65**	**4.1**	3

NOTE: all values in mg/L

samples collected 22/6/2012

TABLE 6 Water Chemistry - Metals

	Fe(T)	Fe	Mn(T)	Mn	Cu	Pb	Zn	Ni	Al	As	Li	Ba	Sr
ANZECC 2000	-	-	1.9	1.9	0.0014	0.0034	0.008	0.011	0.055	0.013 / 0.024	-	-	-
Karignan Ck	1.3	0.82	0.03	0.03	**0.003**	<0.001	**0.014**	<0.01	0.05	<0.01	<0.001	0.026	0.10
Chain Valley Bay	0.10	0.02	0.02	0.01	**0.003**	<0.001	**0.013**	<0.01	0.03	<0.01	0.38	0.041	4.8
GNS SUMP	0.18	0.07	0.06	0.04	**0.004**	<0.001	**0.018**	<0.01	0.04	<0.01	0.98	0.084	31
GNS1 (roof)	0.12	0.07	0.27	0.16	<0.001	<0.001	**0.010**	<0.01	0.03	<0.01	1.3	0.080	44
GNS2 (pond)	0.05	<0.01	<0.01	<0.01	<0.001	<0.001	0.003	<0.01	0.01	<0.01	0.59	0.17	11
Fassifern dyke	2.4	0.08	0.06	0.02	**0.004**	<0.001	**0.019**	<0.01	0.04	<0.01	0.28	0.37	1.0

NOTE: all values in mg/L

metals reported as acidified and 45um filtered samples except where Total (T) values are shown

samples collected 22/6/2012

6. POTENTIAL GROUNDWATER IMPACTS

It is anticipated that subsidence over the 164 – 172 m deep proposed S4 miniwall workings may affect the overlying groundwater system through:

- surface cracking to approximately 20m below surface;
- height of connective fracturing to less than 96 m above the seam (Strata^2, 2019), with partial loss of groundwater if fracturing extends into an overlying aquifer, which can cause minor groundwater inflow from the goaf to the workings;
- an exponential decrease in overburden permeability with height above the workings;
- connectivity between the mine workings and overlying aquifers within the fractured goaf, which can result in depressurisation of the aquifers;
- dewatering and depressurisation of the Great Northern and Fassifern seams as mining progresses;
- increased aquifer permeability, and, potentially;
- reduced groundwater quality in the overlying aquifers.

6.1 Hydraulic Connection to Lake Macquarie

The Forster and Enever (1992) study at Wyee State Mine, with 150 m wide longwalls, indicated there was no hydraulic connection at heights over 115 m above the extracted workings.

It should be noted that the proposed miniwall has a maximum width of 97 m, which means the height of fracturing would be less than that observed over the 150 m wide Wyee State Mine longwalls.

As a result, hydraulic connection between Chain Valley Colliery and Lake Macquarie over the proposed secondary extraction workings associated with Miniwall S4 is not anticipated as the minimum depth of cover is at least 171 m (including lake bed sediments), or from 138 – 158 m of basement (excluding the sediments in Lake Macquarie) .

6.2 Aquifer / Aquitard Interconnection

Mining induced cracking and vertical subsidence of strata over the extraction area may potentially extend up to 20 m below surface, with bedding dilation from below the surface zone down to the upper goaf.

In the upper horizons, subsidence can alter the dominance of the pre-mining horizontal flow along or above aquitards to generate a combination of vertical and horizontal flow regimes as aquitards are breached and water drains to lower elevations in the strata.

Vertical flow continues down the strata until the drainage is restricted by intact aquitards, at which the depth the flow then resumes its horizontal dominance.

Below the surface cracked zone, an increase in horizontal flow component can occur due to dilation and bending of strata, even though the layers are not actually breached by vertical cracking. The increased horizontal permeability extends across the subsided area, gradually diminishing as the subsidence and dilation decreases out to the edge of the subsidence zone.

No adverse interconnection of aquifers and aquitards is anticipated within 20 m of the lake bed as there are no recorded aquifers in this interval.

However, there may be an increased rate of recharge into the upper overburden from the lake waters due to the increased secondary porosity and permeability of the subsided, fractured overburden.

6.3 Regional Groundwater Depressurisation

Extensive mining of the Fassifern, Wallarah and Great Northern seams at Chain Valley and surrounding collieries for more than 60 years has significantly depressurised the overburden within the vicinity of the proposed workings.

Groundwater levels within the Fassifern Seam has already been extensively impacted by mining in the area and therefore continued mining is likely to have little additional impact, if any.

The deeper basement lithologies have increased permeability in areas of partial or full extraction due to subsidence induced caving and fracturing over the workings which results in an increased groundwater storage capacity of the overburden through increased secondary porosity.

Groundwater flow rates within the deeper aquifers are likely to increase within the caved and fractured areas due to greater hydraulic connectivity between horizontal and vertical fractures.

A temporary lowering of the regional piezometric surface over the subsidence area of up to 1.0 m due to horizontal dilation of strata may occur due to the increase in secondary porosity and permeability (GeoTerra, 2013). This effect will be more notable directly over the area of greatest subsidence and dilation, and will dissipate laterally out to the edge of the subsidence zone.

Based on similar observations in NSW with similar mining layouts, surficial and mid depth strata groundwater levels may reduce by up to 15m, and may stay at that reduced level until maximum subsidence develops at a specific location. The duration of the reduction depends on the time required to develop maximum subsidence, the time for subsidence effects to migrate away from a location as mining advances to subsequent panels, and the length of time required to recharge the secondary voids.

The degree of groundwater level decline under the lake due to subsidence is predominantly determined by the proximity to a mined panel, however it can also be significantly affected by the rate of lake water infiltration and terrestrial rainfall recharge to an aquifer, as well as changes in the rate or duration of groundwater extraction in any adjacent groundwater bores.

On the basis that the pre-mining circumstances of lake water and rainfall recharge as well as any local bore pumping remain the same, it is anticipated that groundwater levels will recover over a few months as the secondary void space is recharged by lake water and rainfall infiltration.

There is generally no permanent post mining reduction in groundwater levels under the lake, as no new hydraulically connected outflow paths from within the overburden develop.

6.4 Private Bore Yields and Serviceability

Although registered bore sites are located within the predicted 1.0 m groundwater depressurisation area, no private bore yields or serviceability have historically been reported to be, or are predicted to be affected by subsidence or regional groundwater depressurisation associated with the proposed workings, which are entirely located under Lake Macquarie.

No beneficial users of the deep bedrock/coal measures aquifers have been identified in the vicinity of the GwMP Area.

6.5 Groundwater Dependent Ecosystems

Cumulative impacts from the proposed mining are not anticipated to adversely impact on groundwater dependant ecosystems in the 20 mm subsidence area.

