Centennial Myuna Pty Ltd

Water Management Plan

October 2022

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Glossary

Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates, and carbonates. It is expressed in units of calcium carbonate ($CaCO_3$).
Alluvial	Deposition from running waters.
Ambient	Pertaining to the surrounding environment or prevailing conditions.
Aquifer	An underground layer of permeable material from which groundwater can be usefully extracted.
Australian Height Datum	A common national surface level datum approximately corresponding to sea level
Average recurrence interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, e.g. floods with a discharge equivalent to the 1 in 100-year average recurrence interval flood event will occur on average once every 100 years.
Baseflow	The component of flow in a watercourse that is driven from the discharge of underground water.
Baseline monitoring	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or water quality) prior to the commencement of a specific activity.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the mainstream, as well as tributary streams, to a particular location.
Clean water	Water that has not come into physical contact with coal or mined carbonaceous material.
Dewatering	The removal or pumping of water from an above or below ground storage, including the mine water within the water collection system of mine workings. Water removed from mine workings is regarded as dewatering unless the workings are flooded and at equilibrium with the surrounding strata (in which case the removal is considered groundwater extraction).
Dirty water	Water that has an elevated sediment load.
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Electrical conductivity	A measure of the concentration of dissolved salts in water.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Floodplain	Area of land that is periodically inundated by floods up to the probable maximum flood event.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report relates to the form and structure of waterways.

Goaf	The part of a mine from which the mineral has been partially or wholly removed, including the waste left in workings.
Groundwater	Water occurring naturally below ground level.
Groundwater extraction	For the purposes of this plan, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Guideline	A numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hardness	The concentration of multivalent cations in water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate ($CaCO_3$) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Ion	Electrically charged atom.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated within the site Environmental Protection License.
Median	The middle value, such that there is an equal number of higher and lower values. Also referred to as the 50th percentile.
Percentile	The value of a variable below which a certain percent of observations falls. For example, the 80th percentile is the value below which 80 percent of values are found.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Potable water	Water of a quality suitable for drinking.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Runoff	The amount of rainfall which ends up as streamflow, also known as rainfall excess.
Run of mine	Raw coal production (unprocessed).
Sediment	Soil or other particles that settle to the bottom of lakes, rivers, oceans, and other waters.
Stream order	Stream classification system, where order 1 is for headwater (new) streams at the top of a catchment. Order number increases downstream using a defined methodology related to the branching of streams.
Subsidence	The vertical difference between the pre-mining surface level and the post-mining surface level at a point.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks, and drainage lines.
Topography	Representation of the features and configuration of land surfaces.

Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Tributary	A stream or river that flows into a main river or lake.
Trigger value	The concentration or load of physicochemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of clarity (turbidity) of water. Turbidity more than 5 NTU is just noticeable to the average person.

Abbreviations

AHD	Australian Height Datum
ARI	Average recurrence interval
BOM	Bureau of Meteorology
Centennial	Centennial Coal Company Limited
Centennial Myuna	Centennial Myuna Pty Limited
CHP	Coal handling plant
DPIE -Water	Department of Planning Industry and Environment – Water
RR	Department of Regional NSW – Resource Regulator
EPA	Environment Protection Authority
EPL	Environment protection licence
ESCP	Erosion and sediment control plan
ha	Hectare
HWC	Hunter Water Corporation
kL/day	Kilolitre per day
km	Kilometre
L/s	Litre per second
LDP	Licensed discharge point
LMCC	Lake Macquarie City Council
LOR	Limit of reporting
m	Metre
mg/L	Milligram per litre
ML	Megalitre
ML/day	Megalitre per day
ML/year	Megalitre per year
mm	Millimetre
Mtpa	Million tonnes per annum
NTU	Nephelometric turbidity unit
OEH	Office of Environment and Heritage
PIRMP	Pollution Incident Response Management Plan
ROM	Run of mine
RWMP	Regional water management plan
SILO	Scientific Information for Landowners
SSTV	Site-specific trigger value
TARP	Trigger action response plan
TDS	Total dissolved solids
TOC	Top of casing

TSS	Total suspended solids
WMP	Water management plan
WSP	Water sharing plan
µS/cm	Micro siemens per centimetre

1. Introduction

Myuna Colliery is an underground coal mine owned and operated by Centennial Myuna Pty Limited (Centennial Myuna), a wholly owned subsidiary of Centennial Coal Company Limited (Centennial). Myuna Colliery's Surface Facilities Area is in Wangi Wangi on the western side of Lake Macquarie, 25 km south-west of Newcastle, as shown in Figure 1-1.

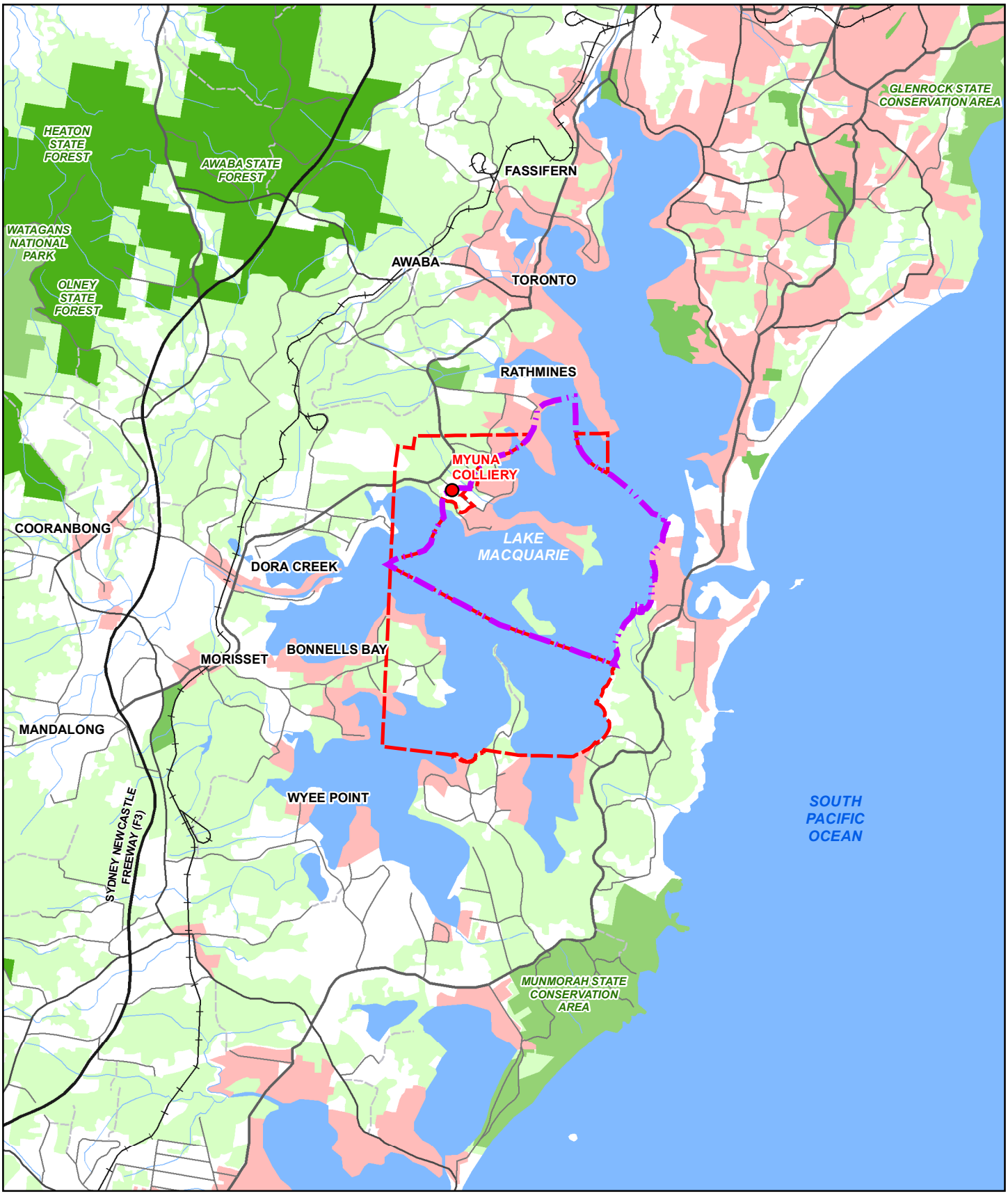
On 27 February 2012 Centennial Myuna received approval for the Myuna Coal Project under Part 3A of the *Environmental Planning and Assessment Act 1979*. The new approval (PA 10_0080) allowed for the continuation of mining at the Myuna Colliery at a maximum extraction rate of 2 Mtpa of ROM coal for a period of 21 years up to 31 December 2032. On 27 February 2015, Centennial Myuna was granted a modification to this approval (MOD 1) which allowed for an increased rate of production up to a maximum of 3 Mtpa and an increase in personnel from 210 to up to 300 full time employees. Mining of three seams, the Wallarah, Great Northern and Fassifern coal seams.

This site-specific Water Management Plan (WMP) was prepared for Myuna Colliery as a sub-plan of the Northern Operations Regional Water Management Plan (RWMP) that encompasses the northern coal operations owned by Centennial. Both the site-specific and regional management plans apply to all operations at Myuna Colliery and include the existing and approved operations and associated infrastructure within the site boundary. The WMP will be progressively updated as water management requirements change over time.

In accordance with the conditions of development consent PA 10_0080 MOD 1 for Myuna Colliery, this WMP has been prepared by Lachlan Hammersley and reviewed by Dr Stuart Gray of GHD Pty Ltd in consultation with Centennial Myuna.

The WMP was provided to the following regulatory authorities for consultation in July 2017:

- NSW Department of Primary Industries – Water (DPI-Water, formerly NSW Office of Water).
- NSW Environment Protection Authority (EPA).
- NSW Department of Industry – Resources and Energy (DRE, formerly Division of Resources and Energy in the Department of Trade and Investment, Regional Infrastructure and Services).
- Lake Macquarie City Council (LMCC).
- NSW Office of Environment and Heritage (OEH).
- Consultation received is provided in Appendix A. A register of comments addressed is provided in Appendix B.



LEGEND

- Principal Road
- Secondary Road
- Minor Road
- Track
- Existing Rail
- Watercourse
- Lake
- Built up areas
- Recreation area
- Nature Conservation Reserve
- State Forest
- Forest Or Shrub
- Development consent boundary
- Myuna Colliery

Paper Size A4

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Centennial Myuna

Centennial Myuna Pty Ltd
Water Management Plan

Locality Plan

Job Number
Revision 1
Date 17 Aug 2021

Figure 1-1

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\221812702_WMP_001_Locality plan_A.mxd

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006; Centennial: Boundaries. Created by:

1.1 Overview of site operations

1.1.1 Site features

Approved Project Area

The approved Project Area for Myuna Colliery includes areas covered by Project Approval 10_0080 and development consent SH110/148. The encompasses the mining leases of:

Mining Lease 1632.

Mining Lease 1370.

Mining Purpose Lease 334.

Mine access and surface facilities

Infrastructure at the Surface Facilities Area is shown in figure 1-2. Personnel and materials are transported underground from the Surface Facilities Area to the underground workings by a combination of rail mounted drift winders via the men and materials drift and mobile vehicles.

Access to Surface Facilities Area is via Summerhill Drive, near the township of Wangi Wangi. The primary items of existing approved infrastructure include mine infrastructure (i.e. portals, drive houses, ventilation shafts and fan houses, bore holes, switch rooms, diesel, oil and water storage tanks and an emergency coal stockpile area), coal handling plant (CHP) (i.e. breakers, crushers, feeders, storage bins and conveyors), workshop and administration infrastructure.

Coal handling, processing, and transport

ROM coal produced at Myuna Colliery is transferred from the underground workings to the surface CHP via underground conveyors. Coal is delivered to the ROM bin and then fed through a primary screen before being transported to a rotary breaker. From the rotary breaker, the coal travels through feeders, screens and into crushers before being loaded into a final product bin. From the final product bin, the coal is loaded onto the Origin Energy-owned enclosed overland conveyor and delivered to the Eraring Power Station.

In the event of break downs or servicing of the enclosed overland conveyor, Centennial Myuna temporarily stores coal in a dedicated stockpile area in the north of the Surface Facilities Area, as shown in figure 1-2.

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Watercourse
- 10m Contours

GHD

Centennial Myuna

Centennial Myuna Pty Ltd
Water Management Plan

Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

Surface Facilities Area and Licensed Discharge Points

Figure 1-2

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_002_SurfaceFacilities_LDPs_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009. Nearmap: Aerial dated 20160504, extracted on 20160720. Created by: smacdonald

Coal is recovered from the stockpile by front end loader, loaded onto trucks and dumped into a CHP reclaim hopper for transportation to Eraring Power Station via the enclosed overland conveyor, as required.

As Myuna Colliery does not wash ROM coal, there is no coal reject material produced on site. A negligible amount of waste rock from the CHP is transported from the waste bin to the Awaba Waste Management Facility for disposal.

1.1.2 Coal production

The approved Project Area encompasses the coal measures and three seams previously mined at Myuna Colliery and as such, includes some previous workings and areas requiring new workings to be developed. Mining operations continue to be carried out using continuous miner methods in the Wallarah, Great Northern and Fassifern coal seams. Product coal is produced at a maximum rate of up to 3 Mtpa of ROM coal.

1.1.3 History

A summary of the history of the Myuna Colliery is provided in Table 1-1.

Table 1-1 History of Myuna Colliery

Date	Event
1977	Construction of Eraring Power Station commenced.
1977	Myuna Colliery granted development consent (SH 110/148) to supply coal to Eraring Power Station.
1979	Development of Myuna Colliery commenced.
1982	Coal production at Myuna Colliery commenced at a maximum rate of 1.3 Mtpa of ROM coal.
2002	Centennial purchased Myuna Colliery as part of the Powercoal acquisition.
2012	Centennial Myuna received PA 10_0080 for the continuation of mining up to 2032 at a maximum rate of 2 Mtpa of ROM coal and a maximum of 210 full time employees.
2015	Centennial Myuna received a modification to PA 10_0080 (MOD 1) allowing an increase in production to a maximum rate of 3 Mtpa of ROM coal and a maximum of 300 full time employees.

1.2 Approvals and licensing requirements

1.2.1 Project approval

The WMP addresses specific water components of the conditions of development consent PA 10_0080 (MOD 1), which was granted in February 2015. The relevant requirements of the WMP are outlined in Table 1-2, along with the sections of the WMP where each of these have been addressed.

Table 1-2 Project approval 10_0080 (MOD 1) conditions

Condition		Where addressed
Schedule 3 22.	The Proponent shall prepare and implement a Water Management Pan for the surface facilities sites to the satisfaction of the Secretary and in consultation with NOW, DRE and LMCC. This plan must:	Section 1
(a)	Be prepared by suitably qualified and experienced persons whose appointment has been approved by the Secretary.	Section 1
(b)	Be submitted for approval to the Secretary within seven months of the date of this approval.	Section 1
(c)	Include: A Site Water Balance. An Erosion and Sediment Control Plan. A Surface Water Management Plan. A Groundwater Monitoring Program. A Surface and Ground Water Response Plan.	See below
Site Water Balance		
Schedule 3 23. (a)	The Site Water Balance must include details of: Sources and security of water supply. Water use on site. Water management on site. Any off-site water transfers. Groundwater transfers from the underground operations to the surface.	Section 3
(b)	Investigate and implement all reasonable and feasible measures to minimise potable water use from the town water supply and to reuse and recycle water.	
Erosion and Sediment Control Plan		
Schedule 3 24. (a)	The Erosion and Sediment Control Plan must: Be consistent with the requirements of the *Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries* (DECC 2008, or its latest version).	Section 3 Section 5
(b)	Identify activities that could cause soil erosion and generate sediment particularly in relation to activities near waterways.	

Condition		Where addressed
(c)	Describe the location, function, and capacity of erosion and sediment control structures.	
(d)	Describe what measures would be implemented to maintain the structures over time.	
(e)	Describe the sediment and erosion control measures to be implemented for all activities undertaken at the site.	
Surface Water Management Plan*		
Schedule 3 25. (a)	The Surface Water Management Plan must: Include detailed baseline data on surface water flows and quality of Wangi Creek.	Section 2 Section 4 Section 5
(b)	Provide a geomorphic description of Wangi Creek up and downstream of the mine water discharge point.	Section 5.4
(c)	Detail surface water quality and stream health assessment criteria, including trigger levels for investigating any potentially adverse surface water impacts.	Section 6
(d)	Provide a program to monitor: Surface water discharges from the surface facilities sites. Stream health, channel stability, water flows and water quality within Wangi Creek. Water quality of Lake Macquarie.	Section 4
(e)	Investigate mitigation and management measures to prevent/limit any incision and degradation of the channel of Wangi Creek from mine discharge water.	Section 3
(f)	Include a detailed review of water management at the Myuna Colliery surface facilities site, with reference to the water storages within the dirty water management system and in consultation with EPA, to: Determine whether the capacity, integrity, retention time and management of the dirty water storages (particularly the CHP Dam) are sufficient to ensure that water discharged from the site. Meets all relevant ANZECC water quality criteria, including for metals and suspended solids.	Section 5

Condition		Where addressed
	Assess all reasonable and feasible options for reducing salt load and/or salt concentration for discharges into Wangi Creek. Assess appropriate options to improve storage and retention times in accordance with *The Blue Book – Managing Urban Stormwater (MUS): Soils and Construction* (Landcom). Propose upgrades of the dirty water storages sufficient that discharges meet all relevant ANZECC criteria. Propose any other appropriate changes to the water management system.	
(g)	Identify and assess practical measures to minimise potable water consumption, maximise recycled water use and improve the management of sewage and surface rainfall runoff for the project, including quantifying the abatement potential of identified measures and their related costs and benefits.	Section 3
Groundwater Monitoring Program		
Schedule 3 26. (a)	The Groundwater Monitoring Program must include: Baseline data of groundwater levels (including alluvial and weathered rock aquifers), yield and quality in the region, and any privately owned groundwater bores that may be affected by mining operations on site.	Section 2.4 Section 5.3 Section 4.3
(b)	Groundwater assessment criteria based upon analysis of baseline data for groundwater, surface water, including trigger levels for investigating any potentially adverse groundwater impacts.	Section 6
(c)	A program to monitor and/or validate the impacts of the project on alluvial and coal seam aquifers, and any groundwater bores.	Section 4.3 Section 7
Surface and Ground Water Response Plan		
Schedule 3 27. (a)	The Surface and Ground Water Response Plan must describe what measures and/or procedures would be implemented to: Respond to any exceedances of the surface water, stream health, and groundwater assessment criteria.	Section 6 Appendix A
(b)	Mitigate and/or offset any adverse impacts on riparian vegetation located within and adjacent to the site.	Section 6

Condition		Where addressed
Environmental Management, Reporting and Auditing		
Schedule 5 2. (a)	The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: detailed baseline data;	Section 5
(b)	A description of: the relevant statutory requirements (including any relevant approval, licence, or lease conditions). any relevant limits or performance measures/criteria. the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 1.2 Section 6
(c)	A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 3 Section 4 Section 6
(d)	A program to monitor and report on the: impacts and environmental performance of the project. effectiveness of any management measures (see c above);	Section 4
(e)	A contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 6.1
(f)	A program to investigate and implement ways to improve the environmental performance of the project over time;	Northern Operations Regional Water Management Plan
(g)	A protocol for managing and reporting any: incidents. complaints. non-compliances with statutory requirements; and exceedances of the impact assessment criteria and/or performance criteria; and	Northern Operations Regional Water Management Plan

Condition		Where addressed
(h)	A protocol for periodic review of the plan.	Northern Operations Regional Water Management Plan

** The Secretary may require the Proponent to implement upgrades and other changes identified under paragraph (f), in accordance with condition 4 of schedule 2. EPA may also require measures to be implemented under the terms of the site's environment protection licence.*

1.2.2 Statement of commitments

The environmental assessment for the 2012 project approval (AECOM, 2011) included a Statement of Commitments detailing additional environmental management measures proposed by Centennial Myuna for the project. Commitments made that are relevant to operational water management at the Myuna Colliery are summarised in Table 1-3.

Table 1-3 Water management actions from Statement of Commitments

Commitment	Action	Where addressed
Operations carried out in a manner that minimises potential impacts to groundwater	Within six months of project approval, a variation to EPL 366 will be lodged with the OEH to: Combine licensed discharge points LDP001 and LDP002 into a single licensed discharge point, LDP B, with a combined discharge volume of 13 ML/day. Establish a licensed discharge point at the Emergency Coal Stockpile Sediment Dam, LDP A, for event-based discharges where rainfall exceeds 80 mm in 24 hours. Enable volumetric exceedances during rainfall events greater than: 15 mm in the preceding 24 hours at LDP B. 140 mm in the preceding 24 hours at LDP A.	Section 1.2.3
	The Proponent (i.e. Myuna Colliery) will undertake an investigation of water reuse options at Myuna Colliery within six months of Project Approval	Section 3

1.2.3 Environment protection licence

Myuna Colliery currently holds environment protection licence (EPL) 366, which includes requirements to monitor water quality and quantity of discharges from the site. Water is currently licensed to be discharged from the mine through the following licensed discharge points (LDPs), as shown in

Figure 1-2:

- LDP 10 (A) – Emergency discharge to Wangi Creek via the Emergency Coal Stockpile Dam for event-based discharges where rainfall exceeds 140 mm in the preceding 24 hours.
- LDP 9 (B) – Discharge of up to 13 ML/day to Wangi Creek via the Mine Water Settling Pond 3.

Water quality concentration limits specified by EPL 366 for LDP 10 and LDP 9 are presented in Table 1-4.

Table 1-4 LDP 10 and LDP 9 water quality concentration limits

Parameter	100th percentile concentration limit
Oil and grease	10 mg/L
pH	6.5–8.5
Total suspended solids (TSS)	50 mg/L

1.2.4 Groundwater bore licences

Centennial Myuna currently holds a Water Access Licence (WAL) 41560 under the Water Management Act 2000, This licence entitles a volume for extraction from the North Coast Fractured and Porous Rock Groundwater Source, of up to 4,380 ML/year from underground workings via the miscellaneous works approval 20MW065029. Groundwater extraction activities from the mine were previously permitted through bore licence 20BL172565 under the Water Act 1912.

1.2.5 Water Management Plan objectives

The WMP has been developed to address the approvals and licensing requirements presented in Section 1.2 through the completion of the following:

- Collation and review of existing information and studies relating to the operation of the water management system at Myuna Colliery.
- Establish an understanding of the water management system at the site.
- Categorise the existing conditions that are specific to water management requirements.
- Develop catchment plans for the site.
- Identify the clean and dirty water management systems.
- Undertake a review of the capacity of the dirty water surface storages in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2* (DECC, 2008).
- Determine the suitability of waterway conditions.
- Undertake a water quality assessment and review of existing water quality assessment criteria.
- Manage water discharge from site, in terms of volume and quality, to a level that is acceptable for environmental management and community expectations.
- Minimise water discharges from the premises by maximising, where practicable, opportunities for the reuse and recycling of water on site.

- Manage discharge to natural waterways in accordance with EPL 366 conditions or as agreed with the EPA
- Determine the future water management requirements.
- Review and develop water monitoring requirements.

2. Environment

2.1 Climate

2.1.1 Rainfall

Myuna Colliery has site-based rainfall and weather stations located on site. Site-specific rainfall data has been collected daily since 2005. For assessments requiring a large historical set of rainfall data (i.e. greater than 50 years), daily rainfall data is obtained from the Scientific Information for Landowners (SILO) database operated by the Queensland Department of Science, Information Technology, and Innovation. SILO patched point data is based on historical data from a particular Bureau of Meteorology (BOM) station with missing data 'patched in' by interpolation with nearby stations.

Rainfall data was obtained from the SILO database for the Toronto WWTP Station (BOM station number 61322), located approximately 8 km north-east of Myuna Colliery. The rainfall data was selected based on the length and quality of the data record and proximity to the site.

Figure 2-1 presents the historical SILO patched point daily rainfall data from the Toronto WWTP Station between 1901 and 2016.

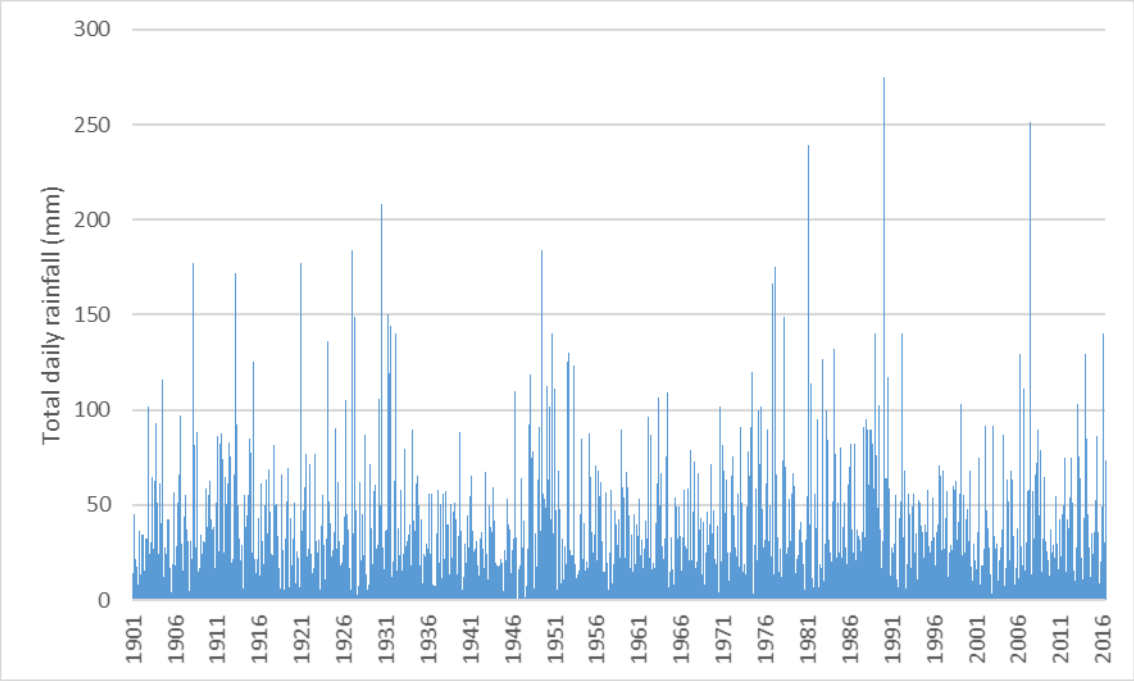


Figure 2-1 Historical daily rainfall at Toronto WWTP Station

The annual statistics associated with Figure 2-1 are:

- Minimum rainfall total – 595 mm in 1944.
- Average rainfall total – 1,116 mm.
- Median rainfall total – 1,062 mm.
- Maximum rainfall total – 2,059 mm in 1990.

2.1.2 Evaporation

Evaporation estimates are not collected by the meteorological station at Myuna Colliery. Evapotranspiration has been collected historically however no basis for this data has been detailed. Historical SILO patched point daily evaporation data was also obtained for the Toronto WWTP Station, which has been interpolated from long term averages from 1901 to 1969 and interpolated daily averages from 1970 to 2016. This data was reviewed, and average monthly evaporation rates were determined. The average daily evaporation rates are presented in Figure 2-2.

