TAHMOOR COAL PTY LTD
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Tahmoor South LWS1A-S6A Water Management Plan

Myrtle Creek and Redbank Creek Remediation Progress Review

121171.17, R02, Rev D
May 2022

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Document Control

Project Name:	Tahmoor South LWS1A-S6A Water Management Plan
Document Title:	Myrtle Creek and Redbank Creek Remediation Progress Review
File Location:	\\atcbnemvpfs01\Synergy\Synergy\Projects\121\121171 1809 Tahmoor (SIMEC) Surface Water Assistance\17 Tahmoor South LW101-106A WMP\Documents\R02\121171.17-R02d.docx
Document Number:	121171.17-R02d.docx

Revision History

Revision	Issue	Issue Date	Prepared by	Reviewed by
A	Draft Issue	11/4/2022	Camilla West	Lee Rigley
B	Second Draft Issue	28/4/2022	Camilla West	Tony Marszalek
C	Third Draft Issue	9/5/2022	Camilla West	Client
D	Final Rev 1	11/5/2022	Camilla West	Client

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1 INTRODUCTION

Myrtle Creek and Redbank Creek are situated in the Nepean River catchment. Myrtle Creek discharges directly to the Nepean River while Redbank Creek discharges to Stonequarry Creek which in turn discharges to the Nepean River.

The upper reaches of Myrtle Creek overlie older Tahmoor Mine longwall panels LW3 to LW5, LW7 to LW9, LW20 and LW21. The mid to lower reaches of Myrtle Creek overlie LW22 to LW29, while Redbank Creek overlies LW24B to LW32 (refer Map 1).

Mining of LW22 commenced in May 2004 with LW32 completed in September 2019. During mining of LW22 to LW32, subsidence related impacts occurred to Myrtle Creek and Redbank Creek. The subsidence related impacts comprised stream bed and rockbar fracturing, reduced pool water holding capacity, diversion of surface flow as subsurface flow and isolated, episodic pulses of elevated concentrations of some water quality constituents. The impacts resulted in exceedances of the surface water triggers in the Trigger Action Response Plan defined in the LW 27-30 Environmental Management Plan (Xstrata Coal, 2013), LW 31 Environmental Management Plan (Glencore, 2017) and the LW 32 Environmental Management Plan (Tahmoor Coal, 2019a).

Accordingly, Tahmoor Coal Pty Ltd (Tahmoor Coal) has developed and implemented a Corrective Management Action Plan to remediate the impact of subsidence effects to Myrtle Creek and Redbank Creek. Remediation works, comprising grout curtains and grout pattern injection, have been conducted at sites in Myrtle Creek and Redbank Creek with the aim of improving pool water holding capacity, restoring overland connective flow and improving aquatic ecosystem health and aesthetic value.

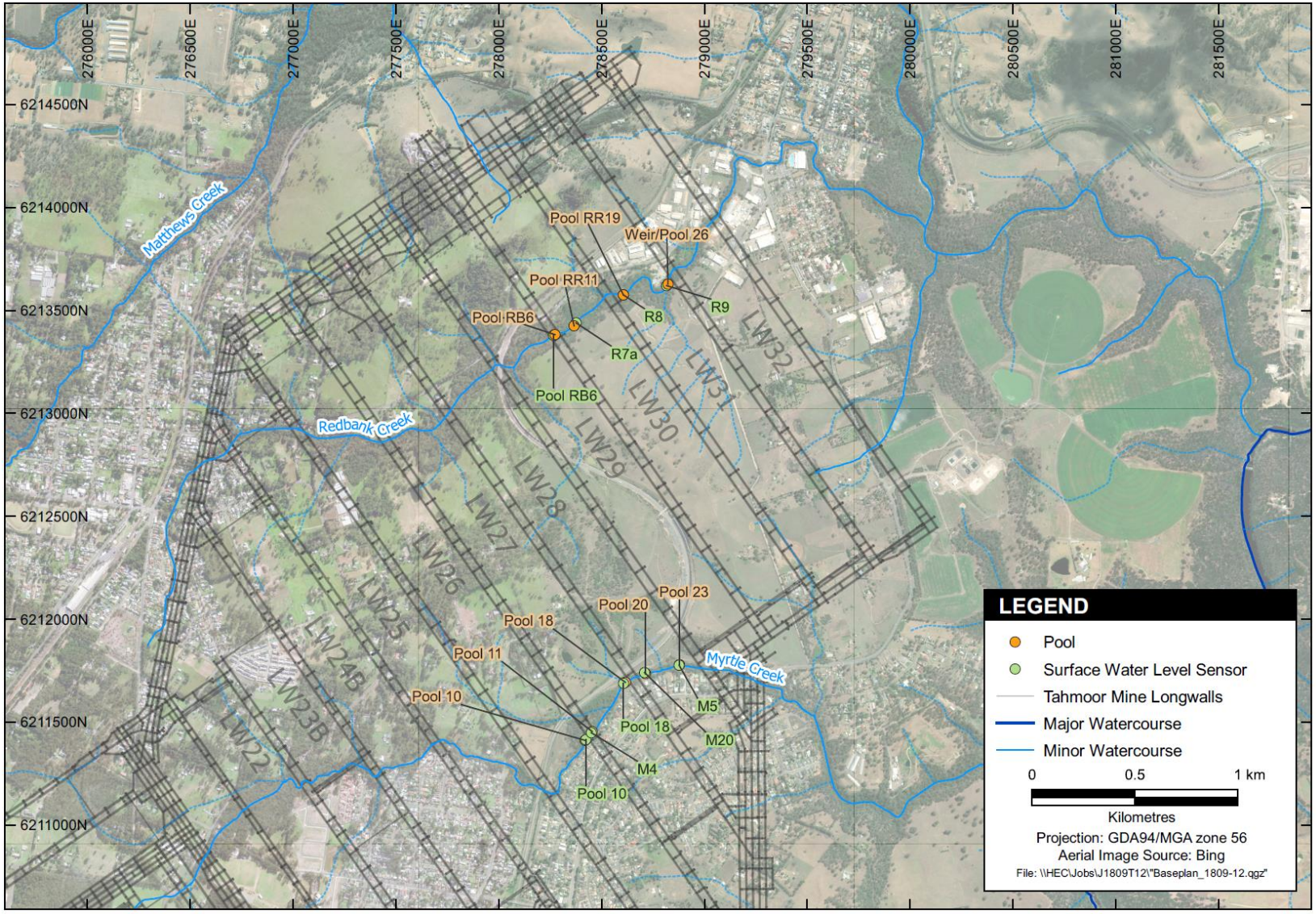
The NSW Department of Planning and Environment (DPE) – Environment, Energy and Science Group (EES) has requested an update on the progress of remediation works in Myrtle Creek and Redbank Creek including review and analysis of monitoring data demonstrating remediation outcomes.

This report details the outcomes of a surface water assessment for remediated pools comprising recession analysis and comparison of remediated pool water level records to reference site water level records. Additionally, a summary of the aquatic ecology survey results for remediated pools is provided.

The analysis has been undertaken for the following pools (refer Map 1):

- Myrtle Creek: pool 23, 20, 18, 11 and 10.
- Redbank Creek: pool RB6, RR11, RR19 and weir/pool 26.

The outcomes of the surface water analysis and aquatic ecology surveys have been used to assess the effectiveness of the remediation works in Myrtle Creek and Redbank Creek to date.



MAP 1: REDBANK CREEK AND MYRTLE CREEK REMEDIATION MONITORING SITES

2 CORRECTIVE MANAGEMENT ACTION PLAN

2.1 CMAP Program of Works

In accordance with the requirements of Section 240(1)(d) of the *Mining Act 1992*, Tahmoor Coal has developed and implemented a Corrective Management Action Plan (CMAP) in relation to exceedances of the surface water triggers in the Trigger Action Response Plan defined in the Environmental Management Plans for LW27-LW32.

The Myrtle Creek CMAP Stage 1 (Tahmoor Coal, 2017) was approved by the NSW Resources Regulator on 4 May 2018 and was completed in February 2020 (Tahmoor Coal, 2020a). The Myrtle Creek CMAP Stage 2 (Tahmoor Coal, 2020b) is currently being implemented. The Redbank Creek CMAP Stage 1 (Tahmoor Coal, 2019b) was initially approved by the NSW Resources Regulator in June 2019 and is currently being implemented.

The CMAP details the required program of works for remediation of subsidence impacts to Redbank Creek and Myrtle Creek associated with mining of LW22-LW32. The works associated with the CMAP comprise:

- high resolution stream and pool mapping;
- characterisation of the fracture network through implementation of a characterisation borehole network (Characterisation Study);
- remediation through grout injection (curtain wall and / or pattern grout injection);
- surface water, groundwater and aquatic ecology monitoring and assessment;
- stakeholder consultation; and
- quarterly reporting.

In addition, groundwater modelling has been undertaken to inform the required remediation works at specific sites.

2.2 Remediation Objectives

As defined in the Redbank Creek and Myrtle Creek CMAPs (Tahmoor Coal, 2019b; 2020b), the remediation works have been conducted with the aim of restoring the post-mining hydrological, ecological and aesthetic characteristics of Myrtle Creek and Redbank Creek to, as close as practically possible, pre-mining conditions. Specifically, the remediation works aim to:

- protect, to the greatest practicable extent, the ecological values of the area;
- as close as practicably possible, restore the post-mining ecosystem function and aquatic ecology to that of pre-mining conditions;
- improve the post-mining aesthetic conditions of the creeks;
- as close as practicably possible, restore the post-mining pool water level recession rates to pre-mining water level recession rates; and
- reduce the interaction between surface water and groundwater where this has been enhanced through mining impacts.

The assessment findings presented in this report pertain to the progress of restoring the post-mining hydrological and ecological characteristics of Myrtle Creek and Redbank Creek to, as close as practicably possible, pre-mining conditions in locations where remediation works have been conducted.

3 REMEDIATION PROGRESS ASSESSMENT METHODOLOGY

3.1 Surface Water Analysis Methodology

3.1.1 Method 1

Method 1 was adopted for assessing the effectiveness of remediation works at pools for which sufficient pre-mining and/or pre-impact water level data was recorded. Method 1 comprised assessment of whether or to what extent the pool water level recessionary behaviour has been restored to pre-impact conditions. During low rainfall conditions, the water level of an un-impacted pool is expected to decline at a similar rate from a given starting level for each dry weather event, with some seasonal variation. Mining related subsidence impacts typically result in a markedly faster water level recession than that observed during pre-impact periods. Successful remediation of an impacted pool is assessed by comparing the dry weather water level recessionary behaviour of a pool during pre-impact and post-remediation periods.

To facilitate the assessment, monitored average daily water level data for each pool was provided by Hydrometric Consulting Services (HCS) for the period of record. Rainfall data recorded at the Myrtle Creek catchment rainfall monitoring station was used to define dry weather events (refer Map 2 for location). The data recorded at the Myrtle Creek rainfall monitoring station was reviewed against rainfall data recorded at the nearby WaterNSW Lake Nerrigorang (212063) and Thurns Road (568296) rainfall stations for comparative periods. The Lake Nerrigorang station (212063) is located approximately 2.5 km to the west of the upstream reach of Myrtle Creek and the Thurns Road station (568296) is located approximately 6 km to the north-east of the downstream reach of Redbank Creek (refer Map 2 for locations). Although the WaterNSW stations are located at a distance from the remediation sites, the rainfall patterns recorded at the three stations were found to be generally consistent. As such, gaps in the Myrtle Creek rainfall record were infilled with data recorded at Thurns Road to September 2014 and Lake Nerrigorang rainfall data post September 2014 (the commencement date of Lake Nerrigorang rainfall station).

The assessment methodology adopted was as per that described in Peabody (2019) and comprised the following steps:

1. Dry weather recession events, defined as a period of at least five days where the maximum recorded total rainfall was 0.5 millimetres (mm) or less, were identified for the pre-impact and the post-remediation periods. A minimum of fifteen dry weather periods for both the pre-impact and post-remediation periods were considered necessary to undertake an adequate assessment. Of these fifteen periods, at least two needed to span ten or more days. Ideally, these periods should be spread over different seasons for a minimum of two years.
2. The average daily water level data was plotted as a series of recession curves for each dry weather recession event. The start time of each recession event was adjusted to form a single recession curve (i.e. plotted on a single time scale).
3. An interpolating exponential equation was then fitted to the derived single recession curve for the pre-impact dataset.
4. The start time for each recession event (on the single recession curve) was readjusted using the interpolating exponential equation to produce a mathematically refined recession curve for the pre-impact dataset. The refined recession curve, considered to be representative of the dry weather water level recessionary behaviour of the pre-impacted pool, was used for comparison with the post-remediation dataset.
5. For the post-remediation data, the start time for each post-remediation recession event was adjusted using the adopted pre-impact interpolating exponential equation to produce a recession curve for the post-remediation data.

The pre-impact and post-remediation recession curves were then compared to assess comparative behaviour.

3.1.2 Method 2

Method 2 was adopted for assessing the effectiveness of remediation works at pools for which sufficient pre-mining and/or pre-impact water level data to enable the use of Method 1 was not recorded. Method 2 comprised two components:

1. assessment of whether or to what extent the pool water level recessionary behaviour has been improved in relation to impact conditions; and
2. comparison of the remediated pool water level with similar, unimpacted pools (reference sites).

The component 1 assessment method comprised the following steps:

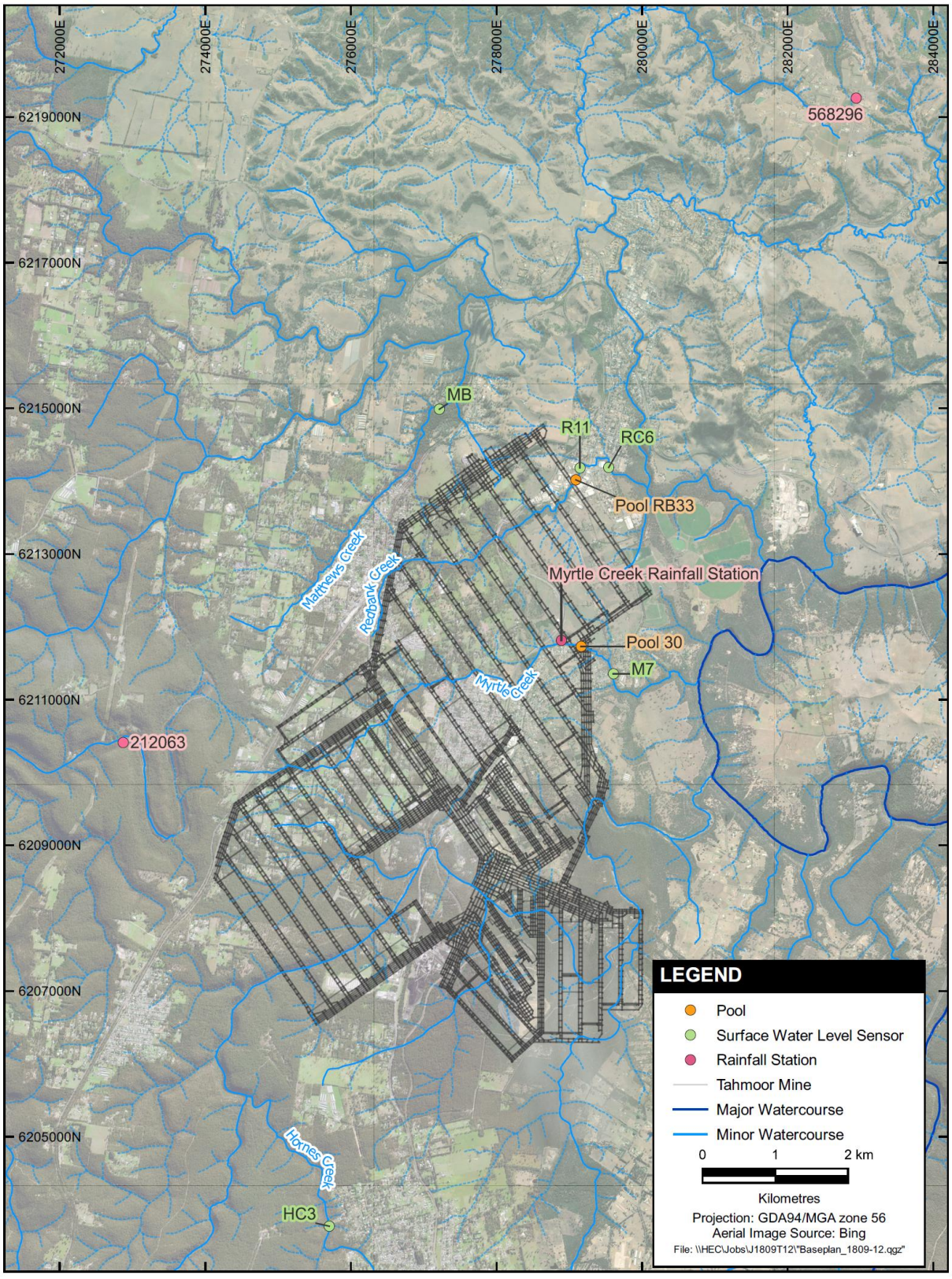
1. A minimum of two dry weather recession events, defined as a period of at least five days where the maximum recorded total rainfall was 0.5 mm or less, should be identified for the impact and the post-remediation periods.
2. The average daily water level data was plotted as a series of recession curves for each dry weather recession event. The start time of each recession event was adjusted to form a single recession curve (i.e. plotted on a single time scale).

The impact and post-remediation recession curves were then compared to assess comparative behaviour.

Component 2 assessment method comprised comparison of the post-remediation water level data with water level data recorded at a minimum of two un-impacted pools with similar hydrological and geomorphological characteristics (reference sites). The reference sites were as follows (refer Map 2 for locations):

- Myrtle Creek M7 – furthest monitoring site downstream in Myrtle Creek located beyond the zone of subsidence impacts and of flow re-emergence from upstream impacted pools.
- Redbank Creek R11 and RC6 – furthest monitoring sites downstream in Redbank Creek located beyond the zone of subsidence impacts and of flow re-emergence from upstream impacted pools.
- Hornes Creek HC3 – located in a catchment which is not influenced by any mining activities and has similar hydrological and geomorphological characteristics to that of Myrtle Creek and Redbank Creek.
- Matthews Creek MB - located upstream of potential mining influences, has a similar catchment area (8.1 km^2) to that of Myrtle Creek (7.9 km^2) and Redbank Creek (5.3 km^2) and similar hydrological and geomorphological characteristics.

The water level monitoring data for each pool was adjusted to a common datum to enable direct comparison of recessionary behaviour. A subjective assessment of the comparability of the water level characteristics for each site (i.e. water level and recessionary behaviour), following remediation of the impacted site, was then undertaken.



MAP 2: REFERENCE SITES AND RAINFALL STATIONS

3.2 Aquatic Ecology Assessment Methodology

Aquatic ecology monitoring, conducted by Niche, was undertaken biannually between 2019 and 2021 at the following sites (refer Map 1 and Map 2 for locations):

- remediated sites: pool 20 and pool 23 and reference site: pool 30 in Myrtle Creek; and
- remediated sites: pool RR11, pool RR19 and weir/pool 26 and reference site: pool RB33 in Redbank Creek.

The aquatic ecology survey methodology and outcomes are detailed in Niche (2021a; 2021b).

Monitoring of the aquatic ecology of remediated sites in Myrtle Creek and Redbank Creek was undertaken to assess the extent of mining related impacts and to monitor the outcomes of remediation works for restoring the ecosystem function and aquatic ecology of impacted sites.

The aquatic ecological monitoring adopted the Australian Rivers Assessment System (AUSRIVAS) method and was primarily focused on macroinvertebrate monitoring. AUSRIVAS is a rapid assessment method based on the presence or absence of invertebrates, where macroinvertebrate samples from impacted sites are assessed against modelled reference sites. The AUSRIVAS method consisted of:

- aquatic habitat assessment
- macroinvertebrate survey; and
- physicochemical water quality monitoring.