This is primarily because no groundwater dependent ecosystems have been identified in the proposed subsidence area within or under Lake Macquarie.

6.6 Groundwater Quality

Previous observations in NSW Coalfields indicates that groundwater quality within the subsided overburden is not generally adversely affected, however there may be increased iron hydroxide precipitation and a lowering of pH if the groundwater is exposed to “fresh” surfaces in the strata with dissolution of unweathered iron sulfide (marcasite) or iron carbonate (siderite).

The degree of iron hydroxide and pH change due to subsidence is difficult to predict, and can range from no observable effect to a distinct discolouration of water pumped out of bores.

The discolouration does not pose a health hazard, however it can cause clogging of pumping equipment and piping in extreme cases.

It should be noted that many bores in the local area can already have significant iron hydroxide levels, and a pre-mining survey of the active bores is required to assess the baseline water quality prior to undermining.

Acidity (pH) changes of up to 1 order of magnitude can occur, however the change can be reduced if the bore has sufficient bicarbonate levels.

The potential for groundwater contamination also exists from spills of fuels, oils and chemicals from both the surface and underground mine workings. Spills may result in the contamination of soil, while the infiltration of rainfall or direct migration of contaminants to the water table has the potential to contaminate shallow aquifers.

The potential for impacts can be minimised through the appropriate storage of fuels and hazardous chemicals, the implementation of appropriate work procedures and regular inspections and maintenance of equipment and plant.

Leaks and spills should be handled in accordance with the PIRMP prepared for the site, and remediated as required on a case by case basis.

Infiltration of potentially contaminated water from the sedimentation dams also has the potential to impact groundwater quality. As the dams receive all site runoff, amenities water and mine water, as well as workshop and wash down water after treatment by an oil separator, there is potential for the water within the dams to be contaminated by dissolved petroleum hydrocarbons and heavy metals. It is understood the dams are not lined with a low permeability layer, and as such, seepage of potentially contaminated water within the dams may be infiltrating alluvial or shallow aquifers.

6.7 Groundwater Seepage to or From Terrestrial Streams

No known springs or streams are present in the GwMP area that would be affected by subsidence and associated regional groundwater depressurisation with the existing and proposed workings.

Overall, the terrestrial streams within the GwMP area will be subjected to no or very low tensile and compressive strains and are not anticipated to be adversely affected by subsidence related stream bed cracking.

No loss of overall stream flow or regional change in stream water quality within the local streams is anticipated to occur.

6.8 Groundwater Inflow to Mine Workings

Loss of lake water or any significant loss of connate groundwater within the overburden to the underlying workings has not been observed in mines in the local area at similar depths of cover to the proposed workings.

Vertical hydraulic connection to the workings is anticipated to be restricted by the Dooralong Shale and the Mannering Park Tuff aquitards, which are not anticipated to be breached by subsidence over the proposed Fassifern Seam workings and are both below the surficial and above the goaf, vertically connected, dilation zones.

The horizontal permeability above and between the aquitards may be enhanced after subsidence, however there is no additional vertical connectivity through or below them to the underlying workings.

Based on available records, the 2018 annual groundwater seepage into the workings was 1,817 ML/yr, or 4.98 ML/day.

No obvious relationship between expansion of the mine and increased groundwater inflow to the workings is evident in the current data, with a reduction in mine water pumping evident over the last three years.

Based on a groundwater modelling assessment (GeoTerra, 2013) the inflow may increase up to 10.5 ML/day as the Colliery expands.

7. GROUNDWATER MONITORING PLAN

The groundwater monitoring program at available (or currently present) locations shown in **Figure 1** is designed to provide a database that enables:

- comparison of anticipated vs observed impacts on the groundwater system through miniwall as well as bord and pillar extraction of the Fassifern Seam at Chain Valley Colliery and any associated subsidence effects; and
- procedures to assess, manage or rehabilitate any adverse effects that exceed specified trigger levels.

As the proposed workings, and the anticipated associated subsidence impacts, are wholly located underneath or within Lake Macquarie, the monitoring plan specifically deals with the following issues.

7.1 Mine Groundwater Inflow

The active underground mining area should be monitored by the underground supervisors to assess whether observable groundwater inflow is occurring to the active panels and if any changes are noted.

Water flow monitoring appliances have been installed to measure pumped water volumes to and from the mine workings. These appliances will be maintained in good working order, and if required, DC will supply a test certificate to certify the current accuracy of the appliances furnished by the manufacturer or by some duly qualified person or organisation.

Daily total mine water pumping records will be maintained, plotted and interpreted annually and will be supplied to DIW within the Annual Environmental Management Report (AEMR).

7.2 Private Bore Water Levels

Where property access is granted and access inside a producing groundwater bore is possible, water levels within the private bores could be measured at least once before and once after mining is conducted in the GwMP area to assess if any adverse effects due to subsidence have occurred as shown in **Table 7**.

It is suggested that all other shallow monitoring or test bores, or waste disposal bores are not to be included in the monitoring suite.

Where monitoring of groundwater levels is not possible due to installed pump head-works, the mine will assess any reports from landowners in regard to adverse effects on bore water availability that may occur during or after extraction of the proposed workings.

Each property owner may be interviewed before and after the proposed mining to assess the bore's status, pumping rate, and its general duration of pumping as well as the type and set up of the pump.

Where feasible, the bore yield should also be measured, and water levels measured where access inside the bore is possible.

Where private bores are being occasionally or frequently pumped, and could thereby temporarily distort the static regional groundwater levels, the depth to groundwater, where accessible, should be monitored during pump resting periods to assess the regional piezometric surface across the area.

TABLE 7 Suggested Producing Groundwater Bore Water Level Monitoring

GW	Monitoring Frequency	Monitoring Method	Units
11915	Upon access / post mining	Dip meter	mbgl
24575	Upon access / post mining	Dip meter	mbgl
80489	Upon access / post mining	Dip meter	mbgl

Note: mbgl = metres below ground level

7.3 Groundwater Quality

7.3.1 Inactive Private Bores

Where property access is granted and access inside a bore is possible, a pre-mining water sample collection and analysis will be conducted within one month of access being granted and available, and will be repeated at the end of mining in the project area to enable assessment of any subsidence related changes in groundwater quality.

Each bore will be purged prior to sampling until pH and salinity measurements stabilise, which usually involves removal of at least three bore volumes of water.

Samples will be collected, appropriately preserved, kept on ice and transported under chain of custody documentation to arrive at the laboratory within appropriate holding times.

In addition, each piezometer or inactive bore will be monitored in the field for bi-monthly salinity (µS/cm) and pH measurements.