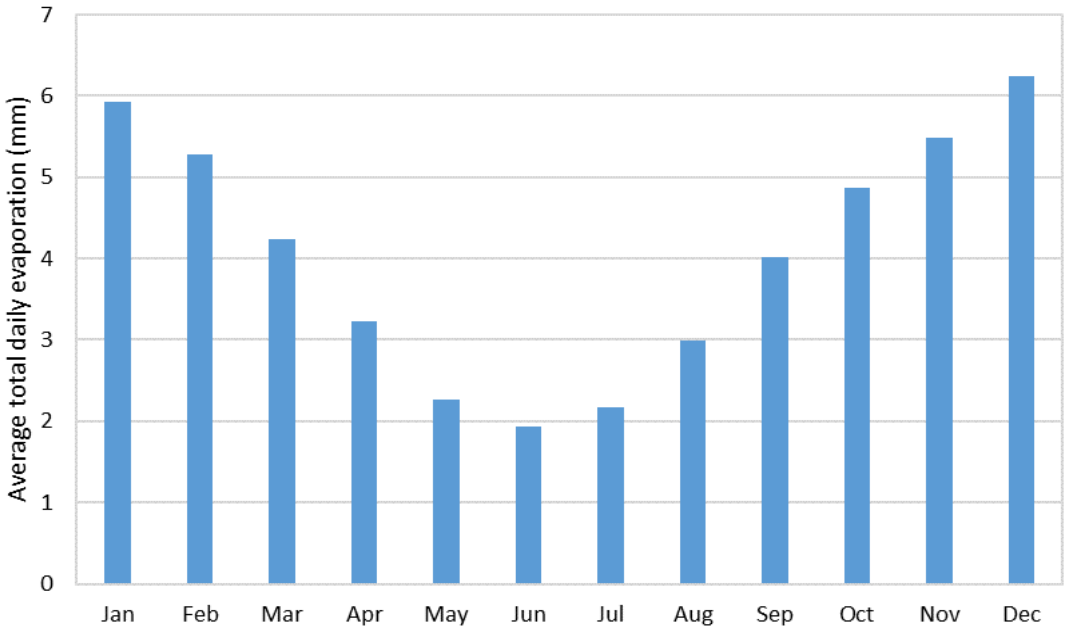


Figure 2-2 Average daily evaporation each month at Toronto WWTP Station

Total average annual evaporation is approximately 1,471 mm, compared to the annual average rainfall total of approximately 1,116 mm. This gives an annual deficit (difference between annual rainfall and annual evaporation) of approximately 355 mm.

2.2 Topography and hydrology

The Surface Facilities Area is located within the catchment of Wangi Creek, which flows into Lake Macquarie. Most existing workings in the Wallarah, Great Northern and Fassifern coal seams are located beneath Lake Macquarie. Ground elevations range from 0 m AHD to approximately 70 m AHD within the Myuna Colliery holding boundary.

The Surface Facilities Area at Myuna Colliery is in the lower reaches of Wangi Creek. Water discharged from Myuna Colliery enters the estuarine reach of Wangi Creek before discharging into Lake Macquarie. Upstream of the Surface Facilities Area, the creek is a freshwater environment. Adjacent to the Surface Facilities Area, Wangi Creek is reasonably well-defined, with a width in the order of 5 m and vegetated along the invert of the creek.

Downstream of LDP 10 and LDP 9, discharges flow through a piped network prior to outflowing into an earthen channel. This channel runs parallel to Wangi Creek for approximately 200 m. The channel is constrained by fill material along the left bank, which is steep and up to 4 m to 5 m high. Along the left bank, a levee type structure exists which separates flows from the LDP discharge channel and flows in Wangi Creek.

Wangi Creek is the only watercourse directly influenced by mine water discharge from Myuna Colliery. However, mine workings are located beneath several other watercourses as well as Lake Macquarie.

The watercourses and catchments within the approved Project Area is shown on Figure 2-3.

2.3 Geology

The geology within the approved Project Area affects both the mining operations and management of water. Water management is affected by the stratigraphy, which influences the potential for infiltration into the workings. The location of regional aquifers in relation to the workings also affects the management of water on-site.

The Newcastle Coalfields Regional Geology 1:100,000 map (NSW Department of Mineral Resources, 1995) indicates that land within the approved Project Area is characterised by outcropping of Triassic Age Munmorah Conglomerate across the onshore areas and Quaternary sand and mud deposits across Lake Macquarie. These deposits are underlain by the late Permian Newcastle Coal Measures.

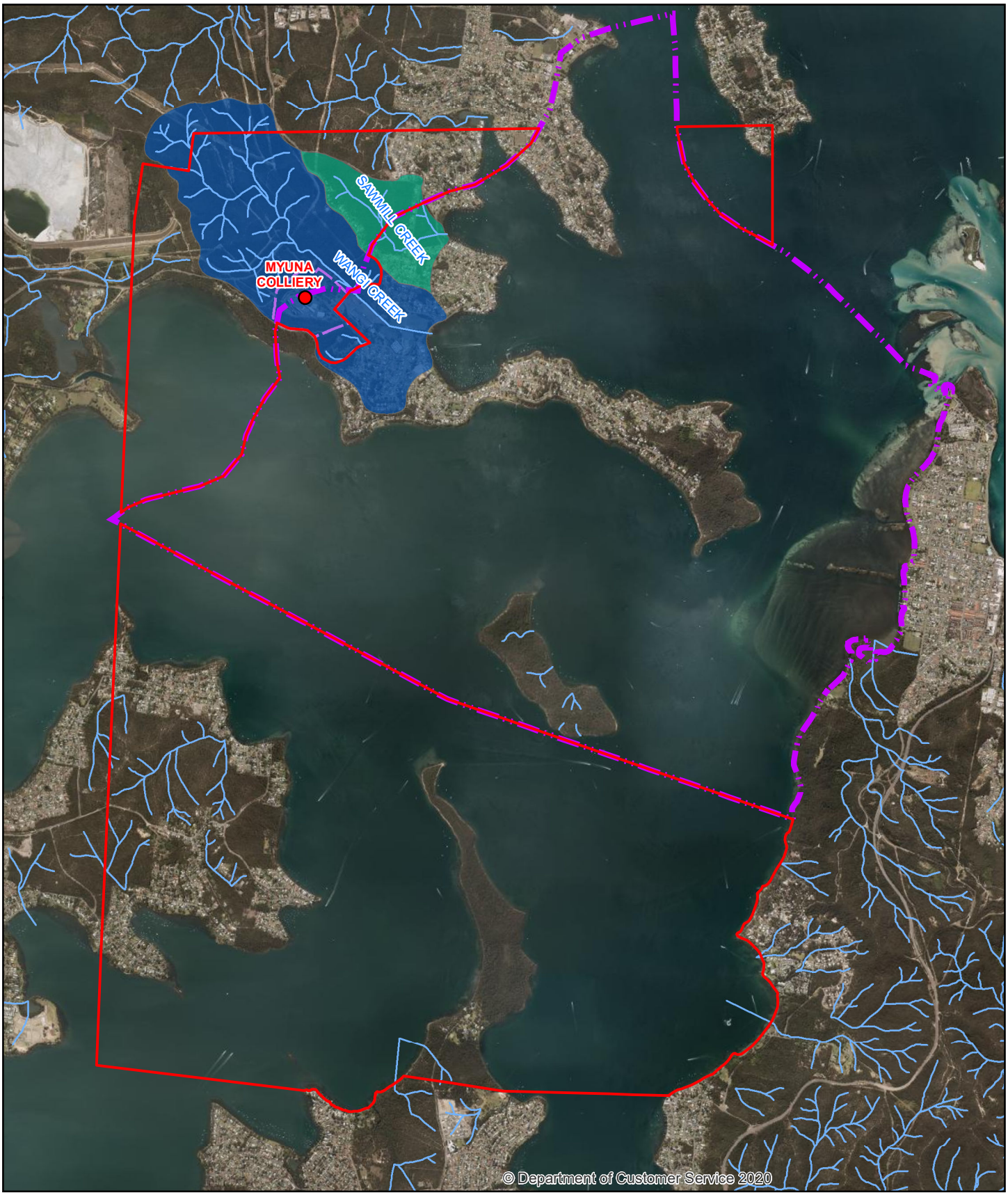
The stratigraphic sequence at Myuna Colliery is outlined in Table 2-1.

Table 2-1 Stratigraphic sequence

Period	Stratigraphy		Unit/lithology
	Group	Subgroup	
Quaternary			Alluvium
Triassic	Narrabeen	Clifton	Munmorah Conglomerate Dooralong Shale
Permian	Newcastle Coal Measures	Moon Island Beach	Vales Point Seam Karignan Conglomerate Wallarah Seam Mannering Park Tuff Teralba Conglomerate Great Northern Seam Karingal Conglomerate
		Awaba Tuff	Awaba Tuff
		Boolaroo	Fassifern Seam

The coal seams mined at Myuna Colliery are part of the late Permian Age Newcastle Coal Measures, which dip to the southeast at a grade of generally less than 1 in 20. The Moon Island Beach, Awaba Tuff and Boolaroo Formations of the Newcastle Coal Measures outcrop and/or subcrop to the north-west, north, north-east, east, and south-east of the Myuna Colliery approved Project Area.

The Wallarah Seam ranges in thickness from between 2 m and 3 m across the approved Project Area and is predominantly overlain by Karignan Conglomerate, described as a medium to coarse grained pebble conglomerate. The Dooralong Shale makes up the roof of the Wallarah Seam in the east and the Wallarah Seam is underlain by Mannering Park Tuff claystone/mudstone.



LEGEND

- Project approval boundary
- Development consent boundary
- Surface Facilities Area
- Watercourse
- Sawmill Creek Catchment
- Wangi Creek Catchment
- Footprint

Paper Size A4

0 180 360 720 1,080 1,440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Water Management Plan

Watercourses within Approved Project Area

Job Number
Revision 1
Date 17 Aug 2021

Figure 2-3

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\2219224_WMP_003_Watercourses_A.mxd

Data source: © LPMA: DCTB & DTDB, 2012; GSS: Aerial; Centennial: Boundaries. Created by:

The Great Northern Seam generally varies in thickness between 2.5 m and 3 m across the approved Project Area. Teralba Conglomerate tends to form the roof of the Great Northern Seam in most areas, although this is replaced by shale, mudstone, or tuffaceous siltstones in some areas. The Awaba Tuff siltstone/claystone underlies the Great Northern Seam in most areas.

Both the Wallarah and Great Northern seams tend to split, deteriorate, and thin along the north/south zone to the west and south-west of the approved Project Area.

The Fassifern Seam is the most extensive coal reserve throughout the lease area, with a thickness more than 6 m in areas where the seam is not split. The seam is at its greatest thickness at Wangi Point. Between the Wangi Peninsula and Pulbah Island the seam splits in two. The lower split is the preferred mining section in this area. The splits coalesce to the south of Pulbah Island and beyond the approved Project Area. Awaba Tuff generally overlies the Fassifern Seam, while the floor is composed of claystones. A schematic of the coal seam stratigraphy and the mining process has been presented in Figure 2-4 (Centennial Myuna, 2014).

2.4 Hydrogeology

The groundwater sources in the vicinity of Myuna Colliery are generally low yielding and predominantly within the Quaternary alluvium, weathered and/or fractured rock and coal seams.

The Quaternary material includes alluvium, which occurs along the watercourses draining into Lake Macquarie and lake sediment underlying Lake Macquarie. The alluvium forms and unconfined shallow aquifer with a thickness of up to 10 m.

Groundwater flow within the Triassic and Permian rocks underlying the Myuna Colliery approved Project Area is predominantly within the coal seams. The overburden and interseam strata tend to have very low hydraulic conductivities (unless fracturing creates a secondary permeability).

2.4.1 Groundwater users

A search of the NSW groundwater bore database was undertaken to identify registered bores within a 3 km radius of the Myuna Colliery underground workings. The search of the database identified 59 bores, most of which are used to extract groundwater from the sandy strata on the eastern side of Lake Macquarie. The remaining bores extract groundwater from the weathered sandstone. The shallow bores were predominantly used for domestic purposes and ranged from depths of 1 m to 10.1 m below ground level.

Approximate groundwater bore locations identified from searches of the NSW groundwater bore database are shown on Figure 2-5. Bore details are provided in the Northern Operations RWMP.

2.4.2 Groundwater dependant ecosystems

Potential groundwater dependent ecosystems (GDEs) within the vicinity of Myuna Colliery have been mapped in the *Groundwater Dependent Ecosystem Atlas* (BOM, 2015). Potential GDEs within 3 km of Myuna Colliery include various vegetation communities that surround Lake Macquarie. Whiteheads Lagoon, Lake Petite and Lake Macquarie are listed by BOM (2015) as potential GDEs.

High priority GDEs are listed in WSPs. The closest high priority GDE listed in the Hunter Unregulated and Alluvial Water Sources WSP are coastal wetlands located approximately 20 km to the north of Myuna Colliery (GHD, 2015b). These are outside the zone of potential influence by the operations.

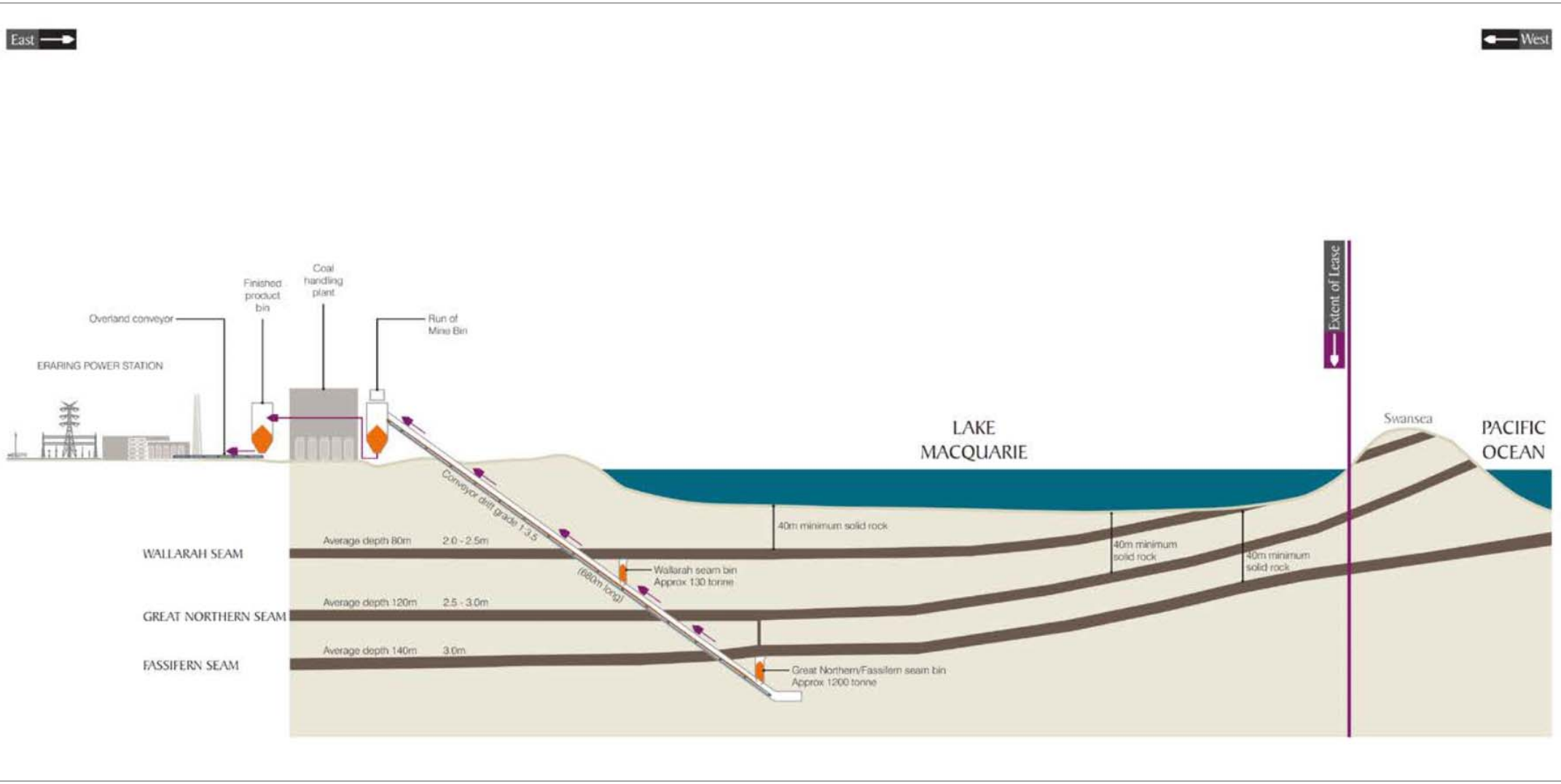
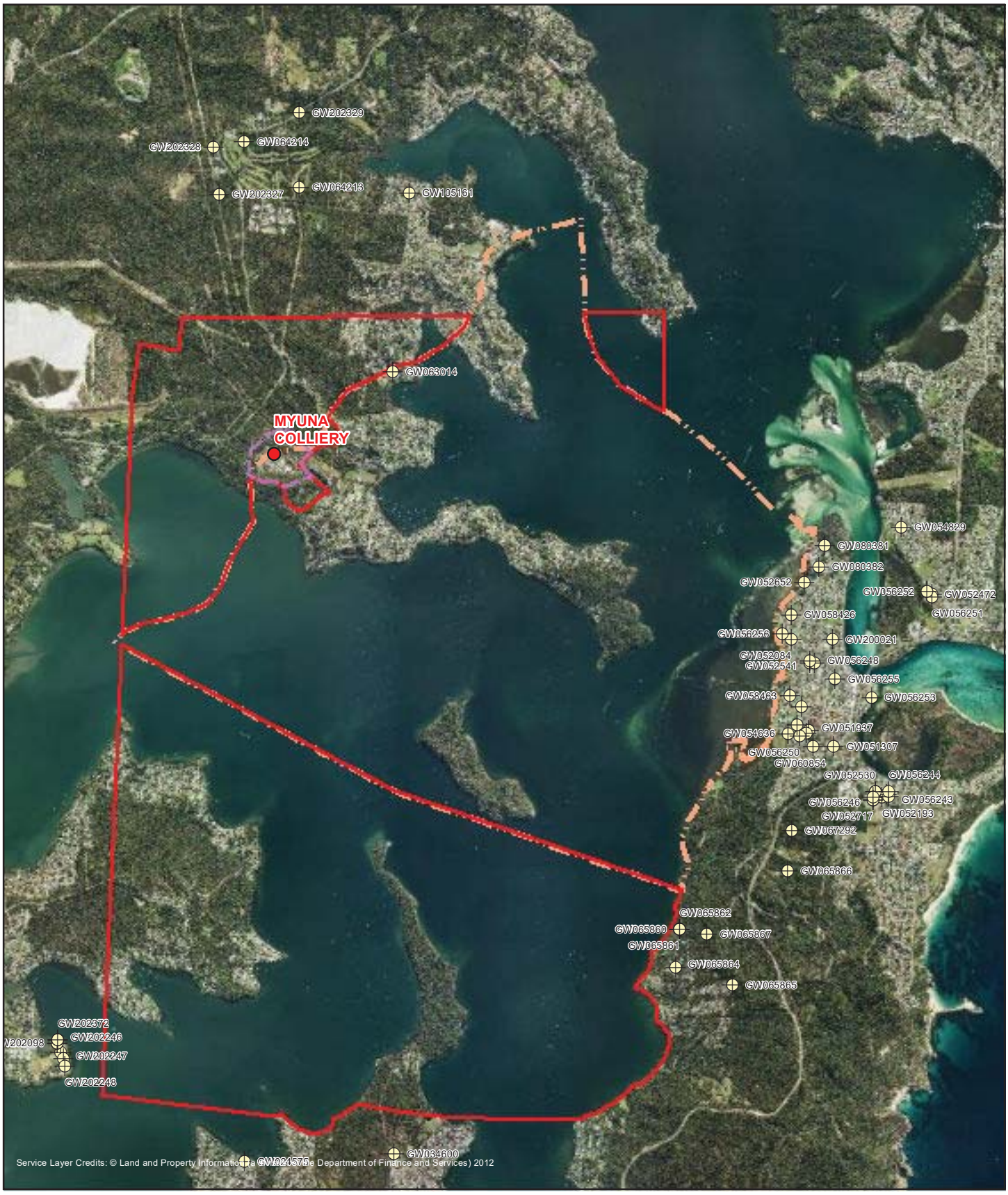


Figure 2-4 Coal seam stratigraphy and mining process (Centennial Myuna, 2014)



LEGEND

- Myuna Colliery Surface Facilities
- Registered bores
- Surface Facilities Area
- Project approval boundary
- Development consent boundary

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Centennial Myuna

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Water Management Plan

NSW groundwater bore database search results

Job Number	22-19224
Revision	A
Date	17 Aug 2016

Figure 2-5

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2219224\Myuna_WMP\2219224_WMP_013_NSWBoreDatabaseSearch_A.mxd

Data source: ESRI: Imagery, 2016; NSW Office of Water: Groundater bores, 2015. Created by: smacdonald

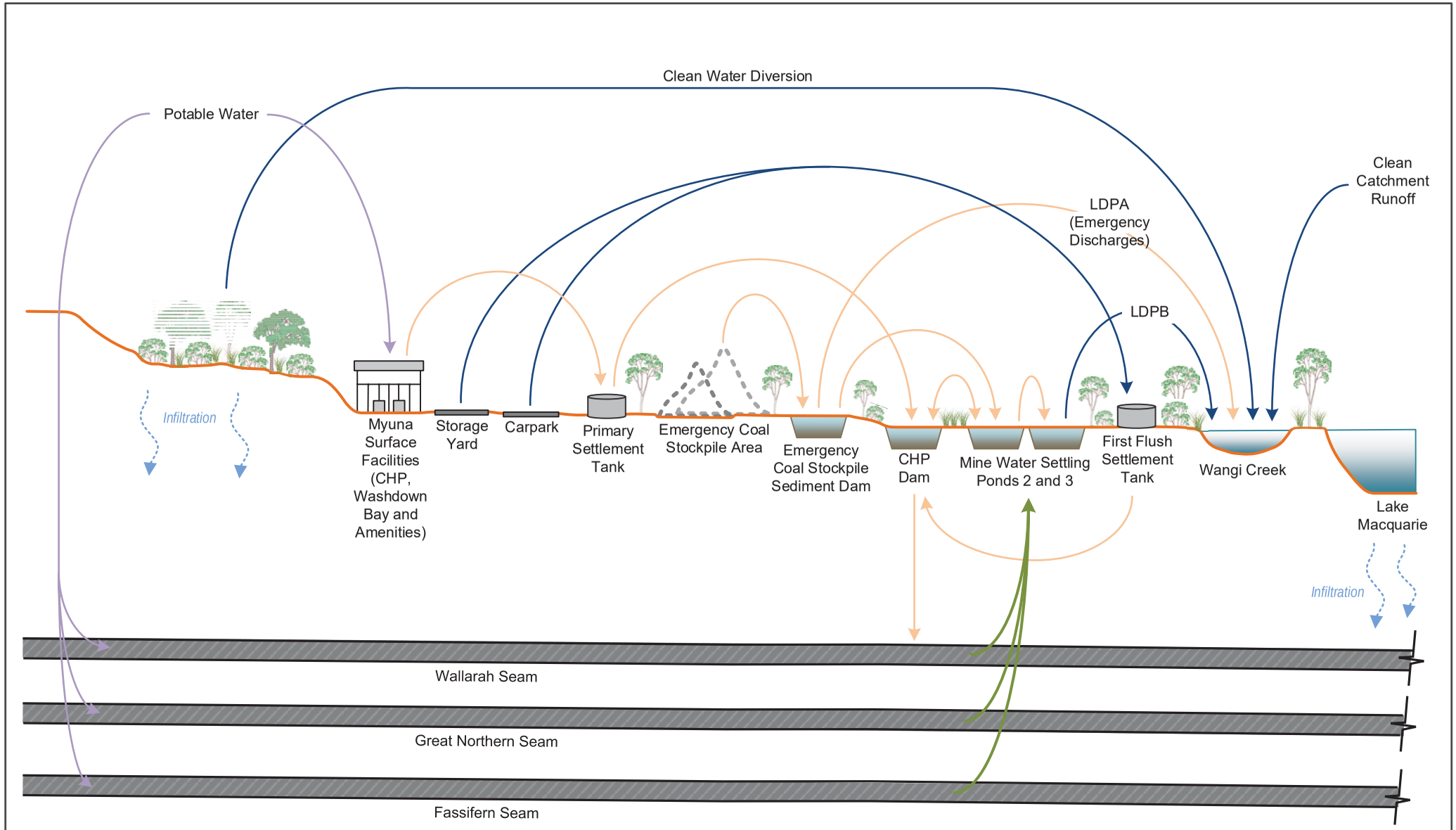
3. Water management

3.1 Water management overview and objectives

The water management system at Myuna Colliery is comprised of clean and dirty surface, potable, waste, and underground elements. Sources of water include potable water supply, rainfall, runoff, and groundwater inflow into the underground mine workings. The primary water demands are for underground operations, machinery washdown, fire-fighting storage and staff amenities.

Surface water runoff from areas where there is no coal storage, transportation, handling or processing or any disturbance, is clean water, as it generally contains negligible concentrations of coal fines or sediments. Runoff is diverted around dirty water and coal-contact catchments to avoid mixing with clean water runoff. Clean water runoff is typically from natural and impervious catchments such as areas of vegetation, sealed roads, and sealed car parks.

Dirty water is runoff from disturbed areas and areas likely to contain suspended sediment, and hydrocarbons. This typically includes workshop and fuel storage areas. Coal-contact water is runoff from catchments where coal storage, transportation, handling, or processing occurs and is managed within the dirty water management system.



Clean water
Potable water
Wastewater
Dirty water
Groundwater

LOCATION	Myuna
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

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Water Management Plan

Water Management Schematic

Centennial Coal

DATE November 2017

Figure 3-1

G:\22\19224\Tech\Visio\Figure_4_4-Myuna_Colliery.vsd

3.2 Surface water management

An assessment of the water management structures associated with the Surface Facilities Area has previously been undertaken by GHD (2012a) and has been summarised in Table 3-1.

Table 3-1 Water management structures

Location	Purpose	Outflow	Water type	Approximate Catchment area (ha)	Capacity (ML)
Workshop Washdown Sump	Capture water from workshop washdown bay and remove hydrocarbons	Primary Settlement Tank	Dirty	0.2	0.25
Primary Settlement Tank	Provides a primary capture and settlement function for the CHP Dam	CHP Dam	Dirty	2.84	0.04
First Flush Tank (GPT)	Emergency fail safe for pollution events in carpark or hardstand	CHP Dam or LDP 9	Clean or Dirty	2.43	0.30
CHP Dam	Receives water from the captured flow in the Primary Settlement Tank.	Underground or overflow to Mine settling pond 2	Dirty	0.93	1.05
Mine Water Settling Pond 2	Receives mine water from the underground, overflows from the CHP Dam and some surrounding runoff.	Mine water settling pond 3	Clean (Mine Water)	0.1	1.80
Mine Water Settling Pond 3	Receives overflows from Mine Water Settling Pond 2.	LDP 9	Clean (Mine Water)	0.1	1.65
Emergency Coal Stockpile Sediment Dam (including additional spill volume)	Receives dirty water from the Stockpile Area and provides a settlement function.	CHP Dam or underground or Overflow via LDP 10	Dirty	2.58	4.55

Of the storages listed in Table 3-1, the First Flush Tank is defined as catering for a clean water inflow. The other storages cater for either a mine or dirty water inflow.

