ILLAWARRA COAL

BULLI SEAM OPERATIONS

GEORGES RIVER ENVIRONMENTAL IMPROVEMENT PROGRAM

CONTENTS

INTRODUCTION

Background

The community has identified the Georges River as being of high value, environmentally, culturally and recreationally and has previously expressed concerns about the impacts on the Georges River due to discharges from Brennans Creek Dam (BCD) (GREA 2012).

Several field and laboratory studies have been carried out to investigate the ecological health of Brennan Creek and the Upper Georges River. These have included various Pollution Reduction Programs (PRP 6, PRP9, PRP10 and PRP 11) as well as studies undertaken by the Georges River Combined Councils Committee (GRCCC) and the Australian Coal Association Research Program (ACARP 2010). These studies indicated that the Georges River downstream of the Brennans Creek confluence has impaired macroinvertebrate fauna relative to control sites. Illawarra Coal is conducting monitoring under EPL2504 (PRP20) which is showing higher densities of pollution tolerant macroinvertebrates at sites closer to the discharge point (Point 10); with the magnitude of influence of mine discharge being less evident at sites further downstream.

An Environmental Protection Licence (2504) is in place for the Bulli Seam Operations (for West Cliff, North Cliff, Appin East and Appin West Mine Sites) which includes licensed points, monitoring and limits for air and water. In 2013, the EPA issued a notice of variation of EPL 2504, which included a requirement to carry out a program of works to reduce the level of contaminants being released to the Georges River via discharge Point 10 (PRP19). PRP20 was also added to the Licence with the aim of assessing the aquatic health of Brennans Creek and the Upper Georges River as projects required under PRP19 are commissioned.

Community Stakeholder Engagement

South32 IC holds regular meetings with community stakeholders to review progress of PRP19 projects and monitoring results from PRP20 (Table 1).

The Progress Meetings include representatives from the EPA; Georges River Combined Councils Committee (GRCCC); Wollondilly and Campbelltown local councils; The Georges River Environmental Alliance (GREA); National Parks Association of NSW (NPA NSW); Bulli Seam Operations Community Consultative Committee (BSO CCC) and Western Sydney University (WSU).

In 2015, a Technical Working Group (TWG) was established (as a subset to the above) to develop water quality and river health objectives for the Upper Georges River. The TWG includes nominated (by the community stakeholders) representatives from the above stakeholders including the GRCCC, WSU, South32 IC and the EPA.

The following community stakeholder meetings have been held since 2014:

Table 1: Summary of the Georges River Community Stakeholder Meetings held since 2014.

Date	Type	Purpose of Meeting	Outcome
Spring 2014	Progress Meeting	Review of PRP20 results (Yr1) and discuss water strategy for PRP19.	Water strategy for PRP19 endorsed by the attendees.
Spring 2015	Progress Meeting	Review of PRP20 results (Yr2) and PRP19 update.	Consensus to establish a Technical Working Group to improve monitoring program under PRP20, develop water quality limits and flow requirements for Point 10. Representatives from GRCCC and Western Sydney University nominated to attend.
Autumn 2016	Technical Working Group	1st Technical Working Group meeting to share monitoring results and	Monitoring results consistent between all parties. Agreed on river health objectives.