7.3.2 Active Private Bores

Where property access is granted and access to the groundwater bore is possible, an initial water sample collection and analysis will be conducted within one month of access being granted and available, and will be repeated at the end of mining in the project area to enable assessment of any subsidence related changes in groundwater quality.

To date, access to one current bore has been granted (GW80489), however no sample could be obtained as the installed pump was not working.

The use, and any treatment, of the bore water should be ascertained and observations made on the quantum of iron hydroxide precipitating from the pumped water before and after mining.

Each bore will be purged prior to sampling until pH and salinity measurements stabilise, which usually involves removal of at least three bore volumes of water.

Samples will be collected from bores that are current and accessible as shown in **Table 8**, and will be appropriately preserved, kept on ice and transported under chain of custody documentation to arrive at the laboratory within appropriate holding times.

TABLE 8 Suggested Producing groundwater Bore Water Quality Monitoring

GW	Monitoring Frequency	Monitoring Method	Units
11915	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)
24575	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)
80489	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)

During extraction within the GwMP area, the frequency of monitoring and the parameters to be monitored may be varied in consultation with DIW once the baseline groundwater quality and its response to mining (if any) is established.

The frequency of post mining monitoring will be reassessed after mining is complete in the GwMP area as it may be possible, depending on results, to lengthen the intervals.

Table 9 presents the physical groundwater quality parameters to be measured.

TABLE 9 Groundwater Quality Monitoring Parameters

SUITE	ANALYTES
Initial monitoring / after mining is completed	Field EC, Eh, pH, temp TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Cs, Rb, Sr (filtered)

7.4 Groundwater Contamination

In accordance with the sites' EPL and WMP, surface water discharged from the dams is monitored monthly for a range of pollutants.

The range of analysis for surface water also includes oil and grease, which allows the assessment of impact, if any, that these dams may be having on underlying aquifers.

8. GROUNDWATER ASSESSMENT CRITERIA AND TRIGGERS

Management of impacts within predictions follow standard assessment review and response protocols.

Contingent measures are included in this plan to ensure the timely and adequate management of the proposed extraction and subsidence impacts outside of anticipated levels.

Where and if required, specialist hydrogeological / hydrological investigations and reports may include:

- the study scope and objectives;
- consideration of any relevant aspect from this plan;
- analysis of trends;
- assessment of any impacts against prediction;
- assessment of the cause of a change or impact;
- options for management and mitigation;
- assessment for the need for contingency measures;
- any recommended changes to this plan; and
- appropriate consultation with DIW, DRE and EPA.

Site specific mitigation / remediation action plans may include:

- a description of the impact to be managed;
- results of the specialist investigations;
- aims and objections for the plan;
- specific actions required to mitigate/manage;
- timeframes for implementation;
- roles and responsibilities;
- identification of and gaining appropriate approvals from landholders and government agencies; and
- a consultation and communication plan.

Trigger values for further assessment of potential subsidence effects on groundwater systems within the plan area are discussed in the following sections.

The triggers have been developed to reflect the current variability in relevant parameters and to enable the identification of any changes that may be due to either subsidence effects, landowner impacts and/or natural causes.

If trigger values are exceeded, the cause and effect will be investigated and a management plan developed if it is directly related to mining.

The Environment and Community Coordinator shall be responsible for the implementation of agreed actions and shall communicate such actions to the relevant landowners or authorities.

8.1 Mine Water Extraction and Discharge

Chain Valley Colliery holds a DIW license (WAL41508) to extract up to 4,443 ML/year from the workings, and currently holds EPL 1770 which permits volumetric discharge of up to 12,161 kL/day via its licensed discharge point.

Mine water extraction will be measured daily and daily discharge volumes will be reported on a monthly basis via the DC website.

As part of the AEMR the average monthly groundwater extraction rates will be determined by assessing the difference between the potable water pumped into the workings and the total water pumped out of the workings. This assumes no hydraulic conductivity with Lake Macquarie, surface potable water leaks, water theft or measurement error.

A trigger for the groundwater extraction will be where the monthly average extracted underground mine water exceeds **10.5 ML/day** (75th percentile groundwater inflow – refer **Table 3**), and this average continues for at least 2 months.

8.2 Private Bore Groundwater Levels

It should be noted that landowners pumping their own bores, as well as the interference effect from other landholders pumped bores can significantly affect temporary standing water levels in a bore, without any influence from mining or subsidence.

On this basis, if the combined monitoring of the outlined private bores indicates a sustained drawdown of **greater than 2 m over a 2 month period** in a private bore, or, if a landowner reports a lack of groundwater availability in a bore that cannot be accessed internally, then the cause of the exceedance will be investigated to assess whether the >2 m drawdown or lack of supply is due to:

- lack of rainfall recharge, using comparison to the cumulative sum of daily rainfall;
- operation of landowner bores either within or outside an affected bores property;
- subsidence; or
- any or all of the above.

The 2 m drawdown trigger level has been derived through extrapolation of similar mining subsidence related effects in similar mining layouts and geomorphological areas in NSW and to be consistent with the minimal impact considerations of the NSW Aquifer Interference Policy.

8.3 Private Bore Groundwater Quality

If a landowner reports an increase in iron hydroxide precipitation or water salinity, as an initial default, the ANZECC 2000 irrigation and livestock guidelines shown in **Table 10** will be used as trigger levels to assess bore water quality.

As no bores are used for drinking water in the GwMP, drinking water quality criteria and triggers are not specified.

TABLE 10 Groundwater Chemistry Criteria (mg/L)

	pH	**TDS**	**Hardness as CaCO3**	Cu	Pb	Zn	Ni	Fe	Mn	As	Cd
Irrigation	*6 - 8.5*	-	*>60-350*	*5*	*5*	*5*	*2*	*10*	*10*	*2.0*	*0.05*
Livestock	-	*<4000/5000*	-	*1 / 0.4*	*0.1*	*20*	*1*	-	-	*0.5*	*0.01*

NOTE: all metals values are for filtered metals;

irrigation criteria for short term trigger values (< 20 years);

livestock criteria for beef / sheep.

9. POTENTIAL GROUNDWATER AMELIORATIVE ACTIONS

9.1 Private Bore Yield

Although it is not anticipated due to the separation distance from the bores to the proposed subsidence area, should the accessibility, available drawdown or yield of a bore be impacted due to subsidence, Chain Valley Colliery is required to provide an alternative water supply until the bore recovers.

If the level does not sufficiently recover and the effect is due to subsidence rather than regional climatic or anthropogenic factors, repairs or maintenance to a bore can be undertaken after maximum subsidence has developed. At this time the pump intake can be lowered, the bore extended to a greater depth or a new bore can be established.

