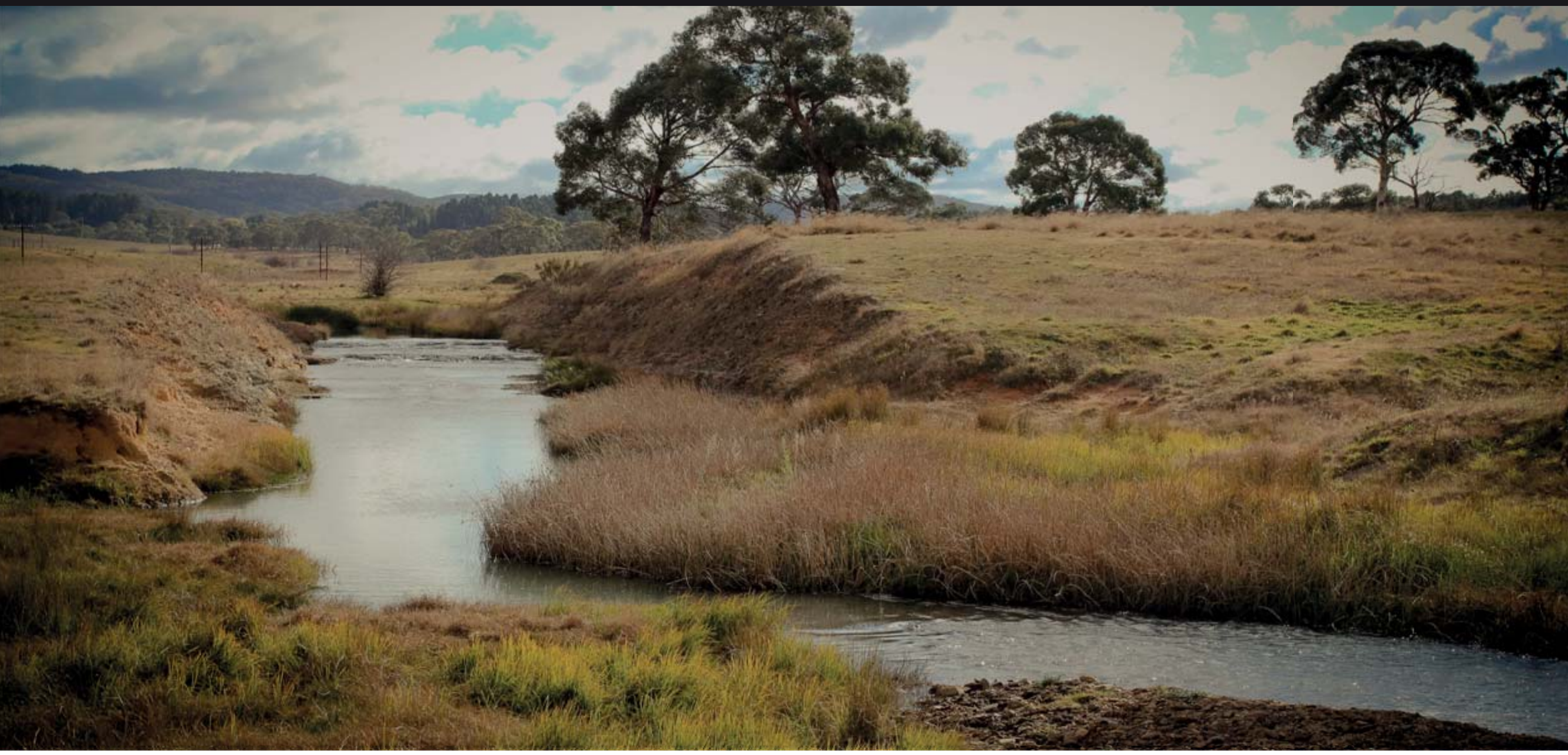
Springvale Water Treatment Project

Modification 3
Modification Report

March 2019



EnergyAustralia Centennial Coal

Executive summary

Springvale Coal is seeking a modification to the Springvale Water Treatment Project (WTP) development consent for the implementation of the proposed interim water management strategy.

The Springvale WTP involves the transfer of water from existing dewatering facilities on the Newnes Plateau for treatment and reuse at the Mount Piper Power Station (MPPS). The project was initiated to improve environmental outcomes for the Coxs River catchment and meet the requirements of the Springvale Mine Extension Project (MEP) consent. Springvale Coal is committed to eliminating mine water discharges from LDP009 to the Coxs River catchment by June 30 2019 in accordance with the Springvale MEP consent requirements.

Development of the Springvale WTP has been undertaken pursuant to an expedited timetable in order to meet the requirements of the Springvale MEP consent with respect to mine water discharge, particularly those water management performance measures set for mine water discharge that are contained in condition 12 of Schedule 4 of the Springvale MEP consent. However, a recent quantitative schedule risk assessment has highlighted the potential that the water treatment process may not be fully commissioned and operational by 30 June 2019. This date corresponds to the deadline by which various mine water discharge water performance measures are required to be achieved pursuant to condition 12 of Schedule 4 of the Springvale MEP consent.

The proposed interim water management strategy will manage a maximum of 2,700 ML of mine water at inflows of up to 24 ML/day during the progressive commissioning of the water treatment facility. The strategy will incorporate the transfer of mine water from dewatering facilities on Newnes Plateau to the new water treatment facility at MPPS in accordance with existing Springvale WTP consent. All incoming mine water will receive filtration for removal of solids and a portion of the filtered water will sequentially bypass the desalination system during the progressive commissioning of reverse osmosis treatment modules. The water will then be transferred to Thompsons Creek Reservoir for storage and subsequent reuse within MPPS. In doing so, it is noted that the water that is stored in the Thompsons Creek Reservoir will still be utilised to meet the following requirements for environmental flow releases from the Thompsons Creek Reservoir set by the water supply work approval 10CA117220:

(a) environmental flow releases equal to or greater than 0.8 ML/day from the Thompsons Creek Reservoir between 1 September and 20 April in a given calendar year; and

(b) environmental flow releases equal to or greater than 0.3 ML/day between 1 May and 31 August in a given calendar year.

The interim water management strategy will provide up to an additional six months flexibility to the delivery program to allow the safe finalisation of construction, commissioning and operation of the water treatment facility. Implementation of the strategy will require minor modifications to the Springvale WTP development consent.

The proposed modification to the Springvale WTP consent would, if approved, be of minimal environmental impact and the development would remain substantially the same development as originally approved. An overview of the proposed amendment to the approved development is included in Table E-1.1.

Table E-1.1 Springvale WTP amendments

Approved development	Proposed amendments
Springvale Water Treatment Project (SSD7592)	
▪ Treatment of all incoming mine water including pre-treatment filtration for solids removal and desalination through reverse osmosis treatment modules	▪ Pre-treatment filtration of incoming mine water and sequential bypass of desalination units during progressive commissioning of the water treatment plant ▪ Treatment of incoming mine water following commissioning of water treatment facility in accordance with existing consent
▪ Transfer of excess treated water to Thompsons Creek Reservoir using existing Coxs River Water Supply Pipeline	▪ Transfer of a maximum of 2,700 ML at up to 24 ML/day of filtered mine water to Thompsons Creek Reservoir using existing Coxs River Water Supply System pipeline ▪ Transfer of excess treated water to Thompsons Creek Reservoir following commissioning of water treatment facility in accordance with existing consent

The proposed development will utilise existing infrastructure approved for use in accordance with the Springvale WTP consent. Potential environmental impacts are therefore restricted to consideration of impacts upon water quality within Thompsons Creek reservoir and the broader Coxs River catchment.

A detailed water resources assessment has been undertaken to assess the proposed strategy, which demonstrates a negligible effect upon water quality in the catchment.

Water will be temporarily stored within Thompsons Creek Reservoir, which is predominantly used as an offline storage dam to provide water security to MPPS. The filtered mine water transfers represent around 10% of the total storage volume within the reservoir and will not result in any new exceedance of relevant guidelines beyond existing background water quality. There is predicted to be an increase in EC of 40 µS/cm, which is considered to have a negligible impact on water quality within Thompsons Creek Reservoir. The water will be stored for subsequent reuse within MPPS during periods of high water demand and will not result in potential toxicity to fish species or impact upon the use of the reservoir by recreational fishers.

A water and salt balance model has also been used to assess the impacts of the strategy on the broader catchment including the requirement for environmental flow releases of between 0.3 and 0.8 ML/day from Thompsons Creek Reservoir. The comparison of predicted flow and electrical conductivity trends for the proposed modification predominantly mirrors the approved development, with an exception of a minor increase in the order of 10 µS/cm for the Coxs River at the confluence with Pipers Flat Creek. Overall, the modelling demonstrates a gradual but significant reduction in electrical conductivity in the broader Coxs River catchment under both the existing consent and the proposed modification.

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1. Introduction

1.1 Overview

1.1.1 Background

The Springvale Water Treatment Project (WTP) was initiated to improve the environmental outcomes and water quality in the Upper Coxs River catchment and achieve compliance with the water management performance measures required under the Springvale Mine Extension Project (MEP) development consent.

The Springvale WTP was approved as State Significant Development (SSD) 7592 on 19 June 2017. Development consent was granted based upon the development described in the Springvale WTP Environmental Impact Statement (EIS), the Response to Submissions and the Amendment to Development Application. SSD 7592 has been modified on two occasions to incorporate a number of minor design amendments and alternate construction processes to improve efficiency for delivery of the Springvale WTP.

The Springvale MEP was approved as SSD 5594 on 21 September 2015 and requires groundwater currently released through the existing Licenced Discharge Point (LDP) 009 into Sawyers Swamp Creek and the Coxs River catchment to cease by 30 June 2019.

Implementation of the Springvale WTP will eliminate direct mine water discharges from the Springvale Delta Water Transfer Scheme (SDWTS) into the Coxs River catchment. The Springvale WTP involves the transfer of water from existing dewatering facilities on the Newnes Plateau to a new water treatment plant located at the Mount Piper Power Station (MPPS). Treated water will be used as a priority within the MPPS cooling water system and excess treated water transferred to Thompsons Creek Reservoir for storage and subsequent reuse in the power station operations. It is noted that the water that is stored in the Thompsons Creek Reservoir will still be utilised to maintain environmental flow releases from the Thompsons Creek Reservoir set by the water supply work approval 10CA117220 including:

(a) environmental flow releases equal to or greater than 0.8 ML/day from the Thompsons Creek Reservoir between 1 September and 20 April in a given calendar year; and

(b) environmental flow releases equal to or greater than 0.3 ML/day between 1 May and 31 August in a given calendar year.

Springvale Coal Pty Ltd (Springvale Coal) and EnergyAustralia has progressed the delivery of the Springvale WTP within a compressed program in order to achieve the mine water discharge criteria and associated timeframes required by the Springvale MEP consent. However, a quantitative schedule risk assessment has recently been undertaken and highlighted the potential that the water treatment process may not be fully commissioned and operational by 30 June 2019.

1.1.2 Interim water management strategy

Springvale Coal is committed to eliminating mine water discharges from LDP009 to the Coxs River catchment by 30 June 2019 in accordance with the Springvale MEP consent.

An interim water management strategy has therefore been developed to provide a contingency for the scenario where the Springvale WTP has not been fully commissioned by the time mine water discharges are required to cease through LDP009.

The interim water management strategy will involve the transfer of mine water from dewatering facilities on Newnes Plateau to the new water treatment facility at MPPS in accordance with existing Springvale WTP consent. The strategy will manage a total of 2,700 ML of mine water at inflows of up to 24 ML/day during the progressive commissioning of the water treatment facility and include:

- Pre-treatment of incoming mine water including filtration to remove solids in accordance with existing consent
- Bypass of desalination system during the progressive commissioning of reverse osmosis treatment modules
- Transfer of filtered mine water to Thompsons Creek Reservoir for storage and subsequent reuse within MPPS.

Springvale Water Treatment Project

The Springvale WTP consent requires the project to be undertaken generally in accordance with the development described in the Springvale WTP EIS. The EIS describes the desalination of all mine water prior to either reuse directly within MPPS or transfer and storage within Thompsons Creek Reservoir.

The proposed interim water management strategy involves a bypass of the desalination system for incoming mine water prior to storage within Thompsons Creek Reservoir. The sequential bypass of the desalination system during commissioning and storage of filtered mine water within Thompsons Creek Reservoir was not described in the EIS and is therefore not considered to be "generally in accordance with the development described in the EIS" as required under Condition 2 of Schedule 3 of the consent.

Springvale Coal therefore proposes to submit Modification 3 to SSD 7592 to procure consent for the implementation of the interim water management strategy.

1.2 Purpose of this report

This modification report has been prepared to support the application to modify development consent SSD 7592 pursuant to Section 4.55 (1A) of the EP&A Act. The report describes the need for the modification and assesses the potential environmental impacts associated with interim water management strategy.

1.3 The applicant

Springvale Mine is owned by Centennial Springvale Pty Limited (50%) and Springvale SK Kores Pty Limited (50%) as participants in the Springvale unincorporated joint venture. Springvale Mine is operated by Springvale Coal for and on behalf of the joint venture participants.

Springvale Coal is the applicant for both the Springvale WTP and Springvale MEP.

The Springvale Water Treatment Project is owned by MP Water Pty Ltd as trustee for the MP Water Trust (MP Water). MP Water has appointed Veolia Australia & New Zealand (Veolia), as the construction and operations contractor to manage the Springvale Water Treatment Project (Project) for MP Water. MP Water has contracted with Springvale SK Kores Pty Limited, Centennial Springvale Pty Limited (together, the Springvale Joint Venturers) and EnergyAustralia NSW Pty Ltd (EnergyAustralia) to provide the water treatment services which are documented under a Water Treatment Services Contract entered into between the parties.

The relevant postal address for Springvale Coal is:

Springvale Coal Pty Limited
Level 18
1 Market St
Sydney NSW 2000

1.4 Stakeholder consultation

Consultation with relevant government agencies has been undertaken during development of the interim water management strategy.

An initial briefing presentation was held with the Department of Planning and Environment (DP&E) on 22 November 2018 and subsequent presentations were provided to WaterNSW and the Environment Protection Authority (EPA) on 5 December 2018. The presentations provided an update on progress of the delivery of the water treatment facility, an overview of the interim water management strategy and discussed potential statutory approval pathways.

Ongoing meetings and updates have been maintained with DP&E, WaterNSW and EPA throughout the preparation of this SEE. Briefings to Lithgow City Council and the Department of Primary Industries (Fisheries) are planned to outline the proposed interim water management strategy.

A site tour of the water treatment facility and discussion on progress of the construction program was also provided to representatives of the Colong Foundation and the Lithgow Environment Group on 15 February 2019.

1.5 Statutory approval framework

1.5.1 Consent modification

Section 4.55 of the EP&A Act contains three modification powers, one of which is the power contained in s 4.55(1A) of the EP&A Act to enable the relevant consent authority to approve a modification application in circumstances where the modification would, if approved:

(a) involve "minimal environmental impact"; and

(b) result in "substantially the same" development as that originally approved, being carried out.

A modification application must include or be accompanied by the information that is contained in Clause 115 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

The focus of the environmental assessment of the proposed modification is related to the assessment of potential impacts upon water quality within Thompsons Creek Reservoir and the broader Coxs River Catchment.

Detailed water quality modelling has been undertaken to assess the potential environmental impacts of the interim water management strategy and is included in Appendix A. The modelling has demonstrated the proposed modification to consent will have negligible environmental impacts upon water quality within Thompsons Creek Reservoir or receiving waters in the Coxs River catchment.

The interim water management strategy will predominantly utilise the existing infrastructure approved for use as part of the project, with the exception of a short bypass pipeline proposed to be established within the existing water treatment plant footprint to allow the bypass of desalination units. Consideration of the impacts of the modification upon biodiversity values *Biodiversity Conservation Act 2016* and *Biodiversity Conservation Regulation 2017* are included in Appendix B.

The appropriate modification pathway for the proposed design changes is considered to be Section 4.55(1A). The requirements of Clause 115 of the EP&A Regulation and where the requirements are addressed in this document are outlined in Table 1.1.

Table 1.1 Requirements for application for modification of development consent

Requirement	Response/reference
(1) An application for modification of a development consent under section 4.55(1), (1A) or (2) or 4.56 (1) of the Act must contain the following information:	
(a) the name and address of the applicant,	Section 1.3
(b) a description of the development to be carried out under the consent (as previously modified),	Section 2.1.
(c) the address, and formal particulars of title, of the land on which the development is to be carried out,	Section 2.1.2
(d) a description of the proposed modification to the development consent,	Section 4
(e) a statement that indicates either: (i) that the modification is merely intended to correct a minor error, misdescription or miscalculation, or (ii) that the modification is intended to have some other effect, as specified in the statement,	Section 1.5.2
(f) a description of the expected impacts of the modification,	Section 5
(g) an undertaking to the effect that the development (as to be modified) will remain substantially the same as the development that was originally approved,	Section 1.5.2
(g1) in the case of an application that is accompanied by a biodiversity development assessment report, the reasonable steps taken to obtain the like-for-like biodiversity credits required to be retired under the report to offset the residual impacts on biodiversity values if different biodiversity credits are proposed to be used as offsets in accordance with the variation rules under the Biodiversity Conservation Act 2016,	Not applicable
(h) if the applicant is not the owner of the land, a statement signed by the owner of the land to the effect that the owner consents to the making of the application (except where the application for the consent the subject of the modification was made, or could have been made, without the consent of the owner),	Not applicable – public notification development in accordance with Clause 49(2)(b) of the EP&A Regulation
(i) a statement as to whether the application is being made to the Court (under section 4.55) or to the consent authority (under section 4.56),	Not applicable - The application is being made to the consent authority under Section 4.55(1A)

When assessing an application under Section 4.55 for modification to consent, the consent authority is required to take into consideration the relevant matters outlined in Section 4.15 of the EP&A Act.

1.5.2 Substantially the same development

The Springvale WTP will remain substantially the same development as originally approved under SSD 7592. The proposed modification does not seek to significantly alter the nature or scale of the proposed development and will continue to facilitate the improved environmental outcomes for the Upper Coxs River catchment.

The project will continue to transfer all mine water from dewatering facilities on the Newnes Plateau to MPPS for treatment and reuse with the power stations cooling water system. The modification involves a sequential bypass of the desalination system during the commissioning of the water treatment facility. This will allow for the storage of up to 2,700 ML of filtered mine water within Thompsons Creek Reservoir to enable subsequent reuse within MPPS.

The strategy will provide up to six month's flexibility to the delivery program based upon anticipated water make and time of the sequential commissioning of the reverse osmosis treatment modules. This will enable the safe finalisation of construction, commissioning and operation of the water treatment facility.

The interim water management strategy will predominantly utilise the existing infrastructure approved for use as part of the project. Impacts are therefore considered to be restricted to potential impacts to water quality within Thompsons Creek reservoir and the broader Coxs River catchment.