4 MYRTLE CREEK REMEDIATION PROGRESS ASSESSMENT OUTCOMES

4.1 Pool 10 and Pool 11

4.1.1 Introduction

The locations of pool 10 and pool 11 are shown in Map 1. Pool 10 is a shallow, elongated pool formed in Hawkesbury Sandstone outcrop and controlled by a shallow rockbar. Pool 11, also formed in Hawkesbury Sandstone, is an incised, elongated pool controlled by a raised rockbar. Underflow beneath the rockbar was visually observed (refer Appendix A), potentially as a result of subsidence induced fracturing of the rockbar. A summary of the geomorphological characteristics of pool 10 and pool 11, following visual inspection conducted on 18 May 2021, is presented in Appendix A.

Subsidence related impacts to pool 10 and pool 11 were initially reported following mining of LW26 which was undertaken between March 2011 and October 2012. Impacts to pool 10 and pool 11 were reported as reduced pool holding capacity (GeoTerra, 2014).

4.1.2 Summary of Remediation Works

Remediation works at pool 10 and pool 11 commenced in October 2021 and were completed in December 2021. The remediation works, as informed by the ground characterisation study (SCT, 2021) and review of groundwater and surface water monitoring data, comprised a 4 metre (m) wide shallow grout curtain (perpendicular to the direction of flow) - drilling and injection to 2 m depth, 0.5 m spacing and 38 mm diameter using Spetec H100 hydrophobic polyurethane (Tahmoor Coal, 2021).

4.1.3 Surface Water Assessment Findings

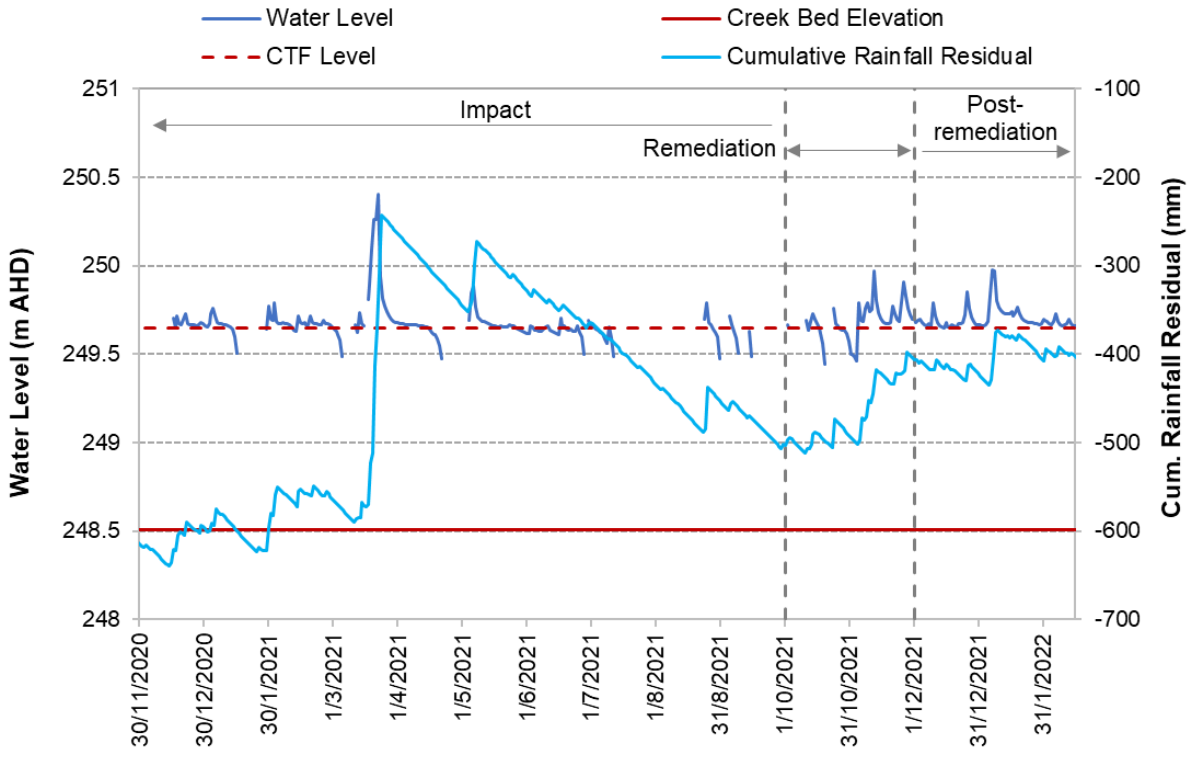
4.1.3.1 Pool 10

Water level data for pool 10 is available for the period November 2020 to February 2022. Pre-mining and/or pre-impact data was not recorded at pool 10.

Only one recession event was available for the post-remediation period and as such a recession analysis has not been conducted. Following a period of additional monitoring, with sufficient dry weather events, Method 2 was applied to assess the recessionary behaviour post-remediation in comparison to the impact period.

Graph 1 presents a graph of water level records for Myrtle Creek pool 10 in comparison with the cumulative rainfall residual[1]. The cumulative rainfall residual shown was calculated for the period March 2010 to March 2022. This period is shown as it is of notable length (more than 10 years of rainfall data) and therefore reflects variability in the rainfall record over time. Additionally, and for consistency, this period corresponds with the longest period of water level monitoring data recorded at the remediated pools.

The creek bed elevation at the base of the pool and cease to flow (CTF) level are also presented in Graph 1. Note that the CTF level refers to the point at which surface water ceases to flow over the streamflow control i.e. the lowest point on a controlling rockbar or boulder field. In the event that streamflow over the rockbar or boulder field ceases, there may still be streamflow around, through or under the rockbar / boulder field control which reports downstream of the control.



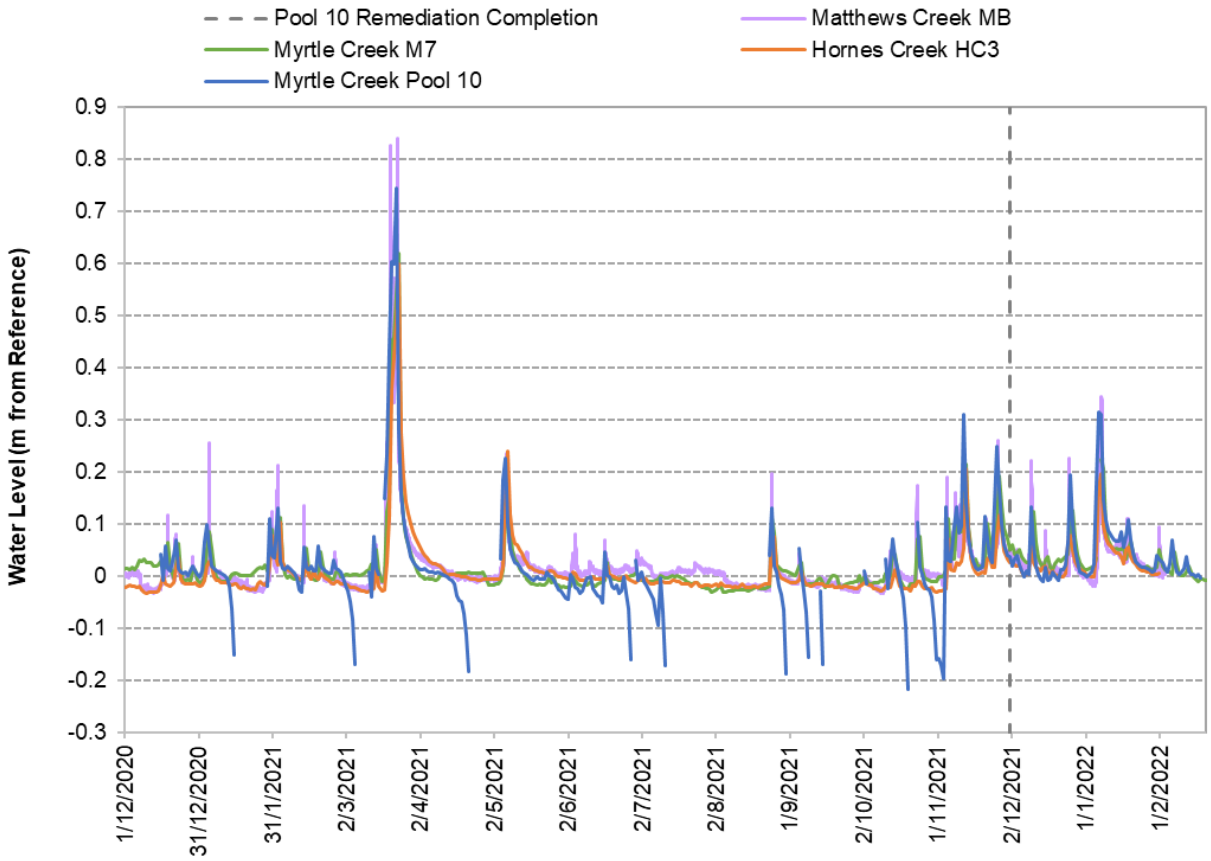
GRAPH 1: MYRTLE CREEK POOL 10 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

The data presented in Graph 1 illustrates that, prior to remediation, the water level at pool 10 regularly declined below the level of the sensor, as illustrated by gaps in the dataset. From mid-way through the remediation period to post-remediation (early November 2021 to February 2022), the water level remained continuously above the CTF level with pool 10 continuously overflowing to the downstream reach of Myrtle Creek. This period coincided with generally above average rainfall as illustrated by the increasing trend in the cumulative rainfall residual. Maintenance of the pool water level above the CTF level is considered likely due to both the remediation works and above average rainfall recorded during

[1] The cumulative rainfall residual was calculated as the cumulative deviation from the average daily rainfall where positive (upward) slope in the plot indicates periods of above average rainfall and negative (downward) slope indicates periods of below average rainfall.

this period. The data presented in Graph 1 illustrates a notable improvement in the pool water holding capacity post-remediation in comparison with the impact period.

Graph 2 presents a comparison of pool 10 water level data and reference site data for Myrtle Creek M7, Hornes Creek HC3 and Matthews Creek MB. The water level monitoring data for each pool was adjusted to a common datum to enable direct comparison of recessionary behaviour.



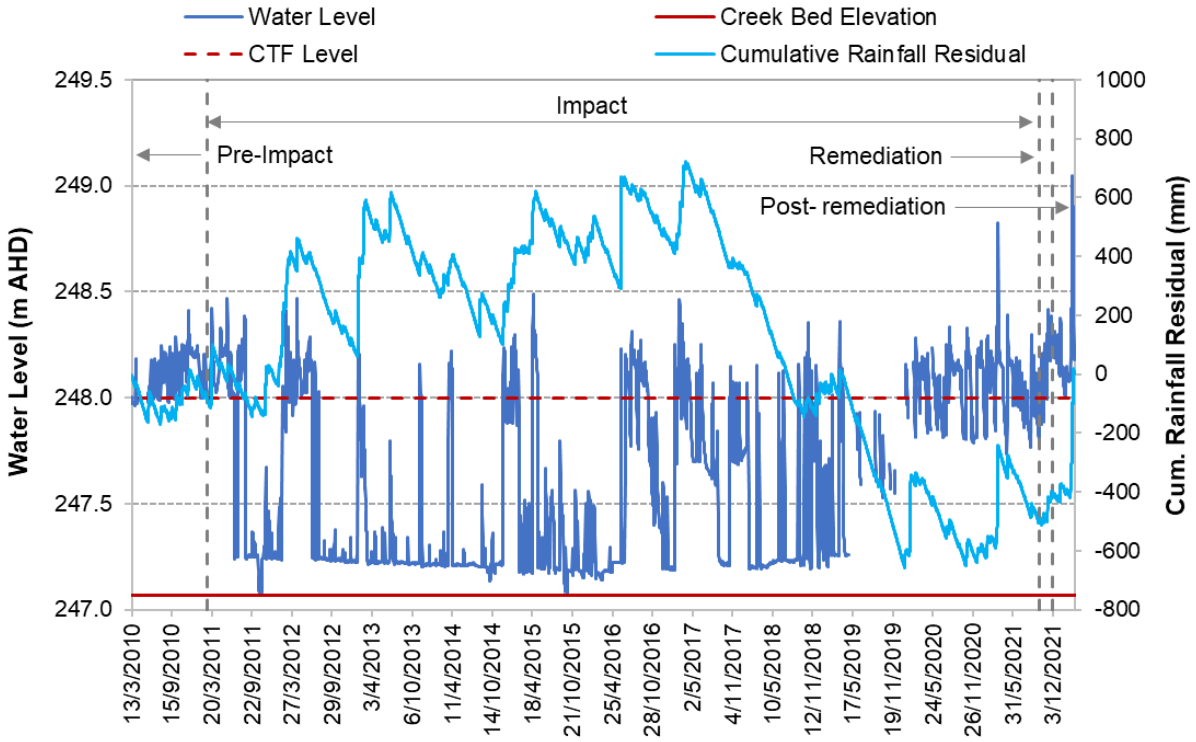
GRAPH 2: MYRTLE CREEK POOL 10 AND REFERENCE SITES - WATER LEVEL COMPARISON

The data presented in Graph 2 shows that the hydrological behaviour of reference sites Myrtle Creek M7, Hornes Creek HC3 and Matthews Creek MB were similar for the period of record although higher water levels tended to be recorded at Matthews Creek MB during rainfall events. There is an evident difference in the pre-remediation hydrological behaviour of pool 10 compared with the reference site water level behaviour. Post-remediation, the water level behaviour of pool 10 is generally consistent with that of the reference sites with similar recessionary behaviour recorded.

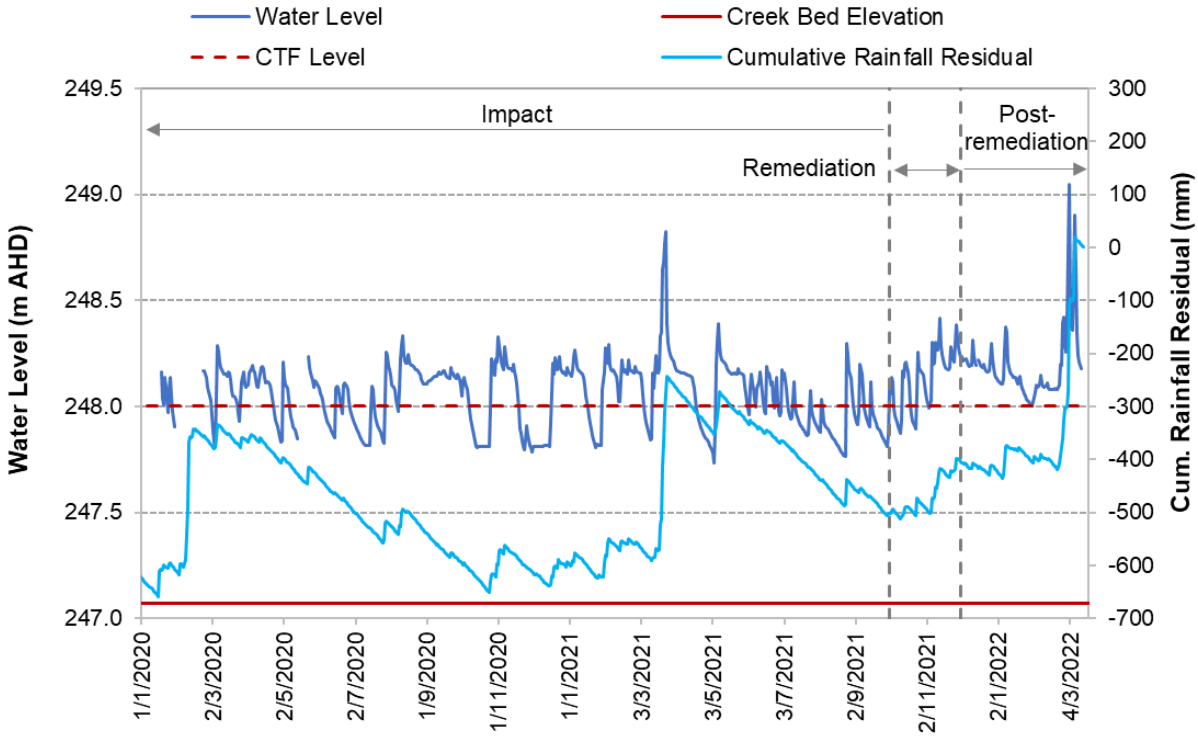
Although it is evident that there has been an improvement in the pool 10 water holding capacity post-remediation, the area has experienced above average rainfall during this period. As such, additional post-remediation monitoring data, recorded during periods of below average rainfall, is recommended to provide further confidence in the effectiveness of remediation works at pool 10.

4.1.3.2 Pool 11

Water level data for pool 11 is available for the period March 2010 to March 2022. Graph 3 (A and B) presents the water level records for Myrtle Creek pool 10 in comparison with the cumulative rainfall residual, the creek bed elevation at the base of the pool and CTF level.



GRAPH 3A: MYRTLE CREEK POOL 11 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2010 TO 2022



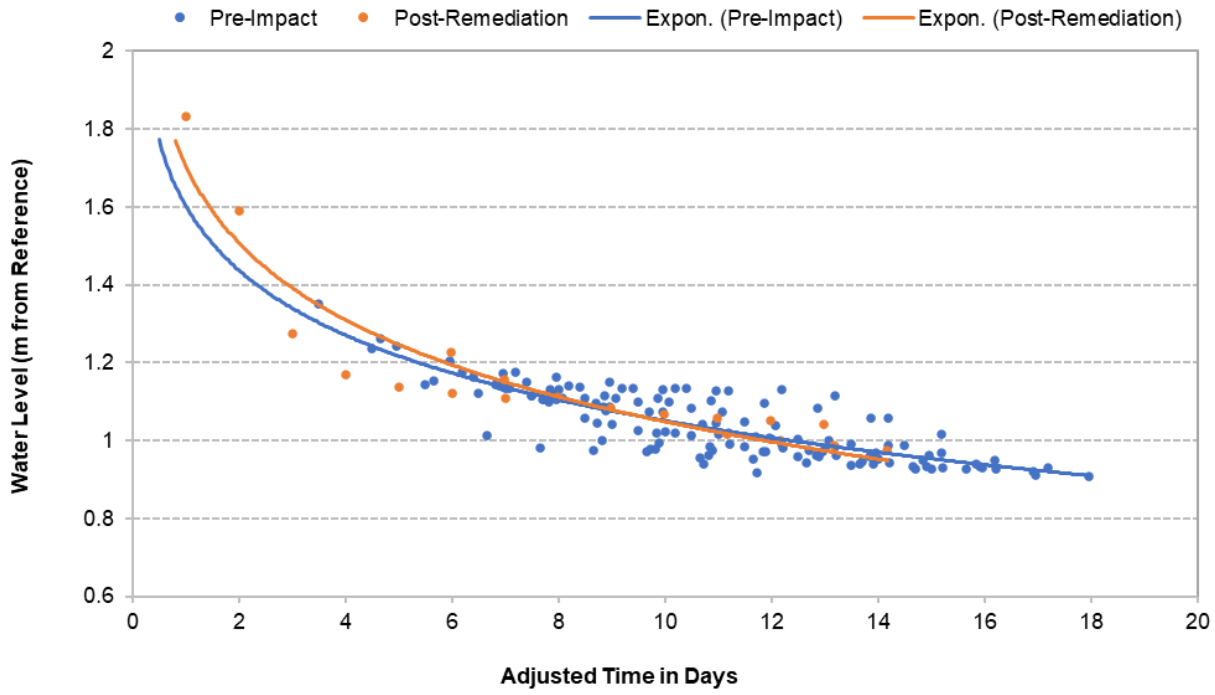
GRAPH 3B: MYRTLE CREEK POOL 11 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2020 TO 2022

Impacts to pool 11 were reported as occurring during mining of LW26 (March 2011 to October 2012) (GeoTerra, 2019), however, the exact date of initial impact was not recorded. During the pre-impact period prior to March 2011, the water level trended was recorded above the CTF level. Following impacts, the water level regularly and rapidly declined to a level close to the pool base. Following

substantial rainfall in early 2020, the water level rose and remained elevated although declines in the water level were regularly recorded. From early 2020 to December 2021, the minimum water level recorded was 247.76 m AHD. Post-remediation, the water level has been maintained above the CTF level (248 m AHD), consistent with that recorded during the pre-impact period. It is noted that above average rainfall was recorded during this period and, as such, maintenance of the minimum water level above 248 m AHD is considered likely due to both the remediation works and above average rainfall recorded during this period.