With these mitigation measures in place it is unlikely that water supply to properties will be significantly impacted by the proposed mining.

In the event of a monitored or reported adverse impacts on the yield or saturated thickness of a private registered bore, the cause will be investigated.

If a groundwater level drop of over 2 m for a period of over 2 months is recorded, and the reduction in bore yield is a consequence of subsidence, the mine will enter into negotiations with the affected landowners and Subsidence Advisory NSW with the intent of formulating an agreement which provides for one, or a combination of:

- re-establishment of saturated thickness in the affected bore(s) through bore deepening;
- establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;
- provision of access to alternative sources of water; and/or
- compensation to reflect increased water extraction costs, e.g. due to lowering pumps or installation of additional or alternative pumping equipment.

9.2 Private Bore Groundwater Quality

In the event of an adverse change in groundwater quality to a private bore, particularly in regard to salinity and / or iron levels, the mine will implement an investigation to determine if the cause is due to subsidence.

Although it is not anticipated due to the separation distance from the bores to the proposed subsidence area, if subsidence cracking has caused a notable increase in iron hydroxide precipitates or the landowner reports an adverse change in salinity, and that change exceeds the trigger levels, the mine will enter into negotiations with the affected landowner with the intent of formulating an agreement which provides for one, or a combination of:

- re-establishment of the water supply from a new bore to provide water equivalent to the pre mining status of the bore (on the basis that the landholder has allowed for pre-mining status of the bore to be established);
- provide access to an alternative source of water, or;
- compensate the bore owner to reflect the economic costs incurred due to the subsidence effects on the water quality.

10. CONTINGENCIES

In the event that the proposed monitoring indicates that a trigger has been reached or is being approached, DC will commission a hydrogeologist or hydrologist to review the data, with the outcomes of that review, including any recommendations, being subject to consultation with DIW.

A trigger of pH or electrical conductivity would initially lead to an increase in the analytes monitored and/or frequency of sampling to confirm the magnitude and extent of the change in groundwater chemistry and verify the change is a consequence of mining.

Should the standing water level trigger be achieved in any bore, the mine staff shall notify the affected landowner(s) and, if it is the hydrogeologist's opinion that the reduction is a consequence of mining, mitigation measures identified in previous sections will be initiated.

An independent authority may also be used where a dispute arises as to the cause of the change, given that groundwater supply and quality can be affected by non-mining related factors such as bore siltation, aquifer depletion by adjoining mining operations, agricultural users, bacterial infection, fertilizer contamination etc.

11. AUDIT AND REVIEW

This document shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Environmental Management Report (AEMR);
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the project approval.

Other factors that may require a review of the GwMP are:

- observation of greater impacts on surface features due to mine subsidence than was previously expected;
- observation of fewer impacts or no impacts on surface features due to mine subsidence than was previously expected; and/or
- observation of significant variation between observed and predicted subsidence.

Internal and external audits of this document will be carried out as described below. If possible, audits shall be objective and be conducted by a person or organisation independent of the document being audited.

Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

11.1 Internal Audits

Internal audits of this document and all other Environmental Management System documents are to be undertaken every three years. Improvements from the audit are to be incorporated in the site action database to ensure the actions are assigned to the relevant people and completed.

11.2 External Audits

External audits will be conducted utilising external specialists and will consider the document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished. External audits will be periodically at a frequency determined by the site General Manager, or in response to significant environmental incidents for which a systems failure has been determined as a contributor to the incident.

An Independent Environmental Audit (IEA) will be undertaken every three years, or as otherwise required by the Department of Planning, Industry and Environment (DPIE).) the audit will be conducted by an audit team whose appointment has been endorsed by the Secretary of DPIE.

Any actions arising from external audits will be loaded into the site actions database to ensure the actions are assigned to the relevant people and completed.

12. RECORDS

Generally, the site Environment and Community Coordinator will maintain all EMS records, which are not of a confidential nature. Records that are maintained include:

- monitoring data and equipment calibration;
- environmental inspections and auditing results;
- environmental incident reports;
- complaint register; and
- licenses and permits.

All records are stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records are maintained for a minimum of 4 years.

13. RESPONSIBILITIES AND ACCOUNTABILITIES

13.1 General Manager

- Ensure that the requisite personnel and equipment are provided to enable this plan to be implemented effectively;

13.2 Environment and Community Coordinator

- authorise the Plan and any amendments thereto;
- ensure this plan is reviewed should any changes to the mine plan or if levels of subsidence are greater than predicted. Notify the relevant authorities of any triggers being exceeded;
- reporting in the AEMR;
- ensure that inspections are undertaken in accordance with the schedule;
- ensure that persons conducting the inspection are appropriately trained, understand their obligations and the specific requirements of this plan;
- review and assess monitoring results and inspection checklists;
- promptly notify the General Manager of any identified environmental issue.

13.3 Hydrogeologist / Hydrologist

- assist in compiling and/or reviewing the monitoring to the standard and frequency as outlined in this plan; and
- promptly notify the Environment and Community Coordinator of any identified environmental issue.

14. TRAINING

All personnel who conduct inspections will be trained in the requirements of the plan.

Training will be conducted on maintaining and downloading monitoring equipment, operation of the field testing equipment and sampling procedure for laboratory analysis identification of the various subsidence impacts detailed in this plan.

15. REPORTING

15.1 Annual Environmental Management Report

An Annual Environmental Management Report (AEMR) will be submitted to DIW each year. As part of the AEMR the groundwater section will include;

- groundwater related activities, and the level of compliance with the GwMP;
- all groundwater monitoring volumes and rates taken by the works;
- the volume groundwater extracted from the works that was discharged via the Licensed Discharge Point;
- all groundwater extraction data;
- the extent of groundwater depressurisation and any groundwater salinity impacts compared with predictions in the Environment Assessment;
- interpretation of the data, discussion of trends and their implications;
- an overall comparison of groundwater performance with predictions for the life of the mine provided in the Environmental Assessment; and
- an outline of proposed adaptive or remediation actions if required.

Notification of the groundwater monitoring results and interpretations will be reported within the required annual period to outline the natural trends and any impacts from mining on the groundwater system.

16. REFERENCES

AECOM, 2011A. Groundwater Impact Assessment, Chain Valley Colliery Continuation of Mining

AECOM, 2011B Mine Water Balance, Chain Valley Colliery Continuation of Mining

AGE Consultants, 2006 Mannering Colliery Continuation of Mining, Environmental Assessment, Groundwater.