1.5.3 Drinking water catchment SEPP

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (the Sydney Drinking Water Catchment SEPP) applies to land within Sydney's Drinking Water Catchment including the Upper Coxs River system. The aims of the policy are:

(a) to provide for healthy water catchments that will deliver high quality water while permitting development that is compatible with that goal, and

(b) to provide that a consent authority must not grant consent to a proposed development unless it is satisfied that the proposed development will have a neutral or beneficial effect on water quality, and

(c) to support the maintenance or achievement of the water quality objectives for the Sydney drinking water catchment.

Under clause 10 of the Sydney Drinking Water Catchment SEPP, the consent authority must "not grant consent to carrying out of development" in the drinking water catchment unless it would have a 'neutral or beneficial effect' on water quality (the NorBe test).

Development consent for the Springvale WTP was granted through the Planning Assessment Commission on 19 June 2017, as the project demonstrated a considerable beneficial effect to the catchment through the elimination of mine water discharges to the environment.

While the consent authority must apply the NorBe test in "*grant(ing) consent to the carrying out of development*", section 4.55 (4) of the EP&A Act provides that the modification of a development consent is "*taken not to be the granting of development consent*". The Sydney Drinking Water Catchment SEPP must be considered as part of the broader considerations under Section 4.15 of the EP&A Act. However, the NorBe test does not apply to a modification in the same way as it does to the granting of consent. In particular, the requirement for a consent authority to be satisfied of NorBe prior to determining a development application does not extend to the determination of a modification application.

However, it is recognised that the intent of the NorBe test is for the protection of water within the catchment and this has been considered as part of the development of the interim water management strategy forming the basis of the proposed modification. Detailed water quality modelling has been undertaken as part of the assessment, which highlights:

- that the interim water management strategy will have negligible impact upon water quality; and
- will continue to result in net beneficial effects upon the catchment during the limited period in which the interim water management strategy operates.

2. Project Setting

2.1 Springvale Water Treatment Project

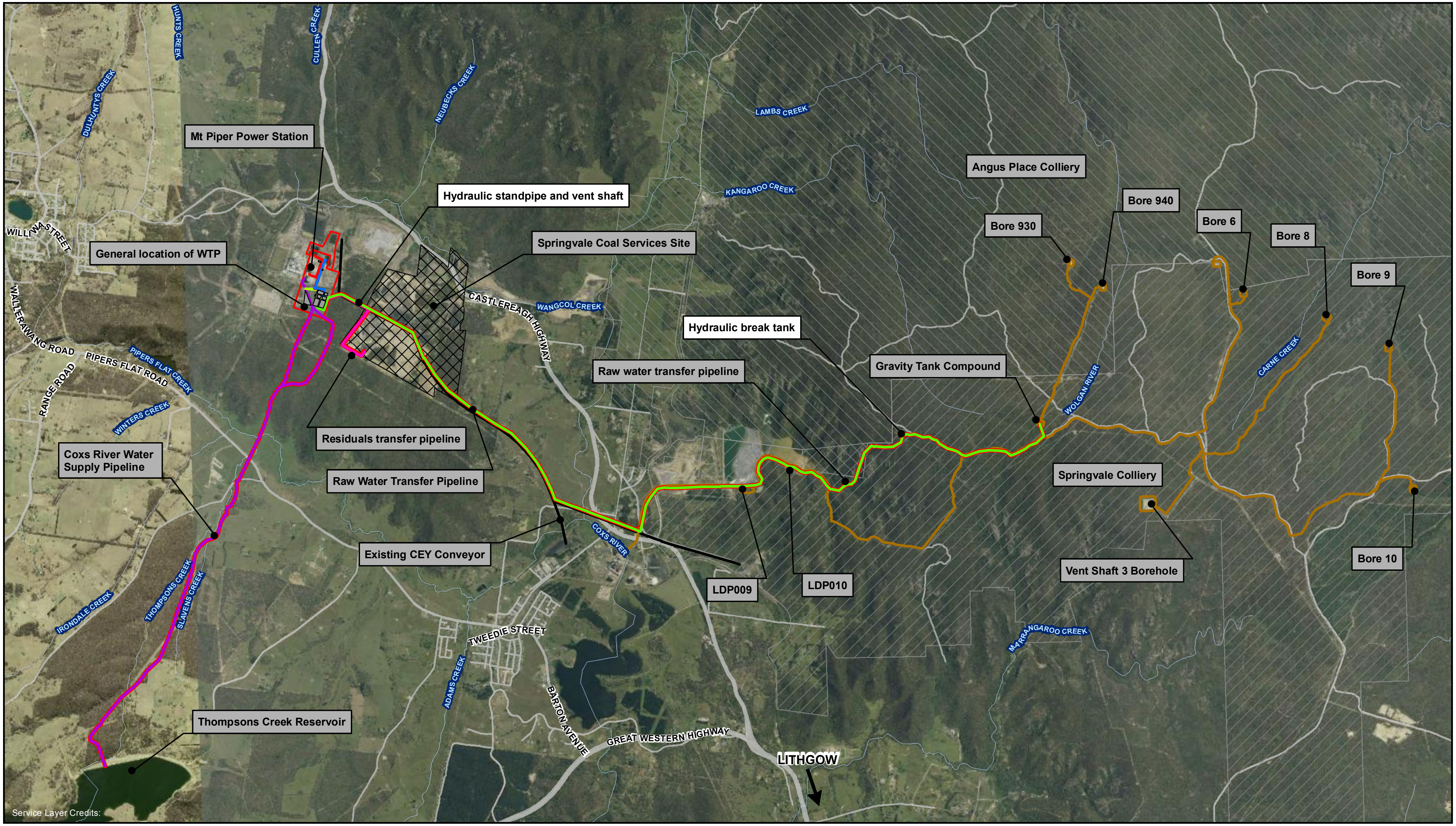
2.1.1 Overview

The Springvale WTP involves the transfer of water from existing dewatering facilities on the Newnes Plateau to a new water treatment plant located at MPPS. Treated water will be used as a priority for industrial reuse to meet the demand for make-up water requirements within the MPPS cooling water system. Any excess treated water will be temporarily stored within Thompsons Creek Reservoir for subsequent reuse during periods of high water demand in the MPPS cooling water system. The approved project as defined in SSD 7592 Modification 2 comprises the following major elements:

- A system to transfer up to 42 ML/day of dewatered mine water from the existing gravity tank forming part of the approved Springvale Delta Water Transfer Scheme (SDWTS) on the Newnes Plateau to the MPPS site.
- A new water treatment plant at MPPS incorporating desalination processes to reduce the salinity in mine water.
- Transfer of treated water from the water treatment plant to the MPPS cooling water system to contribute to the demand for make-up water.
- Use of the existing Coxs River Water Supply pipeline to transfer excess treated water to Thompsons Creek Reservoir for storage and subsequent reuse in the cooling water system.
- Disposal of residuals from the pre-treatment process in the reject emplacement area (REA) at the neighbouring Springvale Coal Services site (part of Western Coal Services Project, SSD 5579).
- Implementation of an Optimised Pre-treatment and Unique Separation (OPUS) process including the addition of an additional reverse osmosis system to replace the use of the brine concentrators and manage salt load from the new water treatment plant (WTP) Disposal of brine will continue in accordance with existing approvals and practices at MPPS.

2.1.2 Site location

The Springvale WTP is located in the western coalfields of NSW near Lithgow. A gravity transfer pipeline will extend from the existing water management infrastructure on the Newnes Plateau approved under the existing Springvale MEP SSD 5594 Consent. The pipeline will transfer mine water from the existing “Gravity Tank” to the MPPS as shown on Figure 2-1.



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Metres

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

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LEGEND

Proposed Alignment
- Raw water transfer pipeline
- Residuals transfer pipeline
- Brine transfer pipeline
- Crystallised salt transfer pipelines
- Treated water pipeline to cooling tower forebay
- Existing and Approved SDWTS
- Existing CEY Conveyor
- Cox's River Water Supply Pipeline
- Treated water pipeline to Coxs River Water Supply Pipeline
- Proposed WTP Layout
- Project application area (representative)
- Springvale Mine
- Angus Place Colliery
- Springvale Coal Services Site

Centennial Coal and EnergyAustralia
EA/CEY Water Treatment Project

Job Number 21-25109
Revision A
Date 15 Oct 2018

Project Application Area

Figure 2-1

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: General Topo - NSW LPI DTDB 2012, Imagery - sixmaps 2015. Created by:afoddy

From the gravity tank on the Newnes Plateau, the pipeline would initially follow the alignment of existing access trails and a former logging trail over the escarpment to Springvale Mines existing LDP 009 on EPL 3607. The remainder of the pipeline alignment between LDP009 and the MPPS follows existing ash pipelines, haul roads and an overland conveyor system. The pipeline will traverse a number of roads including the Castlereagh Highway, the Coxs River and a private rail spur.

The water treatment plant will be located on the MPPS site, to the south of the existing cooling water system.

The existing Coxs River Water Supply pipeline will be used to transfer excess treated water between MPPS and Thompsons Creek Reservoir for storage and subsequent reuse in the power station operations.

The project application area includes a buffer surrounding the proposed water treatment infrastructure at MPPS and 20 m corridor along the proposed pipeline alignments. Lot and DP's remain the same, while land holdings traversed by the project will remain consistent with the existing approval.

2.2 Springvale Mine

The Springvale Mine is an underground coal mine located in the western coalfields near Lithgow. The development consent allows for mining operations to continue until 31 December 2028 and permits:

- extraction of up to 5.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal by longwall mining methods;
- transportation of coal:
  - by overland conveyor to the Western Coal Services Site and to Mount Piper Power Station;
  - by road to local customers; and
- operation of supporting infrastructure, including ventilation shafts, a coal stockpile, mine services bores and offices.

The Springvale Mine water management scheme is integrated with the adjoining Angus Place Colliery operations, with water extracted through mine dewatering activities at both operations transferred to the Springvale Delta Water Transfer Scheme (SDWTS).

The SDWTS was commissioned in 2006 in conjunction with the construction of the now decommissioned Bore 5 Dewatering Facility for Springvale Mine. It includes a network of pipelines to transfer water from the dewatering facilities to the Wallerawang Power Station via LDP009, which is located adjacent to Sawyers Swamp Creek Ash Dam. The gravity tank was also established on the Newnes Plateau to provide interim storage to manage flows prior to transfer for reuse in the Wallerawang Power Station operations. The SDWTS served to both remove discharges from the Newnes Plateau and reduce the volume of water sourced for local power station operations from the regional surface rivers and lakes, which feed into Sydney's drinking water catchment.

The Wallerawang Power Station has ceased operations and has been undergoing a decommissioning, demolition and rehabilitation process since May 2014. All water from the SDWTS is therefore currently discharged through LDP009 to Sawyers Swamp Creek and the Coxs River.

Springvale Mine is licensed to discharge up to 30 ML/day at LDP009 under EPL 3607. Discharges from LDP009 drain via Sawyers Swamp Creek to the upper Coxs River. Springvale

Mine is also licensed to discharge up to 10 ML/day via LDP001 to Springvale Creek, which drains to the Coxs River upstream from Lake Wallace. The mine water releases combine with run-off from the surrounding catchment and flows through a series of water storage dams constructed as part of the Coxs River Water Supply System.

2.3 Coxs River Water Supply System

2.3.1 Existing operations

MPPS primarily sources cooling water makeup water from the Coxs River Water Supply System. The system comprises a number of storage dams, interconnecting pipelines and pumping stations, which were established to provide water for local power station operations as shown on Figure 2-2.

Major water storages include:

- Lake Wallace (Wallerawang Reservoir) with a capacity of around 4,300 ML
- Lake Lyell with a capacity of around 32,000 ML
- Thompsons Creek Reservoir with a capacity about 27,500 ML

MPPS currently draws water from Lake Lyell, which is either is pumped directly to the power station cooling water system or directed into Thompsons Creek Reservoir as an off-line staging dam. A Water Access Licence Authorises up to 23,000 ML/year from the Coxs River System.

MPPS also has access to supplementary water from the Fish River via a limited water allocation of 8,184 ML/yr for supplementary flows from a Water NSW Licence for the Fish River Water supply.

The main function of Thompsons Creek Reservoir is to provide additional off-stream storage of water to drought proof the MPPS operations. The reservoir has a relatively small catchment area of 8.9 km^2 and is primarily filled by pumping from Lake Lyell via a surge tank which gravity feeds to a valve house to enable transfer to either Thompsons Creek Reservoir or directly to MPPS.

The full storage level (FSL) at the reservoir is set at 1,033 m AHD, which is 0.3 m below the invert level of the spillway to allow the reservoir to hold any catchment run-off without spilling. The reservoir is typically operated at between 0.3 m and 2 m below the FSL (between 1,032.7 m AHD and 1031 m AHD). The operating levels are based upon catchment rainfall and management requirements, in addition to safety freeboard requirements between the FSL level and spillway crest.

An 11.6 m submerged inlet/outlet structure is located within the centre of the reservoir and serves as an inlet when the reservoir is being filled and an outlet when water is being drawn from the reservoir to MPPS. Environmental flows are required to be maintained to Thompsons Creek equal to, or greater than, 0.8 ML/day between 1 September and 30 April and equal to, or greater than, 0.3 ML/day between 1 May and 31 August.

Thompsons Creek Reservoir also has an outlet to Pipers Flat Creek, via a valve system on the main Coxs River Water Supply line between the reservoir and MPPS. The valve system has not been historically used as a result of the active management of water levels in the reservoir and the typically high water demands at the MPPS operations.

Thompsons Creek Reservoir arguably offers some of the best lake based fishing for trophy sized rainbow and brown trout in NSW. It is managed as a trophy fishery by the Department of Primary Industries under an access agreement with EnergyAustralia.

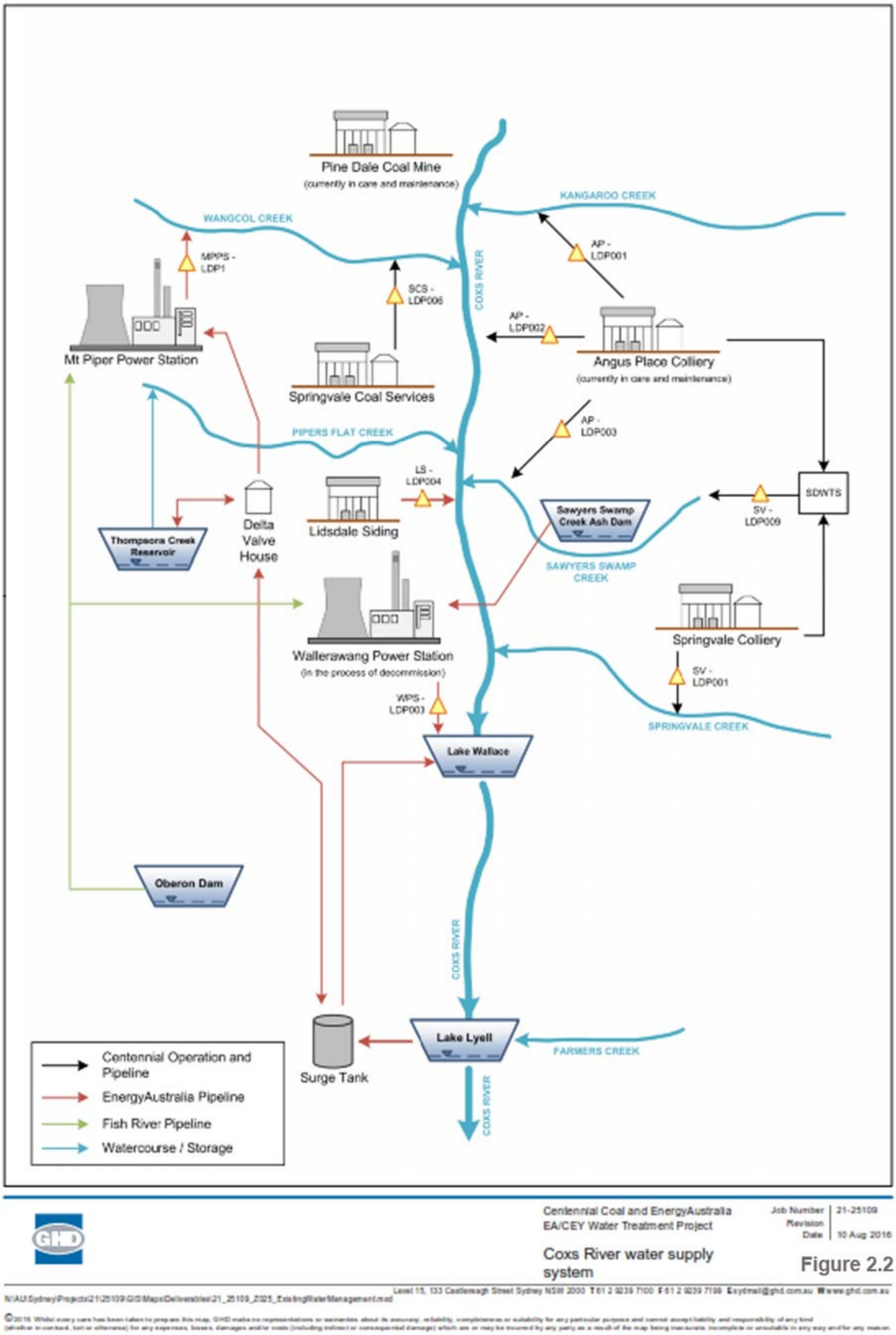

Figure 2-2 Coxs River water supply system

2.3.2 Water treatment facility operation

The Springvale WTP involves the transfer of any excess treated water to Thompsons Creek Reservoir for storage and subsequent reuse during periods of high power station water demands. The project will utilise the existing Coxs River Water Supply system infrastructure, including the existing valve house to regulate flows between Lake Lyell, Thompsons Creek Reservoir and the MPPS.

The existing water supply system, along with its relationship to the Springvale WTP (shown as orange in Figure 2-3) involves a closed loop for reuse of treated water.