Date	Type	Purpose of Meeting	Outcome
		establish water quality limits and flow principals for Point 10.	
Winter 2016	Progress Meeting followed by 2nd Technical Working Group meeting	Site visit to Appin West Water Filtration Plant and discuss water quality and flow principals for Point 10.	In principal support for flow and water quality and endorsed changes to PRP20 monitoring program (increased monitoring frequency etc.).
Winter 2016	Technical Working Group	Further development of flow and water quality principals.	Consensus to replace PRP19/20 with Environmental Improvement Program (this document). South32 IC to submit licence amendment application to include EIP, extend deadline for water quality limits under PRP19 and extend interim limits for Point 10 (with some concentration reductions). The stakeholders will be consulted on the proposed changes.
Spring 2016	Progress Meeting	Seek endorsement for submission of the EIP.	Endorsement from attendees to submit EIP. The attendees requested that the following be noted: • They recognised the value of the in-depth consultative process and the goodwill it generates; • The group appreciated the effort made by South32 to improve the water quality of the Georges River; • The group understood that the current targets need to be realistic and look forward to further planned improvements to pH and salinity.
Spring 2017	Progress Meeting	Tour of the Water Filtration Plant Presentation on the EIP: • Progress on Improvement projects; • Recap on previous data; and Latest results.	S32IC may submit license variation to extend dates for water projects and interim limits due to WFP commissioning date being delayed.
Autumn 2018	Progress Meeting	Presentation on the EIP. Progress on improvement projects. Recap on previous data and latest results	Several recommendations on the EIP were endorsed: 1. Increasing biological replicates 2. Removal of downstream discharge monitoring sites GRQ19 and GROH.

SCOPE

The EIP for the Georges River incorporates:

- Improvement projects as per the previous PRP19 requirements; and
- Monitoring to verify improvements to aquatic health as the above projects are commissioned. Monitoring includes (based on previous PRP20 requirements):
    - Quantitative sampling of macroinvertebrates;
    - Ecological Assessment processes using DNA extracted from sediment;
    - In-stream water quality; and
    - Laboratory water testing.

AIMS

To improve the aquatic health of the Upper Georges River by reducing the concentration of pollutants discharging from Point 10; and

To monitor the changes to biota in-stream and within the sediment of the Upper Georges River as water quality improvement projects are commissioned.

The aims will be verified by:

- Comparing the Brennans Ck/Georges River sites with reference sites (upstream of the Brennans Creek Confluence)
- Estimating changes over time in the composition and abundance of in-stream and sediment biota; and
- Assessing the downstream gradient changes in composition and abundance of in-stream and sediment biota

We hypothesise that the abundance and composition of aquatic biota will become more similar to the reference sites as water projects required are commissioned.

Water quality limits for Point 10 will be determined by June 2019. The limits will be based on the results from the aquatic health monitoring as described in the following sections. Future flow releases from BCD will be determined following the completion of rehabilitation works associated with subsidence impacts from West Cliff Longwalls 33 to 38.

The community stakeholders will be consulted on the proposed limits and future flows from BCD.

DISCHARGE WATER QUALITY IMPROVEMENTS

South32 IC is implementing a program of works to improve the quality of water being discharged from Brennans Creek Dam. The water quality improvement works are summarised in the table below and South32 IC provides 6 monthly progress reports to the EPA. The below works will be completed by February 2019.

Table 2: Water quality improvement works

Works	Purpose	Status Sept 2018
Coagulant / flocculant review. Trial of flocculants at West Cliff Coal Preparation Plant.	Reduction of aluminium concentration within treatment ponds, Brennans Creek dam (BCD) and discharge into the Georges River.	Review completed. Several new products were tested, however none satisfied operational and water quality requirements for the site. Currently implementing an automated dosing system to achieve dosing rate efficiencies.
Water Filtration Plant Upgrade – Appin West	Increase capacity to pre-treat underground pump out. Increase processing capacity of mine water (4.7 ML/Day).	Final commissioning delayed to fix defects/issues that emerged during dry/initial wet commissioning.
Modification to the Washery water management system to create a 'semi-closed loop'. Includes installation of a slurry pipeline.	Reduce BCD water taken for process water in the Washery. Reduce diversion of Washery waters into BCD.	'Semi' closed system is complete. Some minor pipework connections required to bypass Pond 3 (which is the Pond used in the closed loop supply to the Washery). Slurry pipeline is complete.