Method 1 has been applied to preliminarily assess the water level recessionary behaviour for the pre-impact and post-remediation periods. Seventeen (17) dry weather events were assessed for the pre-impact period and three events for the post-remediation period. Note that data recorded during the period of remediation works was excluded from the assessment.

Graph 4 presents the pre-impact and post-remediation period water level records against the adjusted time in days to produce a single recession curve for each period (refer Section 3). The exponential trendline fitted to each dataset is also presented.



GRAPH 4: MYRTLE CREEK POOL 11 – METHOD 1 RECESSION CURVE COMPARISON

Graph 4 shows that the post-remediation exponential curve is generally consistent with that of the pre-impact exponential curve indicating that the water level has declined at a similar rate post-remediation to that of the pre-impact period. The outcomes of the Method 1 preliminary assessment indicate that remediation works have been effective at pool 11. It is noted, however, that only three post-remediation events were available for analysis and above average rainfall was recorded during the post-remediation period. As such, additional post-remediation monitoring data, recorded during periods of below average rainfall, is recommended to provide further confidence in the effectiveness of remediation works at pool 11.

4.2 Pool 18

4.2.1 Introduction

As shown in Map 1, pool 18 in Myrtle Creek is situated above the eastern edge of LW27. The pool is formed in Hawkesbury Sandstone outcrop and is controlled by a rockshelf extending across the width

of the pool. A summary of the geomorphological characteristics of pool 18, following visual inspection conducted on 18 May 2021, is presented in Appendix A.

LW27 was mined between November 2012 and March 2013, however, impacts to pool 18, comprising fracturing and reduced water holding capacity, were reported as occurring during mining of LW26 (March 2011 to October 2012) (GeoTerra, 2014).

4.2.2 Summary of Remediation Works

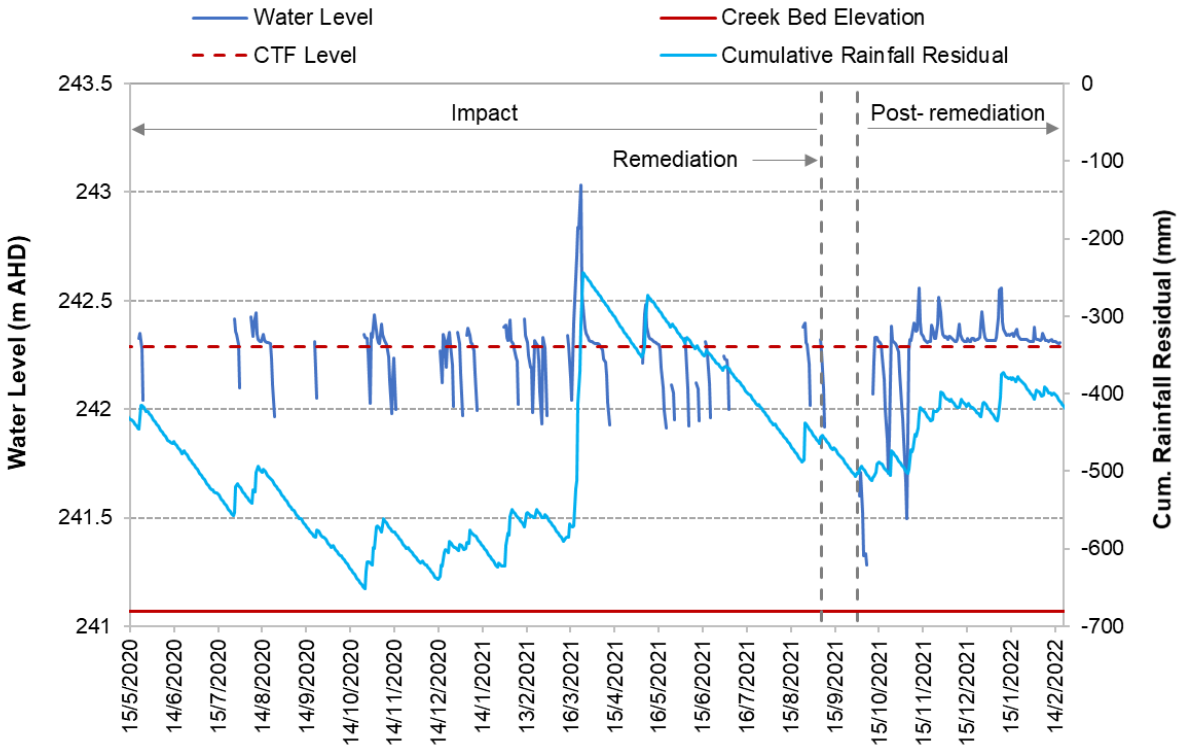
Remediation works at pool 18 commenced on 6 September 2021 and were completed on 1 October 2021. The remediation works, as informed by the ground characterisation study (SCT, 2021) and review of groundwater and surface water monitoring data, were conducted in two stages as follows (Tahmoor Coal, 2021):

1. Stage 1 – 6 metre (m) wide shallow grout curtain (perpendicular to the direction of flow): drilling and injection to 2 m depth, 0.5 m spacing and 38 mm diameter using Spetec H100 hydrophobic polyurethane.
2. Stage 2 – 32 m wide grout curtain to 6 m depth (perpendicular to the direction of flow): drilling of 17 holes (2 m spacing and 76 mm diameter) from 0 m to 6 m depth and injection with Spetec H100 hydrophobic polyurethane.

4.2.3 Surface Water Assessment Findings

Water level data for pool 18 is available for the period May 2020 to February 2022. No pre-mining data is available for pool 18. Graph 5 presents a graph of water level records for Myrtle Creek pool 18 in comparison with the cumulative rainfall residual. The cumulative rainfall residual shown was calculated for the period March 2010 to March 2022.

It should be noted that the water level sensor was relocated to a deeper part of the pool on 30 September 2021 (0.66 m deeper than previous) and hence lower water levels were subsequently recorded. Additionally, on 8 October 2021 a recession test was conducted at pool 18, following the completion of the remediation works, in which 26,000 litres (L) of water was added to the pool and the water level recorded.



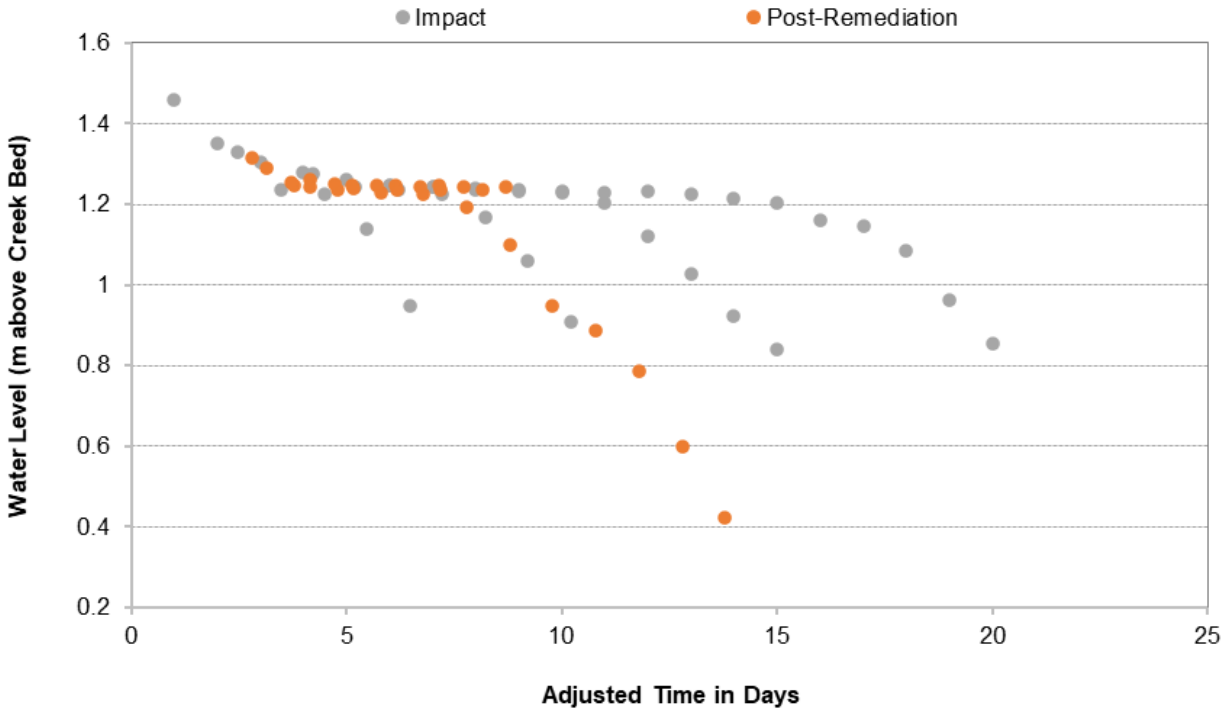
GRAPH 5: MYRTLE CREEK POOL 18 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

The data presented in Graph 5 illustrates that, prior to remediation, the water level recorded at pool 18 in Myrtle Creek regularly declined below the level of sensor, as indicated by gaps in the dataset. Following the recession test on 8 October 2021, two rapid declines in water level were recorded prior to early November 2021. As stated in Appendix A, there is notable sediment, gravel and boulder deposition in the base of pool 18. It is likely that, immediately following remediation, the moisture content of the hyporheic zone beneath the pool base was low thereby causing the higher infiltration rates.

During and following rainfall events from early November 2021, the water level remained elevated and rapid declines in water level were not recorded. It is presumed that the hyporheic zone was saturated during this period and hence infiltration rates declined. This period coincides with a period of generally above average rainfall as illustrated by the increasing trend in the cumulative rainfall residual. From mid-November 2021, the water level has been maintained continuously above the CTF level with pool 18 continuously overflowing to the downstream reach of Myrtle Creek. Maintenance of the pool water level above the CTF level is considered likely due to both the remediation works and above average rainfall recorded during this period.

In the absence of pre-mining and/or pre-impact monitoring data, Method 2 was adopted for preliminary assessment of the effectiveness of remediation works at pool 18 in Myrtle Creek.

Graph 6 presents a plot of the water level (above the creek bed elevation) for the impact and post-remediation period dry weather events against the adjusted time in days to produce a single recession curve for each dataset. Four dry weather events are plotted for the impact period and three for the post-remediation period.



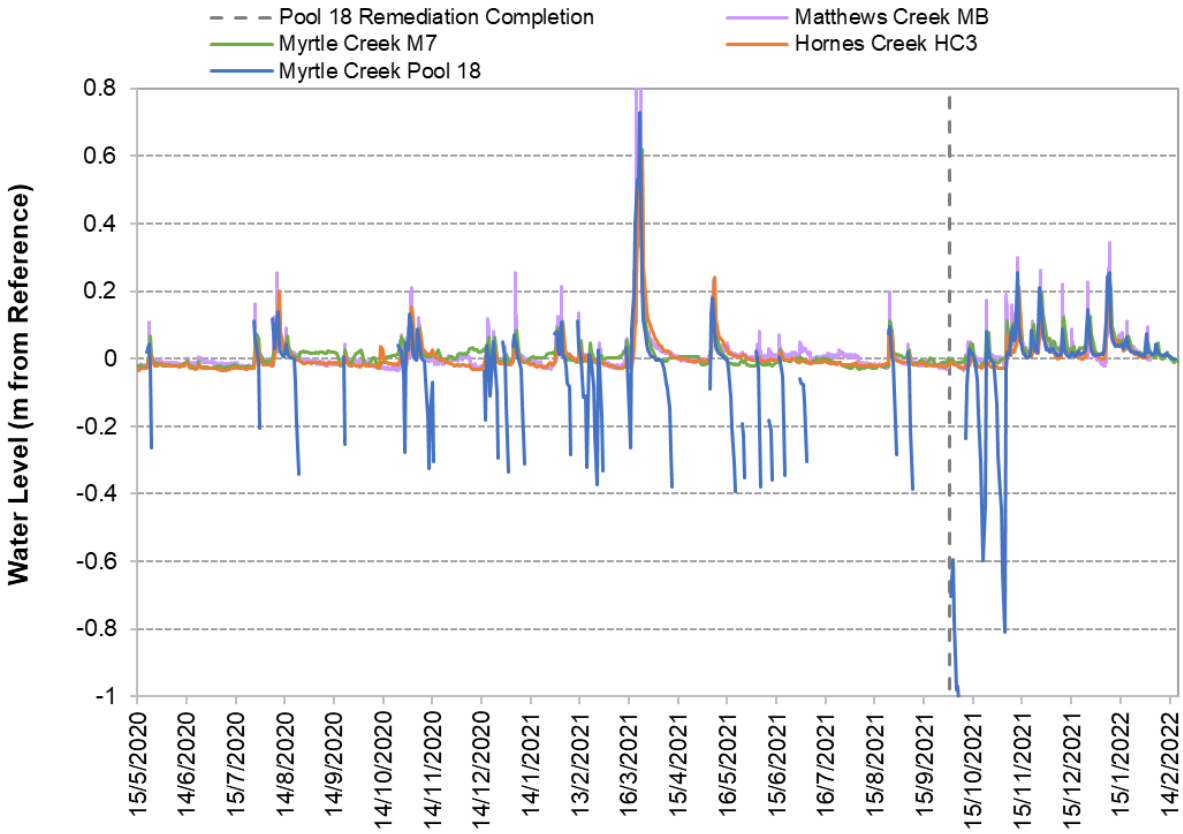
GRAPH 6: MYRTLE CREEK POOL 18 – METHOD 2 RECESSION CURVE COMPARISON

The data presented in Graph 6 indicates that the post-remediation water level has generally declined at a similar rate to the impact period water level. However, it should be noted that two of the recession events are reflective of the rapid declines that occurred during the inferred saturation of the hyporheic zone. Additionally, as the sensor was located at a higher level during the impact period, the impact period recessionary behaviour below 0.8 m depth is unknown.

Graph 7 presents a comparison of pool 18 water level data and reference site data for Myrtle Creek M7, Hornes Creek HC3 and Matthews Creek MB.

The data presented in Graph 7 shows an evident difference in the hydrological behaviour of pool 18 pre-remediation and immediately following remediation completion in comparison to the reference site water level behaviour. However, from mid-November 2021 to February 2022, coinciding with a period of above average rainfall, the water level behaviour of pool 18 was generally consistent with that of the reference sites.

The outcomes of the Method 2 assessment indicate that there has been an improvement in the pool 18 water holding capacity post-remediation, however, the area has experienced above average rainfall during this period. As such, additional post-remediation monitoring data, recorded during periods of below average rainfall, is recommended to provide further confidence in the effectiveness of remediation works at pool 18.



GRAPH 7: MYRTLE CREEK POOL 18 AND REFERENCE SITES - WATER LEVEL COMPARISON

4.3 Pool 20

4.3.1 Introduction

As shown in Map 1, pool 20 in Myrtle Creek is situated above the western edge of LW28. Pool 20 is a large, elongated pool formed in Hawkesbury Sandstone and controlled by a raised rockbar extending across the width of the pool. A summary of the geomorphological characteristics of pool 20, following visual inspection conducted on 18 May 2021, is presented in Appendix A.

LW28 was mined between April 2014 and May 2015, however, impacts to pool 20, comprising fracturing and reduced water holding capacity, were initially reported to have occurred during mining of LW27 between November 2012 and March 2014 (GeoTerra, 2015).

4.3.2 Summary of Remediation Works

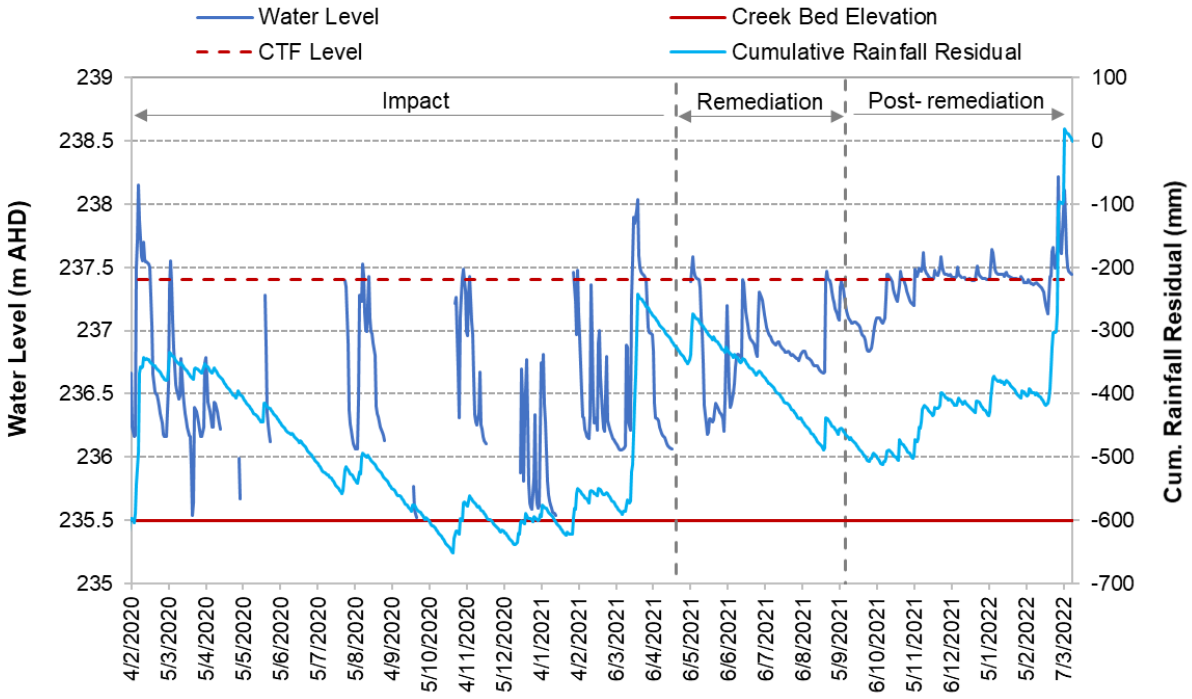
Remediation works at pool 20 commenced in April 2021 and were completed on 10 September 2021. Informed by the ground characterisation study (SCT, 2021) and review of groundwater and surface water monitoring data, the remediation works were conducted in four stages as follows (Tahmoor Coal, 2021):

1. Stage 1 – 6 metre (m) wide shallow grout curtain (perpendicular to the direction of flow): drilling and injection to 2 m depth, 0.5 m spacing and 38 mm diameter using Spetec H100 hydrophobic polyurethane.
2. Stage 2 – 50 m wide grout curtain to 5 m depth (perpendicular to the direction of flow): drilling of 26 holes (2 m spacing and 76 mm diameter) from 0 m to 5 m depth and injection with Spetec H100 hydrophobic polyurethane.

3. Stage 3 - 50 m wide grout curtain to 10 m depth (perpendicular to the direction of flow): drilling of 20 holes (2 m spacing and 76 mm diameter) from 5 m to 10 m depth and injection with Spetec H100 hydrophobic polyurethane.
4. Stage 4 - 50 m wide grout curtain to 15 m depth (perpendicular to the direction of flow): drilling of 20 holes (2 m spacing and 76 mm diameter) from 10 m to 15 m depth and injection with Spetec H100 hydrophobic polyurethane.