3.2.1 Inputs

The inputs into the surface water system consist of:

- Rainfall in catchment areas (both clean and dirty).
- Transfer of water from underground working and storages.
- Potable water from plant and equipment washdown activities.

3.2.2 Outputs

The locations where the surface water system can discharge from the Myuna Colliery are:

- LDP 10 – Emergency discharge to Wangi Creek via the Emergency Coal Stockpile Dam (only after a rainfall event of over 140 mm in a 24-hour period).
- LDP 9 – Discharge of up to 13 ML/day to Wangi Creek via the CHP Dam and Mine Water Settling Pond 3.

3.2.3 Clean water management

Clean water diversions and pipe network

Clean water diversions are constructed to convey the 20-year average recurrence interval (ARI) storm event and are lined such that erosion within the channel is mitigated. The 20-year ARI design storm event is in accordance with the guidance documented in *Managing Urban Stormwater – Soils and Construction Volume 2E: Mines and Quarries* (DECC; 2008) for non-erosive hydraulic capacity of drainage controls.

Figure 3-2 and Figure 3-3 present the clean water catchments and diversions at Myuna Colliery respectively. Table 3-2 summarises the features of the clean water diversions in place at Myuna Colliery.

Table 3-2 Clean water catchment diversion flows

Diversion location	Purpose	Approximate catchment area (ha)	Estimated channel flow (L/s)
Clean Water Diversion 1	Diverting the south eastern external catchment around the pit top to the clean water drainage network and onto Wangi Creek.	3.10	440
Clean Water Diversion 2	Diverting the southern external catchment to the clean water drainage network and onto the proposed LDP B.	4.80	630
Clean Water Diversion 3	Diverting the western external catchment to the clean water drainage network and onto the proposed LDP B.	1.10	180
Clean Water Diversion 4	Diverting the northern external catchment to clean water drainage network and onto the proposed LDP B.	1.00	170
Clean Water Diversion 5	Diverting the northern external catchment to clean water drainage network and onto the proposed LDP B.	3.40	470
Clean Water Diversion 6	Diverting the western catchment of the Coal Stockpile to Wangi Creek.	2.30	340
Clean Water Diversions 7	Diverting the western catchment of the Coal Stockpile to Wangi Creek.	0.50	90
Clean Water Diversion 8	Diverting the clean water from the internal Haul Road to Wangi Creek.	1.60	250
Clean Water Diversion 9	Diverting the north western external catchment to the clean water drainage network and onto the proposed LDP B.	1.00	200

Surface Facilities Area

The topography surrounding the Surface Facilities Area makes the diversion of external clean catchment runoff critical to an effective water management system. The Surface Facilities Area has a series of five diversions that feed into a stormwater pit and pipe network.

Diversion 1 diverts clean water from the southern area of the surface facilities into a stormwater network which discharges to a drainage line and onto Wangi Creek. This portion of the clean water system includes the workshop and store roof and helipad catchments.

Diversions 2, 3, 4, 5 and 9 include the diversions of catchments around the western and northern aspects of the Surface Facilities Area. These catchment areas are conveyed to LDP 9 via a stormwater network through the middle of the facilities area. Located within this same network are the catchments that contribute to the First Flush Tank. This includes catchments from the carpark, bathhouse and office roof area and runoff from around the washdown bay.

Emergency stockpile area

To reduce the runoff loads on the Emergency Stockpile Dam, clean water diversions have been constructed around the stockpile pad. These diversions, identified as channels 6, 7 and 8, effectively reduce the dirty water catchment to the Emergency Stockpile Area by approximately 55%. These diversions all convey water to Wangi Creek via open channels.

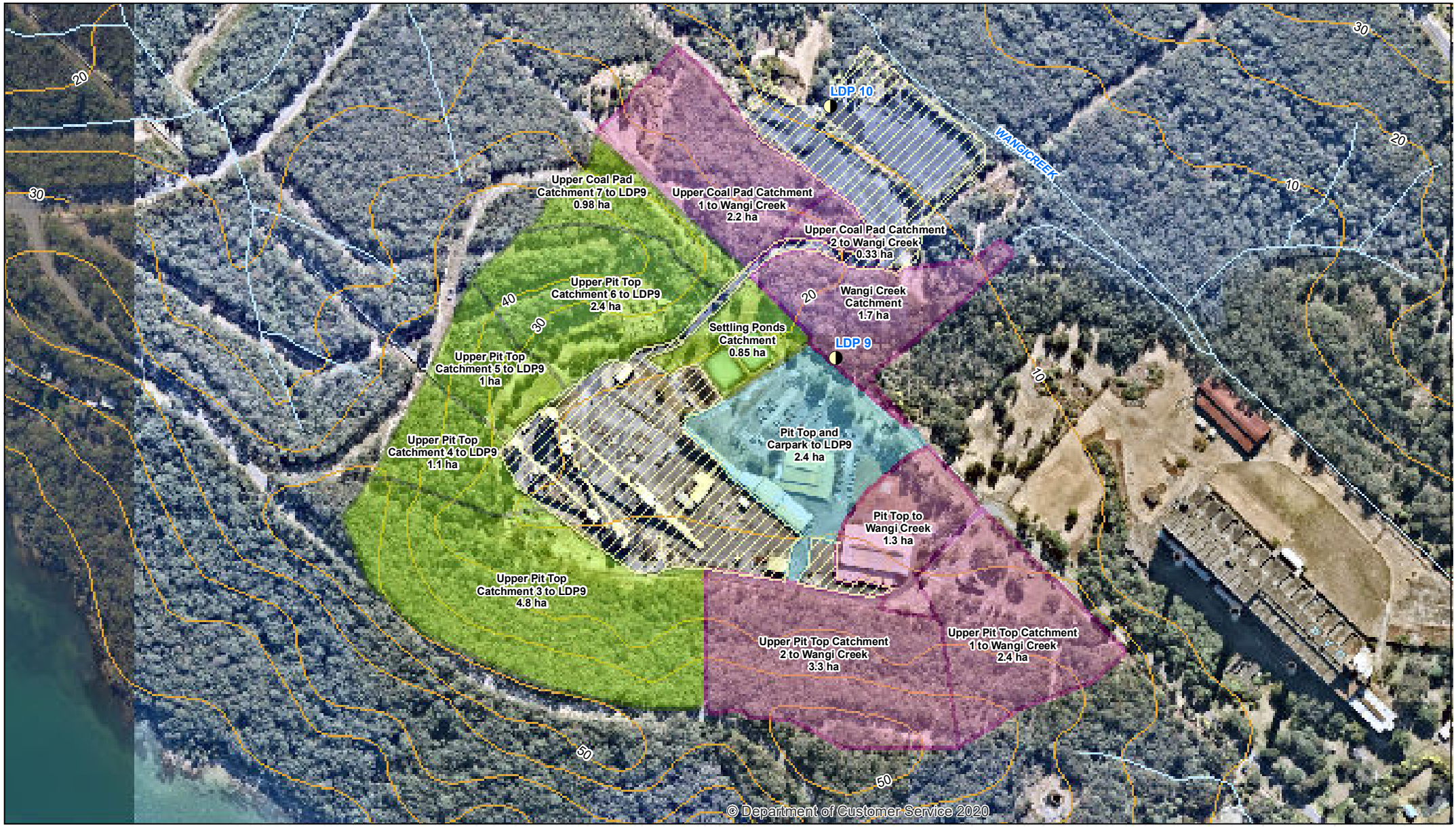
3.2.4 Dirty Water Management

Dirty water management network overview

Dirty water management structures are to be consistent with the requirements of *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2E: Mines and Quarries* (DECC 2008).

Within the Surface Facilities Area there are two key areas where dirty water management is required to mitigate the risk of coal-laden water being discharged from the colliery downstream into Wangi Creek. These two areas can be identified as the CHP processing area and storage yard and the Emergency Stockpile Area.

Dirty water runoff from the CHP processing area and storage yard is directed through a series of open drains, and a drainage network to the Primary Settlement Tank. The Primary Settlement Tank has a limited volume and acts to capture large sediment material conveyed in runoff before discharging into the CHP Dam. The CHP Dam is where the settlement of coal material occurs.



Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- First Flush Tank
- LDP9
- Wangi Creek
- Dirty Water Catchments
- Watercourse
- 10m Contours

Centennial Myuna

Centennial Myuna Pty Ltd
Water Management Plan

Job Number
Revision 1
Date 1 Dec 2021

Clean Water Catchment Areas **Figure 3-2**

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\WMP_004_CleanWaterCatchments_1_20210817.mxd

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 2020,Created by:

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Clean Water Pit and Pipe Network
- Clean Water Diversions
- Watercourse
- 10m Contours

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Job Number
Revision 1
Date 17 Aug 2016

Clean Water Diversion and Stormwater Network

Figure 3-3

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\221812702_WMP_005_CleanWaterDiversions_A.mxd

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 20160504, extracted 20160720; Centennial: Drainage network, 2012. Created by:

Dirty water runoff from the Emergency Stockpile Area is directed to the Emergency Stockpile Dam. This water is transferred to the CHP Dam or directly to the underground workings

The dirty water catchments are shown on Figure 3-4 while the dirty water flow paths and drainage network are shown on Figure 3 5

Workshop Washdown Sump

The Workshop washdown sump receives surface water run-off from the workshop washdown bay, fuels storage area and materials storage. To improve the quality of the water the sump is fitted with an oil water separator system. This is dewatered to the Primary Settlement tank via a float triggered submersible pump.

Primary Settlement Tank

The Primary Settlement Tank has a small capacity and is used to capture sediment material prior to sediment entering the CHP Dam. It receives inflows from a drainage network of surface inlet pits and sheet flow from the surrounding catchment area. The tank has a small pipe which discharges to the CHP Dam and if the capacity if exceeded, the tank will overflow to the CHP Dam.

CHP Dam

The CHP Dam is dewatered to the underground workings water storage by a submersible pump and drainage line. The CHP Dam is managed to prevent overflow into the settlement dams. If overflow occurs the water will mix with settling pond water before being discharged offsite through LDP 9 into Wangi Creek.

- The CHP dirty water catchment and pipe network is presented in Figure 3-6

Emergency Stockpile Dam

Within the western corner of the Emergency Stockpile Area is the Emergency Stockpile Dam Sump which is bound by a bund approximately 1 m high and a storage depth of approximately 0.5 m. The Emergency Coal Stockpile area is used as a dam during extreme rainfall event.

Dirty water runoff from the Emergency Stockpile Area is captured in the Emergency Stockpile Dam. This water is dewatered to the either the CHP dam or directly into the underground workings. If the capacity of the dam is exceeded, then the dam will overflow into Wangi Creek via LDP 10.

The Emergency Stockpile Dam catchment and clean water diversions are presented on Figure 3-7.

Mine Water Settling Ponds 2 and 3

Inflow to the Settling Pond 2 includes pumped water from the underground workings and surface runoff from the surrounding area. Mine Water Settling Pond is constantly overflowing via its concrete weir to Mine Water Settling Pond 3.

Mine Water Settling Pond 3 discharges through an overflow weir outlet. This discharge flows through LDP 9 before reaching Wangi Creek. The volumetric limit for LDP 9 is 13 ML/day. The discharge volumes through LDP 9 can be controlled with the operation of valves and the various underground pumps to the surface. The standard transfer rates per day from underground to the surface are dependent upon operational conditions. Three main transfer pumps can operate simultaneously with a maximum rate of 10.5 ML/day to the surface.

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- 10m Contours
- Watercourse
- CHP Processing Area and Storage Yard
- Emergency Coal Stockpile Area
- Pit Top General

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Job Number
Revision 1
Date 1 Dec 2021

Dirty Water Catchment Areas Figure 3-4

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\WMP_006_DirtyWaterCatchments_1_20210817.mxd

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009. Nearmap: Aerial dated 20160504, extracted 20160720. Created by:

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Dirty Water Pump Locations
- Licensed Discharge Point
- 10m Contours
- Transfer Pipeline
- Dirty Water Pit and Pipe Network
- Watercourse
- Dirty Water Flow Paths
- Injection Point

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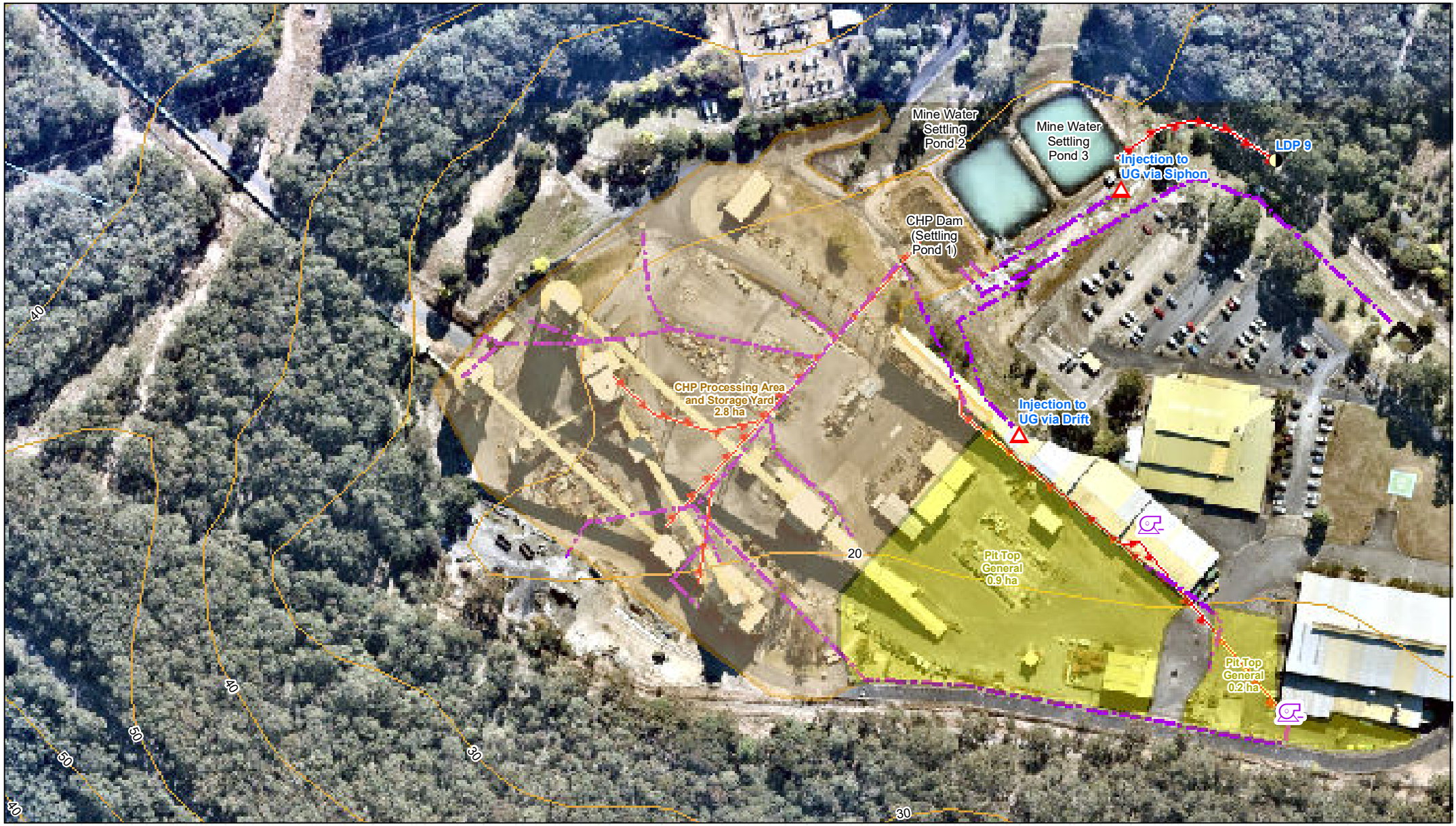
Revision 1
Date 1 Dec 2021

Dirty Water Flow Paths and Pipe Network

Figure 3-5

C:\GIS_Data\Maps\ARCGIS\Deliverables\North\Myuna\WMP Site Updates 2021\WMP_007_DirtyWaterDiversions_1_20210817.mxd

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Centennial: Drainage network, 2012; Nearmap: Aerial dated 20160504, extracted 20160720. Created by:



Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Dirty Water Pump Locations
- Injection Point
- Licensed Discharge Point
- Pit Top General
- CHP Processing Area and Storage Yard
- Dirty Water Pit and Pipe Network
- Dirty Water Flow Paths
- 10m Contours
- Watercourse

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Water Management Plan

Job Number
Revision 1
Date 1 Dec 2021

CHP Dirty Water Catchment and Pipe Network

Figure 3-6

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Data source: © LPMA: DCTB & DTDB, 2007; AECOM: LDP data, 2009; Centennial: Drainage network, 2012; Nearmap: Aerial dated 20160504, extracted 20160720. Created by:

3.2.5 Management of potential contamination

Contamination risks across the general surface areas are mitigated through the establishment of 'dirty' areas for activities with the potential to cause contamination (e.g. re- fuelling), through establishing spill containment areas and by locating emergency spill kits in high-risk areas.

The clean water diversion network redirects water around site and into Wangi Creek. Rooftop and carpark catchments are directed to the First Flush Tank which can either be pumped to the CHP Dam or overflow to LDP 9. To mitigate the risk of a contaminated stormwater system, the First Flush tank is fitted with an oil mop system and can be pumped in the dirty water system, if required.

Run-off from the workshop and Washdown Bay is captured in the Workshop Sump. Oil is removed using by an oil mop. To mitigate this risk of overflow or failure into the clean water system, water levels in the Workshop Sump is monitored through level sensors, inspections are undertaken weekly, and routine maintenance is completed quarterly.

Spills of any hazardous materials, either minor or major are managed in accordance with Myuna Colliery's Pollution Incident Response Plan (PIRP). Clean up equipment and absorbent materials are available from spill stations. They are also available in bulk from the Myuna Colliery store.

3.2.6 Sediment, erosion, and drainage controls

Myuna Colliery will undertake progressive rehabilitation of disturbed areas within the Surface Facilities Area as required Areas of rehabilitation will be inspected regularly and assessed for evidence of erosion or sedimentation. In monitoring of rehabilitated areas, the focus will be on both the level of vegetation establishment and the adequacy of erosion, sediment, and drainage controls.

The condition of erosion and sediment controls will be recorded during site inspections and maintenance will be undertaken as required in response to observed defects. Refer to the Erosion and Sediment Control Plan (GHD, 2013b) for details on sediment loads and location, function, and capacity of sediment control structures. The Erosion and Sediment Control Plan (GHD, 2013b) is consistent with the requirements of the guideline document *Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries* (DECC, 2008).

Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Clean Water Diversions
- Dirty Water Flow Paths
- Emergency Coal Stockpile Area
- Clean Water Pit and Pipe Network
- Watercourse
- 10m Contours

Centennial Myuna

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Water Management Plan

Job Number
Revision 1
Date 1 Dec 2021

Emergency Stockpile Dam Catchment and Clean Water Diversions

Figure 3-7

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Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 20160504, extracted 20160720; Centennial: Drainage network, 2012. Created by:

3.3 Groundwater and underground water management

The underground mine water management system is modified from time to time to adapt to the current mining conditions. Within the current area of operations and within each seam, water in the underground workings is collected and then transferred to underground storages to allow the settling of fines prior to being pumped to the surface.

The underground storages include:

- Great Northern Seam Dam (421 Dam)
- 642 Dam.
- OId Fassifern Dam (720 Dam).
- Wallarah Dam.

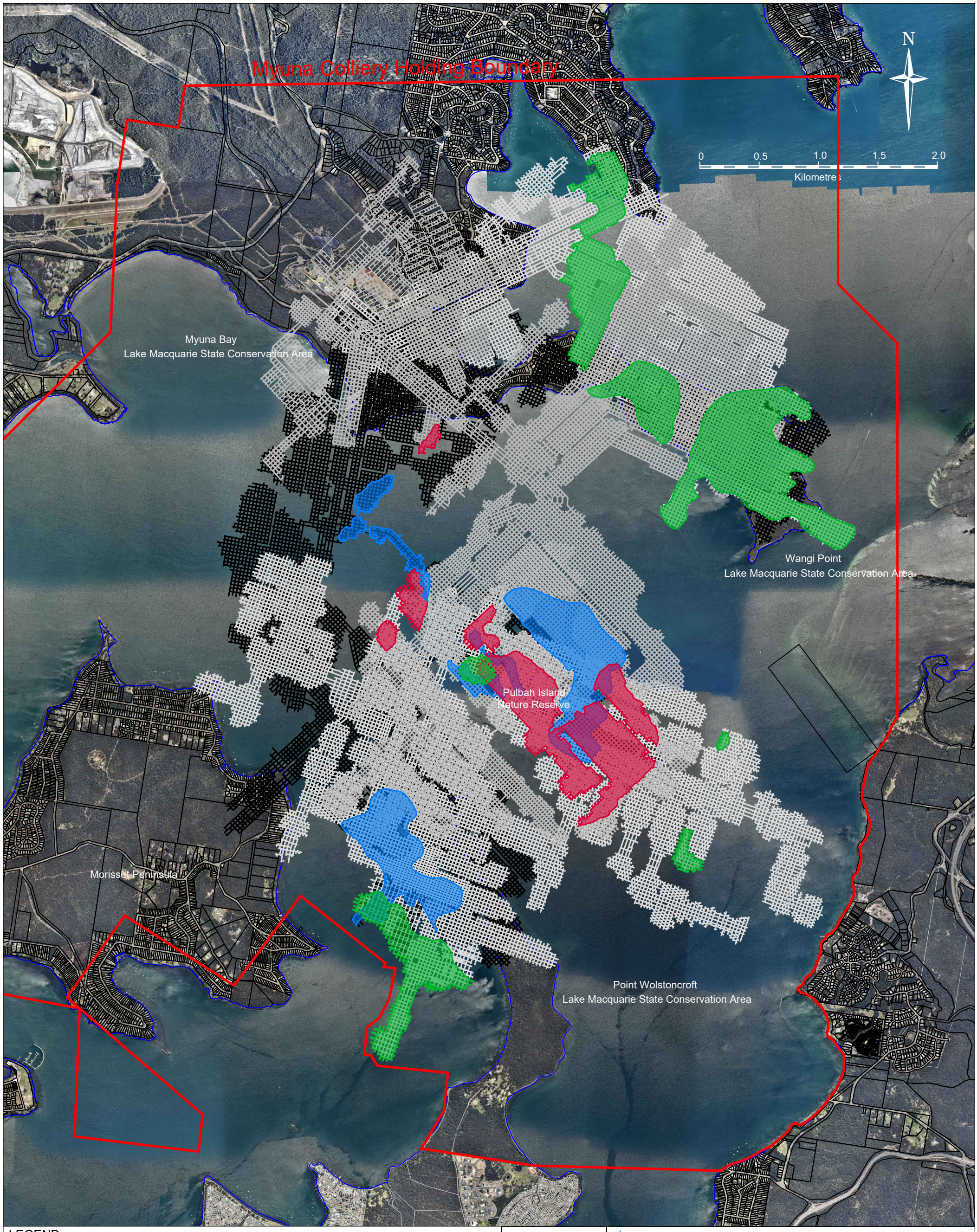
Figure 3-8 shows areas of underground stored water within each seam, as at February 2022

3.3.1 Inputs

The inputs into the underground water system consist of groundwater recharge through natural hydrogeological processes, transfers from the CHP Dam at the surface and potable supply for mining operations.

3.3.2 Outputs

Water from underground is transferred to the surface and is discharged through LDP 9. Myuna Colliery manages water quality in a preliminary way within the underground storages prior to discharge at the surface.



LEGEND

- Myuna Coal Operation Boundary
- Lake Macquarie and Wyong Cadastre
- Fassifern seam workings
- Great Northern seam workings
- Wallarah seam workings

- February 2022 - Wallarah seam Stored water Volume = 1,381 megalitres
- February 2022 - Great Northern seam Stored water Volume = 1,045 megalitres
- February 2022 - Fassifern seam Stored water Volume = 2,184 megalitres

Note: Seam water bodies - Volume calculated using an average seam height of 3m and a recovery ratio of 33.3%.

DRAWN : DH	CENTENNIAL MYUNA — MYUNA COLLIERY
DATE : 13.06.2012	
CHECKED :	TITLE: MYUNA COLLIERY COLLIERY HOLDING SHOWING SURFACE DETAIL AND UNDERGROUND WORKINGS AND AREAS OF STORED WATER February 2022
DATE :	
APPROVED :	
DATE :	
SCALE: Scale Bar	CAD FILE: MY11145_rev6 · PLAN NO.: MY11145 · REV.: 6 · A3

3.3.1 Hydrogeological model

A hydrogeological model to estimate groundwater inflow into the underground workings at Myuna Colliery up to the year 2200 was developed in 2010 by GHD. GHD (2014a) has revised the hydrogeological model for Myuna Colliery as part of the preparation of the Northern Operations Water and Salt Balance (GHD, 2014b).

Figure 3-9 presents the groundwater inflows predicted by hydrogeological modelling for Myuna Colliery. Current groundwater inflows into the active mining areas are estimated to be approximately 6.8 ML/day. Predicted inflows into the mine are expected to peak in 2032 at approximately 7.5 ML/day.