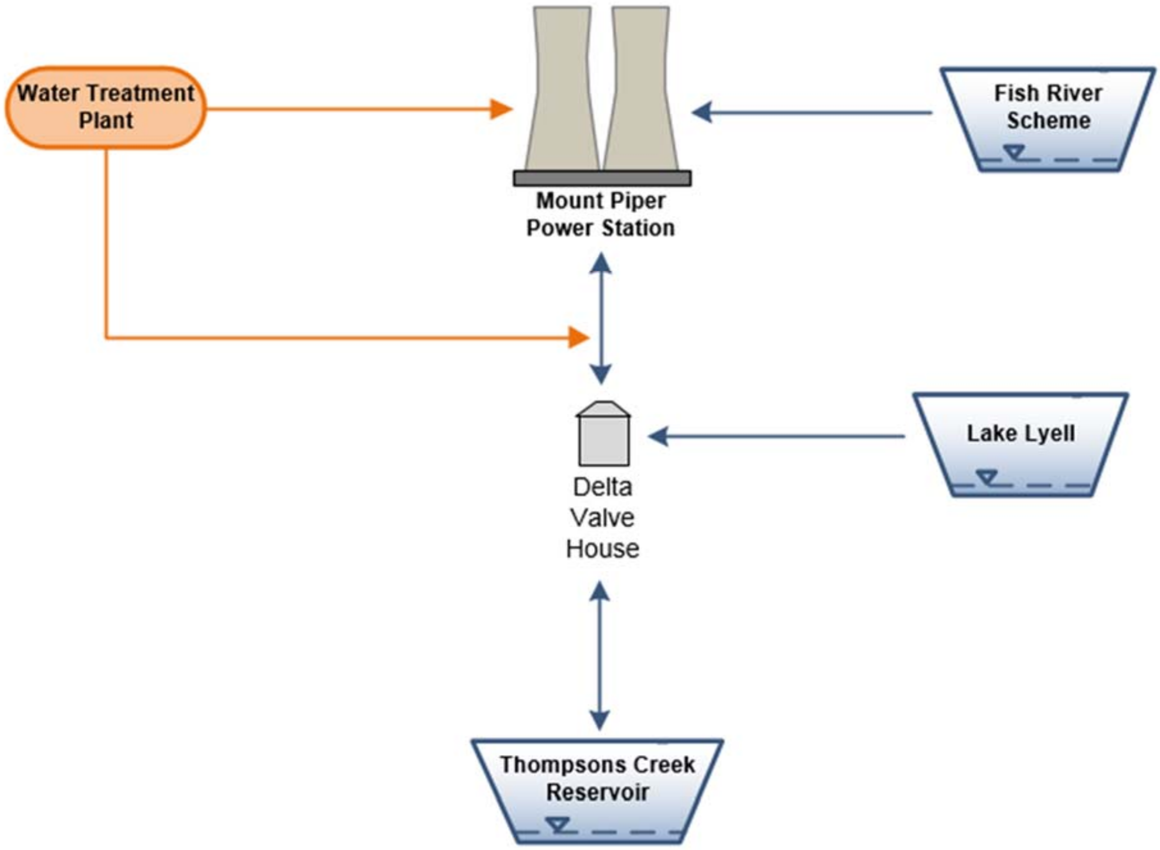

Figure 2-3 Water supply system for Thompsons Creek Reservoir

The current system effectively provides for the indirect reuse of mine water discharges from the SDWTS via LDP009 located upstream in the Coxs River catchment. Current water quality within Thompsons Creek Reservoir is therefore influenced by mine water discharges from LDP009.

3. Need for the modification

3.1 Springvale Mine Extension Project

The Springvale Mine Extension Project was approved as a State Significant Development (SSD) under Section 89E of the Environmental Planning and Assessment (EP&A) Act in September 2015. SSD_5594 provided consent for the continued operation of the Springvale Mine and is subject to a number of specific administrative and environmental conditions included in Schedule 2, 3 and 4 of the consent.

The Springvale MEP included the continuation of all previously approved facilities and infrastructure at the mine as modified by the EIS. This included the continued use of groundwater dewatering infrastructure, which is an essential aspect of underground mining operations. Mine water fed into the SDWTS was to be transferred to the Wallerawang Power Station at up to 30 ML/Day and/or discharged via LDP009 to Sawyers Swamp Creek and the Cox's River. Closure of the Wallerawang Power Station in November 2014 has resulted in all mine water being discharged from the SDWTS via LDP009.

Condition 12 of Schedule 4 (as modified) provides specifications for water management performance measures for the project including:

- *Discharge all groundwater inflow mine water (except from the Renoun workings) through the SDWTS*
- *Meet a limit for salinity of 500 µS/cm (90th percentile) electrical conductivity (EC) by 30 June 2019*
- *Eliminate acute toxicity from LDP009 discharges to aquatic species by 30 June 2017, and chronic toxicity from LDP009 discharges to aquatic species by 30 June 2019, or when the Springvale Water Treatment Project is operational, whichever occurs first with acute toxicity defined as >10% effect relative to the control group and chronic toxicity defined as >20% effect relative to the control group*
- *Meet a discharge limit of 0 ML/day of mine water through LDP009 into the Springvale Delta Water Transfer Scheme by 1 July 2019.*

The Springvale WTP was initiated to achieve compliance with the required performance measures and to improve environmental outcomes for the Upper Coxs River catchment. Springvale Coal are committed to meeting the water management performance measures included in the Springvale MEP consent including ceasing all discharges from LDP009 by July 1 2019.

The proposed interim water management strategy has been developed as a contingency measure to ensure ongoing compliance with the required performance measure, following the identification of potential delays to completion of the new water treatment facility.

All mine water inflow will be discharged through existing dewatering facilities to the SDWTS. The Springvale Water Treatment Project transfer pipeline connects to the SDWTS at the existing Gravity Tank and will be completed prior to 30 June 2019 to allow transfer of water to the water treatment plant site at MPPS.

Commissioning of the new transfer pipeline will transfer all mine water to the new water treatment plant at MPPS in accordance with the SSD 7592 consent. This will meet the discharge limit of 0 ML/day through LDP009, and therefore, eliminate acute and chronic toxicity from LDP009 discharges to aquatic species by 30 June 2019.

The interim strategy allows for the storage of mine water within Thompsons Creek Reservoir prior to subsequent reuse at MPPS. Thompsons Creek Reservoir is managed as an offline storage primarily to provide water security for the power station operations. The reservoir has never spilled during operations but does maintain a small environmental flow release of between 0.3 and 0.8 ML/ day.

Potential impacts to water quality within Thompsons Creek Reservoir and associated with environmental releases from the reservoir have been considered as part of this modification report.

3.2 Program constraints

Springvale Coal and EnergyAustralia have been progressing the procurement, detailed design and construction process for delivery of the project. Veolia were selected as the preferred proponent for delivery of the project on behalf of Springvale Coal and EnergyAustralia.

The proponent has developed a preferred design to improve the operational efficiency and reduce the risk profile for the project. The preferred design is considered to provide long-term benefit to the catchment and was approved as Modification 1 to SSD 7592 on 12 January 2018.

The complexity of the preferred solution has led to delays in the design process and coordination of procurement activities with flow on effects for the construction program. The potential for schedule risk was identified at an early stage in the project delivery process and a quantitative schedule risk assessment was subsequently completed in June 2018. This led to the appointment of a specialist consultant to provide independent advice and development of a recovery plan and assessment of the current baseline program.

A recovery plan has been established to expedite the delivery of a large complex infrastructure project and includes the following actions:

1. Working six days a week on 24 hr shift work (7th day for slippages and opportunities).
2. Engagement of a recovery consultant to run the construction and commissioning.
3. Integrated team between contractor and sub-contractor to have a common goal.
4. Project Control Group (PCG) implemented to streamline escalation decisions.
5. Commercial teams on site to agree costs quickly on a six-day turnaround or goes to PCG.
6. Additional resources recruited, team capability assessed and upgraded.
7. Air freight of key items and acceleration costs to expedite delivery.
8. Focus/task groups managing key process equipment i.e. RO Skids, MCC panels, Tank fabrication etc.
9. Construction ramp up opportunities (civil works and underground services brought forward to clear area).
10. Design product changes to expedite delays.
11. Manpower resource increases to 300 personnel from October to March 2019. This is particularly difficult in a construction boom requiring staff from out of the local/state areas. This has resulted in increased construction budget bring the project back into alignment. It has also increased accommodation demand in the area on top of usual demand from power station/ mining shut down works.
12. Re-sequencing of construction works to align with equipment supply.
13. Commissioning of plant and equipment while construction activities are ongoing at the site.

Considerable progress has been made towards completion of construction and commissioning activities for the project with an aim of accepting mine water by 30 June 2019 corresponding to the requirement to cease discharges from LDP009. The major civil structures at the water treatment facility are complete and mechanical process equipment is currently being installed. The construction of the transfer pipeline is forecast for completion over the coming months.

There are a number of key risks that require ongoing management including:

- Safety risks associated with construction activities at multiple work fronts
- Environmental risks
- Quality
- Delivery risks including procurement, construction, commissioning and process optimisation
- Weather.

Springvale Coal and EnergyAustralia have therefore developed the interim water management strategy to provide the flexibility to accommodate any further delays to the program. The strategy will continue to result in significant net benefits to the Coxs River catchment.

The modification involves a sequential bypass of the desalination system during the commissioning of the water treatment facility. This will allow for the storage of up to 2,700 ML of filtered mine water within Thompsons Creek Reservoir to enable subsequent reuse within MPPS. The bypass of the desalination system during commissioning and storage of filtered mine water within Thompsons Creek Dam was not described in the EIS and is therefore not considered to be “generally in accordance with the development described in the EIS” as required under Condition 2 of Schedule 3 of the consent.

3.3 Alternative contingency strategies

A range of alternative contingency strategies were considered to best meet water management performance measures for the Springvale MEP, while managing potential program constraints for the final commissioning of the Springvale WTP. A review of alternative strategies include:

- Emergency storage of mine water underground within either Angus Place Colliery or Springvale Mine. This option is likely to be limited to between 30 to 40 days of storage but is dependent upon operational conditions leading up to June 2019. Underground storage for extended periods is also subject to operational risks such as flooding of active mine workings impacting upon critical underground infrastructure and potentially detrimental effects on roof strata and support integrity.
- Temporary holding of water within existing and proposed surface water storage basins at the Water Treatment Plant site and Mt Piper Power Station, which is limited to approximately five days of storage.

The alternative contingency strategies are not considered to provide sufficient capacity for management of the estimated 2,700 ML of mine water make at up to 24 ML/day. The alternative strategies will continue to be considered in conjunction with the proposed Thompsons Creek Reservoir transfer for management of any variations in mine water make over the life of the project.

4. Proposed modification

4.1 Overview of proposed change

The interim water management strategy is required to provide a contingency to allow for a potential delay in commissioning of the water treatment plant beyond 30 June 2019. The strategy will provide storage for up to 2,700 ML of filtered mine water within Thompsons Creek Reservoir to provide additional flexibility in program to allow the safe and effective commissioning of the water treatment facility.

The project will remain substantially in accordance with the development as described in the Springvale WTP EIS. An outline of key changes proposed to the approved development are presented in Table 4.1.

Table 4.1 Springvale WTP amendments

Approved development	Proposed amendments
▪ Treatment of all incoming mine water including pre-treatment filtration for solids removal and desalination through reverse osmosis treatment modules	▪ Pre-treatment filtration of incoming mine water and sequential bypass of desalination units during progressive commissioning of the water treatment plant ▪ Treatment of incoming mine water following commissioning of water treatment facility in accordance with existing consent
▪ Transfer of excess treated water to Thompsons Creek Reservoir using existing Coxs River Water Supply Pipeline	▪ Transfer of a maximum of 2,700 ML at up to 24 ML/day of filtered mine water to Thompsons Creek Reservoir using existing Coxs River Water Supply pipeline ▪ Transfer of excess treated water to Thompsons Creek Reservoir following commissioning of water treatment facility in accordance with existing consent

4.2 Interim water management strategy

4.2.1 Mine water transfer system

Water will be transferred from dewatering facilities on the Newnes Plateau to the new water treatment facility at MPPS in accordance with the existing Springvale WTP consent. The transfer pipeline extends from the gravity tank forming part of the SDWTS to the inlet works at the water treatment plant.

Construction and commissioning of the pipeline will be completed prior to 30 June 2019, with the pipeline being available to transfer incoming mine water to MPPS. Transfer of mine water will be limited to 24 ML/day during implementation of the interim water management strategy. This corresponds to current and projected water make during the commissioning phase of the treatment facility and any variation in mine water make will be managed within the underground workings until the water treatment plant is operational. All discharges from the existing LDP009 of the SDWTS will cease by 30 June 2019.

4.2.2 Treatment system

The approved project includes both pre-treatment filtration for solids removal and reverse osmosis treatment units for desalination of the incoming mine water. All incoming mine water will receive pre-treatment filtration for solids removal; hereafter referred to as filtered water.

For the purpose of the modification, it is assumed that incoming mine water may bypass the desalination units and up to 24 ML/day of filtered water will be directed to Thompsons Creek Reservoir resulting in a maximum transfer of 2,700 ML.

It should be noted that in reality the reverse osmosis treatment facility will be commissioned in modules and transfer of the 24 ML/day of filtered mine water during the commissioning period is unlikely to occur. More likely is a step down in transfers to Thompsons Creek Reservoir as each process train is progressively commissioned as represented in Figure 4-1.

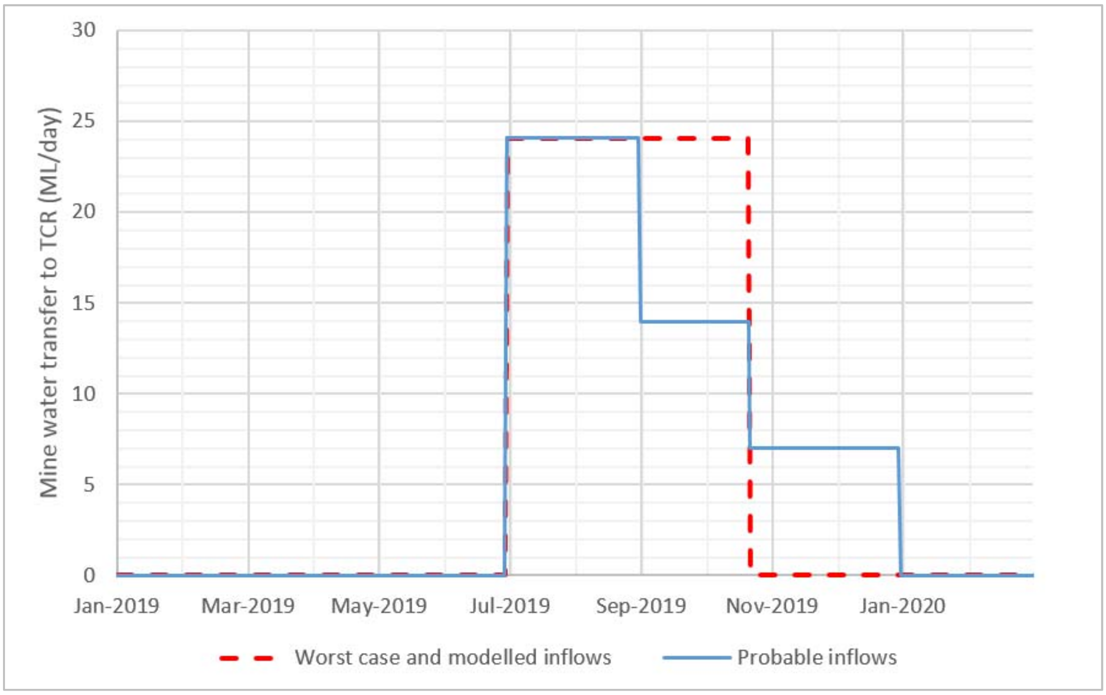

Figure 4-1 Modelled vs likely transfer of mine water to Thompsons Creek Reservoir

Progressive commissioning of reverse osmosis modules will reduce the daily volume of water transferred to Thompsons Creek Reservoir and provide contingency allowance of up to six months to the commissioning period whilst maintaining the maximum transfer volume of 2,700 ML.

4.2.3 Thompsons Creek Reservoir transfer

A bypass pipeline will be established within the water treatment plant footprint to allow bypass of the desalination units to allow filtered water to be pumped directly to Thompsons Creek Reservoir.

Water will be transferred to the reservoir using the existing Coxs River Water Supply Pipeline and associated infrastructure approved for use within the project. A maximum of 2,700 ML of filtered water will be transferred as part of the strategy, which equates to approximately 10% of the storage capacity within Thompsons Creek Reservoir. Water levels within the reservoir will be managed to ensure there is sufficient capacity beneath the full storage level to accommodate the mine water transfers.

The mine water will mix with existing water stored within the reservoir, which is drawn predominantly from Lake Lyell and will be used to supplement the cooling water make-up requirements at MPPS during periods of high water demand. When the power station is operating at full capacity, up to 54 ML/day of make-up water is required. This operational scenario allows for excess water stored in Thompsons Creek Reservoir to be effectively reused in accordance with current practices.

5. Environmental assessment

5.1 Introduction

The interim water management strategy will predominantly utilise the existing infrastructure approved for use as part of the project. The environmental assessment has therefore been targeted towards the potential impacts to water quality associated with the transfer of filtered mine water to Thompsons Creek Reservoir.

A detailed water resources assessment was undertaken to determine the potential for impacts from the interim water management strategy upon the receiving water environment. The water resources assessment is included in full in Appendix A.

The water resources assessment investigated the potential for impacts on water quality and aquatic ecology within the receiving water environment as a result of the modified project. Two methods of water quality modelling were undertaken, being:

- a geochemical model to assess a range of chemical species within the immediate Thompsons Creek Reservoir catchment; and
- a water and salt balance model to assess flow volumes and electrical conductivities within the broader Coxs River catchment.

Consideration of NorBe has also been undertaken as part of the assessment.

5.2 Water Resources

5.2.1 Geochemical modelling

Geochemical modelling was undertaken using the PHREEQc (Parkhurst and Appelo 1999) geochemical modelling program. The modelling was run to indicate the concentration of dissolved solids that would be likely to occur by the mixing of mine water with existing water within Thompsons Creek Reservoir. The modelling also considered the precipitation of solids from solution in the short and long term.

The results of the geochemical modelling were assessed against the relevant default guideline values (DGVs) from the Australia and New Zealand Water Quality Guidelines (ANZG 2018) for 95% species protection of aquatic ecosystems. It is noted that, as of October 2018, very few applicable DGVs for toxicants have changed in ANZG (2018) from those reported in ANZECC & ARMCANZ (2000).

The sediment quality guidelines (SQGs) relevant to precipitated solids from mine water being introduced into Thompsons Creek Reservoir Both sets of guidelines provide scientifically derived values that represent concentrations above which biological effects are either possible, or are expected to occur. were adopted from Simpson *et al.* (2013).

The guidelines have been used to assess the potential risk of impacts to aquatic life in Thompsons Creek Reservoir from the proposed activity.

Existing or baseline water quality data for Thompsons Creek Reservoir (shown in Table 5.1 as the TCR 95 % ile) and modelling results for water quality following mine water discharge into Thompsons Creek Reservoir are presented in Table 5.1. The data shows that the existing, or baseline 95th percentile for pH, EC, and phosphate exceed their respective DGVs. Modelling indicates that the three exceedances will continue following mine water discharge into Thompsons Creek Reservoir, noting however that both the pH value and phosphate concentration move to values more consistent with the DGV prior to the proposed activity.