4.3.3 Surface Water Assessment Findings

Water level data for pool 20 in Myrtle Creek, recorded at monitoring site M20 (refer Map 1) is available for the period February 2020 to mid-March 2022. No pre-mining and/or pre-impact data is available for pool 20. Graph 8 presents a graph of water level records for pool 20 in comparison with the cumulative rainfall residual. The cumulative rainfall residual shown was calculated for the period March 2010 to March 2022. This period is shown as it is of notable length (more than 10 years of rainfall data) and therefore reflects variability in the rainfall record over time. Additionally, and for consistency, this period corresponds with the longest period of water level monitoring data recorded at the remediated pools.



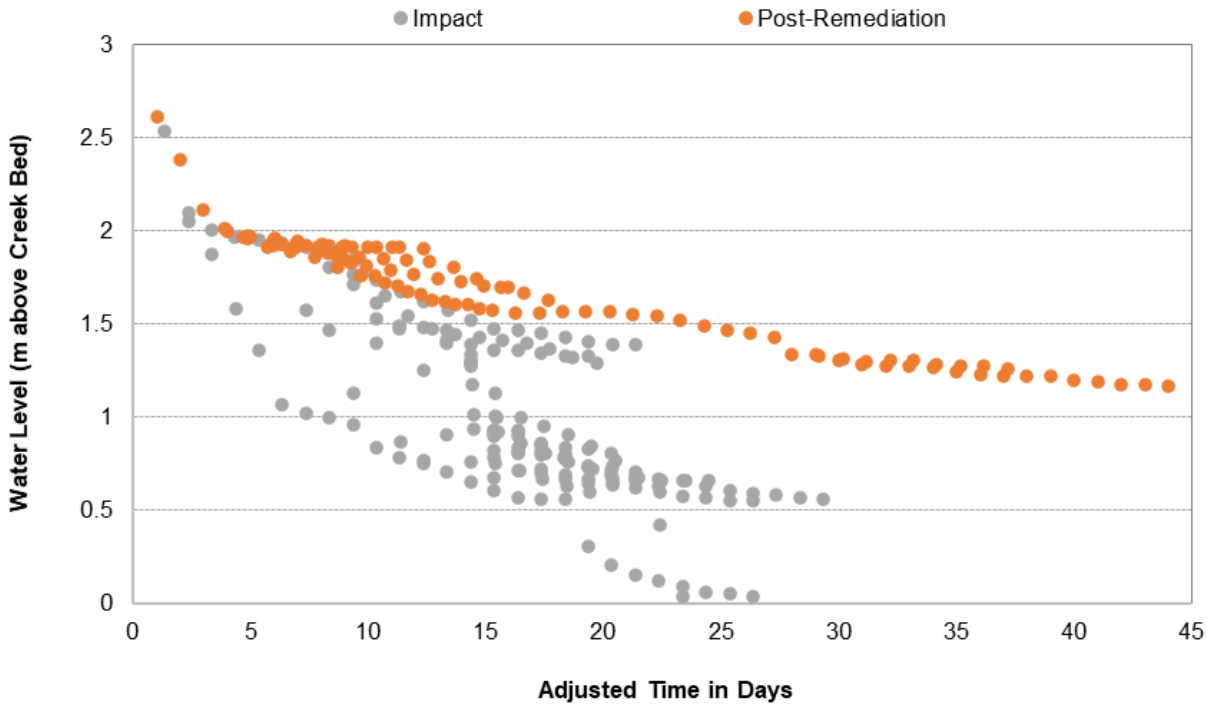
GRAPH 8: MYRTLE CREEK POOL 20 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

The data presented in Graph 8 illustrates that, prior to remediation, the water level recorded at pool 20 in Myrtle Creek regularly declined below the sensor level, as indicated by gaps in the dataset. During the remediation period, the water level remained above the level of the sensor despite a decline in the cumulative rainfall residual recorded during this period. For approximately two months post-remediation completion, the water level of pool 20 remained elevated although below the CTF level. It is noted that pool 20 is a large pool (refer Appendix A). As such, a reasonable period of above average rainfall would be required to fill the pool to the CTF level. From early November 2021, the water level remained above the CTF level with the exception of a short period in late February 2022.

In the absence of pre-mining and/or pre-impact monitoring data, Method 2 was adopted for assessment of the effectiveness of remediation works at pool 20 in Myrtle Creek.

Graph 9 presents a plot of the water level (relative to the creek bed) for the impact and post-remediation period dry weather events against the adjusted time in days to produce a single recession curve for

each dataset. Eighteen (18) dry weather events are plotted for the impact period and ten (10) for the post-remediation period.



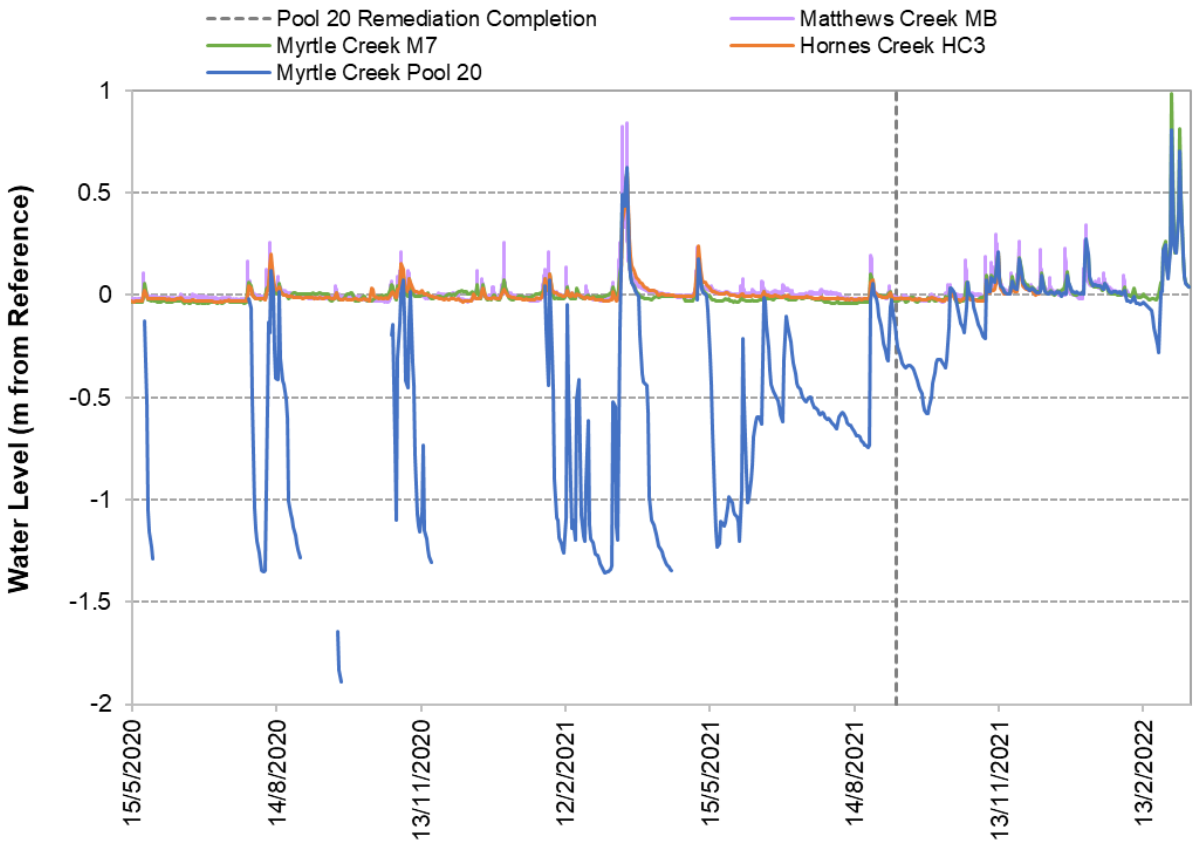
GRAPH 9: MYRTLE CREEK POOL 20 – METHOD 2 RECESSION CURVE COMPARISON

The data plotted in Graph 9 indicates that, during periods of low rainfall, the water level recorded at pool 20 post-remediation has remained at a higher level than that during the impact period and declined at a notably slower rate.

Graph 10 presents a comparison of pool 20 water level data and reference site data for Myrtle Creek M7, Hornes Creek HC3 and Matthews Creek MB.

The data presented in Graph 10 shows an evident difference in the hydrological behaviour of pool 20 pre-remediation in comparison to the reference site water level behaviour. From early November 2021 to March 2022, post-remediation and coinciding with a period of above average rainfall, the water level recessionary behaviour of pool 20 was generally consistent with that of the reference sites.

The outcomes of the Method 2 assessment indicate that there has been a notable improvement in the pool 20 water holding capacity post-remediation. As the area experienced above average rainfall during this period, it is recommended that additional post-remediation monitoring data is recorded during periods of below average rainfall to provide further confidence in the effectiveness of remediation works at pool 20.



GRAPH 10: MYRTLE CREEK POOL 20 AND REFERENCE SITES - WATER LEVEL COMPARISON

4.3.4 Aquatic Ecology Assessment Findings

The following summarises the outcomes of the aquatic ecology survey conducted in September 2021 at pool 20 and pool 30 (reference site), as detailed in Niche (2021a).

During the September 2021 survey, the reference site in Myrtle Creek (pool 30) scored in Band C indicating severely impaired conditions at a site in Myrtle Creek which has not been impacted by subsidence. This compared with a Band B score for the previous six survey events. Niche (2021a) note that the fluctuation in scores over seasons was likely related to natural variation in streamflow which resulted in altering of the aquatic habitat condition and availability, in addition to sampling variability inherent in the survey method.

During the September 2021 survey, pool 20 comprised of a shallow pool dominated by bedrock habitat. No macrophytes were observed in pool 20.

Monitoring results indicated that the water quality of pool 20 was generally consistent with other sites monitored in Myrtle Creek with the exception of pH, electrical conductivity and dissolved oxygen for which lower values were recorded at pool 20.

Based on the AUSRIVAS results, pool 20 scored in Band D which indicates an extremely impaired condition with only six different taxa observed. Pool 20 scored the lowest biotic index grade indicating the dominance of pollution tolerant macroinvertebrates and the presence of few pollution sensitive taxa.

Pool 20 recorded lower stream health results in comparison to other monitoring sites within Myrtle Creek. Niche (2021a) note that this may be indicative of a lag in recovery following remediation and the shallow nature of the pool. It is noted that the aquatic ecology survey was conducted immediately following completion of remediation works and, as such, the survey results do not represent a sufficient period of time for recovery of aquatic habitat at pool 20.

4.4 Pool 23

4.4.1 Introduction

As shown in Map 1, pool 23 in Myrtle Creek is situated above the eastern edge of LW28. The pool is formed in Hawkesbury Sandstone outcrop and is controlled by a raised rockbar extending across the width of the pool. A summary of the geomorphological characteristics of pool 23, following visual inspection conducted on 18 May 2021, is presented in Appendix A.

LW28 was mined between April 2014 and May 2015, however, impacts to pool 23, comprising fracturing of the rockbar control and reduced water holding capacity, were initially reported in April 2013 during mining of LW27 (GeoTerra, 2019b).

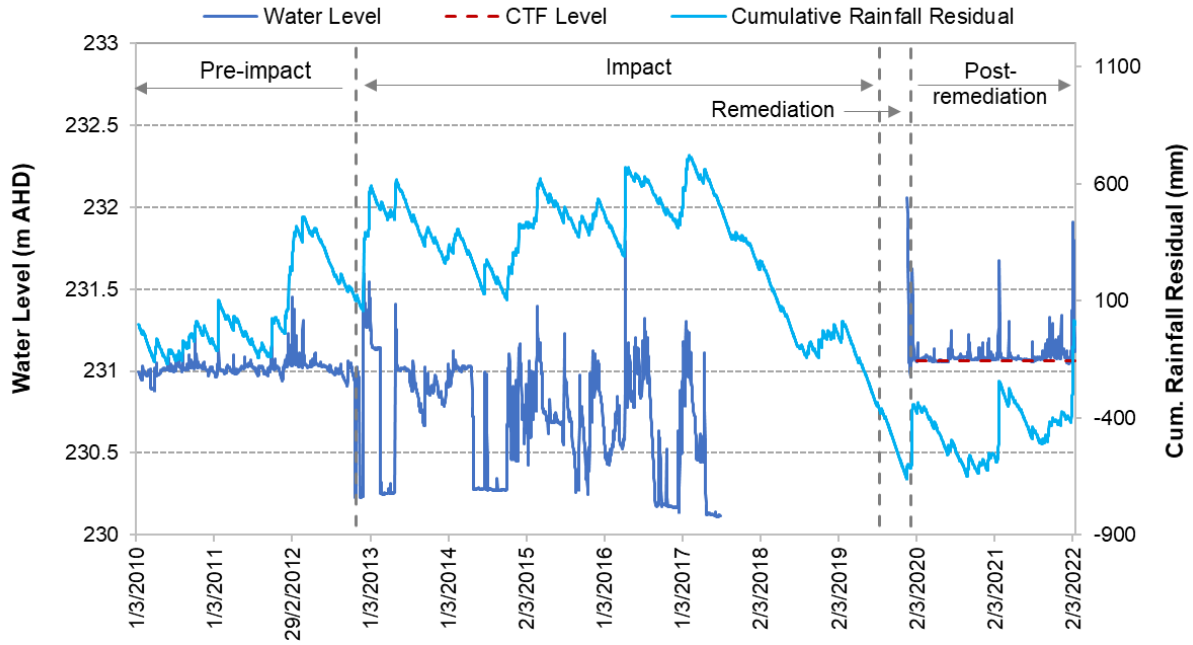
4.4.2 Summary of Remediation Works

Remediation works at pool 23 commenced in September 2019 and were completed in February 2020. The remediation works were conducted in four stages as follows (Pointe, 2020a):

1. Stage 1 – 44 m wide grout wall (perpendicular to the direction of flow): drilling of 10 holes (4 m spacing and 76 mm diameter) to a depth of 17 m below the rockbar and injection with Spetec H100 hydrophobic polyurethane.
2. Stage 2 – curtain infill injection to 2 m (perpendicular to the direction of flow): drilling of 20 holes (0.5 m spacing and 38 mm diameter) from 0 m to 2 m depth and injection with Spetec H100 hydrophobic polyurethane.
3. Stage 3 – drill and injection grid in the base of pool 23 – drilling of 37 holes (38 mm diameter) in a 14 m x 12 m grid with nodes at 2 m centres to a depth of 1 m and injection with Spetec H100 hydrophobic polyurethane; and
4. Stage 4 – curtain infill injection to 7 m (perpendicular to the direction of flow): drilling of 7 holes (76 mm diameter) from 2 to 7 m below the rockbar and injection with Spetec H100 hydrophobic polyurethane.

4.4.3 Surface Water Assessment Findings

Water level data for pool 23 in Myrtle Creek, recorded at sensor M5 (refer Map 1), is available for the period March 2010 to August 2018 and January 2020 to mid-March 2022. Graph 11 presents a graph of water level records for pool 23 in comparison with the cumulative rainfall residual. The CTF level is also presented however an accurate creek bed elevation is not available.



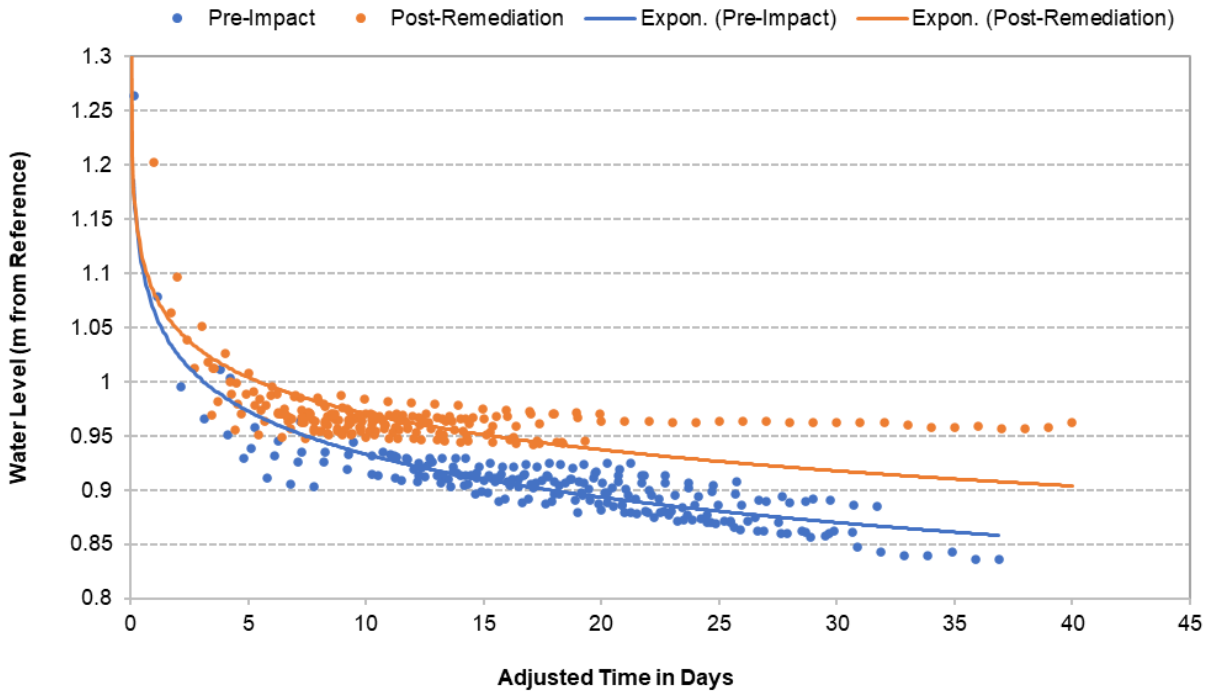
GRAPH 11: MYRTLE CREEK POOL 23 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

The data in Graph 11 shows a notable change in the water level and water level recessionary behaviour of pool 23 following subsidence impacts. Pre-impact, the water level was maintained above 230.9 m AHD. During the impact period, the water level declined below the level of the sensor on a number of occasions. Following remediation works, the pool water level has been recorded continuously above 231 m AHD, and above the CTF level, for 2 years.

During the pre-impact period the water level trended around 231 m AHD, while post-remediation, the minimum water level recorded was 231.1 m AHD. Given the slight difference in the pre-impact and post-remediation water levels, there is potential that a minor datum shift has occurred or that upsidence has resulted in a slight increase in the height of the controlling rockbar.

Method 1 has been applied to assess the water level recessionary behaviour for the pre-impact and post-remediation periods. Twenty-two (22) dry weather events were assessed for the pre-impact period and 18 events for the post-remediation period. Note that data recorded during the period of remediation works was excluded from the assessment.

Graph 12 presents the pre-impact and post-remediation period water level records against the adjusted time in days to produce a single recession curve for each period (refer Section 3). The exponential trendline fitted to each dataset is also presented.



GRAPH 12: MYRTLE CREEK POOL 23 – METHOD 1 RECESSION CURVE COMPARISON

Graph 12 shows that the post-remediation exponential curve is plotted above and is less steep than the pre-impact exponential curve indicating that the water level has declined at a slower rate post-remediation than was recorded pre-impact. This difference may be slightly over-exaggerated due to the potential datum shift, however, if the datum was adjusted, the post-remediation data would still indicate a reduction in the recession rate post-remediation. The results of the recession analysis indicate that the remediation works at pool 23 in Myrtle Creek have been effective in returning the pool water holding capacity to or better than pre-impact conditions.

4.4.4 Aquatic Ecology Assessment Findings

The following summarises the outcomes of the aquatic ecology surveys conducted between May 2019 and September 2021 at pool 23 and pool 30 (reference site), as detailed in Niche (2021a).

Pool 23 was dry in May and September 2019 prior to remediation works and was overflowing on all other survey occasions.