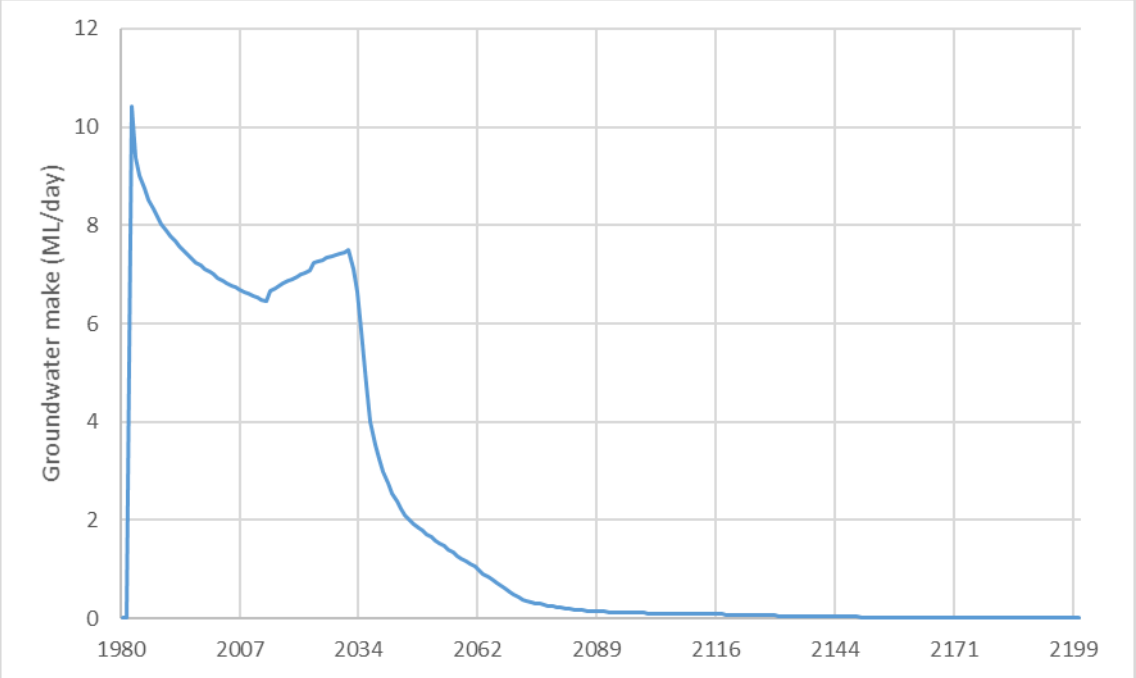


Figure 3-9 Predicted groundwater inflows into underground workings

The hydrogeological model was last review as part of the Annual Groundwater Management Report, prepared in 2020, this also reviewed the potential impact to alluvial aquifers. It was predicted that there will be no drawdown of alluvial aquifers greater than 0.1 m due to mining at Myuna Colliery. The Annual Groundwater Management Report was completed in accordance with 20BL172565 which has been superseded by WAL41560, and is no longer required.

3.4 Potable and wastewater systems

Potable water is provided to Myuna Colliery by HWC, through the Toronto and Wangi Wangi systems. The Wangi Wangi system provides water on demand to the underground workings and Surface Facilities Area while the Toronto system provides a secondary supply and can be switched over to supply the Surface Facilities Area and underground in an emergency.

Wastewater at Myuna Colliery includes grey water and sewage and is also serviced by HWC.

3.4.1 Inputs

The inputs into the site potable and wastewater systems consist of potable water provided to the underground workings, washdown bay, amenities, CHP, and on-site storage tanks.

3.4.2 Outputs

The outputs from the site potable and wastewater system are grey water and sewage from buildings directed to the HWC sewage system.

3.5 Maximisation of water reuse and recirculation

Potable water is provided to Myuna Colliery by HWC. Water reuse options within Myuna Colliery are limited to dust suppression within the Emergency Stockpile Area and firefighting.

At Myuna Colliery there is no permanent stockpile and most trafficked areas are paved. Therefore, opportunities for dust suppression within the Surface Facilities Area are limited.

To reuse water at Myuna Colliery water treatment would be required due to the salt content of the groundwater into the underground workings.

The reuse of captured underground water in mining activities is not possible due to the high electrical conductivity (EC) of the water. This is due to the nature of the groundwater environment and the influence of salt content present within Lake Macquarie.

3.6 Site water balance

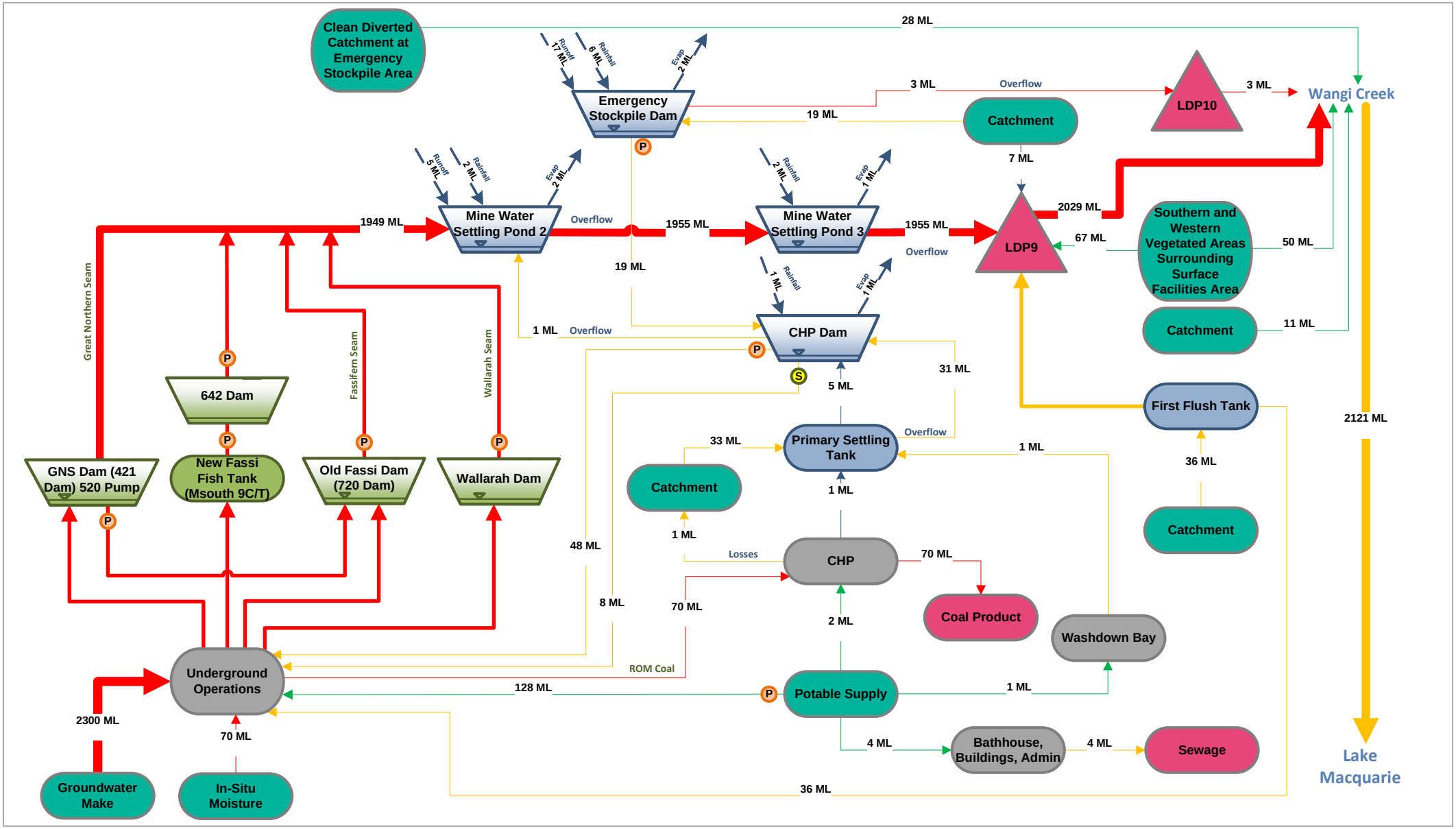
A site water balance was developed for Myuna Colliery in 2010 and has been progressively updated over time (GHD, 2016). The water balance was developed to quantify transfers within the site under existing and future operational conditions using various rainfall patterns.

3.6.1 Annual water balance

A summary of the predicted average annual inputs and outputs for the Myuna Colliery water management system under existing conditions in 2016 is provided in Table 3-3. A water cycle schematic for existing conditions (2021) is shown in Figure 3-10.

Table 3-3 Average Annual Water Balance

Water management element	Volume (ML/year)
INPUTS	
Direct rainfall onto storages and runoff	8.3
Catchment runoff	128.0
Groundwater make	2,474.0
Potable water supply	118.5
TOTAL INPUTS (rounded)	**2,889**
OUTPUTS	
Evaporation	5.1
Discharges through LDP 10	2.1
Discharges through LDP 9	2,712.0
Wastewater system	8.2
CHP losses	1.2
TOTAL OUTPUTS (rounded)	**2,899**
CHANGE IN STORAGE	
Surface water storages	-0.4
Underground water storage	0.2
TOTAL CHANGE IN STORAGE (rounded)	**0**
BALANCE	
Inputs – outputs – change in storage	0



Legend

- Raw water storage
- Mixed water storage
- Inflows
- Treatment process
- Outflows
- Licensed discharge point
- Task
- Category 1
- Category 2
- Category 3
- X (X, X) Mean (10^{th} percentile, 90^{th} percentile)

Centennial Coal Company Limited
Myuna Colliery
Annual water balance - 2021

Water management schematic
Existing conditions (2021)

Project No. 12569542
Revision No. 0
Date 24/03/2022

FIGURE 1

Created by: Tyler Tinkler

\\ghdnet\ghd\AU\Newcastle\Projects\22\12569542\Tech\Myuna_Colliery\Visio\12569542-VIS-Myuna_Colliery_SWB-Water_transfers-2021.vsdm
Print date: 24/03/2022 18:26

3.6.2 Discharge frequency

Discharges through LDP 10 have occurred due to heavy rainfall. The frequency and magnitude of discharges from LDP 10 are expected to remain rainfall-dependant for the life of the site.

The percentiles of the range of daily flow rates predicted to pass through LDP 9 under existing and future conditions are presented in3-11 below. For clarity, the results are shown on a single graph with the current EPL limit of 13 ML/day. Discharges of approximately 7.2 ML/day and 7.8 ML/day for existing and future conditions respectively, consisting predominantly of groundwater make, were modelled to occur for over 80% of days. Discharge greater than this is attributable to the variation in direct rainfall and runoff contributing to storages due to the wide range of possible rainfall conditions modelled.

The maximum discharge modelled was approximately 31 ML/day for both existing and future conditions. The maximum discharge under both existing and future conditions was modelled to occur on less than 0.1% of days. Discharges greater than the current EPL limit of 13 ML/day were predicted to occur on less than 2% of days in the year for both existing and proposed conditions.

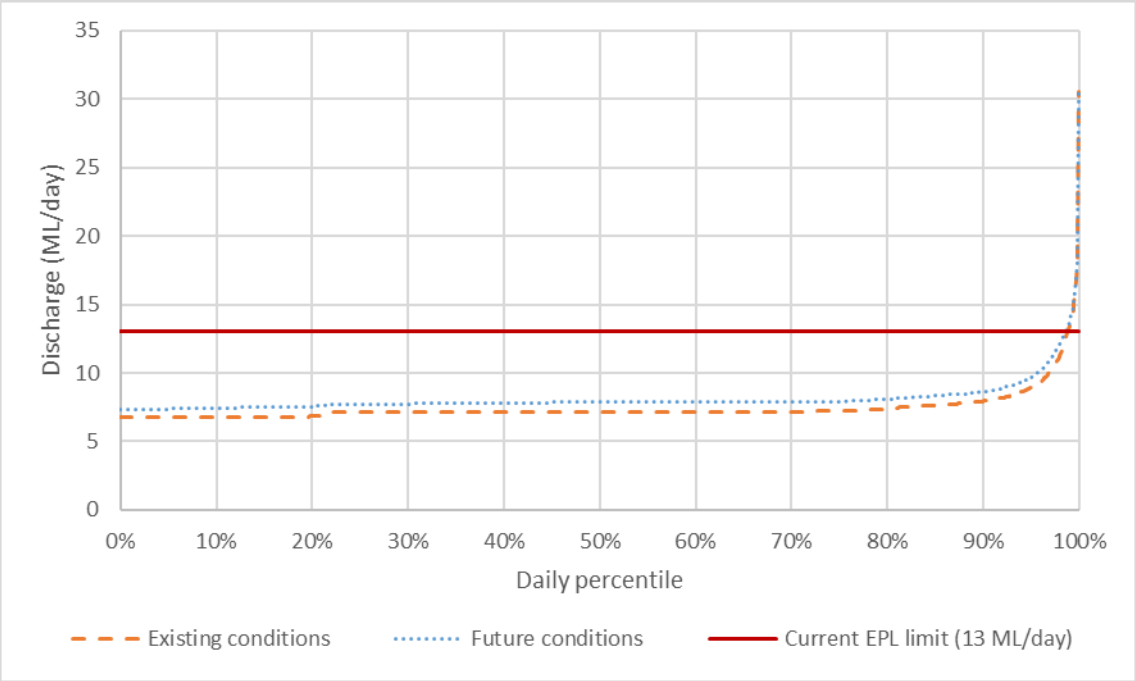


Figure 3-11 Predicted daily discharges from LDP 9

4. Monitoring requirements

4.1 Inspections

Site inspections are completed by the Centennial Myuna Environment and Community Coordinator and occur weekly and following rainfall events exceeding 40mm in 24 hours.

An example of a self-audit is undertaking the following activities:

- Walking around the site systematically.
- Inspecting water management and sediment control structures for capacity, structural integrity, and effectiveness.
- Recording and reporting on the condition of each water management and sediment control structure in place.
- Recording where around the site sediment is deposited.

Corrective actions of the water management and sediment control structures will be implemented when visual defects are observed.

4.2 Surface water monitoring

Surface water quality at Myuna Colliery is currently monitored at the following locations:

- Upstream – located on Wangi Creek approximately 500 m upstream of LDP 9.
- Downstream – located on Wangi Creek approximately 180 m downstream of LDP 9.
- Wangi Lake – located in Lake Macquarie.

The locations of surface water quality monitoring sites are shown in Figure 4-1. All sites are monitored monthly. Water quality parameters are summarised in Table 4-1.

Table 4-1 Surface water quality monitoring parameters

Location	Frequency	Parameter
Upstream, Downstream, Wangi Lake	Quarterly	**Physicochemical** - EC, pH, TSS, turbidity. **Nutrients** - Total phosphorus. **Cations** - Calcium, magnesium, potassium, sodium, sulphur. **Metals (dissolved and total)** - Aluminium, antimony, arsenic, barium, boron, cadmium, cobalt, copper, iron, lithium, manganese, molybdenum, nickel, selenium, titanium, vanadium, zinc **Other parameters** - Oil and grease, silica. **TPH** (Downstream)
T2-5m, T2-10m,	Quarterly As per EPL366 requirements	[1]Manganese (2 samples at each location)

[1]Manganese monitoring at T2 5m and T2 10m is completed to satisfy EPL366 Condition 8 E.1, which is subject to change.

There is no flow rate monitoring at Wangi Creek. Contribution of discharges to Wangi Creek is monitored through LDP 9 and LDP 10 .

LEGEND

- Licensed Discharge Point
- Surface Water Monitoring Location
- Surface Facilities Area
- Watercourse
- Footprint

Paper Size A4

0 55 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Centennial Myuna Pty Ltd
Water Management Plan

Surface water quality monitoring locations

Job Number
Revision 1
Date 1 Dec 2021

Figure 4-2

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Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, 2009. Centennial: Monitoring, 2012; ESRI: Imagery, 2016. Created by:

4.3 Groundwater monitoring

4.3.1 Underground water quality data

The water quality of groundwater transferred from the underground workings to the surface is assessed as required. Monitoring of coal seam aquifers is not possible via boreholes as typically seen at other Centennial sites. This is due to the location of the workings which are primarily under Lake Macquarie or urban residential properties.

4.3.2 Underground water transfers

Daily monitoring of the following underground water transfers is undertaken:

- Supply of potable water to mining equipment within the Myuna workings.
- Transfer of water from underground storage area to mine water settling ponds.

Annual monitoring of water levels within the underground storage area will also be undertaken.

4.3.3 Alluvial groundwater monitoring

The groundwater monitoring network at Myuna includes ten shallow alluvial monitoring bores. These alluvial bores were installed in July 2012. Groundwater level monitoring at these locations commenced in November 2017 and will be sampled on monthly basis until December 2022. To date (October 2022) there has been no significant change to groundwater levels due to mining activities, as predicted in the EIS and the GHD Hydrogeological Model (2016). Myuna will continue to measure and sample groundwater levels (m AHD_and water quality parameters (pH), annually as of Q4 2022. Details of the groundwater monitoring bores are provided in Table 4-2 and locations are shown in Figure 4-2.

Table 4-2 Groundwater monitoring bore details

Bore	Easting	Northing	Bore depth[1] (m)	TOC (m AHD)	Groundwater level July 2012 (m AHD)
MW01	366421.196	6340666.725	6	20.6	19.357
MW05	366382.919	6340757.928	18.5	20.6	13.229
MW06	366352.036	6340702.937	13	20.6	13.211
MW07	366099.275	6340745.900	8.5	25.8	22.134
MW08	366166.975	6340855.902	9	24.6	21.364
MW09	366673.814	6340926.691	11	5.1	17.272
MW10	366253.961	6341072.879	10	30.1	24.666
MW11	366358.936	6340904.374	7	19.4	12.306
MW12	366298.845	6341178.276	7	14.4	6.779
MW13	366523.721	6340866.437	8	9.3	0.53

Notes:

TOC: Top of casing

1. Measured from TOC

4.4 Discharge water monitoring

4.4.1 Surface water discharge flows

Myuna Colliery has recently established monitoring at LDP 10 and LDP 9. The discharge monitoring program is outlined in Table 4-3.

Table 4-3 Discharge Volume monitoring

Location	Frequency	Monitoring device
LDP 10	Daily during discharge	Level sensor
LDP 9	Daily during discharge	Continuous electronic flow meter

4.4.2 Surface water discharge quality

Table 4-4 outlines the discharge water quality monitoring requirements for Myuna Colliery, which fulfils the specifications of EPL 366. *EPL366 requires a monthly sample during discharge, as of September 2022.

Table 4-4 Discharge quality monitoring

Location	Frequency	Parameter
LDP 10	As per EPL366 requirements	Oil and grease, pH, TSS.
LDP 9	As per EPL366 requirements	Oil and grease, pH, TSS.

4.5 Watercourse stability monitoring

Centennial Myuna monitor the extent of channel incision at the downstream extent of reach W2, as shown in Figure 4-3. In the event of substantial incision of a channel (as defined by formation of a head-cut greater than 0.3 m high), structural intervention is likely to be required to stabilise the waterway. Channel incision will be monitored visually during inspections and in accordance with the triggers and actions stipulated within the stream health trigger action response plan (refer to Section 6). Channel incision inspections at the downstream extent of reach W2 will typically occur at least once every six months or during routine water quality sampling events at nearby monitoring locations.

Stream health and channel stability inspections will also be undertaken in areas along reaches W1, W2 and W3 annually. Visual monitoring of watercourses is to be carried out by suitably qualified professionals to identify any instabilities that may form because of discharge activities.

Inspections will identify if any of the following potential impacts occur within the creek lines or immediate catchment flow paths:

- Change in stream bed or bank conditions.
- Incision or head cut development.
- Ponding (particularly ‘out of channel’ ponding).
- Step changes in bed profile.
- Any notable/indicative changes in stream vegetation.

The monitoring locations for assessing watercourse stability (W1, W2, and W3) are presented in Figure 4-3.

LEGEND

Groundwater Monitoring Location

Surface Facilities Area

Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 56

N

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Job Number

Revision 1

Date 1 Dec 2021

Groundwater monitoring locations Figure 4-2

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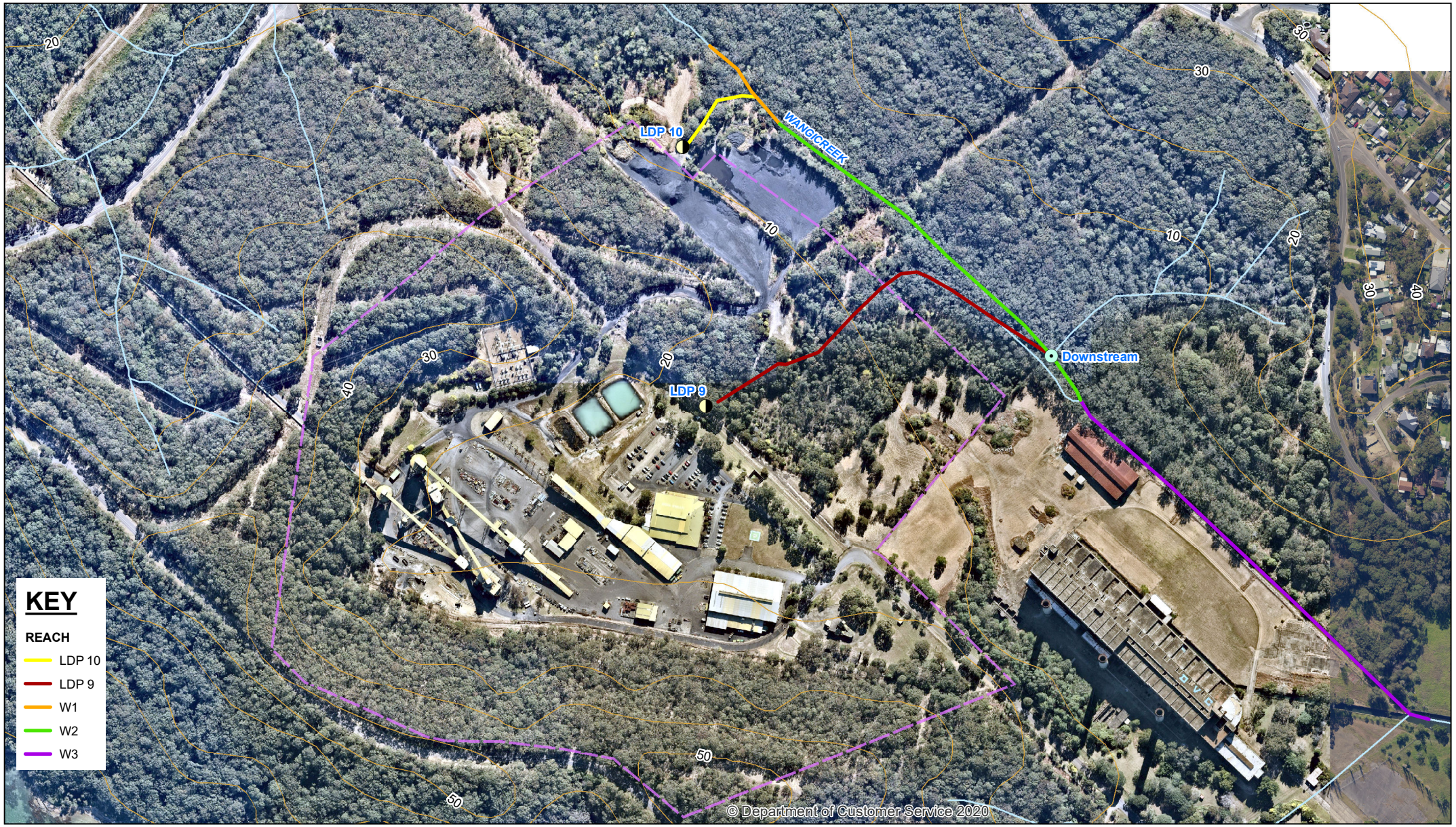
Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, 2009. Centennial: Monitoring, 2012; ESRI: Imagery, 2016. Created by:



Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Surface Water Monitoring Location
- Licensed Discharge Point
- Surface Facilities Area
- Waterways
- 10m Contours

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Job Number
Revision 1
Date 17 Aug 2021

Watercourse geomorphic stability monitoring locations

Figure 4-1

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Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, monitoring, 2009; Nearmap: Aerial dated 20160504, extracted 20160720. Created by:

5. Baseline data

5.1 Surface water flow

Myuna Colliery do not currently undertake flow monitoring of Wangi Creek or any other waterway. Contribution of discharges to Wangi Creek is monitored through LDP 9 with discharges from LDP 10.

Discharge monitoring at LDP 9 between 2013 and 2017 is provided in Figure 5-1.

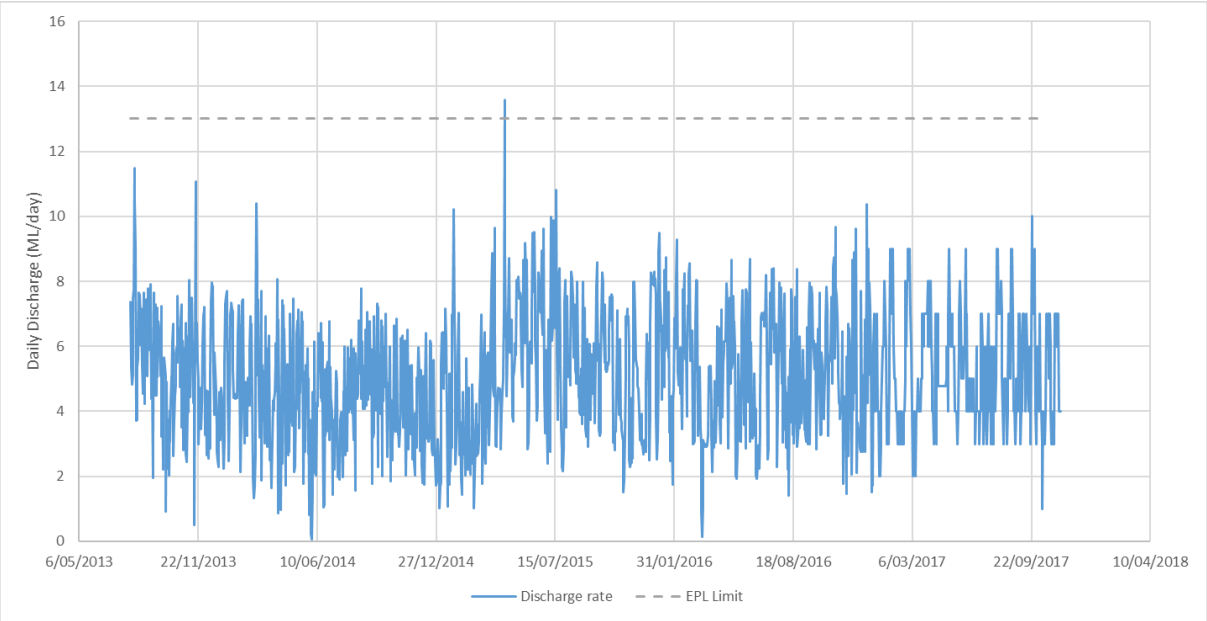

Figure 5-1 LDP9 daily discharges between 2013 and 2017

The discharge limit for LDP 9 is 13 ML/day. From historical monitoring, one event has occurred that exceed this limit in 2015. This event was because of a large rainfall event (299.2 mm in three days) in April, which increased the stored volume in the mine water settling ponds, resulting in an increased discharge volume. More details have been defined within the Annual Review completed for that year. Typically, daily discharge volumes as part of normal operation range between 3 and 8 ML/day

Potential water loss from waterways that exist above areas of mining are monitored through the assessment of alluvial monitoring bores.

5.2 Surface water quality

A surface water quality assessment was undertaken by GHD (2015b) for the following locations, as shown in Figure 4-1:

- Upstream.
- LDP 9.
- Downstream.
- Wangi Lake.

Summary statistics for these sites have also been provided in Appendix A. Time series graphs for selected water quality parameters monitored at LDP 9 over the period January 2011 to December 2015 are provided in Appendix D. The EPL limits for oil and grease, pH and TSS specified by EPL 366 for LDP 9 discharges are also presented in the relevant figures. In cases where results were less than the limit of reporting (LOR), the relevant LOR value has been

plotted. Below is a summary of the baseline water quality data from January 2011 to December 2014.

5.2.1 Upstream

Water quality results for the Upstream site on Wangi Creek indicates the water is slightly acidic with elevated levels of TSS, turbidity and total phosphorus having been reported in recent samples.