The modelling predicts a minor increase in EC (40 µS/cm) within Thompsons Creek Reservoir when the modelled output is compared against the existing, or baseline value. The increased EC is largely due to higher bicarbonate and sodium concentrations in the mine water. The DGV exceedances for phosphate result from the standard level of recording (LOR) for this parameter exceeding the relevant DGVs, so is likely a data quality issue rather than an environmental impact *per se*.

Table 5.1 Water quality modelling results from Scenario 1

Parameter	Units	DGV	TCR 95 %ile	Modelled result
pH	pH units	6.5-8.0	**8.60**	**8.18**
EC	µS/cm	350	**641**	**681**
Bicarbonate alkalinity as $CaCO_3$	mg/L	NA	153	207
Sulfate as SO_4	mg/L	NA	123.8	113
Chloride	mg/L	NA	19.6	18
Calcium	mg/L	NA	17.8	16
Magnesium	mg/L	NA	10.2	9
Sodium	mg/L	NA	97.1	117
Potassium	mg/L	NA	9.1	9
Aluminium	mg/L	0.055	0.012	0.012
Arsenic	mg/L	0.013	0.0008	0.002
Cadmium	mg/L	0.0002	0.00005	0.00005
Copper	mg/L	0.0014	0.0009	0.0009
Cobalt	mg/L	NA	0.0005	0.0009
Nickel	mg/L	0.011	0.002	0.002
Zinc	mg/L	0.008	0.0025	0.004
Iron	mg/L	NA	0.011	0.017
Boron	mg/L	0.370	0.11	0.106
Manganese	mg/L	1.900	0.003	0.004
Lead	mg/L	0.0034	0.0009	0.0009
Mercury	mg/L	0.0006	0.00005	0.00009
Hexavalent chromium	mg/L	0.001	0.001*	0.0009
Selenium	mg/L	0.011	0.0001	0.001
Phosphate as P	mg/L	0.005	**0.01**	**0.009**
Ammonia as N	mg/L	0.900	0.02	0.0005

Exceedances of the DGVs are indicated in **orange bold**.

* Result is for total chromium (unspeciated).

There are no additional water quality parameters that are likely to exceed the relevant DGVs, directly as a result of the transfer of 2,700 ML of mine water to Thompsons Creek Reservoir. Some exceedances were predicted, though these were due to pre-existing conditions within the reservoir (for pH and EC), and the standard laboratory Level of Recording (LORs) exceeding the relevant DGVs for phosphate as noted above.

Modelling of the likely precipitates resulting from the transfer of mine water to Thompsons Creek Reservoir indicated that carbonates associated with alkalinity were the dominant precipitates, with greater volumes predicted to precipitate in the reservoir due to the higher alkalinity of the mine water than of the receiving water body. The carbonates species that precipitate are benign, though may temporarily increase localised turbidity around the inlet pipe prior to settling.

The modelling predicted that no metals or metalloids recognised as being potentially ecotoxic in sediments (Simpson *et al.* 2013) were likely to precipitate over either short or long-term timescales (refer Appendix A).

Three fish species have been previously identified within Thompsons Creek Reservoir during surveys undertaken as part of the original development application. These are the native Flathead gudgeon (*Philypnodon grandiceps*), and two introduced species being Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta*) (GHD 2016a). Only the Flathead gudgeon has a reported tolerance range for turbidity (0.7-38 NTU) (Pusey *et al.* 2004). If this range were exceeded as a result of mine water transfers, it would likely be temporary and localised around the 11.6 m submerged inlet outlet structure that is located within the centre of the reservoir. The localised potential for impact would allow any individual fish to relocate to other areas within the reservoir, which provide superior habitat, thereby preventing any significant impact upon any species within the reservoir.

Similarly, environmental tolerance for electrical conductivity range from 0 – 46,000 µS/cm for trout species and between 122.1 – 2,495 µS/cm for the Flathead gudgeon. The minor increase in electrical conductivity is not likely to impact upon the species identified within Thompsons Creek Reservoir.

Rainbow Trout and Brown Trout also have relatively low critical thermal maxima (CTM; the temperature at which fish movements become disorganised and/or normal activity is no longer possible - Molony 2001) (refer Table 5.2). Records for the temperature of mine water discharges between August 2017 and September 2018 are shown in Figure 5-1, which indicate that the CTM for both species of trout was exceeded on two occasions in the monitoring period. The highest temperature observed in this period also exceeded the CTM for *P. grandiceps*.

Despite these observations, it is unlikely that the temperature of the mine water would have any adverse effect on the fish populations in Thompsons Creek Reservoir, considering the small daily volumes of the transfers (compared to the volume of the reservoir) and the central location of the transfer pipe outfall zone. This location allows for efficient mixing in the reservoir and for the relocation of any nearby fish in the unlikely event that elevated water temperatures result from the transfers.

Table 5.2 Temperature tolerances of fish present in TCR.

Species	Minimum (°C)	Maximum (°C)	Reference
Oncorhynchus mykiss	1	26	Molony (2001)
Philypnodon grandiceps	11	31	Pusey *et al.* (2004)
Salmo trutta	0	26	Molony (2001)

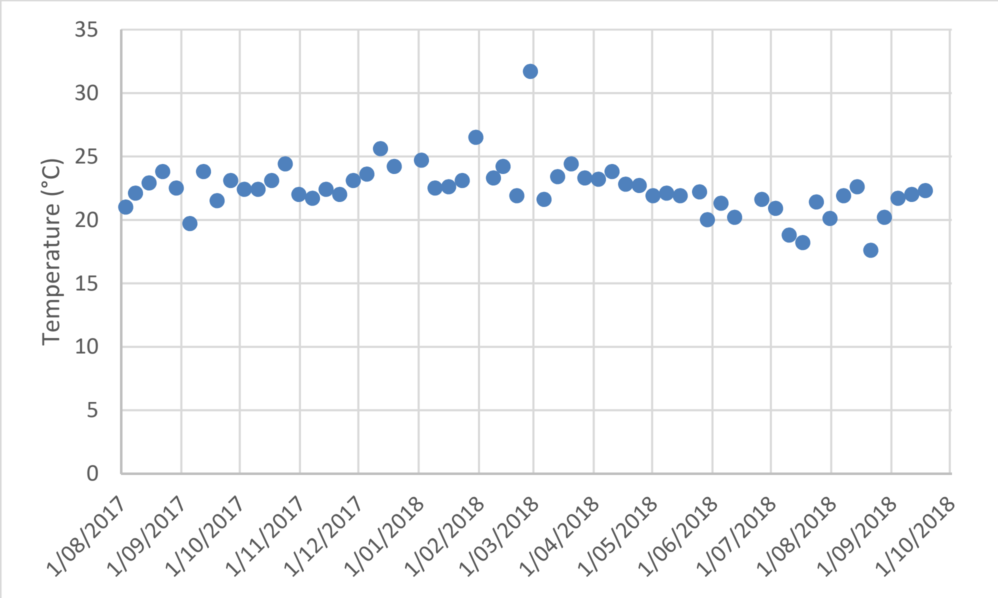

Figure 5-1 Temperature of mine water, August 2017 – September 2018

Recreational fishing for rainbow and brown trout is permitted from the shoreline only and the fishery is not anticipated to be impacted by the proposed modification.

5.2.2 Water and salt balance

A water and salt balance model was also used to assess the impacts of the temporary transfer of filtered mine water to Thompsons Creek Reservoir. A calibrated and independently reviewed GoldSim model for the greater Coxs River catchment was used to compare the changes to flow rate and salinity at three locations within the catchment, being:

- Coxs River at the confluence with Pipers Flat Creek
- Coxs River directly upstream of Lake Wallace
- Coxs River directly upstream of Lake Burragorang.

The modelling highlighted potential changes between the approved conditions under the existing consent and the proposed conditions in accordance with the interim water management strategy. A number of assumptions were adopted in the modelling to ensure a conservative assessment including:

- Total mine water production from 1 July 2019 to 22 October 2019 was assumed to be 24.4 ML/day. This equates to 24.1 ML/day after filtration for a total 2,700 ML over the period for which transfers to Thompsons Creek Reservoir are to occur under the proposed modification. This is slightly higher than the predicted mine water production but is adopted to ensure a conservative scenario.
- The electrical conductivity of the mine water from 1 July 2019 to 22 October 2019 was assumed to be 1,244 µS/cm. This is the median electrical conductivity from August 2017 to September 2018. Outside of this period, the mine water electrical conductivity was allowed to follow the validated predictions of the underlying model.
- All mine water discharges into the Coxs River system (including LDP009 at Springvale and LDP001 at Angus Place) cease on 1 July 2019.
- A low operating water level in Thompsons Creek Reservoir of 1,031 m AHD. This operating water level is associated with a volume of 24,150 ML in the reservoir and reasonably reflects recent historic water levels.

- The electrical conductivity within Thompsons Creek Reservoir at the beginning of the model predictions (1 July 2019) is assumed to be 641 μS/cm. This is the 95th percentile of recorded EC in the reservoir from March 2014 to September 2016.

As discussed in Section 4.2.2, the progressive commissioning of reverse osmosis modules will reduce the daily volume of water transferred to Thompsons Creek Reservoir and provide further contingency allowance to the commissioning period whilst maintaining the maximum transfer volume of 2,700 ML.

As a result of uncertainties in regards to the timing of commissioning of each treatment module, and to ensure a conservative approach to the impact assessment, a transfer volume of 24.1 ML/day has been adopted in the water quality modelling. Maximum transfers over a shorter timeframe were considered to be the most conservative approach as it is representative of adding a single volume of water and salt to the Coxs River system that would result in the most noticeable impacts - if any. Lower transfers over a longer time period would allow for the regular transfers between Lake Lyell, TCR and MPPS to modulate the potential impacts. The modelling, therefore, has been based upon transfers of 24 ML/day over three and a half months.

Coxs River at the confluence with Pipers Flat Creek

A comparison of the predicted flow and electrical conductivity trends of the Coxs River at the confluence with Pipers Flat Creek are presented in Figure 5-2 and Figure 5-3 respectively. The modelling demonstrates that the interim water management strategy is not expected to have any detectable impact on the flows at this location. Electrical conductivity may increase very slightly if the proposed conditions are implemented. The magnitude of this increase is very small (in the order of 10 μS/cm) but may persists for several years.

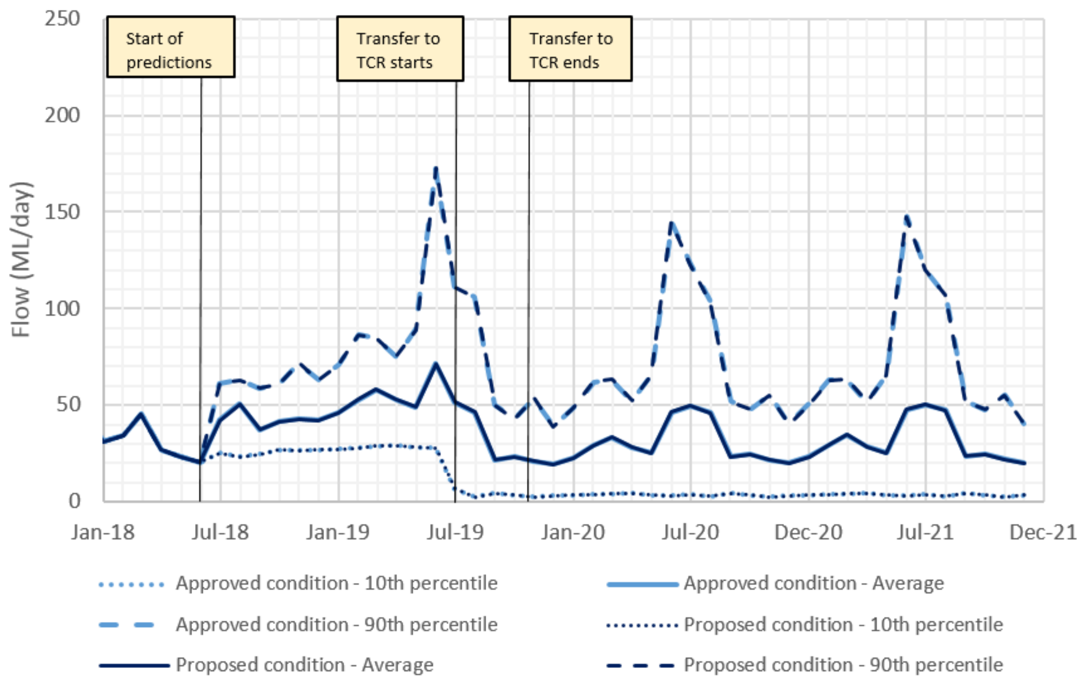

Figure 5-2 Approved condition vs proposed condition flows on Coxs River at the confluence with Pipers Flat Creek

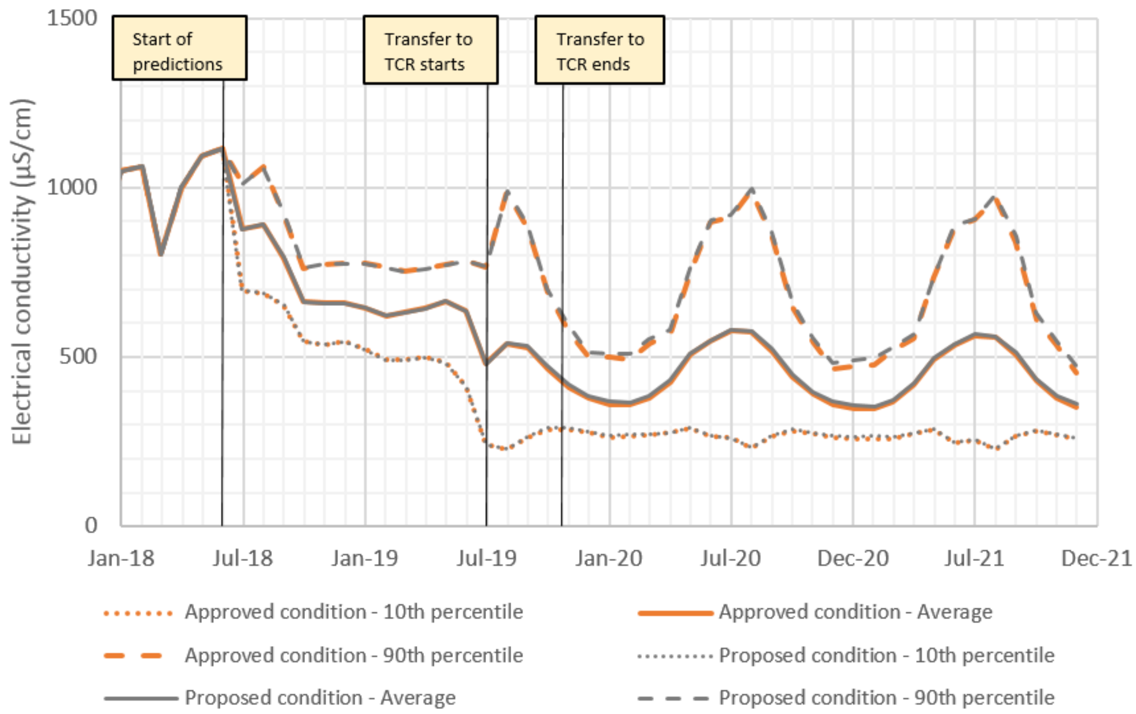

Figure 5-3 Approved condition vs proposed condition electrical conductivity on Coxs River at the confluence with Pipers Flat Creek

The electrical conductivity trend in Figure 5-3 shows two major reductions over the prediction period. The first (from September to November in 2018) is the result of the installation and commissioning of a reverse osmosis unit at Angus Place, which is treating approximately 10 ML/day of mine water to 350 µS/cm before discharging to the Coxs River catchment. The second major reduction (during July 2019) is due to the cessation of all mine water discharges into the Coxs River catchment from LDP009.

Coxs River directly upstream of Lake Wallace

A comparison of the predicted flow and electrical conductivity trends of the Coxs River directly upstream of Lake Wallace are presented in Figure 5-4 and Figure 5-5 respectively. The modelling demonstrates that the interim water management strategy is not expected to have any detectable impacts upon flows or electrical conductivity at this location.

The electrical conductivity trend in Figure 5-5 shows a significant increase at the cessation of mine water discharges into the Coxs River catchment. This is somewhat unexpected but can be explained by the increase in EC corresponding to a decrease in flows, particularly during drought or low flow conditions. The mine water discharges will no longer have a diluting affect to the remaining low volume but higher concentration salt sources in the upper catchment.