Monitoring results indicated that the water quality of pool 23 was similar on all survey occasions and was generally consistent with the water quality of the reference site in Myrtle Creek (pool 30 which has not been directly impacted by subsidence).

In May 2020, following remediation works, pool 23 scored in Band A based on the AUSRIVAS results indicating that the number of invertebrate families observed at pool 23 was considered similar to reference conditions. Between September 2020 and September 2021, pool 23 scored in Band B indicating that fewer invertebrate families were observed than was expected. However, the reference site in Myrtle Creek (pool 30) scored in Band B and Band C during this period indicating significantly to severely impaired conditions at a site in Myrtle Creek which has not been directly impacted by subsidence.

Pool 23 also scored higher than the reference site based on the survey results for habitat quality and ecosystem health.

Following remediation works, pool 23 has continued to provide aquatic habitat with the survey results indicating a recovery in stream health at this location.

5 REDBANK CREEK REMEDIATION PROGRESS ASSESSMENT OUTCOMES

5.1 Pool RB6

5.1.1 Introduction

As shown in Map 1, pool RB6 in Redbank Creek is situated above the maingate of LW29. The stream reach defined as pool RB6 is comprised of a series of pools formed in Hawkesbury Sandstone with notable sediment deposition and is rockbar controlled. A summary of the geomorphological characteristics of pool RB6, following visual inspection conducted on 20 May 2021, is presented in Appendix B.

LW29 was mined between May 2015 and April 2016, with fracturing of rock shelves and reduced pool holding capacity reported in GeoTerra (2016).

5.1.2 Summary of Remediation Works

Remediation works at pool RB6 commenced in July 2021 and were completed on 21 December 2021. Informed by the ground characterisation study (SCT, 2019) and review of groundwater monitoring data, the remediation works were conducted in four stages as follows (Tahmoor Coal, 2021):

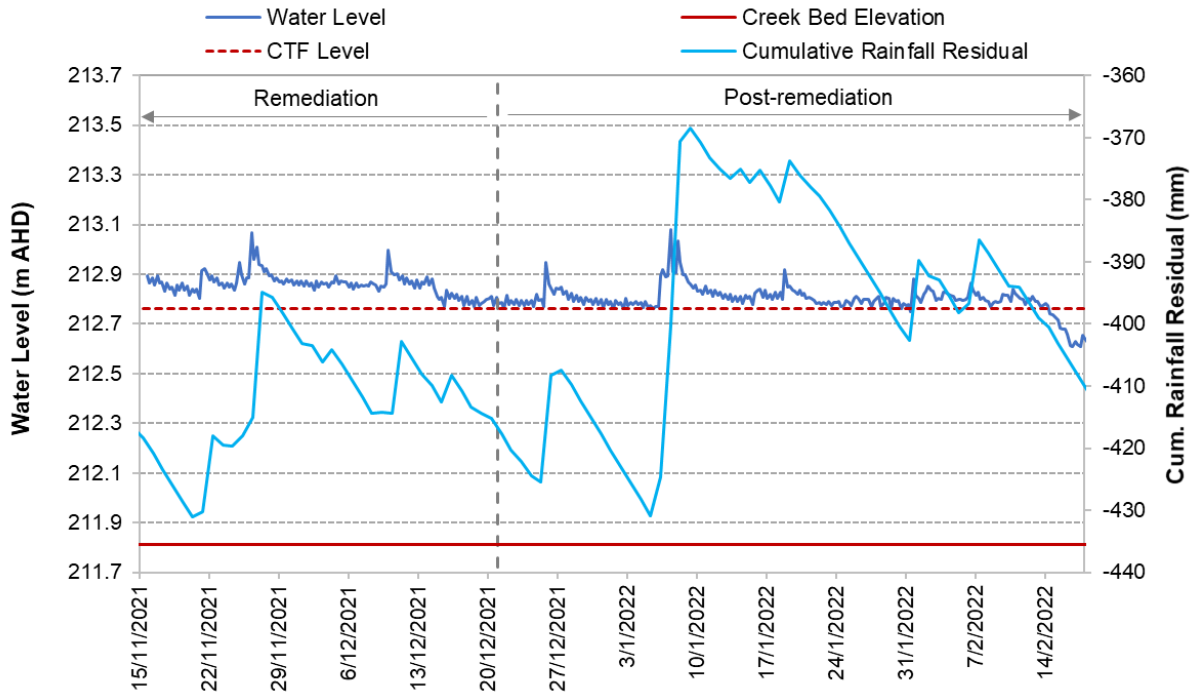
1. Stage 1 – 12 metre (m) wide shallow grout curtain (perpendicular to the direction of flow): drilling and injection to 2 m depth, 0.5 m spacing and 38 mm diameter using Spetec H100 hydrophobic polyurethane.
2. Stage 2 – 50 m wide grout curtain to 6 m depth (perpendicular to the direction of flow): drilling and injection from 0 m to 6 m depth, 2 m spacing and 76 mm diameter using Spetec H100 hydrophobic polyurethane.
3. Stage 3 - 50 m wide grout curtain to 12 m depth (perpendicular to the direction of flow): drilling and injection from 6 m to 12 m depth, 2 m spacing and 76 mm diameter using Spetec H100 hydrophobic polyurethane.
4. Stage 5 - 50 m wide grout curtain to 18 m depth (perpendicular to the direction of flow): drilling and injection from 12 m to 18 m depth, 2 m spacing and 76 mm diameter using Spetec H100 hydrophobic polyurethane.

5.1.3 Surface Water Assessment Findings

Visual inspections of pool RB6 were conducted weekly between December 2014 and March 2017. Prior to impact, pool RB6 was reported as holding water on all inspection occasions. Pool RB6 was initially reported as fractured in March 2016 although continued to hold water until January 2017. From January to March 2017, pool RB6 was reported as dry on nine of 10 inspection occasions (GeoTerra, 2019a). It is noted that the period January to March 2017 comprised the commencement of a drought (BoM, 2022).

Visual inspections of pool RB6 recommenced in 2021, prior to remediation works, and identified that the pool was dry majority of the time and only retained water after notable rainfall occurring over a 24 to 48 hour period (refer Appendix B for May 2021 photographs).

Water level data for pool RB6 in Redbank Creek is available for the period November 2021 to February 2022 which includes a portion of the remediation period and the post-remediation period. Graph 13 presents a graph of water level records for pool RB6 in comparison with the cumulative rainfall residual. The cumulative rainfall residual shown was calculated for the period March 2010 to March 2022. This period is shown as it is of notable length (more than 10 years of rainfall data) and therefore reflects variability in the rainfall record over time. Additionally, and for consistency, this period corresponds with the longest period of water level monitoring data recorded at the remediated pools.



GRAPH 13: REDBANK CREEK POOL RB6 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

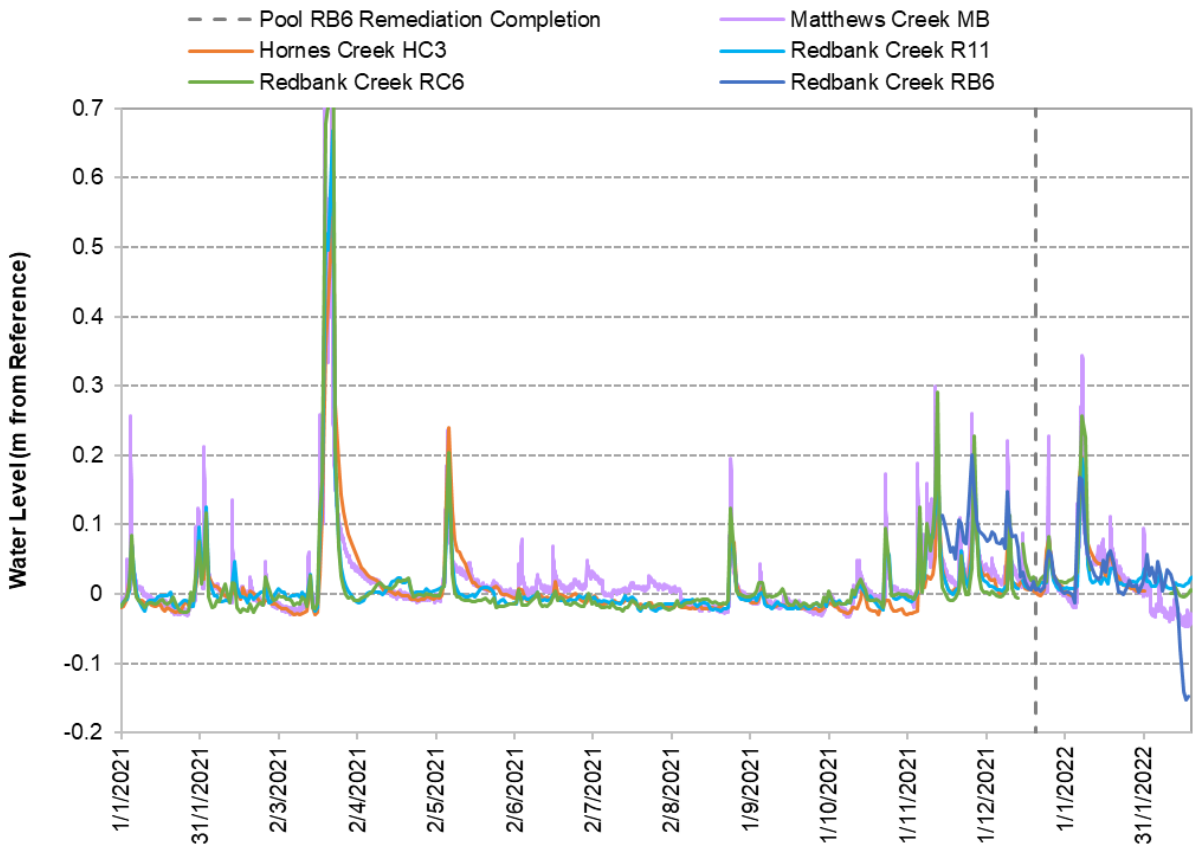
The data presented in Graph 13 shows that, during the remediation period and post-remediation, the pool water holding capacity recovered. This illustrates an evident improvement in pool RB6 water level following the completion of Stage 3 remediation works, in comparison with the visual inspection records for the impact period. The water level has been maintained above the CTF level for the majority of the monitoring period with the exception of a slight decline in water level of approximately 200 mm recorded from mid-February 2022 corresponding with a decline in the cumulative rainfall residual.

As water level monitoring data is not available for the pre-mining or impact periods, recession analysis has not been undertaken at this stage. Following a further period of monitoring in which sufficient dry weather events are available for analysis, the recessionary behaviour of pool RB6 will be compared to that of reference sites to aid in assessment of the effectiveness of remediation works at pool RB6.

Graph 14 presents a comparison of pool RB6 water level data and reference site data for Redbank Creek RC6, Redbank Creek R11, Hornes Creek HC3 and Matthews Creek MB from January 2021 to February 2022.

The data presented in Graph 14 shows that the water level recessionary behaviour of pool RB6 was generally consistent with that of the reference sites from mid-December 2021 to early February 2022. In mid-February 2022, a slight decline in water level was recorded at pool RB6 which was inconsistent in extent to that recorded at monitoring sites RC6 and R11 in Redbank Creek and somewhat inconsistent with the decline in water level recorded at Matthews Creek MB.

As only three months of monitoring data has been recorded post-remediation, additional post-remediation monitoring data is recommended to enable further assessment of the effectiveness of remediation works at pool RB6 in Redbank Creek.



GRAPH 14: REDBANK CREEK POOL RB6 AND REFERENCE SITES - WATER LEVEL COMPARISON

5.2 Pool RR11

5.2.1 Introduction

As shown in Map 1, pool RR11 in Redbank Creek is situated above LW30. The pool is formed in Hawkesbury Sandstone and is rockshelf controlled. A summary of the geomorphological characteristics of pool R11, following visual inspection conducted on 19 May 2021, is presented in Appendix B.

LW30 was mined between June 2016 and May 2017, with fracturing at pool RR11 and reduced pool holding capacity initially reported to have occurred in January 2016 during mining of LW29 (GeoTerra, 2016).

5.2.2 Summary of Remediation Works

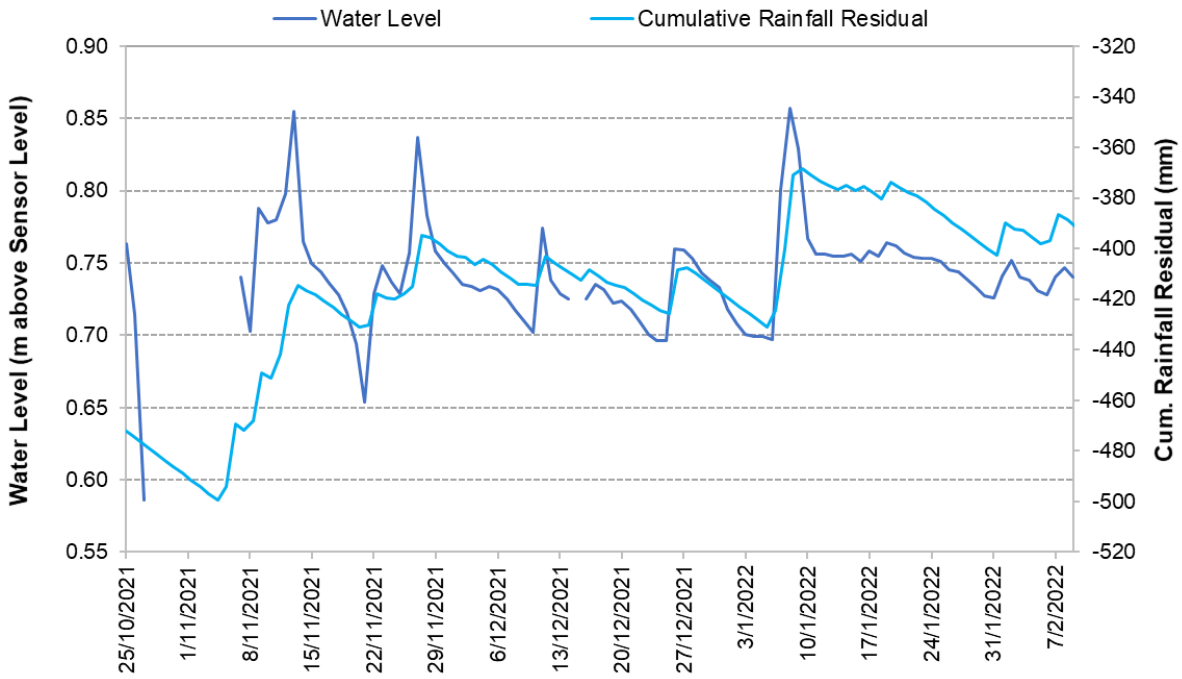
Remediation works at pool RR11 commenced in February 2020 and were completed in April 2020. Informed by the ground characterisation study (SCT, 2019) and review of groundwater monitoring data, the remediation works were conducted in one stage comprising of a 16 m wide grout wall (perpendicular to the direction of flow): drilling of 29 holes (0.5m spacing and 38 mm diameter) to a depth of 2 m and injection with Spetec H100 hydrophobic polyurethane (Pointe, 2020b).

5.2.3 Surface Water Assessment Findings

Visual inspections of pool RR11 were conducted weekly between December 2015 and September 2018. Prior to impact, pool RR11 was reported as holding water on all inspection occasions. Pool RR11 was initially reported as fractured in January 2016 although continued to hold water until January 2017. From

January 2017 to September 2018, pool RR11 was reported as dry on 25 of 27 inspection occasions (GeoTerra, 2019a). It is noted that the period of January 2017 to September 2018 has been classified as a drought (BoM, 2022).

Water level data for pool RR11 in Redbank Creek is available for the period October 2021 to February 2022, post-remediation. Graph 15 presents a graph of water level records for pool RR11 in comparison with the cumulative rainfall residual. An accurate CTF level and creek bed elevation is not available for pool RR11. The cumulative rainfall residual shown was calculated for the period March 2010 to March 2022. This period is shown as it is of notable length (more than 10 years of rainfall data) and therefore reflects variability in the rainfall record over time. Additionally, and for consistency, this period corresponds with the longest period of water level monitoring data recorded at the remediated pools.



GRAPH 15: REDBANK CREEK POOL RR11 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL

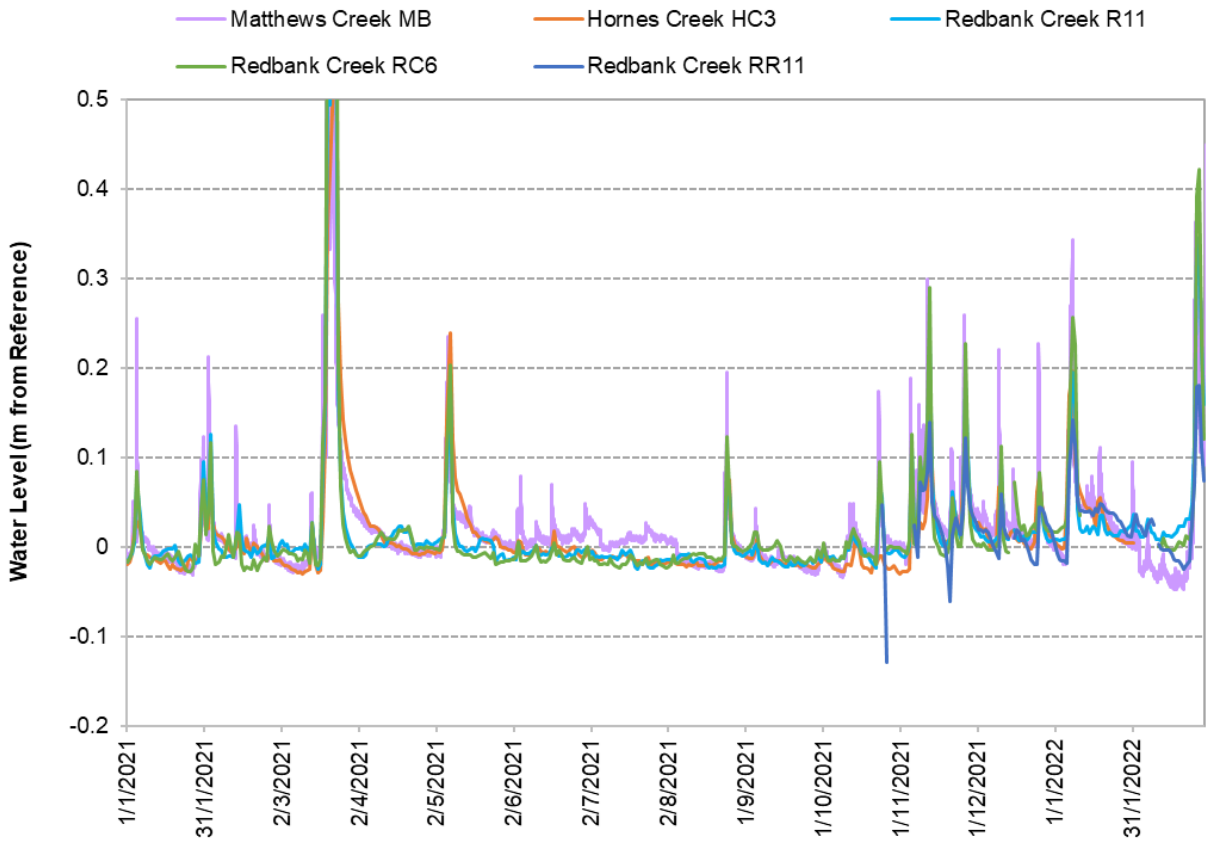
The data presented in Graph 15 shows that the pool RR11 water level averaged 0.74 m during the period October 2021 to February 2022. The water level was recorded above the level of the sensor for the majority of the monitoring period with the exception of late October 2021 to early November 2021 when the water level declined below the level of the sensor during a period of low rainfall. It is noted that pool RR11 was also holding water during a visual inspection conducted in May 2021 (refer Appendix B for photograph).