Relatively low concentrations of the major ions have been recorded at the Upstream site.

Most results for dissolved and total metals were generally reported to be below the LOR, except for aluminium, barium, iron, manganese, nickel, titanium, and zinc.

Data from the Upstream monitoring location was used, in conjunction with ANZECC (2000) guidance, to develop site-specific trigger values (SSTVs). Further details on SSTVs are provided in Section 6.1.1.

5.2.2 LDP 9

Based on the available water quality data for the monitoring period, the water sampled at LDP 9 is slightly alkaline with low levels of TSS, turbidity and oil and grease. All parameters were within the limits specified by EPL 366 during the 24 monthly monitoring events, from March 2013 to February 2015. EC has not been addressed since the receptor is a marine environment.

Most total phosphorus results have been reported to be below the LOR for the most recent data.

Concentrations of the major ionic species were generally greater than those recorded at the Upstream monitoring site.

For assessed dissolved and total metals, most parameters were generally found to be below the LOR for the most recent data, except for barium, boron, iron, and manganese. Barium, boron, and manganese concentrations at LDP 9 were generally elevated compared to the Upstream monitoring site, however iron results were generally lower.

5.2.3 Downstream

Downstream monitoring results followed similar trends to LDP 9 results. The water sampled at the Downstream monitoring site was slightly alkaline, with low levels of TSS, turbidity and oil and grease. Levels of pH were within SSTVs, with the majority of TSS and turbidity results also below SSTVs. One sampling event in April 2013 recorded TSS and turbidity levels exceeding SSTVs. However, as the results for the Upstream monitoring site and LDP 9 discharge do not show the same increase in TSS and turbidity, these results are anomalous.

The majority of total phosphorus results were found to be at or below the LOR for the Downstream monitoring site, however the SSTV of 0.035 mg/L was found to be exceeded in approximately 18% of sampling events during the 24 monthly monitoring events.

Results for the major ions at the Downstream site indicated a similar range as for LDP 9 discharge.

Dissolved and total metal results at the Downstream monitoring site followed similar trends to LDP 9 discharge. Most metals were found to be below the LOR and relevant SSTVs for 24 monitoring events. Recent exceedances of SSTVs at the Downstream site have been reported for dissolved barium, boron, and silver.

Dissolved barium and boron results have consistently been detected at the Downstream site and exceeded SSTVs. Concentrations for both barium and boron at this site are similar in range to the results reported for LDP 9 discharge, which is elevated compared to the Upstream monitoring site.

The SSTV for silver was exceeded on three occasions during the 24 months; however, no dissolved silver has been detected at the Downstream monitoring site since March 2014. Dissolved silver at the Upstream monitoring site and in LDP 9 discharge has not been detected in any monitoring events, with all samples reported to be below the LOR. This indicates that the dissolved silver detected at Downstream was not associated with the upstream conditions or discharges from Myuna Colliery.

Overall, median concentrations during the 24 months of monitoring at site Downstream are below SSTVs except for dissolved barium and boron. These concentrations are most likely attributable to the mine water discharge at LDP 9, although it is noted that dissolved boron concentrations are higher in Wangi Lake.

5.2.4 Wangi Lake

Water quality results for Lake Macquarie from the Wangi Lake monitoring site indicate that the water is slightly alkaline, with very low levels of TSS, turbidity and oil and grease reported.

Total phosphorus results were mostly reported to be at or below the LOR and like the results in Wangi Creek and LDP 9 discharge.

The major ionic species concentrations were slightly elevated compared to the LDP 9 and Downstream site results.

Many dissolved and total metal results were found to be at or below the LOR for the Wangi Lake site during monthly monitoring events, except for barium, boron, and molybdenum. Barium concentrations within Lake Macquarie were reported to be lower than the results recorded within Wangi Creek at the Upstream, LDP 9 and Downstream monitoring locations. Boron and molybdenum concentrations at the Wangi Lake site were reported to be elevated compared to all three Wangi Creek monitoring sites, indicating these parameters may be associated with background levels in Lake Macquarie rather than discharge from Myuna Colliery.

5.3 Groundwater levels and quality

5.3.1 Underground extractions

GHD (2017) has recently undertaken an assessment of the long-term daily underground extraction rate from Myuna Colliery. Daily transfer volumes over the period 2011 to 2015 are shown in Figure 5-2 and ranged from 0 ML/day to 13.6 ML/day. Review of the extraction data indicates that approximately 40% of the extracted volumes are from the Wallarah Seam workings. Note that extraction volumes overestimate groundwater inflows into the mine since they also include potable water transfers to the mine (GHD, 2017).

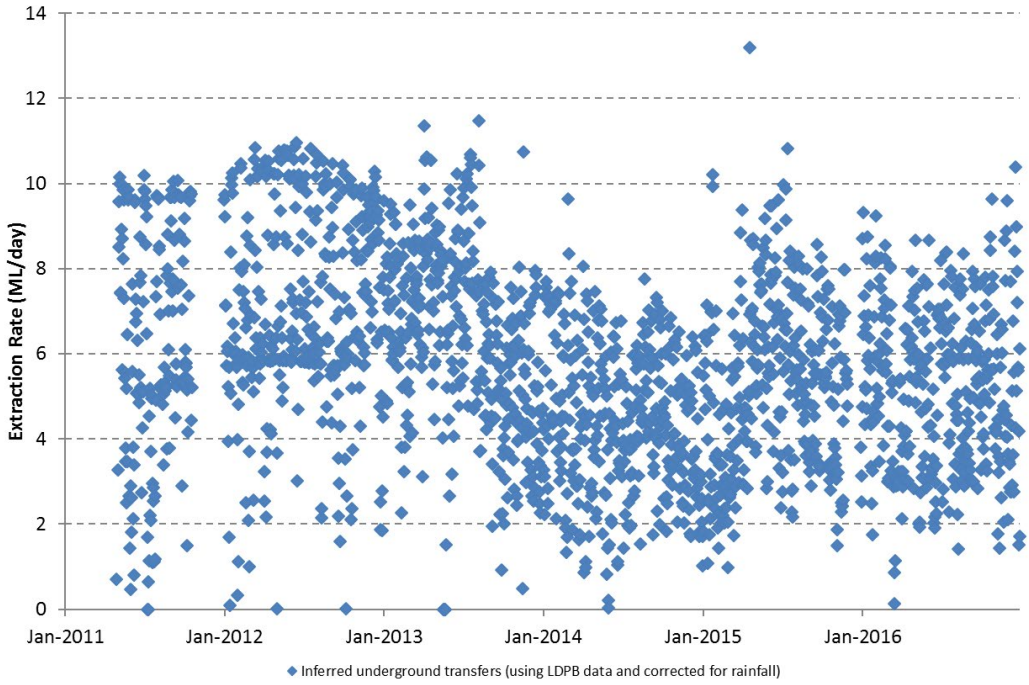

Figure 5-2 Daily total underground water extraction (inferred from LDP 9 discharge volumes)

Visual inspection of the trend in Figure 5-2 indicates that extraction from the underground workings was decreasing from mid-2013 to 2014. Extraction rates began to increase in 2015. This is most likely attributable to the storage of groundwater inflows within old workings and/or underground dams rather than the immediate extraction of groundwater inflows.

Annual extraction volumes between 2011 and 2021 are listed in Table 5-1. Based on these recorded volumes, Centennial Myuna has consistently met Condition 17 of bore licence 20BL172565, and WAL4380 which limits the annual extraction of groundwater to 4,380 ML (GHD, 2017).

Table 5-1 Annual transfers of water from the underground workings

Year	Annual volume (ML)
2011	2,047
2012	2,580
2013	2,281
2014	1,614
2015	1,930
2016	1,902
2017	1,747
2018	1,923
2019	1,864
2020	1,893
2021	1,949

5.3.2 Underground water storages

The underground water storages in the Wallarah Seam, the Great Northern Seam and the Fassifern Seam have been surveyed in March 2021 by Centennial Myuna. Based on assumptions around seam height, water storage areas and recovery rate, an underground stored volume can be determined. Table 5-2 provides the assumed underground storage volume, in 2021.

The hydrogeological model developed for Myuna Colliery assumes that the volumes of each of these storages are relatively constant. Follow up survey is to be conducted as part of the annual review of the site water balance to determine whether storage volumes have changed, and the hydrogeological model recalibrated as required.

Table 5-2 Underground water storage volumes – February 2022

Seam	Water storage volume (ML)
Wallarah Seam	1,381
Great Northern Seam	1,045
Fassifern Seam	2,184

5.3.3 Underground water quality

The underground water quality was slightly alkaline and saline throughout 2014 and 2015. Generally, the underground water from the Fassifern Seam has a higher EC and dissolved iron concentration that the other seams. Underground water from the Great Northern Seam generally has lower dissolved manganese concentrations.

Key monitoring results from both underground water storages and underground water transfers are provided in Appendix C.

5.3.4 Alluvial Groundwater monitoring network

The groundwater monitoring network at Myuna Colliery includes ten alluvial monitoring bores. Observed groundwater levels at these monitoring bores are shown in Table 4-22.

5.4 Watercourse stability

Overall, Wangi Creek was defined as generally well vegetated and stable, although the creek is modified in places due to past disturbances (GHD, 2012a). The reaches inspected as part of the baseline assessment (W1, W2, W3, LDPA and LDPB) were shown previously on Figure 4-3.

The five reaches are described in Table 5-3.

Table 5-3 Summary of baseline conditions of Wangi Creek

Reach identifier	Description
W1	This reach exhibits largely a natural channel of between 2 to 3 m and is generally 1 to 2 m deep. Banks are well-vegetated and there is no evidence of channel instabilities or significant bedload transport. At the downstream extent of this reach, a loose rock structure extends across the creek. Being like a rock grade control, this structure limits the potential for channel bed incision within the reach. Discharges from LDP 10 would enter this reach upstream of the rock structure.
W2	Downstream of the loose rock structure, the channel loses definition and Wangi Creek exhibits a swamp like environment. In this reach flows are dissipated across the entire valley floor which is well vegetated with *melaleuca sp.* and *gahnia sp.* There is largely no evidence of significant instabilities, erosion, or bedload transport in this reach. However, the downstream 20 to 30 m of the reach steepens as the streamline drops to converge with the LDP 9 channel. Along this section, there are a number (4 to 5) of low headcut features less than 0.1 m high. These are stabilised by tree roots and/or small logs. Future decay of the tree roots or logs could result in the reactivation of these headcuts resulting in channelisation of the reach.
W3	This reach exhibits a concrete lined channel invert up to 5 m wide and 1 to 2 m deep. Banks are generally graded and consist of cohesive fine-grained sediments. Given the concrete lining and grassed, graded banks, this reach is considered stable.
LDP 10	The discharges from LDP 10 flow into an earthen channel confined and inset by 4 to 5 m within previously placed fill materials. The invert of this channel is generally 2 to 3 m wide and has a gentle gradient as evidenced by pooling along its extent. The upstream half of this reach is defined by the outlet of the Emergency Stockpile Dam which has created some instability in the channel cross section. Discharges from LDP 10 enter this reach at its upstream extent via a pipe connected to the sedimentation dam that services the emergency coal stockpile area.
LDP 9	Downstream of the LDP 9 discharge point, discharges flow through a piped network before outflowing into an earthen channel. This channel runs parallel to Wangi Creek in Reach W3 for approximately 200 m. The channel is constrained by fill materials along the left bank, which is steep and up to 4 – 5 m high. Along the left bank, a levee type structure exists which separates flows from the LDP 9 discharge channel from flows in Wangi Creek. Towards the upstream extent of this reach, a breach of a levee structure that had occurred in the past was repaired in October 2017. Due to extensive rainfall this has again been breached. Repair works are currently being scoped and due to be completed Mid 2023.

The geomorphic assessment undertaken in 2012 as part of the Surface Water Management Plan (GHD, 2012a) described in Table 5-3 indicates that mine water discharges are not expected to have any significant impacts on the stability of Wangi Creek. Myuna Colliery will continue to monitor channel stability within Wangi Creek in accordance with the inspection process outlined in Section 4.5.

6. Response plans

6.1 Triggers

6.1.1 Surface water quality triggers

GHD (2015b) has undertaken a water quality assessment of background levels at surface water and mine discharge monitoring sites within and surrounding the Myuna Colliery (described in Section 5.1). The SSTVs for surface water sites at Wangi Creek, based on ANZECC (2000) guidelines and site-specific water quality monitoring data, are listed in Table 6-1 (GHD, 2015b).

Table 6-1 Site-specific trigger values for Wangi Creek (Downstream)

Parameter	Units	SSTV
Physicochemical parameters		
pH	pH unit	6.2–8.5
TSS	mg/L	77
Nutrients		
Total phosphorus	mg/L	0.035
Dissolved metals		
Aluminium	mg/L	0.724
Antimony	mg/L	0.27
Arsenic	mg/L	0.023
Barium	mg/L	0.04
Boron	mg/L	5.1
Cadmium	mg/L	0.0055
Cobalt	mg/L	0.001
Copper	mg/L	0.0013
Iron	mg/L	2.1
Lithium	mg/L	0.001
Manganese	mg/L	0.66
Molybdenum	mg/L	0.023
Nickel	mg/L	0.07
Selenium	mg/L	0.01
Silica	mg/L	22.94
Titanium	mg/L	0.01
Vanadium	mg/L	0.1
Zinc	mg/L	0.016

6.1.2 Alluvial Groundwater levels

Groundwater level monitoring within alluvial aquifers commenced in November 2017 and completed monthly until and including December 2022. Monitoring will continue Annually from January 2023 with each set of results reviewed against the trigger values listed in Table 6-2 below. Trigger values are based on baseline monitoring data and the 20th percentile levels.

Table 6-2 Alluvial Groundwater Trigger Levels

Monitoring Well Number	Boredepth[1](m)	TOC (m AHD[2])	Trigger Value (m AHD)
MW01	6	20.6	18.73
MW05	18.5	20.6	12.63
MW06	13	20.6	12.65
MW07	8.5	25.8	21.31
MW08	9	24.6	19.95
MW09	11	5.1	12.63
MW10	10	30.1	22.98
MW11	7	19.4	9.18
MW12	7	14.4	6.17
MW13	8	9.3	0.53

Notes: TOC: Top of casing, 1. Measured from TOC, 2. AHD – Australian height datum

6.1.3 Underground Water Quality

Groundwater quality within each seam is variable and influenced by Lake Macquarie (specifically EC). Groundwater quality can also be compared to the limits for EPL 366 for pH and TSS. Based on underground water quality sampling undertaken between 2014 and 2016, 20th and 80th percentiles were determined for selected parameters monitored in each seam. These are provided in Table 6-2. All metal parameters are representative of filtered concentrations.

Table 6-2 Underground water quality ranges

Percentile	pH	EC (µS/cm)	TSS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Barium (mg/L)	Boron (mg/L)
Fassifern Seam							
20th	7.4	48360	5	0.1	0.421	0.097	0.84
80th	7.8	49920	13.6	2.04	0.677	0.110	1.31
Great Northern Seam							
20th	7.6	40080	5	0.05	0.005	0.193	0.3
80th	8.1	41640	24	0.082	0.095	0.273	0.81

Wallarah Seam							
20th	6.8	35740	5	0.05	0.601	0.105	0.05
80th	7.7	40500	7	0.5	1.130	0.136	0.50

Above in Table 6-2 are the range of water qualities monitored within the underground over a period of two years. Underground is pumped to the surface and regulated through LDP 9. If surface water quality is monitored outside of typical water quality criteria, the underground water quality would be tested. The above table would be used to determine significant changes.,

The values provided in Table 6-2 are intended to inform further management actions to mitigate risk of exceeding water quality limits at LDP 9.

6.1.4 Underground water management

Underground stored water is an issue of operational management with no specific level or volume trigger defined as part of the overall water management system. Monitoring will be undertaken to support calibration and validation exercises for the Hydrogeological Model.

6.1.5 Discharge triggers

Water quality monitoring data for LDP 10 and LDP 9 discharges are compared to EPL 366 concentration limits where applicable, as shown in Table 1-4. The discharge volume limit for LDP 9 as outlined by EPL 366, is 13 ML/day.

6.2 Performance criteria

Performance criteria have been developed based on baseline information and the approach presented within the Northern Operations RWMP.

6.2.1 Surface site operations

The performance criteria for on-site surface water management at Myuna Colliery is outlined in Table 6-3.

Table 6-3 On-site surface water management criteria

Aspect	Criteria
Surface storages	Storages sized in accordance with Landcom (2004) and DECC (2008) and maintained within the capacity of each storage.
Water quality management	Clean and dirty water separation.
Erosion and sediment control	Minimising disturbance area. Pit top disturbance and other construction activities to be managed in accordance with the approach and guidelines outlined in the Northern Operations RWMP. Where construction works are significant an erosion and sediment control plan (ESCP) and construction environmental management plan will be prepared.
Hydrocarbon management	Chemical and hydrocarbon storage to be in accordance Australian Standard AS1940:2017.

6.2.2 Watercourses

Criteria for the management of water quality within watercourses are provided in Table 6-4.

Table 6-4 Watercourse criteria

Aspect	Criteria
Watercourse quality	Below SSTVs provided in Table 6-1.

6.2.3 Groundwater environment

Based on the triggers derived in Section 5.3, Table 6-5 presents the groundwater management performance criteria for Myuna Colliery.

Table 6-5 Groundwater environment criteria

Aspect	Criteria
Alluvial Groundwater level	No impact from mining to water level No complaints from surrounding groundwater users.
Underground water quality	No complaints from surrounding groundwater users.
Underground water level/storage	Within safe operating levels determined by the Myuna Colliery.

6.2.4 Discharge management

Discharge management includes both discharge volume and quality. The criteria applied for Myuna Colliery is presented in Table 6-6.

Table 6-6 Discharge management criteria

Aspect	Criteria
Discharge volume	Discharge is to only to occur in accordance with event-based criterion and the daily discharge limit specified in EPL 366.
Discharge quality	Discharge water quality must be less than EPL criteria provided in Table 1-4.

6.2.5 Stream health

The condition of riparian and in-stream vegetation and channel stability will be used during observation monitoring (in addition to the water quality criteria listed above in Table 6-1) to assess the health of Wangi Creek. The specific stream health assessment criteria (GHD, 2012a) to be followed during observation monitoring are detailed in Table 6-7.

Table 6-7 Stream health assessment criteria

Element	Parameter	Criteria
Riparian and in-stream vegetation	Vegetation condition – photographic log	Photographic log indicates that vegetation has not been detrimentally impacted over time.

Element	Parameter	Criteria
Channel stability	Erosion – photographic log	Photographic log indicates occurrence of erosional processes has not occurred because of water discharges over time.
Watercourse subsidence	Subsidence – photographic log	Photographic log indicates no ponding, changes in stream bed or bank conditions, incision, head cut development, or surface cracking because of subsidence.

7. Site-specific reviews and reports

7.1 Hydrogeological model

Centennial Myuna will review the hydrogeological model for Myuna Colliery on an annual basis and update as necessary. The review has been previously undertaken in conjunction with the annual groundwater report which is no longer required due to the succession of Bore Licence 20BL173259, to WAL41560. Groundwater monitoring data will be used for verification of the hydrogeological model. If the review of monitoring data indicates trends that differ from the predictions of the hydrogeological model, then the hydrogeological model should be recalibrated using monitoring data. To date, the groundwater monitoring results have been in line with the predictions of the hydrogeological model and the project's Environmental Assessment.

7.2 Site water balance

Centennial Myuna will review the site water balance at least every three years or in response to significant changes to water management practices on site.

8. Exploration and Surveys

8.1 Background

Rockhead is the term used for the thickness of bedrock to the coal seam beneath soil cover at the bed of the lake. Understanding the rock depth and thickness is critical to Centennial Myuna's ongoing management of the risk of inrush into its underlying mining operations. Catastrophic inrush of water is a specified principal hazard under relevant safety legislation. All mines are required to address this risk through a Principal Hazard Management Plan. Given Myuna's location this under the Lake Macquarie this issue has relevance. Myuna has a responsibility under the Work Health and Safety Act to ensure, as far as reasonably practicable to ensure the safety of its workers. A significant amount of work has already been completed at Myuna Colliery to manage risks associated with mining beneath tidal waters and foreshore areas. The current mine planning parameters allow for first workings only, with conservative design of pillars providing significant safety factors for long term stability. The continued application of these design parameters for mining under the lake (to the 40 m rock head cover line) has been the major control for managing the risk of potential inrush at the mine.

To determine rockhead depth and thickness, ongoing survey and exploration activities are required to be carried out. These activities are necessary to:

- Enable the coal resource to be defined with greater accuracy.
- Gather information to complete a safe mine design.
- Provide information to assist with future mine planning and design.
- Gather geotechnical information related to strata type, strength, stability, and defects.
- Gather geological information related to the location and magnitude of geological structures.

The types of survey and exploration activities undertaken at Myuna include:

1. Magnetic surveys

Magnetic surveys are used to collect information on the intensity of the magnetic field across the area of interest. This information is used to identify where intrusions may occur within the coal seam. These surveys can be conducted via boat or an unmanned aerial vehicle, commonly referred to as a drone, is used be undertake these surveys. The drones are flown along survey lines at low altitudes (minimum 5 m above the water surface) and at low speeds (approximately 32 km/hr). The magnetic survey would provide exploration without the need for disturbance activities, with staff operating the drone making use of existing publicly accessible areas to launch the equipment.

2. Shallow Marine Survey

Shallow marine survey systems are used to determine physical properties of the sea floor and to image and characterise geological information a few metres below the sea floor. Specifically, this survey technique will be used by Centennial Myuna to provide a higher definition of rock head thickness above the coal seam and provide definition of the rock head features.

The shallow marine surveys are undertaken using a low impact survey method which uses a small boat towing survey equipment called a Sparker. Sound pulses bounce off the lake floor to help map the topography and composition of the lake floor. The acoustic energy is generated by a mechanical device meaning there is no explosive source used to generate energy. A Sparker

converts electrical energy into acoustic energy via the creation of a plasma bubble and the consequent generation of an acoustic pulse. This technique is used worldwide.

In Lake Macquarie similar survey methods are regularly used to monitor how the changing lakebed impacts on boat navigation in Swansea Channel. It is regularly used in Newcastle and Sydney harbours to assess water depth for dredging. Similar technologies are also used by marine scientists in sensitive marine environments, such as the Great Barrier Reef, to develop maps used to model ocean currents, storm surge inundation, and better understand ecosystem and biodiversity patterns on the seabed. These types of maps are widely used across all marine environments.

3. Rockhead drilling

Completed using a combination of rotary drilling methods in soils using HWT and HQ drill casings, and NMLC coring methods in rock; with the target being 1 m length of rock (with drilling ranging in depths of 30 to 40 m). This type of drilling is used to determine rockhead thickness and calibrate the shallow marine survey results. The drill rig would be transported to the relevant drilling location via a 20 tonne Jack-up barge, which would be held in position using spuds/jack-foots up to 30 m long. Jacks simply give the barge stability in water. The area of the barge represents a works site as if it were on land. The barge would remain on station (over borehole) each day / night and during weekends.

4. Surface to Seam Drilling

Completed using a combination of rotary drilling methods in soils using PW and HWT casing, and HQ coring methods in rock; with the target being Fassifern Seam, ranging in depths between 100 m and 170 m. This type of exploration is used to investigate coal quality. The drill rig would be transported to the relevant drilling location via a 20 tonne Jack-up barge, which would be held in position using spuds/jack-foots up to 30 m long. The barge would remain on station (over borehole) each day / night and during weekends.

8.2 Summary of Potential Impacts

8.2.1 Soil Impacts

The drilling programme is the only activity with the potential to impact estuarine sediments because of the anchoring of the barge and completion of drilling activities. Given the small diameter of the drill holes (approximately 100 mm), drilling would have a negligible impact on sub-surface soil structure. The completion of work from the barge would mean sub-surface disturbance is restricted to the area required for drilling as such any impacts would be localised.

8.2.2 Aquatic Ecology Impacts

The potential for benthic disturbance through direct removal of substrate only applies to drilling activities. Removal of these communities will result in the temporary loss of biodiversity from the impact areas however it is expected that biodiversity will not be permanently affected. Following the completion of the boreholes, the impacted seabed will be rapidly colonised by benthic species under a long-term natural recruitment process. It is expected that a mature community comparable to the one currently present, will be achieved within months of drilling activities being completed.

Indirect impacts may also occur to nearby communities, through the generation of turbid plumes and impacts of increased suspended sediment levels on filter-feeding organisms. These localised plumes are temporary and suspended sediments are expected to disperse rapidly.

8.2.3 Noise

Shallow marine surveys will generate underwater noise via the use of an acoustic signal (Squid 501). In addition, artificial noise will also be generated during vessel movements, and during drilling activities. Disturbance to marine fauna from above ground and underwater activities may occur in response to noise generated by these activities.

8.3 Exploration and Survey Management and Mitigation Measures

To manage impacts from the proposed survey and exploration activities, the following mitigation measures will be implemented.

8.3.1 General

All exploration and survey activities will be carried out within standard work hours as defined by the Interim Construction noise Guideline being:

- Monday to Friday: 7:00 am to 6:00 pm.
- Saturday: 8:00 am to 1:00 pm.
- Sundays and public holidays: no work.

8.3.2 Drilling

- Drilling will be conducted in accordance with Australian Standards (AS 1726:2017).
- No drilling in identified seagrass meadows or within 100m of identified artificial reefs.
- Drilling will be carried out using a method appropriate to the sediment characteristics within the site with the method reducing environmental impacts as far as practicable.
- Presence of marine mammals should be visually monitored by crew members for at least 30 minutes before the commencement of drilling, in particular within the shut-down zone (1 km), but also the observation zone (2 km) where possible - with observation continuing throughout operation.
- Drilling will be put on standby to shutdown in the event a marine mammal is observed to come within the observation zone during operation. The drill rig will then be shut down if it comes within the shut-down zone, until such time that it leaves again.
- Waste drilling fluids will be captured and stored onboard for onshore disposal through registered according to legislative requirements
- Physical controls such as silt curtains and/or drill collars will be implemented to contain any disturbance of sediment.
- Drill holes will be rehabilitated in accordance with Departmental guidelines upon completion of drilling activities.

8.3.3 Shallow Marine Survey

- Shallow marine survey works will follow all relevant Legislation and Guidelines.
- Survey activities will implement mitigation measures outlined in EPBC Act Policy Statement 2.1 Part A (DEWHA, 2008) as appropriate for marine mammals.
- The interaction of all vessels with marine mammals will be compliant with Part 8 of the Environment Protection and Biodiversity Conservation (EPBC) Regulations (2000).
- The Australian Guidelines for Whale and Dolphin Watching (Commonwealth of Australia, 2017) for seafaring activities will also be implemented.
- All survey crew members will be briefed on EPBC Act Policy statement requirements, operations and stop work procedures, as well as low visibility procedures.
- Any other mitigation measures proposed by DPI-Fisheries will be implemented as appropriate in consultation with DPI-Fisheries (see Section 8.5 below).