AQUATIC HEALTH MONITORING

Study Area and Sites

The study area is located within the Upper Georges River Catchment (Figure 1), commencing at GRQ1 and runs for 9 kilometres to site GRQ18. Site GRQ18 is located approximately 8 kilometres downstream of the West Cliff licensed discharge Point 10. For full site descriptions see Table 3.

The sampling design consists of two treatments:

- Discharge Monitoring Site (Near) (6 sites), which capture the gradient from the discharge water – Point 10, Point 12, Jutts Crossing; Pool 16, Pool 32 and GRQ18;
- Reference (3 sites) – GRQ1, GR/UFS and Point 11.

There are other anthropogenic influences that could potentially confound the effects of mine water discharge from West Cliff Colliery including runoff from local farms and Appin Township and effects of mining subsidence (The Ecology Lab Pty Ltd, 2004 & 2006). The aquatic monitoring program has been designed to reduce the influence of confounding effects by taking samples at several places well away from the mine discharge point, sampling away from localised influences (Appin village runoff and EPA Licensed Waste disposal sites) and assessing the amount of variation between the sites in the Georges River in accordance with recommendations from Quinn and Keough, 2002.

Point 11 will also be sampled in line with the other sites; this site may be confounded by licensed mine discharge from Appin Colliery (as it is located between the Appin discharge point and the confluence of Brennans Ck with Georges River); however, the results from previous campaigns indicated that Point 11 is more similar in composition to the other reference sites and for this reason is included as a reference site.

Table 3: Site descriptions and locations

Treatment	Watercourse	Site Name	Easting	Northing	Estimated pool depth and width	Distance D/S from LDP10	Gradient	Substrate
Discharge Monitoring	Brennans Ck	Point 10	296844	6213232	Up to 0.5m depth Up to 5m width	0 km	18m/km	Predominantly bedrock, boulder and deposits of sand in areas of low flow
	Georges River	Point 12	297157	6213016	Up to 2.5m depth Up to 5m width	0.5 km	18m/km	Predominantly bedrock, boulder and deposits of sand in areas of low flow
	Georges River	Jutts crossing (Pool 10)	296844	6213232	Up to 3m depth Up to 20m width	1 km	18m/km	Predominantly bedrock with deposits of sand.
	Georges River	Pool 16 (D/S of Marhnyes Hole)	296890	6213908	Up to 0.5m depth Up to 5m width	2 km	18m/km	Predominantly bedrock with deposits of sand
	Georges River	Pool 32 (D/S of Sawpit Gully)	297192	6215029	Up to 2m Up to 20m width	4 km	18km/km	Predominantly bedrock with deposits of sand
	Georges River	GRQ18	296748	6217637	Up to 1m depth Up to 20m Width	8 km	18m/km	Predominantly bedrock, boulder and deposits of sand in areas of low flow. Large amount of macrophytes around edges.
Reference	Georges River	GRQ1	297225	6211446	2m depth 2-3 m width	N/A	18m/km	Predominantly bedrock with deposits of sand. Lots of detritus and submerged logs.
	Georges River	GR/UFS	297082	6211771	0.5 m depth Up to 2-3 m width	N/A	18m/km	Predominantly bedrock with deposits of sand
	Georges River	Point 11	297207	6212940	1 m depth 5m width	N/A	18m/km	Predominantly bedrock, boulder and deposits of sand in areas of low flow, lots of detritus