As pool RR11 water level data was not recorded during the pre-impact or impact periods, recession analysis has not been undertaken. Following a further period of monitoring in which sufficient dry weather events are available for analysis, the recessionary behaviour of pool RR11 will be compared to that of reference sites to aid in assessment of the effectiveness of remediation works at pool RR11.

Graph 16 presents a comparison of pool RR11 water level data and reference site data for Redbank Creek RC6, Redbank Creek R11, Hornes Creek HC3 and Matthews Creek MB.

The data presented in Graph 16 shows that, for the period of record, the water level recessionary behaviour of pool RR11 was generally consistent with that of the reference sites.

Additional post-remediation monitoring data is recommended to enable further assessment of the effectiveness of remediation works at pool RR11 in Redbank Creek.



GRAPH 16: REDBANK CREEK POOL RR11 AND REFERENCE SITES - WATER LEVEL COMPARISON

5.2.4 Aquatic Ecology Assessment Findings

The following summarises the outcomes of the aquatic ecology surveys conducted in autumn and spring 2021 at pool RR11 and pool RB33 (reference site), as detailed in Niche (2021b).

Monitoring results indicated that the water quality of pool RR11 was similar on both survey occasions and was generally consistent with the water quality of the reference site in Redbank Creek (pool RB33 which has not been directly impacted by subsidence) with the exception of elevated turbidity in September 2021.

Based on the AUSRIVAS results, pool RR11 scored in Band C and Band D in autumn and spring 2021 respectively indicating severely to extremely impaired stream health. The reference site pool RB33 scored in Band B and Band C indicating significantly to severely impaired stream health. However, Niche (2021b) note that aquatic ecology surveys conducted in 2007 and 2009 prior to mining indicated that Redbank Creek had significantly to extremely impaired stream health (Band B to Band D).

Pool RR11 scored low biotic index grades (less than 3) indicating a tolerance to pollution and environmental stress. However, Niche (2021b) note that this is common in low flow pool edge habitat in the region.

Few pollution sensitive taxa were observed in autumn 2021 and no pollution sensitive taxa were observed in September 2021. Niche (2021b) note that this may be the result of reduced habitat condition however could also reflect natural variability or sampling methods.

5.3 Pool RR19

5.3.1 Introduction

As shown in Map 1, pool RR19 in Redbank Creek is situated above LW31. The stream reach defined as pool RR19 is comprised of a series of shallow pools formed in a Hawkesbury Sandstone and is rockbar controlled. A summary of the geomorphological characteristics of pool RR19, following visual inspection conducted on 19 May 2021, is presented in Appendix B.

LW31 was mined between June 2017 and August 2018, with fracturing at pool RR19 and reduced pool holding capacity reported from April 2018 in GeoTerra (2019b).

5.3.2 Summary of Remediation Works

Remediation works at pool RR19 commenced in January 2021 and were completed in June 2021. Informed by the ground characterisation study (SCT, 2019) and review of groundwater and surface water monitoring data, the remediation works were conducted in five stages as follows (Tahmoor Coal, 2021):

1. Stage 1 – 6 metre (m) wide shallow grout curtain (perpendicular to the direction of flow): drilling and injection to 2 m depth, 0.5 m spacing and 38 mm diameter using Spetec H100 hydrophobic polyurethane.
2. Stage 2 – 40 m wide grout curtain to 6 m depth (perpendicular to the direction of flow): drilling and injection from 0 m to 6 m depth, 2 m spacing and 76 mm diameter using Spetec H100 hydrophobic polyurethane.
3. Stage 3 - 40 m wide grout curtain to 12 m depth (perpendicular to the direction of flow): drilling and injection from 6 m to 12 m depth, 2 m spacing and 76 mm diameter using Spetec H100 hydrophobic polyurethane.
4. Stage 4 – additional 8 m section of curtain wall to 12 m depth (perpendicular to the direction of flow).
5. Stage 5 – pattern grouting in the centre of pool RR19.

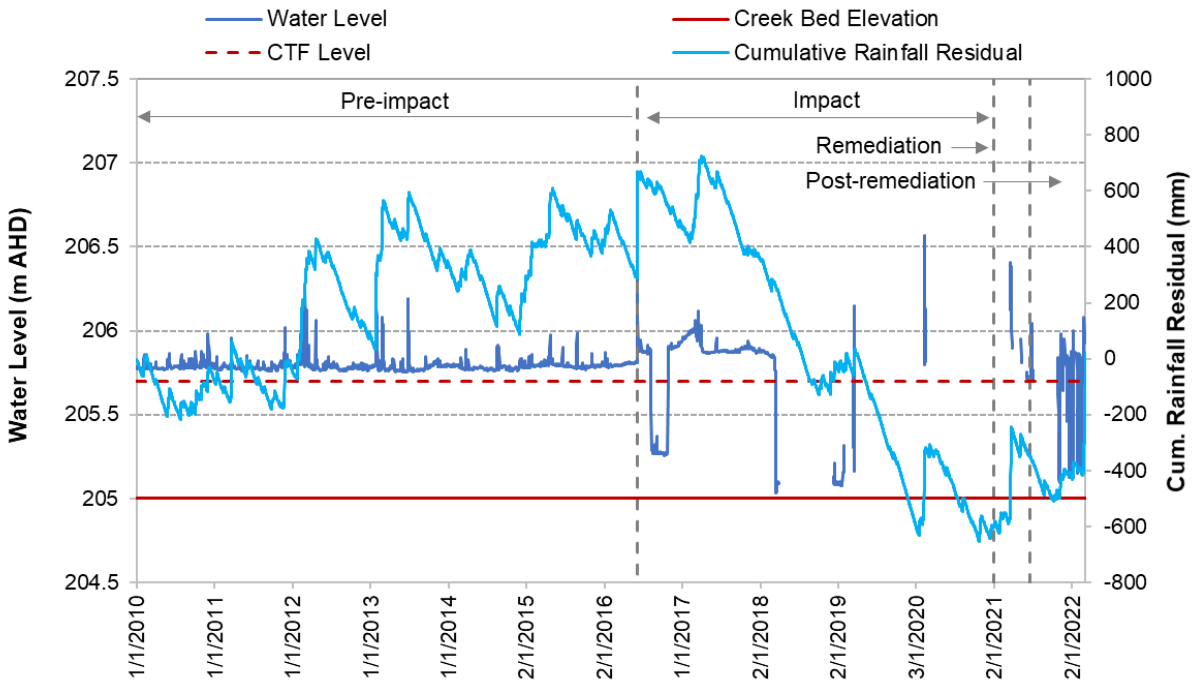
5.3.3 Surface Water Assessment Findings

Water level data for pool RR19 in Redbank Creek is available for the period January 2010 to February 2022. Graph 17 (A and B) presents the water level records for pool RR19 in comparison with the cumulative rainfall residual.

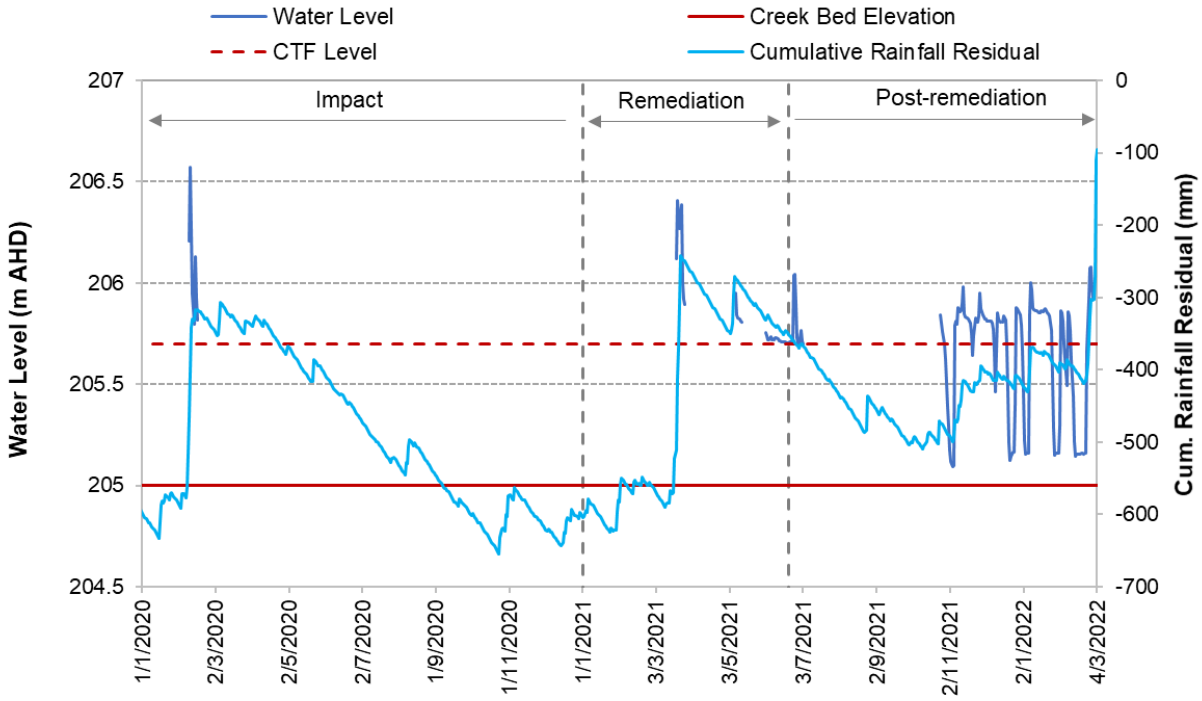
Although impacts to pool RR19 were reported as occurring during mining of LW31 (June 2017 to August 2018), the data indicates that impacts to pool RR19 water level may have occurred as early as mid-2016. Direct subsidence related impacts to pool RR19 may not have occurred as early as mid-2016, however, the decline in water level may reflect subsidence impacts to pools further upstream and/or regional groundwater depressurisation effects due to mining of LW22 to LW31.

Pre-impact, the water level was maintained above 205.8 m AHD. During the impact period, the water level regularly declined below the level of the sensor and was reported as dry on a number of occasions (GeoTerra, 2019a). Pool RR19 was dry for the majority of 2020 to mid-2021 despite substantial rainfall in early 2020 and 2021.

Post-remediation, the pool was recorded as dry until late October 2021 during a period of below average rainfall. From late October 2021, as rainfall increased, the water level rose and fell in response to rainfall events.

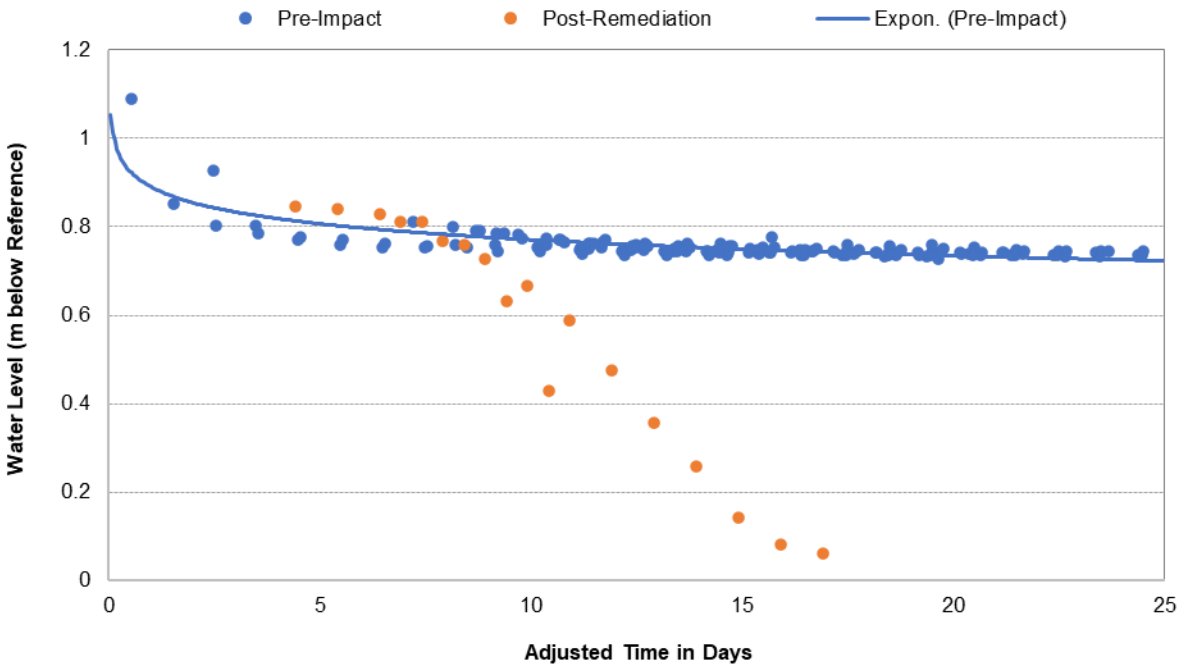


GRAPH 17A: REDBANK CREEK POOL RR19 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2010 TO 2022



GRAPH 17B: REDBANK CREEK POOL RR19 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2020 TO 2022

Method 1 has been applied to undertake a preliminary assessment of the water level recessionary behaviour comparing the pre-impact and post-remediation periods. While 15 pre-impact period dry weather events were able to be used for the assessment, due to the reduction in water level following impact, which has generally continued post-remediation, only two post-remediation dry weather events were able to be used (refer Section 3.1), hence the assessment is preliminary. For comparative purposes only, Graph 18 shows a graph of the pre-impact and post-remediation period water level records against the adjusted time in days. An exponential trendline has been fitted to the pre-impact period water level records, however, was unable to be fitted to the post-remediation water level records due to the decline in water levels.



GRAPH 18: REDBANK CREEK POOL RR19 – METHOD 1 RECESSION CURVE COMPARISON

Although preliminary only, the data presented in Graph 18 shows that, above 0.8 m, the water level recession rate post-remediation is similar to that of the pre-impact period recession rate showing an improvement of the pool holding capacity post-remediation. However, below 0.8m, the water level has declined to lower levels post-remediation than was recorded during the pre-impact period.

As only two post-remediation events were able to be assessed, the collection of additional post-remediation monitoring data, recorded during periods of low rainfall, is recommended to enable further assessment of the post-remediation recession rate of pool RR19.

As the water level regularly declined below the level of the sensor and the pool was reported as dry on a number of occasions during the impact period, insufficient data is available for the impact period to enable the Method 2 assessment to be undertaken for pool RR19.

5.3.4 Aquatic Ecology Assessment Findings

The following summarises the outcomes of the aquatic ecology survey conducted in spring 2021 at pool RR19 and pool RB33 (reference site), as detailed in Niche (2021b).

Monitoring results indicated that the water quality of pool RR19 was generally consistent with the water quality of other sites in Redbank Creek including the reference site (pool RB33 which has not been directly impacted by subsidence).

Based on the AUSRIVAS results, pool RR19 scored in Band C indicating severely impaired stream health. The reference site pool RB33 also scored in Band C in spring 2021.

Pool RR19 scored low biotic index grades (less than 2.2) indicating a tolerance to pollution and environmental stress. However, Niche (2021b) note that this is common in low flow pool edge habitat in the region.

No pollution sensitive taxa were observed in spring 2021 at pool RR19.

5.4 Weir / Pool 26

5.4.1 Introduction

Weir/pool 26 in Redbank Creek is situated above the eastern edge of LW31 (refer Map 1 for site location). The pool is formed in Hawkesbury Sandstone outcrop and is controlled by an approximately 1.5 m high concrete weir. A summary of the geomorphological characteristics of pool 26, following visual inspection conducted on 18 May 2021, is presented in Appendix B. Water level data for weir/pool 26, recorded at sensor R9, is available for the period January 2010 to present.

LW31 was mined between June 2017 and August 2018, however, impacts to the pool and weir, comprising fracturing of the weir and pool base and reduced water holding capacity, were initially reported in March 2017 during mining of LW30 (GeoTerra, 2019b).

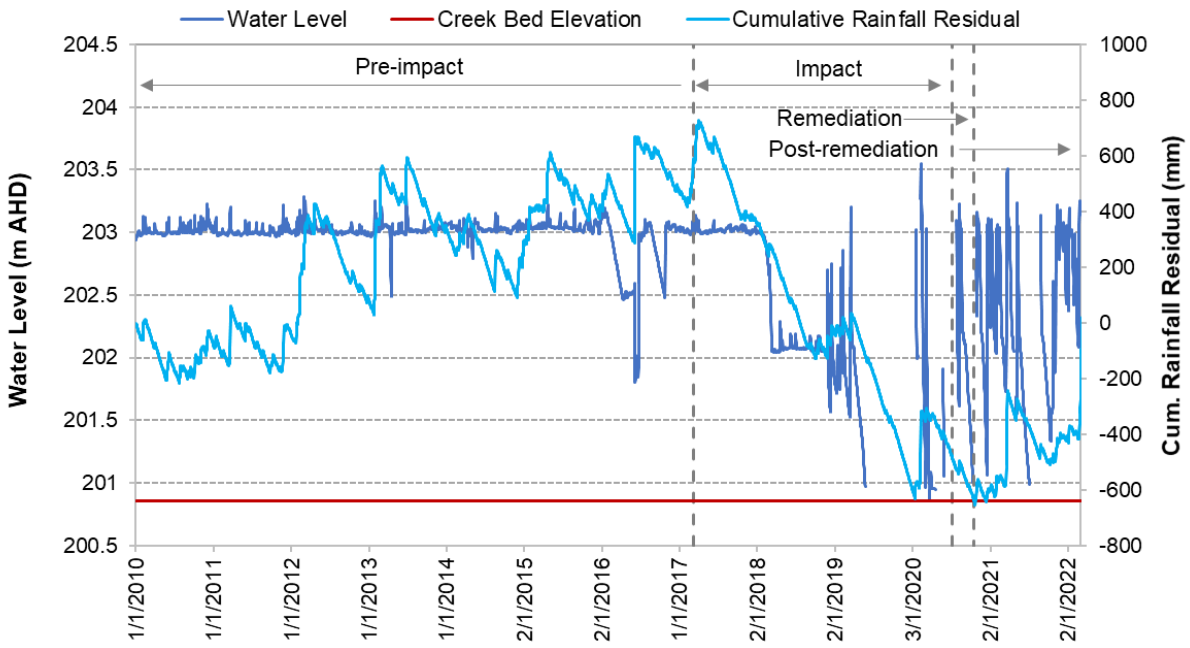
5.4.2 Summary of Remediation Works

Remediation works at weir/pool 26 commenced in July 2020 and were completed in October 2020. Informed by the ground characterisation study (SCT, 2019) and review of groundwater monitoring data, the remediation works were conducted in stages as follows (Pointe, 2020c and Tahmoor Coal, 2021):

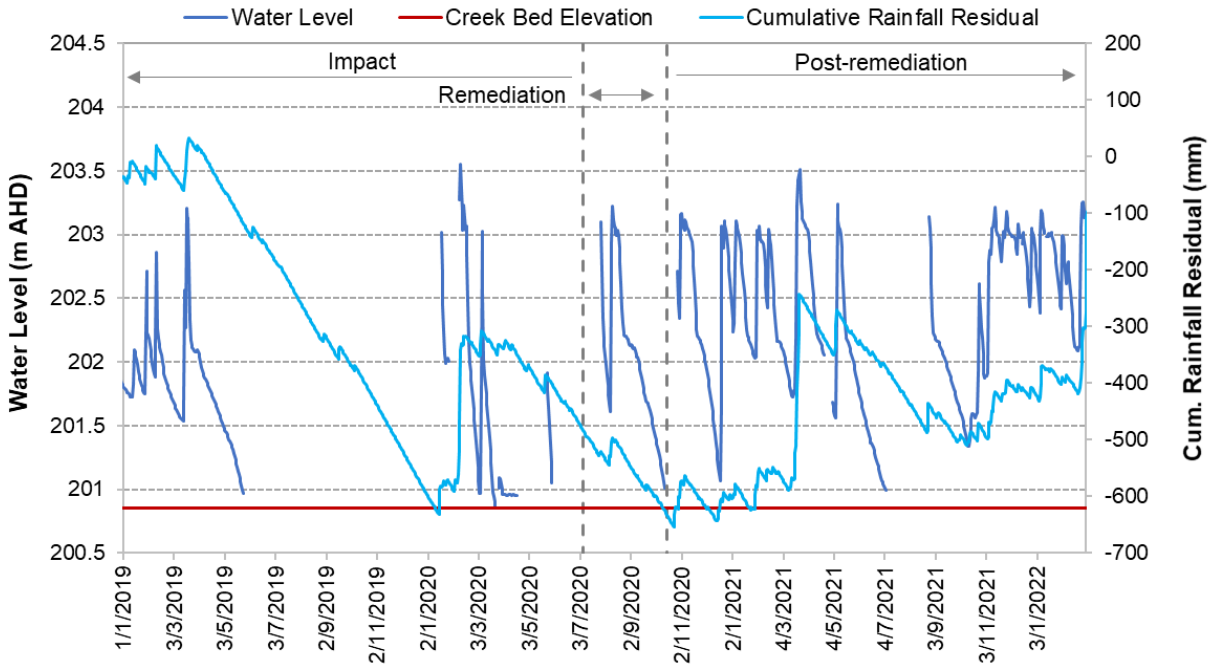
1. Weir cracks were identified and injected with Spetec H100 hydrophobic polyurethane.
2. Stage 1 – 6 metre (m) wide shallow grout curtain to 2 m depth (perpendicular to the direction of flow): drilling of 12 holes to 2 m depth (0.5 m spacing and 38 mm diameter) and injection with Spetec H100 hydrophobic polyurethane.
3. Stage 2 – 40 m wide grout curtain to 6 m depth (perpendicular to the direction of flow): drilling of 20 holes to 6 m depth (2 m spacing and 76 mm diameter) and injection with Spetec H100 hydrophobic polyurethane.
4. Stage 3 - 40 m wide grout curtain to 14 m depth (perpendicular to the direction of flow): drilling of 20 holes from 6 m to 14 m depth (2 m spacing and 76 mm diameter) and injection with Spetec H100 hydrophobic polyurethane.