The survey crew members will be following these mitigation and control procedures to avoid impact:

For Marine Mammals:

- Precaution zones will be implemented (Observation (3+ km) and Shut down (500 m)).
- Pre-start up visual observation of precaution zones (>30 mins before start).
- Survey line pass will not commence if marine mammals are within the low power or shut down zone within intended passage of vessel – alternate route will need to be selected.
- Crew will maintain vigilant observation for marine mammals within precaution zones and vessel planned path throughout shallow marine surveys.
- Survey array will be shut down if a marine mammal enters shut down zone.
- Any other mitigation measures proposed by DPI-Fisheries will be implemented as appropriate in consultation with DPI-Fisheries (see Section 8.5 below).

For dolphins and whales:

- Caution zone (300 m either side of whales and 150 m either side of dolphins) – vessels must operate at no wake speed in this zone.
- Caution zone must not be entered when calf (whale or dolphin) is present.
- No approach zone (100 m either side of whales and 50 m either side of dolphins) – vessels should not enter this zone and should not wait in front of the direction of travel or an animal or pod or follow directly behind.
- If there is a need to stop, reduce speed gradually.
- Do not encourage bow riding. If animals are bow riding, do not change course or speed suddenly.
- Any other mitigation measures proposed by DPI-Fisheries will be implemented as appropriate in consultation with DPI-Fisheries (see Section 8.5 below).

As noted above, many management measures reflect Commonwealth policy and guidelines for survey activities as they represent the most comprehensive recommendations for similar activities. As noted in Section 8.5 below, specific engagement with DPI-Fisheries will be

undertaken to identify any additional management and mitigation measures that should be taken into consideration by Centennial Myuna when carrying out exploration and survey activities on Lake Macquarie.

Should any unexpected impacts to marine species be identified during survey activities that could have been caused by the activities being undertaken, works will cease immediately. Works will not recommence unless Centennial, in consultation with DPI-Fisheries, are satisfied that impacts can be appropriately managed, and any additional management or mitigation measures are implemented where necessary.

8.4 Notifications

Communication regarding proposed exploration and survey activities will be undertaken to:

- Ensure that relevant stakeholders are informed about the proposal.
- Provide stakeholders with an opportunity to ask questions and to identify areas of concern with respect to the proposal.
- Allow Centennial Myuna to implement an approach to stakeholder communications that is transparent and timely.
- Effectively and proactively identify and manage issues and risks.
- Keep accurate records of consultation and communication with stakeholders.

Prior to exploration activities being undertaken, notifications regarding the proposed activities will be provided to stakeholders as identified in Table 8-1 below. The below Stakeholders are minimum notification requirements and additional stakeholders may also be notified as relevant.

Table 8-1 Exploration and Survey Stakeholder Notification

Stakeholder Group	Name
Government	Resources Regulator
	Department of Planning and Environment – Planning & Assessment Group
	Department of Primary Industries - Fisheries
	Roads and Maritime Services
	NSW National Parks and Wildlife Service
	Lake Macquarie City Council
	State MP
Lake Users	South Lake Macquarie Amateur Sailing Club
	Lake Macquarie Yacht Club
	Royal Motorboat Yacht Club Toronto
	Toronto Amateur Sailing Club
	Marmong Point Marina

Stakeholder Group	Name
	Teralba Amateur Sailing Club
	Speers Point Amateur Sailing Club
	Mannering Park Amateur Sailing Club
	Wangi Amateur Sailing Club
	Wangi RSL Fishing Club
	Wyee Point Marina
	Lake Macquarie Game Fishing Club
Residents	Notification in local newspaper
Local Interest Group	Myuna Colliery Community Consultative Committee

8.5 Engagement

8.5.1 Department of Primary Industries – Fisheries

Specific engagement with Department of Primary Industries – Fisheries will be undertaken to identify any additional mitigation and management measures that should be considered as part of the exploration and survey programs. Any mitigation measures proposed by DPI-Fisheries will be implemented as appropriate in consultation with DPI-Fisheries

8.6 Information Availability

Information regarding any exploration and survey activities will be made available on the Centennial website (www.centennialcoal.com.au).

9. Action Plan

MP Section	Location	Requirement	Frequency
Inspection			
4.1	Surface pit top	Site inspections are completed by the Centennial Myuna Environment and Community Coordinator and occur at least weekly. Maintenance of the water management and sediment control structures will be implemented when visual defects are observed.	Weekly and following 40mm of rainfall in a day.
	Emergency Coal Stockpile Dam	An inspection of the Emergency Coal Stockpile Sediment Dam is to be carried out by an Engineer annually	Annually
Surface Water Quality			
4.2	Upstream, Downstream, Wangi Lake	**Physicochemical** - EC, pH, TSS, turbidity. **Nutrients** - Total phosphorus. **Cations** - Calcium, magnesium, potassium, sodium, sulphur. **Metals (dissolved and total)** - Aluminium, antimony, arsenic, barium, boron, cadmium, cobalt, copper, iron, lithium, manganese, molybdenum, nickel, selenium, titanium, vanadium, zinc **Other parameters** - Oil and grease, silica.	Quarterly
	T2-5m, T2-10m	**Metals (dissolved)** - Manganese (2 samples each)	Quarterly
Groundwater Monitoring			
4.3.1	Discharge pipes into Mine Dam 1	The water quality of groundwater transferred from the underground workings to the surface is assessed for: pH, total dissolved solids (TDS), TSS and turbidity.	As required
4.3.1	Underground water storages	The underground water storages are sampled and analysed for:	As required

MP Section	Location	Requirement	Frequency
		pH and TDS.	
4.3.2	Discharge pipes into Mine Dam 1	Daily monitoring of the transfer volume of water from underground storages to the mine water settling ponds.	Daily
4.3.2	Underground water storages	Annual monitoring of water levels within the underground storage area.	Annual
Alluvial Groundwater Monitoring			
4.3.3	MW01, MW05, MW06, MW07, MW08, MW09, MW10, MW11, MW12, MW13	Alluvial groundwater level (m AHD) and water quality monitoring for pH	Annually
Discharge Water Monitoring			
4.4.1	LDP 9	Volume (kL) - Discharge flow via continuous electronic flow meter	Continuously
4.4.1	LDP10	Volume (kL) - Level sensor	Daily during discharge
4.4.2	LDP 9	**Physicochemical** - Oil and grease, pH, TSS.	Monthly during discharge
		Nutrients - Total phosphorus. **Cations** - Calcium, magnesium, potassium, sodium, sulfur. **Metals (dissolved and total)** - Aluminium, antimony, arsenic, barium, boron, cadmium, cobalt, copper, iron, lithium, manganese, molybdenum, nickel, selenium, titanium, vanadium, zinc. **Other parameters** - silica.	Quarterly
		Metals (dissolved and total): chromium, cyanide (total), lead, mercury, **Others:** chlorine (total), cyanide (total), fluoride (total).	Quarterly
4.4.2	LDP 10	**Physicochemical** - Oil and grease, pH, TSS.	Daily during discharge
		Nutrients - ammonia (total), nitrogen (total), phosphorus (total). **Cations** - Calcium, magnesium, potassium, sodium, sulfur.	Monthly during any discharge

MP Section	Location	Requirement	Frequency
		Metals (dissolved and total) - Aluminium, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, cyanide (total), iron, lithium, manganese, molybdenum, nickel, selenium, titanium, vanadium, zinc. **Other parameters** - chlorine (total), cyanide (total), fluoride (total), silica.	
Watercourse Stability Monitoring			
4.5	Reaches W1, W2 and W3	Stream health and channel stability inspections will be undertaken in areas along reaches W1, W2 and W3 annually.	Every 6 months
Site Specific Reviews and Reports			
7.2	Hydrogeological Model	Review the hydrogeological model for Myuna Colliery on an annual basis and update as necessary.	Review Annually Update as necessary.
7.3	Site water balance	Centennial Myuna will review the site water balance at least every three years or in response to significant changes to water management practices on site.	Every 3 years or in response to significant changes
7.4	EPA Quarterly Report	In accordance with Special Conditions E1 of EPL 366 Myuna Colliery will submit a quarterly report to the Regional Manager, Hunter of the EPA.	As per EPL366 requirements (currently Quarterly)

10. References

AECOM (2011), *Myuna Colliery Extension of Mining Environmental Assessment*, prepared by AECOM Australia Pty Ltd for Centennial Myuna Pty Limited.

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DECC (2008), *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and quarries,* NSW Department of Environment and Climate Change.

GHD (2010) *Myuna Colliery – Water Management Assessment*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2012a) *Myuna Colliery – Surface Water Management Plan*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

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NSW Department of Mineral Resources (1995), *Newcastle Coalfields Regional Geology 1:100,000 map*.

Appendices

Appendix A – Correspondence with regulators

Appendix B - Consultation outcomes

Comment	Response
NSW Department of Planning and Environment - letter dated 11 October 2017 (responses to components deemed as not satisfactory)	
Baseline surface water quality data is included in Section 5 of the Myuna WMP (upstream, LDP 9, downstream and Wangi Lake). No information on baseline surface water flow monitoring, however it is noted that flow monitoring has recently commenced at LDPs. *Include baseline flow monitoring data in the Myuna WMP.*	Comments added to Section 4.2 and 5.1.
Section 5.3 of the Myuna WMP includes a very general description of the stability of Wangi Creek. Note: incomplete sentence (1st para). *Include a more detailed geomorphic description of Wangi Creek up and downstream on the mine water discharge point.*	Paragraph updated to include more detail on the baseline conditions. Refer to Table 5-3 which details the outcomes of the geomorphic assessment.
General description of baseline groundwater quality included in Section 5.2.2. of the Myuna WMP. Considered inadequate. No data on baseline groundwater levels or yield. *Include baseline data on groundwater levels, yield, and quality in the Myuna WMP*	Additional information added to Section 5.3
No groundwater assessment criteria included in Section 6.1 (Triggers) of the Myuna WMP. The groundwater TARP at Appendix C indicates that groundwater level and quality triggers are based on complaints from adjacent bore owners and/or a statistically significant change in quality/depth of groundwater. Triggers cannot be determined without baseline data. Groundwater triggers should be better defined *Include groundwater assessment criteria in the Myuna WMP and reflect this in the TARP.*	Information added to sections 6.1.2 and 6.1.3 in addition to a review of Section 6.2.3. Groundwater level criteria unable to be determined until a statistically valid set of data is gathered from alluvial monitoring bores.
Groundwater monitoring described in Section 4.3 of the Myuna WMP. Section 4.3.3 “recommends” monthly monitoring from 10 alluvial monitoring bores. *Remove recommendations for monitoring and include clear commitments of what will be done.*	Section updated with current commitments to monitoring
Surface water quality, discharge and stream health triggers and performance criteria included in Sections 6.1 and 6.2 of the Myuna WMP respectively. These criteria form the basis of the TARPs provided in Appendix C. Considered adequate. Refer to comments on groundwater assessment criteria above. *Include groundwater assessment criteria in the Myuna WMP and reflect this in the TARP.*	Information added to sections 6.1.2 and 6.1.3 in addition to a review of Section 6.2.3. Groundwater level criteria unable to be determined until a statistically valid set of data is gathered from alluvial monitoring bores.

Comment	Response
The Myuna WMP would benefit from a document control register to record the document, approval, and circulation details.	Addressed
NSW Department of Planning and Environment – Division of Resources and Geoscience - letter dated 10 October 2017	
Myuna Colliery must ensure that the Myuna Colliery Water Management Plan and the Mining Operations Plan (MOP) are consistent. Mining activities must be conducted in accordance with an approved MOP	Noted, however the management requirements relevant to closure (indicated below in points a and b) are not relevant to the current stage of the operations. These aspects have not been included in the plan at this stage to provide focus to the key issues and risks requiring management that are of relevance.
The Myuna Colliery Management Plan should: a) determine (with reference to the groundwater assessment) the likelihood and associated impacts of groundwater accumulating and subsequently discharging (e.g. acid or neutral mine drainage) from the underground workings should dewatering of workings be suspended or at the cessation of mining; and	This information is currently not relevant for the Water Management Plan in the Projects current stage. During the stages of the operation's transition towards closure (within the last 5 years of production) these aspects will be incorporated into the plan.
b) consider the likely controls required to either prevent or mitigate against these impacts as part of the closure plan for the site.	The current phase of the Project does not warrant the discussion of these aspects in the Water Management Plan. During the stages of the operation's transition towards closure (within the last 5 years of production) these aspects will be incorporated into the plan

Appendix C – Baseline surface and groundwater water quality data

Table C-1 Statistical summary for water quality monitoring at site Upstream (July 2012 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	137	731	241	306
pH	pH units	24	5.7	6.7	6.1	6.4
TSS	mg/L	24	5	490	19.5	77
Nutrients						
Total phosphorus	mg/L	24	0.01	0.26	0.02	0.04
Major ions						
Calcium	mg/L	24	2	4	3	3
Magnesium	mg/L	24	2	6	5	6
Potassium	mg/L	24	2	3	2	3
Sodium	mg/L	24	21	52	37	45
Sulfur	mg/L	24	1	9	3	4
Filterable/dissolved metals						
Aluminium	mg/L	24	0.05	1.38	0.34	0.72
Antimony	mg/L	24	0.001	0.01	0.001	0.01
Arsenic	mg/L	24	0.001	0.01	0.001	0.005
Barium	mg/L	24	0.025	0.046	0.037	0.040
Boron	mg/L	24	0.05	0.07	0.05	0.05
Cadmium	mg/L	24	0.0001	0.001	0.0001	0.0005
Cobalt	mg/L	24	0.001	0.01	0.001	0.005
Copper	mg/L	24	0.001	0.01	0.001	0.002
Iron	mg/L	24	0.5	7.5	1.1	2.1
Lithium	mg/L	24	0.001	0.004	0.003	0.003
Manganese	mg/L	24	0.028	0.187	0.060	0.095
Molybdenum	mg/L	24	0.001	0.01	0.001	0.001
Nickel	mg/L	24	0.001	0.01	0.001	0.001
Selenium	mg/L	24	0.01	0.1	0.01	0.05
Silica	mg/L	24	13.5	25.6	20.1	22.9
Titanium	mg/L	24	0.01	0.1	0.02	0.06
Vanadium	mg/L	24	0.01	0.1	0.01	0.01
Zinc	mg/L	24	0.005	0.05	0.012	0.016
Total metals						
Aluminium	mg/L	24	0.32	4.05	1.14	1.93

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Antimony	mg/L	24	0.001	0.01	0.001	0.005
Arsenic	mg/L	24	0.001	0.01	0.001	0.002
Barium	mg/L	24	0.031	0.136	0.043	0.058
Boron	mg/L	24	0.05	0.06	0.05	0.05
Cadmium	mg/L	24	0.0001	0.001	0.0001	0.0001
Cobalt	mg/L	24	0.001	0.01	0.001	0.001
Copper	mg/L	24	0.001	0.01	0.002	0.004
Iron	mg/L	24	0.8	163.0	5.6	21.4
Lithium	mg/L	24	0.002	0.01	0.003	0.004
Manganese	mg/L	24	0.029	0.247	0.071	0.127
Molybdenum	mg/L	24	0.001	0.01	0.001	0.001
Nickel	mg/L	24	0.001	0.01	0.001	0.002
Selenium	mg/L	24	0.01	0.1	0.01	0.01
Silica	mg/L	24	16.9	33.4	21.8	25.1
Titanium	mg/L	24	0.001	0.07	0.001	0.010
Vanadium	mg/L	24	0.01	0.1	0.01	0.01
Zinc	mg/L	24	0.005	0.24	0.016	0.023
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-2 Statistical summary for water quality monitoring at site LDP 9 (March 2013 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	31,700	46,700	43,350	44,720
pH	pH units	24	7.6	7.8	7.7	7.8
TSS	mg/L	24	5	28	7	9
Nutrients						
Total phosphorus	mg/L	24	0.01	0.07	0.02	0.05
Major ions						
Calcium	mg/L	24	596	910	743	789
Magnesium	mg/L	24	905	1,370	1,150	1,234
Potassium	mg/L	24	152	247	186	210
Sodium	mg/L	24	6,400	10,000	8,340	9,000

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Sulfur	mg/L	24	377	686	547	609
Filterable/dissolved metals						
Aluminium	mg/L	24	0.01	0.01	0.01	0.01
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.111	0.301	0.147	0.178
Boron	mg/L	24	0.05	1.04	0.73	0.88
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.066	0.010	0.010
Iron	mg/L	24	0.1	0.5	0.5	0.5
Lithium	mg/L	24	0.332	0.619	0.491	0.544
Manganese	mg/L	24	0.206	0.762	0.450	0.656
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.8	17.0	13.4	15.7
Titanium	mg/L	24	0.1	0.1	0.1	0.1
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.050	0.073	0.050	0.050
Total metals						
Aluminium	mg/L	24	0.01	0.46	0.01	0.01
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.116	0.304	0.152	0.187
Boron	mg/L	24	0.50	1.06	0.74	0.91
Cadmium	mg/L	24	0.0001	0.0031	0.0001	0.0001
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.003	0.075	0.010	0.010
Iron	mg/L	24	0.59	1.5	0.88	1.09
Lithium	mg/L	24	0.372	0.921	0.514	0.577
Manganese	mg/L	24	0.229	0.741	0.480	0.689
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.2	17.6	14.1	15.6
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.050	0.103	0.050	0.052
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-3 Statistical summary for water quality monitoring at site Downstream (March 2013 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	13,200	45,700	40,700	44,080
pH	pH units	24	7.3	8.1	7.7	7.8
TSS	mg/L	24	5	88	8	11
Nutrients						
Total phosphorus	mg/L	24	0.01	0.13	0.02	0.05
Major ions						
Calcium	mg/L	24	209	938	709	760
Magnesium	mg/L	24	322	1,270	1,120	1,206
Potassium	mg/L	24	61	237	174	203
Sodium	mg/L	24	2,160	9,290	7,925	8,726
Sulfur	mg/L	24	147	675	526	571
Filterable/dissolved metals						
Aluminium	mg/L	24	0.01	0.1	0.10	0.10
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.051	0.391	0.139	0.173
Boron	mg/L	24	0.18	1.08	0.68	0.86
Cadmium	mg/L	24	0.0001	0.01	0.010	0.010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.01	0.010	0.010
Iron	mg/L	24	0.01	0.5	0.50	0.50
Lithium	mg/L	24	0.100	0.600	0.479	0.507

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Manganese	mg/L	24	0.194	0.809	0.371	0.595
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.2	16.7	12.6	15.4
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.031	0.058	0.050	0.050
Total metals						
Aluminium	mg/L	24	0.01	1.24	0.10	0.26
Antimony	mg/L	24	0.001	0.01	0.010	0.01
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.057	0.298	0.153	0.179
Boron	mg/L	24	0.05	1.00	0.74	0.91
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.01	0.010	0.010
Iron	mg/L	24	0.52	2.14	1.17	1.40
Lithium	mg/L	24	0.117	0.789	0.492	0.546
Manganese	mg/L	24	0.225	0.826	0.402	0.623
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	10.0	17.6	14.6	16.0
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.048	0.073	0.050	0.052
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-4 Statistical summary for water quality monitoring at site Wangi Lake (July 2012 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
EC	µS/cm	24	23,700	56,300	51,350	52,940
pH	pH units	24	7.7	8.2	8.0	8.1
TSS	mg/L	24	5	16	6	7
Nutrients						
Total phosphorus	mg/L	24	0.01	0.12	0.02	0.05
Major ions						
Calcium	mg/L	24	202	478	423	461
Magnesium	mg/L	24	612	1,480	1,285	1,382
Potassium	mg/L	24	246	631	465	513
Sodium	mg/L	24	5,140	13,400	11,250	12,040
Sulfur	mg/L	24	458	1,220	972	1,062
Filterable/dissolved metals						
Aluminium	mg/L	24	0.1	0.16	0.10	0.10
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.001	0.021	0.011	0.013
Boron	mg/L	24	0.23	5.14	3.93	4.64
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.08	0.010	0.010
Iron	mg/L	24	0.1	0.5	0.50	0.50
Lithium	mg/L	24	0.091	0.245	0.183	0.201
Manganese	mg/L	24	0.01	0.019	0.010	0.010
Molybdenum	mg/L	24	0.001	0.017	0.014	0.016
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	0.1	3.9	0.1	1.3
Titanium	mg/L	24	0.1	0.1	0.1	0.1
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.05	0.05	0.05	0.05
Total metals						
Aluminium	mg/L	24	0.01	0.36	0.10	0.13
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Barium	mg/L	24	0.010	0.02	0.012	0.014
Boron	mg/L	24	2.27	6.04	3.86	4.78
Cadmium	mg/L	24	0.0001	0.003	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.077	0.010	0.010
Iron	mg/L	24	0.01	0.52	0.50	0.52
Lithium	mg/L	24	0.100	0.300	0.181	0.201
Manganese	mg/L	24	0.001	0.023	0.010	0.010
Molybdenum	mg/L	24	0.001	0.019	0.014	0.015
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	0.1	3.9	0.1	1.34
Titanium	mg/L	24	0.001	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.05	0.06	0.05	0.05
Other parameters						
Oil and grease	mg/L	24	2	2	2	2

Table C-10-1 Underground water storages – water quality data (2014 to 2016)

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data										
720 Dam	28/03/2014	7.77	48200	ND	ND	ND	<0.05	0.755	0.11	0.84
324 Dam	3/04/2014	7.54	37000	ND	ND	ND	<0.05	0.843	0.124	<0.05
325 Dam	3/04/2014	7.95	30700	ND	ND	ND	<0.05	0.022	0.164	<0.05
930 Dam	24/09/2014	8.07	19300	ND	6	ND	ND	ND	ND	ND
2015 Data										
324 Dam	18/12/2015	7.63	ND	ND	<5	18.1	<0.50	0.709	ND	ND
720 Dam	18/12/2015	7.82	ND	ND	13	2.7	<0.10	0.157	ND	ND
642 Dam	18/12/2015	8.06	ND	ND	90	33.9	<0.05	0.007	ND	ND
421 Dam	18/12/2015	7.96	ND	ND	88	55.7	<0.05	<0.001	ND	ND
2016 Data										
324 Dam	31/03/2016	7.73	ND	ND	<5	ND	<0.5	0.17	0.099	<0.5
720 Dam	5/04/2016	7.59	ND	ND	14	ND	<0.1	0.62	0.096	1.43
421 Dam	20/04/2016	8.14	ND	7190	17	ND	ND	0.008	0.279	0.17
642 Dam	22/04/2016	8.02	ND	22300	24	ND	<0.05	0.005	0.585	0.38
324 Dam	22/06/2016	7.5	ND	25120	5	ND	ND	ND	ND	ND
421 Dam	22/06/2016	8.2	ND	6770	19	ND	ND	ND	ND	ND
720 Dam	28/06/2016	8	ND	28000	14	ND	ND	ND	ND	ND
642 Dam	29/06/2016	8	ND	13970	15	ND	ND	ND	ND	ND
642 Dam	15/09/2016	7.9	ND	29840	ND	ND	ND	ND	ND	ND
421 Dam	15/09/2016	8.2	ND	6340	ND	ND	ND	ND	ND	ND
324 Dam	15/09/2016	7.8	ND	21680	ND	ND	ND	ND	ND	ND

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
720 Dam	15/09/2016	7.8	ND	30800	ND	ND	ND	ND	ND	ND
324 Dam	15/11/2016	7	ND	26300	ND	ND	ND	ND	ND	ND
720 Dam	17/11/2016	7.5	ND	35240	ND	ND	ND	ND	ND	ND
421 Dam	17/11/2016	7.9	ND	12880	ND	ND	ND	ND	ND	ND
642 Dam	17/11/2016	7.6	ND	32040	ND	ND	ND	ND	ND	ND

Notes:

720 Dam – underground storage dam within the Fassifern Seam / 324 Dam – underground storage dam within the Wallarah Seam

325 Dam – underground storage dam within the Wallarah Seam / 930 Dam – underground storage dam within the Fassifern Seam

642 Dam – underground storage dam within the Great Northern Seam / 421 Dam – underground storage dam within the Great Northern Seam

ND – no data

Table C-10-2 Underground water transfers – water quality data (2014 to 2016)

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data										
Fassi	29/09/2014	7.34	49100	ND	9	15.2	1.85	0.549	0.104	0.84
GN	29/09/2014	7.56	39600	ND	6	23.9	0.53	0.095	0.218	0.65
Fassi	1/10/2014	7.53	49600	ND	8	32.4	2.35	0.677	0.106	1.28
Wallarah	1/10/2014	7.3	40400	ND	<5	16.6	0.46	1.21	0.144	0.54
GN	1/10/2014	7.68	40200	ND	<5	26.8	0.13	0.099	0.22	0.93
Fassi	2/10/2014	7.68	50000	ND	5	21.4	2.04	0.554	0.102	0.83
GN	2/10/2014	7.78	40400	ND	<5	0.9	<0.05	0.077	0.204	0.65
Fassi	3/10/2014	7.54	49000	ND	9	33	2.02	0.559	0.086	0.91

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
Wallarah	3/10/2014	7.34	40000	ND	7	16.2	<0.05	0.846	0.108	<0.05
GN	3/10/2014	7.73	45800	ND	8	9.6	<0.05	0.239	0.12	0.76
Fassi	8/10/2014	7.52	50300	ND	<5	23.8	3.04	0.692	0.098	1.24
Wallarah	8/10/2014	7.27	40900	ND	<5	15.2	0.34	0.905	0.116	0.49
GN	8/10/2014	7.64	40600	ND	<5	0.8	<0.05	0.077	0.198	0.88
2015 Data										
Fassi	16/12/2015	7.33	ND	ND	6	18.4	1.4	0.471	ND	ND
Wallarah	16/12/2015	6.79	ND	ND	<5	2.5	0.11	1.17	ND	ND
2016 Data										
Fassi	18/04/2016	7.7	ND	36300	<5	23.4	1.39	0.398	0.11	1.26
Wallarah	19/04/2016	6.82	ND	27500	<5	ND	<0.5	0.889	0.103	0.34
GN	19/04/2016	7.54	ND	26100	<5	ND	<0.5	0.056	0.186	0.71
Fassi	4/07/2016	7.4	ND	31140	19	ND	<0.05	0.421	0.136	1.35
GN	4/07/2016	8.1	ND	6430	5	ND	ND	0.005	0.269	0.18
Wallarah	5/07/2016	7	ND	25600	7	ND	ND	1.12	0.125	0.34
Wallarah	13/09/2016	6.7	ND	29340	12	19	ND	ND	ND	ND
Wallarah	17/11/2016	6.8	ND	26200	14	1.3	ND	ND	ND	ND
Fassi	24/11/2016	7.3	ND	30060	5	11	ND	ND	ND	ND
GN	25/11/2016	7.4	ND	25920	24	3.4	ND	ND	ND	ND

Notes:

Fassi – underground water transfer from the Fassifern Seam / Wallarah – underground water transfer from the Wallarah Seam