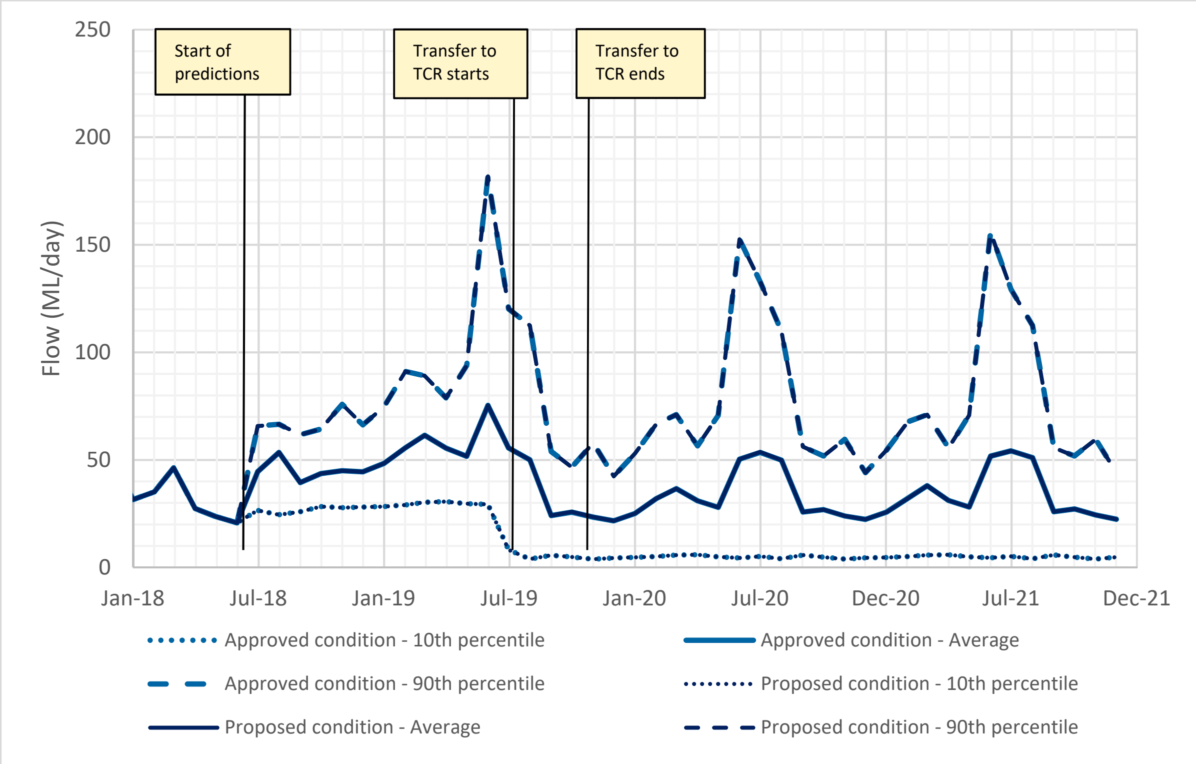

Figure 5-4 Approved condition vs proposed condition flows on Coxs River directly upstream of Lake Wallace

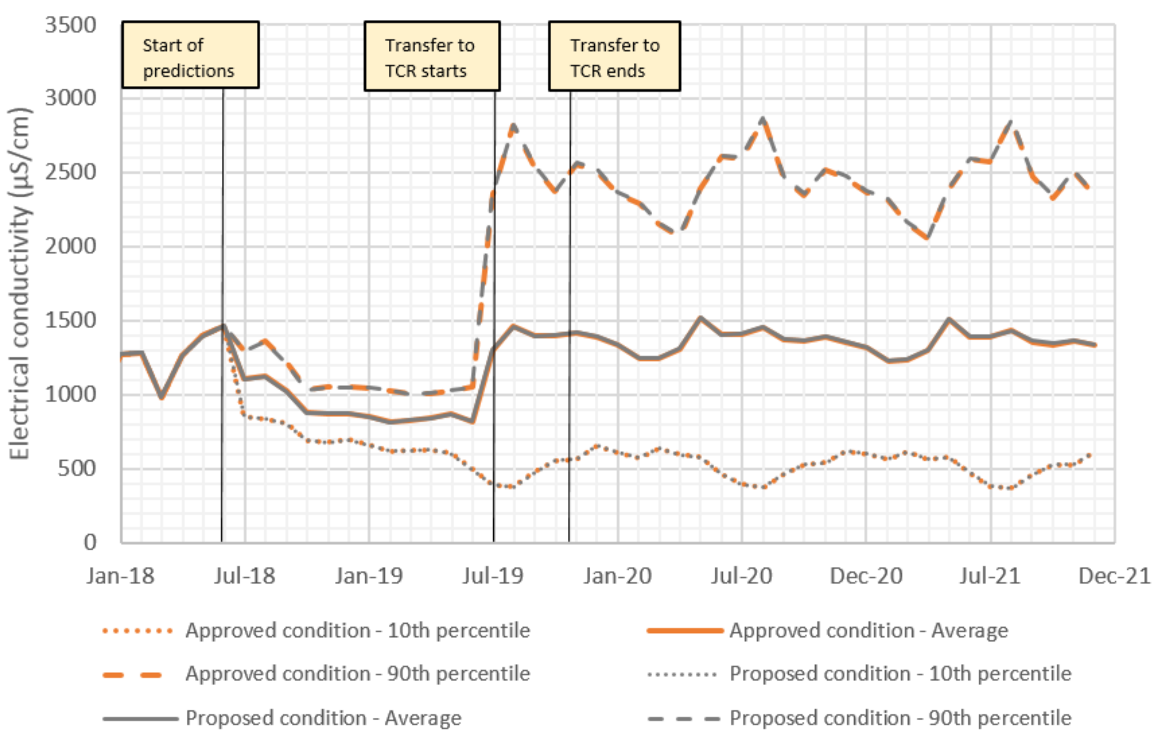

Figure 5-5 Approved condition vs proposed condition electrical conductivity on Coxs River directly upstream of Lake Wallace

Coxs River directly upstream of Lake Burragorang

A comparison of the predicted flow and electrical conductivity trends of the Coxs River directly upstream of Lake Burragorang are presented in Figure 5-6 and Figure 5-7 respectively. The modelling demonstrates that the proposed conditions are not expected to have any detectable impact on the flows or the electrical conductivity at this location.

The electrical conductivity trend in Figure 5-7 shows a gradual but significant reduction over the prediction period. The reasons for this are the same as for Coxs River at the confluence with Pipers Flat Creek. That is, the commissioning of the RO unit at Angus Place in September 2018 and the cessation of mine water discharges from LDP009 in July 2019 will result in considerable improvements to water quality within the catchment. The trend is also partially a consequence of the initial conditions of the model, which occur after a significant dry period in the Coxs River catchment and therefore starting electrical conductivities are higher than average.

The reason that an increase in electrical conductivity is not observed at this location, as it is upstream of Lake Wallace, is due to the diluting impacts from the large catchment between Lake Wallace and Lake Burragorang. Average flows into Lake Burragorang are approximately ten times those flowing into Lake Wallace, and therefore, any remaining salt sources have less of an influence on salt concentrations in the broader catchment.

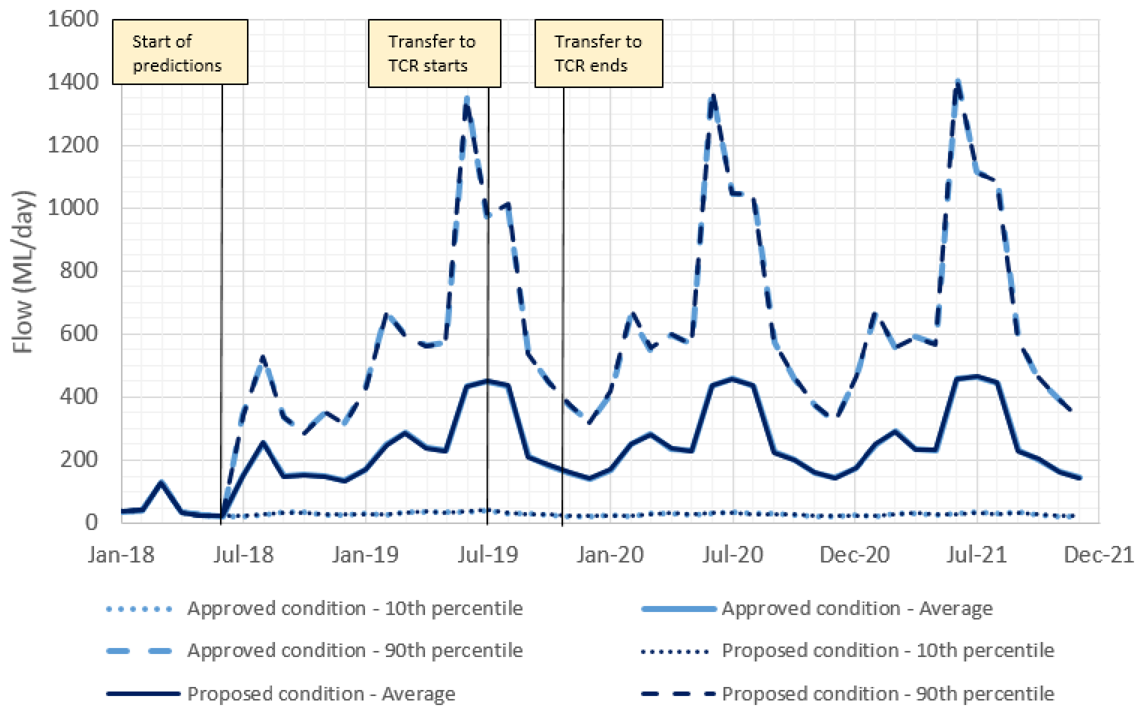

Figure 5-6 Approved condition vs proposed condition flows on Coxs River directly upstream of Lake Burragorang

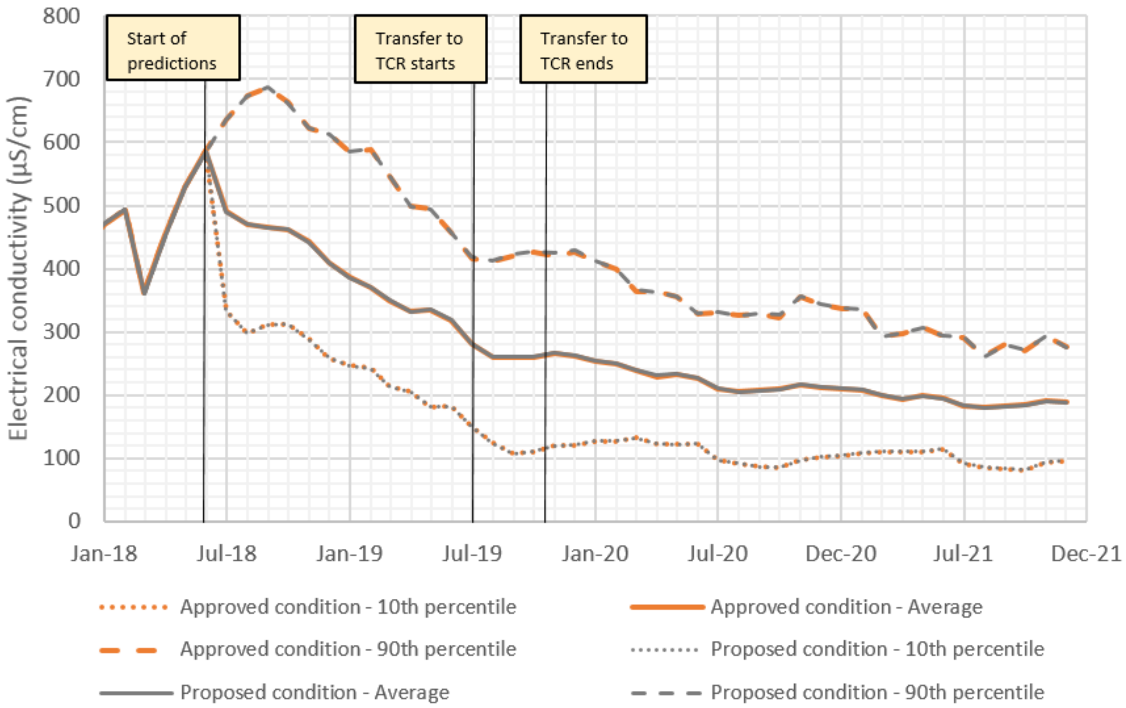

Figure 5-7 Approved condition vs proposed condition electrical conductivity on Coxs River directly upstream of Lake Burragorang

Annual water and salt volumes

A summary of the average total water volumes and salt loads over 2019 are presented in Table 5.3. The comparison between the approved and proposed conditions demonstrates negligible differences in total flows, total salt loads and flow weighted electrical conductivities at all three modelled locations. It confirms the results from the flow and electrical conductivity trend figures above and the fact that the proposed conditions will not have a significant or lasting impact on the Coxs River system compared to the approved conditions.

Table 5.3 Average total water volumes and salt loads for 2019

Location	Parameter (units)	Approved conditions	Proposed conditions	Change
Coxs River at Pipers Flat Creek	Total flow (ML/year)	15,604	15,608	0.0%
Coxs River at Pipers Flat Creek	Total salt load (tonnes/year)	4,225	4,231	+0.1%
Coxs River at Pipers Flat Creek	Flow weighted average EC (µS/cm)	404	405	+0.2%
Coxs River upstream Lake Wallace	Total flow (ML/year)	16,661	16,665	0.0%
Coxs River upstream Lake Wallace	Total salt load (tonnes/year)	6,407	6,412	+0.1%
Coxs River upstream Lake Wallace	Flow weighted average EC (µS/cm)	574	574	0.0%
Coxs River upstream Lake Burragorang	Total flow (ML/year)	97,124	97,308	+0.2%
Coxs River upstream Lake Burragorang	Total salt load (tonnes/year)	13,908	13,977	+0.5%
Coxs River upstream Lake Burragorang	Flow weighted average EC (µS/cm)	214	214	0.0%

It can be observed that discharges of the treated mine water into Thompsons Creek Reservoir lead to a negligible increase in flows into Pipers Flat Creek and a minor (six tonnes/year) increase in salt loads. The flow remains largely unchanged as discharges from Thompsons Creek Reservoir are still predominantly for maintaining riparian flows, which do not change between the approved and proposed conditions. However, the addition of filtered mine water increases the overall EC within Thompsons Creek Reservoir, which is subsequently released for environmental flows and accounts for the increased salt load observed. This also explains the changes observed at Lake Wallace, which is located downstream of the Thompsons Creek Reservoir.

A larger increase in both flow and salt load is observed into Lake Burragorang under the proposed conditions compared to the approved conditions. This at first appears counterintuitive as the changes further upstream are of much smaller magnitude. The reason for this has to do with the impact that the proposed conditions have on the transfers from Lake Lyell to Thompsons Creek Reservoir.

Under the approved conditions, the mine water is filtered and then undergoes desalination via reverse osmosis resulting in an approximate 15% volume loss in the brine stream, prior to being used within MPPS. Under the proposed conditions, mine water is filtered and then discharged into Thompsons Creek Reservoir prior to being used within MPPS. Without the reverse osmosis step in the proposed condition and associated brine losses, a larger amount of the mine water is available for use in MPPS and consequently less water is required to be transferred from Lake Lyell to Thompsons Creek Reservoir. This increases the average water level within Lake Lyell and the associated spill volume and salt load that flows into Lake Burragorang. Should the commissioning occur progressively as described in Section 2.3.2, then average water levels in Lake Lyell would be lower and any spills smaller. Thus, the results presented in Table 5.3 represent the worst-case scenario and in reality, the impacts are likely to be even smaller.

The comparison between the approved and proposed conditions demonstrate some difference in total flows and total salt loads. However, these are generally very small and tend to balance each other out resulting in negligible changes to the flow weighted electrical conductivities at all three modelled locations. It confirms the results from the flow and electrical conductivity trend figures above and the fact that the proposed conditions will not have a significant or lasting impact on the Coxs River system compared to the approved conditions. The results are also generally within the margin of error for the modelling.

5.2.3 Consideration of NorBe

As discussed in Section 1.5.3, a consent authority must not grant consent for a project in the drinking water catchment unless it would have a ‘neutral or beneficial effect’ on water quality (the NorBe test) in accordance with the Sydney Drinking Water Catchment SEPP. Development consent was initially granted for the Springvale WTP, as a result of the beneficial effect to the catchment achieved through the elimination of mine water discharges from LDP009 to the environment.

The proposed modification will continue to realise the overall net benefits of the removal of direct mine water discharges from LDP009 into the catchment by the proposed storage of water in an offline reservoir prior to the full commissioning of the water treatment facility.

While the NorBe test is not considered to strictly apply to determination of a modification, detailed modelling has been undertaken to demonstrate the interim water management strategy will have a negligible effect on the catchment in comparison to the approved development.

Condition 3 of Schedule 3 of the SSD 7592 consent includes water management performance measures including the requirement for negligible environmental consequences to surface water resources beyond those predicted in the EIS, including:

- negligible change in surface water flows beyond those predicted;
- negligible change in surface water quality beyond those predicted; and
- negligible impact to other surface water users beyond those predicted.

The definition of negligible in the consent includes *"small or unimportant, such as not to be worth considering"*.

The water quality modelling undertaken for the project demonstrates a negligible or neutral effect upon water quality in the catchment. Water will be temporarily stored within Thompsons Creek Reservoir, which is managed predominantly as an offline storage to provide water security to MPPS.

Existing, or baseline water quality within Thompsons Creek Reservoir is currently influenced by mine water, as water currently drawn from Lake Lyle downstream in the catchment from LDP009 is reticulated into the reservoir. Geochemical modelling demonstrated that exceedance of relevant DGVs is predominantly as a result of pre-existing water quality within the reservoir, rather than from the proposed activity. The filtered mine water transfers represent around 10% of the total storage volume within the reservoir and will not result in any new exceedance of DGVs, although there is predicted to be a minor increase in EC (40 µS/cm). The water will be stored for subsequent reuse within MPPS during periods of high water demand and is predicted to not result in toxicity to fish species or use of the reservoir by recreational fishers.

A water and salt balance model was also used to assess the impacts of the modification on the broader catchment, including the requirement for environmental flow releases or between 0.3 and 0.8 ML/day from Thompsons Creek Reservoir. The comparison of predicted flow and electrical conductivity trends for the proposed modification predominantly mirrors the approved development, with an exception of a minor increase (in the order of 10 µS/cm) for the Coxs River at the confluence with Pipers Flat Creek. Overall, the modelling demonstrates a gradual but significant reduction in electrical conductivity in the broader Coxs River catchment under both the existing consent and the proposed modification.

6. Conclusion

Springvale Coal is seeking to modify the Springvale WTP (SSD 7592) and the Springvale MEP (SSD 5594) consents for the implementation of the proposed interim water management strategy. The strategy will manage up to 2,700 ML of mine water at inflows of up to 24 ML/day during the progressive commissioning of the water treatment facility.

The strategy will provide up to six months additional flexibility to the delivery program to allow the safe finalisation of construction, commissioning and operation of the water treatment facility.

The Springvale WTP will remain substantially the same developments as originally approved and the proposed strategy will utilise existing infrastructure approved for use under the existing consents. Potential environmental impacts are primarily restricted to potential impacts upon water quality within Thompsons Creek reservoir and the broader Coxs River catchment and are considered to be of “minimal environmental impact”.

A detailed water resources assessment has been undertaken to assess the proposed modification, which demonstrates a negligible effect upon water quality in the catchment.

Water will be temporarily stored within Thompsons Creek Reservoir, which operates as an offline storage to provide water security to MPPS. The filtered mine water transfers represent around 10% of the total storage volume within the reservoir and will not result in any new exceedance of relevant guidelines. There is however predicted to be a negligible increase in EC (40 µS/cm) over existing background water quality within the reservoir. The water will be stored for subsequent reuse within MPPS during periods of high water demand and is predicted to not result in toxicity to fish species or impact upon the use of the reservoir by recreational fishers.

A water and salt balance model was used to assess the impacts of the modification on the broader catchment including the requirement for environmental flow releases or between 0.3 and 0.8 ML/day from Thompsons Creek Reservoir. The comparison of predicted flow and electrical conductivity trends for the proposed modification predominantly mirrors the approved development, with an exception of a negligible increase (in the order of 10 µS/cm) for the Coxs River at the confluence with Pipers Flat Creek. Overall, the modelling demonstrates a gradual but significant reduction in electrical conductivity in the broader Coxs River catchment under both the existing consent and the proposed modification.

Appendices

Appendix A – Water quality assessment

Centennial Coal and EnergyAustralia

Untreated Mine Water Transfers to TCR

Assessment of Water Quality Impacts

February 2019

Centennial Coal

EnergyAustralia

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Figure index

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Appendices

1. Introduction

1.1 Purpose of this report

Centennial Coal Company Limited (CEY) and EnergyAustralia NSW Pty Ltd (EA) engaged GHD Pty Ltd (GHD) to assess the risk of harm to the aquatic environment that could result from degrading water quality from a maximum of 2700 ML of transfers of untreated mine water from the Springvale-Delta Water Transfer Scheme (SDWTS) to Thompsons Creek Reservoir (TCR). To assess the risk, the potential for these transfers to impact upon water quality and sediment quality in TCR has been assessed.