5.4.3 Surface Water Assessment Findings

Graph (A and B) presents the water level records for Redbank Creek pool 26 compared with the cumulative rainfall residual.



GRAPH 19A: REDBANK CREEK POOL 26 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2010 TO 2022

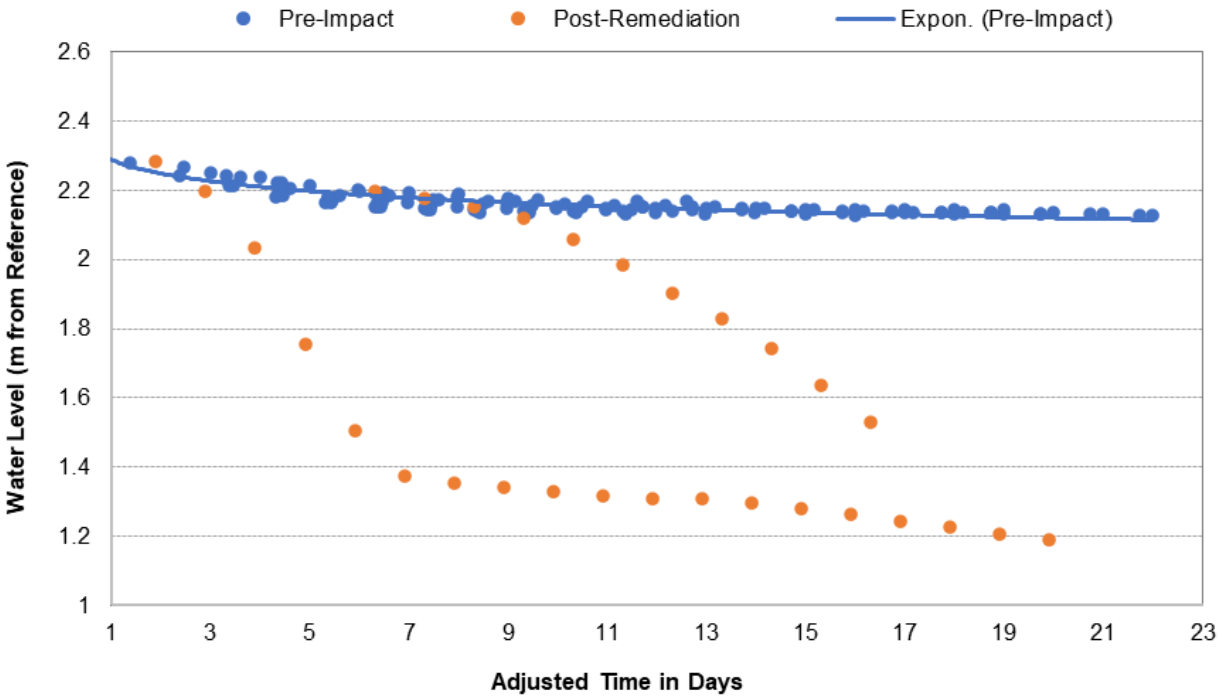


GRAPH 19B: REDBANK CREEK POOL 26 - WATER LEVEL RECORDS AND RAINFALL RESIDUAL – 2019 TO 2022

The data in Graph 19 (A and B) shows an evident change in the water level and water level recessionary behaviour of pool 26 from early 2016 and more substantially from early 2018 as rainfall declined. Prior to impact, the water level was predominately maintained above 202.97 m AHD. During the impact period, the water level declined below the level of the sensor and the pool was reported as dry on a number of occasions (GeoTerra, 2019a).

Following remediation works, the pool has held water more frequently than that during the impact period with the water level rising and falling in response to rainfall events. However, the pool water level behaviour has not returned to pre-impact conditions and the water level has at times declined to a similar minimum level (below the sensor level) to that recorded during the impact period despite above average rainfall during this period.

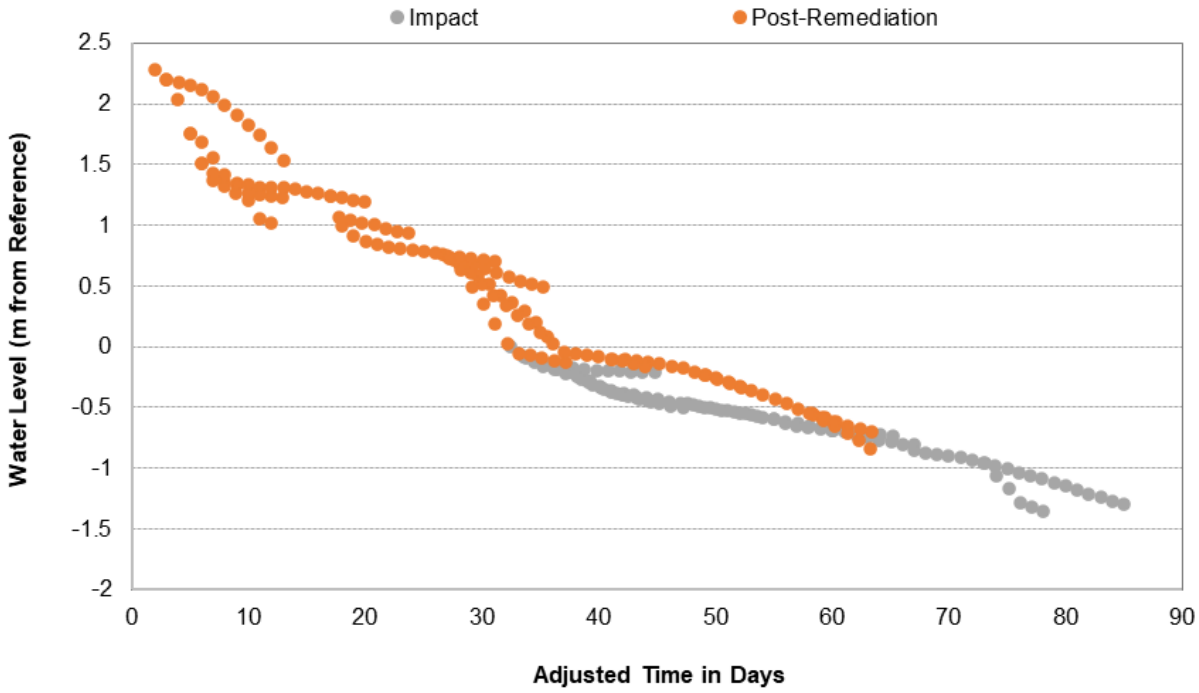
Method 1 has been applied to undertake a preliminary assessment of the water level recessionary behaviour comparing the pre-impact and post-remediation periods. While 24 pre-impact period dry weather events were able to be used for the assessment, only three post-remediation dry weather events were able to be used (refer Section 3.1), hence the assessment is preliminary. For comparative purposes only, Graph 20 shows a graph of the pre-impact and post-remediation period water level records against the adjusted time in days. An exponential trendline has been fit to the pre-impact period water level records, however, was unable to be fit to the post-remediation water level records due to the decline in water levels.



GRAPH 20: REDBANK CREEK POOL 26 – METHOD 1 RECESSION CURVE COMPARISON

Although preliminary only, the data presented in Graph 20 suggests that pool 26 water level declines at a similar rate post-remediation to that recorded during the pre-impact period when the water level is higher i.e. above 2.1 m local datum. Below 2.1 m local datum, the water level has declined at a faster rate and to lower levels post-remediation in comparison to the pre-impact period.

For comparative purposes, Method 2 has been applied to the recorded water level data for the impact and post-remediation periods. Graph 21 presents a plot of the water level (relative to a given reference level) for the impact and post-remediation period dry weather events against the adjusted time in days to produce a single recession curve for each dataset. Nine (9) dry weather events are presented for the impact period and 14 for the post-remediation period. The reference level adopted was the highest water level recorded during the impact period dry weather events (202.98 m AHD).



GRAPH 21: REDBANK CREEK POOL 26 – METHOD 2 RECESSION CURVE COMPARISON

The data plotted in Graph 21 shows that higher water levels (above 0 m from reference level) were recorded during the post-remediation dry weather events than were recorded during the impact period. There appears to have been a reduction in the rate of water level decline post-remediation when the water level was approximately 0 to 0.5 m below the reference level. From 0.5 m below the reference level, the water level appears to decline at a similar rate post-remediation to that recorded during the impact period. As shown in Graph 19B, the water level declined to the level of the sensor during one event post-remediation (the gap in the water level record). The full extent of this recession event is not plotted in Graph 21 because only events in which rainfall was not occurring are plotted.

Although there has been an improvement in the pool water holding capacity post-remediation, the data indicates that the pool water level has continued to decline more rapidly than during the pre-impact period. To enable further recession analysis, it is recommended that water level monitoring at pool 26 is continued and further assessment is undertaken.

5.4.4 Aquatic Ecology Assessment Findings

The following summarises the outcomes of the aquatic ecology surveys conducted in autumn and spring 2021 at weir/pool 26 and pool RB33 (reference site), as detailed in Niche (2021b).

Monitoring results indicated that the water quality of weir/pool 26 was similar on both survey occasions and was generally consistent with the water quality of the reference site in Redbank Creek (pool RB33 which has not been directly impacted by subsidence) with the exception of elevated turbidity recorded at weir/pool 26 in September 2021.

Based on the AUSRIVAS results, weir/pool 26 scored in Band B and Band C indicating moderate to severe impairment of stream health. The reference site pool RB33 also scored in Band B and Band C in autumn and spring 2021.

Weir/pool 26 scored low biotic index grades (less than 3.8) indicating a tolerance to pollution and environmental stress. However, Niche (2021b) note that this is common in low flow pool edge habitat in the region. Two pollution sensitive taxa were observed in both the autumn and spring 2021 surveys.

6 REMEDIATION PROGRESS REVIEW

The aquatic ecology survey results and outcomes of the recession analysis have been used as criteria for assessing the effectiveness of remediation works in Myrtle Creek and Redbank Creek. The effectiveness categories have been defined as:

- Low effectiveness: significantly lower ecological health score in comparison with reference site and no to little improvement in pool water holding capacity and water level recessionary behaviour.
- Low to moderate effectiveness: notably lower ecological health score in comparison with reference site and some improvement in pool water holding capacity and water level recessionary behaviour.
- Moderate effectiveness: lower ecological health score in comparison with reference site and moderate improvement in pool water holding capacity and water level recessionary behaviour.
- Moderate to high effectiveness: similar ecological health score in comparison with reference site and notable improvement in pool water holding capacity and water level recessionary behaviour.
- High effectiveness: similar to higher ecological health score in comparison with reference site and significant improvement in pool water holding capacity and water level recessionary behaviour.

Table 1 presents a summary of the effectiveness of remediation works in Myrtle Creek and Redbank Creek based on the aquatic ecology survey results and outcomes of the water level analysis. It should be noted that, for all pools except pool 23 in Myrtle Creek, the assessment of the effectiveness of remediation works is preliminary only, with additional post-remediation monitoring data required to enable further assessment.

TABLE 1: ASSESSMENT OF REMEDIATION EFFECTIVENESS TO DATE

Pool	Pool Water Holding Capacity	Water Level Recession	Aquatic Ecology	Level of Remediation Effectiveness to Date	Status of Assessment
Myrtle Creek					
Pool 10	Notable improvement – pool overflowing continuously for 2.5 months post-remediation	Similar behaviour to reference sites	No data	High (based on water level behaviour)	Preliminary assessment based on 2.5 months of post-remediation water level data – additional monitoring and assessment required
Pool 11	Moderate to high improvement – minimum water level maintained above the CTF level for over 3 months post-remediation	Similar pre-impact and post-remediation recession rates	No data	Moderate to high (based on water level behaviour)	Preliminary assessment based on 3 months of post-remediation water level data – additional monitoring and assessment required
Pool 18	Notable improvement from mid-November 2021 - pool overflowing continuously for 3 months post-remediation	From mid-November 2021, improvement in water level recessionary behaviour and similar to reference sites	No data	Moderate to high (based on water level behaviour)	Preliminary assessment based on 4.5 months of post-remediation water level data – additional monitoring and assessment required
Pool 20	Notable improvement from early November 2021 - pool overflowing for the majority of the post-remediation period	Notable improvement in water level recessionary behaviour and generally similar to reference sites	Lower ecological health score than reference site – however, only one survey conducted immediately following remediation	High (based on water level behaviour)	Preliminary assessment based on 6 months of post-remediation water level data – additional monitoring and assessment required
Pool 23	Significant improvement - pool overflowing continuously for over 2 years post-remediation	Similar pre-impact and post-remediation recession rates for the full range of recorded water levels	Higher ecological health scores than reference site – four post-remediation aquatic surveys conducted	High	Assessment complete

TABLE 1 (CONT.): ASSESSMENT OF REMEDIATION EFFECTIVENESS TO DATE

Pool	Pool Water Holding Capacity	Water Level Recession	Aquatic Ecology	Level of Remediation Effectiveness to Date	Status of Assessment
Redbank Creek					
Pool RB6	Notable improvement – pool overflowing nearly continuously for 3 months post-remediation	Notable improvement in water level recessionary behaviour (based on impact period visual inspection records) and generally similar to reference sites	No data	High (based on water level behaviour)	Preliminary assessment based on 3 months of water level data – additional monitoring and assessment required
Pool RR11	Pool holding water continuously for 3 months post-remediation	Notable improvement in water level recessionary behaviour (based on impact period visual inspection records) and generally similar to reference sites	Lower ecological health score than reference site	Moderate to high	Preliminary assessment based on 4.5 months of water level data – additional monitoring and assessment required
Pool RR19	Water level rising and falling in response to rainfall events from late October 2021 post-remediation	Some improvement in water level recessionary behaviour	Similar ecological health to reference site	Low to moderate	Preliminary assessment based on 8 months of water level data – additional monitoring and assessment required
Weir / Pool 26	Water level rising and falling in response to rainfall events post-remediation	Moderate improvement in water level recessionary behaviour	Similar ecological health to reference site	Moderate	Assessment based on 16 months of water level data – additional monitoring and assessment required

7 SUMMARY AND CONCLUSIONS

Tahmoor Coal has developed and implemented a Corrective Management Action Plan to reduce the impact of subsidence effects to Myrtle Creek and Redbank Creek. Remediation works, comprising grout curtains and pattern injection, have been conducted at sites in Myrtle Creek and Redbank Creek with the aim of improving pool water holding capacity, restoring overland connective flow and improving aquatic ecosystem health and aesthetic value.

The effectiveness of remediation works in Myrtle Creek and Redbank Creek has been assessed based on the aquatic ecology survey results and detailed analysis of water level recessionary behaviour. The assessment was undertaken for the following pools:

- Myrtle Creek: pool 23, 20, 18, 11 and 10.
- Redbank Creek: pool RB6, RR11, RR19 and weir/pool 26.

It should be noted that, for all pools except pool 23 in Myrtle Creek, the assessment of the effectiveness of remediation works is preliminary only with additional post-remediation monitoring data required to enable further assessment.

The water level data indicates that there has been an improvement in the water holding capacity of all pools post-remediation. The frequency and extent of elevated pool water levels is likely to further improve as remediation of upstream pools is conducted and connective streamflow is reinstated.

The effectiveness of remediation works in Myrtle Creek to date, in relation to improving pool water level recessionary behaviour, pool water holding capacity and ecological health, has been assessed as follows:

- Pool 10: high effectiveness based on water level analysis only;
- Pool 11 and pool 18: moderate to high effectiveness based on water level analysis only;
- Pool 20: high effectiveness based on water level analysis only; and
- Pool 23: high effectiveness.

The effectiveness of remediation works in Redbank Creek to date, in relation to improving pool water level recessionary behaviour, pool water holding capacity and ecological health, has been assessed as follows:

- Pool RB6: high effectiveness based on water level analysis only;
- Pool RR11: moderate to high effectiveness based on water level analysis only; and
- Pool RR19: low to moderate effectiveness; and
- Weir/pool 26: moderate effectiveness.

To enable further assessment of the effectiveness of remediation works, it is recommended that additional post-remediation monitoring data is recorded at all remediated pools in Myrtle Creek and Redbank Creek, with the exception of pool 23 in Myrtle Creek. A minimum of 24 months of post-remediation monitoring data is recommended prior to assessment completion.

Based on the analysis of two years of water level data recorded at pool 23 post-remediation and the results of four aquatic ecology monitoring campaigns, remediation works at pool 23 in Myrtle Creek have been effective in restoring pool water level recessionary behaviour, pool water holding capacity and ecological health to pre-mining conditions.

REFERENCES

BoM (2022). *Drought Knowledge Centre: Previous droughts*. Accessed online: http://www.bom.gov.au/climate/drought/knowledge-centre/, April 2022.

Glencore (2017). *Tahmoor Colliery Longwall 31 Environmental Management Plan.* Revision B.

GeoTerra (2014). *Tahmoor Colliery Longwall 27 End of Panel Surface Water, Dams and Groundwater Monitoring Report*. Prepared for Tahmoor Coal Pty Ltd, August.

GeoTerra (2016). *Tahmoor Colliery Longwall 29 Surface Water, Dams and Groundwater Monitoring End of Panel Report*. Prepared for Tahmoor Coal Pty Ltd, August.

GeoTerra (2019a). *Inspections Redbank Creek*. Prepared for Tahmoor Coal Pty Ltd, March.

GeoTerra (2019b). *Tahmoor Colliery Longwall 31 Surface Water, Dams and Groundwater End of Panel Monitoring Report*. Prepared for Tahmoor Coal Pty Ltd, March.

Niche (2021a). *Myrtle Creek Aquatic Monitoring Report Spring 2021 Tahmoor North*. Prepared for Tahmoor Coal, December.