GN – underground water transfer from the Great Northern Seam / ND – no data

Appendix D – Time series water quality graphs for Licensed Discharge Point B

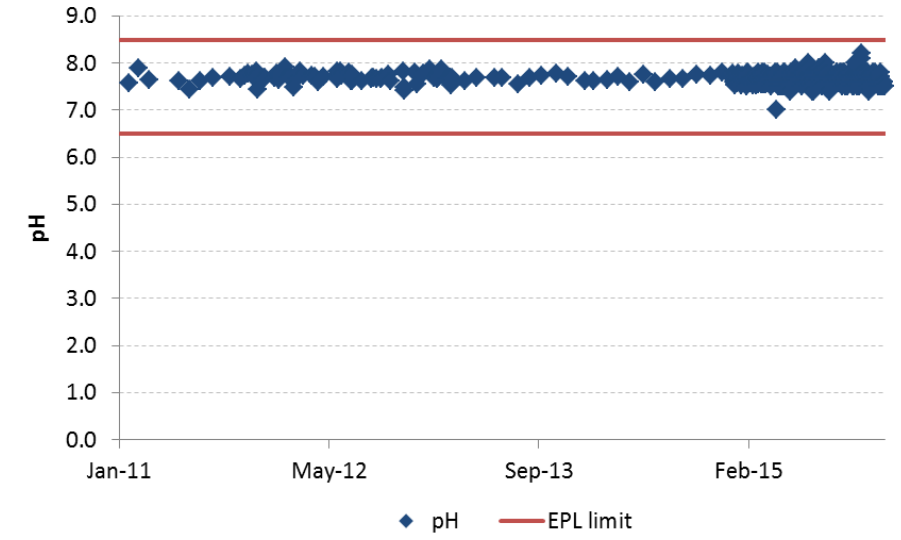

Figure D-1 pH recorded at monitoring site LDP 9

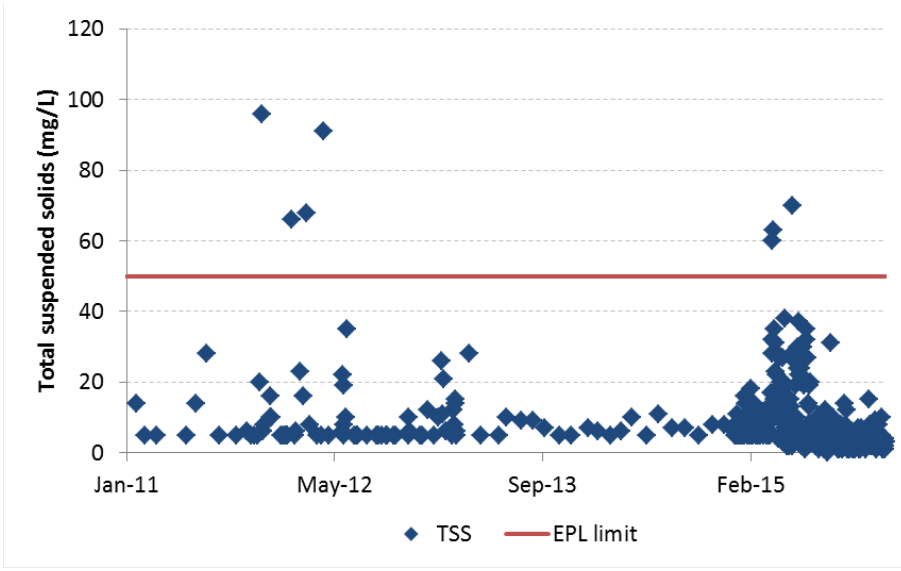

Figure D-2 Total suspended solids recorded at monitoring site LDP 9

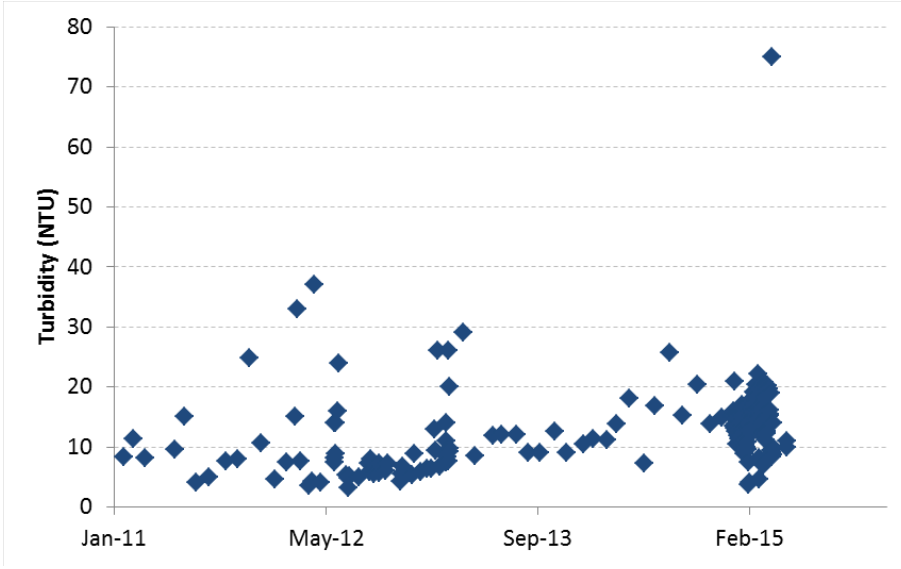

Figure D-3 Turbidity recorded at monitoring site LDP 9

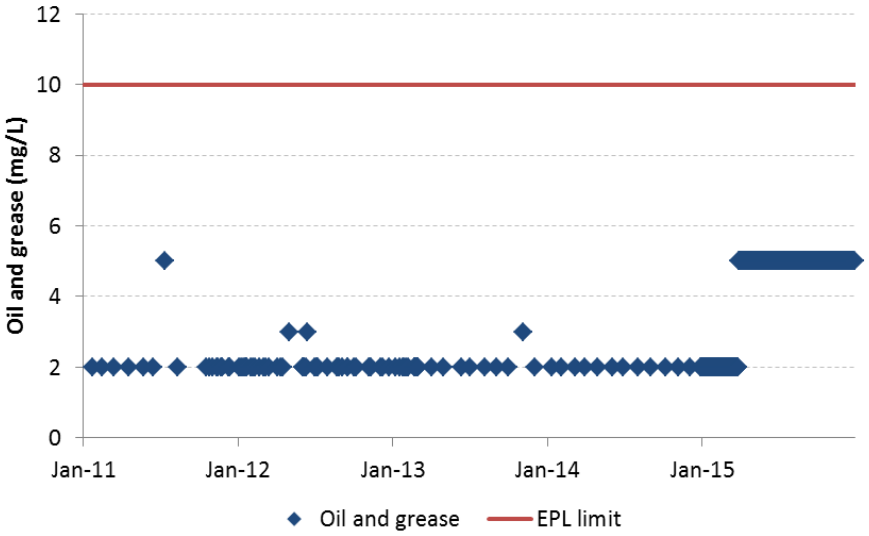

Figure D-4 Oil and grease recorded at monitoring site LDP 9

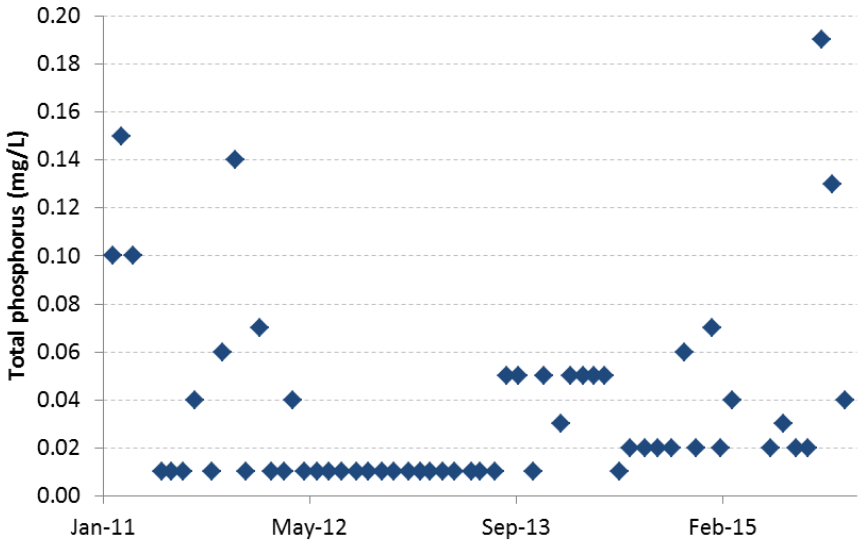

Figure D-5 Total phosphorus recorded at monitoring site LDP 9

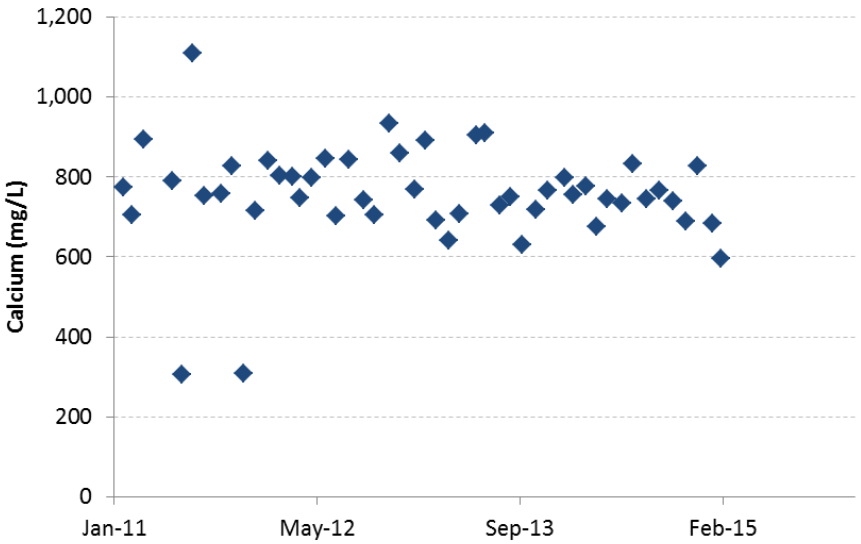

Figure D-6 Calcium recorded at monitoring site LDP 9

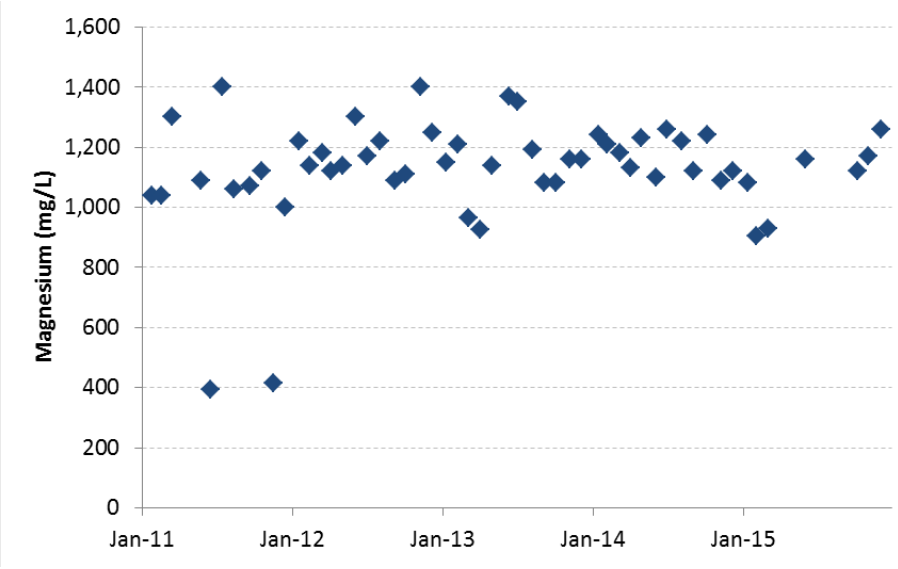

Figure D-7 Magnesium recorded at monitoring site LDP 9

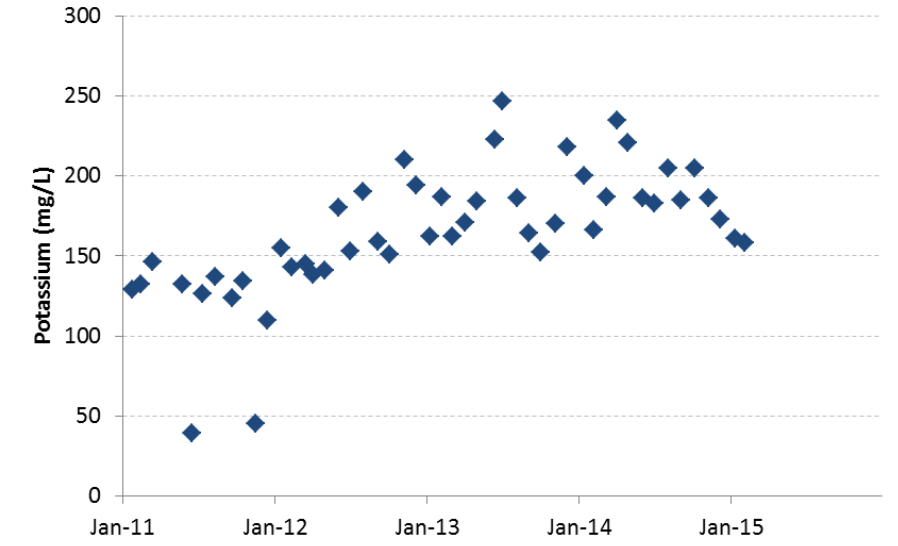

Figure D-8 Potassium recorded at monitoring site LDP 9

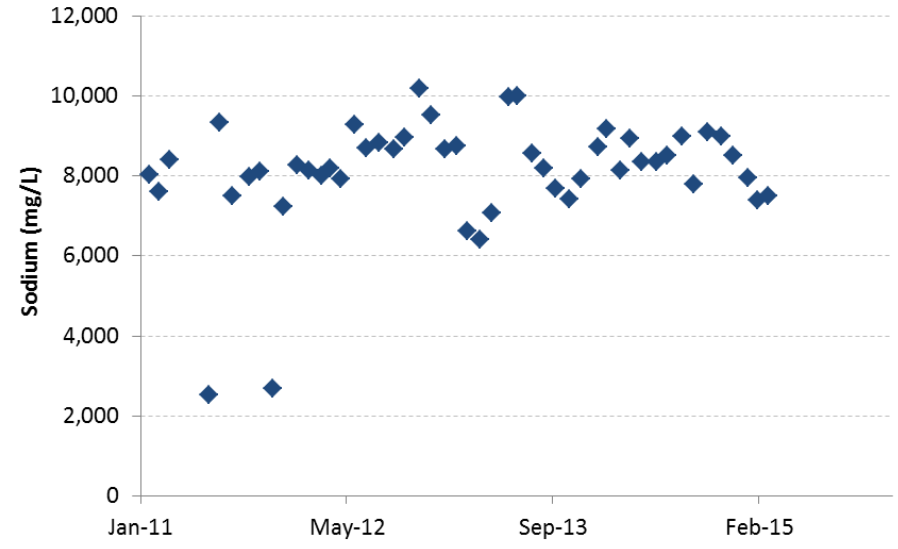

Figure D-9 Sodium recorded at monitoring site LDP 9

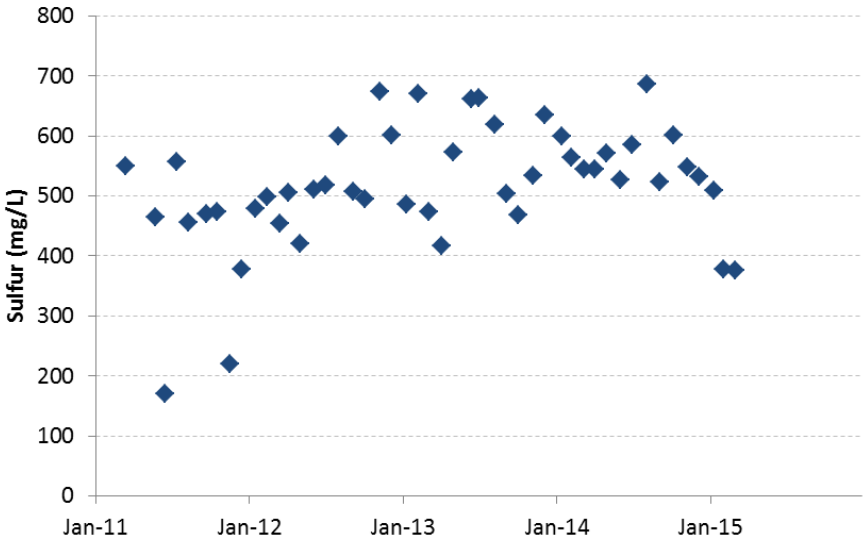

Figure D-10 Sulfur recorded at monitoring site LDP 9

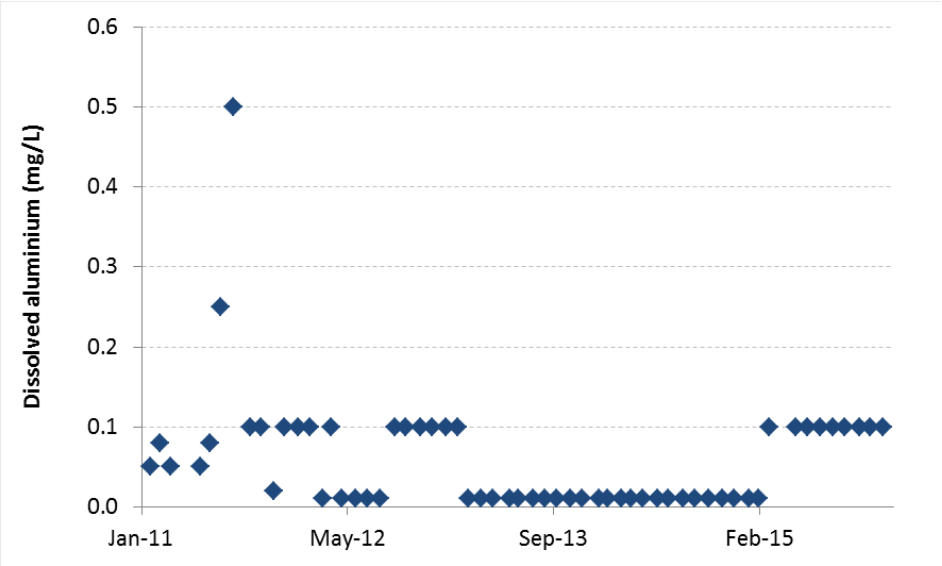

Figure D-11 Dissolved aluminium recorded at monitoring site LDP 9

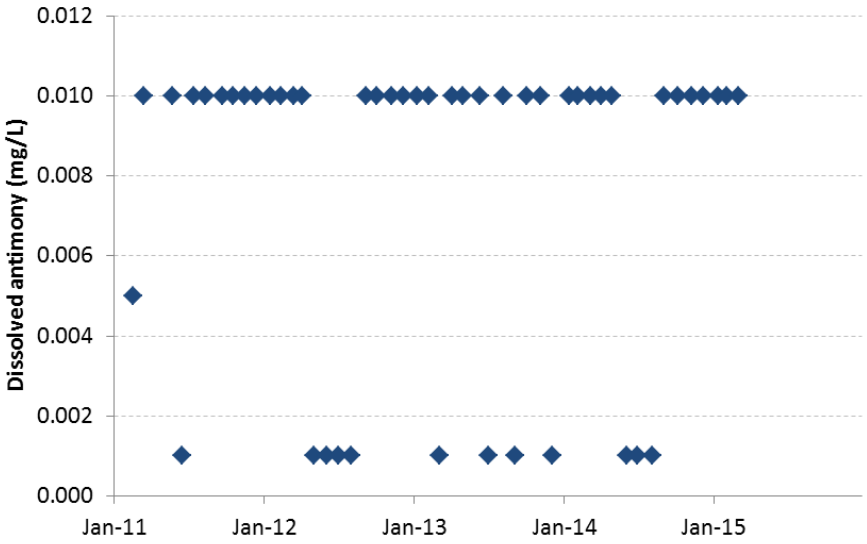

Figure D-12 Dissolved antimony recorded at monitoring site LDP 9

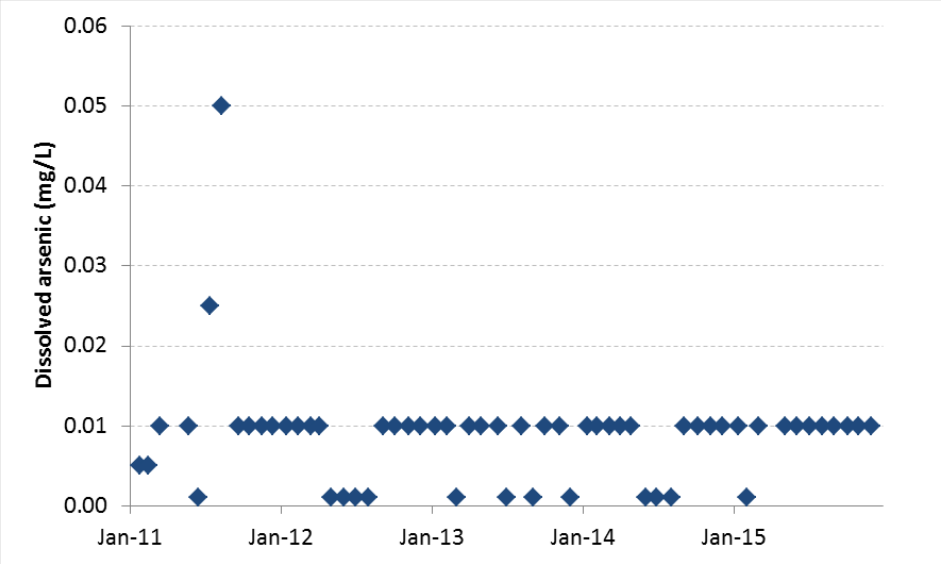

Figure D-13 Dissolved arsenic recorded at monitoring site LDP 9

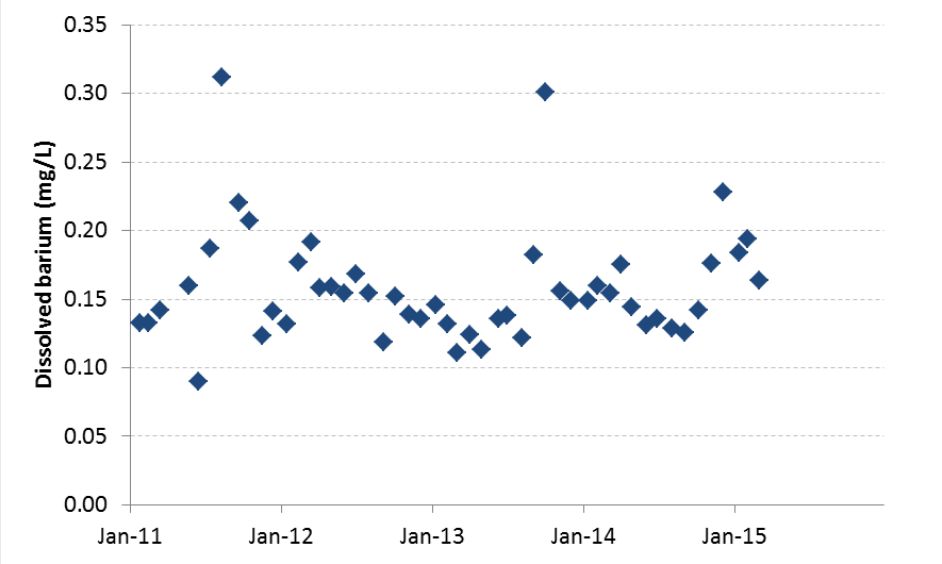

Figure D-14 Dissolved barium recorded at monitoring site LDP 9

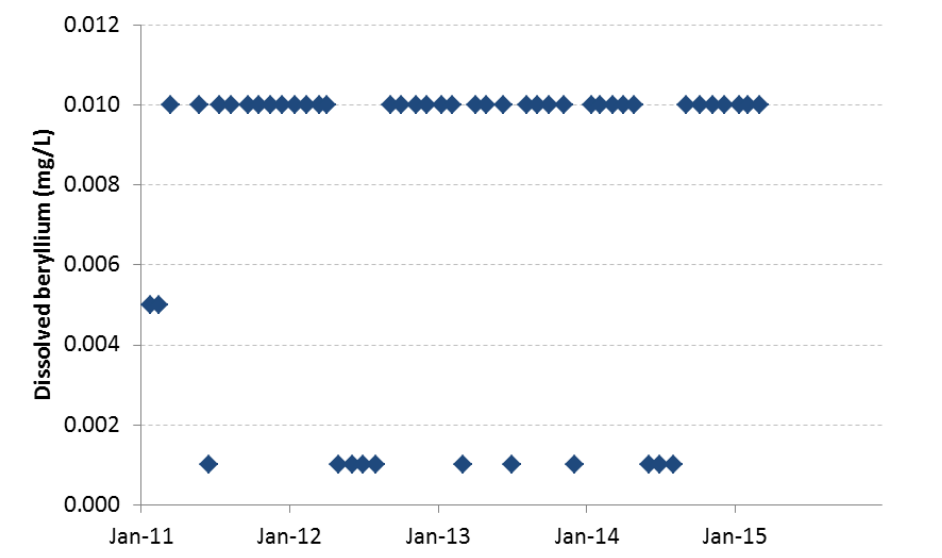

Figure D-15 Dissolved beryllium recorded at monitoring site LDP 9

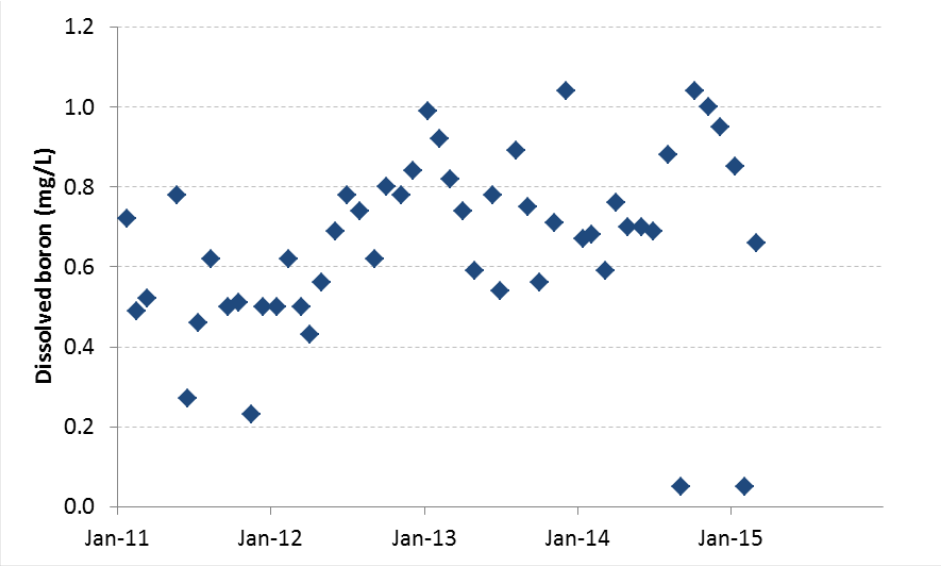