ANZECC & ARMCANZ 2000 National Water Quality Management Strategy. Australian and New Zealand Guidelines For Fresh and Marine Water Quality, Volume 1

DIPNR, 2005 Management of Stream / Aquifer Systems in Coal Mining Developments

Ditton Geotechnical Services, 2013 Subsidence Impact Assessment for the Chain Valley Colliery Mining Extension 1 Project

Forster I.R., 1995 Impact of Underground Mining on the Hydrogeological Regime, Central Coast NSW. From Engineering Geology of the Newcastle Region

Forster I., and Enever J., 1992 Hydrogeological Response of Overburden Strata to Underground Mining – Central Coast, New South Wales, Office of Energy.

GeoTerra, 2013 Chain Valley Colliery Mining Extension 1 Groundwater Assessment, Report LDO2-R1D

GSS Environmental, 2013 Chain Valley Colliery Mining Extension 1 Project – Surface Water Assessment

HLA-Envirosciences, 2002 Mandalong Mine Groundwater Study Stage 1 Preliminary Review. November.

Li, G., Forster, I., Fellowes, M., Myors, A., 2006 A Case Study on Longwall Mining under the Tidal Waters of Lake Macquarie

Mine Subsidence Engineering Consultants, 2018 Miniwalls S2 and S3. Subsidence predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the proposed Miniwalls S2 and S3 in Support of the Extraction Plan

Peabody LakeCoal Pty Ltd, 2008 Annual Environmental Management Report, Chain Valley Colliery, Year Ending 30 June 2008

Peabody LakeCoal Pty Ltd, 2009 Annual Environmental Management Report, Chain Valley Colliery, Year Ending 30 June 2009

Strata^2, 2018 Geotechnical Aspects of S2 and S3 Panel Design

Strata^2, 2019 Lake Coal Chain Valley Colliery, S4 Panel: Geotechnical Environment, Subsidence Estimates and Impacts

DISCLAIMER

This report was prepared in accordance with the scope of services set out in the contract between GeoTerra Pty Ltd (GeoTerra) and the client, or where no contract has been finalised, the proposal agreed to by the client. To the best of our knowledge the report presented herein accurately reflects the client's intentions when it was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document.

The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site / sites in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site / sites at all points. Should information become available regarding conditions at the site, GeoTerra reserve the right to review the report in the context of the additional information.

In preparing this report, GeoTerra has relied upon certain verbal information and documentation provided by the client and / or third parties. GeoTerra did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. GeoTerra assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to GeoTerra.

Interpretations and recommendations provided in this report are opinions provided for our Client's sole use in accordance with the specified brief. As such they do not necessarily address all aspects of water, soil or rock conditions on the subject site. The responsibility of GeoTerra is solely to its client and it is not intended that this report be relied upon by any third party, who should make their own enquiries.

The advice herein relates only to this project and all results, conclusions and recommendations made should be reviewed by a competent and experienced person with experience in environmental and / or hydrological investigations before being used for any other purpose. The client should rely on its own knowledge and experience of local conditions in applying the interpretations contained herein.

To the extent permitted by law, GeoTerra, excludes all warranties and representations relating to the report. Nothing in these terms will exclude, restrict or modify any condition, warranty, right or remedy implied or imposed by any statute or regulation to the extent that it cannot be lawfully excluded, restricted or modified. If any condition or warranty is implied into this license under a statute or regulation and cannot be excluded, the liability of GeoTerra for a breach of the condition or warranty will be limited to the supply of the service again.

Appendix 5: Standard Erosion and Sediment Controls

Land Clearing Procedures (Clearing and Topsoil Stripping)

Minimise land disturbance to avoid exposing unnecessary land to the processes related to erosion and sedimentation. This is achieved by:

- All operations are planned to ensure that only the areas which are under active excavation are cleared and that there is no damage to any trees and pasture areas outside the limits to be cleared.
- Limiting the cleared width to that required to accommodate excavation plus areas required for topsoil stockpiling.
- General vegetation clearing will not be undertaken until earthwork operations are ready to commence.
- All proposed erosion and sediment control measures are implemented in advance of, or in conjunction with, vegetation clearing and soil stripping operations.
- Prior to vegetation clearing or soil stripping operations, the stripping panel is delineated on a plan and in the field will be marked by survey pegs placed at intervals on each side of the disturbed area. Topsoil limits and the topsoil stripping depths are shown on the pegs.
- Where possible, topsoil is stripped in moist but not wet condition to reduce deterioration in topsoil quality and dust generation and only be stockpiled when no areas of reshaped overburden are available for direct placement and spreading.

Topsoil Stockpiles

Where suitable areas are unavailable for the immediate respreading, topsoil is stockpiled to a maximum depth of three metres and subsequently applied when the areas become available. The period of the stockpiling is minimised in order to reduce the detrimental effects of the storage of any native seed in the soil and damage to the soil structure.

All stockpiles are shaped, trimmed (max batter slope 3H:1V) then ripped and immediately sown with a sterile cover crop and permanent pasture species to provide stockpile stabilisation. Sediment fence is constructed around the downslope perimeter of the stockpiles where required to provide temporary sediment control until vegetation becomes established. Surface drainage in the vicinity of the stockpiles is configured as to direct any runoff around the area so not to cause any potential erosion of the loose material.

Where topsoil is used as the growing medium, it is re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Re-spreading on the contour aids runoff control and increased moisture retention for subsequent plant growth. Re-spread topsoil should be levelled to achieve an even surface, avoiding a compacted or an over-smooth finish.

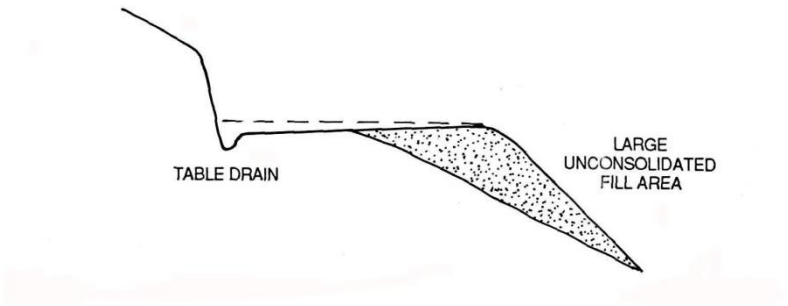
Access Tracks

Access tracks are constructed in accordance with appropriate standards such as those described in *Managing Urban Stormwater: Soils and Construction Vol. C - Unsealed Roads*. Surface drainage is optimised and stabilised, thereby reducing roadside erosion and sedimentation. Appropriate control measures are constructed on all access roads with cross fall drainage at 3% either side of the road crown to be largely responsible for immediate water shed from the road surface. Techniques that could be used to provide crossfall on the track include crowing, infall and outfall

- Crowning

Crowning allows water to be shed on both sides

- Infall



- Outfall

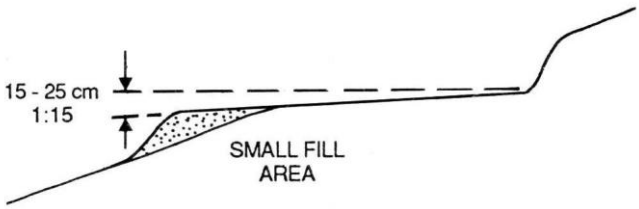


Table Drains, Mitre Drains, Culverts and Cross Drains are used where required to safely convey the water from the track surface so to prevent runoff from eroding them or adjacent land. Mitre Drain spacing should not exceed 50m even on soils with low erodibility. Cross Drains are placed every 20m to 90m depending on

the road grade and soil erodibility as required. Refer to Table 5.2 of Vol2C – Unsealed Roads of the 'Blue Book' for more detail.