This report summarises the findings of a quantitative water quality modelling assessment undertaken to assess the risk of material harm to the aquatic environment from impacts of the transfers on water and sediment quality in TCR.

1.2 Scope and limitations

This report has been prepared by GHD for EnergyAustralia NSW Pty Ltd and Centennial Coal Company Limited (EA/CEY) and may only be used and relied on by EA/CEY for the purpose agreed between GHD and EA/CEY as set out in Section 1.1 of this report, using the methodology documented in Section 2 of this report.

GHD otherwise disclaims responsibility to any person other than EA/CEY arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by EA/CEY and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Analysis scenarios and methodology

2.1 Background

As an operational contingency strategy, short-term transfers of untreated mine water from the SDWTS to TCR may be required in 2019. It is expected that the maximum total volume of these transfers would be 2700 ML. The volume of water transferred may be reduced subject to dewatering volumes from the SDWTS and the progressive commissioning of desalination units within the Water Treatment Plant. Two methods of modelling have been carried out to assess impact. A PHREEQc geochemical model to assess a range of chemical species within the immediate TCR catchment and a GoldSim water and salt balance model to assess flow volumes and electrical conductivities within the broader Coxs River catchment.

2.2 Geochemical Modelling scenarios

Each of the scenarios modelled for this assessment was based on the following assumptions:

- The existing water quality in TCR was assumed to be the 95th percentile water quality based on monitoring data for the period May 2016 to October 2018, as provided by EA (refer Appendix A). These data were selected, as they were the most recent data available from EA on existing TCR water quality, and are expected to be broadly representative of the water quality within the receiving water body. Cobalt, alkalinity, mercury, ammonia and phosphorous data were not available in the May 2016 to October 2018 data set provided by EA. With the exception of alkalinity, a previous data set (March 2014 to September 2016, also provided by EA) was used to fill these gaps. The 95th percentile was calculated for each parameter and these values were used to represent a conservative theoretical TCR water quality with elevated concentrations of dissolved solids. The 95th percentile scenario for alkalinity in TCR was estimated by using PHREEQC to reach ionic balance with the other major ions (for which there were data available). The theoretical water quality was of relatively high pH (8.6), alkalinity and hardness, which provides a conservative scenario in terms of metals and hardness precipitation, as both are close to maximal under these conditions. This also accounts for the possibility that water quality in TCR may change due to water releases from the reservoir to provide capacity for the mine water transfers.
- The quality of the mine water transferred into TCR was determined using mine water characterisation results for site 'LDP009 – Before Treatment' using monitoring data from August 2017 to September 2018, provided by CEY. The median (50th percentile) was calculated for each parameter and these values were used to represent a theoretical mine water quality. In this case, higher percentile results were deemed inappropriate to represent the mine water quality based on an assessment of the water quality data for temporal trends. This assessment indicated that the mine water quality was relatively stable. The water quality data used to represent the mine water transferred to TCR in the geochemical modelling is presented in Appendix B.
- For the calculation of percentiles for each of the above input solutions, all values below the respective limit of reporting (LOR) were assumed to be half of the LOR.
- The mixing ratio of the two solutions was calculated based on the following assumptions, which were adopted to provide a maximal (i.e. conservative) ratio of mine water to TCR volume:
  - A low operating water level in TCR of 1031 m AHD, which is the level that allows for an unplanned outage at Mount Piper Power Station (MPPS) (level L2 in GHD 2018b),

  - with extra capacity to allow for the mine water to be transferred into the reservoir. This operating water level is associated with a volume of 24,150 ML in TCR.
  - Transfer of 2700 ML of mine water to TCR.
- All data for metal concentrations in both solutions were for dissolved metals. No existing solid phases were incorporated in the models, which was considered an appropriate modelling approach considering the low suspended solids concentrations present in the mine water, and the large volume of low turbidity water in TCR.
- Water temperature was set at 25°C. The potential effects of elevated temperatures on the aquatic ecology of TCR was considered separately from the geochemical modelling
- All aqueous concentrations of arsenic were assumed to be present as pentavalent arsenic (AsV), due to the limited reliability of thermodynamic geochemical modelling in predicting arsenic speciation, and the greater toxicity of AsV in freshwater (ANZECC & ARMCANZ 2000). This was therefore a conservative assumption.

Geochemical modelling was undertaken using the PHREEQc (Parkhurst and Appelo 1999) geochemical modelling program. The database minteq.v4.dat (Allison *et al.* 1990; USEPA 1998) was used to define thermodynamic data for aqueous species. The minteq.v4.dat database was chosen as it contains each of the metals that were to be modelled and is applicable to the temperature and ionic strength of the water being investigated. Equilibria based on atmospheric partial pressures of oxygen and carbon dioxide were assumed so that the amount of metal oxidation modelled was conservative (i.e. high).

Geochemical modelling of the following scenarios was undertaken in this assessment:

2.2.1 Scenario 1 – No precipitation

This model was run to indicate the maximal concentrations of dissolved solids that would be likely to occur from mixing the two solutions. The resulting water quality was assessed as detailed below in Section 2.3, with modelling results for dissolved solids presented in mg/L. Electrical conductivity (EC) was calculated by PHREEQC, which uses the diffusion coefficients of the charged species and applies a correction for ionic strength.

Precipitation of solids was not modelled, though the model was run assuming both oxic and anoxic conditions for the mine water, and the output files were inspected for solids with positive saturation indices, which imply that precipitation of the solids was predicted by the model. As this scenario did not consider precipitation and speciation, the results of the model were not sensitive to the water temperature being set at 25°C, as detailed in Section 2.1.

2.2.2 Scenario 2 – Short-term precipitation

Modelling was undertaken to allow the key solids with positive saturation indices from Scenario 1 to precipitate from the solution, assuming that none of these solids were present in the sediment (as sediment quality data were unavailable for TCR). It is noted that the saturation index that each solid is allowed to precipitate at is zero; this is also a potentially conservative assumption, as some solids can remain supersaturated for a period of time. Scenario 2 considered a short-term (hours) timescale, based on the solids, which are more likely to precipitate rapidly.

2.2.3 Scenario 3 – Long-term precipitation

Long-term (months and longer) precipitation was modelled based on the solids that precipitate over geological timescales. This can be considered the more conservative timescale, as solubility is minimised.

Modelling results for Scenarios 2 and 3 were presented as mg/L of precipitates, as well as kilograms of precipitate predicted from the transfer of 2700 ML of mine water to TCR.

2.3 Water quality assessment

The results of the modelling for Scenario 1 were assessed against the relevant default guideline values (DGVs) from the Australia and New Zealand Water Quality Guidelines (ANZG 2018) for 95% species protection of aquatic ecosystems. It is noted that, as of October 2018, very few applicable DGVs for toxicants have changed in ANZG (2018) from those reported in ANZECC & ARMCANZ (2000).

Additionally, no DGVs for physical and chemical stressors are currently published on the ANZG (2018) website for the applicable drainage division ("Southeast Coast"). As such, the DGVs for physical and chemical stressors from ANZECC & ARMCANZ (2000) (tables 3.3.2 and 3.3.3) were used in this assessment. The DGVs applicable to TCR are presented in Table 2.1.

This was a conservative assessment due to the model for Scenario 1 assuming no precipitation, which resulted in maximal concentrations of dissolved solids.

Table 2.1 DGVs for the assessment of water quality in TCR.

Parameter	DGV	Reference and notes
pH	6.5-8.0	ANZECC (2000) Table 3.3.2
EC	350 µS/cm*	ANZECC (2000) Table 3.3.3
Reactive phosphorous (RP) as P	0.005 mg/L	ANZECC (2000) Table 3.3.2
Aluminium	0.055 mg/L	ANZG (2018) DGV for pH > 6.5
Arsenic	0.013 mg/L	ANZG (2018) DGV for AsV
Cadmium	0.0002 mg/L	ANZG (2018)
Copper	0.0014 mg/L	ANZG (2018)
Nickel	0.011 mg/L	ANZG (2018)
Zinc	0.008 mg/L	ANZG (2018)
Boron	0.370 mg/L	ANZG (2018)
Manganese	1.900 mg/L	ANZG (2018)
Lead	0.0034 mg/L	ANZG (2018)
Mercury	0.0006 mg/L	ANZG (2018) DGV for inorganic mercury
Chromium	0.001 mg/L	ANZG (2018) DGV for hexavalent chromium (as per the technical brief)
Selenium	0.011 mg/L	ANZG (2018)

* DGV for upland rivers in southeast Australia used as no relevant value is reported in ANZECC & ARMCANZ (2000) for EC in freshwater lakes and reservoirs in NSW.

2.4 Sediment quality assessment

The sediment quality guidelines (SQGs) relevant to precipitated sediments in TCR are recommended by Simpson *et al*. (2013). The relevant SQGs are presented in Table 2.2. Two guideline value levels are recommended by Simpson *et al*. (2013), SQG and SQG-High. The former value represents the concentration above which biological effects resulting from the contaminant concentration are possible, and the latter represents the concentration above which such effects are expected (Simpson *et al.* 2013).

Estimated concentrations of these metals in the total mass of precipitate can be compared to the values in Table 2.2 to assess the risk of impacts to aquatic life in TCR from sedimentation resulting from the transfer of mine water to TCR. This assessment methodology is inherently conservative, as only precipitates are considered and not suspended solids and transported sediments from within the TCR catchment, which would also contribute to sediment quality in TCR.

Table 2.2 SQGs relevant to precipitated sediments in TCR (Simpson *et al.* 2013)

Metal/Metalloid (mg/kg dry weight)	SQG	SQG-High
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1.0
Nickel	21	52
Silver	1.0	4.0
Zinc	200	410

2.5 Water and salt balance model

In addition to the geochemical model, a water and salt balance model was utilised to further assess the impacts of the temporary transfer of mine water to TCR. A calibrated and independently reviewed GoldSim model for the greater Coxs River catchment had already been developed as part of the Mount Piper Power Station Water Sharing Plan Feasibility Study (GHD 2018a). The model was updated to reflect the most recent knowledge and data of the Coxs River system that has become available since the model was initially developed.

The modelling aimed to compare the changes to salinity and flow at various locations between the approved conditions and the proposed conditions. Assumptions have been adopted to model a conservative scenario in terms of total transfer volumes and salt loads. Both approved and proposed condition models adopt the following assumptions:

- Total mine water production from July 1 2019 to October 22 2019 was assumed to be 24.4 ML/day. This equates to 24.1 ML/day after filtration for a total 2700 ML over the period for which transfers to TCR are to occur under the proposed condition. This is slightly higher than the predicted mine water production but is adopted to model a conservative scenario.
- The electrical conductivity of the mine water from July 1 2019 to October 22 2019 was assumed to be 1,244 µS/cm. This is the median electrical conductivity from August 2017

to September 2018. Outside of this period, the mine water electrical conductivity was allowed to follow the validated predictions of the underlying model.

- All mine water discharges into the Coxs River system (including LDP009 at Springvale and LDP001 at Angus Place) cease on July 1 2019.
- A low operating water level in TCR of 1031 m AHD. This operating water level is associated with a volume of 24,150 ML in TCR and reasonably reflects recent historic water levels.
- The electrical conductivity within TCR at the beginning of the model predictions (July 1 2018) is assumed to be 641 μS/cm. This is the 95th percentile of recorded EC in TCR from March 2014 to September 2016.

2.5.1 Approved conditions

The approved conditions reflect the current approvals for within the Coxs River system. Specifically the full commissioning of the SWTP is assumed to commence on July 1st of 2019. At this point all mine water is fully treated within the SWTP and then utilised within Mount Piper Power Station (MPPS) or directed to TCR for storage and subsequent reuse. The treatment process at the WTP includes filtration and reverse osmosis.

2.5.2 Proposed conditions

Under the proposed conditions, the model assumes that the commissioning of the SWTP is delayed until October 22 2019. From July 1 2019 to October 22 2019, all mine water is assumed to first undergo filtration before being transferred to TCR for storage. After October 22 2019, the SWTP is assumed to be fully commissioned and the mine water transfers (before undergoing reverse osmosis) to TCR cease.

It should be noted that in reality the SWTP will be commissioned in stages and thus full transfer 2700 ML of filtered mine water at 24.1 ML/day to TCR is unlikely. More likely is a step down in transfers to TCR as each process train is commissioned. This is represented in Figure 2.1. This would allow for (but not necessarily require) a longer commissioning period than the 112 days assumed in the modelling. However, it would still remain within the volume limit of 2,700 ML.

Maximum transfers over a shorter timeframe was considered to be the most conservative approach as it is representative of adding a single volume of water and salt to the Coxs River system which would result in the most noticeable impacts. Lower transfers over a longer time period would allow for the regular transfers between Lake Lyell, TCR and MPPS to modulate and the modelling has therefore been based upon transfers of 24 ML/day over three and a half months.

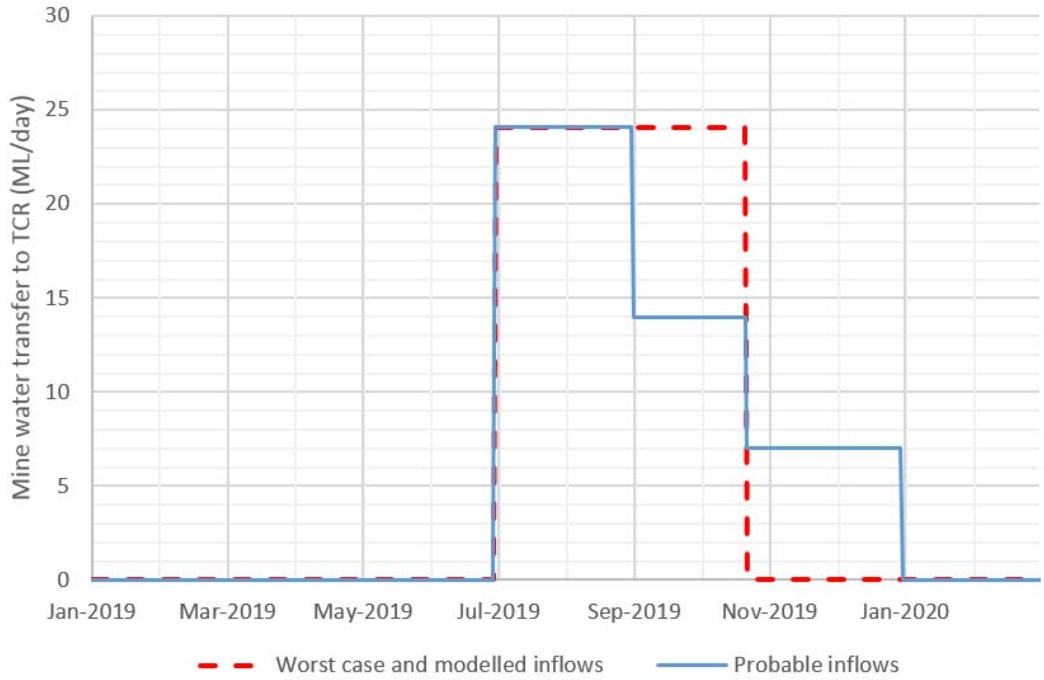

Figure 2.1 Modelled vs likely transfer of mine water to Thompsons Creek Reservoir

2.5.3 Probabilistic modelling

The GoldSim model has adopted a probabilistic modelling methodology using 128 years of historic rainfall and evaporation data to simulate a range of probable climatic conditions. This means that each year within the model prediction period (July 1 2018 to January 1 2022), was subjected in turn to each of the 128 annual historic climate patterns. As a consequence, the results are presented as 10th, median and 90th percentiles of the simulations produced by the model.

3. Results and discussion

3.1 Geochemical model results

3.1.1 Scenario 1 – No precipitation

The results of the modelling of Scenario 1 are presented in Table 3.1 along with the 95th percentile water quality data for TCR. This shows that the pH and EC, and the phosphate concentration predicted by the model exceeded the relevant DGVs. However, none of these exceedances was as a result of mine water transfer, as the TCR 95th percentile water quality exceeded the DGVs for the same parameters.

It is noted that the scenario is predicted to result in a minor increase in EC (40 µS/cm) when the modelled output is compared against the baseline value shown in Appendix A. The increased EC is largely due to higher bicarbonate and sodium concentrations in the mine water.

The DGV exceedance for phosphate resulted from the standard LOR for the parameter exceeding the DGV.

Inspection of the model output for Scenario 1 indicated that there were numerous mineral species predicted to precipitate, which included aluminium, calcium, magnesium, manganese, and iron based minerals. The only predicted precipitates that contain metals for which there are SQGs (Simpson *et al.* 2013) were cupric and cuprous ferrite. Concentrations and masses of these precipitates were modelled for Scenarios 3, as they are known to precipitate over longer time scales (weeks to months).

Table 3.1 Water quality modelling results from Scenario 1

Parameter	Units	DGV	Modelled result	TCR 95 %ile
pH	pH units	6.5-8.0	**8.18**	**8.60**
EC	µS/cm	350	**681**	**641**
Bicarbonate alkalinity as $CaCO_3$	mg/L	NA	207	153
Sulfate as SO_4	mg/L	NA	113	123.8
Chloride	mg/L	NA	18	19.6
Calcium	mg/L	NA	16	17.8
Magnesium	mg/L	NA	9	10.2
Sodium	mg/L	NA	117	97.1
Potassium	mg/L	NA	9	9.1
Aluminium	mg/L	0.055	0.012	0.012
Arsenic	mg/L	0.013	0.002	0.0008
Cadmium	mg/L	0.0002	0.00005	0.00005
Copper	mg/L	0.0014	0.0009	0.0009
Cobalt	mg/L	NA	0.0009	0.0005
Nickel	mg/L	0.011	0.002	0.002
Zinc	mg/L	0.008	0.004	0.0025
Iron	mg/L	NA	0.017	0.011
Boron	mg/L	0.370	0.106	0.11
Manganese	mg/L	1.900	0.004	0.003

Parameter	Units	DGV	Modelled result	TCR 95 %ile
Lead	mg/L	0.0034	0.0009	0.0009
Mercury	mg/L	0.0006	0.00009	0.00005
Hexavalent chromium	mg/L	0.001	0.0009	0.001*
Selenium	mg/L	0.011	0.001	0.0001
Phosphate as P	mg/L	0.005	**0.009**	**0.01**
Ammonia as N	mg/L	0.900	0.0005	0.02

Exceedances of the DGVs are indicated in **orange bold**.

* Result is for total chromium (unspeciated).

3.1.2 Scenario 2 – Short-term precipitation

The modelled concentrations (mg/L) and masses (kg predicted for the 2700 ML discharge) of precipitates for the short-term timescale are presented in Table 3.2. Calcite was the dominant precipitate, with approximately 32 mg/L predicted to form from the transfer of mine water. This would be likely to result in some localised 'cloudy' turbidity, which would be expected to settle relatively quickly (i.e. in the order of hours). Calcite ($CaCO_3$) and the other minerals presented in Table 3.2 are inert species and is do not bioaccumulate.