Niche (2021b). *Redbank Creek Aquatic Monitoring Report – Spring 2021 Tahmoor North*. Prepared for Tahmoor Coal, December.

Peabody (2019). *Metropolitan Coal Stream Remediation Plan*, November.

Pointe (2020a). *Pool 23 Completion Report*. Prepared for Tahmoor Coal, February.

Pointe (2020b). *Completion Report Redbank Creek CMAP RR11*. Prepared for Tahmoor Coal, June.

Pointe (2020c). *Completion Report Redbank Creek CMAP Pool 26*. Prepared for Tahmoor Coal, December.

SCT (2019). *Redbank Creek Characterisation Boreholes*. Prepared for Tahmoor Coal, March.

SCT (2021). *Characterisation of Fracturing Below Pool 10 to 20 in Myrtle Creek*. Prepared for Tahmoor Coal, February.

Tahmoor Coal (2017). *Corrective Management Action Plan*. Final Rev B, June.

Tahmoor Coal (2019a). *Longwall 32 Environmental Management Plan*, May.

Tahmoor Coal (2019b). *Redbank Creek Corrective Management Action Plan – Stage 2*. Ver 2, June.

Tahmoor Coal (2020a). *Quarterly Progress Report Myrtle Creek CMAP & Redbank Creek CMAP*, December.

Tahmoor Coal (2020b). *Myrtle Creek Corrective Management Action Plan – Stage 2*. Ver 2, August.

Tahmoor Coal (2021). *Quarterly Progress Report Myrtle Creek CMAP & Redbank Creek CMAP*, December.

Xstrata Coal (2013). *Tahmoor Colliery Longwalls 27 to 30 Environmental Management Plan*. Revision D, February.

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APPENDIX A – MYRTLE CREEK POOL GEOMORPHOLOGICAL CHARACTERISATION

MYRTLE CREEK
POOL 10

Pool 10 – Downstream View to Rockbar Control

18 May 2021

General		
Stream	Myrtle Creek	
ID	Pool 10	
Approximate coordinates (GDA94) at downstream end of pool	278419 E 6211411 N	
Base RL	Approximately 251 m AHD	
Notable reference points	Water level sensor	
Longwall	Eastern edge of LW26	
Geomorphological Variables		
Description	Elongated pool	
Pool dimensions	Approximately 4 m wide x 20 m long	
Pool depth at overflow point	Approximately 1 m	
Hydraulic control	Rockbar	
Control features	Shallow rockbar extending across width of pool; obstructed by fallen trees and cut privet; flute holes; notable fractures; horizontal bedding planes	
Bed forms	Bedrock outcrop	
Bed material	Hawkesbury sandstone outcrop; bed not visible	
Valley shape	Left bank^: Compound stepped depositional: Approx. 1.5 m high silty/clay banks extending to heavily vegetated benched outcrop	Right bank^: Convex upwards: Approx. 8 m high, steeply inclined outcrop overlain with shallow clay/silty soil vegetation. Residential property on overbank.
Bank vegetation type and cover	Left bank^: Grass, wandering jew, vines privet, trees	Right bank^: Grass, scattered trees
Bed vegetation including debris	Fallen trees and leaf litter	
Pool tree canopy	Moderate to high canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Not visible	
Bed scour features	Some scouring of shallow soil banks	
Bed eroding or accreting	Not visible	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland to the north and residential development to the south	
Structures	N/A	
Mining related impacts	Fracturing and reduced pool water holding capacity	

^ Looking downstream

Surface Water Flow (18 May 2021)	
Pool water depth	Approximately 500 mm
Connective surface flow	Connective surface flow
Other observations	High turbidity

MYRTLE CREEK
POOL 11

Pool 11 – Upstream View from Rockbar Control

18 May 2021

Pool 11 – Downstream View from Rockbar Control

18 May 2021

General		
Stream	Myrtle Creek	
ID	Pool 11	
Approximate coordinates (GDA94) at downstream end of pool	278454 E 6211454 N	
Base RL	Approximately 249 m AHD	
Notable reference points	M4 water level sensor	
Longwall	Chain pillar between Longwall 26 and Longwall 27	
Geomorphological Variables		
Description	Elongated pool	
Pool dimensions	Approximately 4 m wide x 28 m long	
Pool depth at overflow point	Approximately 1 m	
Hydraulic control	Rockbar and boulders	
Control features	Raised rockbar extending across width of pool; weathered; horizontal bedding planes; fractures	
Bed forms	Bedrock outcrop	
Bed material	Hawkesbury sandstone outcrop and boulders; bed not visible	
Valley shape	Left bank^: Convex upwards: Approx. 1.0 m high silty/clay banks extending to gently inclined, approx. 5 m heavily vegetated outcrop	Right bank^: Irregular outcrop: Approx. 8 m high, steeply inclined, irregular outcrop. Some shallow soil and vegetation coverage. Residential property on overbank.
Bank vegetation type and cover	Left bank^: Grass, wandering jew, vines privet, trees	Right bank^: Grass, scattered trees
Bed vegetation including debris	Leaf litter	
Pool tree canopy	Moderate canopy coverage	
Channel width	> 15 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Some scouring of shallow soil banks	
Bed eroding or accreting	Variably eroding and accreting	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland to the north and residential development to the south	
Structures	N/A	
Mining related impacts	Fracturing and reduced pool water holding capacity	

^ Looking downstream

Surface Water Flow (18 May 2021)	
Pool water depth	Approximately 500 mm
Connective surface flow	Connective surface flow; visible flow beneath rockbar
Other observations	High turbidity

MYRTLE CREEK
POOL 18

Pool 18 – Upstream View of Pool

18 May 2021

Pool 18 – Downstream View of Rockbar

18 May 2021

General		
Stream	Myrtle Creek	
ID	Pool 18	
Approximate coordinates (GDA94) at downstream end of pool	2788615 E 6211693 N	
Base RL	Approximately 243 m AHD	
Notable reference points	Water level sensor	
Longwall	Eastern edge of LW27	
Geomorphological Variables		
Description	Shallow, elongated pool	
Pool dimensions	Approximately 4 m wide x 30 m long	
Pool depth at overflow point	Approximately 1 m (pool base not visible)	
Hydraulic control	Rockshelf	
Control features	Elongated rockshelf extending across width of pool; some depressions and fracturing	
Bed forms	Bedrock outcrop	
Bed material	Hawkesbury sandstone outcrop; notable sediment, gravel and boulder deposition	
Valley shape	Left bank^: Compound stepped depositional: Approx. 1.5 m high clay/silt banks, densely vegetated; extending to inclining open grassland	Right bank^: Compound stepped depositional: Approx. 1.5 m high clay/silt banks, densely vegetated; inclining to residential property
Bank vegetation type and cover	Left bank^: Grass, wandering jew, privet, gum trees	Right bank^: Grass, wandering jew, privet, willow and gum trees
Bed vegetation including debris	Pool base not visible	
Pool tree canopy	Substantial canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Bank toe undercutting and exposed roots	
Bed eroding or accreting	Eroding	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland to the north and residential development to the south	
Structures	N/A	
Mining related impacts	Fracturing and reduced pool water holding capacity	

^ Looking downstream

Surface Water Flow (18 May 2021)	
Pool water depth	Approximately 700 mm
Connective surface flow	No connective surface flow
Other observations	N/A

MYRTLE CREEK
POOL 20

Pool 20 – Downstream View to Rockbar Control

18 May 2021

General		
Stream	Myrtle Creek	
ID	Pool 20	
Approximate coordinates (GDA94) at downstream end of pool	278714 E 6211736 N	
Base RL	Approximately 239 m AHD	
Notable reference points	Water level sensor	
Longwall	Western edge of LW28	
Geomorphological Variables		
Description	Large, elongated pool in sandstone race with plunge pool	
Pool dimensions	Approximately 9 m wide x 50 m long	
Pool depth at overflow point	Approximately 1.5 m (plunge pool); approx. 3.5 m total depth at rockbar	
Hydraulic control	Rockbar	
Control features	Raised rockbar extending across width of pool; approximately 2 m high, 5 m wide; open horizontal bedding planes; some lateral accretion	
Bed forms	Bedrock outcrop	
Bed material	Hawkesbury sandstone outcrop; weathered; flute holes; some gravel and sand	
Valley shape	Left bank^: Irregular bedrock: Approx. 5 m high irregular outcrop, horizontal bedding; extending to vegetated incline with large boulders	Right bank^: Compound stepped depositional: Approx. 2 m high stepped outcrop extending to inclined vegetated outcrop with boulders. Residential property on overbank.
Bank vegetation type and cover	Left bank^: Grass, wandering jew, privet, trees	Right bank^: Grass, wandering jew, privet, trees
Bed vegetation including debris	Some sedges; some leaf litter and twigs	
Pool tree canopy	Minor canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Some sculpting of bedrock; flute holes	
Bed eroding or accreting	Accreting	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland to the north and residential development to the south	
Structures	N/A	
Mining related impacts	Fracturing and reduced pool water holding capacity	

^ Looking downstream

Surface Water Flow (18 May 2021)	
Pool water depth	Approximately 200 mm
Connective surface flow	No connective surface flow
Other observations	Notable fracturing of pool base and rock shelf

MYRTLE CREEK
POOL 23

Pool 23 – Downstream View to Rockbar Control

18 May 2021

General		
Stream	Myrtle Creek	
ID	Pool 23	
Approximate coordinates (GDA94) at downstream end of pool	278887 E 6211776 N	
Base RL	Approximately 232 m AHD	
Notable reference points	M5 water level sensor	
Longwall	Eastern edge of LW28	
Geomorphological Variables		
Description	Elongated pool	
Pool dimensions	Approximately 7 m wide x 25 m long	
Pool depth at overflow point	Approximately 800 mm (pool base not visible)	
Hydraulic control	Rockbar	
Control features	Raised rockbar extending across width of pool; approximately 7 m wide x 2.5 m long; evident fracturing	
Bed forms	Bedrock outcrop	
Bed material	Hawkesbury sandstone outcrop; bed not visible	
Valley shape	Left bank^: Irregular bedrock: Approx. 4 m high sheer outcrop, horizontal bedding; upper shallow soil layer	Right bank^: Compound stepped depositional: Approx. 4 m high benched outcrop overlain in parts with soil and vegetation; extending to residential property
Bank vegetation type and cover	Left bank^: Upper soil layer: grass, trees	Right bank^: Grass, wandering jew, privet, trees
Bed vegetation including debris	Negligible	
Pool tree canopy	Moderate canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Not visible	
Bed scour features	Some sculpting of bedrock on left bank	
Bed eroding or accreting	Not visible	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland to the north and residential development to the south	
Structures	N/A	
Mining related impacts	Fracturing and reduced pool water holding capacity during LW27 (GeoTerra, 2019a)	

^ Looking downstream

Surface Water Flow (18 May 2021)	
Pool water depth	Approximately 500 mm
Connective surface flow	Connective surface flow
Other observations	Approx. 20 m long upstream irregular rockbar with low flow channel; some flute holes

APPENDIX B – REDBANK CREEK POOL GEOMORPHOLOGICAL CHARACTERISATION

REDBANK CREEK
POOL RB6

Pool RB6 – Upstream View of Upper Section

20 May 2021

Pool RB6 – Downstream View Mid-Section

20 May 2021

Pool RB6 – Downstream View Rockbar Control

20 May 2021

General		
Stream	Redbank Creek	
ID	Pool RB6	
Approximate coordinates (GDA94) of pool (DS)	278273 E 6213382 N	
Pool base RL	Approximately 214 m AHD	
Notable reference points	Rockbar characterization bore	
Longwall	Far east edge of LW29	
Geomorphological Variables		
Description	Series of pools in elongated reach	
Pool dimensions	Variable; < 6 m wide x < 10 m long; full reach approximately 80 m long	
Pool depth at overflow point	Approximately 1 m	
Pool hydraulic control	Rockbar	
Control features	Extends across width of pool; triangular in shape; approximately 7 m wide x 15 m long; semi-regular; one large fracture, other minor fractures; small to moderate flute holes	
Bed forms	Bedrock outcrop with substantial deposition; notable fractures	
Bed material	Hawkesbury Sandstone outcrop Upper reach – bedrock overlain with delaminated sandstone, boulders, sediment and gravel Upstream pool – bedrock overlain with soil/sediment (silty/clay) – tannic Mid to lower reach – bedrock overlain with sand/silt, some gravel – iron staining; horizontal bedding planes in outcrop; interspersed with boulders	
Valley shape	Left bank^: Largely planar: Steep outcrop, some boulders, soil coverage in parts	Right bank^: Largely planar: Steep outcrop, some boulders, soil coverage in parts
Bank vegetation type and cover	Left bank^: Grass, sedges, interspersed with trees	Right bank^: Grass, sedges, interspersed with trees
Bed vegetation including debris	Patchy grass, climbers in sections; tree branches Debris build-up at rockbar control – tree roots and branches, rubble	
Pool tree canopy	High canopy coverage	
Channel width	Low-flow channel width approximately 5 m; high flow channel width > 10 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Weathering of exposed bedrock; some soil bank undercutting	

^ Looking downstream

Geomorphological Variables	
Bed eroding or accreting	Variable
Catchment landform	Partly confined valley
Catchment Influences	
Catchment landuse	Predominately farmland with urban development in upper reaches
Structures	N/A
Mining related impacts	Fracturing observed during mining of LW29 (GeoTerra, 2016)
Surface Water Flow (20 May 2021)	
Pool water depth	Upstream pool approximately 300 mm
Connective surface flow	No visible surface flow
Other observations	N/A

REDBANK CREEK
POOL RR11

Pool RR11 – Downstream View

19 May 2021

General		
Stream	Redbank Creek	
ID	Pool RR11	
Approximate coordinates (GDA94) of pool	278366 E 6213425 N	
Pool base RL	Approximately 211.5 m AHD	
Notable reference points	N/A	
Longwall	Centre of LW30	
Geomorphological Variables		
Description	Ferruginous pool in outcrop	
Pool dimensions	Approximately 5 m wide x 10 m long	
Pool depth at overflow point	Approximately 750 mm	
Pool hydraulic control	Stepped rockshelf	
Control features	Elongated, stepped rockshelf; horizontal bedding planes	
Bed forms	Bedrock outcrop	
Bed material	Not visible	
Valley shape	Left bank^: Compound stepped depositional: Outcrop with soil and vegetation coverage	Right bank^: Compound stepped depositional: Steep outcrop, massive boulders, soil coverage at toe
Bank vegetation type and cover	Left bank^: Grass, sedges, trees	Right bank^: Grass, sedges, trees
Bed vegetation including debris	Not visible	
Pool tree canopy	Little canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Undetermined	
Bed eroding or accreting	Undetermined	
Catchment landform	Partly confined valley	
Catchment Influences		
Catchment landuse	Predominately farmland with urban development in upper reaches	
Structures	N/A	
Mining related impacts	Fracturing observed during mining of LW29 (GeoTerra, 2019a)	

^ Looking downstream

Surface Water Flow (19 May 2021)	
Pool water depth	Approximately 0.5 m; ferruginous – oily film and floc
Connective surface flow	Visible surface flow to RRS12
Other observations	N/A

REDBANK CREEK
POOL RR19

Pool RR19 - Upstream

19 May 2021

Pool RR19 - Downstream

19 May 2021

Pool RR19 – Rockbar Control Looking Upstream

19 May 2021

General		
Stream	Redbank Creek	
ID	Pool RR19	
Approximate coordinates (GDA94)	278606 E 6213575 N	
Base RL	Approximately 207 m AHD	
Notable reference points	R8 water level sensor Water level sensor (Pointe) Remediation works	
Longwall	West edge of Longwall 31	
Geomorphological Variables		
Description	Rockshelf race with pools	
Pool dimensions	Approximately 4 m wide x 10 m long to upstream boulder field	
Pool depth at overflow point	Approximately 1 m	
Hydraulic control	Rockshelf	
Control features	Rockshelf extends along width of pool; approximately 10 m long; log jam/debris on upstream side; remediation works in place at time of inspection	
Bed forms	Rockshelf outcrop	
Bed material	Irregular rockshelf outcrop; rockbars intersecting shallow pools; deposited sediment; some boulders	
Valley shape	Left bank^: Convex upwards: approximately 3 m high, steeply sloped soil bank extending to moderately sloped convex bank and overbank	Right bank^: Compound stepped depositional: approximately 80 cm high, rockshelf ledge underlain with coarse sediment, extending to stepped outcrop with soil and vegetation coverage
Bank vegetation type and cover	Left bank^: Grass, sedges, privet, trees	Right bank^: Grass, sedges, privet, trees
Bed vegetation including debris	Minor vegetative debris upstream; log jams at downstream rockshelf	
Pool tree canopy	High canopy coverage	
Channel width	> 10 m	
Uniformity of bed profile	Non-uniform; variably contracting/expanding; slightly meandering	
Bed scour features	Erosional undercutting of sediment/soil beneath shallow rockshelf ledge; exposed roots	
Geomorphological Variables		
Bed eroding or accreting	Variable	
Catchment landform	Partly confined valley	

^ Looking downstream

Catchment Influences	
Catchment landuse	Predominately farmland with urban development in upper reaches and industrial development on left overbank and lower reach
Structures	N/A
Mining related impacts	Fracturing observed during LW31 (GeoTerra, 2019a)
Surface Water Flow (19 May 2021)	
Pool water depth	Approximately 150 mm upstream pool; approximately 100 mm downstream pool; ferruginous – oily film
Connective surface flow	No connective flow to pool RR20
Other observations	Reduction in surface flow between pool RR18 and pool RR19 – seepage and/or throughflow occurring

REDBANK CREEK
WEIR / POOL 26

Weir / Pool 26 – Looking Upstream

18 May 2021

Weir / Pool 26 – Concrete Weir

18 May 2021

General		
Stream	Redbank Creek	
ID	Weir / Pool 26	
Approximate coordinates (GDA94)	278823 E 6213627 N	
Base RL	Approximately 204 m AHD	
Notable reference points	Concrete weir R9 water level sensor (one in upstream section and one in downstream section)	
Longwall	East edge of LW31	
Geomorphological Variables		
Description	Concrete weir constrained pool	
Pool dimensions	Approximately 5 m wide x 35 m long	
Pool depth at overflow point	Approximately 1.5 m	
Hydraulic control	Concrete weir	
Control features	Approximately 1.5 m high concrete weir extending across width of pool	
Bed forms	Bedrock outcrop overlain with deposited material	
Bed material	Hawkesbury sandstone outcrop; sediment/mud deposition; rockbar/boulder constriction dividing pool into two parts; notable fractures; instream boulders; iron staining	
Valley shape	Left bank^: Faceted/convex: rockshelf outcrop with soil/sediment layers, approximately 4 m high; extending to moderately sloped vegetated soil bank and overbank	Right bank^: Compound erosional: outcrop largely overlain with soil bank approximately 3 m high; extending to benched outcrop with soil layers
Bank vegetation type and cover	Left bank^: Grass, vines, privet, trees	Right bank^: Grass, vines, privet, trees
Bed vegetation including debris	Vegetative debris	
Pool tree canopy	Moderate canopy coverage	
Channel width	Approximately 10 m	
Uniformity of bed profile	Non-uniform	
Bed scour features	Erosion, some undercutting of soil banks; erosional sculpting of outcrop	
Bed eroding or accreting	Variable	
Catchment landform	Partly confined valley	

^ Looking downstream

Catchment Influences	
Catchment landuse	Predominately farmland with urban development in upper reaches and industrial development on left overbank and in lower reach
Structures	Concrete weir
Mining related impacts	Reduced pool water holding capacity during LW31 (GeoTerra, 2019a)
Surface Water Flow (19 May 2021)	
Pool water depth	Approximately 20 - 30 cm; turbid; slightly ferruginous
Connective surface flow	No connective surface flow to downstream boulder field
Other observations	Seepage under concrete weir