Cut and fill batters associated with service tracks are formed to a safe slope and stabilised by vegetation. Where cut batters are greater than 1.5m, stabilisation methods are applied to these areas such as laying back, revegetation and drainage. Stabilisation is assisted by spreading topsoil and/or by applying chemical or organic mulch over the exposed batter surface. Where fill batters are greater than 2:1, re-grading may be required.

Planning and construction of new tracks is undertaken in accordance with the guidelines presented Vol. 2C - Unsealed Roads of the 'Blue Book'.

Haul Roads

Run off from haul roads to be constructed within Chain Valley Colliery is to be contained within the mine water management system. The ultimate goal for the site is that water is not allowed to discharge from the site unless through a LDP. If the runoff from future haul road constructions are not contained within the existing mine water system, dams will be constructed to contain this water and allow it to be pumped back into the mine water management system for release through the LDPs.

During any construction of haul roads, temporary erosion and sediment controls (see **Section 1.1.8**) will be implemented. Sediment fencing will be strategically located around fill termination points as the road alignment approaches clean water drainage lines. The silt fencing will not be removed until construction of the appropriate drainage and culverts are completed. Temporary sediment trapping devices may be required during construction to treat sediment-laden runoff from small areas (0.5 ha or less). Where haul roads are required to cross any watercourses, they will generally be constructed so that they cross perpendicular to the watercourse, subject to other constraints. Once constructed, long term sediment controls such as mine water sediment dams will be constructed at the outlet points of the storm water drains to contain water within the mine water management system. However haul roads at Chain Valley are currently sealed bitumen surfaces and erosion of the permanent structures may be effectively controlled by regular cleaning to prevent the accumulation of coal fines.

Diversion Structures (Clean Water)

In order to minimise the volume of dirty and mine water to be treated, all clean run-on water is diverted where possible into clean water drainage lines to be directed off-site. This not only reduces the potential for erosion to occur on disturbed areas, but also reduces the pressure on the dirty and mine water management controls which are required to treat sediment-laden runoff to an acceptable standard for discharge. Suitably designed and constructed diversion drains are implemented where practical around the Chain Valley Colliery in accordance with 'Blue Book' standards relating to channel design. In general, the drains should be trapezoidal in shape with maximum side slopes of 1V:2H. Where peak design water velocities exceed 1.5m/s, the drains should be protected from scour using either erosion channel liners and/or geofabric with rock rip-rap armouring.

Diversion Structures (Mine and Dirty Water)

Catch drains are utilised throughout the site to minimise erosion and re-direct potentially contaminated runoff into dirty water sediment dams and mine water dams. Runoff from disturbed areas, such as stockpile areas, is conveyed to these dams by catch drains and bunds.

Bunds shall be constructed similar to top soil emplacement areas, bunds shall be shaped, trimmed (max batter slope 3H:1V) then ripped and immediately sown with a cover crop and permanent pasture species to provide bund stabilization.

For runoff from rehabilitation areas, the water management structures should be appropriately designed before layout and construction. Typically the water management structures include contour banks, which are constructed at intervals down the slope of rehabilitation areas to control surface flow and minimize erosion. The effect of these is to divide long slopes into a series of short slopes with the catchment area commencing at each bank. This prevents runoff from reaching a depth of flow or velocity which would cause erosion. As the slope angle of the landform increases, the banks are spaced closer together. Bank spacing is determined based on the surrounding catchment layout and the bench spacing guide contained in Table 4.1 of *Vol2E – Mines and Quarries* of the 'Blue Book'. The banks should have a longitudinal grade of 1.2%. Where peak design water velocities exceed 1.5m/s, the drains should be protected from scour using either erosion channel liners and/or geofabric with rock rip-rap armouring.

Control Devices

Mine water dams and mine water sediment dams (generally smaller structures) are used at Chain Valley Colliery to contain potentially contaminated 'mine' water. This water has the potential to contain elevated salinity concentrations and/or potential hydrocarbon contamination as a result of runoff from haul roads, workshop areas and areas exposed to carbonaceous material. They also function as sediment dams for sediment control but are not allowed to spill into neighbouring watercourses unless released through a LDP.

Dirty Water sediment dams are intended to catch runoff from disturbed areas that are not exposed to potential contamination of hydrocarbons or carbonaceous material. These include general construction areas and rehabilitation areas. In general dirty water sediment dams should be constructed on all disturbed areas not draining to mine water dams. The dams are constructed for the purpose of capturing sediment-laden runoff prior to off-site release. Dirty water sediment dams assist in improving water quality throughout the mine site.

The number and capacity of dams will be related to the total area of catchment, the duration of disturbance and the anticipated soil loss. The capacity of each dam is derived from the benchmark design reference for sediment control, *Managing Urban Stormwater: Soils and Construction Vol. 1* and *Vol. 2E Mines and Quarries* (the Blue Book) (Landcom, 2004 and DECC, 2008). The dams are constructed to at least the recommended minimum design criteria as presented in Table 6.1 of Vol 2E Mines and Quarries of the Blue Book. For most areas, this is the 90th percentile, 5 day rainfall event for a Type F/D basin (soils that are fine textured and possibly dispersive).

The following points will be considered when selecting future sites for sediment dams:

- Each dam will be located so that runoff may easily be directed to it, without the need for extensive channel excavation or for excessive channel gradient. Channels will discharge into the dam without risk of erosion. Similarly, spillways will be designed and located so as to safely convey the maximum anticipated discharge.

- The material from which the dam is constructed will be stable and be imported from elsewhere on the mine, if necessary. Highly dispersible clays will require treatment with gypsum and/or bentonite to prevent failure.

Temporary Erosion and Sediment Controls

Prior to any construction activity (including soil stripping, road construction, bulk earthworks), temporary erosion and sediment control measures are installed. The following sub-sections include temporary erosion and sediment control features that may be utilized at the site.