The potential for arsenic to re-solubilise from suspended solids in the untreated mine water was considered, as the median dissolved concentration of arsenic in this water exceeds the DGV for pentavalent arsenic. Additionally, arsenic re-solubilisation from calcium arsenates is likely at pH > 8.3 (Magalhães 2002), noting that the median pH of the mine water was 7.6 and that of TCR was 8.44. Despite this, arsenic re-solubilisation was considered unlikely because:

- The suspended solids load of the mine water is low, with 36 of the 58 observations between August 2017 and September 2018 being below the laboratory LOR (5 mg/L) and the 80th percentile being 8 mg/L.
- There was no significant relationship between pH and dissolved arsenic concentrations (R^2 = 0.02) evident in the mine water quality results, as shown in Figure 3.1.

It is considered that the modelled results are conservative as a result of the various conservative model inputs that the scenario utilised, including the assumption that no solid concentrations of the modelled precipitates were present under the initial conditions.

Table 3.2 Modelled precipitates – short-term

Mineral	Chemical formula (repeating unit)	mg/L	kg predicted from 2700 ML discharge
Birnessite	$(Na_{0.3}Ca_{0.1}K_{0.1})(Mn^{4+},Mn^{3+})_2O_4 \cdot 1.5H_2O$	0.006	15.8
Calcite	$CaCO_3$	32.188	86,907
Goethite	$FeOOH$	0.027	72.9
Hydroxylapatite	$Ca_5(PO_4)_3(OH)$	0.003	8.4

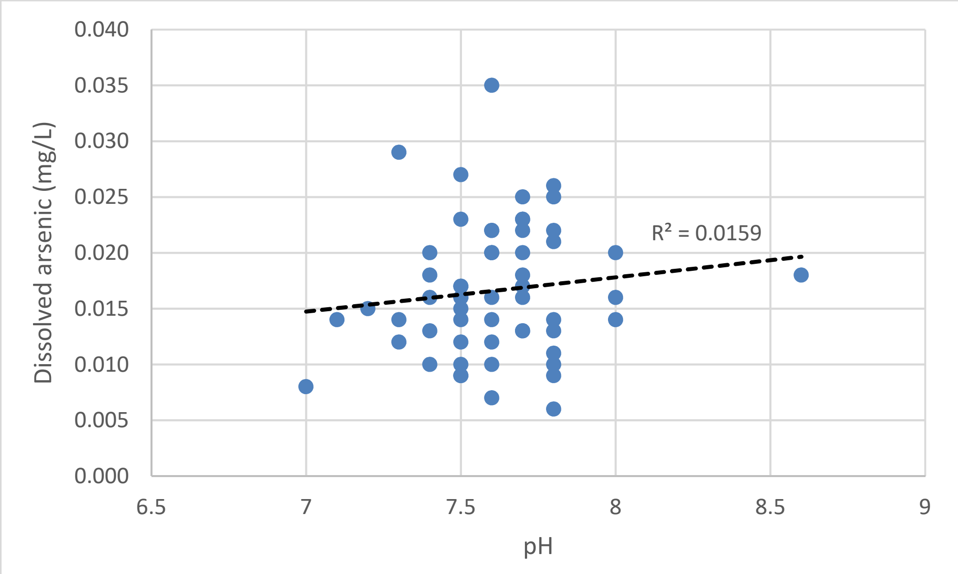

Figure 3.1 Scatterplot of mine water pH versus dissolved arsenic concentrations

3.1.3 Scenario 3 – Long-term precipitation

Table 3.3 presents the modelled concentration (mg/L) and masses (kg predicted from 2700 ML of mine water transfers) of precipitates for the long-term time scale (months and longer). Similar to the short-term timescale results, carbonates associated with alkalinity were the dominant precipitate for the long-term timescale: approximately 55 mg/L of dolomite was predicted to precipitate. A low concentration of cobalt ferrite was predicted by this model, though cobalt is not typically associated with sediment toxicity, especially when co-precipitated with iron, due to the high binding strength and therefore low bioavailability of the precipitate (Su 2011). All other mineral precipitates in Table 3.3 are inert and do not bioaccumulate.

Cupric and cuprous ferrite were predicted to be saturated in solution by the modelling for Scenario 1, however they were not predicted to precipitate over the long-term timescale, likely due to the iron based minerals presented in Table 3.3 being more thermodynamically stable. This indicates that copper is likely to remain in solution following the transfer of untreated mine water to TCR. This poses minimal environmental risk, considering the dissolved copper concentrations in both of the modelled solutions are equivalent to the standard laboratory LOR for copper, and below the relevant DGV.

Table 3.3 Modelled precipitates - long term

Mineral	Chemical formula (repeating unit)	mg/L	kg predicted from 2700 ML discharge
Cobalt ferrite	$CoFe_2O_4$	0.004	10.2
Diaspore	AlOOH	0.022	59.5
Dolomite (ordered)	$CaMg(CO_3)_2$	55.301	149,313
Hematite	Fe_2O_3	0.022	58.6
Hydroxylapatite	$Ca_5(PO_4)_3(OH)$	0.014	38.8
Pyrolusite	MnO_2	0.006	15.8

3.1.4 Aquatic ecology considerations

As TCR has environmental values that include recreational fishing, it is important to consider the potential impacts to resident fish species as a result of the modelled mine water transfers.

Of the three fish species present in TCR (GHD 2016a), only the flathead gudgeon (*Philypnodon grandiceps*) has a reported tolerance range for turbidity (0.7-38 NTU) (Pusey *et al.* 2004). If this range were exceeded in TCR as a result of mine water transfers, it would likely be temporary and localised at the transfer pipe outfall zone, which is centrally located in TCR, thereby limiting the potential impact on *P. grandiceps*. The localised potential impact would also allow *P. grandiceps* to relocate to other areas within TCR in the case that any individuals are affected, thereby preventing any significant impact on the species.

Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*) are both present in TCR (GHD 2016a), and have relatively low critical thermal maxima (CTM, the temperature at which fish movements become disorganised and/or normal activity is no longer possible, Molony 2001) (refer Table 3.4). Figure 3.2 shows the temperature of the mine water between August 2017 and September 2018, which indicates that the CTM for both species of trout was exceeded on two occasions in the monitoring period. The highest temperature observed in this period also exceeded the CTM for *P. grandiceps*. Despite these observations, it is unlikely that the temperature of the mine water would have any adverse effect on the fish populations in TCR, considering the small daily volumes of the transfers (compared to the volume of TCR) and the central location of the transfer pipe outfall zone. This location allows for efficient mixing in TCR and for the relocation of any nearby fish in the unlikely event that elevated water temperatures result from the transfers.

Table 3.4 Temperature tolerances of fish present in TCR.

Species	Minimum (°C)	Maximum (°C)	Reference
Oncorhynchus mykiss	1	26	Molony (2001)
Philypnodon grandiceps	11	31	Pusey *et al.* (2004)
Salmo trutta	0	26	Molony (2001)

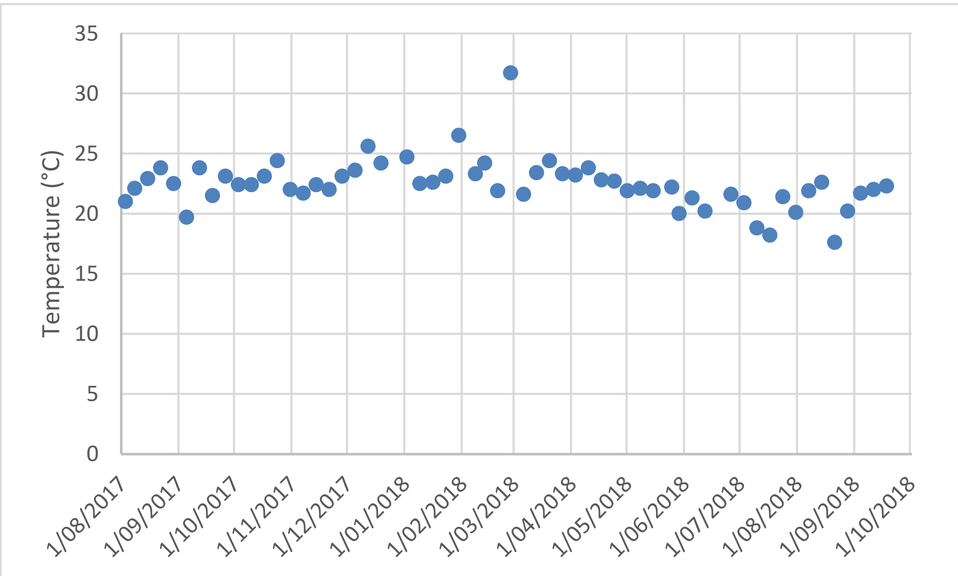

Figure 3.2 Temperature of mine water, August 2017 – September 2018

As no exceedances of the relevant water quality and sediment quality, guideline values are predicted as a result of the transfers, no impact on aquatic species present in the receiving environments of TCR, Pipers Flat Creek, and Coxs River is predicted.

3.1.5 Summary

The modelling indicates that there are no water quality parameters that are likely to exceed the relevant DGVs as a result of the transfer of 2700 ML of mine water to TCR. Some exceedances were predicted, though these were due to pre-existing conditions in TCR (for pH and EC), and the standard laboratory LORs exceeding the relevant DGVs (for chromium and phosphate).

Modelling of the likely precipitates resulting from the transfer of mine water to TCR indicated that carbonates associated with alkalinity were the dominant precipitates, with greater volumes predicted to precipitate in TCR due to the higher alkalinity of the mine water. These carbonates may increase turbidity temporarily prior to settling.

The modelling predicted that no metals or metalloids recognised as being potentially ecotoxic in sediments (Simpson *et al.* 2013) were likely to precipitate over either short or long-term timescales.

The modelling indicates that there were no water quality parameters, or precipitates which contain metals, which would exceed the relevant guideline values (ANZG 2018 and Simpson *et al.* 2013) as a result of mine water transfers to TCR. As such, the risk of impacts from mine water transfers to environmental values in the receiving environments of TCR, and subsequently from environmental releases, to Pipers Flat Creek, and Coxs River (as compared to existing, or baseline conditions) may be considered negligible.

3.2 Water and salt balance model results

Flow and electrical conductivity results are presented at the following locations on the Coxs River.

- Coxs River at the confluence with Pipers Flat Creek
- Coxs River directly upstream of Lake Wallace
- Coxs River directly upstream of Lake Burragorang

3.2.1 Coxs River at the confluence with Pipers Flat Creek

A comparison of the predicted flow and electrical conductivity trends of the Coxs River at the confluence with Pipers Flat Creek are presented in Figure 3.3 and Figure 3.4 respectively. Figure 3.3 demonstrates that the proposed conditions are not expected to have any detectable impact on the flows at this location. Figure 3.4 demonstrates that the electrical conductivity may increase very slightly if the proposed conditions are implemented. The magnitude of this increase is very small (in the order of 10 µS/cm) but may persists for several years.

The electrical conductivity trend in Figure 3.4 shows two major reductions over the prediction period. The first (from September to November in 2018) is the result of the installation and commissioning of a reverse osmosis unit at Angus Place, which is treating approximately 10 ML/day of mine water to 350 µS/cm before discharging to the Coxs River catchment. The second major reduction (during July 2019) is due to the cessation of all mine water discharges into the Coxs River catchment.

3.2.2 Coxs River directly upstream of Lake Wallace

A comparison of the predicted flow and electrical conductivity trends of the Coxs River directly upstream of Lake Wallace are presented in Figure 3.5 and Figure 3.6 respectively. Figure 3.5 demonstrates that the proposed conditions are not expected to have any detectable impact on the flows at this location. Figure 3.6 demonstrates that the proposed conditions are also not expected to have any detectable impact on the electrical conductivity at this location.

The electrical conductivity trend in Figure 3.6 shows a significant increase at the cessation of mine water discharges into the Coxs River catchment. This is somewhat unexpected but can be explained by the increase in EC corresponding to a decrease in flows, particularly during drought or low flow conditions. The mine water discharges will no longer have a diluting affect to remaining low volume but higher concentration salt sources in the upper catchment.

3.2.3 Coxs River directly upstream of Lake Burragorang

A comparison of the predicted flow and electrical conductivity trends of the Coxs River directly upstream of Lake Burragorang are presented in Figure 3.7 and Figure 3.8 respectively. Figure 3.7 demonstrates that the proposed conditions are not expected to have any detectable impact on the flows at this location. Figure 3.8 demonstrates that the proposed conditions are also not expected to have any detectable impact on the electrical conductivity at this location.

The electrical conductivity trend in Figure 3.8 shows a gradual but significant reduction over the prediction period. The reasons for this are the same as for Coxs River at the confluence with Pipers Flat Creek. That is, the commissioning of the RO unit at Angus Place in September 2018 and the cessation of mine water discharges in July 2019. It is also a consequence of the initial conditions of the model. These occur after a significant dry period in the Coxs River catchment and therefore starting electrical conductivities are higher than average.

The reason that an increase in electrical conductivity is not observed here, as it is upstream of Lake Wallace, is due to the diluting impacts from the large catchment between Lake Wallace and Lake Burragorang. Average flows into Lake Burragorang are approximately ten times those flowing into Lake Wallace and therefore any remaining salt sources have less of an influence on salt concentrations in the broader catchment.

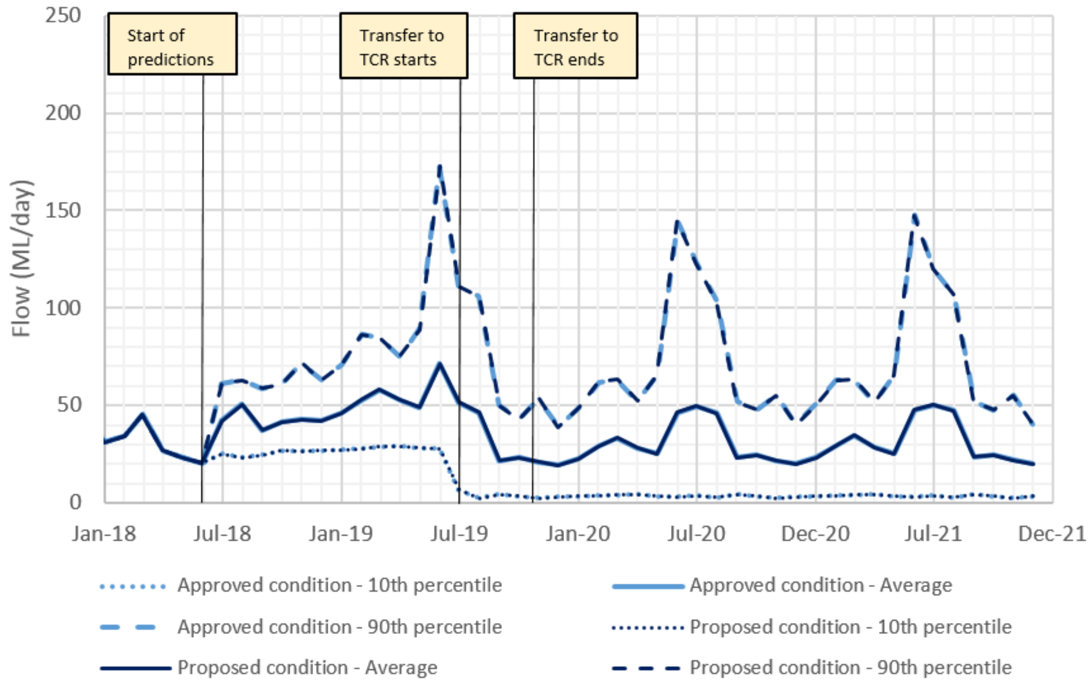

Figure 3.3 Approved condition vs proposed condition flows on Coxs River at the confluence with Pipers Flat Creek

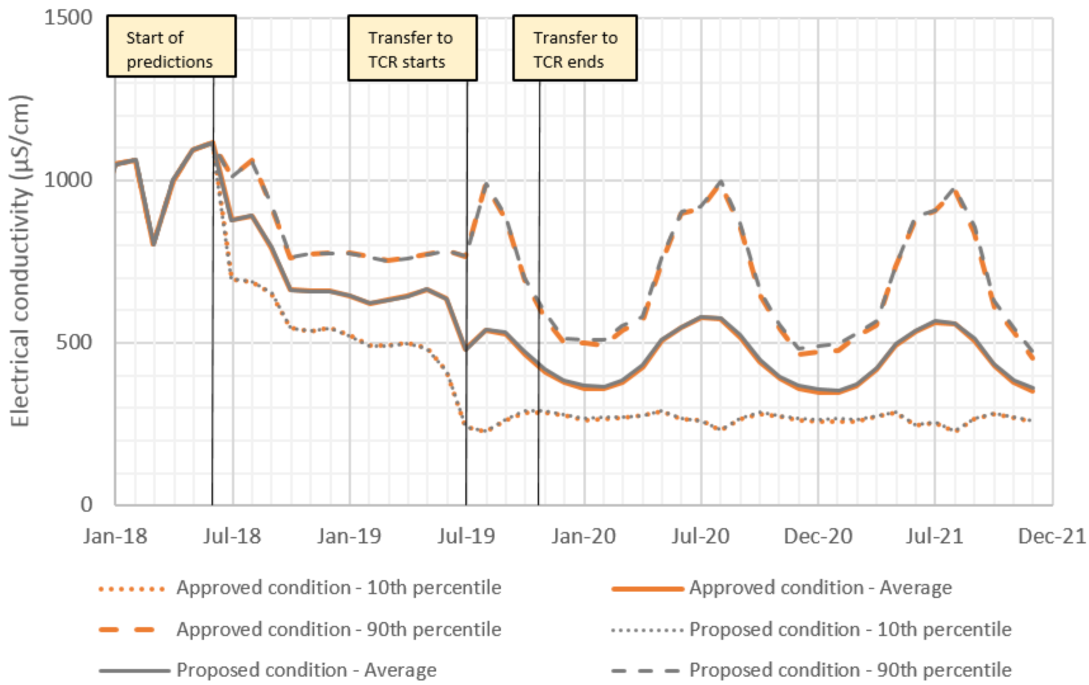

Figure 3.4 Approved condition vs proposed condition electrical conductivity on Coxs River at the confluence with Pipers Flat Creek