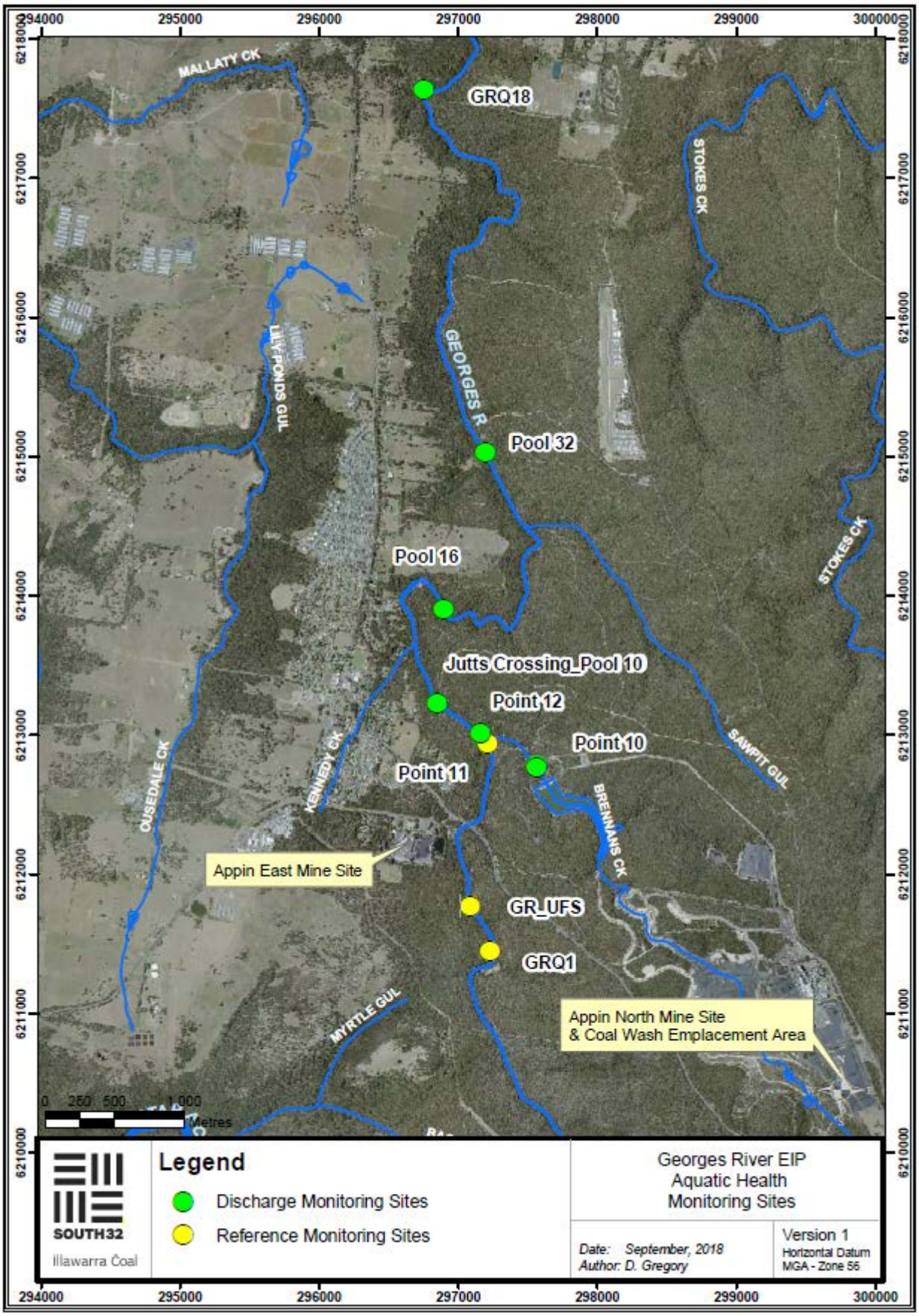

Figure 1: Map of monitoring locations

Sampling Methodology

Water Quality

Field Water Quality Measurements

Measures of water quality indicators will be taken near the surface at each site. Field parameters will include water temperature, electrical conductivity, pH, dissolved oxygen, turbidity.