Sediment Filter Fences

There may, on occasion, be a disturbance area which is either not protected by existing structures or requires additional temporary protection against erosion and sedimentation. In these cases it may be suitable to install sediment filter fencing. Sediment filter fences filter run-off leaving the site, trapping sediment and allowing filtered water to pass. Sediment filter fences are constructed around the base of any areas of exposed land that are not subject to concentrated overland flow, that are not adequately protected by existing structures and that are not within the mine water management system. Sediment filter fencing is installed around the extent of the disturbance areas where sediment-laden water could potentially enter clean downstream receiving waters.

Sediment filter fences are normally placed on the contour or slightly convex to the contour. The contour on each end of the fence should be turned to create a stilling dam up slope of the fence. Where possible, a silt fence system should consist of a series of overlapping fences. Each fence should be NO longer than about 40 metres. They should not intercept large concentrated or channelised flows. The fences are constructed in accordance with the Sediment Fence Standard Drawing (SD6-8) of the 'Blue Book'. Silt fences require regular maintenance. Trapped sediments should be removed, pickets straightened, filter cloth re-secured and tightened.

Sandbag Weirs

Sandbag weirs are sometimes installed within existing swale drains or existing drainage channels, which are not able to be regularly graded. The use of these devices is limited to temporary erosion and sediment control in channels during construction or high disturbance phase mining.

The weirs are typically installed at a minimum of 40 metre intervals. As with sediment filter fences, sandbag weirs may be installed prior to any works commencing on the site in existing channels and immediately after the construction of new channels. Inspections of the sandbag weirs after rain should take place with removal of the collected sediment as required. Damaged/shifted bags should be repaired or replaced.

Temporary Drains

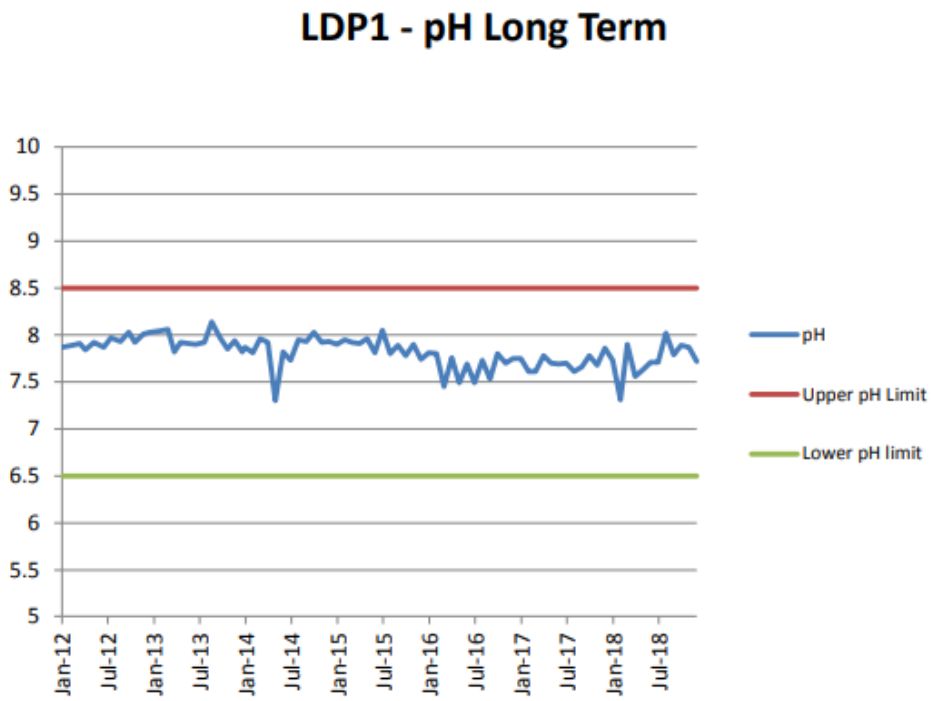
Runoff from areas exposed during the works is to be controlled by construction of temporary contour and diversion drains. These drains generally take the form of channels constructed across a slope, with a ridge of the lower side. They should be implemented immediately after a construction site is cleared to intercept and divert runoff from the site to nearby stable areas at non-erosive velocities. The drains should be formed with a gentle grade of approximately 1.2%