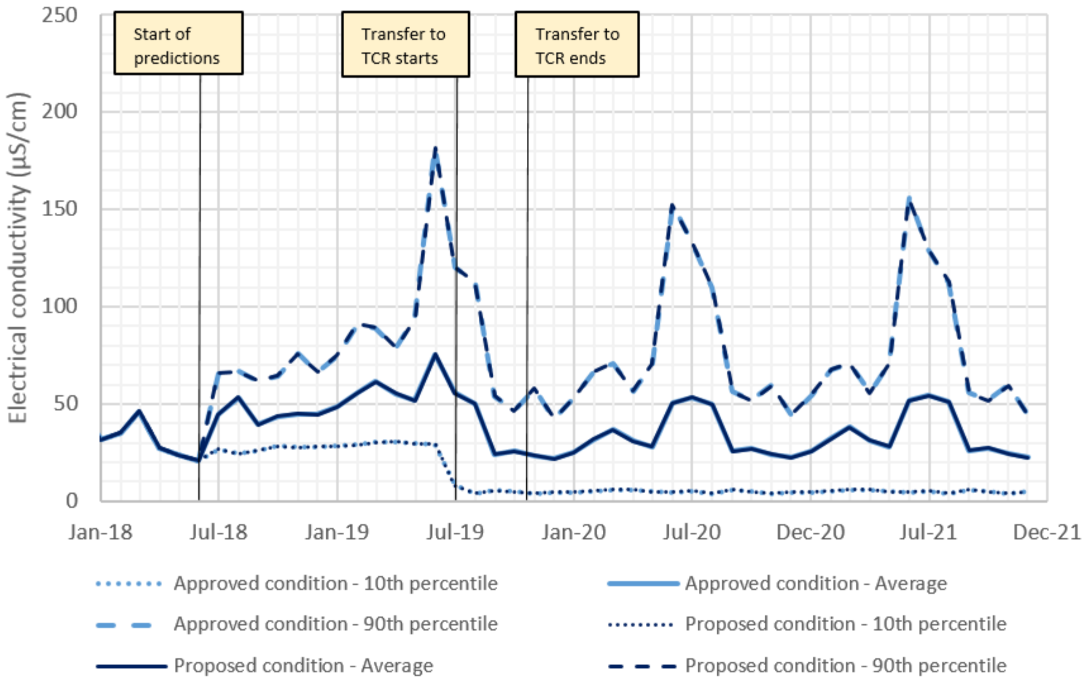

Figure 3.5 Approved condition vs proposed condition flows on Coxs River directly upstream of Lake Wallace

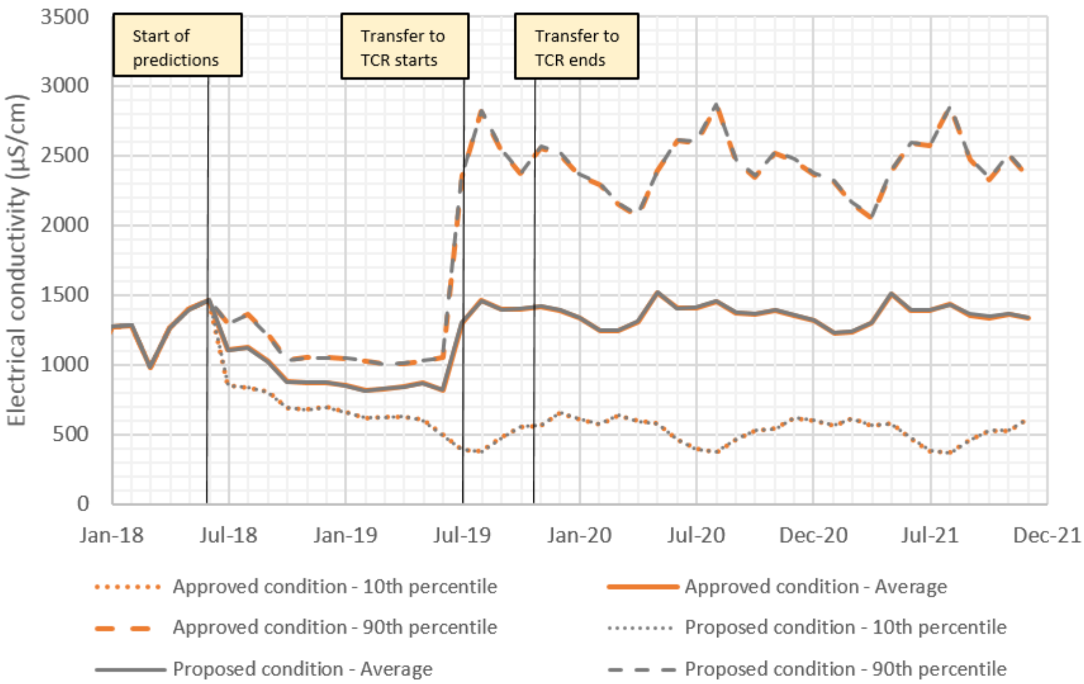

Figure 3.6 Approved condition vs proposed condition electrical conductivity on Coxs River directly upstream of Lake Wallace

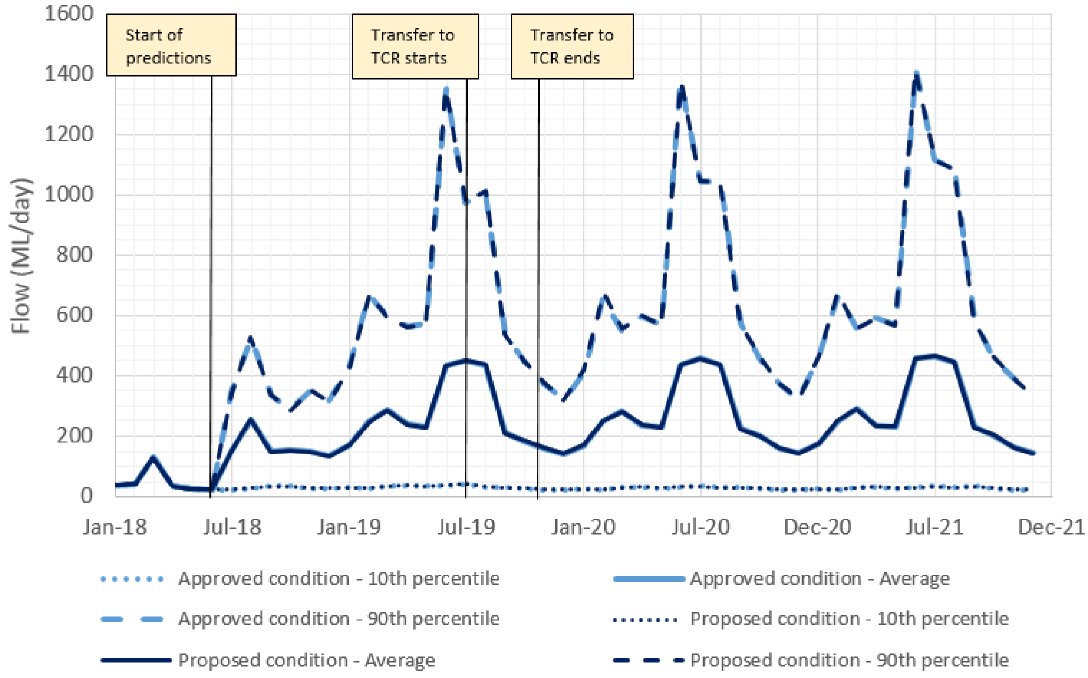

Figure 3.7 Approved condition vs proposed condition flows on Coxs River directly upstream of Lake Burragorang

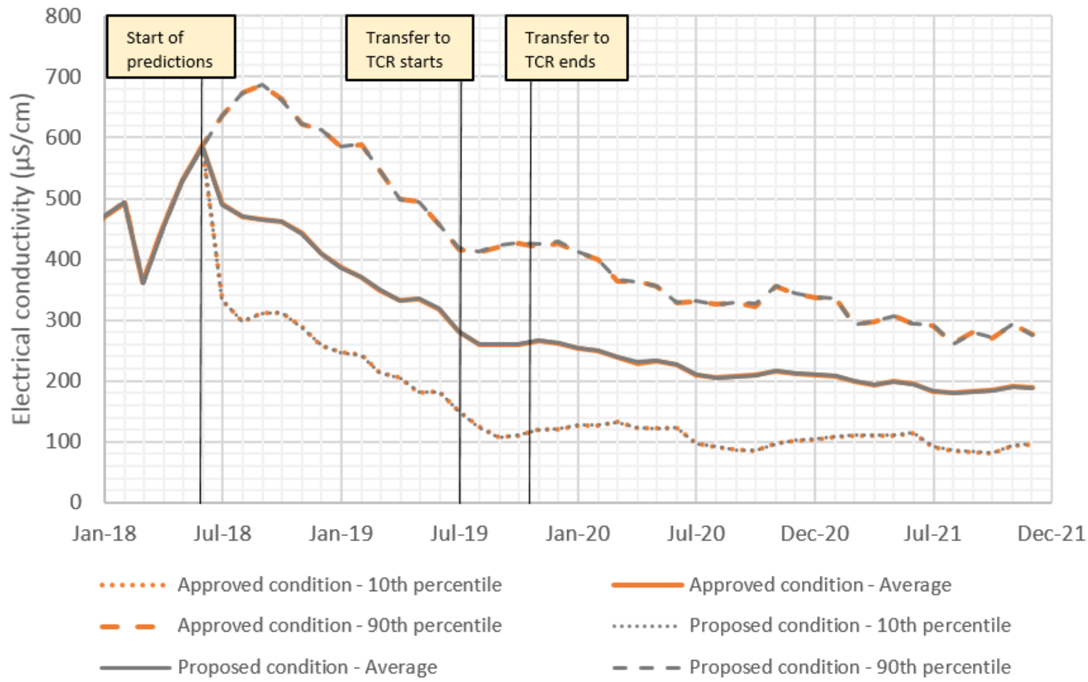

Figure 3.8 Approved condition vs proposed condition electrical conductivity on Coxs River directly upstream of Lake Burragorang

3.2.4 Annual water and salt volumes

A summary of the average total water volumes and salt loads over the year 2019 are presented in Table 3.5. The comparison between the approved and proposed conditions demonstrates negligible differences in total flows, total salt loads and flow weighted electrical conductivities at all three locations. It confirms the results from the flow and electrical conductivity trend figures above and the fact that the proposed conditions will not have a significant or lasting impact on the Coxs River system compared to the approved conditions.

Table 3.5 Average total water volumes and salt loads for 2019

Location	Parameter (units)	Approved conditions	Proposed conditions	Change
Coxs River at Pipers Flat Creek	Total flow (ML/year)	15604	15608	0.0%
Coxs River at Pipers Flat Creek	Total salt load (tonnes/year)	4225	4231	+0.1%
Coxs River at Pipers Flat Creek	Flow weighted average EC (µS/cm)	404	405	+0.2%
Coxs River upstream Lake Wallace	Total flow (ML/year)	16661	16665	0.0%
Coxs River upstream Lake Wallace	Total salt load (tonnes/year)	6407	6412	+0.1%
Coxs River upstream Lake Wallace	Flow weighted average EC (µS/cm)	574	574	0.0%
Coxs River upstream Lake Burragorang	Total flow (ML/year)	97124	97308	+0.2%
Coxs River upstream Lake Burragorang	Total salt load (tonnes/year)	13908	13977	+0.5%
Coxs River upstream Lake Burragorang	Flow weighted average EC (µS/cm)	214	214	0.0%

4. Conclusions

Quantitative modelling has been undertaken for scenarios assuming a total of 2700 ML of untreated mine water is transferred to TCR. This modelling was based on a series of conservative assumptions relating to the existing water quality in TCR, the mixing of the transferred water, and the speciation of metals in the reservoir following the transfers. The assessment indicated that the transfers would not result in any exceedances of the default guideline values for water and sediment quality that are not currently observed under baseline conditions. It also demonstrated negligible electrical conductivity and flow volumes changes within the greater Coxs River catchment including those flowing into Lake Burragorang. These changes were within natural variability and the uncertainty of the model.

Of the three fish species present in TCR (GHD 2016a), only the flathead gudgeon (*Philypnodon grandiceps*) has a reported tolerance range for turbidity (0.7-38 NTU) (Pusey *et al.* 2004). If this range were exceeded in TCR due to mine water transfers, it would likely be temporary and localised at the transfer pipe outfall zone, which would allow *P. grandiceps* to relocate to other areas within TCR, thereby preventing any significant impact on the species. Similarly, the temperature of mine water typically falls within the tolerance range for fish species present within TCR. Two exceedances of the temperature range within monitoring data is not likely to have an adverse effect on fish populations as a result of the small transfer volumes and location of the outfall in a central portion of the reservoir.

It is therefore concluded that the risk of impacts to environmental values within TCR and the receiving environments of Pipers Flat Creek and Coxs River (as compared to existing, or baseline conditions) may be considered negligible from the proposed activity.

5. References

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Appendices

Appendix A – 95th percentile water quality at TCR, March 2014 to September 2016

Parameter	Units	Value
Physicochemical parameters		
pH	pH units	8.6
EC	µS/cm	641
Major ions		
Bicarbonate alkalinity as $CaCO_3$	mg/L	153[a]
Sulfate as SO_4	mg/L	123.8
Chloride	mg/L	19.6
Calcium	mg/L	17.8
Magnesium	mg/L	10.2
Sodium	mg/L	97.1
Potassium	mg/L	9.1
Dissolved metals		
Aluminium	mg/L	0.012
Arsenic	mg/L	0.0008[b]
Cadmium	mg/L	0.00005[b]
Copper	mg/L	0.0009[b]
Cobalt	mg/L	0.0005[bc]
Nickel	mg/L	0.002
Zinc	mg/L	0.0025[b]
Iron	mg/L	0.011
Boron	mg/L	0.11
Manganese	mg/L	0.003
Lead	mg/L	0.0009[b]
Mercury	mg/L	0.00005[bc]
Chromium	mg/L	0.001
Selenium	mg/L	0.0001[b]
Nutrients		
Ammonia as N	mg/L	0.02
Total phosphorous as P	mg/L	0.01
Other		
Dissolved oxygen	mg/L	8.0

[a] Value determined using PHREEQC.

[b] Value is below the laboratory limit of reporting (LOR) for the parameter due to below LOR values in the data being presented as 50 percent of the LOR.

[c] Value calculated from results for March 2014 to September 2016, as provided by EA.

Appendix B – Median mine water quality, August 2017 – September 2018

Parameter	Units	Value
Physicochemical parameters		
pH	pH units	7.6
EC	µS/cm	1244
Major ions		
Bicarbonate alkalinity as $CaCO_3$	mg/L	695
Sulfate as SO_4	mg/L	17
Chloride	mg/L	6
Calcium	mg/L	4
Magnesium	mg/L	2
Sodium	mg/L	295.5
Potassium	mg/L	9
Dissolved metals		
Aluminium	mg/L	0.01
Arsenic	mg/L	0.016
Cadmium	mg/L	0.00005*
Copper	mg/L	0.0005*
Cobalt	mg/L	0.0005*
Nickel	mg/L	0.002
Zinc	mg/L	0.013
Iron	mg/L	0.07
Boron	mg/L	0.07
Manganese	mg/L	0.010
Lead	mg/L	0.0005*
Mercury	mg/L	0.00005*
Chromium	mg/L	0.0005*
Selenium	mg/L	0.005*
Nutrients		
Phosphate as P	mg/L	0.01
Ammonia as N	mg/L	0.510

* Value is below the laboratory limit of reporting (LOR) for the parameter; therefore, the value used is 50 % of the LOR.

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	J Cairns	M. Brannock S.Winchester	record on file	Wayne Schmiedte	record on file	4/12/18
1	J Cairns	M. Brannock S.Winchester	record on file	Wayne Schmiedte	record on file	05/02/19
2	J Cairns	M. Brannock S.Winchester	record on file	Wayne Schmiedte	record on file	20/02/19
3	J Cairns	M. Brannock S.Winchester	[signature]	Wayne Schmiedte	[signature]	28/02/2019

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Appendix B – Biodiversity values

Table 1: Impacts on biodiversity values from the proposed modification			
Biodiversity values	**Meaning**	**Relevant or NA* (✓or NA)**	**Likely impacts**
Vegetation integrity	Degree to which the composition, structure and function of vegetation at a particular site and the surrounding landscape has been altered from a near natural state	NA	The proposed modification to consent is to seek approval for an interim water management strategy to provide contingency for a potential delay in commissioning of the approved water treatment plant. The strategy will primarily utilise existing infrastructure approved for use in accordance with the consent and will not result in any additional land clearance or removal of vegetation. A short bypass pipeline will be established within the existing water treatment plant footprint to allow the bypass of desalination units. The water treatment plant site has been previously cleared of all native vegetation during the initial construction of Mount Piper Power Station and no additional vegetation will be removed as part of the modification.
Habitat suitability	Degree to which the habitat needs of threatened species are present at a particular site	NA	The water treatment plant site has been previously cleared of native vegetation and is an active construction site. The proposed modification has avoided impacts upon threatened species or ecological communities and their habitats through the use of existing infrastructure approved for use as part of the project. There will be no additional clearing required for implementation of the proposed interim water management strategy
Threatened species abundance	Occurrence and abundance of threatened species or threatened ecological communities, or their habitat, at a particular site	NA	The proposed modification has avoided impacts upon threatened species or ecological communities and their habitats through the use of existing infrastructure approved for use as part of the project. There will be no additional clearing required for implementation of the proposed interim water management strategy
Vegetation abundance	Occurrence and abundance of vegetation at a particular site	NA	The water treatment plant site has been previously cleared and is an active construction site. The area to be impacted is limited to a bypass pipeline (less than 5 metres) within the previously approved water treatment facility footprint.
Habitat connectivity	Degree to which a particular site connects different areas of habitat of threatened species to facilitate the movement of those species across their range	NA	The development site does not contribute to habitat connectivity. Physical disturbance is limited to a bypass pipeline to isolate the desalination units within the Water Treatment Plant Footprint.
Threatened species movement	Degree to which a particular site contributes to the movement of threatened species to maintain their lifecycle	NA	The proposed modification will not impact upon the movement of threatened species

Table 1: Impacts on biodiversity values from the proposed modification			
Biodiversity values	**Meaning**	**Relevant or NA* (✓or NA)**	**Likely impacts**
Flight path integrity	Degree to which the flight paths of protected animals over a particular site are free from interference	NA	The bypass pipeline and valve arrangement will be installed adjacent to and beneath the level of the desalination units (eg less than 2 metres above ground level) and will not impact upon the flight path of any protected animals.
Water sustainability	Degree to which water quality, water bodies and hydrological processes sustain threatened species and threatened ecological communities at a particular site	NA	The interim water management strategy involves the storage of filtered mine water within Thompsons Creek Reservoir to allow subsequent reuse at the Mount Piper Power Station. Detailed water quality investigations have been undertaken to demonstrate the modification will have negligible impact upon water quality within both Thompsons Creek Reservoir and the broader Coxs River catchment. The proposed modification will not impact upon water quality or hydrological processes that sustain threatened species or threatened ecological communities.

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	K.Rosen	S.Winchester	[signature]	K. Rosen	[signature]	14/03//2019

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