Laboratory Water Quality

The following chemical parameters have been selected to align with potential toxicants and stressors and the Environmental Protection Licence 2504 conditions. This analysis will be undertaken in conjunction with fauna and algae sampling and field water quality measurements:

- pH and electrical conductivity;
- Major cations: calcium (Ca) magnesium (Mg), potassium (K) and sodium (Na);
- Major anions: chloride (Cl), sulfate (SO4), bicarbonate alkalinity and total alkalinity (T. Alk.);
- Filtered metals: aluminium (Al), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), and zinc (Zn); and
- Filtered ultra-trace nutrients: ammonia (NH3-N), nitrate and nitrite nitrogen (NOx-N), total Kjeldahl nitrogen (TKN), total nitrogen (TN), total phosphorous and dissolved organic carbon (DOC).

Ecotoxicty Monitoring

Ecotoxicity tests will be undertaken as specified in the table below. Samples will be collected simultaneously with the CSIRO and macroinvertebrate monitoring at Point 10 only.

Table 4: Proposed ecotox monitoring

Species	Frequency	Sampling Method
Ceriodaphnia dubia	One sample in Spring 2017, Spring 2019 and Spring 2021	7-day reproductive impairment test (USEPA 2002 – EPA/821/R/02/013)
Paratya australiensis	One sample in Spring 2017, Spring 2019 and Spring 2021.	10-day acute test (USEPA 2002 - EPA/821/R/02/012) Adaptation of Test Method 2007.0 in that mature Paratya australiensis are used, with feeding 3 hours prior to 48-hour renewal of test solutions

CSIRO Method for Invertebrates and Algae (from CSIRO 2015)

Metabarcoding is a relatively new DNA-based approach which examines community structure by high-throughput sequencing targeted genes from bulk DNA extracts. Several studies have demonstrated the capacity of metabarcoding to cover a far wider range of organisms than can be obtained using traditional techniques.

Quantitative Macroinvertebrate Sampling

At least 5 samples will be collected from each pool to represent the different substrates. A suction sampler (Figure 2) described by Brooks (1994) will be placed over the substrate and operated for one minute at each sampling location. The sample is washed thoroughly over a 500-µm mesh sieve. All material retained on the 500-µm mesh sieve is preserved in 70% ethanol for laboratory sorting. This method has been used extensively by NSW Office of Water.

Figure 2: Example of a suction sampler

Sampling Time & Frequency

Frequency of macroinvertebrate sampling will be 2 times per year in autumn and spring up to Spring 2021.

Frequency of CSIRO ecogenomic monitoring will occur in the years 2017, 2019 and 2021 in spring.

Water quality will coincide with the above.

Results Analysis

Permutational ANOVAs (PERMANOVA – Primer) will be used to test for differences in total abundance and richness between treatments (mine discharge vs reference). Mean plots of univariate data will also be provided.

Multivariate analyses will be used to compare taxon composition between mine discharge and reference sites. Analysis of Similarities (ANOSIM) will identify whether the overall composition between treatments is significant. Ordinations of captures using Multidimensional scaling (MDS) will provide graphical interpretation of the separation. To identify which taxon account for the observed assemblage difference, the SIMPER procedure will be used (Clarke and Gorley, 2001). This procedure examines the contribution each species makes to the average similarity within a group (Clarke and Warwick, 2001). Similar methods will be used to identify spatial differences in composition, abundance and richness between far and near sample sites in the Georges River/Brennans Ck. The relationship between environmental gradients and stream biota will be explored with BIOENV (Primer) where possible.

One-way repeated measures ANOVA will be used to test for temporal differences in abundance and taxon richness between reference and treatment at time 1 (2013 sampling period) and time 2 (2015 sampling period) etc.

The significance level of 0.05 will be used in all analyses as protection against false significant results (type one errors). A lower significance level would have increased the likelihood of making type 2 errors (Quin and Keough 2002; Pallant 2005).

EPT index will be used to calculate the relative abundance of pollution sensitive Ephemeroptera, Plecoptera and Trichoptera Orders (Wright *Pers.Comm*) every 6 months. This is a popular biotic index for assessing fresh water pollution (Rosenburg & Resh, 1993; Wright & Ryan, 2016). The following table will be used as a guide when assessing EPT.