Figure D-16 Dissolved boron recorded at monitoring site LDP 9

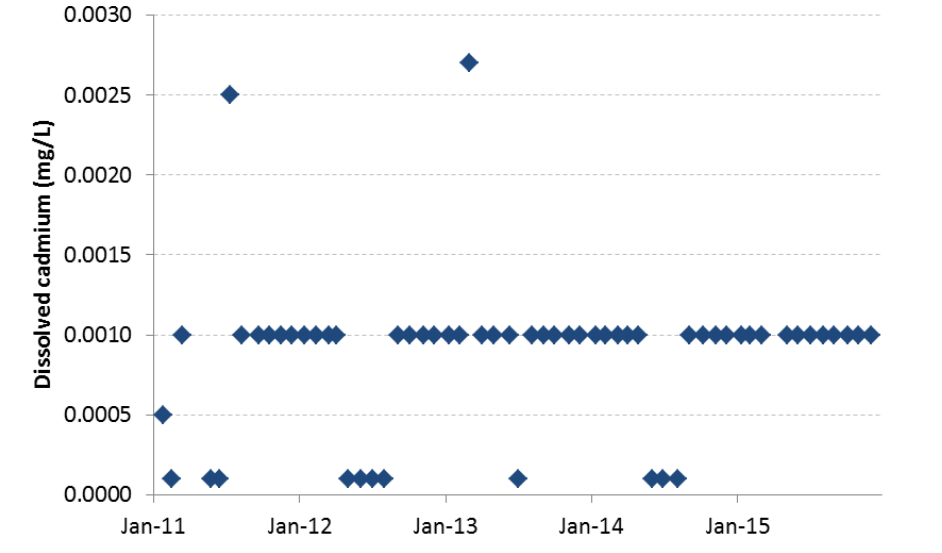

Figure D-17 Dissolved cadmium recorded at monitoring site LDP 9

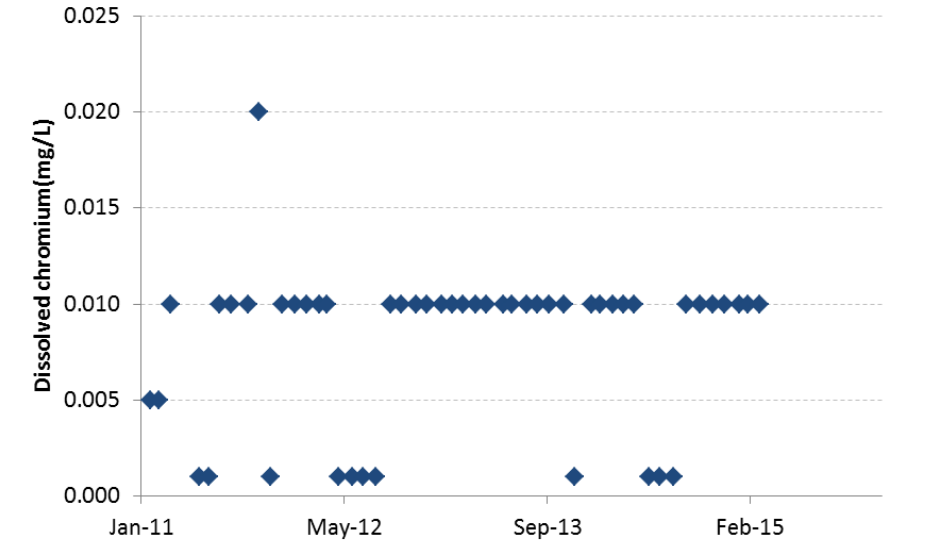

Figure D-18 Dissolved chromium recorded at monitoring site LDP 9

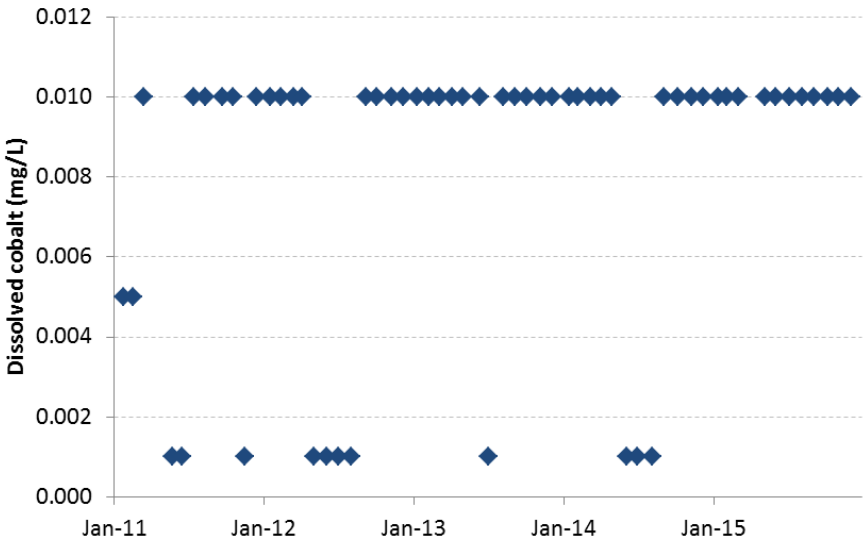

Figure D-19 Dissolved cobalt recorded at monitoring site LDP 9

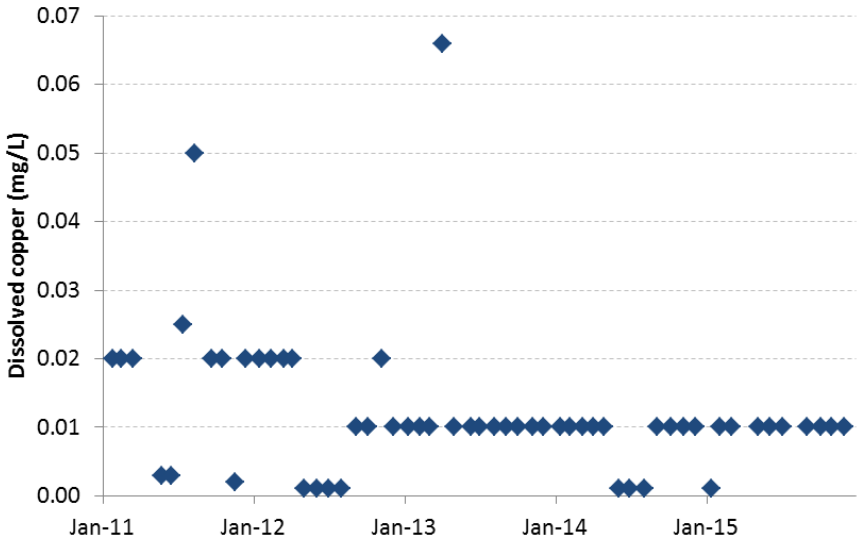

Figure D-20 Dissolved copper recorded at monitoring site LDP 9

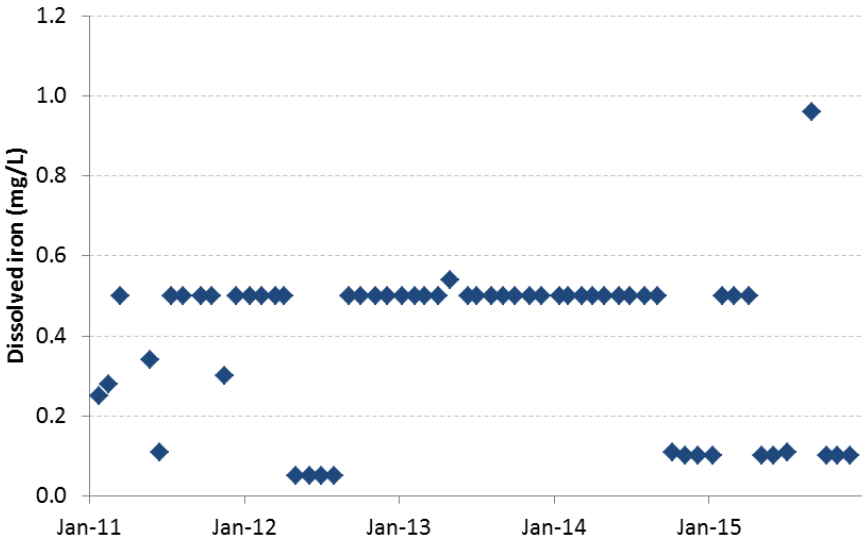

Figure D-21 Dissolved iron recorded at monitoring site LDP 9

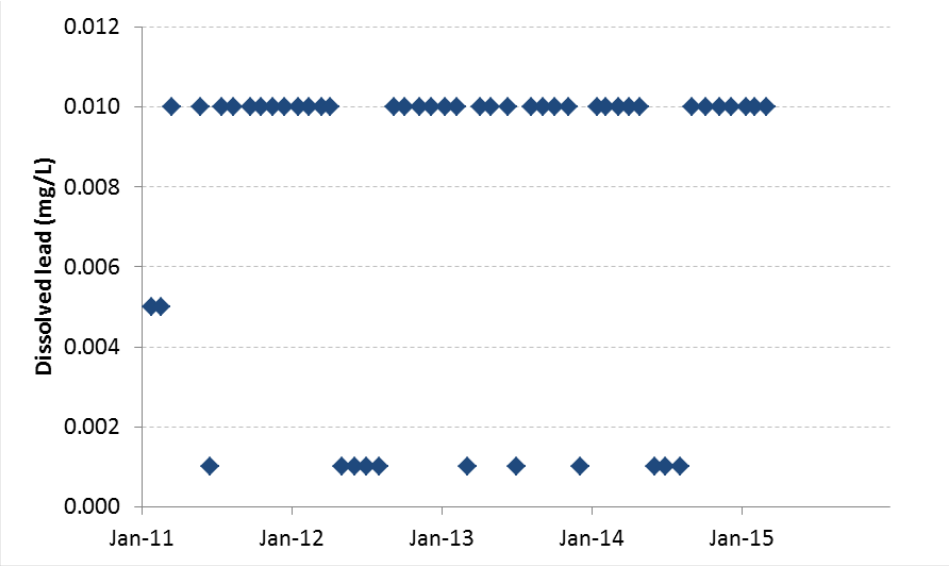

Figure D-22 Dissolved lead recorded at monitoring site LDP 9

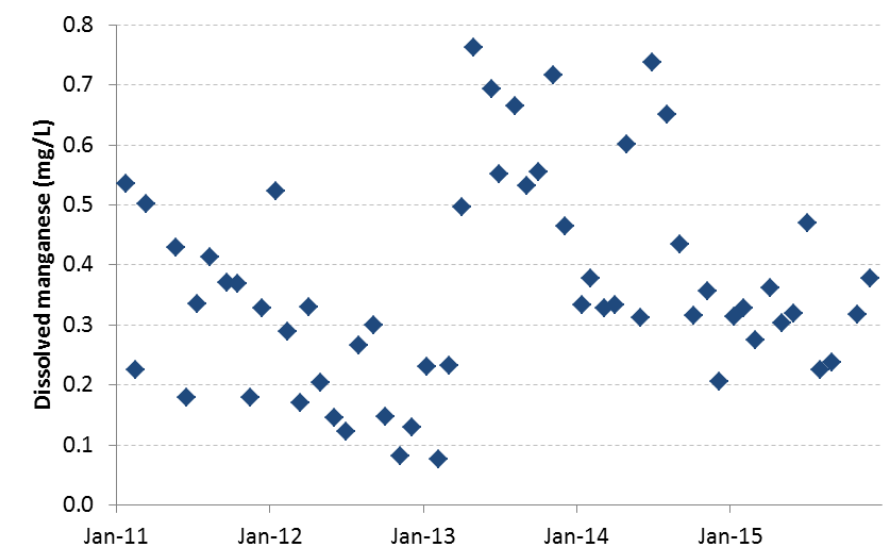

Figure D-23 Dissolved manganese recorded at monitoring site LDP 9

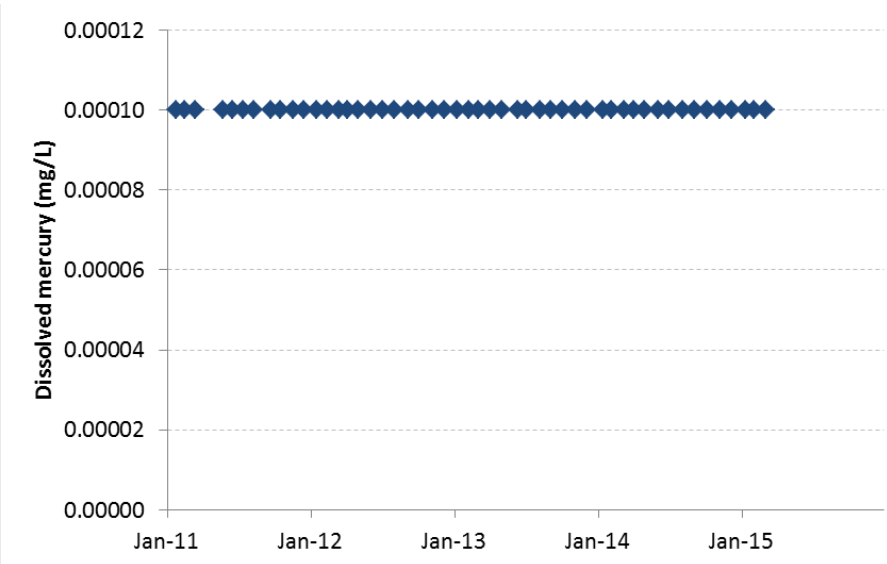

Figure D-24 Dissolved mercury recorded at monitoring site LDP 9

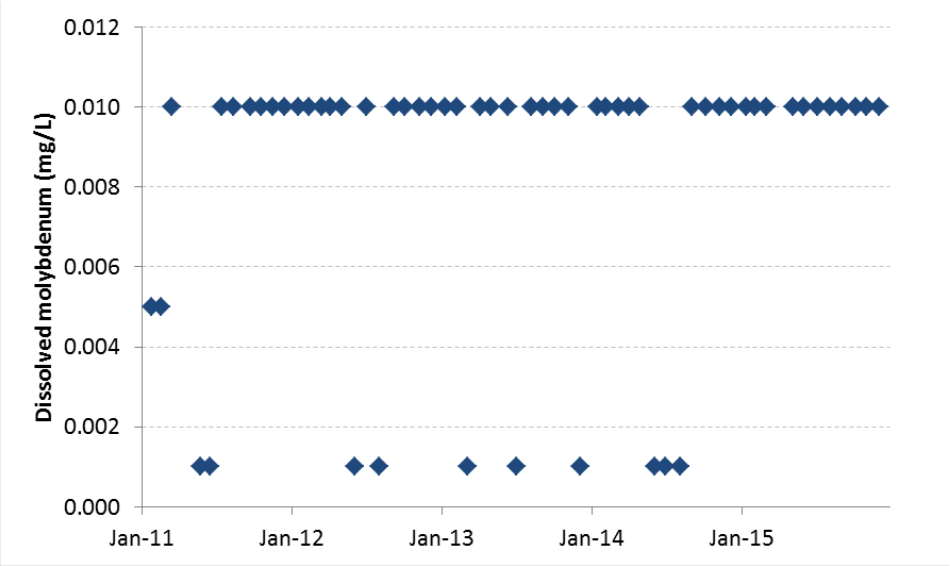

Figure D-25 Dissolved molybdenum recorded at monitoring site LDP 9

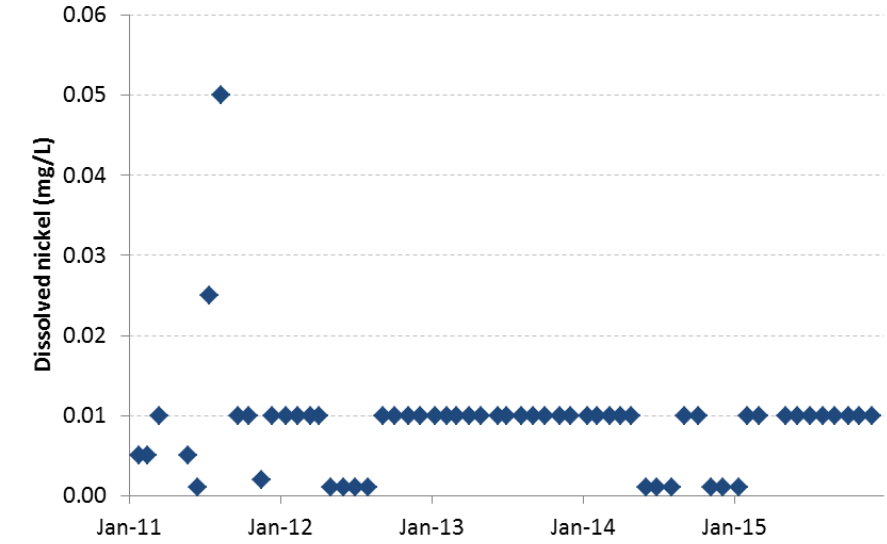

Figure D-26 Dissolved nickel recorded at monitoring site LDP 9

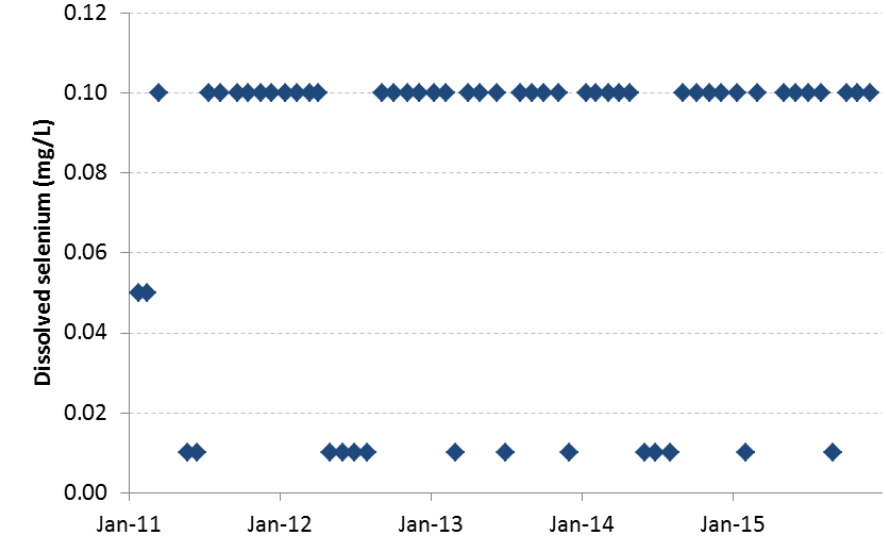

Figure D-27 Dissolved selenium recorded at monitoring site LDP 9

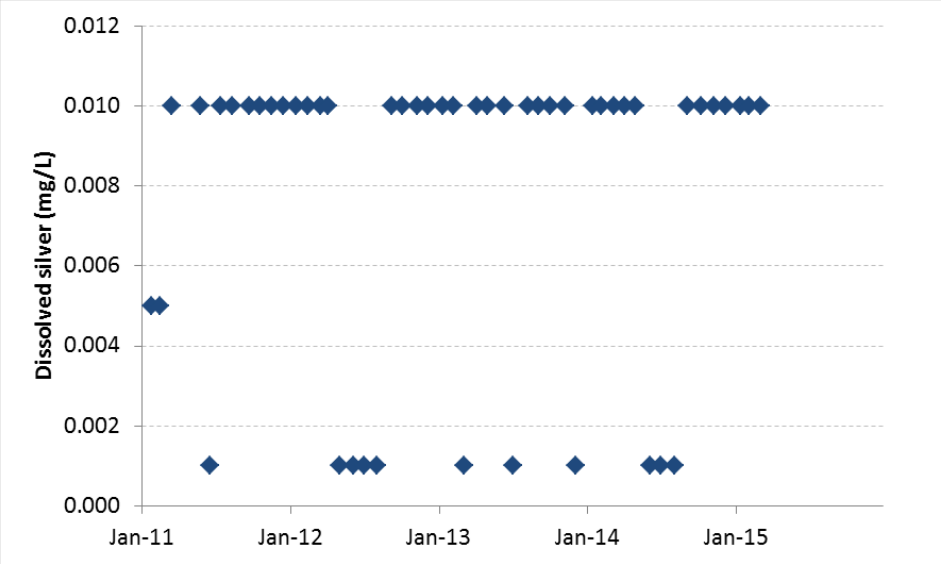

Figure D-28 Dissolved silver recorded at monitoring site LDP

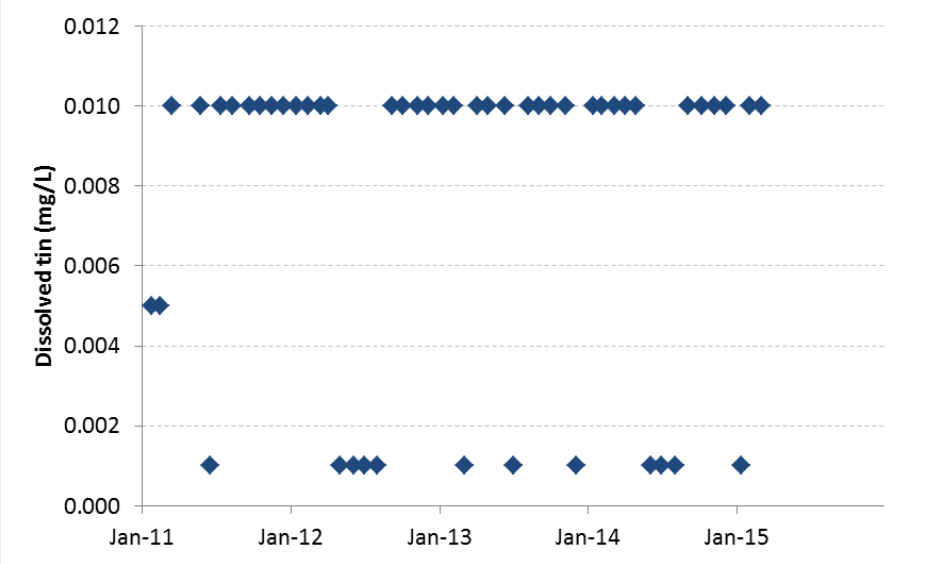

Figure D-29 Dissolved tin recorded at monitoring site LDP 9

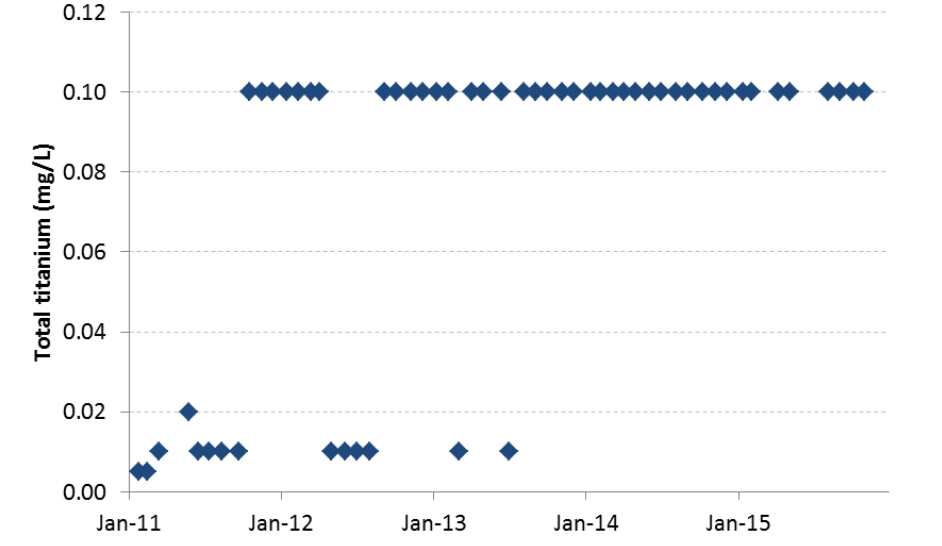

Figure D-30 Dissolved titanium recorded at monitoring site LDP 9

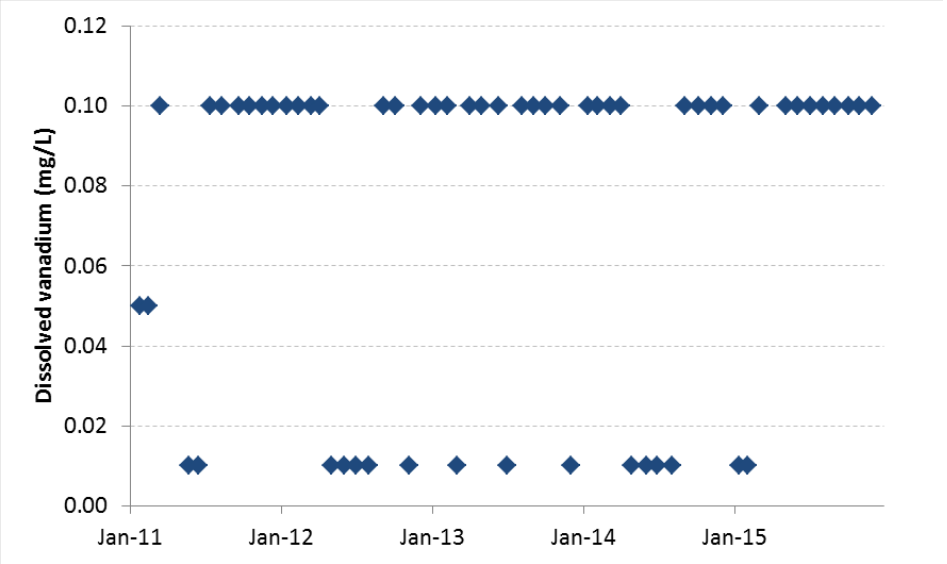

Figure D-31 Dissolved vanadium recorded at monitoring site LDP 9

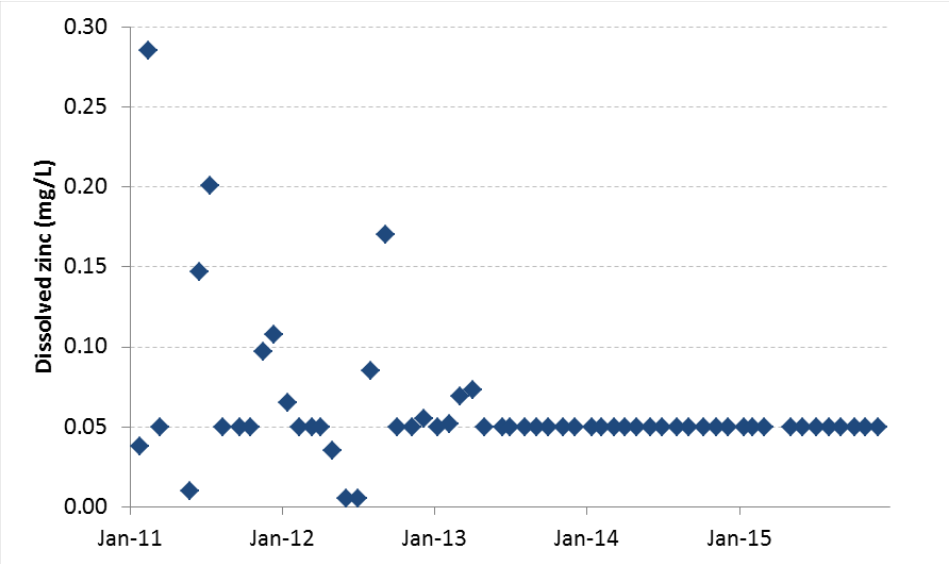

Figure D-32 Dissolved zinc recorded at monitoring site LDP 9