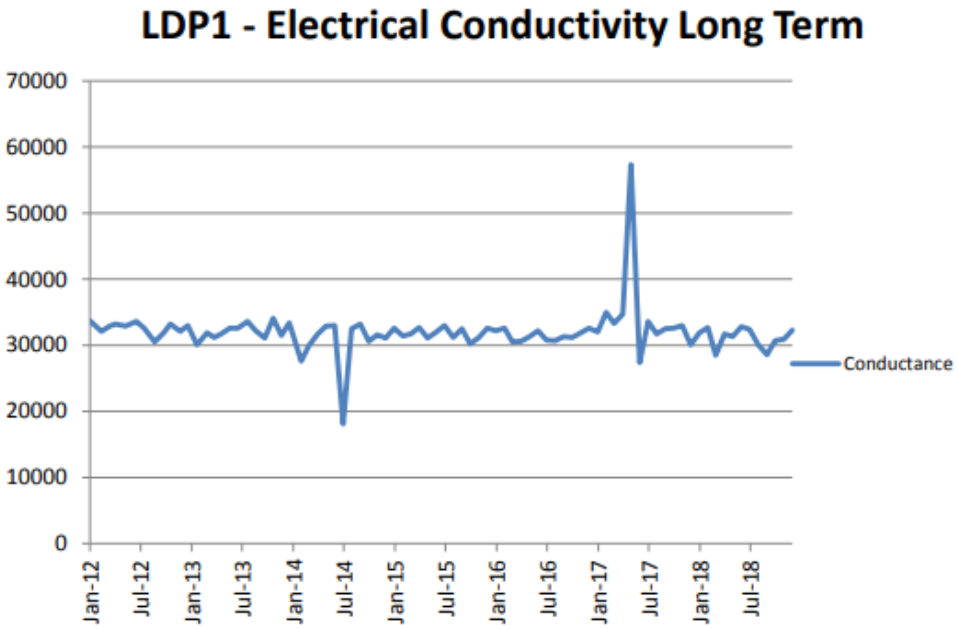
Temporary Silt Traps

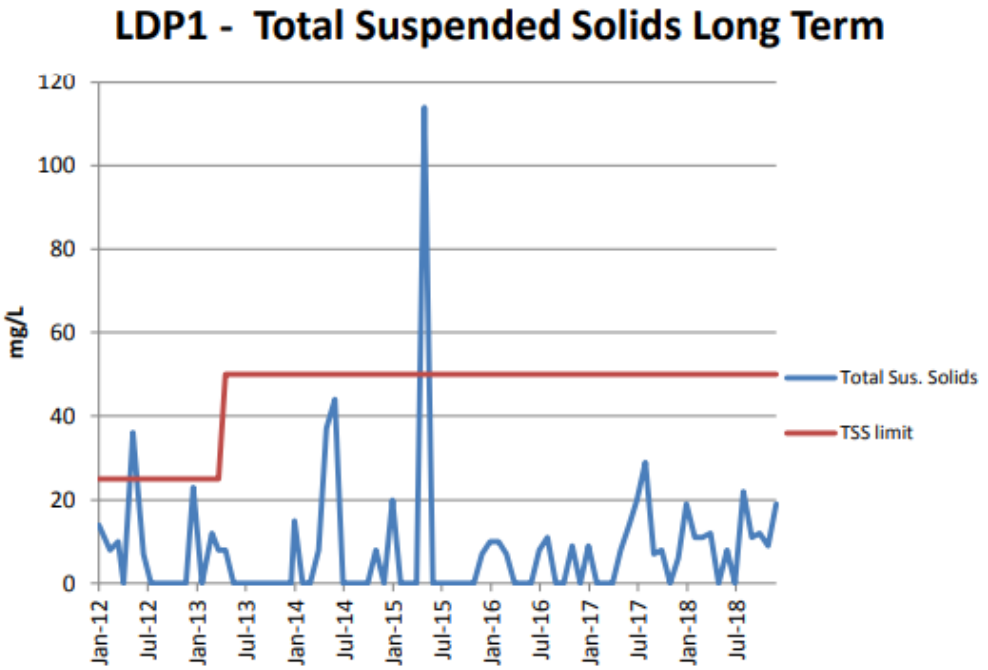
Temporary sediment trapping devices may be required during construction to trap and filter sediment-laden runoff from small areas (0.5 ha or less) prior to discharge. They are used to trap small amounts of run-off water and filter sediment from runoff before entering the natural watercourses or to protect adjacent lands. These would typically be used at the discharge point of mitre drains and other similar devices.

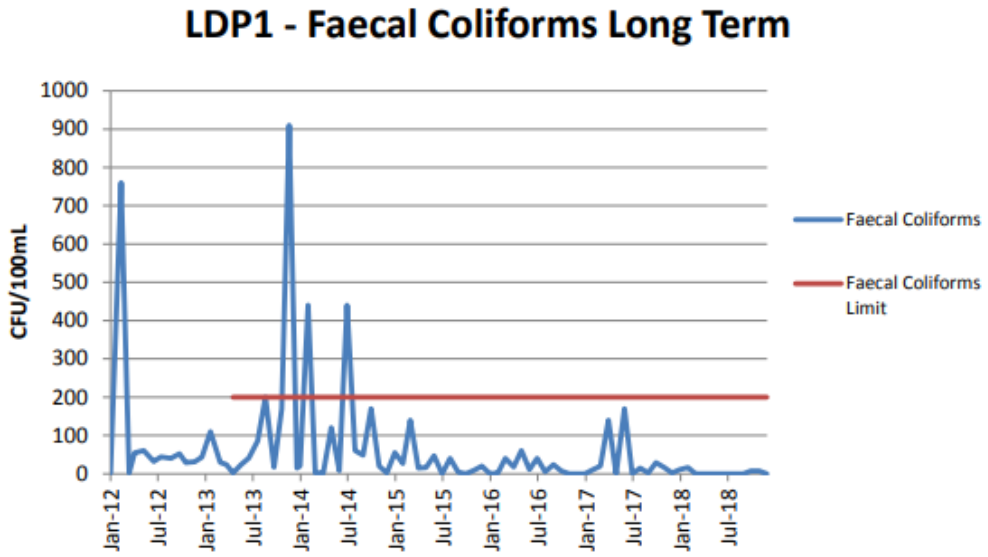
Appendix 4: EPL 1770 Water Quality Monitoring Results

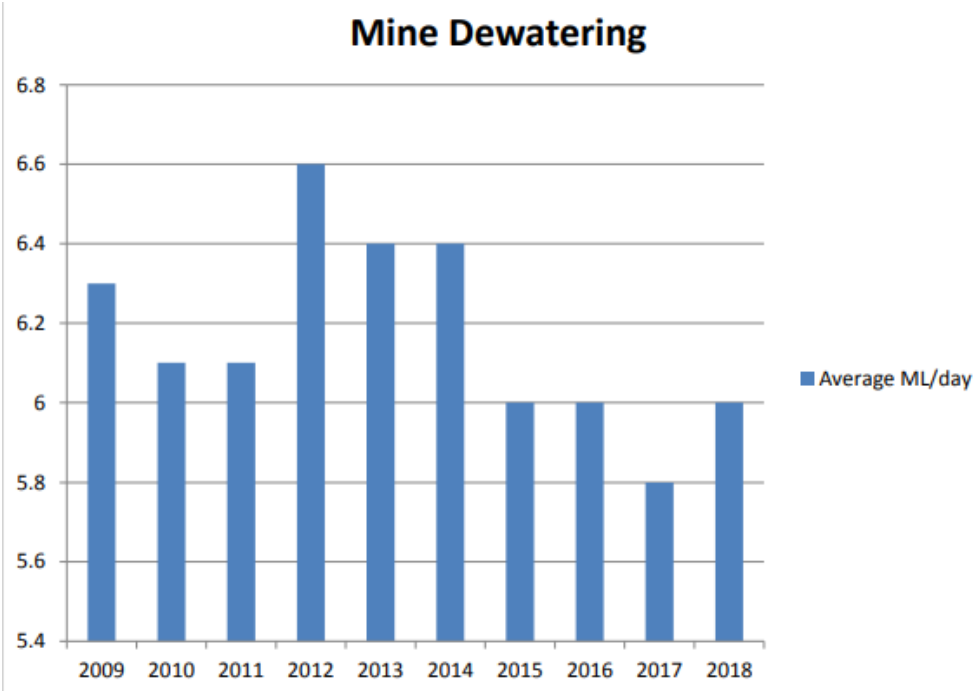
Long term monitoring results from AEMR detailed below.






LDP1 - Total Suspended Solids Long Term
mg/L
120
100
80
60
40
20
0
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Total Sus. Solids
TSS limit


LDP1 - Faecal Coliforms Long Term
CFU/100mL
1000
900
800
700
600
500
400
300
200
100
0
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Jul-18
Faecal Coliforms
Faecal Coliforms Limit


Mine Dewatering
6.8
6.6
6.4
6.2
6
5.8
5.6
5.4
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Average ML/day