Table 5: Trigger Action Response Plan for Assessment of EPT (Will come into effect once water quality improvement is achieved, flow regime in place and Georges River rehab works are completed)

Monitoring	Assessment Criteria	Action
Biodiversity monitoring – 6 monthly macroinvertebrates	***Target*** % EPT @ sites D/S of the discharge (Point 12, Pool 32 & GRQ18) statistically similar to reference sites	Maintain water quality
	Trigger % EPT @ sites D/S of the discharge (Point 12, Pool 32 & GRQ18) significantly lower than reference sites	Action plan developed to adjust water quality to meet biodiversity outcomes in consultation with the EPA and community representatives.

REPORTING AND CONSULTATION

Illawarra Coal will discuss results with the stakeholder groups on a regular basis and formally present progress reports in accordance with the following table:

Table 6: Summary of reporting and consultation commitments for the Georges River EIP.

Report Type or Consultation	Frequency	Report Due
Stakeholder progress meeting with EPA, GRCCC, CCC, Wollondilly and Campbelltown Councils, WSU, Other interest groups	6 monthly	Oct 2016, Winter and Summer 2017, Winter and Summer 2018; Winter and Summer 2019, Winter 2020 (final meeting).
Detailed scientific report on macroinvertebrate and CSIRO monitoring to EPA and loaded onto South32IC Website.	Biennial	26 April 2018; 31 March 2020, 31 March 2022.
Illawarra Coal Community Consultative Committee	Regular updates at meetings which are held every two months	N/A
Technical Working Group – Nominated representatives from Stakeholders	If monitoring TARP (Table 5) is triggered or to address issues from the Stakeholder Progress Meetings.	As required.

CHANGES LOG

Version	Details	Date	Name
2.0	Version 1 updated to reflect comments from the EPA	6 August 2013	David Gregory
3.0	Version 2 updated to reflect comments from the EPA	10 September 2013	David Gregory
4.0	Changes made to Version 3 following a review of the findings from the Year 1 (2013) campaign. These include: Removal of Cascade Creek reference sites as approved by the EPA; Removed GR_OH from the program due to safety concerns with accessing this site Added 3 Georges River sites downstream of the Brennans Ck confluence i.e. Pool 16, Pool 32 and GRQ19. Removed fish monitoring from the program as approved by the EPA. Removed the need to take duplicate water quality samples following a review of the water quality results from the year 1 (2013) campaign.	8 October 2014	David Gregory
5.0	EIP developed to replace PRP19 & 20. mods include: Updated section on background information Increased frequency of macroinvertebrate monitoring to every 6 months Added monitoring trigger (TARP) for macroinvertebrate monitoring Addition of EPT biotic index to analysis Higher level of consultation including establishment of technical working group	7 October 2016	David Gregory
6.0	Extend the date for implementation of water improvement projects to June 2018. Extend the date for interim water quality limits at Point 10 till June 2019. Add additional dates to Table 6	30 November 2017	David Gregory
6.1	Incorporated comments from EPA review. Some further changes to dates in Table 6 following feedback from EPA.	19 Jan 2018	David Gregory
6.2	EPA granted extension of due date for 2018 CSIRO report to 26th April (originally 31 March) – See table 6.	29 March 2018	David Gregory
6.3	Extension of date to complete water improvement projects to February 2019 (was June 2018) due to delays in the commissioning of the Water Filtration Plant Upgrade. Additional detail added to Table 2 (i.e. project status).	21 June 2018	Alex Parro David Gregory
6.3	Updated monitoring program sites and sample replication. Other minor text updates: Remove 6 monthly reporting to EPA (already done in conjunction with the 6 monthly stakeholder meetings) Table 5 TARP to come into effect once all water quality improvements /final flow regime is in place and rehabilitation of longwall subsidence impacts are complete.	24 September 2018	David Gregory

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